OBSIP Quality Plan

April 10, 2014

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Document Change History

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1.1	Draft - incorporates IIC feedback	3/5/2014
1.2	First Release - Incorporates Oversight Committee feedback	4/10/2014

1. Introduction

The Ocean Bottom Seismograph Instrument Pool (OBSIP) is a national facility providing instrumentation and operations support for NSF-sponsored geophysical research. OBSIP operations are manifested in engineering support, provision of instrumentation, offshore field support, and data processing and archiving. For NSF-funded, PI-led and community experiments, the ultimate goal of the facility is to provide:

Timely and accurate OBS data uploaded to the IRIS Data Management Center for the scientific community.

The fundamental tenets of the OBSIP Quality Plan are that:

1. OBSIP is a facility that organizes and provides science instrumentation and technical support to the community.

2. The OBSIP Quality Plan is a framework and living document that will be updated and revised as OBSIP embarks on an effort to improve facility quality now and into the future.

3. Quality at OBSIP is all-encompassing and integral to the success of the facility from start to finish, it is not just quality assessment of the end product - data.

4. The Quality Plan will be implemented across OBSIP in a coordinated effort to standardize processes across the facility.

5. The effort to improve quality at OBSIP will be initiated through an assessment of existing processes with an effort to first recognize best practices and determine existing shortcomings. This initial assessment should be carried out with existing base funding. Additional funding required to meet a baseline level of quality can then be estimated and efforts to improve OBSIP quality can be scoped based on available funding.

The majority of OBSIP operations are focused on a wide array of steps that lead to the collection and timely delivery of accurately archived OBS data. To ensure that OBSIP continues to successfully deliver those data, and to continually improve on the quality of the data, each of those many steps must be executed through routine, well-defined organizational processes. OBSIP will define its facility processes and develop and follow procedures that ensure the successful and routine execution of those processes.

At present, OBSIP activities are focused on operating an existing set of OBSs designed to record both natural and controlled sources that were built using a variety of designs and developed over a span of nearly a decade. OBSIP seeks to develop a robust assessment of the underlying operational processes associated with instrument development, upgrade, maintenance, and deployment as well as quality of the data being produced by OBSIP.

By developing clear metrics of data quality, OBSIP will routinely monitor and assess quality both before and after archiving at the IRIS Data Management Center. This data quality assessment can then be used to investigate data problems, improve upon operational procedures, support engineering changes, and provide public responses to the issues and solutions that may be incorporated.

Initial facility quality metrics are identified and additional ones will be added to assess different and new facility capabilities as needed. The metrics will be computed by the OBSIP Management Office (OMO) on an annual basis and the results provided to the OBSIP Oversight Committee for review and recommendation.

In the pursuit of building a facility that provides higher quality instruments, services and data, the incorporation of the user community in identifying and providing feedback to specific issues and overall success of the facility is paramount. Principal Investigators (PIs) are responsible for communicating with the OMO prior to proposal, prior to fieldwork and after data is in hand and for reporting suspected data problems in a timely manner. The OBSIP Oversight Committee provides broad oversight of the facility and of the implementation and effectiveness of quality plan.

The OBSIP quality plan will be implemented in a series of four phases that result in complete integration and continual re-evaluation of quality processes and procedures in all aspects of OBSIP engineering, operations, and data processing. The four phases of implementation are:

- Phase 1 - Baseline quality monitoring and internal process assessment
- Phase 2 - Internal quality procedure development
- Phase 3 - Facility quality procedure integration and implementation
- Phase 4 - Ongoing operations and re-evaluation

Phases 1-3 are planned to be completed in Q1 of 2016, with the facility transitioning to Phase 4, 'Ongoing operations and re-evaluation', for the long term.

2. Scope

Each aspect of facility operations, from engineering to data dissemination, affects OBSIP's success in delivering timely and accurate data, and the quality of each step is therefore central to every aspect of facility operations. OBSIP's approach to delivering a quality end product - ***data*** - is therefore to incorporate quality into every aspect of the OBSIP facility, from engineering to operations to data processing.

For the purposes of this document, it is assumed that the primary use of OBS instrumentation is to record time series of ocean-bottom ground motion and/or acoustic pressure in the seismic band (~2mHz-200Hz), with sufficient fidelity to probe Earth- and ocean-science problems of interest to the investigator leading the experiment, as well as the broader scientific community. Factors that lead to a reduction in data quality include lost instruments, equipment failures, engineering and operational errors, and noisy deployment conditions.

All members of the OBSIP facility carry out the execution of the Quality Plan - the OBSIP Management Office (OMO), the Institutional Instrument Contributors (IICs), the Oversight Committee, and the user community.

OBSIP will implement quality procedures across its four primary activities: Engineering, Operations, Data Processing and Delivery, and Quality Control.

3. Engineering Development Quality

It is essential that the OBSIP engage in engineering development in order to maintain a modern fleet, upgrade failing or obsolete components and systems, improve on instrument performance and data quality, and modify instruments for specific user requests.

The ongoing upgrade and modernization of OBSIP instrumentation was initiated historically by the individual IICs, but is now managed by the OMO by the evaluation and approval of drop-fee mini proposals. New instrument design and construction is generally funded and managed outside the core OBSIP program.
The OBSIP facility is generally focused on the routine operation of standardized instrumentation that results in the highest return of high-quality seismic data.

3.1. Engineering Development Policy

All engineering development will result in documented, tested instrumentation that provides reliable operation and delivers high-quality seismic data to the IRIS Data Management Center.

3.2. Engineering Development Processes

OBSIP will adopt an engineering development process that ensures all engineering projects and changes are documented, properly tested and formally released for field operations. This controlled engineering development process prevents the release of untested, undocumented, and unreliable equipment into the OBSIP instrument fleet.

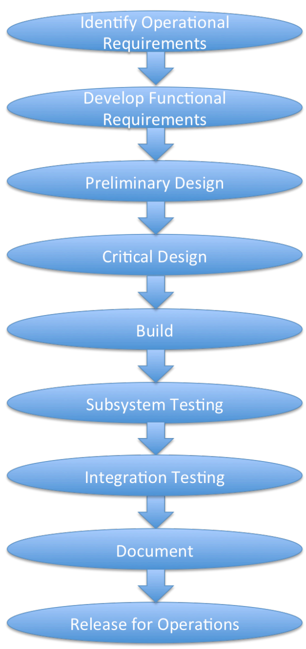

Figure 1. OBSIP Engineering Development Process

The OBSIP engineering development process provides a flexible environment that is tailored to the scope of the engineering project. At the same time the process is specific in that each step must be met to ensure that highly reliable systems are operating in the field. The engineering development process is identified in Figure 1, and will be further defined in the Engineering Development Procedure.

3.3. Engineering Development Procedures

The OBSIP engineering development process is successfully executed through the completion of an engineering procedure that develops a well-defined and well-documented solution to an operational requirement. The engineering development procedure ensures adequate testing, review, and release of engineering projects and changes.

The procedure specifies the documentation and release criteria that are required for an engineering project to be completed and used in field operations. The depth and breadth of that documentation is tailored to the scope and complexity of an engineering project, but at a minimum, will include the following:

1. Engineering Project Plan
2. Requirements Definition
3. Test Requirements and Plan
4. Documentation to define the critical design of the project (may include)
    a. Schematics
    b. Parts lists
    c. Board layouts
    d. Solid models
    e. Mechanical drawings
    f. Product structure
    g. Test procedures
5. Documentation to define successful completion and field readiness of the project
    a. Test results
    b. Operations manuals
6. Formal signed release

3.4. Engineering Development Quality Metrics

The integration of an engineering development process and the metrics that measure its level of success or failure will continue to be developed over time. The primary metric that will be measured at this time is the number of field failures each year that, through root cause investigation, can be traced to a failure in the engineering development process. Examples include data recording or recovery failures and data processing failures that are a result of engineering process failure (such as instrumentation modifications or necessary data post-processing requirements that are a result of engineering changes, and that were not communicated or documented).

Table 1 - Engineering Quality Deliverables

Quality Deliverable	Mustang	OMO	IIC	OC	PI
Engineering Development Procedure		X	X		
Engineering Development Documentation			X		
Engineering Development Metrics		X			

4. Field Operations Quality

Current OBSIP instrumentation requires extensive field support by OBSIP personnel. Collection of high-quality data requires thorough instrument and cruise preparation, and robust, standardized deployment and recovery procedures. While the dynamic nature of the off-shore environment will always require the ability of OBSIP to adapt to changing requirements, quality is enhanced by making those operations as routine as possible.

4.1. Field Operations Policy

All OBSIP field operations will be executed in a safe and prescribed manner that ensures reliable instrument operation and delivers high-quality seismic data to the IRIS Data Management Center.

4.2. Pre-Deployment

Pre-cruise preparation and testing of instruments is paramount to their successful operation at sea. The basic testing and calibration requirements to assure operation and define performance are common to all OBSIP instrumentation even though the specific requirements for each instrument are different. Currently, there is no standardized set of tests that are common to all IICs - each performs pre-cruise preparations independently. The result is that OBSIP's ability to meet community expectations of readiness varies according to the cruise and the instruments deployed.

OBSIP will identify and document common procedures for pre-deployment testing and calibration of instruments. These procedures will be instrument agnostic for a given class of instrument (broadband, short-period) and will identify the minimum testing and calibration that will be required. Each IIC will develop instrument-specific testing procedures that meet the minimum of the common facility requirements if they deem that the common testing procedures are insufficient for their needs or they determine that a higher level of testing is required.

Configuration variation and last-minute changes to instrumentation add significant risk to the successful deployment of instruments and recovery of data. OBSIP will define standard instrument configurations that will be reviewed with and approved by both the Principal Investigator and the OBSIP Management Office. The instrument configuration required to support an experiment's science, at a given cost, will be agreed upon when the experiment Informational Budget is provided to the Principal Investigator (typically prior to proposal submission to NSF). Changes to that approved configuration will not be made under any circumstance without the approval of the Principal Investigator, the IIC, and the OMO. If variations to a standard configuration are requested or needed for operational reasons, an evaluation of project cost impact and experiment success risk will be made. This evaluation may require significant OBSIP effort and sufficient notification of a nonstandard instrument configuration prior to the request of an OBSIP

Informational Budget must be provided or the Informational Budget will be delayed until a thorough evaluation can be made.

All pre-deployment tests and the instrument configuration will be documented prior to shipment for each and every instrument. This will, at a minimum, be performed via a comprehensive, instrument specific checklist, although many more forms of instrument verification may be incorporated. OMO will work with NSF to ensure that ship and instrument schedules provide sufficient time for complete pre-deployment testing. In the case where scheduling precludes completion of all pre-deployment test, OBSIP will work with NSF and the PI to ensure that risk is fully evaluated in the decision whether to move forward with the experiment.

OBSIP will assemble all pre-cruise support information into a standardized Science Support Plan that will be provided to the PI and used to establish the responsibilities of both OBSIP and the PI. This science support plan will provide the basis for all pre-cruise planning and discussion. Any changes made in planed support will be documented in the Science Support Plan. OBSIP, to include the OMO and involved IICs, will at a minimum conduct a pre-cruise planning teleconference with the PI(s) to discuss the planned support.

4.3. Field Operations

Reduced complexity of at-sea operations aids in the execution of routine and standardized instrument deployment, recovery and data download. OBSIP strives to reduce the amount of instrument configuration and testing required at sea to an absolute minimum. Each IIC will develop step-by-step set up and testing procedures and checklists for all at-sea testing and configuration for each particular class of instrument.

The dynamic off-shore environment presents a continual safety risk to all OBSIP personnel when safety practices are not rigorously adhered to. OBSIP will develop or adopt, and practice standard deployment and recovery procedures.

All field set-up tests and the instrument configuration will be documented prior to deployment for each instrument. This will, at a minimum, be performed via a comprehensive, instrument-specific checklist, although many more forms of instrument verification may be incorporated.

4.4. Post-Deployment

Post-deployment processes ensure the immediate and accurate download of data, and provide an assessment of instrument performance. OBSIP will develop general instrument post-deployment processes. If specific processes are required for a particular class of instrument, they will adhere to the general process and provide additional detail as required for that particular instrument.

The post-deployment processes will incorporate an instrument checklist to initially validate performance and detailed data download and decommissioning steps.

Upon return of an instrument to the IIC, it will be immediately re-calibrated. Following recalibration, the instrument will be refurbished and a functional check will be made. If required, an additional calibration will be performed prior to the redeployment of the instrument. All calibrations will be archived.

If an instrument failed to operate at its specified level of performance during its deployment, a root cause investigation will be initiated and the problem identified, resolved and logged. Unresolved root cause analysis investigations will not be closed and the instrument will not be returned to the field until its operating state is returned to the specified performance level.

Each IIC will publish an OBSIP-specific report for each cruise. OBSIP will develop a standardized cruise report format. Specific instrument operational problems will be identified. If the cruise operations included recovery of instruments, both pre-deployment and post-deployment instrument checklists and calibrations will be included in the report. The OMO will publish these cruise reports to the OBSIP website for each experiment.

4.5. Operations Quality Metrics

OBSIP operational quality will be monitored by tracking and reporting metrics that are indicative of its level of performance. Initially, both the number of lost and damaged instruments will be tracked. Additional operations metrics will be developed as they are identified.

Table 2 - Field Operations Quality Deliverables

Quality Deliverable	Mustang	OMO	IIC	OC	PI
Pre-cruise planning: Instrument Configuration, Science Support Plan, Planning Teleconference		X	X		X
Common pre-deployment test and calibration procedures		X	X		
Instrument specific pre-deployment test and calibration procedures			X		
Pre-deployment test, calibration and checklist results			X		
Standard instrument configurations		X	X		
Common field operations procedures		X	X		
Instrument specific field operations procedures and checklists			X		
Field tests and configuration checklist results			X		
Common post-deployment procedures		X	X		
Instrument specific post-deployment procedures			X		
Post-deployment test, calibration and checklist results			X		
Standardized cruise report form		X	X		
IIC cruise reports			X		
Field Operations Metrics		X			

5. Data Processing and Delivery

Instrumentation and field operations support are ancillary activities to OBSIP's primary deliverable:

Timely and accurate OBS data uploaded to the IRIS Data Management Center for the scientific community.

Once data have been recovered from the instruments, it must be processed and uploaded to the DMC.

5.1. Data Processing and Delivery Policy

OBSIP will accurately process and deliver data to the DMC as quickly as possible.

5.2. Data Processing

The IICs process OBS data to prepare it for public distribution at the DMC. The processing steps include, but are not limited to:

- Correcting timing drift
- Correcting leap seconds
- Working with the Navy on data redaction and filtering
- Organizing metadata
- Populating seed headers

OBSIP will develop general instrument data processing processes. Each IIC will develop step-by-step data processing procedures for each particular class of instrument, as required. If specific processes are required for a particular class of instrument, they will adhere to the general process and provide additional detail as required for that particular instrument.

5.3. Data Delivery

OBSIP will develop a data upload procedure that details the steps required to upload and verify the presence and completeness of data at the DMC

5.4. Data Processing and Delivery Quality Metrics

OBSIP will track data processing and delivery metrics that measure its effectiveness in providing timely and accurate data to the DMC. These metrics may over time also provide insight into the relative performance of instrumentation and latent engineering or operations deficiencies. Initially, the data processing metrics will include the data upload lead-time, and the number of DMC uploads that must be retracted and reloaded to be corrected.

Table 3 - Data Processing and Delivery Quality Deliverables

Quality Deliverable	Mustang	OMO	IIC	OC	PI
Data processing processes			X		
Data upload procedure		X	X		

6. Data Quality Control

Ensuring that data delivered to the DMC are complete and error-free requires several quality control steps that are performed through both automated and manual processes at both the OMO and the IICs. In addition to these routine quality control processes, OBSIP will continue to encourage and may provide limited support for more comprehensive data evaluation by the experiment PI and other researchers via their use of the data.

6.1. Automated Data Quality Assurance

Real-time seismic networks managed by IRIS have a successful history of automated data quality analysis. Recently, the IRIS Data Management Center has engaged in the development of a data quality analysis software tool suite that provides similar capability for the analysis of archived data - MUSTANG.

MUSTANG (Modular Utility for STAtistical kNowledge Gathering) (Casey, 2011) is a server-based quality assurance system that runs on any data stored at the IRIS DMC. The MUSTANG system carries out and records standing-order operations on a continual basis to supply standard quality assurance metrics. Client-side user interface tools request on-demand orders, queries, specifications, and views of quality assurance metrics. MUSTANG is capable of calculating an array of seismic data metrics including signal to noise ratio, overlap and gaps in data, percent availability, signal and mass position mean, signal and mass position RMS, STA/LTA ratio, state of health flags: histograms, timings, polarity reversal checks, linearity, multiple station median and range plot, station up/down times, coherence between channels, cross-correlation, Power Spectral Density (PSD) calculations, Probability Density Function (PDF) plots Differential PDFs, spectral differencing, aggregate PDFs across stations, percent or difference above high noise model, spot check channel orientation and computation of synthetic tide and comparison to to observed.

OBSIP will use MUSTANG output for the automated collection of standard OBSIP data quality control metrics.

6.2. Monitoring of Automated Data Quality Metrics

The statistical metrics generated by MUSTANG are used by both the OMO and IICs to evaluate the performance of OBSIP stations and ensure that the highest quality data are archived at the IRIS Data Management Center.

The OMO will monitor MUSTANG metrics that are indicative of data upload or instrument performance problems with the goal of alerting IICs of potential problems.

The IICs will monitor MUSTANG metrics with the goal of improving instrument performance. This may require a more investigative approach that is best suited to the IIC and their direct knowledge of the instrument design.

MUSTANG metrics of interest for these activities may include:

- Signal to Noise Ratio
- Overlap and gaps in data
- Percent availability
- Signal and mass position mean
- State of health flags: histograms, timings
- Linearity
- Multiple station median and range plot
- Station up/down times
- PSD calculations and PDF plots
- Percent or difference above high noise model

6.3. Metadata Quality Monitoring

The OMO will monitor all OBSIP metadata delivered to the IRIS DMC for completeness and accuracy. Specific metadata monitoring includes:

- Station and channel naming correct and present
- Channel orientation conformity to IRIS GSN conventions
- Data availability by channel
- DMC data upload timeliness

6.4. Manual Data Quality Monitoring

As OBSIP gains familiarity with the capabilities of MUSTANG as an automated tool, additional, manual data quality measures may be performed in addition to the metrics generated by MUSTANG. These manual efforts will be identified on an as-needed basis and may be in response to anomalies flagged by the automated QC results, or may become ongoing activities performed in parallel to the automated analysis.

6.5. Data Quality Investigations

Historically, researchers working with OBSIP data have found many instrument and data problems that are difficult to isolate and identify. Improved integration of processes and increased automated and manual quality control will improve the tracking and screening of OBSIP data. However, more subtle problems are likely to continue to be found by the research community. This is especially important with OBS data because the operating and noise environment is both marginal and very dynamic, making the use of routine automated data QC difficult. This user feedback loop is a valuable resource in the continual improvement of OBSIP data quality and it is the PI's responsibility to report suspected problems to the OMO. The OMO will continue to collect feedback via post-cruise data assessments and other means, and the IICs will continually incorporate improvements in instrumentation, operations, and data processing that result from community-identified assessment.

Responding to user-generated reports of data problems can require detailed and extensive investigations to verify and resolve the problem, if one exists, or to resolve that the issue is a result of user-error. These problems are also often instrument-specific, requiring first-hand knowledge of the instrument and its internal operation and processing. OMO will validate user data quality problems in an attempt to screen and trap issues that might be a result of user error before engaging IIC effort.

OMO will work with the IICs and engage qualified external personnel on an as-needed, task-based basis to address validated user community data problems. If a quality problem is identified that is not immediately understood or readily resolved, OBSIP will initiate an investigation of the problem. Upon resolution, OBSIP will develop a Data Quality Investigation Report that clearly explains the problem, its scope, how it may affect data and scientific results, how OBSIP has resolved the problem and what steps the science community may want to take to ensure the integrity of its work based on data that may have been affected.

Results of OBSIP Data Quality Investigations may lead to the generation of IRIS DMC Data Problem Reports (http://www.iris.edu/data/dpr.htm) to document for the user community those problems that may affect science results.

6.6. Data Quality Control Metrics

OBSIP will identify and track data quality control metrics that measure its effectiveness in providing timely and accurate data to the DMC. Initially, OBSIP will measure quality control via the availability of deployed instrument data.

Table 4 - Data Quality Control Deliverables

Quality Deliverable	Mustang	OMO	IIC	OC	PI
Identify data quality problems					X
Automated data quality metrics	X				
Data Quality Investigation Reports		X	X		
Data quality metrics		X			
Data Problem Reports		X	X		

7. Quality Metrics Summary

Data quality metrics have been identified for each component of OBSIP quality. The following defined quality metrics will be used for quality performance evaluation of the OBSIP facility.

Engineering

Engineering process failures - Data availability failures that can be linked to a failure of the engineering development process as a result of root cause analysis.

Operations

Number of instruments deployed - The number of instruments in a given operating year that OBSIP has deployed.

Number of instruments recovered - The number of instruments in a given operating year that OBSIP has recovered.

Number of instruments lost - The number of instruments lost in a given operating year that are not reasonably attributed to a non-OBSIP operating cause (ex. trawling).

Number of instruments damaged - the number of instruments in a given operating year that incur damage that is not reasonably attributed to a non-OBSIP operating cause.

Data Processing and Delivery

DMC data upload retractions or reloads - Data uploads to the DMC that must subsequently be corrected and reloaded.

DMC data upload lead-time - The amount of time from the last day of a recovery cruise until the complete data set is uploaded to the IRIS DMC.

Data Quality Control

Deployed instrument data availability - The amount of time good data were provided by an instrument, divided by the amount of time the instrument was deployed. The minimum time increment is 24 hours. The preliminary minimum acceptable availability of good data in a 24 hour period is 85%.

8. Quality Performance Evaluation

The quality metrics identified above will be compiled annually by the OMO. The OBSIP Management Council will use these metrics to develop an internal review and assessment of facility quality performance to include and explanation of the metric results, identification of external factors that may have overtly biased a result, and proposed proactive adjustments to processes and procedures the Management council believes will address and mitigate future quality problems and improve facility performance against the metrics.

After internal review by the Management Council, the internal evaluation and process changes proposed by the Management Council will be provided to the OBSIP Oversight Committee for review. The Oversight Committee will in turn provide recommendations and direction to the OMO on further suggestions for improvements or specific actions to be taken. The OBSIP quality performance evaluation will be conducted on a yearly basis at the fall OBSIP Oversight Committee meeting.

OBSIP will use the metrics identified above and others, if possible, to establish a baseline level of facility performance. From that baseline, and with the guidance of the Oversight Committee, OBSIP will establish metric-based goals intended to provide a mark for improved facility performance.

The OBSIP Quality Performance Evaluation, and all proposed and implemented process changes will be reported to the NSF. If current NSF funding for OBSIP is not sufficient to implement a recommended process change, OBSIP will estimate the required funding and provide that to the NSF with the OBSIP Quality Performance Evaluation. Because the level of available resources may fall after a change implementation, OBSIP may be required to reverse some changes.

Table 5 - Quality Performance Evaluation Deliverables

Quality Deliverable	Mustang	OMO	IIC	OC	PI
OBSIP Quality Performance Evaluation		X			
OBSIP Quality Performance Review				X	

9. Responsibility Matrix

The responsibility for quality is distributed throughout the OBSIP facility organization. A summary of the basic tasks defined in this plan, and the entities within OBSIP that hold responsibility for those tasks, is provided in the following table.

Table 6 - OBSIP Quality Responsibility Matrix

Quality Activity	Mustang	OMO	IIC	OC	PI
Develop and manage OBSIP Facility Quality Plan		X			
Develop and execute engineering development procedures			X		
Pre-cruise planning: Instrument Configuration, Science Support Plan, Planning Teleconference		X	X		X
Develop and execute field operations procedures			X		
Develop and execute data processing procedures			X		
Perform automated metric generation	X				
Monitor automated metrics		X	X		
Generate complete and accurate metadata			X		X
Evaluate metadata completeness and accuracy		X			
Provide feedback on research-specific data quality issues					X
Respond to community feedback on specific data quality issues		X			
Direct OBSIP resources to evaluate and resolve specific data quality issues		X			
Perform evaluation and resolution of research specific data quality issues			X		X
Evaluate data quality performance		X			
Review data quality evaluation and provide guidance on necessary change				X	

10. Implementation

The process of adopting and fully executing a comprehensive OBSIP quality plan will require an extensive implementation period. Implementation will be performed in four distinct phases:

- Phase 1 - Baseline quality monitoring and internal process assessment
- Phase 2 - Quality procedure development
- Phase 3 - Quality procedure integration and implementation
- Phase 4 - Ongoing operations and re-evaluation

During Phase 1 of the Quality Plan Implementation, OBSIP will initiate a basic level of data quality metric generation and monitoring, and perform an internal review and assessment of its existing quality processes and procedures. The internal monitoring of metrics is intended to rapidly provide a baseline of the current status of OBSIP quality so that future improvements can be measured. The internal review and assessment of existing processes and procedures is intended to identify and formalize the processes that individual IICs may already be using in their engineering development and field operations. The OBSIP Management Council will review these as a group to learn and 'cross-pollinate' each other's processes. OBSIP, in their assessment of existing processes, will identify the 'best practices' to be used to develop common, facility-wide processes and procedures.

During Phase 2, OBSIP will develop common, facility-wide engineering, operations, and data processing processes and procedures. Each IIC will in turn develop any required sub-procedures that may be required for each specific instrument class or that may be specific to their operations.

During Phase 3 of the Quality Plan Implementation, OBSIP will deeply integrate the processes and procedures developed in Phase 2 into all aspects of facility operations. This integration period will allow the facility to refine its procedures as they are put into practice.

Phase 4 of the OBSIP Quality Plan Implementation moves facility to the steady-state operation of a fully integrated Quality Plan. OBSIP continues to re-evaluate its level of quality and introduce new processes, procedures and metrics as it operations and instrumentation evolve. The re-evaluation process is concluded each year with the OBSIP Oversight Committee review of the yearly internal Quality Performance Evaluation.

The offshore nature of OBSIP work requires that it be highly reactive to operational field issues that can disrupt the planned activities of the facility. The task of implementing this quality plan is in addition to current facility duties. Therefore, the implementation of the quality plan may become resource constrained without additional funding. The OBSIP Quality Plan is scalable depending on the level of resources available, and the existing workload of the IICs.

A task breakdown of the time-phased implementation plan is provided in Figure 2.

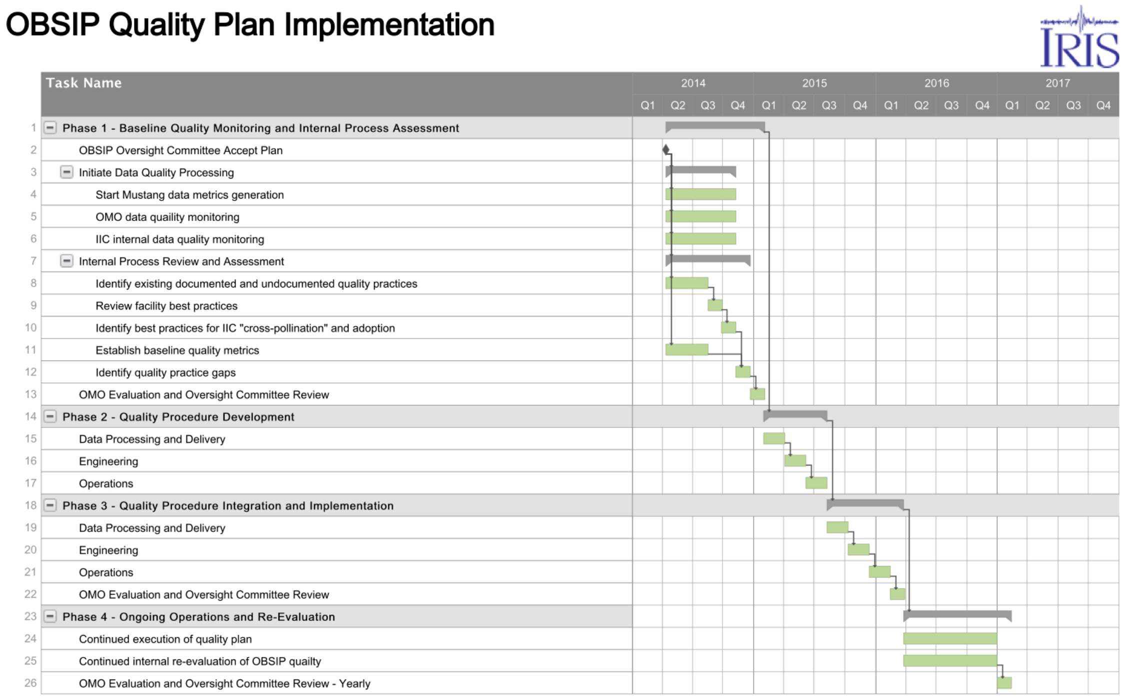

Figure 2 - OBSIP Quality Plan Implementation