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SARAF Cryogenic system

Ido Silverman

DAPNIA visit

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Outline

- Introduction
- SARAF requirements of cryogenic system
- Design issues
- Installation
- Commissioning

Introduction

- ACCEL is the prime constructor for the SARAF accelerator and responsible of the whole system integration and commissioning
- Soreq is responsible of the infrastructure
- The cryogenic system which is tightly connected to the accelerator was initially part of ACCEL scope and later transferred to Soreq

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Timeline

- 2002 – negotiation with ACCEL, Soreq take responsibility on purchasing, installation and commissioning of cryogenic system. ACCEL provide basic requirements and interface
- 11.03 – CDR of accelerator
- 6.04 – Sign of contract with Linde
- 8.04 – Kickoff meeting for cryogenic system design
- 11.04 – Cold test of cavities
- 1.05 – Start construction of accelerator building
- 4.05 – Freezing of cryogenic system design, start of construction
- 8.05 – Building structure is mostly ready, start installation of systems (electrical, water, control, VAC, etc.)
- 9.05 – Linde supply system components
- 1.06 – End of installation, installation of cold transfer line, start of commissioning
- 4.06 – Building transferred to Soreq
- 6.06 – Cryogenic system commissioning
- 1.07 – Start of integration with accelerator
- 8.07 – First successful cool-down and stable operation of combined system

SARAF requirements (2003)

- Preliminary estimation of cooling requirements
- Low working pressure and very high pressure stability 1200+/-1.5 mbar
- Two phase design and construction (prototype & full system)
- LHe volume in modules

Preliminary estimation

Table 1: Estimated cryogenic loads of the LINAC (without losses in distribution system)

Phase	Mode	Refrigeration requirements [W]	
		@4.4K	@70K
I		71	140
II	Stand By	90	750
	RF on, current estimations	670	1050
	RF on, with safety margin	960	1050

Table 2: Estimated heat load sources for cavities and cryostats

Source	# units	Heat losses per unit [W]	
		@4.4K	@70K
Static losses of one Phase I cryostat	1	11	100
Dynamic losses of one β=0.09 cavity (Phase I module)	6	10	6
Static losses of one Phase II cryostat	5	15	130
Dynamic losses of one β=0.15 cavity (Phase II modules)	40	13	6

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System configuration issues

- LN2 vs. GHe for thermal shield
- One large system (operating efficiency) vs. two small (final size flexibility and maintenance advantages)
- Combined vs. separated cold transfer lines

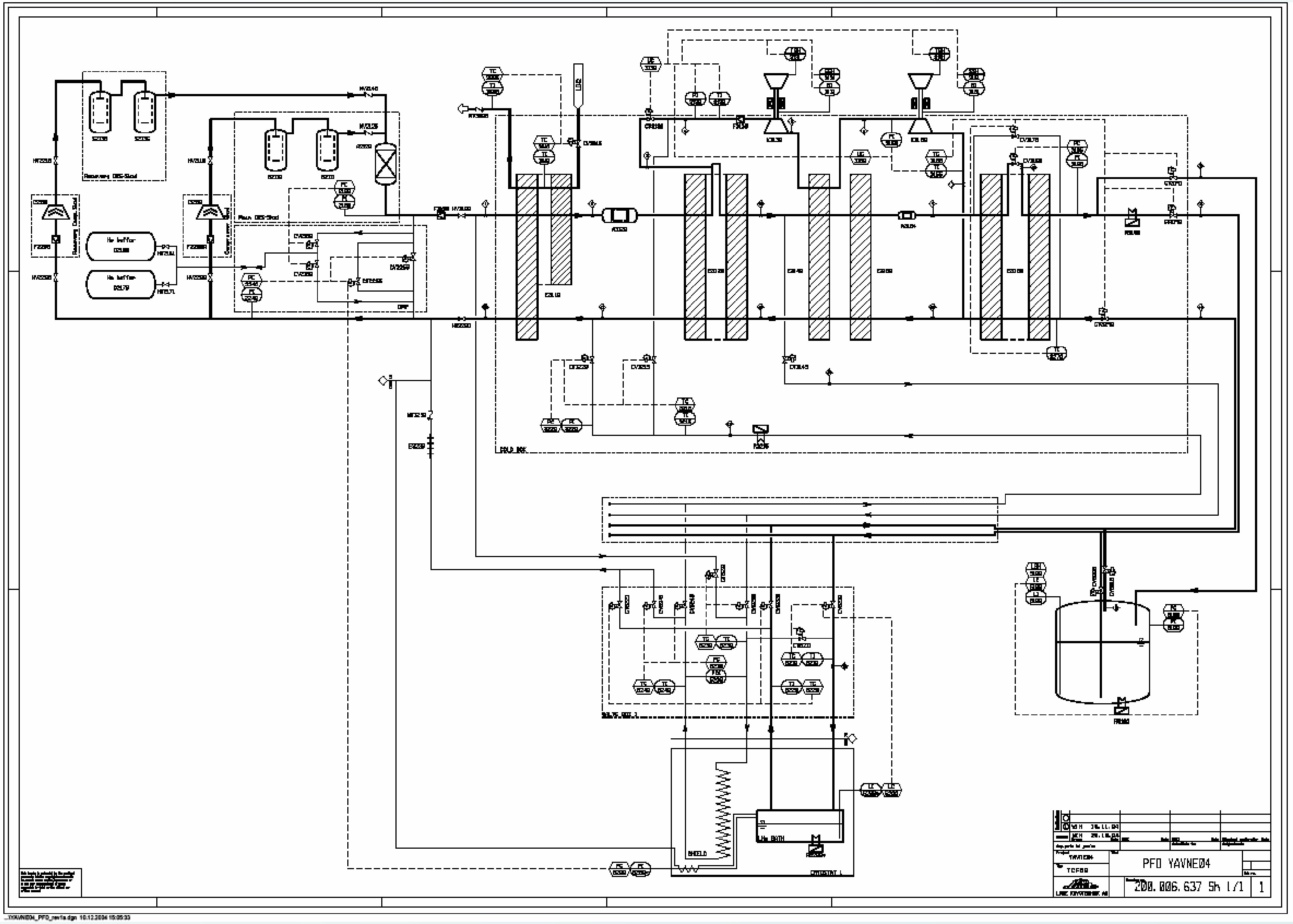
Design issues

- Operating costs (frequency converters)
- Modular design
- Operation logic and system stabilization
- Super-critical He in transfer lines
- Purification
- Gas storage and recovery

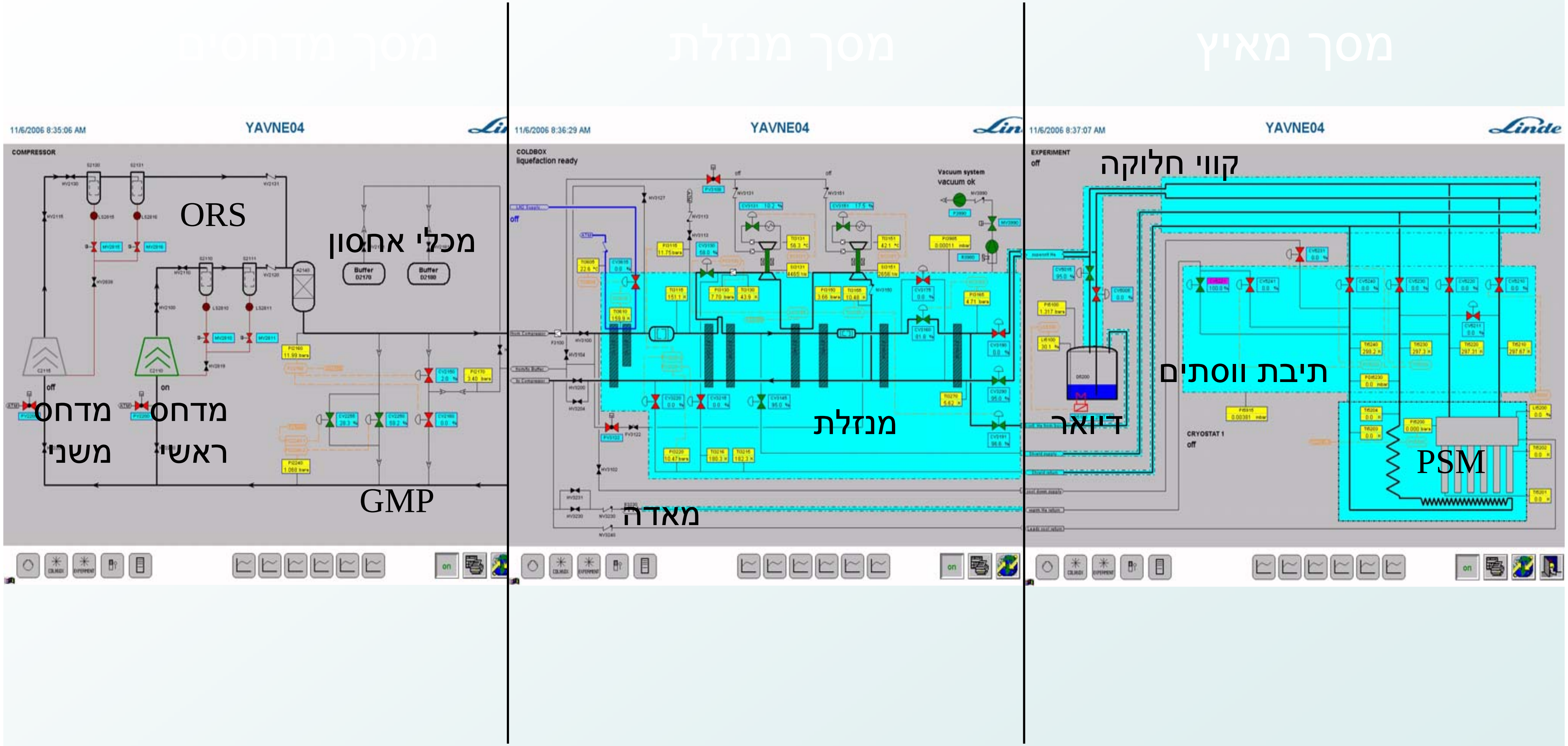
Final system configuration

- GHe cooling for thermal shield
- Two similar refrigerator. The second built with phase II. One can provide cooling capacity at stand-by mode of phase II
- Two cold transfer lines which can be combined into one for stand-by mode cooling
- Medium pressure gas storage buffers
- Super-critical transfer lines with dewars as storage for LHe due to refrigerators over-capacity

System P&ID – Phase I



System scheme

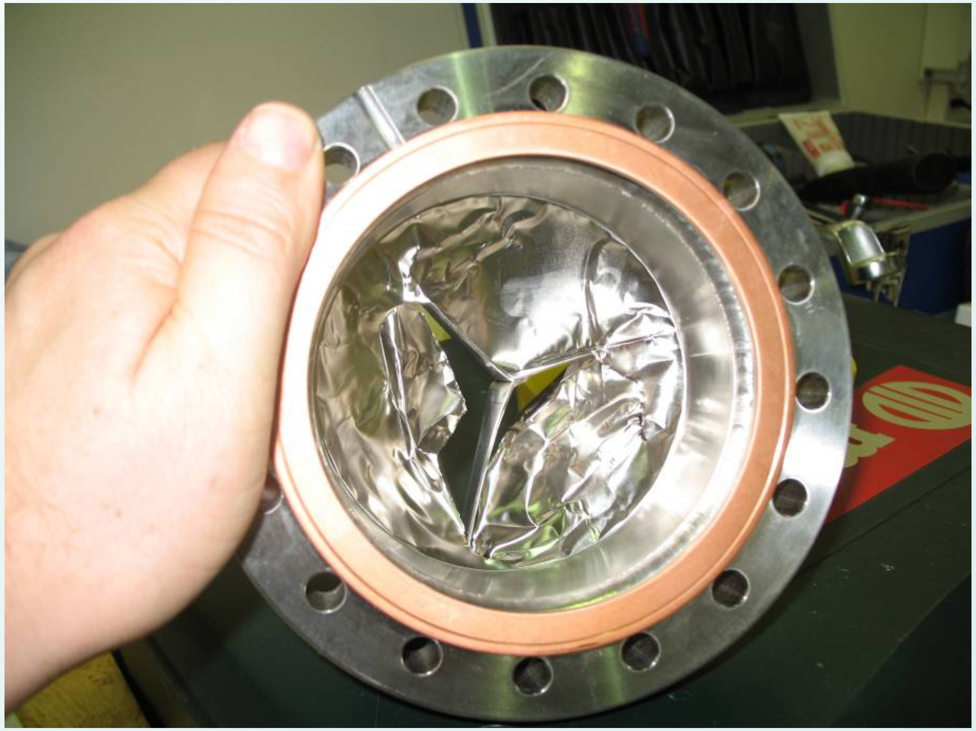


Installation

- All material supplied by Linde
- Done by Soreq with a local team
- Detailed warm transfer line design made on spot by constructor
- Cold transfer line design made on building drawings. Construction and installation by DeMaCo.

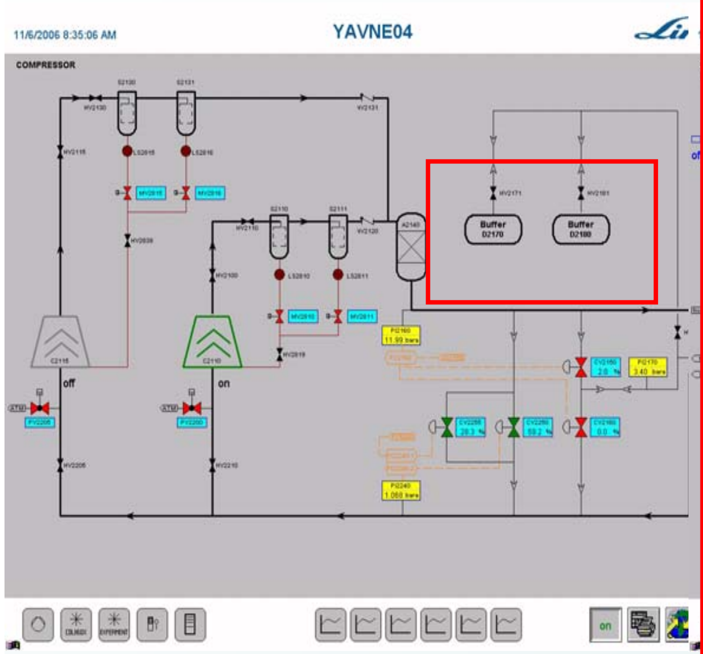
Commissioning

- Operational errors
- Purification
- Control logic
- System simulation
- Operators training



Photos

He Buffers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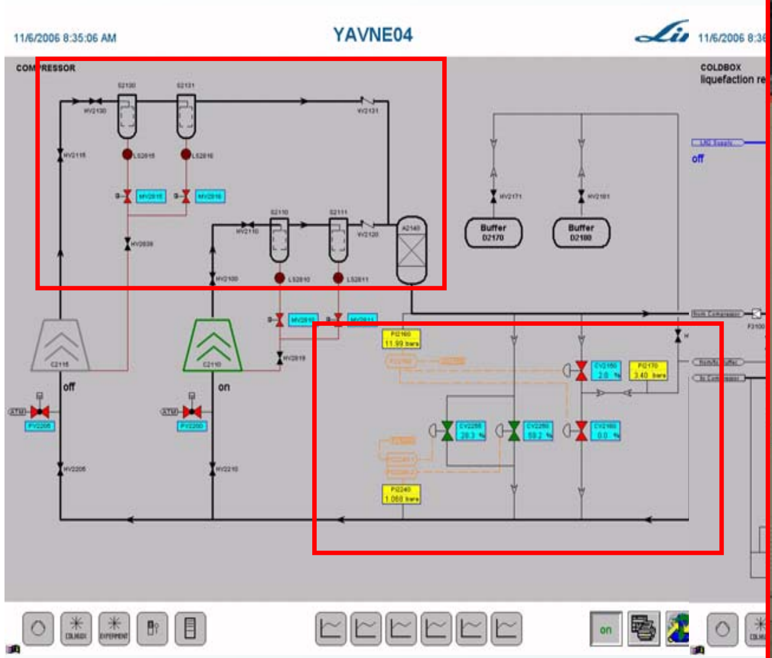
COMPRESSOR
Buffer D2170
Buffer D2180
off
on


HELIUM
HELIUM

Main compressor

Recovery compressor

ORS/GMP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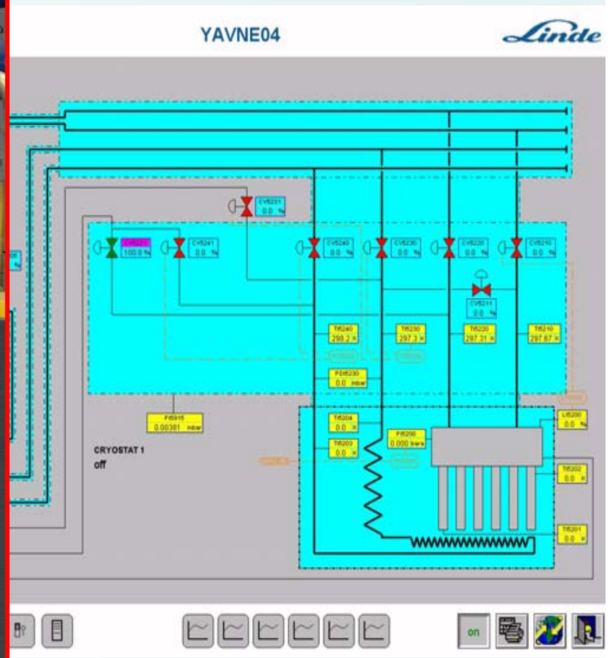
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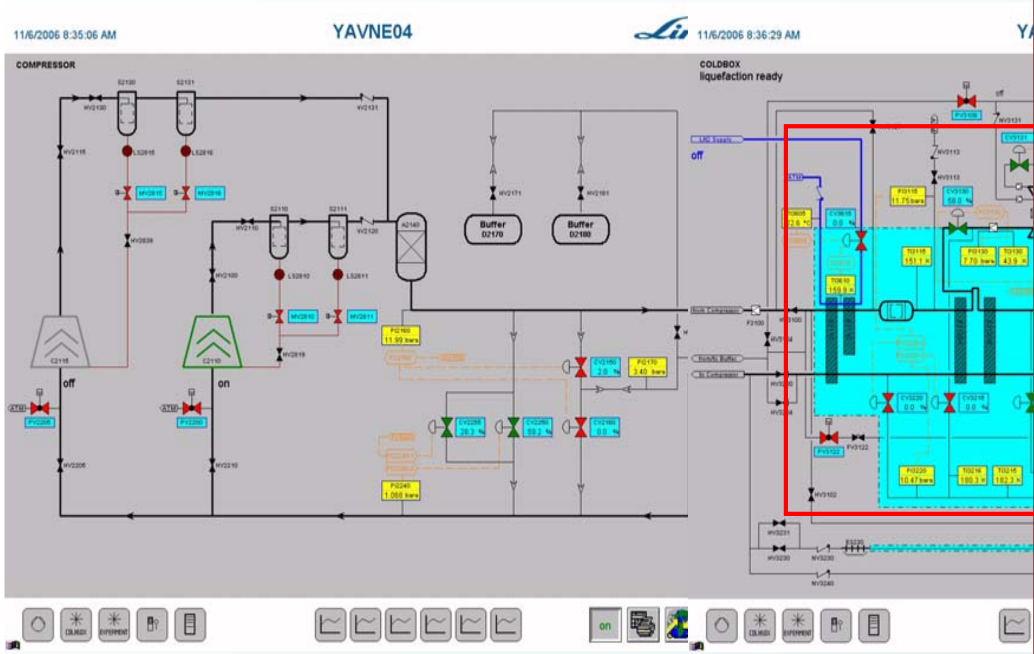
Cold-box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11/6/2006 8:36:29 AM
COMPRESSOR
COLDBOX
liquefaction ready
off
on


Linde
LINDE KRYOTECHNIK AG