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| PROJ MGR <u>[Signature]</u> QUAL MGR <u>[Signature]</u> RELEASE <u>[Signature]</u> | | DATE <u>1/24/14</u> <u>01/24/14</u> <u>1-24-14</u> | | | | | |
| | | | | DRW LEVEL 3 | SCALE NONE | SHEET 1 OF 17 | |

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Open Items:

- 1) Need document numbers
- 2) CCB members need to be decided
- 3) Some project level description is missing
- 4) Cover page needs to be updated and some formatting is wrong

1.0 SCOPE

A Software Development Plan (SDP) describes the development activities to be conducted throughout all phases of the Software Development lifecycle. It describes the organization and responsibilities, management structure, development schedule, deliverable work products, staffing requirements, and other resources that are used to develop a specific software project. The software development plan serves as a vehicle for planning, establishing of project-level controls and the specific operating procedures that will be applied to the software project.

This SDP has been created under the guidance of IEEE 1058-1998 – IEEE Standard for Software Project Management Plans. This SDP describes the development environment, development tool set, internally developed software tools and utilities, COTS tools, and the processes required to manage and control their use during the project.

This SDP applies to the development and release of the TRIGA NMP and NLW Nuclear Channels, software which is being developed to replace the analog design of the NMP-1000 and NLX-1000 monitoring channels.

2.0 PURPOSE

This Software Development Plan describes the process, practices, organization, schedules, and resources that are used to produce the TRIGA NMP-1000 and NLX-1000 Channel Software identified in Section 2.1 below.

In addition to providing traditional project planning information, this software development plan will cite any 'tailoring' to the Software Engineering operating procedures to align with the activities, needs and constraints of this project. The TRIGA INL Software Configuration Management Plan and the Software Quality Plan address the change management and quality requirements planned for developing product software and are each separate documents and are referenced throughout this SDP.

2.1 Project Identification

The TRIGA INL project will replace the existing Neutron Radiography Reactor (NRAD) Instrumentation and Control System Console. The new instrumentation and control console will replace existing systems located in the Hot Fuel Examination Facility (HFEF) at INL. The NRAD instrumentation and control console provides operators with reactor controls, indications, and alarms; balance of plant controls, indications, and alarms; and video surveillance of the NRAD facility.

As part of the replacement, the monitoring channels will be updated to support the new Control System Console. The NRAD utilizes three NMP-1000 and one NLW-1000 monitoring channels. The NMP-1000 monitoring channel is a wide-range linear manual and automatic range switching current-to-voltage signal conditioning device. It includes adjustable bi-stable trip circuits for local and remote alarms and isolated current outputs for display by other devices. The NLW-1000 is a wide-range nuclear power channel monitor capable of resolving power from 1×10^{-7} to 1×10^2 percent.

Each nuclear channel includes a NetBurner Ethernet Module and an Amulet LCD Display. GA-ESI will develop and deliver customized code for both the NetBurner Ethernet Module and Amulet LCD Display for each channel. The software development effort will utilize Perforce for software change management. The source for the NMP-1000 and NLW-1000 will be stored in separate code bases. The NLW-1000 will reuse and leverage as much as possible from the NMP-1000 code base.

Software work activities and project milestones will be captured in the project schedule as discussed in Section 10 of this document.

3.0 DEFINITIONS

This section defines special terms, abbreviations, and acronyms used in this Software Development Plan.

| | |
|----------|--|
| artifact | Record of process such as meeting minutes or review checklists |
| CCB | Change Control Board |
| CDR | Critical Design Review |
| ECN | Engineering Change Notice |
| FMEA | Failure Modes and Effects Analysis |
| IEEE | Institute of Electrical and Electronics Engineers |
| INL | Idaho National Laboratory |
| NLI-1000 | A channel monitor designed to work with a compensated ion chamber and measure seven decades of neutron flux. For use with a TRIGA reactor. |
| NLS-1000 | A channel monitor designed to work with a fission chamber and measure seven decades of neutron flux. For use with a TRIGA reactor. |
| NLW-1000 | A channel monitor designed to work with a fission chamber chamber and measure ten decades of neutron flux. For use with a TRIGA reactor. |
| NLX-1000 | A platform module that can be configured as a NLW-1000, NLI-1000, or NLS-1000. |
| NMP-1000 | The NMP-1000 Module is a wide-range linear power channel module which can be used as part of a research reactor control console to provide a percent reactor power indication and bi-stable trip circuits. |
| NRAD | Neutron Radiography Reactor (NRAD) |
| OP | Operating Procedure |
| PDR | Preliminary Design Review |
| QAP | Quality Assurance Plan |
| SCR | Software Change Request |
| SCM | Software Configuration Management |
| SDD | Software Detailed Design |
| SDN | Software Discrepancy Notice |
| SDP | Software Development Plan |
| SOW | Statement Of Work |
| SQA | Software Quality Assurance |
| SRS | Software Requirements Specification |

| | |
|-------|---|
| SyRS | Systems Requirements Specification |
| SVG | Software Verification Group |
| SVVP | Software Verification and Validation Plan |
| TINA | TRIGA ??? test tool |
| TRIGA | Training, Research, Isotopes, General Atomics |
| TSR | Test Summary Report |
| V&V | Verification and Validation |
| VDD | Version Description Document |

4.0 REFERENCE DOCUMENTS

4.1 Industry Standards

- IEEE 1058-1998 IEEE Standard for Software Project Management Plans
- NQA-1-2000 American National Standards Institute/American Society of Mechanical Engineers "Quality Assurance Requirements for Nuclear Facility Applications"

4.2 GA Process and Operational Procedures And Project Documents

Only cognizant engineers will perform the software engineering activities/tasks and shall be familiar with the following operating procedures:

- OP-4.0-120 Design Documentation
- OP-4.0-130 Engineering Change Notice Rev Y
- OP-4.0-140 Design Control
- OP-4.0-150 Design Reviews
- OP-4.1-100 Software Development Plan Template Rev A
- OP-4.1-120 Software Development Process Rev B
- OP-4.1-130 Software Inspection & Review Process Rev A
- OP-6.2-140 RMS Software Development
- OP-6.2-190 Software Versioning Specification
- OP-6.2-210 Software Tool Validation Procedure Rev A
- OP-6.6-160 Software Change Control Board Procedure Rev C
- OP-6.2-200 Software Hazard/FMEA and Risk Management Procedure
- OP-6.6-210 Software Discrepancy Reporting
- T9S900D970-CMP TRIGA Software Configuration Plan Rev A
- T9S900D97003 TRIGA INL/NRAD Software Quality Assurance Plan Rev C

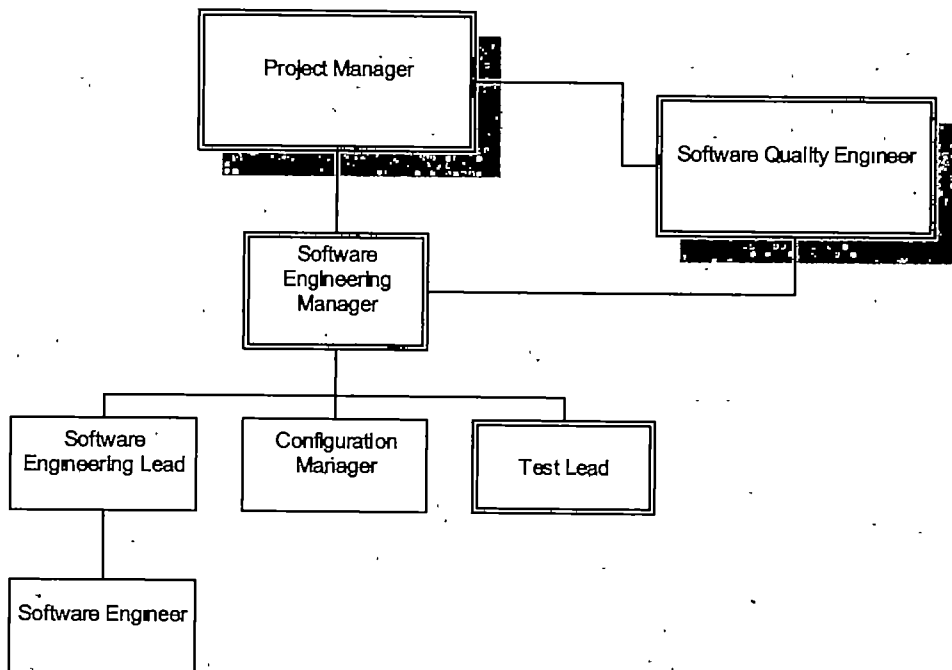
4.3 Customer Documents

- SOW-8330 Statement of Work *Replacement of the NRAD Instrumentation and Control Console*

5.0 PROJECT ORGANIZATION and RESPONSIBILITIES

This section describes the project organization, roles and responsibilities that will be used to execute the Project.

5.1 Organization



5.2 Roles and Responsibilities

| Role | Responsibility | Name | Location |
|---------------------------------|---|------|----------|
| Project Manager | Has responsibility for the overall project especially Budget, schedule, Customer interface. | | |
| Software Engineering Manager | Has responsibility for the overall software project especially in the areas of process compliance, staffing and ultimate software features and quality. | | |
| Software Engineering Lead(s) | Has overall technical responsibility for the software project and product. | | |
| Configuration Manager | Supports the integration of developer's software and maintains the developmental baselines for a specified product line. Oversees all SCM activities. | | |
| Software Quality Engineer | Responsible for ensuring adherence to all GA-ESI procedures concerning software development. | | |
| Test Manager | Perform software testing at ESI. | | |
| Requirements Document Developer | Responsible for creating SyRS and SRS. | | |
| Software Engineer | Responsible software developments. | | |

6.0 TRAINING

All software engineers that are working on this project will be trained on applicable company-wide Standard Operating Procedures and the following set of specific processes and/or guidelines.

7.0 PROJECT MANAGEMENT

7.1 Project Objectives

The primary objective of the software development effort is to deliver the new NMP-1000 and NLX-1000 channel detector module firmware to be used with the TRIGA INL replacement of the NRAD instrumentation and control console.

7.2 Assumptions, Dependencies and Constraints

Assumptions:

The NLX code will leverage a majority of the code/functionality from the NMP.

Dependencies:

Channel testing has a dependency on the completion of the CONSOLE hardware to complete system testing.

Constraints:

The project is already severely over budget and outside of the original schedule, leaving no room for modifications without incurring additional losses.

7.3 Risk Management

Listed below are the current known risks. All risk mitigation is the responsibility of the project manager.

- The software knowledge base consists of a single software engineer.
- Reviewing the code may take significantly longer since it was written using non-standard languages.
- Any hardware defects resulting in the need to create new PCBs could delay final testing.
- An error in estimated work could result in missing the ship date.
- The new digital design may be more susceptible to noise, resulting in unacceptable performance at INL.
- The customer may not accept the final product without modification.
- The new channel monitor design is slightly larger than the previous version and may not fit.

7.4 Project Control

Project progress will be measured by task completion. A Task is deemed to be complete when all associated product requirements have been implemented, be it requirement analysis, design, code implementation or testing.

Weekly meetings will be conducted to track task completion and address any issues that arise. Meeting minutes will be taken and stored in TRIGA INL folder in SharePoint.

Software quality will be provided as stated in the Software Quality Plan.

A Preliminary Design Review (PDR) and a Critical Design Review (CDR) will be held. The PDR will ensure that all requirements documents needed for design of the functional changes are completed. The CDR will ensure the completeness of the design practices, design correctness and all applicable documentation standards.

All artifacts that are not released to the Doc Center will be stored in SharePoint under the TRIGA INL project directory.

<http://teams.ga.com/esi/Projects/trigainl/SitePages/Home.aspx>

7.5 Hazard Management

A system Failure Modes and Effects Analysis (FMEA) will be performed and documented for the NMP-1000. Any hazard or failure modes requiring mitigation will be addressed within the document. Hazards or failure modes that impact requirements or design will be captured as issues in the Defect Tracking Database and tracked to resolution.

No FMEA is planned for the NLW-1000, NLI-1000 or NLS-1000, however since the hardware and code base are similar any hazard mitigation applied to the NMP-1000 will be likewise applied the other monitoring channels.

8.0 PROJECT SOFTWARE DEVELOPMENT MODEL

This upgrade of the NMP-1000 and NLX-1000 shall follow a Waterfall lifecycle model with a phased approach as reflected in the schedule. The project phases reviews shall assess that required artifacts have been completed during the appropriate phase. Each phase has a set of deliverable that should be produced in order to complete/pass the phase. Deliverables that are not complete may be deferred to the next phase by project level approvals (Project Management, Quality, etc.).

8.1 Development Management

The development model Phases begin with an assessment of needed artifacts to perform the work and cannot officially start such artifacts are complete and their quality satisfy the required standards. The Phase entry review serves as the artifact assessment. Completion of the phase will require that all phase deliverables are finished, and ready for check in. This level of completeness shall meet approval of SQA and Document Control Standards.

The Phases are:

- Planning
- Design and Implementation
- Test
- Production

9.0 TECHNICAL METHODS and TOOLS

9.1 Project Documentation

All software project documentation shall use the Microsoft SharePoint directory created for the TRIGA INL project.

All unreleased documents shall be stored in SharePoint and released to the Doc Center upon the release of the software to production.

9.2 Software Change Control

Software change control will be conducted as specified in the Software Configuration Management Plan.

9.3 Development Change Control

Per the Software Development process, Baselines to project deliverables shall be established and maintained. Changes to established baselines affecting software development such as changes to requirements and design input documentation shall be tracked, reviewed and dispositioned by the project cross functional team or Change Control Board (CCB). A project

shall be created and maintained in JIRA to record, and track all changes affecting project scope. The role of the CCB will be to evaluate, coordinate and schedule implementation of said changes. Established baselines reflect the milestones identified in the project schedule.

Scope changes shall be tracked as an entry in the Defect Database. The Originator shall fill out the "Defect Identifiers" section and the "Defect Behavior".

The CCB is responsible for evaluating, scheduling and assigning work to the appropriate engineer. The CCB will be responsible for the "CCB Review" section of the defect.

The engineer is responsible for evaluating and implementing the fix/update to the document or code. The engineer is responsible for filling out the "S/W Development" section of the defect.

Each defect shall be verified for its completion and marked as completed by the Software Verification Group (SVG) and checked by SQA. The SVG shall fill out the "Resolution Narrative" section.

9.4 Release Process

Software releases shall be released as specified in the Software Configuration Management Plan.

9.5 Tools And Development Aids

The essential development tools from vendors and the corresponding products are listed in the following table. The supporting tools such as document sharing, software configuration management and project tracking are also listed, but their functional equivalents are acceptable.

| Vendor | Product |
|--------|--|
| | Programmer for flashing the LCD display |
| | HTML Compiler for compiling code and flashing the LCD display |
| | SharePoint for document sharing and serve as an engineer folder. |
| | a versioning tool for source control. |
| | JIRA a project defect tracking tool |
| | Network development kit for compiling and loading code to the Ethernet Module |
| | Hercules SETUP Utility serial port terminal for communicating to the Ethernet Module |

10.0 PROJECT TASKS, SCHEDULE and ESTIMATES

The tasks and deadlines for the TRIGA INL monitoring channels are laid out in the project schedule. The schedule shall be maintained by the Project Manager and located on the X drive in the TRIGA INL Project folder.

10.1 Tasks

The project tasks are detailed in the schedule. The up-to-date schedule shall be available on the following network drive location:

[REDACTED]

10.2 Resource Requirements

The following resources will be required to complete the project.

| Resource Name | Type | Hours |
|---------------|------------------------|--------------|
| [REDACTED] | Software Configuration | See Schedule |
| [REDACTED] | SQA | See Schedule |
| [REDACTED] | Software Test | See Schedule |
| [REDACTED] | Software Engineer | See Schedule |
| [REDACTED] | Software Documents | See Schedule |
| [REDACTED] | Project Manager | See Schedule |

The CCB shall be established as per OP-6.6-160 and shall be composed of

| Resource Name | Type |
|---------------|--------------------|
| [REDACTED] | Program Management |
| [REDACTED] | Engineering |
| [REDACTED] | Product Assurance |
| [REDACTED] | Production Control |
| [REDACTED] | Purchasing |
| [REDACTED] | Customer Service |

10.3 Dependencies

See Assumptions, Dependencies and Constraints section 7.2 for dependencies.

11.0 PROJECT SOFTWARE DEVICE DESIGN CONTROL

| Phase | Required Deliverable | Yes/No/N A | Document Number, Responsible Person, Notes |
|-------------------------|--------------------------|---------------|--|
| Design Input | NLX-1000 SyRS | Yes | T9S900D950-SYR |
| | NLW-1000 SyRS | No | Will be incorporated in NLX-1000 SyRS |
| | NMP-1000 SyRS | Yes | T9S900D940-SYR |
| | NLX-1000 SRS | Yes | T9S900D951-SRS. SRS will be updated at a later date post release due to time constraints placed on the project. |
| | NLW-1000 SRS | No | Will be incorporated in NLX-1000 SRS |
| | NMP-1000 SRS | Yes | T9S900D941-SRS |
| | Use Case Scenarios | No | |
| | FMEA | Yes | T9S900D980-FME. This is done only for the NMP-1000 due to its safety related nature |
| Design and Dev Planning | Software Quality Plan | Yes | T9S900D97003 |
| | Software CM Plan | Yes | T9S900D970-CMP |
| | Unit Test Plan | Yes | |
| Design Output | NLX-1000 SDD | Yes | T9S900D952-SDD. SDD will be updated at a later date post release due to time constraints placed on the project. |
| | NLW-1000 SDD | No | Will be incorporated in NLX-1000 SDD |
| | NMP-1000 SDD | Yes | T9S900D942-SDD |
| | NLW-1000 Source Code | Yes | |
| | NMP-1000 Source Code | Yes | |
| | Software Hazard Analysis | No | Included as an appendix to the FMEA |

| | | | |
|-------------------------|-------------------------------------|-----|--|
| | NLW Trace Matrix | Yes | T3322000-RTM |
| | NMP Trace Matrix | Yes | T3401000-RTM |
| | Unit Test Protocols and Reports | No | |
| | Coding Standards | No | |
| | Design Reviews | Yes | |
| | Code Reviews | Yes | |
| | Software Project Management Reviews | Yes | |
| | Software Quality Plan | Yes | T9S900D97003 |
| | Software CM Plan | Yes | T9S900D970-CMP |
| | Unit Test Plan | Yes | |
| Testing | NMP System Test Plan (STP) | Yes | T9S900D991-PLN |
| | NLW System Test Plan | Yes | T9S900D981-PLN |
| Design and Dev Planning | Component Test Plan (CTP) | No | |
| | NMP Test Design Specification | No | T9S900D991-TDD |
| | NLW Test Design Specification | No | Letter to file for rationale will be created in place of missing test design specification |
| | NMP Test Case Specification | Yes | T9S900D991-SPC |
| | NLW Test Case Specification | No | This will be rolled into the NLW Test Procedure |
| | NMP Test Procedure Specification | Yes | T9S900D991-CSE |
| | NLW Test Procedure Specification | Yes | T9S900D982-CSE |
| | Test Item Transmittal Reports | Yes | |
| | Test Logs | Yes | |
| | Test Incident Reports (TIR) | Yes | |
| | Test Summary Reports (TSR) | Yes | |

12.0 REVIEWS

This section defines the types of management, technical, and peer reviews which will be conducted during this project.

12.1 Management Reviews

The following software work products will be reviewed and signed off by engineering management.

- NLX-1000 SyRS
- NMP-1000 SyRS
- FMEA
- SDP
- TSR

12.2 Technical Reviews

The following work products will be reviewed or inspected per the Software Inspection and Review Process (OP4.1-130).

- NLX-1000 SyRS
- NMP-1000 SyRS
- NLX-1000 SRS
- NMP-1000 SRS
- NLX-1000 SDD
- NMP-1000 SDD
- NLW-1000 Source Code
- NMP-1000 Source Code
- FMEA

12.3 Software Reviews and Inspections

The procedure for performing software reviews is the Software Inspection and Review Process (OP 4.1-130). The software review and inspection activity is a method that can be used to verify the output from a development activity that cannot be verified by means of an objective test. Records will be kept and stored in accordance with OP 4.1-130 from all software reviews or inspections.

12.4 Software Project Management Reviews

A Software Project Management Review will be held by Software development and supporting groups to determine the fitness of the software for release to formal verification. This review will be held after all code reviews and unit tests have taken place.

13.0 METRICS and MEASUREMENTS

The metrics to be collected provide indicators that track ongoing project progress, software products, and software development processes. This section describes the quality and process measurements that will be obtained for this project and specify the metric data that is to be collected in order to derive the measurement. These metrics are to be collected quarterly unless otherwise noted.

No metrics will be collected on this project to cut cost.

14.0 APPENDICES

None