



QUALITY ASSURANCE AND QUALITY CONTROL PLAN

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Table of Contents:

1	Introduction	1
1.1	Ocean Observatories Initiative (OOI) System of Systems Overview	1
1.2	Document Scope and Organization	1
1.2.1	Acronyms Terms and Abbreviations	1
1.3	Change Control	1
1.4	Parent Documents	2
1.5	Reference Documents	2
2	Quality Management Group	2
2.1	Overview	2
2.2	Goals and Objectives	2
2.3	Independent Reporting	3
2.4	Roles and Responsibilities	4
2.5	Quality Facilities and Tools	4
2.6	Quality Management Training	4
2.7	Customer Communication	4
2.8	OOI Internal/External Audits	5
3	Quality Assurance Activities	5
3.1	Overview	5
3.1.1	Quality Assurance Planning	5
3.1.2	Quality Assurance Evaluations	5
3.2	Quality Assurance Participation	6
3.2.1	Technical Reviews	6
3.2.2	Physical Configuration Audits	6
3.2.3	Functional Configuration Audits	6
3.2.4	Control Board Membership	7
3.2.5	Quality Assurance Work Product Evaluations	7
3.2.6	Other PMO Quality Program Activities	8
3.3	Quality Assurance Evaluation Criteria	8
3.4	Quality Assurance Deficiency Reporting	8
3.5	Quality Assurance Records	8
3.6	Quality Assurance Schedule	8
3.7	Quality Assurance Status and Metrics Reporting	8
3.8	Acceptance	9
3.9	Quality Awareness Training	9
4	IO Quality Plans	9
4.1	Overview	9
4.2	Internal IO Audits	9
4.3	Corrective and Preventive Action	10
4.4	Software Quality Assurance	10
4.5	Other Areas	10
4.6	Control of Procurement/Sub-Contractor Management	11

1 Introduction

This document describes the quality assurance and quality control system that will be employed through the design, development, deployment, operations and maintenance phases of the Ocean Observatories Initiative (OOI) program. This plan will be made available to all Implementing Organization (IO) personnel to form an understanding of the Consortium for Ocean Leadership's (OL) integrated quality management system. All personnel will use this plan as a reference for the IO Quality Plans and as OOI guidance for strategic, enterprise-level quality management and governance. OL fulfills the role of the OOI Program Management Office (PMO).

1.1 Ocean Observatories Initiative (OOI) System of Systems Overview

The OOI comprises four interconnected systems spanning global, regional and coastal marine observatories and the integrating cyber infrastructure and education and public engagement software infrastructure.

- *CyberInfrastructure (CI)* - The CI constitutes the integrating system that links and binds the three types of marine observatories and associated sensors into a coherent system-of-systems. The CI is not an overlay, but integrated functionality imbedded deep into the design of each scale of the observatories.
- *Coastal-Global Scale Nodes (CGSN)* - The global nodes address planetary-scale problems via a network of moored buoys linked to shore via satellite for command and control plus limited near-real time data access. The coastal nodes of the OOI will expand existing coastal observing assets, providing extended opportunities to characterize the effects of high frequency forcing on the coastal environments.
- *Regional Scale Nodes (RSN)* - A regional cabled observatory will 'wire' a single region in the Northeast Pacific Ocean with a high-speed optical and power grid.
- *Education and Public Engagement (EPE)* - *Rutgers, The State University of New Jersey, with its partners University of Maine and Raytheon Mission Operations and Services, is responsible for the education and public engagement software infrastructure of the OOI program. EPE will build the software interfaces and web-based tools that ultimately will allow educators to bring the ocean into their learning environments in real time.*

1.2 Document Scope and Organization

Quality Assurance, Control and Management activities are directed by PMO policies and procedures and the individual IO Quality Program Plans. This umbrella of best practices provides consistent and objective Quality Assurance actions. OOI Quality policies and procedures are maintained by the OOI Quality Manager. PMO project work instructions are maintained by program personnel.

1.2.1 Acronyms Terms and Abbreviations

Please refer to the OOI project glossary (the L2 Reference Module) for acronyms, term and abbreviations that are not defined in this document.

1.3 Change Control

This document is one of the OOI governing documents and is, therefore, an OOI Controlled Document. As such, it is subject to the policies and procedures called out in the OOI Configuration Management Plan, Section 3. Changes to this document may only be made via an Engineering Change Request (ECR) that has been approved by the OOI Change Control Board (CCB).

The most recent document revision maintained in the OOI Document Management System (DMS) is the authoritative version, as printed hard copies are not controlled. Prior revisions of this document may be maintained in the OOI DMS for reference reasons, but are not authoritative.

1.4 Parent Documents

The following documents are the parents from which this document's scope and content derive:

- OOI Program Execution Plan (Document No. 1001-00000)
- IO Subawards

1.5 Reference Documents

- 1000-00000 Configuration Management Plan (CMP)
- 1002-00000 Cost Estimating Plan
- 1004-00000 Commissioning Plan
- 1005-00000 Earned Value Management Plan
- 1007-00000 Risk and Opportunities Management Plan
- 1011-00000 Property Management Plan
- 1012-00000 Cybersecurity Plan
- 1020-00000 Schedule Management Plan
- 1100-00000 Systems Engineering Management Plan (SEMP)
- 1101-00000 Final Network Design
- 1150-00000 OOI Test and Evaluation Strategy
- 3101-00008 CGSN Quality Assurance and Quality Control Plan
- 2010-00002 CI Quality Assurance/Quality Control Plan
- 4010-00001 RSN Quality Assurance and Quality Control Plan

2 Quality Management Group

2.1 Overview

This section describes the Quality Management Group and its relationship to the overall OOI management organization, the OL management organization and IOs, their contractors, and their subcontractors that will perform work on the OOI project. The section includes the goals, objectives, and independent reporting structure, as well as the roles and responsibilities to accomplish quality assurance tasks, within the OOI. Additionally, the section describes the tools and resources required by the Quality Management Group staff members assigned to the program.

2.2 Goals and Objectives

The main goal of the Quality Management Group is to ensure that OOI provides the oceanographic community with research quality data over the lifetime of the project. In order to accomplish this, the PMO must ensure sufficient quality of hardware, instruments, sensors, software, software systems, telecommunication systems and services are provided to the OOI. The Quality of the components for the OOI system-of-systems will be measured at the program level by implementation of a Quality Control system as described in this document. Quality measurements and metrics will be collected by the PMO Project Team, each IO Project Team, and the Quality Management Group in order to make effective decisions to meet the goals of the PMO organization.

An over-arching goal of the Quality Management Group is to ensure that the OOI program is successful, that all required OOI policies and procedures are followed, to help ensure that the data, products, and services provided by the IOs meet or exceed their requirements, and that the stakeholders remain satisfied throughout the duration of the OOI system's useful life.

Quality Assurance and Quality Control Plan

Quality functions are integrated into the entire PMO and OOI team, allowing for a seamless approach and the institutionalization of Quality into the program. The responsibility for quality lies with every individual involved at the PMO and in the OOI. Quality Management personnel are expected to maintain a high-level of professionalism and an example of ethics, objectivity, and Quality workmanship for the rest of the OOI program staff.

The integrated approach to Quality on the PMO and OOI Quality Program consists of two principle elements:

- Quality Assurance (systematic approach to quality and error prevention)
- Quality Control (the product testing and assessment system)

Quality Assurance is a systematic approach to the prevention of errors. The discovery and prevention of defects early in the development lifecycle offers the OOI program a significant return on investment. Quality Assurance focuses on the preventive mission with auditing and other Quality Management reporting functions. The goal of Quality Assurance is to provide management with the data necessary to be informed about product Quality and program status from the customer's viewpoint. It is the Quality Management Group's responsibility to ensure that any issues that arise during the course of the project are addressed. Tasks within quality assurance include: the generation of quality- and compliance-related documentation, review of all OOI Quality plans, hardware and software quality requirements, specifications and records, audit of process, procedures, security mechanisms and developers; monitoring of implementation and required corrective actions, facilitation and reporting for program control gates, design reviews and code inspections, and serving as liaison to each IO, their sub awardees and supplier contractors for issues related to Quality. As the customer advocate, Quality Assurance will be a permanent participant and supporter of the OOI Risk and Opportunities Management Plan (ROMP), partnering with the OOI/OL Program Director, Project Manager, and Deputy Project Manager/Risk Manager to identify risks, to document them, and to assist with the development and implementation of viable risk handling plans.

Quality Control is the product testing and assessment system. Quality Control provides project management with a realistic, fact-based assessment of OOI hardware, software and telecommunication systems during all phases of the project life cycle. From the design/development phase through the implementation/deployment phase and during the Operations and Maintenance phase, Quality Control verifies, validates and documents the Quality of the OOI systems and their requirements. Quality Control includes security testing when required. The QC function will liaise with the IT function in the verification of the basic cyber infrastructure security measures incorporated into the various releases as per the software/firmware design requirements.

2.3 Independent Reporting

The OOI Quality Management Group consists of the OOI Quality Manager (QM), the Associate Project Managers, also known as the Contracting Officer Technical Representatives (COTR), assigned to each IO, the Lead Systems Engineer, the Program Director, and the Senior Project Manager. The IO Quality Representatives, along with the IO Project Managers will also be a part of the Quality Management Group. The Quality Management Group will have the responsibility for directing the OOI Quality Assurance Program. They will serve the Ocean Leadership President by providing independent and objective evaluation of IO process performance and work product quality. The OOI Quality Manager will be the focal point for system Quality coordination with each of the IOs.

The OOI Quality Manager (QM) will report directly to the OL President, but has dotted-line Quality authority over all OOI Quality functions throughout the organization. Within this structure, the OOI Quality Manager (QM) will interact with the OOI Program Director, Associate Director, Project Manager, Deputy Project Manager/Risk Manager, the Lead Systems Engineer and Associate PMs/COTRs, as well as all of the individual IO Quality Assurance groups. This role assures independence and authority through appropriate levels within the PMO and each IO.

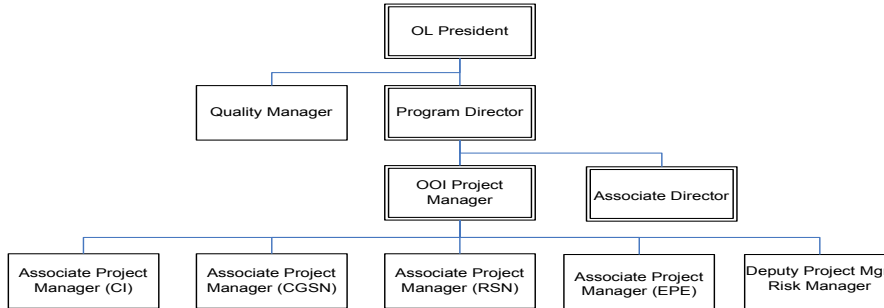


Figure 1, PMO Organization as it applies to OOI Quality Management

2.4 Roles and Responsibilities

The OOI Project Manager (PM) has overall responsibility for controlling the Quality of OOI products and services. The various managers within the OOI team have direct responsibility for controlling the Quality of OOI products and services within their task areas. The OOI Quality Manager develops and implements a Quality Assurance program for OOI to provide the OOI PM with independent and objective evaluation of process performance and work product quality. In addition, the OOI Quality Manager is the focal point for coordination for internal and external quality auditors.

The OOI Quality Manager reports directly to the OL President, is managed by the PM and Program Director (PD), and has dotted-line authority over the QA Reps at each IO. Although the OOI Quality Manager is tightly integrated into the team, the position maintains an independent reporting relationship that promotes objectivity.

Each of the IOs will develop and adhere to their own QA/QC plan which supports the OOI QA/QC Plan. The IOs QA/QC plan will not be in effect until the plan is reviewed and approved by the Quality Management Group. The OOI Quality Manager (QM) and the COTRs who assist the QM are responsible for all activities associated with Quality. The OOI Quality Manager (QM) is also responsible to ensure program performance is consistent with the overall OOI Quality Assurance/Quality Control Plan.

2.5 Quality Facilities and Tools

The OOI Quality Manager is to be provided office space and equipment to support activities at the IOs facilities. Quality reviews and audits of subcontractor plants and facilities will be required. It is the responsibility of the IOs to support these reviews and audits.

2.6 Quality Management Training

Each Quality Management Group staff member will receive training in the fundamental knowledge of QA/QC systems and will be trained in conducting quality audits. Further, the Quality Manager should have experience as a lead auditor and be very familiar with commercial best auditing practices and widely-used quality frameworks.

The Quality Management Group staff will comply with OOI training processes.

2.7 Customer Communication

The OOI Quality Manager will maintain open communications and a close working relationship with National Science Foundation staff, with PMO staff and with staff at each of the IOs. This relationship will allow coordination of work activity and schedule to maximize the value of Quality Assurance with the OOI Project. This is facilitated by frequent working level interactions with customers at the IOs and in the PMO to include periodic status and coordination meetings to review progress to plans, issues and successes.

2.8 OOI Internal/External Audits

Independent evaluations (audits) of each of the IOs, contractors, and sub-contractors will be performed in accordance with a published audit schedule using auditors from within the OL and OOI reporting chain. The audit schedule will define the scope and frequency for each assessment. Each key element of the auditee's Quality System will be assessed at a minimum of annually. However, problematic areas or critical areas may be audited more frequently. Areas of noncompliance will be documented in deficiency reports requiring the individual auditees to resolve all areas of noncompliance. To ensure accountability for the results, audit reports will be distributed to the Ocean Leadership President, the OOI Program Director, and the OOI Quality Manager for review and assessment.

The OOI Quality Manager has the responsibility for determining qualifications and assigning Quality Management Group staff to conduct audits. Auditors will be trained to meet the requirement for conducting internal quality system audits in accordance with Quality Management/System review procedures. Specific qualifications include:

- Knowledge of the quality audit process
- Technical knowledge of the processes to be audited, and the
- Ability to communicate effectively

In addition to the internal IO evaluations, there may be additional audits conducted throughout the year that support independent evaluations. The following audits are likely as per contractual agreement:

- PMO audits of the IOs select suppliers.
- PMO audits of major subcontractors to the IOs, e.g., Scripps Institution of Oceanography, Oregon State University, and a selected group of their suppliers.

3 Quality Assurance Activities

3.1 Overview

This section addresses the activities that are performed by the OOI Quality Management Group. The OOI Quality Manager performs the following activities in accordance with documented procedures for:

- Quality Assurance planning
- Quality Assurance evaluations
- Quality Assurance audits

3.1.1 Quality Assurance Planning

Quality Assurance planning activities are performed in accordance with the IO contracts and with PMO and OOI procedures. The objective of the planning effort is to identify the resources, activities and schedule for the implementation of these Quality activities throughout the OOI Project.

3.1.2 Quality Assurance Evaluations

The OOI Quality Manager will perform Quality Assurance evaluations to provide OOI Project Management insight into the use of and adherence to the standards, processes, and project instructions required for use on the program. There are typically two types of evaluations performed: audits and product evaluations. An audit is an objective examination of documented processes to verify that contractual and supplier Quality requirements are being met. A product evaluation is an objective examination of the work product to verify it is in agreement with OOI Project requirements and contractual specifications.

3.1.2.1 Quality Assurance Audits

OOI audits are conducted according to an audit plan and schedule reviewed in advance with OL Leadership. Auditing will be focused on key processes and scheduled appropriately to coincide with project development and test activities.

The OOI Quality Management Group auditors will follow a separate documented procedure to conduct consistent and objective Quality Assurance process audits. The procedures direct the OOI Quality Management Group staff to prepare and deliver the audit package, conduct the audit, and document the results of the audit. Audit results are documented in audit reports and reviewed with the individuals who participated in the audit, the process owners, and the OOI PM. Findings requiring corrective and/or preventative action are attached to the audit reports and are entered in the JIRA-based OOI Issues Tracking and Management System, where they are tracked through resolution.

When a new PMO or OOI process is published, the OOI Quality Manager will evaluate the procedure and develop an audit strategy. The start-end, frequency, duration, and audit criteria will be determined to demonstrate an acceptable level of quality for the process. A new process should be operational long enough to have an established baseline of performance before it is subject to a quality audit.

At a minimum, the following audits will be conducted per a pre-determined audit schedule:

- Requirements Management
- Configuration Management
- Schedule Management
- System Verification
- Operations and Maintenance Management
- Corrective and Preventive Action
- Training
- Non-Conforming Material

3.1.2.2 Product Evaluations

Product evaluations are basically inspections, verifying product Quality at specified points throughout the assembly and testing processes.

3.2 Quality Assurance Participation

This subsection describes the planned participation of QA personnel in project reviews, audits, and control boards.

3.2.1 Technical Reviews

Quality Assurance monitors the preparation and conduct of internal technical reviews and project milestone reviews to ensure that project quality and technical requirements are adequately addressed.

3.2.2 Physical Configuration Audits

The OOI Quality Management Group provides support to Systems Engineering in the area of Configuration Management (CM) in planning for and participating in the physical configuration audit. The OOI Quality Management group will help conduct the audit, assist in accumulation of data and participate in verification activities. The OOI Quality Management Group will also assist the Systems Engineers in planning audits with a focus on systems Quality, lead the Quality aspects of audits, assign discrepancies, coordinate closure of issues and discrepancies, generate reports and present the audit statistics at program reviews.

3.2.3 Functional Configuration Audits

The objective of the functional configuration audit is to verify that the deliverable's actual performance complies with its requirements and interface specifications. Functional Configuration Audits for the OOI are satisfied by an inspection of the acceptance test results. This inspection confirms the acceptance test results have been properly mapped to requirements, that all results are reported, and that deficiency reports are properly tracked.

3.2.4 Control Board Membership

The OOI Quality Manager is an active participant in the System Level Change Control Board (CCB) and OOI Risk and Opportunity Management Board (ROMB). OOI Quality Manager participation ensures that the documented processes are being followed. The participation also provides a communication path for change requests and risks that are associated to Quality deficiencies or Quality Improvement programs. The participating OOI Quality Management staff member will bring these items to the attention of the control board members. The OOI Quality Manager also participates in the PMO-level boards.

3.2.5 Quality Assurance Work Product Evaluations

The OOI Quality Manager will follow documented procedures to conduct consistent and objective Quality work product evaluations at all OOI and Supplier sites, as necessary. The procedures direct the OOI Quality Management Group to conduct the product evaluation, document the results of the work product evaluation in the ITM, and report the results of the audit to the appropriate point of contact in the functional area.

The following sections provide examples of the IO work products and processes that will be evaluated:

3.2.5.1 Program Management

- Program Planning
- Program Monitoring and Control
- Risk Management Process
- Subcontractor Control
- Corrective Action

3.2.5.2 Systems Engineering

- Configuration Management Processes (Hardware and Software)
- Change Control Board Processes
- Functional Configuration Audits
- Physical Configuration Audits
- Test Plans, Procedures, and Reports
- Decision Analysis and Resolution Process
- Requirements Management Process
- Data Management Process

3.2.5.3 Hardware Design, Development, Test and Maintenance

- Software Inspection Process
- Build requirements planning
- Software Integration and Test Plans
- Integration Testing
- Correction of Software Discrepancies

3.2.5.4 Software Design, Development, Test and Maintenance

- Software Inspection Process
- Build requirements planning
- Software Integration and Test Plans
- Integration Testing
- Correction of Software Discrepancies

3.2.5.5 Operations and Maintenance

- Security Audits
- Establish controls in the Maintenance Phase of the lifecycle.
- Maintenance Schedules

- Establishment of Service Level Agreements to maintain levels of quality during O&M.

3.2.6 Other PMO Quality Program Activities

In addition to the quality assurance activities identified here, the OOI Quality Management Group staff will support the following OOI activities, as required:

- Risk Management Reviews
- Configuration Management
- Test Oversight
- Operations and Maintenance Oversight Activities
- Commissioning of Systems
- Determination of Operational Readiness (DOR)

3.3 Quality Assurance Evaluation Criteria

Quality Management staff will follow documented procedures to develop consistent and objective criteria for Quality evaluations and audits to maintain acceptable levels of Quality. The OOI Quality Manager will audit Quality criteria as applicable.

3.4 Quality Assurance Deficiency Reporting

The OOI Quality Manager will prepare and maintain the results of audits, work product evaluations, and cited deficiencies in the OOI program library, specifically the JIRA-based OOI Corrective Action Issues Tracking and Management system (ITM). OOI Quality Management Group will also be responsible for filing a hard copy of the evaluation and corresponding discrepancy report to the affected and interested parties. OL and OOI Quality Assurance procedures will define the steps taken in reporting deficiencies to increasingly higher levels of management, including the OOI Quality Management Group itself, until resolution is achieved.

OOI Quality Management Group monitors the defect resolutions to ensure that, if the fix implementations represent a change to requirements or baseline documents, that the proposed implementation is referred to the Change Control Board (CCB) as an Engineering Change Request (ECR).

3.5 Quality Assurance Records

All quality assurance records such as audit and product evaluation reports are maintained in the OOI project/document library, specifically the OOI DMS. Additionally, copies of the QA status reports, audit and work product evaluation reports, discrepancy reports, and supporting data are located in the OOI DMS. Quality records will be maintained for the life of the OOI Project. Each OOI site will develop their own record system in order to maintain this requirement.

3.6 Quality Assurance Schedule

The OOI Quality Manager will develop comprehensive quality assurance (QA) schedules in conjunction with the project schedules. QA milestones will be added to the IMS as applicable. Updates are made as required by events. The schedule will include all OOI QA activities, including but not limited to: QA evaluations, formal and informal tests, and QA participation in other related project activities. At a minimum, the QA audit schedule should be evaluated for relevance to the OOI project objectives on a semi-annual basis by the OOI Quality Manager.

3.7 Quality Assurance Status and Metrics Reporting

The OOI Quality Manager will provide a monthly written status report to the Ocean Leadership President and to the OOI Program Director. As OOI Quality Management staff evaluates the IO Quality functional

areas, they will provide a monthly status report to the appropriate IO functional managers and to the IO Quality Assurance group member designated by the IO manager. The report will address the following:

- Number of items entered into the ITM
- Number of compliant and non-compliant evaluations observed per month.
- Total number of QA/QC-related items in the ITM, summed by disposition.
- Number of deficiencies observed, or escalated to the next leadership level.
- Number of days deficiencies remain open and averages.
- Ratio of Quality Assurance evaluations conducted out of the total number of Quality Assurance evaluations scheduled.

The monthly status report will also contain, as appropriate and practical, the System Engineering metrics listed in Section 4.1.2.3 of the System Engineering Management Plan (SEMP). The SEMP calls these metrics out and is the authoritative source for which System Engineering metrics are to be reported.

Section 4.1.2.3 of the SEMP also requires the reporting of:

- The complete set of earned value metrics that encompass cost and schedules in technical areas
- A set of Technical Performance Measurements (TPM) that is derived directly from the performance requirements.

Quality Assurance metrics will be evaluated on a monthly basis and used to make decisions to improve the OOI team's ability to meet program objectives, service level agreements, and other contractual obligations.

3.8 Acceptance

The act of acceptance constitutes acknowledgement that the supplies or services offered to OL conform to applicable contract or sub award Quality and quantity requirements and are subject to and conform to other terms and conditions of the contract or sub award. OOI Quality Management is responsible for working with OOI System Engineering to develop the Acceptance Test Plans and Test Procedures for all formal Configuration Items. OOI Quality Management serves as a witness to formal Acceptance Testing for each configuration item and is one of the sign-off authorities for formal acceptance.

3.9 Quality Awareness Training

The OOI Quality Manager conducts Quality awareness training on a periodic basis to provide an overview of OOI Quality Management and the OOI Quality Assurance and Quality Control Plan to appropriate OOI employees.. The training also explains the purpose of the internal audits, the benefits of adherence to Quality plans and procedures, and how each employee has a role in the Quality System.

4 IO Quality Plans

4.1 Overview

The IOs will develop and implement their own QA/QC Plans that directly support the guidelines set forth in the OOI Quality Assurance and Quality Control Plan. The IO Quality Plans shall either address the following areas or support them as necessary:

4.2 Internal IO Audits

Internal audits of the IO Quality Plans, procedures and processes will be conducted at each of the IO facilities. These audits will be scheduled by the OOI Quality Manager. External Audits will be scheduled by the IO Quality Personnel for their subcontractor facilities on an ongoing basis. A rotating schedule will

be employed and the OOI Quality Manager is responsible for ensuring that all audits are conducted as scheduled. Based on audit results, the frequency and scope may be reduced or increased. Audits are conducted by trained, Quality Assurance staff or other trained personnel as appropriate. Internal and External IO Audit results are provided to the OOI Quality Manager.

4.3 Corrective and Preventive Action

The OOI Quality Manager is responsible for the tracking and status reporting of corrective and preventive actions that result from internal audits, process audits and product evaluations. The OOI Quality Manager reports on quality activities (quality training, scheduled audits, and corrective action status, for example) to the OOI PMO. The IO Quality Representatives are responsible for the tracking and status reporting of corrective and preventive actions that result from internal audits, process audits and product evaluations and their respective sites. The IO Quality Representatives report on quality activities (quality training, scheduled audits, and corrective action status, for example) to the IO Management Team.

4.4 Software Quality Assurance

Each IO will document their Software Quality Assurance (SQA) activities to be implemented in accordance with the OOI Quality Assurance and Quality Control Plan. The (SQA) Plan will typically be a separate document from QA/QC Plan. Prior to putting the plan into effect, the (SQA) Plan will be submitted to the OOI Quality Manager for review. The IOs SQA activities will include the following:

- Software Quality Planning – identify the quality standards that are relevant to the project and determine how to satisfy them.
- Perform Software Quality Assurance – apply the planned, systematic software quality activities to ensure that the project employs all processes needed to meet software requirements.
- Perform Software Quality Control – monitor specific software project results to determine whether they comply with relevant quality standards and eliminate causes of unsatisfactory performance or non-compliance.

Throughout the testing phase, each IO will monitor the control of test procedure versioning, control of test data sets, and retention of test data generation through the execution of formal testing. QA Monitoring of the tests will be reported to the OOI Quality Manager through the Work Product mechanism (*cf.* Section 3.2.5).

During formal testing, IO QA ensures use of approved test procedures and proper documentation of test runs. IO QA signs off on format test runs to signify that the tests were run under known conditions and configurations, and that the run records accurately reflect the test results.

4.5 Other Areas

- Configuration Management as per the OOI Configuration Management Plan to include Document Control and CCB Activity
- Non-Conforming Material as applicable
 - Each IO will develop a process for identifying, segregating, and tracking non-conforming or discrepant materials and equipment. Data from the Non-Conforming Material System will be reviewed by IO and PMO Management.
- Testing Plans & Procedures
- Training: Job-Specific and other required training
- Records

4.6 Control of Procurement/Sub-Contractor Management

Each IO will develop its own plan and subsequent procedures, defining the methods and extent for supplier controls.

- Dissemination of contractual requirements to the supplier (PO or other means)
 - Cost, delivery, logistics, et al.
- Verification that these requirements are being met by the suppliers
- Methodology for resolving disputes over requirements between OOI and the suppliers.