

U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos: 50-454; 50-455  
License Nos: NPF-37; NPF-66

Report Nos: 50-454/97019(DRS); 50-455/97019(DRS)

Licensee: Commonwealth Edison Company

Facility: Byron Nuclear Power Station, Units 1 & 2

Location: 4450 North German Church Road  
Byron, IL 61010

Dates: September 8-18, 1997

Inspector: D. Chyu, Reactor Engineer

Approved by: Ronald Gardner, Chief  
Engineering Specialists Branch 2  
Division of Reactor Safety

## EXECUTIVE SUMMARY

Byron Nuclear Station Units 1 and 2  
NRC Inspection Report 50-454/97019(DRS); 50-457/97019(DRS)

This regional inspection reviewed several post fire safe shutdown issues. The following strengths and weaknesses were identified:

### Plant Support

- The licensee identified, during Thermo-Lag resolution activities, that several incorrect cable separation assumptions could potentially result in the inability to achieve and maintain safe shutdown conditions if a postulated fire occurred in certain fire zones. This is an apparent violation (Section F2.1). All necessary modifications were completed. The long-term corrective actions were adequate and comprehensive.

## Report Details

### IV. Plant Support

#### **F2 Status of Fire Protection Facilities and Equipment**

##### **F2.1 Appendix R Issues**

###### **a. Inspection Scope**

The licensee identified several post-fire safe shutdown deficiencies as part of an effort to evaluate Thermo-Lag installations throughout the plant in response to Generic Letter 92-08. In October 1995, Braidwood personnel identified the potential loss of both trains of miscellaneous electric equipment rooms (MEERs) supply fans. Byron personnel also identified two similar problems in Fire Zones 11.6-0 and 11.4-0. In June 1996, several deficiencies were identified regarding assumptions made in the Byron Fire Protection Report concerning the control room ventilation (VC) system. In November 1996, the licensee identified that a fire in Fire Zones 3.2A-1 and 3.2A-2 could cause damage to redundant engineered safety feature (ESF) buses.

The inspectors reviewed LER 50-454/95005, Supplement 2; licensee letter, "Actions Taken in Response to Fire Protection Report Safe Shutdown Analysis Deficiencies," dated November 20, 1996; and selective portions of the Byron Fire Protection Report.

The licensee completed the verification of all cable routings and components associated with the SSA with no additional deficiencies. An effort to re-verify the entire safe shutdown analysis (SSA) was expected to be completed by the end of 1997. A data base was also developed in which information concerning the cables routings and equipment required for safe shutdown was stored. Based on this information, a fault tree was being developed to better assess safe shutdown capability. A revision to the SSA would be issued in 1998.

###### **b. Observation and Findings**

###### Fire Zone 11.6-0, Auxiliary Building Elevation 426

On October 10, 1995, the licensee identified that a fire in Fire Zone 11.6-0 could render inoperable the Divisions 12 and 22 MEER supply fans. This was contrary to the assumptions made in the Byron Fire Protection Report (FPR), Sections 2.4.2.51 and A5.8.22. Fire Zone 11.6-0 contained motor control centers (MCCs) 132X5 and 232X5, which shared common source breakers with MEER supply fans. A fire in the zone could render MEER supply fans unavailable due to opening of the source breakers. This issue was discussed in Inspection Report 50-454/455-95011.

In addition, control cables associated with the system auxiliary transformer



were routed through the zone. A fire in this zone would cause the loss of offsite power. After reaching the temperature limit for equipment located in the MEER, the diesel generators (DGs) would be rendered inoperable due to the loss of DC control power. Without offsite and onsite emergency power, safe shutdown conditions could not be achieved and maintained. In June 1996 and November 1996, the licensee had installed additional MEER breakers on Units 1 and 2, respectively.

On October 26, 1995, the licensee determined that a fire in this zone could render both Unit 1 auxiliary feedwater (AF) pumps inoperable because two control cables (1AF338 and 1AF346) associated with the 1B AF pump were not protected with a 3-hour rated fire barrier (the 1A AF pump was assumed to be damaged by the fire). These affected cables were associated with the 1B AF pump low suction pressure trip. If these cables were damaged, the 1B AF pump could not be started. Since the offsite power would not be available to the main feed water pumps, the station had to rely on feed-and-bleed operation, which required DC control power, to achieve safe shutdown conditions. The DC power would not be available due to MEER heatup. Therefore, safe shutdown conditions could not be achieved and maintained due to the inability to feed-and-bleed the reactor coolant system. In June 1996, a new switch that would bypass the trip function associated with the affected AF control cables was installed.

#### Fire Zone 11.4-0, General Area of Auxiliary Building, Elevation 383

On October 13, 1995, the licensee identified that a fire in Zone 11.4-0 could render the 1A DG and the Division 11 ESF switchgear room supply fan inoperable. This was contrary to the assumptions made in FPR Sections 2.4.2.43 and A5.8.17. Fire Zone 11.4-0 contained the power cables for the diesel oil transfer pump and MCC 131X3. Motor control center 131X3 shared the same source breaker with the redundant diesel oil transfer pump and the Division 11 ESF switchgear room supply fan. A fire in this zone could cause the opening of the source breaker and damage to the power cable. Therefore, the 1A DG and the Division 11 ESF switchgear room supply fan would not be available. This issue was discussed in Inspection Report 50-454/455-95011 and a Severity Level IV violation was issued.

Subsequently, the licensee indicated that the Unit 1 fire hazard panel (FHP) would not be available because it received power from Division 12, the unprotected division in this fire zone. Offsite power would be available until the ESF switchgear was no longer available due to room heatup caused by the failed supply fan. The effect of a fire in Fire Zone 11.4-0 for Unit 1 would be the loss of DGs, offsite power, VC system (discussed in the paragraph below), and the FHP. Safe shutdown conditions could not be achieved and



maintained upon loss of the equipment mentioned above. In May 1996, the licensee rerouted cables associated with Division 12 DG out of Fire Zone 11.4-0 to ensure the availability of power to the Unit 1 FHP and installed an additional breaker so that MCCs 131X3 and 131X5 did not share the same supply breaker. In August 1997, the Division 11 power supply capability to the Unit 1 FHP was added; therefore, the operators could select the preferred power source for the FHP.

On June 4, 1996, the licensee identified that a fire in Zone 11.4-0 could render the VC system inoperable. In the original SSA, several VC system dampers were not identified as equipment required to achieve safe shutdown conditions. However, the licensee determined that the dampers would fail closed and block the system flow path. Therefore, a fire in this zone would disable the VC system. This would result in a heatup of the main control room (MCR) and the auxiliary electric equipment room (AEER) which would render electrical components in these rooms inoperable. There was an existing procedure BOP-VC-15, Revision 0, which provided alternate methods of cooling the AEER in the event both VC trains were inoperable. The inspectors considered this procedure to be insufficient to control MCR and AEER heatup because the procedure did not require opening the dampers. Upon reaching the equipment temperature limit in the MCR and AEER due to the loss of VC system, the instrumentation required to safely shut down Unit 2 would be lost at the main control room and remote shutdown panel. A fire in Fire Zone 11.4-0 would also disrupt power to the Unit 2 FHP. Therefore, safe shutdown conditions could not be achieved and maintained on Unit 2 if a fire occurred in Fire Zone 11.4-0. In November 1996, cables associated with the Division 22 DG were rerouted out of Fire Zone 11.4-0 to ensure the availability of power to the Unit 2 FHP. The licensee was in the process of adding Division 21 power supply to the Unit 2 FHP (estimated to be completed by the end of September 1997).

#### Fire Zones 3.2A-1 and 3.2A-2, Non-Segregated Bus Duct Areas

On October 26, 1995, the licensee identified that two control cables (1DG157 and 1DG175) for the 1A DG were not protected with a 1-hour rated fire barrier in Fire Zone 3.2A-1. In addition, the Unit 1 bus duct and the cross-tie cables from Unit 2 were also routed through the same zone and could be damaged.

On November 7, 1996, the licensee identified that a fire in Fire Zone 3.2A-1 or 3.2A-2 could render redundant 4 Kv ESF buses and DGs inoperable. The following sequence of events would have to occur to render this equipment inoperable:

- A loss of off-site power occurred and DGs were powering the ESF buses,
- A loss of DC control power to ESF breakers and DG output breakers,
- A fault occurred on the 4 Kv power cable from Bus 141/241 to essential service water (SX) Tower unit substation 131Z/231Z.

In Fire Zone 3.2A-1, Division 11 was considered protected and Division 12 unprotected. This zone contained Division 11 normal and reserve DC control power cables, and a 4 Kv power cable from Bus 141 Cubicle 5 to essential service water tower unit substation 131Z. A fire could cause the loss of DC control power to Buses 141 and 142. This would prevent bus breakers from opening to isolate cable fault currents. The fire could subsequently cause a fault on the 4Kv power cables associated with the ESF buses. The fault current would not be interrupted because the breakers would not have control power to open and damage could occur to the ESF buses and the DGs if they were powering the ESF buses. Fire Protection Report Section 2.4.2.7 addressed the loss of DC power and the resultant loss of ability to close breakers remotely. However, it did not address the loss of DC control power preventing Bus 141 from opening to isolate cable faults.

Before 1994, cables associated with the VC system were routed through this area and could be damaged by a fire. The Unit 1 FHP would not be available because it was powered by Division 12, the unprotected division in this zone. Based on the above, safe shutdown conditions could not be achieved and maintained for a postulated fire in Fire Zone 3.2A-1. After 1994, the affected VC cables were protected by Darmatt. In May 1997, Darmatt was installed on the 4 Kv power cable from Bus 141 to SX tower unit substation 131Z to prevent a fire-induced fault affecting Bus 141 and the 1A DG. The licensee recently approved a modification to reroute one train of a division of DC cables out of this zone. The inspector considered the corrective actions taken to date to be adequate because the operators could use Byron Abnormal Operating Procedure ELEC-5, "Local Emergency Control of Safe S/D Equipment," to manually manipulate breakers upon a loss of DC power.

Fire Zone 3.2A-2 contained Division 21 normal and reserve DC control power cables and 4 Kv power cable from Bus 241 to SX tower unit substation 231Z. The result of a fire was similar to that for Fire Zone 3.2A-1; safe shutdown conditions could not be achieved and maintained if a postulated fire occurred in Fire Zone 3.2A-2. In May 1997, the licensee installed Darmatt on the 4 Kv power cable from Bus 241 to SX tower unit substation 231Z to prevent a fire-induced fault affecting Bus 241 and the 2A DG.

#### Loss of 1B Centrifugal Charging Pump in Fire Zone 11.3-1



On October 26, 1995, the licensee identified that a fire in Fire Zone 11.3-1 could render both Unit 1 charging pumps inoperable because the power cable for the 1B charging pump was not protected with a 1-hour rated fire barrier. This assumption was contrary to FHP Section 2.3.2.38. According to the safe shutdown analysis, the 1B charging pump was to be used with other equipment to assure safe shutdown. However, with the loss of both Unit 1 charging pumps, safe shutdown conditions could not be achieved and maintained if a fire occurred in Fire Zone 11.3-1. In June 1996, the licensee revised the protected division in Fire Zone 11.3-1 from Division 12 to 11 and rerouted the cable for the 1A charging pump out of this zone.

#### Loss of 1RH8701A in Fire Zone 11.5-0

On October 26, 1995, the licensee identified that a fire in Fire Zone 11.5-0 could render motor operated valves (MOVs) 1RH8701A and 1RH8701B inoperable because a control cable (1RH030) for MOV 1RH8701A was not protected with a 3-hour rated fire barrier. This was contrary to the assumption made in FPR Sections 2.4.2.47 and 2.4.3.2.1.3. These two MOVs were considered the isolation for the high-to-low pressure boundary between the reactor coolant system and residual heat removal system. These valves were normally open in Mode 4 for shutdown cooling and closed in Modes 1, 2, and 3. However, a fire in Fire Zone 11.5-0 could induce multiple hot shorts and cause these two MOVs to spuriously open. The result of this fire was an inter-system loss of coolant accident. Safe shutdown conditions could not be achieved and maintained if multiple hot shorts occurred due to a fire in this zone. In May 1996, the licensee revised

Byron General Procedure 100-1T3 to close MOV RH J701B and de-energize the breaker in Modes 1,2, and 3.

In addition, a fire in this zone would cause the VC system to be inoperable. The effect of losing the VC system was identical to that of Fire Zone 11.4-0. The initial SSA did not recognize that VC system dampers would fail closed and block system flow. In addition, the Unit 1 FHP would not be available because it received power from Division 12 that was unprotected in this zone. Upon reaching the temperature limit in the MCR and AEER, the instrumentation required to shut down Unit 1 would be lost at the MCR and remote shutdown panel. Without the Unit 1 FHP, the licensee could not achieve and maintain safe shutdown conditions. In May 1996, the affected Division 12 cables were rerouted out of the zone.

#### Loss of VC system and Unit 1 FHP in Fire Zone 3.2B-1

On June 4, 1996, the licensee identified that a fire in Fire Zone 3.2B-1 would render the VC system inoperable because the VC dampers would fail closed and block system flow path. Upon reaching the temperature limits in the MCR and AEER, instrumentation required to safely shut down Unit 1 would be lost at the MCR and remote shutdown panel. Before May 1996, cables associated with the Division 12 ESF switchgear room fan were routed through the zone. Division 11 was considered protected and Division 12 unprotected. A fire would damage the Division 12 cables and cause the loss of the Division 12 ESF switchgear room fan. Upon reaching the temperature limit in the room, Bus 142 would not be able to supply power to the Unit 1 FHP. Instrumentation at the FHP would not be available. Therefore, before May 1996, the licensee could not achieve and maintain safe shutdown conditions. In May 1996, the affected cables were rerouted out of the zone.

#### Loss of DGs in Fire Zones 3.1-1 and 3.1-2

On October 26, 1995, the licensee identified that a fire in Fire Zones 3.1-1 or 3.1-2 could render the 1A or 2A DG, respectively, inoperable. In both examples, control cables for the DGs were not protected with a 1-hour rated fire barrier. In addition, the offsite power would not be available because cables associated with the system auxiliary transformer were routed through the same zone. In both cases, the operators could use Byron Abnormal Operating Procedure ELEC 3, "Loss of 4KV ESF Bus," to cross-tie power from the opposite unit. Therefore, safe shutdown conditions could be achieved and maintained if a fire occurred in Fire Zones 3.1-1 or 3.1-2. The licensee installed Darmatt on the cables associated with 1A DG in Fire Zone 3.1-1 in September 1995, and rerouted the 2A DG cables out of Fire Zone 3.1-2 in November 1996.



### Loss of 1A SX Pump

On October 26, 1995, the licensee identified that a fire in Zone 11.3-0 could render both Unit 1 SX pumps inoperable because the power cable (1SX001) for the 1A SX pump was not protected with a 3-hour rated fire barrier. This was contrary to the assumption made in FPR Section 2.4.2.37. The cables for the 1A and 1B SX pumps were separated by 30 feet with intervening combustible materials. Upon the loss of both Unit 1 SX pumps, the licensee could use Byron Abnormal Operating Procedure PRI-7, "Essential Service Water malfunction," Attachment A to align for single pump operations and cross-tie the SX header. Therefore, safe shutdown conditions could be achieved and maintained. In May 1996 and November 1996, the licensee rerouted cables for the 1A and 2B SX pumps out of Fire Zone 11.3-0.

### Other Affected Zones Associated With VC System

In addition to the above deficiencies, on June 4, 1996, the licensee identified that a fire in Fire Zones 2.1-0, 11.4C-0, or 11.6-0, could render the VC system inoperable. The existing FPR bounded the consequences of the loss of ventilation to the MCR and AEER assuming instrumentation at the FHPs was available. The instrumentation required to shut down the units would be available at the FHPs. Therefore, these deficiencies would not affect the capability to achieve and maintain safety shutdown conditions. The licensee made a temporary alteration to Byron Operating Procedure VC-15, "Alternate Methods of Cooling the AEER," to operate the VC system in the purge mode. In addition, an alternate power supply to the Unit 1 FHPs was completed in August 1997. The modification to supply an alternate power supply to the Unit 2 FHP was estimated to be completed by September 1997.

### c. Conclusion

A fire in the following zones would affect the ability to achieve and maintain safe shutdown conditions:

- A fire in Fire Zone 11.6-0 would render inoperable the Division 12 MEER supply fan (resulting in the loss of DC power and DGs), offsite power, both AF pumps, and VC system for Unit 1. In addition, a fire in this zone would render inoperable the Division 22 MEER supply fan (resulting in the loss of DC power and DGs), offsite power, and VC system for Unit 2.

- A fire in Fire Zone 11.4-0 would render inoperable the DGs, Division 11 ESF switchgear room fan (resulting in the loss of offsite power), VC system, and FHP for Unit 1 and render inoperable the VC system and

FHP for Unit 2.

A fire in Fire Zone 3.2A-1 would render inoperable the DC power (resulting in the loss of redundant ESF buses and DGs), offsite power, and cross-tie capability from Unit 2 for Unit 1.

A fire in Fire Zone 3.2A-2 would render inoperable the DC power (resulting in the loss of redundant ESF buses and DGs), offsite power, and cross-tie capability from Unit 1 for Unit 2.

A fire in Fire Zone 11.3-1 would render inoperable both charging pumps for Unit 1.

A fire in Fire Zone 11.5-0 would render inoperable MOVs 1RH8701A and RH8701B, VC system and FHP for Unit 1.

A fire in Fire Zone 3.2B-1 would render inoperable the VC system and FHP for Unit 1.

10 CFR 50, Appendix R, Section III.G requires, in part, that one train of systems necessary to achieve and maintain hot shutdown conditions from either the control room or emergency control station(s) is free of fire damage. Section III.G.2 requires that, except as provided in Section III.G.3, where cables of equipment of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are in the same fire area, separation of cables of redundant trains by a fire barrier having a 3-hour rating or 1-hour rating with fire detector and an automatic suppression system shall be provided. Failure to provide separation of cables of redundant trains as evidenced by the above examples is an apparent violation of 10 CFR 50, Appendix R, Section III.G.2 (EEI 50-454/455/97019-01).

The licensee also identified the following zones in which equipment could be damaged but would not affect the ability to achieve safe shutdown conditions.

A fire in Fire Zone 3.1-1 would render both Unit 1 DGs inoperable.

A fire in Fire Zone 3.1-2 would render both Unit 2 DGs inoperable.

A fire in Fire Zone 11.3-0 would render both Unit 1 SX pumps inoperable.

A fire in Zones 2.1-0 or 11.4C-0 would render the VC system inoperable.



Failure to provide separation of cables of redundant trains in the above fire zones is a violation of 10 CFR, Appendix R, Section III,G.2. However, this licensee-identified and corrected violation is being treated as a non-cited violation, consistent with Section VII.B.1 of the NRC Enforcement Policy (NCV 50-454/97019-02(DRS); 50-455/97019-02(DRS)).

**F8 Miscellaneous Fire Protection Issues**

(Closed) VIO 50-454/455-95011-03: A fire in Fire Zone 11.4-0 could render Division 11 ESF switchgear room fan and 1A DG inoperable. The corrective actions were discussed in Section F2.1. The licensee identified additional items of concern in the subsequent review of the safe shutdown analysis. These issues were the subject of this

inspection report. The inspector considered the corrective actions taken by the licensee to be adequate. This item is closed.

(Close) LER 50-454/95005, Revisions 0, 1 and 2: Fire protection report discrepancies due to inadequate evaluation during preparation of original safe shutdown analysis. The items identified in the LER were discussed in Inspection Report 50-454/455-95011 and were the subject of this report. The concerns identified in the LER will be tracked by EEI 50-454/455-97019-01. This item is closed.

(Close) IFI 50-454/455-95003-04: Postulated loss of solid state protection system (SSPS) during a steam line break in the turbine building. The licensee modified the SSPS cabinet fuse circuits feeding the cabinet input channels and logic cabinet power supplies from one fused 15 amps to two 10 amp circuits. The modification was completed in 1996. This item is closed.

## V. Management Meetings

### **X1 Exit Meeting Summary**

On September 18, 1997, the inspectors presented the inspection results to licensee management. The licensee acknowledged the findings presented.

The inspector asked the licensee whether any material examined during the inspection should be considered proprietary. No proprietary information was identified.



## PARTIAL LIST OF PERSONS CONTACTED

### Licensee

K. Kofron, Station Manager  
D. Brindle, Regulatory Assurance Supervisor  
R. Colglazier, NRC Coordinator  
G. Contrady, Site Engineering Program Lead  
D. Robinson, Senior Engineer  
F. Pollak, Fire Protection System Engineer  
D. Wozniak, Site Engineering Manager

### U.S. Nuclear Regulatory Commission

S. Burgess, Senior Resident Inspector

## INSPECTION PROCEDURES USED

IP 64704: Fire Protection Program  
IP 37550: Engineering  
IP92902: Followup - Engineering

## ITEMS OPENED, CLOSED, AND DISCUSSED

### Opened

50-454/455-97019-01	EI	Lack of cable separation in certain fire zones
50-454/455-97019-02	NCV	Lack of cable separation in certain fire zones

### Closed

50-454/455-95011-03	VIO	Postulated loss of Division 11 ESF switchgear room fan and 1A DG in Fire Zone 11.4-0
50-454/455-95003-04	IFI	Postulated loss of solid state protection system during a steam line break in the Turbine Building
50-454/95005	LER	Fire protection discrepancies due to inadequate evaluation during preparation of original safe shutdown analysis
50-454/455-97019-02	NCV	Lack of cable separation in certain fire zones

## LIST OF ACRONYMS USED

CFR	Code of Federal Regulation
AEER	Auxiliary Electric Equipment Room
AF	Auxiliary Feedwater
DG	Diesel Generator
EI	Escalated Enforcement Item
ESF	Engineered Safety Feature
FHP	Fire Hazard Panel
FPR	Fire Protection Report
IFI	Inspection Followup Item
IP	Inspection Procedure
LER	Licensee Event Report
MCC	Motor Control Center
MCR	Main Control Room
MEER	Miscellaneous Electric Equipment Room
MOV	Motor Operated Valve
SSA	Safe Shutdown Analysis
SSPS	Solid State Protection System
SX	Essential Service Water
VC	Control Room Ventilation System
VIO	Violation