FINAL VERIFICATION AND VALIDATION REPORT ON TMI-1 SAFETY PARAMETER DISPLAY SYSTEM

TOPICAL REPORT 027

PROJECT NO: 5400-51702

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SUMMARY

An independent Verification and Validation (V&V) program has been performed on the TMI-1 Safety Parameter Display System (SPDS) to ensure that the system meets design requirements and that it functions as designed. The V&V program consisted of three planned, systematic series of reviews and tests: (1) system requirements verification, (2) design verification, and (3) validation testing.

Documents describing the system requirements, design specifications and SPDS source code listing were reviewed and evaluated in terms of technical correctness, consistency, traceability, and testability. All the system requirements elements were itemized and traced by using the Requirement Traceability Matrix (RTM) technique. A set of 34 tests were defined for the system validation. These Tests were also evaluated against the design requirements and the V&V Test Plan. The V&V team monitored the initial validation testing and identified deficiencies. Retesting was carried out after the deficiencies were corrected and resolved. All the test results from the 34 tests were evaluated and assessed as satisfactory by the V&V team.

The V&V team concludes that: (1) the system requirements were adequately defined, (2) the SPDS software design complies with the system requirements, and (3) the validation testing demonstrated that the SPDS functions as designed. The V&V program identified some significant improvements to the SPDS documentation and software. Three discrepancies, which are not directly related to the SPDS software, were identified. These discrepancy items will be addressed in future SPDS design evolution. These involve: (1) SPDS responses under overloading condition, (2) use of conventional flow charting format, and (3) interruption of the SPDS display by a non-SPDS display, i.e., RCS leak rate.

1. INTRODUCTION

The TMI-1 Safety Parameter Display System (SPDS) was designed and installed to provide an aid to the control room personnel in determining the overall plant safety status during power operation and post-trip condition to allow identification of abnormal conditions.

The Verification and Validation (V&V) program (Ref. 1) was developed and implemented in accordance with NRC requirements (Ref. 2 & 3) to provide a quality system through independent technical review and evaluation of the SPDS software. The purpose of this report is to provide: (1) overall description of the V&V activities performed, (2) summary of the V&V results, and (3) overall assessment of the system's quality based on the V&V evaluation.

1.1 Overview of V&V Program

The objectives of V&V are to ensure: (1) that the system requirements are adequately defined, (2) that the SPDS design satisfies those requirements, and (3) that the SPDS functions as designed. To achieve these goals the V&V procedures (Ref. 1) were developed in accordance with the intent of NRC guidance (Ref. 2 & 3) and good engineering practices.

Figure 1 provides an overview of the V&V activities. These activities include the interface between the Design Team and the V&V Team. In addition, Figure 1

identifies all the documentation which was reviewed or generated by the V&V activities. The three main V&V activities, depicted in Figure 1, are:

- System Requirements Verification
- Design Verification
- System Validation Test

The System Requirements Verification involved an independent review of the system requirements documentation (Ref. 4 & 6) in terms of correctness, completeness, consistency, testability and traceability of the requirements. The system requirements were identified and traced in the Requirements Traceability Matrix (Appendix A). The Requirements Traceability Matrix (RTM) references and traces each requirement from the system requirements document (RTM-I) through the Design document (RTM-II) and the validation test procedures (RTM-III).

An overview of the System Requirements Verification activities is given in Figure 2 and will be further described in Section 2 of this report. The system verification report (Ref. 7) was produced as a result of the System Requirements Verification activity. This report documents the Discrepancy Reports, the RTM-I, and the conclusions of this verification activity.

The key objective of the Design Verification activity was to determine if the design was consistent with the system requirements. The design document

(Ref. 5), which includes flow charts of the SPDS computer programs, was correlated to the requirements given in the system requirements documentation (Ref. 4). This correlation was reflected in the Requirements Traceability Matrix Version II (RTM-II) and it was used to identify tests that were then incorporated into the Validation Testing. The overview of the Design Verification activity is illustrated in Figure 3. The end product of the Design Verification activity was the Design Verification Report along with a completed RTM-II (Ref. 8).

The objective of the System Validation effort was to evaluate and certify that the SPDS operates in accordance with the design requirements. The System Validation activity involved: (1) development of the Validation Test Plan by the V&V Team (Ref. 9), (2) preparation of Validation Test Procedures by the Design Team (Ref. 10), (3) review of the Validation Test Procedures by the V&V Team, (4) performance of the Validation Test Procedures by the Design Team while the V&V Team monitored, and (5) evaluation of the test results by the V&V Team.

The overall description of the System Validation activity is given in Figure 4 and will be detailed in Section 4 of this report. The System Validation activity is documented by the Validation Test Report (Ref. 11) and the completed RTM-III.

Throughout the entire V&V process, i.e., System Requirements Verification, Design Verification, and System Validation, the V&V team communicated with the

Design Team by issuing and resolving Reviewer Comments and Discrepancy Reports. Problems and concerns identified by the V&V Team during preliminary reviews were forwarded to the Design Team as Reviewer Comments. This process is documented per Figure 5. The V&V Team's comments were responded to by the Design Team. Any discrepancies and variances found as a result of the V&V Team's evaluation of the Design Team's responses were issued as Discrepancy Reports (Figure 6). The V&V Team then evaluated the Design Team's Response to each of the Discrepancy Reports. Any V&V Team Discrepancy Reports with an unsatisfactory response from the Design Team was maintained as an Unresolved Discrepancy Report. Each of these Unresolved Discrepancy Reports was evaluated for its potential impact on the SPDS.

1.2 Identification of V&V Documentation

The SPDS V&V program includes auditable documentation. This documentation consists of V&V Procedures, Test Plan and three V&V Reports including numerous memos, letters, and comments/resolution sheets. The key V&V documents are listed below:

Documents	Descriptions
° V&V Procedures	° Defines the content of the V&V program including V&V process required documentation, and V&V techniques (Ref. 1).
° Validation Test Plan	° Provides testing guidelines and philosophies for reviewing the test method/procedures, monitoring the Validation Tests, and evaluating the Test Results (Ref. 9).

Documents	Descriptions
° System Requirements Verification Reports	° Summary of the System Requirements Verification activity (Ref. 7).
° Design Verification Report	° Summary of the Design Verification activity
° Validation Test Report	° Summary of the System Validation activity (Ref. 11).
° Requirement Traceability Matrix-I, II, and III	° References and traces the requirement items from the Requirement Documents (RTM-I), through the Design Document (RTM-II) and the Test Procedures (RTM-III).
° V&V Final Report	° Summarizes the entire V&V activity including the V&V results and an overall assessment of the quality of SPDS (this report).

1.3 V&V Work Scope (Ref. 12)

The TMI-1 SPDS is implemented on the existing plant process computer system (MODCOMP), which was installed prior to and independent of the SPDS design. This V&V activity did not include the review of either hardware or software which had been already installed and operating in the plant. Although a total of 22 new data points, 4 for the reactor building temperature, 4 for the HPI flow, and 14 for the radiation monitoring, were added to the existing data collection system, there was no additional hardware added in order to implement the SPDS design. The additional data points were implemented by routing sensor signals through existing A/D conversion and multiplexing equipment. The installation and testing of these additional points were performed under GPUN standard control procedures and were not included as part of the V&V process. The V&V activity was performed solely on the SPDS software. This software consists of five critical safety function programs and nine SPDS display programs (Table 4).

The V&V Team was responsible for an independent review and evaluation of both the requirements document (Ref. 4) and the design document (Ref. 5) for correctness, completeness, consistency, feasibility, testability and traceability. The V&V Team was also responsible for reviewing and commenting on the Test Procedures prior to Validation Testing. The V&V Team monitored the Validation Testing and evaluated the test results. Based on the evaluation of the test results, the V&V Team could recommend retests or issue discrepancy reports. The V&V Team used the comment and discrepancy process outlined in the V&V procedures (Ref. 1) to communicate with the Design Team. The V&V documentation requirements are given in the V&V procedures (Ref. 1) and described previously in Subsection 1.2 of this report.

The Design Team was responsible for ensuring the requirements setforth in the system requirements document (Ref. 4) meet the SPDS objectives and regulatory requirements (Ref. 6). Human factor reviews were an integral part of the SPDS design process. A human factors evaluation has been performed separately and documented (Ref. 4). Therefore, the human factor concern was outside the V&V work scope.

1.4 V&V Participants

By the time the SAIC V&V Team had completed the early portion of the V&V work, System Requirements Verification, the GPU V&V Team was ready to proceed with the remaining V&V activities which included the Design Verification and Validation Testing along with writing the Final V&V Report.

The GPU V&V Team consists of three persons who did not participate in the TMI-1 SPDS design and its implementation. They are:

Tae Y. Byoun (Nuclear Engineer)

Jim P. Heil (QA Engineer)

Bruce D. Olaf (Computer Analyst)

Review of some portions of the SPDS documents, particularly the comparison of the flow charts to the SPDS program source listings, was performed by certain Design Team members (J. N. Neyman, K. W. Sayers, D. J. Grove, and R. J. Herr) to maximize their expertise and expedite the V&V work. The V&V independence, however, was preserved by having them review those parts of the SPDS they were not involved in developing.

2. SYSTEM REQUIREMENTS VERIFICATION

2.1 Objectives

The system requirements (Ref. 4 and 6) are the foundation upon which the TMI-1 SPDS was designed. The objective of the System Requirements Verification is to review and evaluate the requirement documents with respect to completeness, correctness, traceability, consistency, and testability.

Source materials for the System Requirements Verification were:

- SPDS User Guidelines, TDR-583, Rev. 0 (Ref. 13), and Rev. 1 (Ref. 4)
- TMI-1 SPDS Safety Analysis, TR-018 (Ref. 6)
- Design Team's Responses to Reviewer Comments (Ref. 7)

2.2 Summary of Review Activities

Figure 2 provides an overview of the system requirements verification process. As stated in Section 1.3 of this report, the verification activities did not include: (1) the human factor reviews, (2) correlation with regulatory requirements, and (3) evaluation of the SPDS design basis.

System requirements were identified from the requirement documents (Ref. 4 & 6) by the SAIC V&V Team. Requirement items were numbered sequentially on the Requirements Traceability Matrix, Version I (RTM-I). These requirements were reviewed and concurred by GPU Design Team. V&V evaluation of the system requirements consisted of three main areas: (1) documentation completeness and technical correctness, (2) identification of validation testing concern, and (3) issuing Discrepancy Reports for any discrepancies found.

V&V Team questions and concerns arising during review of the system requirements documents were forwarded to the Design Team as Reviewer Comments. A total of 29 reviewer comments were issued and responded to by the GPU Design Team. All Reviewer Comments, together with the Design Team's responses and the V&V Team's evaluation of those responses were documented in the Requirements Verification Report (Ref. 7).

During the comment/resolution process, the requirements document (TDR-583, Rev. 0 - Ref. 13) was updated and revised to incorporate some of the V&V comments (TDR 583, Rev. 1 - Ref. 4).

Problems and discrepancies remaining after resolution of the Reviewer Comments were issued as Discrepancy Reports. Two Discrepancy Reports were issued and are attached to this report (Tables 1 and 2).

2.3 Summary of Review Results

The SPDS software system requirements in References 4 (SPDS User Guidelines) and 6 (SPDS Safety Analysis) were reviewed and evaluated by the SAIC V&V Team. The details of the verification results are given in Reference 7 along with the Requirement Traceability Matrix, Version 1 (RTM-1). The V&V Team concluded that the GPU System requirements documents (Ref. 4 & 6) define the SPDS software requirements with the exception of two discrepancies given in Tables 1 and 2 in this report. Discrepancy Report 0001 deals with incomplete timing requirements for the SPDS during a possible system overloading condition. Discrepancy Report 0002 points out the use of the unconventional flow charting format in Reference 4. These discrepancies will be further discussed in the following section of this report.

As a result of the system requirements verification reviewer comments, the quality of the principal requirements document, the SPDS User Guidelines (Ref. 13), was improved when Revision 1 was issued.

Validation Test implications were also identified during the verification process. The highlights of these are:

(a) Validation Testing should take place on the plant process computer.

(b) Definition of the data base forming the interface of the SPDS with the remainder of the TMI-1 computer system is to be included in the Test Plan (Ref. 9).

(c) Critical Safety Functions (CSFs) need to be tested in conjunction with the corresponding displays.

(d) The V&V work scope does not include the system response test under full load condition. The system loading test, however, is to be part of the field installation testing.

(e) Dynamic as well as static testing will be needed for several of the SPDS displays:

- Reactivity/Power Distribution and Primary Side Heat Removal Power Operation Level 1 Display (Displays 1, 2 and 3)
- Primary Side Heat Removal Post-Trip Forced Flow Level 1 Display (Display 9)
- Primary Side Heat Removal Post-Trip Natural Circulation Level 1 Display (Display 11).

The above recommendations were incorporated and resolved in the Validation Test Plan (Ref. 9) and test procedures (Ref. 10).

2.4 Deficiencies Identified

Two Discrepancy Reports (DRs) were issued as a result of the System Requirements Verification activities. Discrepancy Report 0001 (Table 1) addresses the SPDS timing requirement problems under the system overload condition. Some non-SPDS programs on the existing MODCOMP computer have higher priority than the SPDS software. During an extreme condition when all of these programs are activated, the SPDS response time may be impacted. Conversely, the operation of the SPDS may affect the operation of real time tasks of a lower priority than SPDS. The timing requirements for the SPDS, according to the system requirement document (Ref. 4) were defined for a computer loading of less than or equal to 100%. The SPDS programs were placed as high in priority as they could be on the existing computer system. Since the system was implemented on the existing computer system and the SPDS is not a safety-grade system, the Design Team decided that the timing requirements as they presently exist are adequate, and did not respond to this Discrepancy Report. This discrepancy item remains unresolved.

Discrepancy Report 0002 points out that the Critical Safety Function (CSF) Flow Charts in the requirements documents (Ref. 4) do not follow standard flow charting format. The Flow Charts in Reference 4 define the CSF logic by using an electrical circuit analogy. The Flow Charts in the design documents (Ref. 5), however, employ standard flow charting format and adequately identify the logic required. The Discrepancy Report 0002, therefore, will not have any impact on either the SPDS design or testing except the inconsistency between two documents (Ref. 4 & Ref. 5).

3. DESIGN VERIFICATION

3.1 Objectives

The purpose of the Design Verification activity was to determine that the system requirements were correctly and consistently implemented in the design.

Source materials for the Design Verification were:

- SPDS Design Documents (Ref. 5 & 15)
- SPDS Code Package
- Background documents - System Requirement Verification Report (Ref. 7), SPDS Safety Analysis (Ref. 6), and SPDS User Guidelines (Ref. 4).

3.2 Summary of Activities

Figure 3 provides an overview of the design verification process. The design verification activity involved both review and evaluation of the design documents for the following five major areas of concern. These were:
(1) correlation of design (Ref. 5) to system requirements (Ref. 4),
(2) addition of design references to the Requirement Traceability Matrix (RTM-II), (3) evaluation of design documents (Ref. 5) for technical correctness and completeness,

(4) comparison of the actual SPDS software to the flow charts given in the design documents, and (5) submitting discrepancy reports for any discrepancies found.

The design verification was, as was the system requirements verification process, a two-phase activity. In the first phase, features identified during the system requirements evaluation activity (Ref. 7) were compared to design documents (Ref. 5) to assure that all applicable system requirements elements (Ref. 4 & 7) were reflected in the design documents. Discrepancies detected during this phase were reflected in Reviewer Comments issued to the Design Team. This phase also included comparisons of the actual SPDS source program to the design document flowcharts to assure that the code accurately reflected the logic paths and operations depicted in its design document (Ref. 5).

The second phase involved evaluation of Design Team's responses to Reviewer Comments. Responses to Reviewer Comments that were not accepted by the V&V Team were re-issued as Discrepancy Reports (DRs). The V&V Team closed out those DRs with satisfactory responses. If Design Team's responses were not acceptable, the V&V Team issued those items as unresolved Discrepancy Reports.

3.3 Summary of Review Results

The Design Verification review activity resulted in the issuance of thirty six (36) Reviewer Comments relating to: (1) completeness, consistency and traceability (Reviewers Comments No.'s VER-001 through VER-004, and VER-033 through VER-035), (2) technical correctness (VER-005 and VER-036), and (3) testability (VER-006 through VER-032).

The V&V Team evaluated the Design Team's responses to these comments and determined that 27 responses were satisfactory. For those nine (9) responses not accepted by the V&V Team, Discrepancy Reports were issued and again responded to by the Design Team. After the evaluation of these responses, eight (8) of the Discrepancy Reports were closed with one exception. Discrepancy Report No. VER/DR-005 remains open pending the future resolution regarding pre-emption of SPDS displays by non-SPDS displays. Details of these results are given in Reference 8.

It was concluded by the V&V Team that the design documents (Ref. 5) meet the system requirements given in the design requirements documents (Ref.'s 4 and 6) with one Discrepancy Report remaining open (See Section 3.4 of this report). The impact of this open item has been evaluated by the V&V Team as minimal because the frequency of occurrence of an SPDS display being pre-emptied by a non-SPDS display (RCS Leak Rate calculation results) is considered low. In addition, control room supervisory personnel (SPDS primary users) are aware when Leak Rate testing is being conducted and can take into account the pre-emption of SPDS displays.

3.4 Deficiencies Unresolved

As mentioned previously in Section 3.3, a total of nine Discrepancy Reports were issued and eight (8) of them were satisfactorily resolved.

The resolution of the 8 Discrepancy Reports is documented in detail by Reference (8).

The Discrepancy Report (VER/OR-005), which was not resolved, is given in Table 3.

The system requirements document (Ref. 4) states:

> "NON-SPDS displays may not automatically PRE-EMPT a SPDS display.
> A SPDS display may PRE-EMPT a SPDS display."

Currently, there is only one non-SPDS automatic display which may interrupt an SPDS display. This is the display that signals the end of the Reactor Coolant System (RCS) Leak Rate calculation.

This deficiency remains open pending the future correction by the Design Team. A task request has been issued to resolve this deficiency.

4. VALIDATION TEST

4.1 System Validation Overview

The purpose of validation is to determine the correctness of the SPDS software with respect to system requirements defined in Reference 4. Planned testing and evaluation were used to demonstrate that all 14 SPDS programs (Table 4) functioned as designed. Source materials for the System Validation were:

- Validation Test Procedures (Ref. 10)
- Requirement Verification Results (Ref. 7)
- Design Verification Results (Ref. 8)
- Design Documents (Ref. 5), System Requirements Documents, and all identified updates (Ref. 15).

Figure 4 illustrates the System Validation activity. The steps of System Validation were: (1) V&V Team's Preparation of its Validation Test Plan, (2) Design Team's Preparations of Validation Test Procedures, (3) Addition of Validation Test Procedure References to the Requirements Traceability Matrix (RTM-III), (4) Monitoring Validation Test Performance, and (5) Evaluation of the Validation Test results. The review process also used the Review Comment and Discrepancy Report process described in Section 3.2 of this report. The above Validation steps were conducted as a closely coordinated activity between Design and V&V Teams.

Some steps of the Validation work were performed in parallel for the cost effectiveness of its project in terms of man-power requirements and schedules.

4.2 Summary of Test Plan & Test Procedures

The Validation Test Plan (Ref. 9) provides testing guidelines and philosophy for V&V Team's activities of (1) reviewing test methods and test procedures, (2) monitoring the actual tests, and (3) evaluating the test results.

To ensure that the SPDS programs functioned in accordance with system requirements, three categories of testing were defined. These were:

a. Functional - included data input to alarm/display output and automatic and manual control of displays.

b. Structural - included testing of data paths, program paths and system level executives and controls.

c. Operational - included dynamic response and impact with already operational software.

These test categories are further described in Table 5 of this report.

Test Procedures (Ref. 10) were written to provide (1) reproducible test results, (2) measurable acceptance criteria where possible, (3) recorded results that were dated and annotated, (4) test environment on the actual computer system, and (5) planning for failed tests.

A set of thirty four (34) tests were defined and are listed in Table 6 of this report. These tests consisted of verifying manual and automatic control of displays (Tests 1 & 2), verifying the shell characteristics of the twelve (12) SPDS displays (Tests 3-15), testing the domain of possible input values and associated quality tagging and alarming for each of its five (5) Critical Safety Functions (Tests 16-22), checking the functionality of the feedwater flow, imbalance plot and the pressure-temperature plot (Test 23-25), performance characteristics for PT-plot (Tests 26-30), and alarm processor timing test (Tests 35-36).

Each test was subdivided into individual test steps. Each of these test steps was provided a chart for acceptance and place for signature of acceptance or rejection. If any step was rejected the entire test was rejected and evaluation was made as to whether the acceptance criteria was wrong or retesting was required. An exception/deficiency list was kept to track these reactions.

4.3 Summary of Validation Test Activities and Test Results

4.3.1 Summary of Validation Test Activities

In the early stage of the System Validation, the V&V Team started reviewing Test Procedure Draft (Ref. 16) and issued a total of approximately one hundred (100) comments, which were grouped into seventeen (17) Reviewer Comments depending on the nature of comments (Ref. 17). The Design Team responded by updating and revising Test Procedure incorporating the V&V comments (Ref.'s 10 and 18).

Upon completing the Initial Testing, which was performed on the Plant Computer System, the majority of the testing was satisfactory to the V&V Team. For those tests, which had not passed the Initial Testing evaluation, a list of exceptions/deficiencies was issued. These deficiencies pertained to display formats, misworded acceptance criteria and required software corrections. The Design Team has made the appropriate changes to the procedures and corrected all of the software deficiencies, and retests were carried out.

When the Test Procedures were checked against the Requirement Traceability Matrix (RTM-III), the V&V Team requested (Ref. 19) additional tests on the "robustness" of the system. The V&V Team evaluated the responses (Ref. 20) and after discussions with the Design Team members, it was decided not to include these additional tests. This will be further discussed in Section 4.3.3 of this report.

4.3.2 Summary of Test Results

A comprehensive set of test procedures was written to test the system requirements implemented by the SPDS software. These tests were divided into three categories, (1) Functional, (2) Structural, and (3) Operational. The entire range of each SPDS parameter as well as the program and data paths of the SPDS software were tested. By testing the SPDS on the existing plant MODCOMP computer, the dynamic response times and "robust" characteristics of the SPDS were demonstrated.

The deficiencies identified during the initial testing were corrected, and retesting has been carried out. A completed Requirement Traceability Matrix (RTM-III) is given in Appendix (A) of this report.

The V&V Team, after evaluating all these test results, concluded that the SPDS software met system requirements and performed as designed. A discrepancy item concerning the "non-SPDS display interrupting the SPDS display" remains open and is in the process of being corrected. This discrepancy item is identical to the Unresolved Discrepancy Report given in Section 3.4 of this report (Table 3).

4.3.3 Discussions

- "Robustness" Tests

After initial testing and completing the Requirement Traceability Matrix, the V&V Team recommended that a "robustness" test be incorporated into the test procedures. This test would include recovery from system power spikes, recovery from system error faults, and checking for incorrect input sequences. The "robust" test would demonstrate the ability of the SPDS software to interact with the other software on the plant MODCOMP computer system.

After discussions with members of the Design Team on these tests, it was decided not to include a "robustness" test. The power spike portion of this test would require a scenario with virtually an infinite number of test cases. Something analogous to power spikes had been demonstrated in TESTS 16-17 since the test cases were not configured to take smooth transitions in data testing. The ability of the SPDS to survive these changes was not in the acceptance criteria but was indirectly demonstrated in that all tests were run to completion. Recovery from system faults is initiated by the Watchdog Timer if the system stalls or hangs up.

The SPDS has been installed on the plant MODCOMP computer since December 26, 1984. The ability of the SPDS to survive illegal operator input sequences, system loading and system faults has been adequately demonstrated over that time period. For this reason it was decided not to include the "robustness" test as part of the V&V test procedures.

° Impact on MODCOMP Computer System

It has been determined by observing the behavior of the SPDS system in conjunction with the existing plant MODCOMP computer software that, because of high CPU utilization of several non-SPDS programs, the SPDS software may impact the real time operation of lower priority programs.

The Periodic Task Scheduler program is a higher priority program than the SPDS software. This scheduler activates software tasks to execute at a certain time period. During operation of the SPDS, several of the tasks activated by the Periodic Scheduler may not execute in the scheduled time period but in a later time period. These tasks are not critical, and an occasional delay of when the task is scheduled to execute will not be detrimental to the computer system. However, the addition of future tasks on the plant computer system will have to be thoroughly examined before implementation. At present, no other impact on the existing plant MODCOMP computer system has been determined.

4.4 Discrepancies and Future Requirements

Item twenty-eight (28) of the Requirements Traceability Matrix (See Appendix A) states "NON-SPDS displays may not automatically PRE-EMPT a SPDS display. A SPDS display may PRE-EMPT a SPDS display". This requirement will be implemented in the future and specific test procedures will be written to test

this requirement. Currently, only one NON-SPDS display does interrupt an SPDS display. This is the display that signals the end of the RCS Leak Rate calculation.

This is the same discrepancy found during the Design Verification and described in Section 3.4 and Table 3.

5. CONCLUSIONS

An independent V&V program has been performed on the TMI-1 SPDS. The V&V program consisted of three systematic series of reviews, evaluations, and tests: (1) system requirements verification, (2) design verification, and (3) validation testing.

The V&V program resulted in:

(A) Improvements on the documentation for both system requirements (Ref. 4) and design (Ref. 5) by incorporating a vast number of V&V comments (over 300 reviewer comments)

(B) Significant software improvements as a result of V&V evaluation on SPDS software and validation testing.

It is concluded that the SPDS software design implemented all the system requirements and that validation testing demonstrated that the SPDS functions reliably as designed.

Three discrepancies were identified for future SPDS design improvements. These are: (1) SPDS timing requirement under an overloading condition, (2) use of standard flow-charting format, and (3) interruption of SPDS display by a non-SPDS display.

6. REFERENCES

1. GPU TDR No. 711, "TMI-1 SPDS V&V Procedures," dated August 7, 1985.

2. NSAC-39, "V&V for SPDS," by SAIC, dated December 1981.

3. NUREG-0696, "Functional Criteria for Emergency Response Facilities," dated February, 1981.

4. GPU TDR 583, Rev. 1, SPDS User Guidelines," by H.C. Crawford, January 15, 1985.

5. GPU TDR 618, Rev. 0, "TMI-1 Safety Parameter Display System," by S. Cafrelli, April 18, 1985.

6. GPU TR018, "TMI-1 SPDS Safety Analysis," H.C. Crawford, April 24, 1984.

7. SAIC-85/1625&264, "System Requirements Verification Report," by G.L. Evans & N.C. Thomas (SAIC), dated March 29, 1985.

8. GPU TDR 737, "TMI-1 SPDS Design Verification Report," dated December 1985.

9. GPU TDR 710, "TMI-1 SPDS Validation Test Plan," dated August 9, 1985.

10. TMI-1 SPDS Validation Test Procedures, dated July, 1985 (referenced in detail in Ref. 11).

11. GPU TDR 738, "TMI-1 SPDS Validation Test Report," dated Dec., 1985.

12. GPU Memo No. SAPC-262, "SPDS V&V Work Scope," dated November 26, 1984.

13. GPU TDR 583, Rev. 0, "SPDS User Guideline," July 30, 1984.

14. SAIC-84/1740&264, "V&V Procedures for GPU Nuclear TMI-1 SPDS," October 22, 1984.

15. GPU Memo No. SAPC 124, "SPDS Requirements Document," dated July 16, 1985, and GPU Memo No. NF-85-4152, "SPDS," dated June 12, 1985.

16. TMI-1 SPDS Test Procedures (Draft), no document I.D. number given, June, 1985.

17. GPU Memo No. 5422-85-083, "V&V of Test Procedures," June 24, 1985, and GPU Memo No. NF-85-4203, "V&V Comments on SPDS Test Procedures," August 6, 1985.

18. GPU Memo. No. 5421-85-0111, "Response to V&V Comments on SPDS Test Procedures," October 7, 1985 and GPU Memo No. 5421-0108, "Original Set of V&V Test Procedure Comments," October 7, 1985.

6. REFERENCES
(Continued)

19. GPU Memo No. 5422-85-0107, "V&V of Test Procedures Against RTM," August 19, 1985.

20. GPU Memo No. 5421-85-0166, "Response to New Tests Request for V&V Testing," October 17, 1985.

FIGURE 1

OVERVIEW OF SPDS V&V ACTIVITIES

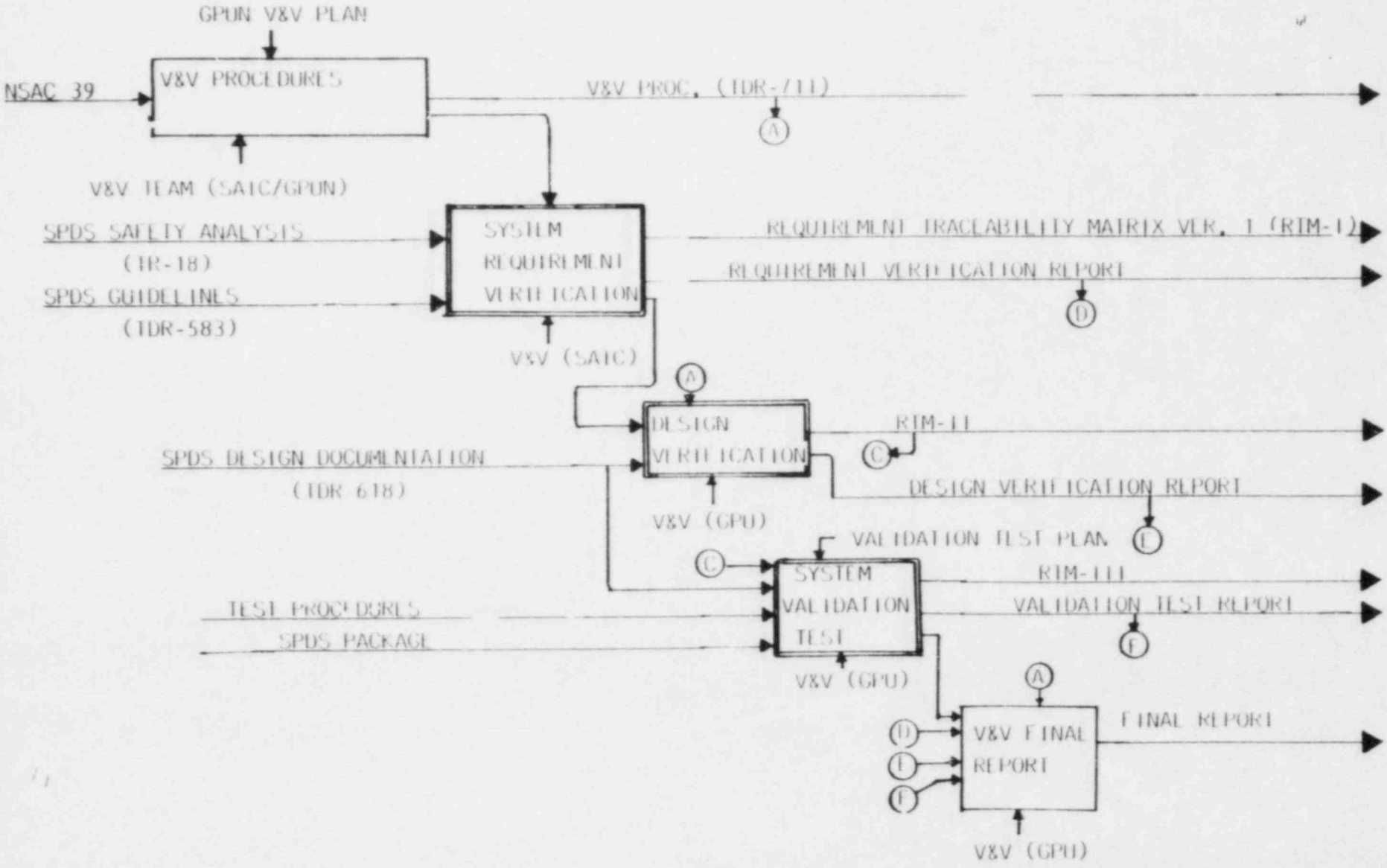

FIGURE 2

SPDS SYSTEMS REQUIREMENTS VERIFICATION

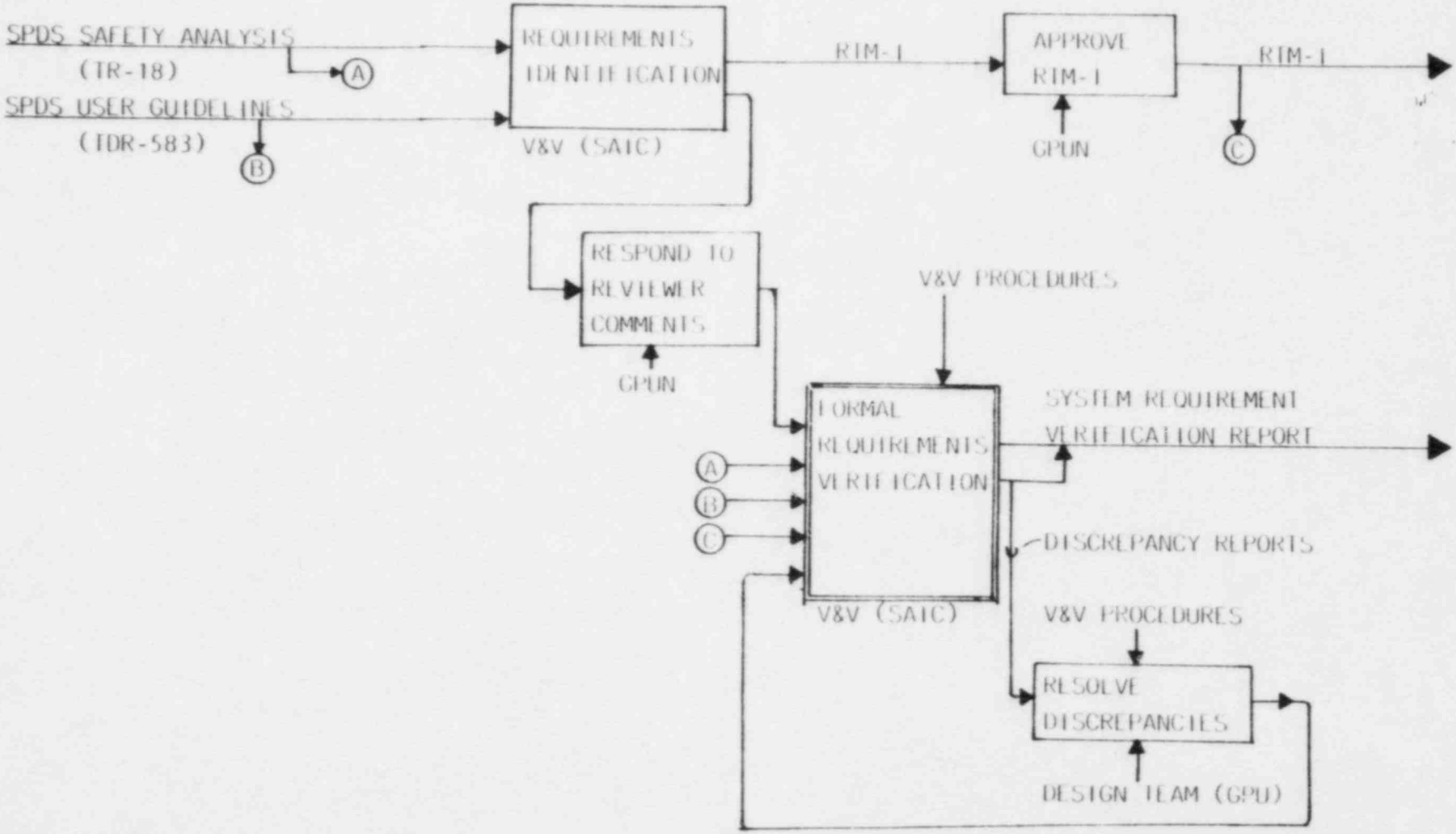

FIGURE 3

DESIGN VERIFICATION ACTIVITIES (GPUN)

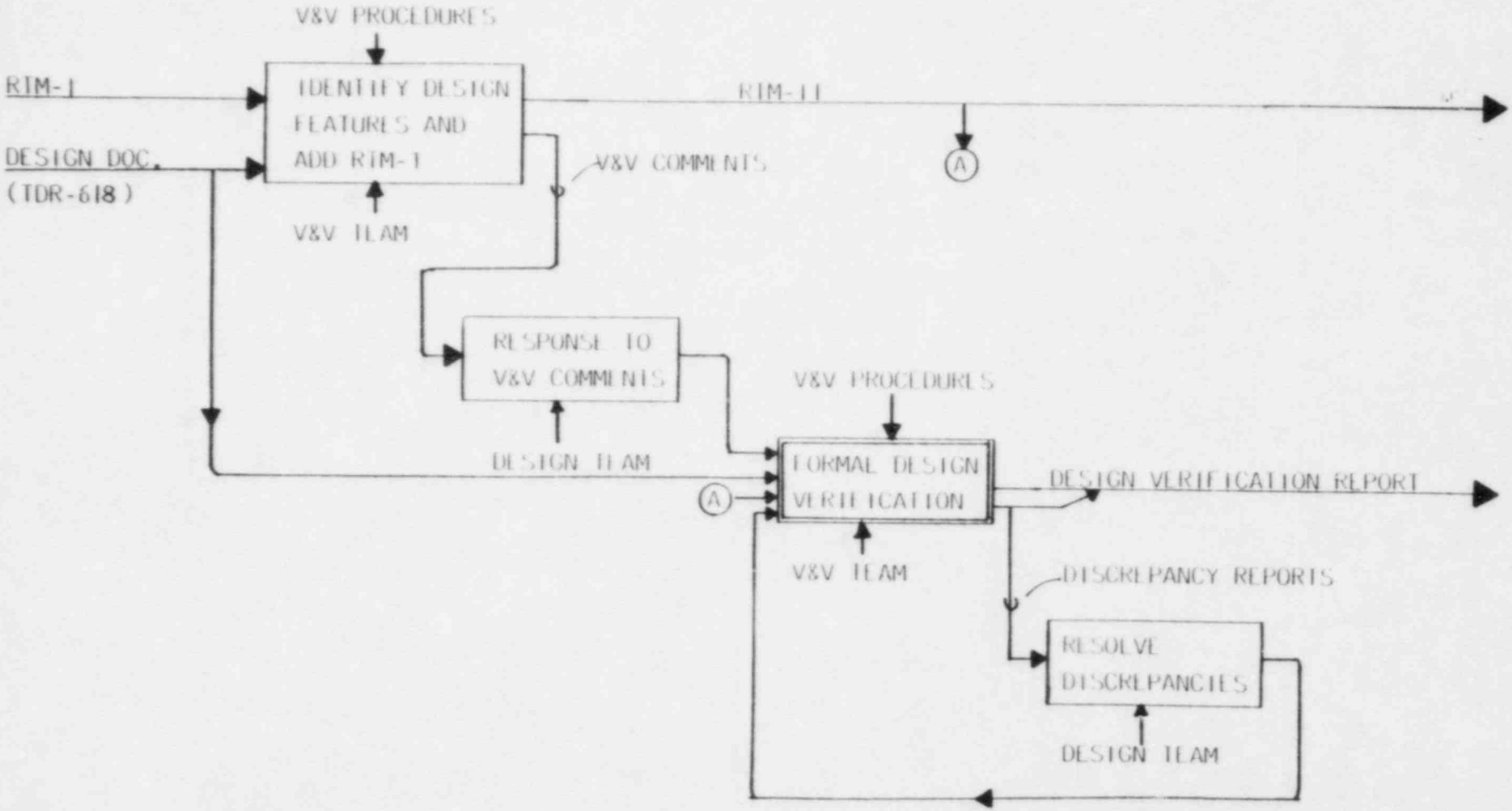

FIGURE 4

VALIDATION TEST AND ANALYSIS (GPUN)

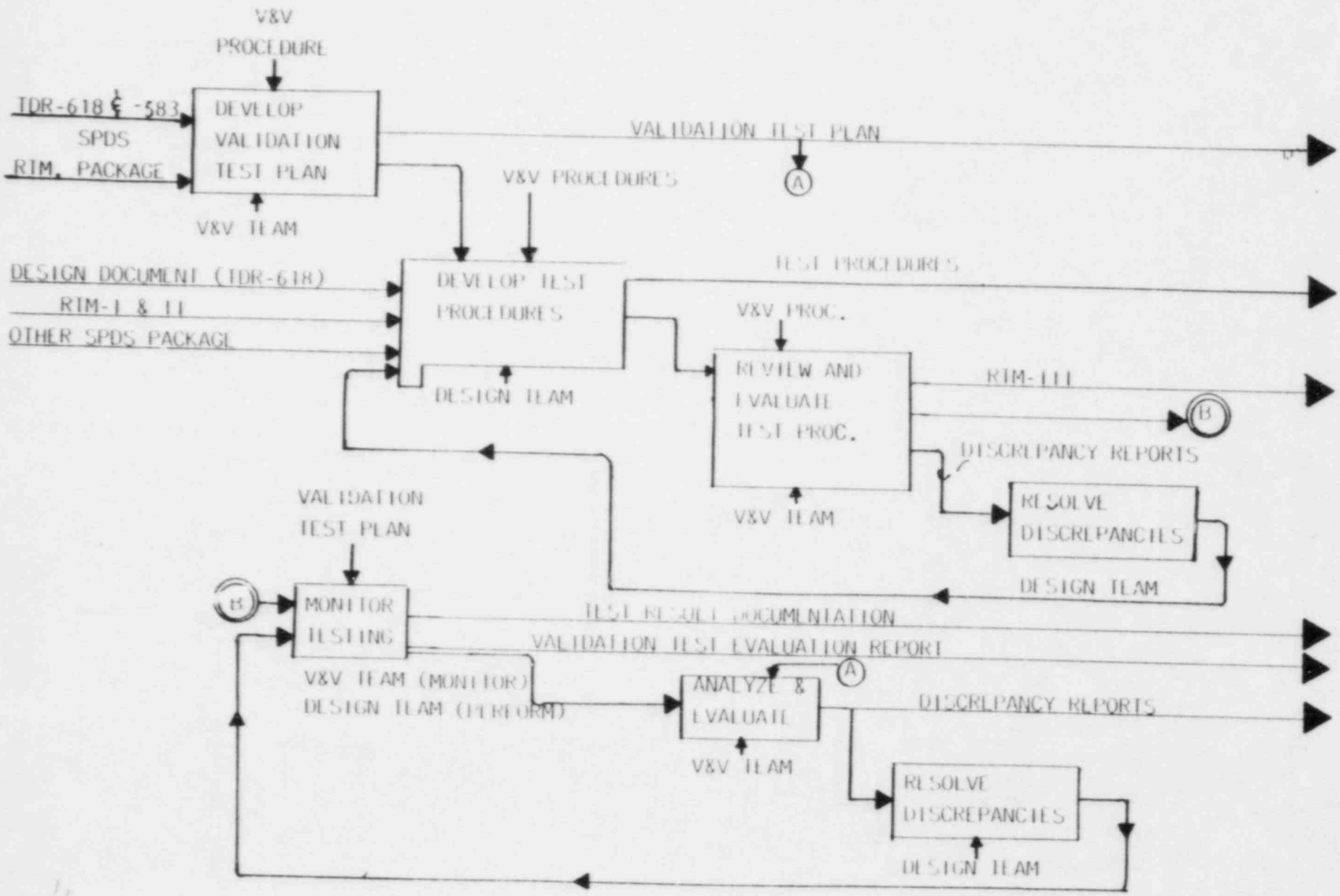

FIGURE 5. V&V Reviewer Comment Form

REVIEWER'S COMMENT	SERIAL NO: VER-xxx	PAGE XX OF XX
PROJECT: TMI-1 SPDS V&V	DATE:	
V&V TASK: Design Verification	ISSUED BY: T. Brown/J. Heil	

DOCUMENT(S) UNDER REVIEW:

COMMENT:

RESPONSE:

RESPONSE BY: DATE:

FIGURE 6. Discrepancy Report Form

	DISCREPANCY REPORT	SERIAL NO: VER/DR-00X	DATE: 08/09/85
	PROJECT: TMI-1 SPDS DESIGN VERIFICATION	PREPARED BY: J.P.HEIL SIGNATURE:	DATE: 08/09/85
	RTM NO.:	REVIEWED BY: T.Y.BYOUN DATE: 08/09/85 SIGNATURE:	APPROVED BY: SIGNATURE: DATE
	DOCUMENT(S) WHERE DISCREPANCY EXISTS: TDR-618, REV 0		
PART 1	REF(S): (A) COMMENT VER-00X MEMO NF-85-4178, 07/02/85 (B) MEMO 5421-85-0062, 07/18/85		
	DESCRIPTION OF DISCREPANCY: PAGE 1 OF xx		
	RESOLUTION ACTION PAGE ____ OF ____		
	RETEST METHOD:		
PART 2	ISSUED BY:	CM REPORT TITLE	
	PM APPROVAL	CM REPORT NO:	
		CM REPORT DATE	
PART 3	DISCREPANCY RESOLVED — INITIAL / POSITION / DATE: V&V TL		
	COMMENTS:		

TABLE 1. System Requirements Discrepancy Report No. 0001

	DISCREPANCY REPORT	SERIAL NO.: 0001	DATE: 02/12/85
	PROJECT: GPUN TMI-1 SPDS V&V	PREPARED BY: C.L. EVANS	DATE: 2/12/85
		SIGNATURE: C.L. Evans	
PART 1	V&V TASK: REQUIREMENTS VERIFICATION	REVIEWED BY: B.I. CANTOR DATE:	APPROVED BY: N.C. THOMAS DATE:
		SIGNATURE: B.I. Cantor 2/13/85	SIGNATURE: N.C. Thomas 2/14/85
	DOCUMENT(S) WHERE DISCREPANCY EXISTS: IDR 583 REV. 1, "SAFETY PARAMETER DISPLAY SYSTEM (SPDS) USER GUIDELINES, PAGES 14-15, 17		
	DESCRIPTION OF DISCREPANCY: PAGE 1 OF 1		
	Timing requirements for SPDS critical safety functions and displays are "valid with a computer loading of less than or equal to 100%." Requirements for loading of greater than 100% are undefined, making the timing requirements incomplete.		
	ESTIMATE OF IMPACT:		
	Major. The data acquisition and alarm processing systems have higher priority than the SPDS, so the possibility of overloading is known to exist. Requirements are necessary to define SPDS response under these conditions.		
	RESOLUTION ACTION: PAGE ___ OF ___		
PART 2	RETEST METHOD:		
	ISSUED BY:	CM REPORT TITLE:	
	PM APPROVAL:	CM REPORT NO.:	
		CM REPORT DATE:	
PART 3	DISCREPANCY RESOLVED — INITIAL / POSITION / DATE		
	COMMENTS:		

COPY

TABLE 2. System Requirements Discrepancy Report No. 0002

DISCREPANCY REPORT | SERIAL NO.: 0002 | DATE: 02/12/85

PROJECT: GPUN TMI-1 SPDS V&V

PREPARED BY: C.L. EVANS DATE: 2/12/85
SIGNATURE: C.L. Evans

PART 1

V&V TASK: REQUIREMENTS VERIFICATION | REVIEWED BY: K.I. CANTOR DATE:
SIGNATURE: K.I. Cantor 2/12/85 | APPROVED BY: N.C. THOMAS DATE:
SIGNATURE: N.C. Thomas 2/12/85

DOCUMENT(S) WHERE DISCREPANCY EXISTS: ADR 583 REV. 1, "SAFETY PARAMETER DISPLAY SYSTEM (SPDS) USER GUIDELINES, FLOW CHARTS 6.1 THROUGH 6.7

DESCRIPTION OF DISCREPANCY:

PAGE 1 OF 1

Flow charts 6.1 through 6.7 do not follow standard flow charting format. AND and OR conditions are not distinguished, and the logic is ambiguous.

ESTIMATE OF IMPACT:

Major. These flow charts define the logic for the SPDS critical safety functions. Their lack of clarity and consistency can be expected to cause problems in maintenance. V&V will be impacted because the flow charts do not provide an adequate baseline for evaluation of the SPDS design.

PART 2

RESOLUTION ACTION:

PAGE ___ OF ___

RETEST METHOD:

ISSUED BY: | CM REPORT TITLE:

PM APPROVAL: | CM REPORT NO.:

| CM REPORT DATE:

PART 3

DISCREPANCY RESOLVED

	INITIAL			
POSITION	V&V TL			
DATE				

COMMENTS:

8704090204

Page 38

03/29/85

TABLE 3. Design Verification Unresolved Discrepancy Report No. VER/DR-005

DISCREPANCY REPORT	SERIAL NO: VER/DR-005	DATE: 08/09/85
PROJECT: TMI-1 SPDS DESIGN VERIFICATION	PREPARED BY: J.P.HEIL SIGNATURE:	DATE: 08/09/85
RTM NO.: 28.00	REVIEWED BY: T.Y.BYOUN DATE: 08/09/85 SIGNATURE: TYB	APPROVED BY SIGNATURE: TYB
		DATE: 11/12/85

DOCUMENT(S) WHERE DISCREPANCY EXISTS: TDR-618, REV 0

REF(S): (A) COMMENT VER-003 MEMO NF-85-4178, 07/02/85 (B) MEMO 5421-85-0662, 07/18/85

PART 1 — DESCRIPTION OF DISCREPANCY — PAGE 1 OF 1

TDR does not address that non SPDS displays may not automatically pre-empt an SPDS display or that an SPDS display may pre-empt another SPDS display.

PART 2 — RESOLUTION ACTION See C.M.Cafre:: memo 5421-85-0120 — PAGE 1 OF 1

RETEST METHOD

ISSUED BY

CM REPORT TITLE

PM APPROVAL

CM REPORT NO

CM REPORT DATE

PART 3 — DISCREPANCY RESOLVED

INITIAL					
POSITION	V&V TL				
DATE					

COMMENTS: Remains an Unresolved Discrepancy pending resolution between TMI-1 Plant Operations and Technical Functions.

Table 4 List of SPDS Programs

A) SPDS Display Programs

SPDS Routine	Display
SPDSXX*	Menu
RQDAXX	1, 2, 3, 4
RCIAXX	5
RADCXX	6
CNCDXX	7
RQDPXX	8
PSHRXX	9, 11
RCIPXX	10
RCINXX	12

*XX = Channel 0 or 2

B) SPDS Critical Safety Functions

Task	CSF
RXQDIS	Reactivity/Power Distribution
PSHTRM	Primary Side Heat Removal
RCINTG	RCS Integrity
RADCTL	Radiation Control
CNTCND	Containment Conditions

TABLE 5

DETAILS OF THREE CATEGORIES OF TESTS
(FUNCTIONAL, STRUCTURE AND OPERATIONAL)

For Functional Tests the following items were included:

A. Testing of Display Shells - each display was checked for format and accuracy (color, lines of demarcation, space between tick marks, resolution, etc.): Tests 3-15

B. Single Variable Functions for Displays - quality checking for good, bad, suspect values was done, values over the entire range of the sensor were checked, alarms and warnings were tested at the setpoint and just above and below the setpoint: Tests 16-22

C. Multivariable Functions - where several functions were used to compute values that were a function of several input values quality tagging for good, bad, suspect values of the input values were tested: Test 34

D. Operation of Displays - the operation of each display and which display was available was tested: Tests 1-2

For Structural Tests the following were considered:

A. Data Paths - all possible input combinations of data to a program path were tested: Tests 16-34

B. Program Paths - all program paths for those flow charts presented in TDR-583 were tested: Tests 16-22

C. Computer Executive and Control - careful control was executed to ensure that the SPDS programs were given the proper prioritization and task activation sequence: Tests 1-36

For Operational Tests the following were included:

A. The tests were run on the real-time plant Modcomp Classic Computer.

B. Dynamic Response Time - call time for displays, response time of displays and alarms, accuracy of trends and traces, calculations and time dependent variables were all checked: Tests 23-27 and 31-32

C. Incorrect Input Sequences - tests were written to display error messages when incorrect input sequences were activated: Tests 1-3

D. Fault Recovery - it has been demonstrated since December 1984, that the SPDS will recover from power spikes to the Modcomp Computer as well as system restarts and cold boot initialization.

TABLE 6

SUMMARY DESCRIPTION OF THE TESTS

TEST	TITLE	DESCRIPTION/PURPOSE
1.	Manual Display Control	Verify that manual paging between displays meets the system requirements.
2.	Automatic Display Control	Verify that the automatic display controls meet the system requirements.
3.	Shell Characteristics of Display 0	Verify that the non-dynamic, non-data dependent characteristics of the displays meet the system requirements.
4.	Shell Characteristics of Display 1	cf. Test 3
5.	Shell Characteristics of Display 2	cf. Test 3
6.	Shell Characteristics of Display 3	cf. Test 3
7.	Shell Characteristics of Display 3	cf. Test 3
8.	Shell Characteristics of Display 5	cf. Test 3
9.	Shell Characteristics of Display 6	cf. Test 3
10.	Shell Characteristics of Display 7	cf. Test 3
11.	Shell Characteristics of Display 8	cf. Test 3
12.	Shell Characteristics of Display 9	cf. Test 3
13.	Shell Characteristics of Display 10	cf. Test 3
14.	Shell Characteristics of Display 11	cf. Test 3

TABLE 6

SUMMARY DESCRIPTION OF THE TESTS
(Continued)

TEST	TITLE	DESCRIPTION/PURPOSE
15.	Shell Characteristics of Display 12	cf. Test 3
16.	Static Function Test of CSFs 1 and 2 and Display 4	Test the domain of possible input values and the associated qualities (includes just above and below alarm limits).
17.	Static Function Test of CSF 3 and Display 5	cf. Test 16
18.	Static Function Test of CSF 4 and Display 6	cf. Test 16
19.	Static Function Test of CSF 5 and Display 7	cf. Test 16
20.	Static Function Test of CSF 1 and Display 8	cf. Test 16
21.	Static Function Test of CSF 3 and Display 10	cf. Test 16
22.	Static Function Test of CSF 3 and Display 12	cf. Test 16
23.	Displays 1-3 Pressure/ Temperature Plot Graphical and Tabular Data Tests	Checks the functionality of the PT Plot.
24.	Displays 1-3 Imbalance Plot Graphical and Tabular Data Tests	Checks the functionality of the Imbalance Plot.
25.	Displays 1-3 Feedwater Flow Graphical and Tabular Data Tests	Checks the functionality of the Feedwater Flow Plot.
26.	Static Function Test of CSF 2 and Display 9	Static performed characteristic of PT Plots for CSF 2.

TABLE 6

SUMMARY DESCRIPTION OF THE TESTS
(Continued)

TEST	TITLE	DESCRIPTION/PURPOSE
27.	Static Function Test of CSF 2 and Display 11	cf. Test 26
31.(*)	Post Trip Forced Flow Test of Display 9	Dynamically test Post Trip Forced Flow PT Plot.
32.	Post Trip Natural Circulation	Dynamically test Post Trip Natural Circulation PT Plot.
33.	Calculation of RB Sump Mass Balance and RCS Flow Balance	Test the implementation of disk interfaces for CSF 3.
34.	Functional Test of Display 5, 10, 12 with Respect to Sump Mass Balance and Flow Balance Alarms	Tests the implementation of display interface for CSF 3.
35.	SPDS/Alarm Processor Interface Test	Alarm processing to SPDS warnings and alarms.
36.	Timing Test of 1 Minute Wait Test for Reactivity Balance CSF	Test of the 1 minute delay for alarm logic.
37.	Void Fractions on Displays 5 and 10	Dynamic Test of Void Fraction Displays

Notes:

(*) Tests from 28 through 30 were absorbed into other tests.

APPENDIX A

REQUIREMENTS TRACEABILITY MATRIX

VERSION III

THREE MILE ISLAND UNIT 1
SAFETY PARAMETER DISPLAY SYSTEM
REQUIREMENTS TRACEABILITY MATRIX (RTM III)

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	(1) REQUIREMENT REFERENCE(S)	(2) DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
01.00	User interacts with SPDS by means of existing plant computer alarm processor, control room alarm CRTs and alarm printer in computer room.				
01.05	User interacts with SPDS by means of existing alarm processor on plant process computer.	(A) P.12	(A) P.7,36 (2)	9.35	
01.10	Ten new alarms displayed on 2 alarm CRTs in control room, and printed on alarm printer in computer room.	(A) P.14 (1)	(A) P.23,33; 36	9.35 (5)	
02.00	Each CSF to have Priority 1 (alarm) and Priority 2 (warning) added to existing alarm processor. A total of 10 new alarms per Table 2.1 of TDR-583.				
02.05	Each CSF to have Priority 1 (alarm) and Priority 2 (warning) added to existing alarm processor.	(B) P.27A	(A) P.33,36	9.35	
02.07	Clarification of 'warning' and 'alarm' terminology.	(C) (3) RC # 0004	VER-001A(4)	N/A	
02.10	If any parameter exceeds setpoint, alarm CRT shows which CSF is in alarm and what priority.	(A) P.12 (A) P.335	(A) P.36	9.35	
02.15	Add 10 points to database - one Priority 1 alarm and one Priority 2 warning for each CSF.	(A) P.14	(A) P.23,33	9.35	
02.20	List of SPDS alarms and warnings added to data base (Table 2.1).	(A) P.16	(A) P.23,34	N/A	
02.30	SPDS display menu - computer points.	(A) P.342	(A) P.23,33	9.3	

Notes:

(1) System requirements document ID No.'s (A), (B), and (C) are given on page (A-24).
Example: Read "(A) p. 14" as "page 14 of System Requirement Ref. (A)"

(2) Design Reference ID No.'s (A) and (B) are shown on page (A-24).
Example: Read "(A) p. 7, 36" as "pages 7 and 36 of Design Document (A)"

(3) RC:0004 = Reviewer Comments and Resolution No. 0004 in System Requirements Verification Report (page A-24)

(4) VER-001A = Reviewer Comments and Resolution No. 001A in the Design Verification Report

(5) 9.35 = Test Procedure Section No. 9.35 (see page A-24)

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
03.00	If a CSF is in alarm, the menu will show the alarming CSF in reverse video yellow for Priority 2 warnings and reverse video red for Priority 1 alarms.	(A) P.17	(A) P.47	9.35	
04.00	If CSF has a level 2 display, menu will indicate which level is in alarm or if both are.	(A) P.17	(B) P. 120-130, 162-165	9.16	VER-003D VER/DR-004
05.00	Internal signal validation requirements.				
05.05	Each SPDS parameter to have a signal quality check performed by the computer.	(A) P.24	(A) P.24,45	9.16-9.22	
05.10	Criteria determining whether SPDS computer point is considered invalid.	(A) P.24	(A) P.24,25	9.16-9.36	
05.15	All computer points describing an SPDS parameter must be invalid for point to be considered invalid.	(A) P.24	(A) P.24	9.33	
05.20	When input to composed point or SPDS calculation is invalid, result is also invalid.	(A) P.24	(A) P.45	9.24, 9.37 9.25, 9.33	
05.25	Requirements for identification of invalid parameters on displays.	(A) P.24	(A) P.45	9.16-9.36	
05.30	Removal of points from scan required if instrument string feeding SPDS computer input is removed.	(A) P.24	VER-003A	N/A	VAL-001
05.35	Redundant sensors used if available SPDS not required to be single failure proof.	(A) P.25	VER-003B	9.33	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
06.00	On SPDS display, the numerically displayed parameters are displayed in reverse video yellow for Priority 2 warnings and reverse video red for Priority 1 alarms.	(A) P.14	(A) P.47	9.16-9.36	
07.00	Warning or alarm identification requirements for graphically displayed parameters.				
07.05	Parameter plot crossing line on graphical display identifies graphically-displayed parameter in alarm.	(A) P.14	VER-002D	9.23-9.27	
07.10	Correction - warning or alarm can be interpreted from parameter plot crossing line on graphical display.	(C) RC # 0017	VER-001A	9.23-9.27	
08.00	Alarm or warning automatically clears when parameter returns to condition within setpoint.	(A) P.14	(A) P.36	9.16-9.36	VER-002D
09.00	Redundant points requirements.				
09.05	When more that one computer point provided for a parameter, use point closest to limit to compare against alarm setpoint.	(A) P.14	VER-003C	9.16-9.22	
09.10	Clarification of choice of redundant points.	(C) RC # 0017	VER-001A	N/A	
09.15	Any valid point for parameter exceeding limit causes CSF alarm or warning.	(C) RC # 0017	VER-001A VER-003D	9.16-9.36	
10.00	SPDS spurious alarms, including L2931, may occur during cooldowns, cold shutdowns, and heatups, and should clear.	(A) P.14	N/A	N/A	VER-003E VER/DR-001

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
11.00	The warning setpoint criteria are presented in Tables 6.6, 6.7, and 6.8, and in Appendix I.				
11.05	All modes warning setpoints.	(A) P.44	(A) P.140, 142-145,153	9.16	
11.10	Power operation warning setpoints (Table 6.7).	(A) P.46	(A) P.121, 122,124,133, 137,138,142, 151,156,157	9.16-9.17 9.23-9.25	
11.15	Post trip warning setpoints (Table 6.8).	(A) P.50	(A) P.128, 133-135,142, 149,154,155	9.20, 9.22 9.27, 9.31 9.32	
11.20	R/PD power operation level 2 display - warning setpoints.	(A) P.362	(A) P.121, 122,124,125	9.16	
11.25	RCS Integrity power operation level 1 display - warning setpoints.	(A) P.368	(A) P.133, 140-142	9.17	
11.30	Radiation Control level 1 display - warning setpoints.	(A) P.372	(A) P. 3- 145	9.18	
11.35	Containment Conditions level 1 display - warning setpoints.	(A) P.375	(A) P. 49, 152-157	9.19	
11.40	R/PD post trip level 1 display - warning setpoints.	(A) P.379	(A) P.128	9.20	
11.45	PSMR post trip forced flow level 1 display - warning setpoints.	(A) P.385	(A) P.134	9.26	
11.50	RCS Integrity post trip forced flow level 1 display - warning setpoints.	(A) P.368	(A) P.133, 140-142	9.21	
11.53	Correction to warning setpoints - ' RC STAT' should be 'RC SAT' on page 388 of TDR-583 R1.	(C) RC # 0029		N/A	VER-001A
11.55	PSMR post trip natural circulation level 1 display - warning setpoints.	(A) P.395	(A) P.134- 135	9.27	
11.60	RCS Integrity post trip natural circulation level 1 display - warning setpoints.	(A) P.398	(A) P.133 141,142,155	9.22	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
12.00	The alarm setpoint criteria are presented in Tables 6.9, 6.10, 6.11, and in Appendix I.				
12.05	All modes alarm setpoints (Table 6.9).	(A) P.53	(A) P.140, 143,144,147	9.18	
12.10	Power operation alarm setpoints (Table 6.10).	(A) P.55	(A) P.117, 118,120,136 140,150,151	9.23-9.25 9.16-9.17	VER-001A VER-004A
12.15	Post trip alarm setpoints (Table 6.11).	(A) P.58	(A) P.132, 140,141,147 148,149	9.20-9.22 9.27, 9.31 9.32	VER-004B
12.20	R/PD power operation level 2 display - alarm setpoints.	(A) P.364	(A) P.117- 120	9.16	VER-001A VER-001B
12.25	RCS Integrity power operation level 1 display - alarm setpoints.	(A) P.369	(A) P.140	9.17	
12.30	Radiation Control level 1 display - alarm setpoints.	(A) P.372	(A) P.143, 144	9.18	
12.35	Containment Conditions level 1 display - alarm setpoints.	(A) P.376	(A) P.147- 151	9.19	
12.40	R/PD post trip level 1 display - alarm setpoints	(A) P.379	(A) P.126, 127	9.20	VER-005A
12.45	RCS Integrity post trip forced flow level 1 display - alarm setpoints.	(A) P.389	(A) P.132, 140,141	9.21	
12.50	PSHR post trip natural circulation level 1 display - alarm setpoints.	(A) P.395	(A) P.140	9.27	VER-005B
12.55	RCS Intergity post trip natural circulation level 1 display - alarm setpoints.	(A) P.399	(A) P.140, 141	9.22	VER-005B

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
13.00	CSF warning and alarm setpoint criteria is presented in flow charts 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, and 6.7, which are repeated in Appendix I.				
13.02	Comparison of flowcharts in Section 6 and Appendix I.	(C) RC # 0028 RC # 0029	VER-001A VER-004C VER-005C	N/A	
13.03	SPDS display menu setpoints table - references flowcharts.	(A) P.343	(A) P.117, 120,121,123, 125-127,129, 132,135,136, 138,141,142, 144,145,157, 158	9.16-9.19 9.26, 9.27 9.31	VER-002B
13.05	Reactivity/Power Distribution warning CSF flowchart.	(A) P.97b (A) P.344	(A) P.116, 121-125,128, 129	9.16	
13.10	Reactivity/Power Distribution alarm CSF flowchart.	(A) P.98 (A) P.345 (C) RC # 0029	(A) P.[illegible] 120,122,127	9.16	
13.13	Correction to Reactivity/Power Distribution alarm flowchart.	(C) RC # 0007		9.16	VER-001A
13.15	Primary Side Heat Removal warning CSF flowchart.	(A) P.100 (A) P.347 (A) P.347	(A) P.130, 133-135,137, 138	9.26-9.27 9.31	VER-005D VER-005E VER-005F VER-005G
13.18	Correction of symbol in PSHR warning CSF flowchart.	(C) RC # 0029		9.26-9.27 9.31	VER-001A
13.20	Primary Side Heat Removal alarm CSF flowchart.	(A) P.101 (A) P.348	(A) P.130, 132,136	9.26-9.27 9.31	
13.25	Reactor Coolant System Integrity CSF flowchart.	(A) P.102 (A) P.349	(A) P.139-142	9.17	VER-005H

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
13.30	Radiation Control Priority 2 CSF flowchart.	(A) P.103 (A) P.350	(A) P.144, 145	9.18	VER-005I VER-005J
13.35	Radiation Control Priority 1 CSF flowchart.	(A) P.103 (A) P.350	(A) P.143, 144	9.18	
13.40	Containment Condition warning CSF flowchart.	(A) P.104 (A) P.351	(A) P.133- 157	9.19	
13.45	Containment Condition alarm CSF flowchart.	(A) P.104 (A) P.351	(A) P.136- 152	9.19	
14.00	SPDS parameters organized into 5 critical safety functions (CSF).	(A) P.12	(A) P.7,19	9.3	
15.00	Reactivity/Power Distribution CSF Parameters.				
15.05	Parameters for CSFs, Table 3.1.	(B) P.28	(A) P.26, 116-118	9.3	VER-004N
15.10	Reactivity/Power Distribution parameter names.	(B) P.30	(A) P.[illegible]27	9.4 - 9.6 9.23-9.25	
15.15	Reactivity/Power distribution critical safety function parameters, point numbers (Table 6.1).	(A) P.39	(A) P.26,27	9.23-9.25	
15.20	R/PD & PSHR power operation level 1 display computer points - PT Plot.	(A) P.354	(A) P.27	9.23	
15.25	R/PD & PSHR power operation level 1 display computer points - Flux Flow Imbalance Plot.	(A) P.355	(A) P.26	9.24	
15.30	R/PD & PSHR power operation level 1 display computer points - Feedwater Flow Plot.	(A) P.355	(A) P.26,27 28 (B) P. 168, 176,189,294 217	9.25	VER-004D VER/DR-006
15.33	Correction to R/PD and PSHR power operation level 1 display computer points.	(C) RC # 0022	VER-001A	9.26-9.27	
15.35	R/PD power operation level 2 display - computer points.	(A) P.361	(A) P.26	9.16	VER-004E

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
15.40	Reactivity/Power Distribution post trip level 1 display - computer points.	(A) P.378	(A) P.26	9.20	
16.00	Primary Side Heat Removal CSF Parameters.				
16.05	Parameters for CSFs, Table 3.1.	(B) P.28	(A) P.27 28,130-138	9.3	
16.10	Primary Side Heat Removal parameter names.	(B) P.30	(A) P.29,30	9.12, 9.14 9.26, 9.27	
16.15	Primary Side Heat Removal critical safety function parameters, point numbers (Table 6.2).	(A) P.40	(A) P.27,28 (B) P.168, 176,189,204 217	9.26, 9.27 9.31	VER-004F VER/DR-006
16.20	R/PD & P2HR power operation level 1 display, computer points - PT Plot.	(A) P.354	(A) P.27	9.23	
16.25	R/PD & P2HR power operation level 1 display computer points - Flux Flow Imbalance Plot.	(A) P.355	(A) P.26	9.24	
16.30	R/PD & P2HR power operation level 1 display computer points - Feedwater Flow Plot.	(A) P.355	(A) P.26,27 28 (B) P.168, 176,189,204 217	9.25	VER-004G VER/DR-006
16.33	Correction to R/PD and P2HR power operation level 2 display computer points.	(C) RC # 0022	VER-001A	9.16	
16.35	Primary Side Heat Removal post trip forced flow level 1 display - computer points.	(A) P.382	(A) P.27,28 (B) P. 168, 176,189,204 217	9.26	VER-004H VER/DR-006
16.40	Primary Side Heat Removal post trip natural circulation level 1 display - computer points.	(A) P.392	(A) P.27,28 (B) P. 168, 176,189,204 217	9.27	VER-004I VER/DR-006

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
17.00	Reactor Coolant System Integrity CSF Parameters.				
17.05	Parameters for CSFs, Table 3.1.	(B) P.28	(A) P.29, 30,140-142	9.3	
17.10	Reactor Coolant System Integrity parameter names.	(B) P.31	(A) P.29,30	9.8, 9.17	
17.15	Reactor Coolant System Integrity critical safety function parameters, point numbers (Table 6.3).	(A) P.41	(A) P.28,29, 30 (B) P. 25	9.17	VER-004J VER/DR-007
17.18	Corrections to Table 6.3.	(C) RC # 0029	VER-001A	9.17	
17.20	Reactor Coolant System Integrity power operation level 1 display - computer points.	(A) P.367	(A) P.28,29, 30 (B) P. 25	9.17	VER-004K VER/DR-007
17.25	Reactor Coolant System Integrity post trip forced flow - computer points.	(A) P.387	(A) P.29,29, 30 (B) P. 25	9.21	VER-004L VER/DR-007
17.30	Reactor Coolant System Integrity post trip natural circulation level 1 display - computer points.	(A) P.397	(A) P.29, 29, 30 (b) P. 25	9.22	VER-004M VER/DR-007
18.00	Radiation Control CSF Parameters.				
18.05	Parameters for CSFs, Table 3.1.	(B) P.28	(A) P.31, 143-145	9.3	
18.10	Radiation Control parameter names.	(B) P.32	(A) P.31	9.9, 9.18	
18.15	Radiation Control critical safety function parameters, point numbers (Table 6.4).	(A) P.42	(A) P.31	9.18	
18.20	Radiation Control level 1 display - computer points.	(A) P.371	(A) P.31	9.18	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
19.00	Containment Conditions CSF Parameters.				
19.05	Parameters for CSFs, Table 3.1.	(B) P.28	(A) P.32, 147-158	9.3	
19.10	Containment Conditions parameter names.	(B) P.32	(A) P.32	9.10, 9.19	
19.15	Containment Conditions critical safety function parameters, point numbers (Table 6.5).	(A) P.43	(A) P.32	9.19	
19.20	Containment Conditions level 1 display - computer points.	(A) P.374	(A) P.32	9.19	
20.00	The computer will determine which of the three (3) design modes (Power Operation, Post Trip Forced Flow, or Post Trip Natural Circulation) should be displayed.				
20.05	SPDS uses 12 displays. Only 5 available at one time depending on plant condition.	(A) P.12 (A) P.335	(A) P.41	9.1	
20.10	SPDS designed for Power Operation, Post Trip Forced Flow, Post Trip Natural Circulation.	(A) P.12 (A) P.335	(A) P.41	9.1 - 9.2	
20.15	Computer determines if display to be Power Operation or Post Trip, Forced Flow or Natural Circulation.	(A) P.17	(A) P.40	9.1 - 9.2	
20.20	For Reactor Coolant System Integrity CSF, computer automatically determines category of display.	(A) P.36	(A) P.40	9.2	
20.25	Radiation Control CSF uses same display for all modes of operation.	(A) P.37	(A) P.40	9.1	
20.30	Containment Conditions CSF uses same display for all modes of operation.	(A) P.38	(A) P.40	9.1	
20.35	SPDS plant condition determination - computer points.	(A) P.340	(A) P.26,27, 29,30,32	9.2	

THREE MILE ISLAND UNIT 1
SAFETY PARAMETER DISPLAY SYSTEM
REQUIREMENTS TRACEABILITY MATRIX (RTM III)

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
20.40	SPDS plant condition determination - operation.	(A) P.340	(A) P.42	9.2	
20.45	Table of displays organized by CSF and plant condition.	(A) P.336	(A) P.43,44	9.3	
21.00	SPDS displays allow user to assess safety independent of alarm setpoints.	(A) P.12	VER-003P	9.1 - 9.2	
22.00	User selects SPDS Display from menu after seeing CSF in alarm on alarm CRT. SPDS button on CRT control console brings up menu.	(A) P.12 (A) P.335	(A) P.7,46,47	9.1, 9.3	
23.00	CRT control console has individual buttons for access of SPDS menu and Primary Side Heat Removal Post Trip Display.	(A) P.17	(A) P.47	9.1 - 9.2	
24.00	Primary Side Heat Removal Post Trip display initiation.				
24.05	PSHR post trip display (PT Plot) automatically appears on CRT-4 after reactor trip. Also has own dedicated button on CRT-4 Control console.	(A) P.12 (A) P.335	VER-004V	9.2	
24.10	On reactor trip, post trip PSHR display (PT Plot) automatically placed on CRT-4.	(A) P.17	VER-004V	9.2	
25.00	SPDS continues to inform user of any new problems in this or any other CSF.	(A) P.13 (A) P.335	(A) P.36	9.16-9.36	
26.00	All graphical displays on CRT-4 only. All other can be placed on CRT-3 or -4. Error message appears on CRT-3 if graphical display requested.	(A) P.17		9.1	VER-004V
27.00	Hard copy requirements.				
27.05	Hard copy of any display to be obtainable on request.	(A) P.17	VER-003Q	9.16-9.36	
27.10	Hard copy of any display will be available using the video copier.	(A) P.224	VER-003Q	9.16-9.36	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
28.00	Non-SPDS displays may not automatically pre-empt SPDS display. SPDS display may pre-empt another SPDS display.	(A) P.17		N/A 9.2	VER-003R VER/DR-005 VAL-001
29.00	When cold leg temperature less than 525 deg. F, provide post trip displays independently of reactor trip signal.	(A) P.17	(A) P.42	9.2	
30.00	Timing requirements for programs calculating 10 new CSF logical points.	(A) P.14	VER-003M VER/DR-003	9.17-9.20 9.26-9.27	
31.00	Timing requirements for programs generating SPDS displays.	(A) P.17	VER-003N VER/DR-003	9.16-9.22	
32.00	SPDS display hierarchy - power operation.				
32.05	Power operation hierarchy chart.	(A) P.21 (A) P.337	(A) P.41, 165,166, 169,206, 226	9.2	VER-002C
32.10	Correction to power operation hierarchy chart.	(C) RC # 0005 RC # 0029	VER-00[illegible]	9.2	
33.00	SPDS display hierarchy - post trip forced flow.	(A) P.22 (A) P.338	(A) P.41, 198,202, 212,226	9.2	VER-002C
34.00	SPDS display hierarchy - Post Trip Natural Circulation.	(A) P.23 (A) P.339	(A) P.41, 198,202, 218,226	9.2	VER-002C
35.00	SPDS menu display criteria.				
35.05	Contents of SPDS display menu. Lists 5 critical safety functions.	(A) P.19	(B) P. 43-45	9.1	VER-004Q VER/DR-008
35.07	SPDS display menu - shell specification.	(A) P.342	(A) P.43, 44 (B) P. 43-45	9.3	VER-004Q VER/DR-008

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
35.10	SPDS display menu - color and pattern coding.	(A) P.342	(A) P.43, 44,159,160 (B) P. 43-45	9.3	VER-004P VER/DR-008
35.15	SPDS display menu - operation.	(A) P.342	(A) P.43, 44,46,47, 159-162 (B) P. 120-133	9.1 - 9.2	VER-003O VER/DR-004
35.20	SPDS CSF selection menu (Display 0).	(A) P.352	(A) P.43, 44,47 (B) P. 43-45	9.1, 9.3	VER-004Q VER/DR-008
36.00	Reactivity/Power Distribution and Primary Side Heat Removal power operation level 1 display criteria.				
36.05	R/PD CSF provides information on gross core reactivity problems. For power operation and post trip. Also core Power Distribution over 15% full power.	(A) P.31	N/A	9.16, 9.29 9.23-9.27	
36.10	Description of plot for Reactivity/Power Distribution critical safety function.	(A) P.32	(B) P. 120-264	N/A	VER-033A
36.15	Information obtainable from Primary Side Heat Removal CSF, power operation.	(A) P.33	(B) P. 120-264	9.23-9.25	VER-033B
36.20	Description of reactor coolant pressure vs. hot leg temperature plot for Primary Side Heat Removal CSF.	(A) P.34	(B) P. 120-264	N/A	VER-033C
36.25	Trending of power operation PT Plot for Primary Side Heat Removal CSF.	(A) P.34	(B) P. 120-264	9.23-9.25	VER-033D
36.30	Description of NI power vs. loop feedwater flow plot for Primary Side Heat Removal.	(A) P.35	(B) P. 120-264	N/A	VER-033E
36.35	PSHR power operation plots to display 20 minutes worth of data.	(A) P.35	(A) P.190, 191	9.23-9.25	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
36.40	R/PD & PSHR power operation level 1 display shell specification - PT Plot.	(A) P.353	(B) P. 43-45	9.4 - 9.6	VER-004D VER/DR-008
36.45	R/PD & PSHR power operation level 1 display shell specification - flux flow imbalance plot.	(A) P.353	(B) P. 43-45	9.4 - 9.6	VER-004D VER/DR-008
36.50	R/PD & PSHR power operation level 1 display shell specification - feedwater flow plot.	(A) P.354	(B) P. 43-45	9.4 - 9.6	VER-004D VER/DR-008
36.53	Correction to feedwater flow plot shell specification.	(C) RC # 0016	VER-001A	9.4 - 9.6	
36.55	R/PD & PSHR power operation level 1 display - color and pattern coding.	(A) P.354	(B) P. 43-45	9.4	VER-004P VER/DR-008
36.60	R/PD & PSHR power operation level 1 display - data trending.	(A) P.355	(B) P. 120-264	9.23-9.25	VER-033F
36.65	R/PD & PSHR power operation level 1 display - operation.	(A) P.357	(A) P.163-165,173, 176-179, 180-182	9.2	
36.70	R/PD & PSHR power operation level 1 display (Display 1).	(A) P.358	N/A	9.2, 9.4 9.23-9.25	
36.75	R/PD & PSHR power operation level 1 display (Display 2).	(A) P.359	N/A	9.2, 9.5 9.23-9.25	
36.80	R/PD & PSHR Power operation level 1 display (Display 3).	(A) P.360	N/A	9.2, 9.6 9.23-9.25	
37.00	Reactivity/Power Distribution Power Operation Level 2 display criteria.				
37.05	Description of Reactivity/Power Distribution CSF level 2 display for power operation.	(A) P.33	(B) P. 43-45,120-264	N/A	VER-033G
37.07	R/PD power operation level 2 display - shell specification.	(A) P.361	(B) P. 43-45	9.7	VER-004D VER/DR-008
37.10	R/PD power operation level 2 display - color and pattern coding.	(A) P.361	(B) P.43-45	9.7	VER-004P VER/DR-008

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
37.15	R/PD power operation level 2 display- operation.	(A) P.362	(A) P.166-169	9.1 - 9.2 9.16	
37.20	R/PD power operation level 2 display (Display 4)	(A) P.366	N/A	9.1 - 9.2	
38.00	Reactor Coolant System Integrity power operation level 1 display criteria.				
38.05	Information available from Reactor Coolant System Integrity CSF.	(A) P.36	(A) P.140-142	9.8, 9.17	
38.10	Discussion of Reactor Coolant System Integrity CSF calculations.	(A) P.37	(A) P.141	N/A	
38.15	Discussion of RCS Integrity in forced flow and natural circulation modes.	(A) P.37	(A) P.140	N/A	
38.17	RCS Integrity power operation level 1 display - shell specification.	(A) P.367	(B) P.43-45	9.8	VER-004D VER/DR-008
38.20	Reactor Coolant System Integrity power operation level 1 display - color pattern coding.	(A) P.367	(B) P.43-45	9.8	VER-004P VER/DR-008
38.25	Reactor Coolant System Integrity power operation level 1 display - operation.	(A) P.368	(A) P.165, 166, 167, 205, 206, 298, 299 (B) P. 35	9.1 - 9.2 9.8, 9.17	VER-034A
38.28	Definition of RCS temperature used in operation is found on page 349 of TDR-583, Rev. 1.	(C) RC # 0018	VER-001A	N/A	
38.30	Reactor Coolant System Integrity power operation level 1 display (Display 5).	(A) P.370	N/A	9.1 - 9.2	
39.00	Radiation Control level 1 display criteria.				
39.05	Purpose of Radiation Control CSF.	(A) P.37	N/A	N/A	
39.07	Radiation Control level 1 display - shell specification.	(A) P.371	(B) P.43-45	9.9	VER-004D VER/DR-008

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
39.10	Radiation Control display level 1 - color pattern coding.	(A) P.361	(A) P.223-225 (B) P.43-45	9.9	VER-004P VER/DR-008
39.15	Radiation Control display - operation.	(A) P.371	(A) P.206, 212,281, 223-226 (B) P.164-165	9.1 - 9.2 9.18	VER-004R VER/DR-009
39.20	Radiation Control level 1 display (Display 6).	(A) P.373	N/A	9.1 - 9.2 9.18	
40.00	Containment Conditions level 1 display criteria.				
40.05	Containment Conditions CSF gives information on effect of reactor building conditions on integrity of building.	(A) P.38	N/A	9.10	
40.07	Containment Conditions level 1 display - shell specification.	(A) P.374	(B) P.43-45	9.10	VER-004Q VER/DR-008
40.10	Containment Conditions level 1 display - color pattern coding.	(A) P.374	(B) P.43-45	9.10	VER-004P VER/DR-008
40.15	Containment Conditions level 1 display - operation.	(A) P.374	(A) P.166, 169,198, 226,233-242 (B) P. 164-165	9.1 - 9.2 9.19	VER-004S VER/DR-009
40.20	Containment Conditions level 1 display (Display 7).	(A) P.377	N/A	9.1 - 9.2 9.19	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
41.00	Reactivity/Power Distribution post trip level 1 display criteria.				
41.03	R/PD post trip level 1 display - shell specification.	(A) P.378	(B) P.43-45	9.11	VER-004O VER/DR-008
41.05	Reactivity/Power Distribution post trip level 1 display - color and pattern coding.	(A) P.378	(A) P.197 (B) P.43-45	9.11	VER-004P VER/DR-008
41.10	Reactivity/Power Distribution post trip level 1 display - operation.	(A) P.378	(A) P.197, 198,202 (B) P. 164-165	9.1 - 9.2 9.11, 9.20	VER-004T VER/DR-009
41.15	Reactivity/Power Distribution post trip level 1 display (Display 8).	(A) P.380	N/A	9.1 - 9.2 9.20	
42.00	Primary Side Heat Removal post trip forced flow level 1 display criteria.				
42.05	Information obtainable from Primary Side Heat Removal CSF, post trip.	(A) P.33	N/A	9.26	
42.07	Changes required to PT Plot when incorporated into SPDS for post trip FSHR.	(A) P.36	N/A	9.26	
42.10	Primary Side Heat Removal post trip forced flow level 1 display - shell specification.	(A) P.381	(B) P.43-45	9.12	VER-004O VER/DR-008
42.15	Primary Side Heat Removal post trip forced flow level 1 display - color and pattern coding.	(A) P.382	(B) P.43-45	9.12	VER-004P VER/DR-008
42.20	Primary Side Heat Removal post trip forced flow level 1 display - data trending.	(A) P.383	(B) P. 129-264	9.26	VER-033H
42.25	Primary Side Heat Removal post trip forced flow level 1 display - operation.	(A) P.384	(A) P.198, 199,200,202 212 (B) P.120-264	9.1 - 9.2 9.26	VER-033I

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
42.28	Correction to operation - under auto. actuation of display should read pumps not equal to zero.	(C) RC # 0023		9.2	VER-001A
42.30	Primary Side Heat Removal post trip forced flow level 1 display (Display 9).	(A) P.386	N/A	9.1 - 9.2 9.12, 9.26	
43.00	Reactor Coolant System Integrity post trip forced flow level 1 display criteria.				
43.03	RCS Integrity post trip forced flow level 1 display - shell specification.	(A) P.387	(B) P.43-45	9.13	VER-004O VER/DR-008
43.05	Reactor Coolant System Integrity post trip forced flow level 1 display - color pattern coding.	(A) P.387	(A) P.214, 215 (B) P.43-45	9.13	VER-004P VER/DR-008
43.10	Reactor Coolant System Integrity post trip forced flow level 1 display - operation.	(A) P.388	(A) P.202, 212,214, 215,226 (B) P.164-165	9.1 - 9.2 9.21	VER-004U VER/DR-009
43.13	Redundant point criteria from TDR-583, Rev 1, page 368 to be included on page 388.	(C) RC # 0017		N/A	VER-001A
43.15	Reactor Coolant System Integrity post trip forced flow level 1 display (Display 10).	(A) P.390	N/A	9.1 - 9.2 9.13	
44.00	Primary Side Heat Removal post trip natural circulation level 1 display criteria.				
44.05	Information obtainable from Primary Side Heat Removal CSF, post trip.	(A) P.33	N/A	9.27	
44.07	Changes required to PT Plot when incorporated into SPDS for post trip PSHR.	(A) P.36	N/A	9.27	
44.10	Primary Side Heat Removal post trip natural circulation level 1 display - shell specification.	(A) P.391	(B) P.43-45	9.14	VER-004O VER/DR-008

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
44.15	Primary Side Heat Removal post trip natural circulation level 1 display - color and pattern coding.	(A) P.392	(B) P.43-45	9.14	VER-004P VER/DR-008
44.20	Primary Side Heat Removal post trip natural circulation level 1 display - data trending.	(A) P.393	(A) P.164, 181,182,185 (B) P.120-264	9.27	VER-033J
44.25	Primary Side Heat Removal post trip natural circulation level 1 display - operation.	(A) P.394	(A) P.198, 200,292,296 (B) P.120-264	9.1 - 9.2 9.27	VER-033K
44.30	Primary Side Heat Removal post trip natural circulation level 1 display (Display 11).	(A) P.396	N/A	9.1 - 9.2 9.27	
45.00	Reactor Coolant System Integrity post trip natural circulation level 1 display criteria.				
45.03	RCS Integrity post trip natural circulation level 1 display - shell specification.	(A) P.397	(B) P.43-45	9.15	VER-004O VER/DR-008
45.05	Reactor Coolant System Integrity post trip natural circulation level 1 display - color pattern coding.	(A) P.397	(B) P.43-45	9.15	VER-004P VER/DR-008
45.10	Reactor Coolant System Integrity post trip natural circulation level 1 display - operation.	(A) P.398	(A) P.171, 172,216-218 (B) P.35	9.1 - 9.2 9.22	VER-034B
45.15	Reactor Coolant System Integrity post trip natural circulation level 1 display (Display 12)	(A) P.403	N/A	9.1 - 9.2 9.22	
45.20	RCS Integrity post trip natural circulation level 1 display - hot leg A/B level resolution.	(A) P.400	(A) P.56, 218,220,222	9.22	
45.23	Accuracy for hot leg A/B level bar chart.	(C) RC ≠ 0001	(B) P. 43	9.22	VER-001A VER-003F VER/DR-002

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
45.25	RCS Integrity post trip natural circulation level 1 display - RV Head level resolution.	(A) P.401	(A) P.83, 217,218,220 222	9.22	
45.28	Accuracy for RV Head level bar chart.	(C) RC # 0001	(B) P. 43	9.22	VER-001A VER-003G VER/DR-002
45.30	RCS Integrity post trip natural circulation level 1 display - Pressurizer level resolution.	(A) P.402	(A) P.216, 218,220,222	9.22	
45.33	Accuracy for Presurizer level bar chart.	(C) RC # 0001	(B) P. 43	9.22	VER-001A VER-003H VER/DR-002
46.00	There will be no audible alarm or user acknowledgement of alarms.	(A) P.12 (A) P.14 (A) P.335	VER-003I	9.16-9.37	
47.00	SPDS is an aid to Control Room personnel to determine safety status and identify abnormal conditions.	(A) P.12 (A) P.335	N/A	N/A	
48.00	Displays give useful information during plant conditions other than power operation and post trip.	(A) P.13	VER-003J	9.16-9.34	
49.00	Accuracy requirements for SPDS displays.			9.3-9.15	
49.05	Accuracy requirements for SPDS tabular displays.	(A) P.18	(B) P.35,43	9.3-9.15	VER-003K VER/DR-002
49.10	Accuracy requirements for R/PD and PCHR power operation plots and PCHR Post Trip Plots.	(C) RC # 0001	(B) P.35,43	9.23-9.25 9.27, 9.31	VER-001A VER-003L

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
50.00	Intentionally left blank.				
51.00	Calculations performed by SPDS.	(A) Sect. 7			
51.05	Reactor power calculation, 7.2.	(A) P.115	(A) P.28 (B) P. 140	9.16	VER-035A
51.10	RCS total flow calculation, 7.3.	(A) P.116	(A) P.26, 117	9.33	
51.15	Reactor coolant pump status calculation, 7.9.	(A) P.118	(A) P.82	9.16	
51.20	RCS flow balance calculation, 7.10.	(A) P.119	(A) P.27,28 (B) P. 140	9.33	VER-035B
51.25	Reactor building sump mass balance calculation, 7.11.	(A) P.120	(A) P.29 (B) P. 140	9.33	VER-035C
51.30	Imbalance operating limit calculation, 7.12.	(A) P.121	(A) P.26, 128 (B) P. 120-133	9.24	VER-036A
51.35	Flux - flow - imbalance calculation, 7.13.	(A) P.121	(A) P.26, 117-128 (B) P. 120-133	9.24	VER-036A
51.38	Correction to equation defining FL in 7.13.	(C) RC # 0024	VER-001A	9.24	
51.40	Feedwater flow limit calculation, 7.14.	(A) P.122	(A) P.26, 28,126,127 (B) P. 120-133, 140	9.25	VER-035D VER-036A
51.45	For feedwater flow limit calculation, 7.14, item B, Loop B, P(min) should be P(max).	(C) RC # 0024	VER-001A	9.25	

GPUN RTM ITEM	REQUIREMENT DESCRIPTION	REQUIREMENT REFERENCE(S)	DESIGN/CODE REFERENCE(S)	TEST PROC. REFERENCE(S)	REMARKS
52.00	Table 1 provides a list of the SPDS computer points and their associated slowest scan rate and calculation rate for the composed points.	(C) RC # 0002	VER-001A	9.16-9.37	
53.00	SPDS is available when plant computer system is available and plant is in a condition for which SPDS was designed.	(C) RC # 0012	VER-001A	9.1 - 9.37	
54.00	SPDS database point definition.	(C) RC # 0013	VER-001A	N/A	
55.00	Following computer restart, SPDS displays and alarms will not provide misleading information. Displays must be re-requested by user before they are provided.	(C) RC # 0026	VER-001A	N/A	VAL-001

REQUIREMENTS REFERENCES

A. GPUN TDR-583, Revision 1, "Safety Parameter Display System (SPDS) User Guidelines".
B. GPUN TR-018, "TMI-1 Safety Parameter Display System Safety Analysis".
C. SAIC-85/1625&264, "System Requirements Verification Report for GPU Nuclear TMI-1 SPDS", Appendix A, 03/29/85

DESIGN/CODE REFENENCES

A. GPUN TDR-618, Rev 0, "TMI-1 Safety Parameter Display System"
B. GPUN TDR-618, Rev 1, "TMI-1 Safety Parameter Display System"

TEST PROCEDURES REFERENCES

TMI SPDS Test Procedures