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NUCLEAR FUELS

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PROCEDURE APPROVAL

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1.0 PURPOSE AND SCOPE

1.1 PURPOSE

(1) The purpose of this program is to ensure that the spent fuel pool storage racks are maintained within their design and licensing basis (CAPR, AR 567353).

(2) The program will identify key components and documents of the spent fuel pool rack design and licensing basis.

(3) The program will ensure that potential deviations from the design and/or licensing basis are evaluated to determine if a noncompliance exists.

(4) The program will ensure that non compliances with the design and/or licensing basis are documented via the corrective action program (CAP), and are identified as having potential operability and/or reportability consequences.

1.2 SCOPE

(1) The scope of the program includes the Boral coupon sampling program (credited for license renewal) and the neutron attenuation testing program.

(2) This program concerns only the condition of the spent fuel fool (SFP) racks, and not the new fuel storage vault (NFV), temporary new fuel storage racks for the Cask Pit, or other fuel storage facilities.

2.0 DEFINITIONS

(1) **DAMAGED FUEL ASSEMBLIES** - Damaged fuel assemblies are assemblies containing fuel rods with known or suspected cladding defects greater than hairline cracks or pinhole leaks. The extent of cladding damage in the fuel assembly is to be limited such that a fuel assembly needs to be handled by normal means and retrievability is assured following normal and off-normal conditions. Any fuel assembly with less than a full complement of rods is also considered damaged (Reference (21)).

(2) **DEVIATION** – An observed or measured difference between expected and actual conditions.

(3) **FAILED FUEL** - Failed fuel is defined as ruptured fuel rods, severed fuel rods, loose fuel pellets, or fuel assemblies that cannot be handled by normal means. Failed fuel assemblies may contain breached rods, grossly breached rods, and other defects such as missing or partial rods, missing grid spacers, or damaged spacers to the extent that the assembly cannot be handled by normal means (Reference (21)).

(4) **NONCONFORMANCE** – A deviation that does not meet the minimum requirements of the design and/or licensing basis.

3.0 RESPONSIBILITIES

3.1 SITE ENGINEERING DIRECTOR

Has overall responsibility for ensuring that the SFP storage racks are maintained as designed and that the CAP is used to document nonconformances with the design and/or licensing basis.

3.2 SYSTEM ENGINEERING MANAGER

Responsible for assigning a SFP system engineer.

3.3 NUCLEAR FUELS ENGINEERING MANAGER (DUANE ARNOLD)

Responsible for the identification of critical characteristics of the SFP storage racks that are assumed in SFP criticality (e.g., rack dimensions) and for ensuring that any changes to those assumptions are communicated to Reactor Engineering.

3.4 REACTOR ENGINEERING SUPERVISOR/REACTOR ENGINEERING

Responsible for ensuring that potential deviations from SFP rack design and/or licensing basis are evaluated to determine whether a nonconformance exists and for ensuring that nonconformances are documented in the CAP. Responsible for reporting identified nonconformances with spent fuel rack design and/or licensing bases in the DAEC CR database. Also responsible for the Boral coupon surveillances and the neutron attenuation testing programs.

3.5 SPENT FUEL POOL SYSTEM ENGINEER

Responsible for actions outlined in ER-AA-103, Core Duties of System Engineering, for the SFP cooling and mechanical systems, and the SFP cooling system health report.

3.6 LICENSING MANAGER

Responsible for ensuring that nonconformances with the spent fuel rack design and/or licensing basis are evaluated for reportability.

4.0 INSTRUCTIONS

4.1 IDENTIFICATION OF DESIGN AND LICENSING BASIS

The spent fuel storage racks provide a means to store nuclear fuel in a configuration that ensures criticality is prevented and also allows decay heat to be removed from irradiated fuel.

Design functions of the spent fuel storage racks are found in the UFSAR (Section 9.1.2) and Technical Specifications (TS 4.3.1.1), therefore, noncompliance with the design and/or licensing basis may result in a violation of Technical Specifications and need to be assessed for operability and reportability.

Spent fuel storage racks 01A through 04C (Attachment 1, white colored racks) were supplied by Programmed and Remote Systems Corporation (PaR) and were installed in accordance with Design Change Package DCP 877. Racks 05A through 07C (Attachment 1, gray colored racks) were supplied by Holtec and were installed in accordance with Design Change Package DCP 1538.

The spent fuel pool racks are currently established under SUS 81.00, with equipment IDs 1S810 A through S.

4.1.1 DESIGN BASIS ITEMS

DAEC‘s licensing bases encompasses two broad categories: safety, and power generation.

(1) Safety: the racks are designed to store fuel, both spent and new, in a subcritical state through all conditions.

(2) Power Generation: the racks are designed and arranged that the fuel assemblies may be efficiently handled during refueling, and to provide maximum storage space in the spent fuel pool.

4.1.2 LICENSING BASIS ITEMS

(1) Criticality Analysis: The spent fuel pool criticality analysis contains assumptions that are made regarding the spent fuel storage racks. These are mostly physical characteristics (e.g., rack cell dimensions).

(2) Boral Coupon Surveillance Program: The Boral coupon surveillance program requires dimensional, visual, and functional testing be performed on a representative Boral coupon as described in UFSAR Section 9.1.2.2.4 and the Boral Surveillance Program. The surveillances are required to demonstrate that the physical condition and B10 content requirements of the Holtec racks continue to be met in the SFP.

(3) Neutron Attenuation Testing Surveillance Program: The neutron attenuation testing surveillance program requires functional testing be performed on a representative selection of PaR rack locations as described in the neutron attenuation testing surveillance program description. The surveillances are required to demonstrate that the B10 content requirements of the PaR racks continue to be met in the SFP.

4.2 IDENTIFICATION OF POTENTIAL DEVIATIONS FROM DESIGN AND/OR LICENSING BASIS

This section provides descriptions of conditions or events that could result in a deviation from the spent fuel rack design and/or licensing basis. This section is not intended to be all-encompassing.

(1) Physical Damage: damage to the SFP storage racks should be evaluated for the potential to damage fuel assemblies currently stored or to be moved into/out of a damaged cell. A brief listing of possible damaging events is as below.

(a) Impacts from items moved within the SFP could alter the physical dimensions of the racks.

(b) Discharge flow from piping in the SFP can impact the racks and cause damage via fatigue failure of structural welds or base metal.

(c) Seismic events can alter the physical dimensions of the SFP.

(2) Foreign Objects: dropping large objects into the SFP could damage the racks, or block/impede cooling flow within a rack cell.

(3) SFP Rack Surveillances: any anomalies identified during required surveillances shall be evaluated to determine whether the assumptions in the criticality analysis regarding B10 content, geometry, etc., are affected. Violation of the assumptions needs to be evaluated as a deviation from the design and/or licensing basis.

4.3 EVALUATION OF POTENTIAL DEVIATIONS FROM DESIGN AND/OR LICENSING BASIS

Potential deviations from the design and/or licensing basis of the spent fuel storage racks shall be evaluated to determine whether the deviation represents a nonconformance. This section provides some considerations, but is not intended to be all-encompassing.

(1) Physical Damage:

(a) Determine whether a spent fuel storage rack cell fails to meet the minimum physical dimensions required by the design basis.

(b) Determine whether the physical integrity of a rack cell has been compromised.

(c) Determine whether the ability to withstand a seismic event is compromised.

(2) Flow Obstructions: Determine whether flow obstructions in rack cells could result in failure to adequately remove decay heat from irradiated fuel.

(3) Criticality Analysis: Determine whether any assumptions in the criticality analysis have been violated.

Nonconformances shall be documented in the Corrective Action Program. These items shall also be identified having potential operability and/or reportability consequences.

4.4 DAEC OPERATING EXPERIENCE

4.4.1 QUARANTINED SPENT FUEL POOL LOCATION

(1) Fuel assembly YJ9902 in Spent Fuel Pool Location 04-08-00 shall not be removed because this location has resulted in two stuck fuel assemblies. Thus, this location is quarantined from further use. (**AR 01686034, AR 00279973**).

(2) Spent Fuel Pool Location 01-22-03 is quarantined from further use due to a momentary hoist jammed light while lifting a new fuel assembly from this location during RFO24. Note that this rack location is empty. (**AR 02000187**)

4.4.2 LIST OF KNOWN DAMAGED FUEL ASSEMBLIES

The table below provides the DAEC fuel assemblies which are classified as damaged based on fission gas analysis.

DAEC Fuel Assembly	Reference
AR0090	8
AR0239	8
AR0341	8
AR0350	8
LJ8738	9
LY2144	10, 11
LY2247	10, 11
JYW842	29
AR156	17, 34
26U453(1)	40, 41, 42
27U040(1)	40, 41, 42
27U064(1)	40, 41, 42
27U152(1)	40, 41, 42

Note (1): One of these four fuel assemblies has a leaking fuel pin based on power suppression testing performed (Reference 41). All four fuel assemblies are being treated as 'damaged' since no fuel sipping was performed to confirm the leaking fuel assembly.

4.4.3 FAILED FUEL ASSEMBLIES AT DAEC

The only fuel assembly at DAEC considered as failed is AR356, due to sustaining handle deformation and indication of cladding damage during a bundle drop event in 1975 (Reference 17).

4.4.4 LIST OF KNOWN FUEL ASSEMBLIES WITH LESS THAN A FULL COMPLEMENT OF PINS

The table below provides the DAEC fuel assemblies that have had pins removed, shipped to the vendor for analysis, and not returned (see Reference 38 for more details). Any assembly with less than a full complement of rods is considered damaged (Reference 21 and 35).

DAEC Fuel Assembly	Reference
LYA480	19
YJ5377	20
YJF343	12
YJF372	13, 33

4.4.5 LIST OF KNOWN FUEL ASSEMBLIES MISSING CHANNEL FASTENERS

The table below provides the DAEC fuel assemblies in the spent fuel pool that have been identified, to date in Reference (14), to be missing the channel fastener.

DAEC Fuel Assembly	Reference
AR001	14
AR003	14
AR005	14
AR006	14
AR007	14
AR008	14
AR010	14
AR011	14
AR012	14
AR013	14
AR015	14
AR016	14
AR021	14
AR022	14
AR023	14
AR028	14

DAEC Fuel Assembly	Reference
AR029	14
AR030	14
AR034	14
AR035	14
AR037	14
AR038	14
AR039	14
AR041	14
AR042	14
AR043	14
AR044	14
AR048	14
AR049	14
AR050	14
AR054	14
AR056	14
AR058	14
AR059	14

DAEC Fuel Assembly	Reference
AR061	14
AR063	14
AR065	14
AR066	14
AR067	14
AR069	14
AR071	14
AR072	14
AR075	14
AR076	14
AR077	14
AR078	14
AR079	14
AR080	14
AR082	14
AR090	14
AR233	14
AR241	14
AR249	14
AR341	14

Note that assemblies missing the channel fastener may be stored in a DSC per Reference (15) provided:

- There is no substantial damage to the fuel channel that results in potential damage to the fuel rod bundle.
- The fuel assembly with the channel is handled by normal means and that the channel remains positioned within the rod bundle envelope during routine handling.
- There is no potential for substantial axial channel movement and /or channel twist resulting in the bottom end of the channel being lodged against the fuel bundle array.

4.4.6 FUEL ASSEMBLIES WITH NON-STANDARD CHANNEL FASTENERS

Although the four central lead test assemblies (LYA476 – LYA479) have the full complement of fuel pins, they have channels and channel fasteners that are non-standard when compared to the GNF production line. Per GE drawing 829E999 (Reference 37), the channel fastener is on the side of the channel (near the A1 pin), not the corner. In addition, the lower tie plate is part of the channel, not the bundle.

4.4.7 LIST OF KNOWN FUEL ASSEMBLIES WITH CHANNEL ISSUES

The table below provides the DAEC fuel assemblies in the spent fuel pool that have been identified, to date in Reference (14), to be missing the channel fastener and have an issue with the channel.

DAEC Fuel Assembly	Additional Notes	Reference
AR021	Channel looks to be not fully seated.	32
AR030	Channel appears to be 180 deg installed.	14
AR056	Channel looks to be not fully seated.	14
AR065	Channel looks to be not fully seated.	14
AR071	Channel looks to be not fully seated.	14
AR080	Channel looks to be not fully seated.	14
AR341	Channel looks to be not fully seated.	14

Note that fuel assemblies containing channels without fasteners that are not fully seated or that are rotated 180 degrees are acceptable for loading in a DSC per Reference (15) provided:

- There is no substantial damage to the fuel channel that results in potential damage to the fuel rod bundle.
- The fuel assembly with the channel is handled by normal means and that the channel remains positioned within the rod bundle envelope during routine handling.
- There is no potential for substantial axial channel movement and /or channel twist resulting in the bottom end of the channel being lodged against the fuel bundle array.

4.4.8 LIST OF FUEL ASSEMBLIES WITHOUT A CHANNEL

The table below provided the DAEC fuel assemblies that have been identified, to date in Reference (14), as being unchanneled.

DAEC Fuel Assembly	Reference
AR239	(14)

(1) Movement of an unchanneled fuel assembly requires that the assembly had been stored in the Spent Fuel Pool longer than 45 days prior to movement. (**AR 00378810**)

(2) Note that unchanneled assemblies may be stored in a DSC per Reference (21).

(3) AR239 is also damaged (See Section 4.4.2). Being unchanneled has no impact on storage requirements for damaged fuel.

4.4.9 CONSIDERATIONS WITH SPENT FUEL RACK POSITIONS

(1) Considerations with spent fuel rack positions (in addition to Spent Fuel Pool locations 04-08-00 and 01-22-03 noted in 4.4.1 above):

(a) Spent fuel rack positions 01-01-00 and 01-02-00 (empty locations) are obstructed by a pipe and therefore will not be used for fuel storage.

(b) Spent fuel rack position 02-33-01 is obstructed by a bent bail handle shall not be used for storage of fuel assemblies/bundles.

(c) Spent Fuel Pool Rack location 07-12-01 is inaccessible due to a bent index guide strip interfering with this location.

(d) Spent Fuel Pool rack positions 03-02-07 and 03-03-00 are storing channels (N4446 and N4691, respectively) removed from irradiated assemblies that were rechanneled due to power suppression for a failed fuel assembly in the affected cell, and should not be used until these channels are removed.

(e) Spent Fuel Pool rack position 07-04-02 is storing blade D526, which has experienced cracking due to exceeding its recommended exposure limits while being used as a suppression blade for failed fuel. This blade should be handled as little as possible to prevent further degradation.

(f) Spent Fuel Pool rack position 07-04-00 is occupied by control blade HY45, an OEM blade discharged after nearly 30 years in the core. Because a long residence time in the core (40 years, per vendor guidance) would cause concern that the bail handle could fail, additional measures should be taken to grapple the body of the blade when handling this component.

(g) Do not plan to move a fuel bundle into the Emergency Set-Down Location as identified in RFP 403 except as needed in an emergency.

(h) When moving items in the Spent Fuel Pool, take care to limit movement over fuel or other components that will be going into the reactor vessel in order to prevent FME from falling onto these components.

(i) When developing a fuel moving plan, ensure that all the following precautions for placement of freshly discharged fuel (fuel having less than one year of decay time) are met:

- Freshly discharged fuel from the reactor core shall not be placed within two rows of the Spent Fuel Pool walls. 'Freshly Discharged Fuel' has less than one year of decay time.
  {C001}
- Freshly discharged fuel from the reactor core shall not be placed in spent fuel rack positions that have leg supports below them. See Attachment 1 for these positions.
  {C002}
- All freshly discharged fuel from the reactor core shall be surrounded by non-freshly discharged fuel assemblies/bundles or empty rack positions on all face-adjacent sides while in the spent fuel pool racks. The exception is during interim configurations during fuel shuffle operations. The Spent Fuel Pool shall be configured prior to every Refueling Outage to support this configuration.
  {C002} {C003}
- For ALARA concerns, minimize the number of freshly discharged bundles placed near the third and fourth rows of the East, South, or West walls of the Spent Fuel Pool. This constraint needs to be weighed against fuel storage limitations in the fuel pool.
- If freshly discharged fuel is placed within the fourth row from the east, west, or south Spent Fuel Pool walls, Health Physics shall perform one of the following:
  (i) Perform radiation surveys of the affected areas on the RB third floor and/or fourth floor during and after the move.

  OR

  (ii) Monitor the areas with ARMs and survey areas after move as determined by the HP Technician.

(j) If possible, do not place new fuel in a row next to the north wall of the Spent Fuel Pool. This row requires more time to latch onto those bundles because of the need to adjust viewing aids on the mast and the SRO must exit the bridge to properly identify the bundles.

(k) Moving fuel into or out of the western-most row in Rack 01 may require use of the frame mounted hoist. Moving bundles using the normal fuel handling mast is preferable.

(l) It is preferred that the PaR racks (Sections 01 through 04) be used for storage of double blade guides because the storage spaces in these racks are larger than in the Holtec racks.

NOTE: All inserts in Rack 7A have been removed as per EC 292906, Removal of SFP Rack 7A Partitions (Ref. (36)).

(m) Any location in Rack 7A which does not have an insert shall not be used for purposes of storing fuel.

- Fuel has not been placed into the dual purpose cells of Rack 7A due to blade storage and other items which potentially could impact (hit) any fuel stored there as these items are being moved into or out of the rack.

(n) When developing control blade movement plans, note that the preferred temporary spent fuel pool storage locations for blade swaps are rack locations 07-06-04 and 07-06-02 in order to avoid interference with vendor tooling and the SFP wall.

(o) Rack locations directly under Spent Fuel Pool Level Instruments (LE-3414 and LE-3415) are inaccessible without moving the bracket and instrument.

Below is a listing of the affected Spent Fuel Pool Cells:

Location	Location
07-38-04	01-01-04
07-38-05	01-01-05
07-38-06	01-01-06
07-38-07	01-01-07
07-37-04	01-02-04
07-37-05	01-02-05
07-37-06	01-02-06
07-37-07	01-02-07
07-36-04	01-03-04
07-36-05	01-03-05
07-36-06	01-03-06
07-36-07	01-03-07
07-35-04	01-04-04
07-35-05	01-04-05
07-35-06	01-04-06
07-35-07	01-04-07

4.4.10 OTHER CONSIDERATIONS

(1) One segment of a fuel pin from Lead Test Assembly LYA477 experienced a five-foot drop in water during inspection operations. After being dispositioned for use, the pin and the assembly were irradiated for an additional two cycles with no adverse consequences. LYA477 is considered an intact fuel assembly (Reference 24).

5.0 RECORDS

This procedure will generate no records on its own; should ARs be written that document the operability of the SFP racking or documenting fuel pool rack issues, they should also be referenced in this procedure via PCR in the section below in order to provide an effective repository for SFP racking issues.

A historical search of the corrective action program for SFP Rack issues was conducted as part of this program; ARs written to document these historical issues have been included in the References section. None of these historical issues impacts the operability of the current spent fuel pool racks.

6.0 REFERENCES

(1) AR 567353, Root Cause Analysis, Unit 3 Spent Fuel Storage Rack Boraflex Degradation Resulting in Non-Compliance with T.S 5.5.1.1.

(2) Not Used

(3) Holtec Report HI-971708, Criticality Safety Evaluation of the Spent Fuel Pool Storage Racks in the DAEC for Maximum Enrichment Capability (IES Utilities PO B12799)

(4) DR #86-737, Control Blade dropped on Spent Fuel (no damage to fuel or racks)

(5) DR #89-157, CRB AR13R dropped and impacted Spent Fuel Pool Rack

(6) DR #89-163, CRB AR32R dropped and impacted SFP rack

(7) AR 01686034, Fuel Bundle Stuck in Spent Fuel Pool at Position 04-08-00

(8) GNF Document 22A7525, Revision 0, “Duane Arnold C4 Cycle Summary Report,” Aug. 1981

(9) GNF Document 22A7509, Revision 0, “Duane Arnold C5 Cycle Summary Report,” Sept. 1981

(10) GNF Letter NGCA-G1-88-12-27013060, “Vacuum Sipping at Duane Arnold EC,” November 1, 1988. (Cycle 9 failed fuel report)

(11) GNF Document 23A4815, Revision 0, “Duane Arnold C9 Cycle Summary Report,” April 1989

(12) DAEC Fuel Moving Plan 02-003, “YJF343,” August 13, 2002

(13) DAEC Fuel Moving Plan 02-004, “YJF372,” August 13, 2002

(14) NG-11-0342, Results of Fuel Observation for CA588338, 2011-09-06

(15) Transnuclear Letter E-31261, “DAEC Channeled Fuel,” July 21, 2011

(16) Calculation DAEC-1FJF-11-106, Revision 3, Irradiated Fuel Assembly Selection for Duane Arnold Energy Center 2011 ISFSI Campaign

(17) DAEC-75-0372, Iowa Electric Light and Power Company Abnormal Occurrence Report Number AO-50-331/75-31A, Inadvertent Dropping of a Fuel Bundle During Fuel Movement Operations

(18) GNF Document 22A5054, Revision 0, “Duane Arnold C1 Cycle Summary Report,” May 1977.

(19) DAEC Fuel Moving Plan 93-LTAS, May 10, 1993

(20) DAEC Fuel Moving Plan 98-009, “YJ5377,” April 4, 1998

(21) Transnuclear NUHOMS System Generic Technical Specifications (included as Appendix K to Certificate No. 1004)

(22) AR 00279973, 004041 Fuel Bundle YJ5427 Stuck in Rack Location 04-08-00, April 2, 1995

(23) AR 00378810, Questions Regarding Analysis of a Fuel Handling Accident in the Spent Fuel Pool

(24) NG-87-2050, Dropped LTA Segmented Fuel Rod, June 1, 1987

(25) **{C001}**, CA 0029518601, Administrative controls for freshly discharged fuel

(26) **{C002}**, RWT 00305038 “Evaluate NEI Letter Concerning Spent Fuel Pool”

(27) **{C003}**, RWT 00359305 "Add additional detail for fuel shuffling to Refuel and RE Procedures for B.5.b"

(28) AR 02000187, Momentary Hoist Jammed Light While Lifting New Fuel Bundle

(29) JMT-NEE-KE1-16-147, Duane Arnold EOC 25 Failed and Sound Fuel Examination FTR and Results Summary.

(30) STP 4.3.1-02, Spent Fuel Pool Neutron Absorber Density Verification

(31) AR 02279938 Double Blade Guide Interference

(32) NG-18-0149, Brandt to Lindley, Documentation of Fuel Bundle AR021 Channel Not Fully Seated

(33) DAEC Fuel Moving Plan 98-007, “YJF372,” April 4, 1998

(34) CR 02330341, Level 1 Assessment: Classification of Damaged / Failed Fuel at DAEC

(35) Interim Staff Guidance - 1, Revision 2, Classifying the Condition of Spent Nuclear Fuel for Interim Storage and Transportation Based on Function

(36) EC 292906, Removal of SFP Rack 7A Partitions

(37) GE Drawing 829E999 Revision 0: LTA Channel with Fastener

(38) Level 1 Assessment 02344998: Fuel Bundles with Less than a Full Complement of Pins

(39) JSC-021-084, Charnley to Thomas, Generic Licensing of 1984 Lead Test Assemblies (Special Report MFN-068-84), June 4, 1984, transmitted by letter Borton to Nodean, NRC Correspondence on LTAs, November 6, 1984.

(40) AR 02352628, Pretreat Sample Results Indicate a Fuel Leak

(41) RSI-4833, On-Line Fuel Inspection at the Duane Arnold Energy Center (Radiological Solutions Incorporated), May 2020

(42) WTB-NEE-KE1-20-043, Bennet to Perryman, DAEC Cycle 27 Failed Fuel Characterization.

ATTACHMENT 1
SFP LEG SUPPORT LOCATIONS

Locations within the spent fuel pool are referred to by the following scheme: section number-row-column. For example, the location reference for the box marked X is shown on the map below would be 03-15-02. Shaded boxes show leg locations. Gray areas are Holtec Racks, white areas are PaR Racks.