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

August 12, 1994

LTR: BYRON 94-0306
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 in accordance with the requirements of 10CFR50.73(a)(2)(i).

This report is number 94-006; Docket No. 50-454.

Sincerely,

Maureen Snow for
G.K. Schwartz
Station Manager
Byron Nuclear Power Station

GKS/DSK/ng

Enclosure: Licensee Event Report No. 94-006

cc: J. Martin, NRC Region III Administrator
NRC Senior Resident Inspector
INPO Record Center
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1/1

(9931R\WPF\080894-11)

SIGNATURE PAGE FOR LICENSE EVENT REPORT

LER Number
454 : 94-006

Title of Event: Fuel Assembly in Wrong Location Spent Fuel Pool due to Personnel Error

Occurred: 09-15-94 / 0930
Date Time

OSR DISCIPLINES REQUIRED: ABCG

SES / 8/12/94
DATE

Acceptance by Station Review:

OE / 8/12/94
Date

SES-ABG / 8-15-94
Date

RAS / 8/15/94
Date

OTHER ACG / 8/15/94
Date

Approved by: Station Manager / 8/15/94
Date

(9931R\WPF\080894-1)

LICENSEE EVENT REPORT (LER)

FACILITY NAME	DOCKET NUMBER	PAGE
BYRON NUCLEAR POWER STATION	0 5 0 0 0 4 5 4	1 OF 0 7

TITLE

FUEL ASSEMBLY LOCATED IN WRONG REGION OF SPENT FUEL POOL DUE TO PERSONNEL ERROR

EVENT DATE			LER NUMBER			REPORT DATE			OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQ. NUMBER	REVISION	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 7	1 5	9 4	9 4	0 0 6	0 0	0 8	1 5	9 4	Byron Unit 2	0 5 0 0 0 4 5 5
										0 5 0 0 0

OPERATING MODE	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (CHECK ONE OR MORE OF THE FOLLOWING)						
1		20.402(b)		20.405(e)		50.73(a)(2)(iv)	73.71(b)
POWER LEVEL 8 0		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)	X	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

NAME	TELEPHONE NUMBER
G. STAUFFER, STATION REACTOR ENGINEER, X2249	8 1 5 2 3 4 - 5 4 4 1

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

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

SUPPLEMENTAL REPORT EXPECTED		EXPECTED SUBMISSION DATE	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).

On July 15, 1994, System Engineering Department (SED) found fuel assembly U38J located in Region II of the Spent Fuel Pool (SFP). The fuel assembly did not meet the burnup requirements specified in Technical Specifications (TS) Section 5, "Design Features," Figure 5.6-1, "Minimum Burnup Versus Initial Enrichment for Region II Storage." The Nuclear Component Transfer List (NCTL) incorrectly specified the placement of U38J into Region II at location HM5. The NCTL also did not place the assembly into Region II in a checkerboard pattern. Administrative controls require any assembly that does not meet minimum burnup to be placed into Region II in a checkerboard pattern. The assembly was placed into the incorrect region of the SFP on September 26, 1993 during a refueling outage on Unit 2.

The error was discovered while preparing for the next refueling outage. The assembly was moved to Region I on July 16, 1994.

This event involved no safety concerns. The safety significance of the misplaced assembly is within the safety analysis presented in the UFSAR. This event is reportable in accordance with 10CFR 50.73(a)(2)(i)(B). Any operation or condition prohibited by the plant's Technical Specifications.

(9931R\WPF\080894-2)

A. PLANT CONDITIONS PRIOR TO EVENT:

Event Date/Time 07/15/94 / 0930

Unit 1 MODE 1 - Power Operations Rx Power 80% in coastdown RCS [AB] Temperature/Pressure NOT/NOP

Unit 2 MODE 1 - Power Operations Rx Power 99% RCS [AB] Temperature/Pressure NOT/NOP

B. DESCRIPTION OF EVENT:

Between mid-August, 1993 and September 10, 1993, a non-licensed engineer (Engineer 1) completed the Nuclear Component Transfer Lists (NCTLs) for offloading the Unit 2 reactor core (Page numbers 93-121 to 93-146). This individual was the station's Nuclear Materials Custodian or NMC. During the writing of the NCTLs, he made two errors. On page 93-139, the NCTL shows fuel assembly U29J going to storage location HM10. This location is in a Region II rack. The burnup of the assembly, at the time the NMC wrote the list, did not meet the minimum burnup requirement for placement into Region II. The NMC made a similar mistake for fuel assembly U38J on page 93-143. The actual burnup of U38J was 29770 MWD/MTU versus a required burnup of 32,540 MWD/MTU. The NCTL shows assembly U38J going to storage location HM5. This location is also in a Region II rack. Both errors were cognitive personnel errors.

After the NMC wrote the NCTL for the offload, for Refueling Outage B2RO4, he completed Byron Administrative Procedure (BAP) BAP 2000-3T2, "Nuclear Component Transfer List (NCTL) Verification Checklist." Step 1 of the checklist requires the preparer of the NCTL to verify that,

> "Fuel assemblies entering Region II of the spent fuel racks meet minimum burnup requirements as described in BAP 2000-3A1 or are placed into a checkerboard configuration. Records of assemblies which meet minimum burnup requirements are kept in file 1.02.1080, which is in the NMC satellite file cabinet."

Records of assemblies that meet minimum burnup are documented on BAP 2000-3-T1, "Spent Fuel Burnup Verification Checklist," and are kept in file location 1.02.1080. BAP 2000-3A1's title is, "Minimum Required Burnup as a Function of Enrichment for Region II High Density Spent Fuel Storage Racks." This attachment gives a listing of initial enrichment versus the minimum burnup required for storage in a Region II rack.

BAP 2000-3, "Safeguarding and Controlling Movements of Nuclear Fuel Within a Station," requires the NMC to complete BAP 2000-3-T1 for each assembly to be placed into Region II of the Spent Fuel Pit (SFP). The NMC started but did not complete these forms for assemblies placed into Region II during Outage B2RO4. The BAP 2000-3-T1 form was completed as part of this investigation.

The NMC used the TOTE data for all the assemblies discharged from the core. TOTE is a computer program that calculates assembly burnup. TOTE data gives the total accumulated burnup for each fuel assembly. The data is stored on the IBM mainframe and is accessible via a personal computer. The NMC used the IBM and mentally went through the burnup verification. He did not complete the information on BAP 2000-3-T1. Nuclear Fuel Services (NFS) is responsible for running the code. They run the code every month and after a unit shutdown.

B. DESCRIPTION OF EVENT: (Cont.)

Using the TOTE burnup data and the initial enrichment of each assembly, the NMC did the burnup check using BAP 2000-3A1. The NMC could not recall why he did not complete the forms as required by procedure or why he made the error when he did the burnup checks. A review of the BAP 2000-3-T1 forms for the previous outage (February 1993, B1R05) showed the NMC had completed the forms.

Discussions with the NMC identified several weaknesses in the NCTL writing process. The process is very complicated and relies heavily on the skills of the individual writing the NCTLs. The Verification Checklist gives criteria that the NCTLs must meet. However, the checklist does not describe the process on "how to" write the NCTLs. The NMC divided the process into three major sequences: the offload, the insert shuffle, and the onload. The process as described by the NMC is given below.

First, the NMC does a comparison between the candidate loading pattern supplied by NFS, and the existing core loading pattern. The candidate loading pattern shows the next cycle's core loading pattern. The NMC obtained the existing loading pattern from the tagboard for the Unit 2 reactor core. The tagboards are located in the area where the NMC sits. The tagboards are used to show the location of every fuel assembly and component in the SFP, the New Fuel Storage Racks, Failed Fuel Storage Racks, and the two reactor cores. The tagboards mimic the physical layouts of each of these areas of the plant. And, the NMC keeps them up-to-date based on completed NCTLs.

Once he completed this comparison, he placed each assembly into categories. He based the categories on the insert a fuel assembly contained in the current cycle and the insert the fuel assembly would have in the next cycle. In other words, categories of assemblies are based on what they "have" and what they are "getting." For this event, there were nine different categories. For example, assemblies that have burnable poisons (BPs) that are getting thimble plugs (TPs) (BPs to TPs), assemblies that have control rods (RCCAs) and are getting thimble plugs (RCCAs to TPs), and assemblies that have thimble plugs and are getting control rods (TPs to RCCAs).

Next, the NMC arranged the categories side-by-side in the SFP such that the insert swaps can occur with the least amount of tool changes. There are five major steps to the insert shuffle.

The NMC did this arrangement in the SFP by iteration until he obtained the most efficient layout. After the arrangement in the SFP is done, the NMC can begin writing the offload. The NMC wrote the offload such that the fuel assemblies were placed into the first open location in each of the nine categories. As he wrote the offload sequence, the NMC also ensured that each step met seven requirements and three optional items.

The NMC went through a similar process to write the insert swaps and the core onload sequences. In all, there were eleven required checks and four desirable items for the entire refueling. During discussions, the NMC identified an additional four criteria he met while writing the NCTLs, that were not part of BAP 2000-3T2. This brought the total number of checks the NMC met to nineteen.

After the NMC wrote the three major sequences, they were loaded into a computer program called Shuffle Works. This program wrote the sequence on NCTL forms that the Fuel Handlers used in the field. A member of the SED nuclear group entered the offload and insert shuffle into the program step-by-step. This was done because Shuffle Works could not perform all of the required checks. However, the program did write the onload sequence since it contained 1) the pool configuration after the core was offloaded and all the insert shuffles were done, 2) the final core configuration, and 3) the loading sequence. Because the program had this information, it, by default, wrote the sequence meeting all the appropriate requirements.

B. DESCRIPTION OF EVENT: (Cont.)

After the NMC wrote the NCTLs, he gave them to an independent reviewer on September 10, 1993. The independent reviewer was a non-licensed engineer (Engineer 2). Engineer 2 did not use the records of assemblies that meet minimum burnup requirements to verify certain assemblies could be placed into Region II. He was unaware of the requirement because he failed to review BAP 2000-3 prior to performing the verifications. This was a cognitive personnel error. Instead, this individual used information from the Nuclear Fuel Services Department (NFS). NFS sent a letter that listed assemblies by region and indicated which assemblies met the minimum burnup requirement for storage in Region II. Attached to the letter, was a printout showing the individual burnups of every assembly.

During his review, Engineer 2 found the error for fuel assembly U29J on page 93-139, but failed to find the error for assembly U38J on page 93-143. He notified the NMC of the error for U29J and the NMC wrote a variation to the NCTL. Engineer 2 did not discover the second error and stated that the cause of the error was most likely due to his performing several checks simultaneously. At the time he reviewed the NCTLs, he was performing multiple checks as he went through the NCTLs. This probably caused him to miss the burnup check for assembly U38J. Engineer 2 and the NMC both signed the verification checklist on September 13, 1993.

Discussions with Engineer 2 indicated that there have been errors in past NCTLs but they had been caught by the independent reviewer. No Problem Identification Forms (PIFs) were written for these events. Although PIFs were not required for these events, opportunities to identify and correct these errors before a higher level event occurred, were missed.

Fuel Handlers placed assembly U38J into a Region II rack on September 26, 1993 in accordance with the NCTL.

On July 15, 1994, a non-licensed engineer (Engineer 3) discovered that fuel assembly U38J was in a Region II spent fuel rack The fuel assembly had been in the Region II rack since September 26, 1993. The Fuel Handlers had placed the assembly in the Region II rack during the last refueling on Unit 2. The assembly did not meet the minimum burnup requirements of Technical Specification Figure 5.6-1, "Minimum Burnup versus Initial Enrichment for Region II Storage."

Engineer 3 discovered the error during preparations for moving fuel assemblies from Region I to Region II for the upcoming refueling outage on Unit 1 (B1R06). The SED Nuclear group reviewed every fuel assembly located in Region II to ensure the assemblies either met minimum burnup or were checkerboarded. After the discovery, Fuel Handlers moved fuel assembly U38J to Region I following an approved Nuclear Component Transfer List (NCTL). The Fuel Handlers moved the assembly into Region I on July 16, 1994.

This event did not involve any inoperable systems and was not effected by plant operations on Unit 1 or 2. No operator actions either increased or decreased the severity of the event.

This event is reportable under 10 CFR 50.73(a)(2)(i)(B), any operation or condition prohibited by the plant's Technical Specifications.

C. CAUSE OF EVENT:

The primary causes of this event were cognitive personnel errors. Both the NMC and the independent reviewer failed to use the approved method to verify assemblies meet the minimum burnup requirements for storage in Region II racks. It should be noted that use of the approved method would not guarantee this mistake would not recur because of a procedural weakness. The procedure will be enhanced. There were also several contributing causal factors for this event that led to the cognitive personnel errors.

The current methodology for writing NCTLs is not well defined and relies heavily on the skills of the preparer. The preparer goes through many manual iterations on the NCTL until the most efficient sequence is found. This method is not conducive to minimizing human error.

The methods to be used for verification are also not well defined. Many verification steps required by BAP 2000-3T2 can be done in several different ways, as occurred during this event. And, some methods may not be as effective as others in catching errors or for performing verifications.

By not writing PIFs for failures found during independent verifications, the ability to find and correct problems before they result in higher level events such as an LER was minimized.

Although the Shuffle Works program is an effective program for its intended purpose, enhancement of the Shuffle Works program could help prevent errors of this type in the future.

A corrective action from a previous event was ineffective. Refer to the Recurring Events Search and Analysis section for an explanation.

D. SAFETY ANALYSIS:

UFSAR Section 9.1.2.3, "Safety Evaluation," says that "The largest reactivity increase occurs from accidentally placing a new fuel assembly into a Region II storage cell with all other cells fully loaded. Under this condition, the presence of 300 ppm soluble boron assures that the infinite multiplication factor would not exceed the design basis reactivity for Region II. With the recommended concentration of soluble poison present (2000 ppm boron), the maximum reactivity, K_∞ is less than 0.95 even if Region II were to be fully loaded with fresh fuel of 4.2% enrichment."

Byron Station normally maintains the boron concentration in the SFP at two thousand ppm and administratively controls the concentration to greater than eight hundred ppm. At the time it was placed into the SFP, fuel assembly U38J had a burnup of 29,770 MegaWatt-Days per Metric-Ton-Uranium (MWD/MTU) and an initial enrichment of 3.802%. Therefore, the UFSAR analysis bounds the misplaced assembly and no safety significance existed while the assembly was in the Region II rack.

E. CORRECTIVE ACTIONS:

Corrective Actions - Long Term

1. The NMC and the individual that performed the independent verification were counseled.

2. The SED nuclear group will write a procedure that explains the methodology to be used to write NCTLs for a refueling operation. In addition, this instruction will give directions on when in the process verifications will be done and the preferred method for performing the verifications. NTS item 454-180-94-00600-01 tracks completion of this item.

3. The SED Nuclear group will determine the preferred method for performing each verification on the Nuclear Component Transfer List (NCTL) Verification Checklist, BAP 2000-3-T1. SED will revise the checklist to:

   a) explicitly define the preferred method of each verification.
   b) indicate whether alternate methods are allowed and explicitly define these alternate methods. These methods will be equivalent to the preferred method.
   c) organize the checklist to distinguish important checks from less important checks.
   d) provide cautions describing the pitfalls for each method.

   NTS Item 454-180-94-00600-02 tracks the completion of these items.

4. The SED nuclear group will pursue revisions to the Shuffle Works program that will allow it to perform more of the verifications the nuclear group presently does manually. NTS item 454-180-94-00600-03 tracks completion of this item.

5. Regulatory Assurance will issue PIF threshold guidelines that will require writing PIFs for errors caught during independent reviews. NTS item 454-180-94-00600-04 tracks completion of this item.

6. The SED nuclear group will revise the BAP 2000-3-T1 form to include a column for recording both the assembly's burnup in addition to the minimum required burnup for storage in Region II. NTS item 454-180-94-00600-05 tracks completion of this item.

7. The SED nuclear group will revise BAP 2000-3 to require a walkthrough of the entire refueling on "paper" tagboards. NTS item 454-180-94-00600-06 tracks completion of this item.

Interim corrective actions for the upcoming refueling outage on Unit 1:

a. The Station Reactor Engineer will discuss this event with all members of the Nuclear Group and place this LER in the Nuclear Group Required Reading. NTS item # 454-180-94-00600-07 tracks this item.

b. BAP 2000-3-T1 will be used prior to moving any fuel into Region II. This is presently a requirement of BAP 2000-3, so no NTS item is needed to track this action.

c. A "paper" tagboard will be used for a step-by-step walkthrough of the entire refueling procedure. NTS item 454-180-94-006-08 tracks this item.

F. RECURRING EVENTS SEARCH AND ANALYSIS:

A search on ETS found one previous event of a misplaced fuel assembly due to an error in an NCTL. DVR 6-1-91-071, "Fuel Transfer List Error," documents this event. A review of the corrective actions for this event indicated that one of the corrective actions was not implemented. Corrective action to prevent recurrence, item 2B, states,

> "BAP 2000-3 will be revised to require the use of a procedural checklist when developing the NCTL. This list will include:"
>
> "B. The requirement to use a tag board."

Currently, BAP 2000-3 does not contain this requirement. Discussions with the Station Reactor Engineer (SRE), at the time of the event, indicated that this corrective action required a step-by-step walkthrough of the entire refueling evolution on the tagboards. However, Engineer 2 indicated that the intent of the corrective action changed. The intent changed to the use of a "paper" tagboard as opposed to the use of the physical tagboards. This would eliminate possible errors from moving chips on the physical tagboards. It cannot be determined why this requirement was not incorporated into BAP 2000-3. A review of the NTS item written to track completion of this corrective action indicated that the NTS was not specific on exactly what changes to BAP 2000-3 were needed. The NTS item simply stated to "develop a procedure checklist that specifies how to prepare an NCTL." At the time the checklist was developed, it failed to incorporate this requirement into BAP 2000-3. Therefore, this corrective action was ineffective.

G. COMPONENT FAILURE DATA:

There was no failed component during this event.