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1. SCOPE

This document describes the ECAL thermal control hardware assembly interfaces, providing information on the location of the hardware provided by CGS onto the detector.

2. DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD	Document Number	Issue/Date	Rev.	Title/Applicability
1	AMS02-TN-004-CGS	5	02/03 /2005	n/a
2	I/020/03/0	n/a	14/05 /2003	n/a

2.2 REFERENCE DOCUMENTS

RD	Document Number	Issue/Date	Rev.	Title/Applicability
1	AMS02-TN-CGS-007	Issue 2, 30/11/2005		AMS 120VDC and 28VDC HEATERS DESCRIPTION

3. ACRONYMS

AD	Applicable Document
AMS-02	Alpha Magnetic Spectrometer 02
ECAL	Electromagnetic Calorimeter
EIB	Electronic Board
PMT	Photomultiplier Tube
RD	Reference Document
TCS	Thermal Control System

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4. HARDWARE DESCRIPTION

4.1 ECAL HARDWARE GENERAL OVERVIEW

The ECAL detector is built by INFN Pisa.
It is composed of a lead/scintillating fibers aluminum pancake, surrounded on the 4 sides by 324 photomultipliers tubes (PMT).

The PMT are kept in place by 2 mechanical structures per side,

- the Lateral Panel (in contact with the Pancake) and
- the Back Panel

On the four corners of the pancake, mechanical fixation brackets are mounted, to connect the detector to the rest of the AMS-02 system

On top and bottom of the pancake, 2 honeycomb panels close the mechanical support structure

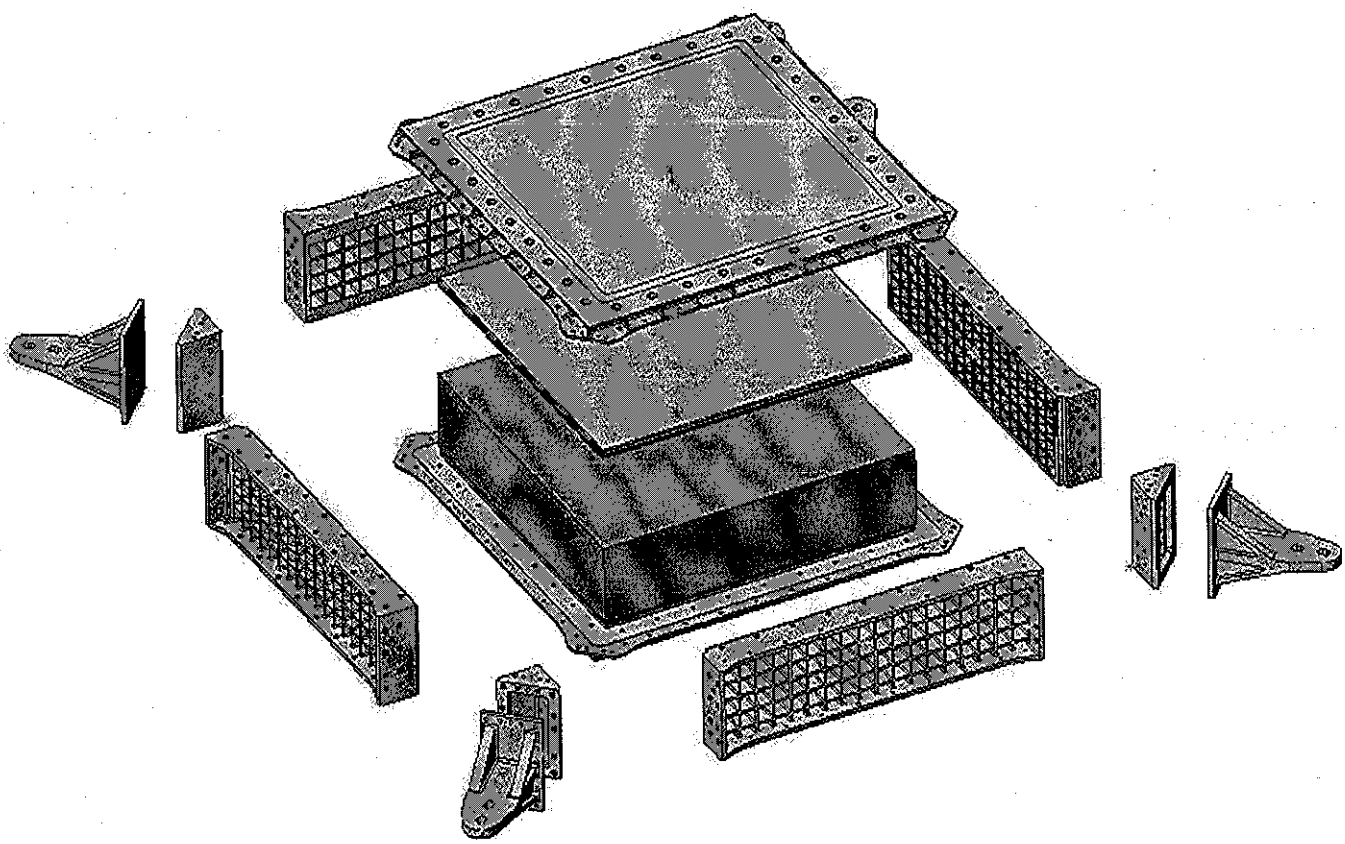

Fig. 4.1: ECAL Exploded view: at the center the pancake, closed on top and bottom by honeycomb panels (in grey). In green, the 4 lateral panels grids and the 4 corner brackets. Back panels, TCS, PMT and EIB are blanked

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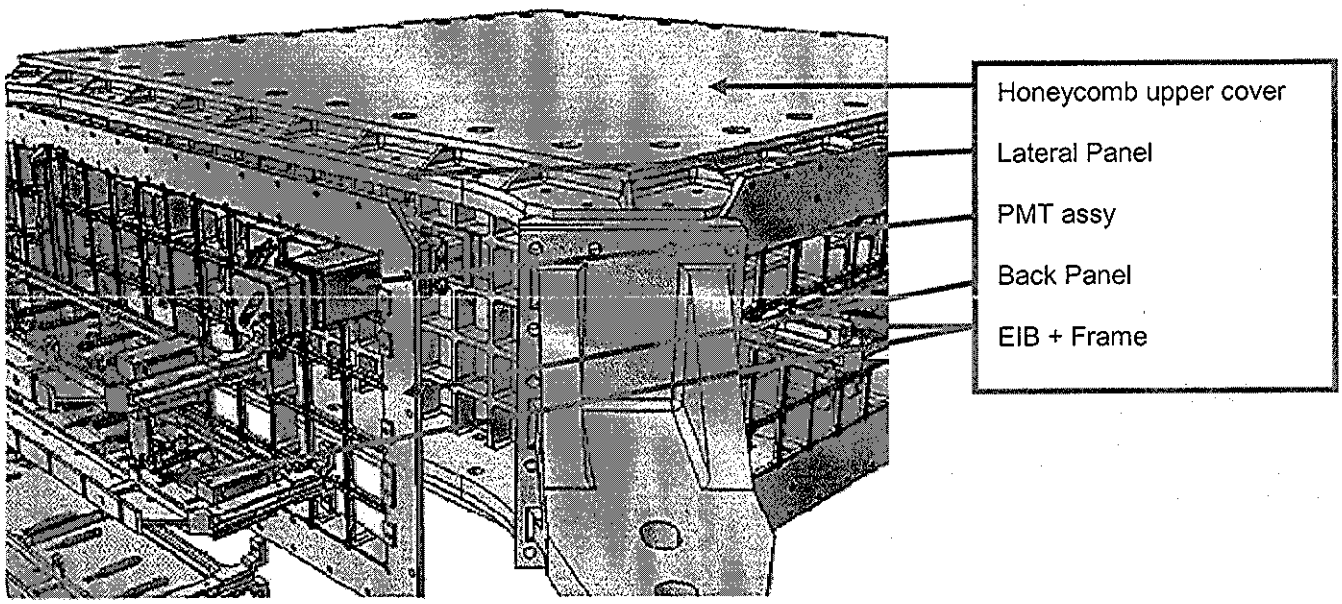

Fig. 4.2: ECAL Exploded view: detail of the back panel, containing a PMT assy In green, the EIB envelope

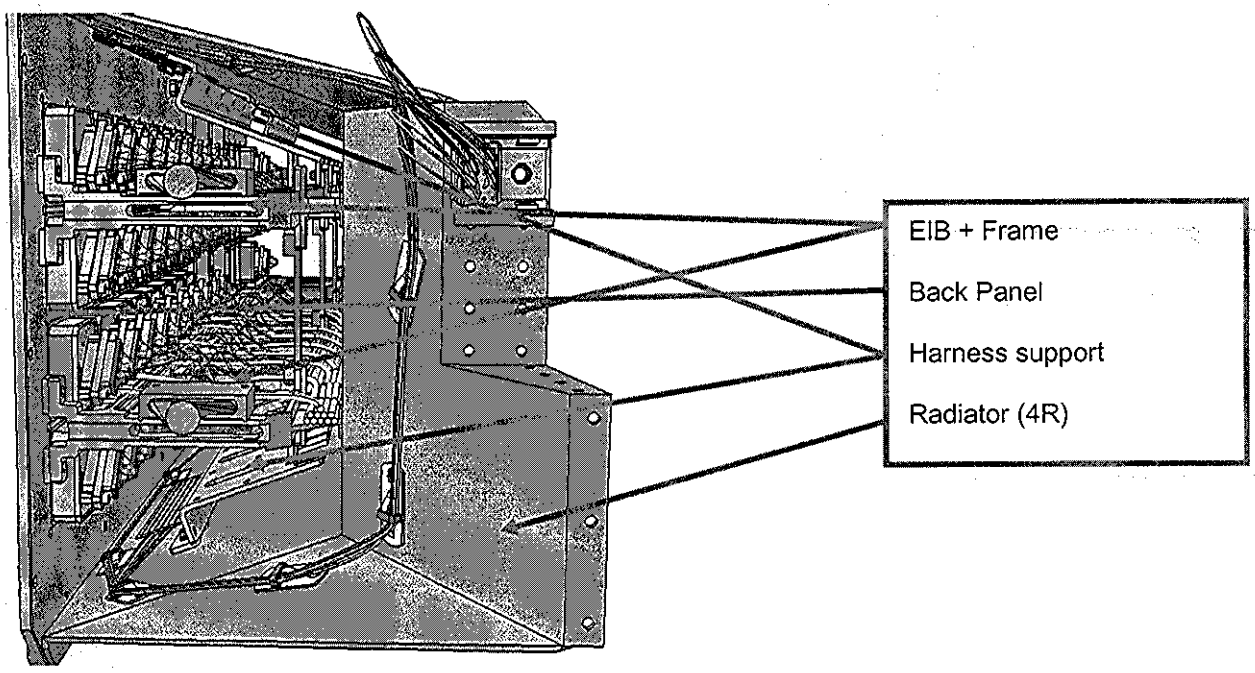

Fig. 4.3: ECAL view of a lateral side, with the radiator installed (4R-radiator). EIB mechanical frame and harness support are present.

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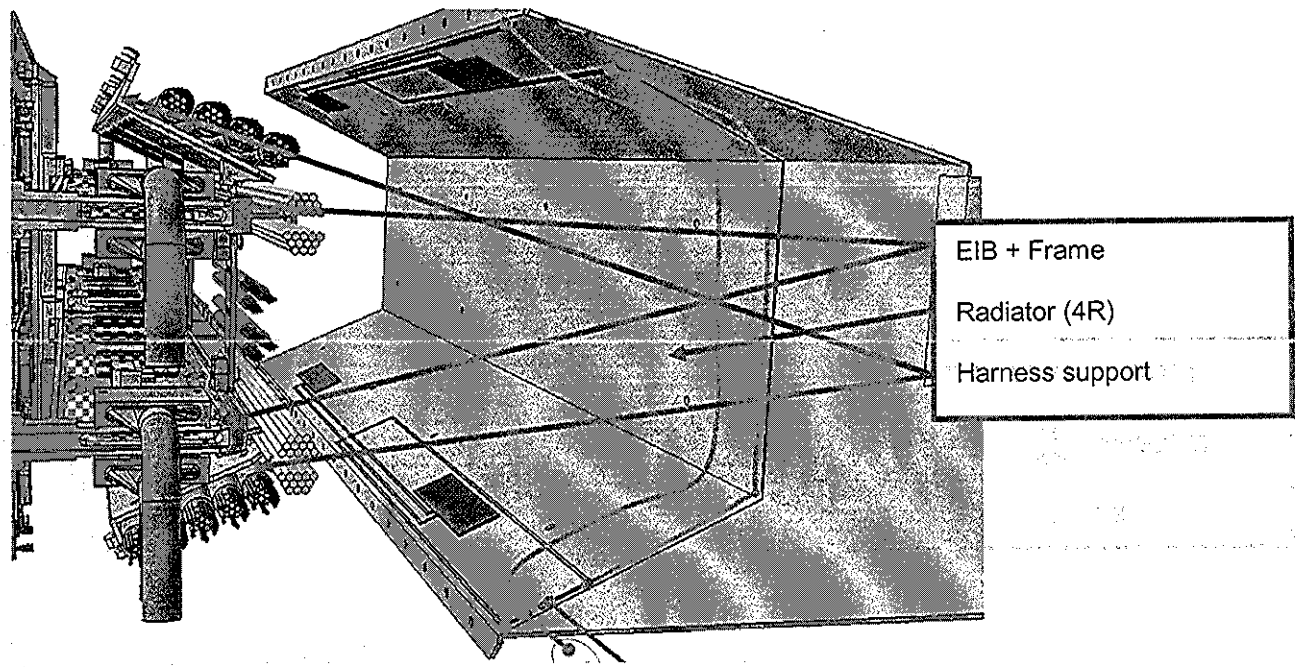

Fig. 4.4: ECAL exploded view of a lateral side, with radiator and heaters (4R-radiator). EIB mechanical frame and harness support are present.

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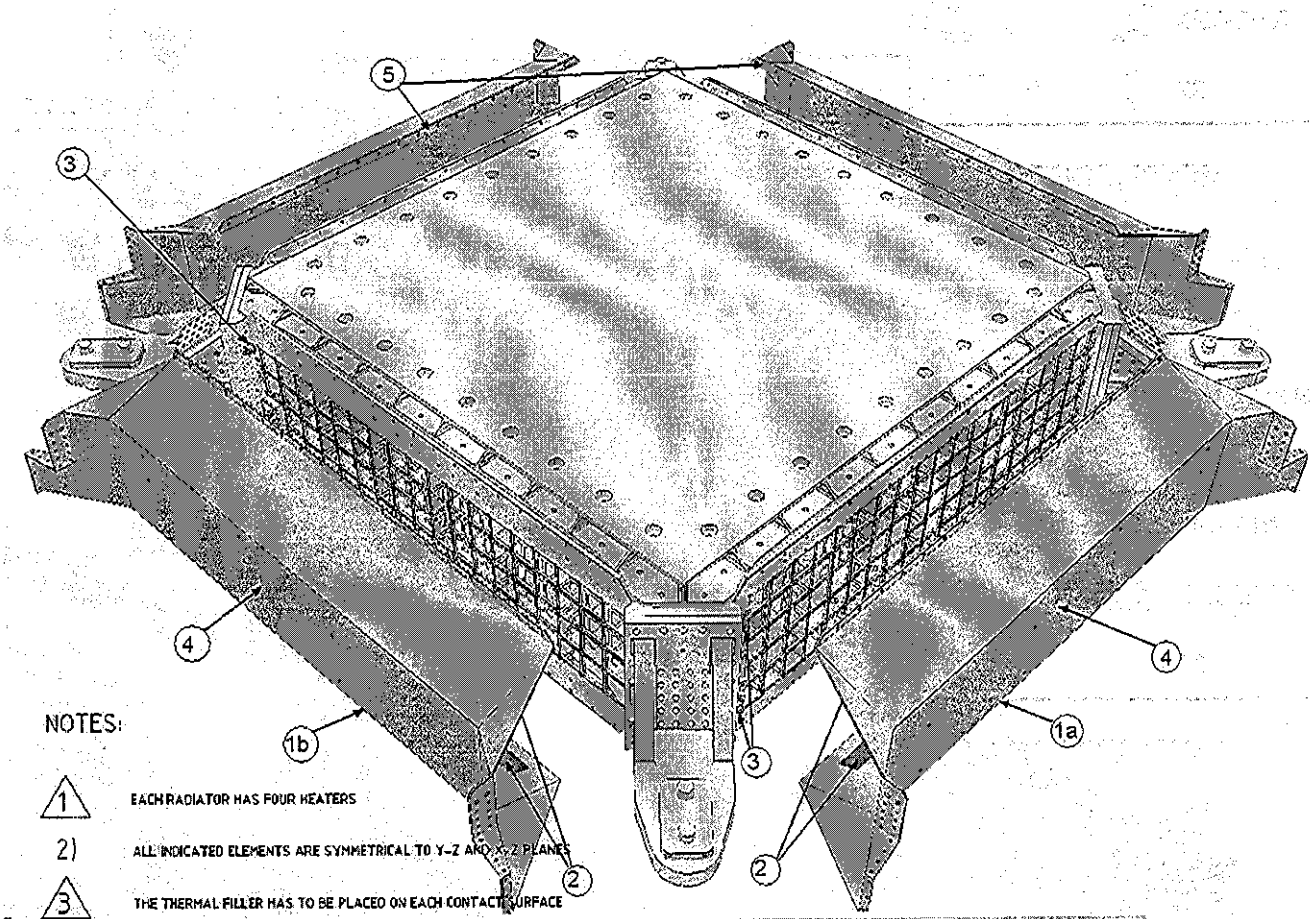
4.2 ECAL THERMAL CONTROL SYSTEM IDENTIFICATION AND DESCRIPTION

The thermal control system (TCS) hardware is composed of.

1. 2 pairs of aluminium radiators (4 in total), also referred as ***4R*** and ***5R*** radiators, equipped with:
   a. 16 heaters, mounted on the radiators bodies, 4 per radiator
   b. Silver Teflon Tape, installed on the external side of the aluminium radiators
   c. Cho-term filler stripes, installed on the mechnical interfaces of the radiator with the *back panels* and with the *EIB mechanical frames*
2. 8 thermostats, mounted on the ECAL mechanical structure (on the *back panel*), 2 per back panel
3. MLI, on the ECAL brackets

Each element location and shape is shown in the next figure, and described following sections.



ITEM	DESCRIPTION	P/N-ID.CODE	QTY
5	THERMAL FILLER	62-10-0909-A274	A.R.
4	RADIATOR TAPE - EMBOSSED TEFLON	167149-001	A.R.
3	THERMOSTAT	7015-01A0011/3/3/7	8
2	HEATER	R0632	16
1b	ECAL RADIATOR 4R	11-RICSYS-20.001	2
1a	ECAL RADIATOR 5R	11-RICSYS-20.002	2

Fig. 4.5: ECAL TCS assembly general overview

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4.3 ECAL RADIATORS

The main element of the ECAL TCS consists of 4 aluminum radiators (aluminum 5086, see RD1 and RD2).
The radiators are equal in couples.

They are installed on the 4 sided of the ECAL, on the back panels. Radiators are opposed each other
The 4R radiators are to be mounted in correspondence of the 4-PMT-rows back panels
The 5R radiators are to be mounted in correspondence of the 5-PMT-rows back panels

Each radiator is mounted by 18+18 bolts (INFN-Pisa responsibility) on the upper and lower edges of the radiator itself.

Moreover, there is a variable number of holes for the fixation on the EIB support frames (3x4 holes on the 5R radiators, 2x4 holes on the 4R radiators).

On the 4R radiators only, other 8 holes are provided on the inclined panels, for the installation of the harness support rails (under INFN-Pisa responsibility)

ECAL radiators details are provided in the manufacturing drawings [RD1 and RD2]

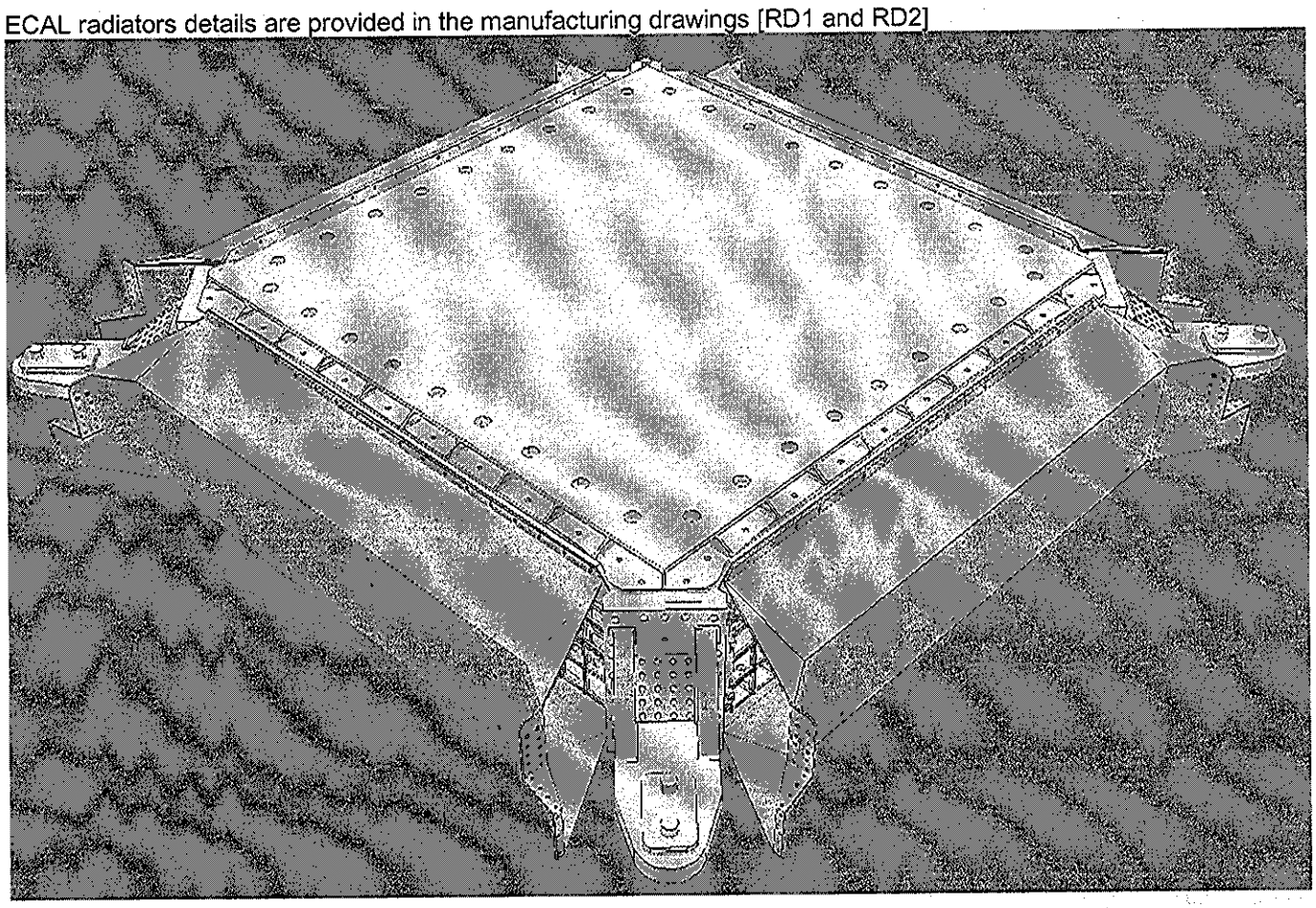

Fig. 4.6: view of the ECAL radiators (in green), on the 4 ECAL sides.

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4.4 ECAL TAPE INTERFACE

Silver Teflon Tape is installed on the external surface of the radiators
The positioning has to maximize the tape-covered area, while avoiding tape bends and superpositions. Gaps have to be minimized.

An example is given in the figure below

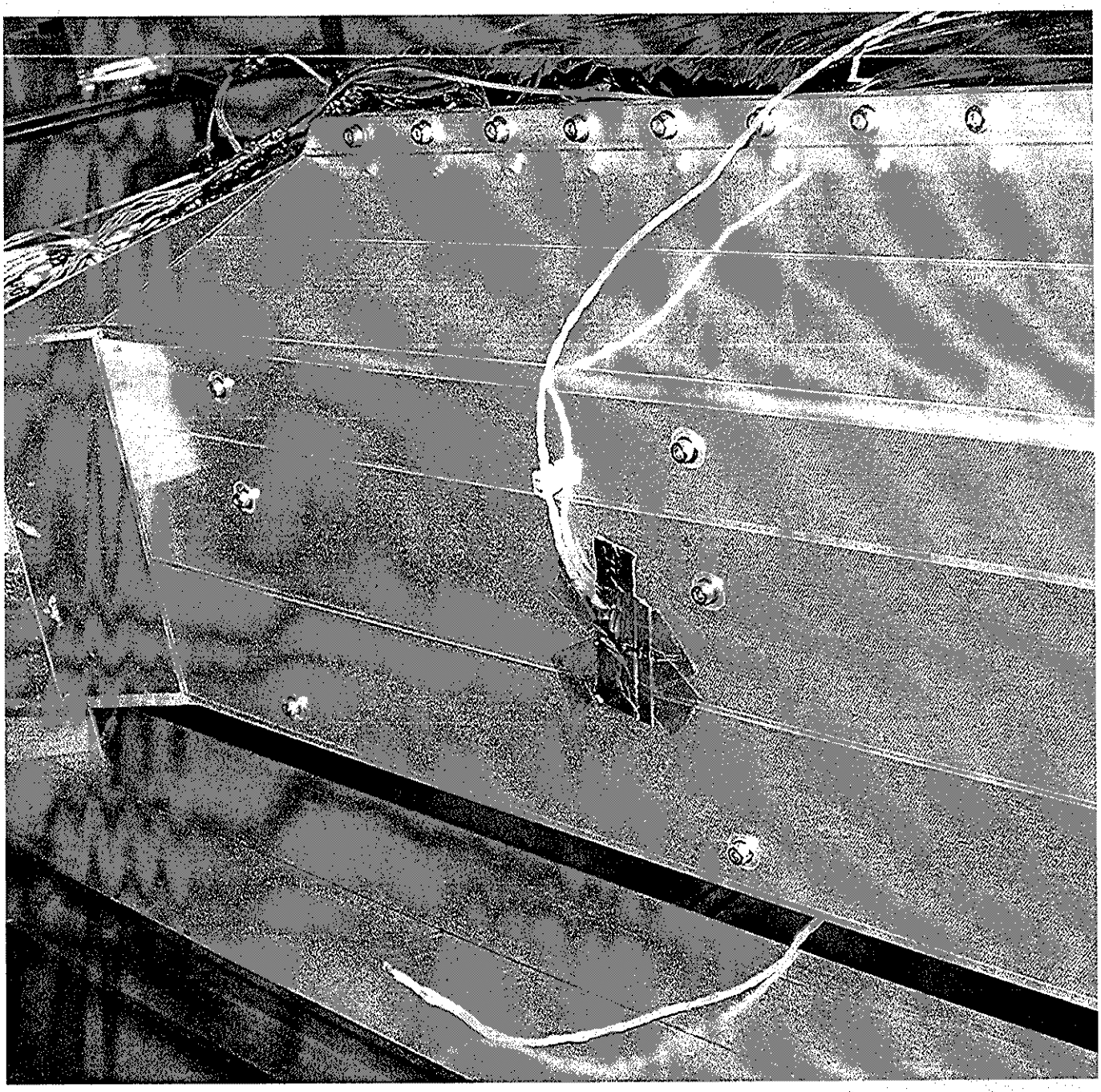

Fig. 4.7: detail of the ECAL radiator Silver Teflon Tape. A thermocouple has been temporarily attached for the thermal vacuum cycling test (at the center of the radiator).

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4.5 ECAL CHOTHERM INTERFACE

Chotherm is installed on the thermal contact surfaces of the radiators with

- the EIB frames and
- the back panel mounting flanges.

Chotherm has been cut in stripes and installed as per the following figures.

The exact position of the cho-therm stripes can be inferred from the locations of the EIB holes on the radiators, being the stripe centered on the holes (tolerance ± 1 mm).

Cho-therm is of 1671 family.

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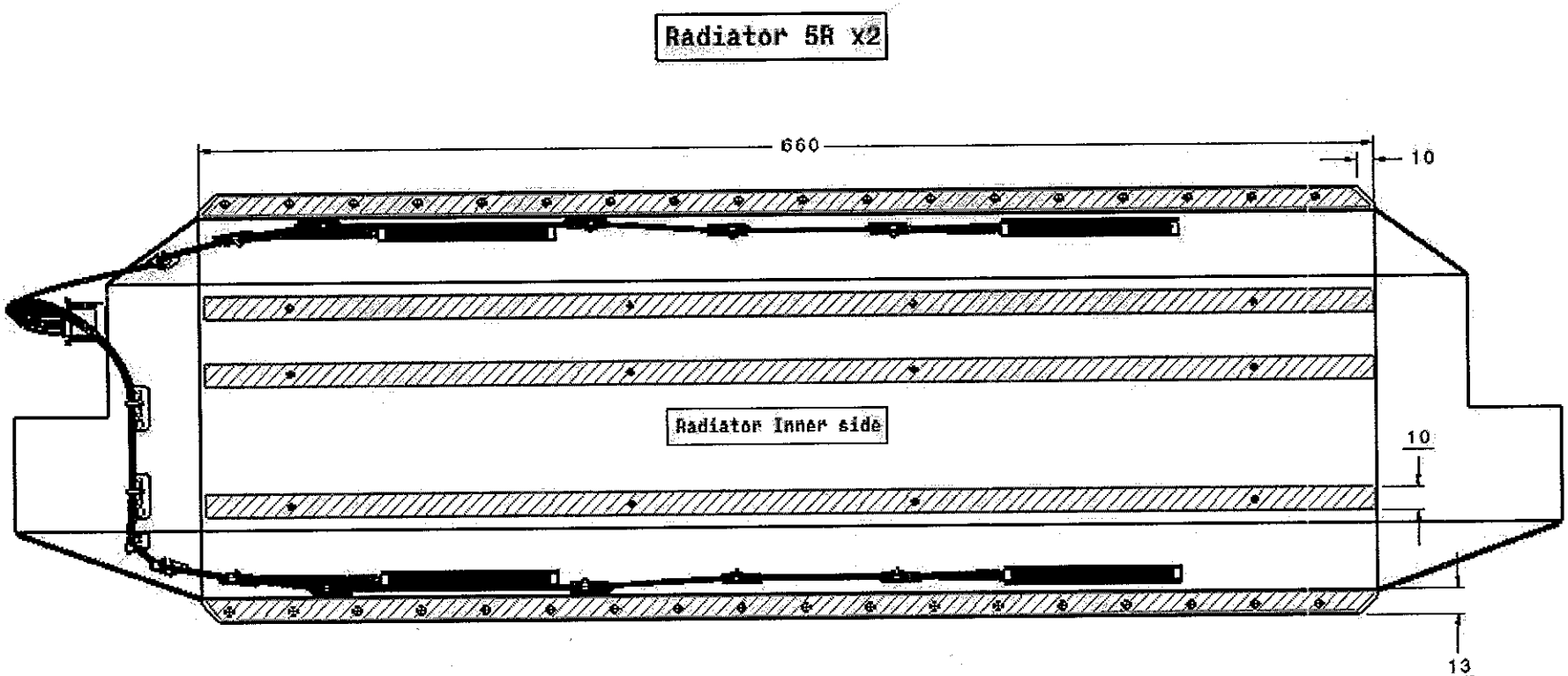

Fig. 4.8: ECAL cho-therm stripes locations on the 5R radiator. Each 5R radiator hosts 2 stripes 660x13mm, and 3 stripes 660x10mm.

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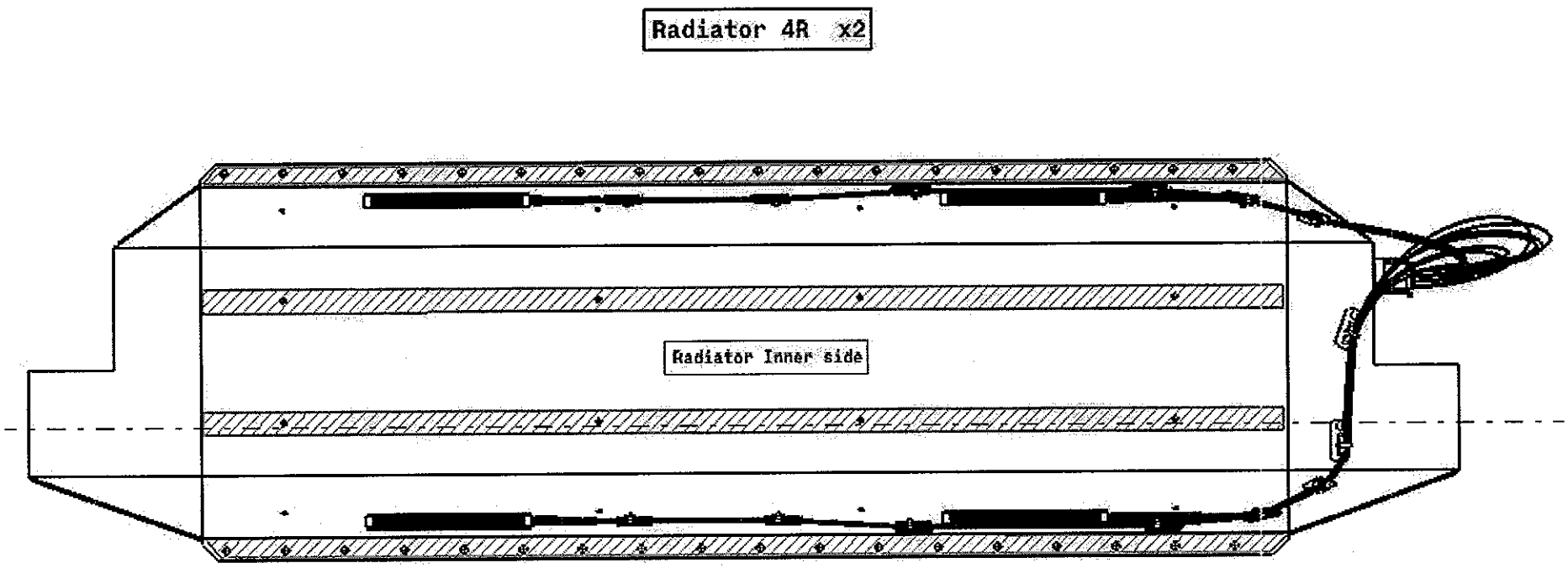

Fig. 4.9: ECAL cho-therm stripes locations on the 4R radiator. Each 4R radiator hosts 2 stripes 660x13mm, and 2 stripes 660x10mm.

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4.6 ECAL HEATERS MECHANICAL INTERFACE

ECAL Heaters are 16 in total, with a nominal resistance of 2850 Ohm each.

They have been glued on the ECAL radiators in the internal side, with ECCOBOND glue, according to the locations specified in the following figures.

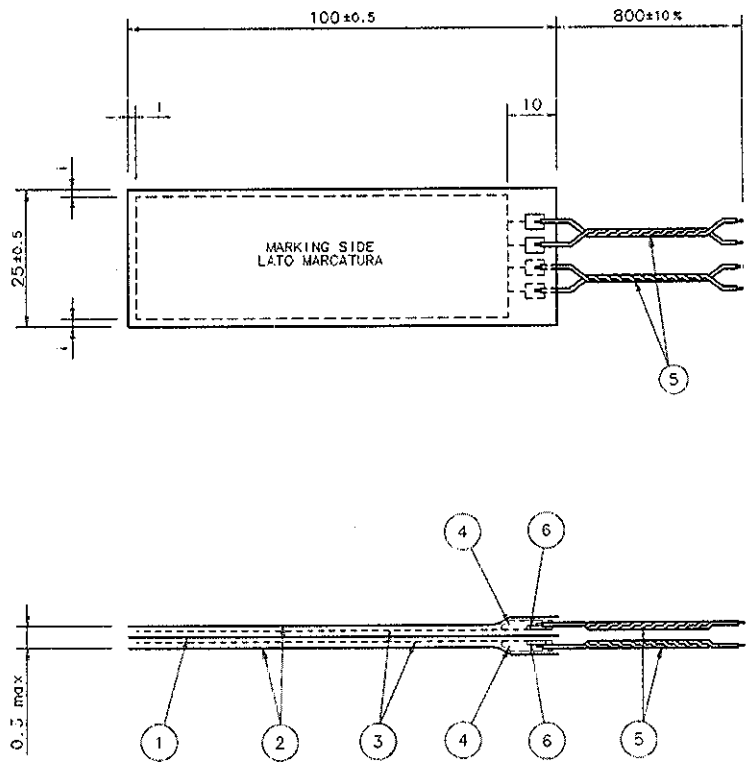

Fig. 4.10: ECAL heater drawing. Each heater is a double layer heater, with 2 equivalent separated circuits.

Fig. 4.11: ECAL heaters installed on a radiator.

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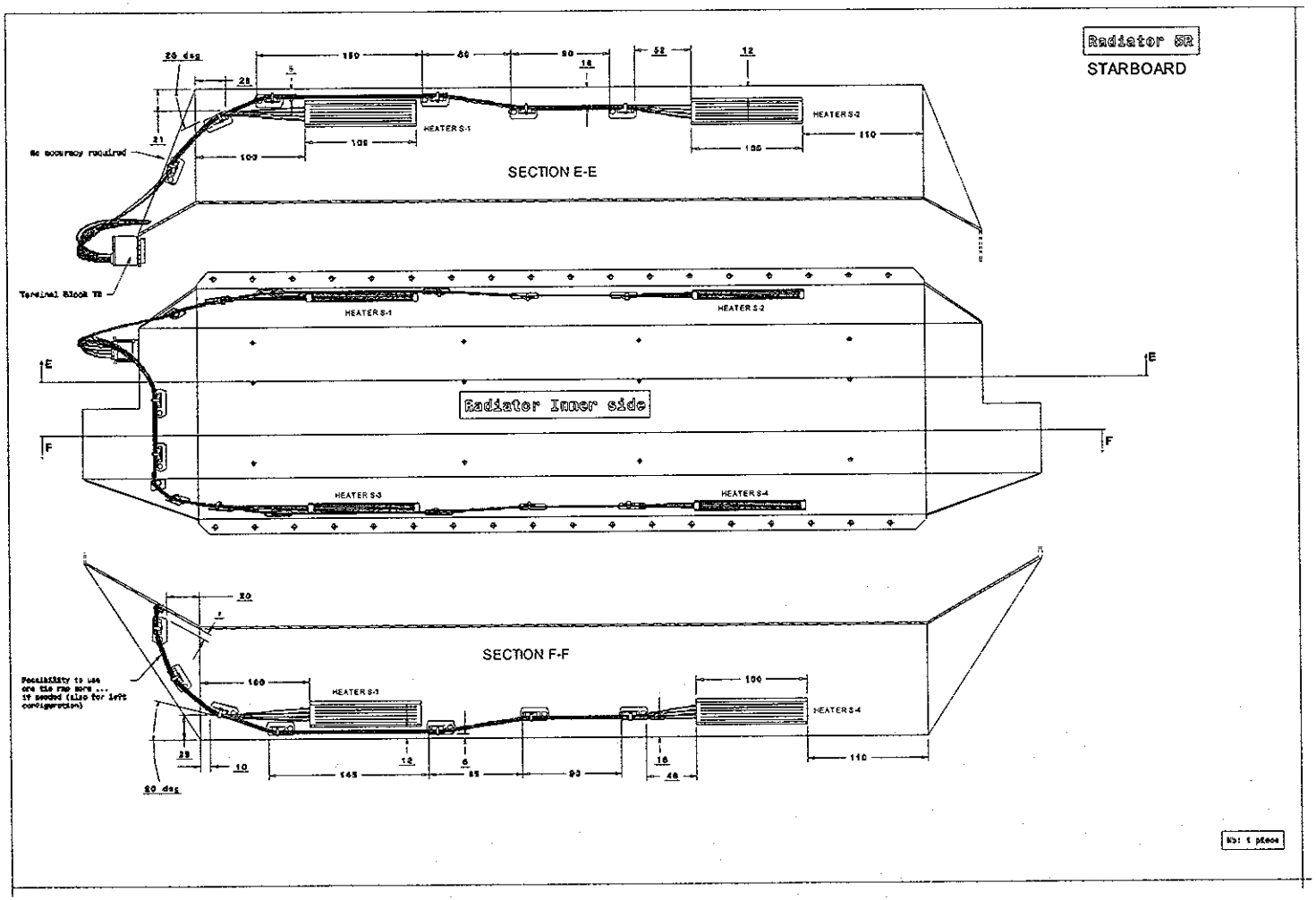

Fig. 4.12: ECAL heater ICD, starboard radiator

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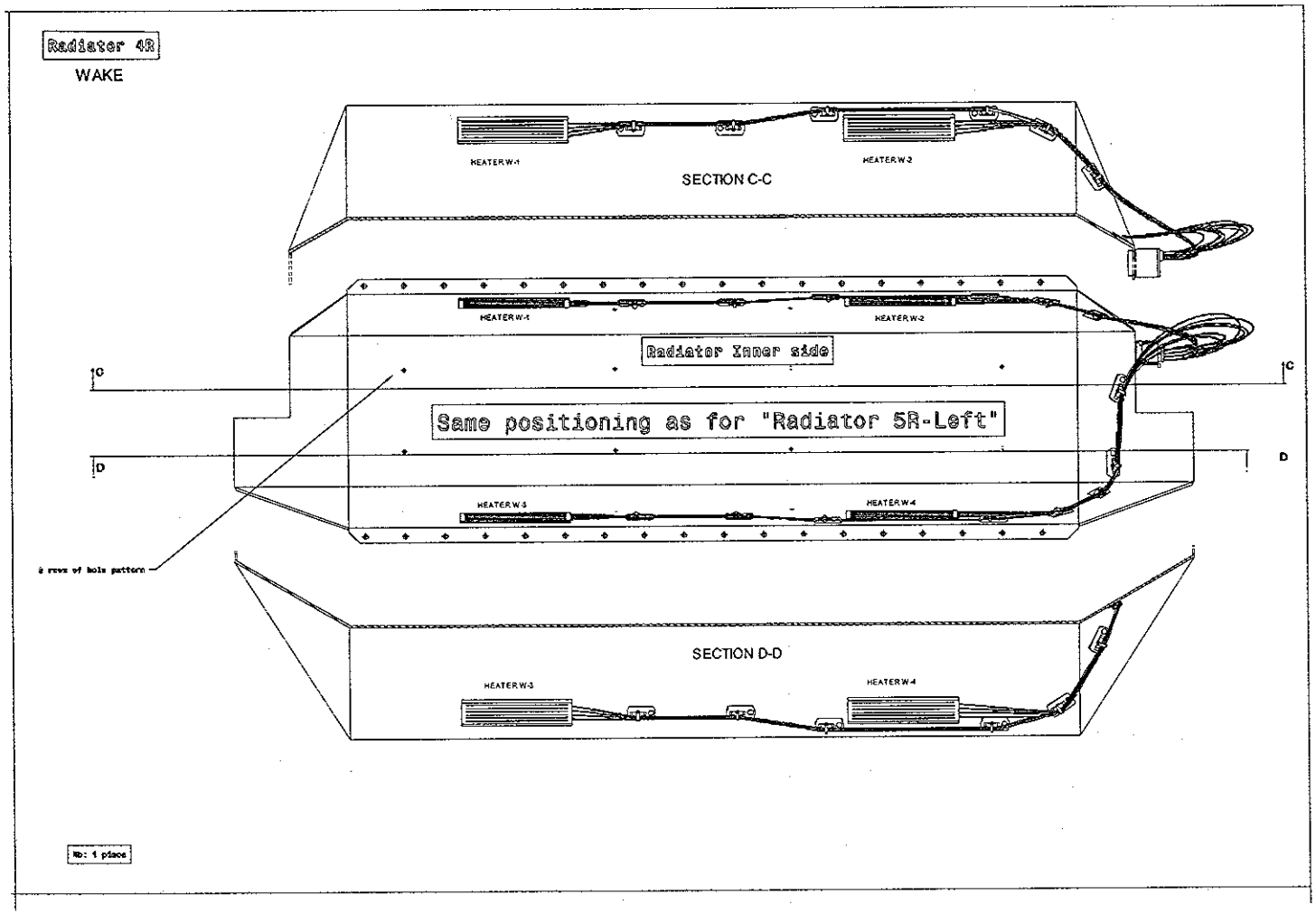

Fig. 4.13: ECAL heater ICD, wake radiator

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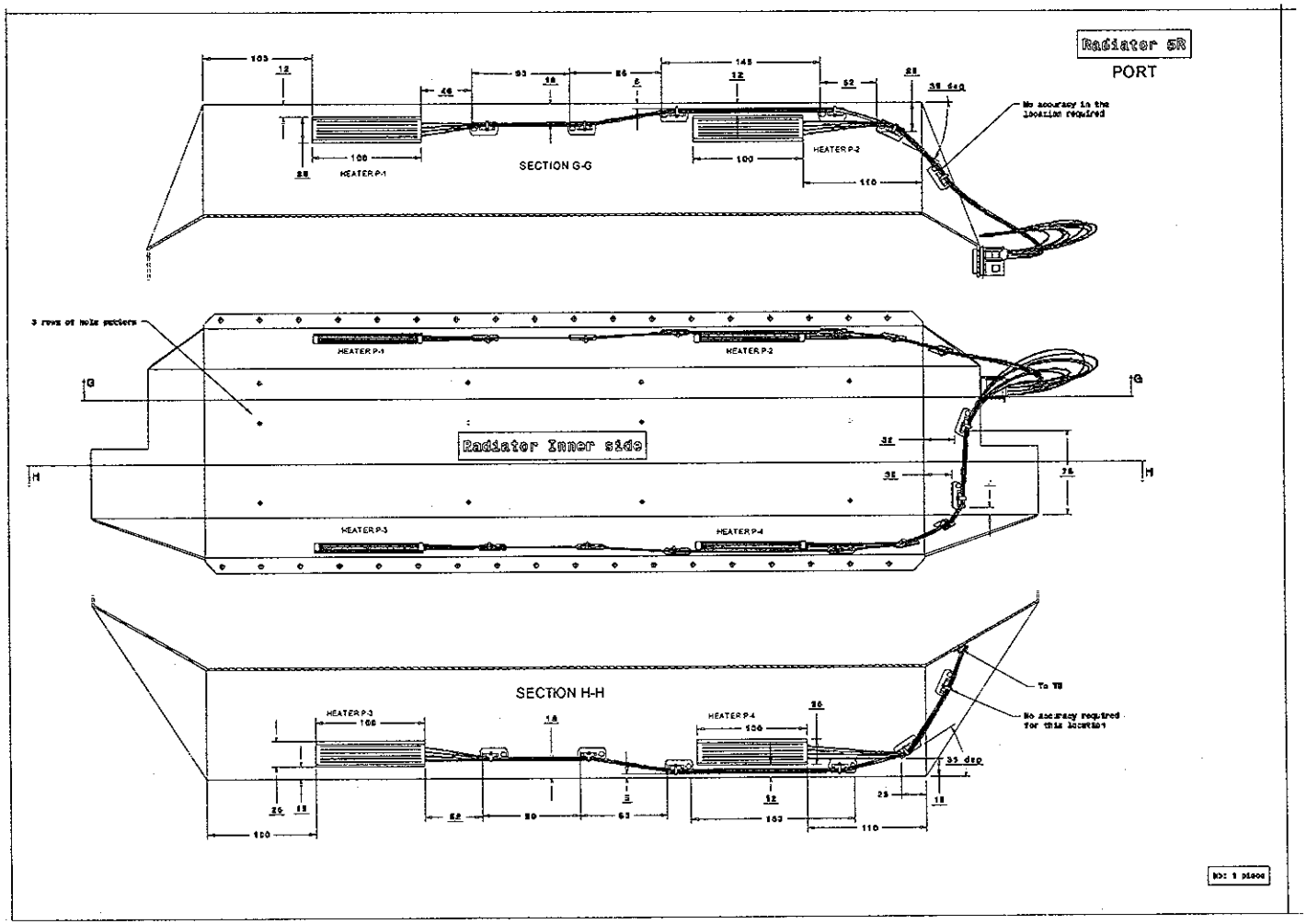

Fig. 4.14: ECAL heater ICD, port radiator

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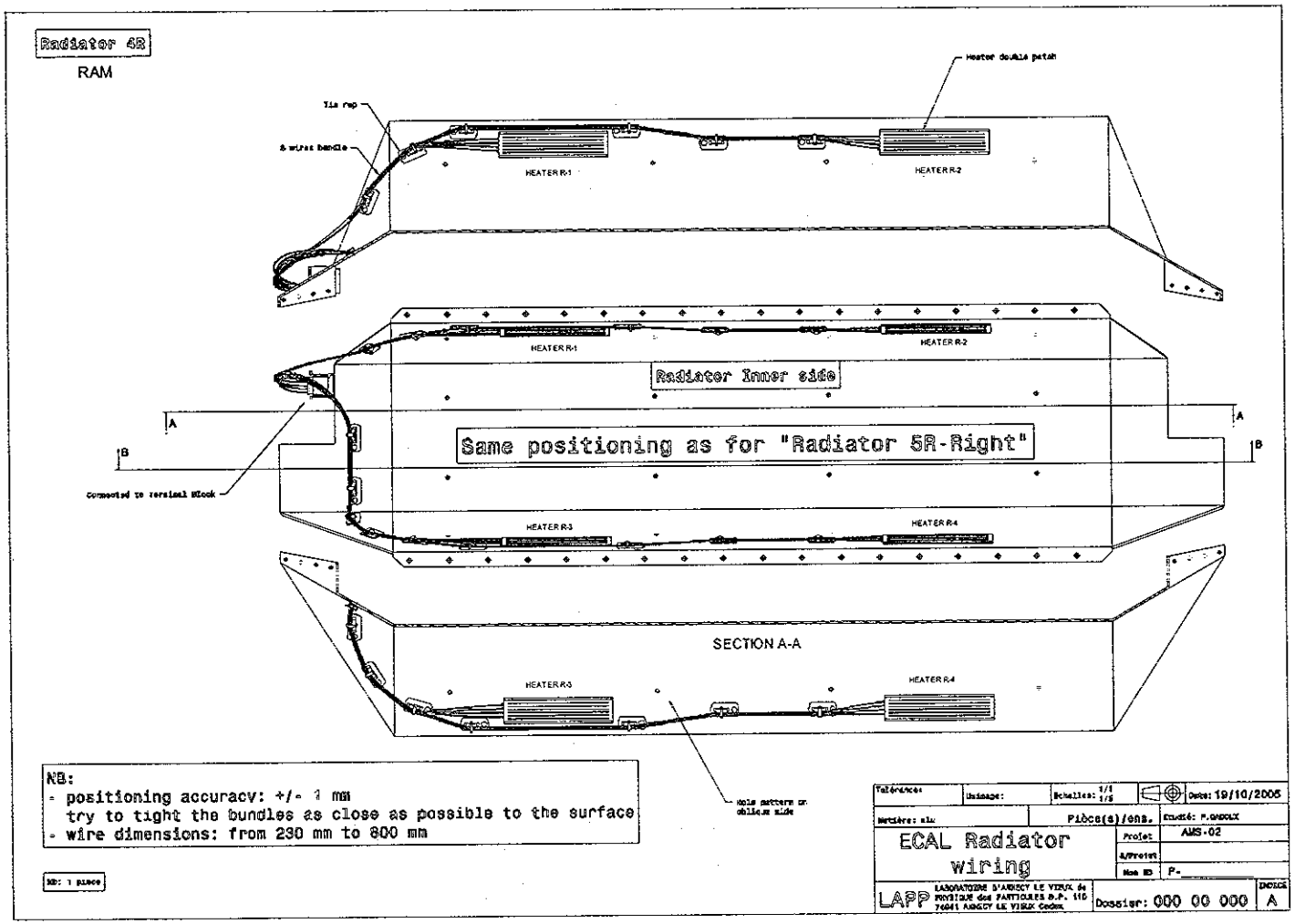

Fig. 4.15: ECAL heater ICD, ram radiator

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4.7 ECAL THERMOSTATS MECHANICAL INTERFACE

ECAL thermostats drive the heaters, and are placed on the Back Panels close to the mounting brackets corners Thermostats are glued with ECCOBOND glue. The location is shown in the following figures:

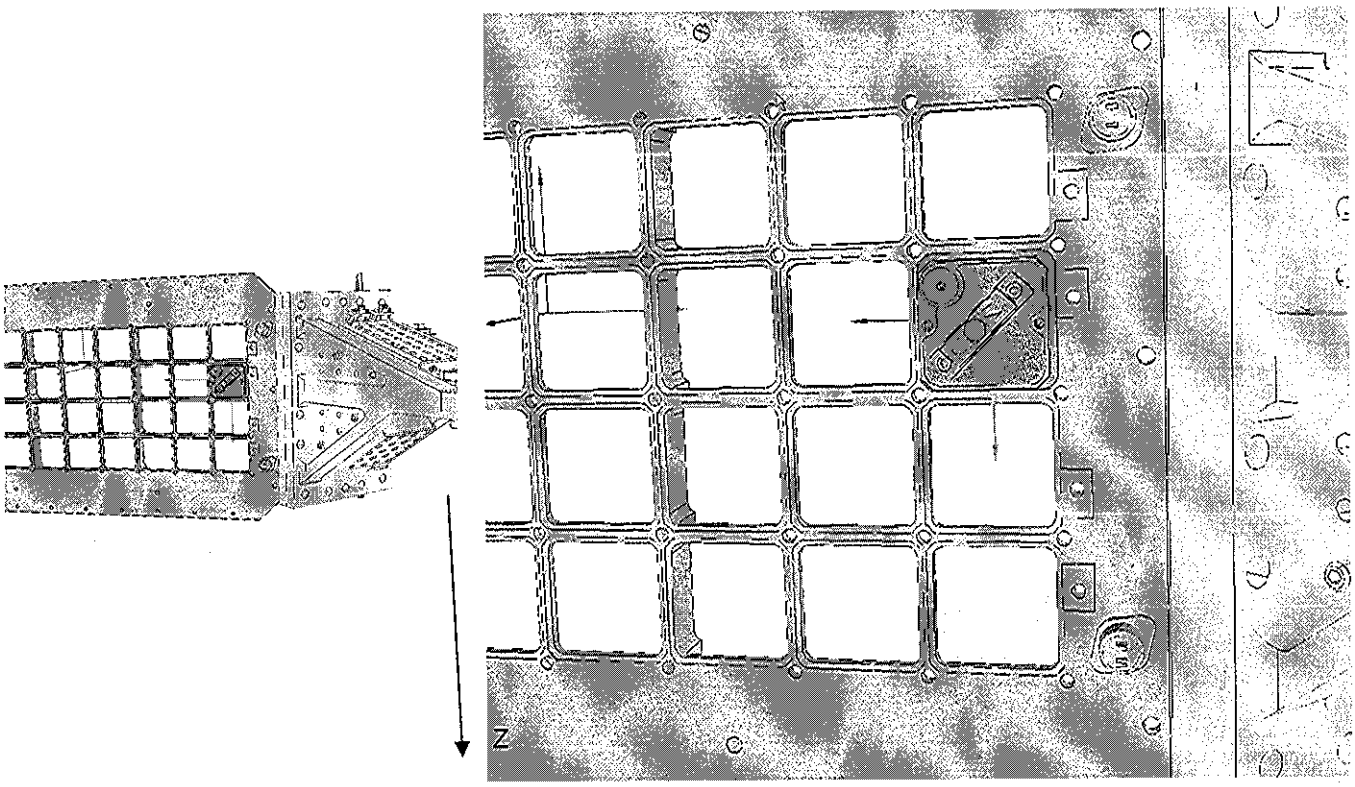

Fig. 4.16: ECAL thermostats location (green), on the 4-PMT rows back panels (pink). Mounting bracket is indicated in yellow. Please note that Z axis is pointing downwards in the figure

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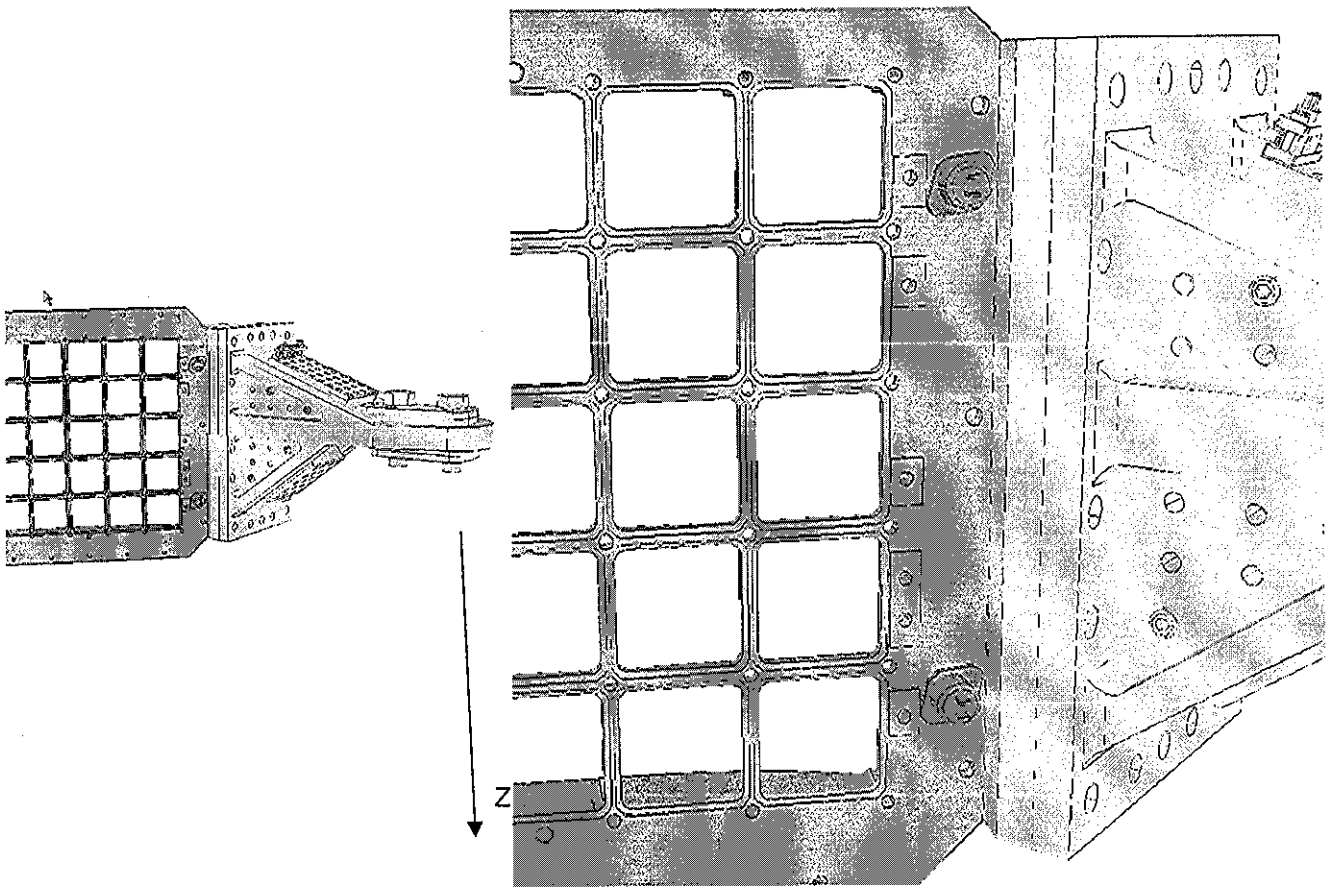

Fig. 4.17: ECAL thermostats location (red), on the 5-PMT rows back panels (green) Mounting bracket is indicated in yellow. Please note that Z axis is pointing downwards in the figure

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4.8 ECAL HEATERS AND THERMOSTATS ELECTRICAL INTERFACE

The heaters and thermostats electrical scheme is the following:

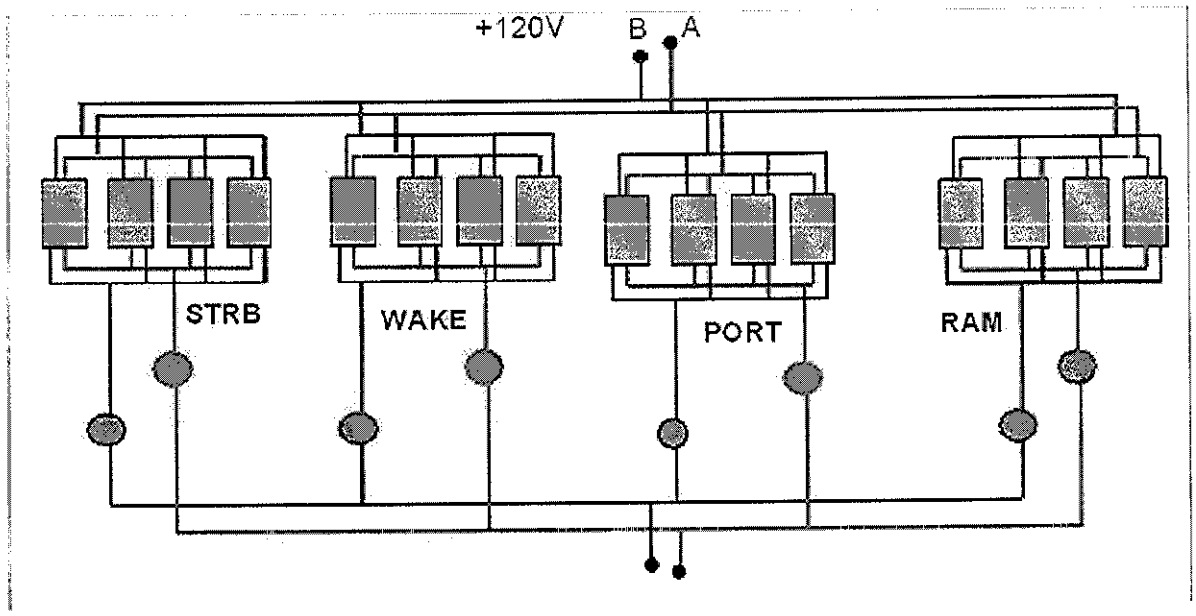

Fig. 4.18: TOF heaters and thermostats electrical scheme.

Each heater patch has a couple of twisted pair wires (4 wires in total) as per the following figure. Each twisted pair is connected to a single feeding line bus (A or B).

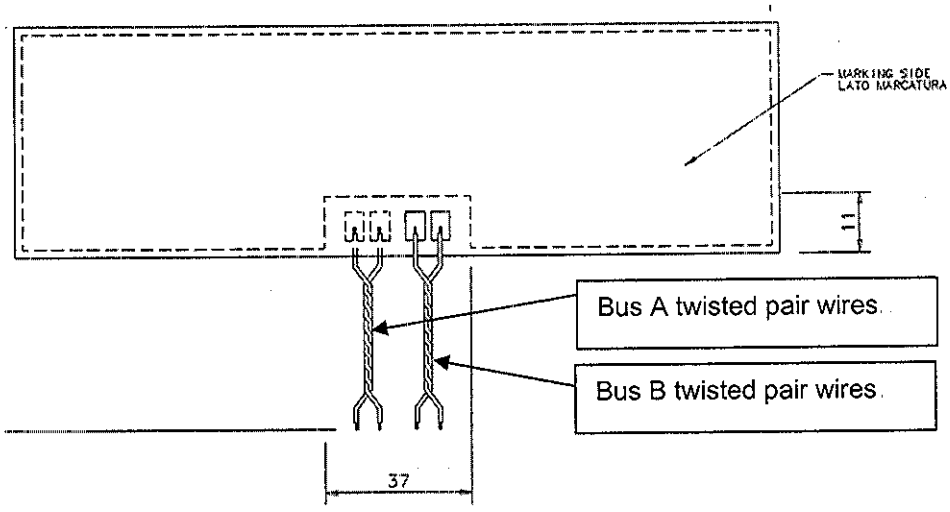

Fig. 4.19: Heater wires

Thermostats are provided with 2 flying leads each.

Harness shall be provided as flying leads, properly labelled as defined in the installation procedure

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