Fermilab MTF Cryogenic System & Vertical RF Cavity Test Facility

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Fermilab, TD/TID

May 11, 2006

Magnet Test Facility (MTF)

- Tevatron magnet test stands
  - Testing temperature range 3.5 K to 4.6 K
- LHC quads test stand 1.80 K to 4.6 K
- VMTF - high field magnet program, 2 – 4.5 K
- Conventional magnet test stands
- Vertical RF cavity test facility is being designed – 2 K

MTF Supporting Systems

- 30 kA DC PS system & other PS
- Low conductivity water cooling system
  - 330 GPM flow rate, closed loop
- 180 ton water chiller & heat exchangers
- 10,000 Gal LN2 dewar filled up twice a day
- 3 ton water chiller
- Industrial cooling water (we are users)

MTF Cryogenic System

- Existing Infrastructures
  - 1500 W helium liquefier (since 1977)
    - Helium compressor skids
    - Cold box
    - LHe storage dewar (10,000 L)
    - 3 X 30,000 Gal helium buffer tanks (4,500 LHe)
    - Tube trailer (to make up if needed)
    - Purifier system
    - Vacuum system
  - Kinney pump systems

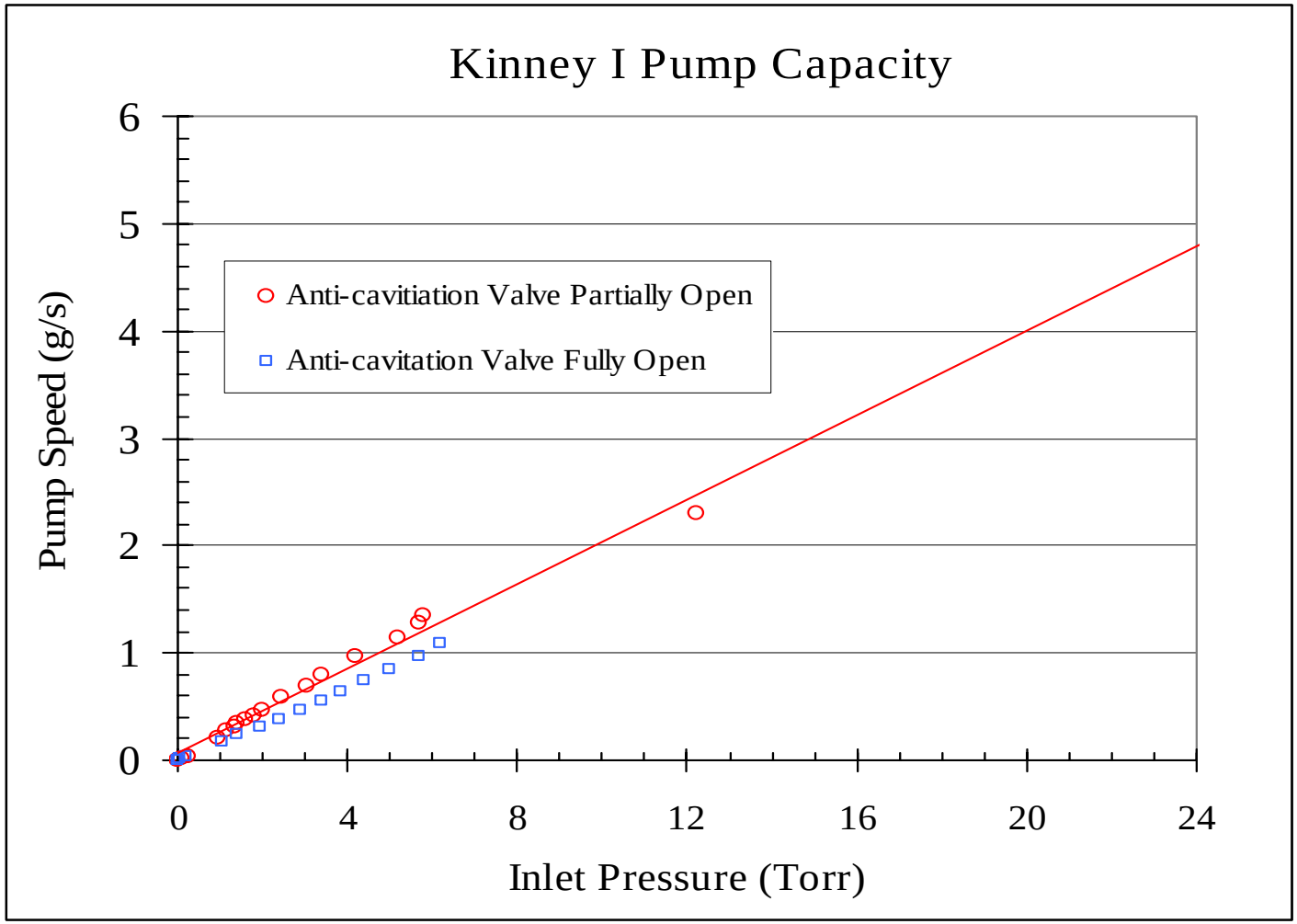
Helium Liquefier Operation

- LHe make rate ~ 250 L/hr
- Buffer tank pressure 50 to 150 psia
- Suction pressure 17.6 psia
- First stage discharge pressure 35.5 psia
- Second stage discharge pressure 150 to 220 psia
- Partial purifier system
- Monitor contamination levels for H_2O, N_2 and O_2 at different locations

Kinney Pump System

- Kinney I & Kinney II
- Measured Kinney I pumping capability ~2.3 g/s at inlet pressure of 12 torr
- Inlet pressure can be as low as 1 torr with anti-cavitation valve partially open
- Kinney II ~ 60% of Kinney I
- So combined pumping capability ~ 4 g/s at 12 torr or ~6 g/s at 20 torr (extrapolated)

Kinney I Pumping Capability

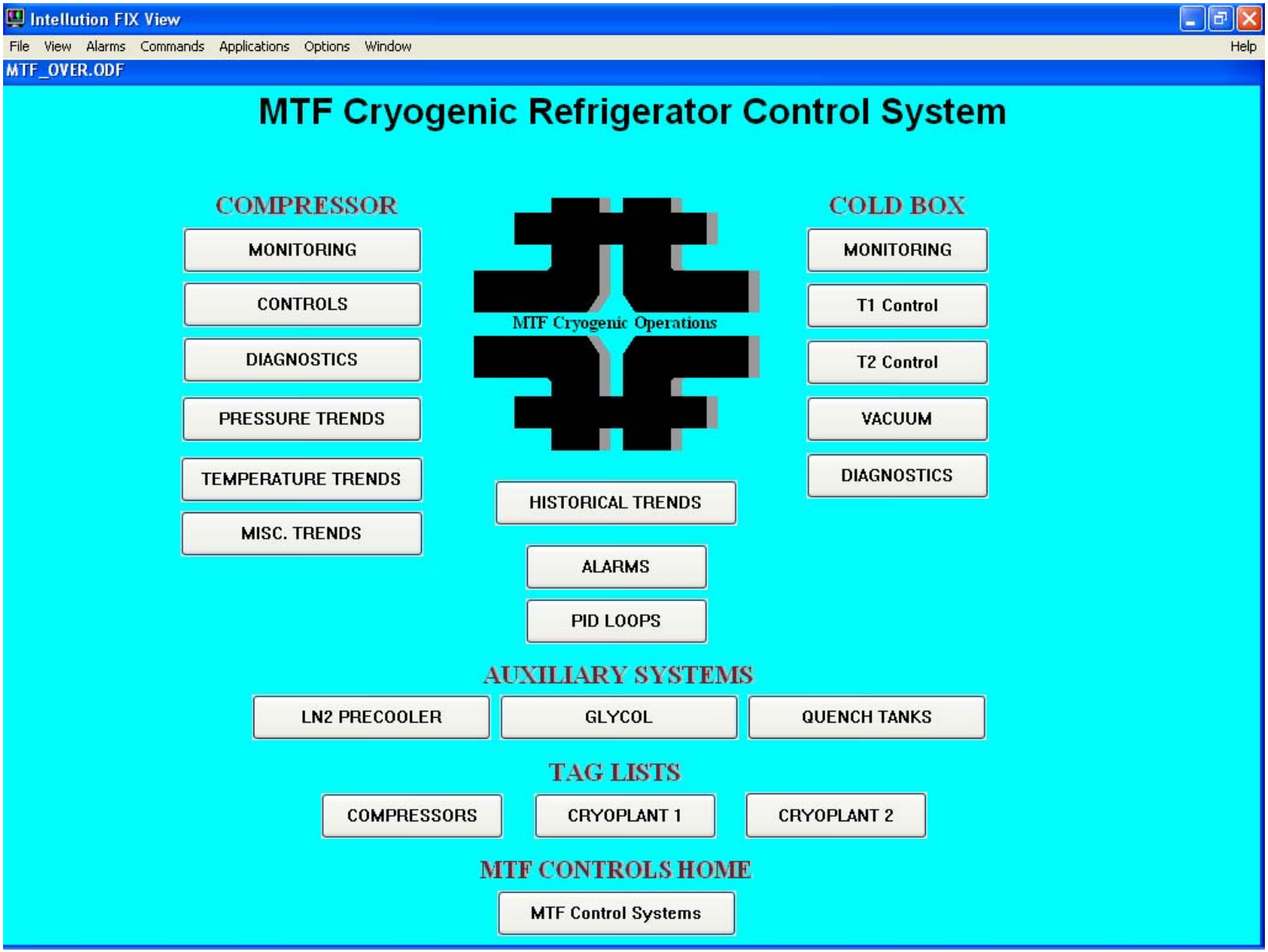


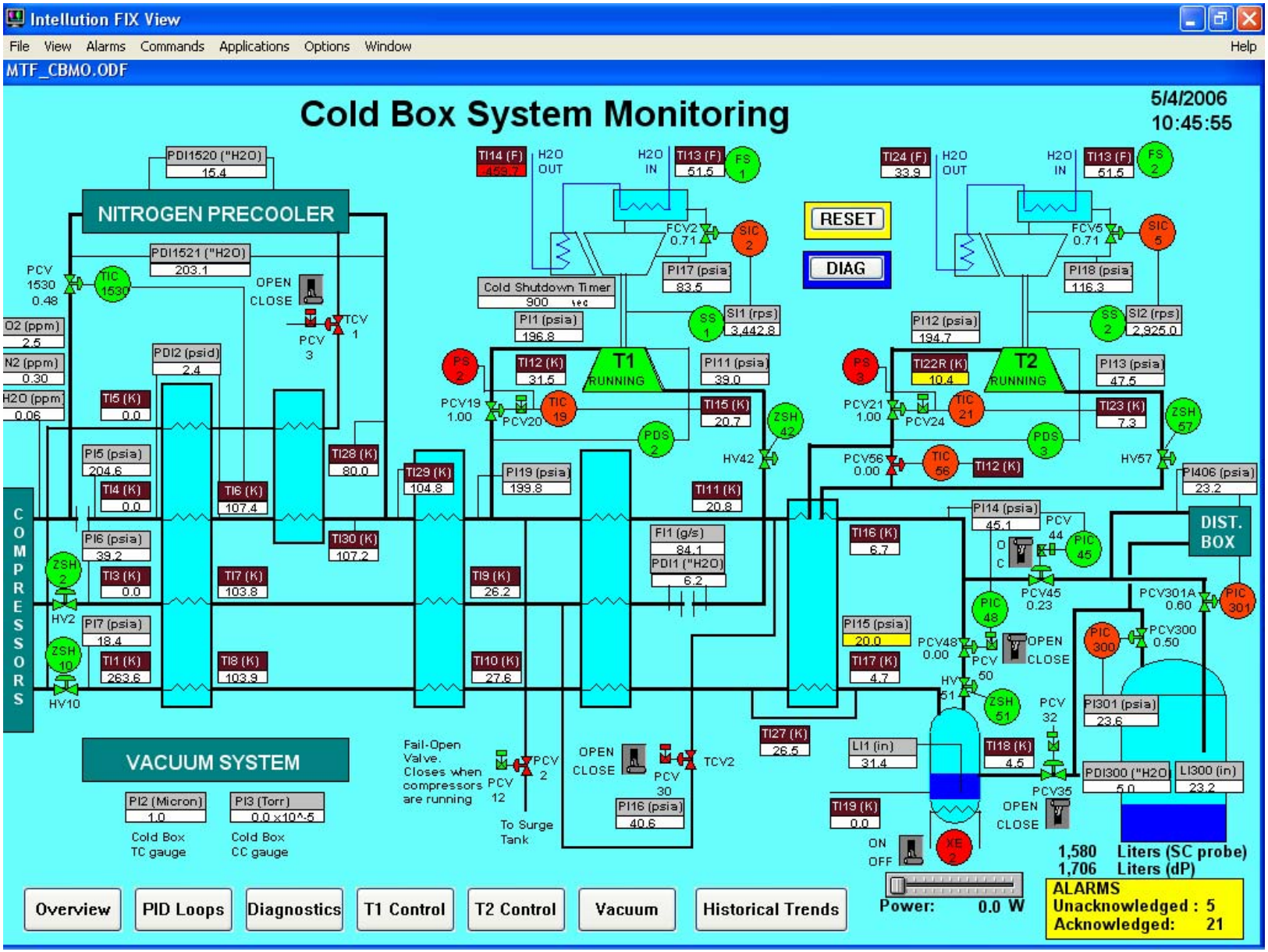
Operation Problems

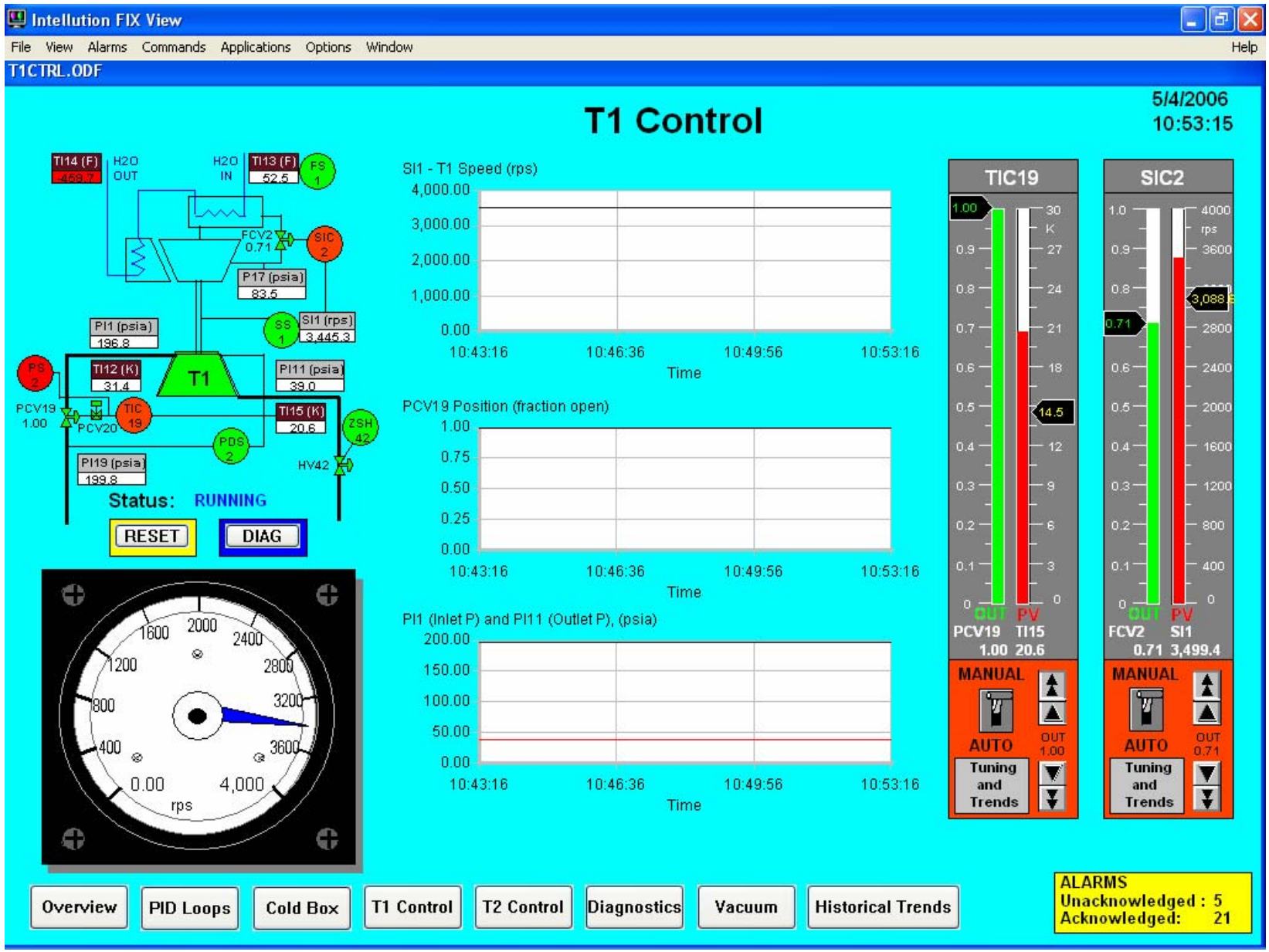
- Contamination, H_2O, N_2 and O_2, Sometimes no liquid make rate at all
- Gas management valves failed (aging problems)
- JT valves and other control valves bellows failed and causing running schedule delayed
- Glycol temperature too high to trip compressors
- Power outage, no cooling water (piping clogged) and glitches will also trip the system

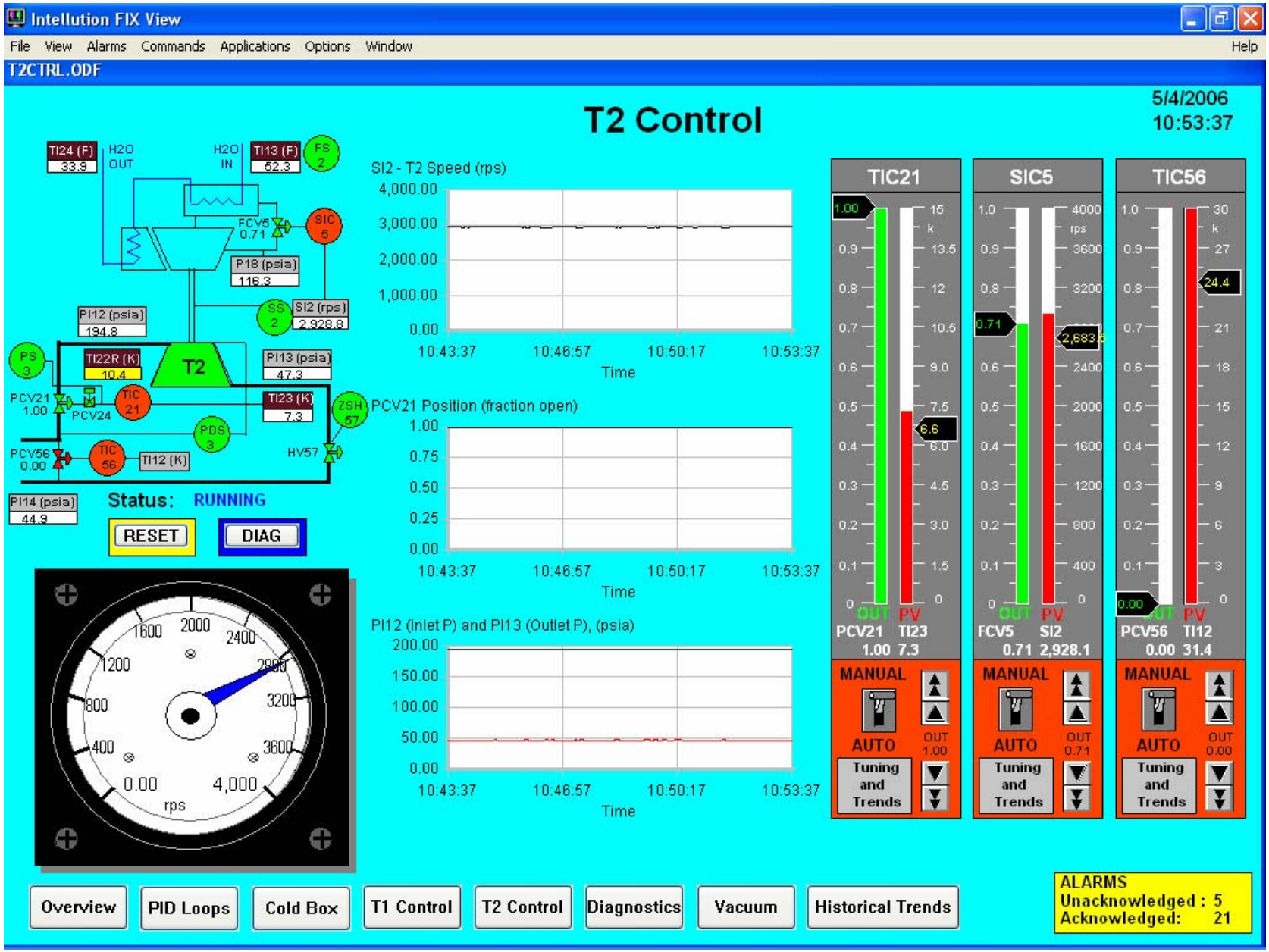
Control System

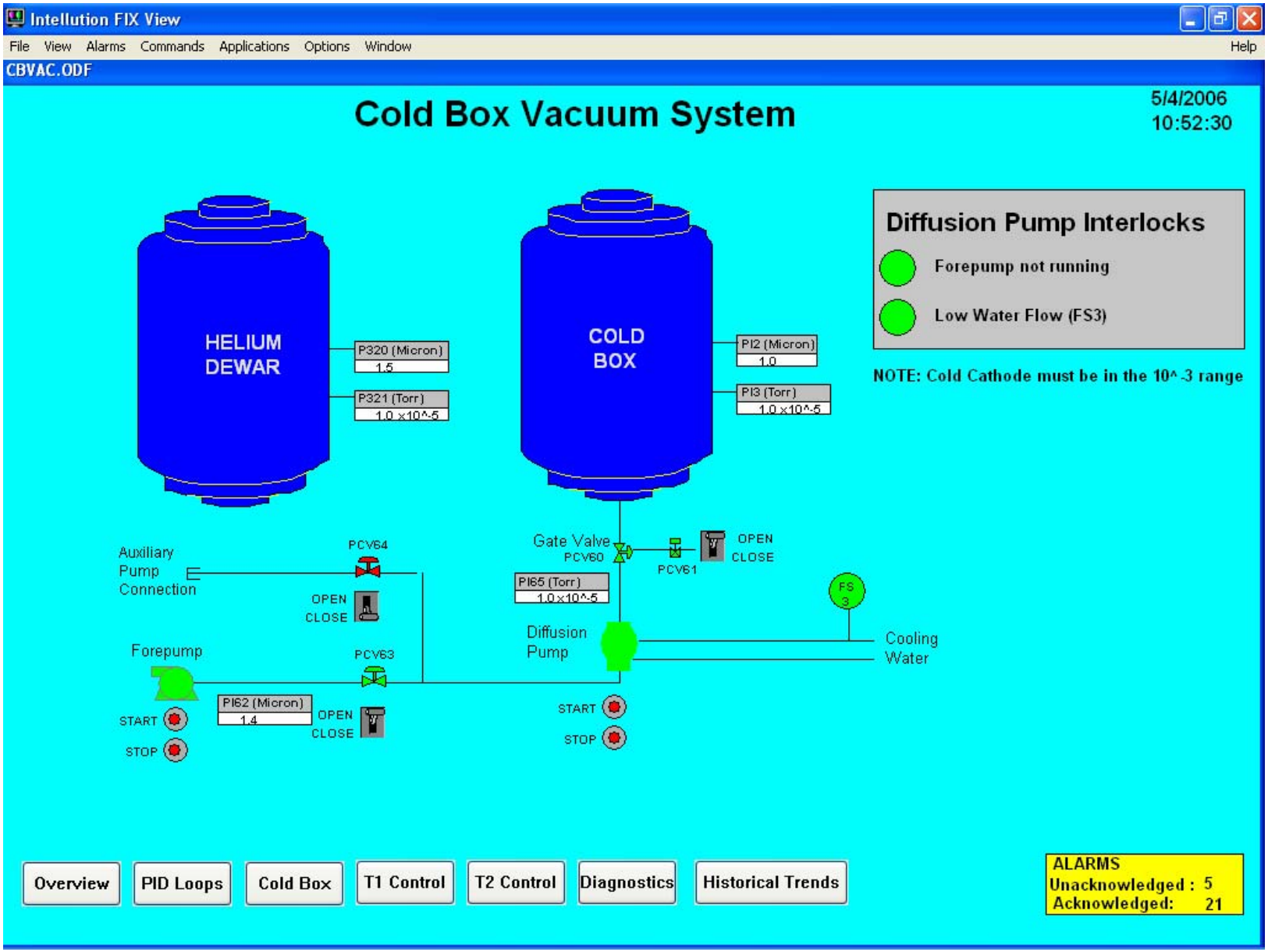
- Pressures, temperatures, flow rate, motor current and liquid levels are monitored via PLC to control room
- iFIX software is launched in the computers operators monitor the system parameters and may adjust the machine if needed
- Interlocks protect the equipments

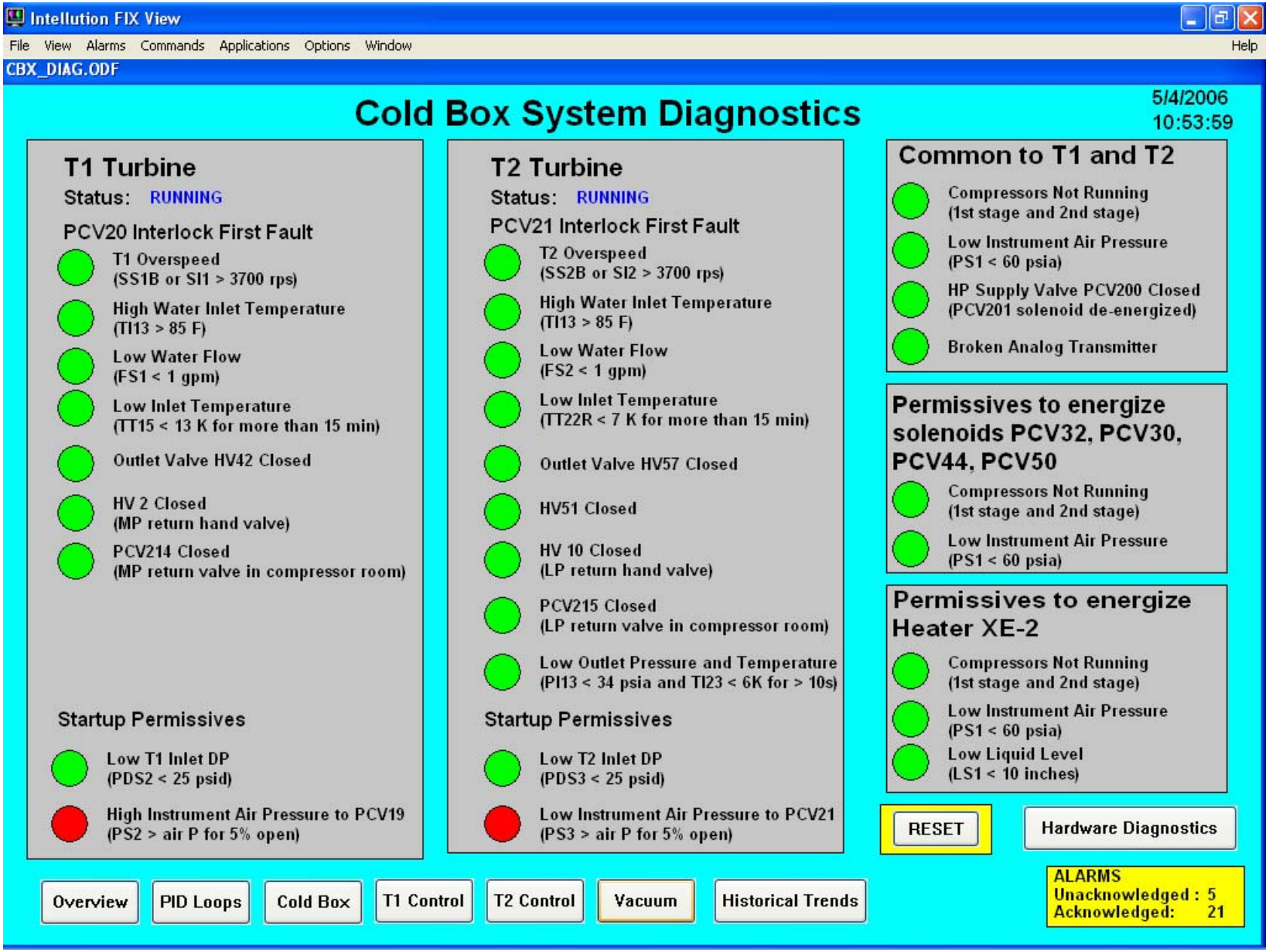

Intellution FIX View
File View Alarms Commands Applications Options Window Help
MTF_OVER.ODF
MTF Cryogenic Refrigerator Control System
COMPRESSOR
MONITORING
CONTROLS
DIAGNOSTICS
PRESSURE TRENDS
TEMPERATURE TRENDS
MISC. TRENDS
MTF Cryogenic Operations
COLD BOX
MONITORING
T1 Control
T2 Control
VACUUM
DIAGNOSTICS
HISTORICAL TRENDS
ALARMS
PID LOOPS
AUXILIARY SYSTEMS
LN2 PRECOOLER
GLYCOL
QUENCH TANKS
TAG LISTS
COMPRESSORS
CRYOPLANT 1
CRYOPLANT 2
MTF CONTROLS HOME
MTF Control Systems

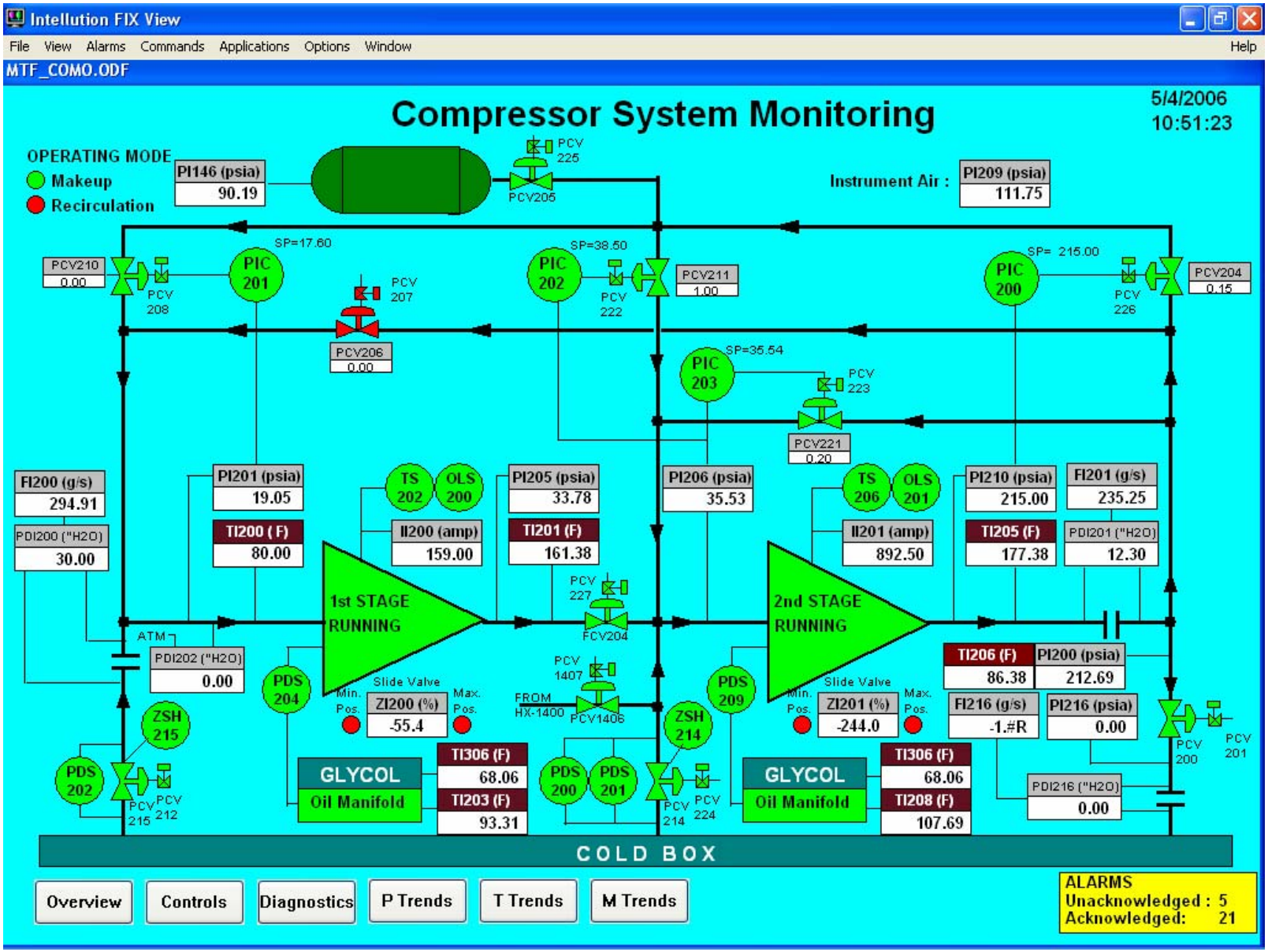

Intellution FIX View
File View Alarms Commands Applications Options Window Help
MTF_CBMO.ODF
Cold Box System Monitoring
5/4/2006
10:45:55
NITROGEN PRECOOLER
PDI1520 ("H2O") 15.4
PDI1521 ("H2O") 203.1
PCV 1530 0.48
TIC 1530
OPEN CLOSE
TCV 1
PCV 3
PDI2 (psid) 2.4
O2 (ppm) 2.5
N2 (ppm) 0.30
H2O (ppm) 0.06
TI5 (K) 0.0
PI5 (psia) 204.6
TI4 (K) 0.0
PI6 (psia) 39.2
TI3 (K) 0.0
PI7 (psia) 18.4
TI1 (K) 263.6
ZSH 2
HV2
ZSH 10
HV10
TI6 (K) 107.4
TI7 (K) 103.8
TI8 (K) 103.9
TI28 (K) 80.0
TI30 (K) 107.2
TI29 (K) 104.8
TI9 (K) 26.2
TI10 (K) 27.6
COMPRESSORS
TI14 (F) 466.7
H2O OUT
H2O IN
TI13 (F) 51.5
FS 1
FCV2 0.71
SIC 2
PI17 (psia) 83.5
Cold Shutdown Timer 900 sec
PI1 (psia) 196.8
SS 1
SI1 (rps) 3,442.8
PS 2
TI12 (K) 31.5
T1 RUNNING
PI11 (psia) 39.0
PCV19 1.00
TIC 19
PCV20
TI15 (K) 20.7
ZSH 42
HV42
PDS 2
PI19 (psia) 199.8
TI11 (K) 20.8
FI1 (g/s) 84.1
PDI1 ("H2O") 6.2
TI16 (K) 6.7
RESET
DIAG
TI24 (F) 33.9
H2O OUT
H2O IN
TI13 (F) 51.5
FS 2
FCV5 0.71
SIC 5
PI18 (psia) 116.3
SS 2
SI2 (rps) 2,925.0
PI12 (psia) 194.7
PS 3
TI22R (K) 10.4
T2 RUNNING
PI13 (psia) 47.5
PCV21 1.00
TIC 21
PCV24
TI23 (K) 7.3
ZSH 57
HV57
PDS 3
PCV56 0.00
TIC 56
TI12 (K)
PI406 (psia) 23.2
DIST. BOX
PI14 (psia) 45.1
PCV 44
PIC 45
PCV45 0.23
PIC 48
PCV301A 0.60
PIC 301
PIC 300
PCV300 0.50
PI15 (psia) 20.0
PCV48 0.00
PCV 50
OPEN CLOSE
TI17 (K) 4.7
HV 51
ZSH 51
PCV 32
PI301 (psia) 23.6
TI27 (K) 26.5
LI1 (in) 31.4
TI18 (K) 4.5
PDI300 ("H2O) 5.0
LI300 (in) 23.2
PCV35
OPEN CLOSE
TI19 (K) 0.0
ON OFF
XE 2
1,580 Liters (SC probe)
1,706 Liters (dP)
VACUUM SYSTEM
PI2 (Micron) 1.0
Cold Box TC gauge
PI3 (Torr) 0.0 x10^-5
Cold Box CC gauge
Fail-Open Valve. Closes when compressors are running
PCV 12
PCV 2
To Surge Tank
OPEN CLOSE
PCV 30
TCV2
PI16 (psia) 40.6
Power: 0.0 W
ALARMS
Unacknowledged : 5
Acknowledged: 21
Overview
PID Loops
Diagnostics
T1 Control
T2 Control
Vacuum
Historical Trends

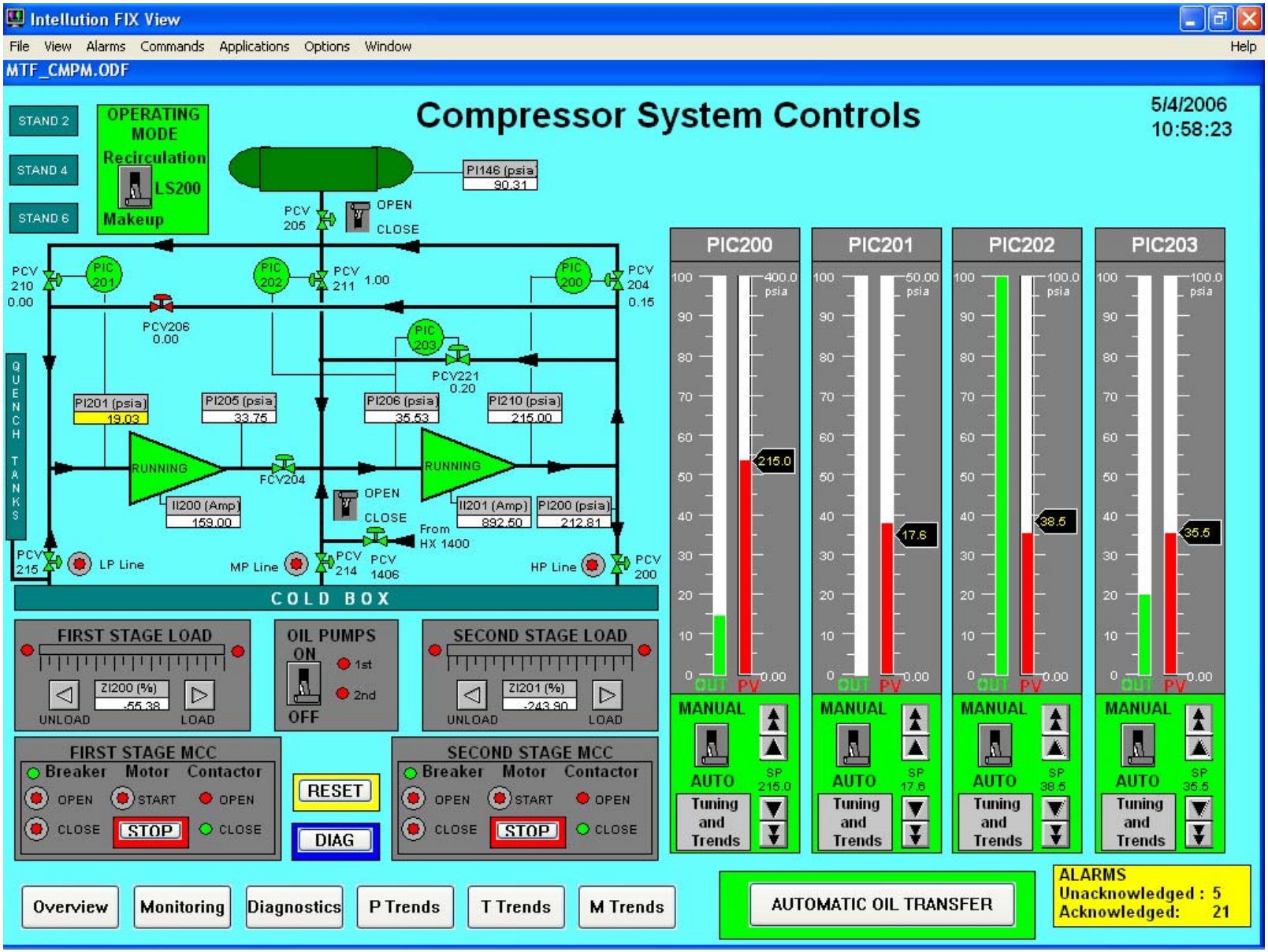

Intellution FIX View
File View Alarms Commands Applications Options Window Help
T1CTRL.ODF
T1 Control
5/4/2006
10:53:15
TI14 (F) -459.7
H2O OUT
H2O IN
TI13 (F) 52.5
FS 1
FCV2 0.71
SIC 2
P17 (psia) 83.5
PI1 (psia) 196.8
SS 1
SI1 (rps) 3,445.3
PS 2
TI12 (K) 31.4
T1
PI11 (psia) 39.0
PCV19 1.00
PCV20
TIC 19
TI15 (K) 20.6
ZSH 42
PDS 2
HV42
PI19 (psia) 199.8
Status: RUNNING
RESET
DIAG
SI1 - T1 Speed (rps)
4,000.00
3,000.00
2,000.00
1,000.00
0.00
10:43:16
10:46:36
10:49:56
10:53:16
Time
PCV19 Position (fraction open)
1.00
0.75
0.50
0.25
0.00
PI1 (Inlet P) and PI11 (Outlet P), (psia)
200.00
150.00
100.00
50.00
0.00
TIC19
SIC2
OUT PV
PCV19 TI15
1.00 20.6
FCV2 SI1
0.71 3,499.4
MANUAL
AUTO
Tuning and Trends
OUT 1.00
OUT 0.71
rps
0.00
4,000
Overview
PID Loops
Cold Box
T1 Control
T2 Control
Diagnostics
Vacuum
Historical Trends
ALARMS
Unacknowledged : 5
Acknowledged: 21

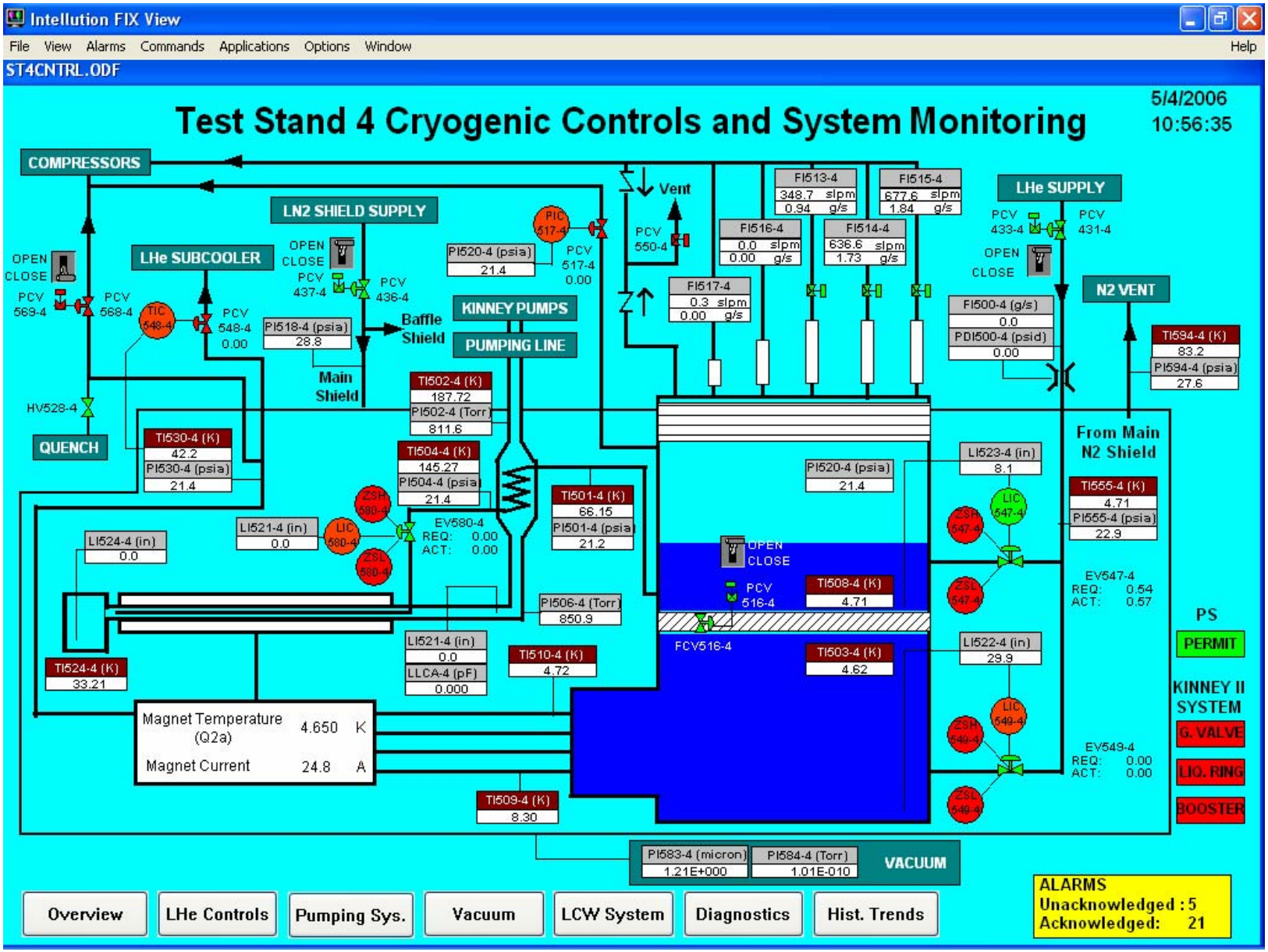

Intellution FIX View
File View Alarms Commands Applications Options Window Help
T2CTRL.ODF
T2 Control
5/4/2006
10:53:37
TI24 (F) 33.9
H2O OUT
H2O IN
TI13 (F) 52.3
FS 2
FCV5 0.71
SIC 5
P18 (psia) 116.3
PI12 (psia) 194.8
SS 2
SI2 (rps) 2,928.8
PS 3
TI22R (K) 10.4
T2
PI13 (psia) 47.3
PCV21 1.00
PCV24
TIC 21
TI23 (K) 7.3
ZSH 57
PDS 3
PCV56 0.00
TIC 56
TI12 (K)
HV57
PI14 (psia) 44.9
Status: RUNNING
RESET
DIAG
SI2 - T2 Speed (rps)
4,000.00
3,000.00
2,000.00
1,000.00
0.00
10:43:37
10:46:57
10:50:17
10:53:37
Time
PCV21 Position (fraction open)
1.00
0.75
0.50
0.25
0.00
PI12 (Inlet P) and PI13 (Outlet P), (psia)
200.00
150.00
100.00
50.00
0.00
TIC21
SIC5
TIC56
OUT PV
PCV21 TI23
1.00 7.3
FCV5 SI2
0.71 2,928.1
PCV56 TI12
0.00 31.4
MANUAL
AUTO
Tuning and Trends
OUT 1.00
OUT 0.71
OUT 0.00
1600 2000 2400 2800 3200 3600 4000
1200
800
400
0.00
4,000
rps
Overview
PID Loops
Cold Box
T1 Control
T2 Control
Diagnostics
Vacuum
Historical Trends
ALARMS
Unacknowledged : 5
Acknowledged: 21

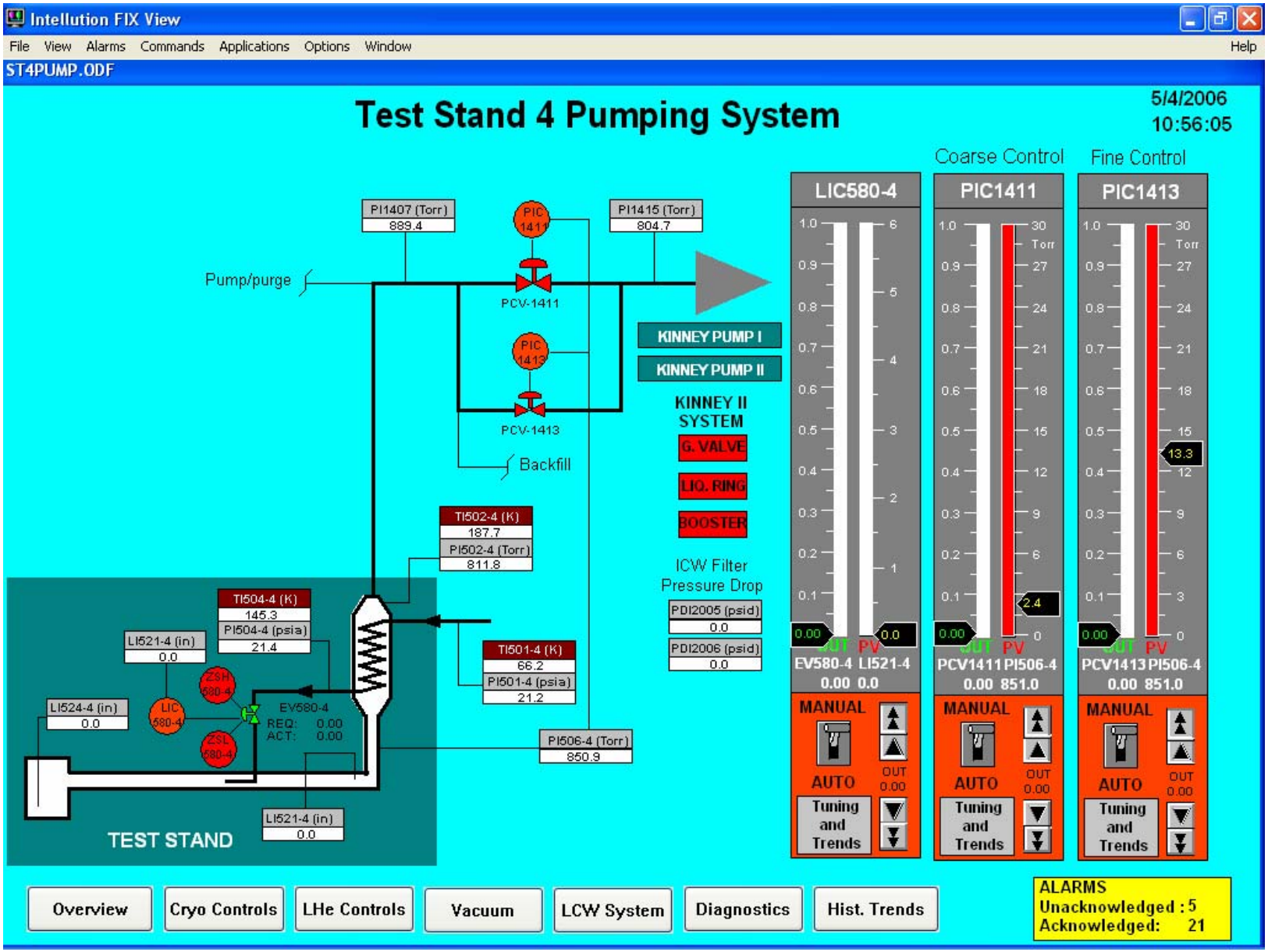

Intellution FIX View
File View Alarms Commands Applications Options Window Help
CBVAC.ODF
Cold Box Vacuum System
5/4/2006
10:52:30
HELIUM DEWAR
P320 (Micron)
1.5
P321 (Torr)
1.0 x10^-5
COLD BOX
PI2 (Micron)
1.0
PI3 (Torr)
1.0 x10^-5
Diffusion Pump Interlocks
Forepump not running
Low Water Flow (FS3)
NOTE: Cold Cathode must be in the 10^-3 range
Auxiliary Pump Connection
PCV64
OPEN
CLOSE
Gate Valve
PCV60
PCV61
OPEN
CLOSE
PI65 (Torr)
1.0 x10^-5
FS 3
Diffusion Pump
Cooling Water
Forepump
PCV63
PI62 (Micron)
1.4
OPEN
CLOSE
START
STOP
START
STOP
Overview
PID Loops
Cold Box
T1 Control
T2 Control
Diagnostics
Historical Trends
ALARMS
Unacknowledged : 5
Acknowledged: 21

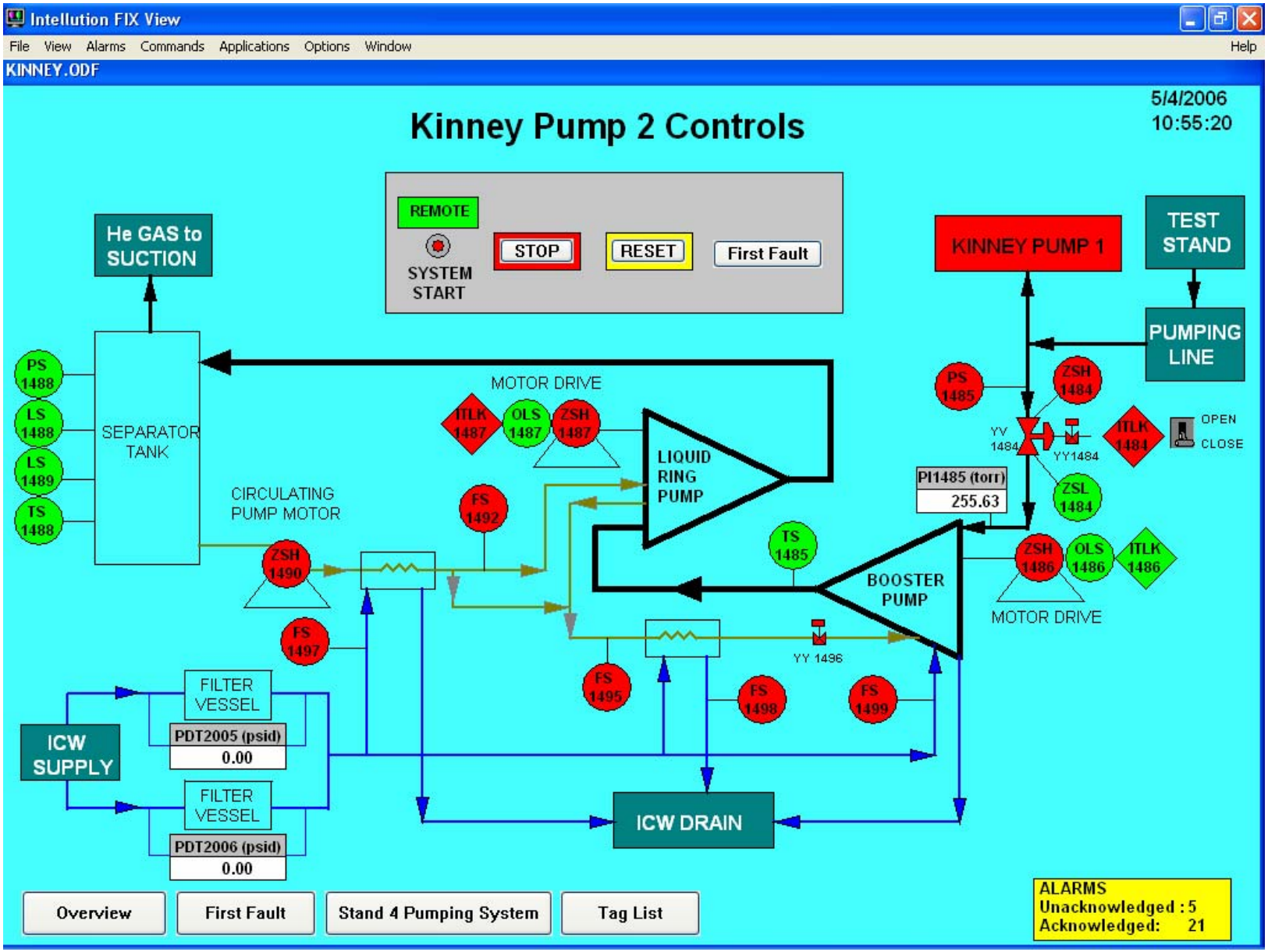

Intellution FIX View
File View Alarms Commands Applications Options Window Help
CBX_DIAG.ODF
Cold Box System Diagnostics
5/4/2006
10:53:59
T1 Turbine
Status: RUNNING
PCV20 Interlock First Fault
T1 Overspeed
(SS1B or SI1 > 3700 rps)
High Water Inlet Temperature
(TI13 > 85 F)
Low Water Flow
(FS1 < 1 gpm)
Low Inlet Temperature
(TT15 < 13 K for more than 15 min)
Outlet Valve HV42 Closed
HV 2 Closed
(MP return hand valve)
PCV214 Closed
(MP return valve in compressor room)
Startup Permissives
Low T1 Inlet DP
(PDS2 < 25 psid)
High Instrument Air Pressure to PCV19
(PS2 > air P for 5% open)
T2 Turbine
Status: RUNNING
PCV21 Interlock First Fault
T2 Overspeed
(SS2B or SI2 > 3700 rps)
High Water Inlet Temperature
(TI13 > 85 F)
Low Water Flow
(FS2 < 1 gpm)
Low Inlet Temperature
(TT22R < 7 K for more than 15 min)
Outlet Valve HV57 Closed
HV51 Closed
HV 10 Closed
(LP return hand valve)
PCV215 Closed
(LP return valve in compressor room)
Low Outlet Pressure and Temperature
(PI13 < 34 psia and TI23 < 6K for > 10s)
Startup Permissives
Low T2 Inlet DP
(PDS3 < 25 psid)
Low Instrument Air Pressure to PCV21
(PS3 > air P for 5% open)
Common to T1 and T2
Compressors Not Running
(1st stage and 2nd stage)
Low Instrument Air Pressure
(PS1 < 60 psia)
HP Supply Valve PCV200 Closed
(PCV201 solenoid de-energized)
Broken Analog Transmitter
Permissives to energize solenoids PCV32, PCV30, PCV44, PCV50
Compressors Not Running
(1st stage and 2nd stage)
Low Instrument Air Pressure
(PS1 < 60 psia)
Permissives to energize Heater XE-2
Compressors Not Running
(1st stage and 2nd stage)
Low Instrument Air Pressure
(PS1 < 60 psia)
Low Liquid Level
(LS1 < 10 inches)
RESET
Hardware Diagnostics
Overview
PID Loops
Cold Box
T1 Control
T2 Control
Vacuum
Historical Trends
ALARMS
Unacknowledged : 5
Acknowledged: 21

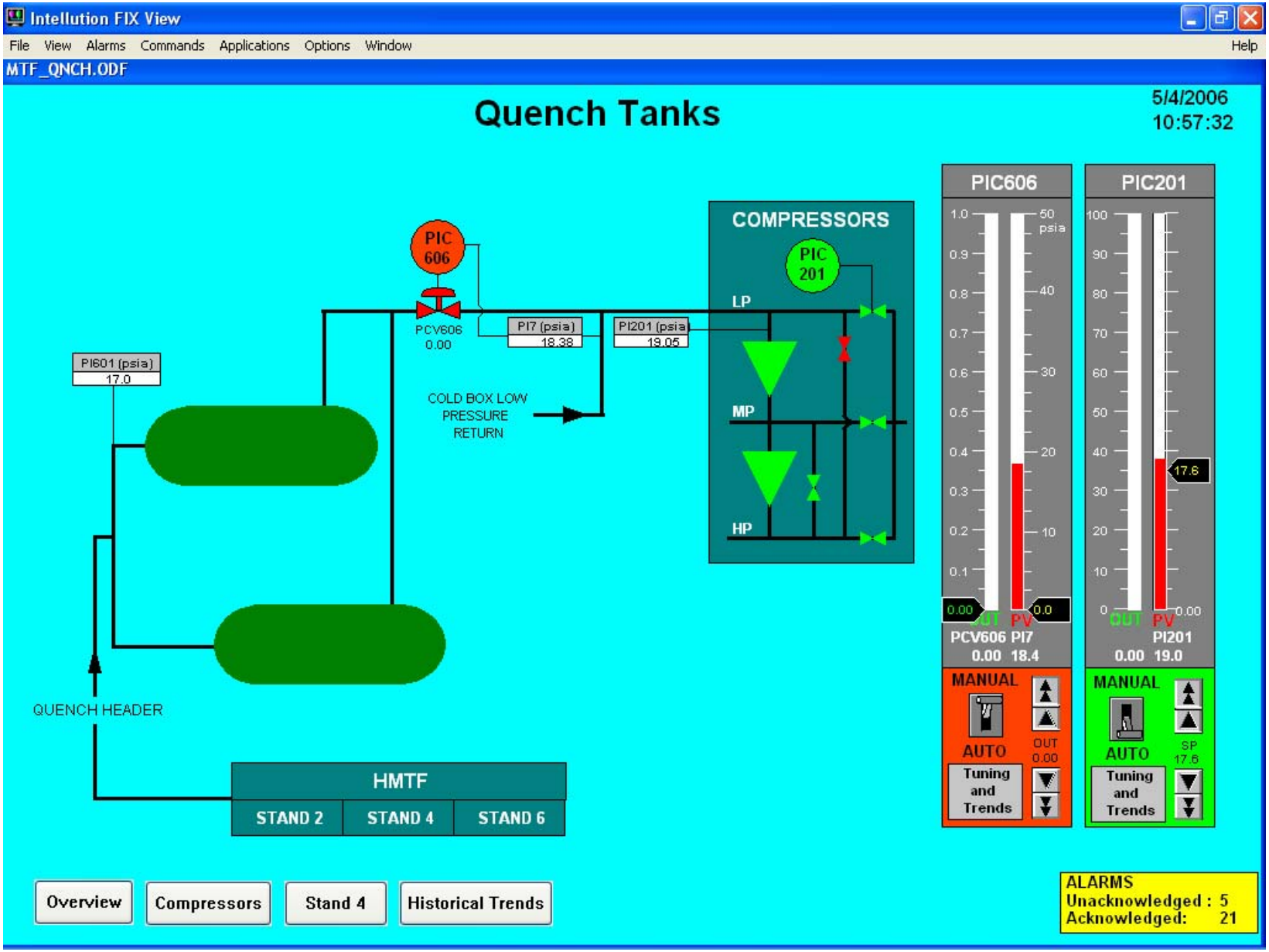

Intellution FIX View
File View Alarms Commands Applications Options Window Help
MTF_COMO.ODF
Compressor System Monitoring
5/4/2006
10:51:23
OPERATING MODE
Makeup
Recirculation
PI146 (psia)
90.19
PCV 225
PCV205
Instrument Air :
PI209 (psia)
111.75
PCV210
0.00
PCV 208
PIC 201
SP=17.60
PCV 207
PIC 202
SP=38.50
PCV 222
PCV211
1.00
PIC 200
SP= 215.00
PCV 226
PCV204
0.15
PCV206
0.00
PIC 203
SP=35.54
PCV 223
PCV221
0.20
FI200 (g/s)
294.91
PDI200 ("H2O)
30.00
PI201 (psia)
19.05
TI200 (F)
80.00
TS 202
OLS 200
II200 (amp)
159.00
PI205 (psia)
33.78
TI201 (F)
161.38
PI206 (psia)
35.53
TS 206
OLS 201
II201 (amp)
892.50
PI210 (psia)
215.00
TI205 (F)
177.38
FI201 (g/s)
235.25
PDI201 ("H2O)
12.30
1st STAGE RUNNING
2nd STAGE RUNNING
PCV 227
FCV204
ATM
PDI202 ("H2O)
0.00
PDS 204
Slide Valve
Min. Pos.
ZI200 (%)
-55.4
Max. Pos.
PCV 1407
FROM HX-1400
PCV1406
PDS 209
ZI201 (%)
-244.0
TI206 (F)
86.38
PI200 (psia)
212.69
FI216 (g/s)
-1.#R
PI216 (psia)
0.00
PCV 200
PCV 201
PDI216 ("H2O)
0.00
ZSH 215
PDS 202
PCV 215
PCV 212
GLYCOL Oil Manifold
TI306 (F)
68.06
TI203 (F)
93.31
PDS 200
PDS 201
ZSH 214
PCV 214
PCV 224
GLYCOL Oil Manifold
TI306 (F)
68.06
TI208 (F)
107.69
COLD BOX
Overview
Controls
Diagnostics
P Trends
T Trends
M Trends
ALARMS
Unacknowledged : 5
Acknowledged: 21

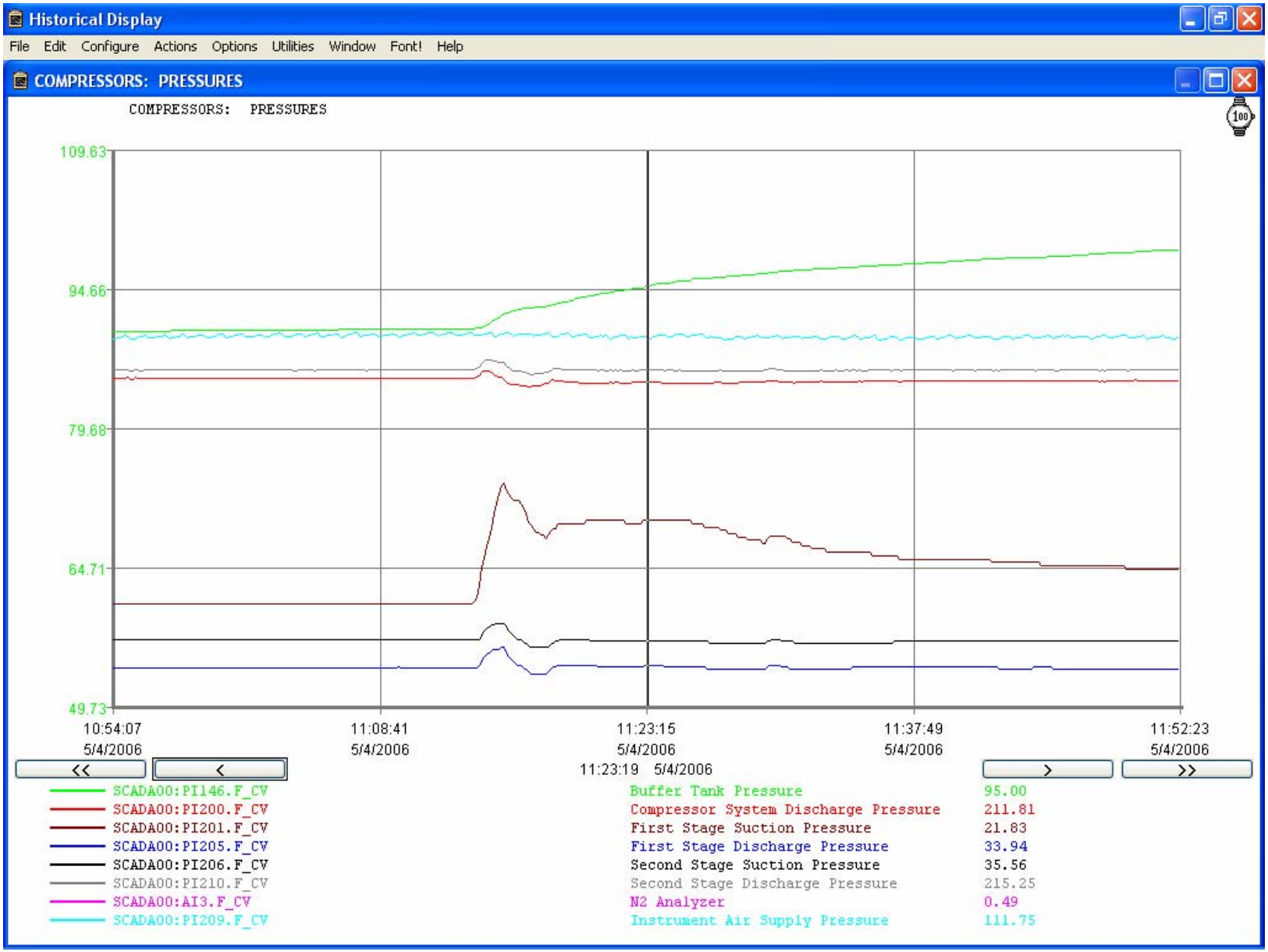

Intellution FIX View
File View Alarms Commands Applications Options Window Help
MTF_CMPM.ODF
Compressor System Controls
5/4/2006
10:58:23
STAND 2
STAND 4
STAND 6
OPERATING MODE
Recirculation
LS200
Makeup
PI146 (psia)
90.31
PCV 205
OPEN
CLOSE
PCV 210 0.00
PIC 201
PIC 202
PCV 211 1.00
PIC 200
PCV 204 0.15
PCV206 0.00
PIC 203
PCV221 0.20
QUENCH TANKS
PI201 (psia) 19.03
PI205 (psia) 33.75
PI206 (psia) 35.53
PI210 (psia) 215.00
RUNNING
RUNNING
FCV204
II200 (Amp) 159.00
II201 (Amp) 892.50
PI200 (psia) 212.81
From HX 1400
PCV 215
LP Line
MP Line
PCV 214
PCV 1406
HP Line
PCV 200
COLD BOX
FIRST STAGE LOAD
ZI200 (%) -55.38
UNLOAD
LOAD
OIL PUMPS
ON
OFF
1st
2nd
SECOND STAGE LOAD
ZI201 (%) -243.90
UNLOAD
LOAD
FIRST STAGE MCC
Breaker Motor Contactor
OPEN START OPEN
CLOSE STOP CLOSE
RESET
DIAG
SECOND STAGE MCC
Breaker Motor Contactor
OPEN START OPEN
CLOSE STOP CLOSE
PIC200
PIC201
PIC202
PIC203
400.0 psia
50.00 psia
100.0 psia
100.0 psia
215.0
17.6
38.5
35.5
OUT PV
MANUAL
AUTO
Tuning and Trends
SP 215.0
SP 17.6
SP 38.5
SP 35.5
Overview
Monitoring
Diagnostics
P Trends
T Trends
M Trends
AUTOMATIC OIL TRANSFER
ALARMS
Unacknowledged : 5
Acknowledged: 21

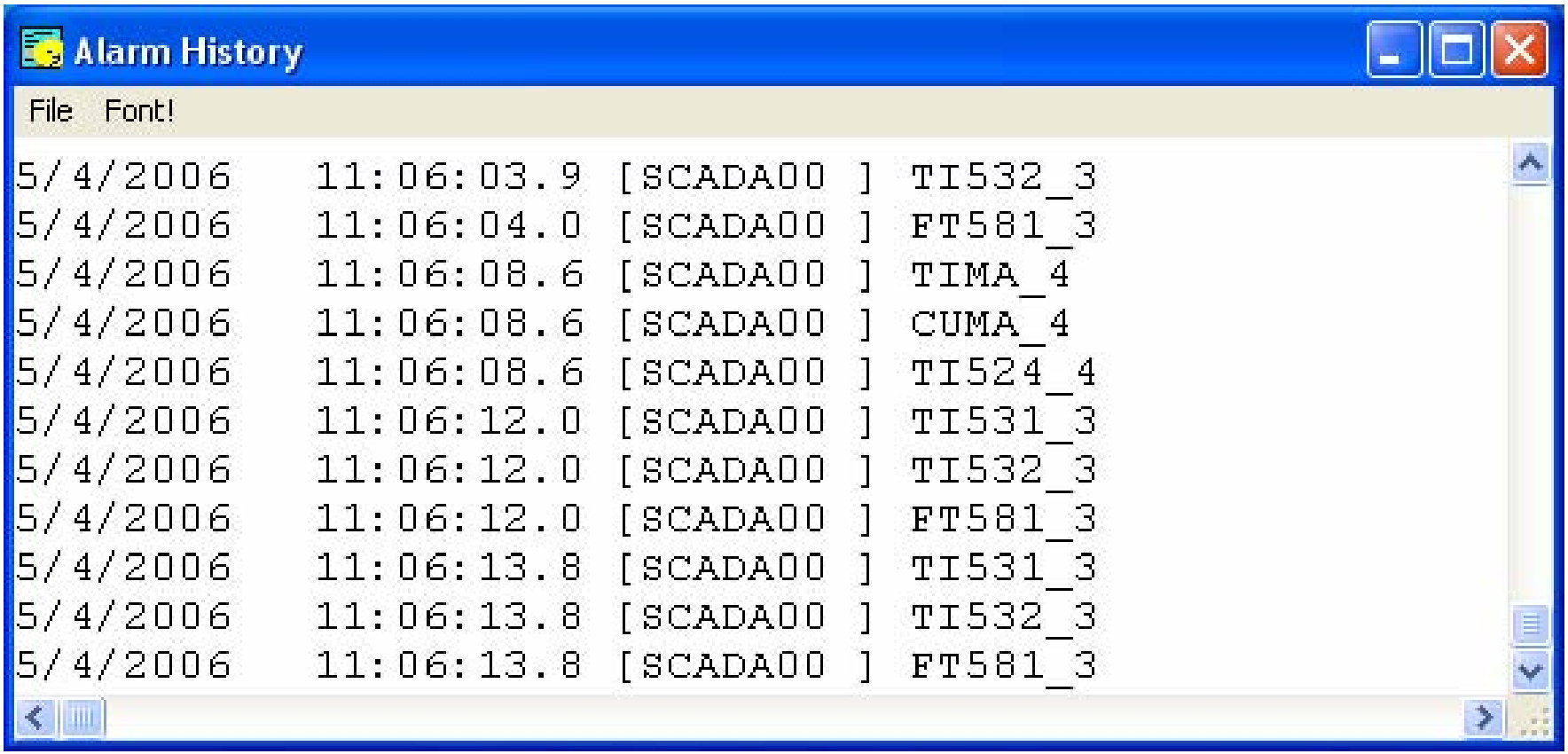

Intellution FIX View
File View Alarms Commands Applications Options Window Help
ST4CNTRL.ODF
Test Stand 4 Cryogenic Controls and System Monitoring
5/4/2006
10:56:35
COMPRESSORS
LN2 SHIELD SUPPLY
LHe SUBCOOLER
KINNEY PUMPS
PUMPING LINE
Baffle Shield
Main Shield
QUENCH
Vent
LHe SUPPLY
N2 VENT
From Main N2 Shield
PS
PERMIT
KINNEY II SYSTEM
G. VALVE
LIQ. RING
BOOSTER
VACUUM
Magnet Temperature (Q2a) 4.650 K
Magnet Current 24.8 A
ALARMS
Unacknowledged : 5
Acknowledged: 21
Overview
LHe Controls
Pumping Sys.
Vacuum
LCW System
Diagnostics
Hist. Trends


Intellution FIX View
File View Alarms Commands Applications Options Window Help
ST4PUMP.ODF
Test Stand 4 Pumping System
5/4/2006
10:56:05
Coarse Control
Fine Control
LIC580-4
PIC1411
PIC1413
PI1407 (Torr)
889.4
PI1415 (Torr)
804.7
Pump/purge
PCV-1411
PCV-1413
Backfill
KINNEY PUMP I
KINNEY PUMP II
KINNEY II SYSTEM
G. VALVE
LIQ. RING
BOOSTER
TI502-4 (K)
187.7
PI502-4 (Torr)
811.8
ICW Filter Pressure Drop
PDI2005 (psid)
0.0
PDI2006 (psid)
0.0
TI504-4 (K)
145.3
PI504-4 (psia)
21.4
LI521-4 (in)
0.0
TI501-4 (K)
66.2
PI501-4 (psia)
21.2
LI524-4 (in)
0.0
EV580-4
REQ: 0.00
ACT: 0.00
PI506-4 (Torr)
850.9
TEST STAND
EV580-4 LI521-4
0.00 0.0
PCV1411 PI506-4
0.00 851.0
PCV1413 PI506-4
0.00 851.0
MANUAL
AUTO
Tuning and Trends
OUT 0.00
Overview
Cryo Controls
LHe Controls
Vacuum
LCW System
Diagnostics
Hist. Trends
ALARMS
Unacknowledged : 5
Acknowledged: 21


Intellution FIX View
File View Alarms Commands Applications Options Window Help
KINNEY.ODF
5/4/2006
10:55:20
Kinney Pump 2 Controls
REMOTE
SYSTEM START
STOP
RESET
First Fault
He GAS to SUCTION
KINNEY PUMP 1
TEST STAND
PUMPING LINE
PS 1488
LS 1488
LS 1489
TS 1488
SEPARATOR TANK
MOTOR DRIVE
ITLK 1487
OLS 1487
ZSH 1487
LIQUID RING PUMP
CIRCULATING PUMP MOTOR
FS 1492
ZSH 1490
FS 1497
PS 1485
ZSH 1484
YY 1484
YY1484
ITLK 1484
OPEN
CLOSE
PI1485 (torr)
255.63
ZSL 1484
TS 1485
BOOSTER PUMP
ZSH 1486
OLS 1486
ITLK 1486
MOTOR DRIVE
YY 1496
FS 1495
FS 1498
FS 1499
FILTER VESSEL
PDT2005 (psid)
0.00
ICW SUPPLY
FILTER VESSEL
PDT2006 (psid)
0.00
ICW DRAIN
Overview
First Fault
Stand 4 Pumping System
Tag List
ALARMS
Unacknowledged : 5
Acknowledged: 21


Intellution FIX View
File View Alarms Commands Applications Options Window Help
MTF_QNCH.ODF
Quench Tanks
5/4/2006
10:57:32
PIC606
PIC201
COMPRESSORS
PIC 606
PIC 201
LP
MP
HP
PCV606 0.00
PI7 (psia) 18.38
PI201 (psia) 19.05
PI601 (psia) 17.0
COLD BOX LOW PRESSURE RETURN
QUENCH HEADER
HMTF
STAND 2
STAND 4
STAND 6
PCV606 PI7 0.00 18.4
PI201 0.00 19.0
MANUAL
AUTO
Tuning and Trends
OUT 0.00
SP 17.6
ALARMS
Unacknowledged : 5
Acknowledged: 21
Overview
Compressors
Stand 4
Historical Trends


Historical Display
File Edit Configure Actions Options Utilities Window Font! Help
COMPRESSORS: PRESSURES
COMPRESSORS: PRESSURES
109.63
94.66
79.68
64.71
49.73
10:54:07 5/4/2006
11:08:41 5/4/2006
11:23:15 5/4/2006
11:37:49 5/4/2006
11:52:23 5/4/2006
11:23:19 5/4/2006
SCADA00:PI146.F_CV Buffer Tank Pressure 95.00
SCADA00:PI200.F_CV Compressor System Discharge Pressure 211.81
SCADA00:PI201.F_CV First Stage Suction Pressure 21.83
SCADA00:PI205.F_CV First Stage Discharge Pressure 33.94
SCADA00:PI206.F_CV Second Stage Suction Pressure 35.56
SCADA00:PI210.F_CV Second Stage Discharge Pressure 215.25
SCADA00:AI3.F_CV N2 Analyzer 0.49
SCADA00:PI209.F_CV Instrument Air Supply Pressure 111.75


Alarm History
File Font!
5/4/2006 11:06:03.9 [SCADA00] TI532_3
5/4/2006 11:06:04.0 [SCADA00] FT581_3
5/4/2006 11:06:08.6 [SCADA00] TIMA_4
5/4/2006 11:06:08.6 [SCADA00] CUMA_4
5/4/2006 11:06:08.6 [SCADA00] TI524_4
5/4/2006 11:06:12.0 [SCADA00] TI531_3
5/4/2006 11:06:12.0 [SCADA00] TI532_3
5/4/2006 11:06:12.0 [SCADA00] FT581_3
5/4/2006 11:06:13.8 [SCADA00] TI531_3
5/4/2006 11:06:13.8 [SCADA00] TI532_3
5/4/2006 11:06:13.8 [SCADA00] FT581_3

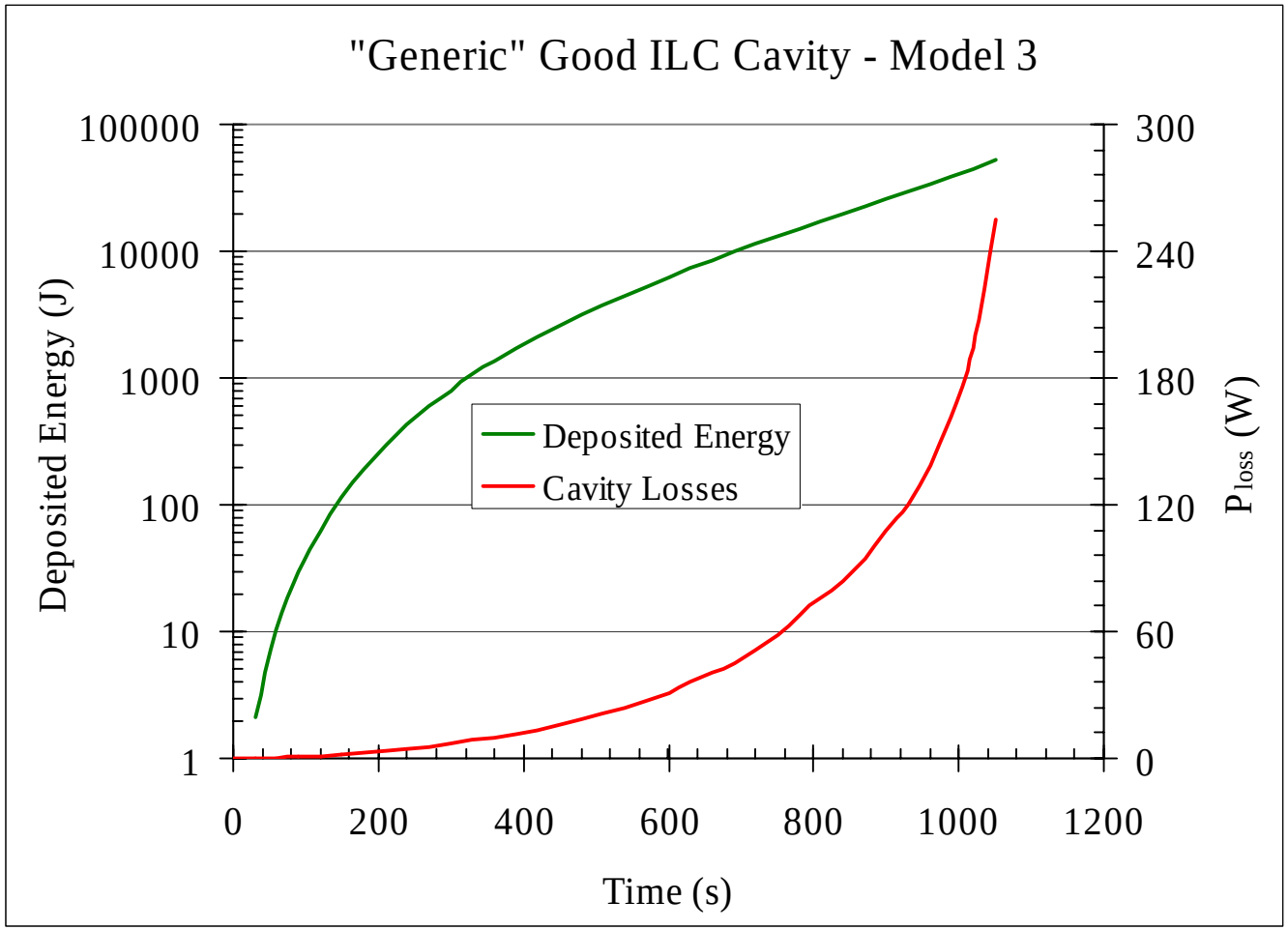
Vertical RF Cavity Test Facility

- SCRF cavity test in saturated helium bath at 2.0 K
- Gradient up to 35 MV/m
- Heat load at 2 K up to 250W
- Cooling capacity ~125 W @ 20 torr
- Bath temperature drifting, by how much?
- Helium level dropping, how much?
- Lowest temperature ~ 1.5 K

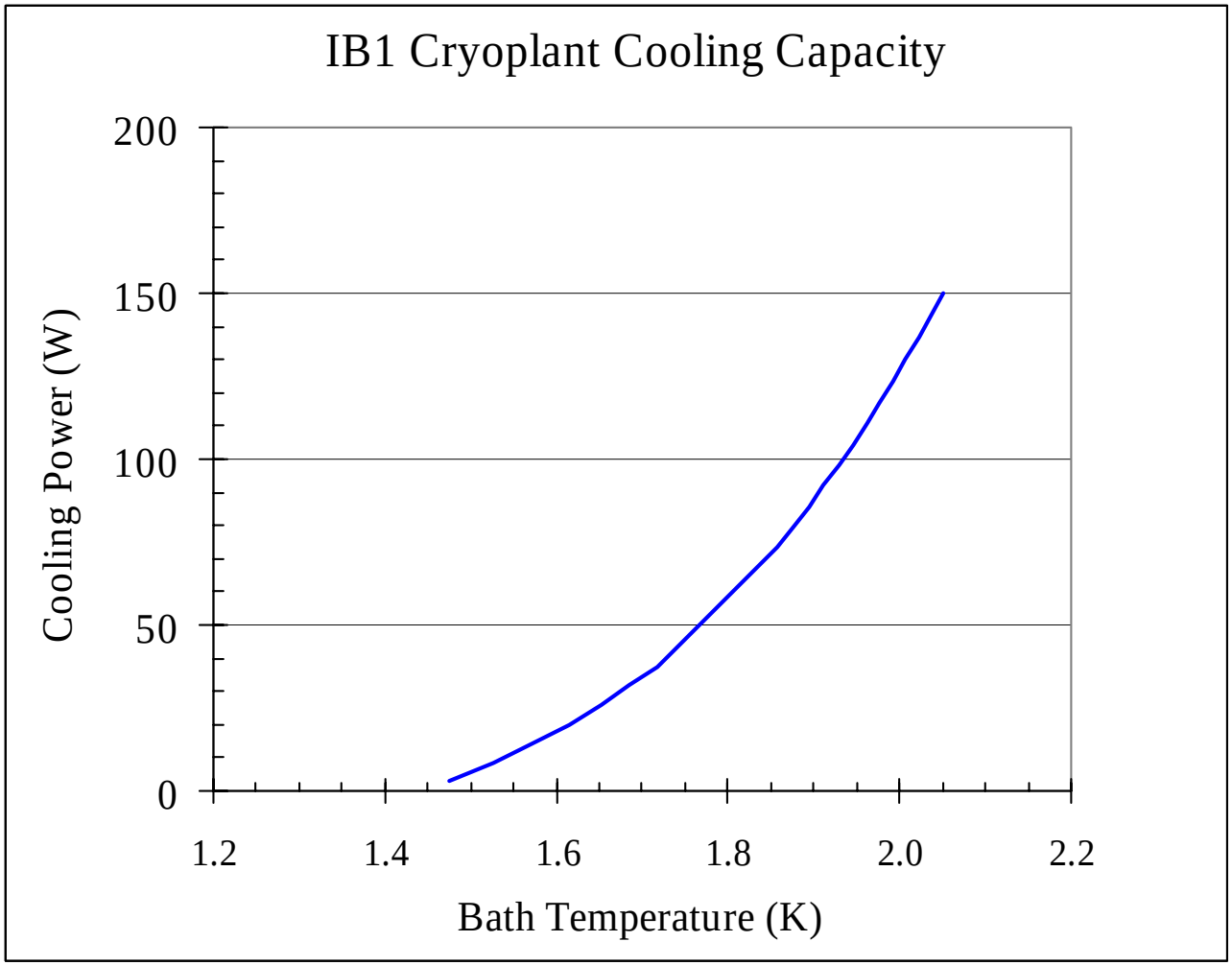
Vertical RF Cavity Test Facility

- Helium vessel inner diameter 27.8 inches
- Helium vessel depth 14 feet
- Helium level 3 feet from top plate
- Total LHe volume 1000 liters
- Static heat load issues
- Cool down time to 4.5 K ~ 4.5 hrs
- Cool down to time 2.0 K ~ 3 hrs

Heat Load at 2.0K

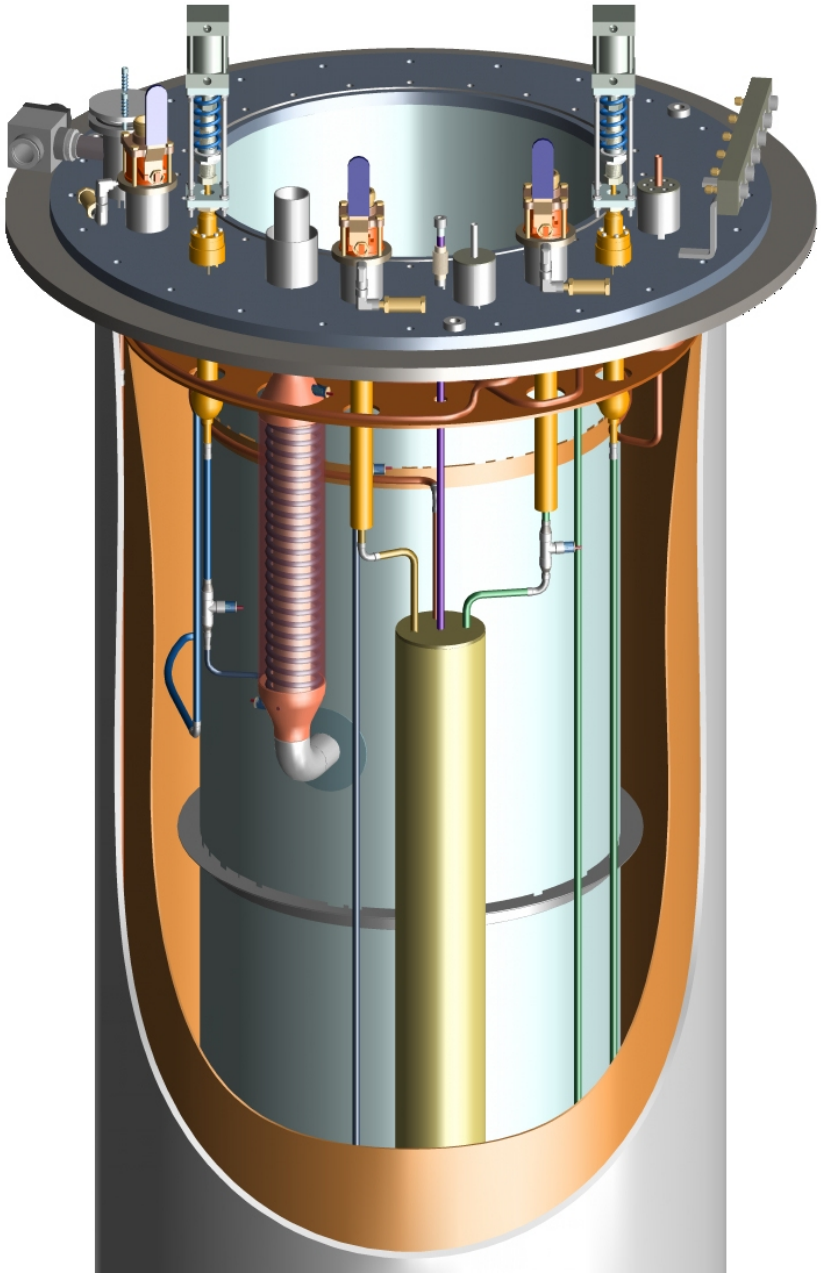


Cooling power at 2.0 K

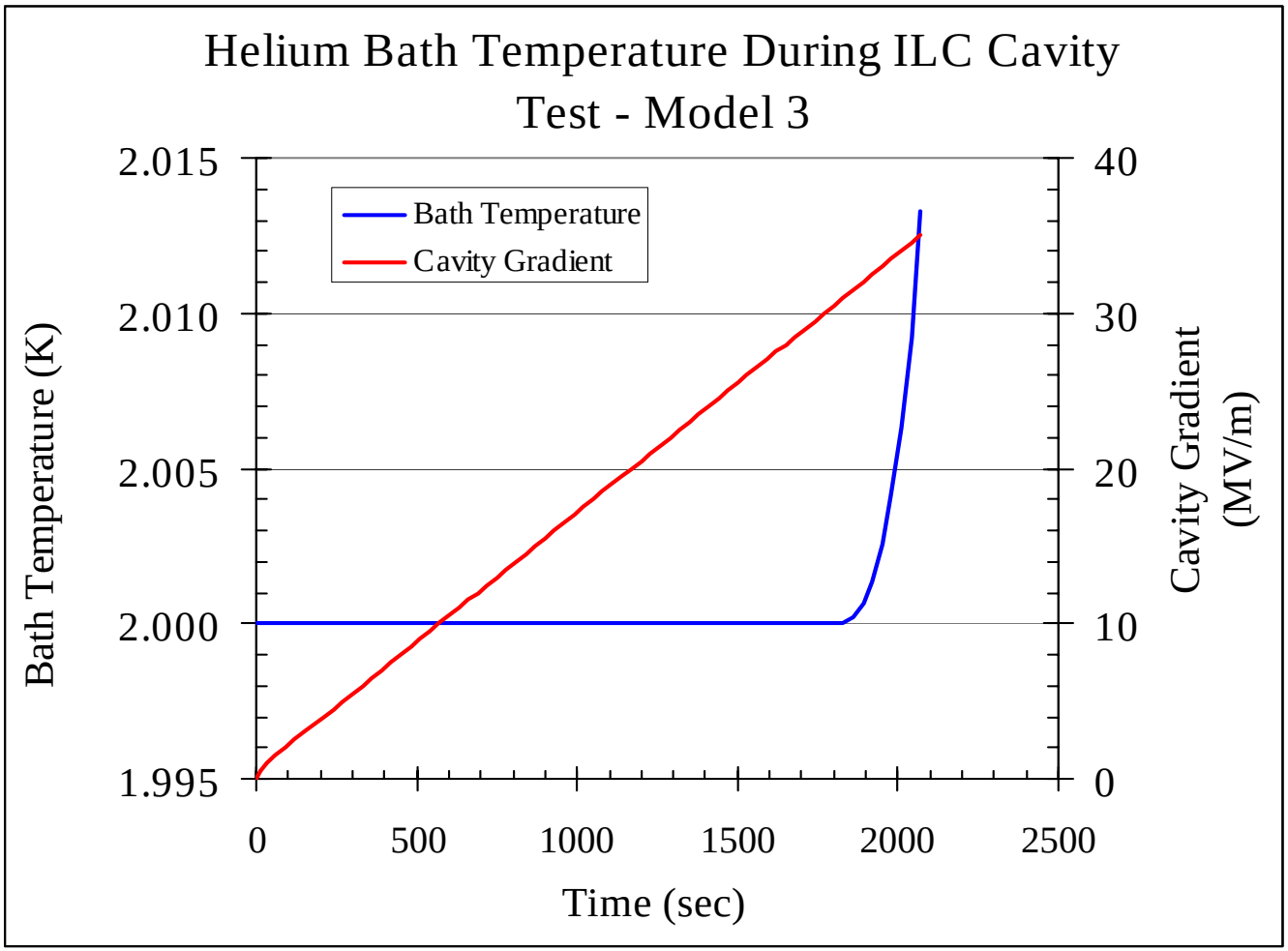


Helium Vessel Design

- Heat load to 2 K bath by conduction alone will be 18 W if no any intercept in between
- 100 K intercept heat load 67 W
- 5 K intercept heat load 5 W
- Heat load to 2 K bath will be only 0.05 W
- Total static heat load to 2 K bath including radiation will be less than 5 W



Bath Temperature Drifting



Summary

- Machine is almost 30 yrs old and still working
- LHC test stand test program will be done soon
- Tevatron magnet test stands continues
- VMTF high field magnet program will keep us busy for a while
- Both vertical and horizontal RF cavity test stands will be our core tasks in the years ahead
- Our current infrastructures meet the requirements for supporting the RF cavity test program