DOE/SF/10499-T59
(STMPO-579)

DOE FILE COPY

BEAM CHARACTERIZATION SUBSYSTEM

PREOPERATIONAL TEST

PROCEDURE 150

UNITED STATES DEPARTMENT OF ENERGY/
SOUTHERN CALIFORNIA EDISON COMPANY

10 MWe SOLAR PILOT PLANT

DAGGETT, CALIFORNIA

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

HUNTINGTON BEACH, CALIFORNIA

AUTHOR: M J Caraway R C Shaw

REVIEWED BY: J C Ivers

APPROVED BY: R L Lewis

TEST SPECIFICATION

TEST NUMBER 150 DATE

TEST TITLE BEAM CHARACTERIZATION SYSTEM REVISION NO. 0

PAGE

1.0 Objectives

1.1 Demonstrate the local handswitch operation of the BCS field receiver pump P-201.

1.2 Demonstrate the functional operation of the temperature control valve TV-1418.

1.3 Demonstrate the coolant fluid high temperature alarm function (TAH-1418).

1.4 Demonstrate the functional operation of the BCS cooling system fans.

1.5 Demonstrate the validity of installation and system generation of BCS software in the OCS computer.

1.6 Demonstrate the validity of installation and system generation of software in the MODACS located in Remote Station No. 1.

1.7 Demonstrate the proper loading of software in the H-P terminal.

1.8 Demonstrate the automatic operation of the target shutters by activating solenoid valves SOV-1410, SOV-1411, SOV-1412, and SOV-1413.

1.9 Demonstrate proper operation of the target pyrheliometers (YT-1414 A-D, YT-1415 A-D, YT-1416 A-D, and YT-1417 A-D).

1.10 Demonstrate the proper operation of the 4 BCS cameras (BCS-901A, BCS-902A, BCS-903A, and BCS-904A) and supporting equipment.

1.11 Demonstrate proper operation of the Quantex digitizer.

1.12 Demonstrate the capability of the BCS to accurately locate the centroid from a reference (calibration) light source.

1.13 Demonstrate the proper operation of the theoretical beam power algorithm based on actual measured conditions.

1.14 Demonstrate proper HAC/OCS message traffic (as appropriate to the BCS functions).

1.15 Demonstrate the proper operation of the off-line candidate list generation function in the OCS.

1.16 Demonstrate the total integrated functional operation of the system, at night.

1.17 Demonstrate the total integrated functional operation of the system, starting with the list and completing with the updating of biases. This test is run during daylight hours.

1.18 Demonstrate BCS capability of detecting hardware status during system startup.

1.19 Demonstrate BCS capability of detecting hardware status during BCS runtime.

1.20 Demonstrate the total system capability of detecting BCS measurement anomalies including beam on target during low level calibration, no beam on target during high level calibration, centroid out of range, and power out of range.

		Verification Paragraph	Objective
2.0	Acceptance Criteria		
2.1	The BSC fluid receiver pump (P-201) and BCS target heat exchanger fans (E-201 and E-202) start when local switch HS 1418 is placed in the ON position.	8.1	1.1, 1.4
2.2	The motor breaker position switch indicator ZI 1418 is activated when local hand switch HS 1418 is placed in the ON position.	8.2	1.2
2.3	Fluid temperature valve TV 1418 opens when the fluid temperature exceeds $75^{O}F$ as measured by TE 1418.	8.3	1.3
2.4	Fluid high temperature alarm TAH 1418 is activated in the fluid temperature reaches $130^{O}F$ as measured by TE 1418.	8.4	1.4
2.5	Camera switcher should gate the output of the proper camera into the digitizer.	8.5.3	1.5
2.6	Video monitor should display data written into the digitizer memory.	8.5.5	1.5

		Verification Paragraph	Objective
2.7	Successful downloading and executing of MODACS III operating system software will be indicated by the following prompt to the OCS system console. Load Complete/LDRIV/LDRIV LIO/LDRIV/LDRIV *K.O. MOGEN III/III/	8.6.2	1.6
2.8	Upon power up with auto start option on, the H.P. 9845B will automatically load the software for BCS operation. At completion of the loading process the BCS software will be put into execution. It will immediately display the BCS option menu.	8.7.1.4	1.7
2.9	Manual loading will proceed in the same manner as automatic loading. Again successful operation will be indicated by BCS option menu on CRT screen.	8.7.2.4	1.7
2.10	The MODACS should respond with a list of tasks executing within it.	8.8.2	1.8
2.11	The system should respond with a back-slash in column 1 such that the command would appear as follows: XSHUTST/RTE LKA NOTE: Allow at least one minute for program to download.	8.8.3	1.8

		Verification Paragraph	Objective
2.12	Each of the four shutter systems should open and close fully.	8.8.5	1.8
2.13	Each theoretical vs. measured power response should agree to within ±5%.	8.9	1.9
2.14	The digital image printed to hardcopy should reveal the position and size of the registration marks and identification mark. The digital data should exhibit a correlation to the video monitor display.	8.10	1.10
2.15	Analysis of data taken in section 8.10.3 and 8.10.5 should reveal a linear relation between background and target image.	8.10	1.10
2.16	Data taken with camera viewing gray level mask should exhibit a step function response appropriate to the position and illumination of the mask.	8.10	1.10
2.17	Pin cushion error should be minimal within center third of camera field of view.	8.10	1.10
2.18	Pin cushion error should be minimal within center two thirds of camera field of view	8.10	1.10
2.19	Controls on digitizer should allow proper settings to be obtained.	8.11	1.11

		Verification Paragraph	Objective
2.20	The static and dynamic centroid can be determined within ±2 pixels.	8.12	1.12
2.21	BCS software algorithm should measure power to within the error band of the measured insolation data.	8.13	1.13
2.22	Acceptance here is dependent upon mode entered. If measurement mode is entered the following sequence is valid.	8.14	1.14

	HAC → BCS	BCS → HAC
T1	Message #1	
T2		Message #2
T3	Message #3	
T4		Message #4
T5	Message #5	
T6		Message #8 or Message #6

NOTE: Sequence T3-T6 will repeat for each heliostat in the list.

T7 Message #10

	The following sequence is valid for the bias update mode of operation.	8.14	1.14

HAC → BCS	BCS → HAC

			Verification Paragraph	Objective
	T1	Message #1		
	T2	Message #2		
	T3	Message #11		
	T4	Up to 3 Message #12's		
	T5	Message #13		
	NOTE:	Sequence T3-T5 will repeat for each heliostat in the list.		
	T7	Message #10		
	NOTE:	Refer to Appendix 10F for explanation and description of BCS message traffic.		
2.23		First candidate list should be printed to line printer. Three files of 60 heliostats should have been generated. Verify the names MORNING, NOON and TARDE are heading each file. Each file name should have a sequence number appended to it in character positions 9 and 10 as follows: MORNING 01 NOON 02 TARDE 03	8.15	1.15
2.24		Compare the second list generated with the first list. Heliostats which were updated prior to the generation of the second list should not appear in the second list.	8.15	1.15

		Verification Paragraph	Objective
2.25	List should be directed to magnetic tape. At completion of list the tape should rewind.	8.15	1.15
2.26	Records kept by field personnel should verify proper heliostats were measured and all blocking/shadowing heliostats were moved to ALT2 stow.	8.16	1.16
2.27	The summary report should indicate each heliostat in the list was measured.	8.16	1.16
2.28	Verify all sixty heliostats have been measured and compare time of measurement logged by field personnel with that recorded by system on report summary.	8.17	1.17
2.29	BCS software should flag to the H.P. console any errors occurring to the digitizer, MODACS III, pyrheliometers or shutters during system startup.	8.18	1.18
2.30	BCS software should flag to the H.P. console any errors occurring to the digitizer, MODACS III, pyrheliometers or shutters during runtime.	8.19	1.19

		Verification Paragraph	Objective
2.31	BCS and HAC BCS software should flag the following errors as appropriate. 1. Beam on target during low level calibration. 2. No-beam on target during high level calibration. 3. Power out of range. 4. Centroid out of range.	8.20	8.20

Verification Paragraph	Objective

3.0 References

3.1 Vendor Data

a) Auroro Pump A04, Model 134 data.

b) Jordan Mark 76 Valve data.

3.2 CS-MCS and CS-Plant Interface Requirements (RADL Item 2-30-1).

3.3 BCS Software Requirements.

3.4 Quantex Corporation and Maintenance Manual.

3.5 Operating and maintenance instructions for 2380 series remote controls. COHU Inc.

		Initial	Date
4.0	Prerequisites		
4.	OCS, HAC and SDPC must be capable of supporting this test.		
4.1	Test procedures number 340 and 100 must be completed.		
4.2	DAS software must be installed and capable of supplying normal incident pyrheliometer data for theoretical power calculation.		
4.3	Maxnet operating system is installed in MODACS III and OCS computers.		
4.4	BCS cameras must be updated and there outputs verified over entire temperature range expected.		
4.5	Camera switching hardware has been powered and cabled. Manual camera switcher on front panel of DTMF transmitter is capable of switching through the cameras.		
4.6	Quantex digitizer is powered up and IEEE-488 interface bus is installed. Output to video monitor is operational.		
4.7	The 4828 link between MODACS III and modcomp classic has been checked out using Modcomp diagnostic software.		

		Initial	Date
4.8	Compressed air and electrical power has been supplied to the target shutter systems.		
4.9	Pyrheliometers from each target have been connected to the proper MODACS III input channels.		
4.10	Link between HAC and OCS has been checked out using Modcomp diagnostic software.		
4.11	BCS master file has been generated and verified.		

		Initial	Date
6.0	Test equipment.		
6.1	Checkout unit.		
6.2	BCS test software file.		
6.3	Binoculars.		
6.4	High intensity light source.		
6.5	Oscilloscope.		
6.6	Walkie talkies.		
6.7	~300 watt handheld spotlight.		
6.8	Perfect mirror including "A" frame, mirror covers, and attachment brackets.		
6.9	Flat black test target for centroid evaluations.		
6.10	Camera remote control unit and field monitor.		
6.11	Camera grey level mask.		
6.12	Tools to remove pyrheliometers.		
6.13	A.C. voltage source capable of generating one volt peak to peak waveform.		
6.14	Calibrated digital voltmeter better than ±1% for measuring output of 6.13.		

		Initial	Date
7.0	Initial Conditions		
7.1	Verify that the BCS fluid receiver is filled with the coolant (ethylene glycol-water) solution by observing the receiver level sight gauge. (An expansion space should be maintained to allow for coolant expansion up to 130°F without overflowing the fluid receiver).		
7.2	Verify that individual isolation valves (4) are open to allow coolant flow to the individual targets once the pump is started.		
7.3	Installation complete, visual inspection of all subsystems done.		

		Verification Paragraph
7.4	Digitizer is in the "MEM" mode as described in Quantex Corporation operation and maintenance manual Page 2-7.	8.5.6
7.5	Maxnet III operating system is generated and resides as the second file on disk partition DST	8.6
7.6	BCS cameras must be focussed aligned and zoomed prior to running this section.	8.12
7.7	An initialized masterfile has been generated and exists on disk partition MFD.	8.15
7.8	HAC timeout function must be disconnected.	8.16
7.9	All BCS hardware must be turned on.	8.14

		Initial	Date
8.0	Procedure and Data Collection		
8.1	Place the local hand switch HS 1418 in the ON position and verify that the BCS fluid receiver pump (P-201) and (2) heat exchanger fans start.		
8.2	With HS 1418 in the ON position, verify that the "Breaker Position" indicator, ZI 1418 is actuated on the receiver SDPC console.		
8.3	Lift thermocouple (TE 1418) leads and using the Checkout Unit (CHU) introduce a test temperature signal.		
	a) Verify that temperature valve TV 1418 opens when a test temperature signal >75°F is introduced into controller TC 1418.		
	b) Verify that temperature valve TV 1418 closes when a test temperature signal <75°F is introduced into controller TC 1418. (Note: when the valve is closed, a minimum coolant flow will continue to pass through the system due to the presence of a "pilot hole" in the valve trim.)		

		Initial	Date
8.4	Using the CHU, verify that an alarm (TAH 1418) is displayed on the receiver SDPC when the simulated coolant temperature is $\geq 130^{\circ}F$. Verify that the high temperature alarm clears when the simulated temperature falls to less than $130^{\circ}F$.		
8.5	Installation and system generation of BCS software in the OCS computer.		
8.5.1	Generate load modules for each BCS module using the procedure "MCBCS". NOTE: A list of BCS modules is given in Appendix 10A.		
8.5.2	Load and execute BCS test module called "IOISTS" by typing the following commands. PRESS "BREAK" KEY TYPE: /IOISTS/EXE Verify the following prompt to crt. "INPUT DESIRED OUTPUT"		

	Initial	Date

8.5.3 Command the camera switcher to cycle through each of the cameras using the following Codes.

Camera #1 south target code = C000		
Camera #2 west target code = 4000		
Camera #3 east target code = 8000		
Camera #4 north target code = 0000		

8.5.4 Load and execute BCS test module called "HILOTST" by typing the following command:

PRESS "BREAK" KEY
TYPE: /HILOTST/EXE

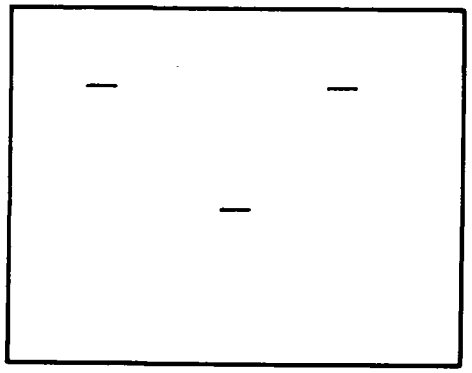
Verify following prompt is sent to the crt:

"INPUT TARGET NUMBER" | | |

8.5.5 Following the prompts from the crt command values of 100 or more be written into any location within the digitizers memory | | |

Initial	Date

8.5.6 Observe video monitor to verify data has been received and stored correctly. The following pattern is typical. Each small line is 3 pixel units wide.



8.6 MODACS III Operation

8.6.1 Download MODACS III operating system by typing the following command at the OCS console:

PRESS "BREAK" KEY
TYPE: //FIL LKA DST 3 2

8.6.2 Wait for the following prompt:

LOAD COMPLETE /LDRIV/LDRIV
LIO /LDRIV/LDRIV

*K.O MOGEN
III/III/

		Initial	Date
8.7	H.P. Software Loading (manual and automatic).		
8.7.1	Automatic software loading.		
8.7.1.1	Load H.P. BCS software cartridge tape into tape drive. Note: See Page 11 of H.P. system 45B beginners guide for tape cartridge loading instructions.		
8.7.1.2	Set autostart switch on H.P. to active.		
8.7.1.3	Turn on power switch located on lower right side of device.		
8.7.1.4	After several minute delay verify BCS option menu appears on screen. See Appendix 10B for BCS option menu display format.		
8.7.2	Manual software loading.		
8.7.2.1	Load H.P. BCS software cartridge tape into tape drive. Note: See Page 11 of H.P. system 45B beginners guide for tape cartridge loading instructions.		
8.7.2.2	Turn on power switch.		
8.7.2.3	Command loading of BCS software by typing: Load "AUTOST"		

	Initial	Date

8.7.2.4 After several minute delay verify BCS option menu appears on screen. See Appendix 10B for BCS option menu display format.

8.8 BCS Target Shutters

8.8.1 Download MODACS III operating system by typing in the following command at the OCS console.

PRESS "BREAK" KEY
TYPE: //FIL LKA DST 3 2

After several minute delay verify the following prompt from MODACS to the OCS console:

LOAD COMPLETE /LDRIV/LDRIV
LIO /LDRIV/LDRIV

*K.O MOGEN
III/III/

8.8.2 Verify MODACS III operation by typing the following command:

PRESS "BREAK" KEY
TYPE: // RFO LKA

Note: See Appendix 10.C for proper response.

	Initial	Date

8.8.3 Download BCS test module "SHUTST" to the MODACS III by typing the following command.

PRESS "BREAK" KEY
TYPE /SHUTST/RTE LKA

Verify proper downloading by observing a backslash in column one of the command such that the command would appear as follows:

X SHUTST/RTE LKA

8.8.4 Load and execute BCS test module "shutter" by typing the following command.

PRESS "BREAK" KEY
TYPE /SHUTTER/EXE

Verify following prompt at OCS console:

Which shutter? (N, E, S, W)

8.8.5 Select east target shutter system for cycling open/closed. Verify full opening and closing of shutters from the field with binoculars. Cycle open/closed five times.

8.8.6 Select west target shutter system for cycling open/closed. Verify full opening and closing of shutters from the field with binoculars. Cycle open/closed five times.

		Initial	Date
8.8.7	Select north target shutter system for cycling open/closed. Verify full opening and closing of shutters from the field with binoculars. Cycle open/closed five times.		
8.8.8	Select east target shutter system for cycling open/closed. Verify full opening and closing of shutters from the field with binoculars. Cycle open/closed five times.		
8.9	Pyrheliometer Calibration		
8.9.1	Install perfect mirror on "A" frame approximately 250 ft from north target. Record location and time of day.		
8.9.2	Move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.9.3	Download BCS test module "PYRTST" to MODACS III by typing the following command. PRESS "BREAK" KEY TYPE /PYRTST/RTE LKA Verify proper downloading by observing a backslash in column one of the command such that the command would appear as follows: XPYRTST/RTE LKA		

		Initial	Date
8.9.4	Load and execute BCS test module "PYR" by typing the following command. PRESS "BREAK" KEY TYPE/PYR/EXE Verify following prompt at OCS console: Which target? (N, E, W, S)		
8.9.5	Read and record pyrheliometer data for north target.		
8.9.6	Cover 1/4 of perfect mirror area.		
8.9.7	Read and record pyrheliometer data from north target.		
8.9.8	Cover 1/2 of perfect mirror.		
8.9.9	Read and record pyrheliometer data from north target.		
8.9.10	Cover 3/4 of perfect mirror.		
8.9.11	Read and record pyrheliometer data from north target.		
8.9.12	Calculate theoretical power as described in Appendix 10D for each of the mirror areas used above.		

		Initial	Date
8.9.13	Generate a plot of measured power as read from the pyrheliometers vs calculated power. Verify a linear relationship exists between the quantities.		
8.9.14	Install perfect mirror on "A" frame approximately 250 ft from west target. Record location and time of day.		
8.9.15	Move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.9.16	Read and record pyrheliometer data from west target.		
8.9.17	Cover 1/4 of perfect mirror area.		
8.9.18	Read and record pyrheliometer data from west target.		
8.9.19	Cover 1/2 of perfect mirror.		
8.9.20	Read and record pyrheliometer data from west target.		
8.9.21	Cover 3/4 of perfect mirror.		
8.9.22	Read and record pyrheliometer data for west target.		
8.9.23	Calculate theoretical power as described in Appendix 10D for each of the mirror areas described above.		

		Initial	Date
8.9.24	Generate a plot of measured power as read from pyrheliometers vs calculated power. Verify a linear relationship exists between the quantities.		
8.9.25	Install perfect mirror on "A" frame approximately 250 ft from south target. Record location and time of day.		
8.9.26	Move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.9.27	Read and record pyrheliometer data for south target.		
8.9.28	Cover 1/4 of perfect mirror area.		
8.9.29	Read and record pyrheliometer data for south target.		
8.9.30	Cover 1/2 of perfect mirror.		
8.9.31	Read and record pyrheliometer data for south target.		
8.9.32	Cover 3/4 of perfect mirror.		
8.9.33	Read and record pyrheliometer data for south target.		
8.9.34	Calculate theoretical power as described in Appendix 10D for each of the mirror areas used above.		

		Initial	Date
8.9.35	Generate a plot of measured power as read from pyrheliometers vs calculated power. Verify a linear relationship exists between the quantities.		
8.9.36	Install perfect mirror on "A" frame approximately 250 ft from east target record location and time of day.		
8.9.37	Move perfect mirror such that reflected beam falls over center three pyreheliometers.		
8.9.38	Read and record pyrheliometer data for east target.		
8.9.39	Cover 1/4 of perfect mirror area.		
8.9.40	Read and record pyrheliometer data for east target.		
8.9.41	Cover 1/2 of perfect mirror area.		
8.9.42	Read and record pyrheliometer data for east target.		
8.9.43	Cover 3/4 of perfect mirror.		
8.9.44	Read and record pyrheliometer data for east target.		
8.9.45	Calculate theoretical power as described in Appendix 10D for each of the mirror areas used above.		

		Initial	Date
8.9.46	Generate a plot of measured power as read from pyrheliometers vs calculated power. Verify a linear relationship exists between the quantities.		
8.10	BCS Camera.		
8.10.1	For north target set focus and adjust zoom for minimum field of view. Make certain all registration marks are within the cameras field of view.		
8.10.2	Load and execute BCS test module "DIR" by typing the following command. PRESS "BREAK" KEY TYPE: /DIR/EXE Verify the following prompt on the OCS Console: "IS DAYLIGHT SAVINGS TIME IN EFFECT?"		
8.10.3	Command a digital picture be taken and list sufficient number of pixel elements to verify image on monitor corresponds to image data from digitizer. Data is printed to the OCS line printer (OCS-701).		

Initial	Date

8.10.4 Point camera such that camera sees left edge of target as shown in Fig. 1.

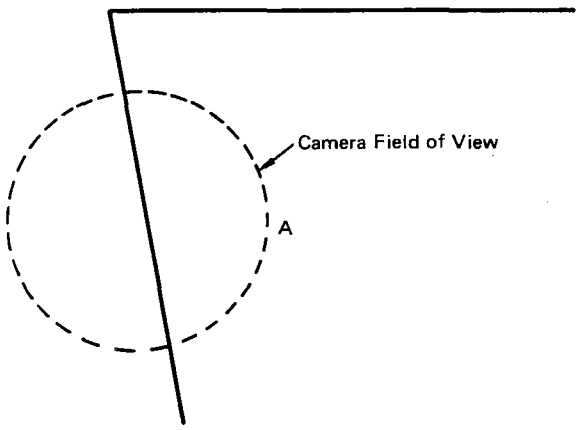


Figure 1

8.10.5 With camera pointing as shown in Fig. 1 and same test software as in section 8.10.2 command a digital image be taken. Print an array of the digitized data which contains the target edge within it.

Note: Data is printed to the OCS line printer (OCS-701)

8.10.6 Move camera such that field of view is as shown in Fig. 1A and repeat step 8.10.5.

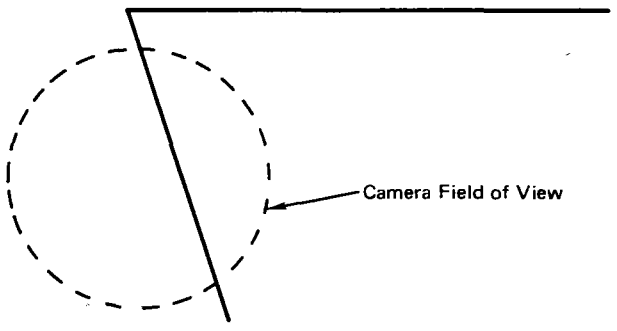


Figure 1A

Initial	Date

8.10.7 Move camera such that field of view is as shown in Fig. 1B. Repeat step 8.10.5.

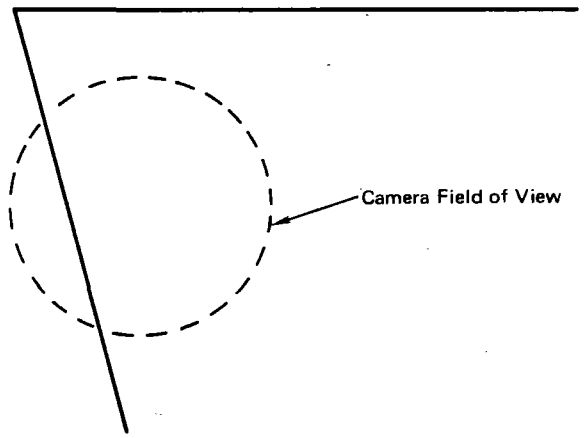
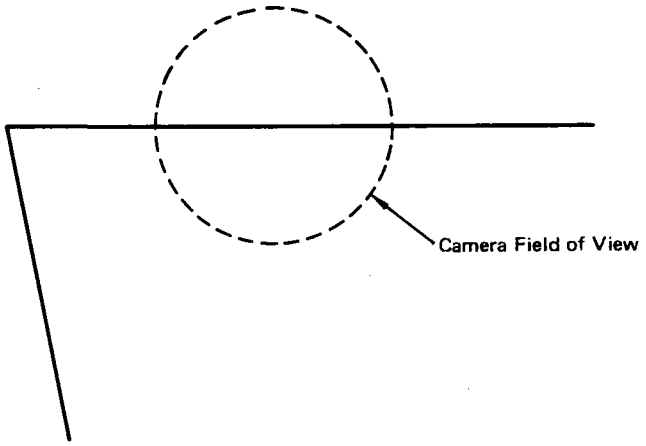


Figure 1B

8.10.8 Compare the data taken from the three different edge locations to verify pixel to pixel linearity.

Note: Several more camera positions may be required. Step 8.10.5 should be repeated as necessary.

8.10.9 Point camera such that camera sees upper edge of target as shown in Figure 2.



Initial	Date

8.10.10 Use same test software as section 8.10.2 to command a digital image be taken. Print an array of the digitized data which contains the target edge within it.

Note: Data is printed to OCS line printer (OCS-701).

8.10.11 Move camera such that field of view is as shown in Fig. 2A. Repeat step 8.10.10.

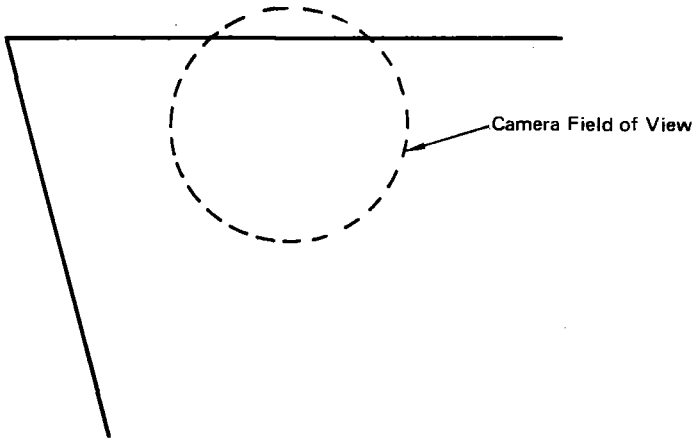


Figure 2A

Initial	Date

8.10.12 Move camera such that field of view is as shown in Fig. 2B. Repeat step 8.10.10.

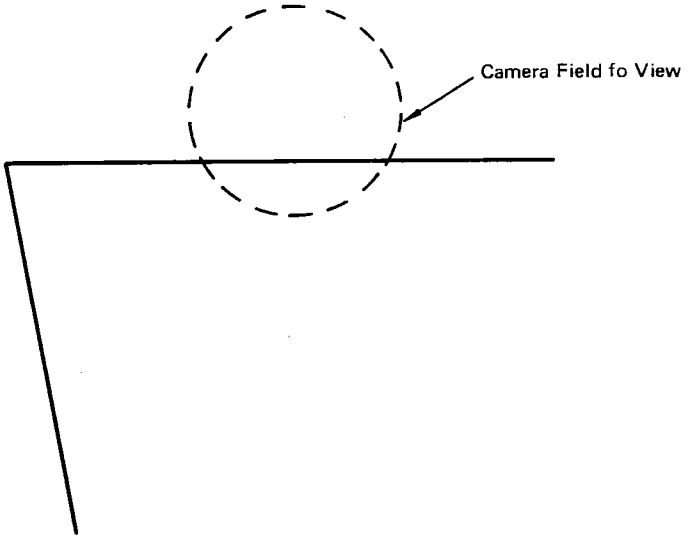


Figure 2B

8.10.13 Compare the data taken from the three different edge locations to verify pixel to pixel linearity.

Note: Several more camera positions may be required. Step 8.10.10 should be repeated as necessary.

8.10.14 Point camera such that all four registration marks are in field of view. Adjust zoom and focus if necessary.

		Initial	Date
8.10.15	Using same test software as in previous steps, command a digital image be taken. Print to hardcopy five rectangles of data four of which contain the registration marks and one containing the target identifier. Verify contrast between black registration marks and white target is sufficient for BCS software to identify. Note: Hardcopy device is the OCS line printer (OCS-701).		
8.10.16	Repeat steps 8.10.1 - 8.10.15 for south, east and west targets.		
	S		
	E		
	W		
8.10.17	For north target during time of homogeneous illumination mount grey level mask in front of camera.		
8.10.18	Using same test software as in previous steps, command a digital image be taken. Print to hardcopy device (OCS-701) a series of lines through the digital image. Verify the camera digitizer system is capable of distinguishing the various levels of grey level mask.		
8.10.19	Repeat step 8.10.18 as many times as necessary moving the grey level mask to different positions. Again verify the systems capability to distinguish the various levels of gray.		
8.10.20	Focus zoom and align each of the four BCS cameras as described in Appendix 10.E.		

		Initial	Date
8.11	Quantex Digitizer		
8.11.1	Connect 1 volt A.C. to TBD input terminal of the Quantex with the video from the camera disconnected.		
8.11.2	Adjust the white level control to register 220 counts on the OCS line printer. (OCS-701).		
8.11.3	Connect 0.1 volt A.C. to the TBD input terminal of the Quantex.		
8.11.4	Adjust the dark level control to register TBD counts on the OCS line printer. (OCS-701).		
8.11.5	Perform linearity test.		
8.12	Centroid Measurement.		
8.12.1	Remove Center hole pyrheliometer from north target and replace with test light source.		
8.12.2	Modify BCS software modules "BHILVL" and "BRPYRL" to remove center hole pyrheliometer affects from the software.		
8.12.3	For 12 P.M. ±1 hour switch test light source on.		
8.12.4	At intervals of 2 min. ± TBD measure centroids with BCS software using 20 groups of 5 centroid scans per group.		

		Initial	Date
8.12.5	Load and execute BCS test software module "DIR" by typing the following command. PRESS "BREAK" KEY TYPE /DIR/EXE Verify the following prompt to the OCS console device. "IS DAYLIGHT SAVINGS TIME IN EFFECT?"		
8.12.6	Using test software loaded in previous step command an image grab be taken. Generate and list to OCS hardcopy device (OCS-701) a rectangle of pixel data within test light source area. Verify location of pyrheliometer hole and distribution of light flux data. Verify reasonableness of flux distribution to measured results.		
8.12.5	Generate scatter diagram of measured centroids taken in step 8.12.4. Verify the average centroid is within acceptable limits of the actual centroid.		
8.12.6	Repeat step 8.12.1 for east target.		
8.12.7	For 9:00 A.M. ±1 hr switch test light source on.		
8.12.8	Repeat steps 8.12.4 - 8.12.6 for east target.		

		Initial	Date
8.12.9	Repeat step 8.12.1 for south target.		
	1:30 ± 1 hour		
8.12.10	For 10:30 ± 1 hour switch on test light source.		
	4:30 ± 1 hour		
8.12.11	Repeat steps 8.12.4 - 8.12.6 for south target.		
8.12.12	Repeat step 8.12.1 for west target.		
8.12.13	For 3:00 P.M. or anytime when sun is not illuminating target switch on test light source.		
8.12.14	Repeat steps 8.12.4 - 8.12.6 for west target.		
8.12.15	For each target at 9:00 AM, 11:00 AM, 1:00 PM, and 3:00 PM ± 30 min command BCS to calculate reference mark locations.		
	N		
	E		
	S		
	W		
8.12.16	As quickly as practical after each of the specified times use test module "DIR" to isolate and print a matrix of pixel data which contains within it one of the four reference marks. Load test software by using the following commands.		
	PRESS "BREAK" KEY		
	TYPE: /DIR/EXE		

		Initial	Date
	Verify the following prompt is written to the OCS CRT screen. "IS DAYLIGHT SAVINGS TIME IN EFFECT?" The isolated data will be printed to the OCS hardcopy device (OCS-701). Verify the contrast between the black registration marks and the white target is sufficient for BCS software detection.		
8.12.17	At time of high beam to background ratio, mount perfect mirror on "A" frame approximately 250 ft. from north target.		
8.12.18	Manually aim mirror such that beam is projected near right hand edge of target. Beam should be aimed approximately midway between righthand corners of target.		
8.12.19	Using BCS centroid calculation routine take centroid readings at invertals of 1 minute until beam leaves opposite edge of target. Record each centroid value.		
8.12.20	At time of high beam to background ratio, mount perfect mirror on "A" frame approximately 250 ft. from east target.		
8.12.21	Manually air mirror such that beam is projected near right hand edge of target. Beam should be airmed approximately midway between righthand corners of target.		
8.12.22	Using BCS centroid calculation routine take centroid readings at intervals of 1 minute until beam leaves opposite edge of target. Record each centroid value.		

		Initial	Date
8.12.23	At time of high beam to background ratio, mount perfect mirror on "A" frame approximately 250 ft from south target.		
8.12.24	Manually aim mirror such that beam is projected near right hand edge of target. Beam should be aimed approximately midway between righthand corners of target.		
8.12.25	Using BCS centroid calculation routine take centroid readings at intervals of 1 minute until beam leaves opposite edge of target. Record each centroid value.		
8.12.26	At time of high beam to background ratio, mount perfect mirror on "A" frame approximately 250 ft from west target.		
8.12.27	Manually aim mirror such that beam is projected near right hand edge of target. Beam should be aimed approximately midway between righthand corners of target.		
8.12.28	Using BCS centroid calculation routine take centroid readings at intervals of 1 minute until beam leaves opposite edge of target. Record each centroid value.		
8.12.29	Mount flat black test target with white lambertian rectangle in such a manner that it exceeds the north cameras field of view the target should be located approximately 50 ft from the camera.		

		Initial	Date
8.12.30	Load and execute BCS test module "BLDCLT" to build a linear calibration table. The following commands should be used. PRESS "BREAK" KEY TYPE: /BLDCLT/EXE Verify the following prompt appears at the CRT. WHICH TABLE (1-4)		
8.12.31	Using BCS test module "DIR" determine the location of the white rectangle on the target. Do a hand calculation to determine the approximate pixel location of the centroid.		
8.12.32	At times when sun illuminates test target calculate the centroid of target and white rectangle using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.33	With same test setup as above add a gray rectangle next to the white rectangle.		
8.12.34	At times when sun illuminates test target calculate the centroid of target and white and gray rectangles using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		

		Initial	Date
8.12.35	Mount flat black test target with white lambertian rectangle in such a manner that it exceeds the east cameras field of view. The target should be located approximately 50 ft from the camera.		
8.12.36	Using BCS test module "DIR" determine the location of the white rectangle on the target. Do a hand calculation to determine the approximate pixel location of the centroid.		
8.12.37	At times when sun illuminates test target calculate the centroid of target and white rectangle using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.38	With same test setup as above add a gray rectangle next to the white rectangle.		
8.12.39	At times when sun illuminates test target calculate the cnetroid of target and white and gray rectangles using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.40	Mount flat black test target with white lambertian rectangle in such a manner that it exceeds the south cameras field of view. The target should be located approximately 50 ft from the camera.		

		Initial	Date
8.12.41	Using BCS test module "DIR" determine the location of the white rectangle on the target. Do a hand calculation to determine the approximate pixel location of the centroid.		
8.12.42	At times when sun illuminates test target calculate the centroid of target and white rectangle using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.43	With same test setup as above add a gray rectangle next to the white rectangle.		
8.12.44	At times when sun illuminates test target calculate the centroid of target and white and gray rectangles using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.45	Mount flat black test target with white lambertian rectangle in such a manner that it exceeds the west cameras field of view the target should be located approximately 50 ft from the camera.		
8.12.46	Using BCS test module "DIR" determine the location of the white rectangle on the target. Do a hand calculation to determine the approximate pixel location of the centroid.		

		Initial	Date
8.12.47	At times when sun illuminates test target calculate the centroid of target and white rectangle using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.48	With same test setup as above add a gray rectangle next to the white rectangle.		
8.12.49	At times when sun illuminates test target calculate the centroid of target and white and gray rectangles using actual BCS centroid calculation module. Verify results of measurement agree within TBD of centroid determined in step 8.12.31.		
8.12.50	Return all center hole pyrheliometers back to their original locations.		
8.12.51	Return modified software modules "BHILVL" and "BRPYRL" to their original states.		

	Initial	Date
8.13 BCS Power Calculation		
8.13.1 Install perfect mirror on "A" frame approximately 250 ft. from north target.		
8.13.2 From H.P. Console initiate the BCS system by typing key #3 of H.P. function keys. Take all default options.		
8.13.3 Load and execute HAC simulator driver "MSGBLD" by typing the following commands. press "Break" key type /MSGBLD/ EXE Verify the following prompt to the CRT screen "Which message do you wish to build?"		
8.13.4 Using above test routine bring BCS to measurement phase.		
8.13.5 With no beam on target command BCS to perform background calibration.		
8.13.6 Move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.13.7 Command BCS to perform high level calibration and measurement process.		
8.13.8 Remove reflected beam from target.		

		Initial	Date
8.13.9	Command BCS to perform background calibration.		
8.13.10	Cover 1/4 of perfect mirror then move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.13.11	Command BCS to perform high level calibration and measurement process.		
8.13.12	Remove reflected beam from target.		
8.13.13	Command BCS to perform background calibration.		
8.13.14	Cover 1/2 of perfect mirror then move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.13.15	Command BCS to perform high level calibration and measurement process.		
8.13.16	Remove reflected beam from target.		
8.13.17	Command BCS to perform background calibration.		
8.13.18	Cover 3/4 of perfect mirror then move perfect mirror such that reflected beam falls over the three center pyrheliometers.		
8.13.19	Command BCS to perform high level calibration and measurement process.		

		Initial	Date
8.13.20	Generate a summary report from the H.P. terminal to print out all measurement results. Verify measured power is within TBD watts of calculated theoretical power.		
8.14	HAC/OCS Message Traffic Interface		
8.14.1	Replace BCS module "BCALLO", BCALHI", "BHISTR", and "BMFUPD" with BCS test modules of the same name.		
8.14.2	Initiate BCS processing from the H.P. console by typing Key #3 of the H.P. function control keys. Verify the following prompt appears on the H.P. CRT: "Is the south target operational?"		
8.14.3	Command HAC to start BCS process NOTE: This is done at HAC console and information regarding actual startup procedure was unavailable at time of publication.		
8.14.4	Verify message sequence and format for each of the messages sent by HAC to OCS. See Appendix 10.F for sequence and format definition.		

		Initial	Date
8.15	Off-Line Candidate List Generation.		
8.15.1	From OCS console load the candidate list generation function and direct its output to the OCS line printer. The following commands will be used: Press "Break" key Type /BCL003/EST Type /BCL003/ASS 6 AG1		
8.15.2	From H.P. terminal request off-line candidate list generation by pressing key #8 of the function control keys.		
8.15.3	Generate a morning file called "MORNING". Request 60 heliostats in this file with a start time of 8:00 and an ending time of 10:00.		
8.15.4	Generate a noon file called "NOON". Request 60 heliostats in this file with a start time of 10:30 and ending time of 12:00.		
8.15.5	Generate an afternoon file called "TARDE." Request 60 heliostats in this file with a start time of 1:00 PM and an ending time of 3:00.		
8.15.6	Load and execute BCS test module "UPDCEN" to update centroid data on any heliostat in the list. The following procedure is used to load and execute "UPDCEN". Press "Break" key Type: /UPDCEN/EXE		

		Initial	Date
	Verify the following prompt appears on CRT screen. "Type in record number of desired Heliostat"		
8.15.7	Repeat steps 8.15.2 - 8.15.5. Verify heliostats updated in step 8.15.6 do not appear on new list.		
8.15.8	Command the candidate list generation function to direct its output to magnetic tape by typing the following command. Press "Break" key Type: /BCL003/DEE		
8.15.9	Repeat steps 8.15.2 - 8.15.5. Verify tape movement and if possible verify HAC can read the tape correctly.		
8.15.9	Generate a new masterfile as described in Appendix 10.G.		
8.16	BCS Dark System Test (run at night).		
8.16.1	From H.P. console generate a heliostat candidate list choosing heliostats approximately 350 ft. from the target. The list should include at least two heliostats per target.		
8.16.2	Modify BCS software routine "BCALLO" to include a pause before sending its completion message to HAC		

	Initial	Date
8.16.3 Initiate BCS from H.P. console by issuing the following command. Press key #3 of function control keys. Verify H.P. prompts operator to continue by issuing the following prompt: "Is the south target operational?"		
8.16.4 Load heliostat candidate list tape on HAC and initiate HAC/BCS software. NOTE: The commands necessary to perform this function were not available at time of this writing.		
8.16.5 At the OCS console monitor the progress of BCS measurement by observing the pause statements written to the CRT. After a pause statement is written to the CRT load and execute BCS test software module "READGC" using the following command: Press "Break" key Type /READGC/EXE verify the following propt appears on the CRT. "INDEX"		
8.16.6 Using above software determine the target and heliostat number being measured.		

		Initial	Date
8.16.7	Have field personnel move to heliostat being measured and direct a spotlite beam to the correct target.		
8.16.8	Resume low level calibration function and allow measurement process to continue by typing the following commands: Press "Break" key Type: /BCALLO/R Verify backslash is written into column one as shown below. XBCALLO/R		
8.16.9	Have field personnel monitor and record heliostat motion.		
8.16.10	Repeat steps 8.16.5 - 8.16.9 until each heliostat in the list has been exercised.		
8.16.11	Return BCS software module "BCALLO" to its original state.		
8.17	Total system integration (normal daylight operation).		
8.17.1	From H.P. console command the heliostat candidate list function be activated by pressing key #8 of H.P. function control.		

		Initial	Date
8.17.2	Generate a heliostat candidate list with a minimum of twenty heliostats. Choose the twenty in a manner such that five heliostats are chosen from each quadrant of the field.		
8.17.3	Initiate BCS from the H.P. console by typing key #3 of the H.P. function keys. Answer all prompts using default options.		
8.17.4	Mount candidate list tape on HAC and initiate HAC/BCS software.		
8.17.5	Have field personnel monitor and record each heliostat measured and time of measurement. Visually verify blocking and shadowing heliostats have responded.		
8.18	BCS software detection of hardware status at system startup.		
8.18.1	MODACS verification.		
8.18.2	Turn off power to MODACS III and digitizer.		
8.18.3	From H.P. console start BCS processing by pressing key #3 of H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.4	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify status report returned to H.P. CRT indicates MODACS III and digitizer are down. Note: Which answers are chosen from prompts is unimportant.		

		Initial	Date
8.18.5	Power up MODACS III and digitizer.		
8.18.6	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.7	From H.P. console start BCS processing by pressing key #3 of H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.8	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify status of digitizer and MODACS III is operational.		
8.18.9	Disconnect north shutter system in a manner such that shutters will not respond to MODACS commands.		
8.18.10	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.11	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		

		Initial	Date
8.18.12	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify shutters for north target are flagged as inoperable by hardware status log written to H.P. CRT.		
8.18.13	Reconnect north target shutter system.		
8.18.14	Disconnect south shutter system in a manner such that shutters will not respond to MODACS commands.		
8.18.15	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.16	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?		
8.18.17	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify shutters for north target are flagged as inoperable by hardware status log written to H.P. CRT.		
8.18.18	Reconnect south target shutter system.		
8.18.19	Disconnect east shutter system in a manner such that shutters will not respond to MODACS commands.		
8.18.20	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		

	Initial	Date
8.18.21 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.22 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify shutters for north target are flagged as inoperable by hardware status log written to H.P. CRT.		
8.18.23 Reconnect East target shutter system		
8.18.24 Disconnect west shutter system in a manner such that shutters will not respond to MODACS commands.		
8.18.25 From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.26 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.27 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify shutters for north target are flagged as inoperable by hardware status log written to H.P. CRT.		
8.18.28 Reconnect west target shutter system.		

		Initial	Date
8.18.29	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.30	Disconnect upperleft pyrheliometer from north target.		
8.18.31	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.32	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upperleft pyrheliometer for north target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.33	Reconnect upperleft pyrheliometer for north target.		
8.18.34	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.35	Disconnect upper right pyrheliometer from north target.		
8.18.36	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		

		Initial	Date
8.18.37	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper right pyrheliometer for north target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.38	Reconnect upper right pyrheliometer for north target.		
8-18-39	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.40	Disconnect lower center pyrheliometer from north target.		
8.18.41	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.42	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify lower center pyrheliometer for north target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.43	Reconnect lower center pyrheliometer for north target.		

		Initial	Date
8.18.44	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.45	Disconnect upper left pyrheliometer from south target.		
8.18.46	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.47	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper left pyrheliometer for south target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.48	Reconnect upper left pyrheliometer for south target.		
8.18.49	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.50	Disconnect upper right pyrheliometer from south target.		
8.18.51	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		

	Initial	Date
8.18.52 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper right pyrheliometer for south target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.53 Reconnect upper right pyrheliometer for south target.		
8.18.54 From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.55 Disconnect lower center pyrheliometer from south target.		
8.18.56 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.57 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify lower center pyrheliometer for south target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.58 Reconnect lower center pyrheliometer for south target.		

	Initial	Date
8.18.59 From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.60 Disconnect upper left pyrheliometer from east target.		
8.18.61 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.62 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper left pyrheliometer for east target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.63 Reconnect upper left pyrheliometer for east target.		
8.18.64 From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.65 Disconnect upper right pyrheliometer from east target.		
8.18.66 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		

		Initial	Date
8.18.67	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper right pyrheliometer for east target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.68	Reconnect upper right pyrheliometer for east target.		
8.18.69	From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.19.70	Disconnect lower center pyrheliometer from east target.		
8.18.71	From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.72	Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify lower center pyrheliometer for east target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.73	Reconnect lower center pyrheliometer for east target.		

	Initial	Date
8.18.74 From H.P. console restart BCS processing by pressing "Stop" then "RUN". Verify BCS option menu appears.		
8.18.75 Disconnect upper left pyrheliometer from west target.		
8.18.76 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?"		
8.18.77 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper left pyrheliometer for west target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.78 Reconnect upper left pyrheliometer for west target.		
8.18.79 From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.80 Disconnect upper right pyrheliometer from west target.		
8.18.81 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. verify following prompt appers: "Is south target operational?"		

	Initial	Date
8.18.82 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify upper right pyrheliometer for west target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.83 Reconnect upper right pyrheliometer for west target.		
8.18.84 From H.P. console restart BCS processing by pressing "Stop" then "Run". Verify BCS option menu appears.		
8.18.85 Disconnect lower center pyrheliometer from west target.		
8.18.86 From H.P. console start BCS processing by pressing key #3 of the H.P. function keys. Verify following prompt occurs: "Is south target operational?		
8.18.87 Respond to all prompts as appropriate and bring BCS to hardware status mode. Verify lower center pyrheliometer for west target is flagged as inoperative by hardware status log written to H.P. CRT.		
8.18.88 Reconnect lower center pyrheliometer for west target.		

		Initial	Date
8.19	BCS software detection of hardware status during BCS runtime.		
8.19.1	Generate a heliostat candidate list from the H.P. console. Construct the list such that three files of 60 heliostats each are generated.		
8.19.2	Initiate BCS processing from the H.P. console by typing key #3 of the H.P. function keys. Answer all prompts using default options.		
8.19.3	Mount candidate list tape on HAC and initiate HAC/BCS software. Verify BCS processing has begun by viewing video monitor.		
8.19.4	With BCS in operation have field personnel located in tower disconnect upper left pyrheliometer from north target. Verify BCS software flags the error to the H.P. console.		
8.19.5	Have field personnel reconnect pyrheliometer. Verify no further errors occur.		
8.19.6	Repeat steps 8.19.4 - 8.19.5 for each pyrheliometer on all four targets.		
8.19.7	Have field personnel disconnect shutters on north target. Verify BCS software flags the error to the H.P. console.		

		Initial	Date
8.19.8	Have field personnel reconnect shutter system. Verify no further errors occur.		
8.19.9	Repeat steps 8.19.7 - 8.19.8 for south, east and west targets.		
8.19.10	Have field personnel disconnect MODACS III cable from I/O port. Verity BCS software flags the MODACS as inoperable.		
8.19.11	Have field personnel reconnect MODACS III I/O cable. Verify no further MODACS errors occur.		
8.19.12	Turn off digitizer in BCS rack located in the equipment room. Verify the BCS software flags the digitizer as inoperable.		
8.19.13	Turn digitizer back on. Verify no further digitizer errors occur.		
8.20	Total system capability of detecting beam on target during low level calibration, no beam on target during high level calibration, power out of range and centroid out of range.		
8.20.1	Using the HAC command "UPBIAS" change the bias of four heliostats in the field such that their beams will not fall on the BCS target during a BCS measurement. Choose one heliostat per target. It is advisable to record the biases of each of the heliostats before using upbias.		

	Initial	Date
8.20.2 From the BCS console command a heliostat candidate list be generated by pressing key #8 of the special function keys. Build a candidate list tape containing the four heliostats with modified biases.		
8.20.3 From H.P. console initiate the BCS system by typing key #3 of the H.P. function keys. Take all default options.		
8.20.4 Mount candidate list tape on HAC and initiate HAC BCS software.		
8.20.5 Verify the following error meassage is alarmed by the HAC for each heliostat. No beam on target for high level calibration. NOTE: The operator should monitor the video monitor to verify a beam does not exist on the BCS target during both low and high level calibration procedures.		
8.20.6 Using HAC command "UPBIAS" return each of the four heliostats used in this test to their original bias points.		
8.20.7 From H.P. console initiate the BCS system by typing key #3 of the H.P. function keys. Take all default options.		

	Initial	Date

8.20.8 From HAC console command one heliostat in each quadrant to track the BCS target.

NOTE: Each target should have a heliostat tracking it. Be certain the tracking heliostats are not the ones in the candidate list.

8.20.9 Mount same candidate list tape as generated in step 8.20.2 on HAC and initiate HAC BCS software.

8.20.10 Verify the following error message is alarmed by the HAC for each heliostat.

Beam on target for low level calibration.

NOTE: The operator should monitor the video monitor to verify a beam is on the target during the low level calibration.

8.20.11 From H.P. console initiate the BCS system by typing key #3 of the H.P. function keys. Change the centroid radius for alarm valve from its default to zero.

8.20.12 Mount same candidate list tape as generated in step 8.20.2 on HAC and initiate HAC BCS software.

8.20.13 Verify for each heliostat the following error message is sent to both the HAC logger and the H.P. console.

Centroid Flag Heliostat #

x centroid =
y centroid =

	Initial	Date
NOTE: The exact format of the message may not be as stated above.		
8.20.14 The following test is contingent upon the appropriate hardware being available to allow the BCS to make accurate power calculations.		

10.0 ATTACHMENTS

Appendix 10.A	BCS software modules and descriptions.
Appendix 10.B	BCS option menu display
Appendix 10.C	Response format for MAXNET remote information format.
Appendix 10.D	Derivation of theoretical beam power.
Appendix 10.E	Camera focus, zoom and alignment procedure
Appendix 10.F	BCS message traffic
Appendix 10.G	Generation of initialized masterfile.
Appendix 10.H	BCS test modules and functions.

Appendix 10.A

BCS003 - Activates BCS Input Executive.

BCSINX - BCS/HAC Input Executive.
- MSG001 - Writes Startup Message to HAC.

BCALLO - BCS Low Level Calibration Function.
- BEAMCHK - Determines if Beam is on Target.
- BEAMON -
- BGRAB - Commands Digitizer to take Image Grab.

BCALHI - BCS High Level Calibration Function.
- BGRAB - Commands Digitizer to take Image Grab.
- BDGTST - Takes Image Grab for High Level Calibration Module.
- BRDPYR - Controls MODACS III Operation.
- NOBEAM - Commands No Beam on Target Message be Sent to HAC.
- EXPCHK - Checks Digitizer to Determine if Camera is Within Exposure Limts.
- EXPOVR - Commands Exposure Over Message Be Sent to H.P.
- BLDCLT - Builds Calibration Table.
- BCURVE - Driver Program for "BCRVFIT" Subroutine.
- BCRVFIT - Performs a Curve Fit of Digital and Pyrheliometer Data.

BMEAS1 - Performs Beam Measurement for South Target.
- TIM1 - Determines Average Time of Measurement.
- BGRAB - Commands Digitizer to take Image Grab.

BMEAS2 - Performs Beam Measurement for West Target.
- TIM2 - Determines Average Time of Measurement.
- BGRAB - Commands Digitizer to take Image Grab.

BMEAS3 - Performs Beam Measurement for East Target.
- TIM3 - Determines Average Time of Measurement.
- BGRAB - Commands Digitizer to take Image Grab.

BMEAS4 - Performs Beam Measurement for North Target.
- TIM4 - Determines Average Time of Measurement.
- BGRAB - Commands Digitizer to take Image Grab.

BGTIM1 - Sets Calibration Necessary Flag for South Target.

BGTIM2 - Sets Calibration Necessary Flag for West Target.

BGTIM3 - Sets Calibration Necessary Flag for East Target.

BGTIM4 - Sets Calibration Necessary Flag for North Target.

BOK - Transmits OCS Permission Flag to H.P.

BHCOUT - BCS/HAC Output Message Processor.

BPT003 - BCS Contour Plotting Function.
- BNORML - Image Normalization Function.
- PLTALL - Plots All Records on a Given File.
- TIMINT - Plots All Records Between a Specified Time Interval.
- INDIVL - Plots Specified Record.
- RITEHP - Writes One Record of Image Data to H.P.
- BMFREC - Finds Record Number of Specified Heliostat.

BHWSTA - BCS Hardware Status Routine.
- SWITCH - Switches Camera to Specified Target.
- BTGRAB -
- BRMARK - Finds Registration Marks on each Target.
- CENT - Determines Centroid of each Registration Mark.
- GETLINE - Get Data From Specified Line in Digitizer.

FINDEM -

FINDC -

BGRAB - Command Digitizer to take Image Grab.

BSE - Sets H.P. Busy Flag.

BMASS - Measurement Assessments Function.

BMPWR - Calculates Theoretical Beam Power.

BMFREC - Finds Record Number of.

BRGEN - Report Generation Function

BTERM - BCS Termination Function.

BGLOBAL - Sets up BCS Global Data Base.

BHILVL - BCS High Level Calibration Function.

BRPYRL - BCS Low Level Calibration Function.

BMFUPD - BCS Master File Update Processor.

BMFREC - Calculates Record Number of Specified.

BHISTR - Historical Data Retrieval Function.

OLHCLG - Off-Line Heliostat Candidate List Generation.

MODTEST - MODACS III Hardware Test Routine.

BSTEP - Steps through BCS Targets.

BHPMSG - H.P. Error Message Processor.

SNDMSG - Sends Message to H.P. Terminal.

JDAT - Calculates Julian Date.

BRF003 - BCS Data Archive Function.

BGM003 - Sends Buffered Messages to H.P.

JDAT - Calculates Julian Date.

RES.1 - Resource Block for MODACS III Routines.

Appendix 10.B BCS Option Menu Display

Key 1 ..... Display Option Menu

Key 3 ..... Initialization

Key 5 ..... Contour Plots

Key 8 ..... Heliostat Candidate List

Key 10 .... Archive Data

Key 12 .... BCS Data Report

Key 14 .... BCS Bias Updates

Appendix 10.C Response Format for MAXNET Remote Information Format.

Appendix 10.D Derivation of Theoretical Beam Power

One of the functions of the BCS is to compare BCS measured beam power against a theoretical beam power. If the difference exceeds a threshold value, an alarm is provided. This memo outlines the requirements for generating the theoretical beam power. The power, P, on the BCS target is:

1) $P = kIA\tau\rho\cos\psi$

where:
- k = Normalization constant
- I = Insolation
- A = Heliostat mirror area
- τ = Atmospheric transmission
- ρ = Mirror specular reflectance
- ψ = Angle between sun vector and mirror surfaces

The normalization constant is a field adjusted factor to allow the measured and theoretical powers to be made equal under idealized conditions (i.e., extremely clear day with a perfectly clean mirror).

Appendix 10.E Camera Focus, Zoom and Alignment

The camera alignment procedure is done in the field using a Cohu Model 2380 Series Remote Control Unit and a standard video monitor. The remote control unit is connected to the back of the camera (see Operating and Maintenance Instructions 2380 Series Remote Controls Manual page 2-2 Figure 2-1). The video monitor can be connected to the back of the remote control unit. Power for the video monitor is available at the camera pedestal. For camera focus, zoom and alignment the following steps should be used.

1) Turn camera and video monitor on.

2) Position camera such that center pyrheliometer is in approximate center of video image.

3) Zoom in on target as close as possible making certain all four registration marks are in view.
Note: Camera aimpoint may need changing as zoom is modified.

4) Focus camera

NOTE: The target image should match as closely as possible Fig. 1.

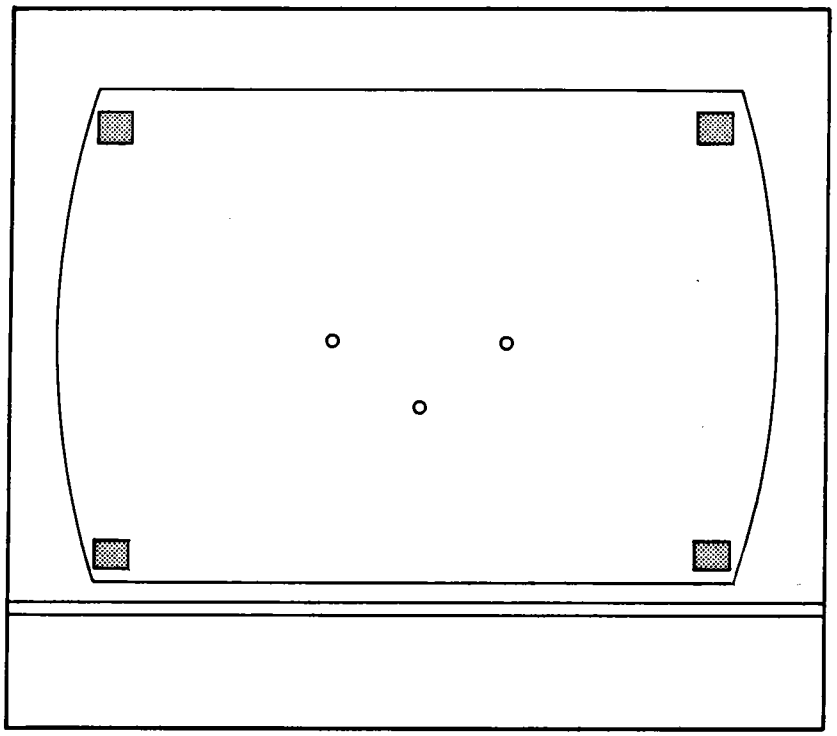


Figure 1

Appendix.F BCS Message Traffic

Message Number	Origination-Destination	Title
BCS-1	HAC-OCS	BCS Initiation Request Message
BCS-2	OCS-HAC	BCS Initiation Response Message
BCS-3	HAC-OCS	BCS Measurement Initiation Request Message
BCS-4	OCS-HAC	BCS Measurement Initiation Response Message
BCS-5	HAC-OCS	Heliostat on BCS Target Message
BSC-6	OCS-HAC	Heliostat BCS Removal Request Message
BCS-8	OCS-HAC	BCS Measurement Results Message
BCS-10	HAC-OCS	BCS Termination Message
BCS-11	HAC-OCS	Hiliostat Measurement Historical Data Request Message
BCS-12	OCS-HAC	Heliostat Measurement Data Response Message
BCS-13	HAC-OCS	Heliostat Bias Results Message

Appendix 10.G Generation of Initialized Masterfile

The following procedure can be used to create a new masterfile.

1. Enter Job Control

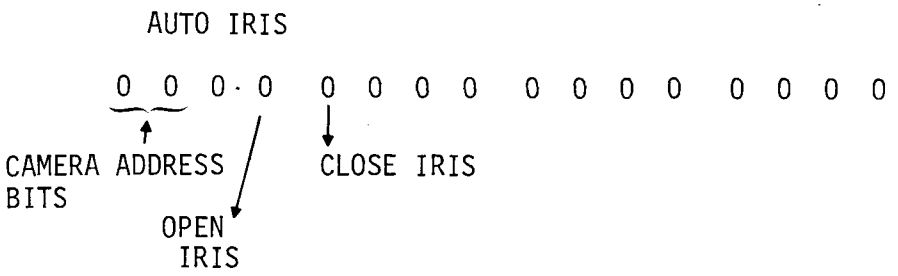
   Type the following commands

1. $EXE TOC
2. ASS 2 CϕT
3. FIL 2
4. Change 500
5. EXI
6. $ SED
7. ASS USL CϕT
8. NOC
9. POS DATA
10. ASS SO ROA
11. REW SO
12. COPY
13. EXI
14. $ ASS 4 ROA 21 MFD
    $ EXEC BMFS

The data file is stored as a source file on the File CϕT of the cartridge disk. Data is stored in MODCOM? Compressed Format. Steps 6 - 13 store the data file in an uncompressed format on file ROA.

Appendix 10.H BCS Test Modules

IOISTS - This routine will output an operator specified code to the 1136 camera switching interface. The operator has the capability of switching to any camera, controlling the Iris manually or controlling the Iris automatically. The following format applies:



Camera Address Bits

South - C000
West - 4000
East - 8000
North - 0000

HILOTST - This test module will write three pixels to the quantex memory. If the quantex is in the "MEM" mode the data will be displayed to the video monitor. The operator can choose the line (1-256), column (1-256) and the value the three pixels will take on.

NOTE: Not all lines and columns are displayed by the video monitor.

SHUTST - This test module executes within the MODACS III. It will receive information from a core device specifying which target system and whether the shutters should be opened or closed. It will then open or close the shutters as specified.

SHUTTER - This test module is the companion module to "SHUTST". It operates within the OCS computer. This module prompts the operator as to which target and whether the shutters should be opened or closed. It then sends this information to MODACS through a core device.

PYRTST - This test module executes within the MODACS III. It will receive information from a core device specifying which target system to operate on. The routine will open the shutters of the specified target and read the pyrheliometers.

PYR - This test module is the companion to PYRTST. It will run within the OCS computer. Its function is to provide a man machine interface to determine which target is desired then relay this information to MODACS through a core device. The routine will then wait for MODACS to complete then read the core device and print the results to the CRT screen.

DIR - This test module provides the capability of looking at any subset of the 64K data array taken by an image grab. It will print all data to the OCS hardcopy device. (OCS-201).

MSGBLD - This test module simulates HAC interface messages. It allows the operator to construct any message he desires and send it to the BCS input executive.

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
ENERGY PROGRAMS
5301 Bolsa Avenue, Huntington Beach, California 92647 (714) 896-3311 Telex: 678426

A3-202-EP-RGR-556
12 October 1981

Department of Energy
San Francisco Operations Office
1333 Broadway
Oakland, California 94612

Attention: Mr. David J. Tenca, Contracting Officer

Subject: CONTRACT DE-AC03-79SF10499
SOLAR FACILITIES DESIGN INTEGRATION
SIXTH PARTIAL SUBMITTAL OF SUBSYSTEM STAND ALONE
(PREOPERATIONAL) TEST PROCEDURES (RADL ITEM 2-45)

References:
(a) MDAC Letter A3-130-EP-DSB-138, dated 3 March 1981, "Revised Delivery Date for Subsystem Stand Alone Test Procedures" (RADL Item 2-45)

(b) MDAC Letter A3-202-EP-RGR-417, dated 17 July 1981, "Partial Submittal of Subsystem Stand Alone (Preoperational) Test Procedures (RADL Item 2-45)

(c) MDAC Letter A3-202-EP-RGR-444, dated 28 July 1981, "Second Partial Submittal of Subsystem Stand Alone (Preoperational) Test Procedures" (RADL Item 2-45)

(d) MDAC Letter A3-202-EP-RGR-494, dated 1 September 1981, "Third Partial Submittal of Subsystem Stand Alone (Preoperational) Test Procedures" (RADL Item 2-45)

(e) MDAC Letter A3-202-EP-RGR-517, dated 15 September 1981, "Fourth Partial Submittal of Subsystem Stand Alone (Preoperational) Test Procedures" (RADL Item 2-45)

(f) MDAC Letter A3-202-EP-RGR-553, dated 5 October 1981, "Fifth Partial Submittal of Subsystem Stand Alone (Preoperational) Test Procedures" (RADL Item 2-45)

Dear Mr. Tenca:

One (1) copy of one of the Preoperational Test Procedures that comprise a portion of the subject RADL item is being submitted in accordance with the requirements of the Phase II Reports and Deliverables List of the subject contract, as modified by the contents of the Reference (a) letter. Previous transmittals were accomplished per the Reference (b), (c), (d), (e), and (f) letters. This letter transmits the following Preoperational Test Procedure:

- 150 Beam Characterization System Revision 0

MCDONNELL DOUGLAS CORPORATION

A3-202-EP-RGR-556
12 October 1981

A copy of this letter also transmits the master copy of the procedure to Southern California Edison (L. H. Chillcott) at the Solar One Site for control and implementation. Any SFDI-oriented revisions to this procedure will be coordinated informally with SCE and subsequently transmitted by letter in the same manner as the subject document.

Additional submittals will be made as other Preoperational Test Procedures become available in Revision 0 versions, and you will be notified when all of the Preoperational Test Procedures that comprise RADL Item 2-45 have been submitted.

Technical questions regarding this procedure should be directed to R. G. Riedesel at (714) 896-3357. For contractual questions, please call the undersigned at (714) 896-1340.

Very truly yours,

D S Butler

D. S. Butler
Contract Administrator
Solar Facilities Design Integration

RGR:bj

Enclosure: as noted

Cy: L. H. Chillcott, SCE-Solar One (1)
J. M. Slaminski, DOE/Daggett (1)
C. W. Lopez, SCE-Solar One (1)
J. J. Bartel, Sandia-Livermore (3)
D. N. Tanner, Sandia-Livermore (1)
R. O. Rogers, Aerospace/STMPO (1)
T. L. Neilsen, Rocketdyne-Daggett (1)
J. M. Friefeld, Rocketdyne (1)
W. R. Lang, Stearns-Roger (1)
J. R. Detweiler, Stearns-Roger-Daggett (1)
R. M. Weeks, MMC-Daggett (3)

(w/o enclosure)
R. N. Schweinberg, DOE/STMPO
J. C. Corcoran, DOE/STMPO
D. W. Christian, DOE/Daggett
A. Maitino, T&B-Daggett
D. L. Williams, Stearns-Roger
H. D. Eden, Aerospace/STMPO
R. W. Wiese, ETEC/STMPO
K. L. Adler, ETEC/STMPO
W. S. Rorke, Sandia-Livermore
J. N. Reeves, SCE
N. J. DeHaven, SCE
C. P. Winarski, SCE
T. E. Olson, SFDI Field Office
F. Kovach, T&B-Daggett