National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO20R3

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC5-DO20R3

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: March 12, 2007 to June 3, 2008

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC5-D020R3

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 5/27/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIGHTWEIGHT / LOW-PROFILE BEARING ASSEMBLIES DO20, Rev. 3 is issued to change the Statement of Work to add Pro-E models of the major bearing components for the wrist, arm, and scye, extend completion date, and increase DO value. Period of Performance: 3/12/07 to 6/3/08	Lot			b4	

RECAP DO VALUE:	PRIOR	THIS ACTION	CUM VALUE
COST FEE	b4	b4	b4
TOTAL	$567,057	$9,020	$576,077

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Lindsay Aitchison, x38657

13. Total
$ 576,077 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO20R 2

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC5-DO20R2

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: March 12, 2007 to May 16, 2008

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC5-D020R2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 12/10/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIGHTWEIGHT / LOW-PROFILE BEARING ASSEMBLIES DO20, Rev. 2 is issued to extend the period of performance to May 16, 2008 at no additional cost to the Government. The total delivery order value remains at $567,057. Period of Performance: 3/12/07 to 5/16/08					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Lindsay Aitchison, x38657

13. Total
$ 567,057 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO20R1, Options 1-3

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC5-DO20R1, Options 1-3

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: March 12, 2007 to March 14, 2008

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC5-D020R1, Options 1-3

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 3/8/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIGHTWEIGHT / LOW-PROFILE BEARING ASSEMBLIES					
	DO20, Rev. 1 is issued to exercise Options 1, 2, and 3. The contractor shall perform and deliver to all requirements of Options 1, 2, and 3 as described in the attached Statement of Work.					
1	Option 1 - Fabrication and Test of Lightweight/Low Profile Wrist Bearings and Disconnects	Lot				
2	Option 2 - Fabrication and Test of Lightweight/Low Profile Scye and Upper Arm Bearings	Lot				
3	Option 3 - Fabrication and Testing of Lightweight/Low Profile Waist Bearing	Lot				
	Period of Performance: 3/12/07 to 3/14/08					
	Prior Value: $141,961; This action: $425,096; Cum. total: $567,057. This is a CPFF delivery order.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Lindsay Aitchison, x38657

13. Total
$ $425,096

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

OPTION 1

OPTION 1 TITLE: Fabrication and Test of Lightweight/Low-profile Wrist Bearings and Disconnects

Purpose of the Current Effort

After receiving approval to proceed to Option 1 of the task, the contractor will use the designs from base contract to fabricate and test bearings. The contractor will be responsible for testing all bearings to ensure that requirements have been met. The contractor will deliver a final report to detail all findings.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the trade study and designs detailed below. The team is to be limited in the number of people to those who are required to form an effective team. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor is to plan to accomplish the entire job without dependence on NASA effort. NASA effort will provide expertise and additional depth of study and prototype design but shall not be planned into the critical task to accomplish the project requirements. The potential availability of Government participants for this task is the same as listed in the base contract

Schedule Project

Develop a schedule detailing the contractor's plan for prototype design, analysis, and manufacturing process and anticipated milestone dates within the given project period.

Develop Task Assignments

Identify all the activities that must be performed for each milestone. Task assignments must be made for the core team. For each activity: estimate work effort necessary for each activity; identify all the people who will be affected by each activity; determine how they should be involved in the work; estimate work duration for each activity in calendar time.

Fabricate and Test Lightweight/Low-profile Bearings

Given the results of the various trade studies and the design concepts developed in the base contract, and NASA input or requested changes, the Contractor shall design, analyze, generate electronic models, generate complete fabrication drawings, fabricate, assemble, PDA test, and deliver lightweight / low-profile bearings (wrist disconnects and wrist bearings) for evaluation testing. The focal points of the lightweight / low-profile bearings design and fabrication shall

include the results of the various trade studies, the design decisions made by NASA at the end of the base contract, and the lightweight / low-profile bearings requirements supplied with this DO. If the Government requires changes to be made to the design proposed in the base contract, these changes will be addressed at the kick-off meeting for Option 1. An informal design review to approve the changes to the original design will be held four weeks after the kick-off meeting, if necessary. The wrist bearings and wrist disconnects shall implement the hole patterns and critical interface dimensions of the EMU Low-torque Wrist Bearing and EMU wrist disconnect per the drawings found in the Technical Library.

Following the fabrication of the bearings and disconnects, the contractor will conduct all necessary tests to ensure that all requirements have been met per the attached requirements document, "Functional Requirements for Lightweight / Low-profile Bearing Assembly." The test plan and test results will be included in the Verification Data Package (VDP).

Should the Government elect to enact multiple options concurrently, the Contractor shall propose a schedule for the completion of each deliverable in the options. The proposed schedule- and any potential modifications- will be discussed and agreed upon by NASA and the Contractor at the Options kick-off meeting.

Progress Reports

The contractor will be required to provide NASA weekly email progress status briefs (specific content to be defined by NASA POC) detailing the current status of their work, what has been accomplished, what work is planned for the next month, what issues/problems/risks (if any) have arisen, and their plan to mitigate any issues/problems/risks. Additionally, the contractor will participate in weekly telecons to address issues as they arise.

Generate Final Report

The contractor is to generate and publish a report detailing their lightweight / low-profile bearing design, all component fabrication procedures, all component and assembly work instructions, assembly/maintenance instructions, operations instructions, test plan, test results, the limitations or unique performance characteristics of the lightweight / low-profile bearings, and their findings/conclusions.

Conduct Final Report Presentation

The contractor is to conduct a formal presentation to NASA detailing their lightweight/low-profile bearing design, assembly/maintenance instructions, operations instructions, test results, what if any are the limitations or unique performance characteristics of their lightweight / low-profile bearing, and their findings/conclusions. The contractor will handover hardware and all other products of the DO at this time.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
	Pair (left and right) of wrist disconnects	2 left, 2 right		IIIW (i.e. controlled Class III)
	Pair (left and right) of wrist bearings	2 left, 2 right		IIIW (i.e. controlled Class III)
	Set of wrist bearing test plugs	1		
	Set of wrist bearing test plugs	1		
	Extra units of all limited life components used in bearings (e.g. seals, gaskets, screws, key inserts, etc.)	2 sets (1 set for left, one set for right) ea.		IIIW (i.e. controlled Class III)

Test				
Verification Data Package	The Verification Data Package shall consist of the following: 1) Component List 2)Verification Compliance Table (details how the design meets each requirement) 3) Verification Test Plan 4) Verification Test Data Sheets (i.e. the results of the verification testing) 5) Functional Equipment Historical Record (JSC Form 772) 6) Limited Life List 7) Shipping Document (DD250) 8) All associated construction, assembly, testing and control TPSs 9) All associated MRBs and DRs 10) Serialized Component and replacement record 11) Repair Limitations 12) Any special instructions for storage, handling, and maintenance 13) MSDS Sheets	3 EA paper and CD (PDF and Word format)		
Software	N/A			
Other Products				
Lightweight/Low-profile Bearing Design and Fabrication Report	A well documented report detailing the bearing design, summarization and interpretation of VDP results, all component fabrication processes, assembly/maintenance instructions, operations instructions, test plan and procedures, test results, what if any are the limitations or unique performance characteristics their Lightweight / Low-profile Bearing Design, and their conclusions	3 EA paper and CD (PDF and Word format)		N/A
Materials Usage List	A list which details all the materials the Contractor used in the fabrication of lightweight/low-profile bearings	3 EA		N/A
Electronic models	All electronic models (Pro/E) of bearing hardware	3 EA CDs		N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and tooling used in the fabrication of bearing hardware	3 EA		N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the bearing hardware	3 EA		N/A

Acceptability for Use Memo	Memo stating bearings are rated for manned use with supporting data and justifications	3 EA		N/A

SCHEDULE

Start Date: March 12, 2007 **Finish Date: November 2, 2007**

ITERIM MILESTONES	DUE DATES (weeks after ATP)
Kick-off Meeting	**1**
Informal Design Review (if required)	**5**
Test Plan and Procedure Delivery	**15**
First Article Review	**20**
Test Review at Contractor Facility	**30**
Final Report Delivery	**38**
Final Presentation	**39**

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan		Once	N	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Five working (5) days following contract start	Weekly	Y	Status Email
3	Written Approval	Project Technical Requirements Specification		Once with Revisions	N	Informal specifications as described in the DO
4	Mandatory Submittal	GFE Systems Requirements Data Package		Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document		Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package		Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List		Once with Revisions	N	
8	Written Approval	Project Schedule	At Kick-off	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document		Once with Revisions	N	
10	Written Approval	GFE End Item Specification		Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report		As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan		Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
13	Written Approval	GFE Software Requirements Specification		Once with Revisions	N	
14	Written Approval	GFE Software Development Plan		Once with Revisions	N	
15	Written Approval	GFE Software Design Document		As Required	N	
16	Written Approval	Engineering Drawings	With final report	Once with Revisions	Y	Pro/E format
17	Written Approval	EEE Parts Lists and Analysis Report		As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package		Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	Y	Requires approval of DO Mgr or Alt. DO Mgr
20	Written Approval	GFE Qualification Test Procedure		Once with Revisions	N	
21	Written Approval	Flight Product User's Guide		Once with Revisions	N	
22	Mandatory Submittal	Software Code		As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports		JPG 2810.1	N	
24	Written Approval	Certification Plan		Once with Revisions	N	
25	Mandatory Submittal	Certification Report		Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Final Design and Fabrication Report	As Required	Y	PDF and Word format

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
27	Mandatory Submittal	Acceptance Data Package		One Time	N	
28	Mandatory Submittal	Export Control Audit Results		Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List		As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List		As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report		As Required	N	
35	Written Approval	Software Quality Assurance Plan Report		Once with Revisions	N	
36	Written Approval	ISS Hazard Report		As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Final Report	One Time	Y	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	With Verification Package	As Required	Y	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data		Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan		Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
44	Mandatory Submittal	Certification Data Package		Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document		Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data		Once	N	
47	Written Approval	GFE Acceptance Test Procedure		One Time	N	
48	Mandatory Submittal	Flight GFE Verification & Validation Report		Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List		As Required	N	
50		**Reserved**	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	**Attachment J-7**	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	**Attachment J-10**	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

<u>CHANGES TO DRDs</u>: NONE

<u>CHANGES TO GOVERNMENT FURNISHED PROPERTY</u>: NONE
(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

OPTION 2

OPTION 2 TITLE: Fabrication and Test of Lightweight/Low-profile Scye and Upper Arm Bearings

Purpose of the Current Effort

After receiving approval to proceed to Option 2 of the task, the contractor will use the designs from base contract to fabricate and test bearings. The contractor will be responsible for testing all bearings to ensure that requirements have been met. The contractor will deliver a final report to detail all findings.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the trade study and designs detailed below. The team is to be limited in the number of people to those who are required to form an effective team. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor is to plan to accomplish the entire job without dependence on NASA effort. NASA effort will provide expertise and additional depth of study and prototype design but shall not be planned into the critical task to accomplish the project requirements. The potential availability of Government participants for this task is the same as listed in the base contract

Schedule Project

Develop a schedule detailing the contractor's plan for prototype design, analysis, and manufacturing process and anticipated milestone dates within the given project period.

Develop Task Assignments

Identify all the activities that must be performed for each milestone. Task assignments must be made for the core team. For each activity: estimate work effort necessary for each activity; identify all the people who will be affected by each activity; determine how they should be involved in the work; estimate work duration for each activity in calendar time.

Fabricate and Test Lightweight/Low-profile Bearings

Given the results of the various trade studies and the design concepts developed in the base contract, and NASA input or requested changes, the Contractor shall design, analyze, generate electronic models, generate complete fabrication drawings, fabricate, assemble, PDA test, and deliver lightweight / low-profile bearings (scye bearings and upper arm bearings) for evaluation testing. The focal points of the lightweight / low-profile bearings design and fabrication shall

include the results of the various trade studies, the design decisions made by NASA at the end of the base contract, and the lightweight / low-profile bearings requirements supplied with this DO. If the Government requires changes to be made to the design proposed in the base contract, these changes will be addressed at the kick-off meeting for Option 1. An informal design review to approve the changes to the original design will be held four weeks after the kick-off meeting, if necessary. The bearings shall implement the hole patterns and critical interface dimensions provided at ATP on Option 2. Examples of current hole patterns are listed in the Technical Library.

Following the fabrication of the bearings, the contractor will conduct all necessary tests to ensure that all requirements have been met per the attached requirements document, "Functional Requirements for Lightweight / Low-profile Bearing Assembly." The test plan and test results will be included in the Verification Data Package (VDP).

Should the Government elect to enact multiple options concurrently, the Contractor shall propose a schedule for the completion of each deliverable in the options. The proposed schedule- and any potential modifications- will be discussed and agreed upon by NASA and the Contractor at the Options kick-off meeting.

Progress Reports

The contractor will be required to provide NASA weekly email progress status briefs (specific content to be defined by NASA POC) detailing the current status of their work, what has been accomplished, what work is planned for the next month, what issues/problems/risks (if any) have arisen, and their plan to mitigate any issues/problems/risks. Additionally, the contractor will participate in weekly telecons to address issues as they arise.

Generate Final Report

The contractor is to generate and publish a report detailing their lightweight / low-profile bearing design, all component fabrication procedures, all component and assembly work instructions, assembly/maintenance instructions, operations instructions, test plan, test results, the limitations or unique performance characteristics of the lightweight / low-profile bearings, and their findings/conclusions.

Conduct Final Report Presentation

The contractor is to conduct a formal presentation to NASA detailing their lightweight/low-profile bearing design, assembly/maintenance instructions, operations instructions, test results, what if any are the limitations or unique performance characteristics of their lightweight / low-profile bearing, and their findings/conclusions. The contractor will handover hardware and all other products of the DO at this time.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
	Pair (left and right) of upper arm bearings	2 left, 2 right		IIIW (i.e. controlled Class III)
	Pair (left and right) of scye (shoulder) bearings	2 left, 2 right		IIIW (i.e. controlled Class III)
	Set of upper arm bearing test plugs	1		
	Set scye of bearing test plugs	1		
	Extra units of all limited life components used in bearings (e.g. seals, gaskets, screws, etc.)	2 sets of ea.		IIIW (i.e. controlled Class III)
Test				
Verification Data Package	The Verification Data Package shall consist of the following: 1) Component List 2)Verification Compliance Table (details how the design meets each requirement) 3) Verification Test Plan 4) Verification Test Data Sheets (i.e. the results of the verification testing) 5) Functional Equipment Historical Record (JSC Form 772) 6) Limited Life List 7) Shipping Document (DD250) 8) All associated construction, assembly, testing and control TPSs 9) All associated MRBs and DRs 10) Serialized Component and replacement record 11) Repair Limitations 12) Any special instructions for storage, handling, and maintenance 13) MSDS Sheets	3 EA paper and CD (PDF and Word format)		
Software	N/A			

Other Products				
Lightweight/Low-profile Bearing Design and Fabrication Report	A well documented report detailing the bearing design, summarization and interpretation of VDP results, all component fabrication processes, assembly/maintenance instructions, operations instructions, test plan and procedures, test results, what if any are the limitations or unique performance characteristics their Lightweight / Low-profile Bearing Design, and their conclusions	3 EA paper and CD		N/A
Materials Usage List	A list which details all the materials the Contractor used in the fabrication of lightweight/low-profile bearings	3 EA		N/A
Electronic models	All electronic models (Pro/E) of bearing hardware	3 EA CDs		N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and tooling used in the fabrication of bearing hardware	3 EA		N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the bearing hardware	3 EA		N/A
Acceptability for Use Memo	Memo stating bearings are rated for manned use with supporting data and justifications	3 EA		N/A

SCHEDULE

Start Date: December 3, 2007 **Finish Date: May 23, 2008**

ITERIM MILESTONES	DUE DATES (weeks after ATP)
Kick-off Meeting	**1**
Informal Design Review (if required)	**5**
Test Plan and Procedure Delivery	**8**
First Article Review	**15**
Test Review at Contractor Facility	**20**
Final Report Delivery	**24**
Final Presentation	**25**

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
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8	Written Approval	Project Schedule	At Kick-off	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document		Once with Revisions	N	
10	Written Approval	GFE End Item Specification		Once with Revisions	N	
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22	Mandatory Submittal	Software Code		As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports		JPG 2810.1	N	
24	Written Approval	Certification Plan		Once with Revisions	N	
25	Mandatory Submittal	Certification Report		Once with Revisions	N	
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34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report		As Required	N	
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50		**Reserved**	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	**Attachment J-7**	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	**Attachment J-10**	
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(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

OPTION 3

OPTION 3 TITLE: Fabrication and Testing of Lightweight/Low-profile Waist Bearing

Purpose of the Current Effort

After receiving approval to proceed to Option 3 of the task, the contractor will use the designs from the base contract to manufacture a waist bearing. The contractor will be responsible for testing all bearings to ensure that requirements have been met. The contractor will deliver a final report to detail all findings.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the trade study and designs detailed below. The team is to be limited in the number of people to those who are required to form an effective team. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

Schedule Project

Develop a schedule detailing the contractor's plan for the manufacturing process and anticipated milestone dates within the given project period.

Develop Task Assignments

Identify all the activities that must be performed for each milestone. Task assignments must be made for the core team. For each activity: Estimate work effort necessary for each activity; Identify all the people who will be affected by each activity; Determine how they should be involved in the work; Estimate work duration for each activity in calendar time.

Fabricate and Test Lightweight/Low-profile Waist Bearing

The focal points of the lightweight / low-profile bearings design and fabrication shall include the results of the various trade studies, the design decisions made by NASA at the end of the base contract, and the lightweight / low-profile bearings requirements supplied with this DO. NASA will provide specific interface requirements at ATP for Option 3. If the Government requires changes to be made to the design proposed in the base contract, these changes will be addressed at the kick-off meeting for Option 3. An informal design review to approve the changes to the original design will be held four weeks after the kick-off meeting, if necessary.

Following the fabrication of the waist bearing, the contractor will conduct all necessary tests to ensure that all requirements have been met per the attached requirements document, "Functional Requirements for Lightweight / Low-profile Bearing Assembly." The test plan and test results will be included in the Verification Data Package (VDP).

Should the Government elect to enact multiple options concurrently, the Contractor shall propose a schedule for the completion of each deliverable in the options. The proposed schedule- and any potential modifications- will be discussed and agreed upon by NASA and the Contractor at the Options kick-off meeting.

Progress Reports

The contractor will be required to provide NASA weekly email progress status briefs (specific content to be defined by NASA POC) detailing the current status of their work, what has been accomplished, what work is planned for the next month, what issues/problems/risks (if any) have arisen, and their plan to mitigate any issues/problems/risks. Additionally, the contractor will participate in weekly telecons to address issues as they arise.

Generate Final Report

The contractor is to generate and publish a report detailing their lightweight / low-profile bearing design, all component fabrication procedures, all component and assembly work instructions, assembly/maintenance instructions, operations instructions, test plan, test results, the limitations or unique performance characteristics of the lightweight / low-profile bearing, and their findings/conclusions.

Conduct Final Report Presentation

The contractor is to conduct a formal presentation to NASA detailing their lightweight/low-profile bearing design, assembly/maintenance instructions, operations instructions, test results, what if any are the limitations or unique performance characteristics of their lightweight / low-profile bearing, and their findings/conclusions. The contractor will handover hardware and all other products of the DO at this time.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				

	Waist Bearing	1		IIIW (i.e. controlled Class III)
	Set of wrist bearing test plugs	1		
	Extra units of all limited life components used in bearings (e.g. seals, gaskets, screws, etc.)	2 ea.		IIIW (i.e. controlled Class III)
Test				
Verification Data Package	The Verification Data Package shall consist of the following: 1) Component List 2)Verification Compliance Table (details how the design meets each requirement) 3) Verification Test Plan 4) Verification Test Data Sheets (i.e. the results of the verification testing) 5) Functional Equipment Historical Record (JSC Form 772) 6) Limited Life List 7) Shipping Document (DD250) 8) All associated TPSs 9) All associated MRBs and DRs 10) Serialized Component and replacement record 11) Repair Limitations 12) Any special instructions for storage, handling, and maintenance 13) MSDS Sheets	3 EA paper and CD (PDF and Word format)		
Software	N/A			
Other				
Lightweight/Low-profile Bearing Design and Fabrication Report	A well documented report detailing the bearing design, summarization and interpretation of VDP results, all component fabrication processes, assembly/maintenance instructions, operations instructions, test plan and procedures, test results, what if any are the limitations or unique performance characteristics their Lightweight / Low-profile Bearing Design, and their conclusions	3 EA paper and CD		N/A

Materials Usage List	A list which details all the materials the Contractor used in the fabrication of lightweight/low-profile bearings	3 EA		N/A
Electronic models	All electronic models (Pro/E) of bearing hardware	3 EA CDs		N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and tooling used in the fabrication of bearing hardware	3 EA		N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the bearing hardware	3 EA		N/A

SCHEDULE

Start Date: May 26, 2008 **Finish Date: November 14, 2008**

ITERIM MILESTONES	DUE DATES (weeks after ATP)
Kick-off Meeting	**1**
Informal Design Review (if required)	**5**
Test Plan and Procedure Delivery	**8**
First Article Review	**15**
Test Review at Contractor Facility	**20**
Final Report Delivery	**24**
Final Presentation	**25**

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

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Functional Requirements for Light-weight/Low-profile Bearing Assembly

Attachment of CRAVE EC5, DO #20R1

February 2007

DEFINITIONS:

The term "bearing" in this document refers to the design of a set of bearing/disconnect which includes the following hardware:

1. scye (shoulder) bearings
2. upper arm bearings
3. wrist disconnects
4. wrist bearings
5. waist bearing

The following definitions differentiate between requirements and other statements:

Shall: These are mandatory requirements that must be met to satisfy the DO.

Should/Goal: These requirements must be addressed by either incorporating features into the design or by providing a detailed explanation in the final report as to why the considerations were not included in the final design.

Results of 001-7520 95% load input to suit

REQUIREMENTS:

This section defines the minimum functional requirements that the bearing must meet.

1.0 Operation and Structure

1.1 The bearing design and construction should minimize the use of special tools for normal maintenance and checkout.

1.2 The bearing should not exceed a maximum of 10% increase in torque from the appropriate maximum torque value listed in section 6.0 when 0.042mL of stimulant JSC-1 is introduced directly into the bearing race each minute while the bearing continuously rotates between 0° and 160° over the span of 8 hrs.

Note: Dust testing shall be conducted by the contractor based on a selected bearing configuration. The properties of JSC-1 are listed in Table 1.2-1.

Table 1.2-1: Characteristics of JSC-1 (NASA)

Parameter	Property
Mean Particle Size	105 µm
Median Particle Size	117 µm
Specific Gravity	2.9 g/cm3
Angle of Internal Friction	45°
Cohesion	1.0 kPa

1.3 The bearing design shall provide and incorporate the NASA designed dust seals described below:

The dust seal is made from 13 oz/yd^2 Nomex felt with minimum cross-sectional dimensions of 0.09 in (h) x 0.07 in (w), as shown in Figure 1.3-1. The diameter of the seal is dependent upon bearing geometry. Figure 1.3-2 shows the placement of a dust seal in a wrist bearing.

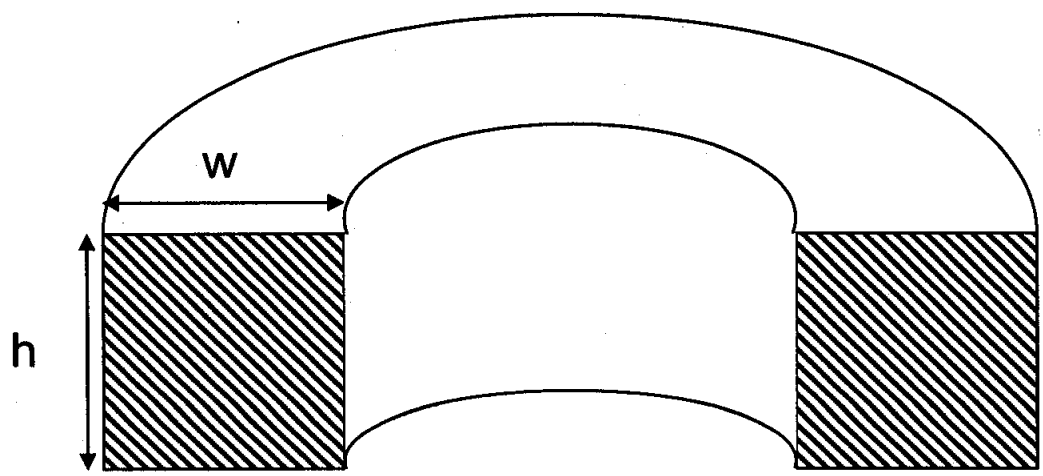

Figure 1.3-1: Cross-section of Nomex Felt Dust Seal

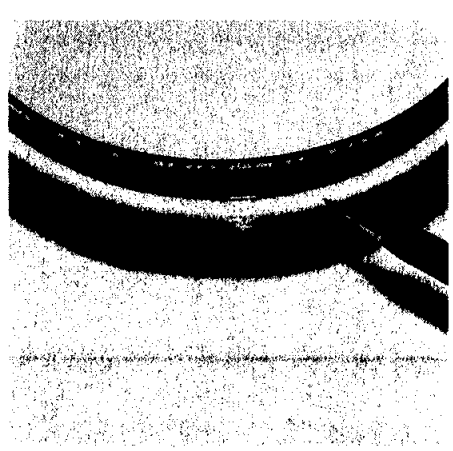

Figure 1.3-2: Dust Seal in Wrist Bearing

1.4 The bearing should minimize the number of pinch points.

Rationale: A lack of comfort can lead to degradation in crew performance.

1.5 The bearing shall comply with all applicable design criteria and standards contained in JPR 8080.5A, "JSC Design and Procedural Standard" as listed in the Technical Library.

1.6 The wrist bearing shall mate with the wrist disconnect.

1.7 The wrist disconnect and wrist bearing shall maintain all structural integrity and functionality as stated in this document when mated.

2.0 Sizing

2.1 The bearing shall have maximum dimensions less than the values listed in Table 2.1-1.

Table 2.1-1: Maximum Bearing Profile Dimensions

Bearing	Height (inches)	Width (inches)
Waist Bearing	1.85	1.95
Scye Bearing	0.580	1.1
Upper Arm Bearing	0.553	1.1
Wrist Disconnect	0.535	0.665
Wrist Bearing	1.25	1.30

Note: for Height (H) and Width (W), please refer to Figure 2.1-1 and Figure 2.1-2.

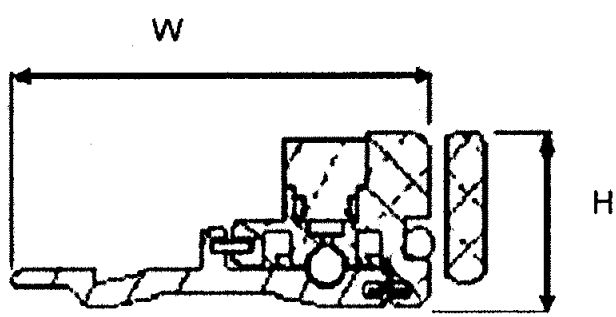

Figure 2.1-1: Disconnect Cross Section Example

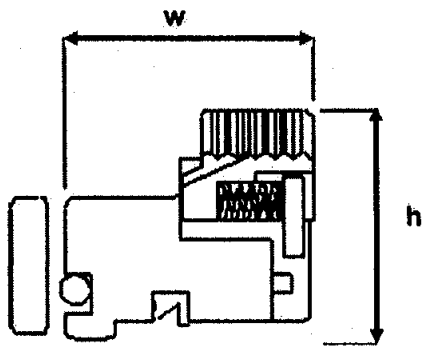

Figure 2.1-2: Bearing Cross Section Example

2.2 The bearing thickness shall not exceed the maximum values listed in Table 2.1-1.

2.3 The bearing design should be scaleable to function in multiple locations (e.g. scye, upper arm, wrists, etc).

Note: It is desired that the bearing design concept and mechanisms be interchangeable between bearings in different locations on the suit.

2.4 The bearing design should be scaleable to accommodate the 1% American female to the 99% American male.

3.0 Weight

Note: Bearing "weight" refers to the weight of the complete bearing or disconnect assembly with the flange clamping rings and attachment screws.

3.1 The wrist bearing shall weigh less than 9.8 oz (278 g); the goal weight is 9.0 oz (255 g).

3.2 The wrist disconnect shall weigh less than 9.8 oz (278 g); the goal weight is 9.0 oz (255 g).

3.3 The arm bearing shall weigh less than 12.0 oz (340g); the goal weight is 8.0 oz (227 g).

3.4 The scye bearing shall weigh less than 18.2 oz (51.6 g); the goal weight is 16.0 oz (454 g).

3.5 The waist bearing shall weigh less than 4.5 lbs (2.04 kg); the goal weight is 4.0 lbs (1.81 kg).

4.0 Environments

4.1 The bearing should meet the performance requirements stated herein when exposed to temperature ranges of -50 °F to +150 °F.

Rationale: While the bearings will be protected by a thermal insulating layer and will therefore not see the true extremes of the space and planetary environments, the bearings will still experience temperatures beyond the bounds of ambient.

4.2 The bearing shall be compatible with a 100% oxygen environment.

Rationale: The bearing hardware and lubricants (if any) must not act as an ignition source when operating in a 100% oxygen environment.

4.3 The bearing shall have a leakage rate less than 1.0 SCCM of air when operating in an atmospheric environment and pressurized to 4.3 ± 0.1 psid (30 ± 1 kPa-d).

Rationale: The volume of bubbles produced by component leakages cause safety concerns in the Neutral Buoyancy Laboratory (NBL). Thus, to facilitate NBL usage when integrated into the pressure garment, this standard will be applied to the bearing.

4.4 The bearings should function nominally after application of a 9g shock, 15 millisecond sawtooth pulse.

4.5 The bearing should function nominally after exposure to the following vibration environment with input applied to the vehicle/suit interface: Input- 20 to 150 Hz (Increase plus 6 db/oct); 150 to 1000 Hz (Constant 0.03g2/Hz); 1000 to 2000 Hz (Decrease minus 6 db/oct); Duration- 48 minutes/axis (100 launches)

4.6 The mated wrist disconnect and wrist bearing shall have a leakage rate less than 1.0 SCCM of air when operating in an atmospheric environment and pressurized to 4.3 ± 0.1 psid (30 ± 1 kPa-d).

4.7 The bearing shall function in the NBL test water environment as defined in Table 4.6-1.

Table 4.6-1: Characterization of NBL Environment

Parameter	Range
Temperature	82-88°F
pH	7.4-7.8
Conductivity	Average range 150-180 US/CM

C12 Residual	1.0 - 5.0 ppm
Alkalinity	80 - 120 ppm
Calcium Hardness	175 - 300 ppm
C12 Combined	0.0 - 0.2 ppm

Rationale: The pressure garment with which the bearing will integrate will undergo extensive testing in the NBL to determine its functionality and capabilities in zero-g applications.

Note: The contractor is to identify specific accommodations (if any) made to make the bearing compatible with NBL environment.

5.0 Pressure Loading

5.1 Normal Operating Pressure shall be 4.3 ±0.1 psid (30 ± 1 kPa-d).

5.2 Maximum Operating Pressure shall be 8.0 psid (55 kPa-d).

5.3 Structural Pressure shall be 6.6 psid (46 kPa-d).

Rationale: The structural pressure is 1.5 times the normal operating pressure of 4.3 psid (30 kPa-d). It is a functional check requirement after maintenance or off nominal operation of the bearing. This functional check should incur no structural damage to hardware.

5.4 Ultimate Pressure shall be 12.0 psid (83 kPa-d).

Rationale: The Ultimate Pressure is 1.5 times the Maximum Operating Pressure of 8.0 psid (55 kPa-d). This is a functional check requirement to ensure that there are no defects or flaws in the bearings post manufacturing. This functional check should incur no structural damage to hardware.

6.0 Torque Loading and Engagement Forces

6.1 The arm bearing shall have a starting torque no greater than 3.5 lb-in (0.40 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.2 The scye bearing shall have a starting torque no greater than 5.0 lb-in (0.56 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.3 The wrist bearing shall have a starting torque no greater than 1.5 lb-in (0.17 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.4 The waist bearing shall have a starting torque no greater than 20 lb-in (2.3 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.5 The arm bearing shall have a running torque no greater than 11.5 lb-in (1.30 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.6 The scye bearing shall have a running torque no greater than 18.0 lb-in (2.03 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.7 The wrist bearing shall have a running torque no greater than 6.0 lb-in (0.68 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.8 The waist bearing shall have a running torque no greater than 80 lb-in (9.0 N-m) when pressurized to 4.3 ± 0.1 psid and secured in contractor designed test plates.

6.9 The wrist disconnect engagement force shall be less than 15 lbs (67 N).

7.0 Limit Loads and Factors of Safety

7.1 The bearing shall withstand applicable limit loads as shown in Table 7.1-1.

Note: Assume loads acting at sets of two symmetric points on bearing-one along the axial restraint line and one orthogonal to the axial restraint.

Table 7.1-1: Limit Loads and FOS

Axial Restraint Line	Limit Load, lb-force, (N)	Yield FOS	Ultimate FOS
Upper Arm Assy	209	1.5	2.0
Lower Arm Assy	204	1.5	2.0
Scye Opening	605	1.5	2.0
Waist	1900	1.5	2.0

7.2 The bearing shall have factors of safety in accordance with Table 7.1-1.

Note: The contractor can reference NASA-STD-5001, "Structural Design and Test Factors of Safety for Spaceflight Hardware" for more detailed definitions.

8.0 Bearing Life Cycles

For the arm bearing, scye bearing, wrist bearing, and waist bearing, a cycle is defined as rotation of the bearing 180° and return to start point. For the wrist disconnect, a cycle is defined as a disconnect engagement / disengagement.

8.1 The arm, scye and waist bearings shall operate nominally after 30 cycles at 8.0 psid (55 kPa) in an ambient environment.

8.2 The arm, scye and waist bearings shall operate nominally after 75 cycles at 5.3 psid (37 kPa) in an ambient environment.

8.3 The arm, scye and waist bearings shall operate nominally after 200 cycles at 4.3 psid (30 kPa) in an ambient environment.

8.4 The wrist bearing shall operate nominally after 20,000 cycles at 4.3 psid (30 kPa) in an ambient environment.

8.5 The wrist bearing shall operate nominally after 2,000 cycles at 5.3 psid (37 kPa) in an ambient environment.

8.6 The wrist bearing shall operate nominally after 1,000 cycles at 8.0 psid (55 kPa) in an ambient environment.

8.7 The arm, scye and waist bearings should operate nominally after 30 cycles at 4.3 psid (30 kPa) in a simulated lunar dust environment.

8.8 The wrist bearing should operate nominally after 500 cycles at 4.3 psid (30 kPa) in a simulated lunar dust environment.

8.9 The bearing shall have a shelf life of 10 years.

Note: This does not pertain to bearing seals.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC5-DO20

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC5-DO20

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/23/06 to 01/22/07 (base)

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC5-D020

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: Ronda Kaurk Date: 10-25-06

10. Name: Robert Kolb

Signature: Robert Kolb Date: 10-24-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIGHTWEIGHT / LOW-PROFILE BEARING ASSEMBLIES					
1	The contractor shall perform and deliver to all base requirements of CRAVE-EC5-DO20 as described in the attached Statement of Work.	Lot			bl	
	Period of Performance: 10/23/06 to 01/22/07					
2	OPTIONS:					
	The Government may require the contractor to continue to perform services under this delivery order. The Contracting Officer may exercise Option 1, Option 2, and Option 3 concurrently or independently by issuance of an unilateral delivery order revision. Should the options					

12. For JSC Internal Use Only:

Requisition No.: _____ ☐ COMP. ☐ PART. PPC: _____

Rissue To: EC/Joe Gensler, x30025 For: EC/Lindsay Aitchison, x38657

13. Total

$ NTE 567,057 w/ Options

14. Quantities in "Quantity Accepted" Column Have Been

☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED

TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	be exercised, the resultant delivery order revision will be priced out as follows.					
	OPTION 1	LOT				
	OPTION 2	LOT			b4	
	OPTION 3	LOT				
	THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.					

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R9

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R9

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 9/19/06 thru 10/3/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R9

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 12/4/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 9 to DO19 is issued to extend completion date to 10/3/08. All other terms and conditions remain unchanged. RECAP DO VALUE: Cum Value Cost Fee bf TOTAL $1,621,095					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Ralph Marak, x39144

13. Total
$ 1,621,095 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R8

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R8

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 9/19/06 thru 9/23/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R8

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/20/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	**Criticality One Certification of Shuttle EVA Tile Repair Hand Tools** Revision 8 to DO19 is issued to award an additional 85 wipes to the DO. The DO value is increased by $96,799 from $1,524,296 to $1,621,095. The completion date is extended to 9/23/08. RECAP DO VALUE: Prior / This Action / Cum Value Cost: 64 / 64 / 64 Fee TOTAL $1,524,296 / $96,799 / $1,621,095	64	LOT		64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 1,621,095 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R7

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R7

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 9/19/06 thru 8/15/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R7

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/4/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 1 to DO19 is issued to add Option 5A Build to Print (see attached page); increase the DO value by $96,799 from $1,427,497 to $1,524,296; and extend the completion date to 8/15/08. RECAP DO VALUE: Prior / This Action / Cum Value Cost — / — / — Fee — / — / — TOTAL $1,427,497 / $96,799 / $1,524,296	LOT			—	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 1,524,296 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

Option 5A Deliverables/Products:

Product	Description	Qty	Due	Class
Flight HW	SED33116397-703		7/23/08	Class I PDA Only
Flight HW	SED33116397-703		8/6/08	Class I (PIA)

NASA has QTY 44, Class I, MARTEX towels, 30 inches x 54 inches, P/N 700262. These towels are available for use no earlier than June 6, 2008, if required. Contractor may choose to order their own towels for this project. NASA assumes at least two wipes may be made from one towel.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R6

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R6

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 9/19/06 thru 7/31/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R6

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 12/11/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 6 to CRAVE EC-DO19 is issued to . . . 1) add Option 4A Build to Print 2) increase DO value by b4 :c $1,427,497 3) extend completion date from 3/31/08 to 7/31/08. Replacement pages to DO 19 SOW for Option 4A are attached. All other terms and conditions of the delivery order remain unchanged. Cost: b4 Fee: b4 Cum DO Value: $1,427,497	Lot			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total
$ 1,427,497 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

PROPOSAL INSTRUCTIONS: __ DRAFT -- COMMENTS DUE BY:
X FINAL -- PROPOSAL DUE BY: 10/12/2007

CRAVE DO 19 TITLE: Certify shuttle orbiter TPS repair hardware to Criticality I requirements.
DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler, EC7	Phone: (281) 483-0025
DO Manager: N/A	Phone: N/A
DO Mgr. Alternate: N/A	Phone: N/A

Concurrences:

Joe Gensler
DO Manager / COTR

Harold Reimers
DO Mgr. Management

Contracts Officer
Ronald Johnson

Ralph Marak
Division TMR

Steve Miller
S & MA

Task Contains Flight Hardware, Flight Software or GSE? X Yes ___No

Program Supported: X Shuttle __ISS X EVA ___Advanced ____

WBS: X 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

*For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for **all** Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

CREW, ROBOTICS AN[illegible]HICLE EQUIPMENT (CRAVE) CONTRAC[illegible]
DELIVERY ORDER #: CRAVE-EC7-019 Rev. 6

NOTE: REVISION D. Page 1 updated for rev D. Build to print option 4A added at the end of this DO, pages 20 through 29, please provide ROM Cost and Schedule for the additional build to print option only.

PROPOSAL INSTRUCTIONS: __ DRAFT -- COMMENTS DUE BY: N/A
X FINAL -- PROPOSAL DUE BY: 11/7/2007 COB

DO TITLE: Certify shuttle orbiter TPS repair hardware to Criticality I requirements.
DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler, EC7	Phone: (281) 483-0025
DO Manager: N/A	Phone:
DO Mgr. Alternate: N/A	Phone: N/A

Concurrences:

Ron Johnson CO	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Ralph Marak Division TMR	Steve Miller S & MA	

Task Contains Flight Hardware, Flight Software or GSE? X Yes ___No

Program Supported: X Shuttle __ISS X EVA ___Advanced _____

WBS: X 1.0 EVA __2.0 FCE __3.0 EVR __ECLSS __5.0 ATCS __6.0 CHeCS

For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for all Delivery Orders on the contract combined.

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Build to Print Contract Options 1A, 2A, 3A, 4A

The following task options shall be priced separately:

Build to Print 1A, 2A, 3A, 4A

Provide pricing to complete this delivery order per the requested schedule milestones. Build to print the quantities of flight hardware listed below. Perform PDA/PIA testing per the CARD and applicable Waivers, deliver ADPs where applicable.
-Shall include pricing for one CARD change CR.
-Shall include pricing for up to 3 drawing change notice, in the event issues are identified during manufacturing or assembly or acceptance.
-Shall include pricing for revisions to existing assembly procedures.
-GFE items, such as bayont probes and equipment hooks, shall be transferred from the One EVA contract to CRAVE via NASA XA tools panel CR.
-Shall not include pricing for changes to existing safety documentation (RAESR).
-Depending on the circumstances with Shuttle Mission needs, the COTR may request that flight hardware be shipped directly to bench review for flight via form 1027. In this case a DD250 will have to follow. Contractor shall assume one form 1027 will have to be prepared. Otherwise, standard DD250 to NASA JSC EC7 is recommended.

Notes:

1. **Contractor shall provide weekly status of Non-Conformance Records (NCR) and issues in the form of an E-mail to the DO Manager (DM).**
2. **Material Review Board (MRB) personnel for the disposition of NCR's shall be provided by the contractor; NASA DO Manager required signature for MRB.**
3. **ADP shall comply with SSP 30695.**
4. **NCR's open at the time of ADP delivery will be transferred into the NASA Quality System by NASA or NASA-designated QA personnel.**
5. **Shall comply with JSC 28035 for PRACA reportable issues.**
6. **Copies of internal vendor procedures referenced in work authorizing documents or NCRs shall be delivered to the government on CD.**
7. **Electronic copies of all work authorizing documents (TPS, Procedures, or equivalent; NCRs or equivalent) shall be delivered to the government on CD (.PDF format is acceptable).**

Option 1A Deliverables/Products:

Product	Description	Qty	Due	Class
Flight HW	1" Gel Brush Assy SED33116394-701	20	3/28/08	I
	3" Gel Brush Assy SED33116394-703	49	3/28/08	I
	Pencil Tip Gel Assy SED33116394-705	21	3/28/08	I
	Netted Foam Brush Assy SED33119588-701	58	3/28/08	I
		-------	x	x
		-------	x	x
	Netted Foam Brush Assy SED33119588-701 (Early Delivery)	10	12/19/07	I
		-------	x	x
		-------	x	x
	Brush Caddy SED33116360-303	2	3/28/08	I
	SED33116902-701 Gel Brush Kit Label	2	3/28/08	I
	SED33116902-703 Gel/Net Brush Label	1	3/28/08	I
	SED33116902-705 Gel Brushes Label	3	3/28/08	I
	SED33116902-707 Gel/Net Kit Label	2	3/28/08	I
Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N or L/N	Due at hardware delivery or 1 week prior to flight shipment	

Option 2A Deliverables/Products:

Product	Description	Qty	Due	Class
Flight HW	1" Gel Brush Assy SED33116394-701 3" Gel Brush Assy SED33116394-703 Pencil Tip Gel Assy SED33116394-705 Netted Foam Brush Assy SED33119588-701 Netted Foam Brush Assy SED33119588-701 (Early Delivery)	20 49 21 58 ------- ------- 10	3/28/08 3/28/08 3/28/08 3/28/08 x x 12/19/07	I I I I x x I
Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N or L/N	Due at hardware delivery or 1 week prior to flight shipment	

Option 3A Deliverables/Products:

Product	Description	Qty	Due	Class
Flight HW	1" Gel Brush Assy SED33116394-701 3" Gel Brush Assy SED33116394-703 Pencil Tip Gel Assy SED33116394-705 Netted Foam Brush Assy SED33119588-701 Netted Foam Brush Assy SED33119588-701 (Early Delivery)	17 51 11 22 ------ ------ 10	3/28/08 3/28/08 3/28/08 3/28/08 x x 12/19/07	I I I I x x I
Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N or L/N	Due at hardware delivery or 1 week prior to flight shipment	

Option 4A Deliverables/Products:

Product	Description	Qty	Due	Class
Flight HW	Netted Foam Brush Assy SED33119588-701	7	3/28/08	I
Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N or L/N	Due at hardware delivery or 1 week prior to flight shipment	

SCHEDULE

Start Date: November 12, 2006 **Finish Date: March 28, 2008**

IMPORTANT MILESTONES	DUE DATES
STS-123/1JA JSC L-10 BR O/D	1/21/08
STS-124/1J JSC L-30 BR O/D	3/28/08

Total Government Estimate for this DO:
Option 1A: $ 600,000
Option 2A: $ 400,000
Option 3A: $ 300,000
Option 4A: $ 50,000

TOTAL COST ESTIMATE FOR THIS DO: $

FEE: $ (If Applicable)

OPTION 1A: $

OPTION 2A: $

OPTION 3A: $

OPTION 4A: $

DATA REQUIREMENTS

All DRDs contained in the contract are applicable and required unless marked N/A below.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Fourteen (14) days following contract start	Weekly	Y	Status Report to report schedule weekly and cost (materials, hours) biweekly
3	Written Approval	Project Technical Requirements Specification			N	
4	Mandatory Submittal	GFE Systems Requirements Data Package			N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document			N	
6	Mandatory Submittal	Preliminary Design Review Data Package			N	CDR documents provided in tech library
7	Written Approval	Flight GFE Workmanship Specifications List			N	
8	Written Approval	Project Schedule	Fourteen (14) days following contract start	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document			N	
10	Written Approval	GFE End Item Specification			N	Governed by CARD
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As needed	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan			N	
13	Written Approval	GFE Software Requirements Specification			N	
14	Written Approval	GFE Software Development Plan			N	
15	Written Approval	GFE Software Design Document			N	

DID #	DATA ITEM	DID TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
16	Written Approval	Engineering Drawings	At PDR, as specified in DO	As Required	Y	
17	Written Approval	EEE Parts Lists and Analysis Report			N	
18	Mandatory Submittal	Critical Design Review Data Package			N	CDR info provided in tech library
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide			N	
22	Mandatory Submittal	Software Code			N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	Attachment J-4 Due 30 days after DO award	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	As needed	As Required	N	
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One ADP per flight unit upon completion of acceptance testing or hardware update(s).	Y	Must comply with SSP 30695
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	Specified in DO	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report & Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N (If Applicable)	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Attachment J-9	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	
41	Upon Request	Nonconformance Record		As Required	Y	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan			N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document		Revise As Required	Y	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	

[illegible]	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR B-CRAVE?	ADDITIONAL INFORMATION
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		Reserved	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment L-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment L-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 - Written Approval Type 2 - Mandatory Submittal Type 3 - Recurring Data Product

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or facilities unless requested by the contractor in their response to a request for bid.

Flight hardware test facilities, such as loads, thermal, and vibration are available for the execution of this delivery order upon submission of JSC Form 90's to the DO Manager. NASA expects to use its own funds for facilities and facility support staff. Test plan, test readiness review, and flight hardware documentation shall be provided by the delivery order contractor.

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R5

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R5

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 9/19/06 thru 3/31/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R5

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 7/12/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 5 to CRAVE-EC-DO19 is issued to add flights STS-122, STS-123, and STS-124 to Option 3 Development Phase Shuttle Flight support. The delivery order value is increased by: b4 The period of performance remains unchanged. See next page for recap of delivery order value.	b4	b4	b4	b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total
$ NTE 1,377,780

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

Order No.: DO19R5

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	RECAP OF DELIVERY ORDER VALUE:					
	PRIOR VALUE (thru DO19R4) / THIS ACTION (DO19R5) / CUM VALUE					
	Cost					
	Fee					
	TOTAL $1,167,216 $210,564 $1,377,780					
	THIS IS A CPFF DELIVERY ORDER.					

b4

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R4

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R4

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 9/19/06 thru 3/31/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R4

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 5/17/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 4 to CRAVE-EC-DO19 is issued to delete and replace DO19R3 in its entirety. Revision 4 revises the Statement of Work. Option 1 has been repriced and the completion date extended to 7/31/07; Option 3 has been added to the DO. Option 2 remains unchanged. Option 1: Price is changed from 64 Option 3: Development Phase Shuttle Flight Support. Option 3 includes 2 flights: STS-118 and STS-120. Period of Performance = 4/4/07 thru 3/31/08 Pricing for Option 3 is valid for work completed by 3/31/08. (continued next page)	Lot	ea	64	64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total
$ 1,167,216

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

Order No.: DO19R4

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	b4					
	CUM REVISED VALUE: $1,167,216					

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC7-019

NOTE: REVISION B. CHANGES MADE THIS REVISION SHOWN IN COLORED TEXT OR DELETION BLOCK. LOCATION OF CHANGES MARKED WITH CHANGE BARS IN LEFT MARGIN

PROPOSAL INSTRUCTIONS: __ DRAFT -- COMMENTS DUE BY: 8/31/2006
X FINAL -- PROPOSAL DUE BY: 9/12/2006

DO TITLE: Certify shuttle orbiter TPS repair hardware to Criticality I requirements.
DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler, EC7	Phone: (281) 483-0025
DO Manager: Mark Dub, EC7	Phone: (281) 483-4471
DO Mgr. Alternate: N/A	Phone: N/A

Concurrences:

Mark Dub DO Manager	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Joe Gensler Division TMR	Steve Miller S & MA	

Task Contains Flight Hardware, Flight Software or GSE? X Yes ___No

Program Supported: X Shuttle __ISS X EVA ___Advanced _____

WBS: X 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

*For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for **all** Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

As a part of the Space Shuttle Program (SSP) Return-to-Flight Effort, a set of EVA Tile Repair tools were developed. The purpose of these tools is to allow crewmembers to effect EVA repair of damaged orbiter thermal protection system surfaces. Included among these repair tools are Emittance Wash Applicator (EWA) Kits and Gel Brush Kits. Both are used, if required, to repair damaged tile surfaces.

The launch schedule of STS-114 coincided with the development schedule of these repair tools, and did not allow for the completion of a traditional certification, which verifies functionality of the hardware for use in its intended (EVA) environment. The shuttle program recognized this, and temporarily reduced the functional criticality of the hardware to a level of 3/3, limiting the scope of the hardware certification to launch, landing, and EVA use safety. The effectivity of this limited certification is for missions STS-114, 121, and 115, and will be extended to include 116 (December 2006)

Based upon this decision, the EWA Kits and Gel Brush Kits were certified as Criticality 3 hardware, and flown aboard STS-114 and 121. Use of the EWA Kit to coat a damaged tile sample was successfully demonstrated during an in-flight DTO experiment on STS-114.

In an effort to develop a maximally robust repair capability, the shuttle program desires to upgrade the existing Criticality 3 certifications of the EWA Kits and Gel Brush Kits to a traditional certification, which verifies functionality in the intended (EVA) environment, and would meet the safety and reliability certification standards required of Criticality 1 hardware.

The scope of this task is to upgrade the present Criticality 3 certifications of existing flight hardware to satisfy Criticality 1 requirements, with the exception of the EVA Wipe as Criticality III, by completing environmental qualification and acceptance testing on qualification and flight hardware articles, and Acceptance Data Packages (ADPs) as applicable, updating the products associated with the Verification Compliance Data Package (including the GCAR, RAESR, CARD-VCM), closing open Discrepancy Reports (DRs/NCRs) on flight articles, and closing constraints to certification including FIARs and RIDs.

The Emittance Wash Applicator Kit (SJD33116880) contains the following hardware:
-Emittance Wash Applicator (SED33116809-302)
-Emittance Wash Applicator Caddy (SED33116933-301)
-Removable Brush Handle Assembly (SED33116385-301)
-Netted Foam Brush Assembly (SED33119588-701)
-EVA Wipes (SEG33116397-703)

The Gel Brush Kit (SJD33117200-30x) contains the following hardware:

-Gel Brush Caddy (SED33116360-30x)
-Removable Brush Handle Assembly (SED33116385-301)
-Sylgard Gel Brushes (SED33116394-70x)

Task Description:

1. Emittance Wash Applicator (EWA) and EWA Caddy

Certify Emittance Wash Applicator (EWA) SED33116809-302, and EWA Caddy SED33116933-301 to meet Criticality I requirements. This task shall encompass deletion of the Rotating Mount Assembly, P/N SED33117870-302, from the EWA Caddy.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD:
-combined load/internal pressure/mechanism testing or analysis of -302 configuration
-qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of the following flight hardware in accordance with CARD:
-7 Emittance Wash Applicator Assemblies SED33116809-302
-7 Emittance Wash Applicator Caddy Assemblies SED33116933-301
- Identify cause of high actuation torque on EWA S/N 1001 Main Valve and repair valve to return actuation torque to limits specified in JSC-62007B, Paragraph 3.1.1.7.1.2
-Rework of seven EWA Caddy Assemblies to include:
-Separable/reconfigurable kit-level labels
-Pocket stiffener design updates to include stiff protector for netted brush head and updated brush handle slider guard to prevent stiffener cracking
-Softgoods tether points sufficient to withstand qualification testing to a minimum 4.0 FOS above tether load requirements specified in CARD.
-Developmental Hardware Phase Shuttle Flight Support
-Fill EWA, PIA, and kit two EWA Kits (SJD33116880) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
-Dekit and inspect hardware for damage upon return from flights STS-115, STS-116, and STS-117.
-Completion of MSVR
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix

-Closure of FIARs JSCEC1203, 1207, 1300, and 1305 including required engineering evaluations, analyses, or tests for final resolution.
-Closure of deferred Review Item Dispositions
- Engineering/technician/quality support for EWA engineering evaluations including sample preparation for arcjet testing.
- Resolution of Rotating Mount FIAR 1323 and DR E10630083 for mechanism cycling failure, including engineering evaluations for failure investigation.

- Delete Rotating Mount from EWA Caddy
  - Interim manufacturing documents and/or dispositions to allow work to proceed pending drawing and CARD updates
  - EWA Caddy drawing update to remove Rotating Mount
  - EWA Kit drawing update to remove/update views of Rotating Mount (as required)
  - Update to CARD JSC-62007 to remove Rotating Mount associated requirements and update envelope and relevant figures
  - EWA Caddy RAESR update to remove references to Rotating Mount
  -Remove rotating mount from EWA caddy and configure caddy as required by updated drawing.
  - Downgrade and/or disposition of existing hardware and return to NASA

2. *Removable Brush Handle Assembly*

Certify Removable Brush Handle Assembly SED33116385-301 to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD.
  -qualification for acceptance vibration testing
  -qualification thermal testing
  -qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 18 flight units in accordance with CARD.
-Completion of Mechanical Systems Verification Plan (MSVP), including MSVR
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Closure of open Review Item Dispositions

3. *Netted Foam Brush Assembly SED33119588-701*

Certify the Netted Foam Brush Assembly SED33119588-701 to meet Criticality I requirements.

Criticality III VCDP and products baselined for the certification of Foam Brush Assemblies (SED33117199) shall be used as a basis for meeting certification requirements for the netted foam brush by similarity unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:

-

-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 25 GFE flight units in accordance with CARD.
-Assembly of Verification Compliance Data Package
  -GCAR
  -Update/develop RAESR
  -Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

4. *Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x*

Certify Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Coordination of a community review meeting to incorporate reviewer comments into draft requirements documents (CARDs) for the Gel Brush Caddy and the Sylgard Gel Brushes
-Coordination of reviewer signoff and XA Tools Panel Baseline of the Gel Brush Caddy and Sylgard Gel Brush CARDs
-Completion and documentation of testing required to extend shelf life of gel brush assemblies to a minimum of five years.

-Completion of testing required to assess functional performance of Sylgard gel with respect to temperature range specified in CARD.
-Rework of six flight unit caddies to include addition of 10-layer MLI insulation, separable/reconfigurable kit-level labels, and softgoods tether points sufficient to withstand qualification testing to a 4.0 FOS above tether load requirements specified in CARD.
-Update of thermal analytical products reflecting addition of MLI insulation.
-Acceptance testing of the following flight hardware in accordance with CARD:
  -6 Brush Caddy Assemblies SED33116385-30x
  -100 Gel Brush Assemblies SED33116394-30x
-Developmental Hardware Phase Shuttle Flight Support
  -PIA and Kit two Gel Brush Kits (SJD33117200) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
  -Dekit and inspect hardware for damage upon return from flights STS-121, STS-116, and STS-117
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

5. *EVA Wipe Assembly SED33116397-703*

Certify EVA Wipe Assembly SED33116397-703 to meet updated Criticality III requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy updated Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Review of Design Memorandum documenting compliance of design with design requirements
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Acceptance testing of 60 flight units in accordance with CARD
-Closure of deferred Review Item Dispositions
- Rework of up to 50 EVA Wipes to correct out of configuration discrepancy (missing labeling on tether loop)
- Flight delivery of unkitted EVA Wipes for STS-116 and STS-117

Contract Options

The following task options shall be priced separately:

1. Alternate Schedule Certification

Provide pricing and schedule to complete this delivery order on a schedule chosen by the bidder to minimize cost. In addition, this option shall include kitting and shipping of flight hardware as Criticality III hardware for flights scheduled to occur during the performance period of this delivery order (STS-116 & STS-117) duration of project. Schedule shall require Sylgard Gel Brush 5-year shelf life extension task to be complete prior to 11/30/06.

2. Post-flight Refurbishment and Maintenance of Emittance Wash Applicator

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, *Maintenance Procedure Emittance Wash Applicator Part No. SED33116809-302.*
-PDA/PIA, and fill Emittance Wash Applicators for flight in accordance with JSC-62007 following refurbishment.
-Pricing shall include completion of task for two units with an option for two additional units to be completed concurrently. Pricing need not be itemized if additional units do not increase cost of task in excess of 10%.
-Pricing shall be provided on a per-mission basis, and option shall be exercisable on a per-mission basis.

3. Developmental Phase Shuttle Flight Support

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, Maintenance Procedure for Emittance Wash Applicator Part No. SED33116809-302.
-PDA and Fill EWA, PIA and kit or refurbish two EWA Kits (SJD33116880) for each shuttle mission supported
-PIA and kit or refurbish two Brush Kits (SJD33117200) for each shuttle mission supported.
-PIA five EVA Wipes SED33116397-703 for each shuttle mission supported.
-PDA/PIA one MMWS Tool Stowage Caddy (GD2051000-301) for each shuttle mission supported.
-Deliver/ship hardware for flight via flight shipping process.
-Dekit (or refurbish) and inspect hardware for damage upon return from flight.

-Pricing shall include the option to repair minor damage and resolve open DRs and FIARs.
-Pricing shall be provided on a per-mission basis, and options shall be exercisable on a per-mission basis.
-Missions to supported shall be identified by the contracting officer and identified in the Purchase Order (PO) purchasing the Option.

Notes:

1. Drawings, CARDs, RID summary and status, and baselined Criticality III VDCPs, CDR presentations are available in CRAVE technical library.
2. Contractor shall provide weekly status of Non-Conformance Records (NCR) and issues in the form of an E-mail to the DO Manager (DM).
3. All TPS (or equivalent documents) performing qualification or acceptance testing, or disassembly, repair, and engineering evaluations of hardware once acceptance testing on that specific S/N has been completed, shall require the signature approval of the COTR or DM as authorization to proceed. The intent of this note is NOT to require approval of every document internal to the contractor authorizing work at their facility.
4. Signature approval is allowed on TPS and NCR's (or equivalent documents) via e-mail or telecon where required to minimize work stoppage; hardcopy signature is required prior to document closure (or equivalent) indication of completion of work.
5. NCR's shall be communicated to the DM in sufficient details to allow for resolution without requiring project personnel to be at contractor facility.
6. Material Review Board (MRB) personnel for the disposition of NCR's shall be provided by the contractor; NASA DO Manager required signature for MRB.
7. ADP shall comply with SN-D-0007 and shall be delivered as required by the relevant CARD. Three revisions will be prepared as follows: Rev IR to include original OSS build with OSS/DCMA approval, Rev A to include records obtained from QARC or OSS records for periods of time when the hardware was not under OSS contract with EC/NT approval only, and Rev B to reflect work done as part of this DO with OSS/DCMA approval,
8. NCR's open at the time of ADP delivery will be transferred into the NASA Quality System by NASA or NASA-designated QA personnel.
9. Copies of internal vendor procedures referenced in work authorizing documents or NCRs shall be delivered to the government. Attachment to the parent document is acceptable.
10. Electronic drafts of all work authorizing documents (TPS, Procedures, or equivalent; NCRs or equivalent) shall be delivered to the DM in an unlocked/fully-serviceable native-format file (where available) or as a searchable PDF (internal OSS forms, handwritten documents, database generated forms, etc.).
11. The certification of the hardware will reflect the requirements in the respective hardware CARDs,.
12. Pricing for this DO shall include five CARD and five drawing updates for each P/N with current released CARDs/Drawings, in addition to those specifically described in this RFP.
13. All technical correspondence shall be directed to Mark Dub (281-483-4471, mark.o.dub@nasa.gov) and Mr. Joe W. Gensler (281-483-0025, joe.w.gensler@nasa.gov).
14. All GFE flight hardware to be returned to NASA for flight or inventory at the direction of the DM. Processing criticality, "safe to fly" or "criticality I" shall also be at the direction of the DM at the time of request.
15. Shipment for flight shall be provided by the contractor, including 1027, 1149, and DD250 generation and approval, where applicable.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certification	**Emittance Wash Applicator Kit (SJD33116880)** Emittance Wash Applicator (SED33116809-302) Emittance Wash Applicator Caddy (SED33116933-301) Removable Brush Handle Assembly (SED33116385-301) Netted Foam Brush Assembly (SED33119588-701) EVA Wipes (SEG33116397-703) **Gel Brush Kit (SJD33117200)** Gel Brush Caddy (SED33116360-30x) -Removable Brush Handle Assembly (*referenced above*) -Sylgard Gel Brushes (SED33116394-70x)	1 per P/N	Per Interim Milestones: VCDP/GCAR Approval Date	I
Flight				I
Training				
Other (test fixture)	Tether End Fixture (SDG38119921-701) Tether End Fixture Cap (SDG38119922-701) Round End Fixture (SDG38119923-701) Round End Fixture Cap (SDG38119924-701)	1 1 1 1	Per testing schedule	STE/D
GSE				
Test				
Software				

Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N flight (or qual) unit	Contract completion	

SCHEDULE

Start Date: September 18, 2006 **Finish Date: May 31, 2007**

Milestones for this project shall be per the project schedule provided by the offeror with their proposal, "DO-19 Option 1 loaded.mpp". Milestones will be updated in the project schedule and resubmitted to match future contract updates.

[redacted]

TOTAL COST ESTIMATE FOR THIS DO: N/A Base

FEE: Fee N/A Base

OPTION 1: [redacted]

OPTION 2a (2 EWAs): [redacted]
[redacted] **OPTION 2b (4 EWAs):** [redacted]

[redacted]

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC7-019

DATA REQUIREMENTS

All DRDs contained in the contract are applicable and required unless marked N/A below.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
[illegible]	Written Approval	High GFE Configuration Management Plan	With Proposal	Quarterly	Attachment [illegible]	
[illegible]	Mandatory Submittal	Regular Status Report Summary Review	Fourteen (14) days following contract start	Weekly	Y	Status Report to report (attend, weekly and [illegible] (minimum hours), unweekly
[illegible]	Written Approval	Project Technical Requirements Specification			N	
[illegible]	Mandatory Submittal	[illegible] Requirements Data Package			N	
[illegible]	Written Approval	High GFE Project Requirements & Verification Document			N	
[illegible]	Mandatory Submittal	Preliminary Design Review Data Package			N	CDR documents provided in tech library
[illegible]	Written Approval	High GFE Workmanship Specification			N	
[illegible]	Written Approval	Project Schedule	Fourteen (14) days following contract start	Monthly Recurrent (due to DO proposal [illegible] as DO [illegible])	Y	
[illegible]	Written Approval	High GFE Interface Control Document			N	
[illegible]	Written Approval	GFE and Item Specification			N	Governed by CARD
[illegible]	Mandatory Submittal	High GFE Failure Analysis Report	As needed	As Required	Y	
[illegible]	Written Approval	High GFE Verification and Validation Plan			N	Covered by VCDP/cert pack: CARD verification compliance matrix, review of design memorandum, and RAESR VTL
[illegible]	Written Approval	GFE Software Requirements Specification			N	

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	REQUIRED FOR PCR Y/N	ADDITIONAL REQUIREMENTS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	CDR info provided in tech library
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Y	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Y	A copy of any internal contractor procedures referenced in qualification test procedures shall be included as an attachment(s).
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Y	Refer to EA-WI-023 and CARDs
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Y	Refer to EA-WI-023 Req's for SAR
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Y	

DRD #	DRD TITLE	CDRL TITLE	DUE	FREQUENCY	REQUIRED FOR JOV	ADDITIONAL REQUIREMENTS
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One ADP per [illegible] (Acceptance Testing, Subsequent Updates)	Y	Must comply with SSP 30695
28	Mandatory Submittal	Temperature and RH Scale	[illegible] DO year on Sept 30 [illegible]	Yearly	Y	
29	Mandatory Submittal	[illegible] Plan	As Required	Once with Revisions	Attachment [illegible]	
30	Mandatory Submittal	Performance Report	As Required	As Required	N	
[illegible]	Mandatory Approval	Software Quality and Safety Data Package	Specified in DO	As Required	Y	
[illegible]	Mandatory Submittal	[illegible]	Specified in DO	As Required	N	
[illegible]	Mandatory Approval	Software Systems Engineering Plan [illegible]	Specified in DO	As Required	N	
[illegible]	Mandatory Approval	Software Requirements Specification Report	Specified in DO	As Required	Y	
[illegible]	Mandatory Approval	Software Integration Test Report	[illegible] Delivery	[illegible]	N (Attachment [illegible])	
[illegible]	Mandatory Approval	Installation Plan	Specified in DO	As Required	N	
[illegible]	Mandatory Approval	Software Test Plan	Prior to Proposal	One Time	Attachment [illegible]	
36	Mandatory Approval	Software Quality Assurance Requirements (SR)	Prior to Proposal	As Required	Y	
37	Mandatory Approval	Radiation Assessment Summary Report (RASR)	Prior to Proposal	As Required	Y	
38	Mandatory Submittal	Product Assurance Data Package (PADP)	[illegible]	[illegible]	Y	
[illegible]	Mandatory Submittal	Non-Conformance Report	[illegible]	As Required	Y	See Notes 3-6, 8
[illegible]	Mandatory Submittal	Government Furnished Data Exchange Report with NASA Analysis Problem Report	Report [illegible]	Once with Revisions	Y	
[illegible]	Mandatory Approval	Electrical, Electronic and Electromechanical (EEE) Parts Control Plan	[illegible]	[illegible]	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document			N	Provided in tech library
46	Upon Request	Wage Salary and Fringe Benefits Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	[illegible] Acceptance Test Procedure	Specified in DO	[illegible]	Y	A copy of any internal contractor procedures referenced in acceptance test procedures shall be included as an attachment(s).
48	Mandatory Submittal	[illegible] Maintenance & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	[illegible]	Specified in DO	[illegible]	Y	
[illegible]		Reserved				
51	Mandatory Submittal	[illegible] Management Reporting	[illegible]	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment 1	
53	Mandatory Submittal	System Safety Plan	With Proposal	Once with Revisions	Attachment 1	
54	Written Approval	Robotics Plan Template	With Proposal/ Revisions as Required	Only applicable to [illegible] in accordance with the SOW and the DRD	Y	

Type 1 - Written Approval Type 2 - Mandatory Submittal Type 3 - Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or facilities unless requested by the contractor in their response to a request for bid.

Flight hardware test facilities, such as loads, thermal, and vibration are available for the execution of this delivery order upon submission of JSC Form 90's to the DO Manager. NASA expects to use its own funds for facilities and facility support staff. Test plan, test readiness review, and flight hardware documentation shall be provided by the delivery order contractor.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list is filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116809-302 (EWA) *S/N 1001: modification/repair per RFP *All: modification per post-flight maintenance/refurbishment procedure	7	$90,000	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116933-301 (EWA Caddy)	7	$16,279	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116360-30x (Gel Brush Caddy)	6	$20,694	Contractor Facility or JSC	2 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06) Balance per project schedule.

SDD33116387-001	25	$159	Contractor Facility or JSC	Per project schedule
SDD33116406-001	30	$.30	Contractor Facility or JSC	Per project schedule
SED33117201-001, -002, -003	90 each dash number	$.30	Contractor Facility or JSC	Per project schedule
SED33116812-701	20	$290	Contractor Facility or JSC	Per project schedule; for use in Option 2; one per applicator per refurbishment. Unused units to be returned upon completion of DO or Option 2.

B. List of Property the Contractor will return in the same configuration:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116385-301 (Removable Brush Handle)	18	$12,000 EA	Contractor Facility or JSC	5 upon award of DO 4 upon return from STS-121 (approx 9/1/06) 4 upon return from STS-115 (approx 10/1/06) Balance per project schedule.
SEG33116397-703 (EVA Wipes)	60	$5,000 EA	Contractor Facility or JSC	16 upon award of DO 11 upon return from STS-115 (approx 10/1/06) Balance per project schedule.
SED33116394-70x (Gel Brushes)	218	$196.31 EA	Contractor Facility or JSC	154 upon award of DO. Balance per project schedule.
SED36148820-301 (EWA Vibration Fixture Assembly)	1	$10,000	Contractor Facility or JSC	Upon award of DO or per project schedule.
SED38119224-	1	$13,500	Contractor	Delivered to contractor

301 (EWA Simulator Assembly)			Facility or JSC	9/25/06
SED38119219-301 (EWA Manifold Assembly)	1	$18,000	Contractor Facility	Delivered to contractor 9/25/06
VT70-191056-031 (EPC Arcjet Tile Array Test Article, Large)	2	$35,000	Contractor Facility or JSC	9/29/06
VT70-191051-013 (EPC Arcjet Tile Array Test Article, Small)	1	$25,000	Contractor Facility or JSC	9/26/06
Netted Foam Brush Assembly SED33119588-701	25	$1,100.50 EA	Contractor Facility or JSC	10/17/06

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

List is inclusive of all hardware referenced in Tables A and B. The government accepts the risk, including repair/replacement cost, of incurring damage to flight hardware during the course of approved qualification and acceptance testing conducted in accordance with the CARD. Efforts to repair/replace property damaged during the course of approved testing are cost-reimbursable, with additional fee for such effort to be considered. If an item is lost or damaged through no fault of the contractor at a facility outside the contractor's control, the contractor will not be held responsible for the loss provided that due care and diligence were taken in transferring the hardware to the facility (i.e., hardware was appropriately packaged, transfer was documented, test facility acknowledged receipt of hardware). Responsibility for loss or damage to hardware, including repair/replacement cost, caused by contractor negligence is the sole responsibility of the contractor.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R3

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R3

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 9/19/06 thru 3/31/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R3

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 4/19/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 3 to CRAVE-EC-DO19 is issued to delete and replace DO19R2 in its entirety. Revision 3 revises the Statement of Work. Option 1 has been repriced and the completion date extended to 7/31/07; Option 3 has been added to the DO. Option 1: Price is changed from $ b4 Option 3: Development Phase Shuttle Flight Support. Option 3 includes 2 flights: STS-118 and STS-120 Period of Performance = 4/4/07 thru 3/31/08 Pricing for Option 3 is valid for work completed by 3/31/08. (continued next page)	Lot	b4	b4	b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total
$ $1,128,283

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO19R2 recap of delivery order value has been deleted in its entirey and replaced with the following corrected recap.					
	RECAP OF DELIVERY ORDER VALUE:					
	PRIOR VALUE THIS ACTION REVISED VALUE					
	CUM REVISED VALUE: $1,167,217					
	THIS IS A CPFF DELIVERY ORDER.					

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC7-019

NOTE: REVISION B. CHANGES MADE THIS REVISION SHOWN IN COLORED TEXT OR DELETION BLOCK. LOCATION OF CHANGES MARKED WITH CHANGE BARS IN LEFT MARGIN

PROPOSAL INSTRUCTIONS: __ DRAFT -- COMMENTS DUE BY: 8/31/2006
X FINAL -- PROPOSAL DUE BY: 9/12/2006

DO TITLE: Certify shuttle orbiter TPS repair hardware to Criticality I requirements.
DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler, EC7	Phone: (281) 483-0025
DO Manager: Mark Dub, EC7	Phone: (281) 483-4471
DO Mgr. Alternate: N/A	Phone: N/A

Concurrences:

Mark Dub DO Manager	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Joe Gensler Division TMR	Steve Miller S & MA	

Task Contains Flight Hardware, Flight Software or GSE? X Yes ___No

Program Supported: X Shuttle __ISS X EVA ___Advanced _____

WBS: X 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

*For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for **all** Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

As a part of the Space Shuttle Program (SSP) Return-to-Flight Effort, a set of EVA Tile Repair tools were developed. The purpose of these tools is to allow crewmembers to effect EVA repair of damaged orbiter thermal protection system surfaces. Included among these repair tools are Emittance Wash Applicator (EWA) Kits and Gel Brush Kits. Both are used, if required, to repair damaged tile surfaces.

The launch schedule of STS-114 coincided with the development schedule of these repair tools, and did not allow for the completion of a traditional certification, which verifies functionality of the hardware for use in its intended (EVA) environment. The shuttle program recognized this, and temporarily reduced the functional criticality of the hardware to a level of 3/3, limiting the scope of the hardware certification to launch, landing, and EVA use safety. The effectivity of this limited certification is for missions STS-114, 121, and 115, and will be extended to include 116 (December 2006)

Based upon this decision, the EWA Kits and Gel Brush Kits were certified as Criticality 3 hardware, and flown aboard STS-114 and 121. Use of the EWA Kit to coat a damaged tile sample was successfully demonstrated during an in-flight DTO experiment on STS-114.

In an effort to develop a maximally robust repair capability, the shuttle program desires to upgrade the existing Criticality 3 certifications of the EWA Kits and Gel Brush Kits to a traditional certification, which verifies functionality in the intended (EVA) environment, and would meet the safety and reliability certification standards required of Criticality 1 hardware.

The scope of this task is to upgrade the present Criticality 3 certifications of existing flight hardware to satisfy Criticality 1 requirements, with the exception of the EVA Wipe as Criticality III, by completing environmental qualification and acceptance testing on qualification and flight hardware articles, and Acceptance Data Packages (ADPs) as applicable, updating the products associated with the Verification Compliance Data Package (including the GCAR, RAESR, CARD-VCM), closing open Discrepancy Reports (DRs/NCRs) on flight articles, and closing constraints to certification including FIARs and RIDs.

The Emittance Wash Applicator Kit (SJD33116880) contains the following hardware:
-Emittance Wash Applicator (SED33116809-302)
-Emittance Wash Applicator Caddy (SED33116933-301)
-Removable Brush Handle Assembly (SED33116385-301)
-Netted Foam Brush Assembly (SED33119588-701)
-EVA Wipes (SEG33116397-703)

The Gel Brush Kit (SJD33117200-30x) contains the following hardware:

-Gel Brush Caddy (SED33116360-30x)
-Removable Brush Handle Assembly (SED33116385-301)
-Sylgard Gel Brushes (SED33116394-70x)

Task Description:

1. *Emittance Wash Applicator (EWA) and EWA Caddy*

Certify Emittance Wash Applicator (EWA) SED33116809-302, and EWA Caddy SED33116933-301 to meet Criticality I requirements. This task shall encompass deletion of the Rotating Mount Assembly, P/N SED33117870-302, from the EWA Caddy.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD:
-combined load/internal pressure/mechanism testing or analysis of -302 configuration
-qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of the following flight hardware in accordance with CARD:
-7 Emittance Wash Applicator Assemblies SED33116809-302
-7 Emittance Wash Applicator Caddy Assemblies SED33116933-301
- Identify cause of high actuation torque on EWA S/N 1001 Main Valve and repair valve to return actuation torque to limits specified in JSC-62007B, Paragraph 3.1.1.7.1.2
-Rework of seven EWA Caddy Assemblies to include:
-Separable/reconfigurable kit-level labels
-Pocket stiffener design updates to include stiff protector for netted brush head and updated brush handle slider guard to prevent stiffener cracking
-Softgoods tether points sufficient to withstand qualification testing to a minimum 4.0 FOS above tether load requirements specified in CARD.
-Developmental Hardware Phase Shuttle Flight Support
-Fill EWA, PIA, and kit two EWA Kits (SJD33116880) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
-Dekit and inspect hardware for damage upon return from flights STS-115, STS-116, and STS-117.
-Completion of MSVR
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix

-Closure of FIARs JSCEC1203, 1207, 1300, and 1305 including required engineering evaluations, analyses, or tests for final resolution.
-Closure of deferred Review Item Dispositions
- Engineering/technician/quality support for EWA engineering evaluations including sample preparation for arcjet testing.
- Resolution of Rotating Mount FIAR 1323 and DR E10630083 for mechanism cycling failure, including engineering evaluations for failure investigation.

- Delete Rotating Mount from EWA Caddy
  - Interim manufacturing documents and/or dispositions to allow work to proceed pending drawing and CARD updates
  - EWA Caddy drawing update to remove Rotating Mount
  - EWA Kit drawing update to remove/update views of Rotating Mount (as required)
  - Update to CARD JSC-62007 to remove Rotating Mount associated requirements and update envelope and relevant figures
  - EWA Caddy RAESR update to remove references to Rotating Mount
  -Remove rotating mount from EWA caddy and configure caddy as required by updated drawing.
  - Downgrade and/or disposition of existing hardware and return to NASA

2. *Removable Brush Handle Assembly*

Certify Removable Brush Handle Assembly SED33116385-301 to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD.
  -qualification for acceptance vibration testing
  -qualification thermal testing
  -qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 18 flight units in accordance with CARD.
-Completion of Mechanical Systems Verification Plan (MSVP), including MSVR
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Closure of open Review Item Dispositions

3. Netted Foam Brush Assembly SED33119588-701

Certify the Netted Foam Brush Assembly SED33119588-701 to meet Criticality I requirements.

Criticality III VCDP and products baselined for the certification of Foam Brush Assemblies (SED33117199) shall be used as a basis for meeting certification requirements for the netted foam brush by similarity unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 25 GFE flight units in accordance with CARD.
-Assembly of Verification Compliance Data Package
  -GCAR
  -Update/develop RAESR
  -Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

4. Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x

Certify Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Coordination of a community review meeting to incorporate reviewer comments into draft requirements documents (CARDs) for the Gel Brush Caddy and the Sylgard Gel Brushes
-Coordination of reviewer signoff and XA Tools Panel Baseline of the Gel Brush Caddy and Sylgard Gel Brush CARDs
-Completion and documentation of testing required to extend shelf life of gel brush assemblies to a minimum of five years.

-Completion of testing required to assess functional performance of Sylgard gel with respect to temperature range specified in CARD.
-Rework of six flight unit caddies to include addition of 10-layer MLI insulation, separable/reconfigurable kit-level labels, and softgoods tether points sufficient to withstand qualification testing to a 4.0 FOS above tether load requirements specified in CARD.
-Update of thermal analytical products reflecting addition of MLI insulation.
-Acceptance testing of the following flight hardware in accordance with CARD:
    -6 Brush Caddy Assemblies SED33116385-30x
    -100 Gel Brush Assemblies SED33116394-30x
-Developmental Hardware Phase Shuttle Flight Support
    -PIA and Kit two Gel Brush Kits (SJD33117200) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
    -Dekit and inspect hardware for damage upon return from flights STS-121, STS-116, and STS-117
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

5. *EVA Wipe Assembly SED33116397-703*

Certify EVA Wipe Assembly SED33116397-703 to meet updated Criticality III requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy updated Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Review of Design Memorandum documenting compliance of design with design requirements
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Acceptance testing of 60 flight units in accordance with CARD
-Closure of deferred Review Item Dispositions
- Rework of up to 50 EVA Wipes to correct out of configuration discrepancy (missing labeling on tether loop)
- Flight delivery of unkitted EVA Wipes for STS-116 and STS-117

Contract Options

The following task options shall be priced separately:

1. Alternate Schedule Certification

Provide pricing and schedule to complete this delivery order on a schedule chosen by the bidder to minimize cost. In addition, this option shall include kitting and shipping of flight hardware as Criticality III hardware for flights scheduled to occur during the performance period of this delivery order (STS-116 & STS-117) duration of project. Schedule shall require Sylgard Gel Brush 5-year shelf life extension task to be complete prior to 11/30/06.

2. Post-flight Refurbishment and Maintenance of Emittance Wash Applicator

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, *Maintenance Procedure Emittance Wash Applicator Part No. SED33116809-302.*
-PDA/PIA, and fill Emittance Wash Applicators for flight in accordance with JSC-62007 following refurbishment.
-Pricing shall include completion of task for two units with an option for two additional units to be completed concurrently. Pricing need not be itemized if additional units do not increase cost of task in excess of 10%.
-Pricing shall be provided on a per-mission basis, and option shall be exercisable on a per-mission basis.

3. Developmental Phase Shuttle Flight Support

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, Maintenance Procedure for Emittance Wash Applicator Part No. SED33116809-302.
-PDA and Fill EWA, PIA and kit or refurbish two EWA Kits (SJD33116880) for each shuttle mission supported
-PIA and kit or refurbish two Brush Kits (SJD33117200) for each shuttle mission supported.
-PIA five EVA Wipes SED33116397-703 for each shuttle mission supported.
-PDA/PIA one MMWS Tool Stowage Caddy (GD2051000-301) for each shuttle mission supported.
-Deliver/ship hardware for flight via flight shipping process.
-Dekit (or refurbish) and inspect hardware for damage upon return from flight.

-Pricing shall include the option to repair minor damage and resolve open DRs and FIARs.
-Pricing shall be provided on a per-mission basis, and options shall be exercisable on a per-mission basis.
-Missions to supported shall be identified by the contracting officer and identified in the Purchase Order (PO) purchasing the Option.

Notes:

1. Drawings, CARDs, RID summary and status, and baselined Criticality III VDCPs, CDR presentations are available in CRAVE technical library.
2. Contractor shall provide weekly status of Non-Conformance Records (NCR) and issues in the form of an E-mail to the DO Manager (DM).
3. All TPS (or equivalent documents) performing qualification or acceptance testing, or disassembly, repair, and engineering evaluations of hardware once acceptance testing on that specific S/N has been completed, shall require the signature approval of the COTR or DM as authorization to proceed. The intent of this note is NOT to require approval of every document internal to the contractor authorizing work at their facility.
4. Signature approval is allowed on TPS and NCR's (or equivalent documents) via e-mail or telecon where required to minimize work stoppage; hardcopy signature is required prior to document closure (or equivalent) indication of completion of work.
5. NCR's shall be communicated to the DM in sufficient details to allow for resolution without requiring project personnel to be at contractor facility.
6. Material Review Board (MRB) personnel for the disposition of NCR's shall be provided by the contractor; NASA DO Manager required signature for MRB.
7. ADP shall comply with SN-D-0007 and shall be delivered as required by the relevant CARD. Three revisions will be prepared as follows: Rev IR to include original OSS build with OSS/DCMA approval, Rev A to include records obtained from QARC or OSS records for periods of time when the hardware was not under OSS contract with EC/NT approval only, and Rev B to reflect work done as part of this DO with OSS/DCMA approval,
8. NCR's open at the time of ADP delivery will be transferred into the NASA Quality System by NASA or NASA-designated QA personnel.
9. Copies of internal vendor procedures referenced in work authorizing documents or NCRs shall be delivered to the government. Attachment to the parent document is acceptable.
10. Electronic drafts of all work authorizing documents (TPS, Procedures, or equivalent; NCRs or equivalent) shall be delivered to the DM in an unlocked/fully-serviceable native-format file (where available) or as a searchable PDF (internal OSS forms, handwritten documents, database generated forms, etc.).
11. The certification of the hardware will reflect the requirements in the respective hardware CARDs,.
12. Pricing for this DO shall include five CARD and five drawing updates for each P/N with current released CARDs/Drawings, in addition to those specifically described in this RFP.
13. All technical correspondence shall be directed to Mark Dub (281-483-4471, mark.o.dub@nasa.gov) and Mr. Joe W. Gensler (281-483-0025, joe.w.gensler@nasa.gov).
14. All GFE flight hardware to be returned to NASA for flight or inventory at the direction of the DM. Processing criticality, "safe to fly" or "criticality I" shall also be at the direction of the DM at the time of request.
15. Shipment for flight shall be provided by the contractor, including 1027, 1149, and DD250 generation and approval, where applicable.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certification	**Emittance Wash Applicator Kit (SJD33116880)** Emittance Wash Applicator (SED33116809-302) Emittance Wash Applicator Caddy (SED33116933-301) Removable Brush Handle Assembly (SED33116385-301) Netted Foam Brush Assembly (SED33119588-701) EVA Wipes (SEG33116397-703) **Gel Brush Kit (SJD33117200)** Gel Brush Caddy (SED33116360-30x) -Removable Brush Handle Assembly (*referenced above*) -Sylgard Gel Brushes (SED33116394-70x)	1 per P/N	Per Interim Milestones: VCDP/GCAR Approval Date	I
Flight				I
Training				
Other (test fixture)	Tether End Fixture (SDG38119921-701) Tether End Fixture Cap (SDG38119922-701) Round End Fixture (SDG38119923-701) Round End Fixture Cap (SDG38119924-701)	1 1 1 1	Per testing schedule	STE/D
GSE				
Test				
Software				

Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N flight (or qual) unit	Contract completion	

SCHEDULE

Start Date: September 18, 2006 **Finish Date: May 31, 2007**

Milestones for this project shall be per the project schedule provided by the offeror with their proposal, "DO-19 Option 1 loaded.mpp". Milestones will be updated in the project schedule and resubmitted to match future contract updates.

[redacted]

TOTAL COST ESTIMATE FOR THIS DO: N/A Base

FEE: Fee N/A Base

OPTION 1: [redacted]

OPTION 2a (2 EWAs): [redacted]
[redacted] **OPTION 2b (4 EWAs):** [redacted]

[redacted]

DATA REQUIREMENTS

All DRDs contained in the contract are applicable and required unless marked N/A below.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report Summary Review	Fourteen (14) days following contract start	Weekly	Y	Status Report to report schedule weekly and cost (materials, hours) biweekly
3	Written Approval	Project Technical Requirements Specification			N	
4	Mandatory Submittal	GFE Systems Requirements Data Package			N	
5	Written Approval	Flight GFE Project Requirements & Verification Document			N	
6	Mandatory Submittal	Preliminary Design Review Data Package			N	CDR documents provided in tech library
7	Written Approval	Flight GFE Workmanship Specifications List			N	
8	Written Approval	Project Schedule	Fourteen (14) days following contract start	Once w/ Revisions (one w/ DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document			N	
10	Written Approval	GFE End Item Specification			N	Governed by CARD
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As needed	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan			N	Covered by VCDP/cert pack: CARD verification compliance matrix, review of design memorandum, and RAESR VTL
13	Written Approval	GFE Software Requirements Specification			N	

ORD #	DATA TYPE	DPD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
14	Written Approval	GFE Software Development Plan			N	
15	Written Approval	GFE Software Design Document			N	
16	Written Approval	Engineering Drawings	At FDR as specified in DO	Once with Revisions	N	
17	Written Approval	FEE Parts Lists and Analysis Report			N	
18	Mandatory Submittal	Critical Design Review Data Package			N	CDR info provided in tech library
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	Y	
20	Written Approval	CDR Qualification Test Procedure	Specified in DO	Once with Revisions	Y	A copy of any internal contractor procedures referenced in qualification test procedures shall be included as an attachment(s).
21	Written Approval	High Product Users Guide			N	
22	Mandatory Submittal	Software Code			N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award and as specified in IPG 2810	IPG 2810	Attachment 14 Due 30 days after DO award	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	Y	Refer to EA-WI-023 and CARDs
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	Y	Refer to EA-WI-023 Req's for SAR
26	Mandatory Submittal	Engineering Analysis	As needed	As Required	Y	

DRD #	DATA TYPE	DRD TITLE	FIRST DUE	FREQUENCY	REQUIRED FOR DO?	ADDITIONAL REQUIREMENTS
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One ADP per flight unit upon completion of acceptance testing or hardware update	Y	Must comply with SSP 30695
28	Mandatory Submittal	Export Control Audit Results	After award of first DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights Report	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	Y	
32	Mandatory Submittal	Loss of Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station OFE Failure Modes and Effects Analysis and Critical Items List	Specified in DO	As Required	N	
34	Written Approval	Space Shuttle OFE Safety Hazard Analysis Report & Hazard Report	Specified in DO	As Required	Y	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N (if Applicable)	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Attachment J-8	
38	Written Approval	Government Contractor Approval Request (GCAR)	Specified in DO	As Required	Y	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	Y	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	24 business days after problem solution but no later than 10 days after discovery	As Required	Y	
41	Upon Request	Nonconformance Record		As Required	Y	See Notes 3-6, 8
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	
43	Written Approval	Electrical, Electronic, and Electromechanical (EEE) Parts Control Plan			N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document			N	Provided in tech library
46	Upon Request	Wage Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFS Acceptance Test Procedure	Specified in DO	One Time	Y	A copy of any internal contractor procedures referenced in acceptance test procedures shall be included as an attachment(s).
48	Mandatory Submittal	Engr. G. F. Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	Y	
50		Reserved				
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 – Written Approval Type 2 – Mandatory Submittal Type 3 – Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or facilities unless requested by the contractor in their response to a request for bid.

Flight hardware test facilities, such as loads, thermal, and vibration are available for the execution of this delivery order upon submission of JSC Form 90's to the DO Manager. NASA expects to use its own funds for facilities and facility support staff. Test plan, test readiness review, and flight hardware documentation shall be provided by the delivery order contractor.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list is filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116809-302 (EWA) *S/N 1001: modification/repair per RFP *All: modification per post-flight maintenance/refurbishment procedure	7	$90,000	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116933-301 (EWA Caddy)	7	$16,279	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116360-30x (Gel Brush Caddy)	6	$20,694	Contractor Facility or JSC	2 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06) Balance per project schedule.

SDD33116387-001	25	$159	Contractor Facility or JSC	Per project schedule
SDD33116406-001	30	$.30	Contractor Facility or JSC	Per project schedule
SED33117201-001, -002, -003	90 each dash number	$.30	Contractor Facility or JSC	Per project schedule
SED33116812-701	20	$290	Contractor Facility or JSC	Per project schedule; for use in Option 2; one per applicator per refurbishment. Unused units to be returned upon completion of DO or Option 2.

B. List of Property the Contractor will return in the same configuration:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED331163[illegible] 301 ([illegible] Brush Handle)	18	$12,000 EA	Contractor Facility or JSC	5 upon award of DO 4 upon return from STS-121 (approx 9/1/06) 4 upon return from STS-115 (approx 10/1/06) Balance per project [illegible]le.
S[illegible]7-703 (EVA Wipes)	60	[illegible]00 EA	Contractor Facility or JSC	[illegible]rd of DO 11 upon return from STS-115 (approx 10/1/06) Balance [illegible] project sch[illegible]le.
SE[illegible] (Gel Brushes)			Contractor	154 upon [illegible]d of DO. Balance [illegible] project schedule.
SED36148820-301 (EWA Vibration Fixture Assembly)	1	$10,000	Contractor Facility or JSC	Upon award of DO or per project schedule.
SED38119224-	1	$13,500	Contractor	Delivered to contractor

301 (EWA Simulator Assembly)			Facility or JSC	9/25/06
SED38119219-301 (EWA Manifold Assembly)	1	$18,000	Contractor Facility	Delivered to contractor 9/25/06
VT70-191056-031 (EPC Arcjet Tile Array Test Article, Large)	2	$35,000	Contractor Facility or JSC	9/29/06
VT70-191051-013 (EPC Arcjet Tile Array Test Article, Small)	1	$25,000	Contractor Facility or JSC	9/26/06
Netted Foam Brush Assembly SED33119588-701	25	$1,100.50 EA	Contractor Facility or JSC	10/17/06

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

List is inclusive of all hardware referenced in Tables A and B. The government accepts the risk, including repair/replacement cost, of incurring damage to flight hardware during the course of approved qualification and acceptance testing conducted in accordance with the CARD. Efforts to repair/replace property damaged during the course of approved testing are cost-reimbursable, with additional fee for such effort to be considered. If an item is lost or damaged through no fault of the contractor at a facility outside the contractor's control, the contractor will not be held responsible for the loss provided that due care and diligence were taken in transferring the hardware to the facility (i.e., hardware was appropriately packaged, transfer was documented, test facility acknowledged receipt of hardware). Responsibility for loss or damage to hardware, including repair/replacement cost, caused by contractor negligence is the sole responsibility of the contractor.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R2

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R2

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2626227 CAGE CODE: 2F262

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Julie K. Karr

Signature: Julie K Karr Date: 4/5/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Criticality One Certification of Shuttle EVA Tile Repair Hand Tools Revision 2 to DO-CRAVE-EC-019 is issued to revise the SOW and increase the delivery order value. Changes to the SOW have been vertically bar-marked in the attached replacement SOW. Option 1 Period of Performance: 9/19/06 to 7/13/07 Option 3 Period of Performance: 4/04/07 to 3/31/08 (Pricing for Option 3 valid for work completed by 3/31/08) THIS IS A CPFF DELIVERY ORDER continued next page	Lot			4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total
$ 2,079,927 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	RECAP OF DELIVERY ORDER VALUE:					
	PRIOR VALUE / THIS ACTION / REVISED VALUE					
	Cost 64 / 64 / 64					
	Fee					
	Total $1,092,020 / $987,907 / $2,079,927					

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC7-019

NOTE: REVISION B. CHANGES MADE THIS REVISION SHOWN IN COLORED TEXT OR DELETION BLOCK. LOCATION OF CHANGES MARKED WITH CHANGE BARS IN LEFT MARGIN

PROPOSAL INSTRUCTIONS: __ DRAFT -- COMMENTS DUE BY: 8/31/2006
_X_ FINAL -- PROPOSAL DUE BY: 9/12/2006

DO TITLE: Certify shuttle orbiter TPS repair hardware to Criticality I requirements.
DO Type: _X_ CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler, EC7	Phone: (281) 483-0025
DO Manager: Mark Dub, EC7	Phone: (281) 483-4471
DO Mgr. Alternate: N/A	Phone: N/A

Concurrences:

Mark Dub DO Manager	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Joe Gensler Division TMR	Steve Miller S & MA	

Task Contains Flight Hardware, Flight Software or GSE? _X_ Yes ___No

Program Supported: _X_ Shuttle __ISS _X_ EVA ___Advanced _____

WBS: _X_ 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

*For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for **all** Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

As a part of the Space Shuttle Program (SSP) Return-to-Flight Effort, a set of EVA Tile Repair tools were developed. The purpose of these tools is to allow crewmembers to effect EVA repair of damaged orbiter thermal protection system surfaces. Included among these repair tools are Emittance Wash Applicator (EWA) Kits and Gel Brush Kits. Both are used, if required, to repair damaged tile surfaces.

The launch schedule of STS-114 coincided with the development schedule of these repair tools, and did not allow for the completion of a traditional certification, which verifies functionality of the hardware for use in its intended (EVA) environment. The shuttle program recognized this, and temporarily reduced the functional criticality of the hardware to a level of 3/3, limiting the scope of the hardware certification to launch, landing, and EVA use safety. The effectivity of this limited certification is for missions STS-114, 121, and 115, and will be extended to include 116 (December 2006)

Based upon this decision, the EWA Kits and Gel Brush Kits were certified as Criticality 3 hardware, and flown aboard STS-114 and 121. Use of the EWA Kit to coat a damaged tile sample was successfully demonstrated during an in-flight DTO experiment on STS-114.

In an effort to develop a maximally robust repair capability, the shuttle program desires to upgrade the existing Criticality 3 certifications of the EWA Kits and Gel Brush Kits to a traditional certification, which verifies functionality in the intended (EVA) environment, and would meet the safety and reliability certification standards required of Criticality 1 hardware.

The scope of this task is to upgrade the present Criticality 3 certifications of existing flight hardware to satisfy Criticality 1 requirements, with the exception of the EVA Wipe as Criticality III, by completing environmental qualification and acceptance testing on qualification and flight hardware articles, and Acceptance Data Packages (ADPs) as applicable, updating the products associated with the Verification Compliance Data Package (including the GCAR, RAESR, CARD-VCM), closing open Discrepancy Reports (DRs/NCRs) on flight articles, and closing constraints to certification including FIARs and RIDs.

The Emittance Wash Applicator Kit (SJD33116880) contains the following hardware:
-Emittance Wash Applicator (SED33116809-302)
-Emittance Wash Applicator Caddy (SED33116933-301)
-Removable Brush Handle Assembly (SED33116385-301)
-Netted Foam Brush Assembly (SED33119588-701)
-EVA Wipes (SEG33116397-703)

The Gel Brush Kit (SJD33117200-30x) contains the following hardware:

-Gel Brush Caddy (SED33116360-30x)
-Removable Brush Handle Assembly (SED33116385-301)
-Sylgard Gel Brushes (SED33116394-70x)

Task Description:

1. Emittance Wash Applicator (EWA) and EWA Caddy

Certify Emittance Wash Applicator (EWA) SED33116809-302, and EWA Caddy SED33116933-301 to meet Criticality I requirements. This task shall encompass deletion of the Rotating Mount Assembly, P/N SED33117870-302, from the EWA Caddy.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD:
-combined load/internal pressure/mechanism testing or analysis of -302 configuration
-qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of the following flight hardware in accordance with CARD:
-7 Emittance Wash Applicator Assemblies SED33116809-302
-7 Emittance Wash Applicator Caddy Assemblies SED33116933-301
- Identify cause of high actuation torque on EWA S/N 1001 Main Valve and repair valve to return actuation torque to limits specified in JSC-62007B, Paragraph 3.1.1.7.1.2
-Rework of seven EWA Caddy Assemblies to include:
-Separable/reconfigurable kit-level labels
-Pocket stiffener design updates to include stiff protector for netted brush head and updated brush handle slider guard to prevent stiffener cracking
-Softgoods tether points sufficient to withstand qualification testing to a minimum 4.0 FOS above tether load requirements specified in CARD.
-Developmental Hardware Phase Shuttle Flight Support
-Fill EWA, PIA, and kit two EWA Kits (SJD33116880) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
-Dekit and inspect hardware for damage upon return from flights STS-115, STS-116, and STS-117.
-Completion of MSVR
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix

-Closure of FIARs JSCEC1203, 1207, 1300, and 1305 including required engineering evaluations, analyses, or tests for final resolution.
-Closure of deferred Review Item Dispositions
- Engineering/technician/quality support for EWA engineering evaluations including sample preparation for arcjet testing.
- Resolution of Rotating Mount FIAR 1323 and DR E10630083 for mechanism cycling failure, including engineering evaluations for failure investigation.

- Delete Rotating Mount from EWA Caddy
  - Interim manufacturing documents and/or dispositions to allow work to proceed pending drawing and CARD updates
  - EWA Caddy drawing update to remove Rotating Mount
  - EWA Kit drawing update to remove/update views of Rotating Mount (as required)
  - Update to CARD JSC-62007 to remove Rotating Mount associated requirements and update envelope and relevant figures
  - EWA Caddy RAESR update to remove references to Rotating Mount
  -Remove rotating mount from EWA caddy and configure caddy as required by updated drawing.
  - Downgrade and/or disposition of existing hardware and return to NASA

2. *Removable Brush Handle Assembly*

Certify Removable Brush Handle Assembly SED33116385-301 to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD.
  -qualification for acceptance vibration testing
  -qualification thermal testing
  -qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 18 flight units in accordance with CARD.
-Completion of Mechanical Systems Verification Plan (MSVP), including MSVR
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Closure of open Review Item Dispositions

3. *Netted Foam Brush Assembly SED33119588-701*

Certify the Netted Foam Brush Assembly SED33119588-701 to meet Criticality I requirements.

Criticality III VCDP and products baselined for the certification of Foam Brush Assemblies (SED33117199) shall be used as a basis for meeting certification requirements for the netted foam brush by similarity unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 25 GFE flight units in accordance with CARD.
-Assembly of Verification Compliance Data Package
  -GCAR
  -Update/develop RAESR
  -Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

4. *Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x*

Certify Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Coordination of a community review meeting to incorporate reviewer comments into draft requirements documents (CARDs) for the Gel Brush Caddy and the Sylgard Gel Brushes
-Coordination of reviewer signoff and XA Tools Panel Baseline of the Gel Brush Caddy and Sylgard Gel Brush CARDs
-Completion and documentation of testing required to extend shelf life of gel brush assemblies to a minimum of five years.

-Completion of testing required to assess functional performance of Sylgard gel with respect to temperature range specified in CARD.
-Rework of six flight unit caddies to include addition of 10-layer MLI insulation, separable/reconfigurable kit-level labels, and softgoods tether points sufficient to withstand qualification testing to a 4.0 FOS above tether load requirements specified in CARD.
-Update of thermal analytical products reflecting addition of MLI insulation.
-Acceptance testing of the following flight hardware in accordance with CARD:
-6 Brush Caddy Assemblies SED33116385-30x
-100 Gel Brush Assemblies SED33116394-30x
-Developmental Hardware Phase Shuttle Flight Support
-PIA and Kit two Gel Brush Kits (SJD33117200) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
-Dekit and inspect hardware for damage upon return from flights STS-121, STS-116, and STS-117
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

5. *EVA Wipe Assembly SED33116397-703*

Certify EVA Wipe Assembly SED33116397-703 to meet updated Criticality III requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy updated Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Review of Design Memorandum documenting compliance of design with design requirements
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix
-Acceptance testing of 60 flight units in accordance with CARD
-Closure of deferred Review Item Dispositions
- Rework of up to 50 EVA Wipes to correct out of configuration discrepancy (missing labeling on tether loop)
- Flight delivery of unkitted EVA Wipes for STS-116 and STS-117

Contract Options

The following task options shall be priced separately:

1. Alternate Schedule Certification

Provide pricing and schedule to complete this delivery order on a schedule chosen by the bidder to minimize cost. In addition, this option shall include kitting and shipping of flight hardware as Criticality III hardware for flights scheduled to occur during the performance period of this delivery order (STS-116 & STS-117) duration of project. Schedule shall require Sylgard Gel Brush 5-year shelf life extension task to be complete prior to 11/30/06.

2. Post-flight Refurbishment and Maintenance of Emittance Wash Applicator

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, *Maintenance Procedure Emittance Wash Applicator Part No. SED33116809-302.*
-PDA/PIA, and fill Emittance Wash Applicators for flight in accordance with JSC-62007 following refurbishment.
-Pricing shall include completion of task for two units with an option for two additional units to be completed concurrently. Pricing need not be itemized if additional units do not increase cost of task in excess of 10%.
-Pricing shall be provided on a per-mission basis, and option shall be exercisable on a per-mission basis.

3. Developmental Phase Shuttle Flight Support

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, Maintenance Procedure for Emittance Wash Applicator Part No. SED33116809-302.
-PDA and Fill EWA, PIA and kit or refurbish two EWA Kits (SJD33116880) for each shuttle mission supported
-PIA and kit or refurbish two Brush Kits (SJD33117200) for each shuttle mission supported.
-PIA five EVA Wipes SED33116397-703 for each shuttle mission supported.
-PDA/PIA one MMWS Tool Stowage Caddy (GD2051000-301) for each shuttle mission supported.
-Deliver/ship hardware for flight via flight shipping process.
-Dekit (or refurbish) and inspect hardware for damage upon return from flight.

-Pricing shall include the option to repair minor damage and resolve open DRs and FIARs.
-Pricing shall be provided on a per-mission basis, and options shall be exercisable on a per-mission basis.
-Missions to supported shall be identified by the contracting officer and identified in the Purchase Order (PO) purchasing the Option.

Notes:

1. **Drawings, CARDs, RID summary and status, and baselined Criticality III VDCPs, CDR presentations are available in CRAVE technical library.**
2. **Contractor shall provide weekly status of Non-Conformance Records (NCR) and issues in the form of an E-mail to the DO Manager (DM).**
3. **All TPS (or equivalent documents) performing qualification or acceptance testing, or disassembly, repair, and engineering evaluations of hardware once acceptance testing on that specific S/N has been completed, shall require the signature approval of the COTR or DM as authorization to proceed. The intent of this note is NOT to require approval of every document internal to the contractor authorizing work at their facility.**
4. **Signature approval is allowed on TPS and NCR's (or equivalent documents) via e-mail or telecon where required to minimize work stoppage; hardcopy signature is required prior to document closure (or equivalent) indication of completion of work.**
5. **NCR's shall be communicated to the DM in sufficient details to allow for resolution without requiring project personnel to be at contractor facility.**
6. **Material Review Board (MRB) personnel for the disposition of NCR's shall be provided by the contractor; NASA DO Manager required signature for MRB.**
7. **ADP shall comply with SN-D-0007 and shall be delivered as required by the relevant CARD. Three revisions will be prepared as follows: Rev IR to include original OSS build with OSS/DCMA approval, Rev A to include records obtained from QARC or OSS records for periods of time when the hardware was not under OSS contract with EC/NT approval only, and Rev B to reflect work done as part of this DO with OSS/DCMA approval,**
8. **NCR's open at the time of ADP delivery will be transferred into the NASA Quality System by NASA or NASA-designated QA personnel.**
9. **Copies of internal vendor procedures referenced in work authorizing documents or NCRs shall be delivered to the government. Attachment to the parent document is acceptable.**
10. **Electronic drafts of all work authorizing documents (TPS, Procedures, or equivalent; NCRs or equivalent) shall be delivered to the DM in an unlocked/fully-serviceable native-format file (where available) or as a searchable PDF (internal OSS forms, handwritten documents, database generated forms, etc.).**
11. **The certification of the hardware will reflect the requirements in the respective hardware CARDs,.**
12. **Pricing for this DO shall include five CARD and five drawing updates for each P/N with current released CARDs/Drawings, in addition to those specifically described in this RFP.**
13. **All technical correspondence shall be directed to Mark Dub (281-483-4471, mark.o.dub@nasa.gov) and Mr. Joe W. Gensler (281-483-0025, joe.w.gensler@nasa.gov).**
14. **All GFE flight hardware to be returned to NASA for flight or inventory at the direction of the DM. Processing criticality, "safe to fly" or "criticality I" shall also be at the direction of the DM at the time of request.**
15. **Shipment for flight shall be provided by the contractor, including 1027, 1149, and DD250 generation and approval, where applicable.**

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certificatio	**Emittance Wash Applicator Kit (SJD33116880)** Emittance Wash Applicator (SED33116809-302) Emittance Wash Applicator Caddy (SED33116933-301) Removable Brush Handle Assembly (SED33116385-301) Netted Foam Brush Assembly (SED33119588-701) EVA Wipes (SEG33116397-703) **el Brush Kit (SJD33117200)** Gel Brush Caddy (SED33116360-30x) -Removable Brush Handle Assembly (*referenced above*) -Sylgard Gel Brushes (SED33116394-70x)	1 per P/N	Per Interim Milestones: VCDP/GCAR Approval Date	I
Fi				I
Traini				
Other (test fixture)	Tether End Fixture (SDG38119921-701) Tether End Fixture Cap (SDG38119922-701) Round End Fixture (SDG38119923-701) Round End Fixture Cap (SDG38119924-701)	1 1 1 1	Per testing schedule	STE/D
GSE				
Test				
Software				

Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N flight (or qual) unit	Contract completion	

SCHEDULE

Start Date: September 18, 2006 **Finish Date: May 31, 2007**

Milestones for this project shall be per the project schedule provided by the offeror with their proposal, "DO-19 Option 1 loaded.mpp". Milestones will be updated in the project schedule and resubmitted to match future contract updates.

Total Government Estimate for this DO: $453,600
Option 1: $ 362,880
Option 2: $ 12,800/mission

TOTAL COST ESTIMATE FOR THIS DO: N/A Base

FEE: Fee N/A Base

OPTION 1: $958,625 + $94,461 Fee = $1,053,086

OPTION 2a (2 EWAs): $17,937
OPTION 2b (4 EWAs): $20,997

TOTAL AWARDED THIS DO: $1,092,020

DATA REQUIREMENTS

All DRDs contained in the contract are applicable and required unless marked N/A below.

DRD	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/Summary Review	Fourteen (14) days following contract start	Weekly	Y	Status Report to report schedule weekly and cost (materials, hours) biweekly
3	Written Approval	Project Technical Requirements Specification			N	
4	Mandatory Submittal	GFE System Requirements Data Package			N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document			N	
6	Mandatory Submittal	Preliminary Design Review Data Package			N	CDR documents provided in tech library
7	Written Approval	Flight GFE Workmanship Specifications List			N	
8	Written Approval	Project Schedule	Fourteen (14) days following contract start	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document			N	
10	Written Approval	GFE End Item Specification			N	Governed by CARD
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As needed	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan			N	Covered by VCDP/cert pack: CARD verification compliance matrix, review of design memorandum, and RAESR VTL
13	Written Approval	GFE Software Requirements Specification			N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
14	Written Approval	GFE Software Development Plan			N	
15	Written Approval	GFE Software Design Document			N	
16	Written Approval	Engineering Drawings	At PDR, as specified in DO	Once with Revisions	N	
17	Written Approval	EEE Parts Lists and Analysis Report			N	
18	Mandatory Submittal	Critical Design Review Data Package			N	CDR info provided in tech library
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	Y	A copy of any internal contractor procedures referenced in qualification test procedures shall be included as an attachment(s).
21	Written Approval	Flight Product User's Guide			N	
22	Mandatory Submittal	Software Code			N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	Y	Refer to EA-WI-023 and CARDs
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	Y	Refer to EA-WI-023 Req's for SAR
26	Mandatory Submittal	Engineering Analysis	As needed	As Required	Y	

DRD	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One ADP per flight unit upon completion of acceptance testing or hardware update(s)	Y	Must comply with SSP 30695
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	Y	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Mode and Effects Analysis/and Critical Items List	Specified in DO	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report & Hazard Report	Specified in DO	As Required	Y	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N (If Applicable)	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Attachment J-9	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	Y	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	Y	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	
41	Upon Request	Nonconformance Record		As Required	Y	See Notes 3-6, 8
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan			N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document			N	Provided in tech library
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	Y	A copy of any internal contractor procedures referenced in acceptance test procedures shall be included as an attachment(s).
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle OFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	Y	
50		Reserved				
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 – Written Approval Type 2 – Mandatory Submittal Type 3 – Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or facilities unless requested by the contractor in their response to a request for bid.

Flight hardware test facilities, such as loads, thermal, and vibration are available for the execution of this delivery order upon submission of JSC Form 90's to the DO Manager. NASA expects to use its own funds for facilities and facility support staff. Test plan, test readiness review, and flight hardware documentation shall be provided by the delivery order contractor.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list is filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116809-302 (EWA) *S/N 1001: modification/repair per RFP *All: modification per post-flight maintenance/refurbishment procedure	7	$90,000	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116933-301 (EWA Caddy)	7	$16,279	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116360-30x (Gel Brush Caddy)	6	$20,694	Contractor Facility or JSC	2 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06) Balance per project schedule.

SDD33116387-001	25	$159	Contractor Facility or JSC	Per project schedule
SDD33116406-001	30	$.30	Contractor Facility or JSC	Per project schedule
SED33117201-001, -002, -003	90 each dash number	$.30	Contractor Facility or JSC	Per project schedule
SED33116812-701	20	$290	Contractor Facility or JSC	Per project schedule; for use in Option 2; one per applicator per refurbishment. Unused units to be returned upon completion of DO or Option 2.

B. List of Property the Contractor will return in the same configuration:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116385-301 (Removable Brush Handle)	18	$12,000 EA	Contractor Facility or JSC	5 upon award of DO 4 upon return from STS-121 (approx 9/1/06) 4 upon return from STS-115 (approx 10/1/06) Balance per project schedule.
SEG33116397-703 (EVA Wipes)	60	$5,000 EA	Contractor Facility or JSC	16 upon award of DO 11 upon return from STS-115 (approx 10/1/06) Balance per project schedule.
SED33116394-70x (Gel Brushes)	218	$196.31 EA	Contractor Facility or JSC	154 upon award of DO. Balance per project schedule.
SED36148820-301 (EWA Vibration Fixture Assembly)	1	$10,000	Contractor Facility or JSC	Upon award of DO or per project schedule.
SED38119224-	1	$13,500	Contractor	Delivered to contractor

301 (EWA Simulator Assembly)			Facility or JSC	9/25/06
SED38119219-301 (EWA Manifold Assembly)	1	$18,000	Contractor Facility	Delivered to contractor 9/25/06
VT70-191056-031 (EPC Arcjet Tile Array Test Article, Large)	2	$35,000	Contractor Facility or JSC	9/29/06
VT70-191051-013 (EPC Arcjet Tile Array Test Article, Small)	1	$25,000	Contractor Facility or JSC	9/26/06
Netted Foam Brush Assembly SED33119588-701	25	$1,100.50 EA	Contractor Facility or JSC	10/17/06

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

List is inclusive of all hardware referenced in Tables A and B. The government accepts the risk, including repair/replacement cost, of incurring damage to flight hardware during the course of approved qualification and acceptance testing conducted in accordance with the CARD. Efforts to repair/replace property damaged during the course of approved testing are cost-reimbursable, with additional fee for such effort to be considered. If an item is lost or damaged through no fault of the contractor at a facility outside the contractor's control, the contractor will not be held responsible for the loss provided that due care and diligence were taken in transferring the hardware to the facility (i.e., hardware was appropriately packaged, transfer was documented, test facility acknowledged receipt of hardware). Responsibility for loss or damage to hardware, including repair/replacement cost, caused by contractor negligence is the sole responsibility of the contractor.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19R1

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 19R1

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Robert Kolb

Signature: Robert Kolb Date: 10-8-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED

12. For JSC Internal Use Only:

Requisition No.: _____ ☐ COMP. ☐ PART. PPC: _____

Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total

$ 1,092,020
NTE

14. Quantities in "Quantity Accepted" Column Have Been

☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED

TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS
OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 19

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.l.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: Accountable Property

Order No.: NNJ05HB40B, CRAVE DO 19

5. Contractor:

Oceaneering Space Systems
Attn: Contracts
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5546

TIN: 95-2938227 CAGE CODE:

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 19

8. Type of Order:

☒ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference: DO-CRAVE-EC-019 SOW

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: 9-20-06

10. Name: Robert Kolb

Signature: Robert Kolb Date: 9.19.06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED

12. For JSC Internal Use Only:

Requisition No.: 4200170573 ☐ COMP. ☐ PART. PPC: _____

Rissue To: EC/Joe Gensler, x30025 For: EC5/Mark Dub, x34471

13. Total

$ 1,002,020 NTE

14. Quantities in "Quantity Accepted" Column Have Been

☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED

TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1998)

CREW, ROBOTICS AN. VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC7-D019

PROPOSAL INSTRUCTIONS: __ DRAFT -- COMMENTS DUE BY: 8/31/2006
X FINAL -- PROPOSAL DUE BY: 9/12/2006

DO TITLE: Certify shuttle orbiter TPS repair hardware to Criticality I requirements.
DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler, EC7	Phone: (281) 483-0025
DO Manager: Mark Dub, EC7	Phone: (281) 483-4471
DO Mgr. Alternate: N/A	Phone: N/A

Concurrences:

Mark Dub DO Manager	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Joe Gensler Division TMR	Steve Miller S & MA	

Task Contains Flight Hardware, Flight Software or GSE? X Yes ___No

Program Supported: X Shuttle __ISS X EVA ___Advanced _____

WBS: X 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for all Delivery Orders on the contract combined.

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

As a part of the Space Shuttle Program (SSP) Return-to-Flight Effort, a set of EVA Tile Repair tools were developed. The purpose of these tools is to allow crewmembers to effect EVA repair of damaged orbiter thermal protection system surfaces. Included among these repair tools are Emittance Wash Applicator (EWA) Kits and Gel Brush Kits. Both are used, if required, to repair damaged tile surfaces.

The launch schedule of STS-114 coincided with the development schedule of these repair tools, and did not allow for the completion of a traditional certification, which verifies functionality of the hardware for use in its intended (EVA) environment. The shuttle program recognized this, and temporarily reduced the functional criticality of the hardware to a level of 3/3, limiting the scope of the hardware certification to launch, landing, and EVA use safety. The effectivity of this limited certification is for missions STS-114, 121, and 115, and will be extended to include 116 (December 2006)

Based upon this decision, the EWA Kits and Gel Brush Kits were certified as Criticality 3 hardware, and flown aboard STS-114 and 121. Use of the EWA Kit to coat a damaged tile sample was successfully demonstrated during an in-flight DTO experiment on STS-114.

In an effort to develop a maximally robust repair capability, the shuttle program desires to upgrade the existing Criticality 3 certifications of the EWA Kits and Gel Brush Kits to a traditional certification, which verifies functionality in the intended (EVA) environment, and would meet the safety and reliability certification standards required of Criticality 1 hardware.

The scope of this task is to upgrade the present Criticality 3 certifications of existing flight hardware to satisfy Criticality 1 requirements by completing environmental qualification and acceptance testing on qualification and flight hardware articles, documenting the completion of these tests in hardware Acceptance Data Packages (ADPs), updating the products associated with the Verification Compliance Data Package (including the GCAR, RAESR, CARD-VCM), closing open Discrepancy Reports (DRs/NCRs) on flight articles, and closing constraints to certification including FIARs and RIDs.

The Emittance Wash Applicator Kit (SJD33116880) contains the following hardware:
-Emittance Wash Applicator (SED33116809-302)
-Emittance Wash Applicator Caddy (SED33116933-301)
-Removable Brush Handle Assembly (SED33116385-301)
-Netted Foam Brush Assembly (SED33119588-701)
-EVA Wipes (SEG33116397-703)

The Gel Brush Kit (SJD33117200-30x) contains the following hardware:
-Gel Brush Caddy (SED33116360-30x)

-Removable Brush Handle Assembly (SED33116385-301)
-Sylgard Gel Brushes (SED33116394-70x)

Task Description:

1. *Emittance Wash Applicator (EWA) and EWA Caddy*

Certify Emittance Wash Applicator (EWA) SED33116809-302, and EWA Caddy SED33116933-301 to meet Criticality I requirements. This task shall encompass certification of the Rotating Mount Assembly, P/N SED33117870-302 , for its application as used on the EWA Caddy.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD:
-combined load/internal pressure/mechanism testing or analysis of -302 configuration
-qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of the following flight hardware in accordance with CARD:
-7 Emittance Wash Applicator Assemblies SED33116809-302
-7 Emittance Wash Applicator Caddy Assemblies SED33116933-301
- Identify cause of high actuation torque on EWA S/N 1001 Main Valve and repair valve to return actuation torque to limits specified in JSC-62007B, Paragraph 3.1.1.7.1.2
-Rework of seven EWA Caddy Assemblies to include:
-Separable/reconfigurable kit-level labels
-Pocket stiffener design updates to include stiff protector for netted brush head and updated brush handle slider guard to prevent stiffener cracking
-Softgoods tether points sufficient to withstand qualification testing to a minimum 4.0 FOS above tether load requirements specified in CARD.
-Developmental Hardware Phase Shuttle Flight Support
-Fill EWA, PIA, and kit two EWA Kits (SJD33116880) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
-Dekit and inspect hardware for damage upon return from flight.
-Completion of MSVR
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix
-Closure of FIARs JSCEC1203, 1207, 1300, and 1305
-Closure of deferred Review Item Dispositions

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2. *Removable Brush Handle Assembly*

Certify Removable Brush Handle Assembly SED33116385-301 to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Completion of open qualification testing required by CARD.
-qualification for acceptance vibration testing
-qualification thermal testing
-qualification life cycling of mechanisms testing
-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 18 flight units in accordance with CARD.
-Completion of Mechanical Systems Verification Plan (MSVP), including MSVR
-Completion of Verification Compliance Data Package
-Update of GCAR
-Update of RAESR
-Update of Verification Compliance Matrix
-Closure of open Review Item Dispositions

3. Netted Foam Brush Assembly SED33119588-701

Fabricate and deliver 25 Netted Foam Brush Assemblies SED33119588-701, and certify the Netted Foam Brush Assembly SED33119588-701 to meet Criticality I requirements.

Criticality III VCDP and products baselined for the certification of Foam Brush Assemblies (SED33117199) shall be used as a basis for meeting certification requirements for the netted foam brush by similarity unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Fabrication of 25 flight units

-Review of Design Memorandum documenting compliance of design with design requirements
-Acceptance testing of 25 flight units in accordance with CARD.
-Assembly of Verification Compliance Data Package
  -GCAR
  -Update/develop RAESR
  -Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

4. *Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x*

Certify Gel Brush Caddy Assembly SED33116360-30x, and Gel Brush Assemblies SED33116394-30x to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Coordination of a community review meeting to incorporate reviewer comments into draft requirements documents (CARDs) for the Gel Brush Caddy and the Sylgard Gel Brushes
-Coordination of reviewer signoff and XA Tools Panel Baseline of the Gel Brush Caddy and Sylgard Gel Brush CARDs
-Completion and documentation of testing required to extend shelf life of gel brush assemblies to a minimum of five years.
-Completion of testing required to assess functional performance of Sylgard gel with respect to temperature range specified in CARD.
-Rework of six flight unit caddies to include addition of 10-layer MLI insulation, separable/reconfigurable kit-level labels, and softgoods tether points sufficient to withstand qualification testing to a 4.0 FOS above tether load requirements specified in CARD.
-Update of thermal analytical products reflecting addition of MLI insulation.
-Acceptance testing of the following flight hardware in accordance with CARD:
  -6 Brush Caddy Assemblies SED33116385-30x
  -100 Gel Brush Assemblies SED33116394-30x
-Developmental Hardware Phase Shuttle Flight Support
  -PIA and Kit two Gel Brush Kits (SJD33117200) each for Shuttle Missions STS-116 and STS-117 and ship for flight.
  -Dekit and inspect hardware for damage upon return from flight.
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR

-Update of Verification Compliance Matrix
-Closure of deferred Review Item Dispositions

5. *EVA Wipe Assembly SED33116397-703*

Certify EVA Wipe Assembly SED33116397-703 to meet Criticality I requirements.

Baselined Criticality III VCDP and products shall be used to satisfy certification requirements unless they are identified by the DM or Safety and Mission Assurance as inadequate to satisfy Criticality I certification requirements. Existing FMEA/CILs or hazard reports shall be revised if an analysis of a problem reveals an increase in risk. A new or revised FMEA/CIL or hazard report shall be generated if a problem analysis reveals an undocumented failure mode or hazard cause.

This task shall include the completion of the following:
-Review of Design Memorandum documenting compliance of design with design requirements
-Completion of Verification Compliance Data Package
  -Update of GCAR
  -Update of RAESR
  -Update of Verification Compliance Matrix
-Acceptance testing of 60 flight units in accordance with CARD
-Closure of deferred Review Item Dispositions

Contract Options

The following task options shall be priced separately:

1. *Alternate Schedule Certification*

Provide pricing and schedule to complete this delivery order on a schedule chosen by the bidder to minimize cost. In addition, this option shall include kitting and shipping of flight hardware as Criticality III hardware for flights scheduled to occur during the performance period of this delivery order (STS-116 & STS-117) duration of project. Schedule shall require Sylgard Gel Brush 5-year shelf life extension task to be complete prior to 11/30/06.

2. *Post-flight Refurbishment and Maintenance of Emittance Wash Applicator*

-Refurbish Emittance Wash Applicators in accordance with JSC-62354, *Maintenance Procedure Emittance Wash Applicator Part No. SED33116809-302.*
-PDA/PIA, and fill Emittance Wash Applicators for flight in accordance with JSC-62007 following refurbishment.

-Pricing shall include completion of task for two units with an option for two additional units to be completed concurrently. Pricing need not be itemized if additional units do not increase cost of task in excess of 10%.
-Pricing shall be provided on a per-mission basis, and option shall be exercisable on a per-mission basis.

Notes:

1. Drawings, CARDs, RID summary and status, and baselined Criticality III VDCPs, CDR presentations are available in CRAVE technical library.
2. Contractor shall provide weekly status of Non-Conformance Records (NCR) and issues in the form of an E-mail to the DO Manager (DM).
3. All TPS (or equivalent documents) performing qualification or acceptance testing, or disassembly, repair, and engineering evaluations of hardware once acceptance testing on that specific S/N has been completed, shall require the signature approval of the DM as authorization to proceed. The intent of this note is NOT to require approval of every document internal to the contractor authorizing work at their facility.
4. Signature approval is allowed on TPS and NCR's (or equivalent documents) via e-mail or telecon where required to minimize work stoppage; hardcopy signature is required prior to document closure (or equivalent) indication of completion of work.
5. NCR's shall be communicated to the DM in sufficient details to allow for resolution without requiring project personnel to be at contractor facility.
6. Material Review Board (MRB) personnel for the disposition of NCR's shall be provided by the contractor; NASA DO Manager required signature for MRB.
7. ADP shall comply with SSP 30695.
8. NCR's open at the time of ADP delivery will be transferred into the NASA Quality System by NASA or NASA-designated QA personnel.
9. Copies of internal vendor procedures referenced in work authorizing documents or NCRs shall be delivered to the government.
10. Electronic copies of all work authorizing documents (TPS, Procedures, or equivalent; NCRs or equivalent) shall be delivered to the government in an unlocked/fully-serviceable native-format file.
11. Certifications shall meet the requirements of the Space Shuttle Program. A materials cert for pressurized, IVA, non-operational stowage only will be needed for stowage of the shuttle equipment on ISS. The ISS materials cert shall be referenced in the Shuttle RAESR.
12. Pricing for this DO shall include five CARD and five drawing updates for each P/N with current released CARDs/Drawings, in addition to those specifically described in this RFP.
13. All technical correspondence shall be directed to Mark Dub (281-483-4471, mark.o.dub@nasa.gov) and Mr. Joe W. Gensler (281-483-0025, joe.w.gensler@nasa.gov).

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Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certification	**Emittance Wash Applicator Kit (SJD33116880)** Emittance Wash Applicator (SED33116809-302) Emittance Wash Applicator Caddy (SED33116933-301) Removable Brush Handle Assembly (SED33116385-301) Netted Foam Brush Assembly (SED33119588-701) EVA Wipes (SEG33116397-703) **Gel Brush Kit (SJD33117200)** Gel Brush Caddy (SED33116360-30x) -Removable Brush Handle Assembly (*referenced above*) -Sylgard Gel Brushes (SED33116394-70x)	1 per P/N	Per Interim Milestones: VCDP/GCAR Approval Date	I
Flight	Netted Foam Brush Assembly SED33119588-701	25	11/10/06	I
Training				
Other				
GSE				
Test				
Software				

Other Products	Acceptance Data Packages (ADPs)	1 ADP per S/N flight (or qual) unit	Due two weeks prior to flight ship for each kit component; balance due within 4 weeks of certification completion date.	

SCHEDULE

Start Date: September 18, 2006 **Finish Date: January 26, 2007**

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ITERIM MILESTONES	DUE DATES
EWA Kit	
Dekit/Inspect STS-115 EWA Kits	9/29/06
EWA Qualification Mechanism Life Cycling	10/13/06
EWA Qualification Crit I Load Testing/Analysis	10/27/06
EWA Crit I Structural Certification	11/17/06
EWA Caddy/GB Caddy Softgoods Crit I/4.0 FOS Qual Load Testing	10/13/06
EWA Acceptance Thermal Test (ATT) - STS-117 flight units	10/20/06
EWA Acceptance Vibration Test (AVT) – STS-117 flight units	11/3/06
EWA Maintenance and PDA – Qual, STS-116 flight units (Applicable if Contract Option #2 is exercised)	10/6/06
EWA Maintenance and PDA – Qual, STS-117 flight units (Applicable if Contract Option #2 is exercised)	11/17/06
EWA Flight Fill / Final Material Buyoff Complete: STS-116/317 flight units	11/3/06
EWA Flight Fill / Final Material Buyoff Complete: STS-117/318 flight units	12/15/06
EWA Caddy – Tether Point and Brush Pocket Rework and PDA/PIA	10/20/06
Brush Handle PDA	10/6/06
Brush Handle QTT/ATT	10/20/06
Brush Handle QAVT/AVT	11/3/06
Brush Handle Qualification Mechanism Life Cycling	11/17/06
EVA Wipe – PDA	11/17/06
Kit and ship STS-116/317 EWA Kits	11/17/06
Kit and ship STS-117/318 EWA Kits	1/12/07
EWA Kit Phase III RAESR – Submit to NT	10/16/06
EWA Kit Phase III RAESR – Submit to SMART	10/30/06

EWA Kit Phase III SMART	11/13/06
EWA Kit RAESR – Baseline by PRCB	12/15/06
EWA Kit VCDP/GCAR – NT Approval	1/19/07
SAR – EWA Kit	1/26/07
[redacted]	
Gel Brush Kits	
Dekit /Inspect STS-115 Gel Brush Kits	9/29/06
Gel Brush Caddy, Gel Brush CARDs – signoff	9/29/06
Gel Brush Caddy, Gel Brush CARDs baselined – XA Tools Panel	10/16/06
PDA Brushes	10/20/06
Update Brush Caddy MLI	10/27/06
PDA Caddies	11/3/06
Caddy Qualification Mechanism (Ball Detent) Life Cycle Test	11/10/06
Gel Brush Material Characterization Testing (DGB)	10/20/06
Gel Brush 5-Year Shelf Life Extension Testing	11/17/06
Gel Brush Kit Phase III RAESR – Submit to NT	10/16/06
Gel Brush Kit Phase III RAESR – Submit to SMART	10/30/06
Gel Brush Kit Phase III SMART	11/13/06
Gel Brush Kit RAESR – Baseline by PRCB	12/15/06
Gel Brush Kit VCDP/GCAR – NT Approval	1/19/07
Kit and ship STS-116/317 Gel Brush Kits	11/17/06
Kit and ship STS-117/318 Gel Brush Kits	1/12/07
SAR – Gel Brush Kit	1/26/07
Milestones, along with subjective measurements, are to be used for measuring performance.	

Total Government Estimate for this DO: $453,600
Option 1: $ 362,880
Option 2: $ 12,800/mission

TOTAL COST ESTIMATE FOR THIS DO: $

FEE: $ (If Applicable)

OPTION 1: $
OPTION 2: $

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC7-___

DATA REQUIREMENTS

All DRDs contained in the contract are applicable and required unless marked N/A below.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Fourteen (14) days following contract start	Weekly	Y	Status Report to report schedule weekly and cost (materials, hours) biweekly
3	Written Approval	Project Technical Requirements Specification			N	
4	Mandatory Submittal	GFE Systems Requirements Data Package			N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document			N	
6	Mandatory Submittal	Preliminary Design Review Data Package			N	CDR documents provided in tech library
7	Written Approval	Flight GFE Workmanship Specifications List			N	
8	Written Approval	Project Schedule	Fourteen (14) days following contract start	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document			N	
10	Written Approval	GFE End Item Specification			N	Governed by CARD
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As needed	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan			N	Covered by VCDP/cert pack: CARD verification compliance matrix, review of design memorandum, and RAESR VTL
13	Written Approval	GFE Software Requirements Specification			N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
14	Written Approval	GFE Software Development Plan			N	
15	Written Approval	GFE Software Design Document			N	
16	Written Approval	Engineering Drawings	At PDR, as specified in DO	Once with Revisions	N	
17	Written Approval	EEE Parts Lists and Analysis Report			N	
18	Mandatory Submittal	Critical Design Review Data Package			N	CDR info provided in tech library
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	Y	A copy of any internal contractor procedures referenced in qualification test procedures shall be included as an attachment(s).
21	Written Approval	Flight Product User's Guide			N	
22	Mandatory Submittal	Software Code			N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	Attachment J-4 Due 30 days after DO award	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	Y	Refer to EA-WI-023 and CARDs
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	Y	Refer to EA-WI-023 Req's for SAR
26	Mandatory Submittal	Engineering Analysis	As needed	As Required	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One ADP per flight unit upon completion of acceptance testing or hardware update(s).	Y	Must comply with SSP 30695
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	Y	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	Specified in DO	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	Y	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N (If Applicable)	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Attachment J-9	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	Y	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	Y	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	
41	Upon Request	Nonconformance Record		As Required	Y	See Notes 3-6, 8
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	
43	Written Approval	Electrical, Electronic, and Electromechanical (EEE) Parts Control Plan			N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document			N	Provided in tech library
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	Y	A copy of any internal contractor procedures referenced in acceptance test procedures shall be included as an attachment(s).
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	Y	
50		Reserved	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or facilities unless requested by the contractor in their response to a request for bid.

Flight hardware test facilities, such as loads, thermal, and vibration are available for the execution of this delivery order upon submission of JSC Form 90's to the DO Manager. NASA expects to use its own funds for facilities and facility support staff. Test plan, test readiness review, and flight hardware documentation shall be provided by the delivery order contractor.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list is filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116809-302 (EWA) *S/N 1001: modification/repair per RFP *All: modification per post-flight maintenance/refurbishment procedure	7	$90,000	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116933-301 (EWA Caddy)	7	$16,279	Contractor Facility or JSC	3 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06)
SED33116360-30x (Gel Brush Caddy)	6	$20,694	Contractor Facility or JSC	2 upon award of DO 2 upon return from STS-121 (approx 9/1/06) 2 upon return from STS-115 (approx 10/1/06) Balance per project schedule.

SDD33116387-001	25	$159	Contractor Facility or JSC	Per project schedule
SDD33116406-001	30	$.30	Contractor Facility or JSC	Per project schedule
SED33117201-001, -002, -003	90 each dash number	$.30	Contractor Facility of JSC	Per project schedule

B. List of Property the Contractor will return in the same configuration:

Deleted: *[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.*

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
SED33116385-301 (Removable Brush Handle)	18	$12,000 EA	Contractor Facility or JSC	5 upon award of DO 4 upon return from STS-121 (approx 9/1/06) 4 upon return from STS-115 (approx 10/1/06) Balance per project schedule.
SEG33116397-703 (EVA Wipes)	60	$5,000 EA	Contractor Facility or JSC	16 upon award of DO 11 upon return from STS-115 (approx 10/1/06) Balance per project schedule.
SED33116394-70x (Gel Brushes)	218	$196.31 EA	Contractor Facility or JSC	154 upon award of DO. Balance per project schedule.

Deleted: *[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.*

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

List is inclusive of all hardware referenced in Tables A and B. The government accepts the risk, including repair/replacement cost, of incurring damage to flight hardware during the course of approved qualification and acceptance testing conducted in accordance with the CARD. Efforts to repair/replace property damaged during the course of approved testing are cost-reimbursable, but no additional fee will be awarded. If an item is lost or damaged through no fault of the contractor at a facility outside the contractor's control, the contractor will not be held responsible for the loss provided that due care and diligence were taken in transferring the hardware to the facility (i.e., hardware was appropriately packaged, transfer was documented, test facility acknowledged receipt of hardware). Responsibility for loss or damage to hardware, including repair/replacement cost, caused by process escapes or negligence is the sole responsibility of the contractor.

(c) The list of personnel and/or facilities (shown below or as specified in the contract Schedule) may, with the consent of the contracting parties, be amended from time to time during the course of the contract to add or delete personnel and/or facilities.

Key Personnel:

1) Project Manager	***Craig Flora***
2) Project Engineer(s)	***Jake Dembeck / Jeremy Neubauer***
3) Production Manager	***Wayne Baumann***
4) Test Manager	***Rick Fanning***
5) Quality Manager	***Richard McWilliams***
6) Quality Engineer	***Julia VanSchooten***

(End of Clause)

End of Section

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO17R4

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO17R4

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 3/5/07 to 12/18/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO17R4

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 12/15/06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Enhanced Right Angle Drive (ERAD) DO 17 Rev 4 is issued to extend the completion date to 12/18/08 at no additional cost to the government. DO VALUE RECAP: Cost b4 Fee TOTAL $1,116,661	LOT			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Ralph Marak, x39144 For: EC7/Gary Nickel

13. Total
$ 1,116,661 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No. NNJ05HB40B, DO17R~~2~~3 mt

2. Date of Order See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**
Order No.: NNJ05HB40B, DO17R~~2~~3 mt

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 3/5/07 to 11/17/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO17R~~2~~3 mt

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 5/27/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	mt Enhanced Right Angle Drive (ERAD) DO 17 Rev ~~2~~3 is issued to add changes associated with design changes to the DO, extend completion date, and increase DO value. The completion date is extended to 11/17/08. DO VALUE RECAP: PRIOR / THIS ACTION / CUM VALUE Cost Fee b4 b4 b4 TOTAL $966,755 $149,906 $1,116,661				b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC7/Gary Nickel

13. Total
$ 1,116,661 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO17R2

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO17R2

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 3/5/07 to 11/04/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO17R2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 5/8/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Enhanced Right Angle Drive (ERAD) Revision 2 to DO 17 is issued to extend the completion date at no additional cost to the government. The new completion dates follows: (1) prototype testing completion prior to delta CDR, a delta CDR in May 2008, (2) qual and acceptance testing complete by 9/30/08, (3) delivery of flight articles by 11/4/08.				b4	

DO VALUE:	Prior Value	This Action	Cum Value
Cost			
Fee		b4	
TOTAL	$931,504	$35,251	$966,755

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC7/Gary Nickel

13. Total
$ 966,755 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO17R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO17R1

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 3/5/07 to 8/25/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO17R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 8/22/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	Enhanced Right Angle Drive (ERAD) Period of Performance: 3/5/07 to 8/25/08 Revision 1 to DO 17 is issued to revise the Statement of Work (SOW) and increase the DO value by $35,251 from $931,504 to $966,755. All changes to the SOW have been vertically bar-marked in the attached replacement SOW. DO VALUE: Prior Value / This Action / Cum Value Cost Fee b4 b4 b4 TOTAL $931,504 $35,251 $966,755				b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC7/Gary Nickel

13. Total
$ 966,755

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-017 ERAD

PROPOSAL INSTRUCTIONS: Rev 1 DRAFT 3 -- COMMENTS DUE BY: _____ COB

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DO TITLE: EVA Enhanced Right Angle Drive

DO Type: _X_ CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler **Phone: (281) 483-0025**

DO Manager: Gary Nickel **Phone: (281) 483-9216**

Deleted: David Glebe

DO Mgr. Alternate: _____ **Phone: _____**

Concurrences:

Gary Nickel **DO Manager**	**Harold Reimers** **DO Mgr. Management**	**Joe Gensler** **COTR**
Joe Gensler **Division TMR**	**Steve Miller** **S & MA**	**Ronald Johnson** **Contracting Officer**

Deleted: David Glebe

Task Contains Flight Hardware, Flight Software or GSE? _X_ Yes ___No

Program Supported: _X_Shuttle _X_ISS _X_EVA __Advanced

WBS: _X_ 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for all Delivery Orders on the contract combined.

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

1.0 Objective

The existing bilateral tool Right Angle Drive (P/N SEG33106925-305) has revealed early cycle life issues that restrict the useful life and impact overall confidence in the output torque values. Design, develop, certify, manufacture, and deliver an Enhanced Right Angle Drive (ERAD) that is suitable for breaking and applying static torques and to use as a continuous torque transmission device.

2.0 Need for an Enhanced Right Angle Drive

The Right Angle Drive (P/N: SEG33106925-305) that is currently being used in International Space Station (ISS) assembly tasks was only designed to remove ninety-six (96) bolts that would require no more than five (5) turns each. Since the RADs initial certification, ISS assembly teams have determined that the RAD needs to be used in other assembly tasks that include driving bolts in excess of five (5) turns as well as performing final bolt torques. Thus, a new "enhanced" right angle drive is required to complete ISS assembly tasks.

3.0 Prior Work

NASA currently uses a Right Angle Drive (P/N: SEG33106925-301/-303/-305) that was not designed to be used as a transmission to continuously drive bolts more than five (5) turns. The current design was extensively fit checked to worksites (at the vendor facilities) throughout the development of ISS. The existing RAD dimensions are believed to be acceptable for the RAD to be used in all assembly tasks which require the use of the RAD.

Task Description:

The contractor is to perform the necessary analysis and design of the ERAD to meet the performance requirements as listed below. The contractor shall present a design concept to NASA detailing the concept's features such as COTS hardware, unique design features, design risks, etc. The contractor shall present a design concept to NASA prior to being awarded the contract to design, fabricate, and certify the ERAD. Upon delivery order by NASA, the contractor shall complete the design, fabrication, testing, and certification of the ERAD. The design shall comply with applicable EVA GDRD requirements. The contractor shall, upon successful completion of testing, manufacture, and certification, deliver one (1) qualification, five (5) flight, no (0) Neutral Buoyancy Laboratory (NBL) compatible ERADs and provide sustaining engineering as required for the hardware for a period of no less than six (6) months*. No part of the design will be proprietary and NASA will have full access and ownership of all engineering drawings, CAD models, procedures, and related documentation. The drawings will be released in the Electronic Drawing Control Center. All drawings will use JSC standard processing (i.e., PRC) callouts. All documentation (requirements documents, assembly procedures, certification documentation, etc) will be released through the JSC document system.

*ERAD Design shall be such that servicing of the internal mechanisms will not be needed; however, NASA expects that the contractor support any Items for Investigation (IFI), In-Flight Anomoly (IFA), Failure Investigation Action Report (FIAR), or any type of failure that may occur within the first six (6) months after the final delivery of the ERAD.

1. **Requirements**

The ERAD shall meet, at minimum, the requirements that are listed in JSC-33601, Revision J for the Right Angle Drive (P/N: SEG33106925-305) with the exceptions defined in the following sections, including capability of being used in either Orbiter payload bay EVA Environment or in the ISS EVA environment as defined in JSC-26626A:

Weight

- The weight of the ERAD shall not exceed 4.0 pounds.

Dimensions

- The ERAD shall not exceed the following envelope dimensions:
  - Stowed (handle closed): 11.1 in. x 2.75 in. x 3.17 in.
  - Deployed (handle extended): 11.1 in. x 2.75 in. 7.32 in.
- Additional envelope dimension constraints:
  - The output housing of the ERAD should not exceed 1.625 inches in diameter

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Interfaces

The enhanced right angle drive (ERAD) shall interface with the following: EVA standard 3/8" male drives and EVA standard female drop proof tethers (DPTs). These interfaces shall function with a maximum 100°F differential over the operational temperature range.

- Extravehicular Activity Standard 3/8" Male Drive Interface
  - Orientation
    - Interface of the ERAD EVA standard 3/8" male drive to the DPT shall be independent of orientation.
  - Interface Definition
    - Interface to the ERAD EVA standard 3/8" male drive shall be in accordance with ICD JSC-33546 (CTSD-SS-1035).
  - 3/8" Drive Gage
    - The ERAD output drive shall interface with the 3/8" male drive go and no-go gage (SDG38114280-001).
- Drop Proof Tether (DPT) Interface
  - Orientation
    - Interface of the ERAD DPT to the EVA standard 3/8" male drive shall be independent of orientation.
  - Interface Definition
    - Interface of the ERAD DPT shall be in accordance with ICD JSC-33546 (CTSD-SS-1035).
  - Drop Proof Tether Gage
    - The ERAD DPT shall interface with the DPT go and no-go gage (SDG38114281-001) and the McTether load fixture (gage) (SDG38114296-001).

- Push-In-Place (PIP) Pin Interface
  - Interface Definition
    - Interface to the standard 3/16" PIP pin shall be in accordance with ICD JSC-33546 (CTSD-SS-1035).
  - Push-In-Place (PIP) Pin Gage
    - The ERAD DPT shall interface with the DPT PIP pin gage (SDG38114295-001).

Life Cycling of ERAD Mechanism

- Drive Mechanism Cycling
  -
  - The total number of output cycles are derived as follows :
    - 2 drive tasks/EVA x 10 cycles/drive task x 31 EVAs/year x 15 years x S.F. [where Scatter Factor (S.F.) = 4.0] = 37,200 cycles
  - The 3/8" male drive shall be capable of withstanding (at minimum) 37,200 cycles to verify life expectancy. A cycle is defined as one clockwise (CW) turn followed by one counterclockwise (CCW) turn. (NOTE: it is acceptable to perform (for acceptance/qualification testing) blocks of cycles as follows: 10 CW turns followed by 10 CCW turns.)
    - CCW: Apply input shaft torque of 12.0, 25.5, or 36.6 ft-lb. (see below for breakdown)
    - CCW: Drive output shaft 10 turns with a running torque (ERAD output load) of 5.0 ft-lbs for 50% of cycles and 2.0 ft-lb for 50% of cycles.
    - CW: Drive output shaft 10 turns with a running torque (ERAD output load) of 5.0 ft-lbs for 50% of cycles and 2.0 ft-lb for 50% of cycles.
    - CW: Apply final input shaft torque 12.0, 25.5, 36.6 ft-lb.
  - 1810 of the break and final torques shall be performed at 12 ft-lb.
  - 1810 of the break and final torques shall be performed at 25.5 ft-lb.
  - 100 of the break and final torques shall be performed at 36.6 ft-lb.
  - 10% of the test shall be performed with a side load equivalent to a 2 lb applied vertically at a distance equal to the location of the PGT trigger..
  - Life cycle testing may be interrupted to allow the ERAD to cool
- Male Drive Cycling
  - The ERAD male drive shall be capable of withstanding 1860 cycles to verify life expectancy (1 tool change out/task x 2 tasks/EVA x 31 EVAs/year x 15 years x S.F. [where S.F. = 2.0].
- Drop Proof Tether (DPT) Mechanism
  - The DPT drive shall be capable of withstanding 5580 cycles to verify life expectancy (3 DPT change outs/task x 2 tasks/EVA x 31 EVAs/year x 15 years x S.F. [where S.F. = 2.0].
- Handle Deployment Cycling
  - The handle shall be capable of withstanding 1860 cycles to verify life expectancy (1 handle deployment/task x 2 tasks/EVA x 31 EVAs/year x 15 years x S.F. [where S.F. = 2.0]).

Loads

- The ERAD shall be able to meet all of the load and cycle requirements over the full operational temperature range of its certification.

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- The design/analysis/testing of the ERAD shall include thermal degradation factors based on the predicted temperature range of the ERAD.
- At the end of the useful life of useful life of the ERAD, the torque transmission efficiency shall not be less than 1.5:1 (output: input) for both static and dynamic load conditions.
- Torque transmission efficiency factor cannot change by more than 0.4 over the life of the tool. This may be described by the equation (*beginning of life - end of life* $\leq$ .4).
- The rotational input speed (at no-load conditions) shall be capable of operating up to speeds of sixty (60) revolutions per minute (RPM).
- The rotational input speed shall not exceed sixty (60) RPM when the output torque is driving a bolt with a two (2.0) foot-pound (ft-lb) running torque.
- The maximum input static load shall not exceed 36.6 ft-lbs (30.5 ft-lbs x 1.20).
- The maximum dynamic input load shall not exceed 28.1 ft-lbs (25.5 ft-lbs x 1.10).
- Qual unit shall pass a proof load test of 36.6 x 1.1FS = 43.9 ft-lb at the end of life cycle testing.
- Qual unit shall pass an ultimate load test of 36.6 x 1.5FS = 54.9 one time only. Unit may be refurbished prior to performing this test.
- Cooling time shall be determined through thermal analysis and/or testing but shall not exceed five (5) minutes based on EVA environments extremes.
- Torque transmission efficiency shall be measured once each at hot and cold extremes at max torque input load and a side load of 2 lb.
- The ERAD shall be designed such that no debris (i.e., Foreign Object Debris [FOD]) will be generated during the life of the tool

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Operational Forces

- The retention force of the DPT locked on an EVA standard 3/8" male drive shall be 18.0 pounds (limit) without functional degradation of the system components. The DPT shall retain an EVA standard 3/8" male drive for a minimum of 60.0 pounds (ultimate).
- 3/8" Male Drive Soft Docking Force
  - The force required to soft dock into a DPT shall measure between 0.5 and 2.5 pounds.
- Handle Actuation Force
  - The force required to open/close the ERAD handle shall measure between 1.0 and 6.0 pounds (measured at the center of the handle).
- PIP Pin Actuation Force
  - The force required to insert or remove the PIP pin into or out of the ERAD DPT shall measure between 0.25 and 3.5 pounds.

Functional Requirements

- Fastener Installation and Removal
  - ERAD shall be capable of performing breaking torque on fasteners, driving the fastener (during installation or removal), and performing final fastener torque.
- Drive Mechanism Capability
  - The ERAD shall allow rotation in both clockwise and counterclockwise directions. The mechanism shall operate freely.
- Torque Output Angle
  - The ERAD output drive axis shall be perpendicular to the input drive axis.
- Output-to-Input Rotation

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  - The ERAD shall have an output drive rotational direction that is the same as the input drive rotational direction.
- Handle Lock
  - The ERAD handle shall be capable of being deployed and locked in eight (8) positions (in 45 degree increments) around the ERAD drive train.
- Handle Position
  - The ERAD handle shall be stowable, and shall have at minimum at least two (2) detent positions (0 degrees [fully stowed] and 90 degrees [fully deployed]).

2. Reporting

The contractor shall provide weekly technical status, a bi-monthly schedule review, and monthly financial management reports as directed in the data requirements table.

3. Earned Value

The contractor shall provide data pertaining to earned value reporting for the milestones identified in the "Interim Milestones" Table. Above and beyond normal CRAVE 533 reporting, the CRAVE contractor shall report earned value on a monthly basis. The earned value baseline shall consist of no fewer than the ten (10) interim milestone breakdown of the project with cost and schedule associated for each line item. A baseline earned value plan review and approval is to be held with NASA not later than two (2) weeks after the delivery order is issued.

4. Government Provided Equipment

See Government Furnished Property section.

5. Project Management Plan

The contractor shall provide a project management plan (PMP) that is limited to three (3) pages in length. The PMP shall be released as a JSC document and shall have a JSC document number. The PMP shall be released prior to SRR, and the PMP shall be riddable at SRR.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype	Functional Prototype (including high fidelity interfaces) for engineering testing demonstrating design durability.	1	7/16/07	III
Certification	Full Class I Flight certification including thermal, load and vibration			
Flight	Full acceptance testing	5		I
Training	N/A			
Other	Qualification Unit	1		I/II
Test	Functional testing (acceptance and qualification)	N/A		I / qual
Software	N/A	N/A	N/A	N/A
Other Products	Acceptance Data Package (ADP) for each flight and qualification units	1 per each flight / qual unit		I / II
Other Products	GCAR	1	8/28/08	N/A

SCHEDULE

Start Date: March 5, 2007 **Finish Date:** August 25, 2008

INTERIM MILESTONES	DUE DATES
System Requirements Review (SRR)	Suggested date 4/05/07
Prototype Fabricated	Suggested date TBD
Prototype Testing Completed	Suggested date TBD
Preliminary Design Review (PDR)	Suggested date 7/13/07
Critical Design Review (CDR)	Suggested date 11/16/07
Hardware Fabrication Complete	Suggested date 3/15/08
Hardware Qual / Acceptance Testing Complete	Suggested date 6/16/08
Certification Complete	Suggested date 7/17/08
SAR	Suggested date 8/1/08
Hardware Delivery	8/25/08

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

Deleted: February
Deleted: July
Deleted: 25
Deleted: 3/1
Deleted: 5/1/07
Deleted: 6/1/07
Deleted: 6/15/07
Deleted: 0
Deleted: 2
Deleted: 5
Deleted: 6
Deleted: 7
Deleted: 7/25

Government Estimate Located in RFO File in Microsoft Project File On CRAVE Web Site
The file is titled:

Total Government Estimate for this DO: $1200K
Option 1: $____ (See Attachment 1)
Option 2: $____ (See Attachment 2)

TOTAL COST ESTIMATE FOR THIS DO: $(Contractor Complete)

FEE: $ (If Applicable)

OPTION 1: $ N/A (See Attachment 1)

OPTION 2: $ N/A (See Attachment 2)

DATA REQUIREMENTS

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	Weekly Tech status
3	Written Approval	Project Technical Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
4	Mandatory Submittal if Flt H/W	GFE Systems Requirements Data Package	If Required for DO See Comments	Once with Revisions	Y	Contractor is responsible for all design reviews for all design stages.
5	Written Approval	Flight GFE Projects Requirements & Verification Document	If Required for DO See Comments	Once with Revisions	N	
6	Mandatory Submittal if Flt H/W	Preliminary Design Review Data Package	If Required for DO See Comments	Once with Revisions	Y	
7	Written Approval	Flight GFE Workmanship Specifications List	If Required for DO See Comments	Once with Revisions	Y	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document	If Required for DO See Comments	Once with Revisions	Y	
10	Written Approval	GFE End Item Specification	If Required for DO See Comments	Once with Revisions	N	
11	Mandatory Submittal if Flt H/W	Flight GFE Failure Analysis Report	If Required for DO See Comments	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in WI-EA-023	Once with Revisions	Y	
13	Written Approval	GFE Software Requirements Specification	If Required for DO See Comments	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
14	Written Approval	GFE Software Development Plan	If Required for DO See Comments	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	If Required for DO See Comments	As Required	N	
16	Written Approval	Engineering Drawings	If Required for DO See Comments	Once with Revisions	Y	Pro-E format CAD Models and Drawing files
17	Written Approval	EEE Parts Lists and Analysis Report	If Required for DO See Comments	As Required	N	No EEE parts
18	Mandatory Submittal if Flt H/W	Critical Design Review Data Package	If Required for DO See Comments	Once with Revisions	Y	
19	Mandatory Submittal if Flt H/W	Engineering Drawing Change Proposal	If Required for DO See Comments	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	If Required for DO See Comments	Once with Revisions	Y	Contractor deliverable
21	Written Approval	Flight Product User's Guide	If Required for DO See Comments	Once with Revisions	N	
22	Mandatory Submittal if Flt H/W	Software Code	If Required for DO See Comments	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	Attachment J-4 Due 30 days after DO award	
24	Written Approval	Certification Plan	If Required for DO See Comments	Once with Revisions	Y	Contractor deliverable
25	Mandatory Submittal if Flt H/W	Certification Report	If Required for DO See Comments	Once with Revisions	Y	Contractor deliverable
26	Mandatory Submittal if Flt H/W	Engineering Analysis	If Required for DO See Comments	As Required	Y	
27	Mandatory Submittal if Flt H/W	Acceptance Data Package	If Required for DO See Comments	One Time	Y	Supplied for qual and Flight Units
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	Only if contractor is using the R-quality plan template instead of ISO, and only if they need to make changes to it.
30	Written Approval	Patent Rights-Retention	As Required	As Required	Y (If Applicable)	
31	Written Approval	Shuttle/Station Payload Safety Data Package	If Required for DO See Comments	As Required	N	
32	Mandatory Submittal if Flt H/W	Limited Life Systems List	If Required for DO See Comments	As Required	Y	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	If Required for DO See Comments	As Required	Y	If applicable
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	If Required for DO See Comments	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	If Required for DO See Comments	As Required	Y	If applicable
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Y	Reliability Plan only, Maintainability plan only applicable if maintainance is needed to sustain hardware intended life.
38	Written Approval	Government Certification Approval Request (GCAR)	If Required for DO See Comments	As Required	Y	Contractor deliverable
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	If Required for DO See Comments	As Required	Y	Contractor deliverable
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	
41	Upon Request	Nonconformance Record	If Required for DO See Comments	As Required	Y	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	If Required for DO See Comments	Once with Revisions	N	
44	Mandatory Submittal if Flt H/W	Certification Data Package	If Required for DO See Comments	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	Y	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	If Required for DO See Comments	One Time	Y	
48	Mandatory Submittal if Flt H/W	Flight GFE Verification & Validation Report	If Required for DO See Comments	Once with Revisions	Y	
49	Mandatory Submittal if Flt H/W	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	If Required for DO See Comments	As Required	Y	If applicable
50		Reserved	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	N	

Type 1 – Written Approval Type 2 – Mandatory Submittal Type 3 – Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY - The list of items below will be provided as Government Furnished Property.

Item	Part Number	Quantity	Value
3/8" Male Drive Go/No-Go Gage	SDG38114280-001	1	$ 2000 each
DPT Go/No-Go Gage	SDG38114281-001	1	$ 2000 each
McTether Load Fixture (Gage)	SDG38114296-001	1	$ 3000 each
DPT PIP Pin Gage	SDG38114295-001	1	$ 2000 each
	(available by October 15, 2007)		

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC7-DO17

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-6828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC7-DO17

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 2/5/07 thru 7/25/08 3/5/07 - 8/25/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC7-D017

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 2/23/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	CRAVE-EC7-DO17 Enhanced Right Angle Drive (ERAD) The contractor shall perform and deliver to all base requirements of CRAVE-EC7-DO17 as described in the attached Statement of Work. Period of Performance: 3/5/07 to 8/25/08 This is a CPFF delivery order.				64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 931,504

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

Narrative Task Description

Background / Problem Description:

1.0 Objective

The existing bilateral tool Right Angle Drive (P/N SEG33106925-305) has revealed early cycle life issues that restrict the useful life and impact overall confidence in the output torque values. Design, develop, certify, manufacture, and deliver an Enhanced Right Angle Drive (ERAD) that is suitable for breaking and applying static torques and to use as a continuous torque transmission device.

2.0 Need for an Enhanced Right Angle Drive

The Right Angle Drive (P/N: SEG33106925-305) that is currently being used in International Space Station (ISS) assembly tasks was only designed to remove ninety-six (96) bolts that would require no more than five (5) turns each. Since the RADs initial certification, ISS assembly teams have determined that the RAD needs to be used in other assembly tasks that include driving bolts in excess of five (5) turns as well as performing final bolt torques. Thus, a new "enhanced" right angle drive is required to complete ISS assembly tasks.

3.0 Prior Work

NASA currently uses a Right Angle Drive (P/N: SEG33106925-301/-303/-305) that was not designed to be used as a transmission to continuously drive bolts more than five (5) turns. The current design was extensively fit checked to worksites (at the vendor facilities) throughout the development of ISS. The existing RAD dimensions are believed to be acceptable for the RAD to be used in all assembly tasks which require the use of the RAD.

Task Description:

The contractor is to perform the necessary analysis and design of the ERAD to meet the performance requirements as listed below. The contractor shall present a design concept to NASA detailing the concept's features such as COTS hardware, unique design features, design risks, etc. The contractor shall present a design concept to NASA prior to being awarded the contract to design, fabricate, and certify the ERAD. Upon delivery order by NASA, the contractor shall complete the design, fabrication, testing, and certification of the ERAD. The design shall comply with applicable EVA GDRD requirements. The contractor shall, upon successful completion of testing, manufacture, and certification, deliver one (1) qualification, five (5) flight, no (0) Neutral Buoyancy Laboratory (NBL) compatible ERADs and provide sustaining engineering as required for the hardware for a period of no less than six (6) months*. No part of the design will be proprietary and NASA will have full access and ownership of all engineering drawings, CAD models, procedures, and related documentation. The drawings will be released in the Electronic Drawing Control Center. All drawings will use JSC standard processing (i.e., PRC) callouts. All documentation (requirements documents, assembly procedures, certification documentation, etc) will be released through the JSC document system.

*ERAD Design shall be such that servicing of the internal mechanisms will not be needed; however, NASA expects that the contractor support any Items for Investigation (IFI), In-Flight Anomoly (IFA), Failure Investigation Action Report (FIAR), or any type of failure that may occur within the first six (6) months after the final delivery of the ERAD.

1. Requirements

The ERAD shall meet, at minimum, the requirements that are listed in JSC-33601, Revision J for the Right Angle Drive (P/N: SEG33106925-305) with the exceptions defined in the following sections, including capability of being used in either Orbiter payload bay EVA Environment or in the ISS EVA environment as defined in JSC-26626A:

Weight

- The weight of the ERAD shall not exceed 4.0 pounds.

Dimensions

- The ERAD shall not exceed the following envelope dimensions:
  - Stowed (handle closed): 10.83 in. x 2.5 in. x 3.10 in.
  - Deployed (handle extended): 10.83 in. x 2.5 in. x 7.25 in.
- Additional envelope dimension constraints:
  - The output housing of the ERAD should not exceed 1.5 inches in diameter

Interfaces

The enhanced right angle drive (ERAD) shall interface with the following: EVA standard 3/8" male drives and EVA standard female drop proof tethers (DPTs). These interfaces shall function with a maximum 100°F differential over the operational temperature range.

- Extravehicular Activity Standard 3/8" Male Drive Interface
  - Orientation
    - Interface of the ERAD EVA standard 3/8" male drive to the DPT shall be independent of orientation.
  - Interface Definition
    - Interface to the ERAD EVA standard 3/8" male drive shall be in accordance with ICD JSC-33546 (CTSD-SS-1035).
  - 3/8" Drive Gage
    - The ERAD output drive shall interface with the 3/8" male drive go and no-go gage (SDG38114280-001).
- Drop Proof Tether (DPT) Interface
  - Orientation
    - Interface of the ERAD DPT to the EVA standard 3/8" male drive shall be independent of orientation.
  - Interface Definition
    - Interface of the ERAD DPT shall be in accordance with ICD JSC-33546 (CTSD-SS-1035).
  - Drop Proof Tether Gage
    - The ERAD DPT shall interface with the DPT go and no-go gage (SDG38114281-001) and the McTether load fixture (gage) (SDG38114296-001).

- Push-In-Place (PIP) Pin Interface
  - Interface Definition
    - Interface to the standard 3/16" PIP pin shall be in accordance with ICD JSC-33546 (CTSD-SS-1035).
  - Push-In-Place (PIP) Pin Gage
    - The ERAD DPT shall interface with the DPT PIP pin gage (SDG38114295-001).

Life Cycling of ERAD Mechanism

- Drive Mechanism Cycling
  - One (1) cycle is defined as one(1) output revolution.
  - The total number of output cycles are derived as follows :
    - 2 drive tasks/EVA x 10 cycles/drive task x 31 EVAs/year x 15 years x S.F. [where Scatter Factor (S.F.) = 2.0] = 18,600 cycles
  - The 3/8" male drive shall be capable of withstanding (at minimum) 18,600 cycles to verify life expectancy. A cycle is defined as one clockwise (CW) turn followed by one counterclockwise (CCW) turn. (NOTE: it is acceptable to perform (for acceptance/qualification testing) large number of cycles as follows: 100 CW cycles followed by 100 CCW cycles.)
    - CCW: Break bolt torque with a 28.1 ft-lbs (25.5 ft-lbs x 1.10) ERAD input load
    - CCW: Drive bolt 100 turns with a bolt running torque (ERAD output load) of 2.0 ft-lbs.
    - CW: Drive bolt 100 turns with an bolt running torque (ERAD output load) of 2.0 ft-lbs.
    - CW: Final bolt torque with a 28.1 ft-lbs (25.5 ft-lbs x 1.10) ERAD input load.
  - The above cycle profile (100 cycles) shall be repeated until the required number of cycles are achieved.
  - Life cycle testing may be interrupted to allow the ERAD to cool
- Male Drive Cycling
  - The ERAD male drive shall be capable of withstanding 1860 cycles to verify life expectancy (1 tool change out/task x 2 tasks/EVA x 31 EVAs/year x 15 years x S.F. [where S.F. = 2.0].
- Drop Proof Tether (DPT) Mechanism
  - The DPT drive shall be capable of withstanding 5580 cycles to verify life expectancy (3 DPT change outs/task x 2 tasks/EVA x 31 EVAs/year x 15 years x S.F. [where S.F. = 2.0].
- Handle Deployment Cycling
  - The handle shall be capable of withstanding 1860 cycles to verify life expectancy (1 handle deployment/task x 2 tasks/EVA x 31 EVAs/year x 15 years x S.F. [where S.F. = 2.0]).

Loads

- The ERAD shall be able to meet all of the load and cycle requirements over the full operational temperature range of it's certification.
- The design/analysis/testing of the ERAD shall include thermal degradation factors based on the predicted temperature range of the ERAD.

- At the end of the useful life of useful life of the ERAD, the torque transmission efficiency shall not be less than 1.5:1 (output: input) for both static and dynamic load conditions.
- Torque transmission efficiency factor cannot change by more than 0.4 over the life of the tool. This may be described by the equation (*beginning of life - end of life* $\leq$ .4).
- The rotational input speed (at no-load conditions) shall be capable of operating up to speeds of sixty (60) revolutions per minute (RPM).
- The rotational input speed shall not exceed sixty (60) RPM when the output torque is driving a bolt with a two (2.0) foot-pound (ft-lb) running torque.
- The maximum input static load shall not exceed 36.6 ft-lbs (30.5 ft-lbs x 1.20).
- The maximum dynamic input load shall not exceed 28.1 ft-lbs (25.5 ft-lbs x 1.10).
    - The cooling time shall be determined through thermal analysis and/or testing but shall not exceed five (5) minutes based on EVA environments extremes
- The ERAD shall be designed such that no debris (i.e., Foreign Object Debris [FOD]) will be generated during the life of the tool

Operational Forces

- The retention force of the DPT locked on an EVA standard 3/8" male drive shall be 18.0 pounds (limit) without functional degradation of the system components. The DPT shall retain an EVA standard 3/8" male drive for a minimum of 60.0 pounds (ultimate).
- 3/8" Male Drive Soft Docking Force
    - The force required to soft dock into a DPT shall measure between 0.5 and 2.5 pounds.
- Handle Actuation Force
    - The force required to open/close the ERAD handle shall measure between 1.0 and 6.0 pounds (measured at the center of the handle).
- PIP Pin Actuation Force
    - The force required to insert or remove the PIP pin into or out of the ERAD DPT shall measure between 0.25 and 3.5 pounds.

Functional Requirements

- Fastener Installation and Removal
    - ERAD shall be capable of performing breaking torque on fasteners, driving the fastener (during installation or removal), and performing final fastener torque.
- Drive Mechanism Capability
    - The ERAD shall allow a continuous rotation in the clockwise and counterclockwise directions. The mechanism shall operate freely.
- Torque Output Angle
    - The ERAD output drive axis shall be perpendicular to the input drive axis.
- Output-to-Input Rotation
    - The ERAD shall have an output drive rotational direction that is the same as the input drive rotational direction.
- Handle Lock
    - The ERAD handle shall be capable of being deployed and locked in eight (8) positions (in 45 degree increments) around the ERAD drive train.
- Handle Position
    - The ERAD handle shall be stowable, and shall have at minimum at least two (2) detent positions (0 degrees [fully stowed] and 90 degrees [fully deployed]).

2. Reporting

The contractor shall provide weekly technical status, a bi-monthly schedule review, and monthly financial management reports as directed in the data requirements table.

3. Earned Value

The contractor shall provide data pertaining to earned value reporting for the milestones identified in the "Interim Milestones" Table. Above and beyond normal CRAVE 533 reporting, the CRAVE contractor shall report earned value on a monthly basis. The earned value baseline shall consist of no fewer than the ten (10) interim milestone breakdown of the project with cost and schedule associated for each line item. A baseline earned value plan review and approval is to be held with NASA not later than two (2) weeks after the delivery order is issued.

4. Government Provided Equipment

See Government Furnished Property section.

5. Project Management Plan

The contractor shall provide a project management plan (PMP) that is limited to three (3) pages in length. The PMP shall be released as a JSC document and shall have a JSC document number. The PMP shall be released prior to SRR, and the PMP shall be riddable at SRR.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype	Functional Prototype (including high fidelity interfaces) for engineering testing demonstrating design durability.	1	7/16/07	III
Certification	Full Class I Flight certification including thermal, load and vibration			
Flight	Full acceptance testing	5		I
Training	N/A			
Other	Qualification Unit	1		I/II
Test	Functional testing (acceptance and qualification)	N/A		I / qual
Software	N/A	N/A	N/A	N/A
Other Products	Acceptance Data Package (ADP) for each flight and qualification units	1 per each flight / qual unit		I / II
Other Products	GCAR	1	8/28/08	N/A

SCHEDULE

Start Date: March 5, 2007 **Finish Date: August 25, 2008**

ITERIM MILESTONES	DUE DATES
System Requirements Review (SRR)	Suggested date 3/1/07
Prototype Fabricated	Suggested date 5/1/07
Prototype Testing Completed	Suggested date 6/1/07
Preliminary Design Review (PDR)	Suggested date 6/15/07
Critical Design Review (CDR)	Suggested date 10/16/07
Hardware Fabrication Complete	Suggested date 2/15/08
Hardware Qual / Acceptance Testing Complete	Suggested date 5/16/08
Certification Complete	Suggested date 6/17/08
SAR	Suggested date 7/1/08
Hardware Delivery	7/25/08

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled:

Total Government Estimate for this DO: $
Option 1: $____ (See Attachment 1)
Option 2: $____ (See Attachment 2)

TOTAL COST ESTIMATE FOR THIS DO: $(Contractor Complete)

FEE: $ (If Applicable)

OPTION 1: $ N/A (See Attachment 1)

OPTION 2: $ N/A (See Attachment 2)

DATA REQUIREMENTS

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	Weekly Tech status
3	Written Approval	Project Technical Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
4	Mandatory Submittal if Flt H/W	GFE Systems Requirements Data Package	If Required for DO See Comments	Once with Revisions	Y	Contractor is responsible for all design reviews for all design stages.
5	Written Approval	Flight GFE Projects Requirements & Verification Document	If Required for DO See Comments	Once with Revisions	N	
6	Mandatory Submittal if Flt H/W	Preliminary Design Review Data Package	If Required for DO See Comments	Once with Revisions	Y	
7	Written Approval	Flight GFE Workmanship Specifications List	If Required for DO See Comments	Once with Revisions	Y	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document	If Required for DO See Comments	Once with Revisions	Y	
10	Written Approval	GFE End Item Specification	If Required for DO See Comments	Once with Revisions	N	
11	Mandatory Submittal if Flt H/W	Flight GFE Failure Analysis Report	If Required for DO See Comments	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in WI-EA-023	Once with Revisions	Y	
13	Written Approval	GFE Software Requirements Specification	If Required for DO See Comments	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
14	Written Approval	GFE Software Development Plan	If Required for DO See Comments	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	If Required for DO See Comments	As Required	N	
16	Written Approval	Engineering Drawings	If Required for DO See Comments	Once with Revisions	Y	Pro-E format CAD Models and Drawing files
17	Written Approval	EEE Parts Lists and Analysis Report	If Required for DO See Comments	As Required	N	No EEE parts
18	Mandatory Submittal if Flt H/W	Critical Design Review Data Package	If Required for DO See Comments	Once with Revisions	Y	
19	Mandatory Submittal if Flt H/W	Engineering Drawing Change Proposal	If Required for DO See Comments	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	If Required for DO See Comments	Once with Revisions	Y	**Contractor deliverable**
21	Written Approval	Flight Product User's Guide	If Required for DO See Comments	Once with Revisions	N	
22	Mandatory Submittal if Flt H/W	Software Code	If Required for DO See Comments	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	If Required for DO See Comments	Once with Revisions	Y	**Contractor deliverable**
25	Mandatory Submittal if Flt H/W	Certification Report	If Required for DO See Comments	Once with Revisions	Y	**Contractor deliverable**
26	Mandatory Submittal if Flt H/W	Engineering Analysis	If Required for DO See Comments	As Required	Y	
27	Mandatory Submittal if Flt H/W	Acceptance Data Package	If Required for DO See Comments	One Time	Y	Supplied for qual and Flight Units
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	Only if contractor is using the R-quality plan template instead of ISO, and only if they need to make changes to it.
30	Written Approval	Patent Rights-Retention	As Required	As Required	Y (If Applicable)	
31	Written Approval	Shuttle/Station Payload Safety Data Package	If Required for DO See Comments	As Required	N	
32	Mandatory Submittal if Flt H/W	Limited Life Systems List	If Required for DO See Comments	As Required	Y	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	If Required for DO See Comments	As Required	Y	**If applicable**
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	If Required for DO See Comments	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	If Required for DO See Comments	As Required	Y	**If applicable**
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Y	**Reliability Plan only, Maintainability plan only applicable if maintainance is needed to sustain hardware intended life.**
38	Written Approval	Government Certification Approval Request (GCAR)	If Required for DO See Comments	As Required	Y	**Contractor deliverable**
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	If Required for DO See Comments	As Required	Y	**Contractor deliverable**
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	
41	Upon Request	Nonconformance Record	If Required for DO See Comments	As Required	Y	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	If Required for DO See Comments	Once with Revisions	N	
44	Mandatory Submittal if Flt H/W	Certification Data Package	If Required for DO See Comments	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	Y	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	If Required for DO See Comments	One Time	Y	
48	Mandatory Submittal if Flt H/W	Flight GFE Verification & Validation Report	If Required for DO See Comments	Once with Revisions	Y	
49	Mandatory Submittal if Flt H/W	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	If Required for DO See Comments	As Required	Y	If applicable
50		Reserved	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	N	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY - The list of items below will be provided as Government Furnished Property.

Item	Part Number	Quantity	Value
3/8" Male Drive Go/No-Go Gage	SDG38114280-001	1	$ 2000 each
DPT Go/No-Go Gage	SDG38114281-001	1	$ 2000 each
McTether Load Fixture (Gage)	SDG38114296-001	1	$ 3000 each
DPT PIP Pin Gage	SDG38114295-001	1	$ 2000 each
	(available by October 15, 2007)		

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
DO-CRAVE-EC-015

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: Charles A. Riley Jr.

Tel No.: 281-483-6280 Fax: ____
E-mail: michael.d.ballard@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: DO-CRAVE-EC-015

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: DO-CRAVE-EC-015

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:____

☒ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: NNJ05HB40B

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: 06/28/06

10. Name: Charles A. Riley Jr.

Signature: [signature] Date 07/14/2006
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	The Contractor shall perform and deliver to all requirements for: DO-CRAVE-EC-015: CI Sublimator EDU The Period of Performance for this DO is: 07-28-06 thru 11-08-06					

12. For JSC Internal Use Only:
Requisition No.: ____ ☐ COMP. ☐ PART. PPC: ____
Rissue To: ____

13. Total
$ $89,860

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: ____ ____
Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Task Order Number	*Revision Number*	*Purchase Request Number*
8	16	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

TRACE GAS ANALYZER (TGA)

Description/Purpose

The purpose of this delivery order revision is to extend the period of performance from October 30, 2009 to November 30, 2009. The tasks required for this revision is identified in the Oceaneering Space Systems letter, CNTR-219-09. The recapitulation of the delivery order value is shown below per this revision.

	Previous Revisions	Action (Rev 16)	Task NTE Value
Cost	b4	b4	b4
Fee			
Total	$5,286,993	$ 302,849.00	$5,589,842

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	9/2/09

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Task Order Number	*Revision Number*	*Purchase Request Number*
8	15	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

TRACE GAS ANALYZER (TGA)

Description/Purpose

The purpose of this delivery order revision is to extend the period of performance from June 18, 2009 to October 30, 2009. The tasks required for this revision is identified in the Oceaneering Space Systems letter, CNTR-156-09. The recapitulation of the delivery order value is shown below per this revision.

	Previous Revisions	Action (Rev 15)	Task NTE Value
Cost	b4	b4	b4
Fee			
Total	$4,889,841	$397,152	$5,286,993

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	7/17/09

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Task Order Number	*Revision Number*	*Purchase Request Number*
8	14	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

TRACE GAS ANALYZER (TGA)

Description/Purpose

The purpose of this delivery order revision is to extend the period of performance from April 15, 2009 to June 18, 2009. The tasks required for this revision is identified in the Oceaneering Space Systems letter, CNTR-047-09; and the associated ROM cost are $174,607.

	Previous Revisions	Action (Rev 14)	Task NTE Value
Cost	$ b4	$ b4	$ b4
Fee	$	$	$
Total	$ 4,715,234	$ 174,607	$ 4,889,841

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	4/16/09

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 13

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 13

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 11/28/2005 - 04/30/2009

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 13

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 11/5/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	Trace Gas Analyzer (TGA)					
1	Revision 13 to DO 8 is issued to perform the tasks outlined on page 2, increase the DO value by [redacted] to $4,715,234, and extend the period of performance to 4/30/09.				[redacted]	
	continued page 2					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Ralph Marak, x39144

13. Total
$ NTE $4,715,234

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

TASKS TO BE PERFORMED UNDER DO 8 REVISION 13

Additional Flight Assembly Tasks:

1. Resolving hardware and electronics issues with this first flight build.
2. Refining complex steps in new assembly and testing documents.
3. Debugging the new Ion Pump throttle down feature.
4. Hurricane Ike prep and recovery.
5. Paperwork and tech time to add a grounded cable shield to the QMSA electronics. Also includes staking screw heads on Circuit Boards and Mechanical Parts.

Additional TGA Lab Tasks:

1. Maintain compliance with JSC's Pressure System Requirements.
2. Provide addition components tallow both the Dev Unit and Flight Unit to be hooked up to the TGA Lab vacuum system at the same time. Needed for continuing software development.
3. Repair failed TGA Lab components and TGA Lab calibration efforts.
4. Self training of the new TGA Manager and new assistant Lab Engineer/Technician, trainer time, and the additional time needed to initially perform useful tasks due to unfamiliarity. This unexpected task is needed due to the company loss of both the primary and secondary TGA lab operators.
5. Enhancing lab documentation for current and future TGA Certification and refurbishment.

Additional Software and JPL Electronics Tasks:

1. Identifying and fixing software bugs in the original TGA Code that reduced accuracy as well as additional time needed to make new algorithms for faster gas scanning.
2. Consolidating and correcting JPL's incomplete and inaccurate electronic design information.
3. Procuring, inspecting, and repairing a backup/spare Set of QMSA Electronics.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 12

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 12

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 11/28/2005 - 04/03/2009

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 12

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 9/26/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 12 to DO 8 is issued for the performance of the following tasks: 1) identification and resolution of thermal performance issues with the existing MCP HV circuit board. 2) design development, manufacturing, and testing of a new MCP HV circuit board design that can operate longer before overheating. 3) build two new flight MCP HV circuit boards. 4) build one unit integrated and tested with the flight TGA. The completion date is extended to April 3, 2009. continued page 2	Lot			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Ralph Marak, x39144

13. Total
$ NTE $3,902,381

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

Order No.: NNJ05HB40B, DO8R12

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	RECAP DO VALUE:					
	PRIOR THIS ACTION CUM VALUE					
	COST					
	b4					
	FEE					
	TOTAL $3,672,777 $229,604 $3,902,381.00					
	FUNDING RECAP					
	PRIOR THIS ACTION CUM FUNDING					
	COST					
	b4					
	FEE					
	TOTAL $3,670,213.61 $99,881.63 $3,770.095.24					

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 11

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 11

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 11/28/05 - 09/30/08

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 11

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/2/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 11 to DO 8 is issued to change the Statement of Work to add tasks 1-5 (see page 2), increase the DO value, and extend the completion date. The DO value is i [illegible] to a cumulative NTE value of $3,672,777. The completion date is extended to 9/30/08. continued page 2	Lot				

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total
$ NTE $3,672,777

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

Order No.: NNJ05HB40B, DO8R11

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	JPL Re-Test	Lot				
2	Inspect, Repair, Assemble JPL Elect	Lot				
3	GFE HV Failures	Lot				
4	Mod Flight HV Board	Lot				
5	Test Stand Leaks & Updates	Lot				

RECAP DO VALUE:

	PRIOR	THIS ACTION	CUM VALUE
COST	64	64	64
FEE			
TOTAL	$3,307,355	$365,422	$3,672,777

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 10

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 10

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11 Below

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 10

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

DEC 13 2007

Signature: Ronald Johnson Date: 12/13/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 10 to DO 8 is issued to . . . 1) increase DO value by $750,000 from $2,557,355 to $3,307,355. 2) extend the period of performance to 3/31/08 and 3) change the delivery date for final flight documentation to 4/30/08. All other terms and conditions of the delivery order remain unchanged.				b4	

	Prior	This Action	Cum Value
Cost	b4	b4	b4
Fee			
Total	$2,557,355	$750,000	$3,307,355

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total
$ NTE $3,307,355

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 9

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 9

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11 Below

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 9

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 9/30/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 9 to DO 8 is issued to increase the DO value by $207,978 from $2,349,377 to $2,557,355 and extend the period of performance to 12/31/07. Period of Performance: 11/28/05 to 12/31/07 RECAP of Value Prior / This Action / Cum Value Cost b4 b4 b4 Fee					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total
$ NTE $2,557,355

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 8

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 8

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 11/28/05 to 9/28/07

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 8

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/28/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 8 to DO 8 is issued to extend the period of performance to September 28, 2007. All other terms and conditions of the delivery order remain unchanged. Period of Performance: 11/28/05 to 9/28/07 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total
$ NTE $2,349,377

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 7

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696.
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 7

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 11/28/05 to 8/10/07

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 7

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/14/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 7 to DO-CRAVE-EC-008 is issued to increase the delivery order value by $35,000 from $2,314,377 to $2,349,377. The contractor will perform trade and analysis assessment to allow the TGA to power-on IVA. The delivery order completion date is extended to 8/10/07. RECAP: Cost b4 Fee Total $2,314,377 $35,000 $2,349,377 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.	LOT			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total
$ NTE $2,349,377

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 6

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 6

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 11/28/05 to 9/28/07

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 6

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 4/19/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	DO-CRAVE-EC-006, Trace Gas Analyzer (TGA) Revision 6 to DO-CRAVE-EC-008 is issued to increase the delivery order value and extend the delivery date for the hardware. The delivery order value is increased by $464,556 from $1,849,821 to $2,314,377. The delivery date for the hardware is being changed from 6/30/07 to 9/28/07. RECAP: Cost b4 b4 b4 Fee Total $1,849,821 $464,556 $2,314,377 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.	LOT			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total
$ NTE $2,314,377

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 5

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 5

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 5

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Robert Kolb

Signature: Robert Kolb Date: 10-31-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO-CRAVE-EC-008, Trace Gas Analyzer (TGA) Revision 5 to DO-CRAVE-EC-008 is issued to increase the delivery order value by $20,000 from $1,829,821 to $1,849,821. This increase supports the purchase of a new RF Detector Printed Circuit Board for the development TGA unit. RECAP: Cost b4 b4 b4 Fee Total $1,829,821 $20,000 $1,849,821 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE. NOTE: DO 8/5 also corrects cost allocations				b4	

12. For JSC Internal Use Only:

Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____

Rissue To: EC2/Joe Gensler, x30025 For: EC2/Ralph Marak, x39144

13. Total

$ NTE $1,849,821

14. Quantities in "Quantity Accepted" Column Have Been

☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED

TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS
OTHERWISE NOTED.

BY:

_____ Authorized U.S. Government Representative

_____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 4

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 4

5. Contractor:

Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 4

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: Ronda Kautz Date: 9-1-06

10. Name: Robert Kolb

Signature: Robert Kolb Date: 8-30-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO-CRAVE-EC-006, Trace Gas Analyzer (Non-Obligating Document) Revision 4 to DO-CRAVE-EC-008 is issued to increase the delivery order value by $20,000 from $1,809,821 to $1,829,821. This increase supports procuring the services of the original TGA software designer to assist in the troubleshooting and documentation of the TGA software codes. RECAP: Cost Fee b4 Total $1,809,821 $20,000 $1,829,821 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.				b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025

13. Total
$ NTE $1,829,821

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 3

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH28/Mary Thomas

Tel No.: 281-483-8828 Fax: 281244-0885
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: Accountable Property

Order No.: NNJ05HB40B, DO 8, Rev. 3

5. Contractor:

Oceaneering Space Systems
Attn: Robert L. Mueller
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5546

TIN: 92-2628227 CAGE CODE:

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 3

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: 10-25-06

10. Name: Robert Kolb

Signature: Robert Kolb Date: 8-21-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO-CRAVE-EC-008, Trace Gas Analyser Revision 3 to DO-CRAVE-EC-008 is issued to change the Statement of Work due dates. The attached revised Page 4 of 9 of the Statement of Work is replaced in its entirety. The delivery order value remains unchanged. RECAP: Cost Fee Total $1,809,821 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Reissue To: EC2/Joe Genaler, x30025

13. Total
$ 1,809,821

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1999)

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-008

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype	Reconfigured Development unit (P/N SEG 39135052-301, S/N 1001) to Hi-Fi flight configuration	1	11/30/06	III
Certification	Utilize Flight item for certification			
Flight	Upgraded TGA w/ new pumping system, display, and microprocessor	1	6/30/07	I
Training	Utilize Prototype unit			
Other				
Test				
Software	Software/firmware associated with TGA and QMSA		11/30/06	
Other Products				

SCHEDULE
Start Date: **Dec. 1, 2005** Finish Date: March 30, 2007

• ITERIM MILESTONES	• DUE DATES
Combined SRR/PDR/CDR	**11/30/06**
Certification Complete	**6/14/07**
Deliver Hardware	**6/30/07**

- **Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.**

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO 8, Rev. 2

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO 8, Rev. 2

5. Contractor:
Oceaneering Space Systems
Attn: Robert L. Mueller
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 92-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, DO 8, Rev. 2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Craig Burridge

Signature: _____ Date Aug 14/06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	DO-CRAVE-EC-008, Trace Gas Analyzer Revision 2 to DO-CRAVE-EC-008 is issued to increase the delivery order value by $15,000 from $1,794,821 to $1,809,821. This increase supports the purchase of additional cables and connectors for a second build of the TGA in 2006 and provides additional spares for the hardware currently being built. RECAP: Cost Fee b4 Total $1,794,821 $15,000 $1,809,821 THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC2/Joe Gensler, x30025

13. Total
$

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
DO-CRAVE-EC-008 Rev 1

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH4/Mike Ballard

Tel No.: 281-244-5350 Fax: ____
E-mail: michael.d.ballard@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: DO-CRAVE-EC-008

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058

Phone: (281) 228-5370 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: See Statement of Work

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: DO-CRAVE-EC-008

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:____

☒ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: NNJ05HB40B

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.
Name: Robert L. Mueller (Person authorized to sign)
Signature: [signature] Date: 1/31/06

10. Name: J. R. Carpentier
Signature: [signature] Date: 1-24-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	The Contractor shall perform and deliver to all requirements for: DO-CRAVE-EC-008: "Trace Gas Analyzer" as revised This is revision 1 to the delivery order. The purpose of this revision is to: 1. Incorporate changes to the Statement of Work to capture aspects of the proposal. (changes are vertically bar-marked) 2. Extend the period of performance from 6/2007 to 9/2007. Delivery Order value remains unchanged: Cost: Fee: bt Total: $1,794,821					

12. For JSC Internal Use Only:
Requisition No.: ____ ☐ COMP. ☐ PART. PPC: ____
Rissue To: ____

13. Total
$ 1,794,821

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: ____
Authorized U.S. Government Representative ____ Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
DO-CRAVE-EC-008

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Michael Ballard

Tel No.: 281-244-5350 Fax: ____
E-mail: michael.d.ballard@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: DO-CRAVE-EC-008

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058
Attn: Contracts

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: DO-CRAVE-EC-008

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:____

☒ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: NNJ05HB40B

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: November 21, 2005

10. Name: N. L. Dawn Alexander

Signature: Dawn Alexander Date: 11/28/05
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	The Contractor shall perform and deliver to all requirements for: DO-CRAVE-EC-008: Trace Gas Analyzer The Period of Performance for this DO is: 12/2005 through 06/2007	64	64	64	64	

12. For JSC Internal Use Only:
Requisition No.: ____
Rissue To: ____
☐ COMP. ☐ PART. PPC: ____

13. Total
$ NTE: $1,794,821

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: ____
Authorized U.S. Government Representative

____
Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
DO-CRAVE-EC5-001 Rev. 2

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH4/Michael Ballard

Tel No.: 281-244-5350 Fax: ____
E-mail: michael.d.ballard@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: DO-CRAVE-EC5-001 Rev. 2

5. Contractor:
Oceaneering Space Systems (OSS)
16665 Space Center Blvd.
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: DO-CRAVE-EC5-001 Rev. 2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:____

☒ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: NNJ05HB40B

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: 3-6-06

10. Name: J.R. Carpentier

Signature: [signature] Date: 3-2-06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	The contractor shall perform and deliver all requirements for: DO-CRAVE-EC5-001: Portable Life Support Subsystem Schematic (PLSS). This is revision 2 to this delivery order. The purpose of this revision is to: 1. Extend the period of performance for this DO through 4/12/06 2. Increase Delivery Order Value from $481,673 by $16,406 to $498,079. Cost / Fee / Total Previous DO value: b4 / b4 / b4 This Revision Total $453,427 / $44,652 / $498,079 All other terms and conditions remain unchanged.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: ____
Rissue To: Gretchen Thomas/EC

13. Total
$ 498,079

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
DO-CRAVE-EC5-001 Rev. 1

2. Date of Order
See Block 10

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Michael Ballard

Tel No.: 281-244-5350 Fax: ____
E-mail: michael.d.ballard@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: DO-CRAVE-EC5-001 Rev. 1

5. Contractor:
Oceaneering Space Systems (OSS)
16665 Space Center Blvd.
Houston, TX 77058

Phone: 281-228-5370 x Fax: 281-228-5545

TIN: 95-2828227 CAGE CODE:

6. Deliver On or Before: See Block 11

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: DO-CRAVE-EC5-001 Rev. 1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:____

☒ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: NNJ05HB40B

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: 10/25/05

10. Name: N.L. Dawn Alexander

Signature: Dawn Alexander 10/27/05
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	The contractor shall perform and deliver all requirements for: DO-CRAVE-EC5-001: Portable Life Support Subsystem Schematic (PLSS). This is revision 1 to this delivery order. The purpose of this revision is to: 1. Extend the period of performance for this DO through 2/20/06 2. Modify the SOW. Changes are vertically bar-marked and a replacement page is attached. 3. Increase Delivery Order Value from $429,319 by $52,354 to $481,673. All other terms and conditions remain unchanged.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: ____
Rissue To: Gretchen Thomas/EC

13. Total
$ 481,673

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

Page 1 of 1 (DO Attached)

1. Order No. DO-CRAVE-EC5-001

2. Date of Order 03/30/05

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mike Ballard

Tel No.: 281-244-5350 Fax: 281-244-5331
E-mail: michael.d.ballard@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: Accountable Property

Order No.: DO-CRAVE-EC5-001

5. Contractor:
Oceaneering Space Systems
16555 Space Center Blvd.
Houston, TX 77058

Attn: Contracts

Phone: 281-226-5370 x Fax: 281-226-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10-17-05

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: DO-CRAVE

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☒ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: NNJ05HB B

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Robert Mueller (Person authorized to sign)

Signature: [signature] Date: 3/30/05

10. Name: N. L. Dawn Alexander

Signature: [signature] Date: 3/30/05
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	The Contractor shall perform and deliver to all requirements for: DO-CRAVE-EC5-001: Portable Life Support Subsystem Schematic (PLSS) Study. The Period of Performance for this DO is 3-30-05 thru 10-17-05	64	64	64	64	

12. For JSC Internal Use Only:
Requisition No.: _____ ☐ COMP. ☐ PART. PPC: _____
Rissue To: _____

13. Total
$ NTE: $429,319

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1998)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
CRAVE DO33, Rev. 2

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: CRAVE DO33, Rev. 2

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/1/08 - 3/28/09

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: CRAVE DO33, Rev. 2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 8/27/0
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	SUBLIMATOR DRIVEN COLDPLATE (SDC) Revision 2 to DO 33 is issued to exercise Phase II of the DO. The contractor shall perform and deliver to the fabrication of all hardware as stated in the Statement of Work. RECAP OF DO VALUE: Prior Value / This Action / Cum Value COST FEE b4 TOTAL $92,997 $120,089 $212,096 THIS IS A CPFF DELIVERY ORDER	Lot			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☒ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ NTE 212,096

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
CRAVE DO33R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: CRAVE DO33R1

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11 Below

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: CRAVE DO33R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date 12/19/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	SUBLIMATOR DRIVEN COLDPLATE (SDC)					
1	This no-cost revision is issued to extend the period of performance for the base to January 21, 2008. All other terms and conditions of the base remain unchanged. Period of Performance: 9/11/07 - 1/21/08					
2	OPTION: The Government may require the contractor to continue to perform services under this delivery order. The Contracting Officer may unilaterally exercise the Option by issuing Revision 1 to DO 33. The government reserves the right not to exercise the Option. (continued next page)	Lot			bt	

12. For JSC Internal Use Only:
Requisition No.: N/A ☒ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 92,007

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

Order No.: CRAVE D033R1

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	Should the Option be exercised, the delivery order revision will be priced as negotiated under the base delivery order. OPTION Period of Performance: 1/14/08 - 7/14/08					

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
CRAVE -EC-033

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: CRAVE-EC-033

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: See Block 11 Below

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: CRAVE-EC-033

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 9/11/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	SUBLIMATOR DRIVEN COLDPLATE (SDC)					
1	The contractor shall perform and deliver to all base requirements of CRAVE-EC-033 as described in the attached Statement of Work.	Lot				
	Period of Performance: 9/11/07 - 12/18/07					
2	OPTION: The Government may require the contractor to continue to perform services under this delivery order. The Contracting Officer may unilaterally exercise the Option by issuing Revision 1 to DO 33. The government reserves the right not to exercise the Option.	Lot				
	(continued next page)					

12. For JSC Internal Use Only:
Requisition No.: N/A ☒ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 92,007

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	Should the Option be exercised, the delivery order revision will be priced as negotiated under the base delivery order. OPTION Period of Performance: 1/14/08 - 7/14/08					

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-033 Sublimator Driven Coldplate

PROPOSAL INSTRUCTIONS: __ DRAFT -COMMENTS DUE BY: 07/16/07 COB
_X_ FINAL -PROPOSAL DUE BY: 08/01/07 COB

DO TITLE: Sublimator Driven Coldplate

DO Type: _X_ CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: David Westheimer **Phone:** (281) 483-2804

DO Manager: Ryan Stephan /EC **Phone:** (281) 483-7182

DO Mgr. Alternate: **Phone:**

Concurrences:

Ryan Stephan DO Manager	Chin H. Lin DO Mgr. Management	Joe Gensler COTR
David Westheimer Division TMR	Ronald Johnson Contract Officer	

Task Contains Flight Hardware, Flight Software or GSE? ___Yes _X_No

Program Supported: __Shuttle __ISS __EVA _X_Advanced-{Thermal (Lunar Ascent Vehicle)}

WBS: __ 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS _X_ 5.0 ATCS __ 6.0 CHeCS

For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for ***all*** *Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order. the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C. Table 1.

Narrative Task Description

Background / Problem Description:

NASA JSC has begun several architecture studies for the upcoming lunar lander and lunar outpost. In performing these assessments, they discovered an innovative way to perform thermal control. The idea for this unique piece of hardware is being referred to as the sublimator driven coldplate (SDC). The SDC is a novel thermal control technique and has several advantages over a traditional thermal control scheme. The principal advantage is the possible elimination of a pumped fluid loop, potentially saving mass, power, and complexity. Because this concept relies on evaporative heat rejection techniques, it is primarily useful for short mission durations. Additionally, the concept relies on a conductive path between the heat-generating component and the heat rejection device. Therefore, it is mostly a relevant solution to for a vehicle with a relatively low heat rejection requirement.

The design of the sublimator driven coldplate will meet the following requirements:

1. The SDC design shall not require any power during nominal operation.
2. The SDC shall be capable of rejecting a minimum of 2.5 kW for a minimum period of 6.5 hours.
3. The SDC shall not exceed a surface area of 4500 in^2 and the maximum dimensional extents shall not exceed 98 inches.
4. The SDC maximum surface temperature shall not exceed 43°C during operation assuming that the 2.5 kW is uniformly distributed on the 4500 in^2 available surface area.
5. The design of the SDC shall require only a single penetration in the vehicle pressure shell.
6. The SDC shall be capable of withstanding a load of 5.0 g's with 133 kg of avionics mounted on the unit.
7. The SDC shall use de-ionized water as the sublimator working fluid.

The current statement of work will be subdivided into two separate phases. The first phase will require the contractor to design and perform thermal and structural analysis for the SDC and also present the results at a conceptual design review. The proposed SDC concepts will be evaluated at the conclusion of phase 1.

Phase I Task Description:

As mentioned above, this task will be separated into two phases. All of the requirements stated in the previous section will be applicable to both phases of this DO.
The first phase will essentially consist of the work necessary to create a SDC design which could be easily fabricated. The first phase will conclude with a conceptual design review that will be attended by both the selected contractor as well as the government representatives. The first phase will include the following tasks:

1. Development of a sublimator driven coldplate design.
2. Thermal analysis of the chosen SDC design.

3. Structural analysis of the chosen SDC design.
4. Drawing package for SDC design in Pro-Engineer format.
5. Presentation of the results at a design review, which will be attended by the government. The expectations of the design review package is that it will include the following:
   a. A Pro-Engineer drawing package of sufficient detail that the SDC could be fabricated.
   b. A review and summary for all of the concepts that were evaluated during the development of the preferred SDC design.
   c. The structural and thermal analysis for the final SDC design.
   d. Recommendations for future SDC trade studies.

Phase I Deliverables/Products:

Product	Description	Qty	Due	Class
Other Products				
Drawing Package	Phase 1: Drawings for SDC in Pro-E format			
Analysis Report	Phase 1: Structural and Thermal Analysis report in MS Office editable format			
Presentation	Phase 1: Conceptual Design Review package			

SCHEDULE – Phase I (Basic Period)

Start Date: 11 September 2007 **Finish Date:** 18 December 2007

INTERIM MILESTONES	DUE DATES
Phase 1/Initial Contract	
SDC Conceptual Design Review	18 December 2007
Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.	

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled: 2007-06-19_SDC-Project-Plan-Phase1.mpp

Total Government Estimate for this DO: $ 217,862 .

bt

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-033 Sublimator Driven Coldplate

TOTAL COST ESTIMATE FOR THIS DO: $

FEE: $ (If Applicable)

OPTION 1: N/A

OPTION 2: N/A

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

Notes: 1. Grey Scaled Rows Need No Additional/Required Fill-ins.
2. On all other rows, If Necessary, Fill in Additional Rqmts/Deliveries in last Column.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
1	Written Approval	FlightGFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	
3	Written Approval	Project Technical Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
4	Mandatory Submittal if Flt H/W	GFE Systems Requirements Data Package	If Required for DO See Comments	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	If Required for DO See Comments	Once with Revisions	N	
6	Mandatory Submittal if Flt H/W	Preliminary Design Review Data Package	If Required for DO See Comments	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	If Required for DO See Comments	Once with Revisions	N	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document	If Required for DO See Comments	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	If Required for DO See Comments	Once with Revisions	N	
11	Mandatory Submittal if Flt H/W	Flight GFE Failure Analysis Report	If Required for DO See Comments	As Required	N	

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER # CRAVE-EC-033 Sublimator Driven Coldplate

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
14	Written Approval	GFE Software Development Plan	If Required for DO See Comments	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	If Required for DO See Comments	As Required	N	
16	Written Approval	Engineering Drawings	If Required for DO See Comments	Once with Revisions	Y	PRO-E Format
17	Written Approval	EEE Parts Lists and Analysis Report	If Required for DO See Comments	As Required	N	
18	Mandatory Submittal if Flt H/W	Critical Design Review Data Package	If Required for DO See Comments	Once with Revisions	N	
19	Mandatory Submittal if Flt H/W	Engineering Drawing Change Proposal	If Required for DO See Comments	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	If Required for DO See Comments	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	If Required for DO See Comments	Once with Revisions	N	
22	Mandatory Submittal if Flt H/W	Software Code	If Required for DO See Comments	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	If Required for DO See Comments	Once with Revisions	N	
25	Mandatory Submittal if Flt H/W	Certification Report	If Required for DO See Comments	Once with Revisions	N	
26	Mandatory Submittal if Flt H/W	Engineering Analysis	If Required for DO See Comments	As Required	Y	Contractor will submit results from final structural and thermal analysis.

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-033 Sublimator Driven Coldplate

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
27	Mandatory Submittal if Flt H/W	Acceptance Data Package	If Required for DO See Comments	One Time	N	
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	Y	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	**Attachment J-11**	Only if contractor is using the R-Quality Plan template instead of ISO, and only if they need to make changes to it
30	Written Approval	Patent Rights-Retention	As Required	As Required	**Y (If Applic'ble)**	
31	Written Approval	Shuttle/Station Payload Safety Data Package	If Required for DO See Comments	As Required	N	
32	Mandatory Submittal if Flt H/W	Limited Life Systems List	If Required for DO See Comments	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	If Required for DO See Comments	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	If Required for DO See Comments	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	**Y (If Applic'ble)**	N/A – no software is being produced
36	Written Approval	ISS Hazard Report	If Required for DO See Comments	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	**Attachment J-9**	
38	Written Approval	Government Certification Approval Request (GCAR)	If Required for DO See Comments	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	If Required for DO See Comments	As Required	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	If Required for DO See Comments	As Required	N	
42	Mandatory Submittal If Required	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	If Required for DO See Comments	Once with Revisions	N	
44	Mandatory Submittal if Flt H/W	Certification Data Package	If Required for DO See Comments	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	If Required for DO See Comments	One Time	N	
48	Mandatory Submittal if Flt H/W	Flight GFE Verification & Validation Report	If Required for DO See Comments	Once with Revisions	N	
49	Mandatory Submittal if Flt H/W	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	If Required for DO See Comments	As Required	N	
50		**Reserved**	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	**Attachment J-7**	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	**Attachment J-10**	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	Only if contractor is using the R-Quality Plan template instead of ISO. and only if they need to make changes to it

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY: NONE

CHANGES TO DRDs: NONE

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE

Background / Problem Description:

After completion of Phase I, the drawings necessary to fabricate a SDC will have already been completed. At this time, the government can exercise an option to fabricate the SDC design. This engineering development unit (EDU) will be delivered to the government at the conclusion of Phase II for thermal vacuum testing. Therefore, the EDU shall be of sufficient quality to be tested at JSC thermal vacuum facilities. The criteria for the selection of Phase II will be total hardware cost, mass, and fabrication complexity. Additionally, an assessment will be made of the proposed feedwater utilization for the selection of Phase II. The feedwater utilization is defined in the attached test report, "Contaminant Insensitive Sublimator EDU Test Report".

Phase II Task Description:

The second phase will begin with the contract award and will conclude with the delivery of an EDU. All of the aforementioned requirements are applicable to both Phase I and Phase II. The second phase will primarily involve the fabrication of the hardware.
The second phase will include the following tasks:

1. The SDC design will be built and delivered to the government for thermal vacuum testing.
2. The contractor will submit a final report to the government. This final report will include the following:
    a. Sublimator Driven Coldplate drawing package.
    b. Lessons learned from the design and fabrication process.
    c. Recommendations for future design iterations following the stated requirements.
    d. The results from the final structural and thermal analyses.
    e. Proposed test points for the government led thermal vacuum testing.

Phase II Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Prototype	Phase II: SDC EDU prototype			
Other Products				
Final Report	Phase II: Final report including final drawings in Pro E format, lessons learned, recommendations, proposed test points			

SCHEDULE – Phase II (Basic Period)

Start Date: 14 January 2008 Finish Date: 14 July 2008

INTERIM MILESTONES	DUE DATES
Phase II/Initial Contract	
SDC engineering development unit delivery	14 July 2008
SDC final report	14 July 2008
Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.	

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled: 2007-06-19_SDC-Project-Plan-Phase2.mpp

Total Government Estimate for this DO: $ 217,862 .

TOTAL COST ESTIMATE FOR THIS DO: $

FEE: $ (If Applicable)

OPTION 1: N/A

OPTION 2: N/A

GOVERNMENT FURNISHED PROPERTY: NONE

CHANGES TO DRDs: NONE

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO 32

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO 32

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: 281-228-5371 x Fax: 281-228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: See Block 11 Below

F.O.B. Point: Destination

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO 32

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 9/20/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED

12. For JSC Internal Use Only:
Requisition No.: N/A ☒ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 341,904

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-032 LAR

PROPOSAL INSTRUCTIONS: __ DRAFT – COMMENTS DUE BY: 07/23/07 COB
_X_ FINAL – PROPOSAL DUE BY: 08/27/07 COB

DO TITLE: Large Area Repair Hole Punch and Handhold

DO Type: _X_ CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler	**Phone:** (281) 483-0025
DO Manager: Ben Greene	**Phone:** (281) 483-3657
DO Mgr. Alternate: Heather Bergman	**Phone:** (281) 483-6053

Concurrences:

Ben Greene DO Manager	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Ralph Marak Division TMR	Steve Miller S & MA	Ron Johnson Contract Officer

Task Contains Flight Hardware, Flight Software or GSE? _X_ Yes ___No

Program Supported: _X_Shuttle __ISS _X_EVA __Advanced

WBS: _X_ 1.0 EVA __2.0 FCE __3.0 EVR __ECLSS __5.0 ATCS __6.0 CHeCS

For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for all Delivery Orders on the contract combined.

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

1.0 Objective

The STS-107 Columbia accident was attributed to debris liberated from the external tank during launch and impacting the reinforced carbon-carbon (RCC) wing leading edge of the Orbiter. Since then, several concepts have been developed and flown for repair of the Orbiter Thermal Protection System (TPS), however, to date none have been developed which have the capability to repair the kind of damage that likely caused the STS-107 TPS failure. The Orbiter Project Office has asked the TPS repair community to continue development of a concept known as Large Area Repair (LAR) for flight on the upcoming Hubble servicing mission. EC7 has been tasked to develop the EVA hardware necessary for installation and verification of the LAR repair system for this project.

2.0 Need for Large Area Repair (LAR)

Current RCC Repair Systems are limited in the size and type of damage that they can repair. The two systems currently certified for flight are known as the Crack Repair System and the Plug Repair System. The Crack Repair System uses a single part pre-ceramic polymer known as NOAX (Non-Oxide Adhesive eXperimental) that is only capable of repairing cracks, coating damage, and small holes (< 0.375" in diameter). The Plug Repair System is capable of repairing larger damage, but its capability is limited to holes smaller than 4 inches.

Because of the limitation of these repair systems, the Orbiter Project Office has been funding R&D for concepts that have the capability to repair larger damage in RCC Panels with minimal impact to stowage. The LAR concept was presented to the PRCB earlier this year (2007) and was selected for additional funding for flight development.

The LAR system is currently comprised of a thin, flexible, Carbon Silicon Carbide laminate that would be attached to the RCC Panel around the perimeter with composite or high temperature super alloy fasteners such as TZM (Titanium Zirconium Molybdenum) (see figures 2.0-1 and 2.0-2). In order to perform the LAR installation and verify it is ready for entry, a collection of EVA and IVA hardware must be provided.

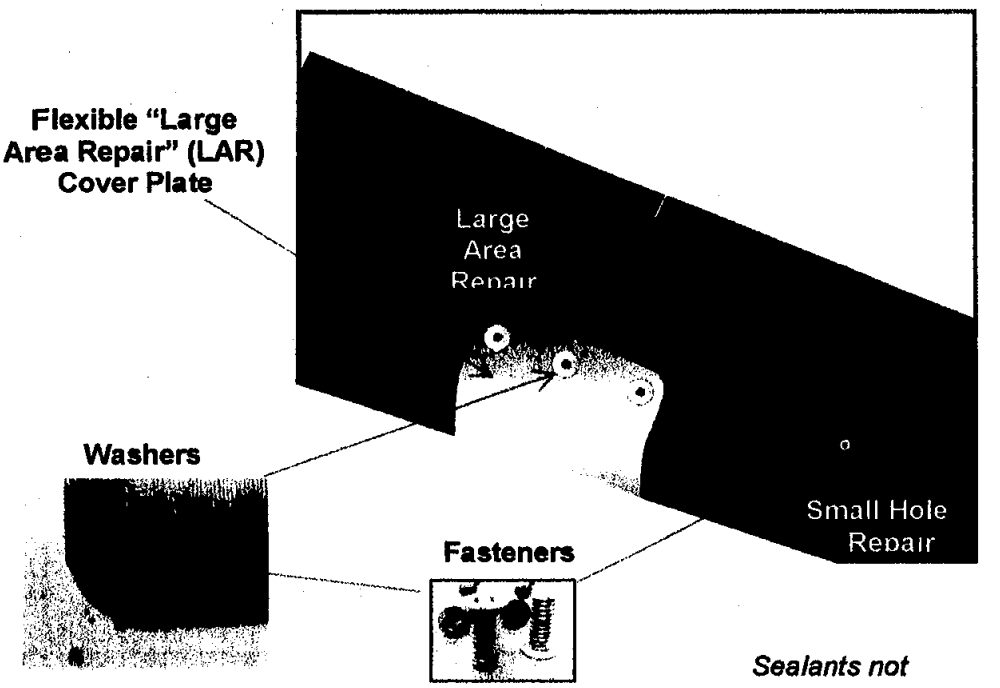

Figure 2.0-1: Diagram of LAR System Installed on Shuttle WLE

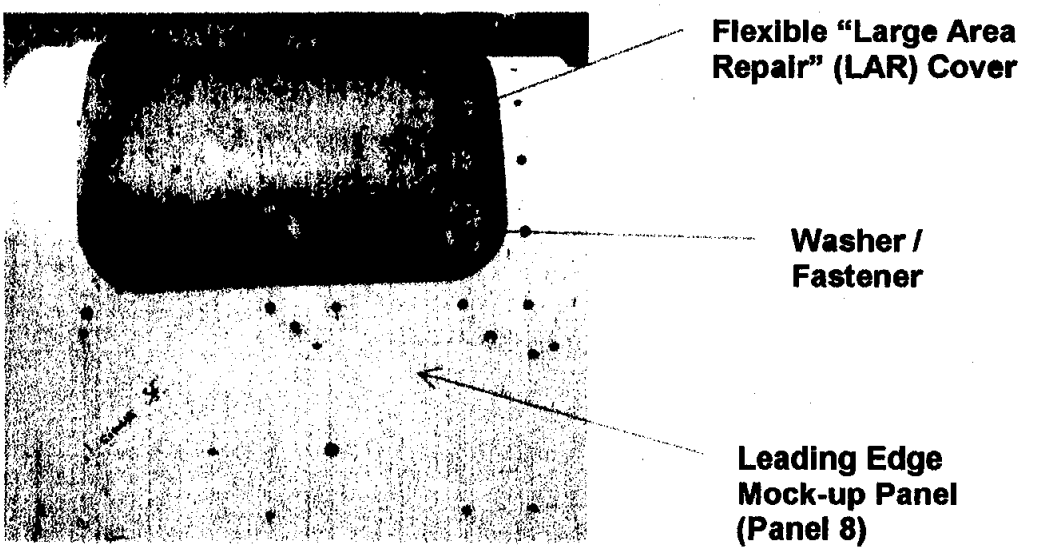

Figure 2.0-2: Image of Sample LAR Cover Plate Attached to Panel Mockup

3.0 Prior Work

A number of tools developed for the RCC Repair Project can be used to aid in the installation and verification of the LAR, however, the majority of them will need minor modifications, testing, and/or certification updates. In addition, a significant knowledge base exists in the TPS Repair community at JSC to draw upon during the development of the hardware required for LAR installation. Many on-orbit and ground based evaluations have been performed that have greatly increased the repair team's knowledge of what our EVA repair capabilities are.

Task Description:

The contractor is to perform the necessary tasks required to design, develop, test, and certify a subset of tools needed for installation and verification of the LAR System. Those tools are as follows:

- IVA Hole Punch – required to punch holes IVA in the LAR Cover Plate. Holes cannot be pre-punched due to possible interference installing and drilling into T-seals and/or panel ribs. New hardware.
- Velcro Handhold – required to provide a temporary handhold on the LAR Cover Plate for aid in placement, alignment, and installation. New Hardware.

The designs shall comply with applicable EVA GDRD (JSC-26626) requirements and follow EA-WI-023 for all project milestones and applicable documentation. Number and classification of hardware components required will be defined in requirements to follow. No part of the designs will be proprietary and NASA will have full access and ownership of all engineering drawings, CAD models, procedures, and related documentation. All drawings will use JSC standard processing (i.e., PRC) callouts. All documentation (requirements documents, assembly procedures, etc) will be released through the JSC document system. All certification documentation (CARD, RAESR, GCAR, etc.) shall be delivered to NASA in an editable electronic format.

Contractors must submit a minimum of one concept design for consideration.

If the use of JSC facilities is required to perform any of the required acceptance testing described in the CARDs (such as use of the thermal test facilities), this must be clearly stated in the contractor's response. NASA/JSC will make the appropriate accommodations to schedule the JSC facilities to perform the desired task upon request.

1. Requirements

1.1. IVA Hole Punch

1.1.1. Design, develop, test, and certify an IVA tool that will be capable of punching holes through a Carbon Silicon Carbide Cover Plate used for the Large Area Repair System.

1.1.1.1. Hole Punch should punch holes 0.4735" + 0.10" / -0.00" in diameter without tearing or damaging the edges of the punched hole. The maximum distance between the edge of the LAR cover plate and the center of the punched hole that the Hole Punch should be capable of producing has not

been determined. However, it is likely this distance will not exceed 2 inches.

1.1.1.2. Hole Punch should capture all debris generated by the hole punching task to prevent damage to IVA systems.

1.1.1.3. Hole Punch should be capable of punching at least 16 holes.

1.1.1.4. It is acceptable for the Hole punch tool to be modified COTs hardware (Ref figure 1.1.1-1). Minimizing weight of the Hole Punch is desirable.

1.1.1.5. Thickness of LAR Cover Plate shall be no thicker than 0.050"

1.1.1.6. Hole punch shall allow for easy visual alignment with pre-installed markings on the LAR Cover Plate identifying where holes should be located. Specific design for the hole markings has not yet been defined. However, early development discussions about the markings agreed that holes should be marked as either a solid or dashed white line outlining the actual hole size in a circle. Inside the circle would be a number identifying the hole.

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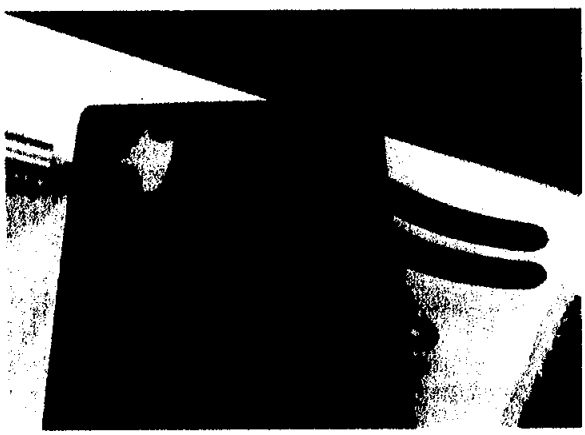

Figure 1.1.1-1: COTS Hole Punch

Figure 1.1.1-2: Conceptual diagram of LAR hole location marking

1.2. Velcro Handhold

1.2.1. Design, develop, test, and certify an EVA tool that will interface with Velcro pads on the LAR Cover Plate to provide alignment and placement of the LAR repair.

1.2.1.1. Handhold shall supply hook style Velcro to interface with pile style Velcro on LAR Cover Plate. The supplier provides the Velcro hook and adhesive with the delivered tool

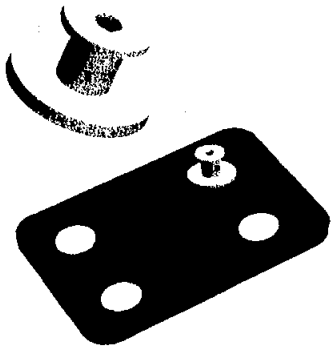

Figure 1.2.1-1: Conceptual diagram of handhold interface with LAR Cover Plate

1.2.1.2. Handhold should require less than 10 lbs force to remove from LAR Cover plate interface for each individual handhold.

1.2.1.3. Handhold should provide at least 5 lbs of retention force with LAR Cover Plate for each individual handhold.

1.2.1.4. Velcro size on LAR Cover plate is TBD, but no larger than 4" in diameter for each individual handhold.

1.2.1.5. The Handhold should also provide an EVA Tether Point and be grasped easily with a single EMU Glove.

1. Reporting

The contractor shall provide weekly technical status, a bi-monthly schedule review, and monthly financial management reports as directed in the data requirements table.

2. Government Provided Equipment

See Government Furnished Property section.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up	None	N/A	N/A	N/A
Prototype	None	N/A	N/A	N/A
Certification	Full Class I Flight certification	AR	5/31/08	N/A
Flight	2 Hole Punch Tools 2 Handhold Tools	2 ea	5/31/08	I
Training	1 High Fidelity Hole Punch Trainer 1 High Fidelity Handle Tainer	1 ea	5/31/08	III
Other	1 Qual Hole Punch Tool 1 Qual Handhold Tools	1 ea	5/31/08	I
Other	Electronic editable format of CARDs, RAESRs, and GCARs. Microsoft Word format required.	AR	5/31/08	N/A
Test	Functional testing (acceptance and qualification)	AR	5/31/08	I / qual
Software	N/A	N/A	N/A	N/A
Other Products	Acceptance Data Package (ADP) for each flight and qualification units	1 per each flight / qual unit	5/31/08	N/A
Other Products	GCARs for each new hardware design	2	5/31/08	N/A

SCHEDULE

Start Date: September 25, 2007 **Finish Date:** July 15, 2008

ITERIM MILESTONES	DUE DATES
System Requirements Review (SRR)	Suggested date10/15/07
Preliminary Design Reviews (PDR)	Suggested date 11/30/07
Critical Design Reviews (CDR)	Suggested date 1/31/08
Hardware Fabrication Complete	Suggested date 5/15/08
Hardware Qual / Acceptance Testing Complete	Suggested date 6/16/08
Certification Complete	Suggested date 6/30/08
SAR	Suggested date 7/7/08
Hardware Delivery	7/15/08

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled: Not provided for this DO

Total Government Estimate for this DO: $400K
Option 1: $___ (See Attachment 1)
Option 2: $___ (See Attachment 2)

TOTAL COST ESTIMATE FOR THIS DO: $(Contractor Complete)

FEE: $ (If Applicable)

OPTION 1: $ N/A (See Attachment 1)

OPTION 2: $ N/A (See Attachment 2)

DATA REQUIREMENTS

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	Weekly Tech status
3	Written Approval	Project Technical Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
4	Mandatory Submittal if Flt H/W	GFE Systems Requirements Data Package	If Required for DO See Comments	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	If Required for DO See Comments	Once with Revisions	N	
6	Mandatory Submittal if Flt H/W	Preliminary Design Review Data Package	If Required for DO See Comments	Once with Revisions	Y	
7	Written Approval	Flight GFE Workmanship Specifications List	If Required for DO See Comments	Once with Revisions	Y	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document	If Required for DO See Comments	Once with Revisions	Y	
10	Written Approval	GFE End Item Specification	If Required for DO See Comments	Once with Revisions	N	
11	Mandatory Submittal if Flt H/W	Flight GFE Failure Analysis Report	If Required for DO See Comments	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in WI-EA-023	Once with Revisions	Y	
13	Written Approval	GFE Software Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
14	Written Approval	GFE Software Development Plan	If Required for DO See Comments	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
15	Written Approval	GFE Software Design Document	If Required for DO See Comments	As Required	N	
16	Written Approval	Engineering Drawings	If Required for DO See Comments	Once with Revisions	Y	Pro-E format CAD Models and Drawing files
17	Written Approval	EEE Parts Lists and Analysis Report	If Required for DO See Comments	As Required	Y	No EEE parts
18	Mandatory Submittal if Flt H/W	Critical Design Review Data Package	If Required for DO See Comments	Once with Revisions	Y	
19	Mandatory Submittal if Flt H/W	Engineering Drawing Change Proposal	If Required for DO See Comments	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	If Required for DO See Comments	Once with Revisions	Y	
21	Written Approval	Flight Product User's Guide	If Required for DO See Comments	Once with Revisions	N	
22	Mandatory Submittal if Flt H/W	Software Code	If Required for DO See Comments	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	If Required for DO See Comments	Once with Revisions	Y	
25	Mandatory Submittal if Flt H/W	Certification Report	If Required for DO See Comments	Once with Revisions	Y	
26	Mandatory Submittal if Flt H/W	Engineering Analysis	If Required for DO See Comments	As Required	Y	
27	Mandatory Submittal if Flt H/W	Acceptance Data Package	If Required for DO See Comments	One Time	Y	Supplied for qual and Flight Units
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	Only if contractor is using the R-quality plan template instead of ISO, and only if they need to make changes to it.
30	Written Approval	Patent Rights-Retention	As Required	As Required	Y (If Applicable)	
31	Written Approval	Shuttle/Station Payload Safety Data Package	If Required for DO See Comments	As Required	N	
32	Mandatory Submittal if Flt H/W	Limited Life Systems List	If Required for DO See Comments	As Required	Y	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	If Required for DO See Comments	As Required	N	If applicable
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	If Required for DO See Comments	As Required	Y	If applicable
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	If Required for DO See Comments	As Required	Y	If applicable
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	If Required for DO See Comments	As Required	Y	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	If Required for DO See Comments	As Required	Y	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	
41	Upon Request	Nonconformance Record	If Required for DO See Comments	As Required	Y	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	If Required for DO See Comments	Once with Revisions	Y	
44	Mandatory Submittal if Flt H/W	Certification Data Package	If Required for DO See Comments	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	Y	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	If Required for DO See Comments	One Time	Y	
48	Mandatory Submittal if Flt H/W	Flight GFE Verification & Validation Report	If Required for DO See Comments	Once with Revisions	Y	
49	Mandatory Submittal if Flt H/W	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	If Required for DO See Comments	As Required	N	If applicable
50		Reserved	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	N	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY - The list of items below will be provided as Government Furnished Property.

Item	Part Number	Quantity	Value
LAR Cover Plate or Mock-up with Pile Fastener	TBD	1	$5,000

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National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, DO27R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, DO27R1

5. Contractor:
Oceaneering Space Systems
Attn: Ronda Kautz
16665 Space Center Blvd.
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 6/6/07 thru 10/31/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, D027R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 10/29/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	COMMON HELMET STUDY AND RISK MITIGATION This revision is issued to grant a no-cost extension for DO27 to October 31, 2007. All other terms and conditions of the delivery order remain the same. Period of Performance: 06/06/07 thru 10/31/07			$-0-	$-0-	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Terry Hill

13. Total
$ 0

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC5-DO27

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC5-DO27

5. Contractor:
Oceaneering Space Systems
16665 Space Center Blvd.
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 6/6/07 thru 10/12/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC5-D027

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/6/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	COMMON HELMET STUDY AND RISK MITIGATION					
1	The contractor shall perform and deliver to all baseline trade study requirements of CRAVE-EC5-DO27 as described in the Statement of Work. Period of Performance: 6/6/07 thru 10/12/07	Lot	b4	b4	b4	
2	OPTION 1: The Government may require the contractor to continue to perform services under this delivery order. The Contracting Officer may unilaterally exercise Option 1 by issuing Revision 1 to DO 27. The Government reserves the right not to exercise Option 1.					

(continued next page)

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC5/Terry Hill

13. Total
$ 171,061

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

Order No.: CRAVE-EC5-DO27

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	Should the Option be exercised, the resultant delivery order revision will be priced as negotiated under the base delivery order.	Lot	b4	b4	b4	
	OPTION 1 Period of Performance: 10/15/07 thru 3/31/08					
	THIS IS A CPFF DELIVERY ORDER.					

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) DELIVERY ORDER
OCEANEERING SPACE SYSTEMS
Contract NNJ05HB40B

Task Order Number	*Amendment Number*	*Purchase Request Number*
24	4	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY10	COTR: Ralph Marak/ER ext:3-1944

Task Order Title

ADVANCED ROBONAUT HARDWARE

Description/Purpose

This delivery order revision:

1) Extends the period of performance from September 30, 2009 to April 2, 2010 (March 20, 2007 – April 2, 2010)
2) Increase the delivery order value by $372,834; recapitulation is shown below

The contractor shall perform the tasks in accordance with the attached delivery order revision. All updated changes within the task description is indicated with a bold "**Rev D**".

Summary	Previous	This Action (Rev 4)	Current Value
Cost			
Fee		64	
TOTAL	$ 2,043,234.00	$ 372,834.00	$ 2,416,068.00

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Adrian D. Clayton	Adrian D. Clayton	09-30-2009

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) DELIVERY ORDER
OCEANEERING SPACE SYSTEMS
Contract NNJ05HB40B

Task Order Number	*Amendment Number*	*Purchase Request Number*
24	3	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/ER ext:3-1944

Task Order Title

ADVANCED ROBONAUT HARDWARE

Description/Purpose

This delivery order revision:

1) Extends the period of performance from June 30, 2009 to September 30, 2009 (March 20, 2007 - September 30, 2009)
2) Increase the delivery order value by $134,591; recapitulation is shown below

The contractor shall perform the tasks in accordance with the attached delivery order revision. All updated changes within the task description is indicated with a bold "**Rev C**".

Summary	Previous	This Action (Rev 3)	Current Value
Cost		b4	
Fee			
TOTAL	$ 1,908,643.00	$ 134,591.00	$ 2,043,234.00

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
RONALD JOHNSON CONTRACTING OFFICER	Ronald Johnson	7/1/09

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) DELIVERY ORDER
OCEANEERING SPACE SYSTEMS
Contract NNJ05HB40B

Task Order Number	*Amendment Number*	*Purchase Request Number*
24	2	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/ER ext:3-1944

Task Order Title

ADVANCED ROBONAUT HARDWARE

Description/Purpose

This delivery order revision:

1) Extends the period of performance from May 14, 2009 to June 30, 2009 (May 14, 2008 - to June 30, 2009)
2) Increase the delivery order value by $69,133; recapitulation is shown below

The contractor shall perform the subject tasks in accordance with the attached delivery order revision.

Summary	Previous	This Action (Rev 2)	Current Value
Cost		64	
Fee			
TOTAL	$ 1,839,510.00	$ 69,133.00	$ 1,908,643.00

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
RONALD JOHNSON CONTRACTING OFFICER	Ronald Johnson	5/12/09

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO24R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-2138
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO24R1

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/20/07 TO 5/14/09

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE DO24R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 5/15/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	ADVANCED ROBONAUT HARDWARE Revision 1 to DO 24 is issued to exercise Option 1 and change the Statement of Work for Option 1. (See revised SOW attached.)	Lot			bl	
	RECAP DO VALUE:					
	PRIOR / THIS ACTION / CUM VALUE					
	COST bl bl bl					
	FEE					
	TOTAL $1,037,729 $801,781 $1,839,510					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 1,839,510 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-ER-024

PROPOSAL INSTRUCTIONS: X DRAFT -- COMMENTS DUE BY: 3/12/07
___ FINAL -- PROPOSAL DUE BY: 3/26/07

DO TITLE: Advanced Robonaut Hardware

DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Joe Gensler	Phone: (281) 483-0025
DO Manager: Ron Diftler/ER4	Phone: (281) 483-0931
DO Mgr. Alternate: Bob Savely/ER1	Phone: (281) 483-8105

Concurrences:

Ron Diftler DO Manager	Rob Ambrose DO Mgr. Management	Joe Gensler COTR
Jared Woodfill Division TMR	Not Required Stephen P. Miller S & MA	Not Required Ron Johnson CO

Task Contains Flight Hardware, Flight Software or GSE? ___ Yes X No

Program Supported: ___Shuttle ___ISS ___EVA ___Advanced X

WBS: ___ 1.0 EVA ___ 2.0 FCE ___ 3.0 EVR ___ ECLSS ___ 5.0 ATCS ___ 6.0 CHeCS

*For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for **all** Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

The Automation, Robotics and Simulation Division (AR&SD) is developing new dexterous robotics technologies for NASA's exploration initiative. This work will create designs for actuators, embedded avionics, power distribution, control, interfaces, and mechatronics and apply them in developing new R&D robotic prototypes. AR&SD Will also mature these technologies for exploration, revising designs to provide a flight path for dexterous robots.

The purpose of this task is to develop these subsystems for new classes of robots and future versions of Robonaut systems. The subsystems include power distribution, skin coverings, joint mechanisms, control software, and embedded avionics. The task will involve design, implementation of the designs, integration, testing, and documentation of all work.

Task Description:

The task shall include, but is not limited to:

a. Power Subsystem
   - i. Support power requirements development
   - ii. Provide power interface schematic
   - iii. Identify items for procurement
   - iv. Design custom power boards, avionics boxes, and interfaces
   - v. Fabricate and procure components for power subsystem
   - vi. Integrate power subsystem
   - vii. Test power subsystem
   - viii. Integrate power subsystem with robot limb
   - ix. Support testing of robot limb

b. Fabric coverings.
   - i. Support fabric covering requirements development
   - ii Provide fabric covering interface definitions
   - iii. Design fabric coverings
   - iv. Build prototypes for fit checks
   - v. Fabricate coverings
   - vi. Install coverings

c. Joint Mechanisms
   - i. Support requirements development
   - ii Provide mechanism interface definitions
   - iii. Identify mechanical items for procurement

iv. Design custom links, drive trains, and interfaces
v. Fabricate and procure components
vi. Integrate Mechanisms
vii. Test Mechanisms
viii. Integrate Mechanisms with robot limb
ix. Support testing of robot limb

d. Control Software
i. Support software requirements development
ii Provide software interface definitions
iii. Design custom drivers, communication routines, and interface subroutines
iv. Code and test software
v. Integrate software with testbeds
vi. Test software on testbeds
vii. Integrate software with robot limbs
viii. Support testing of robot limbs

e. Embedded Joint Avionics
i. Support joint avionics requirements development
ii Provide joint avionics interface schematics
iii. Identify items for procurement
iv. Design custom boards, avionics boxes, and interfaces
v. Fabrication and procurement of parts
vi. Integrate subsystem
vii. Test subsystem
viii. Integrate subsystem into joints
ix. Support testing of joints

1. Requirements Definition:

Narrative Description of Expected Work:

The power subsystem requirements will come from a simulation tool that computes actual voltage and current requirements as the robot operates, allowing for both peak and average loads to be identified over a range of duty cycles. Fabric covering requirements will come from CAD models for geometry, with materials requirements for durability and esthetics. The joint mechanisms requirements will come from a review of existing Robonaut prototypes with added requirements for additional joint range and stiffness characteristics. The control software requirements will come from driver specifications from COTS computer components and interface requirements from high level limb force and trajectory algorithms. The embedded joint avionics requirements will come from the existing performance values taken from the previous Robonaut Prototypes, with the added requirements for environmental tolerance. The work includes an early milestone, delivering the integration schematic that identifies all other subsystems within the robot that will need power, their location, and interfaces with the embedded avionics.

2. **Preliminary Design:**

Narrative Description of Expected Work:

The tasks are largely in support of R&D activities, where low (TRL 2-3) technologies are being developed and matured (TRL 4-6) over the course of a multi-year project. The subsystems being developed will be a part of that effort, typically taking previously developed components and trying new approaches. As with any subsystem its integration into the larger system is essential, and so the work will be driven by interfaces with other parts of the robot. This will require the CRAVE contractor to work with NASA in the development of the requirements and interfaces definitions as well as the design, fabrication, procurement, integration and test activities described in a-e of the task list given above. The work will be performed on-site in JSC's Dexterous Robotics Laboratory.

3. **Detailed Design:**

Narrative Description of Expected Work:

The power subsystem design will require the use of PCB layout and design tools, and will be guided by the interface and requirement definitions. The fabric covering design will use CAD tools and intermediate prototypes that will be fit-checked with the robot structure. The joint mechanism design will use CAD tools and intermediate prototypes will be integrated with testbeds to verify performance. The control software will be developed using a NASA provided C++ real time development tool (CtrlShell) and integrated with testbeds and the robot limb's main computer system. The embedded joint avionics will be modeled with a CAD system and their integration with the mechanisms and structure will be evaluated as part of the design process.

4. **Prototype Production and Testing:**

Narrative Description of Expected Work:

All prototypes, subassemblies, software, designs, drawings, and documentation will be maintained and stored at JSC.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certification				
Flight				
Training				
Other				
Test				
Software				
Other Products				
Prototype	Power Subsystem Design Drawings, Specifications, and Parts Lists	20 Drwgs	8/2007	Non-flight
Development Unit	Fabric Covering	1	6/2007	Non-flight
Test Unit	Fabric Covering	1	10/2007	Non-flight
Prototype	Fabric Covering	1	3/2008	Non-flight
Prototype	Joint Mechanism Design Drawings	50 Drwgs	7/2007	Non-flight
Prototype	Control Software Code	20000 SLOCs	2/2008	Non-flight
Prototype	Embedded Joint Avionics Design Drawings, Specifications, and Parts Lists	20 Drwgs	7/2007	Non-flight

SCHEDULE

Start Date: 4/2/2007 **Finish Date: 5/12/2008**

ITERIM MILESTONES	DUE DATES
Integration Schematic Completed	5/2007
Testbed Integration Complete	10/2007
Subsystem Integration and Testing Completed	1/2008
Robot Limb Integration and Testing Completed	5/2008
Milestones, along with subjective measurements, are to be used for measuring performance	

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled: ***Not provided for this DO.***

Total Government Estimate for this DO: $ 940K
Option 1: $ 800K (See Attachment 1)
Option 2: $ N/A (See Attachment 2)

TOTAL COST ESTIMATE FOR THIS DO: $ 1,037,729

FEE: $ (If Applicable)

OPTION 1: $ bt (See Attachment 1)

FEE: $ (If Applicable)

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	FlightGFE Configuration Management Plan	With Proposal	Once	**Attachment J-8**	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	
3	Written Approval	Project Technical Requirements Specification	Per DO schedule	Once with Revisions	N	
4	Mandatory Submittal	GFE Systems Requirements Data Package	Specified in DO	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	Specified in DO	Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package	Specified in DO	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	Specified in DO	Once with Revisions	N	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	
9	Written Approval	Flight GFE Interface Control Document	Specified in DO	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	Specified in DO	Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As agreed by TMR in DO	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	Specified in DO	Once with Revisions	N	
14	Written Approval	GFE Software Development Plan	Specified in DO	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	Specified in DO	As Required	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
16	Written Approval	Engineering Drawings	Specified in DO	Once with Revisions	Y	
17	Written Approval	EEE Parts Lists and Analysis Report	Specified in DO	As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package	Specified in DO	Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	Specified in DO	Once with Revisions	N	
22	Mandatory Submittal	Software Code	Specified in DO	As Required	Y	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Specified in DO	As Required	Y	
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One Time	N	
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	Y	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	**Attachment J-11**	
30	Written Approval	Patent Rights-Retention	As Required	As Required	**Y (If Applic'ble)**	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	As Early in process as possible.	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N (If Applic'ble)	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	Attachment J-9	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	Specified in DO	As Required	N	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	Specified in DO	Once with Revisions	N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		**Reserved**	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	N	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	**Attachment J-10**	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	N	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY

JSC robotics labs will be the location for this work. Existing lab assets will be made available to the contractor for execution of this DO. The CRAVE contracts do not anticipate the Government providing any property unless requested by the contractor in their response to a request for bid.

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
NA				
NA				
NA				

B. List of Property the Contractor will return in the same configuration:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
NA				
NA				
NA				

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
NA				
NA				
NA				

D. List of Property the Government Will Replace if Damaged or lost during the course of the effort:

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
NA				
NA				
NA				

ATTACHMENT 1

The Government may exercise the option described below for the option value listed on the DO cover page by written notification to the contractor.

OPTION 1 TITLE: Advanced Robonaut Hardware – Option 1

Background / Problem Description:

The purpose of this follow option is to refine the subsystems developed under the base DO, and add new subsystems producing second generation advanced limbs, complete the design of a new Robonaut body ~~and head~~, and integrate all items to produce and test two complete Advanced Robonaut Upper Bodies. The subsystems that are expected to require refinement include skin coverings, joint mechanisms, and embedded avionics. The task will involve design, implementation of the designs, integration, testing, and documentation of all work.

Task Description:

The task shall include, but is not limited to:

a. Body
   - i. Complete design for upper body, including limb attachment points, and electronics housings
   - ii. Provide body interface schematics
   - iii. Identify items for procurement
   - iv. Fabricate and procure body components
   - v. Integrate electromechanical subsystems
   - vi. Support upper body testing

b. ~~Head~~
   - ~~i. Support design for head, including video processing, actuator specification, and mechanism development~~
   - ~~ii. Provide head interface schematics~~
   - ~~iii. Identify items for procurement~~
   - ~~iv. Fabricate and procure head components~~
   - ~~v. Integrate electromechanical subsystems~~
   - ~~vi. Support head testing~~

c. Fabric coverings.

i. Refine fabric covering designs
ii. Build second generation prototypes for fit checks
iii. Fabricate coverings
iv. Install coverings

d. Joint Mechanisms
i. Refine custom links, drive trains, and interface designs
ii. Fabricate and procure mechanical components
iii. Integrate Mechanisms
iv. Test Mechanisms
v. Integrate Mechanisms with second generation robot limb
vi. Support testing of second generation robot limb

e. Dual Limb Control Software
i. Support dual limb control software requirements development
ii. Provide dual limb control software interface definitions
iii. Design software subroutines to support dual limb operations
iv. Code and test software
v. Integrate software with testbeds
vi. Test software on testbeds
vii. Integrate software with Robonaut Upper Body
viii. Support testing of Robonaut Upper Body with dual limbs

f. Embedded Joint Avionics
i. Refine Designs for custom boards, avionics boxes, and interfaces
ii. Support fabrication and procurement of parts
iii. Integrate subsystem
iv. Test subsystem
v. Integrate subsystem into joints
vi. Support testing of joints, limbs, and complete upper bodies.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certification				
Flight				
Training				
Other				
Test				
Software				
Other Products				
Prototype	Generation 2 Fabric Covering	1	8/2008	Non-flight
Prototype	Body Design Drawings	15 Drawings	5/2008	Non-flight
~~Head~~	~~Head Subsystem drawings, Specifications and parts list~~	~~45 drawings~~	~~7/2008~~	~~Non_flight~~
Proptype	Final Fabric Covering	2	12/2008	Non-flight
Prototype	Generation 2 Joint Mechanism Design Drawings	50 Drwgs	8/2008	Non-flight
Prototype	Dual Limb Control Software Code	16000 SLOCs	9/2008	Non-flight
Prototype	Generation 2 Embedded Joint Avionics Design Drawings, Specifications, and Parts Lists	20 Drwgs	10/2008	Non-flight

SCHEDULE

Start Date: 5/14/ 2008 **Finish Date: 5/14/ 2009**

ITERIM MILESTONES	DUE DATES
Two Limb Integration Schematic Completed	7/2008
Two Limb Subsystem Integration and Testing for First Unit Completed	10/2008
Generation 2 Subsystem Integration Complete	12/2008
Two Limb Integration and Testing for Second Unit Completed	5/2009

Milestones, along with subjective measurements, are to be used for measuring performance.

CHANGES TO DRDs: NONE

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE
(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-ER-DO24

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: Accountable Property

Order No.: NNJ05HB40B, CRAVE-ER-DO24

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: ____

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-ER-D024

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: ____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: Ronda Kautz (Person authorized to sign)

Signature: Ronda Kautz Date: 03/19/07

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 3/20/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	CRAVE-ER-DO24, ADVANCED ROBONAUT HARDWARE					
1	The contractor shall perform and deliver to all base requirements of CRAVE-ER-DO24 as described in the Statement of Work. Base Period of Performance: 03/20/07 through 05/12/08	Lot			64	
2	OPTION 1: The Government may require the contractor to continue to perform services under this delivery order. The Contracting Officer may unilaterally exercise Option 1 by issuing Revision 1 to DO 24. The Government reserves the right not to exercise Option 1. continued	Lot				

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: ____
Rissue To: EC/Joe Genaler, x30025

13. Total
$ 1,929,500

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: ____
Authorized U.S. Government Representative ____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

Order No.: CRAVE-ER-DO24

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	Should the Option be exercised, the resultant delivery order revision will be priced out as negotiated under the base delivery order.					
	OPTION 1 Period of Performance: 05/14/08 through 05/14/09					
	THIS IS A CPFF DELIVERY ORDER.					

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO23R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO23R1

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/1/07 to 8/15/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D023R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/28/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	CRAVE-EC-DO23 - 85 FOOT SAFETY TETHERS Revision 1 to DO 23 is issued to extend the period of performance to August 15, 2007. All other terms and conditions of the delivery order remain unchanged. Period of Performance: 3/1/07 to 8/15/07 This is a Firm Fixed Price Delivery Order.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ NTE 263,225

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

Narrative Task Description

Objective / Task Description:

1.0 Objective

Build to print and certify additional 85 Foot Safety Tethers for Extravehicular Activity use for both Orbiter and International Space Station (ISS) use.

2.0 Need for 85 FT Safety Tethers

Currently eight (8) 85 FT Safety Tethers (P/N: SEG33116109-307) exist in the NASA inventory that are being used for Orbiter and International Space Station (ISS) assembly tasks. With the de-manifestation of the Orbiter slidewire assemblies, the 85 FT Safety Tether is now the crew's primary safety restraint for Orbiter payload bay EVAs. Additional 85 FT Safety Tethers are needed to ensure sufficient 85 FT Safety Tethers are available for all future flights and EVAs (planned or contingency) activities.

3.0 Task Description

The contractor shall build to print 85 FT Safety Tethers (P/N: SEG33116109-307) and perform all testing requirements per Certification And Requirements Document (CARD) JSC-60453A[1]. NASA requests a proposal which contains estimates for A, B, and C. One, or a combination, will be considered.

A. Quantity two (2) Class I (flight) Units
B. Quantity four (4) Class I (flight) Units
C. Quantity one (1) Class III (trainer) (assume trainer will be in addition to a flight build of 2 or more, for estimation purposes. Unit must be functional for table-top training purposes only. No acceptance testing or ADP required. This unit shall be delivered without the crew hooks and load alleviating strap. The Velcro breakaway tether strap is required)

The drawings for this hardware are located in the JSC Engineering Drawing Control Center (EDCC). There is also a Disassembly Procedure (SKD33119058) located in the JSC EDCC for the 85 Foot Safety Tether, a link is listed below.

NASA JSC Test facilities for load[2], vibration, and thermal testing will be provided to the contractor at no cost as GFE. Test facility operations, test readiness reviews (TRR), and facility TPS's will be provided by NASA. The contractor shall provide the hardware functional test TPS as required for the TRR process and execution of the test. The contractor is expected to participate in the TRR process, which includes recommendation of environmental and testing levels/limits, placement of sensors on hardware, explanation of fixturing (vibrational and loads). A brief summary of the criticality, purpose, and importance of the hardware shall be provided at the time of TRR to help the test team understand what they are testing.

If cable assemblies (P/N: SDD33105075-004) are not available for the Government to supply, then a load test to failure (lot acceptance test) must be done per CARD JSC-60453A (Requirement 3.1.1.11; 85 Foot Safety Tether Cable Lot Acceptance). One spool of stainless steel cable (P/N: M83420/2-004 L/N: C0108690) with approximately 200 feet will be provided, currently at JSC building 10 bond room. This lot of stainless steel cable has been lot tested per TPS # E60620253. An additional spool (P/N: M83420/2-004 L/N: C0107744) with approximately 200 feet will be provided for the trainer unit, and is currently at JSC building 7 bond room. This secondary spool has not been lot tested.

The vibration test fixture user's manual (JSC 62048) is listed below and contains the procedure required to install the safety tethers to the vibration table in JSC building 49. Both vibration plate fixtures (P/N: SDG36146611-001 & SDG36146612-001) are currently located at JSC building 7 bond room.

JSC 62048 (CTSD-SS-2800) User's Manual for the Safety Tether Vibration Plate Fixtures
http://ctsd.jsc.nasa.gov/doc_library/CTSD-SS-2800.doc

SKD33119058 Disassembly Procedure for the 85 Foot Safety Tether
(http://edcc.jsc.nasa.gov/dbase/edrspub/repository/33/SKD33119058__A_0.PDF

NASA engineering/technical is available to support the execution of this delivery order, not to exceed 4 hours per week. The intent of this offering is to effectively communicate the lessons learned in building and testing this hardware. This support is not intended for changing engineering drawings, or writing task preparation sheets (TPS). If a certification procedure change or clarification is identified, NASA will assist the contractor in walking the change through the approval process at JSC as required.

[1]Reference CR EVA-00063-R1/R2/R3 for updates for additional requirements / verifications. CR EVA-00063R3 is pending approval as of 12/7/06, and contains corrections to the verification of the level wind alignment with the cable on the attachment point of the cable spool, when the cable is fully extended.

[2]Reference closed work authorizing documents for Load Acceptance Testing specific cautions (i.e. TPS # E60620064 Load Acceptance Test). The main caution being the test fixture must have a flexible connection (i.e. soft good knot or containment) to secure the Safety Tether Housing, avoiding damage to the flight hardware.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware	Flight hardware to be provided if option A or B is chosen	Qty 2 Or Qty 4	**4/19/07**	I
Mock Up	N/A	N/A	N/A	N/A
Prototype	N/A	N/A	N/A	N/A
Certification	N/A	N/A	N/A	N/A
Trainer	Class III Trainer to be provided if option C is chosen	1	**4/4/07**	III
Other	N/A	N/A	N/A	N/A
Flight /Test	Functional testing (full acceptance testing including PDA, thermal, load, vibration, and PIA)		**4/11/07**	I
Software	N/A	N/A	N/A	N/A
Other Products	Acceptance Data Package (ADP) for each flight and qualification units	1 per each flight / qual unit	**4/19/07**	I

SCHEDULE

Start Date: March 1, 2007 **Finish Date: June 19, 2007**

ITERIM MILESTONES	DUE DATES
System Requirements Review (SRR)	N/A
Prototype Fabricated	N/A
Prototype Testing Completed	N/A
Preliminary Design Review (PDR)	N/A
Critical Design Review (CDR)	N/A
Hardware Fabrication Complete	Suggested date 3/13/07
Hardware Qual / Acceptance Testing Complete	Suggested date 4/11/07
Certification Complete	N/A
SAR	N/A
Flight Hardware Delivery	4/19/07

Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled: N/A

Total Government Estimate for this DO: $ Option A
N/A Option B
N/A Option C

TOTAL COST ESTIMATE FOR THIS DO: $(Contractor Complete)

FEE: $ (If Applicable)

OPTION 1: $ N/A (See Attachment 1)

OPTION 2: $ N/A (See Attachment 2)

DATA REQUIREMENTS

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	Weekly Tech status
3	Written Approval	Project Technical Requirements Specification	If Required for DO See Comments	Once with Revisions	N	
4	Mandatory Submittal if Flt H/W	GFE Systems Requirements Data Package	If Required for DO See Comments	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	If Required for DO See Comments	Once with Revisions	N	
6	Mandatory Submittal if Flt H/W	Preliminary Design Review Data Package	If Required for DO See Comments	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	If Required for DO See Comments	Once with Revisions	N	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	N	
9	Written Approval	Flight GFE Interface Control Document	If Required for DO See Comments	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	If Required for DO See Comments	Once with Revisions	N	
11	Mandatory Submittal if Flt H/W	Flight GFE Failure Analysis Report	If Required for DO See Comments	As Required	Y	If applicable
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in WI-EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	If Required for DO See Comments	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
14	Written Approval	GFE Software Development Plan	If Required for DO See Comments	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	If Required for DO See Comments	As Required	N	
16	Written Approval	Engineering Drawings	If Required for DO See Comments	Once with Revisions	N	
17	Written Approval	EEE Parts Lists and Analysis Report	If Required for DO See Comments	As Required	N	No EEE parts
18	Mandatory Submittal if Flt H/W	Critical Design Review Data Package	If Required for DO See Comments	Once with Revisions	N	
19	Mandatory Submittal if Flt H/W	Engineering Drawing Change Proposal	If Required for DO See Comments	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	If Required for DO See Comments	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	If Required for DO See Comments	Once with Revisions	N	
22	Mandatory Submittal if Flt H/W	Software Code	If Required for DO See Comments	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	If Required for DO See Comments	Once with Revisions	N	
25	Mandatory Submittal if Flt H/W	Certification Report	If Required for DO See Comments	Once with Revisions	N	
26	Mandatory Submittal if Flt H/W	Engineering Analysis	If Required for DO See Comments	As Required	N	
27	Mandatory Submittal if Flt H/W	Acceptance Data Package	If Required for DO See Comments	One Time	Y	Supplied for each Flight Units

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	Only if contractor is using the R-quality plan template instead of ISO, and only if they need to make changes to it.
30	Written Approval	Patent Rights-Retention	As Required	As Required	Y (If Applicable)	
31	Written Approval	Shuttle/Station Payload Safety Data Package	If Required for DO See Comments	As Required	N	
32	Mandatory Submittal if Flt H/W	Limited Life Systems List	If Required for DO See Comments	As Required	Y	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	If Required for DO See Comments	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	If Required for DO See Comments	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	If Required for DO See Comments	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	If Required for DO See Comments	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	If Required for DO See Comments	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	Y	Contractor to support and implement any corrective action prior to delivery.
41	Upon Request	Nonconformance Record	If Required for DO See Comments	As Required	Y	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	Y	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	If Required for DO See Comments	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
44	Mandatory Submittal if Flt H/W	Certification Data Package	If Required for DO See Comments	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	If Required for DO See Comments	One Time	N	
48	Mandatory Submittal if Flt H/W	Flight GFE Verification & Validation Report	If Required for DO See Comments	Once with Revisions	N	
49	Mandatory Submittal if Flt H/W	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	If Required for DO See Comments	As Required	N	
50		Reserved	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	N	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY - The list of items below will be provided as Government Furnished Property.

Item	Part Number	Quantity	Value
Short Clamp (vibe fixture)	SDG36146611-001	1	$ 2000 each
Long Clamp (vibe fixture)	SDG36146612-001	1	$ 2000 each
Load Alleviating Straps (LAS) [w/ small hook installed]	SEG33108456-703	2/4 *	$ 6000 each
Large Crew Hook	SEG33108084-307	2/4 *	$ 5500 each
Altered-item Cable Assembly Safety Tether - ERCM	SDD33105075-004	5 **	$150 each
Stainless Steel Cable	M83420/2-004	1 spool **	$0.70/ft

*Depending on the number of units built. (i.e. Each 85ft Safety Tether will require qty 1 ea LAS w/ small crew hook installed & qty 1 large crew hook). A class III LAS with "fixed-stitches", and one each small and large crew hooks class III, will be installed by NASA after delivery of the trainer 85 Foot Safety Tether reel subassy.

**Government will provide readily available cabling in inventory; however, contractor should consideration procurement of additional components when developing their propsals. One spool of stainless steel cable (P/N: M83420/2-004 L/N: C0108690) with approximately 200 feet will be provided, currently at JSC building 10 bond room. This lot of stainless steel cable has been lot tested per TPS # E60620253. An additional spool (P/N: M83420/2-004 L/N: C0107744) with approximately 200 feet will be provided for the Class III unit, and is currently at JSC building 7 bond room. This secondary spool has not had a lot test performed, and is not required for the Class III unit.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC-DO23

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC-DO23

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/1/07 to 6/19/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC-D023

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson CONTRACTING OFFICER Date: 3/5/07

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	CRAVE-EC-DO23 - 85 FOOT SAFETY TETHERS The contractor shall perform and deliver to all requirements of CRAVE-EC-DO23 as described in the Statement of Work. Period of Performance: 3/1/07 to 6/19/07 This is a Firm Fixed Price Delivery Order.	Lot			bt	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 263,225

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC-DO23

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC-DO23

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/1/07 to 6/19/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC-D023

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson CONTRACTING OFFICER Date: 3/5/07

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	CRAVE-EC-DO23 - 85 FOOT SAFETY TETHERS The contractor shall perform and deliver to all requirements of CRAVE-EC-DO23 as described in the Statement of Work. Period of Performance: 3/1/07 to 6/19/07 This is a Firm Fixed Price Delivery Order.	Lot			64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025

13. Total
$ 263,225

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Task Order Number	*Revision Number*	*Purchase Request Number*
22	8	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

Manufacture of Fluid Line Repair Components (FLRC) /
Flight Hardware & Certification of Smart Seals

Description/Purpose

The purpose of this delivery order revision is to extend the period of performance from April 15, 2009 to September 30, 2009. The tasks required for this revision is identified in the Oceaneering Space Systems letter, CNTR-109-09; and the associated ROM cost are $116,686.

	Previous Revisions	Action (Rev 8)	Task NTE Value
Cost	b4	b4	b4
Fee			
Total	$ 1,781,069	$ 116,686	$1,897,755

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	4/16/09

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Task Order Number	*Revision Number*	*Purchase Request Number*
22	7	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

Manufacture of Fluid Line Repair Components (FLRC) /
Flight Hardware & Certification of Smart Seals

Description/Purpose

The purpose of this delivery order revision is to execute a no-cost extension. The period of performance shall be extended from February 27, 2009 to April 15, 2009.

The contract value remains unchanged.

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	3/10/09

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Task Order Number	*Revision Number*	*Purchase Request Number*
22	6	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

Manufacture of Fluid Line Repair Components (FLRC) /
Flight Hardware & Certification of Smart Seals

Description/Purpose

The purpose of this delivery order revision is to execute a no-cost extension. The period of performance shall be extended from January 30, 2009 to February 27, 2009.

The contract value remains unchanged.

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	1/28/09

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO22R5

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO22R5

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/22/07 through 01/30/09

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D022R5

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 12/1/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	MANUFACTURE OF FLUID LINE REPAIR COMPONENTS (FLRC) FLIGHT HARDWARE AND CERTIFICATION OF SMART SEALS Revision 5 to DO 22 is issued to extend the completion date to 01/30/09 at no additional cost to the government. All other terms and conditions remain unchanged.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Ralph Marak, 39144

13. Total
$ NTE 1,781,069 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ _____
Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO22R4

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO22R4

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE:

6. Deliver On or Before: 3/22/07 through 11/21/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D022R4

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 11/5/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	MANUFACTURE OF FLUID LINE REPAIR COMPONENTS (FLRC) FLIGHT HARDWARE AND CERTIFICATION OF SMART SEALS Revision 4 to DO 22 is issued to extend the completion date to 11/21/08 at no additional cost to the government. The extension is required to allow OSS to correct the problems associated with their thermal chambers and the 1.0 Smart Seal problem.					

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Ralph Marak, 39144

13. Total
$ NTE 1,781,069 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO22R3

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO22R3

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/22/07 through 8/29/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D022R3

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 5/27/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	MANUFACTURE OF FLUID LINE REPAIR COMPONENTS (FLRC) FLIGHT HARDWARE AND CERTIFICATION OF SMART SEALS Revision 3 to DO 22 is issued to change the completion date of the DO from 5/30/08 to 8/29/08 at no additional cost to the government. The 3-month extension is to allow for the changes to the Qualification and Acceptance verification methods of the Smart Seals flight and qual unit. All other terms and conditions of the delivery order remain the same.				$ 0	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 FOR: EC/Ralph Marak, 39144

13. Total
$ 1,781,069 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative

_____
Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO22R2

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO22R2

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/22/07 through 5/30/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D022R2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 12/10/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	MANUFACTURE OF FLUID LINE REPAIR COMPONENTS (FLRC) FLIGHT HARDWARE AND CERTIFICATION OF SMART SEALS DO 22R2 is issued to revise the deliverable date. All changes have been vertically bar-marked in the attached SOW replacement pages. All other terms and conditions of the delivery order remain the same.				$ 0	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 FOR: EC/Ralph Marak, 39144

13. Total
$ 1,781,069 NTE

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

Deliverables/Products:

Product	Description	Qty	Date	Class
Hardware				
Mock Up				
Prototype	3/8", ½", and ¾" Smart Seals	1ea		
Certification	Upgrade prototypes to Class II after initinal testing and use for certification units			
Flight	Tube Marker (P/N SEG33115315-302) Tube Cutter – Small (P/N SEG33115291-301) Tube Cutter – Large (P/N SEG33115251-301) Smart Seal – 1.0" (P/N SEG33117863-302) Smart Seal – 1-1/2" (P/N SEG33115240-302)	2ea 2ea 2ea 4 ea 4 ea	12/31/07 12/31/07 12/31/07 2/15/08 2/15/08	I
Training				
Other				
Test				
Software				
Other Products				

SCHEDULE

Start Date: January 9, 2007 **Finish Date: May 31, 2008**

ITERIM MILESTONES	DUE DATES
Complete manufacturing	7/27/07
ADP Complete	9/3/07
Certification Complete	4/3/08
Deliver Hardware **Tube Marker and Cutters** **1.0" and 1-1/2" Smart Seals** **Certified Designs 3/8", ½", and ¾" Smart Seals** **Training 3/8", ½", and ¾" Smart Seals**	 **12/31/07** 2/15/08 4/28/08 4/28/08

- Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled:
Total Government Estimate for this DO: $1882 K
Option 1: NA
Option 2: NA

TOTAL COST ESTIMATE FOR THIS DO: [redacted]

FEE: [redacted] **(If Applicable)**

OPTION 1: [redacted] **(See Attachment 1)**

OPTION 2: $ N/A (See Attachment 2)

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO22R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.t.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO22R1

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/22/07 through 5/30/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D022R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.
Name: Wayne White (Person authorized to sign)
Signature: Wayne H. White Date: 7/18/07

10. Name: Ronald Johnson
Signature: Ronald Johnson Date: 7/24/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	MANUFACTURE OF FLUID LINE REPAIR COMPONENTS (FLRC) FLIGHT HARDWARE AND CERTIFICATION OF SMART SEALS The Contractor shall perform and deliver to all requirements of CRAVE DO22R1 for the Manufacture of FLRC Flight Hardware and Certification of Smart Seals as described in the attached Statement of Work. (continued next page)	Lot			W	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 FOR: EC/Ralph Marak, 39144

13. Total
$ 1,259,482.00

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____
Authorized U.S. Government Representative Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	RECAP OF DELIVERY ORDER VALUE:					
	Cost / Fee / Total					
	Base: b4 b4 b4					
	Rev 1					
	CUM TOTAL: $1,658,438 $122,631 $1,781,069					

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC-022, Rev. 1
Manufacture of FLRC Flignt Hardware and Certfication of Smart Seals

PROPOSAL INSTRUCTIONS: _ DRAFT – COMMENTS DUE BY : 12/20/06 COB
X FINAL – PROPOSAL DUE BY: 1/12/07 COB

DO TITLE: Manufacture of Flight Tube Marker and Tube Cutters

DO Type: _x_ CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Ralph J. Marak	Phone: (281) 483-9144
DO Manager: Ralph J. Marak	Phone: (281) 483-9144
DO Mgr. Alternate: Joe Gensler	Phone: (281) 483-0025

Concurrences:

Ralph J. Marak DO Manager	Harold Reimers DO Mgr. Management	Joe Gensler COTR
Ralph J. Marak Division TMR	Steve Miller S & MA	

Task Contains Flight Hardware, Flight Software or GSE? _X_ Yes ___No

Program Supported: __Shuttle _X_ISS _X_EVA __Advanced -

WBS: _X_ 1.0 EVA __ 2.0 FCE __ 3.0 EVR __ ECLSS __ 5.0 ATCS __ 6.0 CHeCS

For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for all Delivery Orders on the contract combined.

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

Narrative Task Description

Background / Problem Description:

1.0 Objective

The objective of the Delivery Order is the fabrication, test, and delivery of the following items of the Fluid Line Repair Components (FLRC):

- 2 each Tubing Cutter, Small (P/N SEG33115291-301)
- 2 each Tubing Cutter, Large (P/N SEG33115251-301)
- 2 each Tubing Marker (P/N SEG33115315-302)
- 4 each 1.0" Smart Seals (P/N
- 4 each 1-1/2" Smart Seals (P/N
- Certification of the 3/8", ½", and ¾" Smart Seals

2.0 Background

The Fluid Line Repair Components (FLRC) provides operational performance to address leaks in the ISS Active Thermal Control System (ATCS) caused by micrometeorite impact, weld failure or a defective Quick Disconnect. The fluid line sizes to be addressed by the FLRC are 1/4", 3/8", 1/2", 3/4", 1" and 1-1/2 " outer tubing diameter manufactured from CRES 316 stainless steel.

The FLRC hardware consists of three separate components:

- Tube cutter, Large and Small
- Tube marker
- Smart Seal Assemblies to fit each tubing size

The FLRC Tube Cutter is used to create a clean cut in a failed line, in preparation for a repair installation. The Tube Cutter cold forges material on the edge of a sharp rolling surface. This operation leaves a clean external fluid line surface with a slight lead-in angle appropriate to the subsequent seal assembly installation. The cutter incorporates numerous EVA interface design features, including soft and hard dock features for attaching the cutter to the tube, an indexing cutting head and drive train so that with input from a single power tool cuts the tube. Two sizes of cutters are provided: a Small Tube Cutter (P/N SEG33115291-301) for cutting tubes from 1/4" through 3/4" in diameter; and a large cutter (P/N SEG33115251-301) for cutting tubes from 1" through 1-1/2" in diameter. The cutting wheels for each of the cutters will be provided as GFP.

The FLRC Tube Marker (P/N SEG33115315-302) is intended to aid a crewmember in determining the exact location to insert the Smart Seal Assembly onto a fluid line stub. The insertion distance is critical to ensure a proper seal engagement depth. The indicator is locked in place until the marker is placed firmly onto the fluid line. Afterwards, the indicator will be moved out of the way so the smart seal assembly can mate to the marker. This provides a positive indication to the crewmember that the fluid line/seal engagement is correct. Also, the Marker provides the Smart Seal with an anti-rotation feature that helps the Smart Seal stay in place when crew

attempts engaging the bolt head on the seal with a socket extension. (**NOTE**: During the design of the 1-1/2" Smart Seal, it was determined that the Tube Marker was not positioning the seal in the proper location on the tubing. To correct the problem, a change to the Tube Marker is being implemented to add an additional tab of approximately ¾ " to the arm. This design change will be completed by 01/15/2007. For the purposes of this DO, cost will be based
on the design that is shown in the referenced drawing.)
The Smart Seals are used to provide either a plug to cap off a fluid line that has that has been prepared for repair or included in a repair assembly to facilitate a permanent repair to the fluid line. The Smart Seal operates by taking torque input from an EVA tool like the PGT to set a polymeric seal ring and collapse a set of mechanical slips against the OD of ISS tubing. These two functions re-establish a very low leakage rate and structurally sound tube connection. The -301 is an open stub end designed for welding to a higher assembly whereas the -302 is a standalone assembly to be used as a line plug since it has a blind stub end. The Smart Seal will be used to create a larger repair assembly that may include Smart Seals, flex lines, hard lines, and QDs. The final design of the repair assembly depends on the location and will not be determined until an actual leak occurs. The Smart Seals that will be fabricated under this task is the -302 assembly.

Task Description:

The contractor shall provide personnel and facilities necessary for the manufacturing, testing and delivery of two each Tube cutter, Large and Small, two each Tube Marker four each Smart Seals (1.0 " and 1-1/2"). The contractor shall also provide the personnel and facilities necessary for the certification of the 3/8", ½" and ¾" Smart Seals.
The tasks shall include:

Flight Item Manufacturing

1. Manufacture and inspection of each of the piece parts
2. Updating of three drawings (if required)
3. Assembly of the end items
4. Acceptance testing of each end item per the requirements of the CARD (JSC-47920B)
5. Assembly of the Acceptance Data Packages (DRD 27) for each end item
6. Delivery of the hardware to JSC

Certification of Smart Seals

1. Design, develop, test, and certify of the 3/8", ½", and ¾" Smart Seals that will be used for the repair of the ATCS fluid lines in accordance with the requirements that are identified in the Fluid Line Repair Kit CARD (JSC47920B0.
2. Deliver certified designs of the 3/8", ½", and ¾" Smart Seals.
3. Deliver Training Hardware

Facilities for vibration and thermal testing at JSC will be made available for acceptance testing, if required and identified.

The drawings for these items are located in the JSC Engineering Drawing Control Center (EDCC).

- Tube Marker (SEG33115315)
  <http://edcc.jsc.nasa.gov/dbase/edrspub/repository/33/SEG33115315__C_0.PDF>
- Tube Cutter - Small (SEG33115291)
  <http://edcc.jsc.nasa.gov/dbase/edrspub/repository/33/SEG33115291__A_0.PDF>
- Tube Cutter – Large (SEG33115251)
  <http://edcc.jsc.nasa.gov/dbase/edrspub/repository/33/SEG33115251__A_0.PDF>
- Smart Seal 1-1/2" (SEG33115240)
  http://edcc.jsc.nasa.gov/edccsearch/getDetail.cfm?ID=33115240
- Smart Seal 1.0" (SEG33117863)
  http://edcc.jsc.nasa.gov/edccsearch/getDetail.cfm?ID=33117863

Solid model of these items are available on CD in Pro-E, wildfire, version 1.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype	3/8", ½", and ¾" Smart Seals	1ea		
Certification	Upgrade prototypes to Class II after initinal testing and use for certification units			
Flight	Tube Marker (P/N SEG33115315-302) Tube Cutter – Small (P/N SEG33115291-301) Tube Cutter – Large (P/N SEG33115251-301) Smart Seal – 1.0" (P/N SEG33117863-302) Smart Seal – 1-1/2" (P/N SEG33115240-302)	2ea 2ea 2ea 4 ea 4 ea	11/15/07 11/15/07 11/15/07 2/15/08 2/15/08	I
Training				
Other				
Test				
Software				
Other Products				

SCHEDULE

Start Date: January 9, 2007 **Finish Date: May 31, 2008**

ITERIM MILESTONES	DUE DATES
Complete manufacturing	**7/27/07**
ADP Complete	**9/3/07**
Certification Complete	**4/3/08**
Deliver Hardware **Tube Marker and Cutters** **1.0" and 1-1/2" Smart Seals** **Certified Designs 3/8", ½", and ¾" Smart Seals** **Training 3/8", ½", and ¾" Smart Seals**	 **11/15/07** **2/15/08** **4/28/08** **4/28/08**

- Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

Government Estimate Located in RFQ File in Microsoft Project File On CRAVE Web Site
The file is titled:
Total Government Estimate for this DO: $1882 K
Option 1: NA
Option 2: NA

TOTAL COST ESTIMATE FOR THIS DO: [redacted]

FEE: [redacted] **(If Applicable)**

OPTION 1: [redacted] **(See Attachment 1)**

OPTION 2: $ N/A (See Attachment 2)

DATA REQUIREMENTS

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
1	Written Approval	FlightGFE Configuration Management Plan	With Proposal	Once	Attachment J-8	
2	Mandatory Submittal	Regular Status Report/ Summary Review	Thirty (30) days following contract start	Monthly	Y	
3	Written Approval	Project Technical Requirements Specification	If Required for DO See Comments	Once with Revisions	N	Requirements identified in CARD (DRD #45)
4	Mandatory Submittal if Flt H/W	GFE Systems Requirements Data Package	If Required for DO See Comments	Once with Revisions	Y	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	If Required for DO See Comments	Once with Revisions	N	Verification Requirements identified in CARD (DRD #45)
6	Mandatory Submittal if Flt H/W	Preliminary Design Review Data Package	If Required for DO See Comments	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	If Required for DO See Comments	Once with Revisions	N	
8	Written Approval	Project Schedule	PDR or 10% effort complete Milestone (See Comments)	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	Baseline scheduled provided at CDR
9	Written Approval	Flight GFE Interface Control Document	If Required for DO See Comments	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	If Required for DO See Comments	Once with Revisions	N	
11	Mandatory Submittal if Flt H/W	Flight GFE Failure Analysis Report	If Required for DO See Comments	As Required	Y	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	Y	Included in CARD provided
13	Written Approval	GFE Software Requirements Specification	If Required for DO See Comments	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
14	Written Approval	GFE Software Development Plan	If Required for DO See Comments	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	If Required for DO See Comments	As Required	N	
16	Written Approval	Engineering Drawings	If Required for DO See Comments	Once with Revisions	Y	Update drawings a: necessary
17	Written Approval	EEE Parts Lists and Analysis Report	If Required for DO See Comments	As Required	N	
18	Mandatory Submittal if Flt H/W	Critical Design Review Data Package	If Required for DO See Comments	Once with Revisions	N	
19	Mandatory Submittal if Flt H/W	Engineering Drawing Change Proposal	If Required for DO See Comments	As Required	Y	
20	Written Approval	GFE Qualification Test Procedure	If Required for DO See Comments	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	If Required for DO See Comments	Once with Revisions	N	
22	Mandatory Submittal if Flt H/W	Software Code	If Required for DO See Comments	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	**Attachment J-4 Due 30 days after DO award**	
24	Written Approval	Certification Plan	If Required for DO See Comments	Once with Revisions	N	Identified in CARI
25	Mandatory Submittal if Flt H/W	Certification Report	If Required for DO See Comments	Once with Revisions	N	
26	Mandatory Submittal if Flt H/W	Engineering Analysis	If Required for DO See Comments	As Required	N	
27	Mandatory Submittal if Flt H/W	Acceptance Data Package	If Required for DO See Comments	One Time	Y	Supplied with hardware delivery

DRD NO.	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly		
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	**Attachment J-11**	Only if contractor i using the R-Qualit Plan template instead of ISO, and only if they need to make changes to it
30	Written Approval	Patent Rights-Retention	As Required	As Required	**Y (If Applic'ble)**	
31	Written Approval	Shuttle/Station Payload Safety Data Package	If Required for DO See Comments	As Required	**N**	
32	Mandatory Submittal if Flt H/W	Limited Life Systems List	If Required for DO See Comments	As Required	**N (if applicable)**	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	If Required for DO See Comments	As Required	**N**	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	If Required for DO See Comments	As Required	**N**	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	**N (If Applic'ble)**	
36	Written Approval	ISS Hazard Report	If Required for DO See Comments	As Required	**N**	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	**Attachment J-9**	
38	Written Approval	Government Certification Approval Request (GCAR)	If Required for DO See Comments	As Required	**N**	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	If Required for DO See Comments	As Required	**N**	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	**Y**	
41	Upon Request	Nonconformance Record	If Required for DO See Comments	As Required	**Y**	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	**Y (if applicable)**	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	COMMENTS
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	If Required for DO See Comments	Once with Revisions	N	
44	Mandatory Submittal if Flt H/W	Certification Data Package	If Required for DO See Comments	Once with Revisions	Y	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	Y	
47	Written Approval	GFE Acceptance Test Procedure	If Required for DO See Comments	One Time	Y	Can use TPS for procedures.
48	Mandatory Submittal if Flt H/W	Flight GFE Verification & Validation Report	If Required for DO See Comments	Once with Revisions	Y	
49	Mandatory Submittal if Flt H/W	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	If Required for DO See Comments	As Required	N	
50		Reserved	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	Y	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD		Only if contractor i using the R-Quality Plan template instead of ISO, and only if they need to make changes to it

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

GOVERNMENT FURNISHED PROPERTY - The list of items below will be provided as Government Furnished Property.

Item	Part Number	Quantity	Value
Cutting Wheel	SDG33119047-001	8	$800.00

ATTACHMENT 1

The Government may exercise the option described below for the option value listed on the DO cover page by written notification to the contractor 15 days before the completion of the Basic delivery order requirement.

OPTION 1 TITLE: No Options are Anticipated

Background / Problem Description:

Task Description:

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
Certification				
Flight				
Training				
Other				
Test				
Software				
Other Products				

SCHEDULE

Start Date: **Finish Date:**

• ITERIM MILESTONES	• DUE DATES

- Milestones, along with subjective measurements, are to be used for measuring performance. For schedule detail see Microsoft Project file located on the CRAVE web site for this DO listed under the Government Cost Estimate below.

CHANGES TO DRDs: NONE

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC-DO22

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC-DO22

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 3/22/07 through 11/15/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC-D022

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 3/21/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	CRAVE-EC-DO22 - FLUID LINE REPAIR COMPONENTS (FLRC) BUILD TO PRINT The contractor shall perform and deliver to all requirements of CRAVE EC-DO22 as described in the Statement of Work. Period of Performance: 3/22/07 - 11/16/07 Value Recap: Cost Fee Total 64 $521,587 This is a CPFF Order.	LOT			64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 FOR: EC/Ralph Marak, 39144

13. Total
$ 521,587

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Delivery Order Number	*Revision Number*	*Purchase Request Number*
21	9	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

LIFE SUPPORT UMBILICAL SYSTEM

Description/Purpose

The purpose of this revision is to correct and replace the delivery order recapitulation for revision #8 as shown below.

Delivery Order 21 Value Recapitulation:

	Prior	This Action DO 21, Rev 9	Cum Value
Cost	b4	b4	b4
Fee			
Total	$ 5,735,553.00	($ 936,829.00)	$ 4,798,724.00

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	6/15/10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Delivery Order Number	*Revision Number*	*Purchase Request Number*
21	8	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

LIFE SUPPORT UMBILICAL SYSTEM

Description/Purpose

The purpose of this revision is to: 1) change the period of performance from 10/16/2006 – 09/01/2009 to 10/16/2006 – 06/05/2009; 2) decrease the delivery order value by $1,036,175 as shown below; 3) notify the contractor that all deliverables/products after June 5, 2009 shall be removed from the Delivery Order Description.

Delivery Order 21 Value Recapitulation:

	Prior	This Action DO 21, Rev 8	Cum Value
Cost	b4	b4	b4
Fee			
Total	$ 5,735,553.00	($ 1,036,175.00)	$ 4,699,378.00

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	6/5/09

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TX 77058

COST REIMBURSABLE INDEFINITE-DELIVERY
INDEFINITE-QUANTITY (IDIQ) TASK ORDER
Oceaneering Space Systems, Inc.
Contract NNJ05HB40B

Delivery Order Number	*Revision Number*	*Purchase Request Number*
21	7	Funded at Contract Level
SOW WBS	*Fiscal Year*	*Technical Monitor/Division/Extension*
	FY09	COTR: Ralph Marak/EC ext:3-9144

Task Order Title

LIFE SUPPORT UMBILICAL SYSTEM

Description/Purpose

CRAVE delivery order 21; revision 7 is issued to add and exercise option 5 and 6 as described in the revised statement of work. The delivery order value is increased by $1,270,620 from $4,464,933 to $5,735,553.

The completion date is extended to 09/01/2009.

Delivery Order 21 Value Recapitulation:

	Prior	This Action DO 21, Rev 7	Cum Value
Cost	b4	b4	b4
Fee			
Total	$4,464,933.00	$ 1,270,620.00	$ 5,735,553.00

THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE TASK ORDER VALUE SPECIFIED HEREIN. THIS IS A COST PLUS FIXED FEE TASK ORDER.

NASA Approval

Contracting Officer	*Signature*	*Date*
Ronald Johnson	Ronald Johnson	11/29/09

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO21R6

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO21R6

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/16/06 to 01/29/09

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D021R6

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 11/6/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIFE SUPPORT UMBILICAL SYSTEM CRAVE DO 21, Rev 6 is issued to exercise Option 4 for tasks described in the revised SOW. The DO value is increased by 54 to $4,464,933. The completion date is extended to 01/29/09. continued next page	LOT			64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Ralph Marak, x39144 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 4,464,933

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIFE SUPPORT UMBILICAL SYSTEM					
	DO 21 VALUE RECAP:					
	PRIOR / THIS ACTION DO21R6 / CUM VALUE					
	COST b4 / b4 / b4					
	FEE					
	TOTAL $3,296,743 / $1,168,190 / $4,464,933					
	THIS IS A CPFF DELIVERY ORDER					

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO21R5

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO21R5

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/16/06 to 07/11/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D021R5

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 3/14/08
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIFE SUPPORT UMBILICAL SYSTEM CRAVE DO 21, Rev 5 is issued to add the following tasks to the delivery order: (1) temperature control value, (2) crew evaluations (3) ganged vs. multiple connectors trade study, and (4) 3/4" breathing gas IVA and EVA hose bundles. Additionally, the DO value is i[illegible] to $3,296,743, and the period of performance is extended to July 11, 2008. continued next page	LOT			64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 3,296,743

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIFE SUPPORT UMBILICAL SYSTEM					
	DO 21 VALUE RECAP:					

	PRIOR	THIS ACTION DO21R5	CUM VALUE
COST	b4	b4	b4
FEE			
TOTAL	$3,232,117	$64,626	$3,296,743

THIS IS A CPFF DELIVERY ORDER

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO21R4

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO21R4

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/13/06 to 6/27/08

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D021R4

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 9/26/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIFE SUPPORT UMBILICAL SYSTEM CRAVE DO 21, Rev 4 is issued to add Option 3 to the delivery order, increase the DO value, and extend the period of performance. The SOW for Option 3 is attached. RECAP OF VALUE: PRIOR / THIS ACTION / CUM VALUE COST b4 / b4 / b4 FEE TOTAL $861,028 / $2,371,089 / $3,232,117 PERIOD OF PERFORMANCE: 10/13/2006 - 06/27/2008	LOT			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 3,232,117

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT. ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

JSC Form 1429 (Rev November 10, 2004) (MS Word August 1995)

CREW, ROBOTICS AND VEHICLE EQUIPMENT (CRAVE) CONTRACT
DELIVERY ORDER #: CRAVE-EC5-D021

DO TITLE: Intravehicular Activity/Extravehicular Activity Life Support Umbilical System, Vehicle Interface Assembly, and Suit Connector Conceptual Development and Prototyping

DO Type: X CPFF ___ FFP

DO Contact Information in Addition to the CRAVE Contract Specialist or CO:

TMR: Raul Blanco/EC5	**Phone: (281) 483-1601**
DO Manager: Nicole Jordan/EC5	**Phone: (281) 483-9127**
DO Mgr. Alternate: Antja Chambers/EC5	**Phone: (281) 483-3683**

Concurrences:

Nicole Jordan/EC5 DO Manager	Craig Dinsmore/EC5 DO Mgr. Management	Joe Gensler/EC COTR
Raul Blanco/EC5 Division TMR	Jeff Dutton CSSS SEB Chair	Steve Miller/NT Safety
Ron Johnson CRAVE CO		

Task Contains Flight Hardware, Flight Software or GSE? ___ Yes X No

Program Supported: ___Shuttle ___ISS X EVA X Advanced Cx PO/EVA

WBS: X 1.0 EVA ___ 2.0 FCE ___ 3.0 EVR ___ ECLSS ___ 5.0 ATCS ___ 6.0 CHeCS

*For purposes of complying with FAR 52.232-22, Limitation of Funds, the total amount allotted by the Government to contract is specified in clause B.6, Contract Funding. The funding listed in B.6 is the amount allotted for **all** Delivery Orders on the contract combined.*

All terms and conditions of the contract apply to this Delivery Order. In the event of a conflict between the contract and this Delivery Order, the contract shall prevail.

WBS reporting shall be done in accordance with applicable WBS reporting categories, as shown above and in the contract within Section C, Table 1.

ATTACHMENT 3

The Government intends to modify this contract by adding a third option. Please submit a written price proposal according to the work described in this document. Due to end of fiscal year schedule constraints, a price proposal is requested by Monday, September 17.

OPTION 3 TITLE: Vehicle Interface Element Initial Capability Hardware Development to Preliminary Design Review

Background / Problem Description

After NASA has had time to evaluate the contractor's progress and design concepts from the options NASA will then decide whether or not to enact the additional contract option(s). Option 3 of the contract will entail the development of the Vehicle Interface Element Initial Capability hardware, excluding the Orion Interface Subsystem Suit/Seat Interface Assembly, to Preliminary Design Review (PDR) maturity. This effort includes further design, analysis, fabrication, testing, delivery of prototypes, participation in a government-led PDR, transition of hardware responsibility, and provision of PDR documentation and data packages to support the government-led PDR. The fabrication of the prototypes will follow the design decisions made by NASA at the conclusion of the base contract, Options 1 and 2, and the requirements in CxP 72007, Vehicle Interface Element (VIE) Element Requirements Document (ERD) Revision A Draft.

Purpose of the Current Effort

Following the conceptual design phase in the Base contract and Options 1 and 2 of this delivery order, it is desired by NASA for the design of the IVA Life Support Umbilical, EVA Life Support Umbilical, VMC, and SMC to be developed to PDR level.

Hardware Classification

During the execution of this DO, the hardware prototypes will be used for table-top testing and unmanned thermal vacuum chamber testing; however, it is expected that these prototypes will eventually be used during Neutral Buoyancy Laboratory testing and testing with oxygen enriched gas. These prototypes will **not** be used to provide life support to humans. This hardware is controlled equipment and classified as Special Test Equipment/Devices (STE/D) defined in NT-CWI-001 "Task Performance Sheet" as "similar to GSE but have not had design and certification reviews. This equipment may be used in support of Class I, II, IIIW, and GSE checkout and service, but STE/D will not directly interface with flight hardware." Prior to testing with oxygen enriched gas, portions of the umbilicals wetted with the oxygen enriched gas shall be cleaned to level 100A otherwise the prototypes shall be maintained Visually Clean (VC) as defined in JPR 5322.1F, "Contamination Control Requirements Manual".

Task Description

Form Team

The contractor shall form a team that has the personnel required to track and perform the required tasks defined in the contract. The team is to be limited in the number of people to those who are required to form an effective team and accomplish the design and performance requirements of the contract while minimizing the contract cost. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor shall plan to accomplish the entire job without dependence on NASA effort, other than initial requirement input, NASA-specific knowledge, documentation, and the execution of the PDR. NASA's effort may provide expertise and additional depth of study but shall not be planned into the critical path of the delivery order.

Develop Task Assignments
The contractor shall develop the appropriate task assignments for the design team. Since the exact nature of the expertise potentially available from NASA is needed in order to do a complete plan, an adjustment to the plan provided in the contractor's bid is expected to formalize the NASA participation. This planning adjustment shall not affect the scope of the contractor's work, but can increase or decrease the scope of NASA participation from that included in the bid plan tasks.

Schedule Project
The contractor shall develop a schedule detailing the contractor's project plan, design process, anticipated milestone dates, and performance metrics. Since the exact schedule availability of the expertise available from NASA which maybe needed in order to do a complete plan, an adjustment to the plan schedule provided in the contractor's bid is expected to formalize the NASA participation. This schedule adjustment shall not affect the scope of the contractor's work but can increase or decrease the scope of NASA participation from that included in the bid.

Organizational Conflict of Interest (OCI) Plan
Because this phase of the project requires a close working relationship with the EVA Project Office, Suit Element, Vehicle Interface Element, and Orion Project, during the time the Constellation Space Suit System (CSSS) contract is in the Request for Proposal (RFP) phase, an OCI agreement is needed. The contractor shall develop an OCI Avoidance Plan and submit it to NASA for approval before the option can be awarded.

Perform Human Testing
The contractor shall execute two phases of testing with human test subjects. This testing shall use the umbilical and connector prototypes delivered to NASA as a part of Options 1 and 2 of this delivery order. The first phase shall evaluate the performance of the T-handle connector and the Circular QD connector and the second phase shall evaluate the forces exerted on the crew by the umbilical in a simulated microgravity environment. Each phase of testing shall include up to six crewmembers plus up to two engineering test subjects. A test report shall be written after each phase (for a total of two test reports) per DRD T-023. These reports shall be delivered to NASA no later than 4 weeks after the conclusion of each test. These two phases of testing can be performed in parallel and are described in Figure 1.

The first phase of testing shall consist of a shirtsleeve test with one engineering and one crew test subject followed by a decision made in coordination with NASA on whether to proceed with the shirtsleeve testing or finish the testing with pressurized, suited test subjects. The contractor shall fabricate a method of firmly attaching the SMC to the shirtsleeve test subject such that the SMC is able to withstand the mating and demating forces with minimal movement. This method of attachment shall allow the SMC to be placed in the following locations: center chest, center waist, off-center waist, and thigh. This test shall be performed while the umbilical is pressurized to between 0.5 and 8 psig for the gas lines and up to 25 psig for the water lines. The contractor shall support each test with a test director. The contractor shall provide the equipment and

personnel to film each test and record test subject comments. If it is determined that shirtsleeve testing is of high enough fidelity to adequately evaluate the connectors, this testing will be repeated for the remainder of the test subjects. If it is determined that shirtsleeve testing does not provide the fidelity needed to evaluate the connectors, the remainder of the testing will be completed with the test subjects in pressurized suits. If this is the case, NASA will provide the means for attaching the SMC to the suit.

The second phase of testing, done in parallel with the first phase, is also unsuited and uses NASA's Partial Gravity Simulator (POGO) facility. The purpose of this testing would be to understand the reaction forces an umbilical will impart on a crewmember in micro-g. The contractor shall fabricate a method of firmly attaching the SMC to the shirtsleeve test subject. This method of attachment shall allow the SMC to be placed in the following locations: center chest, center waist, off-center waist, and thigh. The contractor shall determine a method of hanging the umbilical such that its weight is relieved when the subject is using the POGO facility. This test shall be performed while the umbilical is pressurized to between 0.5 and 8 psig for the gas lines and up to 25 psig for the water lines. During the test, the subject will evaluate the forces imparted to them by the umbilical, but will not be actuating the umbilical connector. The contractor shall support each test with a test director. The contractor shall provide the equipment and personnel to film each test and record test subject comments.

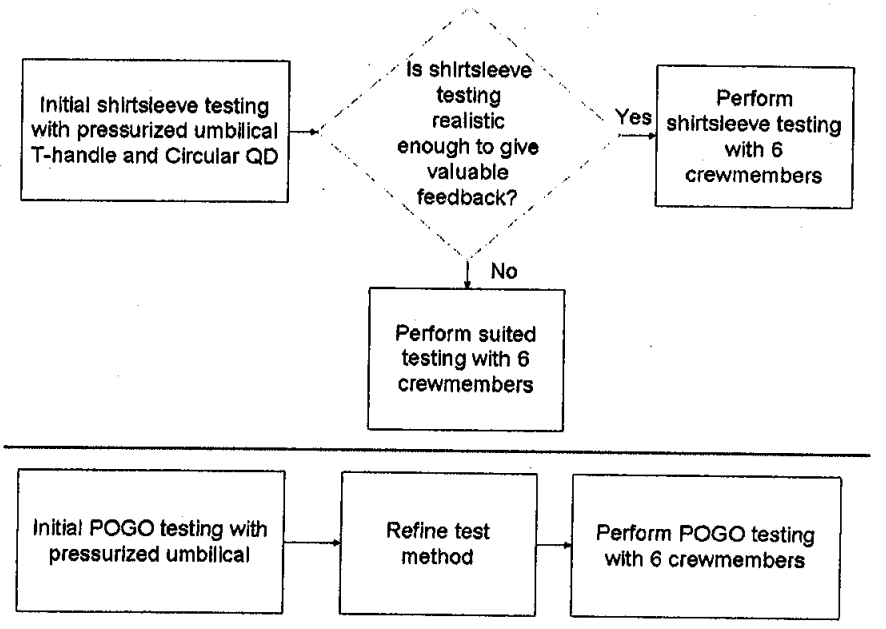


Figure 1 Human Testing Flow Chart

Perform Umbilical Breakaway Capability Study

The incorporation of a breakaway capability in the IVA LSU is currently an issue of debate. Current shuttle system umbilicals break-away with a specified tensile force even if the umbilicals are not disconnected. This capability enhances egress capabilities and prevents injury to the crew during egress as a consequence to fail to disconnect the umbilical. It also eliminates failure modes which could "tether" a crewmember to a vehicle in which he/she needed to rapidly egress. Current shuttle operations have demonstrated that pad crew commonly fails to remove the crew

connections and would injure the crew or delay egress of the crew if the umbilicals did not have a breakaway feature. However, unlike the Shuttle ACES umbilicals, the IVA LSU will be used during times when the cabin is at vacuum and a breakaway feature could introduce a catastrophic failure mode if the umbilical were to breakaway during this time. In addition, the Constellation suits are not expected to have multiple umbilicals like the ACES suits today and it could be assumed that the crew could remember to disconnect a single umbilical whereas they might not always remember to disconnect a series of umbilicals.

To help resolve the issue of whether the IVA LSU is required to have a breakaway capability, the contractor shall perform a study to: (1) assess the need for a breakaway feature in the IVA LSU, (2) define the minimum and maximum force requirements, and (3) determine the impacts to the IVA LSU design if such a feature is incorporated (in the IVA LSU with the T-handle connector or the IVA LSU with the Circular QD connector). In order to complete the first part of the trade study, the contractor shall organize and conduct meetings with key stakeholders in the crew community and ground operations community, including closeout crew members. The third part of the trade study shall consider mass, volume, safety, and complexity impacts of adding a breakaway feature. This part of the trade study shall evaluate at least two conceptual designs for adding breakaway capability. After the completion of the study, the contractor shall support EVA Project meetings including two EVA Systems Engineering Panels and two EVA Project Control Boards related to the results of the report. The Baseline version of the VIE ERD includes breakaway capability as a stretch goal or "should" requirement and retains the requirements for two distinct motions for umbilical disconnection. The results of this trade study will help determine if this requirement will be deleted or changed to a "shall".

Perform Oxygen Recharge Connector Impact Study
It is the responsibility of the Vehicle Interface Element to provide the umbilical and connectors that will be used to recharge the Portable Life Support Subsystem (PLSS) on the lunar surface. It is desired that the recharge connector be as common as possible with the life support umbilical connector. Although the electrical functions of the recharge connector are not defined, it is currently believed that the recharge connector could have a configuration very similar to the IVA and EVA LSU connectors with the addition of a high pressure oxygen line. The contractor shall perform a study assessing the mass and volume impacts to the T-handle connector and the Circular QD connector of scarring the connector for a high pressure (3000 psia) oxygen line. The mass and volume impacts should be calculated considering the following: (1) space needed on the connector to accommodate a future oxygen recharge connector, (2) possible increase in connector structure to accommodate the oxygen recharge connector loads, (3) space needed around oxygen recharge connector for seals. After the completion of the study, the contractor shall support EVA Project meetings including one EVA Systems Engineering Panels and one EVA Project Control Board related to the results of the report. The results of this study will help to determine whether the LSU connector will be modified to leave space for a future oxygen recharge connector.

Complete Preliminary Design of IVA Umbilical, EVA Umbilical, SMC, and UMC
The contractor shall continue to develop the designs of the IVA and EVA LSUs, Circular QD connector, T-handle connector, SMC, and UMC to the PDR level as defined in DRD T-020, attached as an appendix to this document. The contractor shall modify the designs of the connectors according to the feedback given during the crew evaluations. The contractor shall

plan for one other major design change (on the order of adding breakaway capability, adding a high pressure oxygen recharge line, or eliminating the gas connectors on the UMC). Completing the detailed design includes the effort required to make CAD models, complete any thermal, fluids, or loads analysis needed, and generate drawings. The fluids analysis shall include an estimation of the gas velocity during the Circular QD purge as the connector is mating.

Completion of the SMC and VMC detailed designs rely on low level interface requirements that have not yet been developed. The contractor shall initiate meetings with the suit pressure garment team to develop common assumptions regarding the integration of the SMC and EVA LSU pigtail with the suit garment. The contractor shall initiate meetings with the Orion ELCSS team to gather input on the integration of the VMC with the umbilical panel and ECLSS. A NASA representative shall be invited to all meetings with suit garment and/or CEV personnel.

Interim Design Review
At the completion of the preliminary design of the umbilical hardware and prior to the start of prototype manufacturing, the contractor shall hold a design review. This review shall include stakeholders from the suit pressure garment, Orion ECLSS, crew, safety, EVA Project SE&I, and ground operations communities. The purpose of this review is to present the detailed designs of the connectors to the EVA community and gain consensus with the forward plan to PDR. Presentation of the design should include background information explaining how the designs were developed including the results of the crew testing, results of analyses performed, and breakaway study results.

Fabricate Prototypes
The contractor shall fabricate and assemble hardware prototypes in the quantities defined in the deliverables/products table. These prototypes include a full set of umbilicals with the T-handle connector (6 IVA and 2 EVA) and a partial set of umbilicals with the Circular QD connector (2 IVA and 1 EVA) as well as the mating SMCs and VMCs for all umbilicals. In addition, each umbilical shall have a stowage bag and end caps. The EVA umbilical assemblies shall include the suit half of the mate-before-break assembly. These prototypes could be used for table-top testing, vacuum chamber testing, manned testing, Neutral Buoyancy Laboratory testing, and testing with oxygen-enriched gas so documentation should be kept accordingly.

Perform Requirement Verification & Pre-Delivery Acceptance Testing
It is NASA's intent that the contractor perform requirement verification for the IVA and EVA LSU design, VMC design, and SMC design per section 4.0 of CxP 72007, Vehicle Interface Element (VIE) Element Requirements Document (ERD) Revision A Draft. It is acknowledged that verifying each requirement might not be feasible at this time and NASA therefore requests a verification review. During this review, the contractor shall present the proposed verification of each applicable requirement, identifying any verifications that cannot be accomplished at the contractor's facility (such as demonstrations needing pressurized, suited test subjects or tests needing specialized facilities) and any verifications that do not seem feasible at this time. The product of the verification review shall be a verification plan agreed to by NASA and the contractor. Following the review, the contractor shall develop a test plan for the agreed upon testing including a Detailed Verification Objective (DVO) for each test the contractor will perform. The contractor shall then perform the agreed upon testing.

In addition to the verification testing, the contractor shall perform pre-delivery acceptance testing on each copy of each umbilical. This acceptance testing shall consist of the following: (1) tether pull test, (2) electrical continuity test, (3) pressure drop measurement for gas and water, (4) bending moment stiffness test at the worst-case cold operating environment, (5) UMC/SMC and UMC/VMC fit check, and (6) proof pressure test for gas and water. Testing performed at the contractor's facility should be done together as much as possible and should be completed in the presence of a NASA official.

Prepare PDR Documentation
The contractor shall deliver PDR documentation as described in DRD T-020, appended to this document.

Participate in VIE PDR
The contractor shall participate in the government-led PDR for the hardware contained in this delivery order. Participation includes attendance of the PDR kickoff, review panel, pre-board, and board, as well as availability to answer detailed questions during this time.

Weekly Progress Reports
The contractor will be required to provide NASA weekly status email detailing the current status of their work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, and their plan to mitigate any issues/problems. The contractor shall also provide technical cost and schedule status on a bi-weekly basis. The contractor will also be required to support a weekly telecon or meeting with NASA.

Other Notes
Requirements
The technical requirements are contained in CxP 72007, Vehicle Interface Element (VIE) Element Requirements Document (ERD) Revision A Draft. If any technical requirements change during the design or building phase of the prototype, then the contractor will get authorization from NASA. The contractor must demonstrate best effort to meet the "should" statements in CxP 72007. If a "should" statement cannot be met, the contractor must explain why they could not meet the specific "should" statement and what the impact is in not meeting the "should" statement.

Contract End Items
For the purposes of this DO, the following hardware shall be considered Contract End Items (CEIs):

1. IVA Life Support Umbilical (including end covers and stowage bag)
2. EVA Life Support Umbilical (including end covers, stowage bag, and pigtails)
3. Vehicle Multiple Connector
4. Suit Multiple Connector
5. Suit Mate-Before-Break Assembly

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Prototype	IVA LSU with Circular QD Connector	2	April 18, 2008	STE/D
	IVA LSU with T-Handle Connector	6	April 18, 2008	STE/D
	EVA LSU with Circular QD Connector (with Suit Mate-Before-Break Assembly)	1	April 18, 2008	STE/D
	EVA LSU with T-Handle Connector (with Suit Mate-Before-Break Assembly)	2	April 18, 2008	STE/D
	Suit Mate-Before-Break Assembly for EVA LSUs	3	April 18, 2008	STE/D
	IVA LSU Stowage Bag	8	April 18, 2008	III
	EVA LSU Stowage Bag	3	April 18, 2008	III
	SMC for Circular QD Connector	3	April 18, 2008	STE/D
	SMC for T-Handle QD Connector	8	April 18, 2008	STE/D
	VMC for Circular QD Connector	3	April 18, 2008	STE/D
	VMC for T-Handle QD Connector	8	April 18, 2008	STE/D
Test				
	Phase 1 Test (shirtsleeve and/or suited) Report per DRD T-023.	5 EA paper and CD	End of Test + 4 weeks, NLT December 21, 2007	
	Phase 2 Test (POGO) Report per DRD T-023.	5 EA paper and CD	End of Test + 4 weeks, NLT December 21, 2007	
Software	N/A			

Other Products	All electronic document deliverables shall be delivered in .doc and PDF format which was generated directly without printing and scanning. All documentation delivered on CD/DVD should attempt to minimize the number of disks with different content (try to group multiple documents onto the same disk(s)).			
OCI Plan	This plan describes how the contractor plans to avoid conflict of interest between this DO and CSSS procurement efforts.	3 EA paper and CD	ATP + 2 weeks	
Umbilical Breakaway Study	This study is described in the "Perform Umbilical Breakaway Capability Study" section.	5 EA paper and CD	November 30, 2007	
Oxygen Recharge Connector Impact Study	This study is described in the "Perform Oxygen Recharge Connector Impact Study" section.	5 EA paper and CD	November 2, 2007	
Interim Design Review Presentation	Package of slides from the design review.	5 EA paper and CD	January 25, 2008	
Verification Review Presentation	Package of slides from the verification review.	5 EA paper and CD	February 29, 2008	
DVOs	Written for each requirement for which the contractor will perform verification testing. Describes the details for how the verification activities will be performed.	5 EA paper and CD	May 9, 2008	
Test Plan	This plan describes the verification and PDA testing the contractor will perform on the prototypes.	5 EA paper and CD	May 9, 2008	
Verification Test Data Package	Summary of all verification tests completed.	5 EA paper and CD	May 9, 2008	
Acceptance Test Data Package	Summary of all acceptance tests completed.	5 EA paper and CD	May 9, 2008	
Long Lead Item List	Per the description in DRD T-020.	5 EA paper and CD	May 9, 2008	
End Item Specifications	Per the description in DRD T-002.	5 EA paper and CD	May 9, 2008	

CAD Models & Drawings	Per the description in DRDs T-009 and T-032.	5 EA paper and CD	May 9, 2008	
Analysis Results	Per the description in DRD T-010.	5 EA paper and CD	May 9, 2008	
Operational Overview of Crew and Ground Hardware Usage	Per the description in T-020.	5 EA paper and CD	May 9, 2008	
Draft Maintenance Procedures	Per the description in DRD T-031.	5 EA paper and CD	May 9, 2008	
Expected Hardware Life Limitations	Per the description in DRD T-020.	5 EA paper and CD	May 9, 2008	
Identification of GSE, TSE, and Facility Needs/Requirements	Per the description in DRD T-028.	5 EA paper and CD	May 9, 2008	
Draft ICDs	Per the description in DRD T-003.	5 EA paper and CD	May 9, 2008	
Draft Safety Data Package	Per the description in DRDs S-002 and S-006.	5 EA paper and CD	May 9, 2008	
EEE Parts Analysis	Per the description in DRD T-020.	5 EA paper and CD	May 9, 2008	
Materials Usage List	A list which details all the materials the contractor used in the fabrication of the prototypes.	5 EA paper and CD	May 9, 2008	N/A
Weekly Status Report	A weekly e-mail detailing the current status of the contractor's work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, the plan to mitigate any issues/problems, and intermediate results of concept development and trade studies. NASA-agreed to earned value performance and performance metrics and technical cost and schedule status shall be provided bi-weekly.	5 EA e-mail		N/A

SCHEDULE

Start Date: October 1, 2007 **Finish Date:** June 27, 2008

INTERIM MILESTONES	DUE DATES
Receipt of Oxygen Connector Impact Study	November 2, 2007
Receipt of Breakaway Umbilical Study	November 30, 2007
Receipt of Phase A & Phase B Test Reports	December 21, 2007
Interim Design Review	January 25, 2008
Verification Review	February 29, 2008
Prototype Hardware Assembly Complete	March 21, 2008
Draft Connector Specification and Suggested VIE ERD Content to NASA	April 4, 2008
Prototype Hardware Testing Complete	April 18, 2008
Deliver PDR Documentation to NASA	May 9, 2008
VIE PDR (Document drop – Board date)	May 23 – June 27, 2008

Milestones, along with subjective measurements, are to be used for measuring performance.

CHANGES TO DRDs:

DATA REQUIREMENTS

All DRs contained in the contract are applicable *to this option only* and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	N	
2	Mandatory Submittal	Regular Status Report/ Summary Review	ATP plus 2 months	Bi-monthly	Y	Status email
3	Written Approval	Project Technical Requirements Specification	Per DO schedule	Once with Revisions	N	
4	Mandatory Submittal	GFE Systems Requirements Data Package	Specified in DO	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	Specified in DO	Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package	Specified in DO	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	Specified in DO	Once with Revisions	N	
8	Written Approval	Project Schedule	At kick-off meeting	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document	Specified in DO	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	Specified in DO	Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As agreed by TMR in DO	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	Specified in DO	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
14	Written Approval	GFE Software Development Plan	Specified in DO	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	Specified in DO	As Required	N	
16	Written Approval	Engineering Drawings	At Final Presentation	Once with Revisions	N	In Pro/E format.
17	Written Approval	EEE Parts Lists and Analysis Report	Specified in DO	As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package	Specified in DO	Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	Specified in DO	Once with Revisions	N	
22	Mandatory Submittal	Software Code	Specified in DO	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	N	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Specified in DO	As Required	N	Final Design Report in .doc and .pdf format
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One Time	N	
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	**Attachment J-11**	
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	As Early in process as possible.	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	Specified in DO	As Required	N	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	Specified in DO	Once with Revisions	N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		**Reserved**	---	---	---	---
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	**Attachment J-7**	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	**Attachment J-10**	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

CHANGES TO GOVERNMENT FURNISHED FACILITIES:
It is expected that the contractor will need to use some of all of the following government facilities during the execution of this option:

1. Building 33 Chambers
2. Building 29
3. Building 9 (POGO, PABF)
4. Building 7B 2' Chamber
5. Building 7A Space Suit Laboratory

In the event the contractor is using facilities in building 7A, 7B, or 33, the contractor shall submit a JSC Test Request Form 90 at least 30 days in advance of the test date. In the event the contractor is using facilities in building 9, the contractor shall submit a Facilities Usage Request (FUR) at least 15 days in advance of the test date. The contractor will not be responsible for making any changes or upgrades to the chambers, but shall work with the responsible organization (EC4 in the case of building 7A, 7B, 29, and 33 facilities) to develop a plan for any fixturing or facility upgrades needed for the test. The contractor shall prepare the Test Readiness Review (TRR) data package and Task Performance Sheets (TPS) needed for the test.

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or test facilities unless requested by the contractor in their response to a request for bid.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Table 1.1

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

B. List of Property the Contractor will return in the same configuration:

Table 1.2

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

Table 1.3

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

D. List of Property the Government Will Replace if Damaged or lost during the course of the effort:

Table 1.4

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: S-002

TITLE: System Safety Hazard Analysis

DESCRIPTION/USE: The Contractor shall perform a system safety hazard analysis per JSC 17773, "Preparing Hazard Analyses for JSC Ground Operations" Rev. C. This hazard analysis shall include consideration for all of the environments in which the prototype hardware will be used including table-top testing, manned thermal/vacuum chamber testing, Neutral Buoyancy Laboratory testing, and testing with oxygen-enriched gas.

Hazards shall be mitigated according to the following stated order of precedence:

1. Eliminate hazards
2. Design for minimum hazards
3. Incorporate safety devices
4. Provide caution and warning devices
5. Develop administrative procedures and training

Primarily, hazards should be controlled by a system that is failure tolerant. The Constellation Program requires two failure tolerance for catastrophic hazards, and single failure tolerance for critical hazards. In situations where failure tolerance is not technically feasible, or adds complexity which increases cumulative risk, Design For Minimum Risk (DFMR) may be used as a hazard control method. The Contractor shall identify any functions where DFMR is proposed to be used in lieu of failure tolerance and provide an analysis which documents the rationale for acceptance of these DFMR functions. NASA will assess each proposed use of DFMR in the hardware to determine whether or not it meets the program requirements for safety at the Phase I safety review.

DATA PREPARATION INFORMATION:

SCOPE: Safety hazard analyses identify hazards, determine the methods used for controlling the hazards, and establish verification methods and assure closure for the identified hazard. The system safety hazard analysis shall provide a total assessment of the subject systems (hardware and software) and their operational environment.

The hazard analyses shall consider all catastrophic events and the need for highly reliable shut down features (e.g., high speed laser shut down) should such events occur.

The hazard analysis shall be linked to a structured methodology, such as a Fault Tree Analysis and FMEA/CIL, to show how hazards can be flowed down to system

failures.

APPLICABLE DOCUMENTS:

- JSC 17773, "Preparing Hazard Analyses for JSC Ground Operations" Rev. C
- CxP 72007, Vehicle Interface Element (VIE) Element Requirements Document (ERD)

CONTENTS: The Contractor shall perform a system safety hazard analysis in accordance with the methodology outlined in JSC 17773, "Preparing Hazard Analyses for JSC Ground Operations" Rev. C, to identify hazards. Hazard analyses shall address the hazards that arise in the design, development, manufacturing, operations, and disposal associated with the hardware prototypes.

Hazard analyses shall encompass the following for the prototype hardware:

1. Subsystem Hazard Analysis (SSHA)
2. Element Hazard Analysis (EHA)
3. Integrated Hazard Analysis (IHA)

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: S-006

TITLE: Failure Modes Effects Analysis and Critical Items List (FMEA/CIL)

DESCRIPTION/USE: The Failure Modes Effects Analysis is a design tool and will be used to aid design engineering, operations, and manufacturing of the hardware. The Contractor shall perform Failure Modes and Effects Analysis (FMEA) to identify and determine possible modes of failures (including hardware failures, software failures, and human errors), the effects of such failures, and the criticality of such failures to support:

1) Additional design action
2) Safety analysis
3) Test planning
4) Preparation of mandatory inspection points
5) Fault detection and isolation
6) Maintainability design characteristics
7) Maintenance planning

The purpose of the Critical Items List (CIL) is to identify those items or hardware that do not meet failure tolerance requirements, and those items that do not pass the redundancy screens (screening to determine if an item's redundant path can be functionally verified or if a redundant path failure can be detected prior to use, or if all redundant paths can be lost as a result of a single credible common failure cause) that require special attention when establishing hardware specifications and qualification requirements.

The CIL shall consist of all failure modes with criticalities (relative measure of the consequence of the failure,) identified in the FMEA in accordance with the CxP criticality criteria (see CxP 70043, Constellation Program Hardware Failure Modes and Effects Analysis and Critical Items List Methodology, Table 2: Criticality Categories). The FMEA and CIL analysis shall cover Common Cause Failure (CCF) Analysis at the subsystems level and be proof that the design is free from CCF. Each CIL item drives the development and implementation of inspection, process control, and test and verification requirements for the critical items.

REMARKS: At Preliminary Design Review (PDR) the following level of maturity is required:

(a) Detailed subsystem and CEI level Reliability Block Diagrams (RBDs) matching the detail of equipment lists from the Contractor
(b) Failure mode effects will describe the out-of-specification outputs (including higher level element effects) required to support failure propagation assessments

(c) Lowest level effects (subsystem and CEI level) accurately propagated to the high level (element) effects
(d) Failure causes sufficiently developed to a level commensurate with the design
(e) Failure effects developed to a level consistent with design, for both hardware and software

DATA PREPARATION INFORMATION:

SCOPE: The FMEA is an analysis for the hardware to determine possible modes of failure and their effects on the crew, suit system, and ground support equipment, with the provisions for identifying each failure mode by its criticality category number. The FMEA shall include consideration for all of the environments in which the prototype hardware will be used including table-top testing, manned thermal/vacuum chamber testing, Neutral Buoyancy Laboratory testing, and testing with oxygen-enriched gas.

The CIL is a list of hardware identified in the FMEA categorized as being 'Critical' (i.e., those items whose failure could result in a loss of life). The Critical Items List shall consist of those failure modes identified by the FMEA that are Criticality 1, Criticality 2, all Criticality 1R items where the next failure of any redundant item could cause loss of the crew, and all Criticality 1R and 2R items that fail one or more redundancy screens.

The FMEA and CIL worksheet documents (objectively) the 'retention rationale' for the design features, testing, and inspections, operational use, maintainability, and includes the failure history of the item to help minimize the failure occurrence probability.

APPLICABLE DOCUMENTS:

- CxP 70043, Constellation Program Hardware Failure Modes and Effects Analysis and Critical Items List (FMEA/CIL) Methodology Document
- CxP 72007, Vehicle Interface Element (VIE) Element Requirements Document (ERD)

CONTENTS:

a. A brief element and subsystem overview shall be provided along with a subsystem level RBD to reflect the configuration and details of the systems
b. FMEA worksheets shall be prepared at the lowest level (CEI level) required to support potential uses (redesign, testing, failure reporting or corrective action, preparation of mandatory inspection points)
c. FMEA and CIL worksheets shall be prepared as appropriate (with regard to criticality) with 'retention rationale' that contains data that supports the premise that the risk presented by inclusion of the item in the subassembly/assembly/subsystem/ element/system has been minimized by proper design controls, inspections, tests, critical processes and maintenance controls, and that no adverse failure history exists. The rationale shall also contain data, which describes operational constraints caused by occurrence of the failure, and describe the measures taken to ensure that the function is restorable.
d. The fidelity of the FMEA and CIL shall reflect the latest hardware designs and identify risks for all hardware and its interactions during various phases of the prototype testing.

e. A 'single point' failure summary shall be provided as a section of the CIL. An independent redundant items failure analysis shall be done for critical items to evaluate the potential effects for latent defects and other process issues including potential human errors
f. The FMEA and CIL analysis shall cover Common Cause Failure (CCF) Analysis at element and subsystems level and CCF shall be designed out to an acceptable risk level (as approved by NASA) and residual risks shall be documented and controlled.

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-002

TITLE: Preparation of EVA Systems Project Unique Specifications

DESCRIPTION/USE: This DRD documents the process for documenting Vehicle Interface Element requirements as they are allocated and decomposed from the Element level down to the Configuration Item (CI) level.

DATA PREPARATION INFORMATION:
SCOPE: The Preparation of EVA Systems Project Unique Specifications DRD establishes the format and contents of all contractor-developed hardware requirements documents down to and including CI specifications.

APPLICABLE DOCUMENTS:
- CxP 72207, Constellation EVA Systems Vehicle Interface Element Requirements Document

CONTENTS: The Contractor shall develop specifications to the Contract End Item (CEI) level at a minimum.

Currently, CxP 72207 Vehicle Interface Element Requirements Document decomposes requirements down to the subsystem, assembly, and subassembly level, although the decomposition is not complete. It is expected that new requirements will be identified through the design process. The contractor shall work with NASA to identify which of these requirements are appropriate to be included in the ERD and which requirements should be contained in lower level documentation. It is expected that at least one separate specification shall be generated containing requirements specific to the multiple connector. This specification shall contain the technical requirements of the multiple connector (which NASA will develop manage), and the technical details of the connector (which the contractor shall develop). NASA will maintain and control CxP 72007 VIE ERD and the requirements within the connector specification.

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-003

TITLE: Interface Control Documents

DESCRIPTION/USE: To provide configuration controlled documentation in the form of drawings and/or written records to identify necessary design definitions between one or more systems, elements, or subsystems to provide control of and ensure a compatible interface. The Interface Control Document (ICD) provides the design solutions to the requirements found in the requirements specifications and/or the Interface Requirements Document (IRD); the ICDs are companion documents that serve to communicate and control interface design decisions.

REMARKS: None

DATA PREPARATION INFORMATION:
SCOPE: The ICDs identify design definitions for each side of an interface to ensure design control and compatibility. An ICD may describe any number of hardware interfaces.

CONTENTS: The ICD shall document the physical, functional, and procedural interface design. The ICD shall provide the descriptive text and diagrams to fully describe the interface implementation. The ICD shall address all of the engineering disciplines associated with the interface design. The ICD shall identify all applicable workmanship and standards being used as part of the interface design. The ICD shall provide traceability from the requirements specification or IRD to document design compliance with the requirements.

The ICD shall address the following class of interfaces:

(a) Physical – Interfaces involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access
(b) Functional – Interfaces involving the interaction or influence of conditions imposed by one CEI or higher level assembly upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads
(c) Procedural – Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs

The contractor shall develop an ICD for the following:
1. VIE to Suit Element ICD (including SMC/PGS and pigtail/PGS interface)
2. VIE to Orion ICD (including VMC/vehicle interface)

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-009

TITLE: CAD Models

DESCRIPTION/USE: CAD models shall include all solid models, surface models and associated construction references, such as coordinate systems and datum planes, used in the preliminary and detailed design, layout, manufacturing, assembly, testing, certification, and flight hardware processing of the delivered hardware. It is expected that the Contractor provide a solid model for every rigid CEI and at least an outer mold line for flexible (i.e., stowage bag) CEIs.

REMARKS: None

DATA PREPARATION INFORMATION:
SCOPE: This document covers 2-D and 3-D CAD model developed for all hardware. This includes, but is not limited to, wiring, piping, ducting, structure, interfaces, and mechanisms. All models shall include material properties, identification and composition information for all parts represented by the model.

APPLICABLE DOCUMENTS:
- ASME Y14.41 – 2003, Digital Product Definition

CONTENTS: Detailed solid models shall be provided for the preliminary and detailed design, layout, manufacturing, assembly, and testing of the delivered hardware according to the scope outlined in this DRD. The detailed solid models shall be 3-D and shall include the parameters, coordinate systems(s), datum planes, surfaces, axes, points used for model construction and reference purposes.

FORMAT: Model format shall be the native format associated with the model being delivered. Copies of CAD models in an interchange format such as IGES or Standard for the Exchange of Product Data (STEP) may also be requested by NASA. 2D/3D CAD shall be in accordance with ASME Y14.41, in the format specified by the Government, fully parametric and associative. The Contractor shall deliver ProEngineer-compatible 3D models of the components. Alternate formats may be acceptable upon negotiation. All documentation/data shall include the Contractor's CAGE code and document numbers.

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-010

TITLE: Analysis Reports

DESCRIPTION/USE: To document results of analyses performed in support of all phases of hardware development and use.

REMARKS: None

DATA PREPARATION INFORMATION:
SCOPE: All analysis reports either initiated by the Contractor or requested by NASA shall address at a minimum all topics listed in this DRD. The Contractor shall standardize an analysis report format.

APPLICABLE DOCUMENTS: None

CONTENTS: All analysis reports shall include the following:

- Cover page with title, document number for traceability, relevant part and serial numbers (if applicable), analysis cycle, indication of purpose
- Executive Summary
- Objectives/Motivation for the analysis
- Study Requirements and Constraints
- Assumptions and ground rules
- Initializing Data
- Figures of merit
- Analysis tools, tests, and Models used
- Internal Verification and Validation of the results (if applicable)
- Uncertainty of the results
- Detailed results
- Key findings/recommendations

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-020

TITLE: Preliminary Design Review

DESCRIPTION/USE: The primary function of the Design Reviews DRD is to provide the details of what data will be delivered in support of the government-led Preliminary Design Review.

REMARKS: Refer to EA-WI-023, Project Management of GFE Flight Projects for other design review guidance.

DATA PREPARATION INFORMATION:

SCOPE: This document describes the deliverables needed to allow the government to conduct PDR.

APPLICABLE DOCUMENTS: None

CONTENTS:

At a **PDR**, the Contractor products shall at a minimum include:

- Identification of long-lead procurement items in a list with rationale to support designation as long-lead items, cost information, and design details
- Suggested resolution of all applicable "should" statements
- End item specifications per T-002
- Preliminary CAD models and drawings per DRD T-009 and DRD T-032 respectively
- Results of prototype testing
- Supporting test and analysis reports per DRD T- 023 and DRD T-010 respectively
- Operational overview of crew and ground hardware usage
- Draft maintenance procedures per DRD T-031
- Expected hardware life limitations
- Identification of GSE, TSE, and facility needs/requirements per DRD T-028
- Draft ICDs per DRD T-003
- Draft Safety Data Package (System Safety Analysis Report per DRD S-002 and draft FMEA/CILs per S-006)
- EEE parts analysis (if applicable)

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-023

TITLE: Test Reports

DESCRIPTION/USE: To provide the documentation of test results for all tests conducted by the Contractor.

SUBMISSION FREQUENCY:

Test Report	Submission Frequency
Quick Look Report	3 business days after test completion
Final Test Report	21 business days after test completion

REMARKS: None

DATA PREPARATION INFORMATION:
SCOPE: The Contractor shall document the results of all tests in accordance with this DRD.

APPLICABLE DOCUMENTS: None

CONTENTS:
Quick Look Test Reports shall include:
1. Description of the test item
2. Description of the test performed
3. Dates and time performed
4. Data collected (available data)
5. All test anomalies and their impact to the test (tested hardware, facilities, personnel, GSE, and TSE, whether resolved during the test or not)
6. Summary of test results including test objectives met and test objectives not met
7. Constraints to further testing as a result of this test

Final Reports shall include:
1. Description of the test item
2. Description of the test performed
3. Description of the test equipment and facility
4. Test witnesses
5. Test set-up/configuration information
6. Dates and time performed
7. Data collected (databases, photos, video)
8. All test anomalies and their impact to the test (tested hardware, facilities, personnel, GSE, and TSE, whether resolved during the test or not) including failure analysis
9. Test results including:
   - Test conditions as experienced

- Timeline of events as tested
- Specific results with supporting data

10. Test conclusions including comparing the test results against the detailed verification objective requirements

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-028

TITLE: Facility and TSE Requirements

DESCRIPTION/USE: This document defines the requirements for all contractor-provided test and verification facilities, facility systems, and test support equipment (TSE).

REMARKS: None

DATA PREPARATION INFORMATION:
SCOPE: Provide requirements for all contractor-provided test and verification facilities, facility systems, and support equipment needed to support the verification and pre-delivery acceptance test activities described in this DO.

APPLICABLE DOCUMENTS: None

CONTENTS: The Test and Verification Facility Requirement Document shall at a minimum contain the following for each contractor-provided facility and TSE:

a. Narrative description of the purpose and function of the facility, room, and systems
b. Hazard identification requirements (e.g., classification of hazards, types of vents, types of purges, power voltages and frequencies, noise levels, RF radiation levels)
c. Environmental requirements (e.g., temperature, humidity, particle counts, RF shielding, and noise attenuation)
d. Environmental pollution controls
e. Power, grounding and lighting requirements, including the use of uninterruptible power systems and supplies for ground operations activities
f. Backup power and other backup or contingency requirements (chilled water, hot water, and data)
g. Plumbing/venting and commodities requirements for test operations activities
h. Fire and hazard protection requirements
i. Communications and data networking systems requirements (e.g., required connections to other test and operations facilities needed)
j. Special structural needs requirements (e.g., vibration controls and floor loading)
k. Security requirements (e.g., facilities, facility systems, personnel, hardware, software, data, badging, and access control)
l. Material handling requirements (e.g., crane or hoist requirements)
m. Consideration of human engineering requirements
n. Configuration management requirements
o. Scheduling requirements
p. Functional capabilities requirements
q. Facility, facility systems, and support equipment certification requirements

r. Operations requirements, including number and type of personnel required to operate the facility
s. Maintenance requirements
t. Sustaining engineering and obsolescence planning requirements

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-031

TITLE: Maintenance and Assembly Manual

DESCRIPTION/USE: The Maintenance and Assembly Manual documents the detailed instructions needed for disassembling, maintaining, and assembling the prototype hardware.

REMARKS: This is the Chilton's™ for the prototype hardware.

DATA PREPARATION INFORMATION:
SCOPE: A Maintenance and Assembly Manual provides the detailed description of disassembly, maintenance (including standard repair) and assembly steps, and tools and materials required to maintain the prototype hardware. It provides configuration-specific maintenance steps and detailed parts list for subsystems, assemblies, subassemblies, and components of VIE. The Manual also provides the list of approved tools and materials used to accomplish disassembly, maintenance, and assembly tasks. Detailed processing procedures shall be developed from this manual.

APPLICABLE DOCUMENTS: None

CONTENTS: The Maintenance and Assembly Manual shall include for VIE, decomposed by subsystem, assembly, subassembly and component:

1. Identification of next lower level of parts required to construct the specified component
2. Exploded view of hardware item including identification of parts
3. List of tools and fixtures required to disassemble, maintain, and assemble hardware
4. List of materials required to disassemble, maintain, and assemble hardware
5. Constraints, cautions and warnings applicable to each level of disassembly, maintenance, and assembly
6. Detailed instructions for disassembly, maintenance (standard repairs), reassembly, and test of hardware
7. Laboratory conditions to be maintained during maintenance operations

DATA REQUIREMENTS DESCRIPTION (DRD)

DRD NO.: T-032

TITLE: Engineering Drawings and Associated Lists

DESCRIPTION/USE: To provide engineering data defining the design to the extent required to support system design, manufacturing, test, and logistics support of the hardware and required spare parts. Engineering drawings and associated lists shall be sufficient to depict the detailed configuration of all system, subsystem, and component levels and to include ground support equipment (GSE). This DRD applies to released manufacturing, layout, assembly and installation drawings and schematics for all hardware. The level of detail presented in the drawings shall progress from the element and sub-system level to the CEI and CI level over the course of the hardware design lifecycle. All drawings used by the Contractor and their sub-tiers shall be delivered to NASA. The aggregate set of drawings shall define every dimension of the hardware.

REMARKS: None

DATA PREPARATION INFORMATION:
SCOPE: Engineering drawings disclose (directly or by reference) the physical and functional requirements of an item by means of graphics or textual presentation or combinations of both, as supplemented by 3D models.

APPLICABLE DOCUMENTS:

- ASME Y.14.100 – 2004, Engineering Drawing Practices (and associated Appendices B and D)
- ASME Y14.24, Types and Applications of Engineering Drawings
- ASME Y14.34M, Associated Lists
- ASME Y14.35, Revision of Engineering Drawings and Associated Documents
- ASME Y14.41 – 2003, Digital Product Definition

CONTENTS:

a. Part I – Engineering drawings and associated lists of CEIs, elements and/or all components and assemblies shall be provided to define the details necessary for the manufacture, test, inspection, operations, and logistic support of the system. This definition shall:
   1. Reflect the end-product at its current level of design maturity
   2. Provide the engineering data for logistics support products
   3. Provide the necessary data to permit manufacture and/or acquisition of items identical to the original item(s)
   4. Document directly or by reference the following:
      (a) Details of unique processes (i.e., not published or generally available to industry) when essential to design and manufacture
      (b) Performance ratings
      (c) Dimensional and tolerance data (Geometric Dimensioning and

Tolerancing (GDT) shall be required between all external and major internal interfaces)

(d) Critical manufacturing processes and assembly sequences, and rigging procedures
(e) Diagrams
(f) Mechanical and electrical connections
(g) Physical characteristics, including form and finish
(h) Details of material identification, including heat treatment and protective coatings
(i) Inspection, test, and evaluation criteria
(j) Equipment calibration requirements
(k) Quality assurance requirements
(l) Hardware marking requirements
(m) Requirements for reliability, maintainability, environmental conditions, shock, and vibration testing and other operational or functional tests
(n) Cleanliness levels

5. Limited rights-in-data items – Engineering drawings for items which the Government does not have unlimited rights in data shall specify the form, fit, and function requirements of the item and conform to the requirements for a control drawing as defined in ASME Y14.100

b. Part II – Cable interconnect diagrams (CIDs), electrical system schematics, and wiring lists. Cable interconnect diagrams, electrical system schematics, wiring lists, and fluid system schematics shall be prepared in accordance with ASME Y14.100. Part I drawings shall be used to the maximum extent possible in providing the design definition. The drawings shall include the following:

1. Cable interconnect diagrams shall show graphically the arrangement of external electrical cabling which interconnects electrical assemblies and/or equipment. The CID shall show all cable runs and terminations; each cable shall be identified by reference designation number. The connector short sign shall be identified
2. Electrical system schematics shall illustrate and describe circuit items with symbols placed such that a circuit may be traced from item to item in the sequence of its function. The placement and arrangement of these circuits shall follow a logical sequence of presentation to provide a clear description of the distribution
3. Component Level Documentation – Schematics and/or wiring lists for components, including interconnecting cable harnesses, shall be provided
4. Overall Grounding Documentation – The grounding schematic shall show the details of all grounds and power returns from source to loads. All connections shall be shown. It shall also show details of all Electrical Ground Support Equipment interconnections to facility and safety grounds
5. The Fluid system schematic shall illustrate and describe all components with symbols and flow designators such that the fluid system may be traced from component to component (such as pumps, valves, meters, regulators, and filters). The schematics shall document the range requirements (flow, temperature, and pressure) for all component external interfaces and line sizes. The placement and arrangement of these components shall follow a

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO21R3

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO21R3

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/16/06 to 9/28/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D021R3

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 6/1/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIFE SUPPORT UMBILICAL SYSTEM CRAVE DO 21, Rev 3 is issued to perform the following: 1. Revise the Statement of Work to build two high fidelity prototypes. 2. Increase the delivery order value by $126,433 from $734,585 to $861,028. Changes to the Statement of Work (SOW) have been vertically bar-marked in the attached revised SOW. (continued next page)	LOT			64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 861,028

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIFE SUPPORT UMBILICAL SYSTEM					
	DO 21 VALUE RECAP:					

	PRIOR	THIS ACTION DO21R3	CUM VALUE
COST	b4	b4	b4
FEE			
TOTAL	$734,585	$126,443	$861,028

THIS IS A CPFF DELIVERY ORDER

ATTACHMENT 1

The Government may exercise Option 1 described below for the option value listed on the DO cover page by written notification to the contractor within two months after the completion of the Base contract. The Government may choose to exercise any of the remaining options for the values listed on the DO cover page by written notification from the time of completion of the base contract to within two months after the completion of Option 1.

OPTION 1 TITLE: Umbilical Multiple Connector Design Selection and IVA Hardware Prototype Fabrication

Background / Problem Description:

After NASA has had time to evaluate the contractor's progress and design concepts from the base contract NASA will then decide if to enact the additional contract option(s). Option 1 of the contract will entail the selection of an umbilical multiple connector design and the design, analysis, fabrication, testing, and delivery of a prototype IVA Life Support Umbilical, an IVA Vehicle Interface Assembly, and an IVA Suit Multiple Connector to be used in table-top laboratory testing and zero-gravity aircraft testing. This prototype will **not** be used for vacuum chamber testing, manned testing, or with oxygen-enriched gas, but these cases should be considered during the design and fabrication of the hardware. The fabrication of the prototype will follow the design decisions made by NASA at the conclusion of the base contract and the requirements attached to this SOW.

Purpose of the Current Effort

One of the many issues that needs to be addressed is the determination of the IVA Life Support Umbilical, VIA, and Suit Multiple Connector configuration. As a beginning step in the design phase for the IVA Life Support Umbilical, VIA, and Suit Multiple Connector it is desired by NASA to have a Contractor design, fabricate, PDA test, and deliver a prototype system for use in the following flight environments: 1) IVA Open Helmet/ambient environment, 2) IVA Closed Helmet/ambient environment, 3) IVA Closed Helmet/vacuum environment. The prototype fabrication will follow the design decisions made by NASA in the base contract and the requirements as detailed in this SOW. The technical requirements for the IVA and EVA LSUs, VIA, and Suit Multiple Connectors are expected to change during the Basic contract and NASA will notify the contractor of any changes.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the required tasks defined in the contract. The team is to be limited in the number of people to those who are required to form an effective team and accomplish the design and performance requirements of the contract while

minimizing the contract cost. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor is to plan to accomplish the entire job without dependence on NASA effort, other than initial requirement input and NASA-specific knowledge or documentation. NASA's effort may provide expertise and additional depth of study but shall not be planned into the critical path to accomplish the study requirements. The potential availability of government participants for this task is described in the Appendix (below).

Develop Task Assignments

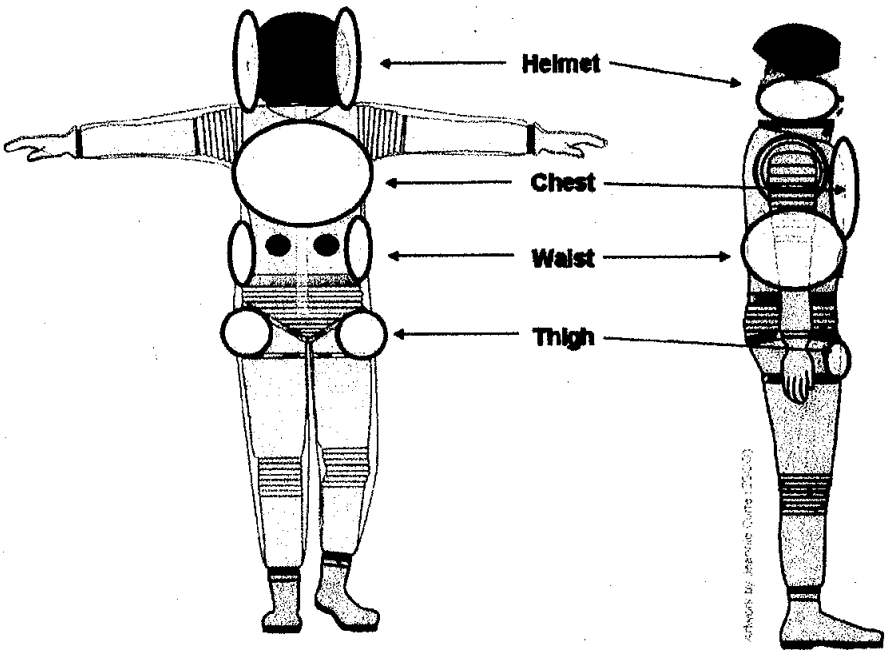
Develop the appropriate task assignments for the umbilical design team. Since the exact nature of the expertise potentially available from NASA is needed in order to do a complete plan, an adjustment to the plan provided in the contractor's bid is expected to formalize the NASA participation. This planning adjustment shall not affect the scope of the contractor's work, but can increase or decrease the scope of NASA participation from that included in the bid plan tasks.

Schedule Project

Develop a schedule detailing the contractor's project plan, design process, anticipated milestone dates, and performance metrics. Since the exact schedule availability of the expertise available from NASA which maybe needed in order to do a complete plan, an adjustment to the plan schedule provided in the contractor's bid is expected to formalize the NASA participation. This schedule adjustment shall not affect the scope of the contractor's work but can increase or decrease the scope of NASA participation from that included in the bid.

Select a Multiple Connector Design

Given the dependency of the umbilical multiple connector design on the placement of the connector on the suit, NASA agreed to carry forward five umbilical multiple connector designs into the options phase: (1) Circular Connector with Quick Disconnects, (2) Cam Ganged Connector with Quick Disconnects, (3) In-Line Two Lever Valve Block, (4) Right Angle Two Lever Valve Block, and (5) Right Angle Single Lever Valve Block. The contractor shall fabricate medium fidelity prototypes of these connector concepts that have realistic mass, volume, and actuation method. The contractor shall fabricate two short lengths of umbilical hose (approximately ten feet), one with an overall diameter of two inches (+0.25 in, -0.0 in) and one with a diameter of three inches (+0.5 in, -0.25 in). These umbilical hoses shall be able to be attached to any of the five connector prototypes. The contractor shall design and fabricate hardware (e.g. straps, Velcro) to enable the attachment of the prototype connectors to the following suit locations: (1) helmet, (2) chest, (3) waist, and (4) thigh (Figure 1). The contractor shall support suited evaluations of the connector prototypes by the development of a test plan and attendance during the evaluations. The contractor shall collect data during the evaluations including photography and evaluator comments and ratings. The contractor shall support a connector concept review and present the results of the testing during which stakeholders (crew, MOD, engineering, safety, e.g.) will provide feedback on the connector design. The contractor



shall prepare a test report summarizing the purpose, method, and results of the connector evaluation. Following the review, NASA will select two connector concepts to proceed with during the high fidelity prototyping phase.

Figure 1. Possible Umbilical Suit Locations

Design Fabricate, and Test Ball Valve Block Assembly

The contractor shall design, fabricate, and test a ball valve block assembly. Laboratory testing will conducted to characterize leakage rates, residual volume, and actuation forces in a vacuum environment. This testing will provide confidence that the ball valve based connectors will work reliably in a vacuum environment, prior to completing the design of the prototype connector.

Design and Fabricate IVA LSU, VIA, and Suit Multiple Connector Prototypes

Using the design concepts developed and agreed to by NASA in the base contract and the connector selection phase of Option 1, the contractor shall design, analyze, generate ProE models (CADKEY for Circular QD connector), generate drawings, fabricate, assemble, verify requirements, PDA test, and deliver 2 prototype IVA Life Support Umbilical System, Vehicle Interface Assembly, and Suit Connector prototypes for laboratory testing. Requirements verification testing performed at the contractor's facility should be done together as much as possible and should be completed in the presence of a NASA official. The focal points of the prototype design and fabrication shall include the results of the trade studies, the design decisions made by NASA at the end of the base contract, and the prototype requirements supplied with this contract. As indicated in the table at the end of this section, the contractor shall also design and fabricate 2 NBL compatible covers for the umbilical.

Hardware Classification

The planned use of this hardware is in a laboratory environment and the prototype is proof of concept hardware only. The prototype hardware will not be used for life support purposes.

Systems Engineering and Document Integration

System-level and development-level requirements will ultimately be entered and managed into Constellation-identified Cradle® requirements management software system. The contractor shall provide all documents to NASA for any requirements that differ or for new requirements. As NASA personnel will have prime responsibility for this conversion and it is expected that contractor support for this activity will be minimal.

General Notes

1. The Cooper-Harper scale will be used to rate all the subjective requirements.
2. The contractor must demonstrate best effort to meet the "should" statements in this document. If a "should" statement cannot be met, the contractor must explain why they could not meet the specific "should" statement and what the impact is in not meeting the "should" statement.
3. If any technical requirements change during the design or building phase of the prototype, then the contractor will get authorization from NASA.

Materials Data Delivery Requirements

All materials information required to satisfactorily complete the CTSD Materials Usage Log. Specific materials test and analysis information related to Section 1.8.1 thru 1.8.7 requirements shall be made available to NASA upon request. Procedure for approving the CTSD Materials Usage log is contained in CTSD document STB-E-083.

Progress Reports

The contractor will be required to provide NASA weekly status email detailing the current status of their work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, and their plan to mitigate any issues/problems. The contractor shall also provide technical cost and schedule status on a bi-weekly basis. The contractor will also be required to support a weekly telecon or meeting with NASA.

Generate Final Report

The contractor is to generate and publish a report detailing their IVA Life Support Umbilical System, Vehicle Interface Assembly, and Suit Connector prototype designs including assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics of their prototypes, and their findings/conclusions to meet the contract delivery requirements for the contract Option 1. The contractor shall also include their

interface assumptions, identify issues/problems that have arisen, and their plan to mitigate those issues/problems.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up	Connector to Suit Attachment Hardware	2	2 April 2007	
Prototype				
	Umbilical Multiple Connector Medium Fidelity Prototypes	5	2 April 2007	
	Umbilical Prototype Hoses	2	2 April 2007	
	Handling Aids	2	September 28, 2007	
	IVA Umbilical	2	September 28, 2007	
	Multiple Connector	4	September 28, 2007	
	Stowage Bag	2	September 28, 2007	
	Suit Connector	2	September 28, 2007	
	IVA Vehicle Interface Assembly	2	September 28, 2007	
	NBL IVA Umbilical Cover	2	September 28, 2007	
Certification				
Flight				
Training				
Other				
Test				
	Verification Data Package	5 EA paper and CD	September 28, 2007	
Software	N/A			

Other Products	All electronic document deliverables shall be delivered in .doc and PDF format which was generated directly without printing and scanning. All documentation delivered on CD/DVD should attempt to minimize the number of disks with different content (try to group multiple documents onto the same disk(s)).			
Prototype Design Report	A comprehensive report (in addition to a MS PowerPoint presentation) detailing the contractor's prototype design, analysis of the hardware (i.e. FMEA, sample test data, etc.), assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics their prototype, and their conclusions.	5 EA paper and CD	September 28, 2007	N/A
Materials Usage List	A list which details all the materials the contractor used in the fabrication of the prototypes.	5 EA paper and CD	September 28, 2007	N/A
Electronic models	All electronic models (Pro/E) of prototype hardware	5 EA CDs	September 28, 2007	N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and specialized tooling developed for the fabrication of prototype hardware	5 EA paper and CD	September 28, 2007	N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the prototype hardware.	5 EA paper and CD	September 28, 2007	N/A
Weekly Status Report	A weekly e-mail detailing the current status of the contractor's work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, the plan to mitigate any issues/problems, and intermediate results of concept development and trade studies. NASA-agreed to earned value performance and performance metrics and technical cost and schedule status shall be provided bi-weekly.	5 EA e-mail		N/A

SCHEDULE

Start Date: February 5, 2007 **Finish Date:** September 28, 2007

INTERIM MILESTONES	DUE DATES
Connector Prototype Hardware for Evaluations Complete	April 2, 2007
Umbilical Multiple Connector Concept Review	May 4, 2007
Prototype Design Documentation Complete	June 29, 2007
Design, Fabrication, and Assembly of Prototype Hardware Complete	August 17, 2007
Prototype Verification Testing Complete	September 7, 2007
Final Presentation of IVA Life Support Umbilical, IVA Vehicle Interface Assembly, and Suit Connector Design, Verification Data, and Interface Assumptions	September 14, 2007
Prototype Design Report Due	September 28, 2007
Verification Data Package, Materials Usage List, Electronic Models, Drawings, Patterns, Tooling, and Build Paperwork Due	September 28, 2007

Milestones, along with subjective measurements, are to be used for measuring performance.

CHANGES TO DRDs:

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	N	
2	Mandatory Submittal	Regular Status Report/ Summary Review	ATP plus 2 months	Bi-monthly	Y	Status email
3	Written Approval	Project Technical Requirements Specification	Per DO schedule	Once with Revisions	Y	Revision of requirements included with SOW
4	Mandatory Submittal	GFE Systems Requirements Data Package	Specified in DO	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	Specified in DO	Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package	Specified in DO	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	Specified in DO	Once with Revisions	N	
8	Written Approval	Project Schedule	At kick-off meeting	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document	Specified in DO	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	Specified in DO	Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As agreed by TMR in DO	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	

DRL SEQ	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DOT Y/N	ADDITIONAL REQUIREMENTS
13	Written Approval	GFE Software Requirements Specification	Specified in DO	Once with Revisions	N	
14	Written Approval	GFE Software Development Plan	Specified in DO	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	Specified in DO	As Required	N	
16	Written Approval	Engineering Drawings	At Final Presentation	Once with Revisions	Y	In Pro/E format. (except for Circular QD connector)
17	Written Approval	EEE Parts Lists and Analysis Report	Specified in DO	As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package	Specified in DO	Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	Specified in DO	Once with Revisions	N	
22	Mandatory Submittal	Software Code	Specified in DO	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	N	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Specified in DO	As Required	Y	Final Design Report in .doc and .pdf format
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One Time	N	

DRD NO.	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	As Early in process as possible.	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	Specified in DO	As Required	N	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	Specified in DO	Once with Revisions	N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		Reserved	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE
(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or test facilities unless requested by the contractor in their response to a request for bid.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Table 1.1

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

B. List of Property the Contractor will return in the same configuration:

Table 1.2

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

Table 1.3

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

D. List of Property the Government Will Replace if Damaged or lost during the course of the effort:

Table 1.4

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

ATTACHMENT 2

The Government may exercise Option 2 described below for the option value listed on the DO cover page by written notification to the contractor from the time of completion of the base contract to within two months after the completion of Option 1.

OPTION 2 TITLE: EVA Life Support Umbilical System with pigtail connections, IVA/EVA Vehicle Interface Assembly, and EVA Suit Connector Prototype Build/Fabrication

Background / Problem Description:

After NASA has had time to evaluate the contractor's progress and design concepts from the base contract and possibly Option 1, NASA will then decide if to enact the additional contract option(s). The intent of Option 2 is to reserve the option to enact it either in parallel or in series with Option 1. Option 2 of the contract will entail the design, analysis, fabrication, testing, and delivery of a prototype EVA Life Support Umbilical System with pigtail connections, an IVA/EVA Vehicle Interface Assembly, and an EVA Suit Connector to be used in table-top laboratory testing and zero-gravity aircraft testing. This prototype will **not** be used for vacuum chamber testing, manned testing, or with oxygen-enriched gas, but these cases should be considered during the design and fabrication of the hardware. The fabrication of the prototype will follow the design decisions made by NASA at the conclusion of the base contract and the requirements attached to this SOW.

Purpose of the Current Effort

One of the many issues that need to be addressed is the determination of the EVA Life Support Umbilical System, VIA, and Suit Connector configuration. As a beginning step in the design phase for the EVA Life Support Umbilical with pigtail connections, VIA, and Suit Connector it is desired by NASA to have a Contractor design, fabricate, PDA test, and deliver a prototype system for use in the following flight environments: 1) IVA Open Helmet/ambient environment, 2) IVA Closed Helmet/ambient environment, 3) IVA Closed Helmet/vacuum environment. The prototype fabrication will follow the design decisions made by NASA in the base contract and the requirements as detailed in this SOW. The technical requirements for the IVA and EVA LSUSs, VIA, and Suit Connectors are expected to change during the Basic contract and NASA will notify the contractor of any changes.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the required tasks defined in the contract. The team is to be limited in the number of people to those who are required to form an effective team and accomplish the design and performance requirements of the contract while minimizing the contract cost. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor is to plan to accomplish the entire job without dependence on NASA effort, other than initial requirement input and NASA-specific knowledge or documentation. NASA's effort may provide expertise and additional depth of study but shall not be planned into the critical path to accomplish the study requirements. The potential availability of government participants for this task is described in the Appendix (below).

Develop Task Assignments

Develop the appropriate task assignments for the umbilical design team. Since the exact nature of the expertise potentially available from NASA is needed in order to do a complete plan, an adjustment to the plan provided in the contractor's bid is expected to formalize the NASA participation. This planning adjustment shall not affect the scope of the contractor's work, but can increase or decrease the scope of NASA participation from that included in the bid plan tasks.

Schedule Project

Develop a schedule detailing the contractor's project plan, design process, anticipated milestone dates, and performance metrics. Since the exact schedule availability of the expertise available from NASA which maybe needed in order to do a complete plan, an adjustment to the plan schedule provided in the contractor's bid is expected to formalize the NASA participation. This schedule adjustment shall not affect the scope of the contractor's work but can increase or decrease the scope of NASA participation from that included in the bid.

Design and Fabricate EVA LSUS with pigtail connections, VIA, and Suit Connector Prototypes

Given the results of the trade studies, the design concepts developed and agreed to by NASA in the base contract, the contractor shall design, analyze, generate 3-D models, generate drawings, fabricate, assemble, verify requirements, PDA test, and deliver a Prototype EVA Life Support Umbilical System with pigtail connections, IVA/EVA Vehicle Interface Assembly, and Suit Connector prototype for laboratory testing. The models and drawings of all except the pigtail connector shall be in Pro/E format. Requirements verification testing performed at the contractor's facility should be done together as much as possible and should be completed in the presence of a NASA official. The focal points of the prototype design and fabrication shall include the results of the trade studies, the design decisions made by NASA at the end of the base contract, and the prototype requirements supplied with this contract.

Hardware Classification

The planned use of this hardware is in a laboratory environment and the prototype is proof of concept hardware only. The prototype hardware will not be used for life support purposes.

Systems Engineering and Document Integration

System-level and development-level requirements will ultimately be entered and managed into Constellation-identified Cradle® requirements management software system. The contractor shall provide all documents to NASA for any requirements that differ or for new requirements. As NASA personnel will have prime responsibility for this conversion and it is expected that contractor support for this activity will be minimal.

General Notes

4. The Cooper-Harper scale will be used to rate all the subjective requirements.
5. The contractor must demonstrate best effort to meet the "should" statements in this document. If a "should" statement cannot be met, the contractor must explain why they could not meet the specific "should" statement and what the impact is in not meeting the "should" statement.
6. If any technical requirements change during the design or building phase of the prototype, then the contractor will get authorization from NASA.

Materials Data Delivery Requirements

All materials information required to satisfactorily complete the CTSD Materials Usage Log. Specific materials test and analysis information related to Section 1.8.1 thru 1.8.7 requirements shall be made available to NASA upon request. Procedure for approving the CTSD Materials Usage log is contained in CTSD document STB-E-083.

Progress Reports

The contractor will be required to provide NASA weekly status email detailing the current status of their work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, their plan to mitigate any issues/problems, and NASA-agreed to earned value performance and performance metrics. The contractor shall also provide technical cost and schedule status as well as intermediate results of concept development and trade studies. The contractor will also be required to support a weekly telecon with NASA.

Generate Final Report

The contractor is to generate and publish a report detailing their EVA Life Support Umbilical System, IVA/EVA Vehicle Interface Assembly, and Suit Connector prototype design including assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics of their prototype, and their findings/conclusions to meet the contract delivery requirements for the contract Option 2. The contractor shall also include their interface assumptions, identify issues/problems that have arisen, and their plan to mitigate those issues/problems.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
	Handling Aids	1	September 28, 2007	
	EVA Umbilical with pigtail connections	1	September 28, 2007	
	Multiple Connector	2	September 28, 2007	
	Stowage Bag	1	September 28, 2007	
	Suit Connector	1	September 28, 2007	
	IVA/EVA Vehicle Interface Assembly	1	September 28, 2007	
	NBL EVA Umbilical Cover	1		
Certification				
Flight				
Training				
Other				
Test				
	Verification Data Package	5 EA paper and CD	September 28, 2007	
Software	N/A			

Other Products	All electronic document deliverables shall be delivered in .doc and PDF format which was generated directly without printing and scanning. All documentation delivered on CD/DVD should attempt to minimize the number of disks with different content (try to group multiple documents onto the same disk(s)).			
Prototype Design Report	A comprehensive report (in addition to a MS PowerPoint presentation) detailing the contractor's prototype design, analysis of the hardware (i.e. FMEA, sample test data, etc.), assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics their prototype, and their conclusions.	5 EA paper and CD	September 28, 2007	N/A
Materials Usage List	A list which details all the materials the contractor used in the fabrication of the prototypes.	5 EA paper and CD	September 28, 2007	N/A
Electronic models	All electronic models (Pro/E) of prototype hardware	5 EA CDs	September 28, 2007	N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and specialized tooling developed for the fabrication of prototype hardware	5 EA paper and CD	September 28, 2007	N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the prototype hardware.	5 EA paper and CD	September 28, 2007	N/A
Weekly Status Report	A weekly e-mail detailing the current status of the contractor's work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, the plan to mitigate any issues/problems, and intermediate results of concept development and trade studies. NASA-agreed to earned value performance and performance metrics and technical cost and schedule status shall be provided bi-weekly.	5 EA e-mail		N/A

SCHEDULE

Start Date: February 5, 2007 **Finish Date:** September 28, 2007

INTERIM MILESTONES:	DUE DATES (weeks from option 1 initiation)
Prototype Design Documentation Complete	June 29, 2007
Design, Fabrication, and Assembly of Prototype Hardware Complete	August 17, 2007
Prototype Verification Testing Complete	September 7, 2007
Final Presentation of EVA Life Support Umbilical, EVA Vehicle Interface Assembly, and Suit Connector Design, Verification Data, and Interface Assumptions	September 21, 2007
Prototype Design Report Due	September 28, 2007
Verification Data Package, Materials Usage List, Electronic Models, Drawings, Patterns, Tooling, and Build Paperwork Due	September 28, 2007

Milestones, along with subjective measurements, are to be used for measuring performance.

CHANGES TO DRDs:

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD NO.	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	N	
2	Mandatory Submittal	Regular Status Report/ Summary Review	ATP plus 2 months	Bi-monthly	Y	Status email
3	Written Approval	Project Technical Requirements Specification	Per DO schedule	Once with Revisions	Y	Revision of requirements included with SOW
4	Mandatory Submittal	GFE Systems Requirements Data Package	Specified in DO	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	Specified in DO	Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package	Specified in DO	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	Specified in DO	Once with Revisions	N	
8	Written Approval	Project Schedule	At kick-off meeting	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document	Specified in DO	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	Specified in DO	Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As agreed by TMR in DO	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	Specified in DO	Once with Revisions	N	

CDRL DATA ITEM NO.	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
14	Written Approval	GFE Software Development Plan	Specified in DO	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	Specified in DO	As Required	N	
16	Written Approval	Engineering Drawings	At Final Presentation	Once with Revisions	Y	In Pro/E format (except for pigtail connectors)
17	Written Approval	EEE Parts Lists and Analysis Report	Specified in DO	As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package	Specified in DO	Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	Specified in DO	Once with Revisions	N	
22	Mandatory Submittal	Software Code	Specified in DO	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	N	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Specified in DO	As Required	Y	Final Design Report in .doc and .pdf format.
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One Time	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	As Early in process as possible.	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	Specified in DO	As Required	N	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	Specified in DO	Once with Revisions	N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		**Reserved**	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE
(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or test facilities unless requested by the contractor in their response to a request for bid.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list filled out to allow the proper control of government property:

B. List of Property the Contractor Shall Replace with modified or upgraded versions:

Table 1.1

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

B. List of Property the Contractor will return in the same configuration:

Table 1.2

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

GOVERNMENT FURNISHED PROPERTY
(Continued)

D. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

Table 1.3

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

D. List of Property the Government Will Replace if Damaged or lost during the course of the effort:

Table 1.4

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO21R2

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO21R2

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/16/06 to 8/31/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D021R2

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order. Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 3/22/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIFE SUPPORT UMBILICAL SYSTEM CRAVE DO 21, Rev 2 is issued to perform the following activities: 1. Revise the Statement of Work for Options 1 and 2. 2. Increase Option 1 value by: Lot Changes to the Statement of Work have been vertically bar-marked in the attached. continued	LOT			64	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 734,585

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIFE SUPPORT UMBILICAL SYSTEM					
	DO 21 VALUE RECAP:					
	PRIOR / THIS ACTION DO21R2 / CUM VALUE					
	BASE b4 / b4 / b4					
	OPTION 1					
	OPTION 2					
	TOTAL REVISED VALUE = $734,585					
	THIS IS A CPFF DELIVERY ORDER					

OPTION 1 TITLE: Umbilical Multiple Connector Design Selection and IVA Hardware Prototype Fabrication

Background / Problem Description:

After NASA has had time to evaluate the contractor's progress and design concepts from the base contract NASA will then decide if to enact the additional contract option(s). Option 1 of the contract will entail the selection of an umbilical multiple connector design and the design, analysis, fabrication, testing, and delivery of a prototype IVA Life Support Umbilical, an IVA Vehicle Interface Assembly, and an IVA Suit Multiple Connector to be used in table-top laboratory testing and zero-gravity aircraft testing. This prototype will not be used for vacuum chamber testing, manned testing, or with oxygen-enriched gas, but these cases should be considered during the design and fabrication of the hardware. The fabrication of the prototype will follow the design decisions made by NASA at the conclusion of the base contract and the requirements attached to this SOW.

Purpose of the Current Effort

One of the many issues that needs to be addressed is the determination of the IVA Life Support Umbilical, VIA, and Suit Multiple Connector configuration. As a beginning step in the design phase for the IVA Life Support Umbilical, VIA, and Suit Multiple Connector it is desired by NASA to have a Contractor design, fabricate, PDA test, and deliver a prototype system for use in the following flight environments: 1) IVA Open Helmet/ambient environment, 2) IVA Closed Helmet/ambient environment, 3) IVA Closed Helmet/vacuum environment. The prototype fabrication will follow the design decisions made by NASA in the base contract and the requirements as detailed in this SOW. The technical requirements for the IVA and EVA LSUs, VIA, and Suit Multiple Connectors are expected to change during the Basic contract and NASA will notify the contractor of any changes.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the required tasks defined in the contract. The team is to be limited in the number of people to those who are required to form an effective team and accomplish the design and performance requirements of the contract while minimizing the contract cost. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor is to plan to accomplish the entire job without dependence on NASA effort, other than initial requirement input and NASA-specific knowledge or documentation. NASA's effort may provide expertise and additional depth of study but shall not be planned into the critical path to accomplish the study requirements. The potential availability of government participants for this task is described in the Appendix (below).

Develop Task Assignments

Develop the appropriate task assignments for the umbilical design team. Since the exact nature of the expertise potentially available from NASA is needed in order to do a complete plan, an adjustment to the plan provided in the contractor's bid is expected to formalize the NASA participation. This planning adjustment shall not affect the scope of the contractor's work, but can increase or decrease the scope of NASA participation from that included in the bid plan tasks.

Schedule Project

Develop a schedule detailing the contractor's project plan, design process, anticipated milestone dates, and performance metrics. Since the exact schedule availability of the expertise available from NASA which maybe needed in order to do a complete plan, an adjustment to the plan schedule provided in the contractor's bid is expected to formalize the NASA participation. This schedule adjustment shall not affect the scope of the contractor's work but can increase or decrease the scope of NASA participation from that included in the bid.

Select a Multiple Connector Design

Given the dependency of the umbilical multiple connector design on the placement of the connector on the suit, NASA agreed to carry forward five umbilical multiple connector designs into the options phase: (1) Circular Connector with Quick Disconnects, (2) Cam Ganged Connector with Quick Disconnects, (3) In-Line Two Lever Valve Block, (4) Right Angle Two Lever Valve Block, and (5) Right Angle Single Lever Valve Block. The contractor shall fabricate medium fidelity prototypes of these connector concepts that have realistic mass, volume, and actuation method. The contractor shall fabricate two short lengths of umbilical hose (approximately ten feet), one with an overall diameter of two inches (+0.25 in, -0.0 in) and one with a diameter of three inches (+0.5 in, -0.25 in). These umbilical hoses shall be able to be attached to any of the five connector prototypes. The contractor shall design and fabricate hardware (e.g. straps, Velcro) to enable the attachment of the prototype connectors to the following suit locations: (1) helmet, (2) chest, (3) waist, and (4) thigh (Figure 1). The contractor shall support suited evaluations of the connector prototypes by the development of a test plan and attendance during the evaluations. The contractor shall collect data during the evaluations including photography and evaluator comments and ratings. The contractor shall support a connector concept review and present the results of the testing during which stakeholders (crew, MOD, engineering, safety, e.g.) will provide feedback on the connector design. The contractor shall prepare a test report summarizing the purpose, method, and results of the connector evaluation. Following the review, NASA will make a determination on the connector design and instruct the contractor how to proceed with the high fidelity prototype.

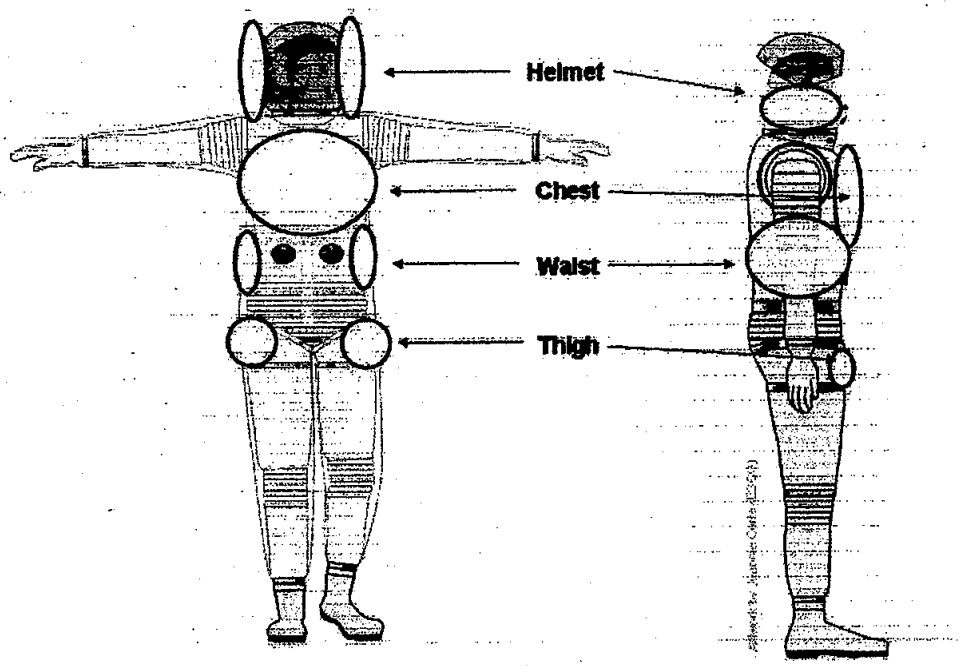


Figure 1. Possible Umbilical Suit Locations

Design and Fabricate IVA LSU, VIA, and Suit Multiple Connector Prototypes

Using the design concepts developed and agreed to by NASA in the base contract and the connector selection phase of Option 1, the contractor shall design, analyze, generate ProE models, generate drawings, fabricate, assemble, verify requirements, PDA test, and deliver a prototype IVA Life Support Umbilical System, Vehicle Interface Assembly, and Suit Connector prototype for laboratory testing. Requirements verification testing performed at the contractor's facility should be done together as much as possible and should be completed in the presence of a NASA official. The focal points of the prototype design and fabrication shall include the results of the trade studies, the design decisions made by NASA at the end of the base contract, and the prototype requirements supplied with this contract.

Hardware Classification

The planned use of this hardware is in a laboratory environment and the prototype is proof of concept hardware only. The prototype hardware will not be used for life support purposes.

Systems Engineering and Document Integration

System-level and development-level requirements will ultimately be entered and managed into Constellation-identified Cradle® requirements management software system. The contractor shall provide all documents to NASA for any requirements that differ or for new requirements. As NASA personnel will have prime responsibility for this conversion and it is expected that contractor support for this activity will be minimal.

General Notes

1. The Cooper-Harper scale will be used to rate all the subjective requirements.
2. The contractor must demonstrate best effort to meet the "should" statements in this document. If a "should" statement cannot be met, the contractor must explain why they could not meet the specific "should" statement and what the impact is in not meeting the "should" statement.
3. If any technical requirements change during the design or building phase of the prototype, then the contractor will get authorization from NASA.

Materials Data Delivery Requirements

All materials information required to satisfactorily complete the CTSD Materials Usage Log. Specific materials test and analysis information related to Section 1.8.1 thru 1.8.7 requirements shall be made available to NASA upon request. Procedure for approving the CTSD Materials Usage log is contained in CTSD document STB-E-083.

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The contractor will be required to provide NASA weekly status email detailing the current status of their work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, and their plan to mitigate any issues/problems. The contractor shall also provide technical cost and schedule status on a bi-weekly basis. The contractor will also be required to support a weekly telecon or meeting with NASA.

Generate Final Report

The contractor is to generate and publish a report detailing their IVA Life Support Umbilical System, Vehicle Interface Assembly, and Suit Connector prototype design including assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics of their prototype, and their findings/conclusions to meet the contract delivery requirements for the contract Option 1. The contractor shall also include their interface assumptions, identify issues/problems that have arisen, and their plan to mitigate those issues/problems.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up	Connector to Suit Attachment Hardware	2	2 April 2007	
Prototype				
	Umbilical Multiple Connector Medium Fidelity Prototypes	5	2 April 2007	
	Umbilical Prototype Hoses	2	2 April 2007	
	Handling Aids	1	August 31, 2007	
	IVA Umbilical	1	August 31, 2007	
	Multiple Connector	2	August 31, 2007	
	Stowage Bag	1	August 31, 2007	
	Suit Connector	1	August 31, 2007	
	IVA Vehicle Interface Assembly	1	August 31, 2007	
Certification				
Flight				
Training				
Other				
Test				
	Verification Data Package	5 EA paper and CD	August 31, 2007	
Software	N/A			

Other Products	All electronic document deliverables shall be delivered in .doc and PDF format which was generated directly without printing and scanning. All documentation delivered on CD/DVD should attempt to minimize the number of disks with different content (try to group multiple documents onto the same disk(s)).			
Prototype Design Report	A comprehensive report (in addition to a MS PowerPoint presentation) detailing the contractor's prototype design, analysis of the hardware (i.e. FMEA, sample test data, etc.), assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics their prototype, and their conclusions.	5 EA paper and CD	August 31, 2007	N/A
Materials Usage List	A list which details all the materials the contractor used in the fabrication of the prototypes.	5 EA paper and CD	August 31, 2007	N/A
Electronic models	All electronic models (Pro/E) of prototype hardware	5 EA CDs	August 31, 2007	N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and specialized tooling developed for the fabrication of prototype hardware	5 EA paper and CD	August 31, 2007	N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the prototype hardware.	5 EA paper and CD	August 31, 2007	N/A
Weekly Status Report	A weekly e-mail detailing the current status of the contractor's work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, the plan to mitigate any issues/problems, and intermediate results of concept development and trade studies. NASA-agreed to earned value performance and performance metrics and technical cost and schedule status shall be provided bi-weekly.	5 EA e-mail		N/A

SCHEDULE

Start Date: February 5, 2007 **Finish Date:** August 31, 2007

INTERIM MILESTONES	DUE DATES
Connector Prototype Hardware for Evaluations Complete	April 2, 2007
Umbilical Multiple Connector Concept Review	May 4, 2007
Prototype Design Documentation Complete	June 1, 2007
Design, Fabrication, and Assembly of Prototype Hardware Complete	July 24, 2007
Prototype Verification Testing Complete	August 7, 2007
Final Presentation of IVA Life Support Umbilical, IVA Vehicle Interface Assembly, and Suit Connector Design, Verification Data, and Interface Assumptions	August 21, 2007
Prototype Design Report Due	August 31, 2007
Verification Data Package, Materials Usage List, Electronic Models, Drawings, Patterns, Tooling, and Build Paperwork Due	August 31, 2007

Milestones, along with subjective measurements, are to be used for measuring performance.

CHANGES TO DRDs:

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	N	
2	Mandatory Submittal	Regular Status Report/ Summary Review	ATP plus 2 months	Bi-monthly	Y	Status email
3	Written Approval	Project Technical Requirements Specification	Per DO schedule	Once with Revisions	Y	Revision of requirements included with SOW
4	Mandatory Submittal	GFE Systems Requirements Data Package	Specified in DO	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	Specified in DO	Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package	Specified in DO	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	Specified in DO	Once with Revisions	N	
8	Written Approval	Project Schedule	At kick-off meeting	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document	Specified in DO	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	Specified in DO	Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As agreed by TMR in DO	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	Specified in DO	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
14	Written Approval	GFE Software Development Plan	Specified in DO	Once with Revisions	N	
15	Written Approval	GFE Software Design Document	Specified in DO	As Required	N	
16	Written Approval	Engineering Drawings	At Final Presentation	Once with Revisions	Y	In Pro/E format.
17	Written Approval	EEE Parts Lists and Analysis Report	Specified in DO	As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package	Specified in DO	Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	Specified in DO	Once with Revisions	N	
22	Mandatory Submittal	Software Code	Specified in DO	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	N	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Specified in DO	As Required	Y	Final Design Report in .doc and .pdf format
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One Time	N	
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	As Early in process as possible.	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	Specified in DO	As Required	N	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	Specified in DO	Once with Revisions	N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		**Reserved**	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval **Type 2 = Mandatory Submittal** **Type 3 = Submittal Upon Request**

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE
(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or test facilities unless requested by the contractor in their response to a request for bid.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list filled out to allow the proper control of government property:

A. List of Property the Contractor Shall Replace with modified or upgraded versions:

Table 1.1

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

B. List of Property the Contractor will return in the same configuration:

Table 1.2

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

GOVERNMENT FURNISHED PROPERTY
(Continued)

C. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

Table 1.3

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

D. List of Property the Government Will Replace if Damaged or lost during the course of the effort:

Table 1.4

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

OPTION 2 TITLE: EVA Life Support Umbilical System, IVA/EVA Vehicle Interface Assembly, and EVA Suit Connector Prototype Build/Fabrication

Background / Problem Description:

After NASA has had time to evaluate the contractor's progress and design concepts from the base contract and possibly Option 1, NASA will then decide if to enact the additional contract option(s). The intent of Option 2 is to reserve the option to enact it either in parallel or in series with Option 1. Option 2 of the contract will entail the design, analysis, fabrication, testing, and delivery of a prototype EVA Life Support Umbilical System, an IVA/EVA Vehicle Interface Assembly, and an EVA Suit Connector to be used in table-top laboratory testing and zero-gravity aircraft testing. This prototype will **not** be used for vacuum chamber testing, manned testing, or with oxygen-enriched gas, but these cases should be considered during the design and fabrication of the hardware. The fabrication of the prototype will follow the design decisions made by NASA at the conclusion of the base contract and the requirements attached to this SOW.

Purpose of the Current Effort

One of the many issues that need to be addressed is the determination of the EVA Life Support Umbilical System, VIA, and Suit Connector configuration. As a beginning step in the design phase for the EVA Life Support Umbilical, VIA, and Suit Connector it is desired by NASA to have a Contractor design, fabricate, PDA test, and deliver a prototype system for use in the following flight environments: 1) IVA Open Helmet/ambient environment, 2) IVA Closed Helmet/ambient environment, 3) IVA Closed Helmet/vacuum environment. The prototype fabrication will follow the design decisions made by NASA in the base contract and the requirements as detailed in this SOW. The technical requirements for the IVA and EVA LSUSs, VIA, and Suit Connectors are expected to change during the Basic contract and NASA will notify the contractor of any changes.

Task Description:

Form Team

Form a team that has the personnel required to track and perform the required tasks defined in the contract. The team is to be limited in the number of people to those who are required to form an effective team and accomplish the design and performance requirements of the contract while minimizing the contract cost. The team shall solicit the input of expertise outside the team as needed to accomplish the task at hand.

The contractor is to plan to accomplish the entire job without dependence on NASA effort, other than initial requirement input and NASA-specific knowledge or documentation. NASA's effort may provide expertise and additional depth of study but shall not be planned into the critical path to accomplish the study requirements. The potential availability of government participants for this task is described in the Appendix (below).

Develop Task Assignments

Develop the appropriate task assignments for the umbilical design team. Since the exact nature of the expertise potentially available from NASA is needed in order to do a complete plan, an adjustment to the plan provided in the contractor's bid is expected to formalize the NASA participation. This planning adjustment shall not affect the scope of the contractor's work, but can increase or decrease the scope of NASA participation from that included in the bid plan tasks.

Schedule Project

Develop a schedule detailing the contractor's project plan, design process, anticipated milestone dates, and performance metrics. Since the exact schedule availability of the expertise available from NASA which maybe needed in order to do a complete plan, an adjustment to the plan schedule provided in the contractor's bid is expected to formalize the NASA participation. This schedule adjustment shall not affect the scope of the contractor's work but can increase or decrease the scope of NASA participation from that included in the bid.

Design and Fabricate EVA LSUS, VIA, and Suit Connector Prototypes

Given the results of the trade studies, the design concepts developed and agreed to by NASA in the base contract, the contractor shall design, analyze, generate ProE models, generate drawings, fabricate, assemble, verify requirements, PDA test, and deliver a Prototype EVA Life Support Umbilical System, IVA/EVA Vehicle Interface Assembly, and Suit Connector prototype for laboratory testing. Requirements verification testing performed at the contractor's facility should be done together as much as possible and should be completed in the presence of a NASA official. The focal points of the prototype design and fabrication shall include the results of the trade studies, the design decisions made by NASA at the end of the base contract, and the prototype requirements supplied with this contract.

Hardware Classification

The planned use of this hardware is in a laboratory environment and the prototype is proof of concept hardware only. The prototype hardware will not be used for life support purposes.

Systems Engineering and Document Integration

System-level and development-level requirements will ultimately be entered and managed into Constellation-identified Cradle® requirements management software system. The contractor shall provide all documents to NASA for any requirements that differ or for new requirements. As NASA personnel will have prime responsibility for this conversion and it is expected that contractor support for this activity will be minimal.

General Notes

4. The Cooper-Harper scale will be used to rate all the subjective requirements.
5. The contractor must demonstrate best effort to meet the "should" statements in this document. If a "should" statement cannot be met, the contractor must explain why they could

not meet the specific "should" statement and what the impact is in not meeting the "should" statement.

6. If any technical requirements change during the design or building phase of the prototype, then the contractor will get authorization from NASA.

Materials Data Delivery Requirements

All materials information required to satisfactorily complete the CTSD Materials Usage Log. Specific materials test and analysis information related to Section 1.8.1 thru 1.8.7 requirements shall be made available to NASA upon request. Procedure for approving the CTSD Materials Usage log is contained in CTSD document STB-E-083.

Progress Reports

The contractor will be required to provide NASA weekly status email detailing the current status of their work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, their plan to mitigate any issues/problems, and NASA-agreed to earned value performance and performance metrics. The contractor shall also provide technical cost and schedule status as well as intermediate results of concept development and trade studies. The contractor will also be required to support a weekly telecon with NASA.

Generate Final Report

The contractor is to generate and publish a report detailing their EVA Life Support Umbilical System, IVA/EVA Vehicle Interface Assembly, and Suit Connector prototype design including assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics of their prototype, and their findings/conclusions to meet the contract delivery requirements for the contract Option 2. The contractor shall also include their interface assumptions, identify issues/problems that have arisen, and their plan to mitigate those issues/problems.

Deliverables/Products:

Product	Description	Qty	Due	Class
Hardware				
Mock Up				
Prototype				
	Handling Aids	1	August 31, 2007	
	EVA Umbilical	1	August 31, 2007	
	Multiple Connector	2	August 31, 2007	
	Stowage Bag	1	August 31, 2007	
	Suit Connector	1	August 31, 2007	
	IVA/EVA Vehicle Interface Assembly	1	August 31, 2007	
Certification				
Flight				
Training				
Other				
Test				
	Verification Data Package	5 EA paper and CD	August 31, 2007	
Software	N/A			
Other Products	All electronic document deliverables shall be delivered in .doc and PDF format which was generated directly without printing and scanning. All documentation delivered on CD/DVD should attempt to minimize the number of disks with different content (try to group multiple documents onto the same disk(s)).			

Prototype Design Report	A comprehensive report (in addition to a MS PowerPoint presentation) detailing the contractor's prototype design, analysis of the hardware (i.e. FMEA, sample test data, etc.), assembly/maintenance instructions, operations instructions, what if any are the limitations or unique performance characteristics their prototype, and their conclusions.	5 EA paper and CD	August 31, 2007	N/A
Materials Usage List	A list which details all the materials the contractor used in the fabrication of the prototypes.	5 EA paper and CD	August 31, 2007	N/A
Electronic models	All electronic models (Pro/E) of prototype hardware	5 EA CDs	August 31, 2007	N/A
Drawings, Patterns, and Tooling	All drawings, patterns, and specialized tooling developed for the fabrication of prototype hardware	5 EA paper and CD	August 31, 2007	N/A
Build Paperwork	All work instructions and procedures developed for the fabrication and assembly of the prototype hardware.	5 EA paper and CD	August 31, 2007	N/A
Weekly Status Report	A weekly e-mail detailing the current status of the contractor's work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, the plan to mitigate any issues/problems, and intermediate results of concept development and trade studies. NASA-agreed to earned value performance and performance metrics and technical cost and schedule status shall be provided bi-weekly.	5 EA e-mail		N/A

SCHEDULE

Start Date: February 5, 2007 **Finish Date: August 31, 2007**

INTERIM MILESTONES	DUE DATES (weeks from option 1 initiation)
Prototype Design Documentation Complete	June 1, 2007
Design, Fabrication, and Assembly of Prototype Hardware Complete	July 24, 2007
Prototype Verification Testing Complete	August 7, 2007
Final Presentation of EVA Life Support Umbilical, EVA Vehicle Interface Assembly, and Suit Connector Design, Verification Data, and Interface Assumptions	August 21, 2007
Prototype Design Report Due	August 31, 2007
Verification Data Package, Materials Usage List, Electronic Models, Drawings, Patterns, Tooling, and Build Paperwork Due	August 31, 2007

Milestones, along with subjective measurements, are to be used for measuring performance.

CHANGES TO DRDs:

DATA REQUIREMENTS

All DRs contained in the contract are applicable and required unless marked N/A below.

NOTES: 1. GREY SCALED ROWS NEED NO ADDITIONAL/REQUIRED FILL-INS.
2. ON ALL OTHER ROWS, IF NECESSARY, FILL IN ADDITIONAL RQMTS/DELIVERIES IN LAST COLUMN.

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
1	Written Approval	Flight GFE Configuration Management Plan	With Proposal	Once	N	
2	Mandatory Submittal	Regular Status Report/ Summary Review	ATP plus 2 months	Bi-monthly	Y	Status email
3	Written Approval	Project Technical Requirements Specification	Per DO schedule	Once with Revisions	Y	Revision of requirements included with SOW
4	Mandatory Submittal	GFE Systems Requirements Data Package	Specified in DO	Once with Revisions	N	
5	Written Approval	Flight GFE Projects Requirements & Verification Document	Specified in DO	Once with Revisions	N	
6	Mandatory Submittal	Preliminary Design Review Data Package	Specified in DO	Once with Revisions	N	
7	Written Approval	Flight GFE Workmanship Specifications List	Specified in DO	Once with Revisions	N	
8	Written Approval	Project Schedule	At kick-off meeting	Once w/Revisions (due w/DO proposal, updates & details provided as DO progresses)	Y	In MS Project Format
9	Written Approval	Flight GFE Interface Control Document	Specified in DO	Once with Revisions	N	
10	Written Approval	GFE End Item Specification	Specified in DO	Once with Revisions	N	
11	Mandatory Submittal	Flight GFE Failure Analysis Report	As agreed by TMR in DO	As Required	N	
12	Written Approval	Flight GFE Verification and Validation Plan	As Specified in EA-023	Once with Revisions	N	
13	Written Approval	GFE Software Requirements Specification	Specified in DO	Once with Revisions	N	
14	Written Approval	GFE Software Development Plan	Specified in DO	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
15	Written Approval	GFE Software Design Document	Specified in DO	As Required	N	
16	Written Approval	Engineering Drawings	At Final Presentation	Once with Revisions	Y	In Pro/E format
17	Written Approval	EEE Parts Lists and Analysis Report	Specified in DO	As Required	N	
18	Mandatory Submittal	Critical Design Review Data Package	Specified in DO	Once with Revisions	N	
19	Mandatory Submittal	Engineering Drawing Change Proposal	As needed	As Required	N	
20	Written Approval	GFE Qualification Test Procedure	Specified in DO	Once with Revisions	N	
21	Written Approval	Flight Product User's Guide	Specified in DO	Once with Revisions	N	
22	Mandatory Submittal	Software Code	Specified in DO	As Required	N	
23	Written Approval	Information Technology (IT) Security Program Plan and Reports	(30) days after DO award, and as specified in JPG 2810.1	JPG 2810.1	N	
24	Written Approval	Certification Plan	Specified in DO	Once with Revisions	N	
25	Mandatory Submittal	Certification Report	Specified in DO	Once with Revisions	N	
26	Mandatory Submittal	Engineering Analysis	Specified in DO	As Required	Y	Final Design Report in .doc and .pdf format.
27	Mandatory Submittal	Acceptance Data Package	Specified in DO	One Time	N	
28	Mandatory Submittal	Export Control Audit Results	After award of 1st DO, yearly on Sept. 30 thereafter	Yearly	N	
29	Written Approval	Quality Plan	With Proposal	Once with Revisions	Attachment J-11	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
30	Written Approval	Patent Rights-Retention	As Required	As Required	N	
31	Written Approval	Shuttle/Station Payload Safety Data Package	Specified in DO	As Required	N	
32	Mandatory Submittal	Limited Life Systems List	Specified in DO	As Required	N	
33	Written Approval	Space Station GFE Failure Modes and Effects Analysis and Critical Items List	As Early in process as possible.	As Required	N	
34	Written Approval	Space Shuttle GFE Safety and Analysis Report &Hazard Report	Specified in DO	As Required	N	
35	Written Approval	Software Quality Assurance Plan Report	90 Days Prior to Software Development	Once with Revisions	N	
36	Written Approval	ISS Hazard Report	Specified in DO	As Required	N	
37	Upon Request	Reliability and Maintainability Plan	With Proposal	One Time	N	
38	Written Approval	Government Certification Approval Request (GCAR)	Specified in DO	As Required	N	
39	Written Approval	Risk Assessment Executive Summary Report (RAESR)	Specified in DO	As Required	N	
40	Written Approval	Problem Reporting and Corrective Action (PRACA)	2 business days of problem isolation but no later than 10 days after detection	As Required	N	
41	Upon Request	Nonconformance Record	Specified in DO	As Required	N	
42	Mandatory Submittal	Government Industry Data Exchange Program and NASA Advisory Problem Data	Reported one time when discrepancy occurs	Once with Revisions	N	
43	Written Approval	Electrical, Electronic, and Electromechnical (EEE) Parts Control Plan	Specified in DO	Once with Revisions	N	
44	Mandatory Submittal	Certification Data Package	Specified in DO	Once with Revisions	N	
45	Written Approval	Certification and Acceptance Requirements Document	At CDR	Once with Revisions	N	
46	Upon Request	Wage/Salary and Fringe Benefit Data	Thirty (30) days after issuance of each DO	Once	N	
47	Written Approval	GFE Acceptance Test Procedure	Specified in DO	One Time	N	
48	Mandatory Submittal	Flight GFE Verification & Validation Report	Specified in DO	Once with Revisions	N	

DRD #	DATA TYPE	DRD TITLE	DUE	FREQUENCY	REQUIRED FOR DO? Y/N	ADDITIONAL REQUIREMENTS
49	Mandatory Submittal	Space Shuttle GFE Failure Modes and Effects Analysis (FMEA) and Critical Items List	Specified in DO	As Required	N	
50		**Reserved**	—	—	—	—
51	Mandatory Submittal	NASA Contractor Financial Management Reporting	After Issuance of 1st DO	Monthly	N	
52	Written Approval	Government Property Management Plan	With Proposal	Once with Revisions	Attachment J-7	
53	Mandatory Submittal	System Safety Plan	With Proposal	One Time	Attachment J-10	
54	Written Approval	R-Quality Plan Template	With Proposal/ Revisions as Required	Only applicable to B-CRAVE contracts in accordance with the SOW and the DRD	Y	

Type 1 = Written Approval Type 2 = Mandatory Submittal Type 3 = Submittal Upon Request

CHANGES TO GOVERNMENT FURNISHED PROPERTY: NONE
(IF YES, THEN INSERT GOVERNMENT FURNISHED PROPERTY TABLES)

GOVERNMENT FURNISHED PROPERTY

The CRAVE contracts do not anticipate the Government providing any property or test facilities unless requested by the contractor in their response to a request for bid.

In some rare cases (such as sustaining engineering task) it is known ahead of time that government property will be provided to the contractor. In those cases the following list filled out to allow the proper control of government property:

B. List of Property the Contractor Shall Replace with modified or upgraded versions:

Table 1.1

Item	Quantity	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

B. List of Property the Contractor will return in the same configuration:

Table 1.2

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

GOVERNMENT FURNISHED PROPERTY
(Continued)

D. List of Property the Contractor Shall Replace if Damaged or lost during the course of the effort:

Table 1.3

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

D. List of Property the Government Will Replace if Damaged or lost during the course of the effort:

Table 1.4

Item	Quantity	P/N	S/N (or L/N)	Acquisition Cost	Use of Property Location	Date to be Furnished to the Contractor
N/A	N/A	N/A	N/A	N/A	N/A	

[Insert a description of the item(s), quantity, acquisition cost, and date the property will be furnished to the Contractor] - List of Property will be added as requirements are further identified and the determination to provide property is determined to be in the best interest of the Government.

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE DO21R1

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-483-4173
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE DO21R1

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/16/06 to 8/31/07

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE D021R1

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☐] is, [☒] is not required. Sign below if required and return to contracting officer.

Name: _____ (Person authorized to sign)

Signature: _____ Date: _____

10. Name: Ronald Johnson

Signature: Ronald Johnson Date: 3/13/07
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
1	LIFE SUPPORT UMBILICAL SYSTEM CRAVE DO 21, Rev 1 is issued to perform the following activities: 1. Revise the Statement of Work to accommodate the additional work performed on the baseline. 2. Increase the DO baseline value by $ b4 from $ b4 o b4 w additional work performed on the baseline. 3. Exercise Options 1 and 2 as prepriced in the baseline. 4. Extend the period of performance from 10/6/06 to 8/31/07. Changes to page 6 of the Statement of Work baseline is attached and have been vertically bar-marked. see next pages	LOT LOT			b4	

12. For JSC Internal Use Only:
Requisition No.: N/A ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 635,734

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED
TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY: _____ Authorized U.S. Government Representative _____ Date

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	LIFE SUPPORT UMBILICAL SYSTEM					
	DO 21 VALUE RECAP:					
	PRIOR / THIS ACTION DO21R1 / REVISED CUM VALUE					
	BASE					
	OPTION 1					
	OPTION 2					
	TOTAL REVISED VALUE = $635,734					
	THIS IS A CPFF DELIVERY ORDER					

b4

5. Connector Study – The contractor shall perform a trade study to determine the best way to connect two umbilicals to a suit at once while minimizing mass. This situation might arise in the case of an LSAM to CEV contingency EVA lunar orbit transfer.

Prototype Conceptual Design

The contractor shall develop design concepts for the LSUS, VIA, and Suit Connectors. The requirements for this hardware are found in the Prototype Umbilical Requirements document and are subject to change. These concepts are due at the end of the basic contract and shall include the following items:

1. Universal Multiple Connector – **The contractor shall complete the conceptual design of four umbilical multiple connectors. This includes preliminary mass, volume, and pressure drop analysis as well as making a volumetric mock-up of each of the design candidates.**
2. IVA Umbilical – The contractor shall design a short, IVA umbilical.
3. EVA Umbilical – The contractor shall design a long, EVA umbilical.
4. Stowage Container – The contractor shall design stowage container(s) for the IVA and EVA LSUSs. The contractor shall consider the requirement to rapidly deploy the short umbilical as well as the desire to manage the long umbilical during use. The stowage envelope, shape, weight, and center of gravity shall be estimated as well as a stowage and deployment operations concept.
5. Handling Aids – The contractor shall design handling aids for the transport, stowage, deployment, and operation of the EVA and IVA umbilicals.
6. Vehicle Interface Assembly – The contractor shall design Vehicle Interface Assemblies for both the EVA and IVA applications.
7. Suit Connector – The contractor shall design suit connectors for interfacing with the IVA and EVA umbilicals.

Materials Data Delivery Requirements

All Materials information required to satisfactorily complete the CTSD Materials Usage Log. Specific materials test and analysis information related to Section 18.0 requirements shall be made available to NASA upon request. Procedure for approving the CTSD Materials Usage log is contained in CTSD document STB-E-083.

Progress Reports

The contractor will be required to provide NASA weekly status email detailing the current status of their work, what has been accomplished, what work is planned for the next week, what issues/problems (if any) have arisen, their plan to mitigate any issues/problems, and NASA-agreed to earned value performance and performance metrics. The contractor shall also provide technical cost and schedule status as well as intermediate results of concept development and trade studies. The contractor will also be required to support a weekly telecon with NASA.

Generate Final Report

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX 77058

ORDER FOR SUPPLIES OR SERVICES

1. Order No.
NNJ05HB40B, CRAVE-EC5-DO21

2. Date of Order
See Block 10 Below

NOTE: MARK ALL PACKAGES AND PAPERS WITH ORDER NO.

Certified for National Defense under DPAS (15 CFR 700) DO-C9

3. Issuing Office:
NASA Johnson Space Center, 2101 Nasa Parkway
Houston, TX 77058-3696
Org./Buyer: BH2/Mary Thomas

Tel No.: 281-483-8828 Fax: 281-244-0995
E-mail: mary.f.thomas@nasa.gov

4. Ship To:
Transportation Officer, Building 421
NASA Johnson Space Center
Houston, TX 77058-3696
Mark For: **Accountable Property**

Order No.: NNJ05HB40B, CRAVE-EC5-DO21

5. Contractor:

Oceaneering Space Systems
16665 Space Center Blvd
Houston, TX 77058

Phone: (281) 228-5371 x Fax: (281) 228-5545

TIN: 95-2628227 CAGE CODE: 2F262

6. Deliver On or Before: 10/16/06 to 01/26/07 (base)

F.O.B. Point: DESTINATION

Discount Terms: Net 30 Days.

7. BILLING ADDRESS:
NASA Johnson Space Center
Attn: LF231/Accounts Payable Group
Houston, TX 77058-3696
Order No.: NNJ05HB40B, CRAVE-EC5-D021

8. Type of Order:

☐ PURCHASE: Please furnish the following in accordance with the conditions specified on this order.
Reference:_____

☐ DELIVERY: Except for the Terms and Conditions of Purchase Order listed on the following page, this delivery order is subject to instructions contained on this form and is issued subject to the terms and conditions of contract number: _____

9. Written acceptance of this order by contractor [☒] is, [☐] is not required. Sign below if required and return to contracting officer.

Name: ____ (Person authorized to sign)

Signature: Ronda Kautz Date: 10-16-06

10. Name: Robert Kolb

Signature: Robert Kolb Date: 10.13.06
CONTRACTING OFFICER

11. Schedule

ITEM NO.	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	INTRAVEHICULAR ACTIVITY/EXTRAVEHICULAR ACTIVITY LIFE SUPPORT UMBILICAL SYSTEM, VEHICLE INTERFACE ASSEMBLY AND SUIT CONNECTOR CONCEPTUAL DEVELOPMENT AND PROTOTYPING					
1	The contractor shall perform and deliver to all base requirements of CRAVE-EC5-DO21 as described in the Statement of Work. Period of Performance: 10/16/06 to 01/26/07 (base)	Lot			b4	
2	OPTIONS: The Government may require the contractor to continue to perform services under this delivery order. The Contracting Officer may exercise Option 1 and Option 2 concurrently or independently by issuance of an					

12. For JSC Internal Use Only:
Requisition No.: _____ ☐ COMP. ☐ PART. PPC: _____
Rissue To: EC/Joe Gensler, x30025 For: EC/Nicole Jordan, x39127

13. Total
$ NTE 674,167 w/ Options

14. Quantities in "Quantity Accepted" Column Have Been
☐ INSPECTED ☐ ACCEPTED ☐ RECEIVED

TO CONFORM TO THE CONTRACT.
ACCEPTANCE WILL BE AT JSC UNLESS OTHERWISE NOTED.

BY:

Authorized U.S. Government Representative Date

Order No.: CRAVE-EC6-DO21

ORDER FOR SUPPLIES OR SERVICES
(CONTINUATION SHEET)

SCHEDULE

ITEM	DESCRIPTION	QUANTITY ORDERED	UNIT	UNIT PRICE	AMOUNT	QUANTITY ACCEPTED
	unilateral delivery order revision. Should the options be exercised, the resultant delivery order revision will be priced out as follows.					
	OPTION 1 (Estimated Period of Performance: 02/05/07 to 10/05/07)	LOT			b4	
	OPTION 2 (if issued concurrently w/ Option 1) (Estimated Period of Performance: 35 weeks after authorization to start	LOT				
	OPTION 2 (if issued independently)	LOT				
	THIS IS A CPFF DELIVERY ORDER. FUNDING IS AT THE CONTRACT LEVEL. THE CONTRACTOR IS NOT AUTHORIZED TO EXCEED THE DELIVERY ORDER VALUE.					