

**QA CHECKLIST FOR WORKER NODE HARDWARE SYSTEM
DEPLOYMENT FOR COMPUTING DIVISION (CD) – FY10
PROCUREMENT**

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1 Purpose

The purpose of this checklist is to address quality assurance requirements as defined in Fermilab's [Integrated Quality Assurance](#) (IQA) manual and the FY11 Worker Node Procurement.

This checklist addresses quality assurance information related to the Fermilab deployment of the major hardware associated with FY10 worker node procurement for Computing Division (CD). This deployment is deemed to be a high-risk work process as defined by the Graded Approach Procedure. In order to be considered a high-risk deployment, one or more of the following selection criteria must be met:

- A. Major processes identified on lists of processes defined by each laboratory organization: No
- B. Reasonable likelihood of a 3 month delay (or 2 months for projects with duration less than 9 months) of the laboratory schedule: No
- C. **Total project cost greater than \$500K:** Yes. With the PO cost >\$500K, the worker node procurement fulfills this condition.
- D. Reasonable likelihood of an occurrence, or repetitive occurrences, with cost impact greater than \$100K: No
- E. Safety or environmental hazards, liabilities or risks greater than those generally accepted in an industrial environment: No.
- F. Reasonable likelihood of a significant reduction in the public trust or scientific reputation: No.
- G. Judgment of line management: No.

Five different sections of the IQA document are applicable to a major hardware deployment. These are:

- Chapter 5: Work Process
- Chapter 6: Design Process
- Chapter 7: Procurement
- Chapter 8: Inspection and Acceptance Testing
- Chapter 10: Suspect/Counterfeit Items

The checklist is based on the IQA requirements for each of the above chapters.

2 Usage

The text in the Section 3 is considered to be a part of the Quality Assurance documentation for the procurement. The IQA requirements for each item in the checklist are detailed in the section 4. When filling out the checklist, the appropriate document names are referenced only once. The use of the checklist is guided by the Graded Approach identified for the system under consideration. This checklist may also be used for other similar procurement.

3 Quality assurance checklist for the Worker node system deployment

System Description

- a. System Name: Fermilab Worker Node Procurement FY10
- b. Brief system description: CD Consolidated Worker Node Deployment.
- c. Reason why it is a high-risk item using Graded Approach: Total Requisition cost; \$781,202.00 > \$500K
- d. Designation of Design Authority: Glenn Cooper

This deployment is associated with multiple project and task codes. The procurement was executed using Purchase Order (PO) 595055 with the following line items:

1. Task Code 50.01.03.60.02 - \$106,493.35
2. Task Code 50.01.04.60.02 - \$ 425,973.38
3. Task Code 50.01.03.60.02 – 57,810.59
4. Task Code 50.01.03.60.01 - \$33,469.34
5. Task Code 50.01.04.60.01 - \$33,469.34
6. Task Code 50.01.06.10.01 - \$36,512.00
7. Task Code 50.01.06.10.04.01 - \$36,512.00
8. Task Code 50.01.06.10.03.01 - \$36,512.00
9. Task Code 40.12.01.23 - \$14,090.00
10. Task Code 50.01.04.60.02 - \$360.00

Detailed documents are available on the Sharepoint Server (restricted):

https://sharepoint.fnal.gov/cd/sites/wn_purchase/Shared_Documents

3.1 Work process

3.1.1 Work process control

- a. Workmanship standards: See Attachment A: Fermilab Worker Node Requirements to the Request for Proposal (RFP) for workmanship standard specification for the supplier.
- b. Equipment to be used: No specific equipment is needed by CD employees. Suppliers are trained in Fermilab procedures. Job Hazard Analysis (JHA) and Supplier Training Records are maintained.
- c. Specification for materials: Main hardware specification is included in the RFP and purchase order documents.
- d. Process measurement points: A detailed schedule and timeline is described in the Attachment A section D of the RFP. During the acceptance test process, milestone data are logged on the Sharepoint Server. A detailed acceptance test sequence is described in the Attachment A section E. During the acceptance test process, data are logged on the monitoring website.
- e. Measurement standards: The methods of collecting and analyzing the data for the deployment system are specified in each vendor's proposal. The winning vendor proposal is on the Sharepoint server.

3.1.2 Specific controls for procurement work processes

3.1.2.1 Item control

Description of how items are identified and controlled, with their traceability maintained during receipt, shipping, storage, handling, installation, use, and disposal: For the worker node cluster, the supplier follows the workflow specified by CD Facility Management group and Fermilab Properties group. Once the supplier assembles the equipment, CD staff members coordinate with the supplier regarding the storage, handling, installation and use. As installation progresses, CD staff members attach the property tags generated by the Fermilab Property databases.

3.1.2.2 Maintenance

Maintenance plan documentation: The system is maintained by the supplier under the three year mandatory warranty. A hardware service call is placed by system administrators if a hardware problem occurs. Hardware service requests are tracked at <http://miscomp.fnal.gov/misjob/svcall.html>

The system is allowed to run beyond this period if it remains trouble-free. When the system is no longer maintainable or not cost effective to maintain, it is decommissioned and disposed of by CD.

3.1.2.3 Readiness review

- a. Readiness review procedure: The acceptance test procedure defined in the Attachment A: Section E which is equivalent to the general purpose Readiness Review procedure for the supplier.
- b. Does this deployment require additional readiness reviews at specified intervals? If yes, explain: For the worker node deployment, CD system administrators execute various burn-in tests. At the conclusion of this test, the system is released to the general users. At this point the system is declared to be in production. At this

3.2 Design process

3.2.1 Design process steps

3.2.1.1 Planning documents

- a. Controlled, documented requirements, including acceptance criteria:
 - Request for Proposal (RFP) package from the previous year
 - Additional information obtained through informal testing by CD personnel.
- b. Additional planning documents: Following documents are also used for planning purposes:
 - a. REX Tactical Plan
 - b. GP Grid Plan

3.2.1.2 Input

- a. Documentation of committee meeting minutes where design inputs and constraints, including applicable orders, codes, standards, policies, and procedures were discussed.
- b. Records of reviews for accuracy and completeness and to identify any ambiguity or conflict:

- a. RFP review meeting minutes and agendas are posted on the Sharepoint server.
- b. Records of the results of Best Value Evaluation activities (July – August 18) for this package is maintained on the Sharepoint server.

3.2.1.3 Process documentation

- a. Design process management procedure including the process of design modification: Design documents, including Technical Specifications, Benchmarking standards, are developed by the DA and his team and extensively reviewed in a collaborative manner using a series of meetings (April 13 – August 18) held with key developers and facility representatives. The procurement package is also reviewed by the Fermilab Buyer. Once released to a predefined list of prospective bidders, if amendments/clarifications are made to RFP, it is communicated to the list of bidders. The final award is given using a documented best value identification process. Minutes of the meeting and the scoring information are documented.
- b. Governing documentation for collaborative design activities, e.g. Memoranda of Understanding (MOU) and/or Statements of Work (SOW): Not applicable.
- c. Risk assessment documentation to define the level of steps / level of rigor of controls prior to commencement of work: Not applicable

3.2.1.4 Outputs

- a. Design documentation including drawings, specifications, test/inspection/acceptance plans, fabrication/assembly procedures, maintenance requirements, and reports: Following documents contains the comprehensive design output:
 - a. Vendor benchmarking for the Fermi Worker Node Requirements FY10
 - b. RFP work package and associated amendments
 - c. Attachment A for the specification
- b. Final post-production and/or construction As-built drawings and fabrication/assembly procedures showing actual configuration are located on the Sharepoint server.
- c. The final design closeout documentation package, including manuals (electronic or otherwise) qualification test results, final revisions of fabrication drawings, marked as-built drawings, proof-tests, operational readiness review/readiness assessments documents etc. : No design closeout documentation is available.

3.2.1.5 Review

Review documentation (as appropriate, design reviews may be formal, structured, documented, comprehensive and objective at a level commensurate to the scope and complexity of the design to ensure conformance to requirements): N/A.

3.2.1.6 Verification and validation

Documentation of verification and validation: The entire system is delivered incrementally with multiple racks and installed as received. These racks are tested incrementally. The supplier fixes problems identified during the acceptance testing. The payment is made when the accounts payable form is signed by the Requestor (DA). Records of the signature and payment are maintained by the Fermilab Accounts Payable. The process described in the Fermilab Procurement Manual¹ is followed.

3.2.1.7 Changes

- a. Requirements change management procedure: Requirements changes and clarifications are managed using amendments to the procurement work package for the RFP.
- b. Design change management procedure including procedure for temporary modifications: As of date, there is no defined CD procedure for managing design changes. However, as of date, no major design changes requiring additional costs were needed for this deployment.
- c. Records of requirements and design change including approval records: No changes were made after the final design. There is no formal procedure for to maintain changes to requirements. However, as of date, no such changes were made after the purchase order was awarded.

3.2.1.8 Configuration management

Configuration control record including plans, specifications, analyses, design and basis for design: There is a layout plan for the cluster is under revision control using CDdocDb. However, a formal configuration management procedure for various components of the system does not exist. Each compute component is under item control using the Properties database. When an item associated with the cluster fails during the warranty period, the element is mostly fixed by the supplier “in situ”. If that is not possible, then the supplier removes the item and takes it out of Fermilab processing the material move with PREP. Some suppliers have their own “material move” processes; however, the current FY10 Worker Node supplier does not have such a process.

3.3 *Procurement*

3.3.1 *Procurement documents*

Content of the RFP package: The RFP package contains the full specification, evaluation criteria, Fermilab standard contractual requirements, and the benchmarking package.

3.3.2 *Supplier evaluation*

The supplier evaluation procedure is defined in the Fermilab Procurement Manual. For the Fermi Worker Node Requirements FY10 procurement a “Best Value Evaluation” process is defined specific to the procurement.

3.3.3 *Purchase requisition review*

Procedure for reviewing procurement packages: The RFP is reviewed by a committee members and senior management. Once the package is readied by the committee, the buyer from the Fermilab procurement department reviews the package. Approvals of senior management are required for the procurement package. After the RFP responses are received, the Best Value Evaluation team determines which supplier should get the Purchase Order (PO) award. The recommendation is documented on the Sharepoint server.

3.4 Inspection and acceptance testing

3.4.1 Inspection and testing process

Procedure to control nonconforming items: Items associated with the worker node cluster are purchased with a three-year warranty which is equal to the typical life-time of the equipment. Non-conforming (failed, damaged or items that failed to meet specification) items are either fixed by the supplier on-site or removed for replacement after completing the Material Move process at CD PREP desk.

Burn-in testing: After the complete installation, the system undergoes a burn-in test. Various online software tools are used during the burn-in test and beyond. These are:

- Nagios: <https://fefmon1.fnal.gov/nagios/> Example: select "All host problems"
- Ganglia: <http://fefganglia.fnal.gov/> Example:
http://fefganglia.fnal.gov/?c=CDFAF&m=load_one&r=hour&s=descending&hc=4&mc=2

At the conclusion of the burn-in testing, an email is sent to the supplier stating the acceptance. Inspection and test records

3.4.2 Documentation of inspection and acceptance test results:

Performance of the cluster is incrementally recorded in a spreadsheet available on the Sharepoint server. Acceptance test records are available on the sharepoint site.

3.4.3 Control of measuring and test equipment

This section is not applicable to this particular procurement. No precision hardware is required for the installation and measurements related to the worker node cluster.

- a. Documentation of the measuring and test equipment (M&TE) used for inspection and acceptance tests including M&TE standards: N/A
- b. Uniquely identified and traceable calibration records: N/A
- c. Identification of computer programs that are part of the calibration of the equipment when calibrating and/or checking the equipment for use: N/A

3.5 Suspect and counterfeit items(S/CIs)

3.5.1 Prevention

Procedure to prevent the purchase of S/CIs: Subcontract requirements for Suspect and Counterfeit Items are defined in the section 38 of the Fermilab Subcontract General Provisions (FL-1) documentⁱⁱ. This document is attached to all RFP work packages. The CD division has a trained S/CI coordinator who is responsible for overseeing all S/CI related activities for the division as specified by the laboratory's S/CI programⁱⁱⁱ document. Managers associated with the facilities received training prescribed by the Laboratory. See the detailed Controlling Suspect/Counterfeit Items Procedures.

3.5.2 Detection

Inspection records for detecting S/CIs: The Laboratory procedure "Controlling Suspect/Counterfeit Items Procedure 1006.1001^{iv}" provides the details for the detection methods for S/CIs. It is not clear how CD uses this procedure to verify that no S/CIs entered the laboratory with the newly procured system.

3.5.3 Reporting

Procedure for reporting S/CIs: The Laboratory procedure “Controlling Suspect/Counterfeit Items Procedure 1006.1001” provides the details for the detection methods for S/CIs

4 Excerpts from IQA: QA requirement for the system deployment process

In this section, excerpts from the applicable sections from IQA are given for reference only.

4.1 Work process

Work includes the design, operation, maintenance, modification, and construction of experiments, accelerators, systems, and procedures by Fermilab employees, regardless of location, and any personnel working on-site at Fermilab. A graded approach is used to determine the level of controls applied to work performed at Fermilab.

The set of controls applied to work processes includes:

- written procedures for activities of sufficient complexity or potential hazard
- periodically monitoring and assessing performance
- personal accountability
- Specific provisions for activities not otherwise covered in this document, including facilities management, maintenance, materials management, shipping and receiving

4.1.1 Work process control

Management defines workmanship standards, equipment to be used, and specification for materials, process measurement points, and measurement standards.

4.1.2 Specific controls for work processes not already defined

4.1.2.1 Item control

Using a graded approach, items are identified and controlled, with their traceability maintained during receipt, shipping, storage, handling, installation, use, and disposal. These controls are commensurate with the item's application, usage, and associated risk and are managed by divisions/sections/centers.

The requirements for controlling and maintaining property, equipment, items, and the site infrastructure follow DOE Order 430.1B, *Real Property Asset Management*. Personal property is controlled according to the Property/Inventory Control Policy & Procedure Manual.

Chapter 10 describes the control of Suspect/Counterfeit Items.

4.1.2.2 Maintenance

Divisions/sections/centers are responsible for ensuring maintenance is performed on facilities and equipment under their care. FESS is the primary maintenance service provider for facilities and the laboratory's infrastructure and these services are agreed upon between FESS and the divisions/sections/centers. Maintenance plans are documented by

divisions/sections/centers. The organization coordinating or performing the maintenance is responsible for ensuring that records of maintenance are kept.

4.1.2.3 Readiness review

Readiness reviews are conducted prior to the start of operations that are new or have been significantly changed. The extent and detail of the reviews are commensurate with the scale, cost, complexity, hazards, and programmatic significance. Reviews which require ES&H approval to operate accelerator facilities are required to follow FESHM 2010. Divisions/Sections/Centers document readiness reviews for specific activities performed in their respective areas. In addition certain research projects are required by orders other than DOE O 414.1C to perform readiness reviews at specified intervals.

4.1.2.4 Calibration of process equipment

It is the responsibility of each division/section/center to identify, monitor and maintain key process equipment that requires calibration or verification. Results are maintained. (See also: Chapter 8 Inspection and Acceptance Testing.)

4.2 Design process

4.2.1 Design process steps

The following steps are applied as appropriate, using graded approach.

4.2.1.1 Planning

The requirements, including acceptance criteria, are understood by all relevant divisions/sections/centers and departments. These requirements are documented and updated accordingly.

All parties agree on the organizational and technical interfaces and arrange information and communication channels.

After sufficient design iteration, requirements, plans, cost, and schedule estimates are established as the baseline. From this stage forward changes are managed in accordance with the project's configuration management plan and implementing procedures.

4.2.1.2 Input

Design inputs and constraints, including applicable orders, codes, standards, policies, and procedures, etc., are identified. Design inputs are reviewed for accuracy and completeness and to identify any ambiguity or conflict.

4.2.1.3 Process

The design process translates inputs into design output documents and actions that are technically correct and compliant with requirements.

The design process is managed by the DA. The design process controls are applicable to in-house, contracted, and collaborative design activities and services. Those providing contracted design services are evaluated and selected based on their ability to meet specified requirements demonstrated by equivalency of their programs or adherence to

Fermilab processes. Collaborative design activities are generally governed by Memoranda of Understanding (MOU) and/or Statements of Work (SOW).

Design processes apply to original design and design modifications.

Design efforts undergo risk evaluation by the DA to define the level of steps / level of rigor of controls prior to commencement of work. When applied to research and development activities, design processes are tailored to meet the controls necessary for successful outcomes. As appropriate, R&D / experimental plans specify the necessary controls and documentation contained in the activity's / project's Project Execution Plan and are approved by the DA.

4.2.1.4 Outputs

The completed design is recorded in design output documents such as drawings, specifications, test/inspection/acceptance plans, fabrication/assembly procedures, maintenance requirements, and reports. As-built drawings and fabrication/assembly procedures are maintained after production or construction to show actual configuration.

A documentation package, including qualification test results, final revisions of fabrication drawings, marked as-built drawings, proof-tests, operational readiness review/readiness assessments, etc., is assembled and retained as the final design closeout package.

4.2.1.5 Review

Reviews are conducted at a level commensurate to the scope and complexity of the design to ensure conformance to requirements. As appropriate, design reviews may be formal, structured, documented, and are comprehensive and objective.

Design reviews are performed by technically knowledgeable persons and may include technical experts from outside the design team and in certain cases, outside of the laboratory.

4.2.1.6 Verification and validation

Fermilab has a documented verification process that reviews design outputs against their ability to meet requirements.

Design validation is accomplished through the use of the construction or assembly or by testing the complete prototype system (or subsystem) during and after assembly. Results of validation tests are documented and maintained.

4.2.1.7 Changes

A design change is defined as one that alters a component or system function, method of performing the function, or design configuration.

Levels of change control vary with the magnitude of the proposed change. Proposed changes are reviewed by the same organizations that reviewed and approved the original design. This ensures that changes do not inadvertently challenge or violate safety or operational boundaries or conditions set by the original design.

Temporary modifications receive the same levels of control as permanent modifications. Clients inform the DA of any new requirements/changes to specifications or acceptance methods via established communication channels. The DA reviews changes to the functional requirements and specifications against their ability to meet requirements.

Changes to requirements are documented and all relevant divisions/sections/centers and departments are made aware of the changes involved.

4.2.1.8 Configuration management

Configuration control includes plans, specifications, analyses, design and basis for design. They provide an accessible, archived history of initial baseline, modifications, and changes.

Changes, additions, and modifications to the design processes are controlled in accordance with the activity's or project's configuration management plan and implementing procedures. Closeout documentation is inspected, reviewed, and accepted by the DA.

4.3 Procurement

4.3.1 Procurement documents

Fermilab procurement documents are generated and managed in accordance with the Procurement Manual. These documents include specifications, standards, and other applicable documents referenced in the purchase requisition and are incorporated into the purchase order.

4.3.2 Supplier evaluation

Prospective suppliers are evaluated based upon their ability to meet quality, technical, and financial performance criteria, and to operate in a safe and environmentally compliant manner. The graded approach is used to determine the level of evaluation and controls. Potential suppliers should be identified early in the design and procurement process to allow sufficient time to evaluate their capabilities. The supplier evaluation process is the joint responsibility of Procurement and the requester when technical expertise is necessary.

Evaluation and monitoring of supplier's performance during the life cycle of the purchase order are performed to ensure that technically acceptable items are produced and services continue to meet the quality, technical, delivery, and other performance requirements. Corrective actions in accordance with purchase order terms and conditions are implemented should suppliers not perform as required.

Flow down of requirements to subcontractors at any tier is assured through terms and conditions of the purchase order.

The supplier evaluation and monitoring process is addressed in the Procurement Manual.

4.3.3 Purchase requisition review

The purchase requisition is created, owned, and processed by the requestor and division/section/center or area requisition preparer. Responsibility for the accuracy of purchase requisition data and requirements resides with the requestor. Requisitions are reviewed and approved by the requisitioning organization prior to being processed by BSS Procurement.

Controls are applied based on purchase categories, dollar value and ES&H impact. Procurement may return incorrect or incomplete purchase requisitions. A history of issues and revision is maintained within the financial system.

4.4 Inspection and acceptance testing

This section establishes the process for the inspections and tests performed at Fermilab that verify that the physical and functional aspects of items, services, and processes meet requirements and are fit for use. The performance expectations, inspections, and tests are considered during the design phase and where appropriate, are specified in the design output and/or procurement documents. The graded approach is used to determine the level of controls applied to specific activities by division/section/center heads or project managers.

4.4.1 Inspection and testing process

Inspection and acceptance testing plans, where applicable, identify item characteristics and processes to be inspected/acceptance tested, inspection techniques, acceptance criteria, hold points, and the organization responsible for performing the inspection. Where deficiencies are identified appropriate corrective and/or preventative actions are taken.

For this purchase, major fixed price procurement, section 4 of the Fermilab Fixed Price Subcontract Terms and Condition (FL-2.pdf) document, attached to the RFP, contains the guiding principles for Inspection and Testing.

4.4.1.1 Control of non-conforming items

Items that do not conform to specified requirements are subject to controls to prevent their inadvertent installation or use. Divisions/sections/centers are responsible for control of nonconforming items. Controls include identification, documentation, evaluation, segregation (when practical), item disposition (reject, repair, rework, use-as-is), and notification to affected organizations: This RFP contains a three-year warranty requirement. The Warranty clause for the procurement is described in the section 5 of the FL-2.pdf document. The supplier is responsible for fixing any issues with the hardware when notified by FEF Department personnel using a Fermilab servicedesk ticket. Any non-conforming item is returned to the supplier immediately and not held in the premises.

4.4.2 Inspection and test records

Documentation and preservation of Inspection and test results: The inspection and test status of items or processes requiring examination are clearly identified to ensure that only those with acceptable results are used. At a minimum inspection/test records identify the following: item(s) inspected, the inspection/test procedure used, who performed the inspection/test, the identification number(s) of the M&TE used to perform the inspection/test, the inspection/test data, the inspection/test criteria, and the inspection/test results.

4.4.3 Control of measuring and test equipment

The measuring and test equipment (M&TE) used for inspection and acceptance tests are identified, calibrated, maintained, and controlled commensurate with their intended use.

Procedures are established by divisions/sections/centers for testing, retesting, adjusting, and recalibrating M&TE.

Equipment is checked to ensure it is the proper type, range, accuracy, and precision and is uniquely identified and traceable to its calibration records.

The process of calibration compares an unknown, a test item, or an instrument with reference standards according to a specific procedure. Calibration standards are traceable to the National Institute of Standards and Technology or equivalent. Where no recognized standard exists, the basis for calibration is defined and documented.

When M&TE or standards are found to be out of tolerance, appropriate evaluations are performed to assess any adverse impact on previous inspection, testing, data collected or calibration using that equipment and to determine the acceptability of items previously inspected or tested and appropriate notifications made. The evaluation, including conclusions, is documented.

All M&TE equipment not operating to specifications is identified and pulled from service or locked out and are not returned to service until passing calibration requirements.

Consideration is given to computer programs that are part of the calibration of the equipment when calibrating and/or checking the equipment for use.

4.5 Suspect and counterfeit items

4.5.1 Prevention

Methods to prevent the purchase of S/CIs are based on making all purchases from reputable suppliers and distributors:

4.5.2 Detection

The primary means of detecting S/CIs is through inspection.

4.5.3 Reporting

If S/CIs are discovered, the reporting process follows the Suspect/Counterfeit Items Program and supporting procedures. This includes notifying the area supervisor, senior safety officer, and quality assurance representative. FESHM manual 3010 is consulted to determine the appropriate reportability category.

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- ⁱ Fermilab Procurement Manual
 - ⁱⁱ Fermilab Subcontract General provisions (FL-1 Rev12-09) – see the section on S/CI
 - ⁱⁱⁱ Suspect/Counterfeit Items Program 1006
http://www.fnal.gov/directorate/OQBP/index/oqbp_active_procedures/Suspect%20Counterfeit%20Items%20Program%20Rev001.pdf
 - ^{iv} Controlling Suspect/Counterfeit Items Procedure 1006.1001
http://www.fnal.gov/directorate/OQBP/index/oqbp_active_procedures/Controlling%20Suspect%20Counterfeit%20Items%20Procedure%20Rev001.pdf