

**ECLSS TEAM PRESENTATION
NEW GROUND COOLANT SYSTEM
PAD A & B**

**PREPARED BY
LOCKHEED SPACE OPERATIONS COMPANY**

SEPTEMBER 1991

AGENDA

- I. Introduction briefing by M. Katz/C. Walker
- II. Operational demonstration of activated ground coolant system
- III. Post discussion of operational demonstration and extended development of ground coolant system for Pad application
- IV. Pad/MLP field inspection
- V. Team evaluation of pad options

LTR

REVISIONS DESCRIPTION

LTR

REVISIONS DESCRIPTION

F INC 1RN 0203 & 0209
H INC 1RN 0238 & 0256

NOTES:

- 1 MINIMUM TO MAINTAIN 10,000 LB/HR FLOW AT 128,000 BTU/HR HEAT LOAD WITHOUT TWO PHASE FLOW. PRESSURE WILL RISE WITH INCREASED S70-0508 RESERVOIR BACK-PRESSURE.
- 2 BOTH POTABLE WATER AND WASTE WATER TANKS CAN BE PRESSURIZED SEPARATELY BY PRESSURIZING THIS INTERFACE.
- 3 DISINFECTANT AGENT FOR POTABLE WASTE WATER SYSTEM IS IODINE.
- 4 MOISTURE CONTENT 37 GRAINS/LB D.A. (40° D.P. MAX.).
- 5 CLEANLINESS CLASS 100,000 PER FED SPEC 209.
- 6 FLOW RATE LIMITED, PRESSURIZATION OR DEPRESSURIZATION, SUCH THAT TANK TEMPERATURE TRANSDUCER DOES NOT EXCEED +175°F DURING PRESSURIZATION OR -55°F DURING DEPRESSURIZATION.
- 7 6 TANKS, FLIGHTS 1 & 2, 990 LBS. TOTAL QUANTITY.
4 TANKS, SUBSEQUENT 4 FLIGHTS 660 LBS. TOTAL QUANTITY.
3 TANKS, OPERATIONAL, 495 LBS. TOTAL QUANTITY.
- 8 CONTROLLED TEMPERATURE WITHIN RANGE TO ±3°F.
- 9 CONTINGENCY ONLY KSC AND VAFB.
- 10 ORBITER 102 ONLY (CONTINGENCY).
- 11 HYDROCARBON CONTENT: 44PPM AS METHANE EQUIVALENT MAXIMUM.
12. (DELETED)
13. (DELETED)
- 14 LIQUID TO GAS DIFFERENTIAL PRESSURE NOT TO EXCEED THIS LIMIT.
- 15 DIFFERENTIAL PRESSURE ACROSS THE BELLOWS FROM GAS SIDE TO LIQUID SIDE SHALL NOT EXCEED 33 PSID NOR 65 PSID FROM LIQUID SIDE TO GAS SIDE.
- 16 DIFFERENTIAL PRESSURE ACROSS THE BELLOWS FROM GAS SIDE TO LIQUID SIDE SHALL NOT EXCEED 100 PSID NOR 15 PSID FROM LIQUID SIDE TO GAS SIDE
- 17 EFFECTIVITY TBD.

TABLE 4.2-6
SHEET 1 of 19ENVIRONMENTAL CONTROL AND
LIFE SUPPORT SYSTEM

INTERFACE CONTROL DOCUMENT

ICD NO.	REV	SHEET
ICD-2-1A002	J	388

LTR	REVISIONS DESCRIPTION	LTR	REVISIONS DESCRIPTION
		F	INC IRN 0203 & 0209
		G	INC IRN 0225
		H	INC IRN 0238, 0240, 0252, 0256, 0259, 0261, 0272, 0275, 0286 & 0300
18	REF DES (90V61TP047-A) IS FOR ICD IDENTIFICATION ONLY AND DOES NOT APPEAR ON ORB COMPONENT.		
19	REF DES (90V61TP046-A) IS FOR ICD IDENTIFICATION ONLY AND DOES NOT APPEAR ON ORB COMPONENT.		
20.	(DELETED)		
21.	(DELETED)		
22.	(DELETED)		
23.	(DELETED)		
24	STS-2 & SUBS		
25	REFRIGERANT R-114		
26	STS-3 & SUBS		
27	CONTINGENCY OPTION		
28	STS-4 & SUBS		
29	LIHIT & P ACROSS TANK BELLOWS TO 10 PSID MAX.		
30	INITIAL CRACK 4.0 MAX.		
31	STS-5 & SUBS		
32	STS-21 & SUBS		
33	STS-IV & SUBS		

TABLE 4.2-6
SHEET 2 of 19

ENVIRONMENTAL CONTROL AND
LIFE SUPPORT SYSTEM

INTERFACE CONTROL DOCUMENT

ICD NO.	REV	SILFT
ICD-2-1A002	J	389

LTR		REVISIONS DESCRIPTION										LTR		REVISIONS DESCRIPTION									
C		INC IRN 0239										A		INC IRN 0001, 0007, 0017, 0025 & 0027									
H		INC IRN 0238 & 0252										C		INC IRN 0050, 0060, 0073, 0081, 0125 & 0129									
												D		INC IRN 0148 & 0156									
												E		INC IRN 0191 & 0197									
												F		INC IRN 0203 & 0209									

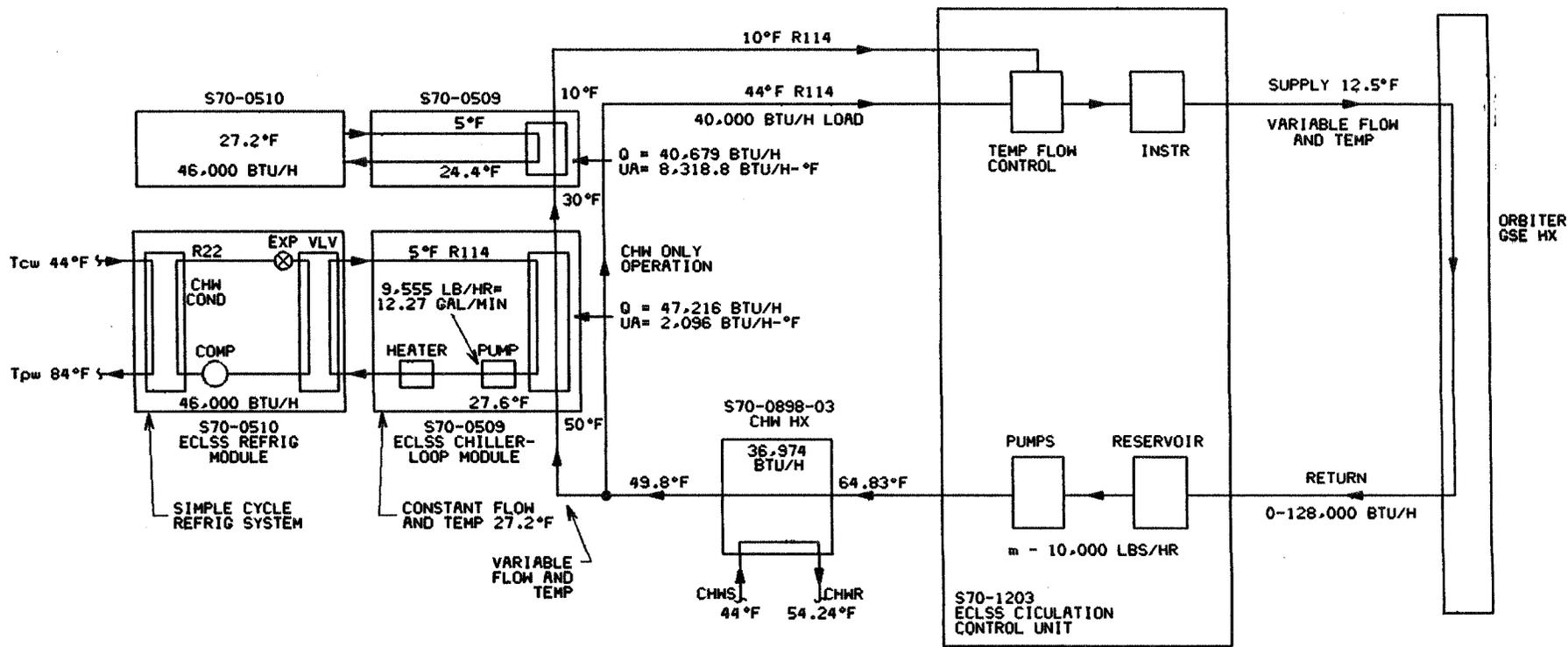
LINE NO.	INTFC NO.	FIG. NO.	REF DES	SOURCE DES	FLOW DIR	FLOW RATE LBS/MIN	MEDIA	PRESS PSIG	LIMIT PRESS PSIG	TEMP °F	TOTAL QTY	FUNCTIONAL OPERATION	REMARKS	ID LT
20	0-2	3.2-2	50V63 PD001	S70-0508	TO	10,000 LB/HR	GN ₂ GHe	110	250	12.5 TO 60	CIRC	PRIMARY GSE COOLANT SUPPLY TO ORBITER/GSE HEAT EXCHANGER	1 26	A
20	0-2	3.2-2	50V63 PD001	C70-0743	TO	0-25 LB/HR	GN ₂ GHe	25-65	250	AMB	5 LBS	CHECKOUT OF ORBITER LINE 21 QD/RV		B
20	0-2	3.2-2	50V63 PD001	C70-0743	TO	N/A	He/ GN ₂	230-250	275	AMB	0.5	LEAK CHECK OF PRIMARY GSE COOLANT SUPPLY TO ORB/GSE HX	9	C
20	0-2	3.2-2	50V63 PD001	C70-0743	TO	N/A	GN ₂	313-333	360	AMB	0.5	OVERPRESSURE OF PRIMARY GSE COOLANT SUPPLY TO ORB/GSE HX		D
21	0-2	3.2-2	50V63 PD002	S70-0508	FROM	10,000 LB/HR	GN ₂	157	N/A	30 TO 100	CIRC	PRIMARY GSE COOLANT RETURN FROM ORBITER/GSE HEAT EXCHANGER	1 26	E
21	0-2	3.2-2	50V63 PD002	C70-0743	TO	0-25 LB/HR	GN ₂ GHe	25-65	250	AMB	5 LBS	CHECKOUT OF ORBITER LINE 20 QD/RV		F
21	0-2	3.2-2	50V63 PD002	C70-0743	FROM	N/A	He/ GN ₂	230-250	275	AMB	0.5	LEAK CHECK OF PRIMARY COOLANT RETURN FROM ORB/GSE HX	9	G
21	0-2	3.2-2	50V63 PD002	C70-0743	FROM	N/A	GN ₂	313-333	360	AMB	0.5	OVERPRESSURE OF PRIMARY GSE COOLANT RETURN FROM ORB/GSE HX		H
22	0-2	3.2-2	50V63 PD003	S70-0508	TO	10,000 LB/HR	GN ₂	110	250	12.5 TO 60	CIRC	SECONDARY GSE COOLANT SUPPLY TO ORBITER/GSE HEAT EXCHANGER	1 10 26	J
22	0-2	3.2-2	50V63 PD003	C70-0743	TO	0-25 LB/HR	GN ₂ GHe	25-65	250	AMB	5 LBS	CHECKOUT OF ORBITER LINE 23 QD/RV	10	K
22	0-2	3.2-2	50V63 PD003	C70-0743	TO	N/A	He/ GN ₂	230-250	275	AMB	0.5	LEAK CHECK OF SECONDARY GSE COOLANT SUPPLY TO ORB/GSE HX	9	L
22	0-2	3.2-2	50V63 PD003	C70-0743	TO	N/A	GN ₂	313-333	360	AMB	0.5	OVERPRESSURE OF SECONDARY GSE COOLANT SUPPLY TO ORB/GSE HX		M

TABLE 4.2-6
SHEET 3 of 19

ENVIRONMENTAL CONTROL AND
LIFE SUPPORT SYSTEM

INTERFACE CONTROL DOCUMENT

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OPF HB-3 GROUND COOLANT SYSTEM
FROM CONCEPT TO START-UP

- Testing of the new ground coolant system substantiated that all of the design concepts are correct.
- Testing also revealed component concern in subsystem areas.

DESIGN CONCERNS

1. Retention of key team personnel required to complete the project effort within a reasonable schedule; i.e., letter from Jim Phillips dated 9-14-90.
2. Refrigeration components to sustain low temperatures at high heat loads for an extended period of time.
 - a. Additional evaluation and/or corrective action will be implemented as follows:
 - Refine S70-0509/S70-0510 operating parameters
 - System expansion valve
 - Chiller
 - Compressor
 - b. Enhance system response time.
3. Pump capability - eliminate high pressure drop generators within the primary loop, discovered during system evaluation.

National Aeronautics and
Space Administration

John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

SEP 19 1990

NASA

Mike,

Thanks for your contribution to
making GSDE known as a center
of excellence.



SEP 18 1990

Reply to Attn of

DE-PMO-4

Lockheed Space Operations Company
Attn: Mr. D. W. Patterson
Code: LSO-383
Kennedy Space Center, FL 32899

SUBJECT: Letter of Commendation

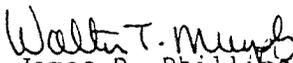
I would like to express my appreciation and commend the LSOC OPF HB-3 ECLSS Ground Coolant Unit design team for an exemplary team effort. The following personnel displayed an outstanding knowledge in carrying out their individual responsibilities with respect to the completion of the design from requirements definition through PDR and CDR.

Mike Hadley	Fred Wallace
Mike Katz	Bill Heil
David Armstrong	Monzy Mathews
Jeff Lagemann	Charles Walker
Dan Moser	Harlan May
Doug Robinson	

The CDR was completed ahead of schedule with a minimal number of RID's submitted and with no outstanding issues or concerns.

Because of the nature of this design and subsequent implementation packages, i.e., integration of multiple modules, it is of the utmost importance that the necessary elements of this team follow the system implementation through validation.

Please convey my sincere appreciation to the OPF HB-3 ECLSS Coolant Unit Team Members for a job well done.


James D. Phillips
for Director of Engineering Development

cc:
LSO-178/H. Lamberth
LSO-042/W. Cowart
LSO-454/K. Geiler
LSO-163/J. Weaver

**COST COMPARISON
GROUND COOLANT SYSTEM (509/510)**

<u>REQUIREMENT</u>	<u>PAD's A & B</u>	<u>MLP's 1-2-3</u>	<u>REMARKS</u>
GSE (Equip)	2,800,000	4,500,000	Equipment must be further sectionalized to fit restricted access ways within MLPs.
Spare/repair parts	413,576	417,427	Includes \$400,000 for LRU (509/510)
Design:			
GSE/Inst.	73,260	91,740	
CCS	7,920	15,840	
Enclosure (Bldg.)	42,240	-0-	Recent Design (80K54209)
FPC:			
GSE/Inst.	300,000	450,000	GSE Interconnect
Utilities/HVAC	411,922	617,883	Non-Collateral Equipment (GSE cooling and 60 hz power)
Enclosure (C of F)	573,728	-0-	Structure, Facility Elect., Fire Protection Sys.
SIES	31,680	36,960	Supervision, inspection & engineering services
CCS (SPC)	16,560	934,500	HIMs and Patch Racks needed for MLPs
Charge/validate (SPC)	91,600	137,400	600 MHs/\$26,000 freon per system
Escalation	139,605	-0-	Escalated 1 year (FY '93-'94) 2% on GSE and spares, 5% on remaining (Enclosure design not escalated)
*Total (Imp.)	\$4,902,091	\$7,201,750	Does not include SPC procurement burden, G&A, and fee
*Division of Imp. funds			
WBS 1.0	4,307,925	7,201,750	
WBS 3.0	594,166	-0-	Collateral equipment installed at pads

THIS COST ESTIMATE IS PROVIDED FOR PLANNING/INFORMATION PURPOSES ONLY, AND DOES NOT CONSTITUTE COST AND PRICING DATA AND IS NOT INTENDED TO BE A BASIS FOR NEGOTIATING BETWEEN LSOC AND NASA. IT IS NOT AN OFFER TO PERFORM THE SUBJECT WORK, BUT REPRESENTS AN ESTIMATE BASED ON OUR CURRENT UNDERSTANDING OF THE TASK.

**COST COMPARISON
GROUND COOLANT SYSTEM (509/510)**

<u>REQUIREMENT</u>	<u>PAD's A & B</u>	<u>MLP's 1-2-3</u>	<u>REMARKS</u>
Implementation	4,902,091	7,201,750	
Maintenance	3,473,551	5,210,328	Over 20 years See maintenance schedule
GSE replacement	4,160,653	6,686,763	After 20 years See replacement schedule
Total (Life cycle)	\$12,536,295	19,098,841	

Note: Projected costs are based on OPF-3 actuals, a C-90 cost estimate on 80K54209, and engineering assessments/ROMs.

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**GSE REPLACEMENT SCHEDULE
GROUND COOLANT SYSTEM (509/510)**

		<u>MLPs 1-2-3</u>	<u>PADs A&B</u>
(Purchase price) Year	1	4,500,000	2,800,000
	2	4,590,000	2,856,000
	3	4,681,800	2,913,120
	4	4,775,436	2,971,382
	5	4,870,945	3,030,810
	6	4,968,364	3,091,426
	7	5,067,731	3,153,255
	8	5,169,086	3,216,320
	9	5,272,467	3,280,646
	10	5,377,917	3,346,259
	11	5,485,475	3,413,184
	12	5,595,184	3,481,448
	13	5,707,088	3,551,077
	14	5,821,230	3,622,099
	15	5,937,654	3,694,541
	16	6,056,408	3,768,431
	17	6,177,536	3,843,800
	18	6,301,086	3,920,676
	19	6,427,108	3,999,089
	20	6,555,650	4,079,071
(Replacement cost)	21	6,686,763	4,160,653

Projected life expectancy of equipment is 20 years. Replacement cost calculated with 2% escalation, compounded annually.

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**GSE MAINTENANCE SCHEDULE
GROUND COOLANT SYSTEM (509/510)**

		<u>MLPs 1-2-3 (3 sys)</u>	<u>PADs A&B (2 sys.)</u>	<u>Exist. 508s (2 sys.)</u>
Year	1	214,440	142,960	285,920
	2	218,729	145,819	
	3	223,103	148,736	
	4	227,565	151,710	
	5	232,117	154,745	
	6	236,759	157,839	
	7	241,494	160,996	
	8	246,324	164,216	
	9	251,251	167,500	
	10	256,276	170,850	
	11	261,401	174,267	
	12	266,629	177,753	
	13	271,962	181,308	
	14	277,401	184,934	
	15	282,949	188,633	
	16	288,608	192,405	
	17	294,380	196,253	
	18	300,268	200,179	
	19	306,273	204,182	
	20	312,399	208,266	
		5,210,328	3,473,551	285,920

Estimated current maintenance per 508 unit is 3120 MHs (\$102,960) labor and \$40,000 material per year. New generation GSE (509/510) first year maintenance derived based on 50% saving over 508s. Maintenance on new buildings at the pads considered offset by greater restraints on MLP accessibility (stacking) and confined working space within MLP. Escalation at 2% per year, compounded annually.

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ECLSS TEAM RECOMMENDATIONS

- Perform further testing
- Utilize HB-3 system for pad developmental purposes
- Fabricate upgraded GSE for implementation on pad surface. (New system support building)