

71-9261



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**BY FAX AND OVERNIGHT MAIL**

February 18, 2000

U.S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Subject: USNRC Docket No. 71-9261; TAC No. L22085  
HI-STAR 100 Transportation CoC 9261  
License Amendment Request 9261-1, Supplement 2

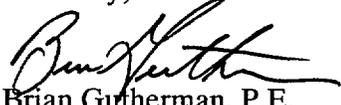
References: 1. Holtec Project 5014  
2. Holtec Letter to NRC dated November 24,1999, LAR 9261-1

Dear Sir:

As committed during our telephone conversation yesterday, we enclose herewith replacement pages for proposed Safety Analysis Report (SAR) Revision 9, a sketch of the criticality model of the QUAD+ assembly, and revised wording for the Certificate of Compliance related to the Antimony-Beryllium neutron source. Please note that while the value of  $S_{by}$  presented in Appendix 2.R is different due to a unit conversion, the value used in the underlying calculation is unaffected and the 33% safety margin remains unchanged.

If you have any questions or require additional information, please contact us.

Sincerely,

  
Brian Gutherman, P.E.  
Licensing Manager

Approval:

  
K.P. Singh, Ph.D, P.E.  
President and CEO

cc: Ms. Marissa Bailey, USNRC (w/10 copies of enclosure)  
Mr. Mark. Delligatti, USNRC (w/ encl.)

Document ID: 5014370

Enclosures: 1. Replacement SAR page 2.R-7, proposed Revision 9 (1 page)  
2. QUAD+ Criticality Model Sketch (1 page)  
3. Mark-ups of CoC 9261, Appendix A (2 pages)

NimSSO (Public)



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Page 2 of 2

**Technical Concurrence:**

Dr. Alan Soler (Structural Evaluation)

Dr. Everett Redmond II (Shielding Evaluation)

Dr. Stefan Anton (Criticality Evaluation)

**Distribution (w/o encl.):**

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Ms. Kathy Picciott	Niagara Mohawk Power Corporation
Mr. John Donnell	Private Fuel Storage, LLC (SWEC)
Dr. Stanley Turner	Holtec International, Florida Operations Center

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{Mx}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{My}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

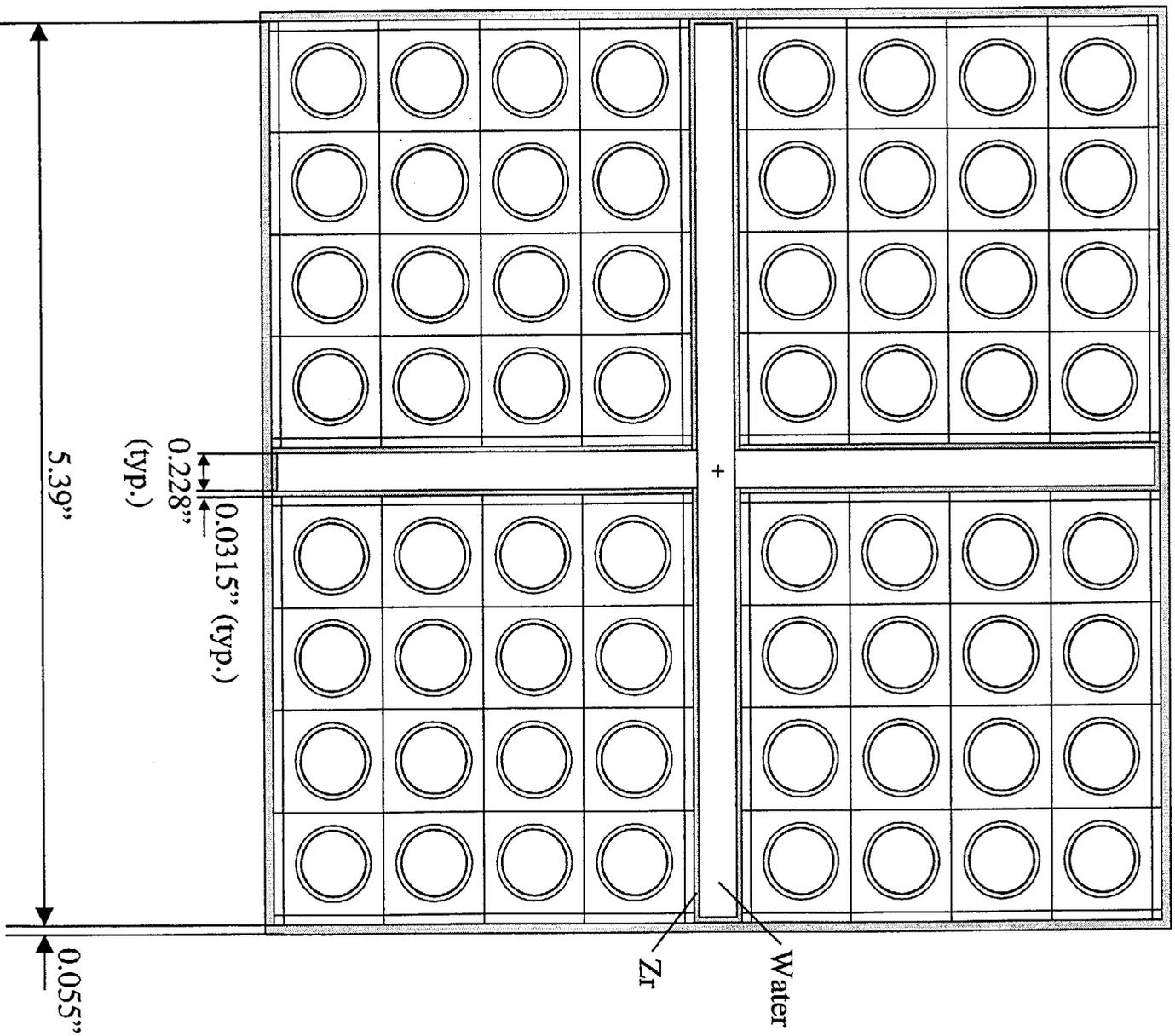
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{\text{eq}} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{\text{eq}} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{\text{req}} := \frac{S_{\text{eq}}}{\sigma_y} \qquad t_{\text{req}} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

- B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.
- C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.
- D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt. % $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$

$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{Mx}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

$$S_{bx} := \frac{My}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

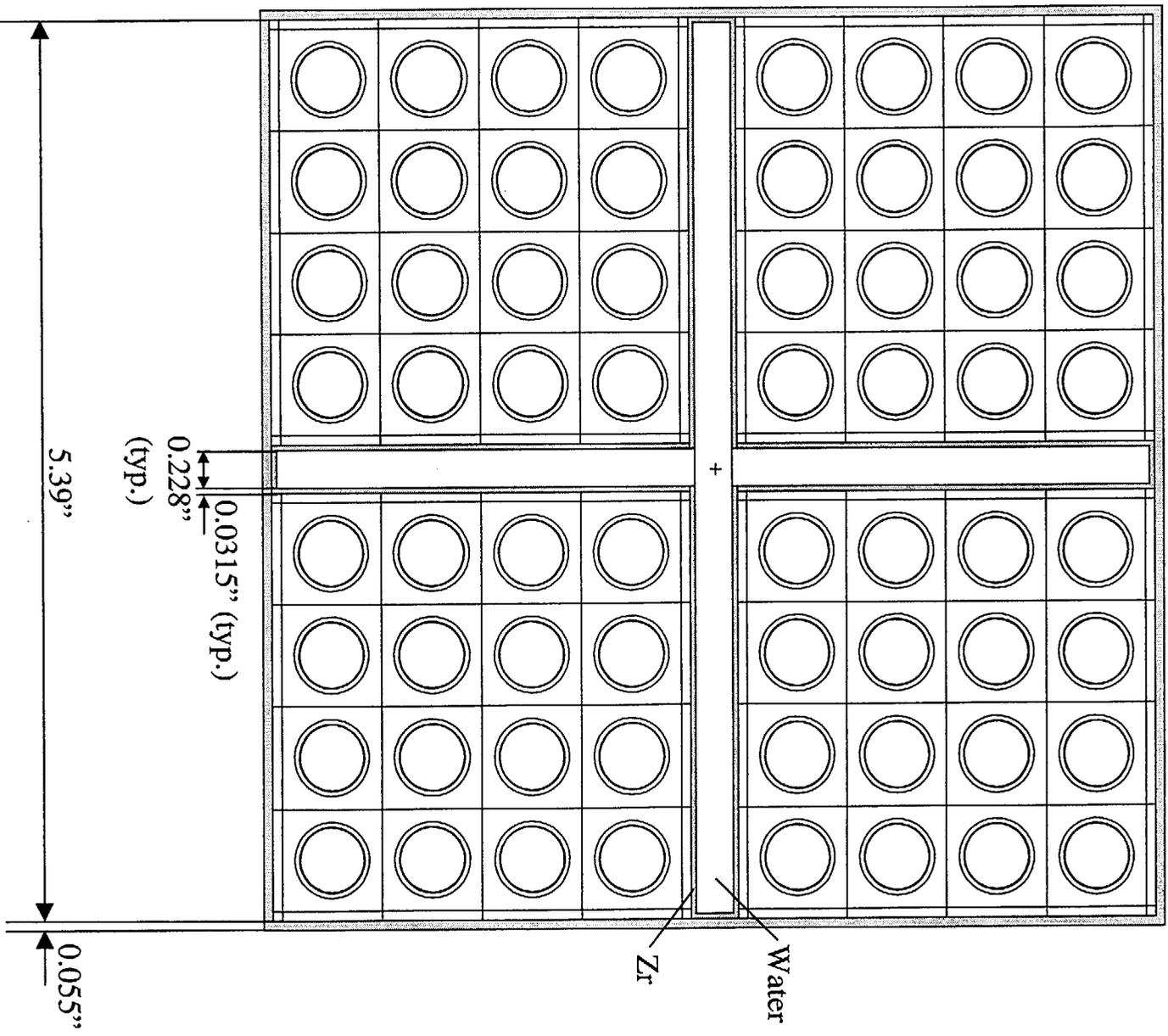
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{\text{eq}} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{\text{eq}} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{\text{req}} := \frac{S_{\text{eq}}}{\sigma_y} \qquad t_{\text{req}} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$

$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{M_x}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

$$S_{bx} := \frac{M_y}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

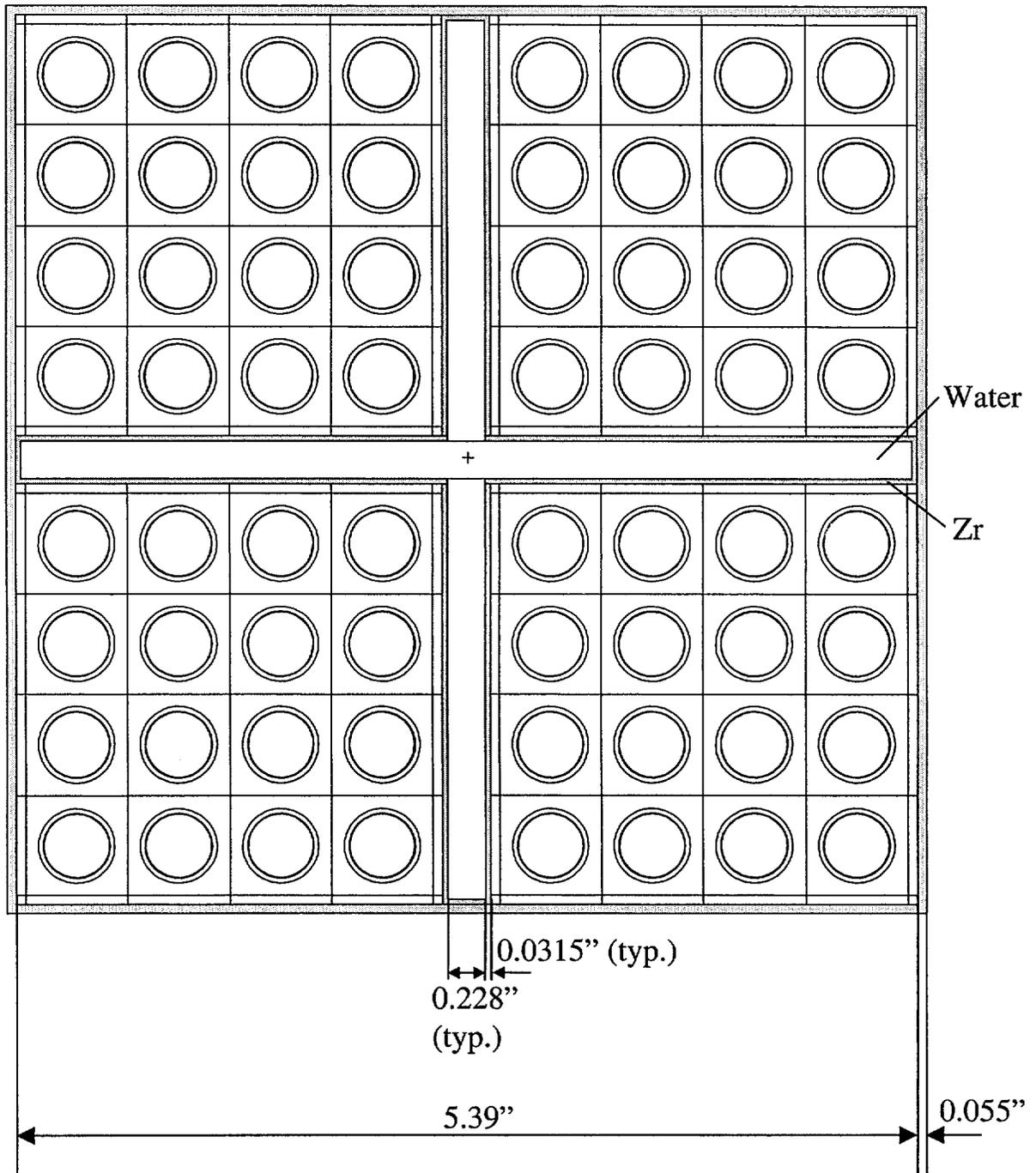
$$S_t := \frac{M_z \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{eq} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{eq} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{req} := \frac{S_{eq}}{\sigma_y} \qquad t_{req} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt. % $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
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e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
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i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{Mx}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{My}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

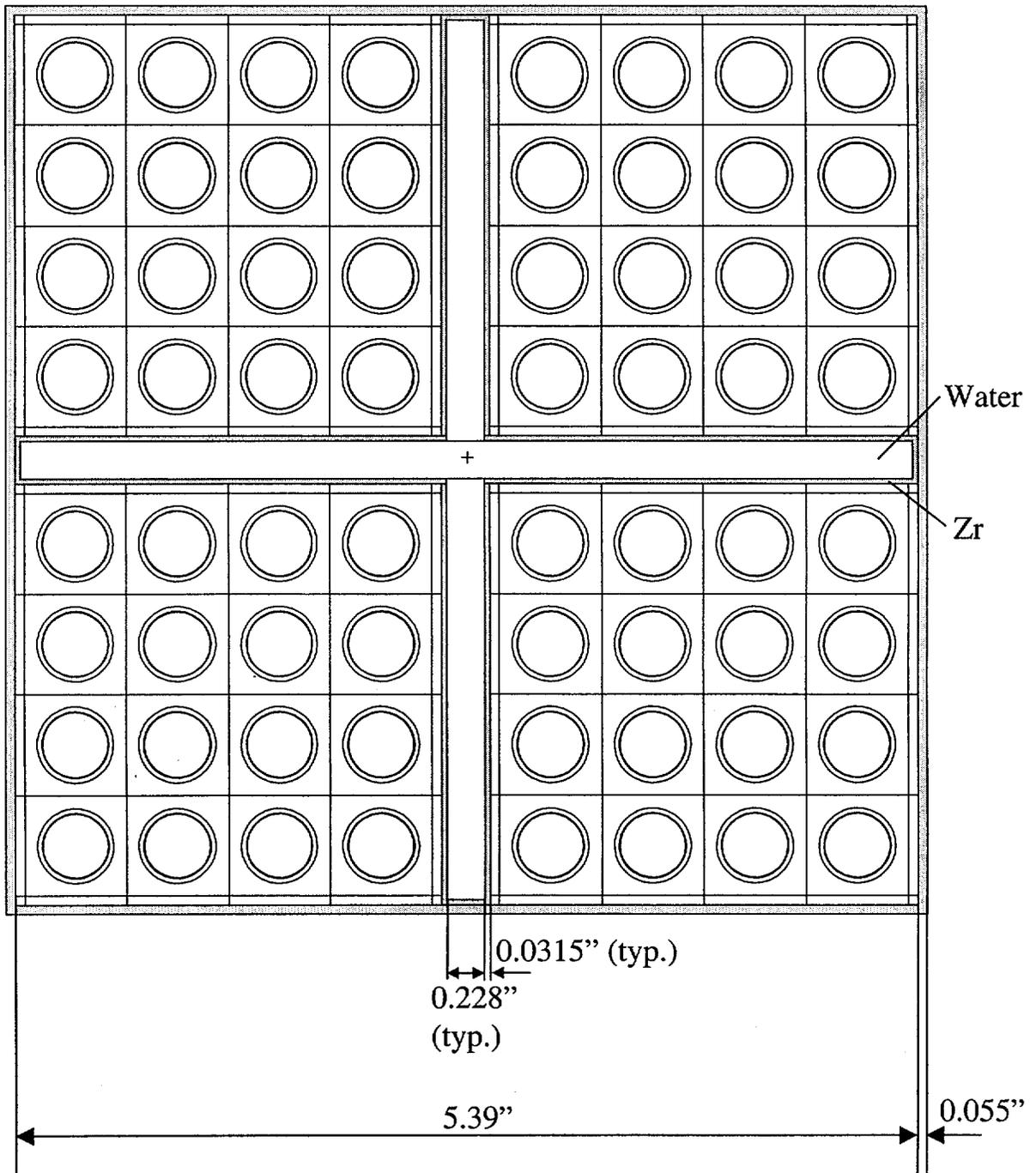
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{\text{eq}} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{\text{eq}} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{\text{req}} := \frac{S_{\text{eq}}}{\sigma_y} \qquad t_{\text{req}} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

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j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

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B. Quantity per MPC:

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The torsional force/unit of throat thickness at point D is determined as:

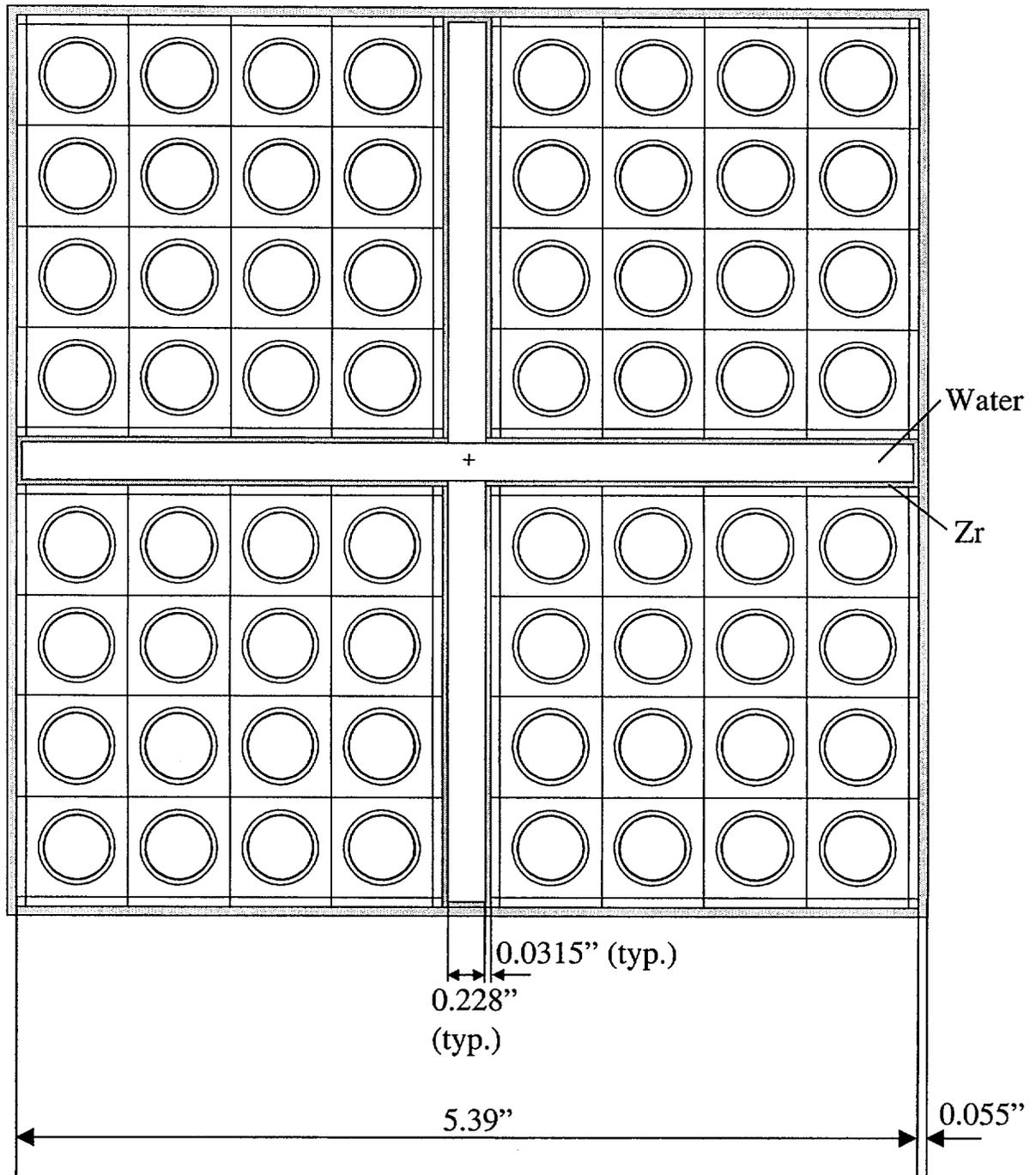
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The net force/unit of weld throat thickness is computed as a root mean square

$$S_{\text{eq}} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{\text{eq}} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{\text{req}} := \frac{S_{\text{eq}}}{\sigma_y} \qquad t_{\text{req}} = 3.187 \text{ in}$$



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Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{M_x}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{M_y}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

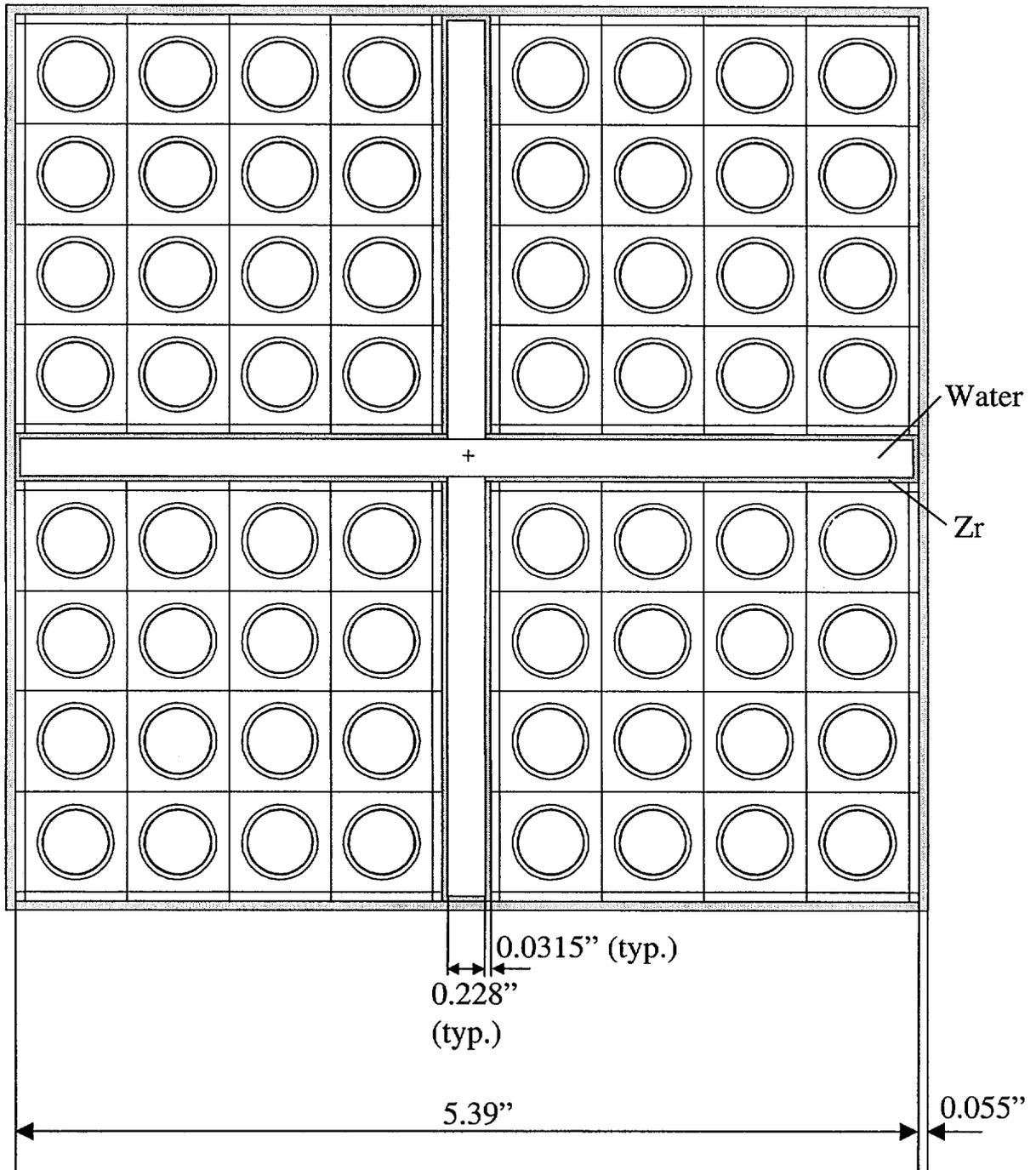
$$S_t := \frac{M_z \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{eq} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{eq} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{req} := \frac{S_{eq}}{\sigma_y} \qquad t_{req} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{Mx}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{My}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

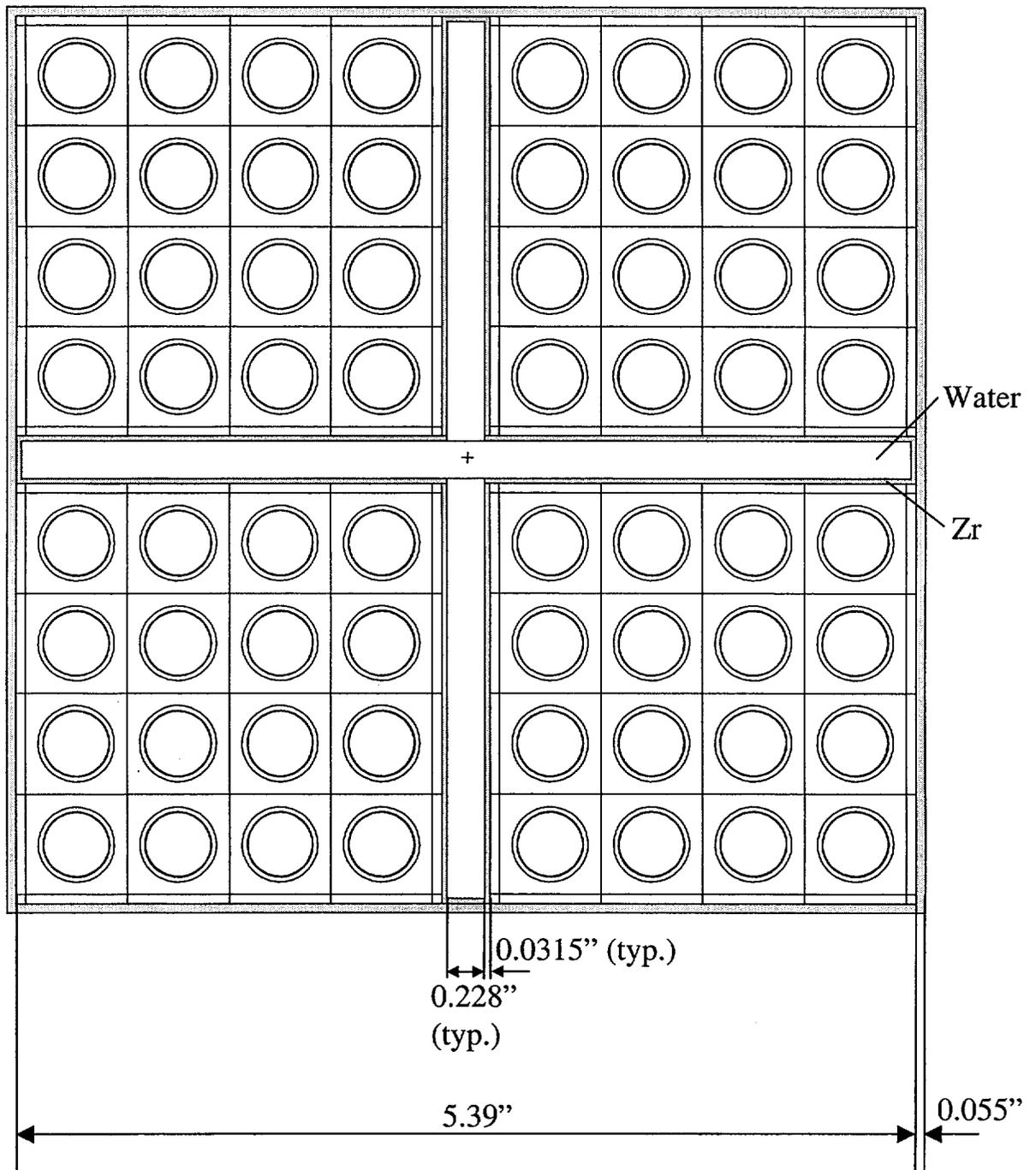
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{eq} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{eq} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{req} := \frac{S_{eq}}{\sigma_y} \qquad t_{req} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

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Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{M_x}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{M_y}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

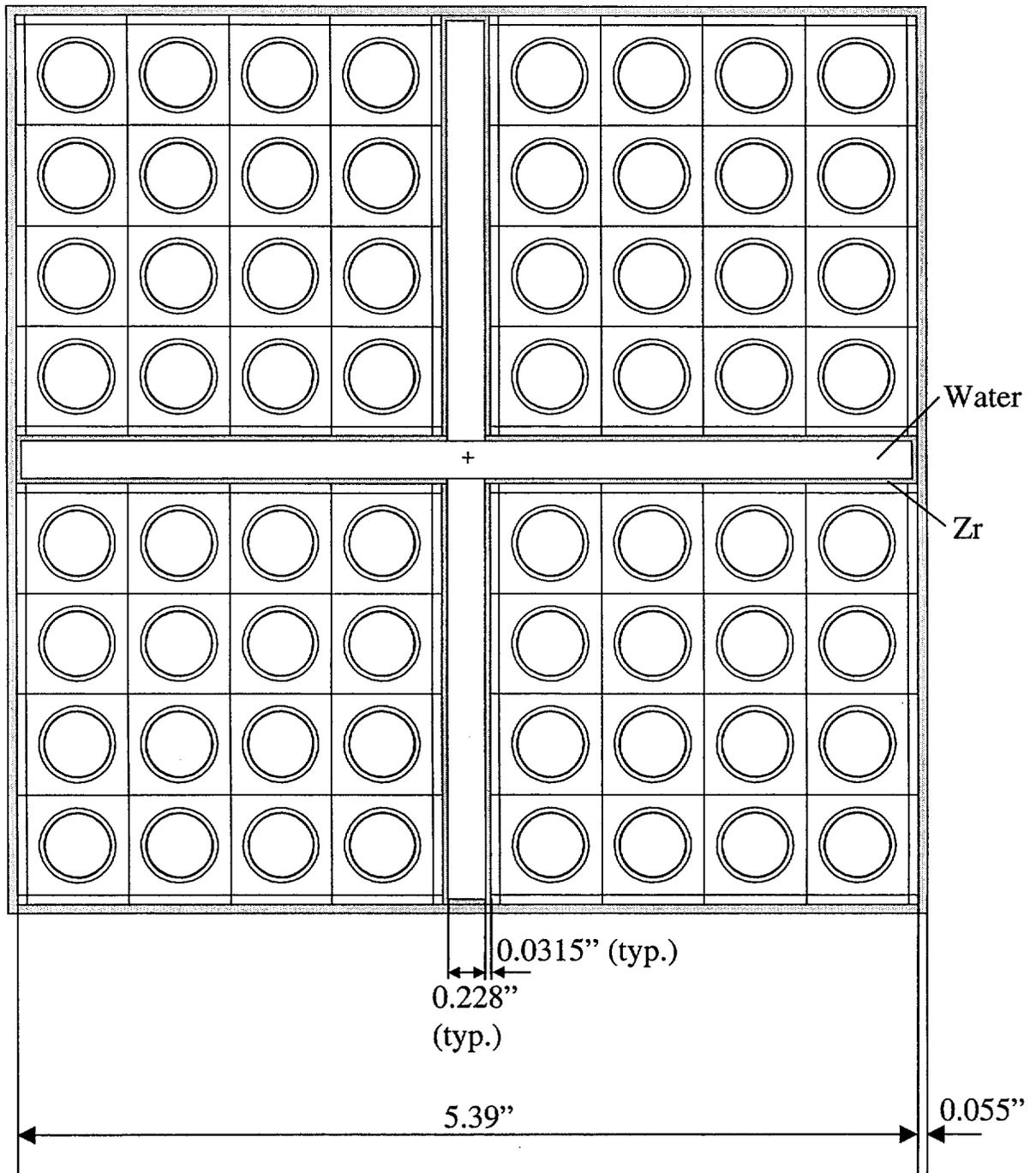
$$S_t := \frac{M_z \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{eq} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{eq} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{req} := \frac{S_{eq}}{\sigma_y} \qquad t_{req} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt. % $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{M_x}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{M_y}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

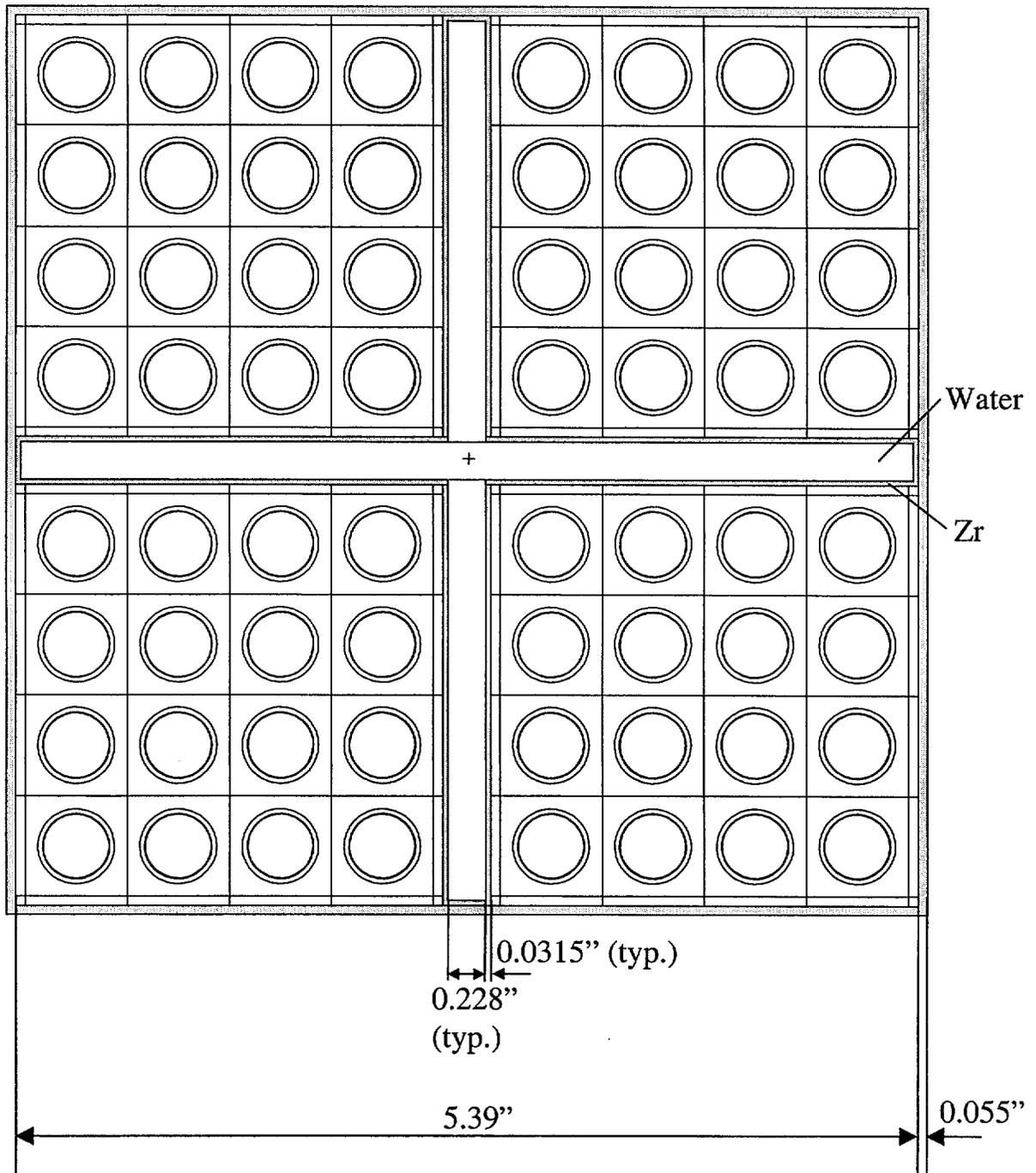
$$S_t := \frac{M_z \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{\text{eq}} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{\text{eq}} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{\text{req}} := \frac{S_{\text{eq}}}{\sigma_y} \qquad t_{\text{req}} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt.% $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

The direct shear force/unit throat thickness is determined as:

$$S_r := \frac{Fr}{A_{\text{weld}}}$$
$$S_r = 4.012 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The force/unit throat thickness at point D, which is farthest from the centroid of the weld group, due to the two bending moments is determined as:

$$S_{by} := \frac{M_x}{S_{xx}} \qquad S_{by} = 1.337 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_{bx} := \frac{M_y}{S_{yyb}} \qquad S_{bx} = 8.307 \times 10^4 \frac{\text{lbf}}{\text{in}}$$
$$S_b := S_{bx} + S_{by} \qquad S_b = 9.644 \times 10^4 \frac{\text{lbf}}{\text{in}}$$

The torsional force/unit of throat thickness at point D is determined as:

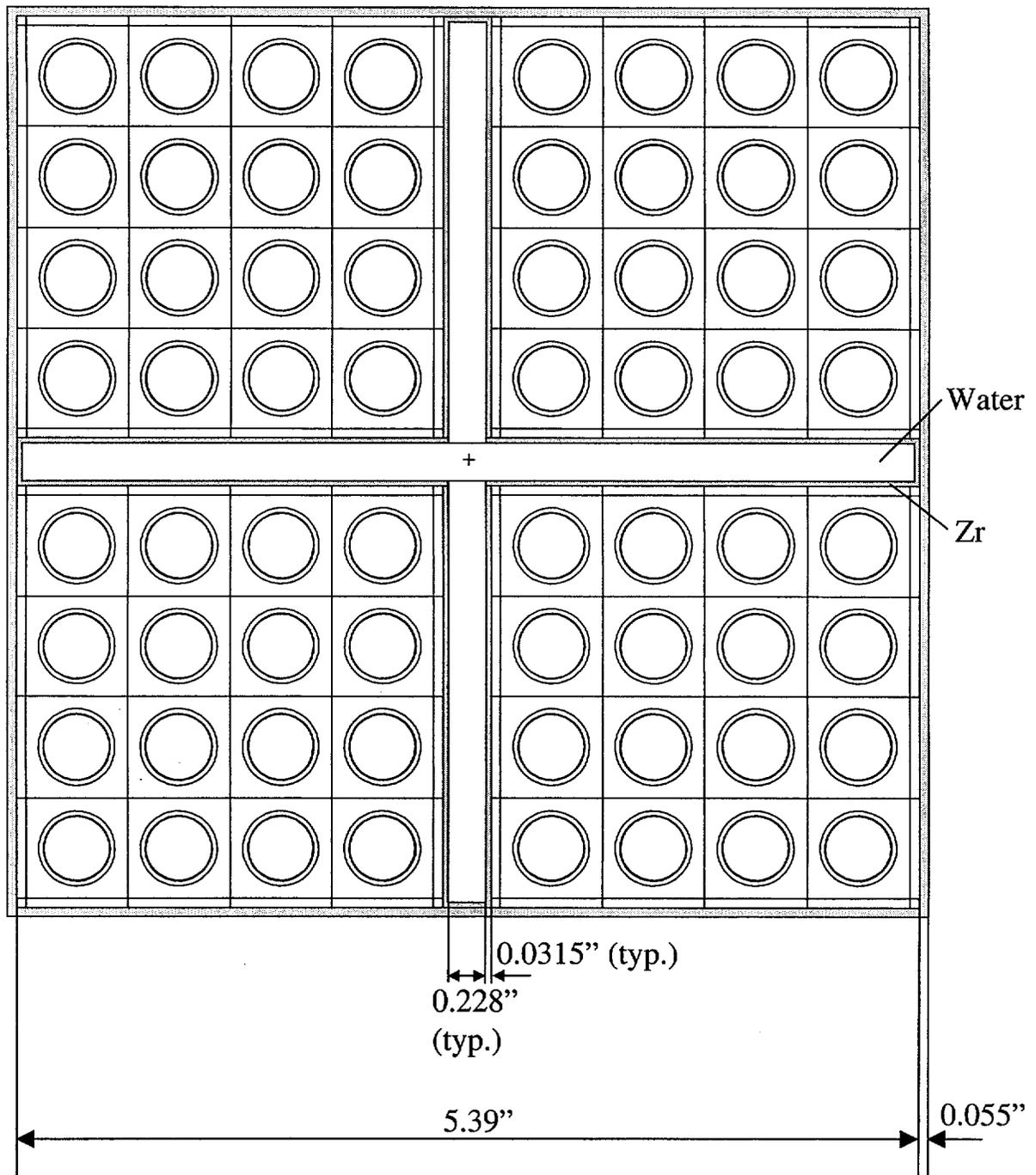
$$S_t := \frac{M_z \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{\text{lbf}}{\text{in}}$$

The net force/unit of weld throat thickness is computed as a root mean square

$$S_{\text{eq}} := \left[ S_b^2 + (S_r + S_t)^2 \right]^{0.5} \qquad S_{\text{eq}} = 1.074 \times 10^5 \frac{\text{lbf}}{\text{in}}$$

Dividing by the yield strength of the material yields a minimum required throat thickness

$$t_{\text{req}} := \frac{S_{\text{eq}}}{\sigma_y} \qquad t_{\text{req}} = 3.187 \text{ in}$$



MCNP Model of QUAD+ Assembly with Dimensions

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt. % $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC: Up to one (1) Dresden Unit 1 Thoria Rod Canister plus any ~~any~~ combination of damaged fuel assemblies in damaged fuel containers and intact fuel assemblies, up to a total of 68.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.

Appendix A-Certificate of Compliance No. 9261

Table A.1 (continued)  
Fuel Assembly Limits

III. MPC MODEL: MPC-68F (continued)

7. Thoria rods ( $\text{ThO}_2$  and  $\text{UO}_2$ ) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:

a. Cladding Type:	Zircaloy (Zr)
b. Composition:	98.2 wt. % $\text{ThO}_2$ , 1.8 wt. % $\text{UO}_2$ with an enrichment of 93.5 wt. % $^{235}\text{U}$ .
c. Number of Rods Per Thoria Rod Canister:	$\leq 18$
d. Decay Heat Per Thoria Rod Canister:	$\leq 115$ Watts
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	A fuel post-irradiation cooling time $\geq 18$ years and an average burnup $\leq 16,000$ MWD/MTIHM.
f. Initial Heavy Metal Weight:	$\leq 27$ kg/canister
g. Fuel Cladding O.D.:	$\geq 0.412$ inches
h. Fuel Cladding I.D.:	$\leq 0.362$ inches
i. Fuel Pellet O.D.:	$\leq 0.358$ inches
j. Active Fuel Length:	$\leq 111$ inches
k. Canister Weight:	$\leq 550$ lbs, including fuel

B. Quantity per MPC:

Up to four (4) damaged fuel containers containing uranium oxide or MOX BWR fuel debris. The remaining MPC-68F fuel storage locations may be filled with array/class 6x6A, 6x6B, 6x6C, 7x7A, and 8x8A fuel assemblies of the following type, as applicable:

1. Uranium oxide BWR intact fuel assemblies;
2. MOX BWR intact fuel assemblies;
3. Uranium oxide BWR damaged fuel assemblies placed in damaged fuel containers; or
4. MOX BWR damaged fuel assemblies placed in damaged fuel containers; or
5. Up to one (1) Dresden Unit 1 Thoria Rod Canister.

C. Fuel assemblies with stainless steel channels are not authorized for loading in the MPC-68F.

D. Dresden Unit 1 fuel assemblies with one Antimony-Beryllium neutron source are authorized for loading in the MPC-68. The Antimony-Beryllium neutron source material shall be in a water rod location.