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TFTR NEUTRAL BEAM TEST FACILITY CRYOPANEL HELIUM REFRIGERATOR

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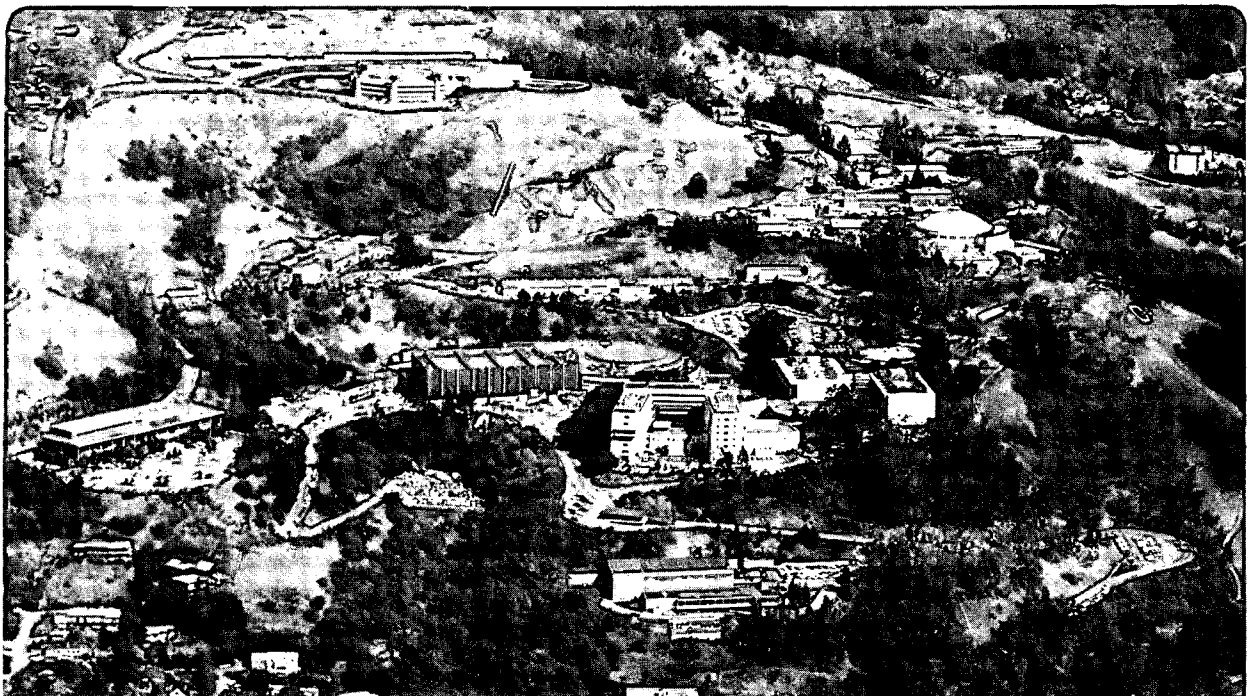
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LAWRENCE BERKELEY LABORATORY UNIVERSITY OF CALIFORNIA	CODE AA0135	SPECIFICATION		SERIAL M507 B	PAGE 1 OF 6
WRITTEN BY R. Byrns	DEPARTMENT Mechanical	LOCATION Berkeley		DATE May 3, 1977	
TITLE TFTR NEUTRAL BEAM TEST FACILITY CRYOPANEL HELIUM REFRIGERATOR				CHECKED BY	

"A" Rev. May 23, 1977

"B" Rev., July 15, 1977

(see p. 4, 5, 6.)

1.0 INTRODUCTION

The Lawrence Berkeley Laboratory (LBL) has need for a helium refrigerator-liquefier. The machine will be used for cryopumping a prototype deuterium neutral beam injector system at Berkeley. Multiple neutral beam systems will be installed later at TFTR (Tokamak Fusion Test Reactor) Princeton, NJ, and Doublet III, General Atomics, San Diego, CA.

LBL is interested in obtaining technical and contractual proposals for this refrigeration requirement. Proposals should include guaranteed minimum delivery and guaranteed maximum consumption values, as well as a detailed description of the equipment offered.

2.0 SCOPE

Supply of a complete helium refrigerator-liquefier is required, including compressor(s), cold box, purifiers, instrument panel and engineering start-up supervision. Components shall be skid mounted, pre-packaged and pre-tested for ease in field assembly. Compressor skid shall be separate from cold box for remote and sound reducing location.

3.0 PERFORMANCE

	<u>Without LN</u>	<u>With LN</u>
Refrigerator at 4.5°K	200 watts	400 watts
Liquefier	40 liters/hr	80 liters/hr

3.1 The above numbers are considered minimum acceptance values. Added potential performance information is required:

1. Refrigeration capacity at 3.5°K.
2. Refrigeration maximum output at 4.5° with heroic effort i.e.
 - a. Continuous addition of liquid helium
 - b. Additional compressor capacity

3.2 Maximum guaranteed values of electrical power and liquid nitrogen consumption are required.

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B

4.0 ACCEPTANCE TESTING

4.1 Prior to contract, seller will define:

- a. Pressure rating of all circuits.
- b. Insulating vacuum pressure attainable at operating conditions with 4" max. dia. diffusion pump.
- c. Maximum values for heat exchanger cross channel leakage, vacuum leakage and external leakage at operating conditions.
- d. Required minimum mass flow.

4.2 Seller will perform tests for 4.1 above and certify procedures and results before shipping to LBL (shop tests).

4.3 LBL may perform all or part of 4.1 tests after arrival at Berkeley.

4.4 After installation the refrigerator will be operated at design conditions, under sellers direction for a period of 168 continuous clock hours prior to start of a 24-hour performance test, demonstrating the capacity capability.

B

5.0 DESIGN AND CONSTRUCTION

5.1 Engineering discussion between seller and LBL prior to contract will be held for further clarification.

5.2 Seller is responsible for providing sufficient drawings and instructions for installation and maintenance. Final drawings and test reports (4.2) shall be certified.

5.3 System shall have sufficient localized valves, controls and sensors to provide simple operation for cool-down, steady-state, warm-up, diagnostics, evacuation and purge. Internal electric heat load will be provided. (4.4)

5.4 System shall have safety devices to meet applicable codes and regulations and protect personnel and equipment during mal-function and fault conditions.

5.5 Expander devices may be rotary or reciprocating. Seller will supply system redundancy or spare parts to provide replacement or repair within three hours maximum.

5.6 Purifiers at 30°K and 20°K sized for 400 or more hour service with on-stream reactivation ability are required.

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- 5.7 System shall be designed and constructed for continuous operation and must meet the latest standards of:
- a. Electrical - AIEE, NEMA, IEEE, UL
 - b. Pressure vessels and heat exchangers: ASME-UPV Section VIII, IX
 - c. Piping, ASAB31.5A, ANSIB31.3
 - d. Occupational Safety and Health Act, 1970 (OSHA)
 - e. Uniform Building Code, Seismic Design for Zone 3

6.0 INSTALLATION AND OPERATION

- 6.1 LBL will provide material and labor for equipment installation and connection, also labor for operation and maintenance. Major modification and repairs are sellers responsibility.
- 6.2 Following utility schedule is available for operation.
- Electrical - Power as required at voltages of 480/240 and 110v.
- Cooling Water - At a minimum pressure of 40 psig and maximum temperature of 85°F, return minimum 10 psig, maximum 105°F
- Liquid Nitrogen - As saturated liquid at 25 psia.
- Instrument Air - Maximum pressure of 80 psia, dry, oil free.
- Helium Gas - Grade E, Quantity as needed.

RB/km

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"B" REVISION - July 18, 1977

Sections 1.0 through 6.0 of the specification are revised as follows:

1.0 INTRODUCTION

2nd paragraph should read:

With this revision, LBL is interested in obtaining technical and contractual proposals, as well as bid prices, for this refrigeration requirement. Proposal should include guaranteed minimum delivery and guaranteed maximum consumption values, as well as a detailed description of the equipment offered. Bid price should be broken down for individual items, i. e., the coldbox assembly, the compressor system with oil removal system, compressor testing, spare parts, and technical supervision for field installation and acceptance tests at LBL.

3.0 PERFORMANCE

This section should be amended as follows:

	<u>Without LN₂</u>	<u>With LN₂</u>
Refrigerator at 4.5°K	200 watts	300 watts
Liquefier	(not required)	80 liters/hr

3.1 The above numbers are considered minimum acceptance values. Information regarding performance capacity, required additional equipment, and estimated cost (in '77 dollars) is desirable but not required for:

1. Refrigeration at 3.5°K.
2. Maximum refrigeration at 4.5°K.

3.2 Maximum values of electrical power and liquid nitrogen consumption are required.

4.0 ACCEPTANCE TESTING

4.1 No changes.

4.2 Seller will perform shop tests for 4.1 above on the coldbox limited to pressure and vacuum integrity tests. Final shop tests will be done in the liquid nitrogen temperature range.

4.3 No changes.

4.4 No changes.

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5.0 DESIGN AND CONSTRUCTION

- 5.1 No changes.
- 5.2 Seller is responsible for providing a minimum of two sets of drawings and instructions sufficient for installation, operation, and maintenance. Final drawings and test reports (4.2) shall be certified.
- 5.3 System shall have sufficient localized valves, controls and sensors to provide simple operation for cooldown, steady-state, warm-up, diagnostics evacuation and purge. Four customer bayonets, and an internal bypass valve and heater system for testing are required at 4.5°K.
- 5.4 No changes.
- 5.5 The coldbox shall incorporate two expanders. These expander devices may be rotary or reciprocating. In quoting, seller will supply separate pricing information for 100% redundancy or spare parts to provide replacement or repair within three hours maximum.
- 5.6 Single purifiers at 80°K, and at 20°K, should be sized for 400 or more hours of service. Piping shall provide for each vessel to be valved off from the main refrigeration stream and reactivated.
- 5.7 No changes.
- 5.8
- a. The compressor system shall use an American made, oil-flooded, single stage, screw compressor with slide valve for variable capacity control. The skid package shall include all controls for compressor operation, including motor line starter and protection devices. Motor shall have internal thermal protection sensors.
 - b. Package shall include bulk-oil separator, aftercooler, oil coolers, demisters, coalescers, charcoal purifiers and final 10-micron filters, for purification of less than 0.5 ppm_v.
 - c. Package and pricing shall include a minimum of one charge of required pre-treated de-gassed and de-watered oil.
 - d. If compressor is hermetic motor drive, seller shall design and construct oil system to provide proper motor cooling without excessive armature gap hydraulic losses. Additional shop system testing may be required.
 - e. Compressor tests shall include pressure/vacuum integrity, oil/water cooling, control operation and mass flow.
 - f. It is desired that compressor be tested at sellers plant, but schedule may require delivery to LBL for on-site testing, with acceptance tests.
- Seller shall provide separate pricing for compressor testing at either site.

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5.9 LBL WILL SUPPLY THE FOLLOWING:

1. The coldbox vacuum system; i.e., air-operated vacuum valve, diffusion and backing pumps.
2. The vacuum system for auxiliary equipment purge and pumpdown.
3. High pressure gas storage vessel.
4. High pressure gas storage bottles or tube bank, manifold, and regulators.
5. Room temperature gas lines interconnecting the compression and purification systems and the coldbox.

6.0 INSTALLATION AND OPERATION

No changes.

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

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