

UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
WASHINGTON, D.C. 20555

October 4, 1994

NRC INFORMATION NOTICE 94-71: DEGRADATION OF SCRAM SOLENOID PILOT VALVE  
PRESSURE AND EXHAUST DIAPHRAGMS

Addressees

All holders of operating licenses or construction permits for boiling water reactors (BWRs).

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the potential failure of scram solenoid pilot valve diaphragms to function properly to the end of their recommended service life. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On March 26, 1994, a control rod failed to scram at Washington Nuclear Plant (WNP-2) during the routine 120-day test of 10 percent of the control rods. Testing was expanded to include all control rods and 5 more rods were identified as having slower than normal notch-45 scram times but were within technical specification limits.

On April 17, 1994, the licensee for Pilgrim Station discovered during routine scram time testing that a control rod exceeded the 7-second full insertion time limit. Several other rods, while within technical specification limits, had notably slower scram times than their previous baseline test data. Three rods were slow enough to cause their 2 by 2 arrays to exceed the technical specification limit. The licensee performed additional testing and, on April 22, 1994, shut down the plant to replace the pilot valve diaphragms for approximately 20 control rods which had exhibited slow but acceptable scram times. The licensee found that the pilot valve diaphragms for five of these control rods were severely hardened.

Discussion

Automatic Switch Company (ASCO) model HVA-90-405 (referred to as the "dual" type valve) is commonly used as the scram solenoid pilot valve in BWR-2, BWR-3, BWR-4 and BWR-5 type plants. It is a 3-way valve and directs supply air to pressurize the scram valves or exhausts air to depressurize the scram valves and cause a reactor scram (Figure 1). The pilot valve has one solenoid

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*updated on 10/6/94*

*PDR I&E*

*Notice 94-071*

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*John McLaughlin  
10-2-94*

and, when the solenoid changes state, the exhaust and pressure diaphragms in each pilot valve flex to allow air to pass through internal pathways or block air from passing. In this way, the air operated scram valves are opened to cause a reactor scram and closed to reset the scram.

Two dual type valves are connected in series and installed at the top of each control rod hydraulic control unit. The upper pilot valve is designated as V-118 and the lower pilot valve is V-117. The location of the V-118 pilot valve, just above V-117, results in slightly higher temperatures for the V-118 valve because it receives some of the heat generated by the V-117 solenoid coil, as well as its own self-generated heat. The V-118 exhaust diaphragm is under the most stress when the system is in the normally energized state (no scram condition) because there is system pressure on the upstream side and atmospheric pressure on the downstream side. The heat and stress combine to cause the V-118 exhaust diaphragm to generally age faster than the other three diaphragms.

The problems at both WNP-2 and Pilgrim were caused by the degradation of the Buna-N rubber diaphragms in the scram solenoid pilot valves. The failure of the control rod to insert at WNP-2 was due to a 90° circumferential crack in the V-118 exhaust diaphragm and a hardened V-118 pressure diaphragm that allowed an air leakage path that prevented the exhaust diaphragm from lifting off its seat when the pilot valve coil was deenergized. The slow control rod at Pilgrim was caused by a 60° circumferential crack in the exhaust diaphragm that prevented full flow of air out of the exhaust port.

The deterioration of the diaphragms at WNP-2 and Pilgrim was much more severe than what has normally been observed at the end of service life for these diaphragms. This may indicate that the life expectancy of the diaphragms is less than the 7-year combined shelf and service life and the 3 to 4-year service life recommended by GENE. Although some diaphragms exhibited overall hardening, the diaphragms at both plants were found to be most severely hardened in areas that are normally in contact with system air (as opposed to areas that are in contact with metal valve surfaces). Any torsional or twisting force applied to the removed degraded diaphragms caused them to crack. According to the NSSS supplier, General Electric Nuclear Energy (GENE), a normal diaphragm at the end of service life tends to have only a slight loss of flexibility and is somewhat hardened all over, with no particular area harder than another.

The diaphragms installed at WNP-2 during the 1990 refueling outage were found to have assembly dates of 1983, 1987 and 1989. Material records from Pilgrim show that all of its scram solenoid pilot valves were rebuilt in June 1991 with kits assembled in either 1987 or 1990. For both plants, the diaphragms that exhibited severe degradation were from the 1989-1990 replacement kits. Analysis by several independent materials laboratories has indicated that the 1989-1990 diaphragms contained somewhat lower levels of nitrile along with indications of different concentrations of plasticizer and variations in the curing agents compared to diaphragms with an earlier assembly date. However, prior to 1993, there is no direct correlation between the actual cure date of the Buna-N components and the assembly date.

In addition to the above, residues were found on some of the degraded diaphragms where none would be expected, indicating that a chemical reaction with some contaminant could have contributed to the deterioration of the diaphragms. The origin of the contaminant is unknown at this time. The licensees involved stated that no chemical agent is used to clean the valve bodies or the Buna-N rubber components during the refurbishment process. The manufacturer (ASCO) indicated that no chemical cleaning agents are used during the assembly process and postulated that a contaminant may be introduced by the licensee air supply system.

In response to recent GENE communications, several licensees have submitted diaphragm samples to GENE for material analysis. Degradation has been observed in a small number of diaphragms from Dresden Station, Quad Cities Station, and Cooper Nuclear Station. However, other diaphragms from these sites, as well as samples from Limerick Nuclear Generating Station and Duane Arnold Energy Center, have not shown signs of degradation.

#### Related Communications from GENE and the NRC

GENE Rapid Information Communication Services Information Letter (RICSIL) No. 069, Rev. 1, issued May 11, 1994, informed licensees that diaphragm kits or valve assemblies assembled after early 1989 may have a shorter service life than the 3 to 4 year service life recommended in earlier GENE communications.

GENE Services Information Letter (SIL) No. 575, issued October 27, 1993, discussed potential causes of slow control rod start of motion times. The SIL indicated that the combined shelf and service life of Buna-N components is 7 years and that the installed service life should be limited to approximately 4 years as recommended in earlier GENE communications.

NRC Generic Letter 91-15, "Operating Experience Feedback Report, Solenoid-Operated Valve Problems at U.S. Reactors," issued September 23, 1991, informed addressees of an Office for Analysis and Evaluation of Operational Data (AEOD) case study report, NUREG-1275, Volume 6, "Operating Experience Feedback Report - Solenoid-Operated Valve Problems," and alerted the industry to the potential for common-mode failure of solenoid-operated valves. Although degradation of Buna-N diaphragms was not specifically addressed, degradation of elastomeric components from aging and thermal factors was discussed.

NRC Information Notice 86-57, "Operating Problems Valves at Nuclear Power Plants," issued July 11, 1986, discussed several causes of solenoid-operated valve failures, including Buna-N diaphragm degradation.

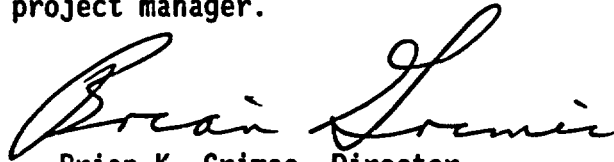
NRC Information Notice 86-109, "Diaphragm Failure in Scram Outlet Valve Causing Rod Insertion," discusses failure of a Buna-N diaphragm in a scram outlet valve because of age related degradation. The notice also discussed lack of an adequate program to monitor shelf life and service life of these diaphragms and similar components susceptible to age-related degradation.

NRC Bulletin 78-14, "Deterioration of Buna-N Components in ASCO Solenoids," issued December 19, 1978, described an event at one licensee facility where a control rod was slow to scram because small pieces of the Buna-N disc in the

scram solenoid pilot valve had wedged between the core assembly and the valve body, preventing movement of the core assembly. The NRC bulletin referenced SIL No. 128.

GENE SIL No. 128, Revision 1, issued January 30, 1976, and its supplement, SIL No. 128, Revision 1, Supplement 1, Revision 2, issued March 2, 1984, addressed deterioration of Buna-N components in scram solenoid pilot valves and recommended that these components be replaced at periodic intervals and that the diaphragms be replaced after 3 to 4 years of service. In addition, the SIL recommended that the work for any one outage be scheduled so that pilot valves are rebuilt in a distributed checkerboard pattern.

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Office of Nuclear Reactor Regulation

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(301) 504-2980

Joseph Petrosino, NRR  
(301) 504-2979

Harold Ornstein, AEOD  
(301) 415-7574

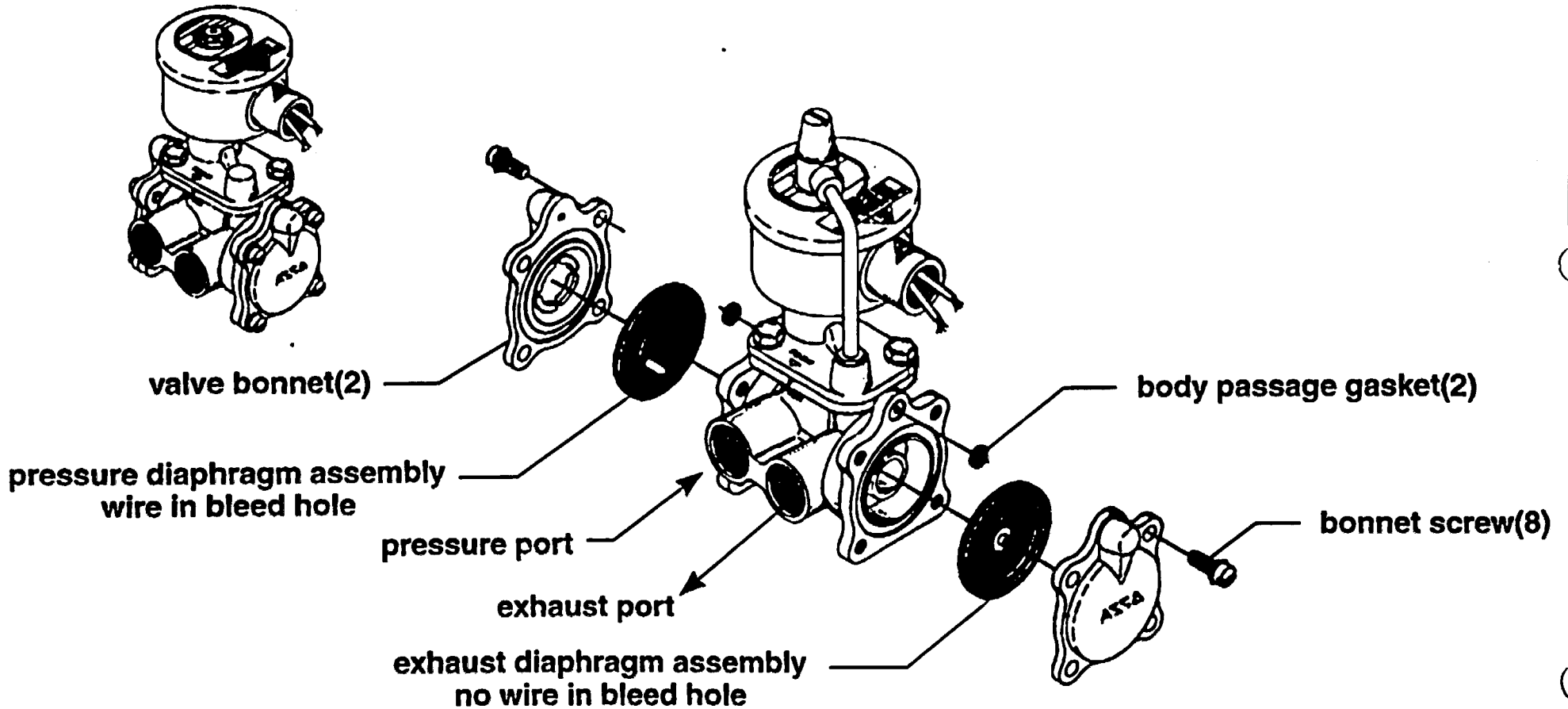
David Skeen, NRR  
(301) 504-1174

Attachments:

1. Figure 1 - ASCO Model HVA-90-405 Scram Solenoid Pilot Valve
2. List of Recently Issued NRC Information Notices

*Attachments filed in Jacket*

**Construction Type "A"  
(Exhaust to Atmosphere)**



**Figure 1 - ASCO model HV-90-405 scram solenoid pilot valve**

LIST OF RECENTLY ISSUED  
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-70	Issues Associated with Use of Strontium-89 and Other Beta Emitting Radiopharmaceuticals	09/29/94	All U.S. Nuclear Regulatory Commission Medical Licensees.
94-69	Potential Inadequacies in the Prediction of Torque Requirements for and Torque Output of Motor-Operated Butterfly Valves	09/28/94	All holders of OLs or CPs for nuclear power reactors.
94-68	Safety-Related Equipment Failures Caused by Faulted Indicating Lamps	09/27/94	All holders of OLs or CPs for nuclear power reactors.
94-67	Problem with Henry Pratt Motor-Operated Butterfly Valves	09/26/94	All holders of OLs or CPs for nuclear power reactors.
94-66	Overspeed of Turbine-Driven Pumps Caused by Governor Valve Stem Binding	09/19/94	All holders of OLs or CPs for nuclear power reactors.
94-65	Potential Errors in Manual Brachytherapy Dose Calculations Generated Using a Computerized Treatment Planning System	09/12/94	All U.S. Nuclear Regulatory Commission medical licensees.
94-64	Reactivity Insertion Transient and Accident Limits for High Burnup Fuel	08/31/94	All holders of OLs or CPs for nuclear power reactors and all fuel fabrication licensees.
94-63	Boric Acid Corrosion of Charging Pump Casing Caused by Cladding Cracks	08/30/94	All holders of OLs or CPs for pressurized water reactors.

OL = Operating License  
 CP = Construction Permit

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Original signed by

Brian K. Grimes  
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 Division of Project Support  
 Office of Nuclear Reactor Regulation

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 Joseph Petrosino, NRR (301) 504-2979  
 Harold Ornstein, AEOD (301) 415-7574  
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1. Figure 1 - ASCO Model HVA-90-405 Scram Solenoid Pilot Valve
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\*See previous concurrence

OFC	OEAB:DORS	SC/OEAB:DORS	PUB:ADM	SPLB:DSSA
NAME	DSkeen*	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94
OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIL	AC/SRXB
NAME	CMcCracken*	JStrosnider*	LNorrholm*	TCollins*
DATE	05/17/94	05/20/94	06/06/94	07/28/94
OFC	AD/DSSA	OGCB:DORS	AC/OGCB:DORS	C/OEAB:DORS
NAME	MVirgilio*	JBirmingham*	EDoolittle*	AChaffee*
DATE	07/29/94	09/16/94	09/16/94	09/18/94
OFC	D/DORS			
NAME	BKGrimes			
DATE	09/28/94			

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NAME	DSkeen*	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94
OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIL	AC/SRXB
NAME	CMcCracken*	JStrosnider*	LNorrholm*	TCollins*
DATE	05/17/94	05/20/94	06/06/94	07/28/94
OFC	AD/DSSA	OGCB:DORS	AC/OGCB:DORS	C/OEAB:DORS
NAME	MVirgilio*	JBirmingham*	EDoolittle*	AChaffee*
DATE	07/29/94	09/16/94	09/16/94	09/18/94
OFC	D/DORS			
NAME	BKGrimes			
DATE	09/ /94			

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NAME	DSkeen*	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94

OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIL	AC/SRXB
NAME	CMcCracken*	JStrosnider*	LNorrholm*	TCollins*
DATE	05/17/94	05/20/94	06/06/94	07/28/94

OFC	AD/DSSA	C/OEAB:DORS	OGCB:DORS	AC/OGCB:DORS	D/DORS
NAME	MVirgilio*	AChaffee*	JBirmingham	ETBooLittle	BKGrimes
DATE	07/29/94	08/08/94	08/16/94	08/16/94	08/ /94

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NAME	DSkeen*	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94

OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIL	AC/SRXB
NAME	CMcCracken*	JStrosnider*	LNorrholm*	TCollins*
DATE	05/17/94	05/20/94	06/06/94	07/28/94

OFC	AD/DSSA	C/OEAB:DORS	OGCB:DORS	AC/OGCB:DORS	D/DORS
NAME	MVirgilio*	AChaffee*	JBirmingham	ELDoolittle	BKGrimes
DATE	07/29/94	08/16/94	08/ /94	08/ /94	08/ /94

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OFC	OEAB:DORS	SC/OEAB:DORS	PUB:ADM	SPLB:DSSA
NAME	DSkeen*	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94

OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIL	AC/SRXB <i>te</i>
NAME	CMcCracken*	JStrosnider*	LNorrholm*	TCollins
DATE	05/17/94	05/20/94	06/06/94	7/28/94

OFC	AD/DSSA <i>108</i>	AC/OGCB:DORS	C/OEAB:DORS	D/DORS
NAME	MVirgilio <i>W</i>	EDoolittle <i>ell</i>	AChaffee	BGrimes
DATE	7/29/94	/ /94	/ /94	/ /94

Related Generic Communications

Generic Letter 91-15 was issued on September 23, 1991, to alert the industry to the potential for common-mode failure of solenoid-operated valves. Although the Buna-N diaphragm age and temperature degradation of SSPVs was not specifically addressed, aging and thermal degradation were discussed in NUREG-1275, Volume 6, "Operating Experience Feedback Report - Solenoid Operated Valve Problems."

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NAME	DSkeen*	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94

OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIN	AD/DSSA
NAME	CMcCracken*	JStrosnider*	LNorrholm* <sup>6/3/94</sup>	MVirgilio*
DATE	05/17/94	05/20/94	06/06/94	06/08/94

OFC	C/OEAB:DORS	AC/OGCB:DORS	D/DORS	
NAME	AChaffee	AKugler	BGrimes	
DATE	/ /94	/ /94	/ /94	

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"Operating Experience Feedback Report - Solenoid Operated Valve Problems."

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NAME	DSkeen	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94

OFC	C/SPLB:DSSA	C/EMCB:DE	<i>J.P. Handberg 5/24/94</i> C/RVIB:DRIL	AD/DSSA
NAME	CMcCracken*	JStrosnider*	LNorholm	MVirgilio
DATE	05/17/94	05/20/94	6/6/94	6/8/94

OFC	C/OEAB:DORS	AC/OGCB:DORS	D/DORS	
NAME	AChaffee	AKugler	BGrimes	
DATE	/ /94	/ /94	/ /94	

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NUREG-1275, Volume 6, "Operating Experience Feedback Report - Solenoid Operated Valve Problems."

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NAME	DSkeen	RDennig*	Tech Ed*	CGratton*
DATE	05/16/94	05/17/94	05/10/94	05/17/94

OFC	C/SPLB:DSSA	C/EMCB:DE	<sup>10</sup> C/RVIB:DRIL	AD/DSSA
NAME	CMcCracken*	JStrosnider*	LNorrholm	MVirgilio
DATE	05/17/94	05/20/94	/ /94	/ /94

OFC	C/OEAB:DORS	AC/OGCB:DORS	D/DORS	
NAME	AChaffee	AKugler	BGrimes	
DATE	/ /94	/ /94	/ /94	

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OFC	C/SPLB:DSSA	C/EMCB:DE	C/RVIB:DRIL	AD/DSSA
NAME	CMcCracken*	JStrosnider	LNorrholm	MVirgilio
DATE	05/17/94	5/20/94	/ /94	/ /94

OFC	C/OEAB:DORS	AC/OGCB:DORS	D/DORS	
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DATE	/ /94	/ /94	/ /94	

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NAME	DSkeen <i>DS</i>	RDennig	Tech Ed*	AChaffee
DATE	5/16/94	5/17/94	05/10/94	/ /94

OFC	SPLB:DSSA	C/SPLB:DSSA	C/OGCB:DORS	D/DORS
NAME	CGratton <i>CG</i>	CMcCracken	AKugler	BGrimes
DATE	5/17/94	5/17/94	/ /94	/ /94

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OFC	OEAB:DORS	SC/OEAB:DORS	PUB:ADM	C/OEAB:DORS
NAME	DSkeen	RDennig	Tech Ed <i>M.M.E.K.C.</i>	AChaffee
DATE	/ /94	/ /94	<i>5/10/94</i>	/ /94

OFC	TECH BRANCH	CHF TECH BR	AC/OGCB:DORS	D/DORS
NAME	CGratton		AKugler	BGrimes
DATE	/ /94	/ /94	/ /94	/ /94

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