



Creating an SQA Program at NREL

A DOE FFRDC Program based on the NDIA/DoD Sponsored CMMI



CMMI Conference 2011

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16 November 2011

The National Renewable Energy Laboratory (NREL) , located in Golden, Colorado is the only Department of Energy (DOE) laboratory in the United States that is “solely” focused on renewable energy with focus on such research areas as:

- Solar
- Wind
- Bio-Mass
- Hydrogen

Research Service Facility (RSF) buildings used for staffing are the most efficient in the world.

- Visitors from all over the world come to see and hear about how these energy efficient buildings were built and how they work
- Newest RSF building scheduled for occupancy starting in December will be zero-net energy.

The past 30 years has seen NREL evolve as a renewable energy facility, non-profit, government-funded entity

Today, after doubling in size in the past 3 years, NREL finds itself being required to be more strictly focused on business with the ability to prove it is focused on continuous process improvement to satisfy both the DOE and its industry and academic partners

In addition, the importance of Software, together with Systems Engineering has risen to a visibility far beyond that of its past 30 years

- Along with that visibility goes software quality and the processes that product it

Software Quality Assurance versus Process Improvement

In the CMMI-based process improvement world, Process Improvement might be considered the overarching umbrella with Quality Assurance operating beneath it.

In the NREL-DOE world Quality Assurance / Software Quality Assurance serves as the overarching umbrella with process improvement operating beneath it.

SQA Program Approach

CMMI Continuous Representation

Incremental process improvement

Problem Solving Approach

- Integrated Models/Standards
- Lack of emphasis on the specific models, standards or techniques such as CMMI, Lean, Six Sigma, ITIL, PMI, Agile, etc.

“Slices of Process Areas for Improvement”

Just in Time Training

Hand-Holding Coaching

Progress Checks

Basic Measurement

SQA Program Approach - 2

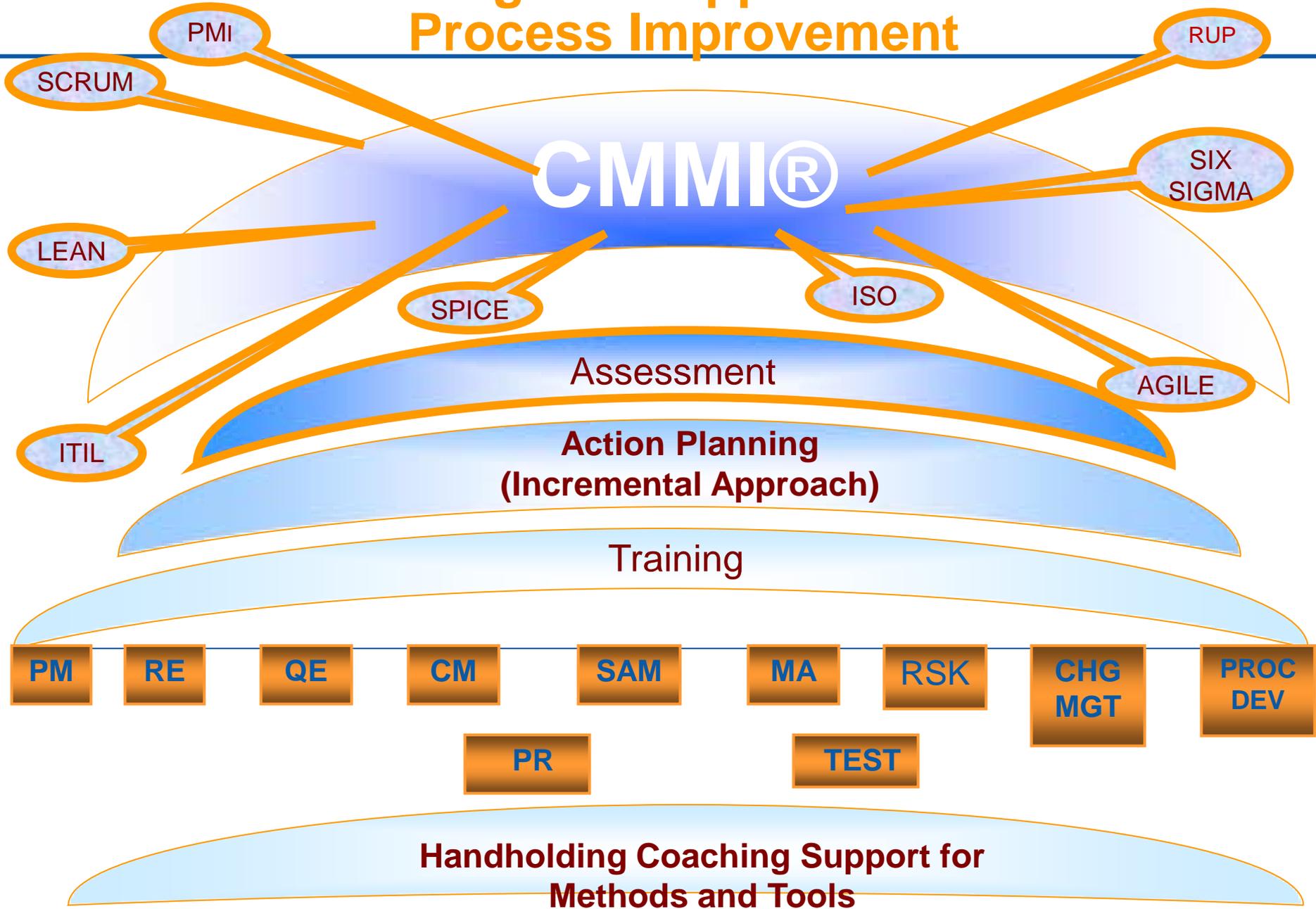
Identifying business objectives for projects, programs and departments

Providing definitions, descriptions, papers, references

Using Peter Block's Consulting Modes (Expert, Collaborative and Observer)

Borrowing Peer Review concept of "Kin Documents"

Integrated Approach to Process Improvement



Software Quality Management

Quality Control and Quality Assurance

Quality Control evaluates the products

- Checks the quality of the product(s)
 - Is the product within tolerance?
 - Is the product (or life-cycle work product) of an acceptable quality?
- Tools and Techniques
 - Reviews
 - Tests
 - Inspections
 - Simulations
 - Observations
 - Demonstrations

Quality Assurance evaluates the process

- Checks that the process is working
 - Is the process being followed?
 - Are the QC checks being applied?
 - Are the QC checks efficient?
 - Is the process causing quality problems?
 - Is the process working for the organization?
- Tools and Techniques
 - Audits / Objective Evaluations
 - Assessments / Appraisals / GAP Analysis

Software Quality Management Functions

Software Quality Management Functions include:

- Setting **Quality Goals** that support business objectives
- Establishing and enforcing a **Quality Policy**
- **Planning** for Quality (Organizational and Project level)
- Developing **Processes** (Organizational and Project level)
- Establishing the use of **Standards and Procedures**
- Performing multiple levels of **Testing**
- Conducting **Peer Reviews** throughout the product lifecycle
- Designing in **Quality Factors** (i.e., safety, security, maintainability, reliability)
- Conducting Quality Audits with respect to **product** quality
- Conducting Quality Audits with respect to **process** quality
- Providing visibility into the process and product quality for management through **Quality Reporting**
- Getting **non-compliance** issues resolved before the product is delivered to the customer (looking for trends)

Software Quality Management Functions - 2

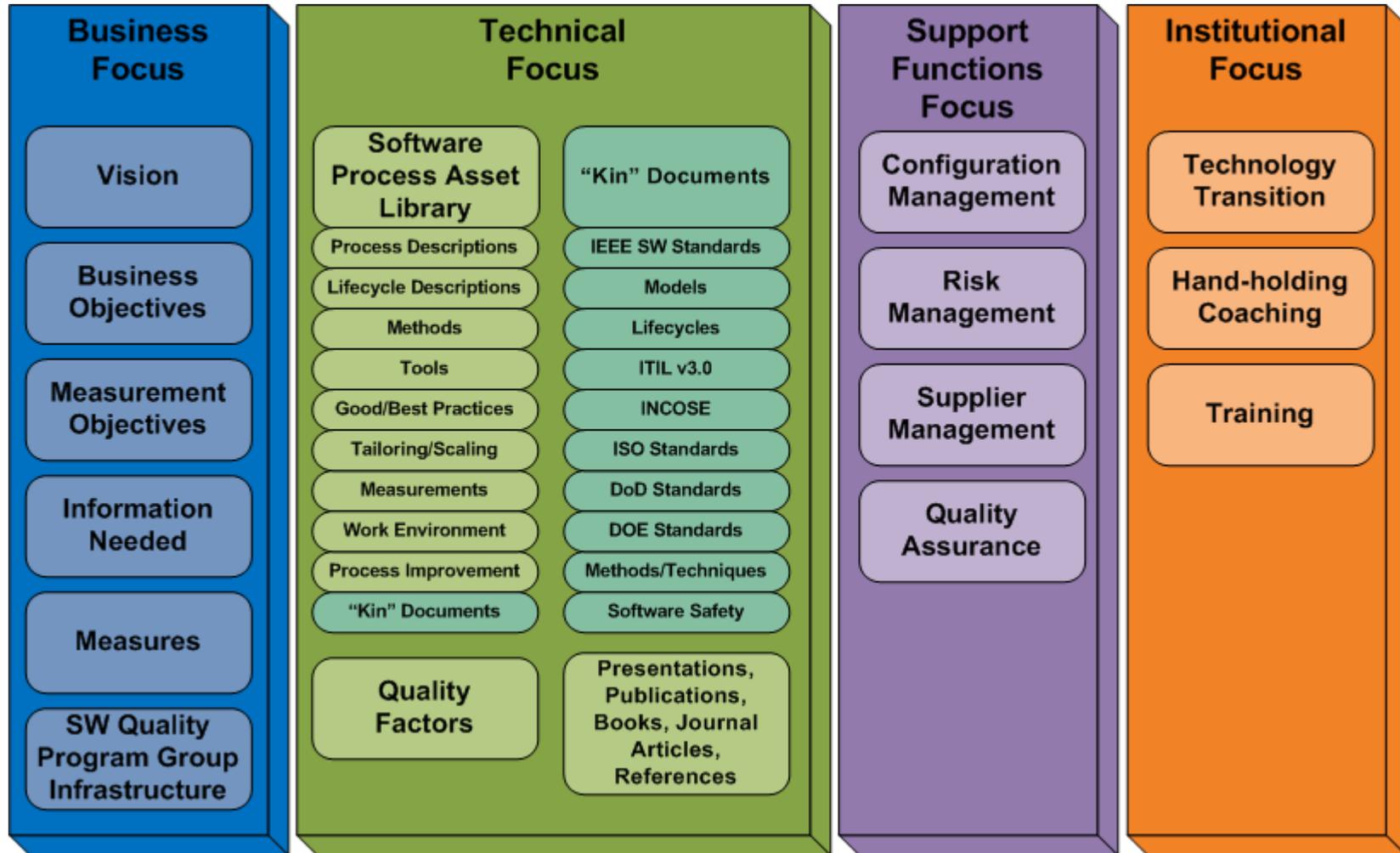
Software Quality Management Functions also include:

- Implementing complementary **Configuration Management** functions
- Identifying **Measurements** that support the information needs of the project and organization
- Conducting **Performance Evaluations** to ensure the system converges to established performance constraints
- Conducting appropriate **Verification** functions
- Conducting appropriate **Validation** functions

Developed the Software Quality Assurance Program based on and linked to the existing Quality Assurance Program.

- Software Quality Assurance Program Architecture developed and placed on Share Point

Software Quality Program Architecture



Software Quality Assurance Program - 2

Emphasis of the SQA Program Architecture is broken into four major areas:

- **Business Focus** – (completely populated)
- **Technical Focus**
 - Software Process Asset Library defined to more detailed levels
 - Software Lifecycle Descriptions defined (Waterfall, V-Model, Waterfall)
 - Software Design Methods defined
 - Process Descriptions started and available for Requirements, Inspections and Risk Management
- **Support Functions Focus** – Executive Overview for Configuration Management, Risk Management, Supplier Management, and Quality Assurance
- **Institutional Focus** – Topics describe the QMS&A approach for technology transition of knowledge to Projects, software systems training that is available to support projects and Hand-holding coaching QMS&A is starting to provide

SW Process Asset Library

Process Descriptions

- Process Architecture
- Sets of Standard Processes
- Policies
- Procedures
- Standards
- Guidelines
- Templates
- Checklists
- Starter Kits

Lifecycle Descriptions

(With Examples)

- Waterfall
- Overlapping Waterfall
- V-Model
- Spiral
- Incremental
- Evolutionary
- Acquisition
- Agile

Methods

- Object Oriented
- Agile
- SCRUM
- SASD
- Top-Down
- Bottom-Up

Tools

- Project Mgmt
- CM
- QA
- Risk Mgmt
- Mind Maps
- Testing

Good & Best Practices

- Lessons Learned
- Good Examples

Tailoring Guidelines / Graded Approach / Scaling

- External and Internal to the Process Descriptions

Measurement Repository

- Actual Project Data
- Measurement Examples
- Guidance for Measures

“Kin” Documents

- IEEE Standards
- CMMI
- EIA-632
- ITIL
- ISO Standards

Work Environment Standards

- Development Environments
- Testing Environments
- Production Environments
- Web Applications

Process Improvement Approaches

- Big Bang
- Incremental based on Project Need
- Incremental based on Business Objectives
- “Constagedeous”

"Kin" Documents

IEEE Software Standards

- 730 – Std for SQA Plans
- 730.1 – Guide for SQA Planning
- 828 – Std for SW Configuration Management (SCM) Plans
- 1008 – Std for Unit Testing
- 1012 – Std for SW VER and VAL
- 1028 – Std for Software Reviews
- 1042 – Guide to SCM
- 1058 – Std for SW Proj Mgmt Plans
- 1059 – Guide for SW VER & VAL Plans
- 1219 – Std for SW Maintenance
- 1540 – SW Lifecycle Processes – Risk Management

INCOSE

- EIA – 731 SE CMM
- EIA – 632 Processes for Engineering a System

DoD Standards

- DoD-Std-2167a
- DoD-Std-2168b

Models

- CMMI-DEV v1.3
- CMMI-SVC v1.3
- CMMI-ACQ v1.3
- ISO 15504 (SPICE)

ITIL v3.0

- Executive Overview
- Service Strategy
- Service Design
- Service Transition
- Service Operation

Lifecycles

- ISO/EIA 12207 SW Lifecycle Processes
- ISO/EIA 15288 SE Lifecycle Processes

Quality

- ISO 9001:2008 – Quality Management Systems - Requirements
- ISO 9004:2009 – Managing for the Sustained Success of an Organization - A Quality Management Approach
- ISO/IEC – 9126 – Software Engineering – Product Quality
 - Quality Model
 - External Metrics
 - Internal Metrics
 - Quality in Use Metrics

“Kin” Documents - 2

ISO Standards

- AS 9100 – ISO 9000 for Aerospace
- TL 9000 – Telecommunications
- ISO 16949 – Automotive Engineering

Methods and Techniques

- Six Sigma
- PMI PMBOKv3
- OPM 3 – Proj Mgmt for the Organization
- Lean

Classes / Workshops/ Tutorials / Presentations

•EXAMPLES:

- Software Quality Engineering
- Software Configuration Management
- Requirements Engineering
- Peer Reviews (Inspections)
- CMMI-DEV v1.3 – SEI Introduction to CMMI-DEV v1.3 with KI Additional Value
- CMMI-ACQ v1.3 – Kasse Initiatives
- CMMI-SVC v1.3 – Kasse Initiatives
- CMMI-based Assessments (SCAMPI)

Incremental Approach

QMS&A guides its NREL customers in developing an **incremental approach to the process improvement needs it has identified** and prioritized, being ever mindful of satisfying the business objectives as well as guidance provided by the CMMI and other standards and models

Increments of approximately 3 months in duration are designed based on the organization's business objectives.

- These increments are populated with improvement tasks that represent achievement of some aspect of planning, developing, testing, controlling, and managing software development

Hand-Holding Coaching

“Hand-holding” support is “roll-up-your-sleeves” support provided to help implement critical processes or “slices” of processes on projects. Projects can expect:

- Knowledge about the software process
- Assistance in developing process descriptions
- Assistance in creating a Project Quality Plan
- Assistance in choosing the right standards for the project’s needs
- Assistance in applying the tailoring guidelines to the organization’s process descriptions for practical use by the projects
- Performing quality and configuration audits
- Assistance in setting up Peer Reviews

Hand-Holding Coaching - 2

Currently being focused on:

- Requirements Development and Requirements Management
- Risk Management
- Software Inspections
- Software Safety
- Web Applications Development
- Change Control Boards

Current Focus Areas

Configuration Management (Serving Project Management and Quality)

Identification

Baselining

Change Control

- Change Advisory Boards

Status Accounting

Configuration Auditing

- Functional Configuration Audits
- Physical Configuration Audits

Hierarchies of CABs



Web Applications Development Process

The Web Applications Development Process is serving as the platform for improvement of the software applications development processes

- These improvements will assist the development of many classes of software and are some of the first steps in the development of the overall Software Quality Assurance (SQA) program

Draft Policy for the Web Applications Development Process has been developed

Web Applications Development Process has been drafted and reviewed by the Task Force

- Has been submitted to the NREL review process to be placed into the NREL Standard Policies and Procedures

CMMI Overview

Level	Process Characteristics	Process Areas
5 Optimizing	Focus is on quantitative continuous process improvement	Causal Analysis and Resolution Organizational Performance Management
4 Quantitatively Managed	Process is measured and controlled	Quantitative Project Management Organizational Process Performance
3 Defined	Process is characterized for the organization and is proactive	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organization Process Definition Organizational Training
2 Managed	Process is characterized for projects and is often reactive	Integrated Project Management Risk Management Decision Analysis & Resolution
1 Initial	Process is unpredictable, poorly controlled, and reactive	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Product and Process Quality Assurance

CMMI-DEV v1.3 Training

Completed CMMI-DEV v1.3 4-Day Training Class for Enterprise Solutions and other specialists such as Internal Audit.

- The Capability Maturity Model Integration (CMMI) was developed by the Software Engineering Institute (an FFRDC) to focus on the Project Lifecycle from requirements elicitation to transfer to the Customers / End Users operational environment.
- The CMMI model is referenced in DOE O 414.1D as one of the international consensus models that may be used to enforce 414.1D requirements.
- The CMMI describes requirements for development activities that not only support the development lifecycle but dovetails into the Service Management activities described by the IT Infrastructure Library (ITIL v3) currently being taught and implemented in ISO.
- Other classes are being scheduled for 1st quarter of FY12 and beyond.

Requirements Engineering Training

Conducted two (2) Requirements Engineering Workshop for Enterprise Solutions with HR, and Business Systems Governance representation.

- The course was well received with one person stating that it was the best course she had received in 20 years on the topic
- Templates for developing Software Requirements Specification and Interface Requirements Specification have been developed and are being used
- Checklists supporting the SRS has been built and put in use
- One more RE Workshops is scheduled at the end of 1st Q FY12.

SQA Program Coaching

SQA Program coaching is starting to take place to support the institutionalization of the concepts being offered in the software quality training classes

- Requirements Engineering coaching for Enterprise Solutions
- Risk Management Coaching
- Software Safety Coaching

Software Safety

Developed Software Quality Assurance (QA) requirements specific to the development of safety-related software

Collected Software Safety research material from the Internet, the Software Engineering Institute, selected government standards on Software Safety and manuscripts written by Dr. Nancy Levinson of MIT.

Started the development of a Software Safety Guidebook based on research material and NREL software safety needs.

Developed a Software Safety Presentation based on the current state of the Software Safety Guidebook, software safety research material, CMMI, and the SQA program that satisfied a DOE compliance action item.

Software Safety - 2

Applied Software Safety concepts by working with the Process Automation software vendor developing the software for the SCADA system, part of Energy Systems Integrated Facility to ensure their software safety activities match the needs of any software safety critical components.

FY12 will see the evolution of the Software Safety Guidebook into a fully developed guide for all of NREL projects that involve safety and particularly software safety.

All Software Safety materials are available from the SQA Program Share Point site!

Summary

The Software Quality Assurance Program's foundation has been established, based on the concepts of the CMMI and its implementation along with continuous improvement is underway

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