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Helium liquefaction and distribution at TIFR, Mumbai, INDIA

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TIFR, Mumbai, INDIA

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Plan of my Talk

1. About TIFR and its activities involving cryogenics.
2. Evolution of LTF and its operation.
3. Contributions in O & M of 1610 KOCH helium liquefier
4. Installation of Linde, L280 helium liquefier

About LTF at TIFR

TIFR
A Deemed University

टाटा मूलभूत अनुसंधान संस्थान
TATA INSTITUTE OF FUNDAMENTAL RESEARCH

TIFR is a national institute of India for research devoted to fundamental aspects of Science

Low Temperature Facility (LTF) of TIFR provides **Liquid nitrogen** and **Liquid helium** to a large number of experiments in various departments, within the institute.

Liquefaction of helium started in LTF during the year 1962 and Liquid nitrogen generator was added later during the year 1968.

Instrument facilities that are supported by LTF

Facilities which are at kept cold continuously

- NMR spectrometers (Three Nos.) 800 MHz, 600 MHz and 500 MHz
- SQUID magnetometers (Three nos.)
- Physical Property Measurement systems (PPMS) – Two Nos.
- VSM magnetometer (Two Nos.)

Other major users of liquid helium

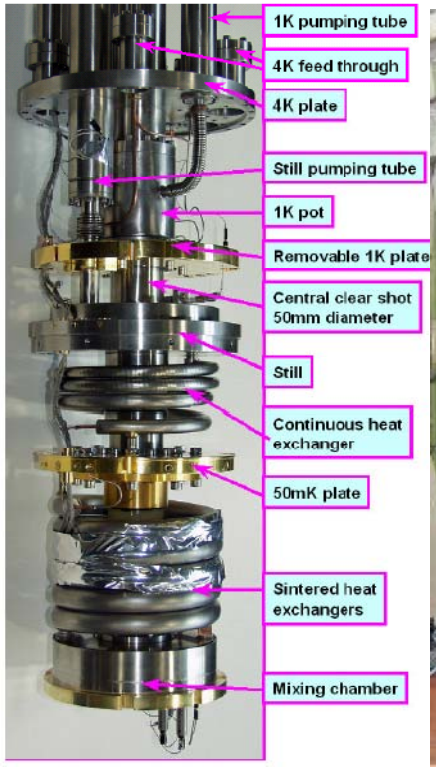
5. Nano-electronics
6. Dilution milli-Kelvin refrigerator,
7. Adiabatic de-magnetization milli-Kelvin refrigerator,
8. Micro-kelvin refrigerator
9. Tunneling Point Spectroscopy,
10. Point Contact Spectroscopy and
11. Photo Electron Spectroscopy.

In addition, about 16 other experiments also make use of liquid helium.

Milli-kelvin refrigerators

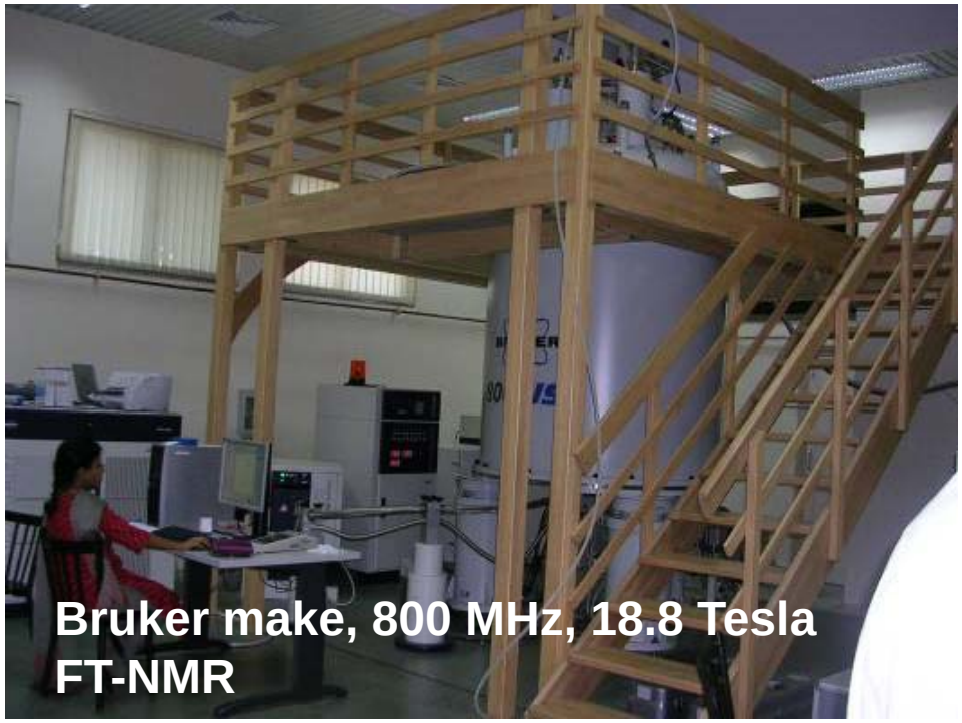
Adiabatic demagnetization

Micro-Kelvin Refrigerator



Dilution fridge – 4.8 milli K & 100 micro K by Cu nuclear demagnetization at 9T magnetic field

Superconducting NMR Spectrometer

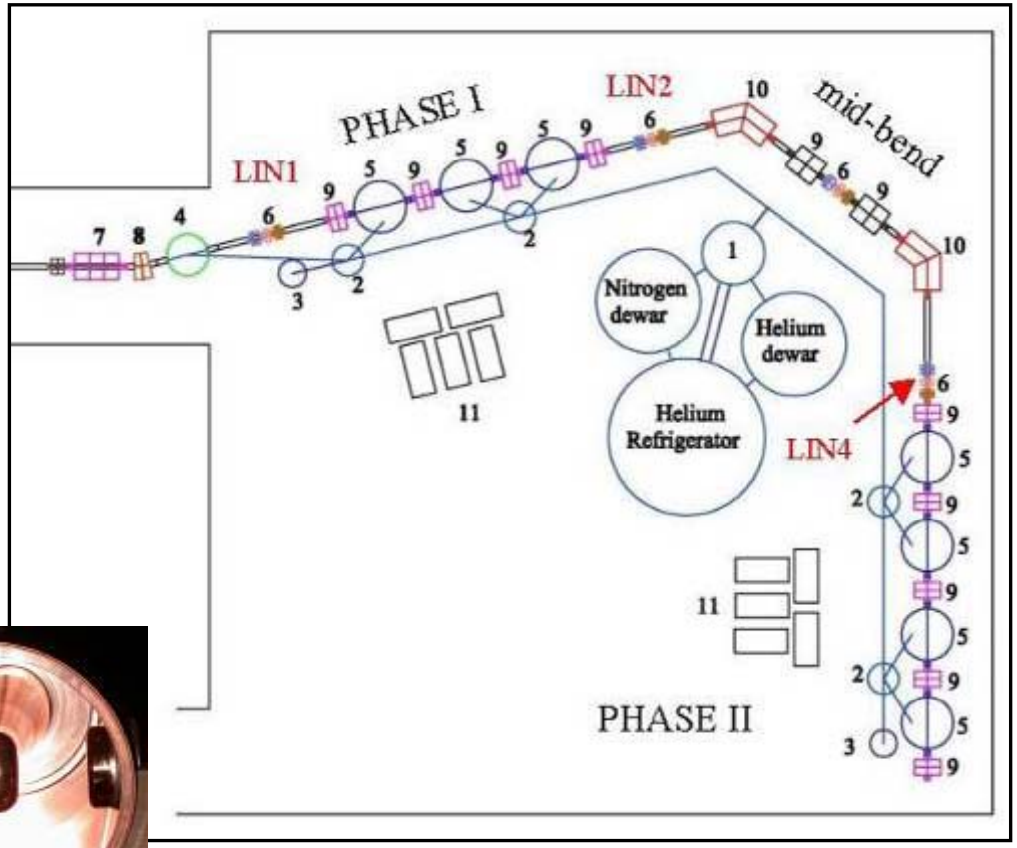


Variable temperature insert (VTI)
1.6K ~10T
With He3 insert 300mK

Superconducting LINAC Booster (joint TIFR-BARC project)

Specifications

Energy gain 14MV/q
Module 7 nos
Resonators 28 nos
Bunch width ~200 ps
Beam Intensity 0.1-10 pnA



Phase I commissioned on Sep 22nd, 02
Phase II on July 9th, 2007
LINAC dedicated to users on Nov. 28th, 2007

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Cryogenics system for the LINAC

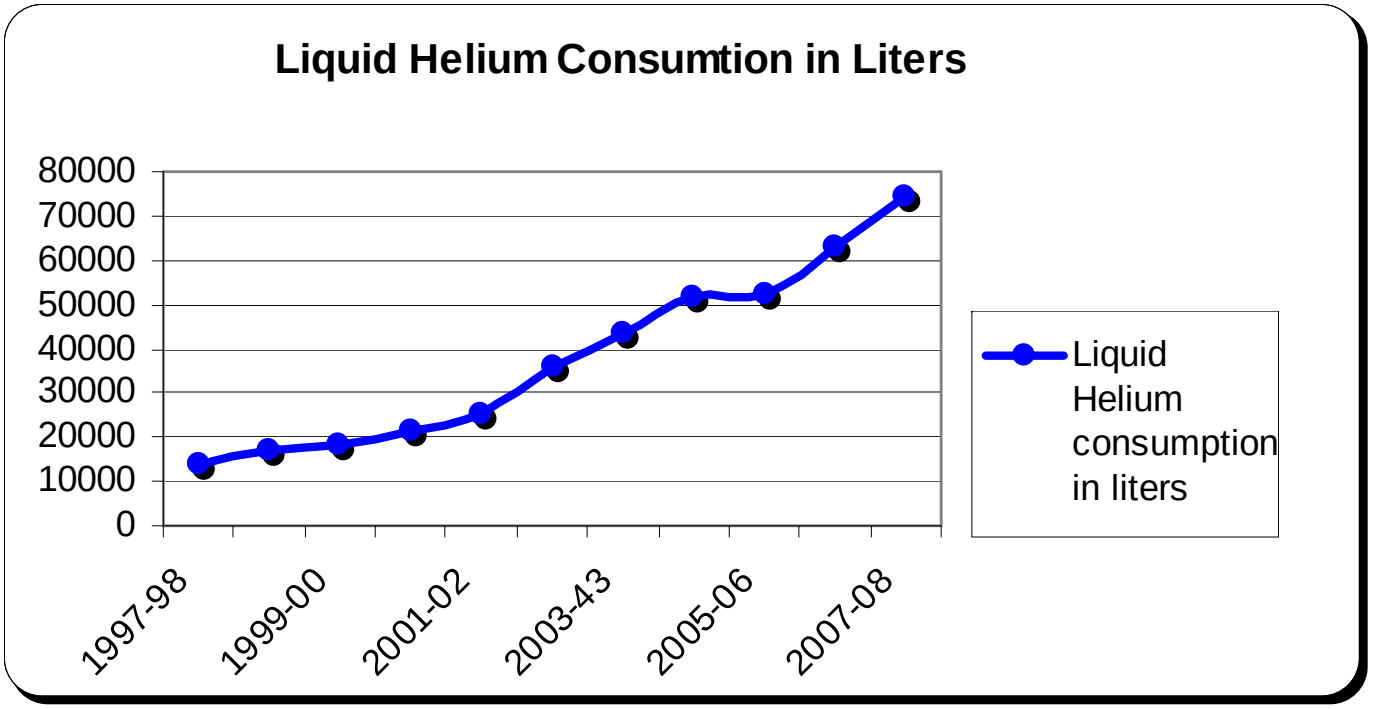
Helium Refrigerator	**Linde TCF-50S**
Al Plate Fin Heat Exchangers	
Two stage Turbine Expansion Engines	
Two stage JT Expansion	
250 KW Screw Compressor	**62 g/s**

Refrigeration at 4.5 K/Liquefaction

Without LN_2	**300 W, 50 l/hr**
With LN_2pre-cooling	**380 W, 120 l/hr**

The entire cryogenic distribution was fabricated and assembled on-site and has performed as per design.

Liquid Helium supply by LTF



In 1974 – **233** liters
In 1976 – 399 liters
In 1978 – 1100 liters
In 1988 – 4300 liters
In 1993 – 6385 liters
In 2000 – 20,000 lts
Currently >75,000 lts

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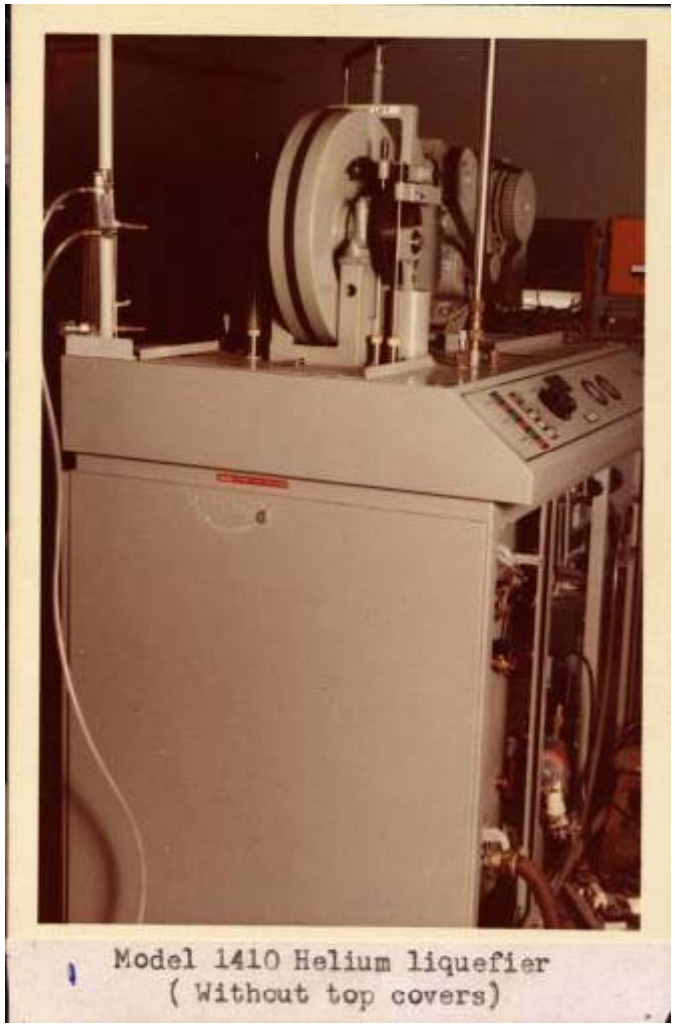
Evolution of LTF

ADL Collins Helium Liquefier

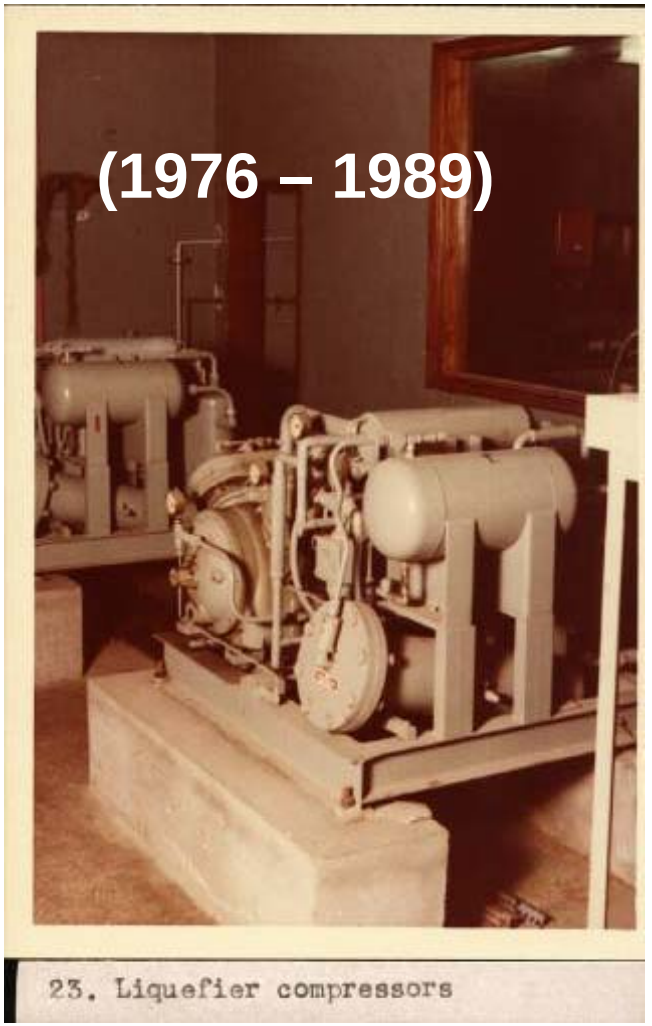
(1962 – 1976)

KOCH 1410 HELIUM Liquefier



Model 1410 Helium liquefier
(Without top covers)

Cover plate assembly being taken out.
Notice concern on the faces & cares being taken.



(1976 – 1989)

23. Liquefier compressors

KOCH 1610 HELIUM Liquefier

(1991 – till date)

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Operation and Maintenance of 1610 KOCH Helium Liquefier

Contributions in reducing the plant down time

Much efforts are required to keep the plant down time less as well as the best utilization of available machine time, so that large number of users requirements are met in time.

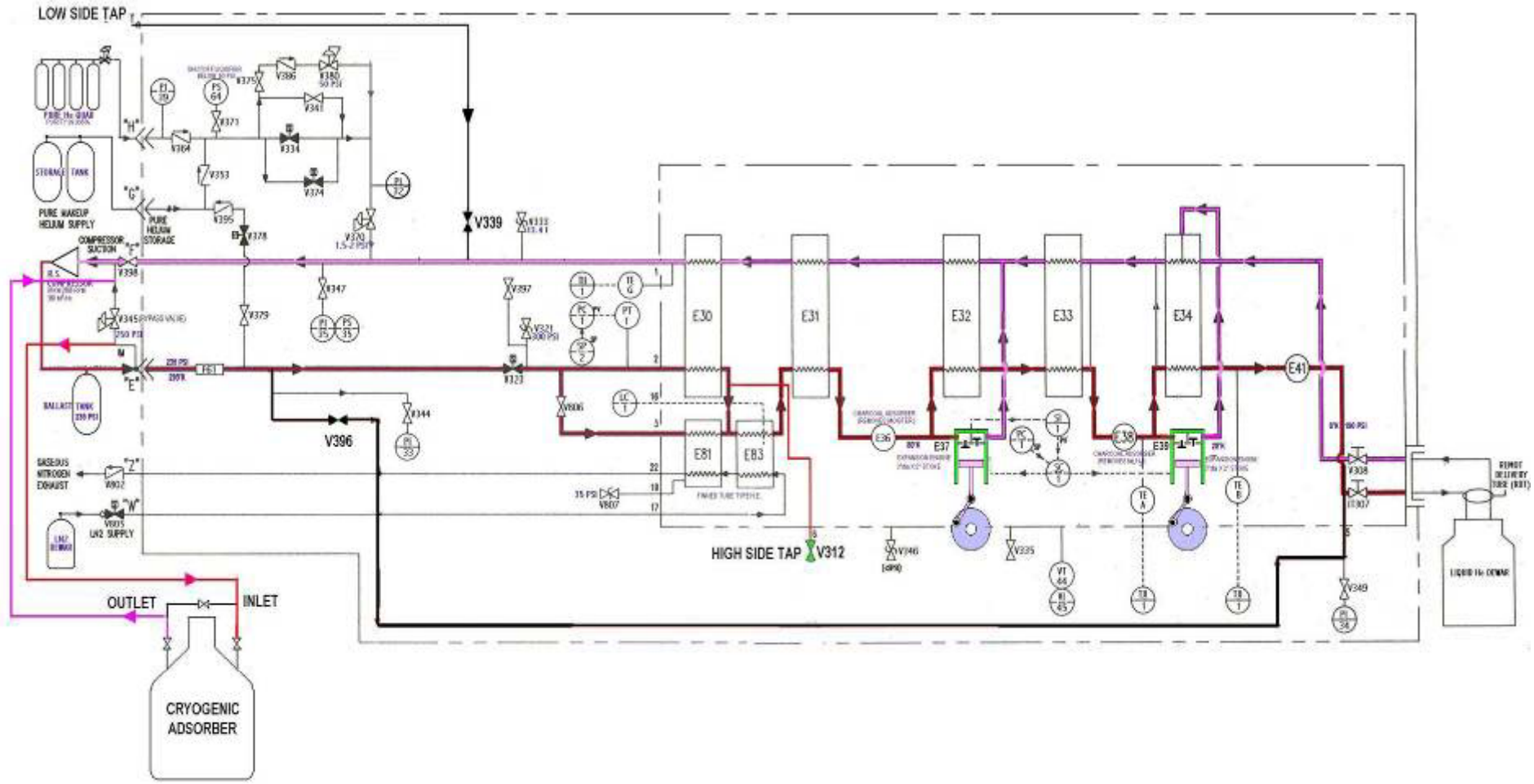
This is particularly essential for the plants under conditions of manual operation, utility failures etc. where unattended operations are not possible.

We need to carry out several modifications and innovative methods in operating these plants to maximize efficiency.

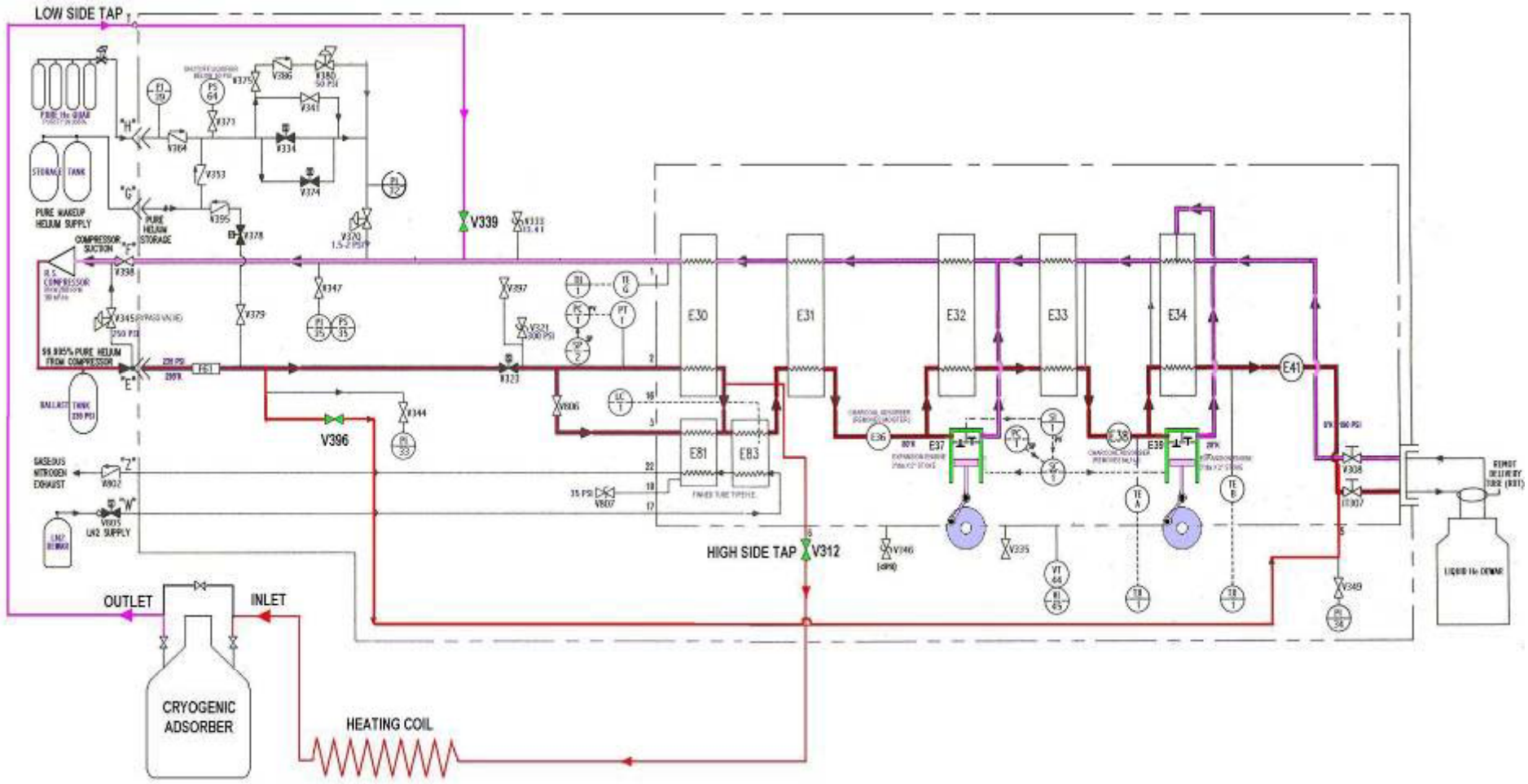
Some of these are presented here.

Reduced decontamination frequency

1610 Koch Liquefier Decontamination (normal method)



1610 Koch Liquefier Decontamination (modified method)



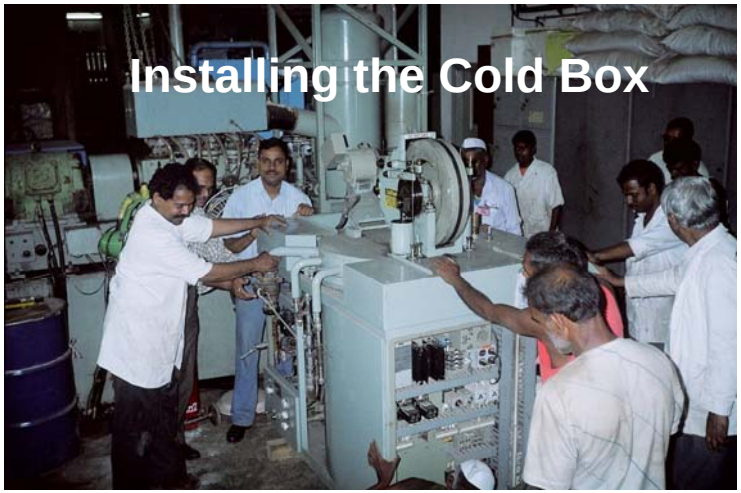
KOCH-1610 Helium liquefier re-installation

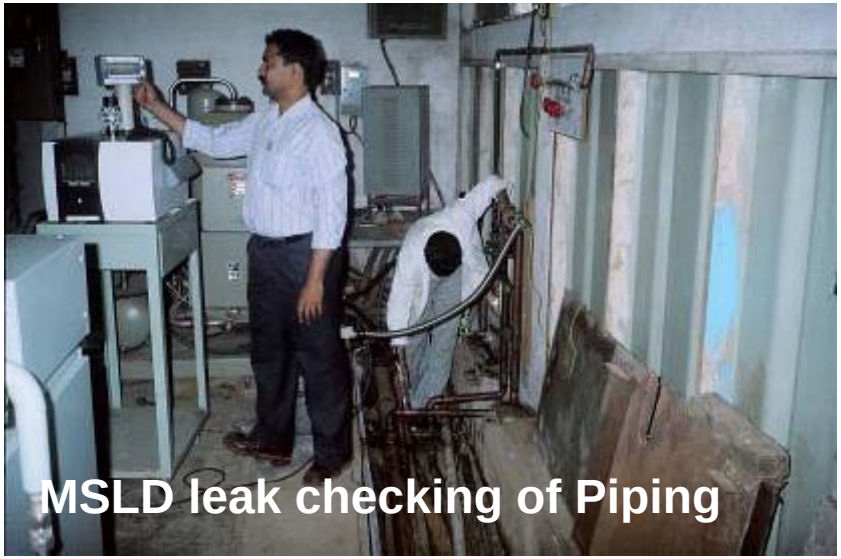
(16 years old plant) FEB-06

- Shifting, re-installation and commissioning to a new location within a period of 10 days
- Planned and executed the shifting, re-installation, commissioning of recovery compressors and auxiliary systems i.e., high pressure piping, valve manifolds, gas bag, purifier etc.
- Work done in-house by us

Helium Liquefier re-installation February 2006


Brazing work in progress


Installing the Cold Box


MSLD leak checking of Piping

Shifting of Mother Dewar

KOCH 1610 HELIUM Liquefier
(in operation at new location)

REPLACEMENT OF COLD BOX VACUUM VALVE

KOCH-1610 cold box vacuum valve replacement

Recovery of liquefier blow down helium gas

Recovery of liquefier blow down helium gas

We measured, 0.3 Cu.M with 85% helium purity is the quality in each blow down operation

Helium gas recovery and gas accounting at TIFR

Helium gas recovery and accounting at TIFR

At TIFR, helium gas is recovered, purified and re-liquefied.

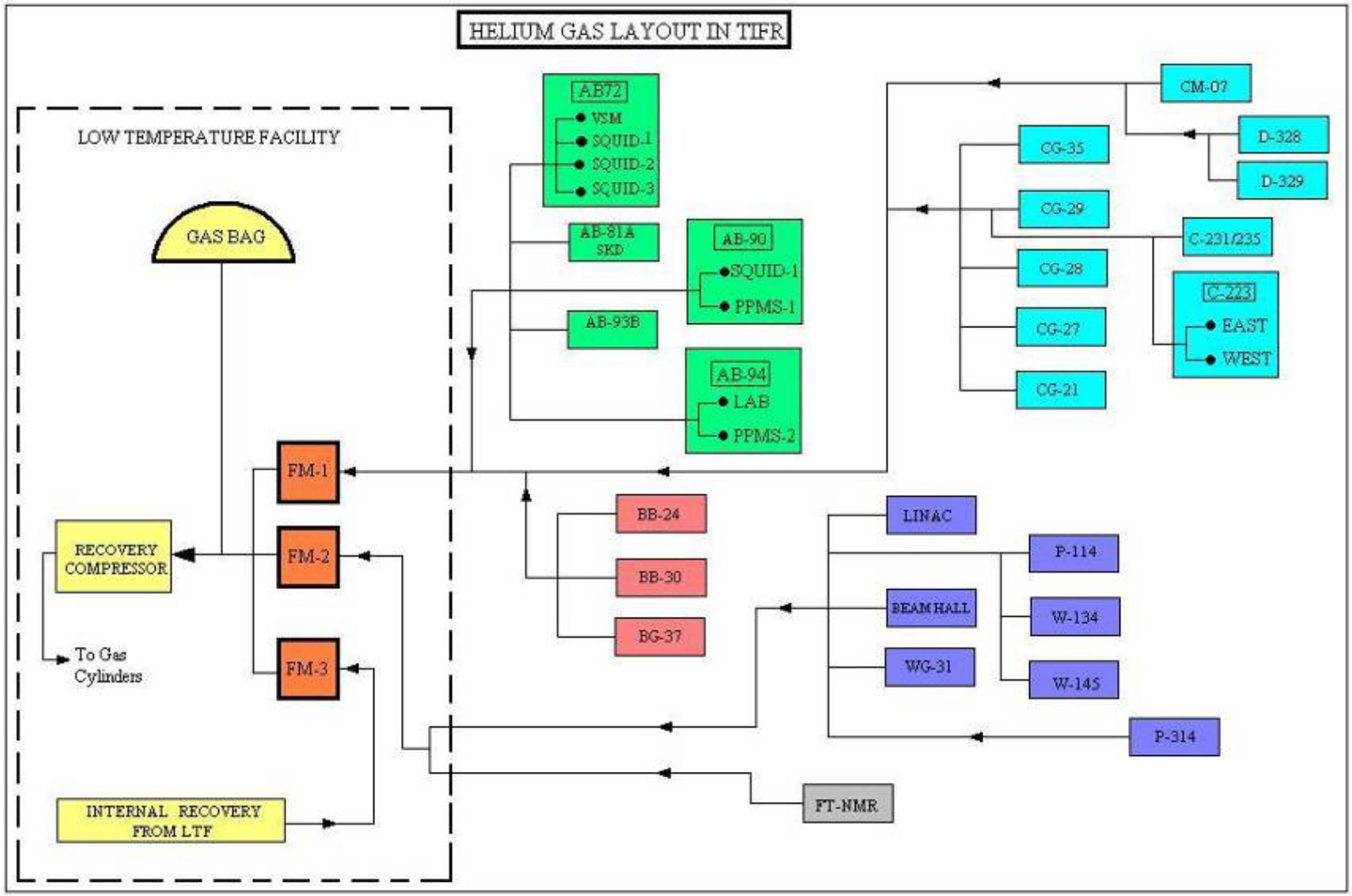
Therefore, there is large recovery line running through the various institute's buildings [~1.62 kms of total length] .

Our recovery lines are of 1" copper lines and all laboratories gets connected to the LTF plant, by a common header pipe. All laboratories are fitted with helium gas flow integrators for easy helium gas accounting.

Gas recovered at plant is recorded and recovery rate is calculated three times a day.

Our gas recovery rate is about 85% and the typical recovered gas purity is around 98%.

Helium Gas Recovery Network Map at TIFR



Helium gas recovery bag

Our recovery rate is 85% and typical recovered gas impurity purity is around 2%

Helium Gas Recovery Compressors

BAUER Model: G 150, 30 m3/hr; motor:11 KW

BAUER Model: G15.1, 22 m3/hr motor:11 KW

BAUER Model: G 22, 45 m3/hr motor:18.5 KW

High Pressure (200 bar) helium gas cylinder Pack (QUAD)

(LTF has more than 1000 cylinders packed in 19 Quads)

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Cryogenic Dewars managed by LTF

Helium Storage Dewars
One 1000 liters capacity, SS dewar.
Two 500 liters capacity, SS dewars.

Transportation Dewars
15nos of 100 liters, lightweight Dewars.
Nine 60 liters capacity, SS Dewars.
Two 65 liters capacity, SS dewars

LN2 Storage Dewars

LTF has 71 liquid nitrogen dewars with the capacity ranging from 85 to 250 liters

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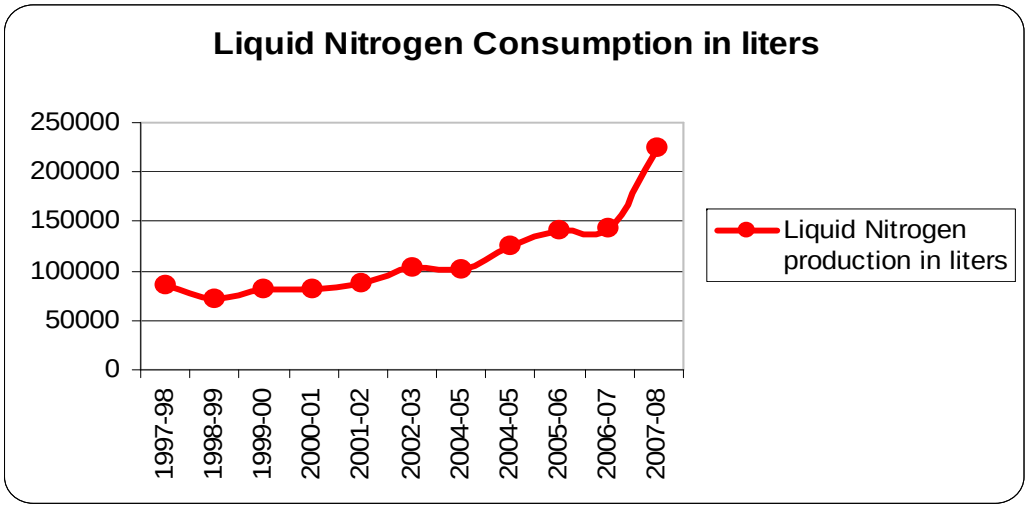
Re-conditioning of dewars – including modification / replacement of vacuum port


Vacuum pinch port replaced with a SS port


Adapters for dewar evacuation


Modified vacuum plug

Liquid Nitrogen at LTF



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New helium Liquefier (Linde,L-280) installation

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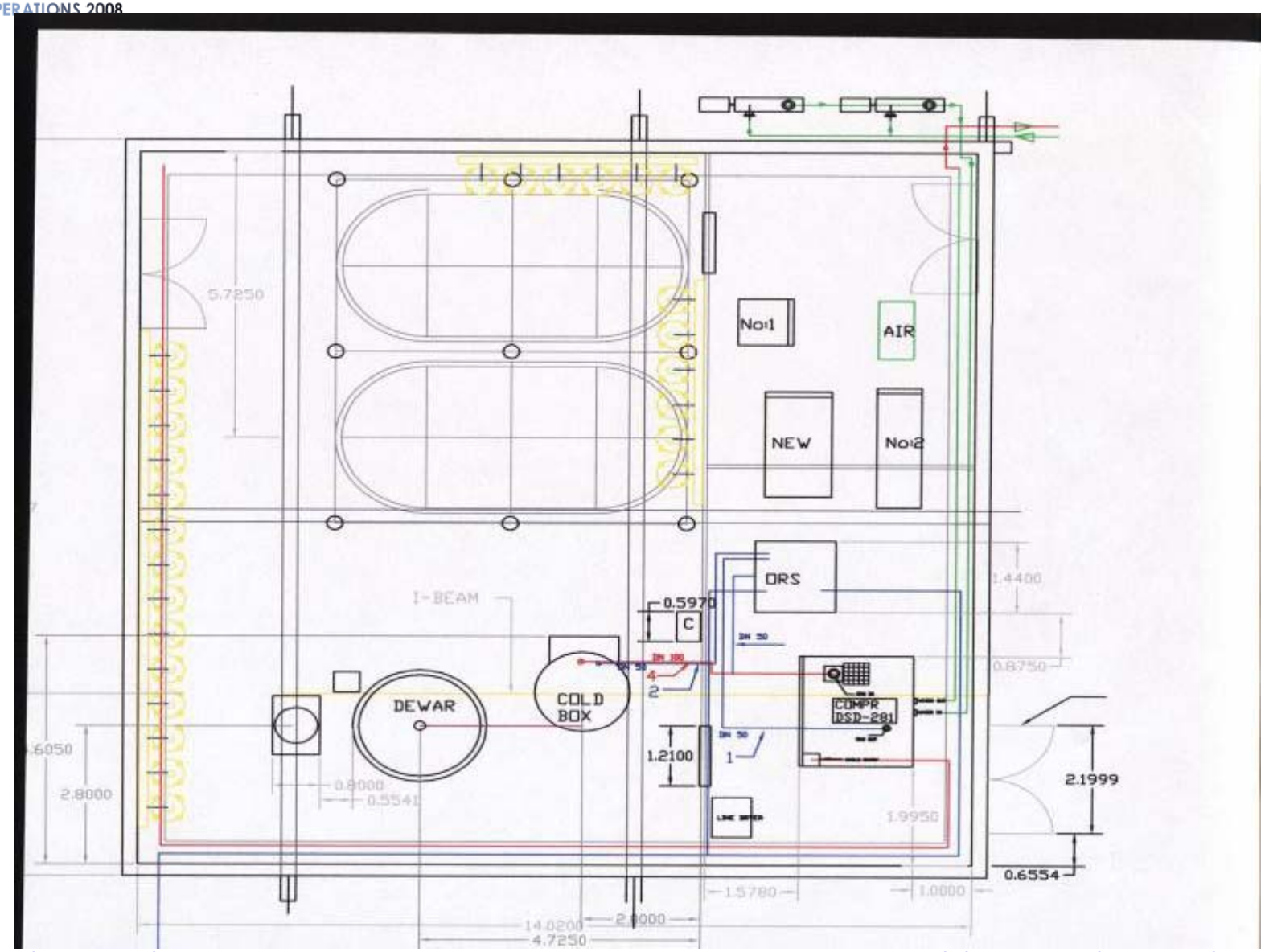
New helium plant installation

- New LINDE make, L-280 helium liquefier was acquired in 2007
- The installation was taken up in house, during Feb'2008
- Planning, drawing, bill of materials, material procurements, Vendor co-ordination, fabrication, testing and commissioning *all done by LTF-TIFR*
- Installation completed well within the target time (45 days)

Buffer Vessel for new helium Liquefier

PLANT INSTALLATION & PIPING LAYOUT



Back side (partition) view of the plant piping

Piping fabrication and plant installation


Set-up for welding with argon gas flushing

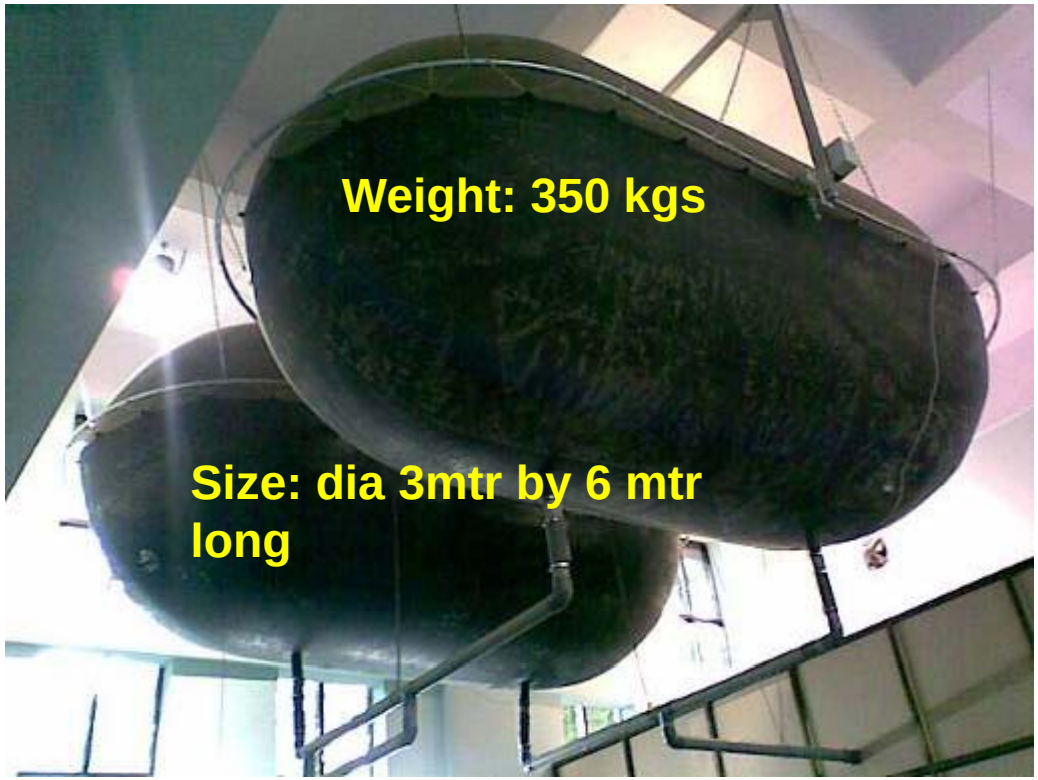

MSLD leak testing


X-ray testing at site

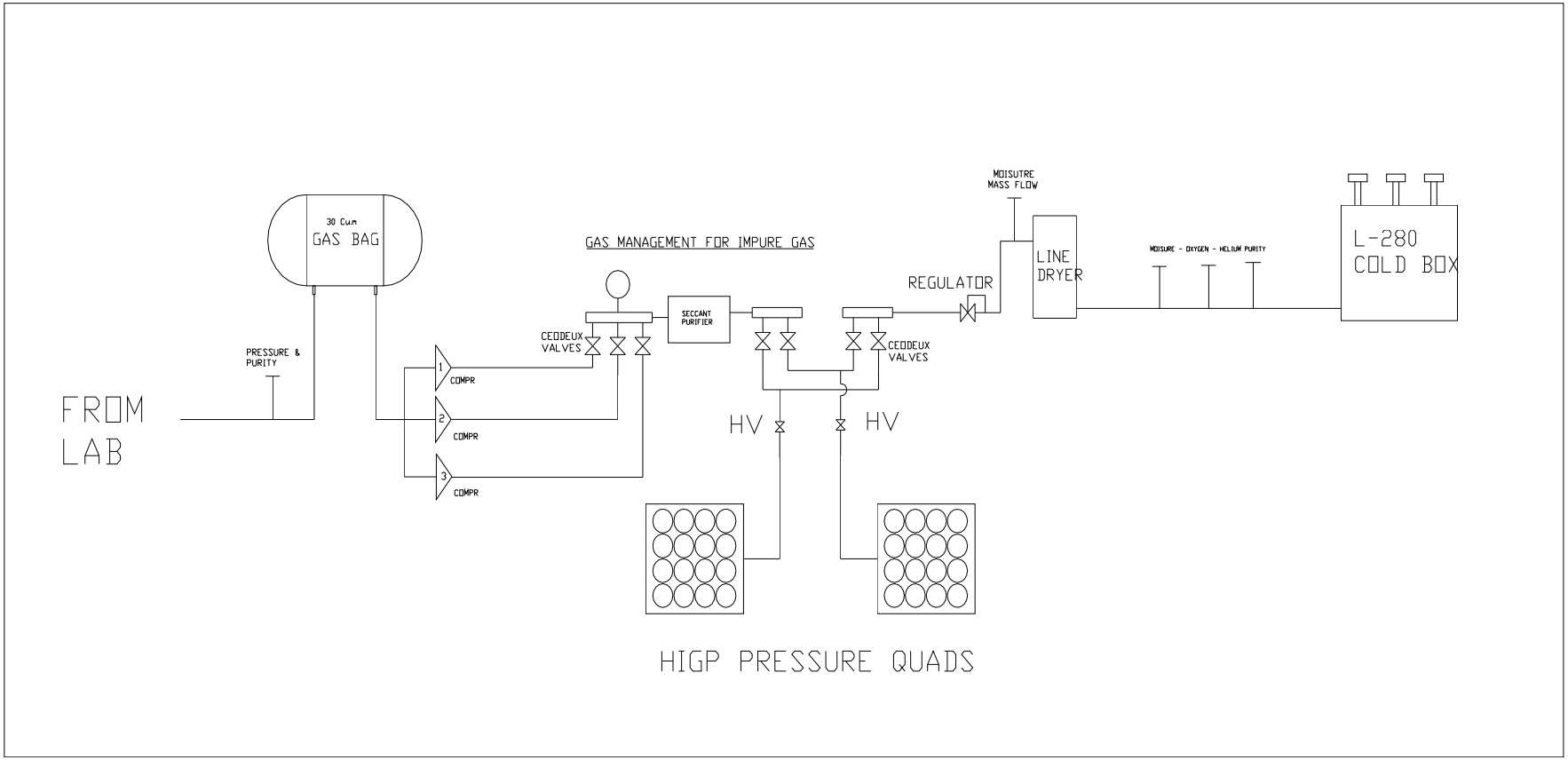

High pressure gas manifold

Fabrication of copper pipes (dia: 40mm & 75mm)

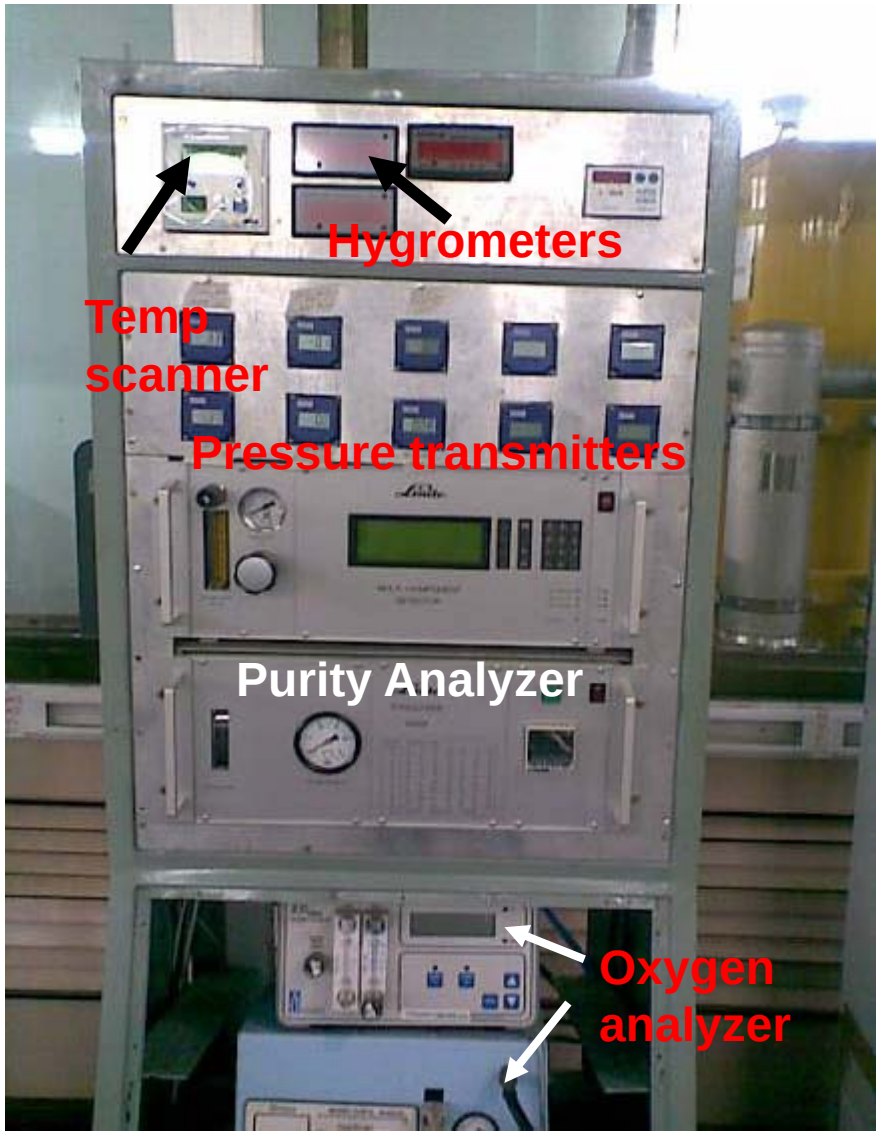
Gas bag installation works

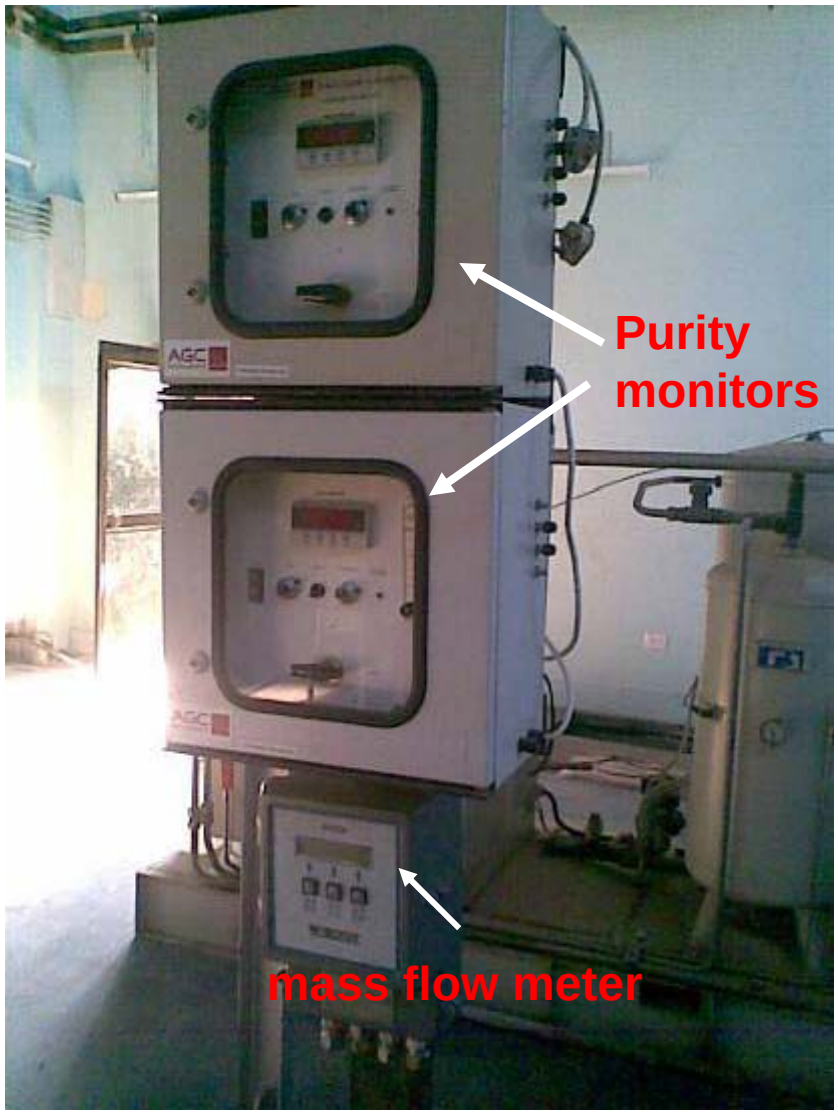


Helium gas purity monitoring circuit



Custom made monitoring and control panel





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Plant commissioned in a record two weeks

Normal time for commissioning is 4 to 6 weeks

We completed in 2 weeks

Reason: Our plant installation, planning and preparation was so perfect *by our highly expertise LTF team.*

Entire job carried out in a safe an secured way

Appreciation from M/s Linde (the manufacturer) and also from all users

A special facility - Liquid Helium Pump

- Submerged liquid helium Pump to transfer liquid from mother dewar (5000 lts) to transportation dewar – Not many such pumps exist in the world

Specifications:

Flow rate	: up to 50 g/s liquid Helium
Pressure head max	. 0,5 bar (optimum at 0,3 bar)
Inlet pressure	: 1,0 ....1,20 bar a
Power supply	: 230 V / single phase / 50 cycles

Liquid Helium Transfer System

Submersible liquid helium pump

Effectively transfers 100 liters in 8 to 11 minutes and with a flash loss of just 3% (as against 20% by normal transfer)

Happy moment after successful plant commissioning

For more details about LTF

Please visit our home page @ www.tifr.res.in/ltf

Acknowledgement

My thanks goes to:

Prof. S K Dhar, Chairman, LTFC
Prof. S Ramakrishnan, [ex-chairman, LTFC]
Prof. R Nagarajan [ex-chairman, LTFC]
Mr. S C Agrawal [ex- Engineer-in-Charge]
Mr. R R Shah
Mr. D S Sandal
Mr. K A Jaison
Mr. Vijay Arolkar
Mr. D G Purao
Mr. Bosco Augustine
Mr. Arvind Hedukar
Mr. R D Despande
Mr. S R Sinha

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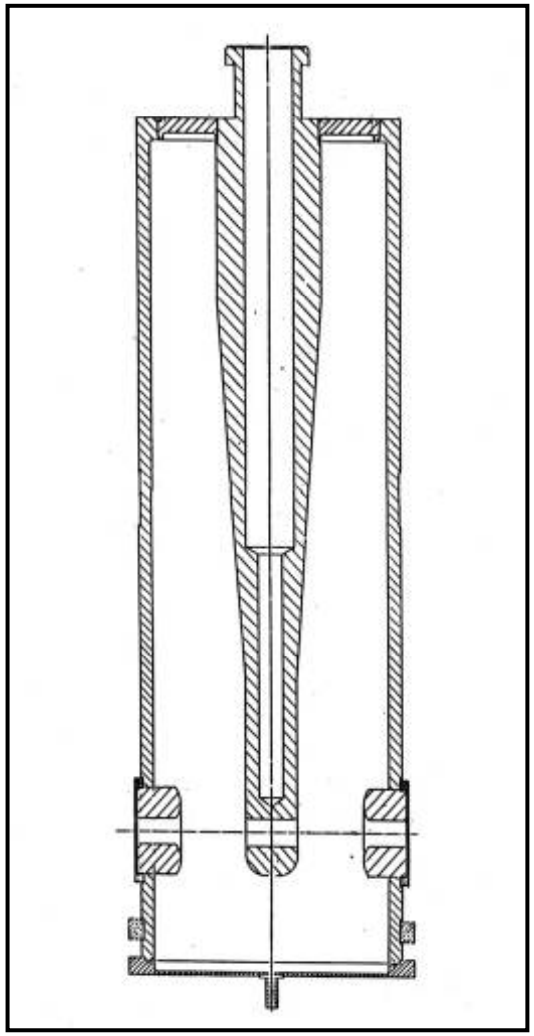
Thanks for your patience

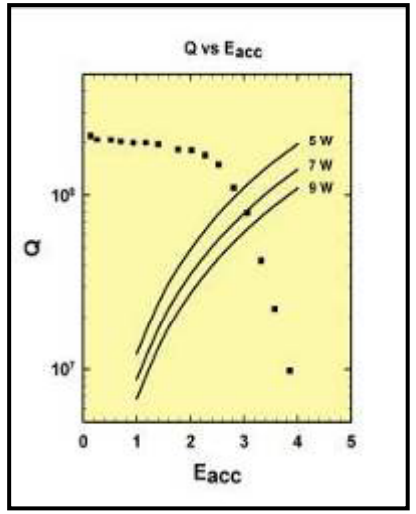
Plant parameters monitoring

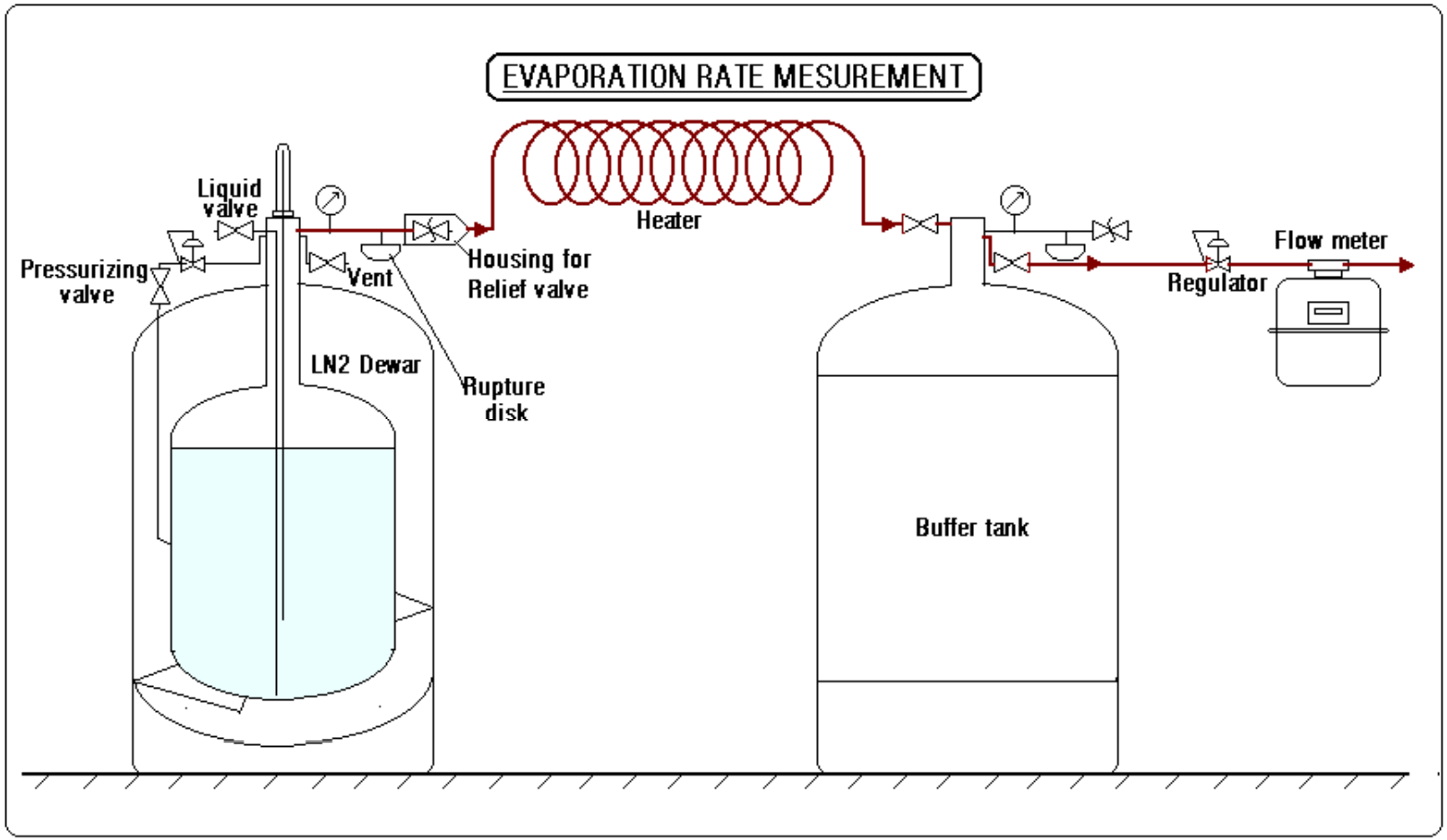
Quarter Wave Resonators



Quarter Wave Resonators

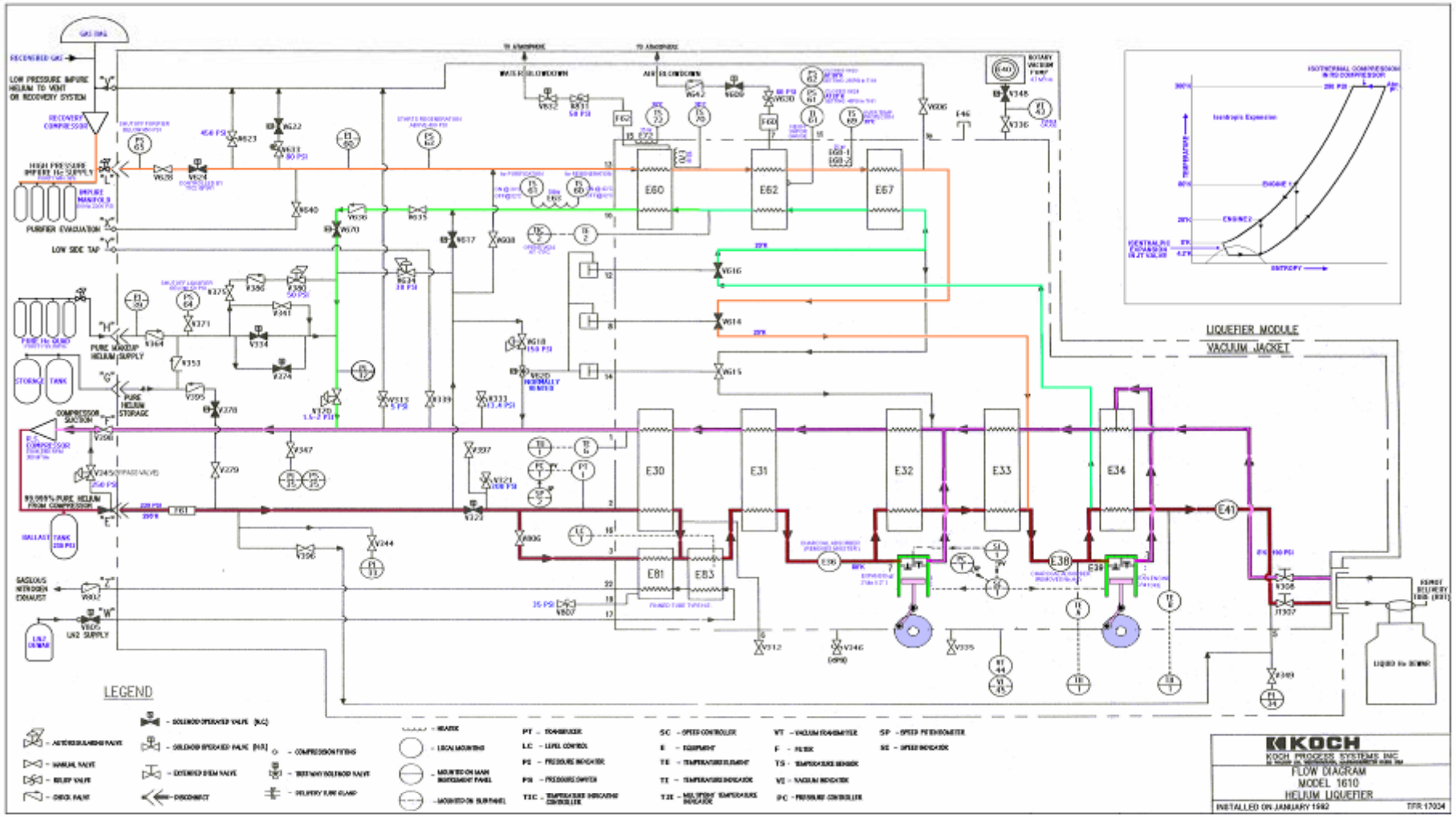
Material	OFHC Cu
Superconducting surface	2 μm thick. Pb
Frequency	150 MHz
Cavity Length	64 cm
Cavity Diameter	20 cm
Optimum velocity	β=0.1
Design goal	2.5 to 3 MV/m @ 6 to 9 Watts



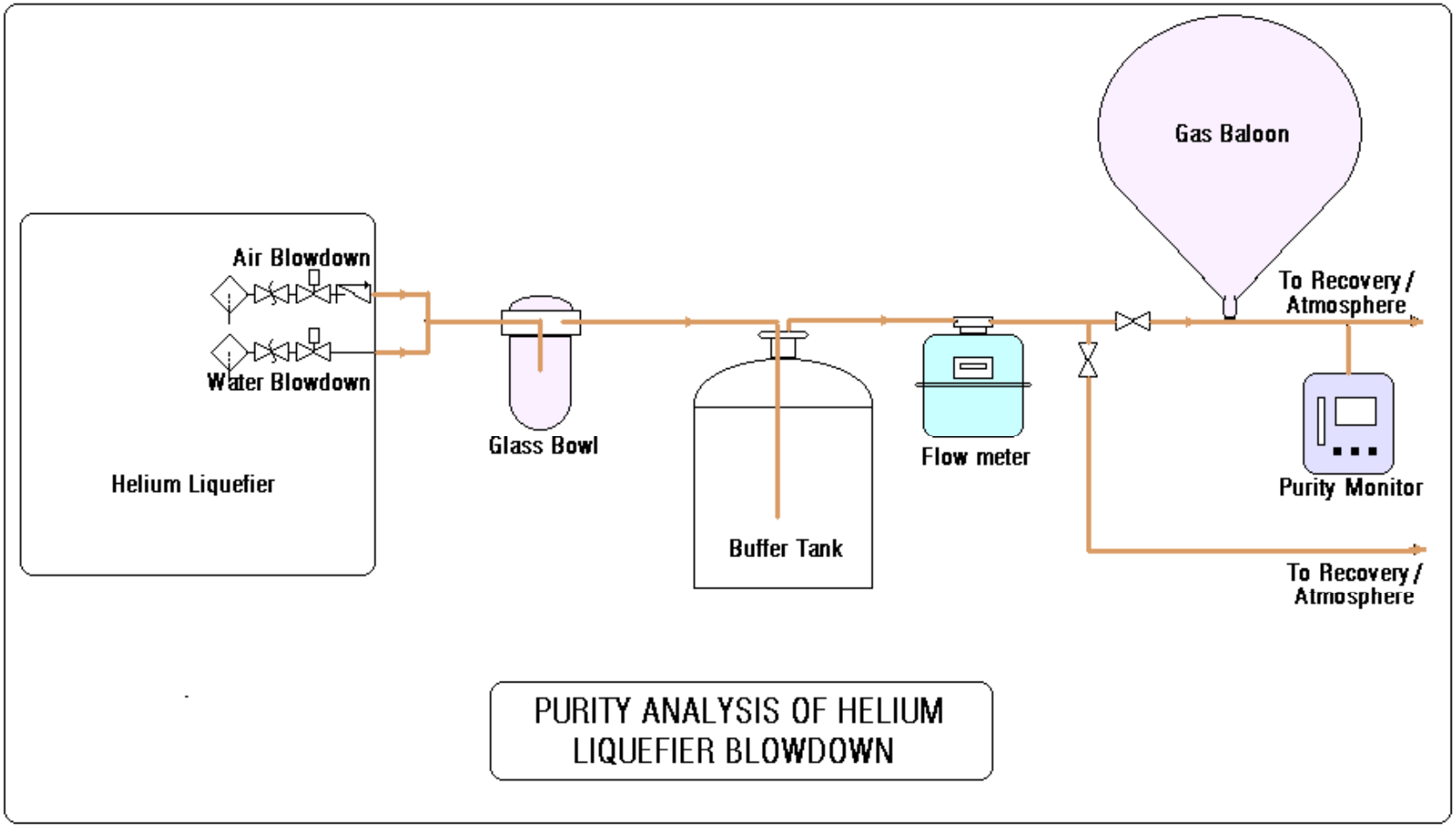

EVAPORATION RATE MESUREMENT
Liquid valve
Pressurizing valve
Vent
Heater
Housing for Relief valve
LN2 Dewar
Rupture disk
Buffer tank
Regulator
Flow meter

Leak testing of high pressure helium recovery compressor

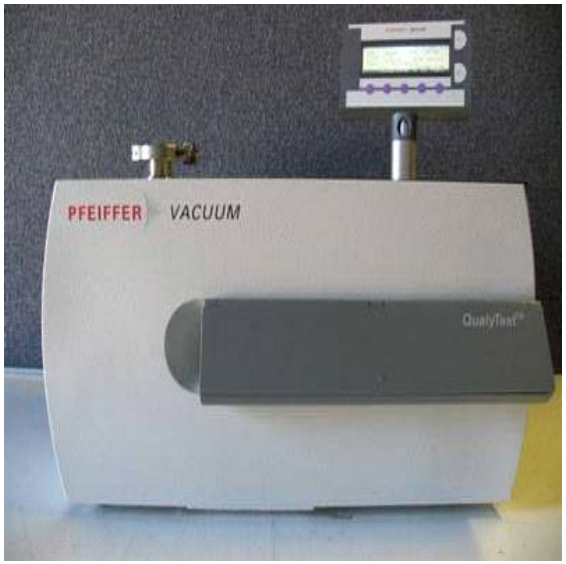
KOCH-1610 Liquefier flow diagram



Set-up for analyzing the liquefier blow down gas



REQUISITION FORM UPDATE REQUISITION REPORTS ABOUT ONLINE REQUISITION FORM



LIQUID HELIUM

IQUID HELIUM IS NOW
'AILABLE "ON DEMAND"
3ASIS. PL CHECK WITH
LTF at Extn 2365/2991

LIQUID NITROGEN

MSLD

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REQUISITION FORM

Faculty Name	Select Faculty Name
Faculty's Email	
Room No.	
Material	Liquid Nitrogen / MSLD
Required Quantity	Select Quantity
Laboratory Name	Select Laboratory
Laboratory Extension(4 Digists only)	
Required on Date	day / September / 2008
Container required for(not to be more than 15 days)	Select Day
Current Empty Dewar	
Special Request if any	

Reset