Statement of Work
NNA15558658L-ALM

Background/History of Requirement:
NASA Ames is conducting a high level aeronautics research program involving materials and structures. Key to this research will be the ability to build custom load testing apparatuses to evaluate structural mechanics and manufacturing strategies. The foundation for these apparatuses that best meets the needs of the program is equivalent to commercially available large format tension and compression testing machines. The items that NASA Ames Research Center would like to purchase would be used as an experimental instrument in the laboratory for advanced aerostructures and manufacturing technology research.

Requirements Specifications:

A. General

The following specification is for a test system capable of applying static tension and compression forces of at least 100 kN. Suppliers should propose an integrated system that meets or exceeds the following specifications for a Load Frame, Load Cells, Closed Loop Digital Controller, Software and Console, and Accessories. The system proposed should be designed to meet or exceed the following Safety, Warranty, Installation, and Support specifications.

B. Load Frame

1. The load frame proposed must have a capacity of at least +/- 100 kN and allow for tensile and compression tests to be performed both below the moving crosshead.
2. The load frame must have a vertical test opening of at least 1829 mm without load cell, grips or T-slot table. The horizontal distance between the load frame's columns must be at least 915 mm, clear of obstructions in front of and behind the test area.
3. A steel T-slot table with a capacity of at least 100 kN and dimensions of at least 900 mm wide x 500 mm deep and no greater than 85 mm high must be provided, with features to allow for the mounting of the grips (F1) and compression platens (F3) with full load specification (i.e. w/o removal of the table). The vertical clearance of the test area with the load cell (C) and T-slot table must be at least 1680 mm.
4. The loading rate of the crosshead must be adjustable from at least 0.001 mm/min to 1000 mm/min with integrated acceleration/deceleration control. The speed accuracy over this range must be better than +/- 0.1% of set speed.
5. The crosshead position control resolution must be no larger than 0.01 µm
6. The load frame and motion system must exhibit negligible (less than minimum position resolution) back-lash when loads change from tension to compression or compression to tension.
7. A remote control panel must be provided with clearly labeled and dedicated buttons for controlling the motion of the moving crosshead.

C. Load Cell

1. The load frame must include a 100 kN capacity load cell that can measure loads between 100 kN and 100 N with an accuracy of better than +/-0.5% of reading.
2. The 100 kN capacity load cell must withstand up to 300% of capacity (300 kN) without mechanical damage and up to 150% of capacity (150 kN) without permanent zero.
3. The load cell provided must be designed to tolerate off-axis loading typically associated with specimen tearing at failure. “S” type load cells will not be acceptable.
4. The load cell must include a precision connection mechanism to allow for quick and accurate changing of heavy grips and fixtures.

D. Closed Loop Digital Controller

1. The system must include a controller that uses digital electronics to close the loop on the load, position, or optional strain channels at a minimum of 1000Hz. Closed loop load control must be achieved through feedback from the load cell. Closed loop Position or Speed control must be achieved through feedback from the crosshead encoder.
2. The sensor conditioners, digital control and data acquisition electronics must be shielded from electrical noise and housed separately from the operator console chassis. AC excitation is preferred.
3. The system with 100 kN (22,500 lbs) load cell supplied must have a load measurement resolution no greater than 0.38 N (38 grams).
4. The system must allow for integration and calibration of third party load cells.
5. The controller must have the ability to send data to a console for storage to disk at rates up to 1000 Hz on the load, displacement and optional sensor channels simultaneously. Changing data rates must not affect the load accuracy or resolution. Adding additional channels must not reduce the maximum data rate of 1000 Hz.
6. At least one sensor conditioner system must be included for use with rationalized extensometers, LVDT, as well as +/-10 Volt DC inputs. This must provide closed loop control and data acquisition capability for optional transducers.
7. The electronics must be capable of accepting at least ten total input signal channels (+/- 10V DC inputs), synchronized with the Load and Displacement from the frame. All of the above channels must be capable of being used for control.
8. The electronics must include an analog output card that includes at least 4 zero suppressed and scaled 10V outputs via BNC connectors.

E. Software and Control Console

1. The software provided must include a Graphical User Interface and be fully compatible with at least one of Windows 8.1, 10, or Ubuntu 14.04LTS.
2. The software must allow a data set to be saved based on a user specified interval of time, load, displacement, strain or any combination thereof.
3. Tension and compression test control functionality must include pre-cycling, pre-loading, dual test speeds with automatic changeover at user specified values, creep and relaxation control, pre- tension grip control and test end/break detection control. Available test results and calculations must include standard modulus, yield, break, pre-set point detection, peak values, slack correction and creep/relaxation (total and delta).
4. Flexure test control functionality must include pre-loading, creep and relaxation control, and test end/break detection control. Available test results and calculations must include standard modulus, outer fiber stress and strain, yield, break, pre-set point detection, peak values, and creep/relaxation (total and delta). Both three and four point flexure tests must be supported.
5. A Block/Cyclic or test profile application must be supplied that allows the user to set up ramps, holds, and cyclic tests with the ability to change control modes between blocks.
6. The software must control movement of the crosshead as a function of load, stress, strain or true strain in addition to position control.
7. The software must allow for saving raw data and calculated results to generic character delimited file formats including CSV, as well as copy and pasting of calculated results to standard spreadsheet software including Microsoft Excel.
8. The software must offer detection of break values, as a percent drop from 0.02% to 99% from the peak load, with user configurable minimum break load. Sample break must be detectable based on a load or extension level being achieved, defined as a transducer feedback level or rate level for any transducer.
9. The software above must be able to be used in US Customary (lb, inch), SI (N, mm) and or Metric (kg, mm) units as desired by the operator.
10. The above software's documentation should explain the algorithms used in calculating results, provide a graphical example of how calculations are performed and also allow for printing of this information.
11. During a test, the software should allow the display in real time graphs and calculated results. It should also

provide displays that can be configured to display load, displacement, strain, time, or cycle count.

12. The system should be supplied with a control console with the following minimum specifications: US Manufacturer; Processor: Intel® Core i5-2400 3.1 GHz; Memory: 4 GB DDR3; Hard drive: at least 500 GB 7200RPM SATA; 3 PCI expansion slots.

F. Accessories

1. One set of mechanical wedge type grips with a capacity of 100 kN must be supplied with adapters to work on the load cell (C). These grips must have a temperature range of at least -70 °C to 250 °C.
2. Sets of serrated faces must be included that allow for testing of specimens from 0 to 12 mm thick and 25 mm (1 inch) wide, and vee-serrated faces that allow for testing of rod specimens 10 mm in diameter.
3. Two Compression Platens with a capacity of at least 100 kN and at least 150 mm (6 inch) diameter must be provided. This anvil must be hardened and include mounting holes for an LVDT.

G. Safety

1. The test frame must include a large ISO approved emergency stop switch.
2. The system must automatically disable the frame if the control console is shut down or disconnected.
3. The system must have the capability to detect the disconnection of a load cell and an optional extensometer, cable faults and signal loss and prevent that transducer from being used for control.
4. All rotating machinery must be fully enclosed to avoid pinch points and contamination.
5. Column covers should include features such as T-slots for mounting of safety shields and accessories.
6. The test frame must include mechanical limit switches on the front of the frame that prevents the crosshead from traveling too high or too low.
7. The system should have a CE certification for susceptibility and emissions.

H. Installation, Support and Warranty

1. NASA Ames will be responsible for uncrating the system, moving the system into its lab and providing the proper utilities for the test frame.
2. Once the system is moved into the lab, the system must be installed and calibrated on-site by the vendor's factory trained service engineer. Installation will include set-up of the interconnections between the control console and Frame
3. On-site verification of one load cell per ASTM E-4 must be performed by the vendor during installation. Factory verification is not acceptable.
4. Once the system is installed and calibrated, the vendor's service engineer will perform on-site training of at least three NASA Ames personnel.
5. All vendors must provide detailed information regarding its US based service staff that would be used to support the installation, maintenance, and repair of the system defined by this specification. This should include the experience of the service staff.
6. The electronics must include self-test diagnostics with an external display for hardware and communication status.
7. The frame, electronics and software provided must be a standard product, designed for materials testing and installed in at least one other customer laboratory. The vendor should describe its past history of reliability with manufacturing mechanical systems of this type, and providing software support (bug fixes, support of new operating systems). Custom/prototype hardware or software is not likely to be accepted.
8. All items supplied by vendor must carry at least a one-year warranty against defects in material and workmanship.

** Vendor personnel providing the installation and training on-site at NASA Ames Research Center must be U.S. persons (either U.S. citizens or U.S. permanent residents).

I. Required Dates

1. Delivery Date: Vendor to propose
2. On-Site Calibration and Training Date: Within 2 weeks of delivery