



Commonwealth Edison
Byron Nuclear Station
4450 North German Church Road
Byron, Illinois 61010

April 2, 1993

LTR: BYRON 93-0197
FILE: 3.03.0800 (1.10.0101)

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Dear Sir:

The Enclosed Licensee Event Report from Byron Generating Station is being transmitted to you as a Voluntary Report.

This report is number 93-003; Docket No. 50-454.

Sincerely,

G.K. Schwartz
Station Manager
Byron Nuclear Power Station

GKS/CW/ng

Enclosure: Licensee Event Report No. 93-003

cc: A. Bert Davis, NRC Region III Administrator
NRC Senior Resident Inspector
INPO Record Center
CECo Distribution List

090010

9304090200 930405
PDR ADOCK 05000454
S PDR

(0995R/VS-9)

JE 2/1

LER Number

454: 93-003

Title of Event: Unit One Damaged Fuel Assemblies and Upper Internals

Occurred: 03-06-93 / 1500
Date Time

Acceptance by Station Review:

W. L. Latta , 4/2/93
OE Date

M. O. O'Connell , 4-2-93
TSS Date

C. A. Anderson , 4/2/93
RAS Date

M. E. Bynum , 4-2-93
OTHER Date

Approved by:

G. K. Schwartz , 4/5/93
Station Manager Date

LICENSEE EVENT REPORT (LER)

Form Rev 2.0

Facility Name (1) Byron, Unit 1										Docket Number (2) 0 5 0 0 0 4 5 4				Page (3) 1 of 0 7				
Title (4) Damaged Fuel Assemblies and Upper Internals																		
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)					
0 3	0 6	9 3	9 3	0 0 3	0 0	0 4	0 5	9 3	None				0 5 0 0 0 1 1					
OPERATING MODE (9)			6		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10CFR (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)		X Other							
					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)				Voluntary Report					
					20.405(a)(1)(v)		50.73(a)(2)(iii)		50.73(a)(2)(x)									
LICENSEE CONTACT FOR THIS LER (12)																		
Name Myra Burgess, Technical Superintendent Ext. 2014										TELEPHONE NUMBER								
										AREA CODE								
										8 1 5		2 3 4 - 5 4 4 1						
COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)																		
CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRPDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRPDS								
D B			W 1 2 0	Y														
SUPPLEMENTAL REPORT EXPECTED (14)																		
Yes (If yes, complete EXPECTED SUBMISSION DATE)										X NO		Expected Submission Date (15)		Month Day Year				
ABSTRACT (Limit to 1400 spaces, i.e. approximately fifteen single-space typewritten lines) (16)																		

At 1500 hours on March 6, 1993, during Control Rod Drive Shaft latching activities (FH) [DB], the Fuel Handling Supervisor experienced difficulty latching Rod Control Cluster Assembly (RCCA) R543 at core location N-09. The Upper Internals Package (UIP) was removed and an investigation determined that the guide pins for core locations L-09, M-09, N-09, P-09 and R-09 had not properly seated into their respective fuel assemblies "S" holes. As a result, the removable top nozzles for fuel assemblies G17E, H17E, and G22E were pushed down damaging the guide thimbles. A total of eleven guide pins were bent. RCCA R543 in fuel assembly G22E and its drive shaft were also damaged.

Two multi-disciplinary teams were formed, one to address the bent pins and recover the damaged assemblies and a second to perform the Root Cause Analysis for the event. Westinghouse Electric Corporation straightened or removed the damaged UIP guide pins prior to reinstallation of the Upper Internals. Commonwealth Edison performed design analyses as required for core redesign and to disposition the removed fuel assembly guide pins.

Recovery activities were initiated for removal of the damaged fuel assemblies. The Fuel Handlers placed the damaged fuel assemblies in the Spent Fuel Pool. Nuclear Fuel Services Department redesigned the core loading pattern with available assemblies and the Fuel Handlers reloaded the core to the new loading pattern. Technical Staff Nuclear Engineers performed a special procedure, SPP 93-016, "Core Alignment Verification," to ensure the assemblies were properly aligned in the core. Eleven pins were observed to be bent, two were cut, and nine were straightened prior to resetting the UIP.

This event is being submitted as a Voluntary Report.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

Form Rev 2.0

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)						Page (3)		
		Year	///	Sequential Number	///	Revision Number				
Byron, Unit 1	0 5 0 0 0 4 5 4	9 3	-	0 0 3	-	.0 0	0 2	OF	0 7	

TEXT Energy Industry Identification System (EIIIS) codes are identified in the text as [XX]

A. PLANT CONDITIONS PRIOR TO EVENT:

Event Date/Time 03-06-93 / 1500

Unit 1 MODE 6 - Refueling Rx Power 0% RCS [AB] Temperature/Pressure 85°F / 0 psig

B. DESCRIPTION OF EVENT:

At 1500 hours on March 6, 1993, during Control Rod Drive Shaft latching activities (FH)[DB], the Fuel Handling Supervisor experienced difficulty latching Rod Control Cluster Assembly (RCCA) R543 at core location N-09. The drive shaft would not latch. Several other latching attempts were performed and each time the shaft indication was that the RCCA had "latched". However, during drag force testing the RCCA would not move. Interviews later confirmed that the RCCA did not move on the second and third attempts. The Upper Internals Package (UIP) was removed, and it was discovered that the guide pins for core locations L-09, M-09, N-09, P-09 and R-09 had not properly seated into their respective fuel assemblies "S" holes. As a result, the removable top nozzles for fuel assemblies G17E, H17E, and G22E were pushed down damaging the guide thimbles. A total of eleven guide pins were bent. RCCA R543 in fuel assembly G22E and its drive shaft were also damaged.

This event is being submitted as a Voluntary Report.

C. CAUSE OF EVENT:

Two multi-disciplinary teams were established, one to perform the recovery actions and a second to perform the Root Cause Analysis of this event. The Root Cause Analysis investigation of the event determined that the Upper Internals Package (UIP) fuel assembly guide pins at core locations L-09, M-09, N-09, P-09, and R-09 did not properly engage in their respective fuel assembly top nozzle "S" holes. The result was that fuel assemblies G17E, H17E and G22E were damaged and eleven UIP guide pins were bent when the UIP was reinstalled into the reactor vessel. The cause of the improper guide pin engagement has been attributed to misalignment of selected fuel assemblies in Row 9 with respect to the Upper Internals Package. A combination of three factors contributed to the cause.

The first factor was the loss of available design clearances between the fuel assembly top nozzles and the baffle wall.

The Root Cause Analysis team performed a dimensional analysis of the core barrel, fuel assembly top grid, and upper internals "S" pins. The analysis showed that sufficient displacement between the UIP guide pins and the fuel assembly "S" holes will cause the pins to miss the "S" holes. The available clearance between the fuel assembly top nozzles and the "as built" inside dimension of the core barrel is sufficient to cause a displacement such that the UIP guide pins will miss the fuel assembly "S" holes.

A sufficient clearance loss can occur after the eighth assembly. Core locations N-09, P-09 and R-09 are thirteen, fourteen and fifteen assemblies from the south baffle wall.

The second contributing factor is fuel assembly bow/twist. Fuel assembly bow/twist is an observed characteristic of irradiated nuclear fuel that is not completely understood by the industry.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION													Form Rev 2.0	
FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)										Page (3)		
		Year	///	Sequential Number	///	Revision Number								
Byron, Unit 1	0 5 0 0 0 4 5 4	9 3	-	0 0 3	-	0 0	0 3	OF	0 7					
TEXT Energy Industry Identification System (EIIS) codes are identified in the text as [XX]														

C. CAUSE OF EVENT: (continued)

The Fuel Handling Supervisor's Log entries noted reload difficulties due to bow/twist of "G" region fuel assemblies. The log entries noted fuel assemblies G17E (R-09), G22E (N-09), and G67F (R-10) as bowed. The log noted assembly G67F had a corkscrew twist, also. Log entries made during the reload stated assemblies G17E (at core location R-09) and G14E (at core location R-07) were bowed into the envelope for location R-08 and required a variation to the planned loading sequence. The Nuclear Engineer on duty wrote a variation to:

move assembly G14E (R-07) to an open location in the core,
load assembly G73F into its specified R-08 location,
and then reload G14E back into location R-07.

After UIP removal, damaged assembly G17E was removed from the core and was noted to be bowed approximately 0.800 inches.

The third factor contributing to the event was the core loading sequence. The core loading sequence used during reload is called a "crescent" shaped loading. A "crescent" loading sequence maximizes the number of "open water" fuel loading movements while minimizing the number of moves into three sided fuel assembly boxes. This minimizes grid-to-grid interactions. Fuel Handlers also use fuel assembly guides to assist in aligning the fuel assembly bottom nozzle during reload. The loading sequence is accomplished by:

1. First, building a "nucleus" of nine assemblies, (3X3), in front of each of the source range detectors. This is done to maintain required counts on the source range detectors during core load. One of the assemblies in each of the nuclei contains a neutron source.
2. Next, the assemblies are loaded alternately in east positions and then in west positions working towards row B. This alternating pattern is used until a crescent shape is formed from west to east along the north side of the core. Assemblies are then loaded in a serpentine fashion from north to south.

Assembly G17E was the first assembly loaded in row 9. The assembly displayed significant bowing, displacing the top nozzle from the north baffle wall in a southern direction. As other assemblies were loaded in row 9, towards the south baffle wall, the crescent loading sequence allowed a loss of available clearances to occur.

D. SAFETY ANALYSIS:

There was no plant equipment inoperable at the time of the event that impacted the severity of the incident nor any that directly caused the event. The unit did not operate at power under this condition and maintained Refueling Mode conditions throughout the event. The unit was under the control of plant Technical Specifications and a Shutdown Risk Assessment Program. There was no fuel rod damage identified.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

Form Rev 2.0

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)					Page (3)		
		Year	///	Sequential Number	///	Revision Number			
Byron, Unit 1	0 5 0 0 0 4 5 4	9 3	-	0 0 3	-	0 0	0 4	Of	0 7
TEXT Energy Industry Identification System (EIIS) codes are identified in the text as [XX]									

D. SAFETY ANALYSIS: (continued)

The Shutdown Risk Assessment Program provides administrative controls to maintain Containment Closure Capability, Core and Spent Fuel Pool Cooling, Inventory Control, Reactivity Control, RCS Integrity, and Electrical Sources by providing defense in depth planning and contingency planning for all shutdown mode outage activities. The reactor cavity level was maintained greater than 23 feet above the reactor flange throughout the event. The equipment hatch was closed with the personnel hatch capable of being closed. Containment ventilation requirements and radiation monitoring requirements were maintained.

Under a worst case scenario at actual Reactor Power conditions, where assembly top nozzles are crushed and canted, the following must be considered:

- Other plants have unknowingly operated with similarly damaged fuel assemblies and were unable to detect the damage during routine operations, it is not clear that any anomaly would have been detected by the incore flux profiles and reactor coolant activity analysis in Byron Station's case.
- The event could have potentially had an adverse impact on DNBR limiting accidents due to flow distribution anomalies resulting from thimble or fuel damage and the tilted top nozzle.
- The flow anomaly may also have impacted the fuel assemblies FNΔH; however, if no operational anomalies were indicated by fluxmaps or thermocouple readings, there is a very high probability that all power distribution Technical Specifications would have continued to be met.
- The reduced space for fuel rod growth, which resulted from the top nozzle being pushed down, could have led to some fuel rod bowing.

The deformation of the fuel assembly could limit the performance of the assembly in its required safety function during LOCA and Seismic Design Basis events. Visual inspections of the damaged assemblies showed the top nozzles to be displaced vertically down and canted at an angle. The structural guide tubes were observed to be partially collapsed near the top nozzle due to the vertical displacement of the nozzle.

Fuel assembly design assumptions require the fuel assembly hold-down springs to maintain the fuel assembly seated during DBA events. Under the worst case conditions, hard contact between the upper internal guide pins and the fuel assembly top nozzle would have been maintained. Lateral support from the core baffles and adjacent fuel assemblies would have provided acceptable radial positioning of the top of the fuel assemblies and would have prevented displacement of the damaged fuel assemblies during postulated events. During normal operating conditions, Technical Specifications (3/4.4.8) limit the amount of reactor coolant iodine and gross activity which would detect any fuel cladding defects that may have resulted.

Safety Analysis was performed for the two removed upper internals alignment pins and the evaluation ensures that future reload designs will continue to meet all neutronic and thermal/hydraulic requirements.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

Form Rev 2.0

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)						Page (3)		
		Year		Sequential Number		Revision Number				
Byron, Unit 1	0 5 0 0 0 4 5 4	9	3	-	0	0	3	-	0	0
TEXT	Energy Industry Identification System (EIIS) codes are identified in the text as [XX]									

E. CORRECTIVE ACTIONS:

Corrective Actions Taken During Refueling:

A risk analysis and a 50:59 Safety Evaluation were performed prior to moving the damaged fuel assemblies from the Reactor Core to the Spent Fuel Pool. The Fuel Handlers placed the damaged fuel assemblies in the Spent Fuel Pool. Nuclear Fuel Services Department redesigned the core loading pattern, and the Fuel Handlers reloaded the core to the new loading pattern. Technical Staff Nuclear Engineers performed a special procedure, SPP 93-016, "Core Alignment Verification," to ensure an excessive loss of available clearances did not occur and the assemblies were properly aligned in the core prior to setting the UIP.

A multi-disciplinary recovery team was formed to address the bent pins and recover the damaged assemblies. Westinghouse Electric Corporation straightened or removed the damaged UIP guide pins prior to reinstallation of the Upper Internals Package. Commonwealth Edison performed design analyses as required for core redesign. Commonwealth Edison and Westinghouse Electric Corporation dispositioned the removed and repaired UIP fuel assembly guide pins.

A second multi-disciplinary team was established to perform the Root Cause Analysis of this event and develop corrective actions to prevent recurrence.

The following actions are being taken to prevent recurrence of this event:

1. Evaluate fuel design changes to address top nozzle clearance. (Action assigned to Nuclear Fuel Services under NTS Item 454-180-93-00300-01.1).
2. Evaluate fuel design changes to address assembly bow/twist. (Action assigned to Nuclear Fuel Services under NTS Item 454-180-93-00300-01.2).
3. Develop a permanent core alignment and fuel realignment procedure. (Action assigned to Technical Staff under NTS Item 454-180-93-00300-02).
4. Evaluate straightening bowed/twisted assemblies prior to reloading them in the core to prevent loss of available clearance. (Action assigned to Nuclear Fuel Services under NTS Item 454-180-93-00300-05).
5. Evaluate boxing bowed/twisted assemblies instead of using shoe horns and off-indexing to seat bowed/twisted assemblies in the core as a general rule to be used during core reload. (Action assigned to Technical Staff and Fuel Handling under NTS Item 454-180-93-00300-06).
6. Evaluate the use of the "crescent" loading pattern versus alternate loading patterns. (Action assigned to Technical Staff and Fuel Handling under NTS Item 454-180-93-00300-07).
7. Evaluate the use of a camera to inspect the RCCA hub for damage and/or misalignment if the drag test fails. This will be included in procedure BFP FH-16. (Action assigned to Fuel Handling under NTS Item 454-180-93-00300-09).

Other corrective actions for non-consequential problems are identified in the Root Cause Analysis Report.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION														Form Rev 2.0	
FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)						Page (3)							
		Year	///	Sequential Number	///	Revision Number									
Byron, Unit 1	0 5 0 0 0 4 5 4	9 3	-	0 0 3	-	0 0	0 6	OF	0 7						
TEXT Energy Industry Identification System (EIIIS) codes are identified in the text as [XX]															

F. RECURRING EVENTS SEARCH AND ANALYSIS:

a) EVENT SEARCH (DIR, LER)

Byron 2 (10-90)

DVR 6-2-90-042, "Reactor Vessel Upper Internals Alignment Pin Damage due to Personnel Error"

The UIP guide pins were damaged when they contacted the UIP storage stand during installation activities. The pins were examined and repaired prior to installation of the UIP on the core.

b) INDUSTRY SEARCH (OPEX's NPRDS)

- a. SER 21-86, "Dropped Fuel Assembly", dated July 18, 1986. IEN 86-58, "Dropped Fuel Assembly", dated July 11, 1986.

Haddam Neck

During upper internals movements during refueling outage, a fuel assembly was removed from the core. The cause was attributed to a previously bent upper internals fuel assembly guide pin.

- b. OE 2052, "Fuel Assembly Lifted from the Core with the Upper Internals", dated May 14, 1987. Updated under OE 2089.

Almaraz 2

During upper internals movements during refueling outage, a fuel assembly was withdrawn from the core. The attributed root cause was debris in the fuel assembly alignment pin hole which prevented the upper internals guide pin from properly engaging the fuel assembly top nozzle.

- c. OE 2862, "Fuel Bundle Removed from Core During Upper Guide Structural Removal", dated September 6, 1988.

Palisades

During upper internals movements during refueling outage, a fuel assembly was withdrawn from the core. The attributed root cause was pre-existing bent pins on the upper internals upper core plate.

- d. OE 4167, "Fuel Assemblies Withdrawn With Upper Internals", dated October 5, 1990. Updated under OE 4177, OE 4187, OE 4212 and OE 4214.

Indian Point 3

During upper internals removal operations during refueling outage activities, two fuel assemblies were withdrawn from the core. The attributed root cause was pre-existing bent pins on the upper internals upper core plate.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION												Form Rev 2.0											
FACILITY NAME (1)		DOCKET NUMBER (2)				LER NUMBER (6)				Page (3)													
						Year	///	Sequential Number	///	Revision Number													
Byron, Unit 1		0	5	0	0	0	4	5	4	9	3	-	0	0	3	-	0	0	0	7	OF	0	7
TEXT Energy Industry Identification System (EIIS) codes are identified in the text as [XX]																							

F. RECURRING EVENTS SEARCH AND ANALYSIS: (continued)

e. OE 4195, "Reactor Vessel Upper Internals Guide Pins Damaged Due to Contact with the Storage Stand", dated October 22, 1990.

f. Information Notice 90-77, Supplement 1, "Inadvertent Removal of Fuel Assemblies from the Reactor Core", dated February 4, 1991.

Reference the events at Indian Point 3 (October 4, 1988), Haddam Neck (February 20, 1986), Palisades (September 3, 1988), and Byron 2 (October 8, 1990).

g. OE 5140, "Stuck Fuel Bundle", dated March 3, 1992. Updated under OE 5143.

Palisades

Fuel assembly was removed when the upper internals were removed from the core. The cause of the event was attributed to previously bent pins on the upper internals.

h. Oconee 2 Fuel Damage Task Force Report, BWFC Confidential dated April 25, 1985.

Five fuel assemblies were damaged when fuel assembly "dog ears" did not properly mate in the upper internals alignment holes. There was insufficient prevent video tape documentation to ascertain the root cause of the misalignment.

c) NWR

Not applicable.

d) ANALYSIS

Not applicable.

G. COMPONENT FAILURE DATA:

<u>MANUFACTURER</u>	<u>NOMENCLATURE</u>	<u>MODEL NUMBER</u>	<u>MFG PART NUMBER</u>
---------------------	---------------------	---------------------	------------------------

Not applicable.

EVENT SUMMARY AND CAUSE CODES

DVR Number *NA**06*-----*454-93-003*

<input type="checkbox"/> Lost generation	<input type="checkbox"/> Reactor trip	<input type="checkbox"/> NRC violation, level____
<input type="checkbox"/> Cost > \$25,000	<input type="checkbox"/> ESF actuation	<input type="checkbox"/> GSEP event, class_____
<input type="checkbox"/> Hazard or Spill	<input type="checkbox"/> NRC reportable	<input type="checkbox"/> Tech Spec LCO
<input type="checkbox"/> Personnel injury	<input checked="" type="checkbox"/> LER	<input type="checkbox"/> Potential or future loss
Component type	PSE	SALP functional area <i>OL</i>
	Failure mode	

Department

Voluntary Report

X							
X							
X							
X							

Licensed? L or blank

Type

Level

Detail code

Department

A							
A							
A							

Type

Detail Code

Department

B	D	A-5	NSIC	Design clearances, fuel assembly hoist			
B				COC loading sequence			
B							
B							

Type

Detail code

C							
---	--	--	--	--	--	--	--

Type of deficiency

Detail code

Procedure type

D							
D							
D							

Type

Detail code

Department

E							
E							
E							
E							