

Specifications for LN2 Delivery System

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I. Overview

This document outlines the required parts and specifications (Section II) for a new liquid nitrogen delivery system to continuously feed multiple molecular beam epitaxy (MBE) chambers. Liquid nitrogen will be delivered from an exterior liquid nitrogen tank to multiple phase separators located in an overhead utility area. This project will enable delivery to a new Riber Compact 21T MBE reactor with 3 inlet and 3 outlet lines. Additionally the design must be compatible with existing infrastructure for connecting with an existing phase separator and components for a Veeco Gen II MBE reactor as well as a potential third MBE reactor at a later date without interrupting operation of the initially installed Riber machine. General Specifications are outlined in section II, and terms of delivery and warranty are outlined in section III. Once the contract is awarded, prospective vendors are required to visit NRL to gather the necessary information to provide detailed designs for the overall system, which must be approved by NRL before the installation. Vendors are then responsible for delivery of parts and installation of the system.

II. Required Items

A. Phase separator:

1. A phase separator with at least 6 ports to allow for 3 supply and 3 return lines to a single MBE chamber.
2. If the cost of a 6 port phase separator exceeds that of a phase separator with more than 6 ports, the latter can be used with the additional ports capped off.
3. Phase separator must be able to provide continuous supply of 25 l/hr to the MBE reactor
4. The phase separator will include hangers, supports and drip pans as needed to ensure proper location and operation.

B. Vacuum jacketed (VJ) pipe: VJ pipe will ensure efficient delivery of LN2 from the tank to each phase separator. Unless otherwise noted, VJ line must be helium leak checked to 1×10^{-9} cc/sec. and have a demonstrated heat loss of less than 1.6 BTU/Ft/Hr.

1. Up to three phase separators (II.A. plus an existing 4 port phase separator and an additional phase separator which may be installed at a later date) will be fed from a tank outside of the building requiring a single VJ supply line that will T off to supply each phase separator. The length of VJ line between the tank and the building will be no less than 40 ft and the distance from entry into the building to the lab will be no less than 70 ft. The height from the supply of the LN2 tank to the building entry point will be no less than 20 ft. Inlet supply capacity

shall be sufficient to operate three phase separators all providing 25 l/hr liquid nitrogen to three separate machines simultaneously. Additional flex, elbows, tees, valves and relief valves must be included to meet the project requirements.

2. Return from each of the phase separators will be exhausted at the side of the building (~80 ft from the labs) via VJ pipe. Each phase separator will have its own return line. The two return lines can be joined at a T to enable a single return line from the two phase separators to the side of the building. Alternatively, the exhaust from each phase separator may be directed into the utility area or the buildings non-hazardous exhaust lines contingent on approval from NRL Facilities and Safety personnel. Additional flex, elbows, tees, valves and relief valves must be included to meet the project requirements.
 3. No less than 15 ft of VJ pipe will be connected to the main supply line with a valve that will allow installation of a future second and third phase separator in an adjoining lab space without interruption of the operation of the phase separator described in section A.
- C. VJ flex line for connection from the 6 port phase separator to the Riber MBE machine. Unless otherwise noted, vacuum jacketed line must be helium leak checked to 1×10^{-9} cc/sec. and have a demonstrated heat loss of less than 1.6 BTU/Ft/Hr.
1. 6 VJ flex lines will be used for supply and return from the phase separator to the MBE system
 2. The phase separator will be installed no less than 12 ft above the MBE chamber
 3. 4 of the connections to the MBE chamber must be TAL VBC A5
 4. 2 of the connections to the MBE chamber must be 5/8" Swagelok
- D. VJ LN2 isolation valves:
1. A minimum of three VJ valves will be provided such that nitrogen flow may be independently provided to each input line into the MBE chamber. Standard operation of the tool will not require removal on any of the vacuum jacketed lines while nitrogen is flowing to the chamber. If proper operation of the phase separator cannot be provided with only valves on the input lines, three additional valves must be provided on the exhaust lines to insure adequate isolation of each input during normal operation. Additional valves will be added to allow for the flow of nitrogen gas through the cryovalves when the system is not being actively cooled.
- E. Vacuum system: If active pumping is to be used, necessary pumps and connections to ensure that VJ pipes remain in the low mT range or below.

- F. Exhaust heaters. Vent heater assembly will be provided to remove buildup of condensation at the end of the exhaust line.

III. Installation time and warranty

The design of the system, shipment and installation must be completed within 8 weeks of award of the contract. Unless otherwise approved, VJ lines must have a warranty of no less than 10 years, and the phase separator will have a warranty of no less than 3 years.