D0 CRYOGENIC SYSTEM

OPERATOR TRAINING

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ENGINEERING NOTE
3740.512-EN-331

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30 November 91

D0 CRYOGENIC OPERATOR TRAINING

OVERVIEW:

D0 is a collider detector. It will be operating and doing physics at the same time as CDF, therefore it has been decided to train CDF operators to operate and respond to the D0 cryogenic control system.

A cryogenic operator will be required to be in residence at D0, during the cooldown and liquid Argon fill of any of the calorimeters.

The cryogenic system at D0 is designed to be unmanned during steady state operation. CDF operations has 2 man cryogenic shifts 24 hours a day. It is intended that CDF operators monitor the D0 cryogenic systems, evaluate and respond to alarms, and notify a D0 cryo expert in the event of an unusual problem. A D0 cryogenic system view node has been installed at CDF to help facilitate these goals. It should be noted that even though the CDF view node is a fully operational node it is intended that it be more of an information node and is therefore password protected. The D0 cryo experts may reassess the use of the CDF node at a later date based on experience and operating needs.

This engineering note outlines the format of the training and testing given to the CDF operators to make them qualified D0 operators.

TRAINING:

The training session itself is at least one 4 hour session with a written test following. This session may be expanded based on questions by the operators or if a less experienced level of operators is being trained. This session is highly focused on safety systems such as ODH, interlocked devices, and cryo spill systems.

This class has been and will be taught by a D0 cryo expert, usually Dan Markley. This class is intended only as an introduction to D0's cryogenic, safety, auxiliary, and comprehensive computer based control systems. We intend to get most, if not all CDF operators involved in one or more of the calorimeter cooldowns. This will allow them to gain experience with the D0 cryogenic systems with cryo expert help.

CONCLUSION:

Completion of this training class makes the operator a D0 qualified cryogenic operator. See accompanying list for definition of terms and a list of personnel.

D0 CRYOGENIC OPERATING PERSONNEL

1. A DØ qualified cryogenic operator may make adjustments and evaluate alarms for corrective action for the DØ cryogenic systems and subsystems. He may operate the DØ cryogenic systems from the operating procedures as directed by a cryo expert.

2. A DØ cryogenic expert may manage the DØ cryogenic systems and subsystems. He may deviate from, or instruct the deviation from the operating procedures, usually with the consent of another cryo expert. He will oversee, if not do, unusual procedures, troubleshooting of systems and devices, any modifying/additions of software controls or programming.

DØ CRYO EXPERTS

DAN MARKLEY	KELLY DIXON	KURT KREMPETZ
RUSS RUCINSKI		

DØ QUALIFIED CRYOGENIC OPERATORS

BRUCE LAMBIN	BILL KELLOGG	DAVE DURANDO
BRUCE SQUIRES	CRAIG DRENNAN	BOB CARRIER
STEVE GORDON	PETE CROSS	

SCHEDULED FOR TRAINING CLASS

BOB PUCCI	MIKE MCGEE	CHUCK MCNEAL
BOB KUBINSKI	BILL HENCHELL	JOHN WORSTER
ED HILL	BILL HUGES	BRIAN JOHNSON

APPROVED_____

DATE_____

DØ CRYOGENIC OPERATING TRAINING MANUAL

FIRST EDITION
10/1/91

DØ CONTROL AND OPERATING LESSON OUTLINE

I. DØ cryogenic description
II. Power
    A. Emergency Generator
    B. U.P.S.
III. Control System Description
IV. DMACS --Distributed Manufacturing Automation and Control Software
    A. Graphics (review pages)
        1. Device control and interlocks
        2. Loop blocks
        3. Control verses status
    B. Historical Trending
        1. Groups and lists(trend assignments)
        2. setup for displays
        3. Speed, resolution, archiving, time
V. Alarm Handling
    A. Digital
        1. Disabled/Enabled in DMACS
    B. Analog
        1. Disabled/Enabled/setpoints in DMACS
    C. Auto dialer
        1. Acknowledging over phone
        2. Time delays and list cycling
        3. Controlling Auto Dialer in DMACS
    D. ODH
VI. PLC
    A. Modules
        1. Spares
        2. Replacing
    B. Fuse Replacing
VII. Loop Access Modules
    A. How to control from them
    B. Tuning from them
    C. How to monitor from them
    D. Locations
VIII. Operating/Emergency Procedures
IX. Systems Schematics/Descriptions
X Device Interlocks

TERMS TO KNOW(CONTROLS COMPONENTS)

PLC -Programmable Logic Controller

PC- Personal Computer such as Gateway 486

TI565- Texas Instruments model type of programmable logic controller

DMACS- Distributed Manufacturing Automation and Control Software. Written by Intellution and is the operator graphical interface to the DØ control environment.

SCADA NODE- Supervisory, Control, and Data Acquisition Node. Houses database and runs Scan, Alarm, and Control (SAC). They also share their data with view nodes.

VIEW NODES- Access and display data from SCADA nodes. They do not contain databases.

TISOFT- Program that runs on PC's, used to program programmable controller(TI565).

IBM Token Ring- A Network on which DMACS nodes communicate with each other.

I/O Bases- Texas Instrument crates located at the bottom of the south stairwell at which all the Input/Output physical wiring is tied to.

Hot Backup- PLC configuration where two PLC's run in tandem. If one should fail the other takes over automatically.

LAM- Loop Acess Module. An operater loop control station hardwired directly to the PLC. It can control any of the 64 PID loops in the PLC.

SAC- Scan, Alarm, and Control. DMACS background task that handles the database updating and scanning. Only on a SCADA NODE.

I/O Modules- Cards that plug into the I/O base that condition input/output devices for PLC interface.

Auto Dialer- A voice synthesized alarm chassis that can call on or off site and page people. Its inputs are from the PLC, can be controlled from DMACS View, and its output is over the telphone line.

TERMS TO KNOW(MECHANICAL COMPONENTS)

NEC- North End Calorimeter

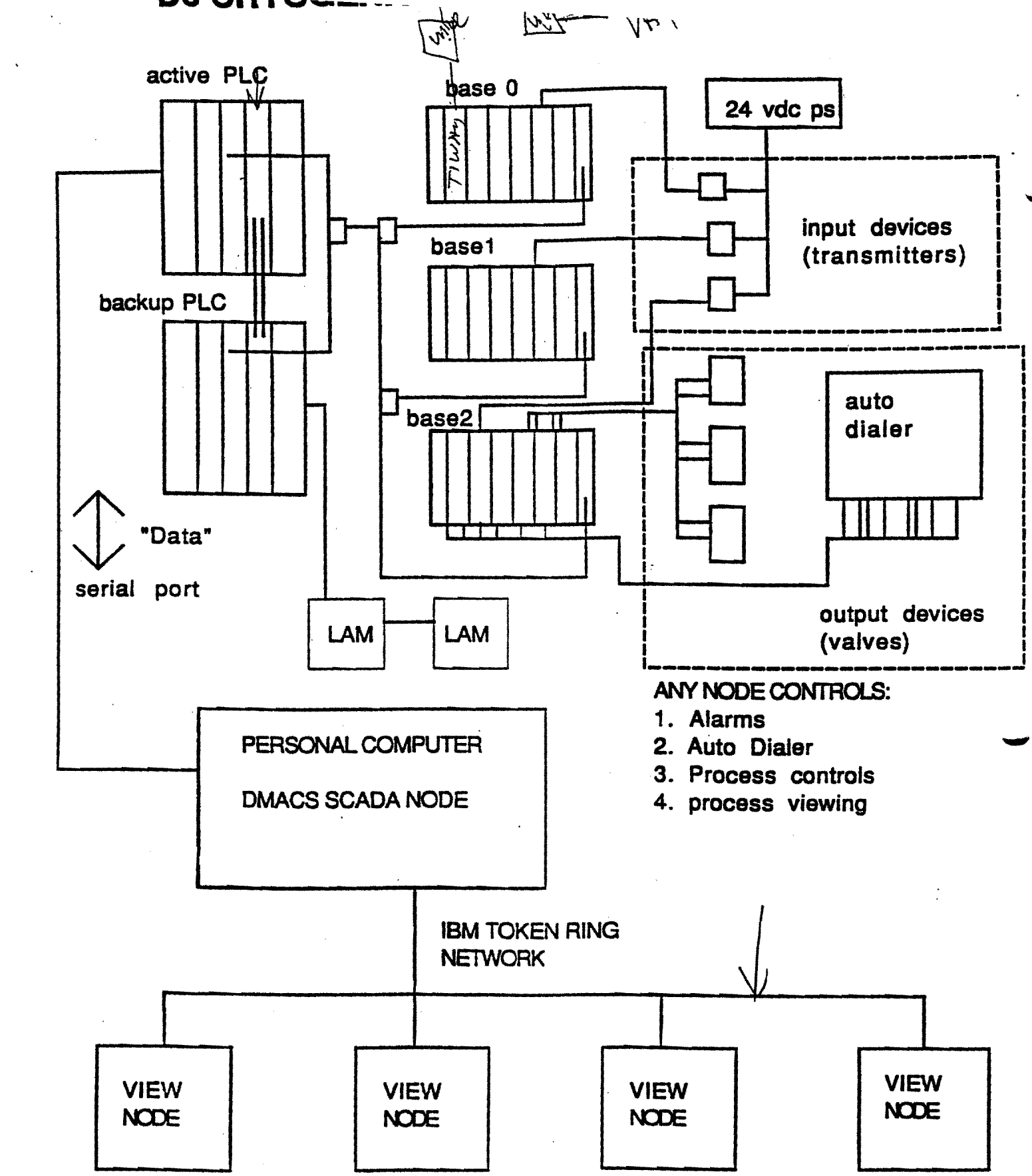
CC- Center Calorimeter

SEC- South End Calorimeter

Platform- The large frame that the calorimeters reside on. It can roll between the collision hall and the assembly hall. The platform and everything it supports weighs about 1000 tons.

South Side- Cryo Control room side of the DØ complex.
ATC- Argon Test Cell, used for electron mobility testing
U.P.S- Uninterruptable power supply, 10KV A.C. power for D0 cryogenic controls.
Cryocorner- SouthEast corner of the Platform where cryogenic and utility piping is attached.
Cryobridge- Cryogenic Piping manifolds that run from the cryocorner to the Calorimeters.
Rotating Bayonets- Rotating cryogenic jumpers that tie the NEC and SEC to the cryobridge.
Pump room- Utilities room off 4th floor catwalk next to cryogenic control room.
I/A- Instrument Air.
E/A- Emergency Backup Air(high pressure trailer).
ODH Platform- Raised platform in south stairwell where two relay racks that contain ODH and Vacuum equipment.
EF-7- Ventilation Fan for cryogenic areas which is always on(4500 CFM).
EF-6- Emergency ventilation fan for cryogenic areas(13000 CFM). Automatically started on ODH or cryogenic spill alarm.
UV- Utility Vacuum system.
IV- Insulating Vacuum System.
PV- Pneumatic Valve.
PT- Pressure Transmitter.
DPT- Differential Pressure Transmitter.
EV- Electric Valve
CC- Cold Cathode Vacuum instrumentation
TG- Thermocouple Vacuum gage
Pipe Chase- A vertical corridor on the South side that runs from the roof to the sump. All of its acess points are normally locked.
Sump- Cavity under the LAR Dewar room. Part of ventilation path.
CRYOSTAT- Interchangable with the word Calorimeter.
DEVICE NUMBERS:

Series	Associated Equipment
1XX	NEC
2XX	CC
3XX	SEC
4XX	Argon Truck Fill/DUMP
5XX	Nitrogen Dewar
6XX	Argon Dewar
7XX	I/A and Vacuum Systems


active PLC
base 0
24 vdc ps
input devices
(transmitters)
base1
backup PLC
base2
auto
dialer
"Data"
serial port
LAM
LAM
output devices
(valves)
ANY NODE CONTROLS:
1. Alarms
2. Auto Dialer
3. Process controls
4. process viewing
PERSONAL COMPUTER
DMACS SCADA NODE
IBM TOKEN RING
NETWORK
VIEW
NODE
VIEW
NODE
VIEW
NODE
VIEW
NODE

DØ cryogenic Description

The DØ detector consists of 3 liquid Argon Calorimeters (ECN,CC,ECS). The Argon used in these calorimeters is high purity. The Argon must contain less than .5 ppm of O2 and pass an electron mobility test. The calorimeters contain arrays of particle detectors. These calorimeters sit on what's refered to the DØ detector platform. The platform can be rolled in and out of the collision hall. The calorimeters can be cooled down and operated in the collision hall or the assembly hall. ECN and ECS can hold 4300 gls of LAr. CC can hold 5300 gls of LAr.

The liquid Argon is stored in a 20,000 gallon vacuum insulated vessel, located at the 1st level at the bottom of the South stairwell. The cryostats and the LAr dewar have cooling coils inside the pressure vessel with both inlet and outlet control valves.

The calorimeters and the Argon dewar is cooled by LN2 from a LN2 20,000 gallon dewar which is located on the South side of the DØ complex.

Each cryostat vacuum shell can be pumped on by a diffusion pump or a common blower backed by a common Mechanical pump.

Power

The electrical power for DØ is provided by commercial power which has an automatically controlled diesel generator for emergency power for selected crucial items. Some of these items are ODH related ventilation fans, I/A compressor, IV and UV vacuum pumps, Glycol cooling pumps, glycol cooling tower, and Cryogenic controls U.P.S.. This generator requires about 15 seconds to supply power when commercial power fails.

The electric power for the cryogenic control system is provided through the emergency generator backed U.P.S.. The U.P.S. provides power to the PLC, I/O bases, ODH monitoring system, IBM compatibles, micro vax, vacuum monitoring relay rack, and the control room Mac II. The U.P.S. supplies power immediately upon commercial power failure. The control system performs without interruption on a commercial power loss. The U.P.S. backup time is about 2 hours at the current load.

Control System Description

The cryogenic processes are controlled by pneumatically driven valves which receive an electrical control signal from the input/output bases of the Programmable Logic Controller(TI565).

The PLC controls the cryogenic processes through PID loop and programmed ladder logic.

The operator interface to the PLC control system is done through IBM compatible computers(PC'S). The PC'S run software that communicates to the PLC through graphic control screens. The PC'c also perform historical trending and historical data archiving. The PLC runs the control system with or without the PC communicating with it, in other words the PLC is still controlling even if all the PC's are turned off.

Another Operator interface to the PLC which is limited to the PID control loops is called a loop access module(LAM). This device looks like a standard loop controller except that it can control all the loops.

DMACS Overview (Distributed Manufacturing Automation and Control System)

DMACS allows an operator to control a system through graphical computer view screens. At DØ these screens were designed to look like the physical devices and configurations as much as possible. In most cases the view screen is a portion of the flow diagram, with device values displayed right on the picture. Changes to control parameters can be made right on these pictures, such as a controlling setpoint change. These pictures are also password protected to prevent unauthorized access.

DMACS has 2 types of nodes. A node is one station(one personal computer). They are SCADA node(Supervisory, Control, and Data Acquisition) and View node. The SCADA node is a node that communicates directly to the PLC, contains the database, and passes information to all the view nodes over the IBM token ring network. There is normally only one SCADA node operating. The view node is used primarily for operator displays and gets it's values from the SCADA node over the IBM token ring network. It is transparent to the user whether he is operating from a View or SCADA node.

DMACS is a distributed system, that is all the nodes function off of one database. This means any value change whether it is process generated or operator generated will be reflected on all of the nodes.

NOTE: The PLC will continue controlling all of the processes with the current setpoints even with DMACS off.

ALARM HANDLING

The control system has three type of alarms, Analog, Digital, and Auto Dialer. Each node can be configured to beep if an alarm is generated. Normally only one of the control room nodes is configured with the "horn" on.

Analog alarms are generated from the SCADA node database. Each analog input in the database can be configured with alarm setpoints. There are four main types of alarms HH, HI, LO, LL. Most analog inputs are not alarmed, however the ones that are are displayed on the analog alarm graphics control page in view. From view all of their setpoints and enabling/disabling can be manipulated. When there is an analog alarm all nodes that have the horn on, will beep.

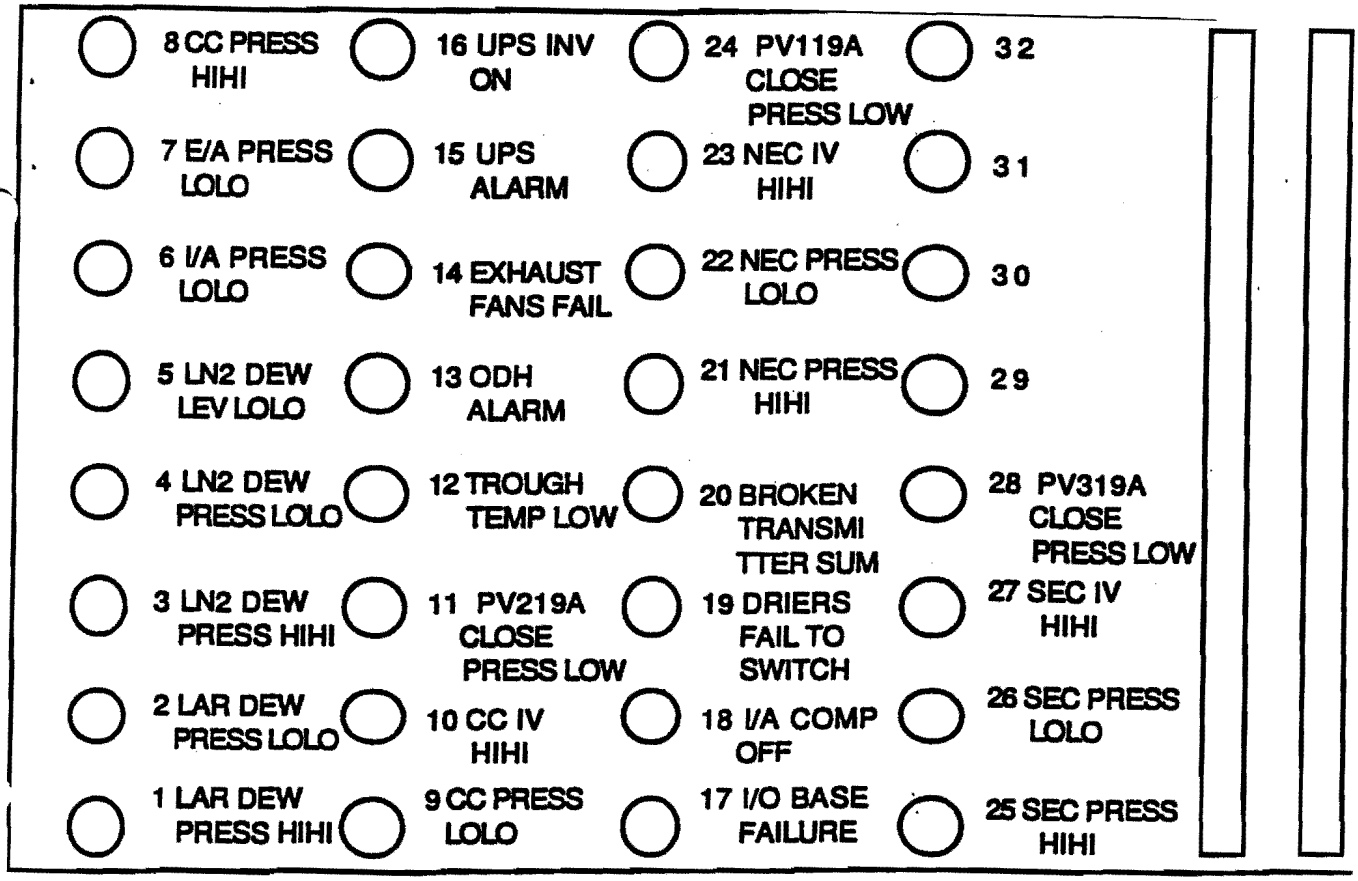
Digital alarms are generated in the ladder logic of the PLC. They can be enabled/disabled from the digital alarm supervisor page. When there is a digital alarm, all nodes that have the horn on, will beep.

Auto Dialer Operation

The Auto Dialer monitors alarm conditions via the TI565 PLC. Upon an alarm condition it initiates a phone calling sequence of preprogrammed lists with assigned priorities. When someone is reached, the Auto Dialer describes the individual alarm it is calling for, by a preprogrammed set of words for that individual alarm, spoken by a female voice. The called person then has a chance to acknowledge the alarm over the telephone. If the alarm is not acknowledged, the Auto Dialer will disconnect and call the next person on the list and will continue to cycle through the list until it is acknowledged, reset, or the alarm condition no longer exists.
NOTE: The Auto Dialer will function properly as long as the PLC is operating. DMACS doesn't have to be running.

Currently Programmed Auto Dialer Messages

CH #	Voice Synthesized Message
1.	L A R tank pressure high.
2.	L A R tank pressure low.
3.	L N 2 tank pressure high.
4.	L N 2 tank pressure low.
5.	L N 2 tank level low.
6.	Compressor air pressure low.
7.	Emergency air pressure low.
8.	C C tank pressure high.
9.	C C tank pressure low.
10.	C C I V pressure high.
11.	Cold valve pressure low.
12.	Temperature device cold.(Trough Temperature)
13.	O D H alarm.
14.	Air flow device failure. (Ventilation)
15.	U P S alarm. (Parameter Alarm)
16.	U P S power on. (Inverter On)
17.	I O base failure. (Blown Fuse)
18.	Air compressor failure. (Off)
19.	Air Treatment failure. (Air Drying System)
20.	Analog fault. (Transmitter Failure)
21.	NEC pressure HIHI
22.	NEC pressure LOLO
23.	NEC IV HIHI
24.	PV119A close pressure low
25.	SEC pressure HIHI
26.	SEC pressure LOLO
27.	SEC IV HIHI
28.	PV319A close pressure low
29.	Unused.
30.	Unused.
31.	Unused.
32.	Unused.



CALL LISTS

1) DM PAGE
2) KD PAGE
3) KK PAGE
4) CRYO PAGE
5) DM HOME
6) KD HOME
7) KK HOME
8) RR HOME

CURRENT SETTINGS

1) MESSAGE REPEAT=2
2) INTERCALL DELAY=60MINS
4) BYPASS TO RUN=60MINS
5) CALLING HOURS=24
6) ACCESS CODE=1,2,3,4
7) POWER FAIL MON=DISABLED
8) TIME BETWEEN CALLS=5MINS

PRIORITY

1) ODH
2) CC PRESS HIHI &LOLO
2) CC IV PRESS HIHI
3) ALL THE REST

TO ACKNOWLEDGE AN ALARM

1) ON PHONE PUNCH "8" WHEN ASKED FOR ACKNOWLEDGEMENT
OR
2) CALL UP BETWEEN OUT CALLS. (840-8065)WHEN THE LINE
OR RINGS IT'S ACKNOWLEDGED
3) PUNCH "RESET"(PUTS IN BYPASS)
DON'T FORGET TO PUT IN RUN MODE WHEN
CONDITION CLEARS. IT WILL AUTOMATICALLY
GO BACK TO RUN MODE IN 60MINS IF YOU DON'T.

CALL IN CODES

RUNMODE=(2,7)
BYPASS =(2,2)
PREVIOUS
MODE =(2,3)
VERIFY =(*)
PROGRAM=(#)
DIAL OUT=(3)

TO PUT IN SERVICE PUNCH "RUN" ON KEYPAD

Auto dialer Alarm Acknowledging

When receiving an auto dialer alarm it can be dealt with in several ways.

1. Punch 8 on a touch tone phone after the message, to acknowledge.
2. Hang up, call it back,(840-8065) after the telephone rings all current alarms will be acknowledged
3. Open the Auto Dialer door and push the reset button .
   CAUTION: Doing this puts <u>all</u> of the auto dialer alarms in the bypass mode for the "bypass to run delay" time period. This should only be used temporarily to stop the outgoing calls from the auto dialer while you are assessing the alarm, because you will not be notified by the auto dialer while in this mode, if another auto dialer alarm is triggered. For longer term acknowledgment for a particular alarm, it should be disabled.
4. The individual alarm that has been triggered can be disabled, while assessing the alarm. This will disable the alarm to the auto dialer also.

ODH Alarm configuration

ODH alarms are generated by the Research Division ODH monitoring chassis. DØ has two ODH zones, the detector platform(14 heads) and the south side building (10 heads). The ODH alarms are linked directly to FIRUS. The PLC also monitors them and their status is available in view. The auto Dialer is also activated on an ODH alarm.

Whenever there is a change of state in the ODH sytem ie. alarm, trouble, or bypass, Security Dispatch (x3414) should be advised of the situation as soon as possible.

During an ODH alarm the cryo control room may be entered if the doors are propped open. There are several O2 monitors near the double door, which should be worn during an alarm.

Since DØ has 24 ODH heads installed, they are allowed to keep 2 spare heads. RD safety also allows DØ to keep a set of ODH bypass keys for maintenance and trouble shooting.

Warning: DØ's cryogenic safety subcommittee, will only allow the ODH bypass key, to be be used by a DØ designated cryoexpert.

DØ Cryo expert list as of 10/1/91

Dan Markley	x2849	p-992	815-741-1521
Kelly Dixon	x2634	p-334	708-741-8747
Russ Rucinski	x2888	p-527	815 ~~708~~-393-3314
Kurt Krempetz	x4657	p-509	708-830-4009

cryopager Long Distance 708-314-5192

Safety Interlock summary list

TRIGGER	ACTION	DESCRIPTION
1) LAR Dewar LL	Closes PV612N	LAR DEW Cond OFF
2) LAR Dewar HH	Closes PV601A	LAR DEW Vaporizer OFF
3) DPS560N	Closes PV513N	High Platform LN2 Flow, Is
4) DPS563N	Closes PV548N	High LAR DEW, LN2 Flow,
5) TS132E	Closes PV101N & PV102N	LN2 in Vent NEC Cond OFF
6) TS232E	Closes PV201N & PV202N	LN2 in Vent CC Cond OFF
7) TS332E	Closes PV301N & PV302N	LN2 in Vent SEC Cond OFF
8) DPS138A	Closes PV119A	High LAR Flow, NEC Isolati
9) DPS238A	Closes PV219A	High LAR Flow, CC Isolation
10) DPS338A	Closes PV319A	High LAR Flow, SEC Isolatic
11) Any ODH Alarm	EF-6 ON	13000 CFM Building vent
12) Any CryoSpill	EF-6 ON	13000 CFM Building Vent
13) Keylock	PV118A	NEC Fill/Drain locked closed
14) Keylock	PV218A	CC Fill/Drain locked closed
15) Keylock	Pv318A	SEC Fill/Drain locked closed

Interlocks #3 through #10 are latching. They will not reset when the triggering action clears. They must be reset by pressing the cryo control room reset button, located in the relay rack.

DØ OPERATOR TEST

NAME_____

1. Where can the initial assessment be made of an ODH alarm?
   A. DØ main control room without portable O2 detector.
   B. Cryo control room without portable O2 detector..
   C. Detector Platform without portable O2 detector.
   D. ODH Platform without portable O2 detector.
   E. Outdoor ODH status panel without portable O2 detector.

2. Name the two ODH zones? _____ and_____ .

3. Circle equipment not on emergency power.
   A. Glycol cooling tower.
   B. Glycol system pumps.
   C. IV mechanical pump.
   D. UV mechanical pump.
   E. EF-6 and EF-7.
   F. U.P.S.
   G. I/A comp #1.
   H. I/A comp #2.
   J. Air Driers.
   K. Diffusion pumps.

4. Circle the equipment not on the U.P.S. .
   A. PLC #1 & #2.
   B. ODH equipment rack.
   C. Gate A.
   D. Gate B.
   E. Vacuum rack.
   F. AST #1
   G. AST #2
   H. Control room clock
   J. I/O bases.

True or False

1. The sump is considered a confined space. True False

2. The pipe chase is considered a confined space. True False

3. EF-6(13000 cfm) & EF-7(4500 cfm) are always on. True False

4. Each calorimeters N2 cooling loop and pressure vessels relief have a common exhaust line to vent. True False

5. During cooldown of a calorimeter an operator should try to maintain liquid N2 in the exhaust line. True False

6. The calorimeters can be filled warm. True False

7. During cooldown of a calorimeter the condenser pressure is kept higher at about 40 psia to keep from raining Argon on warm modules. True False

8. The keyswitches to the fill/drain line PVx18A may be left "enabled" all the time. True False

9. The Auto Dialer may be temporarily bypassed to assess an alarm. True False

10. The LAr dewar has two relief valves, 65 and 20 PSIG. True False

11. A calorimeter may be filled from the LAr dewar with the 65 PSIG relief valve on line. True False

12. The calorimeters pressure vessel relieves at 13 PSIG. True False

13. The calorimeters may be cooled down as fast as possible. True False