OOI Preliminary Design Review

Conducted for the
National Science Foundation
Ocean Technology and Interdisciplinary Coordination
Division of Ocean Sciences

Location: Key Bridge Marriott, Arlington VA
December 4-7, 2007

Final Report Date: 16 December, 2007

Summary

The proposed Ocean Observing Initiative (OOI) will fundamentally change the way that science is done in the ocean. The OOI as proposed will build a networked sensor grid that will collect ocean and seafloor data at high sampling rates over years to decades. Researchers will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, biological, severe storms), to more subtle, longer-term changes or emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, ecosystem trends). OOI offers exciting opportunities upon which to build a transformational Education and Public Engagement program that will "engender national support for OOI, the innovative technology it employs and the science it enables." Among these opportunities are the lifetime of the user facility, the rich research program, the technology itself, the extensive cyberinfrastructure, the need for a diverse workforce, and the potential offered by partner organizations in the science and ocean education community. The amount of work required and the level of detail needed to bring the OOI project to the Preliminary Design Review (PDR) is impressive. The Ocean Leadership (OL) office and Implementing Organization (IO) institutions are to be commended for this effort.

The OOI Preliminary Design Review (PDR) / Final Design Review (FDR) Panel (see Charge to Panel, Appendix 1) was asked to advise the NSF whether the project was ready to begin construction/implementation. Under the current definition of the Major Research and Facilities Construction (MREFC) approval process as defined in the Large Projects handbook, upon PDR approval, a project is taken to the National Science Board (NSB) for approval. There is a period of up to two years before money is appropriated for MREFC funding. The Large Facilities Guide wisely utilizes this period to complete the detailed design stage and has a Final Design Review stage gate before MREFC funds can actually be spent. The OOI is in an anomalous position since it has already been approved by the NSB and funds have been appropriated. This not the fault of the OOI or the NSF, merely a consequence of changes being made in the MREFC process. The Panel was asked to take this into account in framing their recommendations to NSF.

Has the OOI successfully reached a level of maturity to hold a successful PDR? Without doubt, the answer is yes; in our view the OOI has passed the PDR. Is the project at FDR level? The answer is no. The OOI team is pursuing a concurrent engineering approach to allow them to both manage and retire risk. In this concurrent engineering model, the existing plan defines a series of Internal Final Design Reviews (hereinafter referred to as *ifdrs* to avoid confusion with the MREFC-defined FDR) that will be held at Implementing Organization (IO) level at the appropriate time. This is not an unusual approach for substantial projects, and the Panel feels this is a pragmatic way to minimize cost and schedule risk. The Panel also noted that the Cyberinfrastructure IO utilizes a spiral development methodology where each of the five planned releases has its own *ifdr*. This is good practice and represents a well thought out solution to managing risk in delivering software. The Panel endorses the concept of concurrent engineering for the OOI and breaking the FDR into a series of IO level *ifdrs*. We believe that these *ifdrs* would benefit from external membership and/or appointment of NSF ad hoc committees to oversee the reviews. We also recommend a yearly MREFC programmatic review (Table 1) and annual IO reviews to ensure that overall project systems engineering and education are given the appropriate priority and oversight. The Panel also recommends an annual Education and Public Engagement review to ensure this critical component is integrated at all management, engineering, science and cyberinfrastructure levels of the program

Table 1. Recommended Program and IO Review Schedule				
Review	**Purpose**	**Component**	**Frequency**	**Panel Membership**
NSF Yearly OOI MREFC Review	Determine if overall program meeting construction, EPE, O&M and Science Goals	All	Q1	NSF Appointed Panel
OOI Advisory Comm. Yearly RN IO Review	Determine if overall RN meeting construction and science goals	RN	Q2	OOI Advisory Comm, External community, PI/PM's from other components
OOI Advisory Comm. Yearly G/CN IO Review	Determine if overall G/CN meeting construction and science goals	GCN	Q3	OOI Advisory Comm, External community, PI/PM's from other components
OOI Advisory Comm. Yearly CI IO Review	Determine if overall CI meeting construction and science Goals	CI	Q4	OOI Advisory Comm, External community, PI/PM's from other components
OOI Advisory Comm. Yearly OOI EPE Review	Determine if EPE fully integrated in OOI management, science, CI, and IO EPE programs	All	TBD	OOI Advisory Comm., External EPE members

Because of this need for additional planning, the Project Team was asked by the Panel to estimate the impact of completing a formal, external FDR before receiving MREFC funding. In a worst case scenario the Team estimated a delay of two years with a minimum effect of a $20M ($FY2007) cost increase to the MREFC line and a cost increase to the R&RA line of $60M ($FY2007) to carry out the detailed design work. The view of the Panel was that absorbing a $20M cost increase through further reduction in the science capability, coupled with the delay, would severely jeopardize the transformational nature of the OOI, and would push the OOI below an acceptable science floor.

The Panel was tasked by NSF to assess the robustness of the technical design and completeness of the budget and construction planning, the effectiveness of project management through the PDR stage of development, as well as plans for the remaining design work, construction, commissioning and eventual operation of the network. The Panel was requested to review progress made by the Project Team after the findings of the Conceptual Design Review (CDR) Panel. The PDR Panel evaluated material provided prior to the review (including static copies of OOI Project Execution Plan (PEP), Cost Book, Earned Value Management System, WBS/Dictionary etc), Project Team presentations, responses from the Project Team to written questions from the Panel; and Project Management (PM), Cyberinfrastructure (CI), Global and Coastal Scale Nodes (GCSN), Regional Scale Nodes (RSN), and Education and Public Engagement (EPE) breakout sessions. The findings based on the Panel Charge were summarized in Appendix 2 of this report. When the Panel found areas lacking in sufficient information, specific recommendations were then listed in this document. It should be recognized that most of the criteria for the EPE PDR has not been met, primarily due to the Project Team not having the Education and Public Engagement IO (EPE IO) in place. The panel was also asked to review the recommendations and Project Team responses from the CDR. In general, the CDR responses as written were sufficient and the PDR Panel reviewed a number of issues raised by the CDR Panel. Where issues remained, the Project Team either explained them in adequate detail or they have since been included as recommendations in this report.

In conclusion, the Panel, recognizing the unique circumstances of the OOI, and taking into account the successful PDR, advises the NSF to approve the OOI to enter the detailed design and construction phase, first utilizing current funding to begin detailed planning and followed by utilizing the MREFC funds for construction and concurrent detailed planning.

OOI Management

The formal management structure of the OOI is a program office (Ocean Leadership) with three Implementing Organizations (IOs) for Cyberinfrastructure (CI), Coastal/Global Scale nodes (CGSN) and Regional Scale nodes (RSN). A fourth IO for Education and Public Engagement (EPE) will be added upon completion of the Education and Public Engagement RFP process (called the Education Infrastructure Facility in the OOI PDR documents). Fully integrating the Education and Public Engagement activities into a fourth IO, with oversight from the education community including users, into program structure will help realize the education goals, and support efforts to engage members of underrepresented groups in ocean science. The formal line of authority is from the Project Director in the OOI Program Office to each of the PIs of the IOs.

There are project managers and systems engineers in the program office and each of the IOs. Each IO Project Manager (PM) and Systems Engineer (SE) formally reports to the IO PI and not to the OOI PM or SE. Arguably this is a weakness. The relationship is through matrix reporting.

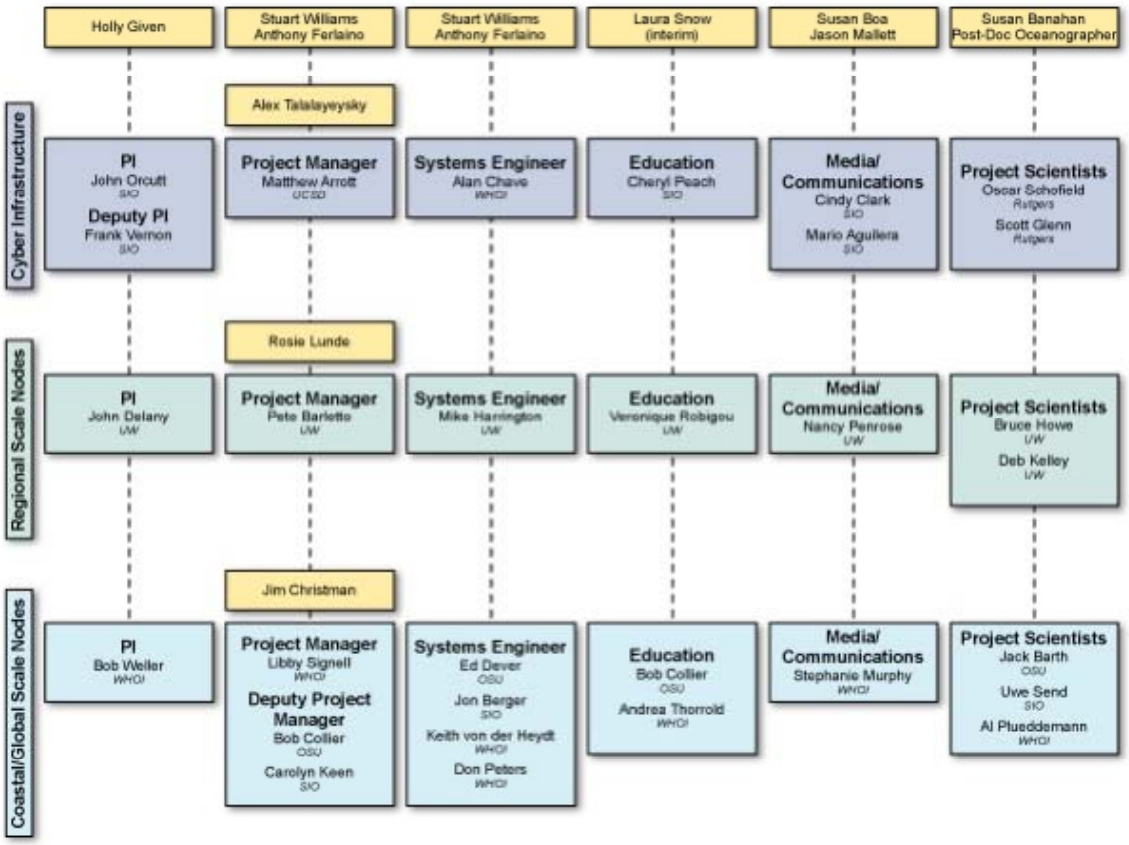

Figure 1. Matrix management organizational chart for OOI

However it is clear that there are regular and appropriate communications between OOI and IO line management and there is robust communication and integration between the IOs. Furthermore the Project Director has formal authority to control the work of an IO through the subaward process, including the ultimate sanction if necessary.

How robust is this structure? The OOI presently has three strong PIs and a strong Project Director (Figure 1). This has both positive and negative aspects. The negative aspect is that building consensus could be time consuming, and there is likely to be conflict. However the decision making though the change control process is well documented. The positive aspect of course is that each IO is led by a highly motivated individual who has an enormous personal and organizational investment in achieving success. Furthermore, the deliverables of the two Marine IOs (CGSN and RSN) are not vastly interdependent (although it is clear that the interactions have been good and they have arrived at common standards and processes). The CI IO is of course critical for the success of all IOs. The structure in Figure 1 will need to be changed to reflect the addition of the EPE IO.

Perhaps the best test of the structure, and proof that it is working, is the fact that the OOI team has made it to this point. The team members have clearly had to go though some very difficult times and have had to make some very difficult decisions in descoping the project. They appear to have done this in a very effective way. In the final analysis, the players understand that they stand or fall together, they understand the flow of authority, and they have demonstrated their commitment to making the project a success.

Are the necessary project management tools in place and solid? All necessary management tools including an earned-value system, change control system, Work Breakdown Structure (WBS), cost control accounts, work packages coupled to the WBS system, and risk management/tracking systems are in place and well understood by OL and IO cost control managers and the contracting officer's technical representatives (COTRs).

We determined that OOI is ready to move forward to construction phase, but that portions of the program require detailed planning generally performed during the detailed design phase. The Panel is confident that this planning can advance considerably in the coming months with remaining R&RA funding prior to the release of the MREFC funding. Areas that will require additional planning and documentation include the Education and Public Engagement Program and certain aspects of: Cyberinfrastructure IO, systems engineering documentation across the components, and all activities associated with preparing to implement the Operations and Maintenance phase.

Listed below are a series of specific OOI Management recommendations based on the Panel's findings, all of which we believe are significant, but none of which we view as stage gates prior to NSB approval or the subsequent release of MREFC funds. The recommendations are numbered for tracking purposes and do not reflect priority.

1. **Recommendation**: OL leadership must be completely transparent in all aspects of the MREFC, including community and NSF interactions. We recommend that the Project Team engage the science and education communities through a series of workshops and site visits, and that it adopt a very open, transparent mode of operation including direct web access to all project documents, source code, design documents, meeting minutes, and schedules.

2. **Recommendation**: NSF should mandate a yearly MREFC programmatic review and annual IO reviews to ensure that all key milestones and *ifdrs* are met, and the overall project systems engineering and education are given the appropriate priority and oversight (Table 1).

3. **Recommendation**. OL should establish a Working Executive Committee, consisting of the IO PIs (including the Education and Public Engagement PI when selected through the RFP) and the Project Director, with the Project Director as chair with the deciding vote in the case a split vote. The committee should coordinate key project issues.

4. **Recommendation**. The project team should establish a set of critical path milestones for starting the MREFC program on the proposed funding schedule. The NSF should review the progress of these milestones through review structure proposed in Table 1. Examples of critical path issues include permitting and cyberinfrastructure development.

5. **Recommendation:** The project team must expedite the Education and Public Engagement IO and submit the RFP for the EPE IO by spring 2008.

6. **Recommendation**. The highest-level advisory Committee should report directly to the OL Board of Trustees. This committee should represent the OOI user community to ensure that the project's scientific, educational, and operational goals are met.

7. **Recommendation**. The team should carefully evaluate issues associated with installing their moorings, including such issues as concerns of local groups, coastal zone management topics and possible environmental assessments. A cost and schedule risk assessment should be performed, and resulting project changes should be managed through the Change Control Process. There is significant risk associated with project permitting, including NEPA compliance and environmental permitting. These are key critical path issues. In addition, each of the Marine IOs carry substantial risk with owner/supplier ocean/land use permits. The project team must give this the highest possible priority and create project contingency plans in case the key NEPA milestone is missed. .

8. **Recommendation**. Any plans for "upscope" must be removed from the project baseline as they set a high community expectation and have no Operations and Maintenance (O&M) support. As the project moves through the construction phase, NSF and OOI leadership can discuss how and where any available funds should be applied.

9. **Recommendation**: The team should formalize and document their approach to economies of scale and efficiency in a common procurement plan.

10. **Recommendation**. The OOI Data Policy must clearly state there is no proprietary period for exclusive use of data.

11. **Recommendation:** OOI must develop a set of education drivers, with external community input, to direct and integrate the Education and Public Engagement effort, just as science drivers are integrated throughout the IOs and program management structure. The project team should develop a formal EPE Requirements document externally reviewed and incorporated into the existing process of deriving design details from the requirements with the same level of importance and significance as the other requirements, e.g. the Science Requirements.

12. **Recommendation**: The project team should adopt and implement formal version control, change management, and archiving for the project's documentation and management/accounting tools e.g. the Cost Book.

13. **Recommendation:** The project team should demonstrate that adequate schedule contingency has been incorporated into the baseline plan. They should clearly state the methodology used for estimating and incorporating schedule contingency.

14. **Recommendation:** The project team should complete the O&M plan, including a transition plan for equipment and staffing from the implementation phase to O&M, a detailed operating cost and maintenance schedule, and a basis of estimate couched in terms of equipment and mission scope and a Reliability, Availability, Maintainability (RAM) analysis. This should be driven by the top-level O&M Requirements Document which needs to be developed.

15. **Recommendation:** The project team should provide an estimated contingency usage profile by year and include these in the project contingency management plan.

16. **Recommendation**: Quality and configuration management need to be defined in the top level, perhaps in the O&M Requirements Document. A full time quality professional should be included at the highest level in the OL project office and in each of the IOs. The team should evaluate the impact of the requirements on the program and handle changes through the change control process.

17. **Recommendation**: Education Health & Safety (EH&S) requirements should be defined in the top-level O&M Requirements Document. The team should evaluate the impact of the requirements on the program and handle changes through the change control process.

18. **Recommendation**: The project team should consider engaging a cultural anthropologist to study the processes involved in designing, implementing, operating and decommissioning the system.

Education and Public Engagement

Education and Public Engagement (EPE) are critical to the vitality and sustainability of OOI as the number of scientists served will be significantly less than the number of students and members of the public who will use OOI web services. Educators and the public are key users. OOI Project Management must provide support and oversight from the top, developing a management structure that fully integrates the various EPE components in the IOs. Educators must have input into program design, especially data streams, analysis tools and cyberinfrastructure. OOI also provides an exceptional opportunity for engaging scientists and students from other disciplines in ocean observing infrastructure and oceanic processes. Support (FTEs) for the EPE infrastructure beyond those individuals designed as education leaders must be provided by the three current IOs, in partnership with the new EPE IO. The EPE IO is required immediately to begin the process of establishing the teaching/outreach web sites.

Three groups have important responsibilities for OOI Education and Public Engagement: (1) educators who embed user interfaces in best practices programs and web sites, (2) scientists who provide data with superior background information and visualizations, and (3) CI to provide important middleware infrastructure. The Panel has concerns about the integration of EPE into the OOI culture. Just as science drivers are integrated seamlessly throughout the IOs and program management structure, OOI must develop a set of EPE drivers with external community input to help integrate the EPE effort. The Panel found the level of EPE integration in OOI culture inconsistent across the project. The integration of EPE is weakest at the network level and the GCSN IO; the RSN and CI IOs do consider EPE essential to their mission; however, the implementation is erratic and does not flow from an integrated plan across the IOs. The RSN IO is committed to providing public access to OOI high definition TV footage and data streams during construction and has demonstrated capability and success in this effort. The CI education specialist is a member of the CI IO executive team, and the team has end user point-of-contacts for science and education. The full integration of education into program management at the highest level of the CI IO group is commendable and serves as a model for the other groups.

The EPE plan must be placed in the context of what is being done nationally with respect to ocean education. The role of the Centers for Ocean Science Education Excellence (COSEE) is particularly important; the panel noted exciting and timely synergies with ongoing and proposed COSEE programs. In addition to applying current best practices to OOI education, the EPE plan should propose innovative approaches using OOI data to increase ocean literacy, to engage students, educators and the public in ocean science, and to reach diverse and underserved audiences. This vision should help guide the development of the RFP for education and public outreach. OL and NSF should engage in broad community discussions in developing the EPE IO RFP, with representatives from the potential users in addition to the external advisory education committee and OL management team. The RFP should require partnerships with other education entities, including other MREFC projects, to broaden participation in OOI, and include external (system testing) evaluation for activities.

It appears that the opportunity to create transformational programs requires investment in the "free choice" education program described in the Project Execution Plan (PEP), while the need to develop a diverse workforce suggests investment in online training programs. It is not clear that there are sufficient funds to support both of these efforts. Furthermore, it is difficult to evaluate the focus of the education plan in the PEP and how it will contribute to other ocean education community efforts. The panel concludes that the Education and Public Engagement design will be robust when:

- The plan is expressed in the context of the larger ocean education program.
- The action plan describes the full operating program structure along with the elements that will be built by MREFC funds.
- Terms such as "transformation education, outreach," etc. are defined and used consistently throughout OOI.
- Goals are strengthened beyond "awareness" and critical milestones are established and tracked for OL and OI accountability.
- Management linkages with science are clearly defined.
- Roles and responsibilities for and commitments from science for appropriate data streams and analysis tools and from CI for infrastructure are defined.
- Steps to outsource the system testing, establish an external advisory committee and develop partnerships are explained.
- The management structure including the EPE IO is defined.

- The selection of proposed education efforts in free-choice learning and workforce development are justified.
- A clearly defined set of performance criteria against which the program can be evaluated is established.

19. **Recommendation:** The panel considers the Education and Public Engagement effort underfunded. The project team should develop a plan for increasing funding for EPE Programs.

20. **Recommendation:** The project team should integrate Education and Public Engagement with OOI science and CI.

21. **Recommendation**. The project team should ensure that the EPE plan capitalizes on the unique opportunities for transformative education provided by OOI.

Cyberinfrastructure

The Cyberinfrastructure (CI) IO has designed a comprehensive and state-of-the-art cyberinfrastructure for the OOI. The panel was impressed by the detail of the design, the existing prototypes and the design methodology. The groups and individuals in the CI team have substantial background and experience in delivering strong, reliable and flexible systems. The Panel believes that the management and development plan presented by the CI IO are appropriate for advancement to MREFC funding.

The panel feels an important measure of success of the CI IO project is the early integration of the instruments, and early use of the cyber facilities by representative end users. The project should include distinct milestones for critical instrument integration for alpha and beta usability testing cycles by end users. The panel recognizes that CI is one of the largest risk items in the project. This risk is mitigated by the fact that CI has a system of phased "*internal final design reviews*" (*ifdrs*) built into its development model and it is therefore inherently a function flexible deliverable model. The NSF should appoint external CI experts to the yearly OOI MREFC Project Review and annual CI Component Review (Table 1).

The CI IO has a strong focus on the creation of a service-oriented architecture, built around an enterprise service bus, "wrappers" coded by the CI IO, and other components. The software is used to build a computing facility. The facility consists of a number of modest "cyberPoPs" controlled by the project, and many other computers not controlled by the project. The responsibility for deployment and management of these cyberPoPs will need to be carefully negotiated with the other implementing organizations. A substantial amount of computing capability is envisioned to be supplied by TeraGrid, Open Science Grid, and similar resources where the facility software will be dynamically deployed. The result is an extended facility that will require O&M support (e.g., software updates, configuration management, administration, data administration, user support and security). In addition, end-to-end monitoring of all data collection and analysis capabilities is critical.

The CI IO project plan allows for a variable amount of integration with the diverse tools and methods of its end user community. The CI IO has made it clear that the science and education requirements will drive the development and integration of external tools. The Panel agrees with this approach. The amount of integration the project can bring to bear on this is budget-limited. The overall project, along with the OOI oversight group, should take care to track the amount of

integration that is feasible, making sure that the resultant product at least meets (but hopefully exceeds) the expectation of the user community.

There are, however, a number of recommendations that will improve the project. The overall OOI systems engineering is set up to maintain a close relationship among all IOs. This is especially important for CI. The overall systems engineering of the entire project should be part of the annual system level review discussed above.

22. **Recommendation:** The panel is pleased with the CI interface agreements between CI IO and the other IOs. A similar practice should establish clear specification for interfaces between CI IO software and user software (e.g. how will user community hardware and software interface with OOI CI products and services)

23. **Recommendation:** To enable the early integration of the instruments, and early use of the cyber facilities by representative end users, the project should include distinct milestones for critical instrument integration including implementing alpha and beta usability cycles by end users.

24. **Recommendation**: The team should make certain that *ifdrs* include external participants to provide a broader perspective and to insure that the architecture and technologies that were selected remain appropriate.

25. **Recommendation**: The CI IO project plan relies on integrating a number of outside software projects into its infrastructure. Some of the projects (e.g., iRODS for federated authentication) provide essential functionality to the cyberinfrastructure. The project has statements of work and reasonable controls. Other substantial software projects, however, have underestimated the level of attention that these relationships require. The project must completely understand the capabilities of these suppliers and monitor the ongoing interactions.

26. **Recommendation:** The CI IO should take due care to understand the O&M requirements, and to ensure that the construction project provides tools and methods to facilitate this work.

27. **Recommendation**: The CI IO should create a list of prioritized software tasks that enhance the degree of integration of software tools. Priorities should be consistent with the rollout of core CI features.

28. **Recommendation**: The OOI team, with input for design requirements from external participants, should document their plans for a fully functional data portal with extensibility to accommodate linkages to OOI-funded science and education results and other pertinent MREFC data portals. Development should start early in the OOI MREFC so that these interfaces work correctly when the first data streams come on line.

Coastal/Global Nodes (CGSN)

The Coastal/Global Node (CGSN) IO demonstrated a readiness for the next phase of construction within the MREFC. The approach for these components of the OOI is largely based on well-established technology augmented by carefully selected enhancements such as the “resident” gliders, enhanced buoy power systems and the winched profilers that are

necessary to fully meet the science requirements. The efforts of the CGSN to standardize technology approaches across the IOs where possible and to advantageously integrate their technologies with those of the other IOs is commendable.

The program management structure has created a traceable cost structure and associated risks within the WBS. Their approach for acquisition, testing and implementation is sound but they need to implement an explicit traceable documentation trail as they move forward in this process. It is recognized that the cost estimates must inherently be somewhat less robust for out years. On the plus side, most costs are associated with techniques and approaches applied previously by participants in this IO team such that estimates are likely to be much more accurate than might be the case for a less experienced team.

The approach presented for the engineering phase is one of progressively building the system from proven technology with an incremental build of testing new technology to minimize risk. This is a sound approach as long as the system build is accompanied by documenting the functional requirements, the test and development plan, and implementation plan. It was noted by the Panel that the level of quality control associated the engineering was high, but it was not clear that a sufficiently developed quality control tracking system was in place.

This documentation of requirements, implementation planning and quality control should be common across the CGSN sensor systems and should be integrated into the Regional Scale Nodes (RSN) as well. This approach helps provide standardization across the IOs. Implementation of this documentation should be coordinated by the respective Program Managers, Principal Investigators, and OOI management across the entire scope of the OOI.

A major comment of the recent Blue Ribbon Review was insufficient justification for the specific choice of sites for the moorings and their configuration. The Panel felt that the science justification presented at the PDR was very clear, specifically with regards to global regions most susceptible to CO_2 increase and acidification, study of shelf/slope exchange processes, and controls on shelf hypoxia. The Blue Ribbon Review also noted a lack of clarity regarding how the scientific priority for the next Pioneer Array site would be chosen. This latter issue was not as clearly addressed at the PDR

29. **Recommendation**: The CGSN plans were presented with several optional items retained as potential upscope components. The Panel strongly recommends that all upscope components be removed from the formal planning documents.

30. **Recommendation**: The current level of detail in the planning process is understandable given the relatively late start of this group. The depth of documenting requirements, budgeting, implementation and quality control needs to be further developed in order to be consistent with the entire OOI project.

31. **Recommendation**: The winched profiler component is one of the significant technical risks. The team should more clearly document approaches to reduce this risk.

32. **Recommendation**: The Panel felt that the coordinating ship time was a greater risk factor for the global moorings than was emphasized during the PDR. The planned approach for optimizing acquisition and use of ship time should be strengthened.

33. **Recommendation**: The team should consider economies of scale and efficiency that might be achieved by a common procurement plan. This could be extended beyond the

CGSN common sensors and subsystems to include components (e.g. sensors) in the RSN.

34. **Recommendation**: A formal procedure for community requests to add sensors and coordinate experiments with the CGSN must be established as soon as possible.

35. **Recommendation**: The team should document the "site survey" requirements for the mooring sites in a public, formal, versioned, traceable document. The document must include mooring site selection criteria, technical, and scientific requirements.

36. **Recommendation**: As part of the O&M plan, the team must document the steps necessary for the operator and the community to establish the next Pioneer Array site.

37. **Recommendation:** The team should carefully evaluate the issues associated with installing their moorings, including such issues as concerns of local groups, coast zone management issues, and possible environmental assessments. A cost and schedule risk assessment should be performed and changes to the project managed through the change control process.

Regional Scale Nodes

The Panel believes that the Regional Scale Nodes (RSN) IO has sufficient management depth and expertise to proceed to a design/build construction phase. The RSN IO should ensure that particular attention is directed to the management of permits, management of the integration with CI, management of the technical risks associated with the medium voltage converter, and management of schedule contingency. It must be noted that the medium voltage converter is a critical technology development that has the potential to be a project "show stopper". Experience with other projects such as MARS and NEPTUNE Canada has shown that this continues to be a difficult technological challenge.

The Panel believes that the cost estimates are reasonable at this stage of project development. The Panel is encouraged to see that the RSN IO is pursuing a fixed price procurement strategy for the primary elements of the subsea infrastructure. The RSN IO should pay particular attention to the testing requirements for the primary infrastructure and the need for a well-crafted test and integration plan for the secondary and tertiary sub sea elements. The proposed implementation schedule is reasonable and supportable.

The Panel has identified the following risk elements that should be revisited by the RSN IO:

a. The Medium Voltage Converter is the highest technical risk item. Experience on other projects shows that this is non-trivial. The current assessment of risk does not accurately reflect the potential impact of major development issues with the converter. Satisfactory completion of the ongoing medium voltage converter developments in other projects may allow this risk element to be reduced. Until this is demonstrated, the Panel recommends that this risk element should be reassessed High.

b. The successful completion of the primary subsea infrastructure contract should depend on the ability to demonstrate complete system performance. This will require representative elements of the secondary and tertiary sub sea elements be successfully integrated prior to final acceptance of the system. The RSN IO needs to ensure that the

overall integration plan will have these elements in place for acceptance testing of the primary sub sea elements.

38. **Recommendation**. The current risk assessment of the medium voltage converter development should be increased to High until another Project has deployed a reliable medium voltage converter that is representative of the RSN converter requirements or some alternative solution is attained.

39. **Recommendation**. The RSN IO needs to develop and document contingency plans to address the situation in which the current medium voltage converter developments fail to reach a satisfactory conclusion.

40. **Recommendation**. The RSN IO needs to develop the overall test, integration and deployment plans early in the Project. The breadth of the secondary and tertiary subsea elements, both in spatial coverage and number of elements, will place significant demands on the test and integration team. A careful examination early in the Project will help assure that sufficient resources are allocated to achieve this critical function in a timely manner.

41. **Recommendation**: The RSN IO needs to develop and document contingency plans to address the availability of ship time and suitable Remotely Operated Vehicle (ROV) assets during the installation and operation of the RSN.

42. **Recommendation**: A formal procedure for community requests to add sensors and coordinate experiments with the RSN must be established as soon as possible.

Appendix 1 – Charge to OOI PDR

Charge to the Ocean Observatories Initiative

Preliminary Design Review
December 4-7, 2007

The NSF requests that the OOI Preliminary Design Review (PDR) Panel assess the robustness of the technical design and completeness of the budget and construction planning for the Ocean Observatories Initiative (OOI) project. The PDR Panel will scrutinize the effectiveness of project management through this stage of development, as well as plans for the remaining design work, construction, commissioning and eventual operation of the network. The Panel will also review progress made by the Project Team on the findings of the Conceptual Design Review Panel.

Specifically, the PDR Panel will review the following major elements of the OOI Project Execution Plan (PEP):

Management:

- Work breakdown structure (WBS) and structure dictionary defining scope of WBS elements
- Project schedule (resource-loaded)
- Project governance and organizational structure
- Plans and commitments for interagency and international partnerships
- Acquisition plans, sub-awards and subcontracting strategy
- Configuration control plans
- Internal and institutional oversight plans, advisory committees, and plans for building and maintaining effective relationships with the broader research community that will eventually utilize the facility to conduct research
- Quality control and quality assurance plans
- Environmental plans, permitting and assessment of future permitting needs
- Safety and health issues
- Systems integration, testing, acceptance, commissioning and operational readiness criteria
- Plans for transitioning to operational status, including systems integration, testing, acceptance, commissioning, and operational readiness criteria for all components of the OOI

Scope: (Will largely rely on the "Blue Ribbon" results from the October-November review)

- Description of the research objectives motivating the facility proposal
- Science Requirements – the comprehensive statement of the science requirements to be fulfilled by the proposed facility (to the extent possible identifying minimum essential as well as desirable quantitative requirements), which provide a basis for determining the scope of the associated infrastructure requirements
- Description of the infrastructure necessary to obtain the research objectives
- Systems engineering requirements
- Description of scope and schedule contingency

Budget:

- Project budget, by WBS element
- Description of the basis of estimate for budget components
- Project risk analysis and description analysis methodology
- Contingency budget and description of method for calculating contingency
- Contingency management
- Project technical and financial status reporting, function of the Program Management Control Software (PMCS), and description of financial and business controls
- Estimates of operations and maintenance cost for the facility

The OOI Program Manager will work with the Panel to identify in advance specific questions and areas of concern related to the preliminary design of the OOI and its oversight and planning. These topics, in addition to the two questions below, will serve to focus the review on the areas of most critical concern:

- *Is the project ready to begin construction/implementation?*
- *Are there recommendations for further planning activities that should be done before NSF makes MREFC construction funding available to the project office?*

Panel Report:
The panel's final OOI PDR Review report will respond to each section of the charge. NSF requests that the draft report be submitted at the end of the review (December 7th) to the Project Team for fact checking. Any comments on the draft must be submitted to NSF by December 9th through the OOI Program Manager who will distribute them to the Panel. The final PDR report from the panel should be submitted to NSF by December 16th.

Appendix 2 – MREF Panel PDR Review Criteria

Management	PM	CGN	RN	CI	EPE
Work breakdown structure (WBS) and structure dictionary defining scope of WBS elements	Y	Y	Y	Y	N
Project schedule (resource-loaded)	YR	YR	YR	YR	N
Project governance and organizational structure	Y	Y	Y	Y	N
Plans and commitments for interagency and international partnerships	Y	Y	Y	Y	N
Acquisition plans, sub-awards and subcontracting strategy	YR	YR	YR	YR	N
Configuration control plans	Y	Y	Y	Y	NA
Internal and institutional oversight plans, advisory committees, and plans for building and maintaining effective relationships with the broader research community that will eventually utilize the facility to conduct research	YR	YR	YR	YR	N
Education and outreach plans	N	N	N	N	N
Quality control and quality assurance plans	YR	YR	YR	YR	N
Environmental plans, permitting and assessment of future permitting needs	YR	YR	YR	YR	NA
Safety and health issues	Y	Y	Y	Y	NA
Systems integration, testing, acceptance, commissioning and operational readiness criteria	YR	YR	YR	YR	N
Plans for transitioning to operational status, including systems integration, testing, acceptance, commissioning, and operational readiness criteria for all components of the OOI	YR	YR	YR	YR	N
Scope	**PM**	**CGN**	**RN**	**CI**	**EPE**
Description of the research objectives motivating the facility proposal	Y	Y	Y	Y	Y
Science Requirements Š a comprehensive statement of the science requirements to be fulfilled by the proposed facility which provide a basis for determining the scope of the associated infrastructure requirements	Y	Y	Y	Y	Y
Description of the infrastructure necessary to obtain the research objectives	Y	Y	Y	Y	Y
Systems engineering requirements	YR	YR	YR	YR	NA
Description of scope and schedule contingency	YR	YR	YR	YR	N
Budget	**PM**	**CGN**	**RN**	**CI**	**EPE**
Project budget, by WBS element	YR	YR	YR	YR	YR
Description of the basis of estimate for budget components	Y	Y	Y	Y	Y
Project risk analysis and description analysis methodology	YR	YR	YR	YR	N
Contingency budget and description of method for calculating contingency	Y	Y	Y	Y	N
Contingency management	YR	YR	YR	YR	N
Project technical and financial status reporting, function of the Program Management Control Software (PMCS), and description of financial and business controls	Y	Y	Y	Y	Y
Estimates of operations and maintenance cost for the facility	YR	YR	YR	YR	N

Is the project ready to begin construction/implementation?	Yes	Yes	Yes	Yes	Yes
Are there recommendations for further planning activities that should be done before NSF makes MREFC construction funding available to the project office?	Yes	Yes	Yes	Yes	Yes

Definitions

PM – Project Management, CGN - Coastal/Global Nodes, RN - Regional Nodes, CI – Cyberinfrastructure, EPE - Education and Public Engaugement.

Y – compliant, YR – compliant with recommendations, N – not compliant, NA – not applicable