Iowa Electric Light and Power Company

April 21, 1992
NG-92-2091

Mr. A. Bert Davis
Regional Administrator
Region III
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Duane Arnold Energy Center
Docket No: 50-331
Op. License DPR-49
Licensee Event Report #92-004

Gentlemen:

In accordance with 10 CFR 50.73 please find attached a copy of the subject Licensee Event Report.

Very truly yours,

David L. Wilson
Plant Superintendent - Nuclear

DLW/JP/pwj

cc: Director of Nuclear Reactor Regulation
Document Control Desk
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, D. C. 20555

NRC Resident Inspector - DAEC

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NRC Form 366A (6-89) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO 3150-0104

EXPIRES 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Duane Arnold Energy Center	0 5 0 0 0 3 3 1	1 OF 1 1

TITLE (4): Cable Spreading Room Fire Suppression System Test Results in Excess Intrusion of Carbon Dioxide into Control Room

EVENT DATE (5)			LER NUMBER (6)				REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR		SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
										None	0 5 0 0 0
0 3	2 2	9 2	9 2	-	0 0 4	- 0 0	0 4	2 1	9 2		0 5 0 0 0

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	X 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
	AREA CODE
Jim Probst, Technical Support Engineer	3 1 9 8 5 1 - 7 3 0 8

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On March 22, 1992, with the reactor shutdown and defueled, a Special Test of the Cable Spreading Room (CSR) carbon dioxide fire suppression system resulted in intrusion of carbon dioxide into the Control Room which lead to an unacceptable reduction in area oxygen levels within a few minutes. Due to this possibility, some Control Room personnel had been equipped with self-contained breathing apparatus at the time of the test, and manning of the area was maintained. Non-essential personnel left the area. Oxygen levels of 17% (chest level) and 15% (floor level) were recorded at various times versus the plant criteria of 19.5%. The test was conducted to check corrective actions taken following a similar event in 1990. The cause of the lower oxygen levels was overpressurization of the CSR directly beneath the Control Room. Sealed penetrations between the two rooms leaked under the high differential pressure. Corrective actions include an additional vent path to the CSR (pending development of final actions), and continuing to require SCBA use upon actuation of the CSR fire suppression system. The additional vent path has been verified as adequate through further testing.

I. DESCRIPTION OF EVENT:

On March 22, 1992, with the reactor shutdown and defueled, a Special Test of the Cable Spreading Room (CSR) carbon dioxide fire suppression system was conducted. This test was designed to demonstrate the adequacy of the fire suppression system (the CARDOX) in achieving and maintaining a CSR atmosphere with acceptable levels of carbon dioxide (CO_2). The test was also designed to monitor the effect of the CARDOX discharge upon the Control Room atmosphere. The Control Room is located directly above the CSR. Following a partial CARDOX discharge in 1990, intrusion of carbon dioxide into the Control Room had been noted. This resulted in lower than normal oxygen levels in the Control Room for a brief period of time. (See Historical Background, at the end of this section). Changes to the Control Room and CSR ventilation systems to minimize CO_2 intrusion into the Control Room had since been completed. The Special Test on March 22, 1992, was the first initiation of CARDOX since those modifications were installed.

The Special Test performed on March 22, 1992 specified certain conditions prior to CARDOX actuation to ensure continued personnel safety and adequate Control Room staffing regardless of the test results. These included monitoring of Control Room oxygen and CO_2 levels by hand-held, portable monitors, the addition of a wintergreen scent to the CO_2, and the posting and control of access to nearby areas due to the possibility of CO_2 intrusion. As an added precaution, the test called for two licensed operators in the Control Room to be outfitted in Self-Contained Breathing Apparatus (SCBA) prior to the test beginning, and an additional individual wearing an SCBA to be posted outside the Control Room in order to assist in removal of personnel from the area, if that became necessary. The test designated 19.5% as the minimum level of o[illegible]n necessary for continued occupancy of the Control Room by personnel without SCBAs. This value is considered the lowest acceptable oxygen level for worker occupancy per OSHA standards. Plant management was present to observe the test, and two Senior Reactor Operators were designated to wear the SCBAs.

Immediately prior to the test, steady-state oxygen levels of 21.3% and CO_2 levels of 0.3% were recorded in the Control Room. At approximately 1050 hours, Control Room personnel were informed of the pending initiation of the CARDOX. At the beginning of the test they noted the CARDOX initiation alarms, and then, approximately forty seconds later, the sound of the CO_2 injection itself could be heard as it was occurring one floor below. Approximately a minute after the injection of carbon dioxide into the CSR was first heard in the Control Room, personnel in that area began noticing leakage of the gas up through fire penetrations in the floor. Air flow could be felt and in some cases there was dust blown into the air. The wintergreen scent of the CO_2 could also be detected.

Monitoring of oxygen levels in the Control Room continued, and roughly three to four minutes after the CARDOX initiation (first audible alarm), an oxygen level below 19.5% was observed at waist level in the back panel area just behind the main control panels by a hand-held monitor. The senior Shift Supervisor on duty was informed of the reading, and he immediately ordered all non-essential personnel to leave the Control Room, as per the test requirements. At approximately the same time, other Control Room supervisory personnel were observing a stationary oxygen monitor positioned in the front panel area at roughly chest level. They also noted an oxygen level reading of 19.5%, and announced that non-essential personnel should leave. As personnel exited the area, an oxygen reading of 20% at waist level was recorded on the hand-held monitor in the main (front) control panel area.

As non-essential personnel left the Control Room, the two Senior Reactor Operators wearing SCBAs remained behind and began breathing from their SCBAs. As previously planned, outside air flow was directed into the Control Room to purge its atmosphere. The testing of the CARDOX system was also halted, approximately four minutes into the injection and just as the planned discharge of CO2 into the CSR was completed. Shortly before, or just after the CO2 injection into the Cable Spreading Room had been completed, one of them noted the stationary oxygen monitor at the front panel area was reading 17%.

As previously planned, temporary ductwork was set up through the main Control Room entrance to allow for increased venting of the area. Additional personnel began returning to the Control Room in SCBA's approximately seven minutes after the room had been cleared of non-essential personnel. The lowest oxygen reading recorded during the event were taken with the hand-held monitor shortly after these personnel returned, in the back panel area previously noted. The oxygen content of the air was recorded at 15% at floor level (and 18.5% at waist level). For CO2, the floor level concentration in this area was recorded at 12%. Shortly thereafter, oxygen levels in the front panel area of the Control Room were noted to be 17% at floor level, and 19.5% at waist level. Also at this time, the concentration of CO2 for the front panel area was recorded as 12% and 4% for floor and waist levels, respectively. Soon afterwards, oxygen levels in the Control Room began increasing steadily, as the venting of the room began to take effect. Oxygen levels had returned to acceptable levels within twenty minutes of the CARDOX initiation.

Historical Background:

The Duane Arnold Energy Center completed installation of the carbon dioxide fire suppression system for the Cable Spreading Room in 1974. At that time, during pre-operational testing, CO2 leakage into the Control Room was first detected. Overpressurization of the Cable Spreading Room during the CARDOX initiation was thought to be the cause, and modifications were performed to provide a pathway to relieve this excess pressure. An additional fire damper was installed and designed to close only if high temperatures indicative of an actual fire were detected (>360F) (See Figure 1, Damper A).

In 1980, a review of Control Room habitability was performed in accordance with NUREG 0737. This review did not evaluate the possibility of CO2 intrusion into the Control Room during a CARDOX actuation, as it was assumed the Control Room isolated from the Cable Spreading Room when this occurred.

On September 19, 1990, an inadvertent initiation of the CARDOX system occurred during a scheduled surveillance procedure. Approximately 25% of the CARDOX tank's capacity was discharged into the Cable Spreading Room. (Later tests have shown 30% to be a full discharge.) During this event, CO2 intrusion into the Control Room via fire penetrations in the floor was observed by Operations personnel. Unnecessary personnel exited the room at that time, and the availability of SCBAs was verified. Subsequent measurements of Oxygen concentrations in the Control Room found none below 19.4%. Control Room ventilation was increased and oxygen levels were returned to normal (21%) within minutes. This event and the corrective actions stemming from it were discussed in an October 28, 1991 letter from Iowa Electric, NG-91-3284, to Dr. T. Murley, Office of Nuclear Reactor Regulation.

Further review after the September, 1990 event determined that a backdraft damper, designed to prevent a ventilation path from the CSR to the toilet area of the Control Room, was not installed as indicated on design drawings. (See Figure 1, Damper B). Its presence was assumed for the 1980 NUREG 0737 review. It has not been determined why the damper was not installed. It was also determined the modification made in 1974 to increase the CSR vent path and reduce the atmospheric pressure in the room had been rendered ineffective by a damper and fan further along in the ducting, which on a CARDOX initiation would close, and shut off, respectively. (See Figure 1, Damper C and Fan X). The increase in the atmospheric pressure of the CSR during CO2 injection therefore would be higher than desired, which in turn could lead to higher flow rates into the Control Room via the toilet exhaust ventilation, and leakage of the penetration seals between the CSR and the Control Room.

As an initial corrective action for the September 1990 event, Control Room personnel were instructed to don SCBAs at the time of CARDOX initiation. Procedures were modified accordingly, including a provision to require removal of all non-essential personnel from the Control Room. In addition, as a long-term corrective action, design modifications to the CSR and Control Room ventilation systems were initiated. As planned, these design enhancements were completed prior to shutdown for the current refueling outage. The modifications included 1) elimination of the direct vent path from the CSR to the Control Room toilet area and 2) a modification to the CSR damper controls to provide better venting of the room during initial stages of a CO2 injection by leaving the exhaust damper open for four and a half minutes following the initiation. (See Figure 3, Damper C). Also provided were modifications to Control Room ventilation controls to make ventilation of the room with outside air an easier task. A wintergreen scent had been added to the CO2 as well. The Special Test performed on March 22 was designed to test the effect of these modifications on CSR fire-suppression capabilities, and Control Room ventilation and oxygen supply during a CARDOX initiation.

At the time the March 22 test was stopped, the system design requirement (per NFPA 12-1973 and the UFSAR) of a 30% CO2 concentration within two minutes had been satisfied. 50% concentration was achieved approximately four minutes after CARDOX initiation. This was an expected result and met the NFPA 12-1973 requirement of seven minutes. (It did not fully conform to the current UFSAR and June 1978 Fire Protection SER values of three minutes, twenty seconds, as the calculations that these values are based on do not take into account the additional time after full discharge that is required for the CO2 distribution system to empty.)

II. CAUSE OF EVENT:

Review of the Special Test data indicate that the cause of the unacceptable levels of CO2 intrusion into the Control Room on March 22, 1992 was an unacceptably high pressure in the CSR during the initial stages of CARDOX operation. Atmospheric pressure in the CSR peaked at over 13 inches H20 (gage) approximately four minutes into the CARDOX initiation. The fire penetrations between the CSR and Control Room were unable to maintain an air-tight seal under this substantial pressure. The root cause of the event was the (prior to 1990) unrecognized negative impact of the CARDOX on Control Room habitability. This required corrective actions be taken. The need to verify the adequacy and effect of these actions lead to the performance of the Special Test on March 22, 1992. The test demonstrated that the actions taken up to that time did not provide sufficient venting capability for the CSR if CARDOX were initiated.

III. ANALYSIS OF EVENT:

As noted in the event description, the possibility of an unacceptable displacement of oxygen by CO2 during the Special Test was recognized beforehand, and a great number of precautions were included in the test to prevent any negative effect on plant or personnel safety. There was increased management attention throughout the test process due to this concern. The test was run with the plant in a shutdown condition. Because of the extensive precautions taken, the resulting removal of non-essential personnel from the Control Room did not adversely affect the safe operation of the plant.

IV. CORRECTIVE ACTIONS:

The review of the test data from March 22 indicated that enhancements to reduce pressure further in the CSR during CO2 injection would likely result in significantly less CO2 intrusion into the Control Room while not greatly effecting the fire suppression system. Therefore, an additional, manually-operated temporary vent was added to the Cable Spreading Room (see Figure 3, Damper D), and the automatic damper on the existing vent path (Damper C) was also set to remain open an additional thirty seconds. The test was rerun on April 5, 1992. The reactor vessel was partially fueled, with no fuel movement in progress, nor other work with the potential to drain the vessel. As with the first test on March 22, a number of precautions were taken, including the wearing of SCBAs by Control Room personnel prior to the test commencing. Management personnel were again present.

At approximately 1110 hours on April 5, 1992, the second Special Test commenced. The temporary vent was opened when CSR atmospheric pressure reached one inch H20 (gage). The results of the test were very positive with respect to both Control Room habitability and the functioning of CARDOX as a fire suppression system. The maximum CSR atmospheric pressure recorded during the test was 4.5 inches H20, which was a significant reduction from the March 22 test. Oxygen levels in the Control Room changed little from their pre-test levels of 21% (front panel) and 20.8% (back panel). (All gas levels given were measured at waist height unless otherwise specified). The lowest front panel Oxygen reading was 20.5% near the end of the CO2 discharge, and a back panel Oxygen reading of 20.5% was taken shortly thereafter. (A floor level reading of 19.5% for oxygen was recorded in the back panel area during the discharge). The highest waist-height CO2 readings were 1.1% at the front panel during the discharge and 2.9% in the back panel area shortly after the discharge. (A floor level reading of 6% was recorded in the back panel area during the discharge). Regarding fire suppression capabilities, the applicable NFPA standard (12-1973) was met for CO2 levels in the CSR. These levels were above the requirements after 2 minutes (30%) and seven minutes (50%). CO2 levels remained above 50% for greater than 20 minutes, which meets the 1989 NFPA standard (12-1989).

Long-term corrective actions are as follows:

1. To assure Control Room habitability upon a CARDOX initiation, the additional venting capability for the CSR that was tested on April 5 will be retained, pending the development of final corrective actions. A schedule for these activities will be developed by July 5, 1992.

2. As a further contingency to ensure continuing personnel safety and adequate staffing, Control Room personnel will continue to be required to don SCBA gear upon a CARDOX initiation. Following a CO2 discharge into the CSR, Control Room oxygen levels will be monitored to ensure these levels are safe and stable prior to removal of the SCBAs. An oxygen level monitor has been provided to the Control Room.

This contingency action of donning SCBAs ensures conformance with the guidelines of Regulatory Guide 1.78 regardless of the operability of the additional vent path. RG 1.78, "Assumption for Evaluating the Habitability of a Nuclear Power Plant Control Room

During a Postulated Hazardous Chemical Release", indicates that the time from detection to incapacitation due to a chemical release should be greater than two minutes to provide sufficient time for a trained operator to put a self-contained breathing apparatus into operation. The March 1992 test demonstrates that (given the unlikely failure of the additional vent path), the time from a CARDOX initiation signal to a low Control Room oxygen level would be over two minutes.

3. The UFSAR will be updated in the next submittal to reflect the information contained in this report.

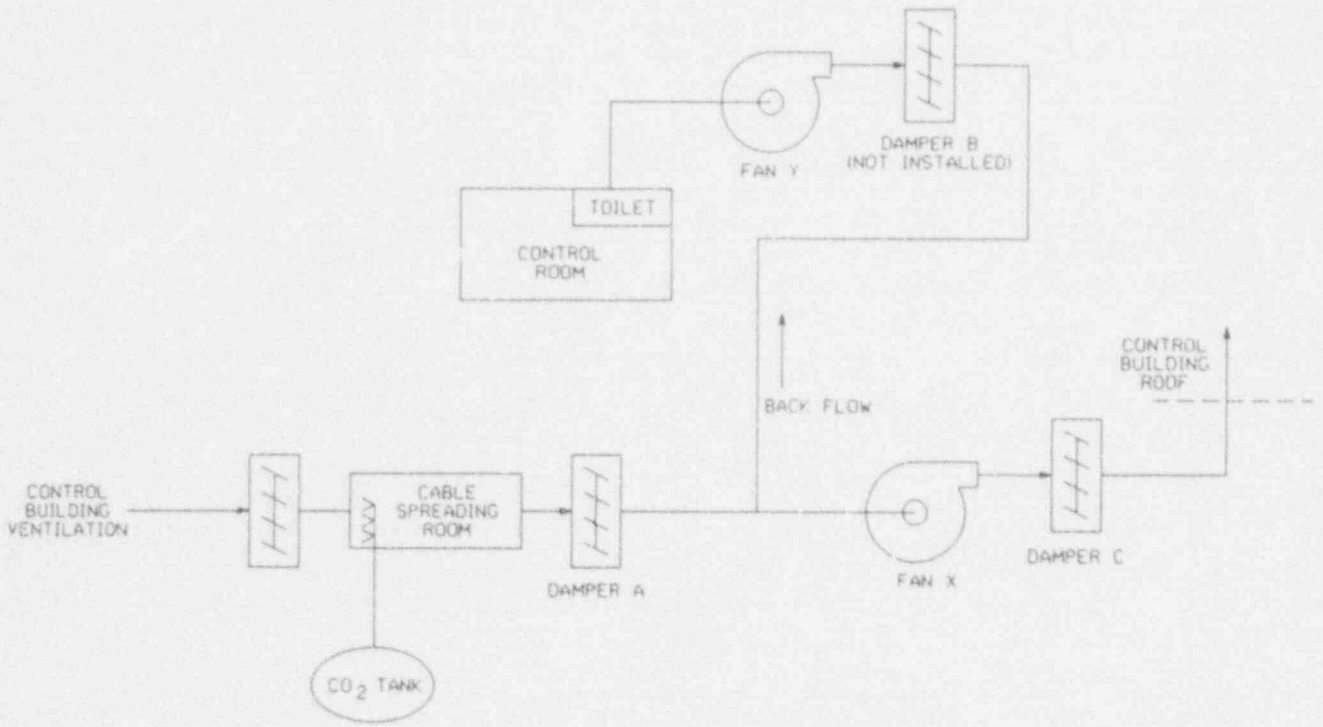
4. INPO NETWORK entries have been made describing the March 22 event, and the corrective actions being taken.

V. ADDITIONAL INFORMATION:

There have been no previous similar events apart from those previously discussed.

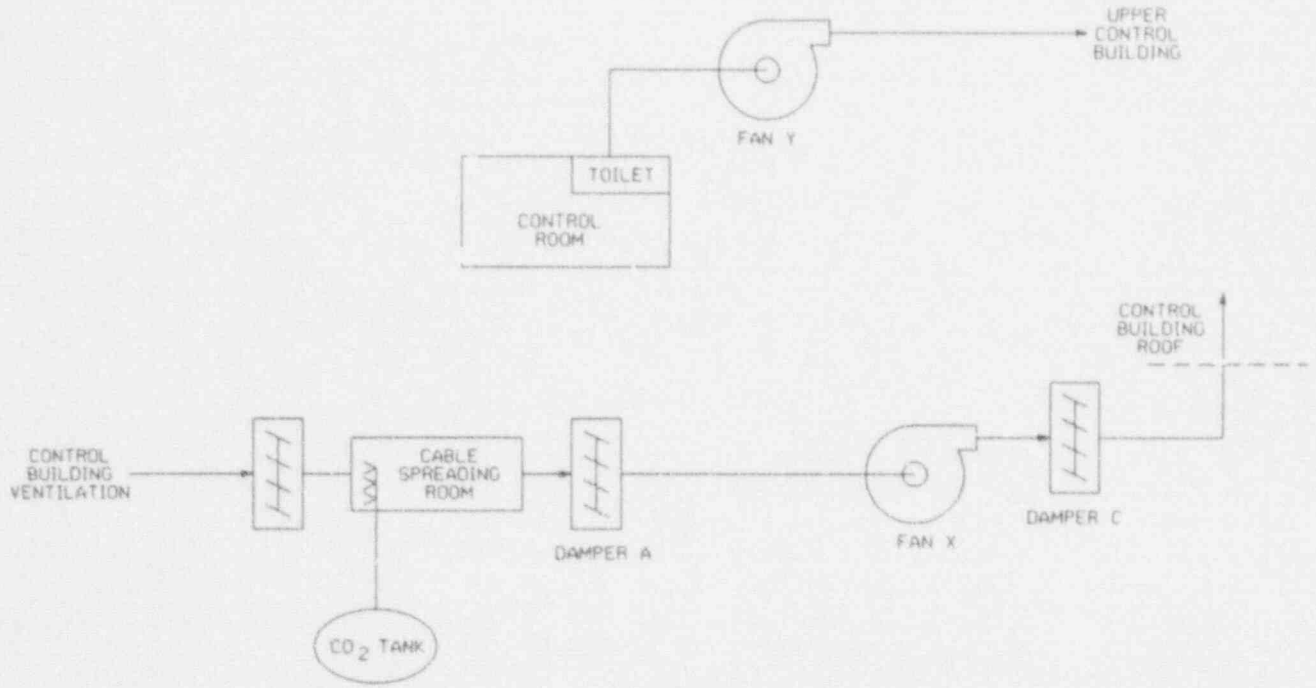
This event is being reported pursuant to 50.73(a)(2)(x), as an event which significantly hampered site personnel in the performance of duties necessary for the safe operation of the plant. As previously noted, contingency plans in place at the time of the event resulted in its having a minimal impact.

EIIS System Codes:
Cable Spreading Room Fire Suppression System -- KQ
Control Room Ventilation System -- VI



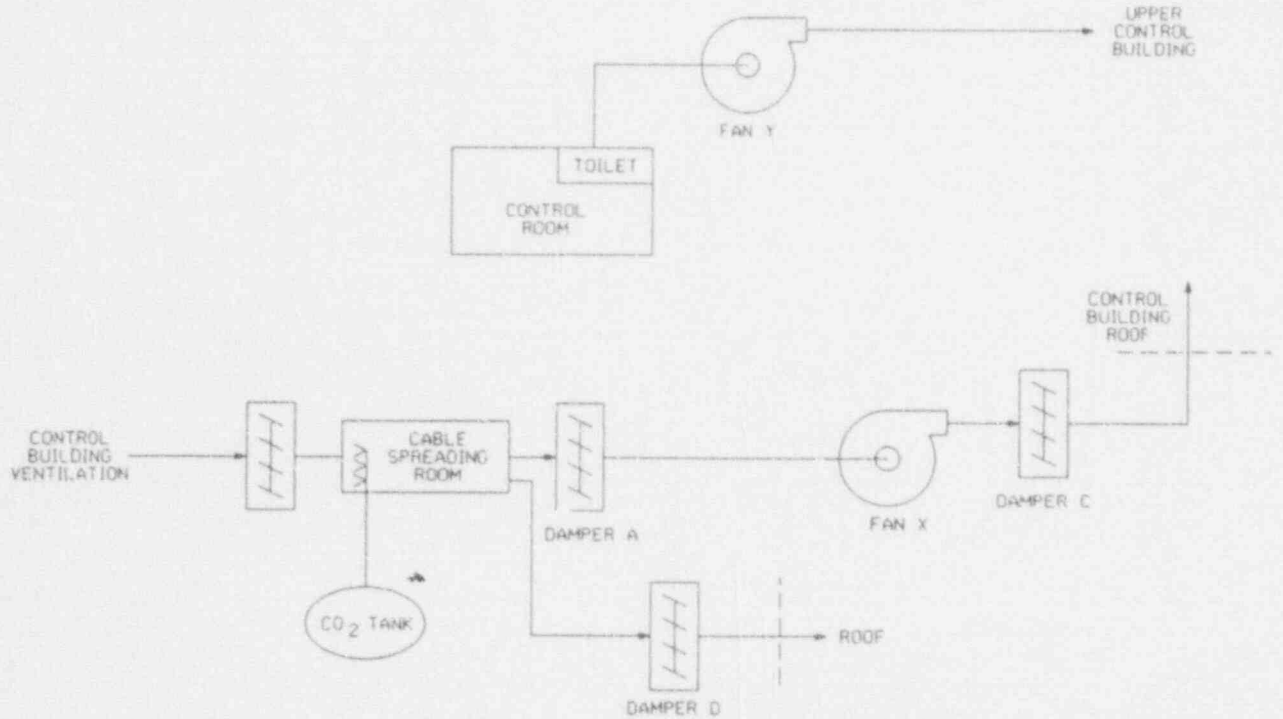
CONTROL BUILDING VENTILATION
as of SEPTEMBER, 1990
(Simplified)

Figure 1: Cable Spreading Room and Control Room Ventilation Interfaces, September, 1990



CONTROL BUILDING VENTILATION
as of MARCH 22, 1992
(Simplified)

Figure 2: Cable Spreading Room and Control Room Ventilation Interfaces, March 22, 1992



CONTROL BUILDING VENTILATION
as of APRIL 5, 1992
(Simplified)

Figure 3: Cable Spreading Room and Control Room Ventilation Interfaces, April 5, 1992

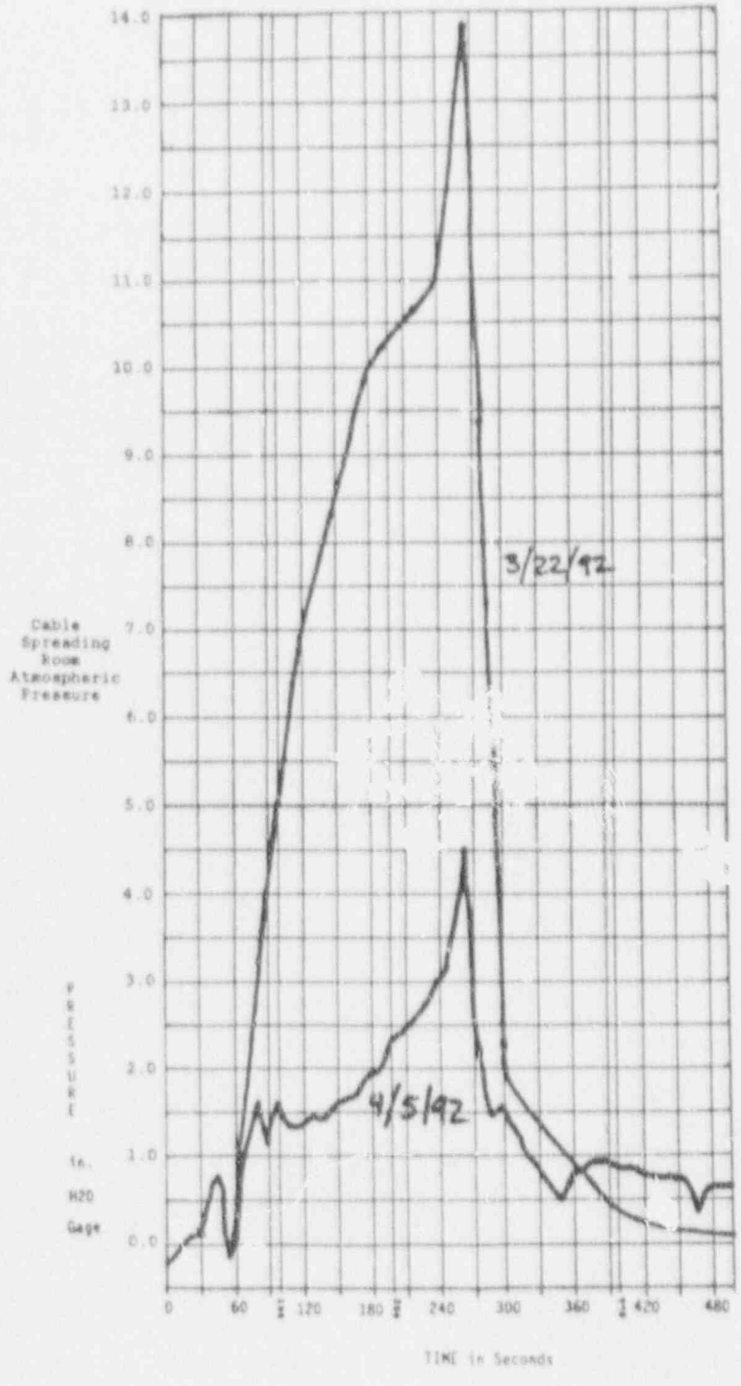


Figure 4:

Comparision of Cable Spreading Room Atmospheric Pressures:

A. 3/22/92 Without additonal vent path

B. 4/5/92 With additional vent path