

2. CONTRACT NO _____ 3. AWARD/EFFECTIVE DATE _____ 4. ORDER NUMBER _____
 5. SOLICITATION NUMBER NNS06175431R 6. SOLICITATION ISSUE DATE 02/14/2007

7. FOR SOLICITATION INFORMATION CALL:  a. NAME Michelle Stracener b. TELEPHONE NUMBER (No collect calls) 228-688-1720 8. OFFER DUE DATE/LOCAL TIME 03/16/2007 1600 LT

9. ISSUED BY CODE SSC
 NASA/Stennis Space Center
 Acquisition Management Office
 Program Management Support Division
 Building 1100 Room 251H
 Stennis Space Center MS 39529-6000

10. THIS ACQUISITION IS
 UNRESTRICTED OR SET ASIDE: % FOR:
 SMALL BUSINESS EMERGING SMALL BUSINESS
 HUBZONE SMALL BUSINESS
 NAICS: 334519
 SIZE STANDARD: SERVICE-DISABLED VETERAN-OWNED SMALL BUSINESS 8(A)
 500

11. DELIVERY FOR FOB DESTINATION UNLESS BLOCK IS MARKED SEE SCHEDULE 12. DISCOUNT TERMS _____
 13b. RATING DO-C9
 14. METHOD OF SOLICITATION RFQ IFB RFP

15. DELIVER TO CODE SSC
 NASA/Stennis Space Center
 Stennis Space Center MS 39529-6000

16. ADMINISTERED BY CODE SSC
 NASA/Stennis Space Center
 Acquisition Management Office
 Building 1100 Room 251H
 Stennis Space Center MS 39529-6000

17a. CONTRACTOR/OFFEROR CODE _____ FACILITY CODE _____ 18a. PAYMENT WILL BE MADE BY CODE _____

TELEPHONE NO. _____

17b. CHECK IF REMITTANCE IS DIFFERENT AND PUT SUCH ADDRESS IN OFFER 18b. SUBMIT INVOICES TO ADDRESS SHOWN IN BLOCK 18a UNLESS BLOCK BELOW IS CHECKED SEE ADDENDUM

| 19 ITEM NO | 20 SCHEDULE OF SUPPLIES/SERVICES | 21 QUANTITY | 22 UNIT | 23 UNIT PRICE | 24 AMOUNT |
|---------------|---|----------------|------------|------------------|--------------|
| | Contractor is to provide all resources necessary to supply the following: Thrust Measurement Systems (TMS) for the J2X Engine Program. The work for this requirement consists of, but is not limited to the following: Providing all labor, materials, equipment and tools for the design, fabrication, testing, and technical support during installation, commissioning, and training of TMS to support the Thrust Measurement requirements of the J2X Engine in accordance with the specifications, scope of work, and terms and (Use Reverse and/or Attach Additional Sheets as Necessary) | | | | |

25. ACCOUNTING AND APPROPRIATION DATA _____ 26. TOTAL AWARD AMOUNT (For Govt Use Only) _____

27a. SOLICITATION INCORPORATES BY REFERENCE FAR 52 212-1, 52 212-4 FAR 52 212-3 AND 52 212-5 ARE ATTACHED ADDEND ARE ARE NOT ATTACHED
 27b. CONTRACT/PURCHASE ORDER INCORPORATES BY REFERENCE FAR 52 212-4 FAR 52 212-5 IS ATTACHED ADDENDA ARE ARE NOT ATTACHED

28. CONTRACTOR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE CONTRACTOR AGREES TO FURNISH AND DELIVER ALL ITEMS SET FORTH OR OTHERWISE IDENTIFIED ABOVE AND ON ANY ADDITIONAL SHEETS SUBJECT TO THE TERMS AND CONDITIONS SPECIFIED HEREIN. 29. AWARD OF CONTRACT REF. _____ OFFER DATED _____ YOUR OFFER ON SOLICITATION (BLOCK 5), INCLUDING ANY ADDITIONS OR CHANGES WHICH ARE SET FORTH HEREIN, IS ACCEPTED AS TO ITEMS:

30a. SIGNATURE OF OFFEROR/CONTRACTOR _____ 31a. UNITED STATES OF AMERICA (SIGNATURE OF CONTRACTING OFFICER)
 30b. NAME AND TITLE OF SIGNER (Type or print) _____ 30c. DATE SIGNED _____ 31b. NAME OF CONTRACTING OFFICER (Type or print) James D. Huk II 31c. DATE SIGNED _____

| 19 ITEM NO. | 20. SCHEDULE OF SUPPLIES/SERVICES | 21. QUANTITY | 22 UNIT | 23 UNIT PRICE | 24. AMOUNT |
|----------------|---|-----------------|------------|------------------|---------------|
| 001 | <p>conditions herein. Installation will be performed by Stennis Space Center. FOB is Destination. The initial delivery period for this requirement shall be eighteen (18) calendar months. The performance period of the contract shall be three (3) years. Quality Assurance Requirements - AQC08-Special Processes Certification and AQC12-Critical Processes INCO TERMS 2: DESTINATION</p> <p>Thrust Measurement Systems (TMS) - Carbon Steel. (See Attachment 2, Data sheet 1.1). In accordance with clause 52.216-19, Order Limitations, the Minimum order is estimated to be 1 EA carbon steel or stainless steel and the Maximum order is estimated to be 3 EA carbon steel or stainless steel or any combination thereof.</p> | 1 | EA | | |
| 002 | <p>Thrust Measurement Systems (TMS) - Stainless Steel. (See Attachment 2, Data sheet 1.2). In accordance with clause 52.216-19, Order Limitations, the Minimum order is estimated to be 1 EA carbon steel or stainless steel and the Maximum order is estimated to be 3 EA carbon steel or stainless steel any combination thereof.</p> | 1 | EA | | |

32a. QUANTITY IN COLUMN 21 HAS BEEN RECEIVED INSPECTED NOTED: _____ ACCEPTED, AND CONFORMS TO THE CONTRACT, EXCEPT AS

32b. SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE _____ 32c. DATE _____ 32d. PRINTED NAME AND TITLE OF AUTHORIZED GOVERNMENT REPRESENTATIVE _____

32e. MAILING ADDRESS OF AUTHORIZED GOVERNMENT REPRESENTATIVE _____ 32f. TELEPHONE NUMBER OF AUTHORIZED GOVERNMENT REPRESENTATIVE _____
 32g. E-MAIL OF AUTHORIZED GOVERNMENT REPRESENTATIVE _____

33. SHIP NUMBER _____ 34. VOUCHER NUMBER _____ 35. AMOUNT VERIFIED CORRECT FOR _____ 36. PAYMENT COMPLETE PARTIAL FINAL 37. CHECK NUMBER _____
 PARTIAL FINAL

38. S/R ACCOUNT NUMBER _____ 39. S/R VOUCHER NUMBER _____ 40. PAID BY _____

41a. I CERTIFY THIS ACCOUNT IS CORRECT AND PROPER FOR PAYMENT _____ 41b. SIGNATURE AND TITLE OF CERTIFYING OFFICER _____ 41c. DATE _____ 42a. RECEIVED BY (Print) _____
 42b. RECEIVED AT (Location) _____ 42c. DATE REC'D (YY/MM/DD) _____ 42d. TOTAL CONTAINERS _____

52.212-4 Contract Terms and Conditions - Commercial Items. (SEP 2005)

ADDENDA TO 52.212-4, CONTRACT TERMS AND CONDITIONS - COMMERCIAL ITEMS:

52.204-7 Central Contractor Registration. (JUL 2006)

52.204-9 Personal Identity Verification of Contractor Personnel. (JAN 2006)

52.209-6 Protecting the Government's Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment. (SEP 2006)

52.211-15 Defense Priority and Allocation Requirements. (SEP 1990)

52.216-22 Indefinite Quantity. (OCT 1995) Fill In: (d) the expiration date of the last Delivery Order

52.219-16 Liquidated Damages - Subcontracting Plan. (JAN 1999)

52.228-5 Insurance - Work on a Government Installation. (JAN 1997)

52.233-3 Protest after Award. (AUG 1996)

52.233-4 Applicable Law for Breach of Contract Claim. (OCT 2004)

52.237-2 Protection of Government Buildings, Equipment, and Vegetation. (APR 1984)

52.246-2 Inspection of Supplies – Fixed Price (Aug 1996)

52.247-34 F.o.b. Destination. (NOV 1991)

1852.219-75 Small Business Subcontracting Reporting. (MAY 1999)

1852.223-70 Safety and Health. (APR 2002)

1852.223-75 Major Breach of Safety or Security. (FEB 2002) -- Alternate I (FEB 2006)

52.225-8 Duty-Free Entry. (FEB 2000)

(a) *Definition.* Customs territory of the United States means the States, the District of Columbia, and Puerto Rico.

(b) Except as otherwise approved by the Contracting Officer, the Contractor shall not include in the contract price any amount for duties on supplies specifically identified in the Schedule to be accorded duty-free entry.

(c) Except as provided in paragraph (d) of this clause or elsewhere in this contract, the following procedures apply to supplies not identified in the Schedule to be accorded duty-free entry:

(1) The Contractor shall notify the Contracting Officer in writing of any purchase of foreign supplies (including, without limitation, raw materials, components, and intermediate assemblies) in excess of \$10,000 that are to be imported into the customs territory of the United States for delivery to the Government under this contract, either as end products or for incorporation into end products. The Contractor shall furnish the notice to the Contracting Officer at least 20 calendar days before the importation. The notice shall identify the -

(i) Foreign supplies;

(ii) Estimated amount of duty; and

(iii) Country of origin.

(2) The Contracting Officer will determine whether any of these supplies should be accorded duty-free entry and will notify the Contractor within 10 calendar days after receipt of the Contractor's notification.

(3) Except as otherwise approved by the Contracting Officer, the contract price shall be reduced by (or the allowable cost shall not include) the amount of duty that would be payable if the supplies were not entered duty-free.

(d) The Contractor is not required to provide the notification under paragraph (c) of this clause for purchases of foreign supplies if -

(1) The supplies are identical in nature to items purchased by the Contractor or any subcontractor in connection with its commercial business; and

(2) Segregation of these supplies to ensure use only on Government contracts containing duty-free entry provisions is not economical or feasible.

(e) The Contractor shall claim duty-free entry only for supplies to be delivered to the Government under this contract, either as end products or incorporated into end products, and shall pay duty on supplies, or any portion of them, other than scrap, salvage, or competitive sale authorized by the Contracting Officer, diverted to nongovernmental use.

(f) The Government will execute any required duty-free entry certificates for supplies to be accorded duty-free entry and will assist the Contractor in obtaining duty-free entry for these supplies.

(g) Shipping documents for supplies to be accorded duty-free entry shall consign the shipments to the contracting agency in care of the Contractor and shall include the -

(1) Delivery address of the Contractor (or contracting agency, if appropriate);

(2) Government prime contract number;

(3) Identification of carrier;

(4) Notation UNITED STATES GOVERNMENT, National Aeronautics and Space Administration (NASA), Duty-free entry to be claimed pursuant to Item No(s) 001 through 008, Harmonized Tariff Schedules of the United States. Upon arrival of shipment at port of entry, District Director of Customs, please release shipment under 19 CFR part 142 and notify John C. Stennis Space Center, Acquisition Management Office for execution of Customs Forms 7501 and 7501-A and any required duty-free entry certificates.;

(5) Gross weight in pounds (if freight is based on space tonnage, state cubic feet in addition to gross shipping weight); and

(6) Estimated value in United States dollars.

(h) The Contractor shall instruct the foreign supplier to -

(1) Consign the shipment as specified in paragraph (g) of this clause;

(2) Mark all packages with the words UNITED STATES GOVERNMENT and the title of the contracting agency; and

(3) Include with the shipment at least two copies of the bill of lading (or other shipping document) for use by the District Director of Customs at the port of entry.

(i) The Contractor shall provide written notice to the cognizant contract administration office immediately after notification by the Contracting Officer that duty-free entry will be accorded foreign supplies or, for duty-free supplies identified in the Schedule, upon award by the Contractor to the overseas supplier. The notice shall identify the -

- (1) Foreign supplies;
- (2) Country of origin;
- (3) Contract number; and
- (4) Scheduled delivery date(s).

(j) The Contractor shall include the substance of this clause in any subcontract if -

- (1) Supplies identified in the Schedule to be accorded duty-free entry will be imported into the customs territory of the United States; or
- (2) Other foreign supplies in excess of \$10,000 may be imported into the customs territory of the United States.

(End of clause)

52.216-18 Ordering. (OCT 1995)

(a) Any supplies and services to be furnished under this contract shall be ordered by issuance of delivery orders or task orders by the individuals or activities designated in the Schedule. Such orders may be issued from contract award through three (3) years.

(b) All delivery orders or task orders are subject to the terms and conditions of this contract. In the event of conflict between a delivery order or task order and this contract, the contract shall control.

(c) If mailed, a delivery order or task order is considered issued when the Government deposits the order in the mail. Orders may be issued orally, by facsimile, or by electronic commerce methods only if authorized in the Schedule.

(End of clause)

52.216-19 Order Limitations. (OCT 1995)

(a) *Minimum order.* When the Government requires supplies or services covered by this contract in an amount of less than one (1) each, the Government is not obligated to purchase, nor is the Contractor obligated to furnish, those supplies or services under the contract.

(b) *Maximum order.* The Contractor is not obligated to honor -

- (1) Any order for a single item in excess of three (3) each;
- (2) Any order for a combination of items in excess of three (3) each; or
- (3) A series of orders from the same ordering office within thirty (30) days that together call for quantities exceeding the limitation in subparagraph (b)(1) or (2) of this section.

(c) If this is a requirements contract (*i.e.*, includes the Requirements clause at subsection 52.216-21 of the Federal Acquisition Regulation (FAR)), the Government is not required to order a part of any one requirement from the Contractor if that requirement exceeds the maximum-order limitations in paragraph (b) of this section.

(d) Notwithstanding paragraphs (b) and (c) of this section, the Contractor shall honor any order exceeding the maximum order limitations in paragraph (b), unless that order (or orders) is returned to the ordering office within three (3) days after issuance, with written notice stating the Contractor's intent not to ship the item (or items) called for and the reasons. Upon receiving this notice, the Government may acquire the supplies or services from another source.

(End of clause)

52.252-2 Clauses Incorporated by Reference. (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es): Federal Acquisition Regulation (FAR) clauses: <http://www.acqnet.gov/far/>; NASA FAR Supplement (NFS) clauses:; <http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm>

(End of clause)

1852.215-84 Ombudsman. (OCT 2003) Alternate I (JUN 2000)

(a) An ombudsman has been appointed to hear and facilitate the resolution of concerns from offerors, potential offerors, and contractors during the preaward and postaward phases of this acquisition. When requested, the ombudsman will maintain strict confidentiality as to the source of the concern. The existence of the ombudsman is not to diminish the authority of the contracting officer, the Source Evaluation Board, or the selection official. Further, the ombudsman does not participate in the evaluation of proposals, the source selection process, or the adjudication of formal contract disputes. Therefore, before consulting with an ombudsman, interested parties must first address their concerns, issues, disagreements, and/or recommendations to the contracting officer for resolution.

(b) If resolution cannot be made by the contracting officer, interested parties may contact the installation ombudsman, Arthur E. Goldman, Stennis Space Center, MS 39529-6000, Phone (228) 688-2123, Fax (228) 688-3542, or email Arthur.E.Goldman@nasa.gov. Concerns, issues, disagreements, and recommendations which cannot be resolved at the installation may be referred to the NASA ombudsman, the Director of the Contract Management Division, at 202-358-0445, facsimile 202-358-3083, e-mail james.a.balinskas@nasa.gov. Please do not contact the ombudsman to request copies of the solicitation, verify offer due date, or clarify technical requirements. Such inquiries shall be directed to the Contracting Officer or as specified elsewhere in this document.

(c) If this is a task or delivery order contract, the ombudsman shall review complaints from contractors and ensure they are afforded a fair opportunity to be considered, consistent with the procedures of the contract.

(End of clause)

1852.219-76 NASA 8 Percent Goal. (JUL 1997)

(a) Definitions.

Historically Black Colleges or University, as used in this clause, means an institution determined by the Secretary of Education to meet the requirements of 34 CFR Section 608.2. The term also includes

any nonprofit research institution that was an integral part of such a college or university before November 14, 1986.

Minority institutions, as used in this clause, means an institution of higher education meeting the requirements of section 1046(3) of the Higher Education Act of 1965 (20 U.S.C. 1135d-5(3)) which for the purposes of this clause includes a Hispanic-serving institution of higher education as defined in section 316(b)(1) of the Act (20 U.S.C. 1059c(b)(1)).

Small disadvantaged business concern, as used in this clause, means a small business concern that (1) is at least 51 percent unconditionally owned by one or more individuals who are both socially and economically disadvantaged, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one or more socially and economically disadvantaged individuals, and (2) has its management and daily business controlled by one or more such individuals. This term also means a small business concern that is at least 51 percent unconditionally owned by an economically disadvantaged Indian tribe or Native Hawaiian Organization, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one or more of these entities, which has its management and daily business controlled by members of an economically disadvantaged Indian tribe or Native Hawaiian Organization, and which meets the requirements of 13 CFR 124.

Women-owned small business concern, as used in this clause, means a small business concern (1) which is at least 51 percent owned by one or more women or, in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women, and (2) whose management and daily business operations are controlled by one or more women.

(b) The NASA Administrator is required by statute to establish annually a goal to make available to small disadvantaged business concerns, Historically Black Colleges and Universities, minority institutions, and women-owned small business concerns, at least 8 percent of NASA's procurement dollars under prime contracts or subcontracts awarded in support of authorized programs, including the space station by the time operational status is obtained.

(c) The contractor hereby agrees to assist NASA in achieving this goal by using its best efforts to award subcontracts to such entities to the fullest extent consistent with efficient contract performance.

(d) Contractors acting in good faith may rely on written representations by their subcontractors regarding their status as small disadvantaged business concerns, Historically Black Colleges and Universities, minority institutions, and women-owned small business concerns.

(End of clause)

52.212-5 Contract Terms and Conditions Required to Implement Statutes or Executive Orders - Commercial Items. (SEP 2006)

(a) The Contractor shall comply with the following Federal Acquisition Regulation (FAR) clauses, which are incorporated in this contract by reference, to implement provisions of law or Executive orders applicable to acquisitions of commercial items:

(1) 52.233-3, Protest After Award (AUG 1996) (31 U.S.C. 3553).

(2) 52.233-4, Applicable Law for Breach of Contract Claim (OCT 2004) (Pub. L. 108-77, 108-78).

(b) The Contractor shall comply with the FAR clauses in this paragraph (b) that the Contracting Officer has indicated as being incorporated in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items: Contracting Officer check as appropriate.

(1) 52.203-6, Restrictions on Subcontractor Sales to the Government (JUL 1995), with

Alternate I (SEP 2006) (41 U.S.C. 253g and 10 U.S.C. 2402).

(2) 52.219-3, Notice of Total HUBZone Set-Aside (JAN 1999) (15 U.S.C. 657a).

(3) 52.219-4, Notice of Price Evaluation Preference for HUBZone Small Business Concerns (JUL 2005) (if the offeror elects to waive the preference, it shall so indicate in its offer) (15 U.S.C. 657a).

(4) Reserved.

(5)(i) 52.219-6, Notice of Total Small Business Set-Aside (JUN 2003) (15 U.S.C. 644).

(ii) Alternate I (OCT 1995) of 52.219-6.

(iii) Alternate II (MAR 2004) of 52.219-6.

(6)(i) 52.219-7, Notice of Partial Small Business Set-Aside (JUN 2003) (15 U.S.C. 644).

(ii) Alternate I (OCT 1995) of 52.219-7.

(iii) Alternate II (MAR 2004) of 52.219-7.

(7) 52.219-8, Utilization of Small Business Concerns (MAY 2004) (15 U.S.C. 637 (d)(2) and (3)).

(8)(i) 52.219-9, Small Business Subcontracting Plan (SEP 2006) (15 U.S.C. 637(d)(4)).

(ii) Alternate I (OCT 2001) of 52.219-9.

(iii) Alternate II (OCT 2001) of 52.219-9.

(9) 52.219-14, Limitations on Subcontracting (DEC 1996) (15 U.S.C. 637(a)(14)).

(10)(i) 52.219-23, Notice of Price Evaluation Adjustment for Small Disadvantaged Business Concerns (SEP 2005) (10 U.S.C. 2323) (if the offeror elects to waive the adjustment, it shall so indicate in its offer).

(ii) Alternate I (JUN 2003) of 52.219-23.

(11) 52.219-25, Small Disadvantaged Business Participation Program - Disadvantaged Status and Reporting (OCT 1999) (Pub. L. 103-355, section 7102, and 10 U.S.C. 2323).

(12) 52.219-26, Small Disadvantaged Business Participation Program - Incentive Subcontracting (OCT 2000) (Pub. L. 103-355, section 7102, and 10 U.S.C. 2323).

(13) 52.219-27, Notice of Total Service-Disabled Veteran-Owned Small Business Set-Aside (May 2004).

(14) 52.222-3, Convict Labor (JUN 2003) (E.O. 11755).

(15) 52.222-19, Child Labor - Cooperation with Authorities and Remedies (JAN 2006) (E.O. 13126).

(16) 52.222-21, Prohibition of Segregated Facilities (FEB 1999).

(17) 52.222-26, Equal Opportunity (APR 2002) (E.O. 11246).

(18) 52.222-35, Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (SEP 2006) (38 U.S.C. 4212).

(19) 52.222-36, Affirmative Action for Workers with Disabilities (JUN 1998) (29 U.S.C. 793).

(20) 52.222-37, Employment Reports on Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (SEP 2006) (38 U.S.C. 4212).

(21) 52.222-39, Notification of Employee Rights Concerning Payment of Union Dues or Fees (DEC 2004) (E.O. 13201).

(22)(i) 52.223-9, Estimate of Percentage of Recovered Material Content for EPA-Designated Products (AUG 2000) (42 U.S.C. 6962(c)(3)(A)(ii)).

(ii) Alternate I (AUG 2000) of 52.223-9 (42 U.S.C. 6962(i)(2)(C)).

(23) 52.225-1, Buy American Act - Supplies (JUN 2003) (41 U.S.C. 10a-10d).

(24)(i) 52.225-3, Buy American Act--Free Trade Agreements-- Israeli Trade Act (JUN 2006) (41 U.S.C. 10a-10d, 19 U.S.C. 3301 note, 19 U.S.C. 2112 note, Pub. L. 108-77, 108-78, 108-286) and 109-53

(ii) Alternate I (JAN 2004) of 52.225-3.

(iii) Alternate II (JAN 2004) of 52.225-3.

(25) 52.225-5, Trade Agreements (JUN 2006) (19 U.S.C. 2501, et seq., 19 U.S.C. 3301 note).

(26) 52.225-13, Restrictions on Certain Foreign Purchases (FEB 2006) (E.o.s, proclamations, and statutes administered by the Office of Foreign Assets Control of the Department of the Treasury).

(27) 52.226-4, Notice of Disaster or Emergency Area Set-Aside (42 U.S.C. 5150).

(28) 52.226-5, Restrictions on Subcontracting Outside Disaster or Emergency Area (42 U.S.C. 5150).

(29) 52.232-29, Terms for Financing of Purchases of Commercial Items (FEB 2002) (41 U.S.C. 255(f), 10 U.S.C. 2307(f)).

(30) 52.232-30, Installment Payments for Commercial Items (OCT 1995) (41 U.S.C. 255(f), 10 U.S.C. 2307(f)).

(31) 52.232-33, Payment by Electronic Funds Transfer - Central Contractor Registration (OCT 2003) (31 U.S.C. 3332).

(32) 52.232-34, Payment by Electronic Funds Transfer - Other than Central Contractor Registration (MAY 1999) (31 U.S.C. 3332).

(33) 52.232-36, Payment by Third Party (MAY 1999) (31 U.S.C. 3332).

(34) 52.239-1, Privacy or Security Safeguards (AUG 1996) (5 U.S.C. 552a).

(35)(i) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (FEB 2006)

(46 U.S.C. Appx 1241(b) and 10 U.S.C. 2631).

[](ii) Alternate I (APR 2003) of 52.247-64.

(c) The Contractor shall comply with the FAR clauses in this paragraph (c), applicable to commercial services, that the Contracting Officer has indicated as being incorporated in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items: (Contracting Officer check as appropriate.)

[](1) 52.222-41, Service Contract Act of 1965, as Amended (JUL 2005) (41 U.S.C. 351, et seq.).

[](2) 52.222-42, Statement of Equivalent Rates for Federal Hires (MAY 1989) (29 U.S.C. 206 and 41 U.S.C. 351, et seq.).

[](3) 52.222-43, Fair Labor Standards Act and Service Contract Act--Price Adjustment (Multiple Year and Option Contracts) (MAY 1989) (29 U.S.C. 206 and 41 U.S.C. 351, et seq.).

[](4) 52.222-44, Fair Labor Standards Act and Service Contract Act--Price Adjustment (FEB 2002) (29 U.S.C. 206 and 41 U.S.C. 351, et seq.).

(d) *Comptroller General Examination of Record.* The Contractor shall comply with the provisions of this paragraph (d) if this contract was awarded using other than sealed bid, is in excess of the simplified acquisition threshold, and does not contain the clause at 52.215-2, Audit and Records - Negotiation.

(1) The Comptroller General of the United States, or an authorized representative of the Comptroller General, shall have access to and right to examine any of the Contractor's directly pertinent records involving transactions related to this contract.

(2) The Contractor shall make available at its offices at all reasonable times the records, materials, and other evidence for examination, audit, or reproduction, until 3 years after final payment under this contract or for any shorter period specified in FAR Subpart 4.7, Contractor Records Retention, of the other clauses of this contract. If this contract is completely or partially terminated, the records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement. Records relating to appeals under the disputes clause or to litigation or the settlement of claims arising under or relating to this contract shall be made available until such appeals, litigation, or claims are finally resolved.

(3) As used in this clause, records include books, documents, accounting procedures and practices, and other data, regardless of type and regardless of form. This does not require the Contractor to create or maintain any record that the Contractor does not maintain in the ordinary course of business or pursuant to a provision of law.

(e)(1) Notwithstanding the requirements of the clauses in paragraphs (a), (b), (c), and (d) of this clause, the Contractor is not required to flow down any FAR clause, other than those in paragraphs (i) through (vii) of this paragraph in a subcontract for commercial items. Unless otherwise indicated below, the extent of the flow down shall be as required by the clause--

(i) 52.219-8, Utilization of Small Business Concerns (MAY 2004) (15 U.S.C. 637(d)(2) and (3)), in all subcontracts that offer further subcontracting opportunities. If the subcontract (except subcontracts to small business concerns) exceeds \$550,000 (\$1,000,000 for construction of any public facility), the subcontractor must include 52.219-8 in lower tier subcontracts that offer subcontracting opportunities.

(ii) 52.222-26, Equal Opportunity (APR 2002) (E.O. 11246).

(iii) 52.222-35, Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (SEP 2006) (38 U.S.C. 4212).

(iv) 52.222-36, Affirmative Action for Workers with Disabilities (JUN 1998) (29 U.S.C. 793).

(v) 52.222-39, Notification of Employee Rights Concerning Payment of Union Dues or Fees (DEC 2004) (E.O. 13201).

(vi) 52.222-41, Service Contract Act of 1965, as Amended (JUL 2005), flow down required for all subcontracts subject to the Service Contract Act of 1965 (41 U.S.C. 351, et seq.).

(vii) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (FEB 2006) (46 U.S.C. Appx 1241(b) and 10 U.S.C. 2631). Flow down required in accordance with paragraph (d) of FAR clause 52.247-64.

(2) While not required, the contractor may include in its subcontracts for commercial items a minimal number of additional clauses necessary to satisfy its contractual obligations.

(End of clause)

52.212-1 Instructions to Offerors - Commercial Items. (SEP 2006)

ADDENDA TO 52.212-1, INSTRUCTIONS TO OFFERORS - COMMERCIAL ITEMS

52.232-38 Submission of Electronic Funds Transfer Information with Offer. (MAY 1999)

52.252-1 Solicitation Provisions Incorporated by Reference. (FEB 1998)

This solicitation incorporates one or more solicitation provisions by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. The offeror is cautioned that the listed provisions may include blocks that must be completed by the offeror and submitted with its quotation or offer. In lieu of submitting the full text of those provisions, the offeror may identify the provision by paragraph identifier and provide the appropriate information with its quotation or offer. Also, the full text of a solicitation provision may be accessed electronically at this/these address(es): Federal Acquisition Regulation (FAR) clauses: <http://www.acqnet.gov/far/>; NASA FAR Supplement (NFS) clauses: <http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm>

(End of provision)

52.211-14 Notice of Priority Rating for National Defense Use. (SEP 1990)

Any contract awarded as a result of this solicitation will be [] DX rated order; [X] DO rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation. (*Contracting Officer check appropriate box.*)

(End of provision)

52.212-2 Evaluation - Commercial Items. (JAN 1999)

(a) The Government will award a contract resulting from this solicitation to the responsible offeror whose offer conforming to the solicitation will be most advantageous to the Government, price and other factors considered. The following factors shall be used to evaluate offers: See Addendum to FAR 52.212-2; Technical and past performance, when combined, are See Addendum to FAR 52.212-2

(b) *Options*. The Government will evaluate offers for award purposes by adding the total price for all options to the total price for the basic requirement. The Government may determine that an offer is unacceptable if the option prices are significantly unbalanced. Evaluation of options shall not obligate the Government to exercise the option(s).

(c) A written notice of award or acceptance of an offer, mailed or otherwise furnished to the successful offeror within the time for acceptance specified in the offer, shall result in a binding contract without further action by either party. Before the offer's specified expiration time, the Government may accept an offer (or part of an offer), whether or not there are negotiations after its receipt, unless a written notice of withdrawal is received before award.

(End of provision)

52.212-3 Offeror Representations and Certifications-Commercial Items. (JUN 2006) -- Alternate I (MAY 2002)

An offeror shall complete only paragraph (j) of this provision if the offeror has completed the annual representations and certifications electronically at <http://orca.bpn.gov>. If an offeror has not completed the annual representations and certifications electronically at the ORCA website, the offeror shall complete only paragraphs (b) through (i) of this provision.

(a) Definitions. As used in this provision:

"Emerging small business" means a small business concern whose size is no greater than 50 percent of the numerical size standard for the NAICS code designated.

"Forced or indentured child labor" means all work or service-

(1) Exacted from any person under the age of 18 under the menace of any penalty for its nonperformance and for which the worker does not offer himself voluntarily; or

(2) Performed by any person under the age of 18 pursuant to a contract the enforcement of which can be accomplished by process or penalties.

"Service-disabled veteran-owned small business concern"-

(1) Means a small business concern-

(i) Not less than 51 percent of which is owned by one or more service-disabled veterans or, in the case of any publicly owned business, not less than 51 percent of the stock of which is owned by one or more service-disabled veterans; and

(ii) The management and daily business operations of which are controlled by one or more service-disabled veterans or, in the case of a service-disabled veteran with permanent and severe disability, the spouse or permanent caregiver of such veteran.

(2) Service-disabled veteran means a veteran, as defined in 38 U.S.C. 101(2), with a disability that is service-connected, as defined in 38 U.S.C. 101(16).

"Small business concern" means a concern, including its affiliates, that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria in 13 CFR part 121 and size standards in this solicitation.

"Veteran-owned small business concern" means a small business concern-

(1) Not less than 51 percent of which is owned by one or more veterans (as defined at 38 U.S.C. 101(2)) or, in the case of any publicly owned business, not less than 51 percent of the stock of which is owned by one or more veterans; and

(2) The management and daily business operations of which are controlled by one or more veterans.

"Women-owned business concern" means a concern which is at least 51 percent owned by one or more women; or in the case of any publicly owned business, at least 51 percent of its stock is owned by one or more women; and whose management and daily business operations are controlled by one or more women.

"Women-owned small business concern" means a small business concern-

(1) That is at least 51 percent owned by one or more women; or, in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women; and

(2) Whose management and daily business operations are controlled by one or more women.

(b) Taxpayer Identification Number (TIN) (26 U.S.C. 6109, 31 U.S.C. 7701). (Not applicable if the offeror is required to provide this information to a central contractor registration database to be eligible for award.)

(1) All offerors must submit the information required in paragraphs (b)(3) through (b)(5) of this provision to comply with debt collection requirements of 31 U.S.C. 7701(c) and 3325(d), reporting requirements of 26 U.S.C. 6041, 6041A, and 6050M, and implementing regulations issued by the Internal Revenue Service (IRS).

(2) The TIN may be used by the Government to collect and report on any delinquent amounts arising out of the offeror's relationship with the Government (31 U.S.C. 7701(c)(3)). If the resulting contract is subject to the payment reporting requirements described in FAR 4.904, the TIN provided hereunder may be matched with IRS records to verify the accuracy of the offeror's TIN.

(3) Taxpayer Identification Number (TIN).

TIN: _____
 TIN has been applied for.
 TIN is not required because:

Offeror is a nonresident alien, foreign corporation, or foreign partnership that does not have income effectively connected with the conduct of a trade or business in the United States and does not have an office or place of business or a fiscal paying agent in the United States;

Offeror is an agency or instrumentality of a foreign government;

Offeror is an agency or instrumentality of the Federal Government.

(4) Type of organization.

Sole proprietorship;
 Partnership;
 Corporate entity (not tax-exempt);
 Corporate entity (tax-exempt);
 Government entity (Federal, State, or local);
 Foreign government;

___ International organization per 26 CFR 1.60494;
 ___ Other _____.

(5) Common parent.

___ Offeror is not owned or controlled by a common parent;
 ___ Name and TIN of common parent:
 Name _____
 TIN _____

(c) Offerors must complete the following representations when the resulting contract will be performed in the United States or its outlying areas. Check all that apply.

(1) Small business concern. The offeror represents as part of its offer that it ___ is, ___ is not a small business concern.

(2) Veteran-owned small business concern. (Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.) The offeror represents as part of its offer that it ___ is, ___ is not a veteran-owned small business concern.

(3) Service-disabled veteran-owned small business concern. (Complete only if the offeror represented itself as a veteran-owned small business concern in paragraph (c)(2) of this provision.) The offeror represents as part of its offer that it ___ is, ___ is not a service-disabled veteran-owned small business concern.

(4) Small disadvantaged business concern. (Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.) The offeror represents, for general statistical purposes, that it ___ is, ___ is not a small disadvantaged business concern as defined in 13 CFR 124.1002.

(5) Women-owned small business concern. (Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.) The offeror represents that it ___ is, ___ is not a women-owned small business concern.

Note: Complete paragraphs (c)(6) and (c)(7) only if this solicitation is expected to exceed the simplified acquisition threshold.

(6) Women-owned business concern (other than small business concern). (Complete only if the offeror is a women-owned business concern and did not represent itself as a small business concern in paragraph (c)(1) of this provision.) The offeror represents that it ___ is a women-owned business concern.

(7) Tie bid priority for labor surplus area concerns. If this is an invitation for bid, small business offerors may identify the labor surplus areas in which costs to be incurred on account of manufacturing or production (by offeror or first-tier subcontractors) amount to more than 50 percent of the contract price: _____

(8) Small Business Size for the Small Business Competitiveness Demonstration Program and for the Targeted Industry Categories under the Small Business Competitiveness Demonstration Program. (Complete only if the offeror has represented itself to be a small business concern under the size standards for this solicitation.)

(i) (Complete only for solicitations indicated in an addendum as being set-aside for emerging small businesses in one of the designated industry groups (DIGs).) The offeror represents as part of its offer that it ___ is, ___ is not an emerging small business.

(ii) (Complete only for solicitations indicated in an addendum as being for one of the targeted industry categories (TICs) or designated industry groups (DIGs).) Offeror represents as follows:

(A) Offeror's number of employees for the past 12 months (check the Employees column if size standard stated in the solicitation is expressed in terms of number of employees);
or

(B) Offeror's average annual gross revenue for the last 3 fiscal years (check the Average Annual Gross Number of Revenues column if size standard stated in the solicitation is expressed in terms of annual receipts). (Check one of the following):

| Number of Employees | Average Annual Gross Revenues |
|--------------------------------------|--|
| <input type="checkbox"/> 50 or fewer | <input type="checkbox"/> \$1 million or less |
| <input type="checkbox"/> 51-100 | <input type="checkbox"/> \$1,000,001-\$2 million |
| <input type="checkbox"/> 101-250 | <input type="checkbox"/> \$2,000,001-\$3.5 million |
| <input type="checkbox"/> 251-500 | <input type="checkbox"/> \$3,500,001-\$5 million |
| <input type="checkbox"/> 501-750 | <input type="checkbox"/> \$5,000,001-\$10 million |
| <input type="checkbox"/> 751-1,000 | <input type="checkbox"/> \$10,000,001-\$17 million |
| <input type="checkbox"/> Over 1,000 | <input type="checkbox"/> Over \$17 million |

(9) (Complete only if the solicitation contains the clause at FAR 52.219-23, Notice of Price Evaluation Adjustment for Small Disadvantaged Business Concerns, or FAR 52.219-25, Small Disadvantaged Business Participation Program-Disadvantaged Status and Reporting, and the offeror desires a benefit based on its disadvantaged status.)

(i) General. The offeror represents that either-

(A) It is, is not certified by the Small Business Administration as a small disadvantaged business concern and identified, on the date of this representation, as a certified small disadvantaged business concern in the database maintained by the Small Business Administration (PRO-Net), and that no material change in disadvantaged ownership and control has occurred since its certification, and, where the concern is owned by one or more individuals claiming disadvantaged status, the net worth of each individual upon whom the certification is based does not exceed \$750,000 after taking into account the applicable exclusions set forth at 13 CFR 124.104(c)(2); or

(B) It has, has not submitted a completed application to the Small Business Administration or a Private Certifier to be certified as a small disadvantaged business concern in accordance with 13 CFR 124, Subpart B, and a decision on that application is pending, and that no material change in disadvantaged ownership and control has occurred since its application was submitted.

(ii) Joint Ventures under the Price Evaluation Adjustment for Small Disadvantaged Business Concerns. The offeror represents, as part of its offer, that it is a joint venture that complies with the requirements in 13 CFR 124.1002(f) and that the representation in paragraph (c)(9)(i) of this provision is accurate for the small disadvantaged business concern that is participating in the joint venture. The offeror shall enter the name of the small disadvantaged business concern that is participating in the joint venture: _____

(10) HUBZone small business concern. (Complete only if the offeror represented itself as a small business concern in paragraph (c)(1) of this provision.) The offeror represents, as part of its offer, that--

(i) It is, is not a HUBZone small business concern listed, on the date of this

representation, on the List of Qualified HUBZone Small Business Concerns maintained by the Small Business Administration, and no material change in ownership and control, principal office, or HUBZone employee percentage has occurred since it was certified by the Small Business Administration in accordance with 13 CFR part 126; and

(ii) It ___ is, ___ is not a joint venture that complies with the requirements of 13 CFR part 126, and the representation in paragraph (c)(10)(i) of this provision is accurate for the HUBZone small business concern or concerns that are participating in the joint venture. (The offeror shall enter the name or names of the HUBZone small business concern or concerns that are participating in the joint venture: _____.) Each HUBZone small business concern participating in the joint venture shall submit a separate signed copy of the HUBZone representation.

(11) (Complete if the offeror has represented itself as disadvantaged in paragraph (c)(4) or (c)(9) of this provision.)

(The offeror shall check the category in which its ownership falls):

___ Black American.

___ Hispanic American.

___ Native American (American Indians, Eskimos, Aleuts, or Native Hawaiians).

___ Asian-Pacific American (persons with origins from Burma, Thailand, Malaysia, Indonesia, Singapore, Brunei, Japan, China, Taiwan, Laos, Cambodia (Kampuchea), Vietnam, Korea, The Philippines, U.S. Trust Territory of the Pacific Islands (Republic of Palau), Republic of the Marshall Islands, Federated States of Micronesia, the Commonwealth of the Northern Mariana Islands, Guam, Samoa, Macao, Hong Kong, Fiji, Tonga, Kiribati, Tuvalu, or Nauru).

___ Subcontinent Asian (Asian-Indian) American (persons with origins from India, Pakistan, Bangladesh, Sri Lanka, Bhutan, the Maldives Islands, or Nepal).

___ Individual/concern, other than one of the preceding.

(d) Representations required to implement provisions of Executive Order 11246-

(1) Previous contracts and compliance. The offeror represents that-

(i) It ___ has, ___ has not participated in a previous contract or subcontract subject to the Equal Opportunity clause of this solicitation; and

(ii) It ___ has, ___ has not filed all required compliance reports.

(2) Affirmative Action Compliance. The offeror represents that-

(i) It ___ has developed and has on file, ___ has not developed and does not have on file, at each establishment, affirmative action programs required by rules and regulations of the Secretary of Labor (41 CFR parts 60-1 and 60-2), or

(ii) It ___ has not previously had contracts subject to the written affirmative action programs requirement of the rules and regulations of the Secretary of Labor.

(e) Certification Regarding Payments to Influence Federal Transactions (31 U.S.C. 1352). (Applies only if the contract is expected to exceed \$100,000.) By submission of its offer, the offeror certifies to the best of its knowledge and belief that no Federal appropriated funds have been paid or will be paid

to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress or an employee of a Member of Congress on his or her behalf in connection with the award of any resultant contract.

(f) Buy American Act Certificate. (Applies only if the clause at Federal Acquisition Regulation (FAR) 52.225-1, Buy American Act-Supplies, is included in this solicitation.)

(1) The offeror certifies that each end product, except those listed in paragraph (f)(2) of this provision, is a domestic end product and that the offeror has considered components of unknown origin to have been mined, produced, or manufactured outside the United States. The offeror shall list as foreign end products those end products manufactured in the United States that do not qualify as domestic end products. The terms component, domestic end product, end product, foreign end product, and United States are defined in the clause of this solicitation entitled Buy American Act--Supplies.

(2) Foreign End Products:

| | |
|---------------------|-------------------|
| Line Item No. | Country of Origin |
| (List as necessary) | |

(3) The Government will evaluate offers in accordance with the policies and procedures of FAR Part 25.

(g)(1) Buy American Act Free Trade Agreements Israeli Trade Act Certificate. (Applies only if the clause at FAR 52.225-3, Buy American Act Free Trade Agreements Israeli Trade Act, is included in this solicitation.)

(i) The offeror certifies that each end product, except those listed in paragraph (g)(1)(ii) or (g)(1)(iii) of this provision, is a domestic end product and that the offeror has considered components of unknown origin to have been mined, produced, or manufactured outside the United States. The terms component, domestic end product, end product, foreign end product, Free Trade Agreement country, and United States are defined in the clause of this solicitation entitled Buy American Act Free Trade Agreements Israeli Trade Act.

(ii) The offeror certifies that the following supplies are Free Trade Agreement country end products (other than Moroccan end products) or Israeli end products as defined in the clause of this solicitation entitled Buy American Act Free Trade Agreements Israeli Trade Act:

Free Trade Agreement Country End Products (Other than Moroccan End Products) or Israeli End Products:

| | |
|---------------------|-------------------|
| Line Item No. | Country of Origin |
| (List as necessary) | |

(iii) The offeror shall list those supplies that are foreign end products (other than those listed in paragraph (g)(1)(ii) of this provision) as defined in the clause of this solicitation entitled Buy American Act Free Trade Agreements Israeli Trade Act. The offeror shall list as other foreign end products those end products manufactured in the United States that do not qualify as domestic end products.

Other Foreign End Products

| | |
|---------------|-------------------|
| Line Item No. | Country of Origin |
|---------------|-------------------|

(List as necessary)

(iv) The Government will evaluate offers in accordance with the policies and procedures of FAR Part 25.

(2) Buy American Act Free Trade Agreements Israeli Trade Act Certificate, Alternate I. If Alternate I to the clause at FAR 52.225-3 is included in this solicitation, substitute the following paragraph (g)(1)(ii) for paragraph (g)(1)(ii) of the basic provision:

(g)(1)(ii) The offeror certifies that the following supplies are Canadian end products as defined in the clause of this solicitation entitled Buy American Act Free Trade Agreements Israeli Trade Act:

Canadian End Products:

| | |
|---------------|-------------------|
| Line Item No. | Country of Origin |
|---------------|-------------------|

(List as necessary)

(3) Buy American Act Free Trade Agreements Israeli Trade Act Certificate, Alternate II. If Alternate II to the clause at FAR 52.225-3 is included in this solicitation, substitute the following paragraph (g)(1)(ii) for paragraph (g)(1)(ii) of the basic provision:

(g)(1)(ii) The offeror certifies that the following supplies are Canadian end products or Israeli end products as defined in the clause of this solicitation entitled Buy American Act Free Trade Agreements Israeli Trade Act:

Canadian or Israeli End Products:

| | |
|---------------|-------------------|
| Line Item No. | Country of Origin |
|---------------|-------------------|

(List as necessary)

(4) Trade Agreements Certificate. (Applies only if the clause at FAR 52.225-5, Trade Agreements, is included in this solicitation.)

(i) The offeror certifies that each end product, except those listed in paragraph (g)(4)(ii) of this provision, is a U.S.-made or designated country end product, as defined in the clause of this solicitation entitled Trade Agreements.

(ii) The offeror shall list as other end products those end products that are not U.S.-made or designated country end products.

Other End Products:

| | |
|---------------|-------------------|
| Line Item No. | Country of Origin |
|---------------|-------------------|

(List as necessary)

(iii) The Government will evaluate offers in accordance with the policies and procedures of FAR Part 25. For line items covered by the WTO GPA, the Government will evaluate offers of U.S.-made or designated country end products without regard to the restrictions of the Buy American Act. The Government will consider for award only offers of U.S.-made or designated country end products unless the Contracting Officer determines that there are no offers for such products or that the offers for such products are insufficient to fulfill the requirements of the solicitation.

(h) Certification Regarding Debarment, Suspension or Ineligibility for Award (Executive Order

12689). (Applies only if the contract value is expected to exceed the simplified acquisition threshold.) The offeror certifies, to the best of its knowledge and belief, that the offeror and/or any of its principals--

(1) ___ are, ___ are not presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency; and

(2) ___ have, ___ have not, within a three-year period preceding this offer, been convicted of or had a civil judgment rendered against them for: Commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a Federal, state or local government contract or subcontract; violation of Federal or state antitrust statutes relating to the submission of offers; or Commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, tax evasion, or receiving stolen property; and

(3) ___ are, ___ are not presently indicted for, or otherwise criminally or civilly charged by a Government entity with, commission of any of these offenses.

(i) Certification Regarding Knowledge of Child Labor for Listed End Products (Executive Order 13126). (The Contracting Officer must list in paragraph (i)(1) any end products being acquired under this solicitation that are included in the List of Products Requiring Contractor Certification as to Forced or Indentured Child Labor, unless excluded at 22.1503(b).)

(1) Listed end products.

| Listed End Product | Listed Countries of Origin |
|--------------------|----------------------------|
| N/A | [] |

(2) Certification. (If the Contracting Officer has identified end products and countries of origin in paragraph (i)(1) of this provision, then the offeror must certify to either (i)(2)(i) or (i)(2)(ii) by checking the appropriate block.)

___ (i) The offeror will not supply any end product listed in paragraph (i)(1) of this provision that was mined, produced, or manufactured in the corresponding country as listed for that product.

___ (ii) The offeror may supply an end product listed in paragraph (i)(1) of this provision that was mined, produced, or manufactured in the corresponding country as listed for that product. The offeror certifies that it has made a good faith effort to determine whether forced or indentured child labor was used to mine, produce, or manufacture any such end product furnished under this contract. On the basis of those efforts, the offeror certifies that it is not aware of any such use of child labor.

(j)(1) Annual Representations and Certifications. Any changes provided by the offeror in paragraph (j) of this provision do not automatically change the representations and certifications posted on the Online Representations and Certifications Application (ORCA) website.

(2) The offeror has completed the annual representations and certifications electronically via the ORCA website at <http://orca.bpn.gov>. After reviewing the ORCA database information, the offeror verifies by submission of this offer that the representations and certifications currently posted electronically at FAR 52.212-3, Offeror Representations and Certifications--Commercial Items, have been entered or updated in the last 12 months, are current, accurate, complete, and applicable to this solicitation (including the business size standard applicable to the NAICS code referenced for this solicitation), as of the date of this offer and are incorporated in this offer by reference (see FAR 4.1201), except for paragraphs _____.

(Offeror to identify the applicable paragraphs at (b) through (i) of this provision that the offeror has completed for the purposes of this solicitation only, if any.

These amended representation(s) and/or certification(s) are also incorporated in this offer and are current, accurate, and complete as of the date of this offer.

Any changes provided by the offeror are applicable to this solicitation only, and do not result in an update to the representations and certifications posted on ORCA.)

(End of provision)

52.225-2 Buy American Act - Certificate. (JUN 2003)

(a) The offeror certifies that each end product, except those listed in paragraph (b) of this provision, is a domestic end product and that the offeror has considered components of unknown origin to have been mined, produced, or manufactured outside the United States. The offeror shall list as foreign end products those end products manufactured in the United States that do not qualify as domestic end products. The terms component, domestic end product, end product, foreign end product, and United States are defined in the clause of this solicitation entitled Buy American Act--Supplies.

(b) Foreign End Products:

Line Item NoCountry of Origin

| | |
|-------|-------|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

(List as necessary)

(c) The Government will evaluate offers in accordance with the policies and procedures of Part 25 of the Federal Acquisition Regulation.

(End of provision)

52.233-2 Service of Protest. (SEP 2006)

(a) Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the Government Accountability Office (GAO), shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from John C. Stennis Space Center, Acquisition Management Office, Bldg 1100, Mail Code BA30, Stennis Space Center, MS 39529-6000

(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

(End of provision)

52.211-14 Notice of Priority Rating for National Defense Use. (SEP 1990)

Any contract awarded as a result of this solicitation will be [] DX rated order; [X] DO rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR 700), and the Contractor will be required to follow all of the requirements of this regulation. (Contracting Officer check appropriate box.)

(End of provision)

1852.223-73 Safety and Health Plan. (NOV 2004)

(a) The offeror shall submit a detailed safety and occupational health plan as part of its proposal (see NPR 8715.3, NASA Safety Manual, Appendices). The plan shall include a detailed discussion of the policies, procedures, and techniques that will be used to ensure the safety and occupational health of Contractor employees and to ensure the safety of all working conditions throughout the performance of the contract.

(b) When applicable, the plan shall address the policies, procedures, and techniques that will be used to ensure the safety and occupational health of the public, astronauts and pilots, the NASA workforce (including Contractor employees working on NASA contracts), and high-value equipment and property.

(c) The plan shall similarly address subcontractor employee safety and occupational health for those proposed subcontracts that contain one or more of the following conditions:

(1) The work will be conducted completely or partly on premises owned or controlled by the government.

(2) The work includes construction, alteration, or repair of facilities in excess of the simplified acquisition threshold.

(3) The work, regardless of place of performance, involves hazards that could endanger the public, astronauts and pilots, the NASA workforce (including Contractor employees working on NASA contracts), or high value equipment or property, and the hazards are not adequately addressed by Occupational Safety and Health Administration (OSHA) or Department of Transportation (DOT) regulations (if applicable).

(4) When the assessed risk and consequences of a failure to properly manage and control the hazards warrants use of the clause.

(d) This plan, as approved by the Contracting Officer, will be included in any resulting contract.

(End of provision)

ADDENDUM TO 52.212-1, INSTRUCTIONS TO OFFERORS:**INSTRUCTIONS REGARDING SUBMISSION OF OFFER:**

(a) Past performance Information and Relevant Experience Information shall include the three (3) most recent (within three years from the offer due date listed on page 1 in Block 8 of the SF1449) and relevant (as outlined in the Federal Acquisition Regulation) references (whether federal, state, or local government or private industry) for the prime contractor, and significant subcontractors. THIS OFFICE STRONGLY ENCOURAGES ALL OFFERORS TO SUBMIT THEIR PAST PERFORMANCE INFORMATION IMMEDIATELY. The offeror shall ensure that the three (3) references identified complete Attachment 3, the Contractor Performance Questionnaire. Completed questionnaires shall be sent directly to the government by the reference completing the questionnaire. It is the sole responsibility of the offeror to track submittal of the performance questionnaires, and ensure that they are received by the government by the date established in this RFP for proposal submission. Technical Compliance information shall be submitted in accordance with the Technical Proposal requirements outlined in the Scope of Work section 4.1. to demonstrate the degree to which it can satisfy the government's requirement. Schedule information shall include guaranteed delivery and/or completion dates to demonstrate the degree to which offer meets the government's requirement. This information must be submitted no later than the date and time specified on page 1 in Block 8 of the SF 1449.

(b) Signed offer(s)/quotation(s) may be submitted in hard copy only. However, an additional electronic copy may be submitted via CDROM. All copies must be received no later than the date specified on page 1 in Block 8 of the SF 1449.

(c) All offeror questions regarding subject solicitation must be submitted no later than 3pm local time on 02/27/2007. Questions submitted after this date/time will not be accepted. Questions must be submitted via e-mail to: michelle.m.stracener@nasa.gov (cc: james.d.huk@nasa.gov). Faxed or telephoned questions will not be accepted.

(End of provision)

ADDENDUM TO 52.212-2, EVALUATION - COMMERCIAL ITEMS

COMPETITIVE NEGOTIATED PROCUREMENT USING QUALITATIVE CRITERIA

This procurement is being conducted utilizing Best Value Selection (BVS), which seeks to make an award based on the best combination of price and qualitative merit (including Technical Compliance/expertise, past performance, and schedule) of the proposals submitted and reduce the administrative burden on Offerors and the Government. BVS predefines the value characteristics which will serve as discriminators among proposals. BVS evaluation is based on the premise that, if all quotes are of approximately equal qualitative merit, award will be made to the Offeror with the lowest evaluated price (fixed-price contracts) or the lowest most probable cost (cost type contracts). However, the Government will consider awarding to an Offeror with higher qualitative merit if the difference in price is commensurate with added value. Conversely, the Government will consider making award to an Offeror whose quote has lower qualitative merit if the price (or cost) differential between it and other quotes warrant doing so.

EVALUATION CRITERIA

- a. The award will be made where the offeror is determined to be responsible, and the proposal is responsive and offers the best value to the government. Best value will be determined based on an integrated assessment of each proposal in terms of technical compliance/expertise, cost, past performance, and schedule. Therefore, subjective judgment by the government is implicit in the evaluation process. Technical Compliance/Expertise and Past performance, when combined, are significantly more important than cost or schedule. However, if offeror does not have relevant past performance history, the offeror may not be evaluated favorably or unfavorably on past performance and will be given a neutral rating as detailed in this plan. In addition, award may be made without conducting discussions.
- b. Once all responses have been gathered, proposals will be quantitatively evaluated by team members using the below value characteristics. These value characteristics are performance-based and permit evaluation of the proposal, which provides better results for a reasonable marginal increase in price. All proposals will be judged against these value characteristics.

EVALUATION PROCESS

The Government will evaluate quotes in two general steps:

Step One -- An initial evaluation will be performed to determine if all required information has been provided and the Offeror has presented an acceptable proposal. Offeror may be contacted only for clarification purposes during the initial evaluation. Should a proposal be determined unacceptable, the offeror shall be notified that their proposal has been rejected and the reasons therefore, and the proposal shall be excluded from further consideration.

Step Two -- All acceptable proposals will be evaluated against the specifications/statement of work and the value characteristics identified below. Based on this evaluation, the Government has the

option, depending on the specific circumstances of the proposals received, to utilize one of the following methods: (1) Make selection and award without discussions, (preferred method); or (2) after establishment of the competitive range, hold discussions with all finalists and afford each Offeror an opportunity to revise its proposal, and then make selection. You are cautioned that omissions or an inaccurate or inadequate response to these evaluation factors may have a negative effect on your overall evaluation.

References other than those provided by the offeror may be contacted and their comments considered during the evaluation process. The information submitted may be verified by the Government through discussions with the references provided. While the Government may elect to consider data obtained from other sources, the burden of providing relevant references that the Government can readily contact rests with the Offeror.

VALUE CHARACTERISTICS

Listed below are the value characteristics that will be utilized in the evaluation of each quote. Each value characteristic is further defined to explain the rating that each offeror will receive.

- a) Technical Compliance/ Expertise, 40% - The government will evaluate to what extent proposal is in compliance with required specifications/Scope of Work.
- b) Cost, 10% - The government will evaluate offeror's proposed price for reasonableness and realism.
- c) Past Performance, 35% - The government will evaluate past and present performance based on the offeror's recent and relevant performance.
- d) Schedule, 15% - The government will evaluate to what extent proposed schedule meets the government's needs as specified in the solicitation.

(End of provision)

LIST OF ATTACHMENTS

The following documents are attached hereto and made a part of this contract:

| | | | |
|--------------|--------------------------------|----------|----------|
| Attachment 1 | Scope of Work | Feb 2007 | 11 pages |
| Attachment 2 | Specifications | Feb 2007 | 54 pages |
| Attachment 3 | Past Performance Questionnaire | Nov 2006 | 6 pages |
| Attachment 4 | List of Required Documents | Jan 2007 | 1 page |

SCOPE OF WORK
FOR THE PROCUREMENT OF
THRUST MEASUREMENT SYSTEMS
FOR
J-2X ENGINE PROGRAM
20000-GM29

Prepared By
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHN C. STENNIS SPACE CENTER
SSC, MISSISSIPPI 39529

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| Rev. No. | Date | Description | Prepared By: | Systems Integration Engineer |

SCOPE OF WORK
FOR THE PROCUREMENT OF
THRUST MEASUREMENT SYSTEMS
FOR
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SCOPE OF WORK
FOR THE PROCUREMENT OF
THRUST MEASUREMENT SYSTEMS
FOR THE J-2X ENGINE PROGRAM

1.0 WORK INCLUDED

Unless otherwise specified in Document No. 20000-GM28, the work includes furnishing all labor, technical and professional services, and materials necessary to design, fabricate, assemble, calibrate, package for delivery, ship, and commission the Thrust Measurement Systems to be installed at the NASA test stands used for J-2X engine testing. The location of each Thrust Measurement System is discussed in the data sheets of Document No. 20000-GM28. Training of NASA personnel is also included in the scope of work, and is discussed in detail in the technical specifications. The thrust stand is to make highly accurate and reliable multi-component force measurements resulting from the captive firing of liquid chemical rocket engines.

The manufacturer shall be responsible for transportation FOB to job site listed in the data sheets of Document No. 20000-GM28.

This document describes the overall responsibilities of the Vendor and the submittal requirements for calculations, documentation, and drawings.

2.0 ROLE OF THE VENDOR

- 2.1 The Vendor shall function as the Integrator of the Thrust Measurement System (TMS). As such, the Vendor shall ensure that all components of the complete system will perform properly together. By the "complete system" is meant all components furnished by the Vendor. The facility control system is not considered to be a part of this system.
- a. It shall be the responsibility of the Vendor to obtain sufficient information about the interface to the thrust take-out structure, the engine and the Data Acquisition System (DAS) to ensure proper integration and operation of the TMS.
 - b. This information will be provided to the Vendor by the Customer, who will obtain it from other sources, as necessary.

c. The Vendor will not be responsible for the accuracy of the interface information provided by the Customer, or for proper operation of the DAS

2.2 The TMS shall be designed to be as fully self-contained as possible, to minimize installation requirements at the stand.

3.0 SUBMITTAL REQUIREMENTS

3.1 The manufacturer is responsible for supplying all submittals in accordance with the requirements in Section 4.0 and additional submittals as necessary to confirm compliance with the requirements of this procurement package. Partial submittals will not be acceptable and will be returned without review.

3.2 Instructions:

All submittals are to be forwarded to:

Configuration Coordinator
Building 8301
Stennis Space Center, MS 39529-6000

3.3 TIME LIMITS

Unless otherwise stated, "Time" as stated in the Table in Section 4 is the number of weeks after notice to proceed for each TMS installation for receipt by the person named in Section 3.2 of initial documents and the number of weeks after return of reviewed initial documents for receipt by the same person of final documents.

3.4 DRAWINGS

Vendor drawings will be reviewed only as to overall compatibility and conformance with interface requirements and related drawings, and such review shall not be construed to relieve or mitigate the Supplier's responsibility for accuracy, adequacy, and suitability of materials and/or equipment presented thereon.

- (a) Proposal drawings shall be the Vendor's standard drawings (catalog cuts are acceptable) in sufficient detail for the Customer to determine compliance with specifications. Drawings will include to load string locations and end connections of each load string component.

- (b) Initial drawings shall include purchase order number and shall show all information necessary for the design of structural supports and any connections to other equipment and structures.
- (c) Final drawings shall include purchase order number. The drawings shall also be stamped CERTIFIED FOR CONSTRUCTION and signed by a person authorized to bind the partnership or corporation. These drawings shall show all details of the TMS that are required for installation, operation, and maintenance. Shop drawings need not be provided

3.5 BILL OF MATERIALS

A complete parts list including materials of construction is required after placement of the order.

3.6 CATALOG CUTS

Submittals on off-the-shelf items shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, and applicable industry or technical organization (e.g. ASME, ANSI) references, and specification paragraph reference.

3.7 CALCULATIONS

Calculations demonstrating compliance with the requirements in the specifications shall be submitted.

3.8 MATERIAL CERTIFICATIONS

The Vendor shall obtain and supply to the Customer material certifications on all structural steel, flexures, and fasteners.

3.9 OPERATION AND MAINTENANCE MANUAL

3.9.1 The following subjects shall be covered: (Disassembly/assembly instructions needed)

- a. Description of system design.
- b. Structural, mechanical and electrical drawings
- c. Operating instructions.

- d. Discussion of sources of error and final uncertainty analysis
- e. Data reduction equations and procedures.
- f. Disassembly and re-assembly of the structural assembly and attached equipment.
- g. Maintenance procedures of all systems, including:
 - 1. Routine maintenance.
 - 2. Maintenance intervals.
 - 3. Removal and installation of equipment, load cells, and flexures.

3.9.2 A description of the results of the TMS acceptance tests shall be included in the operation and maintenance manual.

3.9.3 The following data shall be included in the operation and maintenance manual:

- a. Load cell calibration reports.
- b. Final dimensional inspection reports for the structural assembly.
- c. Material certifications for structural steel, piping, and fasteners.
- d. Parts list, including manufacturer and model number, of TMS components which are commercially available.
- e. Evidence of compliance with requirements for load cell thermal zero and sensitivity coefficients.

3.10 DOCUMENTATION MEDIA AND QUANTITY

The submittals shall be submitted in both electronic form (unless not technically possible) and hard copy. Electronic files shall be readable with Adobe Acrobat ® or other software pre-approved by the Customer. Unless otherwise specified, three (3) hard copies of each submittal are required. Seven (7) hard copies of the Operations and Maintenance Manual for each TMS installation are required.

4.0 SUBMITTAL MILESTONES AND CONTENT

4.1 PROPOSAL

4.1.1 The Vendor shall submit with his proposal:

- a. Conceptual drawings illustrating
 - (1) The measurement concept.
 - (2) Location and orientation of load strings.

- (3) Space envelope.
- (4) Block diagram

- b. Preliminary uncertainty analysis showing how uncertainty requirements will be met.
- c. Load cell specifications.
- d. Range of the calibration cells and method used to determine the range.
- e. Flexure specifications
- f. Information on procedure on precipitation hardening temperature to be used.
- g. A plan for calibration of calibration system load cells, including:
 - (1) A description of the calibration process.
 - (2) Accuracies to be achieved.
 - (3) Evidence of traceability to NIST.
- h. A description of means which will be used for achieving acceptable dimensional tolerances during fabrication.
- i. If the live and ground plates are each constructed of two sections of plate, a description of the method for joining the plates.
- j. A description of means which will be used for verifying dimensional tolerances during inspections.
- k. A preliminary plan for installation for each TMS.
- l. A preliminary plan for acceptance tests for each TMS
- m. A preliminary plan for commissioning of each TMS.
- n. A description of operator interface features, with operational scenario.
- o. Weld inspection program proposed, including the type and extent of NDT inspection based on the weld type and location.

4.1.2 In the proposal, the Vendor shall quote prices for the following spare parts:

- a. One load cell of each capacity
- b. One flexure of each type.
- c. Vendor recommended spare parts.

4.2 PROJECT SCHEDULE

Within one month from the date of notice to proceed for each TMS installation, the Vendor shall submit to the Customer a bar chart schedule for the accomplishment of the contract. With exception of the submittals required by Section 4.4, Design Review, the schedule shall include 10 working days for Customer review of submittals. Thereafter, the Vendor shall submit an updated schedule on the first of each month, along with a brief written statement covering the following topics:

- a. Work Accomplished.
- b. Problems Encountered.
- c. Tests accomplished.
- d. Certifications and material tests obtained.
- e. Procurement Status.
- f. Inspections Accomplished.
- g. Plans for correcting any identified schedule slippage.

4.3 PROJECT TELECONFERENCES

There will be a weekly teleconference between representatives of the Customer and Vendor to discuss project schedule and issues.

4.4 DESIGN REVIEWS

4.4.1 A Preliminary Design Review (PDR) shall be held within eight weeks of notice to proceed for each TMS installation. This review shall take place at the Vendor's office. The design review packages shall be submitted to the Customer at least two weeks before the date of the PDR. The Vendor shall present and discuss the following information:

- a. Calculations and equations confirming compliance with key specification requirements.
- b. Layout drawings.
- c. Catalog cuts on all proposed off-the-shelf equipment and components.
- d. Product information on the paint to be used for each TMS installation.
- e. Status of long lead procurement plans and specifications.
- f. If the live and ground plates are each constructed of two sections of plate, the procedure for joining the plates.
- g. Uncertainty analysis plans.
- h. Maintenance expectations.
- i. Facility interface requirements.
- j. Commercial off-the-shelf hardware selection status.
- k. Material selection status.
- l. Detailed schedule.
- m. Computer software design and test plan.

4.4.2 A Critical Design Review (CDR) shall be held within fourteen weeks of notice to proceed for each TMS installation. This review shall take place at the Vendor's office. The design review packages shall be submitted to the Customer at least two weeks before the date of the CDR. Within 4 weeks after the CDR, the Vendor shall submit documentation verifying

that that the Customer's CDR comments have been addressed. The Vendor shall present and discuss the following information:

- a. Evidence of compliance with each specification requirement.
- b. Drawing tree.
- c. Detailed mechanical, structural and electrical drawings
- d. DAS interface verification
- e. Stress analysis results
- f. Materials selected.
- g. Manufacturing process selected.
- h. Inspections required.
- i. Detailed installation plan.
- j. Acceptance test plan.
- k. Commissioning plan.
- l. Uncertainty analysis results
- m. Maintenance requirements / schedule.
- n. Operation walk-through.
- o. Detailed schedule status.
- p. Answers to PDR action items.
- q. Evidence of compliance with requirements for load cell thermal zero and sensitivity coefficients.

4.5 TABLE – OTHER DOCUMENTATION AND DRAWING REQUIREMENTS:

| Description | Time (see Section 3.3) | |
|---|---|--------------------------|
| | Initial Submittal | Final Submittal |
| Complete Parts List with Part No., Material of Construction and Description | 18 | 4 |
| Load Cell Calibration Procedure including Name of Calibration Agency | 18 | 4 |
| Welding Procedure Qualifications and Welder Qualification Records (if applicable) | 12 | 4 |
| Welding NDE Plan and Procedure and Qualifications of NDE Personnel | 12 | 4 |
| Surface Preparation and Painting Procedure | 12 | 4 |
| Test Reports including Dimensional and NDE Inspection Reports | ----- | 1 week after test |
| Operation and Maintenance Manuals | ----- | 1 week prior to shipment |
| Cleaning Procedures | 12 | 4 |
| Mill Certs and Material Test Reports | 1 wk after receipt of reports from material suppliers | 3 |
| Cleaning Inspection Reports | ----- | 1 week prior to shipment |
| Certification of | ----- | 1 week prior to shipment |

| | | |
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| Compliance | | |
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5.0 COORDINATION OF VENDOR ACTIVITIES WHILE AT THE NASA SITE

5.1 The Vendor shall coordinate all personnel issues at each TMS installation through the designated NASA site contact person. The site contact person shall be designated at the time of notice to proceed for the specific site.

5.2 The Vendor shall identify a single person with an alternate in charge of Vendor personnel.

5.3 The Vendor shall provide a list of all personnel to be stationed at or visiting the site for the TMS installation to the site contact person at least 10 days prior to arrival. Each person to be stationed at the NASA site shall report to the following gate to obtain a badge and vehicle pass: South Gate Entrance at SSC and Main Gate at PBS.

5.4 The Vendor shall comply with all aspects of the Safety Manual for the respective NASA site while on the NASA premises. The relevant manuals are as follows:

Plum Brook Station GRC-MQSA.001
(Available at http://smad-ext.grc.nasa.gov/gso/manual/chapter_index.shtml)

Stennis Space Center SSP -8715-0001

5.5 The Vendor further agrees to comply with all NASA site security regulations.

TECHNICAL SPECIFICATION
FOR THE PROCUREMENT OF
THRUST MEASUREMENT SYSTEMS

FOR

J-2X ENGINE PROGRAM

20000-GM28

Prepared By

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

JOHN C. STENNIS SPACE CENTER

SSC, MISSISSIPPI 39529

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| 1 | 2/12/07 | Include revisions from NASA Safety and renumbering of site tubing standard. | P. Rieder | B. Maynard |
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| Rev. No. | Date | Description | Prepared by: | System Integration Engineer |

TECHNICAL SPECIFICATION
FOR THE PROCURMENT OF THE
THRUST MEASUREMENT SYSTEMS
FOR
J-2X ENGINE PROGRAM

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| 1.0 GENERAL | |
| 1.1 INTRODUCTION | |

This specification describes the requirements for the labor, materials, and services necessary to design, fabricate, assemble, calibrate, package for delivery, ship, and commission a Thrust Measurement System (TMS). TMS's will be installed at J-2X Engine Test Stands designated in the attached data sheets. Each TMS is to make highly accurate and reliable force and moment measurements resulting from the captive firing of liquid chemical rocket engines. Each TMS will also be used in flight certification testing of liquid chemical rocket engines.

1.2 DEFINITION OF TERMS

This section contains definitions of terms and acronyms which are used in a specific sense in this specification.

Accuracy: The closeness of agreement between a measured value and the actual value.

Alignment: The relative position of all force measuring and calibration load cell strings' centerlines with respect to each other and to the test article axial centerline.

Calibration control equipment: (A component of the TMS.) Electronic equipment that controls the application of calibration forces to the measurement system.

Certification: The process of quantitatively determining the performance of an item and the associated uncertainty by measuring its characteristics with instruments of known NIST traceable performance.

Confidence level: The probability that the true value falls within the specified limits.

Customer: In addition to NASA, this term shall apply to NASA's authorized agents and contractors.

DAS: Data Acquisition System: Equipment to accomplish the functions of on-line data acquisition and conversion, and interaction computation and compensation.

ECC: Error Checking and Correction, software which detects and corrects single-bit and multiple bit errors in small sections of code.

Error: The difference between the measured value and the actual value.

Hysteresis: Greatest difference between the measured output at equal applied forces when one output is obtained by increasing the force from zero to full-scale and the other by decreasing from full-scale. Expressed as a percentage of full-scale output.

Interaction: The influence exerted on a measuring element of the multi-component thrust system by the measuring action (deflection or restraint) of other elements in the system. A non-zero reading of a load cell on one axis caused by a force or moment applied to a different axis.

Load cell string: Also called a load string or load cell train. An assembly for measuring forces consisting of a load cell, elastic pivots, and adapting

hardware. The flexures assure that only axial loads are applied to the load cell.

Maximum thrust capacity: The maximum thrust from an engine that will impose an axial load on the thrust measurement system. This capacity does not include the dynamic loads.

NIST: National Institute for Standards and Technology.

Non-linearity: The greatest deviation in measured output between any calibration points made with an increase in force from zero to full-scale force and a straight line drawn through the zero and full scale force outputs. Expressed as a percentage of full-scale output.

Null condition: Condition of the engine under test in which the nozzle gimbal mechanism is located in a fixed position. In an ideal null condition, the centerline of the engine is coincident with the coordinate system vertical axis. In practice, the centerline of the engine is approximately coincident with the coordinate system vertical axis.

Operator interface equipment: (A component of the TMS.) Electronic equipment mounted in the TCC that provides the operator interface for the calibration system.

PBS: Plum Brook Station; Sandusky, Ohio

Repeatability: Greatest deviation in the measured output when the same force is applied from the same direction under the same environmental conditions. Expressed as a percentage of full-scale output.

Sensitivity: Output from the load cell usually expressed in millivolts per volt (mV/V).

SSC: NASA Stennis Space Center, Mississippi.

Structural assembly: (A component of the TMS.) The structure which is mounted in the test stand and supports the engine under test, and which contains the measurement and calibration load cells.

TCC: Test Control Center:

TEFC: Totally enclosed fan-cooled

TMS: Thrust Measurement System

Thrust Stand System: The equipment to be supplied by the contractor to fulfill the requirements of this specification.

Thrust Vector: The magnitude and direction of the thrust generated by a test article.

Uncertainty (U): The estimate of the error between the true and measured values. $\pm U$ is the interval about the measurement that contains the true value for a given confidence level. Uncertainty is calculated by the methodology described in Appendix B.

1.3 RELATED DOCUMENTS

- 1.3.1. Sketches in Appendix A are a part of this specification.
- 1.3.2. The methodology described in Appendix B for calculating uncertainty is a part of this specification.
- 1.3.3. Data sheets in Appendix C are part of this specification.

1.4 DESCRIPTION OF SYSTEM

The general requirements for the TMS are discussed in the following paragraphs. Specific requirements for each TMS are discussed in the attached data sheets.

1.4.1 FUNCTIONAL DESCRIPTION

- 1.4.1.1 The TMS consists of a measurement system and a calibration system. The measurement system reacts and measures the three orthogonal forces and three orthogonal moments produced by the thrust of the engine under test.
- 1.4.1.2 The calibration system provides the in-place capability of applying accurately known traceable loads and moments to the measurement system. The calibration system shall be used to reduce uncertainties in the calibration of measurement system which would otherwise be introduced by engine tare weight, propellant run lines and purge lines, and other causes. The calibration system includes equipment and software which impose accurate loads on the structural assembly and the control equipment and software which shall provide the capability of performing calibrations automatically.
- 1.4.1.3 During engine testing, force and moment data by each measurement load cell shall be recorded by the existing facility DAS. Summations of the loads and calculations of moments shall be performed by the facility

DAS using equations provided by the Vendor. During calibration, loads from both the calibration and measurement load cells shall be simultaneously recorded by the existing facility DAS. As specified elsewhere in this specification, data from one of bridges on each load cell will bypass the facility DAS and send signals directly to the calibration control equipment. Summations of the applied and measured loads and moment calculations using applied and measured load shall be performed by the facility DAS using equations provided by the Vendor. The TMS shall be compatible with the DAS at each TMS installation.

1.4.2 PHYSICAL DESCRIPTION

- 1.4.2.1 The TMS consists of equipment which shall be located in various locations. A structural assembly will be mounted in the J-2X Test Stand. Operator interface equipment shall be mounted in the J-2X Test Stand control room. Control equipment not requiring operator access may at the option of the Vendor be mounted in the temperature-controlled areas in the J-2X Stand core building (close to the J-2X Test Stand) or in the J-2X Test Stand control room. A hydraulic pump skid shall be installed in the J-2X Test Stand core building. The distances between the locations for each TMS installation are indicated in the individual data sheets.
- 1.4.2.2 The structural assembly is approximately the shape of a horizontal cube. A vertical hole shall pass through the axial centerline of the cube for the passage of propellant lines to the engine. Dimensional limitations are discussed in the subsequent sections of this document.
- 1.4.2.3 The structural assembly consists of the ground frame and live bed. The upper surface of the ground frame will be supported by the thrust take-out structure of the test stand. A thrust adapter will be mounted to the bottom surface of the live bed. The engine under test will be mounted to the thrust adapter.
- 1.4.2.4 Unless otherwise specified, the structural assembly shall be designed for operation in the vertical and canted orientation. The centerline of the engine will be coincident with the centerline of the TMS. The maximum canted angle from the vertical axis of test stand is 20 degrees. For TMS installations at vacuum chamber with thermal conditioning, the structural assembly shall be operated in the vertical orientation only.
- 1.4.2.5 Fuel and oxidizer ducts (installed by the Customer) connecting to the engine which pass through the hole in TMS will contain bellows that minimize forces imposed by the ducts on the engine

1.4.2.6 The structural assembly shall contain force-measuring load cells for both the measurement and calibration systems. Screw jacks shall impose the axial loads for the calibration measurement systems. The jacks shall be actuated hydraulically.

1.4.2.7 The operator interface equipment controls forces applied by the calibration system in response to commands from the operator.

1.5 OPERATION OF VACUUM CHAMBER WITH THERMAL CONDITIONING

1.5.1 Test stands designated in the individual data sheets as a vacuum chamber with thermal conditioning will operate in two configurations.

1.5.2 The first configuration is engine testing at high altitude. This configuration requires thrust measurement. The conditions of the vacuum chamber at this configuration are specified in the individual data sheets.

1.5.3 The second configuration is engine restart in deep space. This configuration does not require thrust measurement. However, the structural assembly remains in place. The temperature of the chamber is at cryogenic conditions. The specific temperature is specified in the individual data sheets. This test configuration requires removal of the following systems: screw jacks, hydraulic motors, and associated instrumentation; both calibration and measurement load strings and associated data wiring. The measurement load strings are replaced with austenitic stainless steel stiffarms. These stiffarms will transmit the loads due to engine firing from the live bed to the ground frame. The hydraulic fluid inside of the vacuum chamber will be drained, and hydraulic tubing inside of the vacuum chamber will be removed. All remaining TMS structural hardware inside of the vacuum chamber shall be capable of withstanding the test conditions specified in the individual data sheets. In the Proposal, the Vendor will list any other non-essential TMS hardware inside of the vacuum chamber that should be removed,

1.6 STANDARDS AND CODES

TMS requirements shall comply with the latest edition of the following referenced publications unless shown or specified otherwise. In the event of conflicts, this specification shall govern:

NASA/SSC SSTD-8070-0126

Tubing Systems for Facility Systems,
Special Test Equipment, and Aerospace
Hardware.

| | |
|--------------------------------|--|
| NASA/SSC SSTD-8070-0089-FLUIDS | Surface Cleanliness Requirements for SSC Fluid Systems. |
| NASA/SSC DWG 54000-GP11 | Packaging and Preservation of Cleaned Components. |
| AISC | Steel Construction Manual. |
| ANSI/ASME B16.5 | Pipe Flanges and Flanged Fittings, NPS ½ through NPS 24 Metric/inch Standard. |
| ANSI/AWS D1.1 | Structural Welding Code, Steel. |
| ASME B31.3 | Process Piping: ASME Code for Pressure Piping. |
| ASME PTC 19.1 | Test Uncertainty. |
| ASTM A36/A36M | Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality. |
| ASTM A194/A194M | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both. |
| ASTM A240/A240M | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications. |
| ASTM A312/A312M | Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes. |
| ASTM A320/A320M | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service. |
| ASTM E74 | Calibration of Force-Measuring Instruments for Verifying the Force Indication of Testing Machines. |
| ASTM A574 | Alloy Steel Socket-Head Cap Screws. |

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|------------------------|--|
| ASTM E587 | Practices for Ultrasonic Angle-Beam Examination by the Contact Method. |
| ASTM E595 | Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment. |
| FF-S-86 | Federal Specification, Socket Head Cap Screw. |
| MIL-DTL-53039B | Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant. |
| MIL-P-53030A | Primer Coating, Epoxy, Water Reducible, Lead and Chromate Free. |
| MIL-PRF-83282D | Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537. |
| NEMA Standard No. 250 | Enclosures for Electrical Equipment. |
| NEMA Standard No. ICS6 | Enclosure for Industrial Controls and Systems. |
| NFPA 70 | National Electric Code. |
| SAE/ASM 5659 | Steel, Corrosion Resistant, Bars, Wire, Forgings, Rings, and Extrusions (15 Cr-4.5Ni-0.3 Cb-3.5 Cu). |
| SAE/ASM 5862 | Steel, Corrosion Resistant, Sheet, Strip, and Plate (15 Cr-4.5Ni-0.3 Cb-3.5 Cu). |

2.0 PRODUCTS

2.1 SCOPE OF SUPPLY-BY THE VENDOR

The Vendor shall provide the following:

- 2.1.1 Unless otherwise specified in Section 2.2, the Vendor shall supply the TMS and all ancillary equipment required for its operation, including the following (see Glossary):

- a. The structural assembly.
 - b. Load cell strings.
 - c. Calibration control system (includes equipment and software).
 - d. Operator interface equipment.
 - e. Hydraulic pump skid.
 - f. Any special tooling or equipment needed for operating and maintaining the TMS.
 - g. Bolthole template for attachment of the structural assembly to the thrust take-out structure. The template shall be constructed of the same material as the plates for the ground frame with a minimum thickness of 0.25 inches.
 - h. Stiffarms to replace measurement load strings for engine restart testing in deep space conditions. This only applies to vacuum chamber test stands with thermal conditioning.
 - i. Mating connectors for all Vendor-supplied instrumentation which the Customer has responsibility for installing the wiring.
- 2.1.2 The Vendor is responsible for providing and installing interconnecting tubing between the hydraulic screw jacks and the hydraulic interface box mounted on the structural assembly. Further discussion on the interface box is In Section 2.10.
- 2.1.3 The following applies to TMS installations in vacuum chamber test stands. If resistive type devices (e.g. potentiometers, LVDT's) are used to sense screw jack position, the Vendor shall provide 100 feet of attached wiring.
- 2.1.4 The Vendor shall supply all software required for operator interface equipment and calibration control equipment.
- 2.1.5 The Vendor shall supply data reduction equations for determination of forces and moments, which shall be used by the Customer to process calibration data and engine test data recorded by the facility DAS.
- 2.1.6 The Vendor shall review and comment on the Customer's thrust take-out structure (TTOS) design drawings. The review will include verification of the structural adequacy of the TTOS, verification of structural interfaces with the TMS, and a check for any operational concerns. Structural adequacy is defined in the paragraph as the ability to react dead weight and thrust loads with a minimum deflection. The Customer is responsible for providing the required documentation. The Vendor is not responsible for checking the Customer's structural calculations.
- 2.1.7 Acceptance tests: Acceptance tests are performed at the Vendor's factory. During acceptance tests, the Vendor shall supply all labor,

materials, and equipment to permit operation of all TMS functions during tests.

- 2.1.8 Installation: During installation of the TMS structural assembly, the Vendor shall provide consultation, and shall monitor operations performed by the Customer. The Vendor shall provide detail instructions for the installation of all TMS hardware and connection of DAS, control, and power cabling. The Vendor shall review and comment on the Customer's installation plans.
- 2.1.9 Commissioning: The Vendor shall operate and maintain his equipment during the commissioning tests of the TMS equipment.
- 2.1.10 Training: The Vendor shall provide training on the theory and use of the thrust measurement system, and operation and maintenance of the thrust measurement system.

2.2 SCOPE OF SUPPLY-BY THE CUSTOMER

The following shall be provided by the Customer:

2.2.1 Equipment:

- a. Test stand data recording equipment (facility DAS).
- b. Thrust adapter.
- c. Thrust take-out structure
- d. 120 or 480 VAC electric power at each TMS installation, from a source of the required voltage to the interface points for each TMS equipment location.
- e. 28 VDC power supply
- f. 28 VDC power from the supply to the interface points for each TMS equipment location.

2.2.2 Cables and conduit:

- a. All cable that that connects the load cells to the DAS and in-frame calibration system.
- b. All wire and conduit to supply power to the in-frame calibration system, the structural assembly, and the hydraulic pump skid.
- c. All cable and conduit to connect control signals from the interface connections on the structural assembly, the in-frame calibration control equipment, and hydraulic pump skid.
- d. All cable required to connect control signals from the TMS to the facility control system.

- 2.2.3 Tubing: All tubing between the hydraulic interface box mounted on the structural assembly and the hydraulic interface box mounted on the hydraulic skid. Further discussion on interface boxes is in Section 2.10.
- 2.2.4 Hydraulic fluid: Customer will supply the specified hydraulic fluid required for the installations at the test stands.
- 2.2.5 For TMS installations in vacuum chamber test stands, the Customer shall connect the 100 feet of attached wiring from resistive type devices (if used) sensing screw jack position or disengagement to the appropriate equipment.
- 2.2.6 The following coding of software shall be provided by the Customer:
 - a. Software to process TMS data.
- 2.2.7 Installation of the following items shall be provided by the Customer:
 - a. Lifting and structural installation of the TMS structural assembly and hydraulic skid.
 - b. Installation of DAS and control equipment in the Test Stand core building and TCC.
 - c. Installation of the engine under test and all related propellant piping, tubing and electrical connections.
 - d. Installation of any required work platforms and ladders to access the TMS.
 - e. Cables and conduit that interconnect the DAS components in the TMS structure, hydraulic pump, and in-frame calibration system.
 - f. As required, control power and wiring and conduit between the structural assembly, hydraulic skid, and in-frame calibration system.
 - g. Hydraulic tubing between the hydraulic interface box mounted on the structural assembly and the hydraulic interface box mounted on the hydraulic skid. Further discussion on the interface boxes is In Section 2.10.
 - h. For all test stands, installation of the interface box in the signal conditioning room in the test stand core building. Further discussion on the interface box is In Section 2.10.
- 2.2.8 Commissioning: Operation and maintenance of the DAS and other facility equipment during commissioning tests of the TMS shall be performed by the Customer.

2.3 MATERIALS

All material to be incorporated into the work shall be of adequate grade to meet minimum requirements, free from significant defects and imperfections, of recent manufacturers and new (unless otherwise specified), and suitable for its intended purpose. Standard, readily replaceable material shall be used wherever possible. When the Vendor has a choice of several suitable materials for a particular application, the chosen materials shall be used for like applications throughout. Items not manufactured by the Vendor shall be the products of recognized reputable manufacturers and subject to approval by the Customer. Workmanship shall be of acceptable quality in conformity with applicable codes, including amendments, in effect on the date of issue of the bid documents.

2.4 PERFORMANCE AND PRODUCT CHARACTERISTICS

The equipment supplied shall be durable and of high quality since it will receive long duty in essential rocket motor research and development programs in which safety, reliability, and accuracy are of prime importance.

2.5 NAMEPLATES

Manufacturer's nameplates, showing the manufacturer's name, model, serial number, and other pertinent data required by industry standards, shall be provided on each item of equipment for which nameplates are furnished in commercial practice. Data shall be stamped onto the nameplates. Nameplates shall be constructed of corrosion resistant metals such as stainless steel.

2.6 GENERAL

2.6.1 All materials for manufactured components shall be new and shall conform to the latest applicable specifications and standards as specified. All commercial components shall be new and standard products of manufacturers regularly engaged in the manufacture of the product.

2.6.2 Use of Class I ozone depleting substances is not allowed. The use of Class II ozone depleting substances and EPCRA Section 313 chemicals must be identified, justified and minimized.

2.7 TMS STRUCTURAL ASSEMBLY

2.7.1 For test stands operating at temperatures above -20 degrees F (see attached data sheets), the structural assembly shall be constructed of carbon steel. Carbon steel materials shall meet the requirements of the

latest edition of ASTM A36/A36M or an equal material approved by the Customer. Unless otherwise approved by the Customer, the plates for the ground frame and live bed shall each be constructed of one continuous piece.

- 2.7.2 For test stands operating at temperatures below -20 degrees F (see attached data sheets), the structural assembly shall be constructed of stainless steel. Stainless steel materials shall meet the requirements of the latest edition of ASTM A240 for Type 304 or an equal material approved by the Customer. One piece construction of the plates for the ground frame and live bed is preferred, but construction of each plate can be from two sections of plate. The Vendor shall describe the method for joining the two plates in the Proposal. The description shall include a discussion that the joining method will not compromise specified dimensional and uncertainty requirements. Fasteners shall be constructed of austenitic stainless steel.
- 2.7.3 Unless otherwise indicated, bolting shall conform to ASTM A574, or FF-S-86 (for austenitic stainless steel) and shall be installed to the intent of the AISC Specification for structural joints in slip-critical type connections.
- 2.7.4 For vacuum chamber test stands, blind threaded holes in bolted connections are not permitted. Venting shall be provided in the base material or bolting. All enclosed structural members (e.g. box beams, structural tubing) shall have vent holes.
- 2.7.5 Where stiffarms are required, the construction shall be austenitic stainless steel. The design shall include the effects of thermal contractions. The stiffarm shall be capable to transmitting and withstanding all specified loads.
- 2.7.6 Materials such as carbon steel that would rust or corrode or otherwise deteriorate due to exposure to weather shall be painted or coated with a material that will prevent deterioration. Coating materials shall not be used that would degrade the accuracy of the TMS. Coating materials shall not be used that would crack, chip or scale with age or extremes of environmental conditions.
- 2.7.7 Wiring on the structural assembly shall be done with materials that will not deteriorate due to exposure to weather or radiant heat from engine firings.

2.8 FUNCTIONS

2.8.1 MEASUREMENT SYSTEM

- 2.8.1.1 The measurement system shall react the three orthogonal forces and three orthogonal moments applied to the live bed by the engine under test.
- 2.8.1.2 The measurement system shall measure forces and moments with reference to an orthogonal coordinate system:
- a. The y-axis of the coordinate system shall be coincident with the axial centerline of the engine and TMS.
 - b. The x- and z-axes shall be perpendicular to the y-axis.
 - c. The origin of the coordinate system shall be 73.5 inches below the bottom surface of the live bed. (This is the gimbal plane of the engine.)
 - d. The orientation of the orthogonal axis system is defined in Appendix A, SK-9.
- 2.8.1.3 The measurement shall measure x-, y-, and z-components of force, and moments about the x-, y-, and z-axes.
- 2.8.1.4 The Vendor shall supply data reduction equations for converting the forces and moments so measured into engine thrust in the following format:
- a. Thrust vector, x-, y-, and z-components.
 - b. Thrust vector displacements, x- and z-components.
- 2.8.2 CALIBRATION SYSTEM
- 2.8.2.1 The calibration system shall apply accurately measured forces and moments to the measurement system.
- 2.8.2.2 It shall be possible to load each force or moment axis separately, or to load several forces and moments simultaneously in any combination.
- 2.8.2.3 The calibration system shall be capable of applying forces up to the following values:
- a. y-axis: maximum thrust capacity of 350,000 lbf
 - b. x-and z-axes: 31,000 lbf
- 2.8.2.4 Calibration control equipment shall be provided. Equipment constituting this system may be separated into two locations.
- a. The operator interface equipment shall be located in the J-2X Test Stand control room.

- b. Equipment which must be near the structural assembly may be located in the J-2X Test Stand core building.
- 2.8.2.5 The operator interface shall have two modes of operation: manual and automatic.
- 2.8.2.6 In the manual mode, the operator enters the desired load and then commands the load to be applied. The system will return to the unloaded position when directed by the operator. The system shall have failsafes to prevent executing load conditions which could damage the TMS.
- 2.8.2.7 In the automatic mode, the operator shall first enter the desired loads into the operator interface, and then issue a command causing the forces to be applied. The system shall permit up to 100 points (50 points ascending and 50 points descending) between 0 and 100% of the maximum thrust capacity. The calibration system shall automatically then perform 1 to 5 runs sufficiently dwelling at each point to take readings from the measurement and calibration cells. Simultaneously, each of the calibration and measurement load cells in Bridges A and B shall send output to the facility DAS. The calibration system shall permit the operator to pause and continue to the next load point and to stop and return the calibration system to the unloaded position.
- 2.8.2.8 The calibration control system shall provide the means to simulate the thrust vector and the forces and moments imposed by engine gimbaling. The operator interface software shall be capable of calculating the desired load by inputs of the engine thrust and thrust vector (angle and displacement) or gimbal angle.
- 2.8.2.9 The calibration control system shall be capable of preventing the application of loads which could damage the TMS.
- 2.8.2.10 The system shall allow the operator to monitor actual applied forces during ramp up and at final calibration force.
- 2.8.2.11 Additional operator interface features which would save time or reduce the possibility of errors are desired. The Vendor shall describe proposed operator interface features in his proposal.
- 2.8.2.12 The calibration control system shall supply the following status signals in the form of contact closures for use by the facility control system or DAS:
- a. A signal indicating that the calibration system is completely disengaged from the live bed.

- b. A signal indicating that calibration forces requested by the operator have been set within tolerance, and are stable.

2.8.2.13 The calibration control system shall permit the operator to perform the following during manual or automatic calibrations:

- a. Command to stop movement of the screw jacks (pause mode).
- b. Command to remove all calibration loads and return to the disengaged state. This command shall be executed in a manner that does not cause damage to the TMS.
- c. If in pause mode, command to proceed to the next load point (applies to automatic calibration).

2.8.2.14 The forces and moments applied by the calibration system may deviate by up to 0.5% of the values set by the operator. Once the desired force or moment is attained, it shall be stable and not fluctuate.

2.8.2.15 It shall be possible to apply a 20 (10 points ascending and 10 points descending) point calibration to the TMS in less than twenty minutes. It shall be possible to apply a 1 point calibration to the TMS in less than five minutes. This includes the time to move from the disengaged condition to the first load condition, then to the remaining load condition, then back to the disengaged condition.

2.8.2.16 Except during an actual calibration, the calibration system force producing devices shall be disengaged from the live bed. The calibration system shall not introduce errors into the force measuring system during engine firing tests. Limit switches or other reliable means shall be provided to indicate positively that the calibration system is disengaged.

2.8.2.17 During calibration, the position of each screw jack shall be measured by a potentiometer, LVDT, or another reliable device. The positions of each screw jack shall be monitored by the calibration control system.

2.8.2.18 It shall be possible to save the results displayed by the operator interface to an external storage drive with USB connections provided by the Customer.

2.8.2.19 Isolation, drain, and vent valves shall be provided for each screw jack to allow removal of an individual screw jack without the necessity of draining the entire system.

2.9 HYDRAULIC PUMP SKID

- 2.9.1 The Vendor shall supply a system to furnish hydraulic pressure to the screw jacks in the calibration system of the TMS. The system shall consist of a hydraulic pump, electric motor, and NEMA combination starter, interconnecting tubing and wiring, sump (reservoir), and necessary cooling, control, and relief devices to ensure safe and reliable operation.
- 2.9.2 The pump skid shall include a station which includes a manual/automatic selector switch, "ON" button and "OFF" button.
- 2.9.3 The hydraulic pump skid shall have manual and automatic settings. In the automatic mode, the skid shall be energized by the operator interface during TMS calibrations. The manual mode shall permit operation from a line of sight "ON" and "OFF" push buttons.
- 2.9.4 The hydraulic pump skid shall have provisions to permit the Customer to remotely shut down the hydraulic pump by emergency shutdown switches installed in the J-2X test stand core building and/or the J-2X control room. The switches will be hard-wired by the Customer to the hydraulic pump skid motor control system.
- 2.9.5 The NEMA combination starter shall contain a 120 VAC control transformer.
- 2.9.6 The electric motor speed shall not exceed 1800 RPM. The motor shall have a service factor of 1.15. The motor shall be energy efficient. The motor nameplate shall contain efficiency labeling for full-load efficiency with indicated maximum and minimum expected efficiencies.
- 2.9.7 Tee connections shall be provided to permit the installation of pressure transducers to remotely monitor hydraulic pressure at the pump inlet and outlet.
- 2.9.8 Filters shall have isolation, vent, and drain valves to permit removal of the filter without the necessity to drain the entire system.
- 2.9.9 The hydraulic system shall contain a flow bypass system to permit the continued operation under zero pressure of the pump when the calibration system is unloaded.
- 2.9.10 The servo valves shall be located at the hydraulic pump skid.
- 2.9.11 The maximum hydraulic pressure shall be 3000 psig.
- 2.9.12 The hydraulic system shall be able to be de-pressurized remotely.

2.10 INTERFACES

2.10.1 Equipment Locations: It is anticipated that TMS electronic equipment will be installed in the J-2X Test Stand, the core building, and the control room. The Vendor shall contact the Test Stand Manager, who shall allocate space for this equipment.

2.10.2 Mechanical Interfaces:

2.10.2.1 The entire structural assembly shall fit within the space envelope shown in Sketch SK-1. The hole through the center of the structural assembly should conform to the dimensions indicated in SK-1. Variances from the hole dimensions shall require written acceptance by the Customer.

2.10.2.2 The thrust adapter shall be attached to the live bed by using the holes for fasteners and alignment pins shown in Sketches SK-2 and SK-3.

- a. The Customer will supply to the Vendor a drill template having all pertinent engine interface holes. The template shall be used by the Vendor to locate interface holes in the structural assembly.

2.10.2.3 The TMS shall be mounted to the test stand thrust take-out structure as shown in Sketch SK-4.

2.10.2.4 Any work platform and ladders required for access to the TMS will be installed by the Customer. Electrical and fluid connections to the engine will be routed by the Customer. The Vendor shall provide attachments to accommodate these items as shown in Sketches SK-5, SK-6, SK-7. Design loads for attachments are shown in table, Sketch, SK-5.

2.10.3 Electrical Interfaces: Interfaces between the TMS and the facility DAS and power systems are discussed in the following paragraphs and Sketch SK-8.

2.10.3.1 Load measurements in both the measurement system and the calibration system shall be made by means of load cells containing strain gage bridges. Each load cell shall have three bridges. Bridges A and B shall be suitable for recording by the J-2X test facility DAS. Bridge C will be used as feedback by the TMS calibration system control.

2.10.3.2 For vertical measuring load cells: Bridge A shunt calibration resistor shall simulate a force nominally equivalent to the load reacted during application of the nominal engine thrust (with extended nozzle) specified elsewhere in this specification. Bridge B shunt calibration resistor shall

simulate a force that is 2% to 5% less than the force simulated by Bridge A.

2.10.3.3 For vertical calibration load cells: Bridge A shunt calibration resistor shall simulate a force nominally equivalent to the load reacted during application of the nominal engine thrust (with extended nozzle) specified elsewhere in this specification. Bridge B shunt calibration resistor shall simulate a force that is 2% to 5% less than the force simulated by Bridge A.

2.10.3.4 Horizontal measuring load cells: Bridge A shunt calibration resistor shall simulate a force nominally equivalent to the load applied at the nominal gimbale angle and nominal thrust level (with extended nozzle) specified elsewhere in this specification. Bridge B shunt calibration resistor shall simulate a force that is 2% to 5% less than the force simulated by Bridge A.

2.10.3.5 Horizontal calibration load cells: Bridge A shunt calibration resistor shall simulate a force nominally equivalent to the load applied at the nominal gimbale angle and nominal thrust level (with extended nozzle) specified elsewhere in this specification. Bridge B shunt calibration resistor shall simulate a force that is 2% to 5% less than the force simulated by Bridge A.

2.10.3.6 Calibration system controls, such as hydraulic servo valves, electric motor contactors, limit switches, and LVDTs, which interface only with Vendor-supplied equipment may be selected by the Vendor to suit his requirements with Customer's acceptance.

2.10.3.7 Electrical loads smaller than 2 kva shall be powered from a 120 volt, 60 hz, single-phase source. Larger loads shall be powered from a 480 volt, 60 hz, three-phase source.

2.10.3.8 The structural assembly shall have one interface box. This box shall contain the hydraulic tubing connections. There shall also be interface boxes mounted on the hydraulic skid for hydraulic and 28 VDC power connections. If the Vendor requires 28VDC power at the structural assembly, an interface box for power connections shall be provided and installed on the structural assembly by the Vendor. For power connections in this box, screw type terminals shall be used.

2.10.3.9 The DAS and opto control connections shall be housed in an interface box located in the signal conditioning room in the test stand core building. This room is temperature-controlled by an HVAC system. The Customer shall provide and install fiber optic wire between the

calibration control computer in the TCC and interface box in the test stand core building.

2.10.3.10 The load cells shall have a Bendix type PC02E-12-8P connector.

2.10.3.11 If applicable, resistive-type devices (e.g. potentiometers, LVDT's) measuring the positions of the screw jacks shall have a Bendix type connector.

2.11. **MAXIMUM AND OPERATIONAL LOADS AND ENGINE DATA**
The information in this section are the design conditions for the TMS.

2.11.1 Maximum and normal operating static loads on the TMS are determined by the engine specifications below. The TMS shall react these loads. Angles and displacement are with respect to the orthogonal coordinate system. These numbers include the effects of tolerances on engine thrust, gimbal angle and thrust vector displacement. They do not include allowances for dynamic loads.

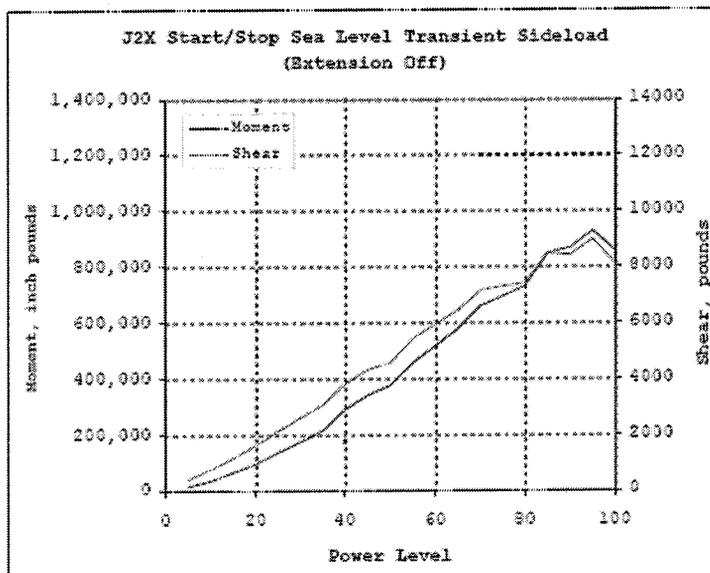
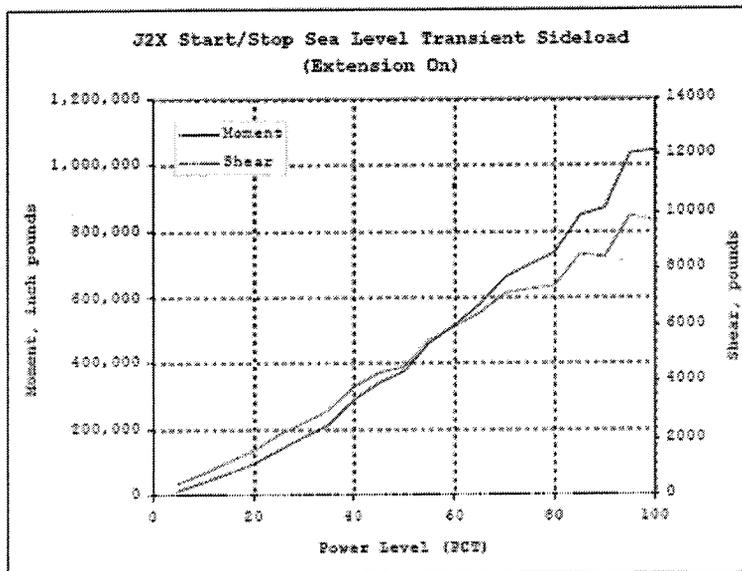
- | | |
|--|--|
| 1. Maximum thrust capacity | 350,000 lbf |
| 2. Nominal engine thrust (extended nozzle): | 294,000 lbf |
| 3. Minimum engine thrust (extended nozzle) | 217,231 lbf |
| 4. Nominal engine thrust (non-extended nozzle): | 157,000 lbf |
| 5. Minimum engine thrust (non-extended nozzle): | 115,000 lbf |
| 6. Thrust angle in null condition: | 0.72degrees |
| 7. Thrust vector displacement (null condition): | 0.55inches |
| 8. Maximum thrust angle, engine gimbale | 11degrees |
| 9. Nominal thrust angle, engine gimbale: | 4degrees |
| 10. Engine weight (extended nozzle - wet): | 7000lbm |
| 11. Engine weight (non-extended nozzle – wet) | 6000lbm |
| 12. Thrust adapter weight | 6000lbm |
| 13. Engine length (extended nozzle) | 185inches |
| 14. Nozzle extension length | 94inches |
| 15. Center of gravity of thrust adapter and engine | 74 inches below live bed lower surface |

2.11.2 The gimbal loads at the nominal engine thrust and nominal gimbal angle with the extended nozzle shown in the following table act at the gimbal center. The gimbal center is located 73.5 inches below the lower surface of the live bed. The loads indicated in the following table includes dynamic loads.

| Loads (klbf) Moment | Fx | Fy | Fz | Mx | My | Mz |
|---------------------------|----|----|----|----|----|----|
| | | | | | | |

| | | | | | | |
|-------------|--------|--------|--------|---------|---------|---------|
| (inch-klbf) | | | | | | |
| | ± 28.2 | -431.8 | ± 46.1 | ± 247.0 | ± 211.2 | ± 234.2 |

2.11.3 The moments about the gimbal center and side shears for sea level startup/shutdown with and without the nozzle extension are listed in the figures below.



2.11.4 The following is in addition to the static loads specified in Paragraph 2.11.1 For test stands other than vacuum chambers with thermal conditioning, the structural assembly (does not include the load cell strings and screw jacks) shall be designed for the following static load:

1. Engine thrust: 600,000 lbf

2.11.5 Peak static-plus-dynamic load which will not exceed 1.5 times the static load.

2.11.6 In addition, gimbaling of the engine will apply acceleration loads to the TMS:

1. Maximum gimbal rate: 30 degrees/sec
2. Maximum gimbal acceleration: 32 radians/sec²
3. Gimbaled mass: Same as engine weight
4. Mass CG location in null condition: x: 0.55 inches
y: 102.3 inches
z: 0.55 inches

2.11.7 The lowest resonant frequencies of the structural assembly shall exceed the following values:

1. Vertical mode: 30 Hz
2. Horizontal mode: 20 Hz

2.12 REQUIRED UNCERTAINTY (ACCURACY)

2.12.1 The accuracy required of TMS measurements is described in terms of the "Uncertainty" of the measurement. An uncertainty analysis for each TMS installation shall be calculated by the methodology described in Appendix B. Uncertainty shall be verified and validated by the acceptance tests. The required maximum allowed uncertainties are specified as follows:

Vertical direction: 0.15% of nominal thrust level (with extended nozzle) specified in Section 2.11.

Horizontal direction: 0.75% of maximum side load at nominal thrust level (with extended nozzle) and nominal gimble angle specified in Section 2.11.

Thrust offset: 0.10 inches

2.12.2 In achieving the specified uncertainties, interactions of orders higher than the first shall not be corrected. A higher order interaction is a force

or moment reading on one axis proportional to the product of forces or moments applied to other axes.

- 2.12.3 The uncertainties due to the facility DAS and temperature effects at the test stand are not included in the above specified uncertainty limits.

2.13 DESIGN FEATURES AND REQUIREMENTS

- 2.13.1 All electrical systems to be furnished by the Vendor shall comply with NFPA 70. All electrical components and all wiring, including control and instrumentation wiring, which are mounted on the structural assembly or on the exterior of the vacuum chamber (where applicable) shall conform to the requirements of the NFPA 70, Article 500, "Hazardous Locations", for Class I, Group B, Division 2 locations. Equipment which is installed in the signal conditioning room in the J-2X test facility core building or in the TCC is considered non-classified and is exempted from this requirement. Hazardous classifications for the electrical components and wiring associated with the hydraulic pump skid are discussed in the individual data sheets.
- 2.13.2 All power and DAS wiring installed by the Vendor in the structural assembly shall be stranded. Solid wiring has been found to easily break at high vibration conditions, especially at connections. All wiring used inside of vacuum chambers shall have Teflon (TFE) insulation; this supersedes the requirements in the paragraph 2.13.3.
- 2.13.3 All power and control wiring shall be copper. Aluminum wire is not permitted. Ground conductors shall be insulated (green). Power conductors No. 10 AWG and smaller shall be 600 V, type THHN/THWN. Power conductors No. 8 and larger shall be stranded, type THHN/THWN. For the latter conductors, splices and connections shall be made by application of crimp-type connectors specifically designed and sized properly for the conductors being spliced, and insulated for 600 volts, minimum. Use No. 12 AWG minimum for all power wiring and current transformer wiring. Use No. 14 AWG minimum, stranded, 300V, for all control wiring.
- 2.13.4 For electrical devices mounted on the structural assembly, the voltage shall be no greater than be 28 VDC. However, electrical devices operating inside of vacuum chambers shall operate at a maximum voltage of 10VDC.
- 2.13.5 Enclosures for electrical power shall conform to NEMA Standard No. 250. Enclosures for data and control shall conform to NEMA Standard No. ICS 6. Enclosures for indoor or outdoor classified locations shall have a NEMA 8 rating. For TMS installations at sea-level test stands, a

NEMA 4X enclosure of stainless steel construction that is purged and pressurized is an acceptable alternate for this service. For purged and pressurized enclosures, the Customer shall supply nitrogen gas at the required pressure. Enclosures in non-classified outdoor locations shall have a NEMA Type 4X rating and be constructed of stainless steel. Enclosures in non-classified indoor locations shall have a NEMA 12 rating. Data shall not be placed in the same enclosures as hydraulic, power, or controls. Hydraulic tubing connections shall not be placed in the same enclosure as bare power or controls connections. Enclosures for electrical power higher than 28 VDC shall have padlocking provisions (lock-out/tag-out).

- 2.13.6 Tubing installed by the Vendor shall be 37° flare tubing and fittings conforming to NASA/SSC SSTD-8070-0126.
- 2.13.7 Tooling bars or alignment pins which secure the live bed to the ground frame shall be provided by the Vendor for use during replacement of load cell strings. The tooling bars or alignment pins shall secure each load cell string in a neutral, unloaded position. The bars or pins shall employ means to maintain the alignment between the ground frame and live bed. The bars shall be constructed such that they do not require hammering to be inserted.
- 2.13.8 The structural assembly shall incorporate safety stops which shall prevent hazardous movement of the live bed and engine, in the event that one or more load cell strings fail during an engine test. The stops shall be capable of absorbing maximum TMS loads (includes dynamic effects) with a safety factor of 4.0 based on the ultimate strength of the material. The stops are not intended to protect load cell strings from excess loads.
- 2.13.9 The TMS shall be designed for a life of 25 years.
- 2.13.10 The equipment in the calibration system and hydraulic skid shall be able to operate with hydraulic fluid conforming to MIL-PRF-83282D.
- 2.13.11 All TMS components which are mounted on the test stand shall be designed to perform to specifications under the ambient conditions specified below and in the attached data sheets.
- 2.13.12 TMS components, tubing, and wiring which are mounted to the structural assembly shall not be damaged by exposure to the conditions specified in the attached data sheets and the following conditions:
 - 1. Heavy rain.
 - 2. Sand and dust.

3. Deluge water
4. Condensation

- 2.13.13 Drain holes shall be provided as necessary to prevent water from collecting in the structural assembly. For TMS installations at sea-level test stands, the TMS shall be operable in rainy or sub-freezing (10 degrees F) weather. For TMS installations at vacuum chamber test stands, the TMS shall be operable at conditions specified in the attached data sheets. Uncertainty requirements and load cell accuracy specifications shall be met when operating under these conditions.
- 2.13.14 Load cell strings shall use universal flexures where pivots are required. Ball joints, spherical bearings or knife edges shall not be used.
- 2.13.15 The structural assembly shall be designed so that it is possible to remove and replace any load cell string in the measurement system or the calibration system in two hours or less. This shall be possible with the structural assembly installed on the test stand, and the engine under test and all process piping installed.
- 2.13.16 Means shall be provided for locating each load cell string with sufficient precision so that replacing a load cell string (as above) requires no adjustment or alignment, and does not cause a measurable change in interactions.
- 2.13.17 The structural assembly shall be designed so that it is possible to remove and replace the force producing devices in the calibration system without removing the live bed. This shall be possible with the structural assembly installed on the test stand, and the engine under test and all process piping installed. The alignment between the live bed and ground frame shall be maintained.
- 2.13.18 The identification number of each load cell shall be etched on the upper surface of the plate for the live bed.
- 2.13.19 Components of the load cell strings and structural assembly shall be designed as follows:
- a. The flexures shall be able to withstand a load of least 1.75 times the force imposed by the maximum thrust capacity on the load cell string without yielding.
 - b. The load cells shall be able to withstand a load of 2 times the maximum thrust capacity without sustaining mechanical failure.

- c. Components of the structural assembly shall be designed in accordance with AISC Steel Construction Manual, at the maximum load the component will encounter during TMS operation, including dynamic loading.
- 2.13.20 In the design of the structural assembly, consideration shall be given to ease of handling of engines, personnel access to components, and safety.
- a. Components which cannot be handled by hand shall have appropriate lifting lugs.
 - b. Lifting points shall be prominently marked.
 - c. Such components shall have weight, and if appropriate, center of gravity prominently marked thereon.
- 2.13.21 Maximum deflection of the live bed under the maximum thrust load on any of the orthogonal axes shall not exceed 0.15 inches.
- 2.13.22 Small gaps between the live bed and ground frame shall be protected in some manner to prevent entry of tools, dirt or other material which might cause binding of the live bed and hence inaccurate readings of the TMS. Such gaps shall also be protected from formation of ice to such an extent that readings would be affected.
- 2.13.23 For TMS installations at vacuum chamber test stands, all materials installed inside of the chamber shall have a total mass loss less than 1% and collected volatile condensable materials less than 0.1% as determined by ASTM E595. A suggested database of materials is <http://outgassing.nasa.gov>.
- 2.13.24 Stress Analysis: During design, the Vendor shall perform a stress analysis of the structural assembly and where required, the stiffarms. The design shall include stresses due to temperature changes. The allowable stresses used in the design shall conform to the requirements of AISC Steel Construction Manual. The analysis shall include the dynamic nature of the loads to be applied.
- 2.13.25 Permanent alignment marks shall be inscribed to indicate the axial and vertical centerlines of the structural assembly.
- 2.13.26 Adapters in the load cell string shall be split to permit ease of installation. The adapters may be integral to the flexures. An alternation of right and left hand threaded connections shall also be used to permit ease of installation.

2.13.27 The vertical hole in the structural assembly permits the passage of propellant lines to the engine. Since the propellants can be liquid oxygen and hydrogen, provisions shall be made to protect the components in the structural assembly, as well as the structural assembly itself, from dripping liquid air.

2.13.28 The screw jacks in the calibration system shall be protected with torque limiting provisions. A mechanical or structural means shall be provided to ensure that overtravel by the screw jacks does not damage the structural assembly or load cell strings.

2.13.29 The measuring and calibration load cells shall be protected from radiant heat and fires by corrosion resistant metal covers. The covers shall be removable to permit servicing of the load cells.

2.14 LOAD CELL SPECIFICATIONS

2.14.1 Load cells shall be used which are capable of satisfying the accuracy requirements of this specification.

2.14.2 Load cells shall have a sensitivity of 4 +/- 0.004 mV/V at the full range of the load cell.

2.14.3 Load cells shall be capable of a maximum repeatability of +/- 0.02% (of full scale) or better.

2.14.4 Load cells shall have a maximum thermal zero coefficient of +/- 0.0014% (of full scale)/ degrees F and a maximum thermal sensitivity coefficient of +/- 0.0008% of the applied load/ degrees F. The Vendor shall provide evidence of compliance with this requirement.

2.14.5 Load cells shall accommodate the specified maximum dynamic loading with no change in calibration.

2.14.6 Load cells shall be fatigue rated for a service life of 100 million fully reversed loading cycles at the full rated capacity of the load cell.

2.14.7 The load cells used in all TMS installations shall be capable of operating in vacuum chambers. The load cells shall be designed to not retain atmospheric pressure as a vacuum is being applied.

2.15 LOAD CELL CALIBRATION

2.15.1 Each calibration system load cell shall be sent to a suitable agency for calibration. The agency selected to perform the calibration shall be subject to the approval of the Customer.

2.15.2 The calibration of the calibration system load cells shall meet the following conditions:

2.15.2.1 All bridges of each load cell shall be calibrated.

2.15.2.2 The calibration shall be traceable to NIST.

2.15.2.3 The uncertainty in the calibration shall be 0.05% as determined per ASTM E74.

2.15.2.4 Calibrations shall have been performed within 4 months prior to TMS delivery.

2.15.2.5 Calibrations shall consist of at least three runs from zero to load cell full range and back to zero, with data recorded at each 10 % increment of full scale.

2.15.2.6 Raw calibration data shall be supplied with calibration certificates.

2.15.3 Factory calibration data shall be supplied for each measurement system load cell.

2.16 FLEXURE SPECIFICATIONS

2.16.1 Material

2.16.1.1 Material shall meet requirements of SAE/AMS 5659 or SAE/AMS 5862. Vendor may use an alternate material if approved by the Customer.

2.16.1.2 Charpy V-notch impact strength shall be 15 ft-lbf minimum at room temperature.

2.16.1.3 Certified copies of all test reports are to be supplied to the Customer before final acceptances of flexures.

2.16.2 Flexures shall be inspected for material and manufacturing process defects in accordance with the requirements of ASTM E587.

2.16.3 All welding associated with the fabrication and assembly of flexure components shall be performed in accordance with the requirements of ANSI/AWS D1.1.

- 2.16.4 Inspections, Examinations, and Testing: Inspection methods and equipment used in the inspection, examination, and testing of welds shall conform to all applicable requirements of SAE/AMS, ASME/ANSI, and ANSI/AWS standards, and the Vendor's approved NDT weld inspection program.
- 2.16.5 Single point of rotation with minimum angle of rotation of 4 degrees.
- 2.16.6 Capacity: The flexure vendor shall propose and guarantee the following:
- a. Capacity at 0.0, 0.25 and 1.0 degrees.
 - b. Maximum stress level at rated capacity as a percent of the ultimate strength.
 - c. Restoring moment in in-lbf per degree versus axial load.
 - d. Axial stiffness and total deflection for load identified in Paragraph 2.15.5.
- 2.16.7 Final shop drawings and complete engineering analysis shall be approved by the Customer prior to the start of fabrication. Flexures deviating from the approved drawings shall be subject to rejection.
- 2.16.8 Handling: A threaded hole for mounting a lifting eye shall be located on each of the four sides of the flexure body as close to the center of gravity as is practical.

2.17 ELECTRONIC EQUIPMENT SPECIFICATIONS

Computer systems shall meet the following specifications:

- 2.17.1 Computer systems shall use an Intel processor.
- 2.17.2 Processor shall be a 4 GHz Pentium 4, Dual Core or better.
- 2.17.3 System bus speed of 800 MHz or better
- 2.17.4 System shall have a 256 bit video card with 1GB GDDR3 SDRAM memory or better.
- 2.17.5 System shall have at least 1 GB, 667 MHz of DDR2 SDRAM.
- 2.17.6 System shall have either an internal DVD-ROM with a DVD read speed of 16X.
- 2.17.7 System shall have an internal DVD-RW with a DVD-R/DVD-RW/playback speed of at least 16/4/16X.

- 2.17.8 System shall have an internal 1.44 MB 3.5 inch floppy disk drive.
- 2.17.9 System shall have at least a 24 inch flat screen LCD monitor with an AGP video adapter. Monitor resolution shall be capable of 1920 x 1200 at a minimum refresh rate of 60 Hz. The minimum response time shall not exceed than 10 ms.
- 2.17.10 Minimum of 8 USB 2.0 ports.
- 2.17.11 System shall have an USB 2.0 enhanced keyboard.
- 2.17.12 System shall have a USB 2.0 mouse.
- 2.17.13 System shall have a minimum number of the following slots: 3 PCI, 1 PCIe x1, 2 PCIe x16, 1 PCIe x8.
- 2.17.14 System shall have a 10/100/1000 PCI Ethernet card.
- 2.17.15 The operating system shall be Microsoft Windows XP Professional or later.
- 2.17.16 System shall have a minimum hard drive of 200 GB.

2.18 DATA REDUCTION

- 2.18.1 The Vendor shall provide detailed descriptions of data reduction procedures to be carried out in the DAS, covering the following processes:
 - a. Processing of calibration data.
 - b. Calculating and storing calibration coefficients for use in reducing data from the measurement system.
 - c. Processing measurement system data during an engine firing.

2.19 TRAINING

The Vendor shall provide up to one week of training for each J-2X TMS installation. Approximately 20 people, engineers and technicians, are to be trained at each session. The following subjects shall be covered:

- a. Principals of operation (theory of thrust measurement).
- b. Operating procedures for the TMS.
- c. Data reduction procedures.
- d. Troubleshooting (include special safety considerations).

- e. Routine maintenance, including change out of load cell strings, calibration equipment, etc (include special safety considerations).

2.20 PRESSURE SYSTEMS

2.20.1 All pressure vessels shall be designed, fabricated, inspected, and stamped per the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. The working pressure for pressure tubing and components shall have a factor of safety of not less than 4. The factor of safety is the ratio of the ultimate strength of a material to allowable stress. This results in working pressure being a safe operation pressure, allowing personnel to work adjacent to the operating system. Pressure system tubing and components shall be proof pressure tested to a factor of 1.5 times the maximum working pressure. The proof pressure test shall be a minimum of 5 pressure cycles. Piping shall be designed, fabricated, and installed per ASME B31.3.

2.20.2 Hydraulic pipe shall be constructed of ASTM A312 Gr TP304L stainless steel pipe. Flange bolting shall be studs conforming to ASTM A320 Gr. B8 (AISI Type 304 stainless steel) and nuts conforming to ASTM A194 Gr. 8F (AISI Type 303 stainless steel). Gaskets shall meet SSC 54000-GM00. All pipe flanges shall permit 100% radiography; slip-on flanges are not permitted. Flanges dimensions and drilling shall be in accordance with ANSI/ASME 16.5. Flanges shall have raised faces with concentric serrations.

3.0 EXECUTION

3.1 FABRICATION

3.1.1 WELDING

3.1.1.1 Structural Welding: All welding associated with the fabrication and assembly of structural components shall be performed in accordance with the requirements of ANSI/AWS D1.1, Structural Welding Code.

3.1.1.2 Pipe Welding: All welding associated with the fabrication and assembly of structural components shall be performed in accordance with the requirements of ASME B31.3.

3.1.1.3 Weld Metal: All weld metal used in association with the welding specified herein shall be suitable for the base metal being joined and shall have a minimum ultimate tensile strength equal to or greater than the base metals. The welding processes and procedures shall be low-hydrogen.

- 3.1.1.4 Welder and Welding Operator Qualification: Welders and welding operators shall be qualified in accordance with ANSI/AWS D1.1 for structural welding and with ASME B31.3 for pipe welding.
- 3.1.1.5 Inspections, Examinations, and Testing: Inspection methods and equipment used in the inspection, examination, and testing of welds shall conform to all applicable requirements of ASME/ANSI and ANSI/AWS standards and the Vendor's approved NDT weld inspection program. With exception of the flexures, all full penetration welds shall be inspected by 100% visual and radiography. Flexures shall be inspected by 100% visual and radiography where physically possible. One hundred percent (100%) ultrasonic inspection shall be employed where radiography is not possible. Piping shall be hydrostatically tested per ASME B31.3.
- 3.1.1.6 Preheat and Post Weld Heat Treatment: Unless otherwise specified, the requirements for preheat and post weld heat treatment of components shall be established by the Vendor in compliance with AWS D1.1 for structural welding and ASME B31.3 for pipe welding. If heat treatment is required, a detailed description of how it shall be performed shall be submitted to the Customer for approval.
- 3.1.1.7 Acceptance Standards: The acceptance standards shall be those specified by AWS D1.1, Section 6 for the structural welding and ASME B31.3 for pipe welds.

3.2 MACHINING, TOLERANCES, AND FINISHES

- 3.2.1 All structural assembly component which interface to test stand components shall be machined to the tolerances and surface finishes as specified in the Vendor's drawings.
- 3.2.2 The Vendor shall perform a dimensional inspection of all dimensions which are critical to the accuracy of the TMS. Certified copies of the inspection report shall be furnished to the Customer. Other dimensions shall be inspected in accordance with good shop practice.
- 3.2.3 All machining and finishing shall be performed after welding and post-weld heat treatment are complete.

3.3 PAINTING

- 3.3.1 Painting for TMS installations at sea-level test stands.
 - 3.3.1.1 All exposed, non-machined steel surfaces shall be painted as follows:

- 3.3.1.2 Surface Preparation: Pressure wash equipment to remove surface dirt and mold. Delicate electrical, hydraulic and machined surfaces must be protected during pressure wash task from moisture damage. Equipment shall be blown down using dry facility air after wash down is complete to speed drying process. Clean surface rust and blistered areas with pneumatic needle scaler, wire brush and hand scraper. Apply rust converter (Restore brand name or equal) to all exposed rust affected areas, allow to air dry for 24 hours minimum.
- 3.3.1.3 Priming: Apply a thin (0.8-0.9 mil.) coat of MIL-P-53030A water reducible epoxy primer coating over the entire surface of the piece of equipment.
- 3.3.1.4 Painting: Apply two coats of Aliphatic Polyurethane topcoat, MIL-DTL-53039B over entire surface of the piece of equipment.
- 3.3.2 The paints used for TMS installations at vacuum chamber test stands shall have a total mass loss less than 1% and collected volatile condensable materials less than 0.1% as determined by ASTM E595. A suggested database for paints is <http://outgassing.nasa.gov>.
- 3.4 MECHANICAL WORKMANSHIP
 - 3.4.1 Workmanship shall conform to good current shop practice and shall conform to applicable codes.
 - 3.4.2 All components shall be fabricated and finished in accordance with the best commercial practices. Particular attention shall be given to: freedom from blemishes, defects, burrs, and sharp edges; thoroughness of cleaning; neatness of welding and surface finishes; alignment of parts; tightness of threaded fasteners; integrity of mechanical fasteners and lockware assemblage.
 - 3.4.3 Cleaning of the hydraulic system shall be per Level 4 in NASA/SSC SSTD-8070-0089-FLUIDS for all TMS installations.
 - 3.4.4 All dimensions given are to finished surfaces and the Vendor shall provide allowance for machining, shrinkage due to welding or fitting of components.
 - 3.4.5 All components requiring precise location to achieve satisfactory performance shall be located by means of dowel pins or fitted bolts. All dowels shall be hand fitted to reamed holes.
- 3.5 MANUFACTURING TOLERANCES

3.5.1 At the engine attachment bolt holes, the bottom of the live bed shall be parallel to the top of the ground frame within 0.024 inches.

3.6 INSTALLATION

3.6.1 Vendor's responsibility during installation is covered in Section 2.1 of this specification.

3.6.2 The Vendor shall provide up to two non-consecutive weeks of consulting services during installation. This time shall be exclusive of the one week for training.

3.6.3 The Vendor shall develop a detailed plan for installation of the TMS. The plan shall take into account lifting equipment which will be available at the J-2X Test Facility. Structural modifications to the stand which are necessary to accommodate the engine installation are the Customer's responsibility. The TMS installation plan shall be coordinated with this design.

3.6.4 The Vendor shall provide lifting features on the structural assembly as required by the installation plan.

3.6.5 If special slings or spreaders are required for the structural assembly installation, the Customer shall provide these.

3.7 FACTORY ASSEMBLY AND ACCEPTANCE TESTS

3.7.1 The complete TMS, including structural assembly, calibration control system and operator interface equipment shall be assembled at the Vendor's factory and operated before shipment. The Customer shall be permitted to witness final inspection of TMS dimensional tolerances. The following shall be a part of the acceptance tests:

- a. All specified features and systems of the system shall be functionally tested. The test will demonstrate conformance to the specifications.
- b. Conformance with the specified uncertainty requirements (see 3.7.2 for details).
- c. Determine the degree of interaction between the load cells in the three axes.

3.7.2 The tests shall verify and validate that the specified uncertainty requirements have been met. For sea-level test stands and vacuum chambers operating above -20° F, factory testing shall be performed in the vertical and canted orientations (engine nozzle pointed downward). For the canted orientation, the factory testing shall be conducted at the

maximum angle specified in Section 1.4. For vacuum chamber test stands with thermal conditioning (operating below -20° F), factory testing shall be performed in the vertical orientation only. Equipment to react the loads on the structural assembly in the null and maximum gimbaled positions shall be used. The uncertainty requirements for the null condition thrust vector shall also be verified and validated. The testing will be performed with the thrust adapter attached to the structural assembly. The Customer shall be responsible for shipment of the thrust adapter to the Vendor.

- 3.7.3 The Vendor shall develop plans for the acceptance tests of each TMS.
- 3.7.4 The Customer shall be permitted to witness shop tests of the TMS.
- 3.7.5 Vendor shall notify the Customer at least ten working days in advance of the date for factory tests.
- 3.7.6 Test equipment and methods used in final dimensional inspections and acceptance tests shall be subject to approval and validation by the Customer.
- 3.7.7 Following successful completion of the acceptance tests, a sample of the hydraulic fluid shall be sent to a third party laboratory for analysis of contaminants or particles.
- 3.8 COMMISSIONING
 - 3.8.1 The Vendor shall develop plans for commissioning each TMS. The plans shall describe tests to be performed after installations at each NASA sites are complete.
 - 3.8.2 The tests shall verify that all design features of the TMS are operational.
 - 3.8.3 The tests shall verify and validate that the installed TMS still meets the specified uncertainty requirements.
 - 3.8.4 During commissioning tests, the Vendor shall be responsible for proper functioning of his equipment, and for the accuracy of the data reduction procedures he has supplied. He shall not be responsible for proper coding of his procedures in the DAS, or for proper operation of the DAS or the facility control system.
- 3.9 PRODUCT PACKING, SHIPPING, STORAGE, AND HANDLING
 - 3.9.1 General

- 3.9.1.1 The Vendor shall be responsible for shipping of the TMS to the J-2X test facility.
- 3.9.1.2 The Vendor shall select the means of transportation.
- 3.9.1.3 The Vendor shall be responsible for packaging and crating (to the extent necessary) and loading the structural assembly and all ancillary equipment to be supplied under this contract, properly securing it and protecting it for transportation.
- 3.9.1.4 Weight and size of each package shall be clearly marked on the exterior of the package.
- 3.9.1.5 Any permits or other authorizations required for shipment shall be obtained by the Vendor.
- 3.9.1.6 The structural assembly shall be shipped fully assembled.
- 3.9.2 Protection of Materials and Equipment
 - 3.9.2.1 The Vendor shall use all means necessary to protect the work and materials of this specification, before, during, and after fabrication.
 - 3.9.2.2 The Vendor shall protect materials and equipment, including surface finish, against detrimental conditions, including freezing and corrosion, during fabrication, storage, and shipping, until delivered to the Customer at the J-2X test facility. The Vendor shall conform to the applicable requirements of NASA/SSC DWG 54000-GP11 for all TMS installations.
 - 3.9.2.3 All threaded connections shall be kept sealed with caps or plugs to prevent entry of dirt.
 - 3.9.2.4 All exposed, machined, contact surfaces shall be coated with a removable rust preventative and protected against mechanical damage during shipment by suitable covers.
 - 3.9.2.5 All exposed steel surfaces that are not machined surfaces or otherwise protected shall be primed and painted.
 - 3.9.2.6 If, as determined by the Customer, material, equipment, supplies, and work performed are not adequately protected by the Vendor, the Customer may protect such property and the costs thereof may be charged to the Vendor or deducted from any payments due.
- 3.10 ELECTRICAL

3.10.1 Installation by the Vendor of all power and control systems shall be in accordance with NFPA 70.

4.0 QUALITY ASSURANCE

4.1 Qualifications of Vendor

4.1.1 The Vendor shall be familiar with the codes, standards, and techniques listed in this specification. The Vendor shall demonstrate relevant experience in the design, manufacture and calibration of multi-component thrust measurement systems.

4.2 Qualifications of Workmen

4.2.1 Throughout the progress of the work, the Vendor shall employ adequate numbers of workmen who are thoroughly skilled in the required crafts. In acceptance or rejection of items of this contract, no allowance shall be made for lack of skill on the part of the workmen.

4.2.2 During the entire course of this contract, the Vendor shall appoint at least one person with at least one alternate contact who are thoroughly familiar with the requirements of this specification, and the necessary steps for its proper execution, and who shall personally direct all work performed.

4.3 Quality Control Program

4.3.1 The Vendor shall have and maintain a quality control system which shall document that all contract requirements including material, fabrication, inspection and testing by the Vendor and inspection by the Customer are satisfied.

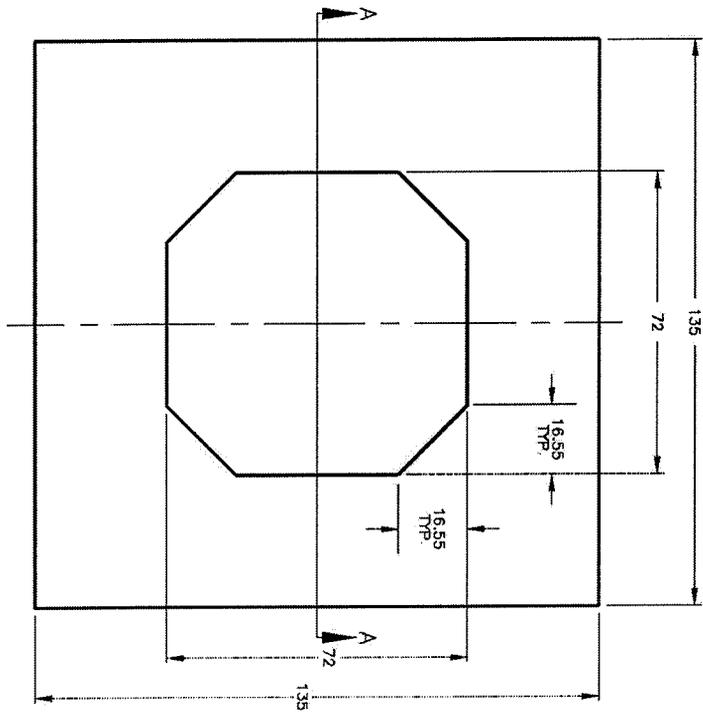
4.3.2 All material and workmanship shall be subject to inspection and test by the Customer and/or designated representatives at any and all times during the fabrication. Inspection of all or any part of the material, equipment, and workmanship may be waived by the Customer, but this shall not in any way be interpreted as relieving the Vendor of his responsibility for the fabrication, inspection, and testing of all work in accordance with the requirements of this Specification. The Customer shall have the right to reject defective material or workmanship or to require its correction. Without charge therefore, rejected workmanship shall be corrected satisfactorily and rejected material shall be replaced with material which meets the requirements of this Specification.

END OF MAIN TEXT

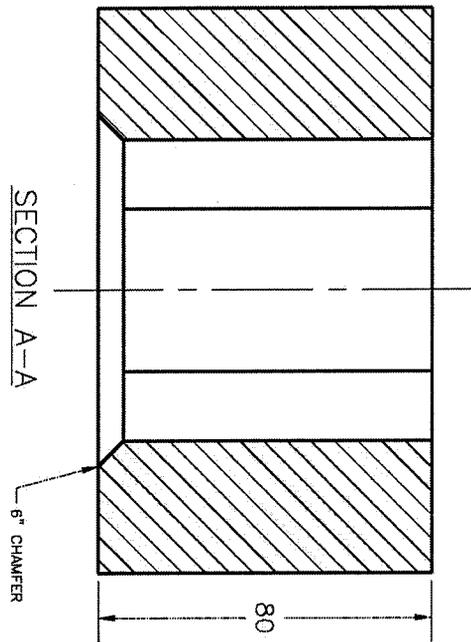
APPENDIX A - SKETCHES

SKETCHES

| | |
|------|---|
| SK-1 | TMS Space Envelope |
| SK-2 | Engine Attachment Details, Bottom Surface of Live Bed |
| SK-3 | Engine Attachment Details, Detail 1 |
| SK-4 | TMS Attachment Details, Top Surface of Ground Plate |
| SK-5 | TMS Center Opening Attachment Locations, Plan View |
| SK-6 | TMS Center Opening Attachment Locations, Elevations |
| SK-7 | Typical Bracket Detail |
| SK-8 | TMS Data Acquisition System Block Diagram |
| SK-9 | TMS Orthogonal Coordinate System Orientation |



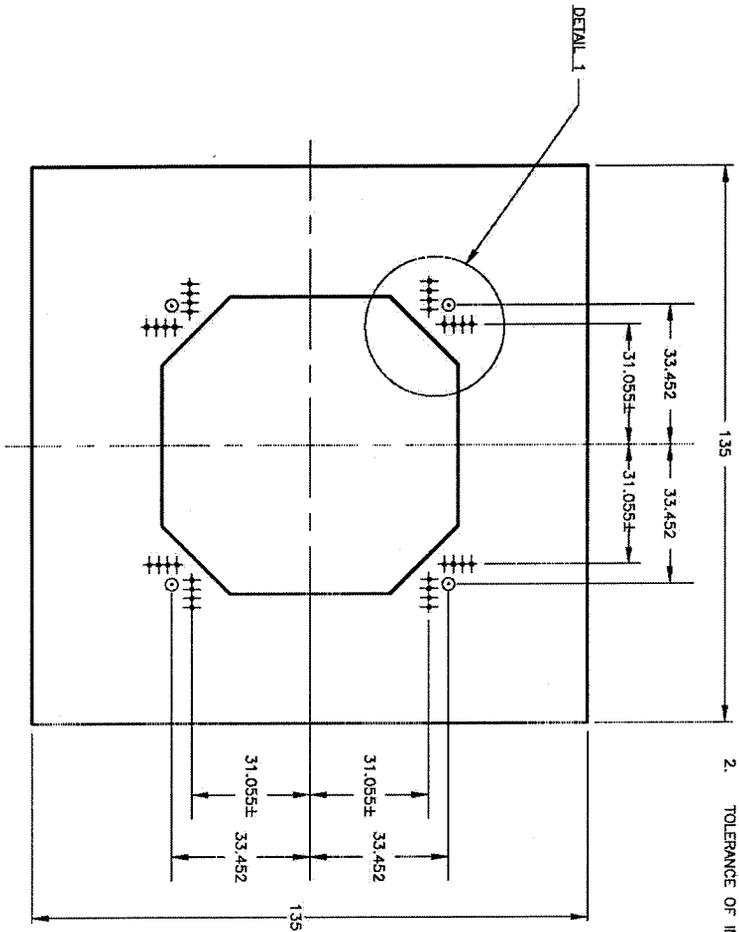
IIMS SPACE ENVELOPE



NOTES:

1. ALL DIMENSIONS ARE IN INCHES.

SK-1

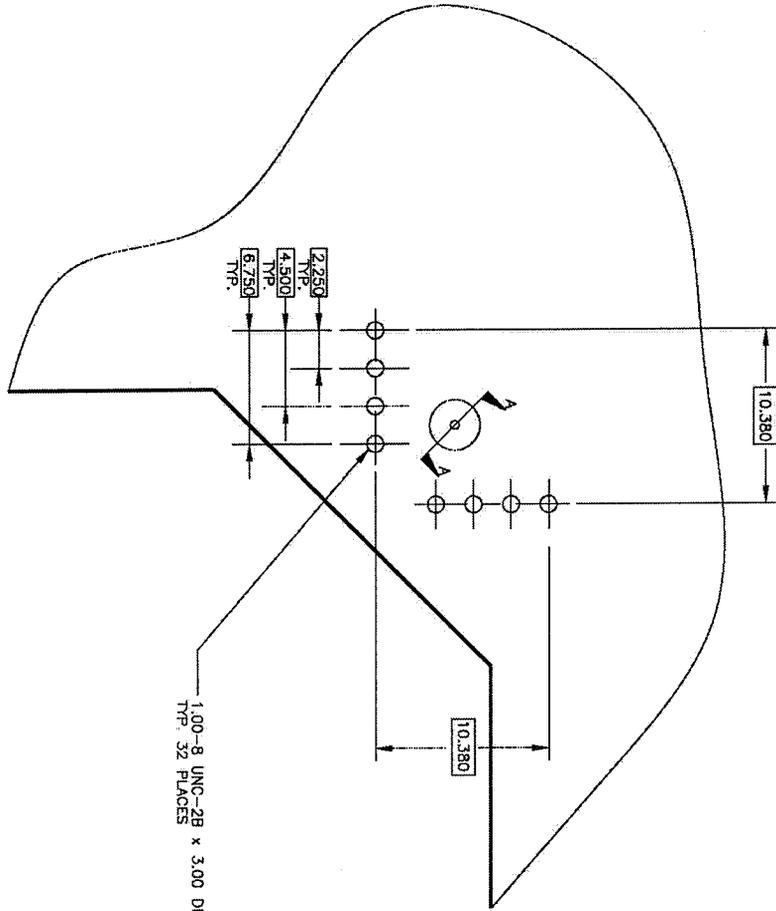


NOTES:

- 1. ALL DIMENSIONS ARE IN INCHES.
- 2. TOLERANCE OF INDICATED DIMENSIONS IS ± 0.005".

ENGINE ATTACHMENT DETAILS
BOTTOM SURFACE OF LIVE BED

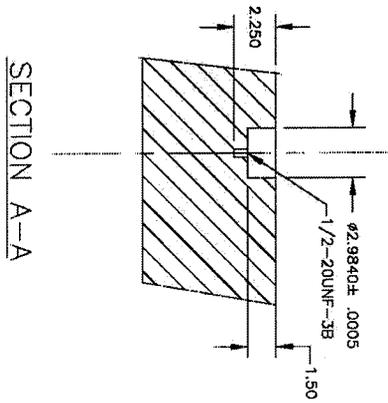
SK-2



DETAIL 1

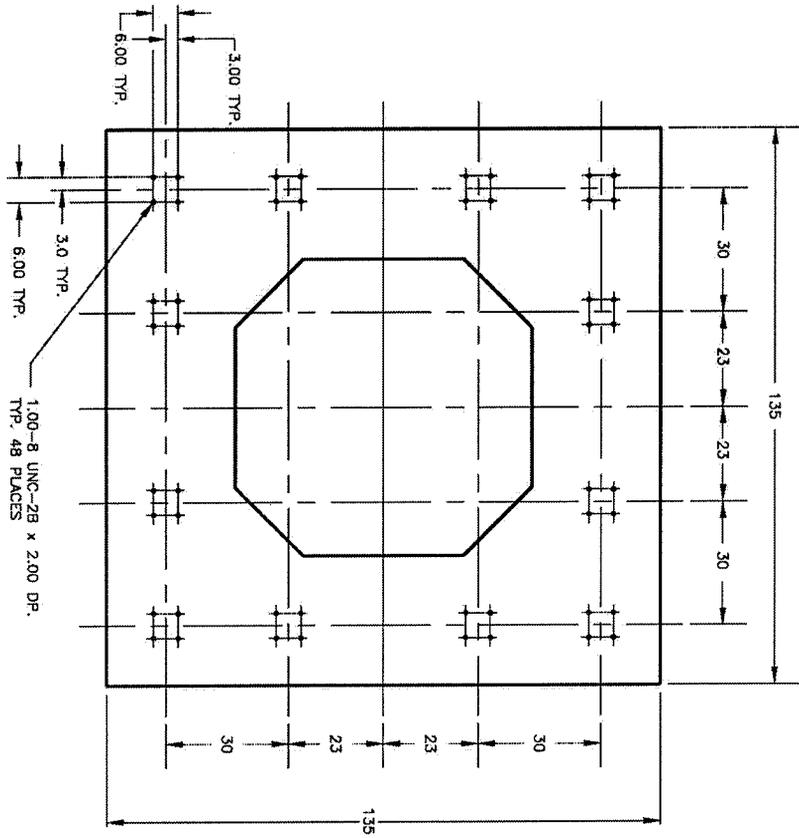
NOTES:

1. ALL DIMENSIONS ARE IN INCHES.



SECTION A-A

SK-3

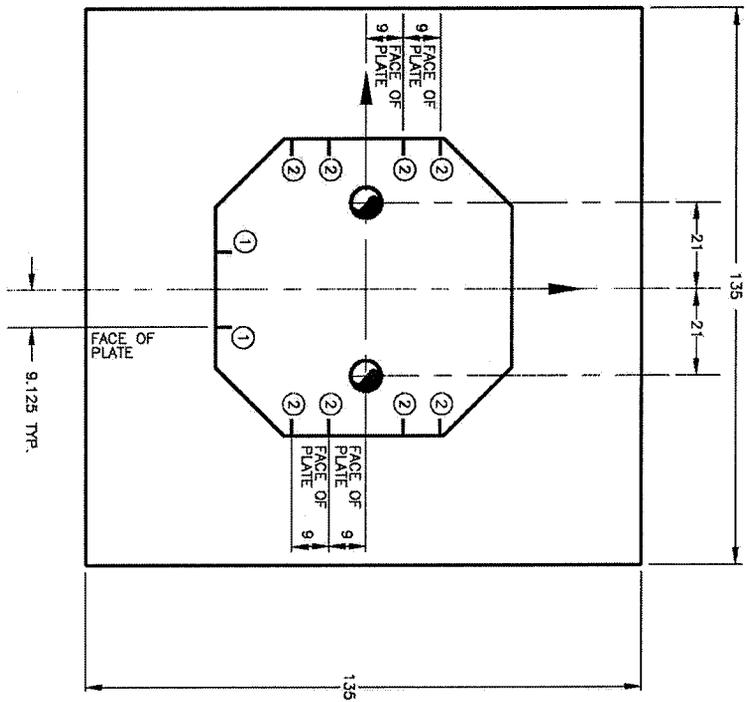


NOTES:

1. ALL DIMENSIONS ARE IN INCHES.

TMS SPACE ENVELOPE
TOP SURFACE OF GROUND PLATE

SK-4



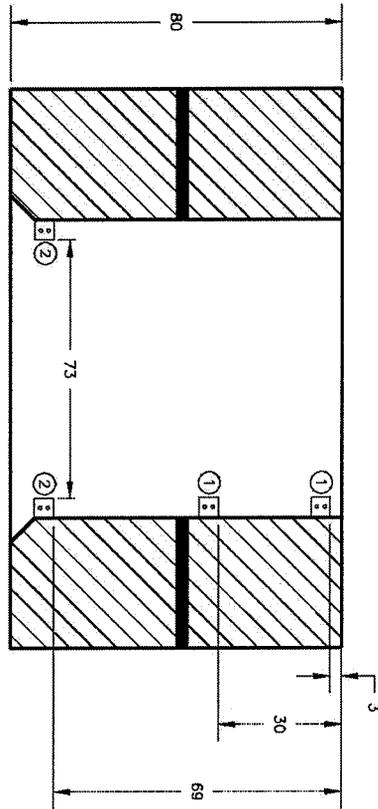
LOADING TABLE

| BRACKET | Fx (LBS) | Fy (LBS) | Fz (LBS) | Mx(FT-LB) | My(FT-LB) | Mz(FT-LB) |
|---------|----------|----------|----------|-----------|-----------|-----------|
| 1 | 0 | -300 | 0 | 0 | 0 | 0 |
| 2 | 0 | -1500 | 0 | 0 | 0 | 0 |

NOTES:
 1. ALL DIMENSIONS ARE IN INCHES.

TMS CENTER OPENING ATTACHMENT LOCATIONS PLAN VIEW

SK-5

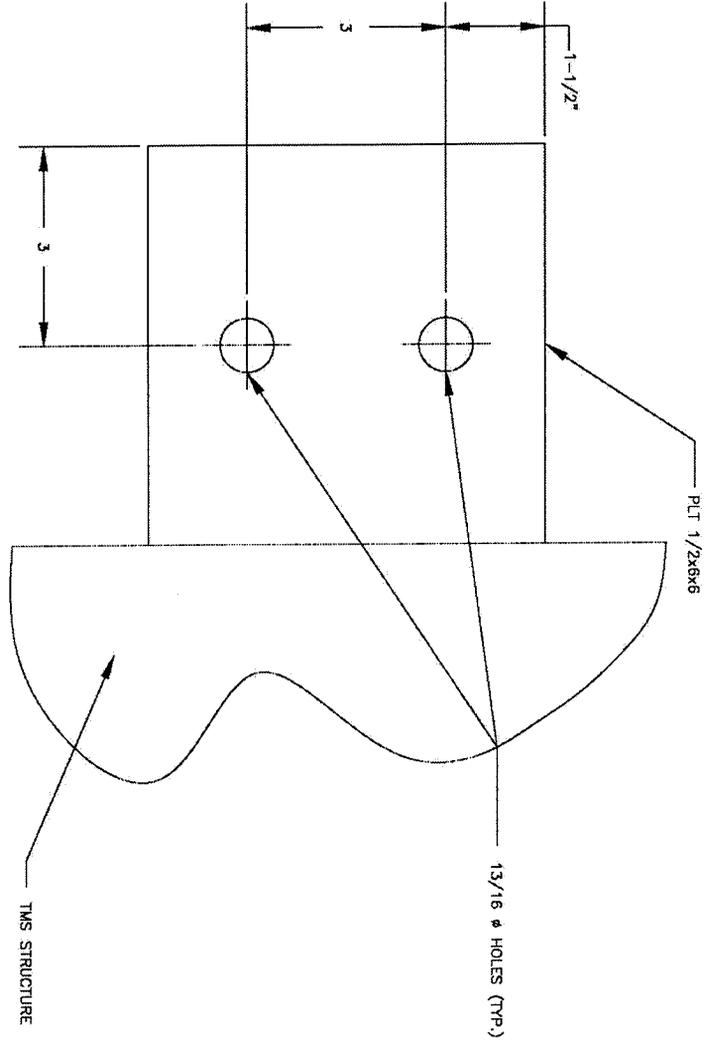


NOTES:

1. ALL DIMENSIONS ARE IN INCHES.

TMS CENTER OPENING ATTACHMENT LOCATIONS ELEVATIONS

SK-6

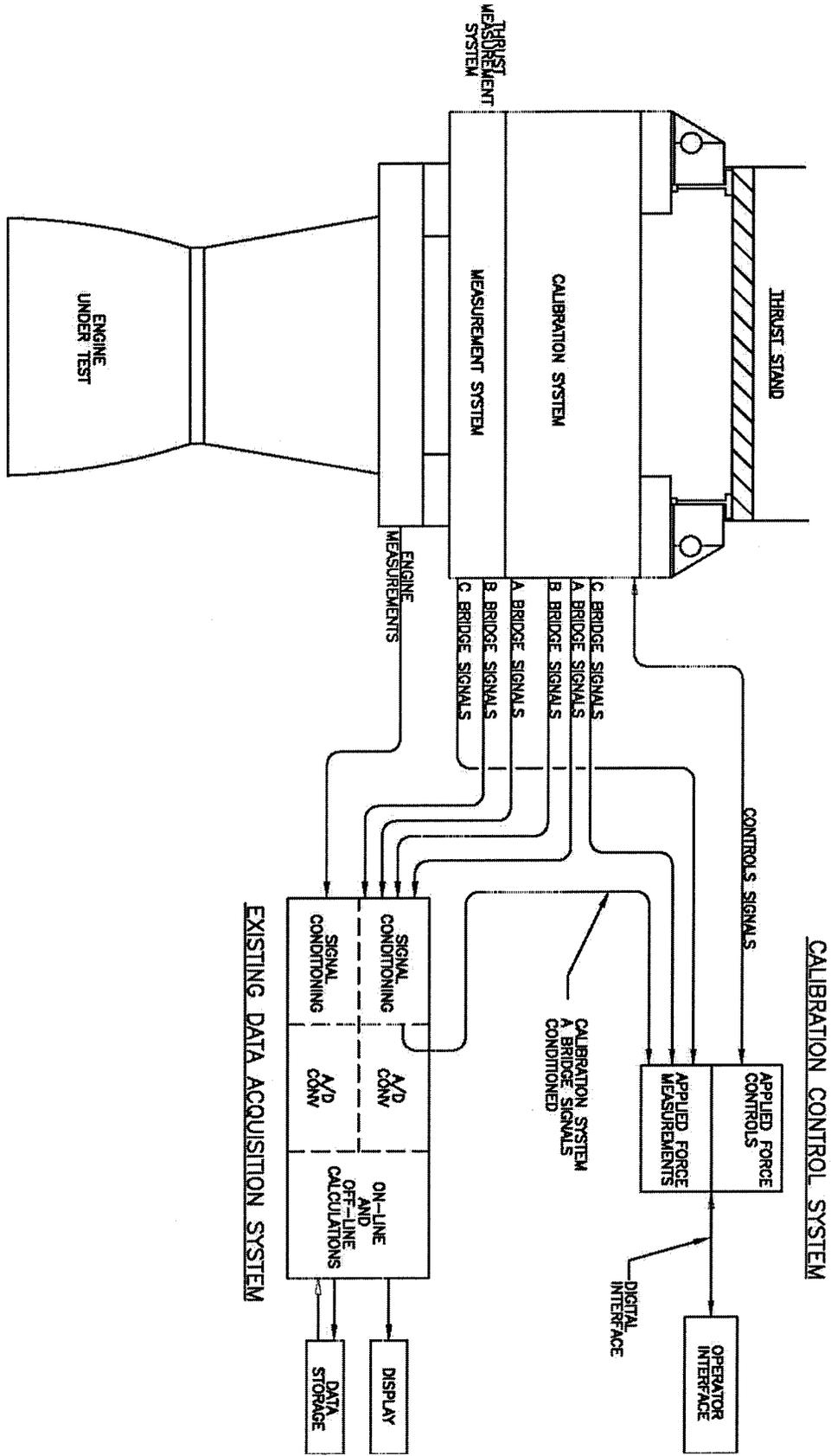


TYPICAL BRACKET DETAIL FOR ① AND ②

NOTES:

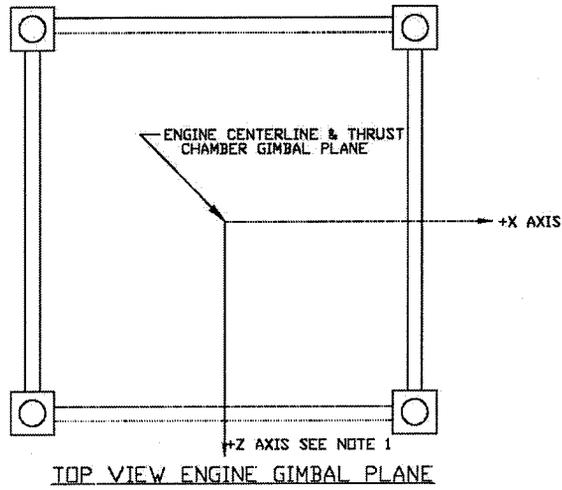
1. ALL DIMENSIONS ARE IN INCHES.

SK-7

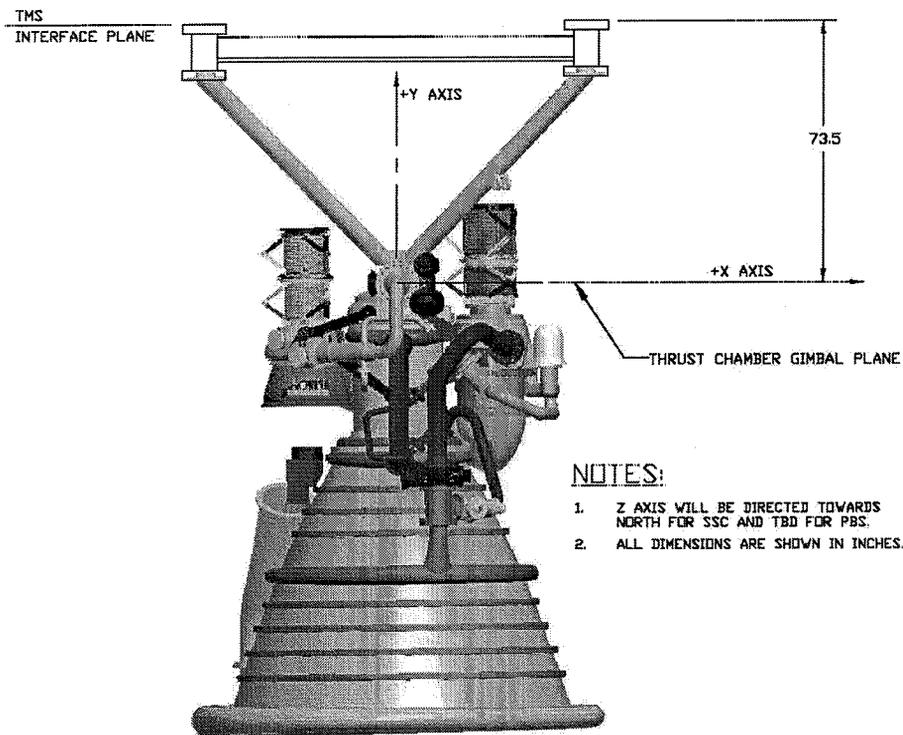


TMS DATA ACQUISITION SYSTEM BLOCK DIAGRAM

SK-8



TOP VIEW ENGINE GIMBAL PLANE



NOTES:

1. Z AXIS WILL BE DIRECTED TOWARDS NORTH FOR SSC AND TBD FOR PBS.
2. ALL DIMENSIONS ARE SHOWN IN INCHES.

FRONT VIEW ENGINE GIMBAL PLANE

APPENDIX B

UNCERTAINTY ANALYSIS

This appendix describes the methodology which shall be used in calculating the uncertainty of TMS measurements. It shall be used during the proposal, design, construction, installation and commissioning phases of the project. The uncertainty analysis will be performed per ASME PTC 19.1.

1. Processes which could contribute to the uncertainty of TMS measurement system during acceptance testing shall be identified in the analysis. Examples of such processes are as follows:

- A. Uncertainty of the methodology to determine the applied force imposed by the force-producing equipment.
- B. Uncertainty due assembly and manufacturing tolerances of the fixtures used to secure the force-producing equipment and structural assembly of the TMS.
- C. Uncertainty due to temperature effects on load cells and other components during acceptance testing.
- C. Uncertainty due to methodology to determine the interactions in the calibration system and in the measurement system..
- D. Uncertainties in transferring a calibration from the calibration system to the measurement system.
- H. Uncertainties due to shunt calibration resistance tolerances.
- I. Uncertainty due to the DAS used during acceptance testing.

2. The uncertainty from each possible error source is separated into systematic uncertainty and random uncertainty:

Systematic uncertainty, such as an uncertainty in calibration, has the same value for each measurement in a series of measurements.

Random uncertainty, such as an uncertainty from noise pickup, which shall have a different value for each measurement in a series of measurements.

3. The total systematic uncertainty is calculated as the square root of the sum of the squares of the individual bias errors in the measurement.
4. The total random uncertainty is calculated as the square root of the sum of the squares of the individual random uncertainties. The result is multiplied by the Student's T-factor for a 95% confidence level. The factor depends on the

number of degrees of freedom which is calculated by the Welch-Satterthwaite formula.

5. The total uncertainty for the TMS is calculated as the square root of the sum of the squares of the total systematic uncertainty and the total random uncertainty.

**APPENDIX C
DATA SHEETS**

Data Sheet 1.1

FACILITY INFORMATION

Facility Name: A-1 Test Stand
Facility Location: Stennis Space Center, MS
Type of Facility: Liquid rocket engine sea-level test stand
Test site altitude: Sea Level

CONDITIONS DURING TEST AND STANDBY

Temperature range: 0 ° to 135 ° F
Relative Humidity: 5% to 100%
Barometric pressure: 14.7 psia

HYDRAULIC SKID

Location: Indoor, Level 7 , test stand core building.
Hazardous classification: Non-classified. Use TEFC motor.

DISTANCES

| Location | Location | Distance between locations (feet) |
|---|--|--|
| Signal conditioning room in test stand core building | Test Control Center | 1500 |
| Signal conditioning room in test stand core building | Structural assembly | 150 |
| Hydraulic pump skid location on Level 7 of test stand core building | Structural assembly | 200 |
| Hydraulic pump skid location on Level 7 of test stand core building | Signal conditioning room in test stand core building | 50 |

Data Sheet 1.2

FACILITY INFORMATION

Facility Name: B-2 Test Facility
Facility Location: Plum Brook Station; Sandusky, Ohio
Type of Facility: Liquid rocket engine vacuum chamber test stand
Test site altitude: High vacuum with thermal conditioning

AMBIENT CONDITIONS DURING STANDBY

Temperature range: 0 ° to 100 ° F
Relative Humidity: 5% to 100%
Barometric pressure: 14.7

TEST CONDITIONS IN VACUUM CHAMBER

During engine firing at reduced pressure

Temperature range: -0° to 135° F
Relative Humidity: ~0%
Barometric pressure: 0.004 psia

During engine restart at deep space conditions

Temperature range: -323° to -150° F
Relative Humidity: ~0%
Barometric pressure: 5×10^{-8} Torr

HYDRAULIC SKID

Location: Indoor, Diffusion pump level, test stand core building.

Hazardous classification: Class I, Division 2, Group B.

DISTANCES

| Location | Location | Distance between locations (feet) |
|--|--|--|
| Signal conditioning room in test stand core building | Test Control Center | 3000 |
| Signal conditioning room in test stand core building | Structural assembly | 150 |
| Hydraulic pump skid location on diffusion pump level of test stand core building | Structural assembly | 100 |
| Hydraulic pump skid location on diffusion pump level of test stand core building | Signal conditioning room in test stand core building | 250 |

ATTACHMENT 3
Past Performance Questionnaire

PART 1: INSTRUCTIONS. The company who has provided your name is participating in a Request for Proposal (RFP) with NASA Stennis Space Center for Thrust Measurement Systems for the J-2X Engine. We would greatly appreciate you taking the time to complete this form.

Please provide a thorough assessment and immediately return to the following address or fax not later than March 9, 2007.

This completed form is to be provided directly to the address below:

NASA Stennis Space Center Acquisition Management Office
ATTN: Michelle Stracener (Mail Code BA 33)
Stennis Space Center, MS 39529-6000
Commercial: (228) 688-1720
FAX: (228) 688-1141

PART 2: GENERAL INFORMATION

1. a. Company's Name and Address (Contractor and/or sub being evaluated)

NOTE: Offerer fill out before forwarding

2. Respondent Organization Name and Address

3. a. Evaluator's Name

b. Evaluator's involvement with contractor:

c. Title/Telephone Number:

4. Contract Number _____

5. Contract Value (Basic and Options)

6. Award Date _____

7. Contract or Task Order Completion Date (Include extensions): _____

8. Contract Type: Firm Fixed Price (FFP) _____
Cost Plus Fixed Fee (CPFF) _____
Cost Plus Award Fee (CPAF) _____
Other (Please Specify) _____

Note: If an award fee contract, please provide a synopsis of available award fee pool and percentage of that pool awarded the contractor each evaluation period over the life of the contract.

9. Brief description of YOUR contract requirements including type of work, services involved, degree of self direction:

10. Additional data:

a. What was the intended application for the Thrust Measurement System?

Rating "G" for Very Good – Performance meets contractual requirements and exceeds some to the Government’s benefit. The contractual performance of the element or sub-element being assessed was accomplished with some minor problems for which corrective actions taken by the contractor were effective.

Rating "S" for Satisfactory – Performance meets contractual requirements. The contractual performance of the element or sub-element contains some minor problems for which corrective actions taken by the contractor appear or were satisfactory.

Rating "M" for Marginal – Performance does not meet some contractual requirements. The contractual performance of the element or sub-element being assessed reflects a serious problem for which the contractor has not yet identified corrective actions. The contractor’s proposed actions appear only marginally effective or were not fully implemented.

Rating "U" for Unsatisfactory – Performance does not meet most contractual requirements and recovery is not likely in a timely manner. The contractual performance of the element or sub-element contains serious problem(s) for which the contractor’s corrective action appear or were ineffective.

Rating "N/A" for Not Applicable - was not required to perform in this area.

___ 1. Preparation, use and quality of contractor’s internal Quality Control plan/program in identifying, correcting, and preventing problems.

___ 2. Were the safety rules, regulations and practices properly followed?

___ 3. How many accident/incident reports were filed for the duration of the contract?

___ 4. Was there an unusually high turnaround rate in management employees?

___ 5. Did the work teams report on time with proper working equipment?

___ 6. Was the contractor able to consistently maintain a qualified and experienced workforce to perform necessary services?

___ 7. Did the contractor respond timely and effectively to unexpected changes and emergency requirements?

___ 8. Did the contractor respond timely and effectively in resolving poor performance problems associated with its employees?

___ 9. How would you rate contractor's adherence to contract/delivery schedules?

___ 10. Were reports & documentation submitted timely and in a professional manner?

___ 11. Prompt response to technical direction & change orders?

___ 12. Timely responses to resolving problems?

COMMENTS:

Would you award another contract/task order to this company? Why?

___ Yes ___ No

ADDITIONAL COMMENTS (PRO AND CON)

PART FOUR: EVALUATOR'S CERTIFICATION:

I HEREBY CERTIFY THAT THE INFORMATION IN THIS FORM IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

Signature of Evaluator

Date

Title of Evaluator

ATTACHMENT 4
List of Required Documents

The following is a list of major required documents provided for the Offeror's convenience. There may be other documents, either required or necessary for effective evaluation, which do not appear on this list. It is the Offeror's responsibility to ensure that the proposal submitted is complete in every respect and not rely solely on this list to prepare the proposal.

1. Completed SF1449
2. Completed Representations and Certifications, FAR 52.212-3 located at page 17 of 28.
3. Required number of copies of the Technical Proposal
4. Past Performance Proposal with completed questionnaire (Attachment 3) and list of references
5. Sub-contracting Plan (large businesses only)
6. Safety and Health Plan IAW NASA Far Supplement (NFS) 1852.223-73
7. Verification of insurance in IAW FAR 52.228-5 and NFS 1852.228-75