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Report of leak rate tests of ASG JT-60SA electrical breaker in ENEA Superconductivity lab

Project Details	JT-60SA Advanced Superconducting Tokamak BA-Satellite Tokamak Program — FUSION FOR ENERGY *This document is issued for the execution of the Agreement of Collaboration (AoC) between Fusion for Energy (F4E) and ENEA for the supply of 9 TF coils of JT-60SA*	
	JT-60SA DMS	BA_D_23QLZL
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Distribution List	Internal ENEA	**1.** UTFUS
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Abstract	The measurement of the integrity at cryogenic temperature of three electrical insulation breakers produced by ASG for the TF coils of the JT-60SA Tokamak has been carried out at the Superconductivity Laboratories of ENEA. During all tests carried out, the insulation breakers have shown leakage values below the acceptable leak rate.	

Rev.	Date	Issued by	Reviewed by	Approved by
0	08/07/2013	R. Freda	L. Affinito	A. della Corte

Historical list of document revisions

Rev.	Description	Date	Summary of modifications with motivations notes

1.0 Introduction

The integrity of the insulation breakers for the TF coils of the JT-60SA Tokamak has been tested at cryogenic temperature.

Scope of the present document is to illustrate the activities carried out to test the insulation breakers id n. #1, #5, #022.

2.0 Sample preparation

At one end of the insulation breaker a plug was attached by Tig-welding; the opposite side was welded to an OD 12 mm stainless steel pipe connected to a leak detector by a KF25 flange (see fig. 1 and 2).

The stainless steel tube was equipped with a KF T-piece to insert and to move the breaker inside a liquid Helium dewar (see fig. 3 e 4).

On the pipe, nearest to the upper side of the insulator, a PT100 thermometer was installed, except for breaker #1 (see fig. 5). The total length of the sample from the welded plug to the end of the resin was about 230 mm.

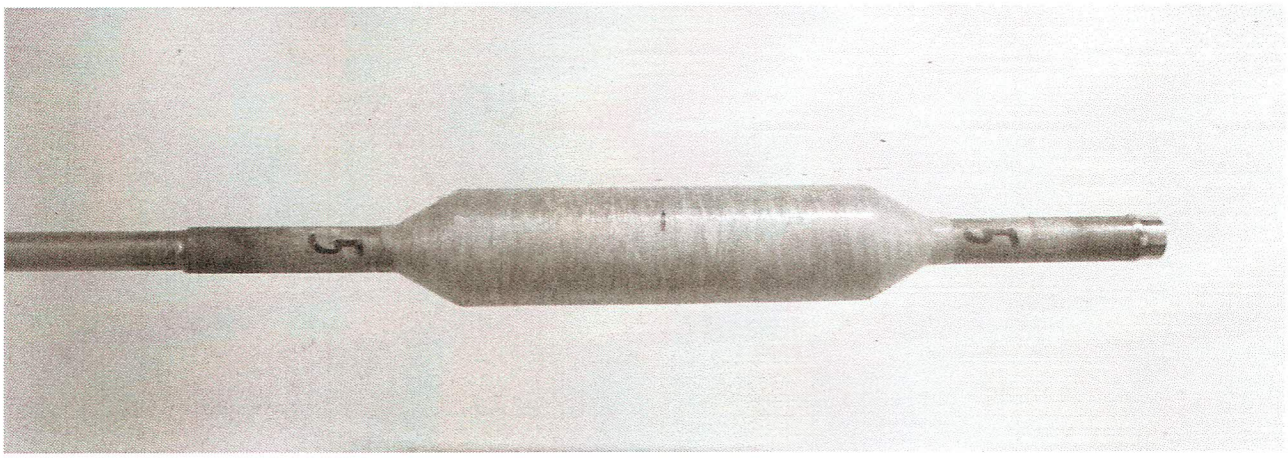


Fig. 1 – breaker plugged and welded to the pipe

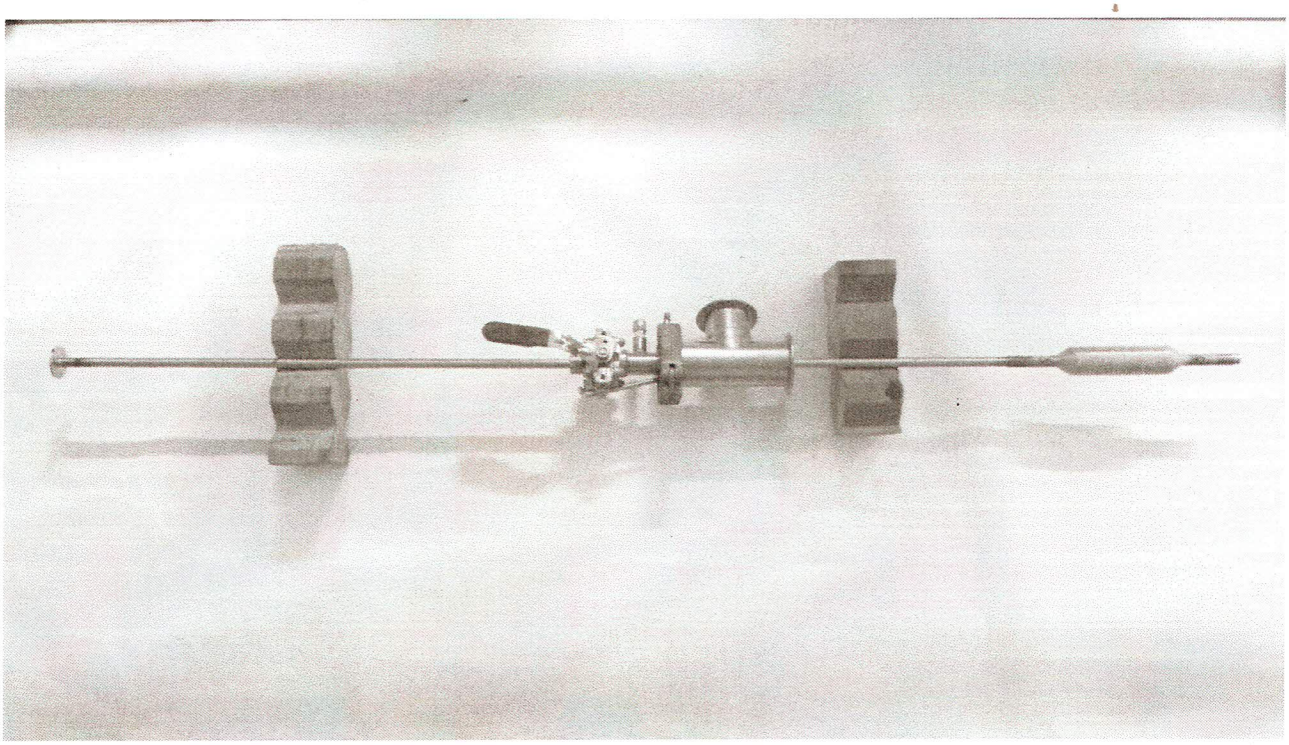


Fig. 2 – breaker assembly

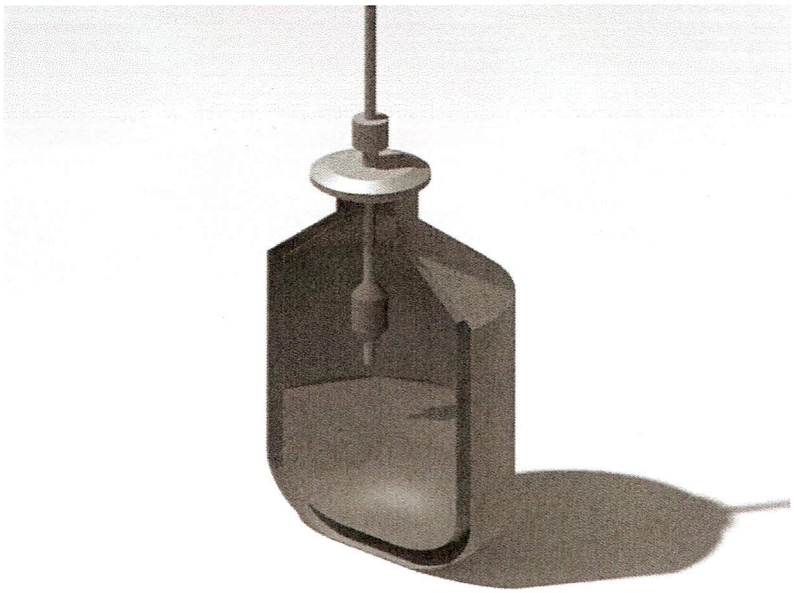


Fig. 3 – schematic breaker position inside the dewar

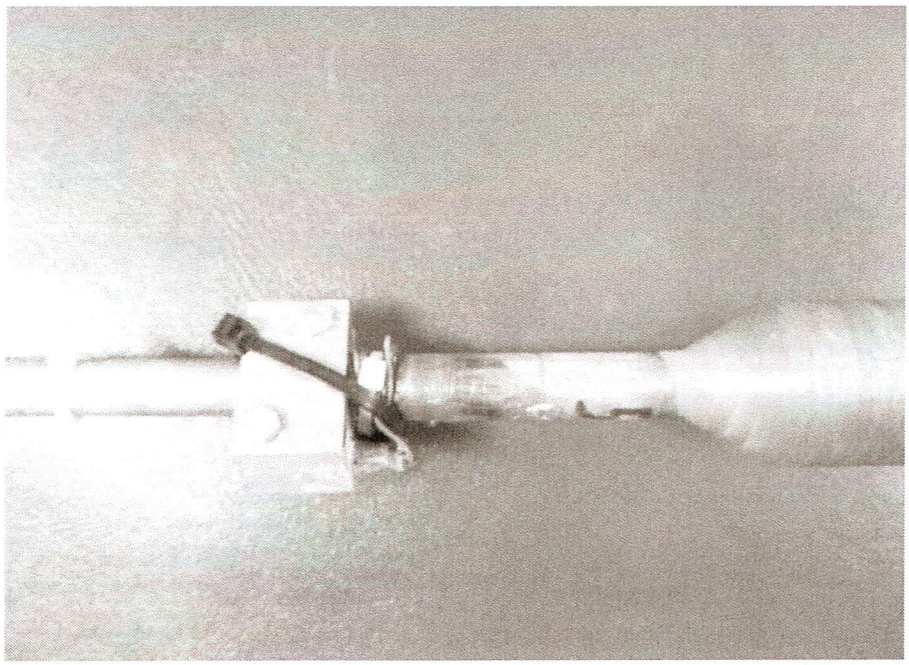


Fig. 4 – PT100 location

3.0 Instrumentation

Leak detector: VARIAN 979C

External calibrated leak (CL): ALCATEL N° FC07000096

Nominal value CL: 1.9E-08 mBar l/sec

Uncertainty measurement: ± 10%

CL calibration date: 26.01.2007 to 20°C

4.0 Measurement

For every insulation breaker, the following tests were performed:

1. preliminary test at room temperature with vacuum inside and Helium at atmospheric pressure outside. Leak integrity checked with a leak detector Varian 979C (see fig. 5).

2. cryogenic test with insulation breakers positioned above the liquid Helium level in a dewar with about 60 liters of liquid (see fig. 6). After temperature stabilization, breakers were dipped completely in liquid Helium for about 60 minutes. Thermal cycles were performed by repeating this operation three times. Leak rate was continuously monitored with the leak detector Varian 979C.

3. Final test at room temperature, as in point 1 above.

All the test results are reported in the following pages.

Maximum acceptable leak rate was: 1.0E-08 mbar l/sec (1.0E-09 Pa m^3/sec).

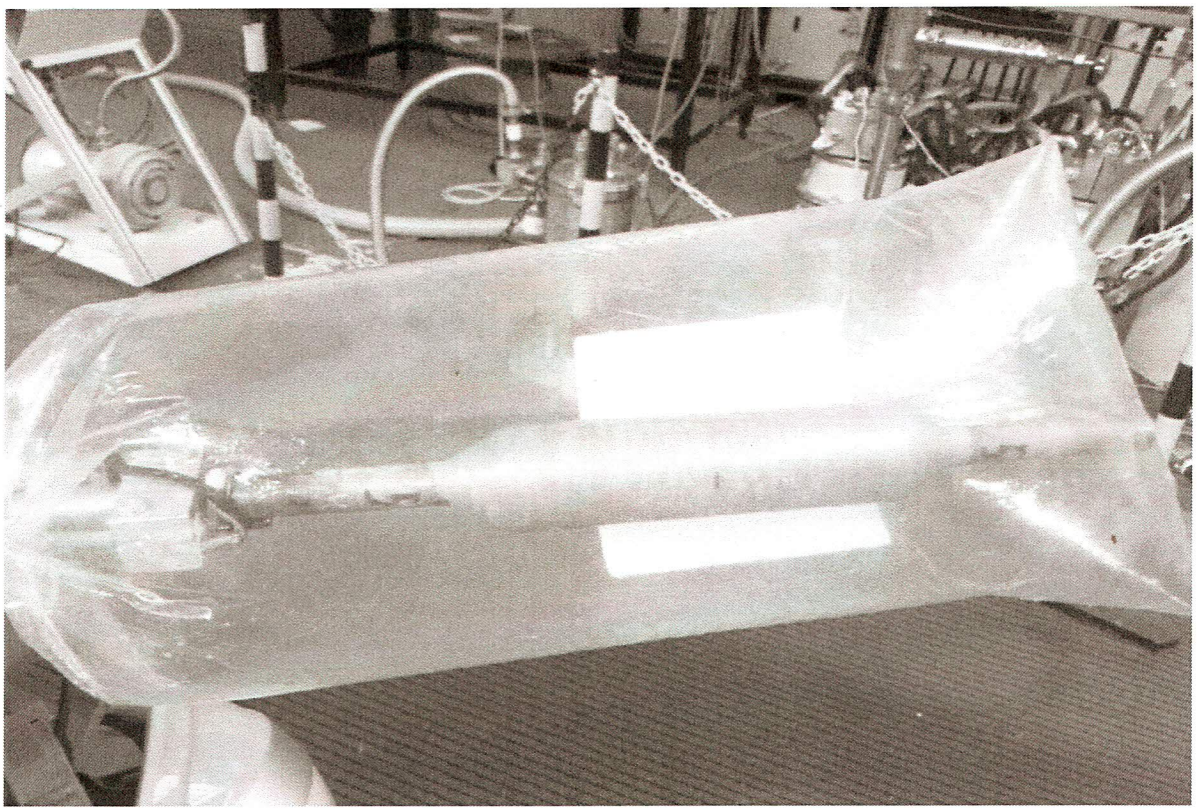


Fig. 5: room temperature test

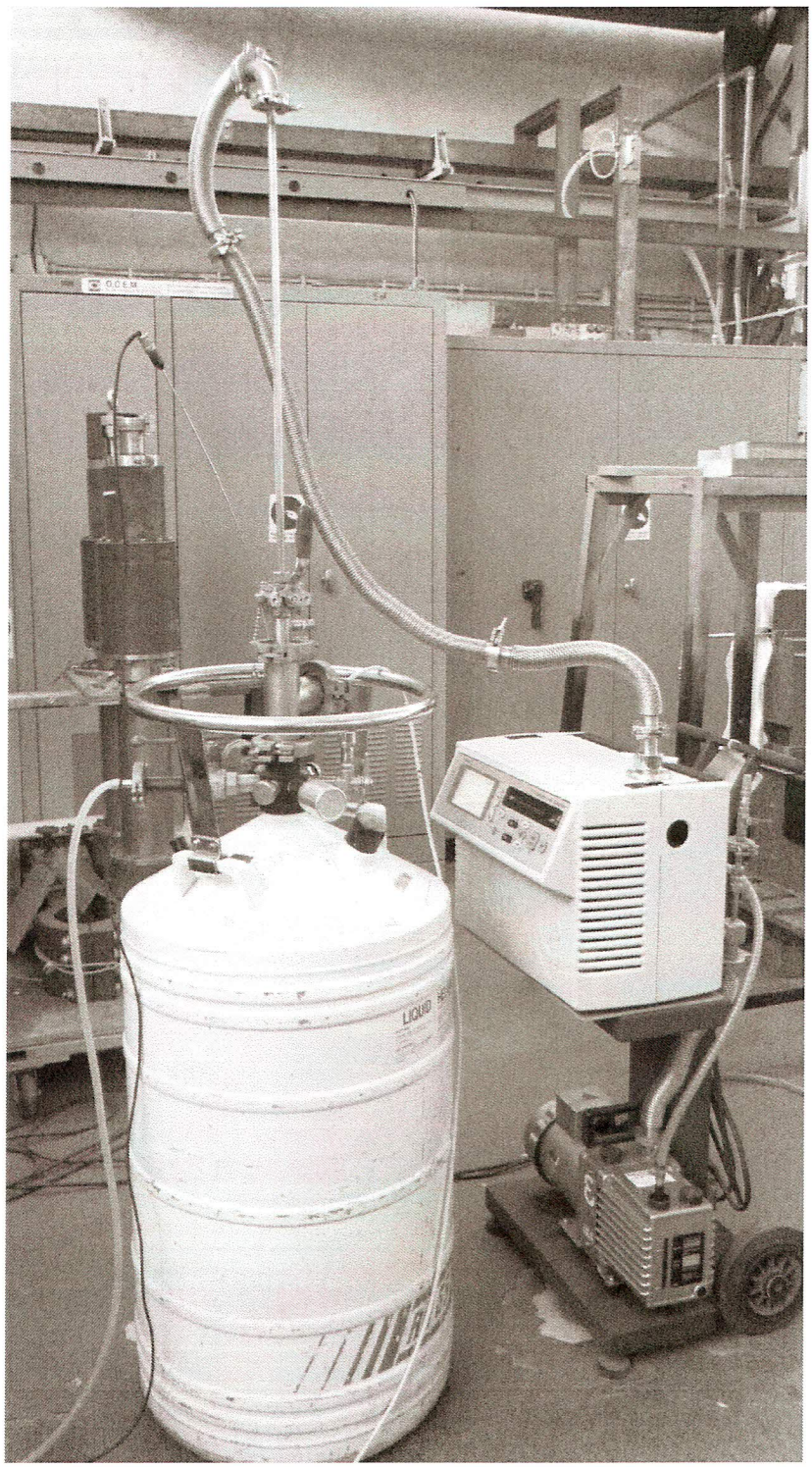
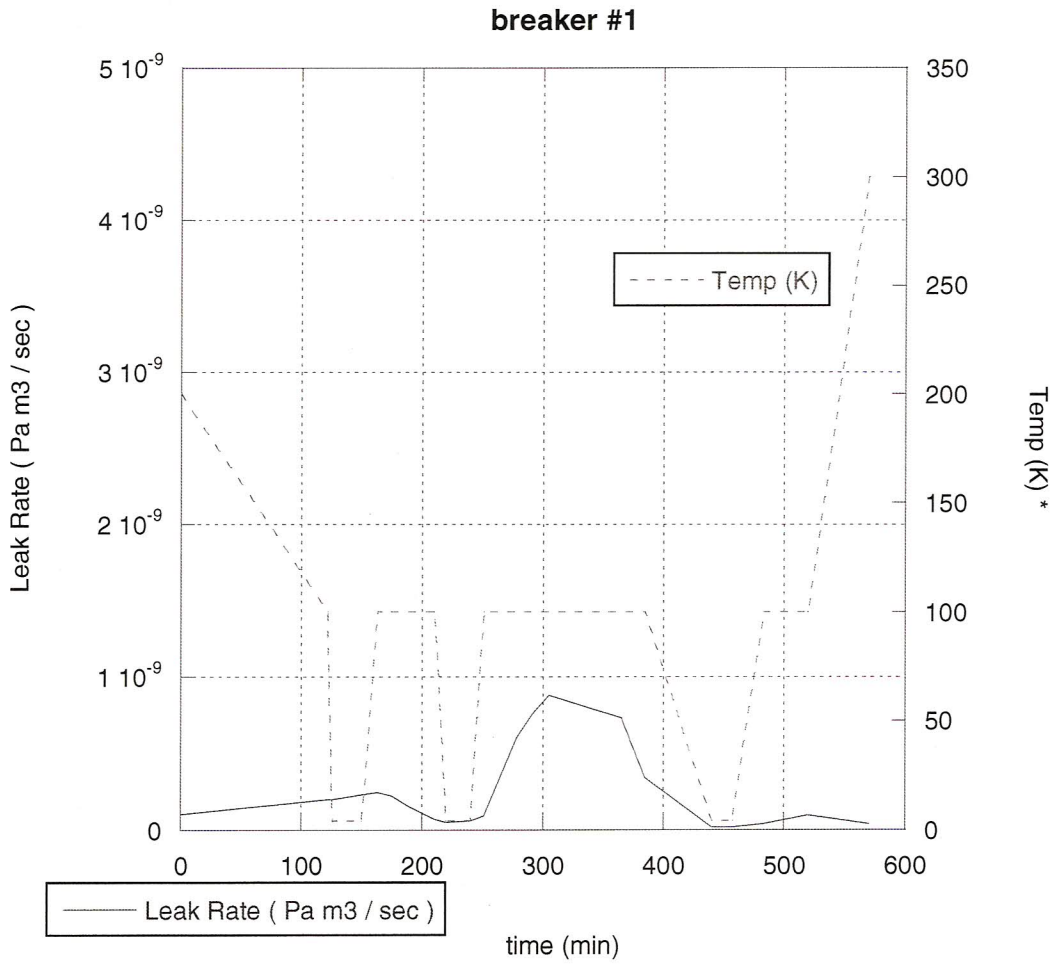


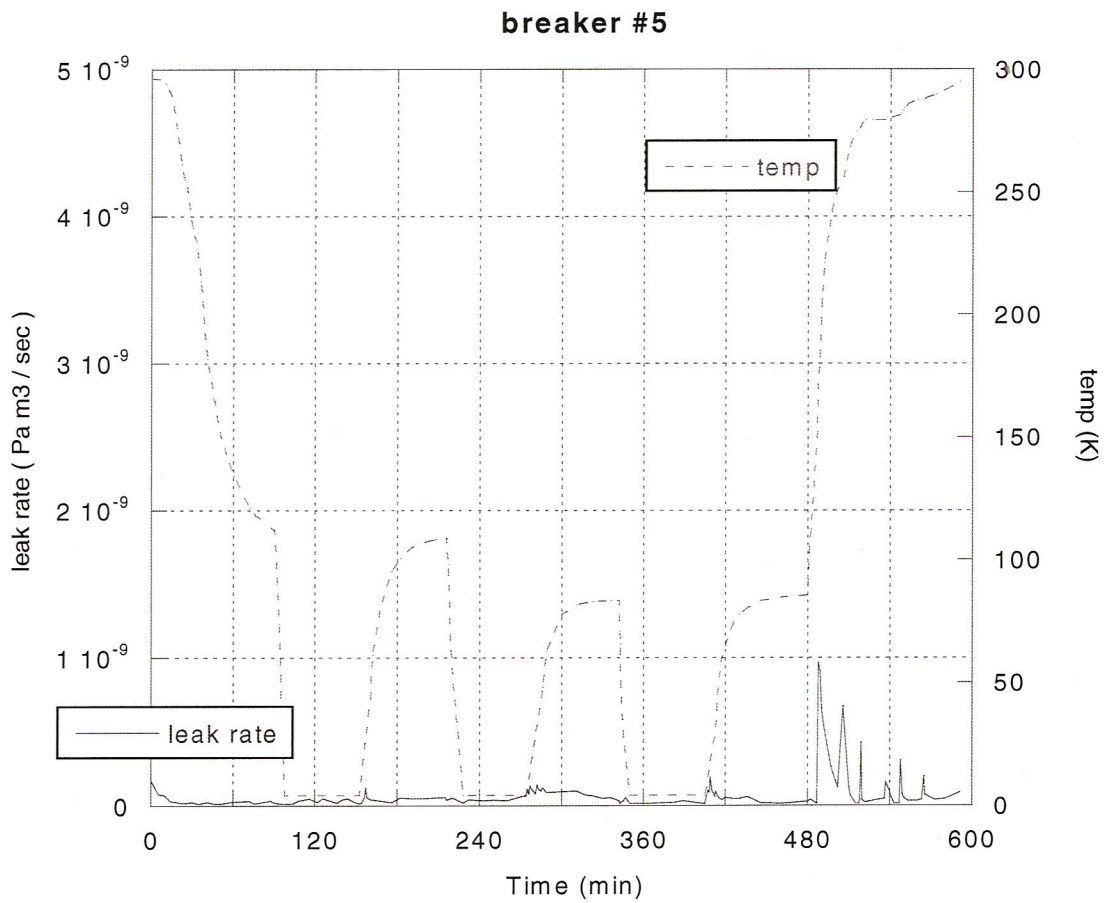
Fig. 6: test in liquid Helium

Breaker #1	**CONDITIONS: ROOM TEMPERATURE**	Liquid Helium level: 320 mm Minimum level for total breaker coverage: 230mm
Test Port (TP) 0.0E-04 mbar	**PRELIMINARY TEST**	**FINAL TEST**
Calibrated Leak (CL)	1.86E-08 mbar l/sec	
Background value without breaker	<1E-09 mbar l/sec	
Background value with breaker	<1E-09 mbar l/sec	<1E-09 mbar l/sec

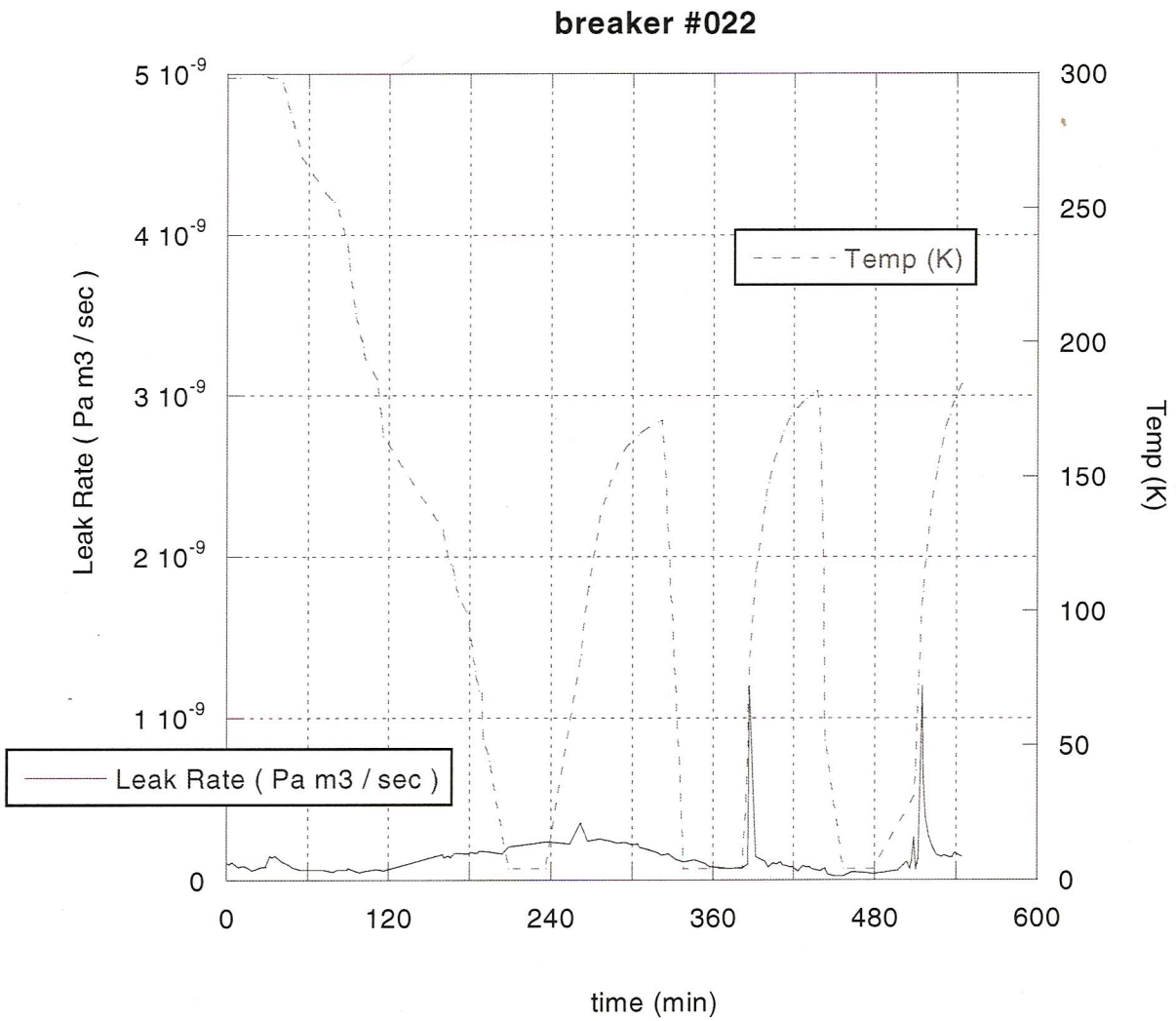


*Note : the temperature during this test was not measured, but a reference signal is reported, to indicate the breaker position in the dewar.

Breaker #5	CONDITIONS: ROOM TEMPERATURE	Liquid Helium level: 350 mm Minimum level for total breaker coverage: 230mm
TP 0.0E-04 mbar	PRELIMINARY TEST	FINAL TEST
CL	1.92E-08 mbar l/sec	
Background value without breaker	<1E-09 mbar l/sec	
Background value with breaker	<1E-09 mbar l/sec	<1E-09 mbar l/sec



Breaker #022	CONDITIONS: ROOM TEMPERATURE	Liquid Helium level: 350 mm Minimum level for total breaker coverage: 230mm
TP 0.0E-04 mbar	PRELIMINARY TEST	FINAL TEST
CL	1.87E-08 mbar l/sec	
Background value without breaker	<1E-09 mbar l/sec	
Background value with breaker	<2E-09 mbar l/sec	<2E-09 mbar l/sec



Conclusions

The tests carried out on all the insulation breakers have shown leakage values below the maximum acceptable leak rate, during all the performed tests.

The presence of some peaks during breakers lift from liquid Helium to warmer zones of the dewar are caused by a cryo-pumping effect of the breakers, with an effectiveness larger than that of the leak detector turbo pump.