NRC Form 366 (9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150–0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

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Fort St. Vrain, Unit No. 1	0 5 0 0 0 2 6 7	1 OF 1 1

TITLE (4)
During SR 5.1.2c-X, Only ½ Of Total RSD Material Was Discharged From CRD#21

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)
1 1	0 5	8 4	8 4	0 1 2	0 1	0 2	2 8	8 5	N/A	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): N

POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

[ ] 20.402(b)	[ ] 20.405(c)	[ ] 50.73(a)(2)(iv)	[ ] 73.71(b)
[ ] 20.405(a)(1)(i)	[ ] 50.36(c)(1)	[X] 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)	[ ] 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (AREA CODE)
Jim Eggebroten, Technical Services Engineering Supervisor	3 0 3 7 8 5 - 2 2 2 4

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

CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFAC-TURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

[X] YES (If yes, complete EXPECTED SUBMISSION DATE) [ ] NO

EXPECTED SUBMISSION DATE (15): MONTH 0 5 DAY 2 8 YEAR 8 5

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

At 0830 hours on November 5, 1984, with the reactor shutdown for control rod drive (CRD) inspection and maintenance, the reserve shutdown hopper of control rod drive and orifice assembly (CRDOA) #21 was functionally tested in the hot service facility per SR 5.1.2c-X, "Reserve Shutdown Assembly Functional Test". During performance of the test, it was discovered that about 40 pounds of reserve shutdown material (40 weight percent boron) had been discharged from the hopper assembly. The reserve shutdown hopper is designed to release approximately 80 pounds of reserve shutdown material containing neutron absorbing boron carbide into the core upon manual actuation of the hopper pressurizing system, resulting in rupture of the hopper rupture disc.

The event was reported to the Nuclear Regulatory Commission at 1225 hours on November 5, 1984, per the requirements of 10 CFR 50.72(b)(2) "four hour report".

The failure of the CRDOA #21 hopper assembly to discharge an acceptable amount of reserve shutdown material during performance of SR 5.1.2c-X is being reported pursuant to the requirements of 10 CFR 50.73(a)(2)(v).

The reactor remained in a cold shutdown condition throughout this event.

Extensive analyses have been conducted on absorber material collected from the hopper assembly of CRDOA #21. This supplement reports the cause of this event and presents both completed and planned corrective actions.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

EVENT DESCRIPTION:

The purpose of the reserve shutdown system is to provide a means of admitting sufficient negative reactivity into the core to ensure an adequate core shutdown margin from any reactor operating condition completely independent of the control rod system.

The reserve shutdown system is composed of a storage hopper located between the control rod drive mechanism and the thermal shield at the lower end of each refueling penetration. Each hopper contains nominally spherical neutron absorber material composed of boron and graphite. This absorber material is held inside the hopper by a rupture disc.

A steel guide tube extends from the underside of the hopper to the top control reflector block of the associated core region. The guide tube engages the top reflector block, forming a clear passageway for the reserve shutdown material to fall from the hopper, through the guide tube, and into the core (see Figures 1, 2, and 3).

Rupture of the hopper rupture disc and subsequent release of the absorber material into the core is initiated by pressurizing the hopper with helium. Each hopper is connected to a separate high pressure helium bottle (2200 psi nominal) by a pressurizing line that allows helium flow from the bottle into the hopper immediately above the rupture disc (Figure 4). These bottles have an alarm system associated with them that will actuate when the bottle pressure drops below approximately 1640 psig, at which time the bottles are replaced. Section 3.8.3.2 of the FSAR analyzes reserve shutdown system performance with a minimum helium bottle pressure of 1500 psig. In this case, if the rupture discs fail to burst at the design differential pressure of 165 ± 50 psi, the hopper pressure could build to a maximum of 1015 psia. Since the reactor pressure is 700 psia, a minimum differential pressure of 315 psi can be imposed across the disc, assuring its rupture.

SR 5.1.2c-X is performed to determine the reliability of the differential burst pressure of the disc, and detect any tendency of the poison material to bridge or deteriorate in the hoppers over extended periods of time. The surveillance test consists of placing the CRDOA inside the hot service facility over a pre-weighed container, so that the reserve shutdown material will fall into the container when the rupture disc bursts. A helium line and pressure guage are connected to the CRDOA hopper assembly, and the hopper is pressurized until the rupture disc bursts. The container is then weighed to determine the amount of reserve shutdown material released during the test. Eighty ± eight pounds of reserve shutdown material must be released in order to satisfy SR 5.1.2c-X acceptance criteria.

Upon discovering that only forty pounds of reserve shutdown material had been released during the test, maintenance personnel performed a visual inspection of the hopper internals using a borescope. Examinations indicated that the rupture disc had ruptured cleanly and that the absorber material in the bottom half of the hoppper had discharged. When the hopper fill plug was removed, the absorber material in the upper most portion of the hopper was found to be in essentially normal condition. However, the absorber material in the middle of the hopper was found to be agglomerated. This agglomeration of the absorber material resulted in the material "bridging" across the middle of the hopper and being unable to fall through the guide tube into the pre-weighed container.

ANALYSIS:

The reserve shutdown system is designed to provide sufficient negative reactivity control to achieve hot shutdown conditions from any operating condition without movement of the control rods. This condition can be met with two of the thirty-seven reserve shutdown hoppers inoperable per LCO 4.1.6, providing for a total negative reactivity insertion of at least .088ΔK in the equilibrium core.

The capability of pressurizing the reserve shutdown hoppers is demonstrated once each quarter, during normal plant operation. The "low bottle pressure" alarm circuitry is functionally tested once per quarter, and calibrated annually to ensure that any loss of the minimum required rupture gas pressure is readily detected (see SR 5.1.2).

An off-line functional test of a reserve shutdown assembly has been performed following each of the three previous refueling cycles, as required per the Fort St. Vrain Technical Specifications. During each of these tests, the rupture disc burst pressure was below 300 psid as required per Section 3.8.3.5 of the FSAR, and acceptable amounts of absorber material were released from the hoppers.

FSAR Section 3.8.3.4 analyzes the reserve shutdown neutron absorber material and concludes that bridging and deterioration are not anticipated under the temperature, radiation, and helium environment in which the material is stored inside the hoppers during operation.

The two reserve shutdown hoppers were functionally tested as a result of control rod drive problems recently encountered (see LER #84-008). The two reserve shutdown hoppers tested were on CRDOA #26 and CRDOA #21. During testing of CRDOA #26, all of the reserve shutdown material (20 weight percent boron) was released from the hopper as designed, however, the hopper assembly of CRDOA #21 (40 weight percent boron material) did not release an acceptable amount of absorber material when tested per SR 5.1.2c-X.

Samples of absorber material were collected from the top, middle, and bottom of the hopper assembly of CRDOA #21 for examination and analysis. Crystals were occasionally found on absorber material collected from the top and bottom of the hopper and extensive crystal growth was found on the absorber material collected from the middle of the hopper. In the middle section, several large clumps of absorber material were found firmly stuck together by the crystalline substance. Absorber material from the hopper assembly of CRDOA #26 was also collected for analysis, although the material appearance was completely normal.

The absorber material samples were extensively analyzed to determine the composition of the crystals, the manner in which they were formed, and whether significant oxidation of B_4C had occurred. Scanning Electron Microscopy (SEM) and Debye-Scherer X-Ray analysis were performed on the crystals to determine their chemical constitution and possible source. Chemical analyses were also performed to determine the leachable boron and total boron content of the sample absorber material. Detailed accounts of these analyses findings are contained in the report submitted to the Nuclear Regulatory Commission on January 28, 1985, P-85027. This report found through Debye-Scherer analysis of the crystals obtained from the agglomerated absorber material from CRDOA #21, that the crystals were pure anhydrous boric acid, HBO_2. This is consistent with the observation of cubic crystals in the SEM. Small amounts of HBO_2 could be expected since the as-manufactured absorber material was allowed by specification, to contain up to 1% by weight of boric oxide, B_2O_3. In the presence of moisture, the following reaction takes place: $H_2O + B_2O_3 \rightarrow 2HBO_2$. The report concludes that water vapor or liquid water entered the hopper assembly of CRDOA #21 and reacted with the boric oxide to form boric acid. This reaction is believed to have occurred in the bottom of the hopper where the highest temperatures are found. Over an extended period of time (the hoppers have been loaded since 1973) the growth of boric acid crystals would occur in the most favorable temperature zone of the hopper. This zone appears to be in the middle section of the hopper where temperatures around 300°F to 500°F occur during reactor power operation.

The two most likely causes of moisture ingress into the reserve shutdown hopper assemblies are "breathing" and moisture flow through the purified helium purge system. "Breathing" occurs via the vent/purge line due to changes in the primary system helium pressure. This phenomenon is postulated to have occurred numerous times during reactor shutdown when moisture concentrations in the primary coolant system were above normal levels. Calculations show that the breathing phenomenon could account for a large portion of the moisture necessary to react with the available B_2O_3. The other most likely pathway of moisture ingress is through the purified helium purge system. Since the Helium Purification System is a common supply to both the CRDOA purge and the Helium Circulator/Steam Generator interspaces, a mechanism exists to get moisture from the interspaces into the purge system during depressurization of the core. If water exists in the bottom of the interspaces when pressure is dropped in the Helium Purification System, expansion of helium in the interspace can force water out of the interspace and into the CRDOA purge system. Scenarios have been investigated, which could result in water being introduced into all, or selected, reserve shutdown hoppers. The results of these investigations are contained in the reports submitted to the Nuclear Regulatory Commission on January 4, 1985, P-85003, and January 30, 1985, P-85032.

A number of chemical analyses for leachable boron and total boron content were performed on the reserve shutdown material from the hoppers of CRDOA #21 and #26. These analyses were performed to determine whether oxidation of B_4C had occurred during the last twelve years in the hopper, and whether any significant loss of boron from the reserve shutdown material had occurred. The analyses were performed independently at GA Technologies and at Advanced Refractory Technologies. Analyses results were in excellent agreement, and it was concluded that there has been no measurable loss of B_4C due to oxidation in either CRDOA #21 or #26 hopper assemblies. This is a significant finding, which verifies that if crystallized absorber material is dropped into the reactor, it will contribute the required negative reactivity as assumed in the FSAR.

CORRECTIVE ACTION:

Corrective actions that are directly related to insuring proper operation of the reserve shutdown system are as follows:

1) Although there is no evidence that all Reserve Shutdown Hoppers have been affected by the formation of boric acid crystals, all of the hoppers will be emptied, the original absorber material discarded, and the hoppers will be reloaded with new absorber material. The replacement absorber material residual B_2O_3 content is lower by a factor of 20 for the 20 w/o material and by a factor of 10 for the 40 w/o material. Therefore, the replacement material is relatively less susceptible to moisture induced agglomeration caused by the hydrolysis of B_2O_3. The density of the replacement material spheres is slightly lower, and the actual w/o boron of the spheres increased slightly in order to maintain the boron content of the spheres. The reactivity worth of the reserve shutdown system will remain unchanged.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

2) The Reserve Shutdown System surveillance program will be expanded to include functional testing of two hopper assemblies, one containing 20 w/o boronated material and one containing 40 w/o boronated material, at the end of every refueling cycle up to the end of plant life. The absorber material from the tested hoppers will be visually examined for evidence of boric crystal formation and chemically analyzed for boron carbide and leachable boron content. Failure of a hopper assembly to perform acceptability during functional testing will be reported to the Nuclear Regulatory Commission. Technical Specification SR 5.1.2c will be changed to reflect these new surveillance commitments.

Secondary corrective actions, not directly related to reserve shutdown system operability, but associated with the problem of moisture ingress into the primary coolant/buffer helium purge system, are as follows:

1) Formation of the Fort St. Vrain Improvement Committee, whose primary function is to review and evaluate modifications to Fort St. Vrain that will ultimately reduce the frequency of moisture ingress related events. This committee replaces and expands the functions of the Moisture Ingress Committee, which proposed and completed various modifications to the Helium Circulator Auxillary systems. A description of this committee and the issues being addressed were submitted to the Nuclear Regulatory Commission on January 24, 1985, P-85022.

2) To preclude moisture being carried into the CRDOA cavities, knock-out pots complete with a high water level alarm will be installed on both loop steam generator and helium circulator interspaces. This system will automatically alert plant operators of water leakage into the interspaces. Interspaces can then be drained preventing water from backing up into the purified helium header when the core is depressurized (refer to P-85032 for detailed information).

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U.S. NUCLEAR REGULATORY COMMISSION

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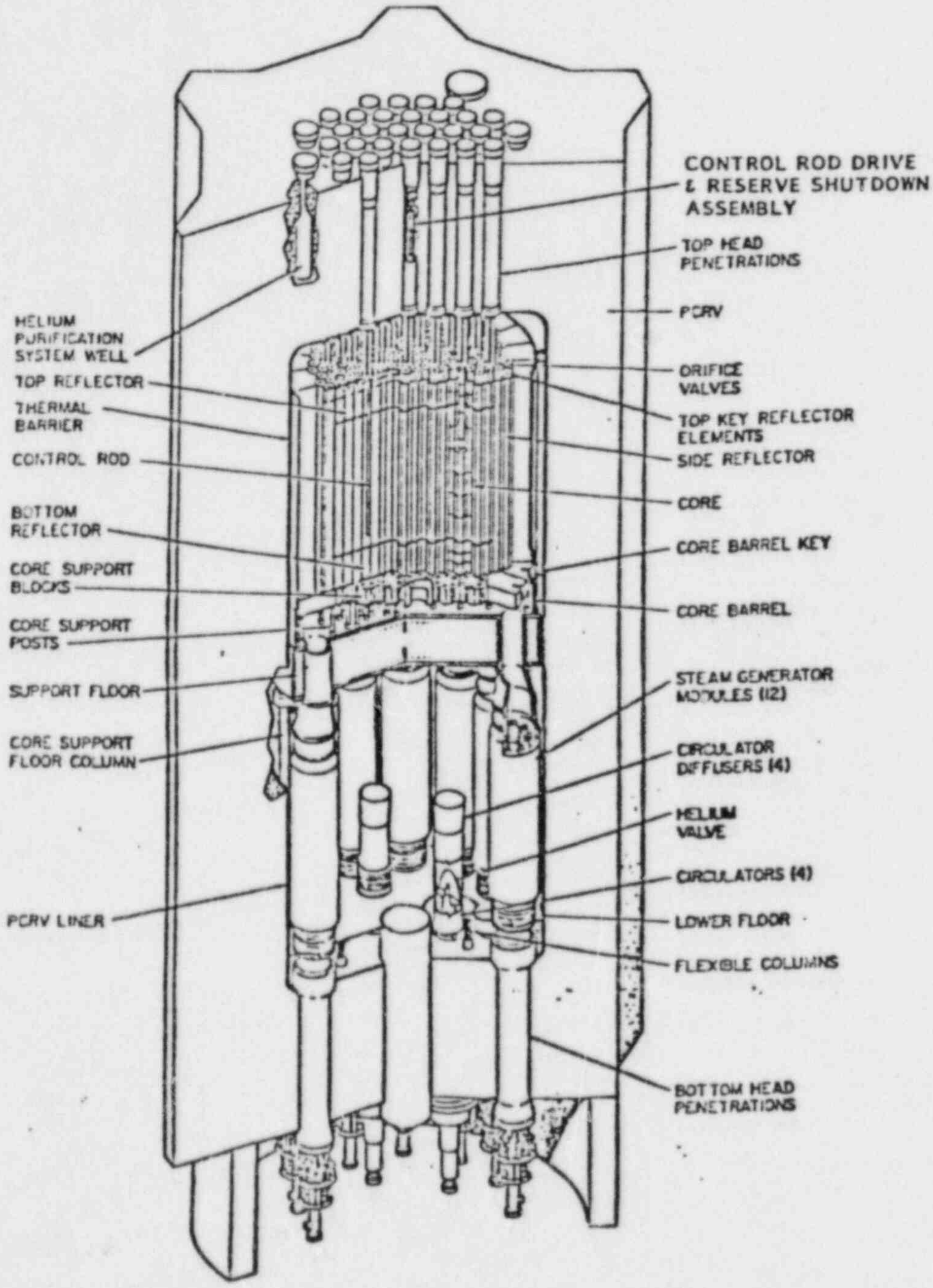

Figure. 1. Reactor Arrangement

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U.S. NUCLEAR REGULATORY COMMISSION

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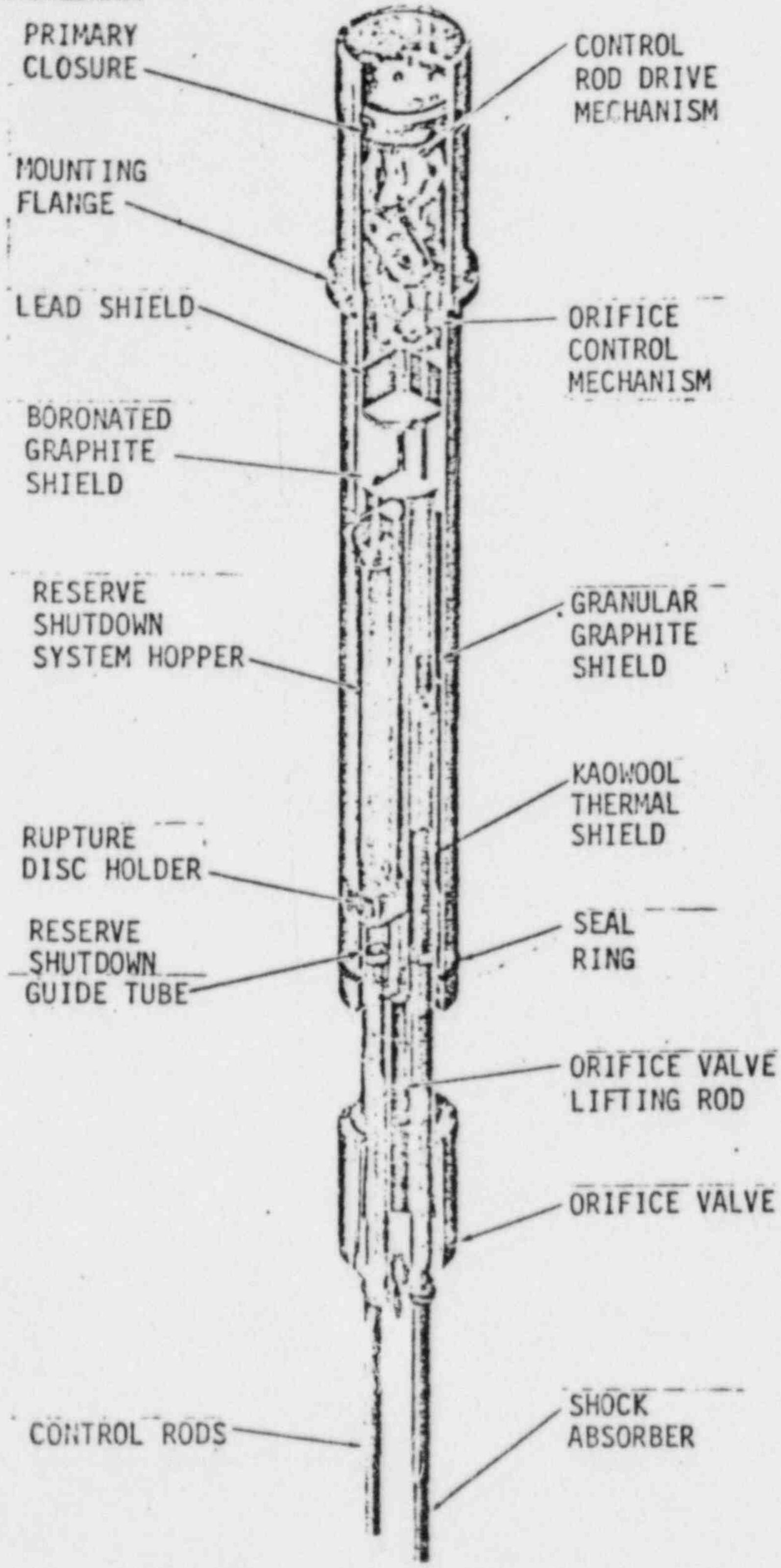

FIG. 2 CONTROL AND ORIFICING ASSEMBLY

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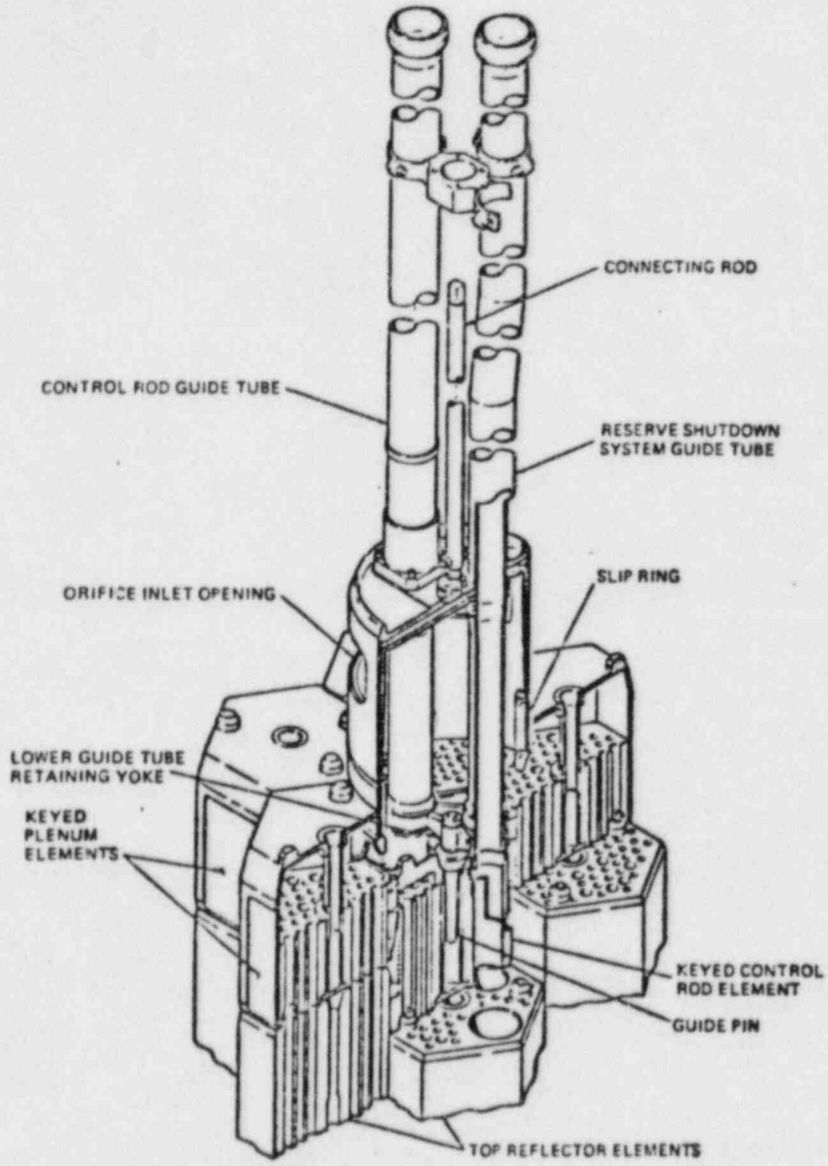

Figure 3. Top Plenum and Orifice Valve Arrangement

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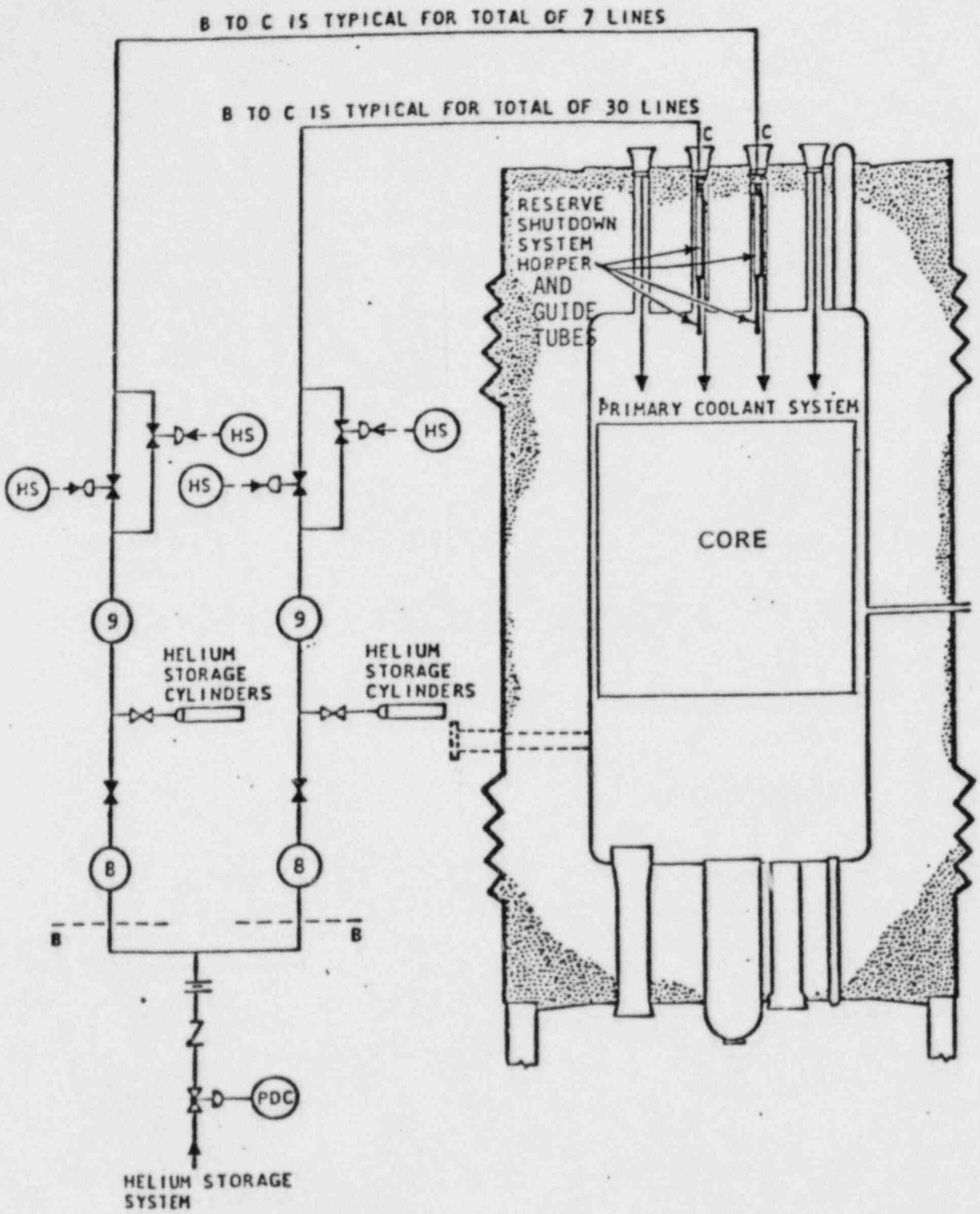

Fig. 4. Reserve shutdown system flow diagram.

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Jim Hill
Techical Services Technician

Jim Eggebroten
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February 28, 1985
Fort St. Vrain
Unit #1
P-85068

Regional Administrator
Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

ATTN: Mr. E. H. Johnson

Docket No. 50-267

REFERENCE: Facility Operating License No. DPR-34

SUBJECT: Licensee Event Report 84-012

Dear Mr. Johnson:

Enclosed please find a copy of Licensee Event Report No. 50-267/84-012, Supplemental, submitted per the requirements of 10 CFR 50.73(a)(2)(v).

Sincerely,

J. W. Gahm
Manager, Nuclear Production

JWG:dr

Enclosure

cc: Director, MIPC

85-01

H005

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