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Nationaal Lucht- en Ruimtevaartlaboratorium

National Aerospace Laboratory NLR

AMS Tracker Thermal Control Subsystem

QM/FM condenser He leak & proof pressure test procedure

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Document change log

Change Ref.	*Section(s)*	*Issue draft*
-	All	Initial issue

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Summary

This document describes the Helium leak test and proof pressure test for the QM&FM TTCS condenser tubes and the QM&FM TTCS condenser assembly. The document includes procedure sheets to be filled in during testing.

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1 Scope of the document

The procedure describes the QM & FM condenser Helium leak test and proof pressure test on single condenser tubes and condenser assembly. In the overall manufacture sequence the bold indicates the step in which these procedure has to be applied. In case a brazing manifold test sample has to performed helium leak test and proof pressure test, please refer to "AMSTR-NLR-PR-002-v.2.0-Condenser tube He leak procedure" and the "addendum: Proof pressure test procedure for brazed manifold samples."

Overall QM /FM Condenser Manufacturing sequence

1. Bend individual tubes
2. Label tube
3. **He leak test for individual tubes AMSTR-NLR-PR-040**
4. Cut tubes to exact length according to the cutting procedure AMSTR-NLR-PR-008-v.2. QM/FM condenser He leak &proof pressure test procedure
    a. Avoid chips entering the tubes during cutting
5. Clean tubes inside & outside and seal the end: AMSTR_NLR-039
6. Manufacture brazing plates
7. Apply stop off agent on brazing component AMSTR-NLR-041
8. Manufacture bottom, top plates and strain relieves in AL 2024 T351
9. Convert to AL 2024 T851 (worksheet by AIDC)
10. Manufacture manifold parts and filters
11. Clean manifold parts and filter AMSTR-NLR-039 (to be approved)
12. Perform nickel plating on tubes side to be brazed according to AMS 2403L
13. Spot weld condenser tubes to manifold and apply solder around tubes
14. Braze tubes and manifolds AMSTR_NLR-041
15. **He leak test on condenser tubing lay-out AMSTR-NLR -040**
16. He leak test on manifold test sample AMSTR-NLR-004 issue 04
17. Proof pressure test and burst pressure test on manifold test sample up to 2.5 MDP = 2.5 * 160 = 400 bar per AMSTR-NLR -004 Iss04
18. **Proof pressure test up to 1.5 MDP = 1.5 * 160 = 240 bar AMSTR-NLR -040**
19. **He leak on condenser tubing lay-out AMSTR-NLR –PR 040**
20. He leak on manifold test sample AMSTR-NLR –PR 004 issue 04

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21. Install nutplates on top plate
22. Surface treatment of condenser plates and tube before gluing AMSTR-NLR-PR -38
23. Glue the condenser tubes to the base plate AMSTR-NLR-PR-38
24. Glue the top plate to the bottom plate and glue strain reliefs; AMSTR-NLR-PR-
25. Glue foil heaters on top plate; AMSTR-NLR-PR-38
26. Clean outside tubes, manifold and condenser plates according to : AMSTR-NLR-PR.039 (to be approved)
27. Apply wire heater according to AMSTR-NLR-PR-043
28. Do a mass check/measurement on the condenser and condenser bolts
29. Fix condenser with bolts to transport jig AMSTR-AIDC-PR-023 (to be written)
30. Perform an outgoing inspection (visual and electrical) according to AMSTR-NLR-PR-47 (to be written)
31. Perform thermal cycling test according TTCS-SYSU-TEMP-001 (to be written): only for QM
32. Apply TS according to AMSTR-NLR-PR-49 (to be written) only for FM
33. Integrate the condenser to radiator according to AMSTR-NLR-PR-48

2 References documents

	Title	Number	Date
RD-1	TTCS Leak rate	AMSTR-NLR-TN-046-Issue 1.0	April 2006
RD-2	Proof pressure test procedure for brazed manifold samples	AMSTR-NLR-PR-040-issue 1.0	June 2008
RD-3	Helium leak test procedure EM condenser tubes and condenser assembly	AMSTR-NLR-PR-002-issue 2.0	May 2007

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3 Helium leak and proof pressure test description

3.1 Helium leak test

The vacuum method is the most sensitive leak detection technique.
Two sub methods can be distinguished. Only the "Helium outside -vacuum inside" method is described here.

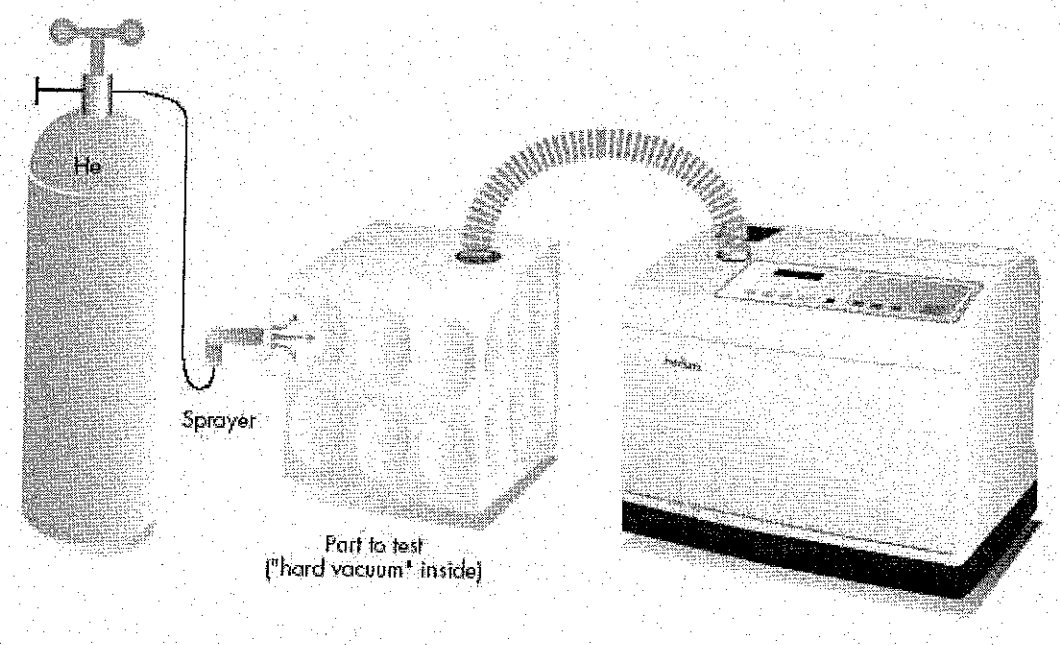

Figure 1. ***He leaktest, vacuum method***

When this method is applied the object to be examined for leaks is evacuated and sprayed from the outside with a search gas, helium. The side which is placed under vacuum is connected to the leak detector. The gas enters through any leaks present in the object and is detected by a sensor connected to the leak test instrument. Quantitative overall leak measurements can be performed by covering the test item with a bag and saturate the inside with helium.
Excessive use of helium shall be avoided as it will increase the detector's background detection level (decrease its leak test sensitivity). The helium that leaks into the test item is monitored and should be less than the required value.
State of the art helium leak rate testers can measure leak rates in the order of 1*10-10 mbar.l/s, however one should keep in mind that this value is often very difficult to obtain in practical situations. Very little helium contamination already can disturb the background detection level.

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The limit for this TTCS component required from RD-1 document is 1x10-9 mbar.l/s.
Owing to the AIDC equipment measuring the He leak in atm·cc/s, the following unit conversion can be used:

1 atm·cc/s = 1,03 mbar·l/s

The equipment used of this QM and FM was changed compared to the EM because of the oil sealed pump in the leak detector :for the QM and FM condenser any oil contamination needs to be avoided. For that reason an oil-free pump (see spec.) was used to replace the oil-seled pump in the He leak tester.

Dry running vacuum pump for cleanliness – no oil costs, no oil changes, no oil disposal
Speed 12.5 m^3h^{-1} at 50Hz, **15 m^3h^{-1} at 60Hz** (約 8.83 CFM, 250 L/Min, 250000 cm^3/min)
Ultimate vacuum <1.6 x 10^{-2} mbar
Ideal for all clean processes

Displacement (swept volume)	
50 Hz	15 m^3h^{-1} / 8.8 ft^3min^{-1}
60 Hz	18 m^3h^{-1} / 10.6 ft^3min^{-1}
Peak pumping speed	
50 Hz	12.5 m^3h^{-1} / 7.3 ft^3min^{-1}
60 Hz (CFM)	15 m^3h-1 / 8.8 ft^3min-1
Ultimate vacuum (total pressure)	1.6 x 10^{-2} mbar / 1 x 10^{-2} Torr
Inlet connection	NW25
Outlet connection	NW16
Motor power	0.4 kW
Electrical supply, 1-phase	
50 Hz	200 / 230 V
60 Hz	110 / 115 V
Enclosure rating	IP44
Operating temperature range	5 to 40 °C / 41 to 104 °F
Weight	25 kg / 55 lbs
Noise level at ultimate (at 1 metre)	58 dB(A)
Vibration	1.5 mms^{-1}
Leak tightness (static)	10^{-4} mbar I s^{-1}.

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3.2 Proof pressure test

The proof pressure test will be performed using a NSU (Nitrogen service unit) with gas and liquid N2. The pump inside the NSU is oil-free pump avoiding oil contaminations on the condenser tubes while testing.

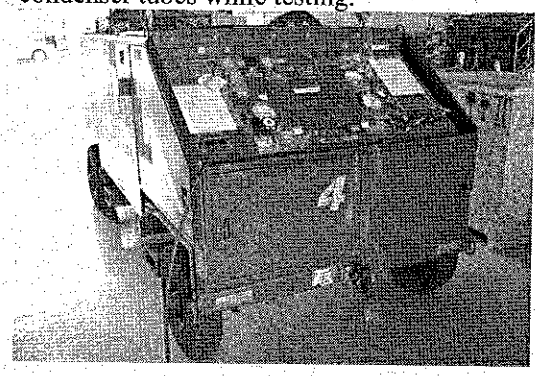

Figure 2. Nitrogen service unit available in AIDC facility

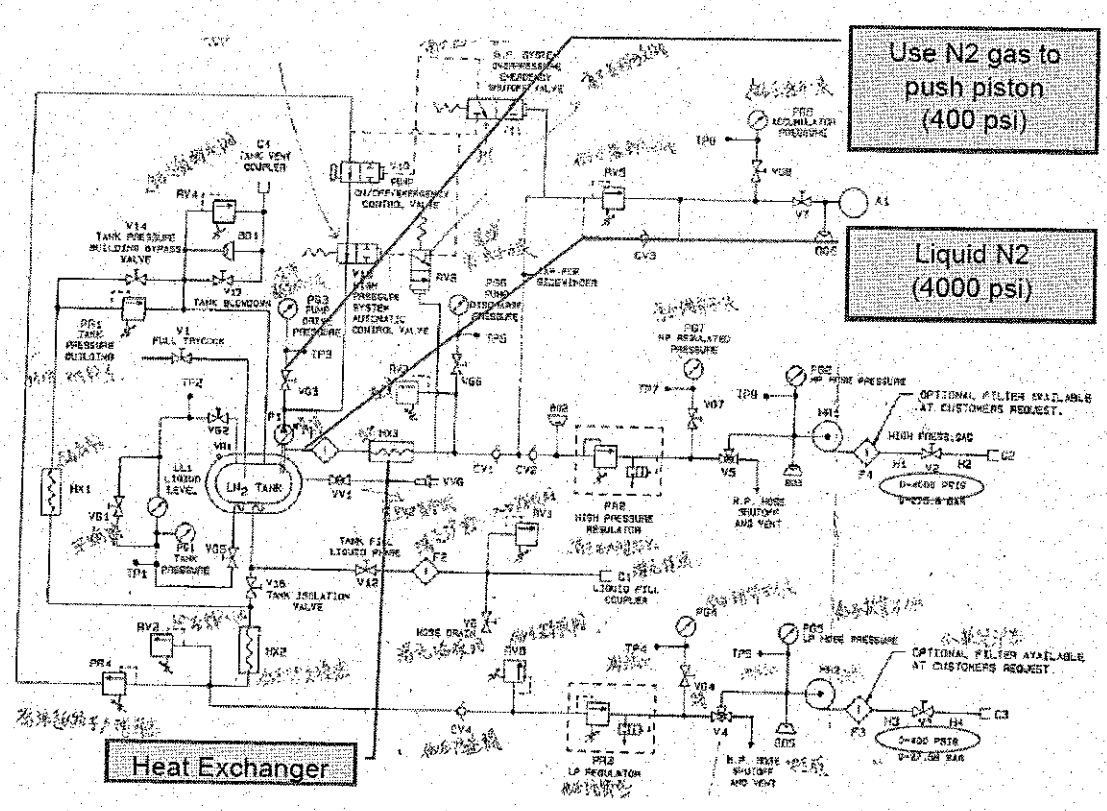

Figure 3. Schematic of the Nitrogen service unit

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4 Helium leak test procedure sheets

The helium leak test procedure sheets shall be filled in, and shall accompany the condenser during it's lifetime in order to be able to show the procedure was followed.
Each condenser consists of 7 Inconel tubes with a different bending lay-out and finally will consist of an integrated tube system combining the tube ends into two manifolds (one inlet and one outlet).

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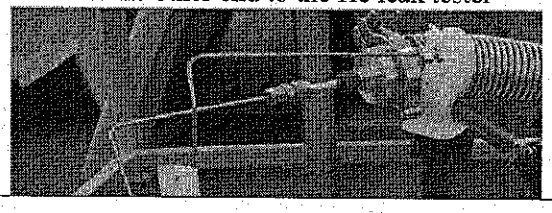
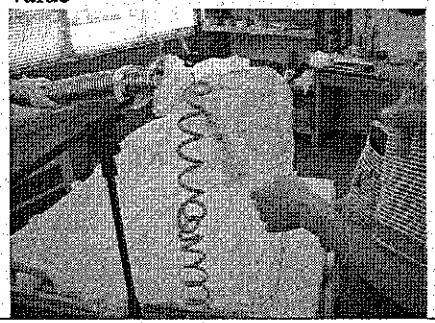
4.1.1 Helium leak test procedure sheet for individual TTCS condenser tubes

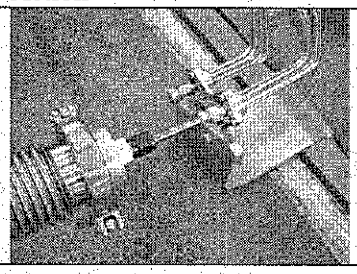
	Fill in by hand		engineer:		location: date:	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Type condenser (Primary RAM/ Primary Wake/Secondary RAM/ Secondary Wake)	T.I. description				
2.	Condenser tube number					
3.	Record model type	model	EM/QM/ FM			
4.	Record test equipment used: 979 Varian equipped with oil-free pump.	Manufacturer, type/serial number				
5.	Measure equipment background level (put cap on tester, without test item being connected). Make digital picture of the value	background He-leak rate	$<2*10^{-10}$ mbarl/s (or $1,94*10^{-10}$ atm cc /s)			
6.	Connect one end of the bent condenser tube to Swagelok stop (closing connector)	Leak tight volume				
7.	Connect the other end to the He leak tester 					

	Fill in by hand		engineer:		location: date:	
Step	Action	Monitoring	Value	**Result**	Comment	√
8.	Measure leak rate value without spraying helium. Make digital picture of the value	background He-leak rate	$<5*10^{-10}$ mbarl/s (or $4,854*10^{-10}$ atm cc /s)			
9.	Cover the bended tube with a plastic bag and measure leak rate value when the bag is filled with helium.Make digital picture of the value 	He leak rate	$<1*10^{-9}$ mbarl/s (or $0,9708*10^{-9}$ atm cc /s)			
10.	General remarks and notes					

Repeat steps 5-10 for each condenser tube (total 7 times)

4.1.2 Helium leak test procedure sheet for condenser assembly (after brazing): prior and after pressure test

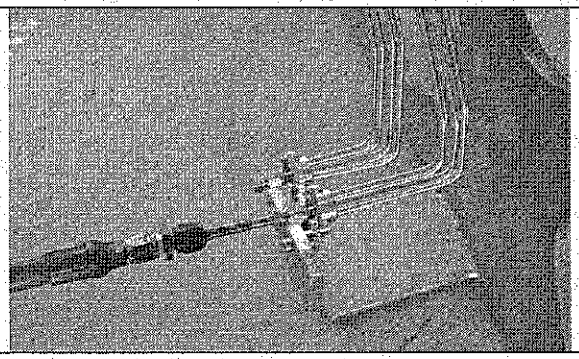
	Fill in by hand		engineer: Shrek, cc Y		location: AIDC date: 1st 2008.10.21 2nd 2008.10.28	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Type condenser (Primary RAM/ Primary Wake/Secondary RAM/ Secondary Wake)	T.I. description				
2.	Record model type	model	EM/QM/ FM	FM2		
3.	Record step sequence: before/after proof pressure test					
4.	Record test equipment used: 979 Varian equipped with oil-free pump.	Manufacturer, type/serial number				
5.	Measure equipment background level (put cap on tester, without test item being connected). Make digital picture of the value	background He-leak rate	$<2*10^{-10}$ mbarl/s (or $1,94*10^{-10}$ atm cc /s)	ok		
6.	Connect the end of one manifold to a Swagelok stop (closing connector)	Leak tight volume		ok		
7.	Connect the other manifold to the He leak tester			ok		

	Fill in by hand		engineer:		location: date:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
8.	Measure leak rate value without spraying helium. Make digital picture of the value	background He-leak rate	$<5*10^{-10}$ mbarl/s (or $4,854*10^{-10}$ atm cc /s)	ok	1st : 1×10^{-10} snd : 1×10^{-10}	
9.	Cover the integrated condenser tube system (with brazed manifolds) with a plastic bag and measure leak rate value when the bag is filled with helium Make digital picture of the value 	He leak rate	$<1*10^{-9}$ mbarl/s (or $0,9708*10^{-9}$ atm cc /s)	ok	1st : 1×10^{-10} snd : 1×10^{-10}	
10.	General remarks and notes					

5 Proof pressure test procedure sheets

5.1 Proof pressure test procedure sheet for condenser assembly (after brazing)

	Fill in by hand		engineer: Shrek, cCY		location: cok date: 2008.10.24	
Step	Action	Monitoring	Value	**Result**	Comment	√
1.	Type manifold (Pprimary RAM/Primary Wake/Secondary RAM/Secondary Wake)	T.I. description				
2.	Type Manifold number					
3.	Record model type	model	EM/QM/ FM	FM2		
4.	Record test equipment and fluid used	Manufacturer, type/serial number	1.2 K-AV 04 II Nitrogen	ok		
5.	Measure equipment background level					
6.	Connect the end of one manifold to a Swagelok stop (closing connector)			ok		
7.	Connect the other manifold to proof pressure tester			ok		

	Fill in by hand		engineer:		location: date:	
Step	Action	Monitoring	Value	**Result**	Comment	√
						
8.	Shut off valves (by hand) until the pressure on pressure gauge grows to 70 bar and maintain until stability. Record time needed	Pressure Time	70 bar/1015 PSI 20-30 sec	ok		
9.	Shut off valves (by hand) until the pressure on pressure gauge grows to 140 bar and maintain until stability. Record time needed	Pressure Time	140 bar/2030 PSI 20-30 sec	ok		
10.	Shut off valves (by hand) until the pressure on pressure gauge grows to 210 bar and maintain until stability. Record time needed	Pressure Time	210 bar/3045 PSI 20-30 sec	ok		
11.	Shut off valves (by hand) until the pressure on pressure gauge grows to 240 bar and maintain until stability. Record time needed	Pressure Time	240 bar/3480 PSI 20-30 sec	ok		
12.	Maintain the pressure of 240 bar for 10 minutes.	Pressure Time	240 bar/3480 PSI 10 min.	ok		
13.	Release fluid and disconnect manifold			ok		
14.	Visual inspection			ok		

	Fill in by hand		engineer:		location: date:	
Step	Action	Monitoring	Value	**Result**	Comment	√
15.	Seal manifold end with plastic cap/Swagelok stop			ok		
16.	General remarks and notes					

END OF DOCUMENT