36-01520.017

ACIS Verification Summary Report

Specification:	AXAF Observatory to Science Instrument ICD (IF1-20)
Requirement Number/Title:	3.3.1.1.1.1.8 ACIS DA Thermal Interfaces (VRSD 3.3.1.1.1.1.8)

Requirement Statement: For ACIS cold case analysis, ACIS operating in the viewing position, the SIM translation table I/F temperature shall be assumed to be ≥ -38°C (TBR).

Verification Method:	Validation of Records
Procedure Number:	N.A.
Configuration:	ACIS thermal models
Cycle Time:	N.A.

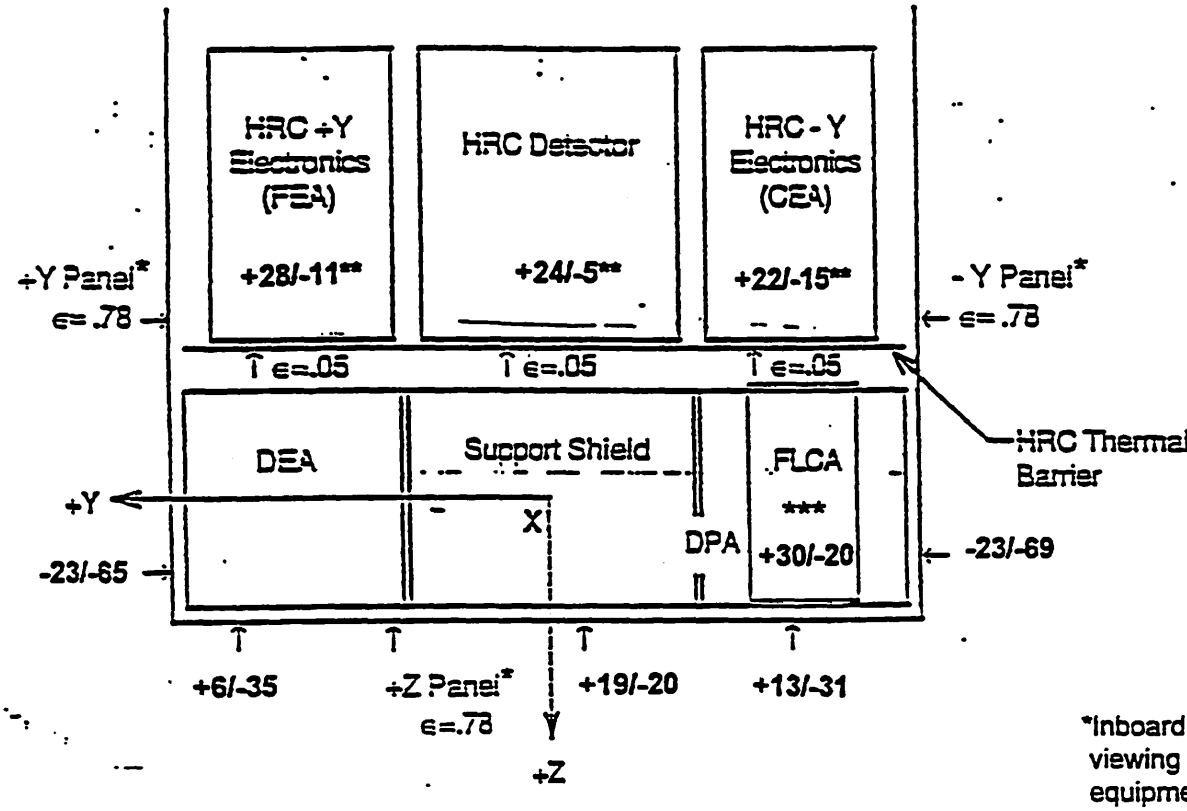
Verification Discussion/Results:

ACIS thermal models assume that the cold case temperature of the SIM translation table is ≥ -40C, per PIRN 20-0030 for the thermal ICD (CM07A). See attached Figure 3.3-1.

Ellen M Ser 5/22/97

ACIS Cognizant Engineer Date

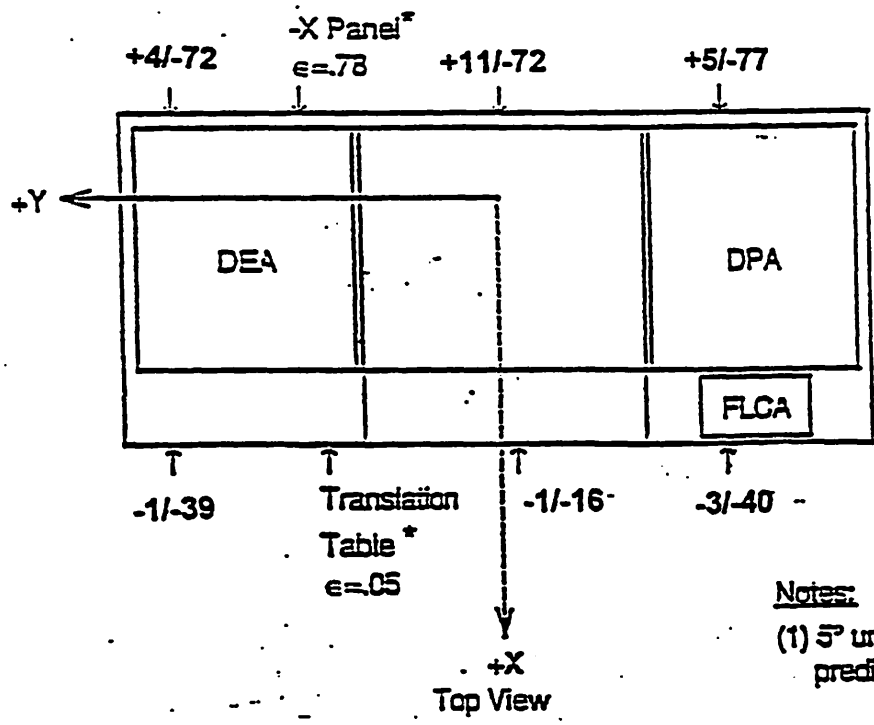
12/3/98 TRW ECP E0109



*Inboard surface viewing SI equipment
**HRC thermal barrier temperature
***FLCA emittance = 0.84 on -X face, 0.78 on +Z & +Y faces, and 0.10 on remaining faces

Hot Case (°C) ACIS Viewing, 180° Sun, 6 ACIS CCDs On

Cold Case (°C) HRC Viewing, 45° Sun, 2 ACIS CCDs On



Notes:

(1) 5° uncertainty included in predicted temperatures shown

Figure 3.3-1: ISIM Hot and Cold Operational Case Boundary Temperatures and IR Emittances for ACIS Detector Cables and ACIS Protron Shield/DPA/DEA Thermal Analysis

ACIS Verification Summary Report

Specification:	AXAF Observatory to Science Instrument ICD (IF1-20)
Requirement Number/Title:	3.3.1.1.1.1.8 ACIS DA Thermal Interfaces (VRSD 3.3.1.1.1.1.8)

Requirement Statement: For ACIS cold case analysis, HRC operating in the viewing position, the SIM translation table I/F temperature shall be assumed to be $\geq$ -53°C.

Verification Method:	**Analysis and Test**

Procedure Number: Verification Report LMA Report # ACIS-500-77-01VR

Configuration:

ACIS Instrument installed in ISIM

Cycle Time:

Verification Discussion/Results:

This is the second submittal for the verification of this requirement. The first submittal did not adequately address the complete verification of requirements.

This requirement was verified by both analyisis and test as documented in the Thermal Control System Thermal Test Report (ACIS-500-77-01VR). For cold case condtions, the SIM I/F was conservatively tested and analysed to be -58°C (See Attachment 1 and 2). This is a more conservative analysis and test since adequate heater sizing is the primary constraint in cold case analysis conditions. The detector housing is controlled to -60°C in normal operating mode and +25°C in bakeout mode with heaters. The analysis and test shows that the heaters have significant margin over that required even at an interface temperature of -58°C. Therefore the requirements of paragraph 3.3.1.1.1.1.8 have been satisfied with a conservative analysis and test.

Neil W. Tice 6/19/97

ACIS Cognizant Engineer Date

3.2.3.2 Test 2 and 2a-Cold Case Operating

Test 2 consisted of setting the boundary conditions to the minimum SIM on-orbit operating temperatures with margins. Test 2a was performed to determine how focal plane temperature varied with focal plane power. The power was set at .25 Watts to simulate the expected CCD dissipation. For this test, the sun and telescope shades were considered quasi-static and acceptable for math model correlations. Math model correlations can still occur since the parasitics to the warm and cold radiators are very small at cold temperatures (i.e. -100°C). In the math model correlations, the actual temperatures are used as boundary conditions in the thermal model. The boundary temperatures are listed in the As-Run Procedure. The transient test data plots for this test have been included in Appendix C. The measured steady state temperatures and math model predictions are shown in table 3.2-3 and 3.2-4 for each thermal measurement location. The model correlates within +/-4°C for all thermocouples and within +/-1°C at critical areas like the focal plane,camera body, and radiators. The average delta for all thermocouples is within +/-0.2°C for both tests. The heater power required to hold the camera body at temperature (-76°C and -60°C respectively) was within 3 percent of the measured data. In summary, the measured data correlated very well with the math model and should be considered acceptable for verification of thermal requirements.

Attachment 1 - Verif. Rpt 36-01520.017A

(2)

Table 3.2-3 Test 2 Predicted and Measured Data

TEST 2	THERMOCOUPLE DESCRIPTION	Predicted (deg. C)	Measured (deg. C)	DELTA (deg. C)
TC1	+Z COLLIMATOR FOOT	-58.12	-58.30	0.18
TC2	+Y COLLIMATOR FOOT	-58.27	-57.60	-0.67
TC3	MECHANSIM ACCESS COVER	-59.28	-61.00	1.72
TC4	ACTUATOR COVER -X	-59.12	-59.60	0.48
TC5	ACTUATOR COVER +X	-59.12	-59.80	0.68
TC6	+Z SIDE OF COLLIMATOR-CENTERED	-59.25	-61.30	2.05
TC11	-Y COLD STRAP FLANGE AT CAMERA	-134.04	-132.50	-1.54
TC12	+Y COLD STRAP FLANGE AT CAMERA	-134.04	-132.70	-1.34
TC13	+Z CAMERA BODY-CENTERED	-62.27	-62.80	0.53
TC14	-Z CAMERA BODY-CENTERED	-60.01	-60.00	-0.01
TC15	-X CAMERA BACK PLATE-CENTERED	-61.17	-62.30	1.13
TC16	SNORKEL TUBE-CENTERED		-63.20	
TC17	SNORKEL TUBE-AT BELLOWS		-65.40	
TC18	LARGE VENT VALVE BODY		-67.80	
TC21	-Y COLD STRAP FLANGE AT RADIATOR	-137.52	-135.60	-1.91
TC22	+Y COLD STRAP FLANGE AT RADIATOR	-137.51	-135.80	-1.71
TC23	+X +Y CORNER OF COLD RADIATOR	-139.96	-137.70	-2.26
TC24	-Y WARM STRAP FLANGE AT RADIATOR	-81.45	-81.30	-0.15
TC25	+Y WARM STRAP FLANGE AT RADIATOR	-81.32	-83.80	2.48
TC26	+X +Y CORNER OF WARM RADIATOR	-93.01	-95.70	2.69
TC31	TELESCOPE SHADE -Y,-X CENTERED	-89.94	-92.90	2.96
TC32	TELESCOPE SHADE-Y,+XCENTERED	-89.42	-84.40	-5.02
TC33	TELESCOPE SHADE +Y,-X CENTERED	-89.95	-86.00	-3.95
TC34	SUN SHADE -Y,+X CENTERED	-118.43	-120.20	1.77
TC35	SUN SHADE -Y,-X CENTERED	-118.46	-116.70	-1.76
TC36	SUN SHADE +Y,+XCENTERED	-118.43	-118.40	-0.03
TC37	+Y SHADE SUPPORT POST-CENTERED	-114.68	-115.20	0.52
TC38	-Y SHADE SUPPORT POST-CENTERED	-114.68	-117.40	2.72
TC41	SIM SIMULATOR NEAR +Z FOOT	-57.50	-57.90	0.40
TC42	SIM SIMULATOR NEAR +Y FOOT	-57.50	-56.80	-0.70
TC43	+Z SIDE OF SUPPORT STRUCT. SIM.	-26.00	-25.50	-0.50
TC44	+Z SIDE OF SUPPORT STRUCT. SIM.	-26.00	-26.10	0.10
TC45	-X SIDE OF SUPPORT STRUCT. SIM.	-26.00	-25.60	-0.40
TC46	TELESCOPE SIMULATOR PLATE	-61.90	-61.90	0.00
TC47	-Y HALF OF +Z PANEL	-30.00	-30.00	0.00
TC48	+Y HALF OF +Z PANEL	-30.00	-29.90	-0.10
TC49	LN2 SHROUD NEAR TCS	-193.00	-192.20	-0.80
HTR1	CAMERA BODY HEATER 1(WATTS)	11.28	11.03	0.25
HTR2	FOCAL PLANE HEATER 2 (WATTS)	0.00	0.00	0.00
HTR3	FOCAL PLANE HEATER 3 (WATTS)	0.00	0.00	0.00
RTD1	RTD 1 ON FOCAL PLANE -Y +Z FOOT	-131.05	-130.10	-0.95
RTD2	RTD 2 ON FOCAL PLANE +Y +Z FOOT	-131.05	-130.20	-0.85
RTD3	RTD 3 ON FOCAL PLANE -Y -Z FOOT	-130.72	-129.60	-1.12
RTD4	RTD 4 ON FOCAL PLANE +Y -Z FOOT	-130.69	-129.50	-1.19
			Average	-0.17

Capability 49 Watts Marg 33.4°

Attachment 1- Verif. Rpt. 36-01520.017A (3)

3.2.3.4 Test 4-Cold Case Bake-out Mode

Test 4 consisted of setting the boundary conditions to the minimum SIM on-orbit operating temperatures with margins. The focal plane heaters and camera body heater were set at the expected bakeout mode dissipations and allowed to control at +30°C and 25°C respectively. For this test, the sun and telescope shades were considered quasi-static and acceptable for math model correlations. Math model correlations can still occur since the parasitics to the warm and cold radiators are very small at cold temperatures (i.e. -100°C). In the math model correlations, the actual temperatures are used as boundary conditions in the thermal model. The boundary temperatures are listed in the As-Run Procedure. The transient test data plots for this test have been included in Appendix E. The measured steady state temperatures and math model predictions are shown in table 3.2-5 for each thermal measurement location. The model correlates within +/-12°C for all thermocouples and within +/-4°C at critical areas like the focal plane,camera body, and radiators. Due to the extreme temperature gradients (i.e. 82°C across the collimator) , absolute temperature predicitions were not considered important as long as predicted power dissipations were close. The thermal model does not have the resolution to accurately predict temperatures for individual thermocouples when large thermal gradients are involved. For example, node sizes on the collimator are 4.3 inches in the X direction whereas a thermocouple can measure down to a .1 inch. Therefore inaccuracies can be expected. Even so, the average delta for all thermocouples is within 1°C for the test so the model still is considered acceptable. The heater power required to hold the camera body at temperature (25°C) was within 4 percent of the measured data. The heater power required to hold the focal plane at temperature (30°C) was within 5 percent of the measured data. In summary, the measured data correlated very well with the math model and should be considered acceptable for verification of thermal requirements.

Table 3.2-4 Test 4 Predicted and Measured Data

TEST 4	THERMOCOUPLE DESCRIPTION	Predicted (deg. C)	Measured (deg. C)	DELTA (deg. C)
TC1	+Z COLLIMATOR FOOT	-41.84	-43.40	1.56
TC2	+Y COLLIMATOR FOOT	-37.93	-44.50	6.57
TC3	MECHANSIM ACCESS COVER	-16.25	-8.70	-7.55
TC4	ACTUATOR COVER -X	-17.71	-19.00	1.29
TC5	ACTUATOR COVER +X	-17.71	-19.00	1.29
TC6	+Z SIDE OF COLLIMATOR-CENTERED	-16.69	-4.80	-11.89
TC11	-Y COLD STRAP FLANGE AT CAMERA	-5.30	-4.10	-1.20
TC12	+Y COLD STRAP FLANGE AT CAMERA	-5.14	-5.00	-0.14
TC13	+Z CAMERA BODY-CENTERED	20.43	17.90	2.53
TC14	-Z CAMERA BODY-CENTERED	24.97	25.00	-0.03
TC15	-X CAMERA BACK PLATE-CENTERED	22.78	19.80	2.98
TC16	SNORKEL TUBE-CENTERED		-9.40	
TC17	SNORKEL TUBE-AT BELLOWS		-36.30	
TC18	LARGE VENT VALVE BODY		-66.60	
TC21	-Y COLD STRAP FLANGE AT RADIATOR	-43.56	-47.00	3.44
TC22	+Y COLD STRAP FLANGE AT RADIATOR	-43.55	-48.50	4.95
TC23	+X +Y CORNER OF COLD RADIATOR	-63.07	-69.90	6.83
TC24	-Y WARM STRAP FLANGE AT RADIATOR	-26.40	-28.20	1.80
TC25	+Y WARM STRAP FLANGE AT RADIATOR	-26.17	-34.30	8.13
TC26	+X +Y CORNER OF WARM RADIATOR	-53.89	-61.40	7.51
TC31	TELESCOPE SHADE -Y,-X CENTERED	-84.94	-89.90	4.96
TC32	TELESCOPE SHADE-Y,+XCENTERED	-84.48	-80.30	-4.18
TC33	TELESCOPE SHADE +Y,-X CENTERED	-84.95	-81.10	-3.85
TC34	SUN SHADE -Y,+X CENTERED	-119.60	-122.40	2.80
TC35	SUN SHADE -Y,-X CENTERED	-119.63	-119.60	-0.03
TC36	SUN SHADE +Y,+XCENTERED	-119.61	-119.60	-0.01
TC37	+Y SHADE SUPPORT POST-CENTERED	-111.24	-108.40	-2.84
TC38	-Y SHADE SUPPORT POST-CENTERED	-111.24	-111.60	0.36
TC41	SIM SIMULATOR NEAR +Z FOOT	-57.00	-57.10	0.10
TC42	SIM SIMULATOR NEAR +Y FOOT	-57.00	-55.90	-1.10
TC43	+Z SIDE OF SUPPORT STRUCT. SIM.	-26.00	-25.80	-0.20
TC44	+Z SIDE OF SUPPORT STRUCT. SIM.	-26.00	-26.60	0.60
TC45	-X SIDE OF SUPPORT STRUCT. SIM.	-26.00	-25.70	-0.30
TC46	TELESCOPE SIMULATOR PLATE	-17.70	-17.70	0.00
TC47	-Y HALF OF +Z PANEL	-29.35	-29.20	-0.15
TC48	+Y HALF OF +Z PANEL	-29.35	-29.50	0.15
TC49	LN2 SHROUD NEAR TCS	-193.00	-190.60	-2.40
HTR1	CAMERA BODY HEATER 1(WATTS)	29.08	30.33	-1.25
HTR2	FOCAL PLANE HEATER 2 (WATTS)	4.37	4.60	-0.23
HTR3	FOCAL PLANE HEATER 3 (WATTS)	15.83	16.66	-0.82
RTD1	RTD 1 ON FOCAL PLANE -Y +Z FOOT	31.56	29.30	2.26
RTD2	RTD 2 ON FOCAL PLANE +Y +Z FOOT	31.69	30.00	1.69
RTD3	RTD 3 ON FOCAL PLANE -Y -Z FOOT	34.89	31.10	3.79
RTD4	RTD 4 ON FOCAL PLANE +Y -Z FOOT	34.89	30.70	4.19
			Average	0.89

Capability 49 Watts

Margin 62%

Attachment 2 - Verif. Rpt 36-01520.017A (5)

AXAF-I Verification Requirement Compliance Data Submittal

Element: ICD/ACIS

Requirement Number: 3.3.1.1.1.8

Verification Item: 3.3.1.1.1.8

Evaluators: THRM

Type of Review:
- ☐ Verification Item Closure
- ☒ Requirement Closure

Requirement Title: Thermal Analysis Constraint

Compliance Data/Location: MA-130/36-01520.017/Rm 522 Bldg 4200 (MIT Closure Report)

Verification Method: Validation of Records

Comments:
This requirement is outdated. The current BASD thermal analyses is not in agreement with latest ICD numbers. The current numbers are higher (more benign) than ICD numbers. This requirement is approved with this knowledge. It is not worth updating ICD, but MIT/LMAC response should address correct requirement and respond accordingly.

6/23/97 – Second submittal by LMAC states that detector assembly hardware was tested and analyzed to -58C. Changed recommendation to Approved based on Revision A submittal of 36-01520.017.

Status: Open 5/30/97 due 6/27/97

Recommendation:
- ☒ Approve
- ☐ Disapprove
- ☐ Other (Explain)

Action Required for Closure: Based on 36-01520.017 Revision A

MSFC Evaluator:	Date:	Organization:	Phone Number:
John Sharp	6/23/97	NASA/MSFC/ED83	205-544-5156

Disposition:
- ☒ Approve
- ☐ Disapprove
- ☒ Other (Explain)

Action Required for Closure: I agree. However, we should update the ICD.

Chief Engineer:	Date:
Anthony R. Lavoie	6/25/97