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SPECIFICATION FOR THE ACCUMULATOR VACUUM BAKEOUT SYSTEM MAGNET VACUUM CHAMBERS HEATING BLANKETS

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FERMI NATIONAL ACCELERATOR LABORATORY

TEVATRON I SECTION

VACUUM GROUP

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MAGNET VACUUM CHAMBERS HEATING BLANKETS

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REVISED _____

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1.0 GENERAL DESCRIPTION

This document specifies a 300°C bakeout system utilizing a heating blanket comprised of heating elements incorporated or attached in or on to glass fiber cloth carrier, a layer of ceramic fiber thermal insulation, and an outer surface glass fiber cloth. The insulation material has to be well attached to the carrier cloth in order not to be displaced. This type of heating blanket will be wrapped around stainless steel vacuum chambers, then covered by copper sheet heat sinks, and installed in the gap of the Accumulator magnets. Heating elements and any other metallic components in the blanket shall be non-magnetic. This specification is for the heating blankets only ready to be installed custom fit on the chambers as specified.

The following Accumulator magnets, with their different shaped vacuum chambers, will need heating blankets:

SMALL QUADRUPOLES Type SQA, SQB, SQC, SQD, SQE	Total Req'd 54
LARGE QUADRUPOLES Type LQA, LQB, LQC, LQD	Total Req'd 30
SMALL DIPOLES Type SDA, SDB, SDC	Total Req'd 18
LARGE DIPOLES Type LDA	Total Req'd 12

2.0 OPERATING CONDITIONS AND CONTROLS

The heating blankets will be tightly compressed between the vacuum chambers and the copper sheet heat sinks inside the magnets. The blankets shall be suitable for direct contact with the above mentioned metals for an average temperature of 300°C±15°C on the surface of the stainless steel chambers. The surrounding atmosphere will be air of about 35°C and 60 to 70% relative humidity.

The rate of temperature increase will be controlled by a microprocessor. Control and regulation of the temperature of the vacuum chambers will be done by type E thermocouple probes attached on the outside surface of the chambers. Each vacuum chamber section will have up to 10 thermocouples. Bakeouts at 300°C average temperature of the vacuum chambers will usually last for about 20 hours, and the descent to ambient temperature will last about two hours.

3.0 TECHNICAL SPECIFICATION OF HEATING BLANKET

The various drawings accompanied with this specification give the different shapes and lengths of the stainless steel chambers that the blankets have to be made for. The drawings also show the copper heat sink jackets around the blankets and the maximum space available for the heating. Note that the chambers used in the dipole magnets are curved along the length. The blankets shall fit properly so not to have any wrinkles after installation.

In order of location next to the stainless steel chambers, the heating blankets shall consist of:

a. glass or ceramic fiber cloth carrier

b. heating elements incorporated or attached in or on the fiber cloth carrier (.078 inches maximum thickness). The elements must be non-magnetic with maximum permeability ≤ 1.02.

c. a layer of ceramic fiber thermal insulation having a thermal conductivity value at 300°C of approximately 0.08 W/m°C (0.6 Btu-in/HR FT^2 °F). The required thickness shall be according to the drawings to give the required blanket overall thickness. The insulation material shall be well attached to the carrier cloth in order not to be displaced by material weight. Uniform overall thickness of the blanket is very

important for proper fit inside the copper heat sink jacket.

d. the outer surface finish shall be of a glass or ceramic fiber cloth.

The heating blanket shall have good mechanical strength and flexibility. There shall be no possibility of the elements or the thermal insulation being displaced in this blanket. The vendor shall propose a way to wrap and close the blanket tight against the chamber for Fermilab approval.

The finished blanket shall be baked at 305°C for two hours with proper ventilation to remove any sizings or finishes used in the manufacturing of the materials. After baking the blanket shall conform to this specification.

3.1 Electrical Insulation

The heating elements within the blanket and the leads shall withstand a voltage of 1000 volts between the elements themselves and the surface of the chamber. Tests will be carried out at room temperature and at 300°C average temperature.

3.2 Electrical Connection

The cold leads shall be multistranded copper/nickel extending 6 feet from one end of the blanket. The leads shall be electrically insulated (300°C) and securely crimped to the heating elements (crimps non-magnetic). The connection shall incorporate a strain relief feature so that pulling on the leads no force is exerted on the heating element/lead joint. Any force applied on the lead shall be taken up by the cloth carrier. No connectors are required at the end of the leads. All heating element circuits shall be

marked and the location identified from the vendor supplied drawing.

3.3 Power Supply

The heating blankets shall be suitable for use on 208 volts alternating current per circuit.

3.4 Distribution of Heating Capacity

The heating blanket shall be constructed in such a way that the heating elements provide a homogeneous temperature on the chamber surface. The power required for each type of blanket is given in the corresponding drawings. The heating elements shall cover the maximum possible chamber surface area. 100% redundancy is required for the heating elements. For example if 8 circuits are required to supply the heat as specified on the drawings, 16 circuits shall be installed equally distributed so that every other circuit is powered. This is necessary because the heating elements cannot be repaired after installation in the large magnets. The 100% redundancy for the heating elements is NOT required for the small quadrupoles magnets (see paragraph 1.0).

4.0 IDENTIFICATION OF HEATING BLANKETS

All heating blankets shall be clearly marked (labelled or otherwise) with loading in watts at 208 volts AC and with corresponding drawing number.

5.0 PRODUCTION

One prototype of each type will have to be approved by Fermilab in writing before production can start.