71-9261

HOLTEC INTERNATIONAL

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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)

NMSS01 Public

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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:

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

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

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:

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

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

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

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

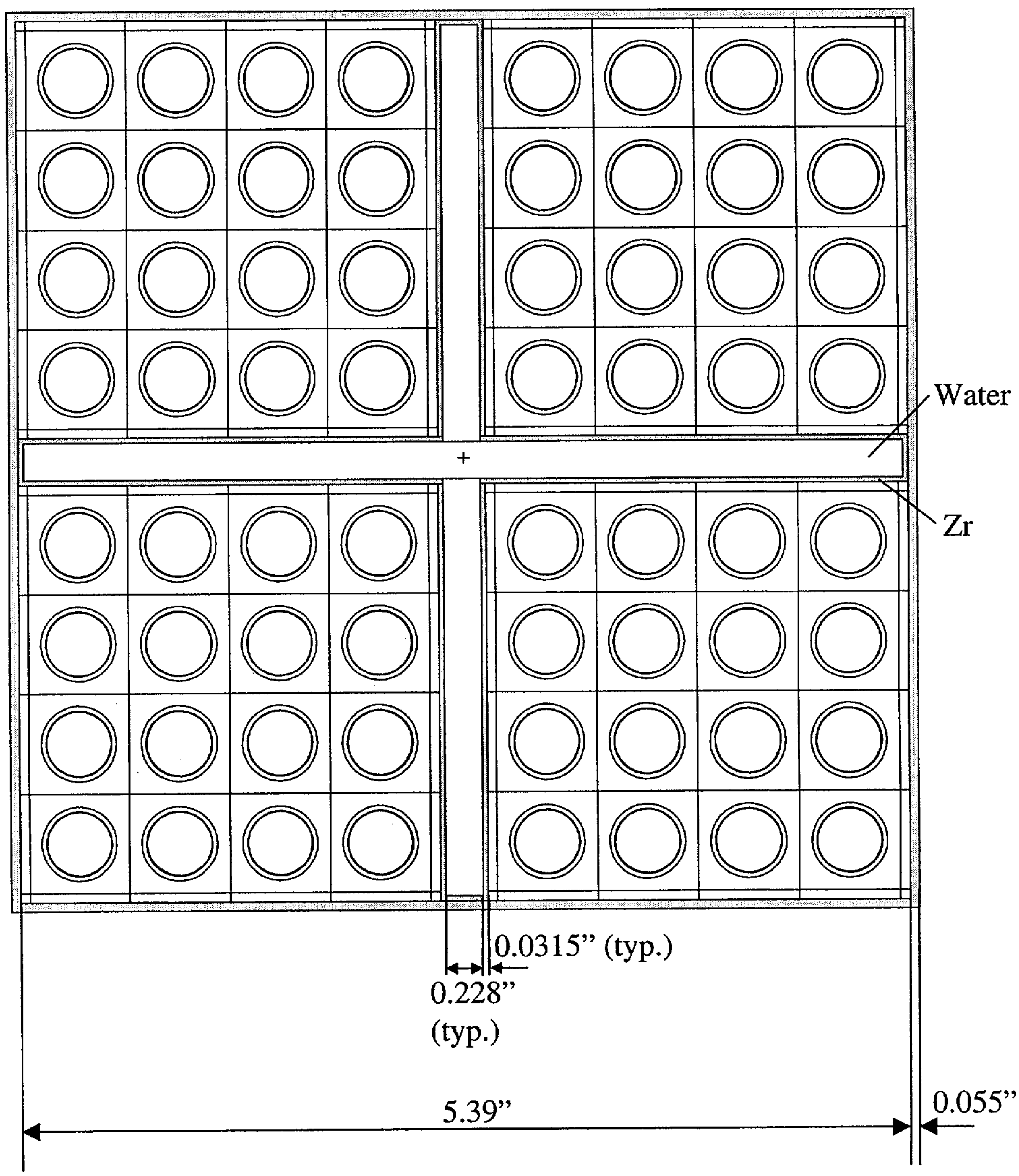
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

Table A.1 (continued)
Fuel Assembly Limits

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

7. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.*

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

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

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

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:

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

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

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

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

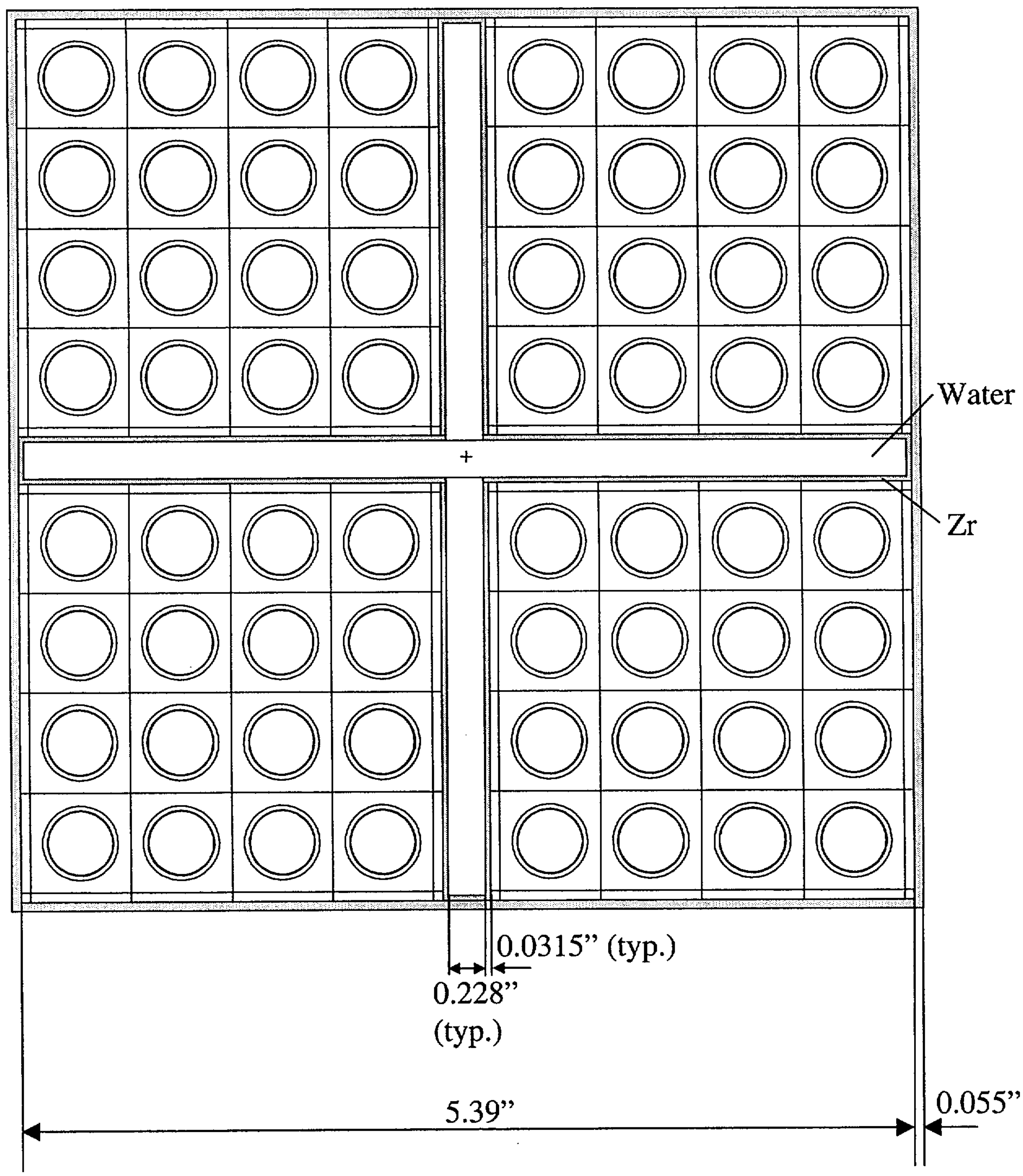
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

Table A.1 (continued)
Fuel Assembly Limits

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

7. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

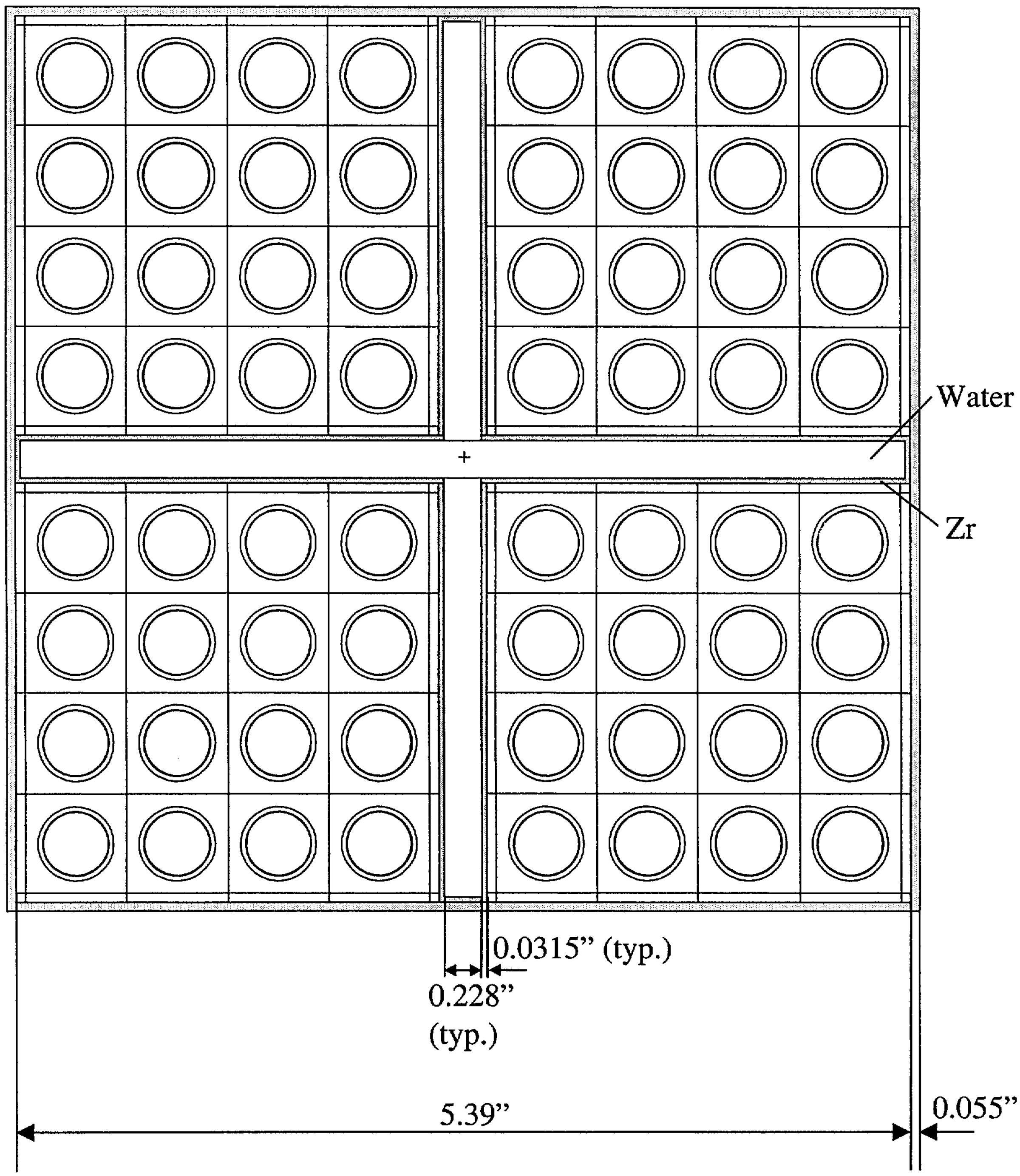
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

Table A.1 (continued)
Fuel Assembly Limits

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

7. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

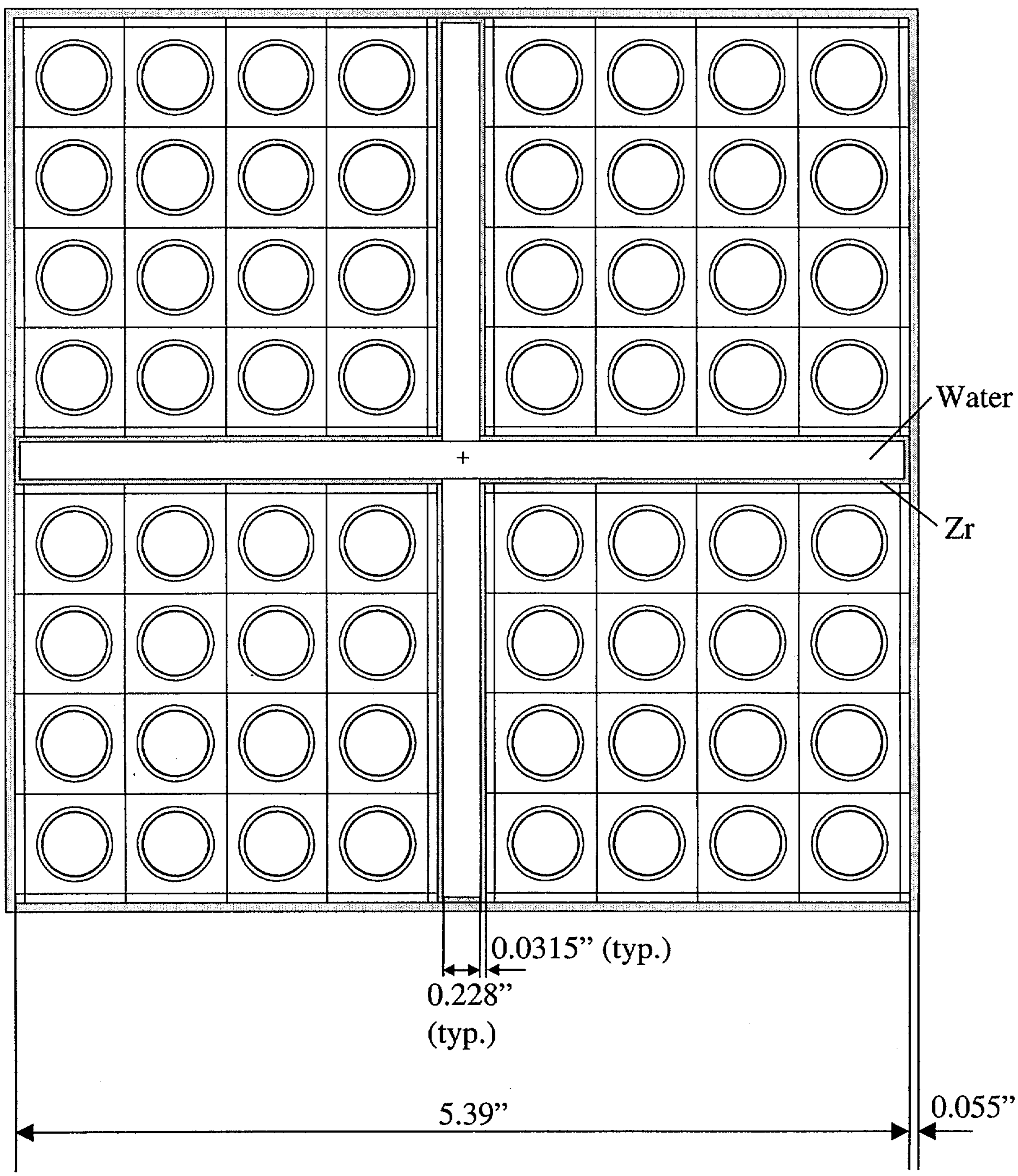
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.*

Table A.1 (continued)
Fuel Assembly Limits

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

7. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

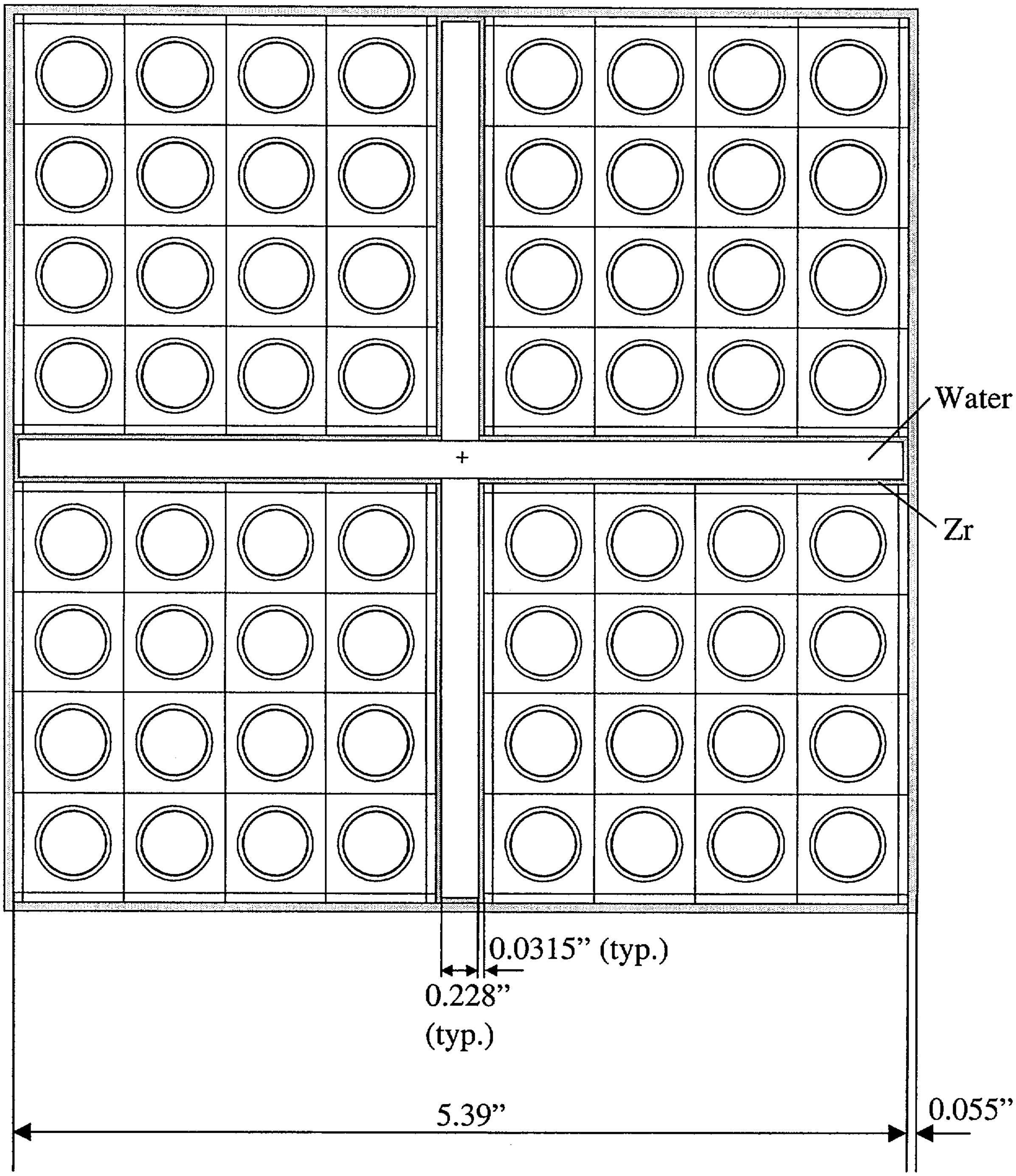
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and UO_2) placed in Dresden Unit 1 Thoria Rod Canisters and meeting the following specifications:*

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b. Composition:	*98.2 wt.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}U.*
c. Number of Rods Per Thoria Rod Canister:	*≤ 18*
d. Decay Heat Per Thoria Rod Canister:	*≤ 115 Watts*
e. Post-irradiation Fuel Cooling Time and Average Burnup Per Thoria Rod Canister:	*A fuel post-irradiation cooling time ≥ 18 years and an average burnup ≤ 16,000 MWD/MTIHM.*
f. Initial Heavy Metal Weight:	*≤ 27 kg/canister*
g. Fuel Cladding O.D.:	*≥ 0.412 inches*
h. Fuel Cladding I.D.:	*≤ 0.362 inches*
i. Fuel Pellet O.D.:	*≤ 0.358 inches*
j. Active Fuel Length:	*≤ 111 inches*
k. Canister Weight:	*≤ 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-Berylium neutron source material shall be in a water rod location.*

Table A.1 (continued)
Fuel Assembly Limits

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

7. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

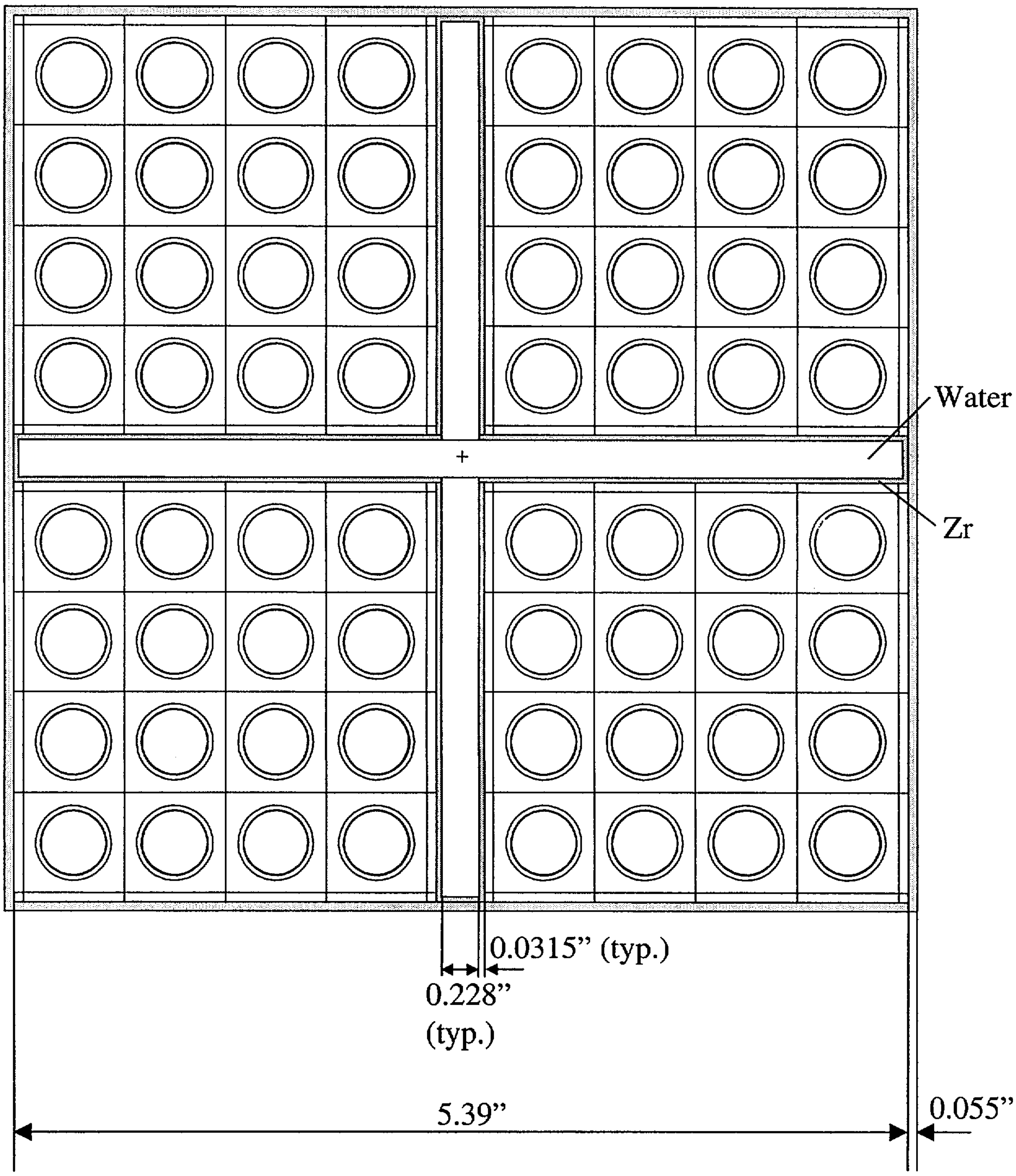
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

Table A.1 (continued)
Fuel Assembly Limits

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

7. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

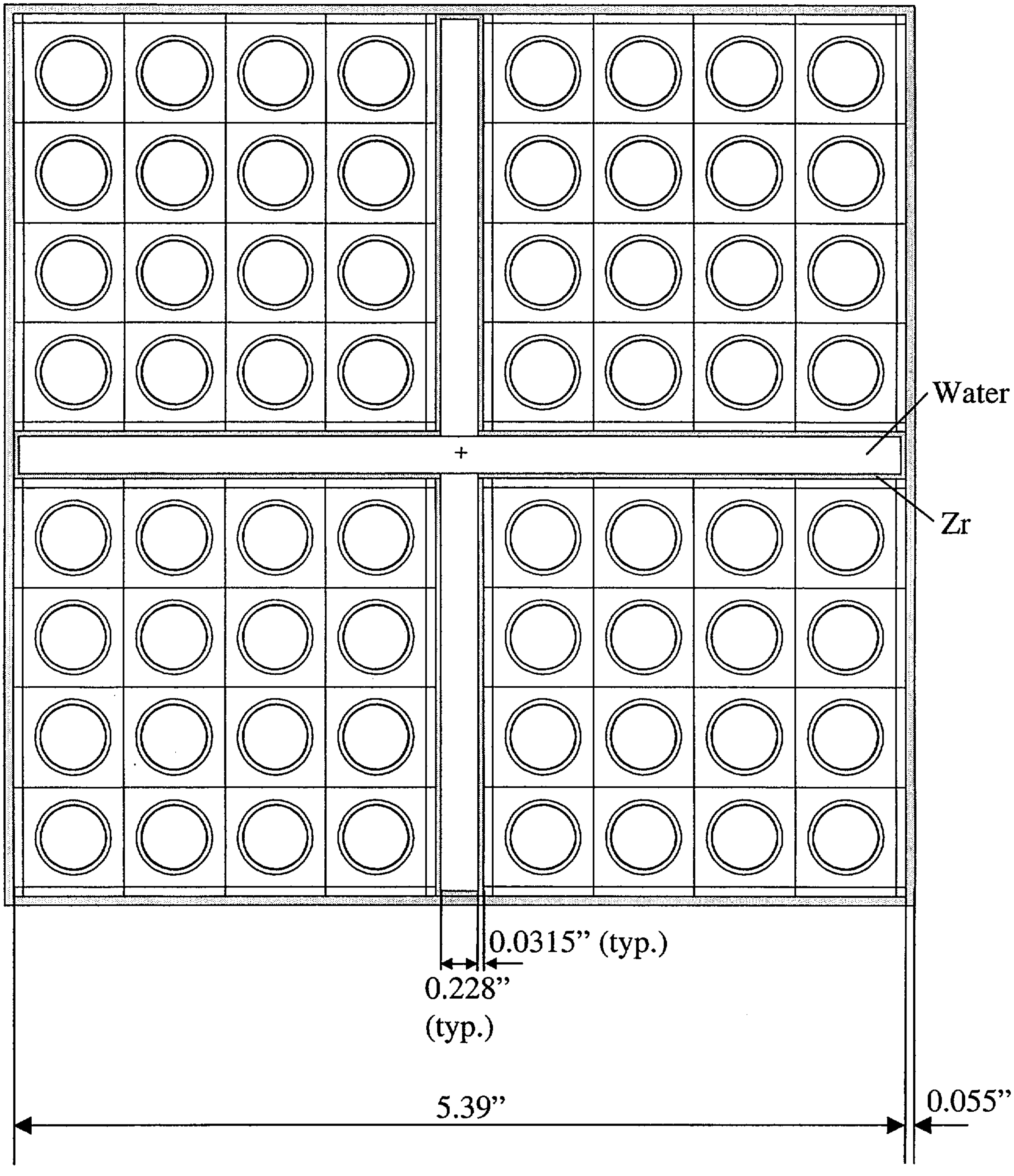
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.*

Table A.1 (continued)
Fuel Assembly Limits

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

7. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

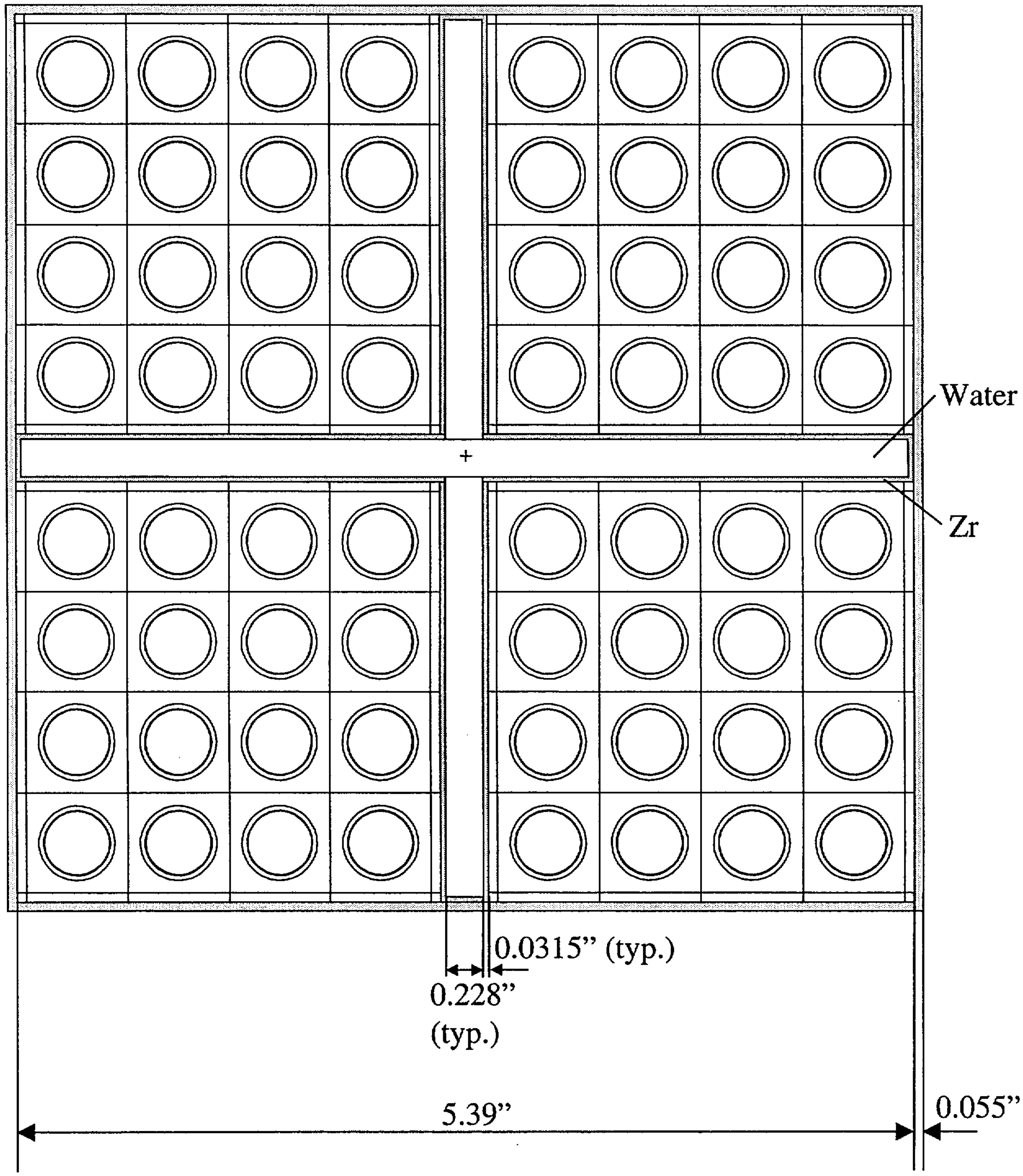
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

Table A.1 (continued)
Fuel Assembly Limits

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

7. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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:

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

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

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:

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

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

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

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

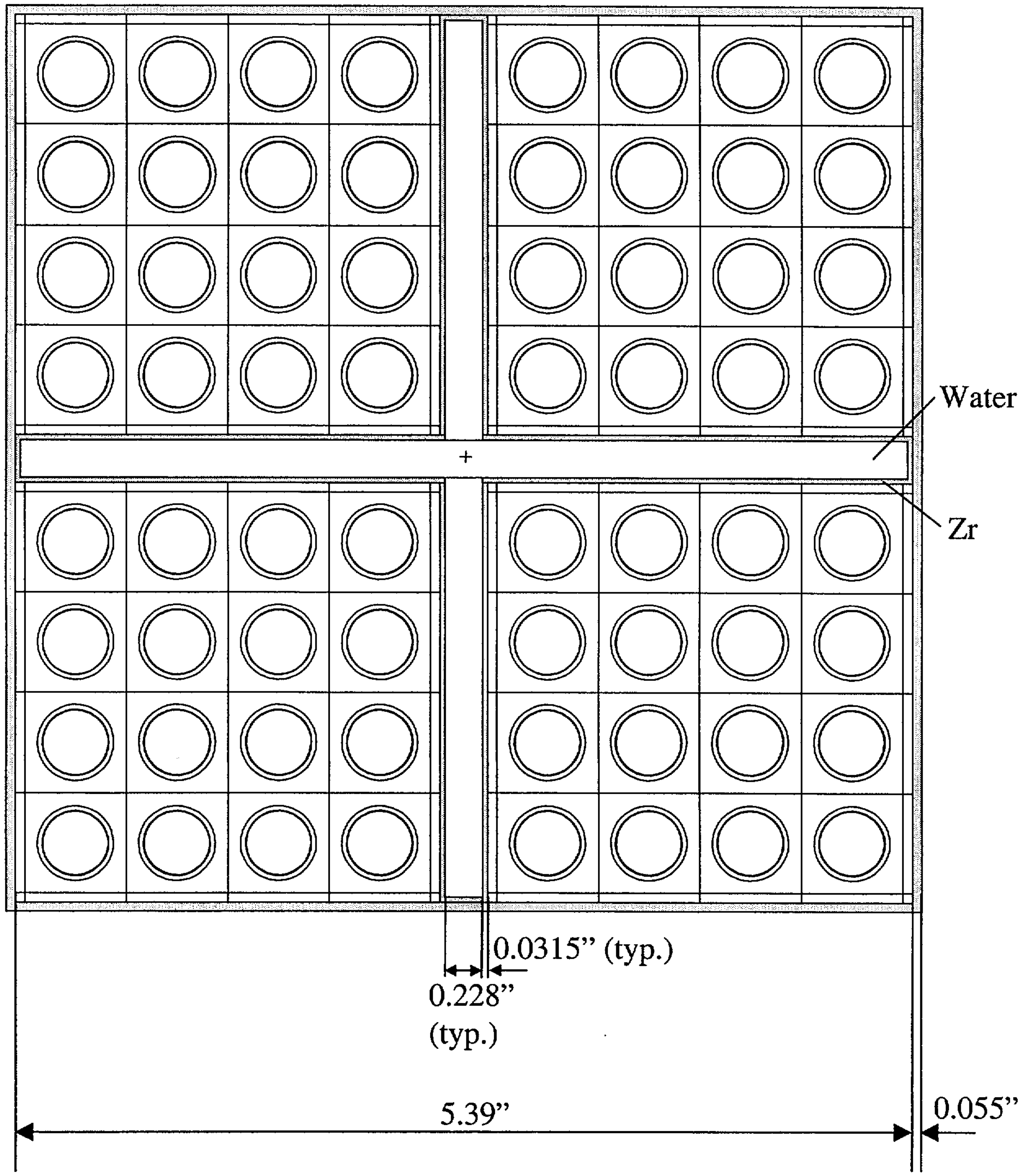
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

Table A.1 (continued)
Fuel Assembly Limits

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

7. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.

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

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

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

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:

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

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

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

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

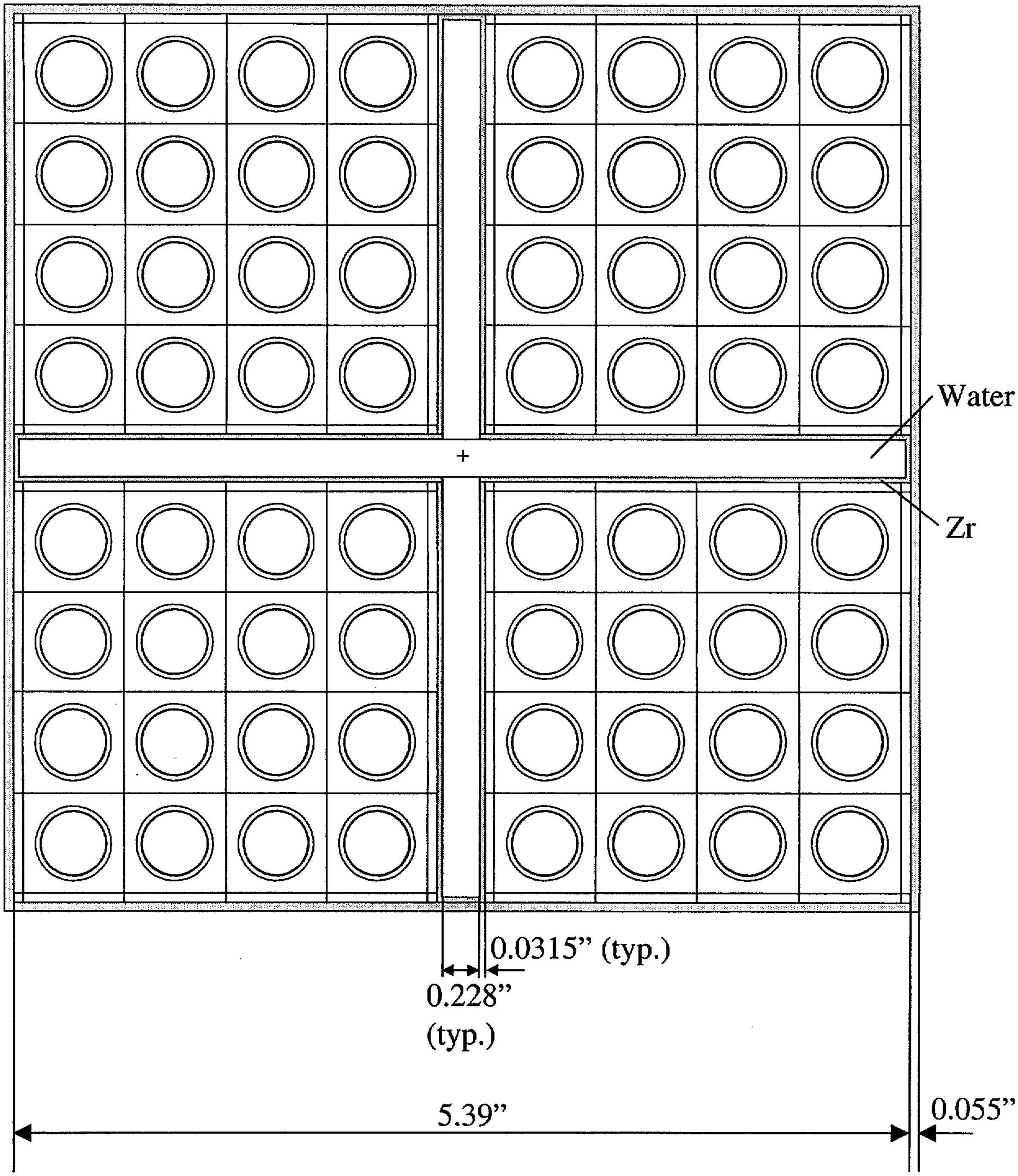
$$S_t := \frac{Mz \cdot \frac{w}{2}}{J_w} \qquad S_t = 7.148 \times 10^3 \frac{lbf}{in}$$

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

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

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

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



MCNP Model of QUAD+ Assembly with Dimensions

Table A.1 (continued)
Fuel Assembly Limits

II. MPC MODEL: MPC-68 (continued)

5. *Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.*

Table A.1 (continued)
Fuel Assembly Limits

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

7. Thoria rods (ThO_2 and 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.% ThO_2, 1.8 wt. % UO_2 with an enrichment of 93.5 wt. % ^{235}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-Berylium neutron source material shall be in a water rod location.