Jefferson Lab
Thomas Jefferson National Accelerator Facility

Hall A Moller Polarimeter Q4 Quadrupole Magnet

TECHNICAL SPECIFICATION

A000000401-0800-SPEC

March 19th, 2012

Written By Robin Wines Date 10 Apr 2012
Robin Wines– Hall A Engineer

Approved _____ Date 4/13/12
Javier Gomez – Deputy AD for Physics

Approved _____ Date 4/13/12
John LeRose– CAM

Approved _____ Date 4/13/2012
Glenn Young - APM for Physics

Approved _____ Date 16-APR-2012
~~Steven Smith– Hall QA/CLM~~ BRUCE LENZER, 12GEV QA OFFICER

Approved _____ Date 4/13/2012
Paul Collins – 12 GeV Safety Manager

TABLE of CONTENTS

1.0 INTRODUCTION

1.1 Purpose

The Thomas Jefferson National Accelerator Facility (Jefferson Lab) Hall A Moller Polarimeter requires 4 quadrupole magnets to be installed in the Experimental Hall A facility. Three of the quadrupole magnets exist. This Statement of Work covers the requirements for the 4th quadrupole (Moller Q4) magnet.

1.2 Scope of Work

1.2.1 The subcontractor shall, unless otherwise noted, furnish all labor, materials, equipment and facilities to fabricate, test, inspect and deliver the Moller Q4 magnet in accordance with this specification and the specified drawings. Jefferson Lab will appoint a Subcontracting Officer Technical Representative (SOTR) upon award of this contract. Any deviation from this specification and/or specified drawings is to be submitted to the SOTR for approval. The SOTR will respond within 10 working days.

1.2.2 Jefferson Lab reserves the right to have its SOTR and/or Subcontracting Officer witness any or all manufacturing steps, tests and inspections. Jefferson Lab is to be notified 10 working days prior to any testing.

1.2.3 Upon receipt, Jefferson Lab will inspect the magnet assembly. Acceptance will be defined by full compliance with this specification, drawings and contract agreement.

1.2.4 The subcontractor shall supply all documentation required in this specification.

1.2.5 Subcontractor may submit alternatives to the design as defined in this specification and drawings for Jefferson Lab approval. Any alternatives will require documentation that the performance requirements will be met as defined in Table 1.

2.0 REQUIREMENTS

2.1 Performance

The Moller Q4 magnet consists of four yoke/pole quadrant assemblies that are composed of machined 1018 steel and assembled with its electrical water-cooled windings. The electrical windings consist of four main water cooled coils electrically connected in series such that adjacent poles are of opposite magnetic polarity, forming a quadrupole magnetic field. The Moller Q4 magnet is to meet the performance requirements as defined in Table 1.

Moeller 4th Quadrupole Magnet	
Bore, cm	10.16
Effective Length, cm	35.66
Maximum current ,A	280
Pole tip field at 100A, kG	2.42
Pole tip field at 300A, kG	6.135
Integrated GL at 100A, G	17524
Yoke	solid
Yoke material	1018
Weight,kg	500
Number of coils	4
Turns per coil	50
Resistance @20C, ohm	0.0767
Voltage drop at max current	8.5VDC
Total water flow, gpm	1.0
Max. operating pressure, psi	35
Cooling medium	LCW
Temperature Rise	40 F

Table 1. Moller 4th Quadrupole Parameters

2.2 Dimensional Control

The Moller Q4 Quadrupole Magnet Assembly and parts of the Assembly shall conform to the geometry and tolerances stated on the drawings and within this specification.

2.3 Material and Parts

2.3.1 The Moller Q4 Magnet shall be fabricated of only materials and components as defined on the drawings and within this specification. No alternate sources, types or methods are allowed to be used without written permission from the Jefferson Lab Subcontracting Officer's Technical Representative (SOTR).

2.3.2 No magnetic chucks, lifting devices or degaussing coils shall be used in the handling, machining and processing of the steel cores at any point in the manufacturing, assembly or transportation process.

2.3.3 Materials shall be rejected in the event that they have been shipped or stored improperly such that contamination or degradation has taken place. No material shall be used that is beyond its published shelf life.

2.3.4 All items listed by brand name are appended as "or Jefferson Lab approved equivalent".

2.4 Coil Fabrication

2.4.1 Coil assemblies shall be fabricated with no conductor joints or splices.

2.4.2 Conductor Development Association Alloy #C10200 or Alloy #C10300 annealed hollow OFHC copper conductor shall be used. The conductor used shall be within dimensional tolerances as stated in the drawings. Documentation of the conductor compliance shall be provided to Jefferson Lab.

2.4.3 The conductor shall be inspected by the subcontractor to verify it is free from excessive warp, twist and camber; free from slivers, burrs or other injurious defects on the surface; and free from bore obstructions that may compromise the flow requirements.

2.4.4 Conductor surfaces shall be cleaned at stages of fabrication such that dusts, oils and other contaminants are removed prior to assembly and preparation for delivery to Jefferson Lab. Subcontractor shall insure that no lint, dirt or any other inclusion is encapsulated during the winding and curing process.

2.4.5 The conductor turns are to be insulated from each other with fiberglass sleeving or tape. The coil assembly is to be insulated from electrical ground and bound in a stable configuration using a fiberglass ground wrap.

2.4.6 Wire turn-to-turn bonding shall be by a vacuum pressure impregnation (VPI) and heat cured process. The process shall structurally secure all turns and result in a void-free monolithic matrix construction. The subcontractor shall design a sizing fixture or VPI mold to accomplish this task. Fixture/mold must be sized so that cured coils are within specified

tolerances. Excess epoxy shall be removed/cleaned so that dimensional tolerances are maintained.

2.4.7 Water cooling passages shall be capped during fabrication in order to exclude epoxy and other particulates. Passages shall be verified to be free of obstructions, internally cleaned, rinsed, dried/purged and recapped prior to preparation for shipment.

2.4.8 Subcontractor shall use a degassed clear epoxy capable of withstanding a 200C continuous duty operating temperature. Any alternative epoxy formulation and curing process is to be submitted to Jefferson Lab for approval. Submittal must include documentation verifying radiation hardness of the proposed alternative epoxy.

2.4.9 Each coil shall be identified and labeled by a unique number.

2.5 Steel Yoke and Pole

2.5.1 The Moller Q4 yoke and poles shall be fabricated from 1018 hot rolled steel.

2.5.2 The subcontractor shall provide a certified chemical analysis of the steel.

2.5.3 The Moller Q4 magnet is to be fabricated from one heat of steel.

2.5.4 Final machining shall be such that work hardening is limited to less than 0.02 inches beneath the finished pole surfaces and 0.05 inches beneath all other outer yoke surfaces.

2.5.5 Should a void be exposed during machining of the parts, the Jefferson Lab SOTR shall be notified for approval of repair procedures. Plugging by welding is not acceptable.

2.6 Assembly

2.6.1 Coils shall be centered around the poles.

2.6.2 Coils shall be mounted on each pole using an insulating barrier to prevent epoxy from rubbing directly on the yoke and pole steel.

2.6.3 Busses shall be electrically isolated from the core.

2.6.4 Terminal blocks for the power cable connections shall be attached to the yoke and supporting of the power cable weight.

2.6.5 Coils and water connections shall be labeled to identify assembly procedure.

2.6.6 Magnet shall be assembled in an environment which prevents particulates and debris from being trapped between mating surfaces.

2.6.7 The completed core assembly shall be cleaned, masked, primed and painted as noted on the drawings. All hardware is to be masked during painting. All unpainted surfaces shall be covered with a heavy duty rust inhibitor.

3.0 INSPECTION AND TESTING

3.1 Vendor shall document all material, dimensional and testing inspections during the manufacturing process in a quality control form. All results are to be supplied to Jefferson Lab on the quality control form.

3.2 The subcontractor shall perform detailed dimensional inspections on the coils and core assembly during the manufacturing process to provide proof of compliance to the required tolerances. Subcontractor shall verify quadrants are aligned according to the drawing dimensions. Subcontractor shall measure and document the gap dimension and the coil spacing. Any manufactured tooling required to verify dimensions is to be supplied to Jefferson Lab.

3.3 Hi-Pot Test – Each assembly shall be tested for insulation integrity and ground shorts with a Hi-Pot tester. A recorded leakage current of less than 10 microAmperes is required for acceptance.

3.4 Turn-to-Turn Test – Subcontractor shall prove and document that any delivered coil has the specified number of turns and that no turn-to-turn shorts exist in the coils. This shall be done by performing a Surge Comparison Test between a standard coil and each production coil.

3.5 Pressure Test – Cooling system shall be leak tight tested and documented to internal pressure of 180psi for 30 minutes and verified that no water leaks exist.

3.6 Flow Test – Cooling system shall be water flow tested to insure no restrictions exist and the required flow rate can be obtained at the pressure differential.

4.0 SHIPPING

4.1 The subcontractor shall package the magnet assembly in a container suitable for ground transportation. This shall include measures to protect the assembly from damage in transit and from weather during transit and outdoor storage. The magnet shall be bagged in clear polyethylene plastic with desiccant salt packets added for moisture protection. Crates or pallets shall be provided such that handling can be done with slings from overhead cranes and forklift transport.

4.2 The crate shall be marked with the addressee, shipper, contract number, contents and shipping weight.

4.3 A complete copy of manufacturing records (quality control and test results) shall accompany the magnet assembly.

4.4 Subcontractor shall arrange and be responsible for the safe delivery of the magnet assembly to Jefferson Lab.

5.0 QUALITY ASSURANCE PROGRAM REQUIREMENTS

The subcontractor shall have written QA procedures that cover at least all of the below items. This QA process and procedure shall be described in a written manual or plan and shall be subject to review and approval by the Jefferson Lab Technical Representative and Jefferson Lab QA Department prior to start of work. This review will require fourteen calendar days after receipt of documents by Jefferson Lab. The manual or plan shall, as a minimum, cover the following requirements.

5.1 Organization

The subcontractor's organization, to be represented on an organizational chart, shall demonstrate that personnel responsible for quality assurance shall have sufficient authority and independence to identify quality problems, verify conformance of supplied items to specified requirements, control nonconformance and obtain satisfactory resolution of conflicts involving quality.

5.2 Scope of Quality Assurance Activity

The offeror shall demonstrate that a Quality Assurance Program that the offeror and subcontractor have utilized will be effective in all phases of the project. This shall include design, procurement, manufacturing, inspection, installation and test. There shall be hold points in the subcontractor's manufacturing plan for required JLAB witness inspections and a minimum of 10 days notice required for all JLAB witness inspections.

5.3 Procurement Control

The offeror shall prepare a manufacturing plan that will include milestones. This plan shall demonstrate the offeror's ability to meet the schedule required by Jefferson Lab. This plan shall require Jefferson Lab approval prior to award of subcontract. This plan must address the specific materials inventory control and traceability of materials.

5.4 Document Control

The subcontractor's Quality Assurance Program shall provide for a system of distribution and control of approved engineering and procurement documents (including specifications, drawings, CAD files, procedures, purchase orders, and other critical documents) as well as changes thereto. Such a system shall provide for control of superseded or voided documents by such means as recall, clearly marking as "VOID", or other effective means of assuring that superseded documents are not inadvertently used.