

Argonne National Laboratory

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**DOCUMENT NO. L143-00093**

**SLAC NO. SP-381-004-26**

**STATEMENT OF WORK**

**FOR**

**LCLS UNDULATOR SUPPORT**

**AND**

**MOTION SYSTEM ASSEMBLY**

**WBS L.1.04.03**

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# ARGONNE NATIONAL LABORATORY

\*Document No.  
**L143-00093**

## NOTIFICATION OF SPECIFICATIONS REVISION

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**Title: Statement Of Work For LCLS Undulator Support  
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\*The document number as it appears on this page only shall be used to identify this document. The last two digits denote the revision number of this document (see Revision Authorization block below).

This document is fully representative of the Document No. only when the revision number on its pages correspond with those in the index below.

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**1.0 INTRODUCTION:**

The Linac Coherent Light Source (LCLS) will be the world's first x-ray free electron laser when it becomes operational in 2009. The LCLS is a US-DOE-funded project that is currently under construction. Design and construction are accomplished by a partnership of three US national laboratories including the Stanford Linear Accelerator Center (SLAC) as home laboratory, together with the Lawrence Livermore National Laboratory (LLNL) and Argonne National Laboratory (ANL). The start of construction was in FY2006. Pulses of x-ray laser light from the LCLS will be many orders of magnitude brighter and several orders of magnitude shorter than presently-available x-rays from other sources. These characteristics will enable frontier new science in areas that include discovering and probing new states of matter, understanding and following chemical reactions and biological processes in real time, imaging chemical and structural properties of materials on the nanoscale, and imaging non-crystalline biological materials at atomic resolution.

In a FEL, the actual lasing occurs as a result of the electron beam passing through a precision magnetic device called an undulator. Construction of the undulator system is the responsibility of ANL.

**2.0 SCOPE:**

**2.1 Scope of Work for the Support and Motion System.**

Thirty-four (34) support and motion systems, each comprised of a girder assembly and a fixed support general assembly, are required for the LCLS project. The present procurement is for the manufacture and assembly of the LCLS Undulator Support and Mover System Assembly which is two separate assemblies, the Fixed Support General Assembly and Undulator Girder Assembly. An experimental support and motion system with undulator was constructed and tested at the Advanced Photon Source (APS) at ANL. Some design and value engineering changes were made as a result, and are incorporated into the production unit design.

The production contract may be awarded to one or two Contractors with each delivering a First Article set of LCLS Undulator Support and Motion System Assembly. After a positive evaluation of contractor performance on the First Article, the contractor or



contractors would be given approval to proceed with the manufacture of additional sets of undulator supports up to a total of 34 sets including First Articles. If two contractors are used, the quantity awarded to each could vary according to their performance on the first article.

**2.2 ANL Furnished Components.**

**2.2.1** The following motors, potentiometers, bearings, gear boxes, and positioning tables shall be furnished by the Laboratory: The quantities shipped to the contractor(s) may be in excess of the amount needed for building the required quantities of the Support Mover system. The contractor(s) shall ship the spare parts with the last of the assemblies to SLAC.

- a) IMAC Motion Control 174804-CPO-S115, 170 series position table.
- b) IMAC Motion Control EPL-N34-490G Gearbox 490:1 NEMA Output Face.
- c) IMAC Motion Control UPL-N23-010 Gearbox 10:1 NEMA Output Face.
- d) RPL-H-064-050 3 Stage Reducer from IMAC Motion Control.
- e) Animatics Smart Motor, part number: SM2320D-PLS
- f) Novotechnik Rotary Potentiometer P2201-A502
- g) Novotechnik Linear Potentiometer TR100 Position Transducer
- h) All bearings for the Cam Actuators.

**2.2.2** The Housing Support Plates, L1430401-100405, shown on the Slide Assemblies, L1430401-100424 and 1000425, are being furnished by ANL and will be shipped direct to SLAC.

**2.3 First Article.**

Each Contractor shall deliver one First-Article set of the Fixed Support General Assembly per L1430802-200000 and one First-Article Undulator Girder Assembly per L1430401-100396 no later than 10 weeks after award of the contract. The Contractor shall not proceed with the remainder of the contract unless and until the First Article is accepted and the Laboratory approves proceeding with the remaining units in the contract.



## **2.4 Delivery.**

The delivery of the First Article is expected within the time period given in Section 2.3. The authorization for the construction of the remaining units depends on the acceptance of the First Article. Once authorized to proceed, the next set of units from each Contractor shall be delivered within 6 weeks. Deliveries shall proceed with at least two units per week, one from each Contractor if two contractors are chosen. Faster delivery is encouraged provided quality is not sacrificed. It is desired to have all deliveries complete by September, 2007, however the current funding is under continuing resolution at 2006 levels and funds for production units may not be available until fiscal 2008 (October 2007 or later), depending on acts of Congress. The contracts for the Support Motion System will not be awarded in fiscal 2007 unless funds are available for at least the First Article items. The approval for manufacture of production units will be made as funds become available.

## **3.0 APPLICABLE DOCUMENTS AND /OR SPECIFICATIONS:**

### **3.1 Application.**

#### **3.1.1 Deviations.**

The documents listed in Section 3.2 form a part of this Statement of Work to the extent specified herein. Any deviations from these documents or their requirements shall be requested by the contractor and approved by the Laboratory prior to any contractor action being taken. Requests for Deviations shall be made on a Supplier Disposition Request (ANL-311).

#### **3.1.2 Conflicts.**

Any conflicts between the requirements of this Statement of Work and those of any applicable document shall be brought to the attention of the Laboratory's Procurement Official prior to any related action on the part of the contractor.



### **3.1.3 Exceptions.**

Where the materials or standards to be employed in the manufacture of any part are not identified in this Statement of Work or the documents referenced herein, the contractor shall submit for the Laboratory's approval the materials or standards they propose to use.

### **3.1.4 Referenced Documents.**

Documents which are referenced without citation of section or paragraph shall apply in their entirety. Where there is a citation of section or paragraph, only that cited portion is applicable.

## **3.2 Applicable Documents.**

The contractor effort shall be in conformance with this Statement of Work and the following referenced documents, drawings, and specifications as applicable:

### **3.2.1 Drawings.**

**3.2.1.1** L1430802-200000 “Undulator Support System, Fixed Support Assembly, General Assembly” and all its sub-tier drawings.

**3.2.1.2** L1430401-100396 “Undulator Magnet, Magnet Assy & Supports, Undulator Support Assembly, Undulator Girder Assembly” and all its sub-tier drawings.

### **3.2.2 Welding.**

**3.2.2.1** ANSI/AWS A2.4-93, “Standard Symbols for Welding, Brazing and Nondestructive Examination.”

**3.2.2.2** ANSI/AWS D1.1/D1.1M:2004, “Structural Welding Code-Steel.”



### **3.2.3 Black Oxide Coating.**

MIL-DTL-13924D, “Coating, Oxide, Black, for Ferrous Metals.”

### **3.2.4 Assembly and Test Procedures.**

**3.2.4.1** L143-00094. “Assembly Procedure for LCLS Undulator Cam Actuator Assemblies.”

**3.2.4.2** L143-00095. “Test Procedure for LCLS Undulator Cam Actuator Assemblies.”

## **4.0 TECHNICAL TASKS AND QUALITY ASSURANCE**

### **4.1 Fabrication.**

With the exception of the parts defined in Section 2.2, the Contractor shall furnish all materials, personnel, facilities, tools, equipment, and services to fabricate, test, document and deliver the Fixed Support General Assembly and Undulator Girder Assembly per drawings L1430802-200000, “Undulator Support System, Fixed Support Assembly, General Assembly” and L1430401-100396 “Undulator Support Assembly, Undulator Girder Assembly.”

#### **4.1.1 Design Requirements.**

The designs of the support assemblies are defined in the drawings, and their associated sub-tier drawings, which are listed in Section 3.2.1 of this Statement of Work.

#### **4.1.2 Drawings.**

**4.1.2.1** Since the drawings and documents listed in section 3.2.1 completely define the fabrication requirements of the LCLS Undulator Fixed Support General Assembly, the preparation of new drawings by the contractor will not be required unless alternate designs and/or modifications to the designs submitted by the Laboratory are proposed by the contractor (see section 4.7.2 of this Statement of Work).



**4.1.2.2** The contractor is required to review the drawings and other documentation provided by ANL for errors and to inform ANL of any discrepancies and errors. Any changes or corrections must be documented by the contractor as "marked drawing" changes to the engineering drawings for the affected item and submitted for ANL's approval. If approved, revised drawings will be issued by ANL.

**4.1.2.3** The marking and submission of marked drawings to ANL to indicate any "as-built" changes is the responsibility of the Contractor.

**4.1.2.4** Drawings and 3D models can be furnished to the contractor on disk or by E-mail in ProE format, or STEP and DWG or DXF formats. The contractor should submit any corrected or modified drawings to ANL for approval in any of the above formats with ProE preferred.

### **4.1.3 Material Requirements.**

The contractor shall use the materials specified in the drawings, and their associated sub-tier drawings. The contractor shall not change any material unless he has ANL approval on a submitted Supplier Disposition Request (SDR), form ANL-311.

### **4.1.4 Welding.**

**4.1.4.1** Drawing weld symbol interpretation shall be in accordance with ANSI/AWS A2.4-93.

**4.1.4.2** For all the welded parts, the welding practice shall conform to the Structural Welding Code, ANSI/AWS D1.1-D1.1M:2004

**4.1.4.2.1** Structural welds shall be made by qualified welders as defined in section 4 part C of the Structural Welding Code. The properly documented use of previously qualified welders is acceptable. The documentation shall be submitted to ANL.

**4.1.4.2.2** All structural welds shall be visually inspected as defined in section 6.9 of the Structural Welding Code. The contractor shall certify that the welds were inspected and were acceptable.



**4.1.4.3** All welded parts shall have a post-weld stress relief as specified in the Structural Welding Code, ANSI/AWS D1.1-D1.1M:2004, Section 5.8 unless otherwise specified on the drawing. Note that the Girder, L1430401-100400, requires a full anneal. The stress relief, or anneal shall be documented with a chart of the furnace cycle showing the heat, soak, and cooling times and temperatures.

#### **4.1.5 Painting and Coating.**

**4.1.5.1** Steel surfaces that are specified on the drawings to be painted shall be painted with epoxy paint. The paint shall be non-dusting or chalking, with a gloss or semi-gloss finish. Paint types and colors are specified on the applicable drawings.

**4.1.5.2** On steel parts requiring a black oxide surface, the parts shall be black oxide coated by immersion in a hot alkaline bath in conformance with MIL-DTL-13924D, "Coating, Oxide, Black, for Ferrous Metals," Class 1. After the parts are coated and dry, they shall be dipped in a suitable corrosion-preventive oil.

#### **4.1.6 Assembly and Workmanship**

**4.1.6.1** The parts shall be free of burrs and sharp edges, and free of dents, gouges and scratches.

**4.1.6.2** The parts shall be clean and free of dirt, oil and grease with the exception of the appropriate lubrication on moving bearing surfaces, and unpainted mild steel mounting surfaces. Bearing surfaces shall be lubricated as required by the assembly drawing. Unpainted steel mounting surfaces (those surfaces clearly defined on the engineering drawing to be paint free) shall be clean, rust free and coated with a light film of machine oil.

**4.1.6.3** Painted surfaces shall be free of chips, cracking or peeling. Painted, black oxide coated or anodized surfaces shall be uniform in color and texture.



**4.1.6.4** All assembly requirements for alignment marks, keying or pinning specified on the appropriate assembly or sub-tier drawing shall be done after verification that the assembly meets the dimensional requirements of the drawing.

#### **4.1.7 Assembly Procedure.**

The critical components are designed to be to a great extent self-aligning. To achieve successful self-alignment, the components on which they mount must conform exactly to the prints. In Section 4.5.2, the critical dimensions which implement the self-aligning features are to be measured and recorded.

**4.1.7.1** The cam mover mounting surfaces on the fixed supports have edges which precisely align the movers and set the distance between them.

**4.1.7.2** The support pads on the bottom of the girder assembly are keyed so that they should fit on the girder in only one orientation. The mounting area for the support pads has two precision aligned edges against which the pads are to be positioned.

**4.1.7.3** The mounting areas for the two cross slides on the top of the girder are provided with three pins in each area. The slides are to be positioned against these pins for proper alignment.

**4.1.7.4** The assembly of the Single Cam Actuator Assemblies, L1430401-100100 and L1430401-100300, and the Double Cam Actuator assemblies, L1430401-100200, are described in "Assembly Procedure for LCLS Undulator Cam Actuator Assemblies", L143 00094.

#### **4.1.8 Marking.**

**4.1.8.1** Each assembly shall be marked for identification with its ANL Part Number and Revision Number, and its SLAC part number. These numbers are all on the assembly drawings. In addition, each assembly shall be marked with a serial number to distinguish it from the other assemblies so that accompanying documents and data can be correctly correlated to the correct individual assembly. All these identifying marks are to be etched or stamped in three lines in the areas identified below in sections



4.1.8.3 and 4.1.8.4. The markings shall be filled with a contrasting color for good visibility.

**4.1.8.2** The serial numbers for the Fixed Support General Assembly, L1430802-200000, and Undulator Girder Assembly, L1430401-100396, are to be separate sequences of two digit numbers. Each sequence of serial numbers shall start with “01.” If two contractors are selected to manufacture the same assembly, one contractor shall use odd number serial numbers and the other contractor shall use even serial numbers as determined by ANL.

**4.1.8.3** The identifying markings for the Fixed Support General Assembly, L1430802-200000, shall be stamped or engraved on each of the two sub-assemblies. All identifying marks are to be located on the 711 mm long, 44.5mm high edge (shorter edge) of the upper rectangular flange on the Support Stand Assembly, L1430802-100025. The markings should be on the left side when looking in the downstream beam direction.

- a) The first line shall be the ANL Part Number-Revision Number (L1430802-200000-00).
- b) The second line shall be the SLAC Part Number (EA-381-0010-50).
- c) The third line shall be the unique serial number for the particular assembly.

The information above in parentheses is an example of the information to be stamped or etched on the assembly. The actual drawing number, and revision stamped or etched on the parts shall be whatever is applicable to the assembly being marked at the time it is marked.

**4.1.8.4** The identifying markings for the Undulator Girder Assembly per L1430401-100396, shall be stamped or engraved on the support girder in the area labeled “Surface ‘G.’” The markings should be near the left side and bottom of “Surface ‘G’” as shown on L1430401-100400, but at least 20 mm from either edge.

- a) The first line shall be the ANL Part Number-Revision Number (L1430401-100396-00).
- b) The second line shall be the SLAC Part Number (SA-381-002-76).
- c) The third line shall be the unique serial number for the particular assembly.

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The information above in parentheses is an example of the information to be stamped or etched on the assembly. The actual revision and serial numbers shall be whatever is applicable to the assembly being marked.

**4.1.9 Packaging and Shipping.**

**4.1.9.1** The shipping containers and the means used to constrain the Fixed Support General Assembly and Undulator Girder Assembly shall be sufficiently sturdy to insure the units suffer no damage in shipment and are protected from weather. The shipping container must be designed to keep the supports upright during shipment. No nicks, dents or scratches are acceptable. The Contractor shall forward their proposed shipping containment design to ANL for review no later than the second monthly progress report.

**4.1.9.2** The Fixed Support General Assembly consists of two different major sub-assemblies, the Single Cam Mover and the Double Cam Mover, and each should be crated separately. The assembly type and serial number are to be printed on the exterior of the shipping crate for assembly staging purposes. A shipment manifest shall be included with each shipment listing the various assemblies and all parts included in the shipment. The manifest shall be attached externally to a shipping crate in a conspicuous envelope with a second copy inside that same crate. An electronic copy of each manifest shall also be sent to ANL prior to shipment.

**4.1.9.3** Shipment of the Fixed Support General Assembly and Undulator Girder Assembly shall be FOB ANL docks for the First Article and FOB SLAC docks for the remaining assemblies. The shipping costs are to be prepaid by the Contractor. These shipping costs should be included in the bid. Argonne National Laboratory and Stanford Linear Accelerator Center shall be notified immediately of a shipment's tracking information and estimated arrival time when a shipment leaves the Contractor's dock. (See Section 5.3)



## **4.2 Program Plan.**

The contractor shall prepare and maintain a Program Plan describing and scheduling all phases of this program. The Laboratory shall review and approve the Program Plan and all changes thereto prior to implementation by the contractor.

### **4.2.1 Program Plan General Description.**

The program management plan describes the contractor's concept, plan, practice, and approach for accomplishing (managing and controlling) project tasks, management interfaces, time-phased relationships of tasks and program elements, and the criteria against which performance may be judged. The plan is to be used as the basis for organizing, administering, and measuring work. The plan, with its interrelated and referenced documents, shall include sufficient data to demonstrate the capability to accurately report schedule, and technical performance indicators. The plan shall also be used to explain variances, to describe corrective actions and decisions, and to indicate required recovery or expeditious efforts.

### **4.2.2 Program Plan Content.**

The plan shall describe the programmatic and management structure along with the management tools, which shall be used by the contractor in performance of the contractual effort. The following shall be included:

**4.2.2.1** A brief description of the program objectives, with a summary of requirements and specifications as well as a concise description of the hardware and associated components.

**4.2.2.2** Summary schedules, which reflect a direct condensation of the master schedules, and which are suitable for management review.

**4.2.2.3** A description of the organization for the management of the program, indicating the internal interfaces between management and other elements of the contractor's organization.



**4.2.2.4** A key personnel list, portraying the contractor's key personnel, beginning with the highest level program manager (or equivalent position) descending to the lowest echelon of key staff positions necessary for effective program management.

**4.2.2.5** A description of the contractor's plan for interfacing with the Laboratory and with associated contractors, as well as technical management.

**4.2.2.6** A description of the contractor's management information system as applied to the data management, configuration management, and schedule management function of this contract.

**4.2.2.7** Copies of the Work Breakdown Structure (if applicable).

**4.2.2.8** A subcontractor plan which includes the method of procurement, procurement schedules, and procedures by which control shall be exercised for planned subcontract effort (if applicable).

**4.2.2.9** A description of the contractor's resources being used in performance of the program, including plant capacity, facilities, machine tools, and manpower for all contract phases including fabrication.

**4.2.2.10** A description of program tasks to be accomplished and a general outline of the methods and systems which the contractor shall utilize to accomplish each major task.

**4.2.3 Program Plan Format.**

The contractor's own format shall be satisfactory. Contents should be displayed in sections for ease of separate consideration.

**4.2.4 Program Plan Maintenance.**

The plan shall be maintained current by page revision or complete reissue to reflect all approved program changes. Change to the key personnel list, consistent with the standard Terms and Conditions Clause, shall be forwarded to the Laboratory as soon as



practical after the decision to make a change, and not later than the next scheduled progress report.

**4.3 Program Meetings.**

The contractor shall provide for program meetings with Laboratory representatives for purposes of reviewing and resolving progress, fabrication, testing, and managerial issues. Meetings will be held at the discretion of either the Laboratory or the contractor. Current information on all aspects of the program shall be made available by the contractor to the Laboratory one week in advance. Meetings shall be held at the contractor's facility, unless the Laboratory chooses otherwise. A mandatory notice and meeting agenda will be provided by the Laboratory one week before a program meeting can be held. The contractor shall have the responsibility to provide minutes of the meeting within two (2) weeks following the session.

**4.4 Program Schedule.**

The contractor shall prepare and maintain a Program Schedule. This schedule shall include the major program milestones. The Laboratory shall review and approve the Program Schedule and all changes thereto prior to implementation by the contractor.

**4.4.1 Program Schedule General Description.**

The program schedules depict the period of performance for work specified by the contract. They portray significant program/project milestones necessary to measure, analyze, and perform corrective action as well as indicate progress and performance.

**4.4.2 Program Schedule Content.**

In addition to major milestones required by the Laboratory and stipulated by the Statement of Work, the schedules shall also include where applicable:

**4.4.2.1** Major milestones which depict program baselines, phase start and completion, go/no-go decision points, design and inspection reviews, delivery dates, etc.



**4.4.2.2** Second level milestones which include long-lead procurement, intermediate design, manufacturing, and procurement points, development milestones and interfacing points, intermediate test and analysis points, etc.

**4.4.2.3** Third level milestones which include all detail control milestones that govern the preparation of work package schedules.

#### **4.4.3 Program Schedule Format.**

The schedules shall be compatible with the Program Plans.

#### **4.4.4 Program Schedule Maintenance.**

The schedules shall denote the most recent actual results compared with the forecasted progress. When major deviations between actual results and the baseline persist to the extent that the baseline becomes of little or no value for measuring and forecasting, the contractor shall change the appropriate parts of the baseline, subject to the following:

**4.4.4.1** Changes shall be announced and described in the progress report for the period in which the change is made. Reasons for the change shall be described as well as the related effects on the work packages, and/or manufacturing schedules.

**4.4.4.2** Schedule changes to (or affecting) Laboratory milestones shall be approved by Argonne prior to implementation.

### **4.5 Measurements and Testing.**

The contractor shall conduct testing of the Fixed Support General Assembly and Undulator Girder Assembly prior to delivery and acceptance by the Laboratory. All measurements (including temperature) and tests shall be performed using calibrated test instruments that are traceable to the National Institute of Standards and Technology (N.I.S.T.) or equivalent. Acceptance tests shall be in accordance with Section **4.5.1** of this Statement of Work. Certified test results shall be submitted by the contractor to the Laboratory within two weeks after conclusion of the test. Each shipment shall be accompanied or preceded by reports of actual test results identifiable to the acceptance criteria of items submitted and shall meet the requirements of the contract document and



applicable drawings and specifications. These reports shall contain the signature and title of the authorized contract representative of the agency performing the tests and shall be subject to review and acceptance by Supplier Quality Control. The data submitted shall also be transmitted in electronic PDF format directly to the responsible ANL Engineer.

#### **4.5.1 Measurements.**

The Fixed Support General Assembly and Undulator Girder Assembly shall be measured or otherwise tested by the contractor to verify all dimensions and other drawing requirements. While most dimensions may be reported as in conformance with the drawing, critical features shall be reported with the actual measured values and with the drawing required value or tolerance. Any non-conforming dimension or feature must be reported with the measured value and the required value or tolerance using form ANL-311.

#### **4.5.2 Critical Features.**

##### **4.5.2.1 Fixed Support General Assembly**

The following items are critical features of the Support needing actual measured values to be reported.

**4.5.2.1.1** On L1430802-200011, measure and report the following dimensions:

- a) Flatness of Datum A (the cam actuator mounting surfaces on Cam Block "A" and Cam Block "B"). (0.02)
- b) Perpendicularity of Datum B (the outer edge of the double cam actuator mounting surface on Cam Block "A") to Datum A. (0.02)
- c) Parallelism of the inner edge of the double cam actuator mounting surface on Cam Block "A" to Datum B. (0.02)
- d) Parallelism of the inner edge of the single cam actuator mounting surface on Cam Block "B" to Datum B. (0.02)
- e) Parallelism of the outer edge of the single cam actuator mounting surface on Cam Block "B" to Datum B. (0.02)
- f) Width of single cam mover mounting surface on Cam Block "B". (142.01 <sup>+0.02</sup>/<sub>-0.00</sub>)



- g) Width of double cam mover mounting surface on Cam Block “A”. (254.00 <sup>+0.02</sup>/<sub>-.00</sub>)
- h) Separation the outer edge of single cam mover mounting surface on Cam Block “B” from the outer edge of double cam mover mounting surface on Cam Block “A.” (685.42)

**4.5.2.1.2** On L1430802-200021, measure and report the following dimensions:

- a) Flatness of Datum A, the two single cam actuator mounting surfaces on Cam Block “C.” (0.02)
- b) Perpendicularity of Datum B, the lower edge of the single cam actuator mounting surface on the lower Cam Block “C.” to Datum A. (0.02)
- c) Parallelism of the upper edge of the single cam mover mounting surface on the lower Cam Block “C” to Datum B. (0.02)
- c) Parallelism of the lower edge of the single cam mover mounting surface on the upper Cam Block “C” to Datum B. (0.02)
- d) Parallelism of the upper edge of the single cam mover mounting surface on the upper Cam Block “C” to Datum B. (0.02)
- e) Width of each single cam mover mounting surfaces on the two Cam Blocks “C.” (142.01 <sup>+0.02</sup>/<sub>-.00</sub>)
- e) Separation of inner edge of the single cam mover mounting surface on the upper Cam Block “C” from inner edge of the single cam mover mounting surface on the lower Cam Block ”C.” (457.43)

#### **4.5.2.2 Undulator Girder Assembly**

The following items are critical features of the Girder needing actual measured values to be reported.

**4.5.2.2.1** On L1430401-100400, page 2, top view, measure and report the following dimensions:

- a) Flatness of Datum B. (0.030)
- b) Perpendicularity of Datum B to Datum C. (0.25)
- c) Flatness of Datum A. (.030)
- d) Perpendicularity of Datum A to Datum C. (0.25)



- e) Diameters of the six holes labeled “D.” ( $\phi$  6.315-6.329)
- f) True positions of six “D” holes referenced to Datum A and Datum B. (0.030)

**4.5.2.2.2** On L1430401-100400, page 2, side view, measure and report the following dimensions:

- a) Flatness of Datum C. (0.030) The method of supporting the girder while measuring the flatness of Datum C should be agreed upon between the Contractor and ANL.

**4.5.2.2.3** L1430401-100400, bottom view on page 2, and Section B-B on page 3, measure and report the following dimensions related to the mounting surfaces for the four support pads:

- a) The distance from Datum B to each of the first two mounting pad area leading edges. (749.78 $\pm$ 0.15)
- b) The distance from the first two mounting pad area leading edges to the second two mounting pad area leading edges. (2340.00 $\pm$ 0.15)
- c) Parallelism of all four support pad area leading edges to Datum B. (0.05)
- d) Parallelism of all four support pad area longitudinal edges to Datum A. (0.03)
- e) Parallelism of all four support pad surface areas to Datum C. (0.07)
- f) The distance from Datum C to each support pad surface area. (109.5 $\pm$ 0.2)

### **4.5.3 Assembly Tests.**

#### **4.5.3.1 Stationary Tests.**

The two support assemblies shall be positioned as shown in the assembly drawing L1430802-200000. The supports must be properly leveled and the top plates adjusted to a uniform height. The separation of the two fixed support top plates (1628.8) will be measured and recorded. The undulator girder assembly shall be mounted onto the cam movers on the top of the two supports. Exercise care in setting the girder on the cam actuators to avoid damage to the cam actuators and insure the girder is oriented in the proper direction and properly sitting with the pads on the actuator cams. Proper orientation is defined by the Beam Direction as shown on the two assembly drawings



being in the same direction. The four support pads on the bottom of the undulator girder assembly must be aligned with the four sets of cam actuators on the supports in both the longitudinal and transverse directions. The fit of the mounting pads with the cams shall be documented with photographs that clearly show the alignment in the longitudinal direction and in the transverse direction.

#### **4.5.3.2 Dynamic Test of Cam Actuators**

Each of the Single Cam Actuator Assemblies, L1430401-100100 and L1430401-100300, and the Double Cam Actuator assemblies, L1430401-100200, shall be tested to verify the range of motion, repeatability of the motion and the deviation of the motion from a sinusoidal wave form. The testing is to be performed under a vertical load of approximately 300 kg on the cam surface. The test procedure is given in “Test Procedure for LCLS Undulator Cam Actuator Assemblies,” L143-00095.

- The measured RMS deviation of the motion from a sinusoidal wave form shall be 15 microns or less (where a micron is  $1 \times 10^{-6}$  meters).
- Measurements of the motion for five repeated revolutions shall repeat the same wave form within 10 microns.
- The magnitude of the radial variation of the cam shall conform to the drawing.
- The measured RMS deviation of the data taken from three different positions on the outer ring of the cam shall be within 5 microns This is a test of the bearing repeatability with the outer ring (ring 1 ) being manually repositioned between tests.

The Laboratory shall provide the test fixtures, test controls, and pre-programmed computer to test the Cam Actuators. The test procedure and data logging shall be programmed into the test control computer. The contractor selected test personnel shall be trained in use of the test equipment during a day at Argonne National Laboratory. It is estimated that the set up and testing shall take no more than one to two hours per Cam Actuator. If the Cam Actuators do not pass the tests, they shall be examined for part compliance to the part drawings. If some Cam Actuators fail the test with parts in compliance to the drawings, ANL shall negotiate with the contractor whether to tighten tolerances, manufacture sufficient numbers of Cam Actuators to qualify the required number of units, or take other actions to satisfy the requirements.



#### **4.5.3.3 Optional Dynamic Tests.**

At the option of the Laboratory, dynamic tests of the motion systems may be performed to confirm proper operation of the cam movers and cross slides under full load provided by a dummy undulator mounted on the cross slides. If the Laboratory decides to do the optional dynamic tests at the contractors' sites, the details of the tests will be negotiated with the contractors at that time.

#### **4.5.4 Test Conditions.**

All dimensions apply at a temperature of 20°C. The part must be in thermal equilibrium during measurements and at the same temperature at the beginning and conclusion of the measurements within 2°C. Experience with the prototype fixed supports indicates that at least 24 hours is needed for the support to get near thermal equilibrium with the measurement room. The part temperature, before and after dimensional measurements, shall be recorded and reported.

#### **4.6 Special Tooling.**

The contractor shall design and fabricate any special tooling and fixtures required for fabrication of the Fixed Support General Assembly and Undulator Girder Assembly, which are not provided by the Laboratory. All special tooling fabricated by the contractor is the property of the Laboratory and shall be accounted for by the contractor. Disposition of the special tooling at the conclusion of contract shall be at the option of the Laboratory in accord with FAR clause 52.245-17.

#### **4.7 Quality Control.**

The contractor shall adhere to all quality control requirements as specified in this Statement of Work. The contractor shall adhere to the DOE policy that prohibits the use of any suspect or counterfeit parts.



**4.7.1 First-Article Inspection.**

A first-article inspection shall be performed in the presence of a designated representative of ANL. The first-article inspection shall be accomplished using the first deliverable item of several of the same design or same type. The processes used and standards of workmanship shall as a minimum be representative of all items to be produced. The supplier shall notify the Laboratory Procurement Official at least seven (7) days prior to the time that the first-article is available for inspection. Unless otherwise designated by the Laboratory Procurement Official, first-article inspection will be conducted at the supplier's facility. The First Article Inspection shall consist, as a minimum, witnessing the verification of critical dimensions, reviewing Q/A documentation and material certification. Continued fabrication of additional items prior to notification of first-article acceptance shall be entirely at supplier's risk, and may result in non-reimbursement of related costs by the Laboratory.

**4.7.2 Changes Proposed by Contractor.**

Prior to effecting any change in ANL approved (1) design, (2) workmanship standards, (3) manufacturing process or (4) inspection procedure for use in this procurement, the supplier shall obtain the Laboratory's written approval. Such changes must be documented by the contractor as "marked drawing" changes to the engineering drawings for the affected item prior to the Laboratory's approval. If approved by the Laboratory, revised drawings shall be issued by the contractor.

**4.7.3 Proprietary Designs and Processes.**

The contractor shall notify ANL prior to effecting any change in proprietary processing or design. A meeting between the supplier, the Laboratory Procurement Official and Laboratory Quality Assurance shall be called to determine the method by which contract requirements will be met while accommodating the contractor's proposed change.

**4.8 Inspection and Test Plan.**

The contractor shall prepare and maintain an Inspection and Test Plan. The contractor shall submit to the Laboratory Procurement Official for written approval by Laboratory



Quality Assurance prior to its required use, a plan, in the contractor's format, listing components, subassemblies and assemblies; and identifying those inspections and tests planned for verification of quality and identifying documentation/planning to be used for such accomplishment. The test plan shall identify the measurement and test equipment to be used for the inspections and tests.

#### **4.9 Quality Assurance.**

The contractor shall submit and maintain a Quality Verification Plan for control of quality of articles furnished in accordance with this contract. The Plan should address the following quality assurance topics:

- a) Quality Assurance System.
- b) Employee qualification process.
- c) Engineering design process.
- d) Document control process.
- e) Records control process.
- f) Work control process.
- g) Purchasing process.
- h) Subcontractor selection process.
- i) Subcontractor monitoring process.
- j) Inspection and Testing process.
- k) Frequency of inspection and testing performed on incoming products.
- l) Frequency of inspection and testing performed on outgoing products.
- m) Calibration of test and measurement equipment.
- n) Control of nonconforming products.
- o) Internal audit type and frequency.
- p) External audit type and frequency.

A plan shall be prepared and submitted to the Laboratory Procurement Official for written approval by LCLS –ANL Quality Assurance prior to its required use by the contractor. The contractor's quality assurance manual may suffice providing it adequately addresses the assurance topics listed above.



#### **4.10 Source Inspection.**

The Laboratory reserves the right to perform source inspection of any and all materials, parts, subassemblies and assemblies required for performance of this contract.

#### **4.11 Testing Surveillance.**

The Laboratory reserves the right to witness any testing accomplished by the contractor. This surveillance will be informal except for final acceptance tests. The contractor shall notify the Laboratory two (2) weeks prior to the conduct of any test.

#### **4.12 Test Failures.**

The Laboratory shall be notified by the contractor within 48 hours after the failure of any material to meet the requirements of acceptance or qualification testing. The Laboratory shall be notified immediately of any failure occurring during assembly or acceptance testing of the LCLS Undulator Main Assembly.

#### **4.13 Red Flag Notice.**

The contractor shall immediately notify the Laboratory of any occurrence, which will impact contract schedule. The notification shall be either written or oral with written confirmation within 48 hours on a Red Flag Report, and shall include remedial action taken to offset the problem. The contractor shall provide his own format compatible with the following requirements:

##### **4.13.1 Date and Number.**

Each Red Flag Notice is to be dated and consecutively numbered.

##### **4.13.2 Contract Required Delivery Date.**

Contract delivery date for the subject of the report does not normally change from one report to the next.



### **4.13.3 Estimated Shipping Dates.**

Include the prior Report estimate and this Report estimate.

### **4.13.4 Statement of Problem.**

All problems shall be presented as separate items in clear concise text describing the reason why the end item is late, the reason for any slippage since the last report and the current status of the work.

### **4.13.5 Consequence.**

The consequence of the problem or delay shall be concisely stated in terms of impact on delivery, the meeting of key milestones, the progress of other work, or on meeting specification requirements, etc.

### **4.13.6 Action Taken.**

The action being taken to resolve the problem and recover schedule delays shall be described and the estimated effect of this action shall be highlighted. The name of the key individual in the contractor's organization who must act to resolve the problem shall be shown.

### **4.13.7 Action Required.**

Future action to recover schedule shall be identified. The action shall be described, with the action party identified by name, title and organization, and the date when completion of the action is required shall be set forth.

### **4.13.8 Assistance Required.**

Any assistance required from the Laboratory to further the progress of the recovery program shall be set forth. The exact nature of any required assistance shall be stated and the date by which such action must be taken shall be provided.



**4.13.9 Number of Times Reported.**

The number of previous critical items reports which have identified the same problem as critical to the progress of the work or to satisfaction of the technical requirements shall be set forth.

**4.13.10 Acknowledgement of Responsibility.**

Each report shall acknowledge that the reporting of the critical items therein does not relieve the writer of responsibility for seeing that the necessary corrective action is taken on each item.

**4.14 Nonconformance Reporting.**

The contractor shall report any non-conformances to specifications, drawings, or other contract requirements on ANL Form 311.

**4.15 Approvals.**

All Laboratory approvals required by this contract shall be acted upon within two (2) weeks of receipt by ANL of submission by the contractor. Action will consist of a notice of approval, clarification request or rejection in writing from the Laboratory Subcontract Administrator. Approvals shall not relieve the contractor of any responsibility for reliability, quality, delivery, cost, performance or other requirements of this contract.

**5.0 REPORTS, DATA, AND DELIVERABLES:**

**5.1 Progress Report.**

The contractor shall submit monthly progress reports during the execution of this program. The progress report shall include narrative and tabular summary of performance during the report period. It shall include work performed, work forecast, and problem description and resolution. The contractor shall emphasize any deviations from plan or schedule, the reasons and impacts of such deviations, and the effects of management efforts undertaken for corrective or expeditious actions.



**5.2 Technical Data.**

The Contractor shall deliver all technical data as specified below.

**5.2.1** For each of the following items, one (1) electronic copy in PDF format (preferred) or two (2) paper copies are required once 30 days after award of contract. Any changes to these documents must also be submitted.

- a) Program Plan (Section 4.2)
- b) Program Schedule (Section 4.4)
- c) Inspection and Test Plan (Section 4.8)
- d) Quality Verification Plan (Section 4.9)

**5.2.2** For Progress Reports (Section 5.1), one (1) electronic copy in PDF format (preferred) or two (2) paper copies are required monthly 10 days after the end of the month. The first report shall be due 40 days after award of contract.

**5.2.3** For test results, measured values, certifications and Acceptance Criteria Listings (Sections 4.1.3, 4.1.4, 4.5), one (1) electronic copy in PDF format (preferred) or two (2) paper copies are required within two (2) weeks of completion of testing of a given LCLS Undulator Support and Motion System Assembly.

**5.2.4** For each of the following items, one (1) electronic copy in PDF format (preferred) or two (2) paper copies are required. These items are on an “as required” basis.

- a) Red Flag Notice (Section 4.13), submit within 48 hours of an occurrence.
- b) Nonconformance Report (Section 4.14), ANL approval required for disposition of a non-conformance.
- c) Program Meeting Minutes (Section 4.3), submit within 2 weeks of a Program Meeting.

**5.2.5** Provide MSDS or product data sheets for the paint and oil used to coat the surfaces of the Support and Motion System components in PDF format/



**5.3 Delivery.**

The Contractor shall deliver the Fixed Support Full Assemblies and Undulator Girder Assemblies in Section 2.1 of this Statement of Work per the schedule indicated in Sections 2.3 and 2.4 of this Statement of Work. With the exception of the First Articles which are to be delivered to ANL, all Fixed Support Full Assemblies and Undulator Girder Assemblies shall be delivered to Stanford Linear Accelerator Center. SLAC wants to have the complete QA document package in their hands prior to shipment. The contractor shall not ship a Support Motion System assembly until ANL confirms that SLAC has received the complete document package for that assembly. This process can be executed quite quickly if the data is given to the Laboratory in electronic format so it can be posted to an FTP site.

Below is the contact information for SLAC. The contractor shall notify Rodd Pope at SLAC of a SLAC shipment expected arrival date, and the contractor shall have the truck driver contact him about 2 hours prior to arrival at SLAC.

SLAC Undulator System Contact:

Shipping address for equipment:

Rodd Pope  
Phone: (650) 926-2487  
Mobile Phone: (650) 814 5999.  
E-Mail: pope@SLAC.Stanford.EDU  
Fax: (650) 926-8533

Ben Poling  
Stanford University - SLAC  
Building 081 Room 118  
2575 Sand Hill Road  
Menlo Park, CA 94025  
Phone: (650) 926-3077  
Mobile Phone: (408)250 6877

**6.0 OTHER SPECIAL CONSIDERATIONS:**

**6.1 Subcontractors.**

Should the Contractor intend to subcontract any portion of this work, such intentions, possible subcontractors, and the scope of their involvement shall be included in the proposal. ANL is to be informed of any change in subcontractors prior to any such

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change taking effect. ANL reserves the right to both evaluate and reject the use of any particular sub-contractor.