JAN 2 7 1998 (21) ENGINEERING DATA TRANSMITTAL

Station 15

Page 1 of 2

1. EDT 620930

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) LDUA Project	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: TWRS	6. Design Authority/ Design Agent/Cog. Engr.: GA Barnes	7. Purchase Order No.: N/A
8. Originator Remarks: ETN-96-0007		9. Equip./Component No.: LDUA/6230
		10. System/Bldg./Facility: N/A
11. Receiver Remarks: 11A. Design Baseline Document? [ ] Yes [X] No		12. Major Assm. Dwg. No.: N/A
ENGINEERING DATA TRANSMITTAL		13. Permit/Permit Application No.: N/A
		14. Required Response Date: February 28, 1997

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-SD-TD-CGA-001		0	Calibration, Grooming, and Alignment for LDUA High Resolution Stereoscopic Video Camera System (HRSVS)	N/A	2	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
1	1	Cog Eng. AF Pardini		2/26/97	K5-25
1	1	Cog Mgr. TJ Samuel		2/27/97	K5-22
1	1	GA Barnes		1-20-98	84-51
1	1	Informal Review SR Kiebel		2/26/97	K5-22
3		LDUA System File, (5 copies)			K5-17

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN

18. G.A. Leshikar — Signature of EDT Originator — Date 2/26/97

19. Authorized Representative for Receiving Organization — Date 1/26/98

20. Design Authority/ Cognizant Manager — Date 2/26/97

21. DOE APPROVAL (if required) Ctrl. No.
[ ] Approved
[ ] Approved w/comments
[ ] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

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TWRS	GA Barnes	N/A
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		10. System/Bldg./Facility: N/A
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18.	19.	20.	21. DOE APPROVAL (if required) Ctrl. No.
G.A. Leshikar Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	Design Authority/ Cognizant Manager / Date	[ ] Approved [ ] Approved w/comments [ ] Disapproved w/comments

Calibration, Grooming, and Alignment for LDUA High Resolution Stereoscopic Video Camera System (HRSVS)

AF Pardini
Pacific Northwest National Laboratory, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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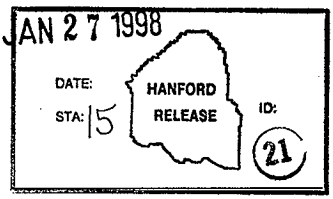
Key Words: LDUA, Light Duty Utility Arm, HRSVS, robot arm, stereoscopic

Abstract: The system undergoing calibration, grooming, and alignment (CG&A) is the Light Duty Utility Arm system 6230, High Resolution Stereoscopic Video Camera System. The HRSVS is a dual color camera system designed to provide stereo viewing of the interior of waste tanks in a Class 1, Division 1, flammable atmosphere. The HRSVS is an end effector to the LDUA.



Karen L. Noland 1/27/98
Release Approval Date
Release Stamp

Approved for Public Release

CALIBRATION, GROOMING, AND ALIGNMENT

FOR

LIGHT DUTY UTILITY ARM HIGH RESOLUTION STEREOSCOPIC VIDEO CAMERA SYSTEM (HRSVS)

NOVEMBER 12, 1995

BY

A. F. PARDINI

REMOTE SYSTEM AND SENSOR APPLICATIONS

WESTINGHOUSE HANFORD COMPANY
RICHLAND, WASHINGTON

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CALIBRATION, GROOMING, AND ALIGNMENT FOR LIGHT DUTY UTILITY ARM HIGH RESOLUTION STEREOSCOPIC VIDEO CAMERA SYSTEM (HRSVS)

1.0 CG&A ITEM IDENTIFICATION

The system undergoing calibration, grooming, and alignment (CG&A) is the Light Duty Utility Arm (LDUA) system 6230, High Resolution Stereoscopic Video Camera System (HRSVS). The property number is a Westinghouse Savannah River Company number, 00363307, and the serial number is 005. The system to CG&A includes the end effector and control electronics.

2.0 GENERAL DESCRIPTION

The High Resolution Stereoscopic Video Camera System (HRSVS) was designed by the Savannah River Technology Center (SRTC) to provide routine and troubleshooting views of tank interiors during characterization and remediation phases of underground storage tank (UST) processing. The HRSVS is a dual color camera system designed to provide stereo viewing of the interior of the tanks including the tank wall in a Class 1, Division 1, flammable atmosphere. The HRSVS was designed with a modular philosophy for easy maintenance and configuration modifications. During operation of the system with the LDUA, the control of the camera system will be performed by the LDUA supervisory data acquisition system (SDAS). Video and control status will be displayed on monitors within the LDUA control center. All control functions are accessible from the front panel of the control box located within the Operations Control Trailer (OCT). The LDUA will provide all positioning functions within the waste tank for the end effector.

3.0 INSTRUMENTS AND CALIBRATION

Various electronic measurement instruments will be used to perform CG&A activities. The instruments may include a digital volt meter, oscilloscope, signal generator, and other electronic repair equipment. None of these instruments will need to be calibrated beyond what comes from the manufacturer. During CG&A a temperature indicating device will be used to measure the temperature of the outside of the HRSVS from initial startup until the temperature has stablilized. This device will not need to be in calibration during CG&A but will have to have a current calibration sticker from the Standards Laboratory during any acceptance testing. This sensor will not need to be in calibration during CG&A but will have to have a current calibration sticker from the Standards Laboratory during any acceptance testing.

4.0 FACILITIES, EQUIPMENT, AND MATERIALS

The HRSVS CG&A will be performed in the Fuels and Materials Examination Facility (FMEF) on either the 0'-0" level (truck lock), or up on the 42' -6" level (mezzanine). Some additional CG&A activities may require that part or all of the HRSVS system be moved to Pacific Northwest National Laboratory facilities for machining modifications. The equipment and materials listed below may be necessary to perform this CG&A procedure:

- HRSVS, including control electronics wiring umbilical.
- Fiber optic cable (minimum of 900 feet when working with the system on the 42'-6" level) to connect control electronics to the OAS.
- 110 VAC power source and power strip
- Temperature indicating device and thermocouple (>200 Celsius)
- Pressure sensor/guage (0 to 100 inches of water)
- Miscellaneous electronic equipment including volt meter, oscilloscope, signal generator, soldering station, and extra wire.
- Miscellaneous (e.g. duct tape, common tools, etc.)

5.0 SAFETY

The HRSVS is a completely enclosed camera system, therefore no external wires or mechanical assemblies will be exposed as a shock hazard. During CG&A activities it may be necessary to work on the electrical components within the system. All WHC applicable procedures will be adhered to during CG&A. The following safety considerations shall be observed and adhered to during all CG&A activities.

- Equipment shall be operated in accordance which WHC-CM-1-10, Safety Manual and/or PNL safety practices when in the PNL facility.
- Lifting and rigging of equipment must comply with the Hanford Site Hoisting and Rigging Manual, DOE-RL-92-36.
- The FMEF lock and tag procedure will be used as applicable.

The surface of the camera can reach temperatures of approximately 280 degrees Fahrenheit, therefore care must be taken by CG&A personnel if the equipment is to be worked on under this condition.

6.0 CG&A DATA

Data from CG&A activities will be noted on progress reports each week as the CG&A progresses. These progress reports will status events and resolutions as they occur each week. They will also serve to demonstrate the actual working condition of the camera system at each stage of the CG&A activity. All drawings for the HRSVS system will be received from SRTC. If during the CG&A process, a modification to the hardware is made, the drawings must be changed to reflect the modification. The SRTC drawings will be redlined and sent back to SRTC to incorporate. SRTC will forward new revised drawings back to WHC.

7.0 CG&A PERSONNEL REQUIREMENTS

CG&A activities for the HRSVS will be coordinated by the LDUA end effector cognizant engineer. Personnel from WHC, PNL, and SRS will be involved during the CG&A activities.

8.0 CG&A PLANNING

The general steps below will be used to perform the actual CG&A of the HRSVS system.

- When the HRSVS arrives at the FMEF trucklock it must be uncrated. WHC will perform this operation and will place the HRSVS on a table in the mezzanine area of the FMEF.

- The system can be powered using plugins located on the north side of the mezzanine. Cables should be maintained out of the access ways as best as possible.

- During CG&A, coax cables will be used to assure all controls and video are working with the control box. Once this is completed and working the coax will be replaced with a fiber optic cable to test fiber communication between the control box and the tank top electronics.

- System checkout will include all functions of the camera system, lights, zoom, focus, and iris. Components that do not function will be noted in the progress reports and either SRTC or WHC personnel will perform modification and fabrication activities to get the camera system operational.

- Once the system is fully operational and all systems function as designed then the HRSVS will be ready for the acceptance testing.

APPENDIX A - HRSVS PROGRESS REPORTS

PROGRESS REPORT

Week Ending September 22, 1995

Frank Heckendorn shipped the rest of the TIP mounted end effectors this week. They arrived on Tuesday at the PNL shipping dock. We hauled the wooden boxes to 305 and uncrated. The camera parts were then transported out to the FMEF facility. The HRSVS was disassembled and Frank began to assemble. He did not have time to do much but was able to test the HRSVS to make sure it basically worked (i.e. lights worked but were not in their housings etc.).

Al Pardini

PROGRESS REPORT

Week Ending December 8, 1995

This week we installed the lights in the HRSVS. This involved installing the lights in their sockets and then installing the front cover plate over all the light assemblies. We also removed and installed new brackets that hold the black and white Watec cameras. The original brackets were weak and needed to be replaced.

Al Pardini

PROGRESS REPORT

Week Ending December 22, 1995

This week Frank Heckendorn and Dave Pace were here to assist in putting the HRSVS together. Frank had only wired in 8 of the lights but there were 10 available, so he wired in the other two lights. He also put in new turrets. The original turrets were made of aluminum and he replaced them with brass. Frank also rewired the Hypertronic connector to accomodate the two new lights. Frank put in two slower speed motors to slow down the turrets. The turrets spun too fast and could not be controlled to the precision necessary.

There was a problem with the large lens focus. He narrowed the problem down to the vicoax box in the unit that goes in the ATIE. He eventually changed out the vicoax box that will go in the ATIE which seemed to fix the problem. He also noted that the micro switch which is supposed to stop the lens from running into the turret lenses needed some stand offs. With the stand off they will not hit the lenses. He did not have any available so we will have to fix these later. Frank also noted that he forgot to put in the fiber optic transceiver in the ATIE box. He will have to send one up to me.

Al Pardini

PROGRESS REPORT

Week Ending January 5, 1996

Near the end of this week we had some meetings to discuss using the INEL opto22 approach to end effector control and not using Frank's design. This opto22 would be a common video control for all video camera system currently being developed.

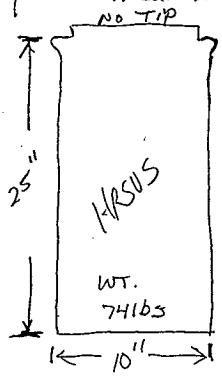
Al Pardini

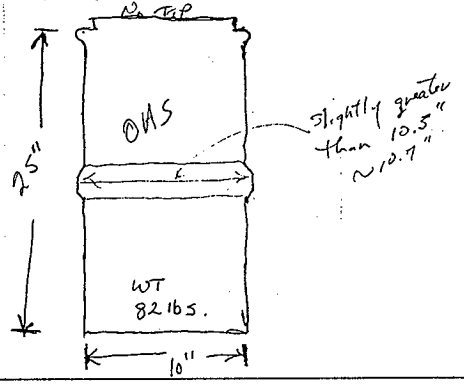
HRSVS TEST 1/10/96

Power Up - OK ✓
Two Sony Camera's operating. ✓
Aux (Lights) - Lights turn on and off. (All 10) ✓
Toggle Lever Up and the two Watec cameras come on ✓
Image looks good.
Toggle Lever Down (Sony Camera's are on) Image looks good.
Iris Function operates the convergence motor and is OK ✓
With A/P toggled off the right turret rotates using the zoom in & out. ✓
With A/P toggled ON the left turret rotates using the zoom in & out ✓
Speed Control operates on motor functions ✓ Both Directions ✓
Focus Function operates the large focusing lens. and work OK ✓ Near & Far ✓
Using the toggle lever with the lights on provides: / toggle Left gives 6 lights ON ✓
toggle right gives 4 lights ON ✓

Both Limit relays work properly and shut off lens movement as ✓
designed. Stand offs are needed to protect the lens.
on limit switch

Physical Measurements of HRSVS & OAS





PROGRESS REPORT

Week Ending January 12, 1996

Further discussions ensued concerning using of the INEL opto22 design. The LDUA lead decided that INEL would design and build a system to interface to the OAS and HRSVS. The system would be a common video end effector control and INEL estimated that they would be complete with the design and fab by the end of this month.

I weighed and measured the HRSVS this week. The weight of the end effector not including the TIP was 74 pounds (the outside shell weighed 44 pounds, and the inside camera/lens assembly weighed 30 pounds). The design criteria stated that the end effectors were not to weigh more than 75 pounds and that included the weight of the TIP which was estimated to weigh 15 pounds. Therefore the HRSVS should not weigh more than 60 pounds. It is 14 pounds over weight. I discussed this with the technical leads. It was decided not to do anything at this time. SPAR has mentioned that they feel the arm can hold more than what was initially thought.

The other measured values were within the design envelope. The diameter of the HRSVS was 10.0 inches and 10.5 inches where the TIP mates. The overall length was 25 inches. This will allow for a TIP of 5 inches and still be under the 30 inch total length requirement.

I also completed an initial functional test using Frank's control box. Everything seemed to work.

Al Pardini

PROGRESS REPORT

Week Ending January 19, 1996

Dave Pace from INEL came over this week. He wanted to sit down and take the HRSVS apart to know exactly what was inside. We did this and went through the system wire by wire and compared to the drawings. We marked up the drawings accordingly. Dave will incorporate the changes on the CVEE drawings he is making up for us. I will also forward the changes down to Frank so he can change his drawings.

We also noted that Frank had forgotten to put in the fiber converter boxes in his control box. I called Frank and he will send them up to us. We currently have the smaller ones FR-1001-1 but need the two larger ones.

Al Pardini

PROGRESS REPORT

Week Ending January 26, 1996

Frank Heckendorn arrived from SRS this week. His plan was to work on all the camera systems as needed. We initially discussed the CVEE drawings that INEL had provided. He seemed to think he would have no problems interfacing with their design.

Frank was unable to work on the HRSVS this week. He concentrated on the other systems.

Al Pardini

PROGRESS REPORT

Week Ending February 16, 1996

Dave Pace and Ray Johnson arrived to work on the HRSVS with the new CVEE design. They set up the system and demonstrated control using Labview software set up on a laptop computer. The system worked very well. The only problem encountered was that the two Sony cameras in the HRSVS were not getting enough voltage to run properly. Dave and Ray fixed this problem and the system works great.

Al Pardini

PROGRESS REPORT

Week Ending March 1, 1996

This week we tapped new holes for the ball plungers that Frank had sent us. There was no method to move the cameras for convergence when the cam rotated. Frank had not gotten around to installing this. Frank sent us up some short ball plungers that were spring loaded. We had to grind them down a bit to give them more travel. We also had to fill a preexisting hole from the previous design. We installed the plungers and the convergence worked relatively smooth.

We also tapped the four holes that are in the bracket which hold the Sony cameras in place. Using set screws, this provided a very stable method to hold the cameras tight to the side of the bracket. The are very sturdy now and won't move at the slightest hit or bang.

The cam also seemed to be a bit large and would hang during its rotation. We ground it down some. All the drawings were marked up to reflect these changes.

We also began to do some preliminary alignment of the cameras with the lenses. This task will take some time and require a target of some sort.

Al Pardini

PROGRESS REPORT

Week Ending March 8, 1996

This week we replaced the ball plungers we put in last week. We decided that we did not need any more travel than what a normal plunger has. By replacing these the convergence mechanism worked much more smoothly.

We also worked a considerable amount on camera alignment. This required using shims to get the cameras rotated in the right plane and level.

Chris Smith drew up a target which was simple a circle and crosshair pattern. The target also had a 3 dimensional pyramid attached to provide us with depth perception.

Al Pardini

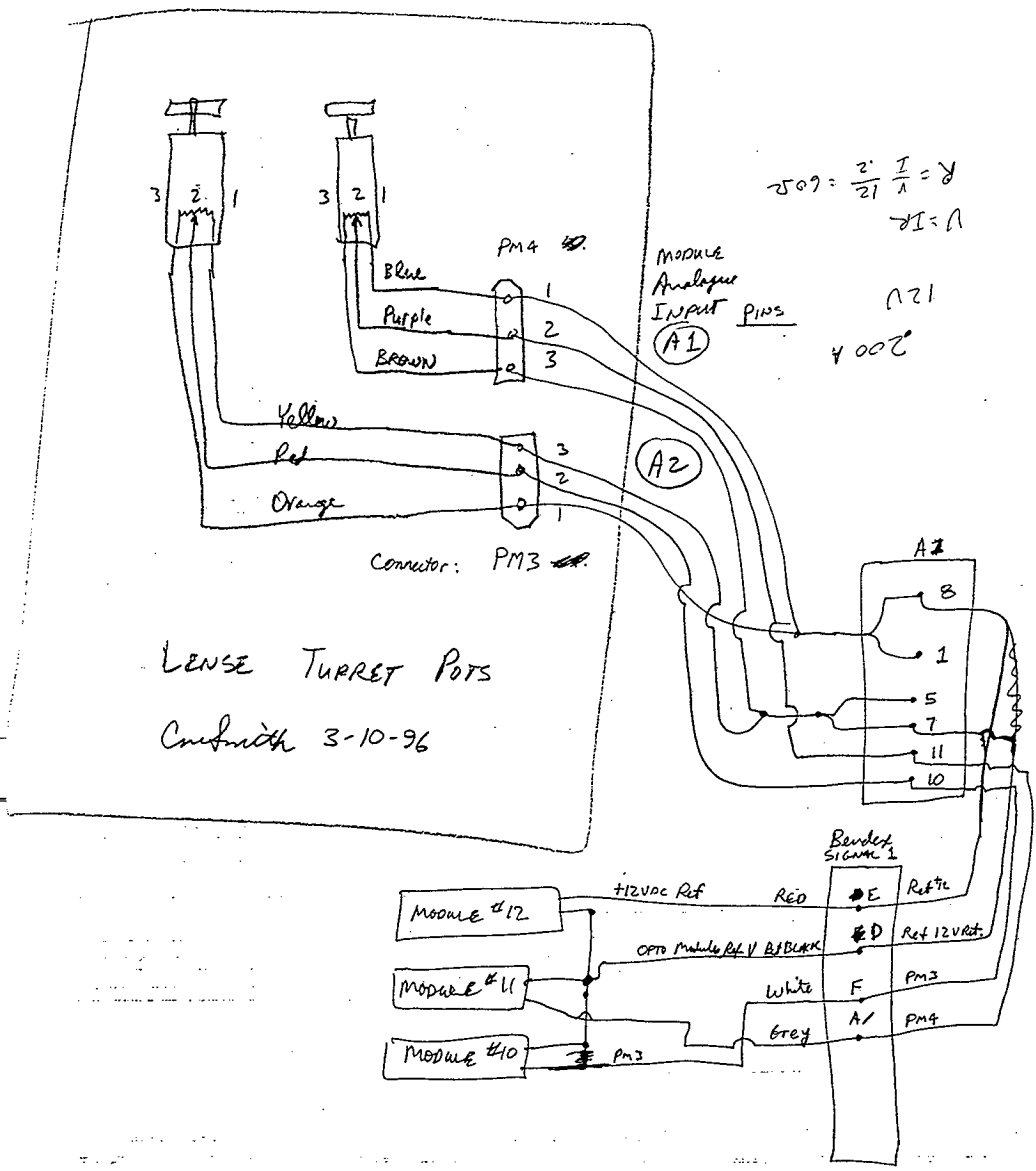
PROGRESS REPORT

Week Ending March 22, 1996

Chris Smith worked this week getting the camera lenses adjusted so that proper focus and iris settings could be obtained. Chris also installed the opto-22 modules and rang out the wiring.

Al Pardini

HRSUS ECN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7
11
10
Bender SIGNAL 1
MODULE #12
MODULE #11
MODULE #10
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E
Ref +12
OPTO Module Ref V BLACK
D
Ref 12V Ret
White
F
PM3
Grey
A1
PM4
PM3

PROGRESS REPORT

Week Ending March 29, 1996

This week we epoxyed the lens so that they could not be misaligned or unintentionally rotated causing the camera to go unfocused.

Al Pardini

PROGRESS REPORT

Week Ending April 5, 1996

This week we had to reepoxyed the one of the lenses because the epoxy had broken loose. This required that we realign the lens. We also readjusted the potentiometer because the software operators had run the turret to far in on direction causing it to rotate all the way to the hard stop. We returned the pots to the midpoint setting.

This completes the CG&A for the HRSVS.

This week we sent out the post delivery acceptance test on the HRSVS for review.

Al Pardini

APPENDIX B - HRSVS DRAWINGS

HIGH RESOLUTION STEREOSCOPIC VIDEO CAMERA SYSTEM (HRSVS)

DRAWINGS

The drawings for the high resolution stereoscopic video camera system (HRSVS) (sometimes referred to as the close-up stereo video system (CSVS) include both mechanical and electrical and can be found in the WHC LDUA Certified Vendor Information (CVI) files. The drawings have a WHC drawing number and are listed as follows. In parenthesis are the Savannah River Site (SRS) original drawings numbers.

MECHANICAL DRAWINGS

H-6-14242 SH 1 Rev. 0 (EES-22408-R1-027 Rev. B)	Close-Up Video System Assembly
H-6-14242 SH 2 Rev. 0 (EES-22408-R1-027 Rev. B)	Close-Up Video System Assembly
H-6-14243 SH 1 Rev. 0 (EES-22408-R4-028 Rev. B)	Close-Up Video System Details - Sheet 1
H-6-14243 SH 2 Rev. 0 (EES-22408-R4-029 Rev. B)	Close-Up Video System Details - Sheet 2
H-6-14243 SH 3 Rev. 0 (EES-22408-R4-031 Rev. B)	Close-Up Video System Details - Sheet 3
H-6-14244 Rev. 0 (EES-22408-R4-030 Rev. B)	Close-Up Video System Camera Housing Weldment
H-6-14245 Rev. 0 (EES-22408-R3-032 Rev. B)	Close-Up Video System Light Baffle Weldment and Misc Details

ELECTRICAL DRAWINGS

H-6-14246 Rev. 0 (EES-22408-L7-048 Rev. B)	UST-ID Close-Up Stereo Camera Housing Schematic

APPENDIX C - HRSVS INTEGRATION TEST

INTEGRATION TESTING

HIGH RESOLUTION STEREOSCOPIC VIDEO CAMERA SYSTEM (HRSVS)

Initial integration testing was performed using the electronics supplied by Savannah River Technology Center (SRTC). The data below was taken while using the SRTC electronics. This test consisted of simulating the SDAS system using a Beckman test station configured to provide camera control functions. This configuration provided the test information needed by the SDAS system for camera control. The serial data which is output to SDAS for information was also tested using a MediaData XL20 terminal. Each camera pin out and function were tested and described as follows:

FUNCTION CONTROL TEST

Pin Number	Drawing Indicates	Actual Function	Comments	SDAS Function
1	Aux 1 (LED output)	Aux 1 (LED output)		Aux 1 (LED output)
2	Focus Far	Focus Near	Switch with pin 15	Focus Far
3	Zoom Out	Zoom In	Switch with pin 16	Zoom Out
4	Tilt Up	Tilt Down	Switch with pin 17	Tilt Up
5	Pan Right	Pan Right		Pan Right
6	Failed Camera (LED output)	Failed Camera (LED output)		Failed Camera (LED output)
7	NC	NC		NC
8	NC	NC		NC
9	Aux 3	Aux 3		Aux 3
10	Aux 1	Aux 1		Aux 1
11	A/P (Lights on/off)	A/P (Lights on/off)		A/P (Lights on/off)
12	Iris Open	Iris Open		Iris Open
13	Power Supply Reference	N/A		Power Supply Reference

Pin Number	Drawing Indicates	Actual Function	Comments	SDAS Function
14	Bank A Relay Common	N/A		Bank A Relay Common
15	Focus Near	Focus Far	Switch with pin 2	Focus Near
16	Zoom In	Zoom In	Switch with pin 3	Zoom In
17	Tilt Down	Tilt Up	Switch with pin 4	Tilt Down
18	Pan Left	Pan Left		Pan Left
19	A/I (Output)	A/I (Output)		A/I (Output)
20	Bank B Relay Common	N/A		Bank B Relay Common
21	Set Bank B	N/A		Set Bank B
22	Aux 2	N/A		Aux 2
23	A/I	A/I		A/I
24	Iris Close	Iris Close		Iris Close
25	A/P (Led Output)	A/P (Led Output)		A/P (Led Output)

SERIAL DATA CONNECTOR TEST

This test was performed on a couple of data points to simply verify that serial data is being presented to SDAS on the proper pin number. The HRSVS does not provide any serial data to SDAS.

Channel 1 - No Function on HRSVS

Channel 2 - No Function on HRSVS

Channel 3 - No function on HRSVS

APPENDIX D - CONCLUSIONS AND OUTSTANDING ISSUES

Conclusions and Outstanding Issues

The High Resolution Stereoscopic Video Camera System (HRSVS) has undergone calibration, grooming and alignment (CG&A) and is now ready to undergo acceptance testing. The system has been modified from the original design. Below is a listing of the modifications performed as a result of the CG&A:

1) The two lights that were not initially wired are now completely operational and function as intended.

2) The original aluminum turrets were replaced with brass turrets.

3) New motors were installed on the turret rotation. These new motors had a lower gear ratio so that the turret could be rotated at a much slower speed.

4) The pressure sensor was removed from the end effector and the through-wall penetration was welded shut. The LDUA purge system will provide the necessary shutdown of power mechanism for the end effectors.

5) Potentiometers were installed on the turrets to provide position of the lenses during rotation.

6) Roll pins were installed on the turret shafts to prevent the coupling bellows from deforming causing wobble in the turret rotation.

7) The control system provided with the HRSVS will no longer be used for controlling the HRSVS during LDUA operation. The system proved to be unstable during initial testing and it was decided to use an alternate control system. The common video end effector system (CVEE) provided by INEL will provide the control function for the HRSVS end effector.

8) Installed new brackets which support the Watec cameras in the front of the HRSVS.

9) Installed new ball plungers which function to provide the Sony camera convergence.

Issues:

The HRSVS is now controlled using the CVEE provided by INEL. All of the original SRS control equipment will now be used for spare parts to support other camera systems as necessary.

The LDUA purge system has not provided much allowance for air leaks from the end effector. Sealing of the HRSVS may be critical. Modification to improve the sealing at the end joint and around each optical window should be considered.

The weight of the HRSVS is greater than the end effector specifications allow (which was 75 pounds including the TIP which we estimated to weigh 15 pounds). The weight of the HRSVS (not including the tool interface plate, TIP) was 74

pounds. The HRSVS exceeds the weight by 14 pounds. The LDUA technical leads have been apprised of this situation and have decided that the weight of the HRSVS is acceptable as is and no further modifications to this HRSVS will be necessary. Since the HRSVS is an end effector which will be rigorously used by the LDUA in all positions it may become necessary to reduce the weight at a later date.

Frank has yet to provide the new optical lens that attach directly to the Sony cameras. These lenses should improve the quality of the images. It is uncertain when these lenses will become available.

During TIP fit up it was noticed that two of the cap screws which hold the TIP to the end effector were not drilled in the correct location. The cap screw can be slightly ground (threads) and it will start and can be tightened but if possible these two holes should be welded and redrilled in the proper location. This was brought to the attention of the technical leads.