Stress Intensity Factor Influence Coefficients for External Surface Flaws in Boiling Water Reactor Pressure Vessels

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Generalize FAVOR Code to Include BWRs and Heat-up Transients



PWR vessels in the US have internal radius to wall thickness (*R*_i/*t*) ratio approximately 10;

BWR vessels in the US have *Rilt* ratio between 15 and 20;

Previous versions of FAVOR has been developed for PWRs subjected to PTS;

The NRC is performing work to enable a risk-informed revision to the requirements of 10CFR50 Appendix G, which provides operational limits for scheduled transients, including cool-down and heat-up transients.



SIFICs for Boiling Water Reactor Pressure Vessels



Complete SIFIC database have been developed for three flaw geometries often utilized in fracture analyses of BWR pressure vessels subjected to heat-up transients:

> Semi-elliptical finite-length external surface flaws with aspect ratio (*L/a*) of 2, 6, and 10;
> infinite-length axial external surface flaws;

360° circumferential external surface flaws.



Mode I Stress-Intensity Factors



For the cracked structure under LEFM conditions, the singular stress field in the vicinity of the crack tip can be characterized by a single parameter. This one-parameter model has the form

$$\sigma_{\theta\theta} = \frac{K_I}{\sqrt{2\pi r}} \text{ for axial flaws}$$
$$\sigma_{zz} = \frac{K_I}{\sqrt{2\pi r}} \text{ for circumferential flaws}$$

The stress intensity factor, *K*_i, can be calculated by a linear superposition technique.



Semi-elliptic Finite-Length Surface Flaws



Influence coefficients, K^* , have been calculated for finite-length semielliptical external-surface flaws with aspect ratios L/a = 2, 6, and 10 for *BWRs*.



Linear Superposition Technique Used to determine finite-length 3D flaw SIFICs



Crack-surface Loading Cases for determining finitelength 3D flaw SIFICs:

Uniform unit load









Finite-element Model for an External Finite-length Axial Flaw





Influence Coefficients for Outside Axial Surface Crack: Rilt=20, and alt=0.1

Aspect Ratio = 2:1

K2 K0 **K1 K**3 Φ (Uniform) (Linear) (Quad) (Cubic) 0.6919 0.1113 0.0429 0.0227 0.0 3.9 0.7084 0.1348 0.0506 0.0263 12.1 0.6805 0.1711 0.0644 0.0318 21.1 0.6548 0.2126 0.0894 0.0442 31.1 0.6475 0.2640 0.1311 0.0717 42.1 0.6520 0.3233 0.1910 0.1209 47.9 0.6347 0.3437 0.2193 0.1487 60.7 0.6196 0.3848 0.2813 0.2180 67.8 0.6954 0.4666 0.3639 0.3000 74.8 0.6548 0.4487 0.3609 0.3077 90.0 0.6077 0.4386 0.3676 0.3257

K3 (Uniform) (Linear) (Quad) (Cubic) 0.5023 0.0784 0.0277 0.0137 0.5173 0.0940 0.0319 0.0152 16.1 0.5119 0.1256 0.0440 0.0196 22.6 0.5912 0.1680 0.0642 0.0293

K2

Aspect Ratio = 6:1

K1

31.3 0.6510 0.2237 0.0990 0.0495

45.1 0.7408 0.3202 0.1757 0.1058

52.5 0.7618 0.3627 0.2187 0.1443

60.6 0.8075 0.4146 0.2704 0.1930

75.7 0.8474 0.4774 0.3424 0.2689

82.6 0.8625 0.4959 0.3632 0.2916

90.0 0.8727 0.5056 0.3734 0.3023

K0

Φ

0.0

5.7

Aspect Ratio = 10:1

Φ	K0 (Uniform)	K1 (Linear)	K2 (Quad)	K3 (Cubic)
0.0	0.1918	0.0152	0.0048	0.0023
5.3	0.5177	0.0708	0.0202	0.0086
11.3	0.5329	0.0997	0.0281	0.0108
21.3	0.6157	0.1645	0.0567	0.0227
31.0	0.7411	0.2512	0.1083	0.0519
40.7	0.8261	0.3390	0.1757	0.0996
47.7	0.8667	0.3966	0.2290	0.1441
60.7	0.9581	0.5088	0.3421	0.2511
70.6	0.9834	0.5602	0.4052	0.3204
81.6	1.0127	0.6023	0.4554	0.3767
90.0	1.0142	0.6097	0.4661	0.3899



⁸ Managed by UT-Battelle

Influence coefficients, K^{*}, have been calculated for finite-length semielliptical external-surface flaws with relative flaw depths of a/t = 0.1, 0.2,0.3, 0.4, and 0.5 (with *L/a* = 2, 6, and 10), $R_{i}/t = 20$.

External Infinite-Length Surface Flaws



360° circumferential flaw on external surface



Influence coefficients, *K**, have been calculated for axial and circumferential infinite-length external-surface flaws for *BWRs*.



Linear Superposition Technique Used to Determine Infinite-length Flaw SIFICs



Influence coefficients, K*, represent stress intensity factor per unit load applied to the crack face.



Finite-element Models for External Infinite-length Flaws in BWR



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Influence Coefficients for External Axial Infinite Surface Crack in BWR

a'/a	a/T = 0.01	a'/a	a/T = 0.02	a'/a	a/T = 0.03	a'/a	a/T = 0.05	a'/a	a/T = 0.075
0.1263	1.3469	0.1156	1.0302	0.1156	0.8553	0.1380	0.6756	0.1517	0.5716
0.2364	1.3512	0.2312	1.0283	0.2313	0.8533	0.2759	0.6740	0.3034	0.5686
0.3468	1.3614	0.3469	1.0311	0.3469	0.8550	0.4138	0.6784	0.4578	0.5722
0.4048	1.3788	0.4304	1.0418	0.4532	0.8652	0.5286	0.6937	0.5783	0.5896
0.4591	1.3986	0.5042	1.0612	0.5428	0.8873	0.6212	0.7223	0.6723	0.6198
0.5100	1.4241	0.5696	1.0880	0.6184	0.9195	0.6960	0.7621	0.7456	0.6630
0.5578	1.4559	0.6274	1.1236	0.6822	0.9628	0.7563	0.8139	0.8028	0.7192
0.6026	1.4950	0.6786	1.1686	0.7360	1.0173	0.8051	0.8777	0.8474	0.7886
0.6445	1.5433	0.7239	1.2231	0.7814	1.0831	0.8444	0.9543	0.8823	0.8726
0.6838	1.5990	0.7640	1.2883	0.8197	1.1615	0.8762	1.0449	0.9094	0.9728
0.7207	1.6673	0.7994	1.3645	0.8520	1.2531	0.9019	1.1510	0.9306	1.0919
0.7553	1.7463	0.8308	1.4544	0.8792	1.3608	0.9226	1.2754	0.9472	1.2327
0.7877	1.8401	0.8586	1.5606	0.9022	1.4871	0.9393	1.4209	0.9601	1.4009
0.8181	1.9541	0.8831	1.6866	0.9217	1.6360	0.9528	1.5926	0.9701	1.6021
0.8465	2.0900	0.9049	1.8383	0.9380	1.8144	0.9637	1.7973	0.9780	1.8481
0.8732	2.2602	0.9241	2.0244	0.9518	2.0304	0.9725	2.0431	0.9841	2.1520
0.8981	2.4752	0.9412	2.2602	0.9635	2.3007	0.9796	2.3475	0.9889	2.5434
0.9218	2.7633	0.9562	2.5684	0.9733	2.6478	0.9853	2.7357	0.9926	3.0699
0.9437	3.1684	0.9696	3.0016	0.9816	3.1242	0.9900	3.2525	0.9955	3.8377
0.9644	3.8153	0.9813	3.6754	0.9886	3.8383	0.9937	3.9987	0.9978	5.1601
0.9835	5.0853	0.9917	4.9976	0.9945	5.1216	0.9967	5.2431	1.0000	12.6594
1.0000	12.7060	1.0000	12.6985	1.0000	12.6924	1.0000	12.6879		
a'/a	a/T = 0.1	a'/a	a/T = 0.2	a'/a	a/T = 0.3	a'/a	a/T = 0.4	a'/a	a/T = 0.5
a'/a 0.1263	a/T = 0.1 0.5175	a'/a 0.1735	a/T = 0.2 0.4653	a'/a 0.1735	a/T = 0.3 0.5156	a'/a 0.0884	a/T = 0.4 0.6402	a'/a 0.2056	a/T = 0.5 0.8074
a'/a 0.1263 0.2366	a/T = 0.1 0.5175 0.5135	a'/a 0.1735 0.3469	a/T = 0.2 0.4653 0.4503	a'/a 0.1735 0.3469	a/T = 0.3 0.5156 0.4859	a'/a 0.0884 0.1769	a/T = 0.4 0.6402 0.6137	a'/a 0.2056 0.3581	a/T = 0.5 0.8074 0.7194
a'/a 0.1263 0.2366 0.3469	<i>a/T</i> = 0.1 0.5175 0.5135 0.5118	a'/a 0.1735 0.3469 0.5322	a/T = 0.2 0.4653 0.4503 0.4415	a'/a 0.1735 0.3469 0.5323	a/T = 0.3 0.5156 0.4859 0.4596	a'/a 0.0884 0.1769 0.2653	a/T = 0.4 0.6402 0.6137 0.5874	a'/a 0.2056 0.3581 0.5105	a/T = 0.5 0.8074 0.7194 0.6468
a'/a 0.1263 0.2366 0.3469 0.4991	a/T = 0.1 0.5175 0.5135 0.5118 0.5161	a'/a 0.1735 0.3469 0.5322 0.6649	a/T = 0.2 0.4653 0.4503 0.4415 0.4475	a'/a 0.1735 0.3469 0.5323 0.6651	a/T = 0.3 0.5156 0.4859 0.4596 0.4465	a'/a 0.0884 0.1769 0.2653 0.4739	a/T = 0.4 0.6402 0.6137 0.5874 0.5450	a'/a 0.2056 0.3581 0.5105 0.6248	a/T = 0.5 0.8074 0.7194 0.6468 0.5869
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692 0.5035	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122	a/T = 0.2 0.4653 0.4503 0.4415 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302	a'a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4465 0.4500 0.4692 0.5035 0.5533	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717 0.4840	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8688	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373	a/T = 0.2 0.4653 0.4503 0.4415 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4465 0.4500 0.4692 0.5035 0.5533 0.6196	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717 0.4840 0.5121	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8688 0.9001	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553	a/T = 0.2 0.4653 0.4503 0.4415 0.4415 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692 0.5035 0.5533 0.6196 0.7044	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717 0.4840 0.5121 0.5563	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8280 0.8688 0.9001 0.9242	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684	a/T = 0.3 0.5156 0.4859 0.4596 0.4500 0.4692 0.5035 0.5533 0.6196 0.7044 0.8105	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717 0.4840 0.5121 0.5563 0.6175	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7769 0.7749 0.8280 0.8688 0.9001 0.9242 0.9427	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9124 0.9375 0.9555 0.9684 0.9777	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8072 0.8022 0.9017 0.9299 0.9502 0.9647	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717 0.4840 0.5121 0.5563 0.6175 0.6979	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8688 0.9001 0.9242 0.9242 0.9242	a/T = 0.1 0.5175 0.5135 0.5135 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331 1.1745	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4692 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.92502 0.9647 0.9751	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4717 0.4840 0.5121 0.5563 0.6175 0.6979 0.8003	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8688 0.9001 0.9242 0.92427 0.9569 0.9678	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6062 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9888	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036 1.3036	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9502 0.9647 0.9751 0.9826	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4761 0.4717 0.4840 0.5121 0.5563 0.6175 0.6979 0.8003 0.9293	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7749 0.8280 0.8688 0.9001 0.9242 0.9427 0.9569 0.9678 0.9762	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9888 0.9922	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036 1.5530	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879	a/T = 0.4 0.6402 0.6137 0.5874 0.4994 0.4761 0.4944 0.4717 0.4840 0.5121 0.4840 0.5121 0.5563 0.6175 0.6979 0.8003 0.9293 1.0915	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6320 0.6320 0.6926 0.7724 0.8737
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7749 0.8280 0.8688 0.9001 0.9242 0.9427 0.9569 0.9678 0.9762 0.9827	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474 1.7958	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9848 0.9922 0.9946	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613 2.2290	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9841 0.9825 0.9949	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.4692 0.55035 0.55035 0.6196 0.7044 0.8105 0.9418 1.1036 1.3036 1.3530 1.8671	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4747 0.4840 0.5121 0.5563 0.6175 0.6079 0.8003 0.9293 1.0915 1.2967	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831 0.9879	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724 0.8737 1.0035
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8280 0.8688 0.9001 0.9242 0.9427 0.9569 0.9678 0.9762 0.9827 0.9827	a/T = 0.1 0.5175 0.5135 0.5138 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474 1.7958 2.1054	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9682 0.9774 0.9840 0.9888 0.9922 0.9946 0.9964	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613 2.2290 2.6927	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9655 0.9684 0.9777 0.9843 0.9891 0.9925 0.9949 0.9949 0.9967	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4650 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036 1.5530 1.8671 2.2765	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917 0.9945	a/T = 0.4 0.6402 0.6137 0.5874 0.4994 0.4761 0.4717 0.4840 0.5121 0.5563 0.6175 0.6979 0.8003 0.9293 1.2967 1.2668	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831 0.9879 0.9916	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724 0.8737 1.0035 1.1734
a'/a 0.1263 0.2366 0.3469 0.4991 0.6169 0.7749 0.8280 0.8688 0.9001 0.92427 0.9569 0.9678 0.9678 0.9762 0.9876 0.9876 0.9815	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474 1.7958 2.1054 2.5013	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9888 0.9922 0.9946 0.9964 0.9976	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613 2.2290 2.6927 3.2976	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925 0.9949 0.9949 0.9979	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4650 0.5035 0.5033 0.6196 0.7044 0.8105 1.3036 1.3036 1.3036 1.8671 1.8671	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9875 0.9945 0.9945	a/T = 0.4 0.6402 0.6137 0.5874 0.4994 0.4761 0.4717 0.4840 0.5121 0.5121 0.6175 0.6979 0.8003 0.9293 1.0915 1.2967 1.5608 1.9109	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831 0.9879 0.9916 0.9945	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724 0.8737 1.0035 1.1734 1.4053
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.8280 0.8688 0.9001 0.92422 0.9427 0.9569 0.9678 0.9762 0.9876 0.9915 0.9944	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6062 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474 1.7958 2.1054 2.5013 3.0366	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9888 0.9922 0.9946 0.9964 0.9965	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613 2.2990 2.6927 3.2976 4.1276	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925 0.9949 0.9967 0.9988	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4502 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036 1.3036 1.5530 1.8671 2.2765 2.8327 3.6491	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917 0.9945 0.9945	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4761 0.47717 0.4840 0.5121 0.5121 0.5121 0.6175 0.6075 0.8003 0.9293 1.0915 1.2967 1.5608 1.9109 2.4037	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831 0.9879 0.9916 0.9945 0.9967	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724 0.8737 1.0035 1.1734 1.4053 1.7463
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7059 0.7749 0.8280 0.8688 0.9001 0.9242 0.9427 0.9569 0.9678 0.9762 0.9827 0.9876 0.9944 0.9944 0.9944	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.60622 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474 1.7958 2.1054 2.5013 3.0366 3.8108	a'a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9840 0.9848 0.9922 0.9946 0.9965 0.9995 0.9992	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613 2.2990 2.6927 3.2976 4.1276 5.3602	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925 0.9943 0.9925 0.9948 0.9979 0.9988 0.9994	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4500 0.5035 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036 1.1036 1.8530 1.8671 2.27655 2.8327 3.6491 5.0438	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917 0.9945 0.9945 0.9964	a/T = 0.4 0.6402 0.6137 0.5874 0.5450 0.4994 0.4761 0.4761 0.4747 0.4840 0.5121 0.5563 0.6175 0.6979 0.8003 0.9293 1.0915 1.2967 1.5608 1.9109 2.4037 3.1720	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831 0.9879 0.9916 0.9945 0.9945 0.9984	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724 0.8737 1.0035 1.1734 1.4053 1.7463 2.3293 2.3293
a'/a 0.1263 0.2366 0.3469 0.4991 0.6160 0.7749 0.8280 0.8280 0.9001 0.9242 0.9427 0.9569 0.9678 0.9762 0.9876 0.9876 0.9915 0.9944	a/T = 0.1 0.5175 0.5135 0.5118 0.5161 0.5338 0.5640 0.6068 0.6622 0.7310 0.8143 0.9141 1.0331 1.1745 1.3438 1.5474 1.7958 2.1054 2.5013 3.0366 3.8108 5.1461	a'/a 0.1735 0.3469 0.5322 0.6649 0.7601 0.8283 0.8772 0.9122 0.9373 0.9553 0.9682 0.9774 0.9840 0.9888 0.9922 0.9946 0.9964 0.9964 0.9964 0.9985 0.9992 1.0000	a/T = 0.2 0.4653 0.4503 0.4415 0.4475 0.4694 0.5071 0.5603 0.6302 0.7186 0.8280 0.9620 1.1253 1.3237 1.5648 1.8613 2.2290 2.6927 3.2976 4.1276 5.3602 12.6576	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9843 0.9891 0.9925 0.9949 0.9979 0.9988 0.9994 1.0000	a/T = 0.3 0.5156 0.4859 0.4596 0.4465 0.4652 0.5035 0.5533 0.6196 0.7044 0.8105 0.9418 1.1036 1.3036 1.5530 1.8671 2.2765 2.8327 3.6491 12.6841	a'/a 0.0884 0.1769 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9879 0.9879 0.9945 0.9979 0.9989 0.9996	a/T = 0.4 0.6402 0.6137 0.5874 0.5874 0.4994 0.4761 0.4717 0.4840 0.5121 0.5563 0.6175 0.6979 0.8003 0.9293 1.0915 1.2967 1.5608 1.9109 2.4037 3.1720 4.6883	a'/a 0.2056 0.3581 0.5105 0.6248 0.7126 0.7801 0.8319 0.8717 0.9024 0.9259 0.9440 0.9579 0.9685 0.9768 0.9831 0.9879 0.9946 0.9944 0.9997	a/T = 0.5 0.8074 0.7194 0.6468 0.5869 0.5466 0.5217 0.5102 0.5110 0.5232 0.5467 0.5820 0.6300 0.6926 0.7724 0.8737 1.0035 1.1734 1.4053 1.7463 2.3293 3.8709

12 Managed by UT-Battelle for the Department of Energy Influence coefficients, *K**, have been calculated for infinite-length axial external-surface flaws with relative flaw depths of a/t = 0.01, 0.02, 0.03, 0.05, 0.075, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9,and 0.95, R/t = 20.



Influence Coefficients for External 360° Circumferential Surface Crack in BWR

a'/a	a/T = 0.01	a'/a	a/T = 0.02	a'/a	a/T = 0.03	a'/a	a/T = 0.05	a'/a	a/T = 0.075
0.0884	0.9212	0.1156	0.7587	0.1156	0.6466	0.1030	0.5163	0.1156	0.4360
0.1769	0.9306	0.2312	0.7599	0.2313	0.6466	0.2061	0.5161	0.2313	0.4343
0.2653	0.9404	0.3469	0.7644	0.3469	0.6491	0.3092	0.5167	0.3469	0.4341
0.3306	0.9512	0.4414	0.7748	0.4531	0.6571	0.4122	0.5205	0.4663	0.4379
0.3919	0.9661	0 5230	0 7950	0.5427	0 6752	0.5194	0.5303	0 5644	0 4497
0 4494	0 9846	0.5935	0.8220	0.6184	0 7005	0.6075	0.5502	0.6451	0 4675
0.5032	1 0073	0.6546	0.8572	0.6822	0 7341	0.6800	0.5772	0.7113	0 4920
0.5538	1 0364	0 7072	0.9016	0 7360	0 7767	0 7394	0.6121	0 7658	0.5236
0.6000	1.0001	0.7527	0.0010	0 7814	0.8279	0 7884	0.6555	0.8106	0.5623
0.6455	1 1 1 5 2	0.7021	1 0168	0.8197	0.8889	0.8286	0 7075	0.8474	0.6087
0.0400	1 1660	0.8260	1.0100	0.8520	0.0000	0.8617	0.7688	0.8777	0.6636
0.0071	1 2260	0.8553	1 1744	0.8792	1 0434	0.8889	0.7000	0.9026	0.0000
0.7200	1 2077	0.8806	1 273/	0.07.02	1 1/11	0.0000	0.0407	0.0020	0.8056
0.7020	1 3 9 3 5	0.0000	1 3 2 0 2	0.3022	1.1711	0.0206	1 0235	0.3230	0.00000
0.1901	1 4 9 6 4	0.9020	1.5092	0.9217	1 20/0	0.9290	1 1/02	0.9399	1 0079
0.0200	1,4004	0.9213	1.0200	0.9300	1.5940	0.9447	1.1402	0.9557	1 1 1 4 4 2
0.0090	1.0140	0.9379	1.0901	0.9516	1.0000	0.9571	1.2/91	0.9050	1.1443
0.0074	1.7790	0.9520	2 1700	0.9033	2.0264	0.9073	1.4404	0.9744	1.5107
0.9130	1.9971	0.9042	2.1709	0.9733	2.0304	0.9757	1.0090	0.9020	1.0400
0.9304	2.3073	0.9746	2.5345	0.9616	2.4040	0.9625	1.9299	0.9664	1.6705
0.9619	2.8028	0.9839	3.0741	0.9886	2.9538	0.9882	2.3033	0.9935	2.3957
0.9835	3.8248	0.9917	4.0237	0.9945	3.9444	0.9929	2.8676	0.9978	3.5422
1.0000	9.7845	1.0000	9.7816	1.0000	9.7746	0.9967	3.8932	1.0000	9.7259
						1.0000	9.7621		
a'/a	a/T = 0.1	a'/a	a/T = 0.2	a'/a	a/T = 0.3	a'/a	a/T = 0.4	a'/a	a/T = 0.5
a'/a 0.1735	a/T = 0.1 0.3897	a'/a 0 1735	a/T = 0.2	a'/a 0 1735	a/T = 0.3	a'/a 0 1327	a/T = 0.4 0.3952	a'/a 0 2061	a/T = 0.5 0 4479
a'/a 0.1735 0.3469	a/T = 0.1 0.3897 0.3871	a'/a 0.1735 0.3469	a/T = 0.2 0.3367 0.3271	a'/a 0.1735 0.3469	<i>a/T</i> = 0.3 0.3501 0.3317	a'/a 0.1327 0.2653	a/T = 0.4 0.3952 0.3726	a'/a 0.2061 0.4122	a/T = 0.5 0.4479 0.3976
a'/a 0.1735 0.3469 0.5203	a/T = 0.1 0.3897 0.3871 0.3911	a'/a 0.1735 0.3469 0.5205	a/T = 0.2 0.3367 0.3271 0.3220	a'/a 0.1735 0.3469 0.5323	a/T = 0.3 0.3501 0.3317 0.3166	a'/a 0.1327 0.2653 0.4739	a/T = 0.4 0.3952 0.3726 0.3451	a'/a 0.2061 0.4122 0.5791	a/T = 0.5 0.4479 0.3976 0.3568
a'/a 0.1735 0.3469 0.5203 0.6477	a/T = 0.1 0.3897 0.3871 0.3911 0.4095	a'/a 0.1735 0.3469 0.5205 0.6481	a/T = 0.2 0.3367 0.3271 0.3220 0.3277	a'/a 0.1735 0.3469 0.5323 0.6651	a/T = 0.3 0.3501 0.3317 0.3166 0.3121	a'/a 0.1327 0.2653 0.4739 0.6233	a/T = 0.4 0.3952 0.3726 0.3451 0.3230	a'/a 0.2061 0.4122 0.5791 0.6987	a/T = 0.5 0.4479 0.3976 0.3568 0.3325
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844	a/T = 0.5 0.4479 0.3976 0.3568 0.3325 0.3227
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458	a/T = 0.5 0.4479 0.3976 0.3568 0.3325 0.3227 0.3255
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8274	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3667	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195 0.3352	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8898	a/T = 0.5 0.4479 0.3976 0.3568 0.3325 0.3227 0.3255 0.3298
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8086	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3667 0.4071	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195 0.3352 0.3616	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8898 0.9213	a/T = 0.5 0.4479 0.3976 0.3568 0.325 0.3227 0.3255 0.3398 0.3650
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979 0.9252	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3667 0.4071 0.4596	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195 0.3352 0.3616 0.3993	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8898 0.8898 0.9213 0.9439	a/T = 0.5 0.4479 0.3976 0.3568 0.3255 0.3227 0.3255 0.3398 0.3650 0.4017
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979 0.9252 0.9453	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259 0.9460	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098 0.5813	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3667 0.4071 0.4596 0.5259	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3155 0.3352 0.3616 0.3993 0.4491	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.8898 0.9213 0.9439 0.9601	a/T = 0.5 0.4479 0.3976 0.3568 0.3325 0.3227 0.3255 0.3398 0.3650 0.4017 0.4506
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979 0.9252 0.9453 0.9600	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.6971 0.8006	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8617 0.8614 0.8986 0.9259 0.9460 0.9608	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098 0.5813 0.6683	a'a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8285 0.8774 0.9124 0.9375 0.9555	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195 0.3352 0.3616 0.3993 0.4491 0.5120	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.8458 0.8458 0.9213 0.9439 0.9601	a/T = 0.5 0.4479 0.3976 0.3568 0.3325 0.3227 0.3255 0.3398 0.3650 0.4017 0.4506 0.5134
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979 0.9252 0.9453 0.9453 0.9600	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259 0.9460 0.9608	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098 0.5813 0.6683 0.6735	a'a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081 0.7092	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9251	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195 0.3352 0.3616 0.3993 0.4491 0.5129 0.5229	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.9213 0.9439 0.9601 0.9718 0.9801	a/T = 0.5 0.4479 0.3976 0.3568 0.3225 0.3225 0.3255 0.3398 0.3650 0.4017 0.4506 0.5134 0.5925
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8407 0.8979 0.9252 0.9453 0.9600 0.9709 0.9709	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.9259 0.9460 0.9608 0.9717 0.9706	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098 0.4513 0.6683 0.7735 0.9043	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9842	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3191 0.3375 0.3677 0.4071 0.4596 0.4071 0.4599 0.6081 0.7092 0.8333	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3195 0.3352 0.3616 0.3993 0.4491 0.5129 0.6929 0.6925	a'/a 0.2061 0.4122 0.5791 0.7844 0.8458 0.8458 0.8898 0.9213 0.9439 0.9601 0.9718 0.9801	a/T = 0.5 0.4479 0.3976 0.3568 0.3325 0.3227 0.3255 0.3398 0.3650 0.4017 0.4506 0.5134 0.5925 0.6913
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.9379 0.9252 0.9453 0.9600 0.9709 0.9788 0.9600	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482 1.4586	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259 0.9460 0.9608 0.9717 0.9796 0.9855	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5813 0.5813 0.5813 0.5683 0.7735 0.9013 1.0575	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9841	a/T = 0.3 0.3501 0.317 0.3166 0.3121 0.3191 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081 0.7092 0.8333 0.9862	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9820	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3155 0.3352 0.3616 0.3993 0.4491 0.5129 0.5929 0.6925 0.8170	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.9213 0.9439 0.9601 0.9718 0.9801 0.9860 0.9860	a/T = 0.5 0.4479 0.3976 0.3568 0.325 0.3255 0.3255 0.3255 0.3255 0.3265 0.4017 0.4506 0.5134 0.5925 0.6913 0.8140
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979 0.9252 0.9453 0.9600 0.9709 0.9788 0.9847 0.98847	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482 1.4586 1.7115	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259 0.9460 0.9608 0.9717 0.9796 0.9865 0.9855	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098 0.5813 0.6683 0.7735 0.9013 1.0570 1.2427	a'a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9655 0.9684 0.9777 0.9843 0.9891	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081 0.7092 0.8333 0.9862 1.1766	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3155 0.3352 0.3616 0.3993 0.4491 0.5129 0.5929 0.6925 0.8170 0.9738	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.9213 0.9439 0.9601 0.9718 0.9801 0.9800 0.9803	a/T = 0.5 0.4479 0.3976 0.3568 0.3255 0.3227 0.3255 0.3398 0.3650 0.4017 0.4506 0.5134 0.5925 0.6913 0.8149 0.9705
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.8979 0.9252 0.9453 0.9600 0.9709 0.9788 0.9847 0.9890 0.92880 0.9095 0.928800 0.9288000 0.9288000 0.9288000 0.92880000000000000000000000000000000000	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482 1.4586 0.7115 2.0190	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.9259 0.9460 0.9608 0.9717 0.9796 0.9855 0.9885 0.9232	a/T = 0.2 0.3367 0.3271 0.3220 0.3277 0.3433 0.3691 0.4050 0.4516 0.5098 0.56813 0.6683 0.7735 0.9013 1.0570 1.2487 1.4295	a'a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925 0.9240	a/T = 0.3 0.3501 0.3317 0.3166 0.3121 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081 0.7092 0.8333 0.9862 1.1766	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3155 0.3352 0.3616 0.3993 0.4491 0.5129 0.5929 0.6925 0.8170 0.9738	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.9213 0.9439 0.9601 0.9718 0.9801 0.9801 0.9800 0.9903 0.9903 0.9903	a/T = 0.5 0.4479 0.3976 0.3568 0.3255 0.3227 0.3255 0.3398 0.3650 0.4017 0.4506 0.5134 0.5925 0.6913 0.8149 0.9705 1.1702
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.9252 0.9453 0.9600 0.9709 0.9788 0.9847 0.9890 0.9222	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482 1.4586 1.7115 2.0180	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8614 0.88614 0.9259 0.9460 0.9608 0.9717 0.9796 0.9855 0.9898 0.9930 0.9052	a/T = 0.2 0.3367 0.3271 0.32277 0.3433 0.3691 0.4050 0.4516 0.5098 0.5098 0.5813 0.6683 0.7735 0.9013 1.0570 1.2487 1.4895 1.8051	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925 0.9949 0.9925	a/T = 0.3 0.3501 0.3147 0.3161 0.3121 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081 0.7092 0.8333 0.9862 1.1766 1.4160 1.4720	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8072 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917 0.9945	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3155 0.3352 0.3616 0.3993 0.4491 0.5129 0.6925 0.8170 0.9738 1.1748 1.4400	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.9213 0.9439 0.9601 0.9718 0.9801 0.9801 0.9800 0.9903 0.9934 0.9956	a/T = 0.5 0.4479 0.3976 0.3568 0.3227 0.3255 0.3227 0.3255 0.398 0.4017 0.4506 0.5134 0.5925 0.6913 0.8149 0.9705 1.1702 1.4345
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.9252 0.9453 0.9600 0.9709 0.9788 0.9845 0.9890 0.922 0.9945 0.9890	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482 1.4586 1.7115 2.0180 2.3931 2.8561	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259 0.9460 0.9608 0.9717 0.9796 0.9855 0.9858 0.9858 0.9930 0.9953 0.0927	a/T = 0.2 0.3367 0.3271 0.3220 0.3433 0.3691 0.4050 0.4050 0.5518 0.5508 0.5513 0.6683 0.7735 0.9013 1.0570 1.2487 1.2487 1.2485 1.8001 2.2202	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9859 0.99891 0.9925 0.9949 0.9925	a/T = 0.3 0.3501 0.317 0.3166 0.3131 0.3191 0.3375 0.3667 0.4071 0.4596 0.5259 0.6081 0.7092 0.8333 0.9862 1.1766 1.4160 1.7279 2.1512	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9917 0.9945 0.9964	a/T = 0.4 0.3952 0.3726 0.3451 0.3230 0.3150 0.3155 0.3352 0.3616 0.3993 0.4491 0.5129 0.6925 0.8170 0.9738 1.1748 1.4409 1.4140	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.9213 0.9439 0.9601 0.9718 0.9801 0.9800 0.9903 0.9934 0.9956 0.9972 0.0022	a/T = 0.5 0.4479 0.3976 0.3568 0.3227 0.3255 0.3298 0.3650 0.4017 0.4506 0.5134 0.5925 0.6913 0.8149 0.9705 1.1702 1.4345 1.9062
a'/a 0.1735 0.3469 0.5203 0.6477 0.7413 0.8102 0.8607 0.9379 0.9252 0.9453 0.9600 0.9709 0.9788 0.9600 0.9709 0.9788 0.9847 0.9892 0.9945 0.9962 0.9062	a/T = 0.1 0.3897 0.3871 0.3911 0.4095 0.4401 0.4837 0.5404 0.6111 0.6971 0.8006 0.9245 1.0720 1.2482 1.4586 1.7115 2.0180 2.3931 2.8561	a'/a 0.1735 0.3469 0.5205 0.6481 0.7419 0.8107 0.8614 0.8986 0.9259 0.9460 0.9608 0.9717 0.9706 0.9855 0.9858 0.9930 0.9953 0.9970 0.9062	a/T = 0.2 0.3367 0.3271 0.3220 0.3271 0.3433 0.3691 0.4050 0.44516 0.5083 0.5813 0.6683 0.7735 0.9013 1.0570 1.2487 1.4895 1.4895 1.4895 1.4895	a'/a 0.1735 0.3469 0.5323 0.6651 0.7603 0.8285 0.8774 0.9124 0.9375 0.9555 0.9684 0.9777 0.9843 0.9891 0.9925 0.9949 0.9925 0.9949 0.99267 0.9979	a/T = 0.3 0.3501 0.317 0.3166 0.3121 0.375 0.3667 0.4071 0.45269 0.6081 0.7092 0.6081 0.7092 0.8333 0.9862 1.4766 1.4160 1.47279 2.1512 2.7729	a'/a 0.1327 0.2653 0.4739 0.6233 0.7304 0.8072 0.8622 0.9017 0.9299 0.9502 0.9647 0.9751 0.9826 0.9879 0.9875 0.9945 0.9945	a/T = 0.4 0.3952 0.3726 0.3451 0.3251 0.3155 0.3155 0.3352 0.3616 0.3993 0.4491 0.5129 0.5929 0.6925 0.8170 0.9738 1.1748 1.4409 1.8147 2.2066	a'/a 0.2061 0.4122 0.5791 0.6987 0.7844 0.8458 0.8458 0.9213 0.9439 0.9601 0.9718 0.9800 0.9903 0.9903 0.9956 0.9972 0.9985	a/7 = 0.5 0.4479 0.3976 0.3568 0.325 0.3255 0.3255 0.3255 0.3255 0.3088 0.4017 0.4506 0.5134 0.5925 0.6913 0.8149 0.9705 1.1702 1.4345 1.8068 2.264
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13 Managed by UT-Battelle for the Department of Energy Influence coefficients, *K**, have been calculated for external 360° circumferential surface flaws with relative flaw depths of a/t = 0.01, 0.02,0.03, 0.05, 0.075, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, and 0.95, *R*/*t* = 20.



Complete SIFIC Database for Generalized FAVOR, v09.1

(Ri / t)	application	Inr	ng flaws	Outer-surface breaking flaws					
		aspect ratio			aspect ratio				
		2	6	10	infinite	2	6	10	infinite
type of analysis		Initiation Thru-wall			Initiation Thr			Thru-wall	
10	PWR	WR SIFIC databases completely generated, implemented, and validated. Previous versions of FAVOR limited to inner surface breaking flaws for PWR geometries				SIFIC ge implei vi	C datab neratec mented alidatec	SIFIC databases generated, implemented, and validated	
10 < (Ri / t) < 20	BWR	interpolative routine successfully developed for semielliptical and infinite length flaws				interpolative routine successfully developed for semielliptical and infinite length flaws			
20	BWR	SIFIC databases completely generated implemented, and validated				SIFIC ge impler va	C datab nerated mented alidated	ases I, , and I	SIFIC databases generated, implemented and validated



14 Managed by UT-Battelle for the Department of Energy Reported in the paper

Summary

Complete SIFIC database were developed for surface flaws often utilized in fracture analyses of BWRs and PWRs;

The complete SIFIC database have been implemented, and validated in the new version of FAVOR, v09.1;

FAVOR 09.1 has the capability to perform PFM analyses on PWRs and BWRs for heat-up and/or cool-down transients in which the RPVs contain embedded and/or surface breaking (inner surface breaking/external surface breaking/or both);

The generalized version of FAVOR will be a baseline tool in the project to determine if a risk-informed technical basis can be established to provide a relaxation to the current regulations for normal transients associated with reactor start-up and shutdown.

