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PALO VERDE NUCLEAR GENERATING STATION
5801 S. WINTERSBURG ROAD TONOPAH, ARIZONA 85354-7529

WILLIAM L. STEWART
EXECUTIVE VICE PRESIDENT
NUCLEAR

102-03579-WLS/SAB/JRP
January 5, 1996

U. S. Nuclear Regulatory Commission
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Washington, DC 20555-0001

Dear Sirs:

Reference: Letter 102-03465, dated September 7, 1995, from W. L. Stewart, Executive Vice President, Nuclear, APS, to USNRC

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 2
Docket No. STN 50-529
Steam Generator Evaluation

This letter transmits the Arizona Public Service Company (APS) Steam Generator Evaluation for the Palo Verde Nuclear Generating Station Unit 2. The recently completed Unit 3 steam generator inspection and subsequent results confirmed that the modeling approach employed by APS is conservative in projecting the end of cycle structural and leakage integrity condition of steam generator tubes in the ARC region of the steam generators.

Based on the Unit 3 steam generator results along with the benchmarks reported in the referenced letter, and the defense-in-depth steam generator defect management program employed at PVNGS, APS concludes that the integrity of the Unit 2 steam generators will be maintained and the unit can be safely operated until the next scheduled refueling outage at the end of cycle 6.

Should you have any questions, please call Scott A. Bauer at (602) 393-5978.

Sincerely,

WLS/SAB/JRP/pv
Enclosure

cc: L. J. Callan
K. E. Perkins
B. E. Holian
K. E. Johnston
I. Barnes

190008

A001

ENCLOSURE

ARIZONA PUBLIC SERVICE COMPANY

EVALUATION OF UNIT 3 REFUELING 5

STEAM GENERATOR INSPECTION RESULTS

APS Evaluation of U3R5 Steam Generator Inspection Results

APS has reviewed the U3R5 Steam Generator inspection results with respect to Staff information requests stemming from the September 20, 1995 meeting between the USNRC and APS. The requested information included predictive modeling output for the U3R5 ARC defect population. The actual inspection results are intended to provide additional benchmarking for the modeling techniques employed by APS in Reference 1. The following discussion provides a summary comparison of the actual results versus pre-outage predictions.

1. Total crack population

The total number of ARC region cracks detected by a Plus Point MRPC inspection in SG 3-1 and SG 3-2 was 48 as shown in Tables 1 and 2. This defect total is less than the mean projection provided in Figures 1 and 2 attached and originally provided in Reference 2. It is APS's position that the results indicate that the crack initiation and crack growth functions developed in the APS model are conservative. The Plus Point POD curve is considered appropriate, since it is estimated that 45% of the defects would not have been called by 0.115 pancake coil alone in a normal production ECT inspection. Consequently, Figure 3, attached and originally provided in Reference 2 would also have been a conservative projection had APS not elected to use the Plus Point MRPC. The use of the Plus Point probe for crack detection, and the plugging of all detectable cracks, utilizes the best available technology to minimize the undetected defect population at the beginning of the following operating cycle.

2. Crack Growth Rate

APS in its submittals to the NRC Staff has used MRPC (Pancake Coil) voltage growth rate as a means of projecting defect growth with respect to end of cycle structural and leakage integrity. Prior to the inspections conducted in Unit 3, APS provided to the Staff, a projection of Unit 3 estimated voltage growth rate in volts/EFPY. The projection in Figure 4 indicated that 90% of the projected growth rates would be less than one (1) volt per EFPY. The actual results are tabulated in Tables 1 and 2 and presented graphically in Figure 5. The actual results indicate that voltage growth did not exceed 0.5 volts per EFPY. These results confirm the conservative projection techniques employed by APS and may indicate the positive effects of corrective measures taken by APS to reduce defect growth rates.

3. Crack Length Distribution.

As reported in previous information submitted to the Staff, the crack length distribution used in the APS structural and leakage integrity analyses is not a projection, but an output distribution of actual ECT results. Consequently, the distribution is impacted by the size of the defect population and is also probe dependent. Since the Plus Point probe "sees" more of the defect, a Plus Point crack length distribution is considered conservative compared to pancake coil length distributions. It should be noted, that the

APS structural evaluations performed and verified by tube pull, indicate good correlation of structurally significant crack length and ***0.115 pancake coil detected length.*** Consequently, the use of a Plus Point length distribution is considered conservative. APS's assessment of the Unit 3 Plus Point detected crack lengths indicates the following. The upper end of the distribution in Figure 7 is shifted to the right when compared to Figure 6. In other words, several defects in excess of six (6) inches in length were detected and measured using the Plus Point probe. It should be noted, that the longest defect of 9.5" in tube R103C142 was barely detectable and unmeasurable via the 0.115 pancake coil. Since the Framatome burst equation used by APS indicates that the Regulatory Guide 1.121 allowable crack depth limit flattens out for defects greater than 1.4 inches in length, this upper end shift has no impact on the end of cycle projection for Regulatory Guide exceedances. APS has found that the biggest impact of a Plus Point probe crack length distribution has been on estimating the cumulative probability of tube rupture at MSLB conditions. The critical crack length for this calculation is 0.8 inches. By comparing Figures 6 and 7, it is shown that the frequency of defects exceeding this value is nearly the same in both cases. Consequently, APS's position regarding the consistency and appropriateness of the crack length distribution used in the Unit 2 and 3 analyses is supported.

4. Regulatory Guide 1.121 exceedances

APS had projected a low probability of more than one Regulatory Guide 1.121 exceedance in U3R5. The results indicate that zero (0) exceedances were detected. The largest Unit 3 voltage recorded for a defect greater than 0.5 inches in length was 0.43 volts. Using the upper bound MRPC voltage/average depth correlation developed by APS, the limiting voltage would be 1.3 volts. The best estimate regression fit limit is 2.25 volts.

Conclusion

The Unit 3 steam generator inspection results confirmed that the modeling approaches employed by APS are conservative in projecting the end of cycle structural and leakage integrity condition of steam generator tubes in the ARC region of the PVNGS steam generators. Based on this additional benchmark, the benchmarks reported in Reference 1 and the defense-in-depth steam generator defect management program employed by APS as described in Reference 1, APS believes that the position presented in Reference 1 regarding Unit 2 Cycle 6 operation is justified.

References

1. Unit 3 Refueling Outage 5 ARC Region Projections, submitted to USNRC via letter 102-03513-WLS/SAB/RJR , dated October 16, 1995

2. Unit 2 Steam Generator Evaluation August 1995, submitted to USNRC via letter 102-03465-WLS/SAB/JRP, dated September 7, 1995

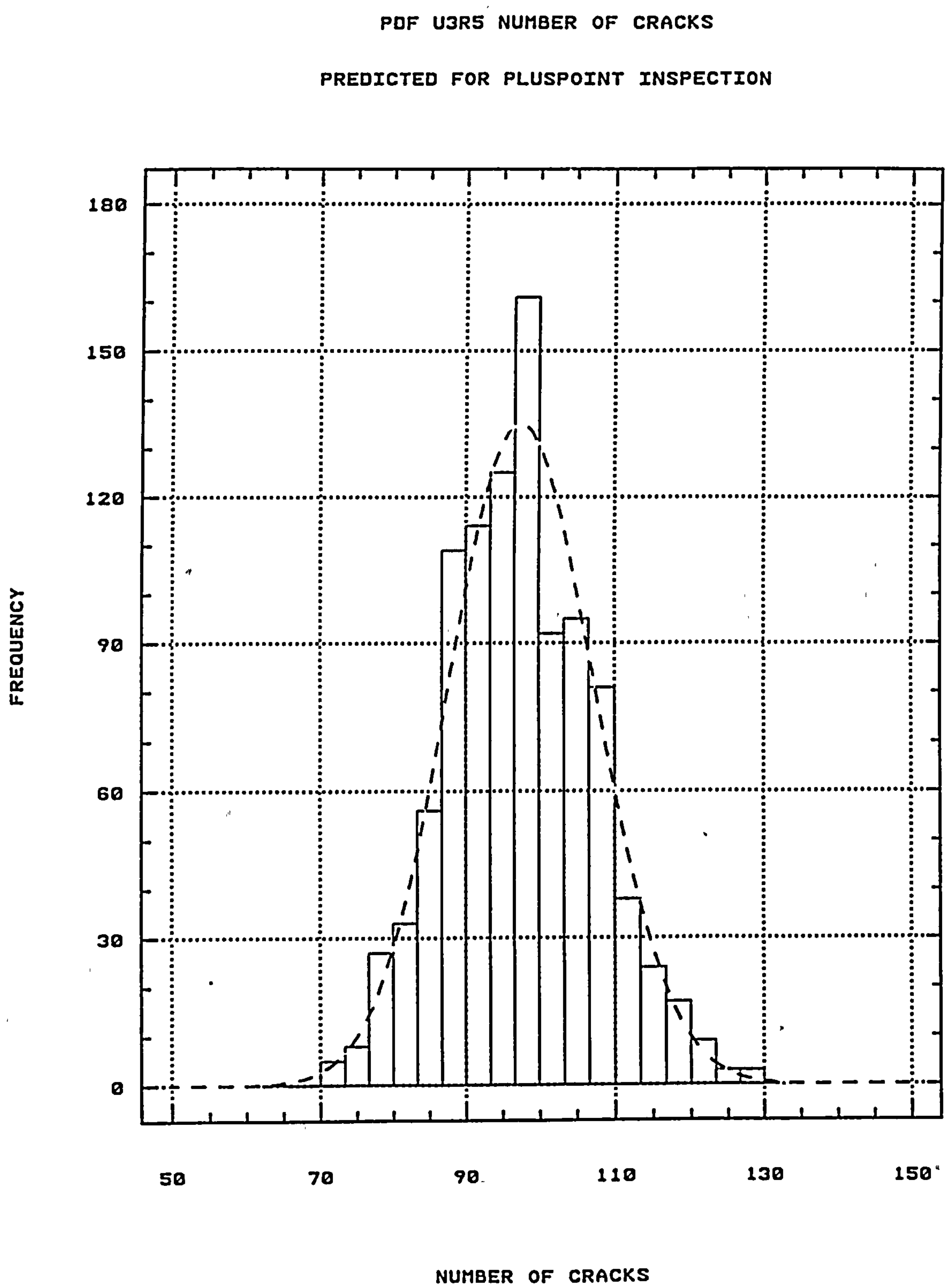
Steam Generator 3-1
U3R5 ARC Region Results

SG	Number	Row	Line	Location	Length	Pancake Volts	Plus point Volts	ECT	Historical Length	Historical Pancake Volts	Historical PP Volts	Volts/EFPY
31	1	108	43	BW1 +2.33	1.8	0.23	0.56	SAI	NDD	0		0.23
	2	107	44	BW1 -0.26	0.9	0	0.64	SAI	0.6	0	0.52	0.00
	3	116	45	08H +38.84	3.5	0.27	0.54	SAI	1.4	0.19	0.41	0.06
	4	109	52	BW1 +0.73	2	0.4	0.47	SAI	1.2	0.2	0.36	0.18
	5	102	55	BW1 -0.57	2.2	0.31	0.67	SAI	1.9	0.22	0.67	0.07
	6	121	56	BW1 -0.76	1.2	0.4	0.65	SAI	0.6	0.17	0.55	0.21
	7	147	60	09H +7.97	0.7	0.25	0.31	SAI	None	None	None	0.27
	8	112	67	BW1 -0.90	1.8	0.35	0.85	SAI	0.8	0.2	0.73	0.13
	9	149	82	BW1+20.96	0.5	0	0.61	MAI	None	None	None	0.00
	10	149	82	BW1 +20.98	0.8	0	0.42	MAI	None	None	None	0.00
	11	149	92	BW1 +1.02	1.8	0.01	0.52	MAI	NDD	NDD	NDD	0.01
	12	149	92	BW1 +18.14	0.5	0.43	0.64	MAI	NDD	NDD	NDD	0.47
	13	149	92	BW1 +19.74	1	0.3	0.64	MAI	NDD	NDD	NDD	0.33
	14	132	95	09H +15.88	1.1	0.24	0.38	SAI	1	0.1	0.21	0.13
	15	137	98	BW1 +7.18	0.5	0	0.36	SAI	0.3	0	0.18	0.00
	16	135	100	BW1 -0.33	0.7	0	0.36	MAI	NDD	NDD	NDD	0.00
	17	135	100	BW1 +2.02	0.8	0.34	0.46	MAI	NDD	NDD	NDD	0.37
	18	119	132	08H +40.14	0.5	0	0.4	SAI	0.2	0	0.3	0.00
	19	103	140	08H +35.13	7.5	0.31	0.5	MAI	0.3	0.1	0.35	0.20
	20	103	140	BW1 +0.00	2.4	0.26	0.71	MAI	0.7	0.1	0.21	0.15
	21	103	142	08H +34.69	9.5	0.2	0.54	SAI	5	0.11	0.39	0.08
	22	103	144	08H +32.99	2.7	0.1	0.31	MAI	1.2	0	0.16	0.10
	23	103	144	08H +36.59	4.2	0.32	0.8	MAI	0.7	0.27	0.55	0.03
	24	103	144	BW1 -0.25	3	0.42	0.8	MAI	0.4	0.2	0.36	0.20

Steam Generator 3-2
U3R5 ARC Region Results

SG	Number	Row	Line	Location	Length	Pancake Volts	Plus point Volts	ECT	Historical Length	Historical Pancake Volts	Historical PP Volts	Volts/EFPY
32	1	96	37	VS2 -0.34	0.3	0.3	0.66	MAI	0.3	0.11	0.34	0.18
	2	96	37	VS2 +3.80	0.7	0.2	0.49	MAI	0.6	0.2	0.47	-0.02
	3	106	39	BW1 +0.53	0.6	0	0.53	MAI	0.2	0	0.27	0.00
	4	106	39	VS2 +4.22	0.6	0.11	0.56	MAI	0.4	0.09	0.37	0.01
	5	101	42	VS2 +3.96	0.9	0.31	0.47	SAI	0.6	0.06	0.47	0.24
	6	102	45	VS2 +4.66	0.5	0.31	0.5	SAI	0.4	0.1	0.28	0.20
	7	102	49	BW1+21.54	0.5	0.16	0.27	MAI	0.3	0.09	0.18	0.06
	8	102	49	BW1+23.58	1.1	0.33	0.4	MAI	0.8	0.17	0.28	0.14
	9	96	51	BW1 -1.20	0.6	0	0.26	SAI	0.4	0	0.26	0.00
	10	104	51	08H +37.49	4.1	0.35	0.5	MAI	0.4	0.1	0.22	0.24
	11	104	51	BW1 +1.60	0.2	0.18	0.19	MAI	NDD	NDD	NDD	0.20
	12	96	53	BW1 +0.00	1.1	0.4	0.57	SAI	0.4	0.19	0.34	0.19
	13	133	56	VS1 +0.80	0.5	0.28	0.47	MAI	0.5	None	0.31	0.31
	14	133	56	VS1 +7.31	4.1	0.31	0.54	MAI	2.8	None	0.34	0.34
	15	102	57	BW1 -0.57	0.9	0.19	0.78	MAI	0.67	0	0.4	0.19
	16	102	57	BW1 +0.65	0.4	0.01	0.57	MAI	0.3	0	0.2	0.01
	17	105	60	08H +35.98	0.4	0.48	0.72	SAI	0.3	0.38	0.6	0.07
	18	128	89	BW1 +3.34	0.3	0.34	0.44	SAI	0.2	0.12	0.2	0.21
	19	112	97	08H +41.94	5	0.38	0.46	SAI	None	None	None	0.41
	20	142	97	BW1 +3.15	0.6	0.18	0.45	SAI	0.4	0.21	0.4	-0.05
	21	145	100	BW1 +2.34	1.6	0.01	0.23	MAI	NDD	NDD	NDD	0.01
	22	145	100	BW1 +19.65	1.8	0.2	0.23	MAI	NDD	NDD	NDD	0.22
	23	109	152	08H -0.17	0.9	0.08	0.57	SAI	NDD	NDD	NDD	0.09
	24	99	160	BW1 -1.23	0.7	0.01	0.48	SAI	0.5	0	0.47	0.01

Figure 1

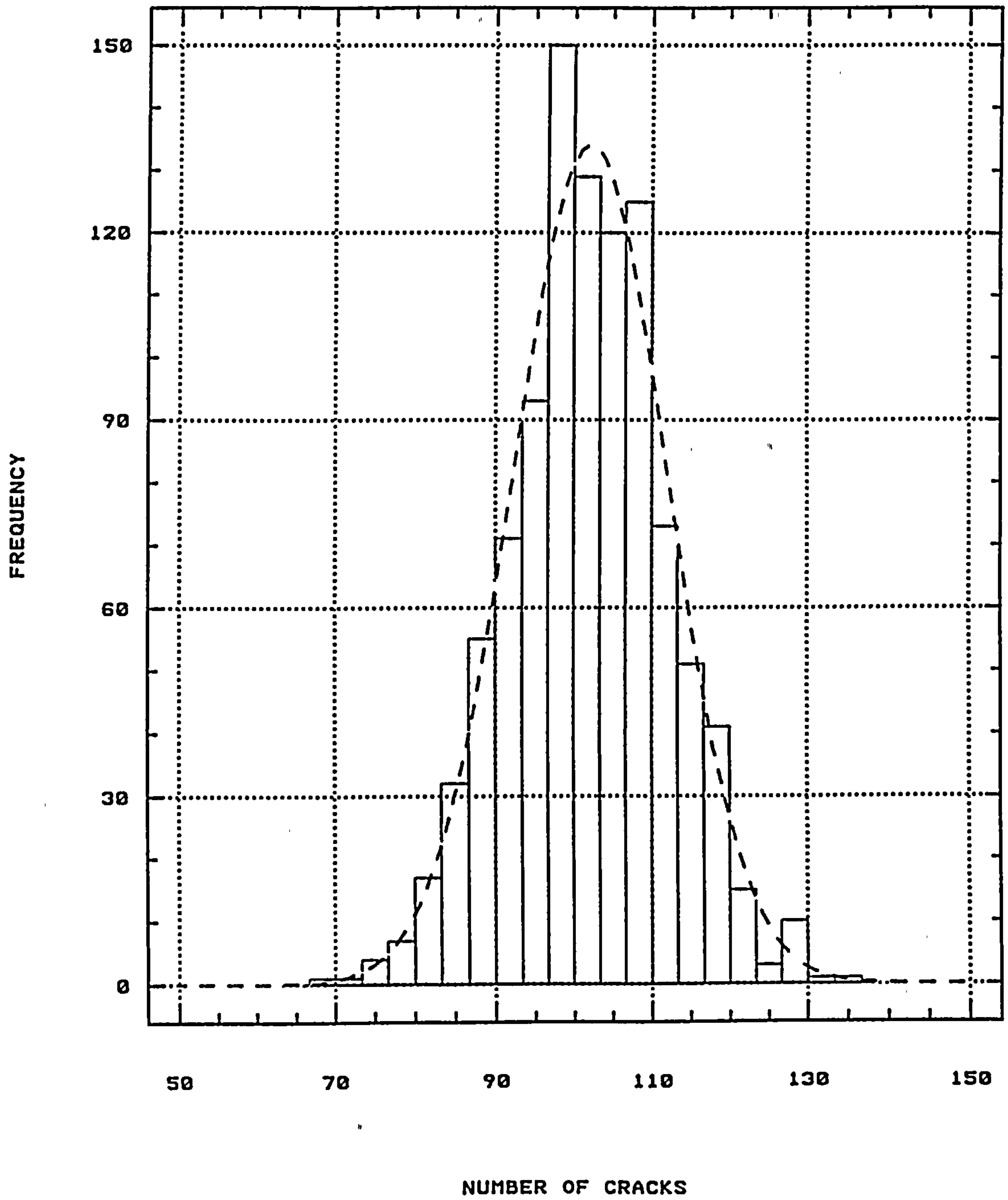


U3 BEST ESTIMATE GROWTH RATES

Figure 2

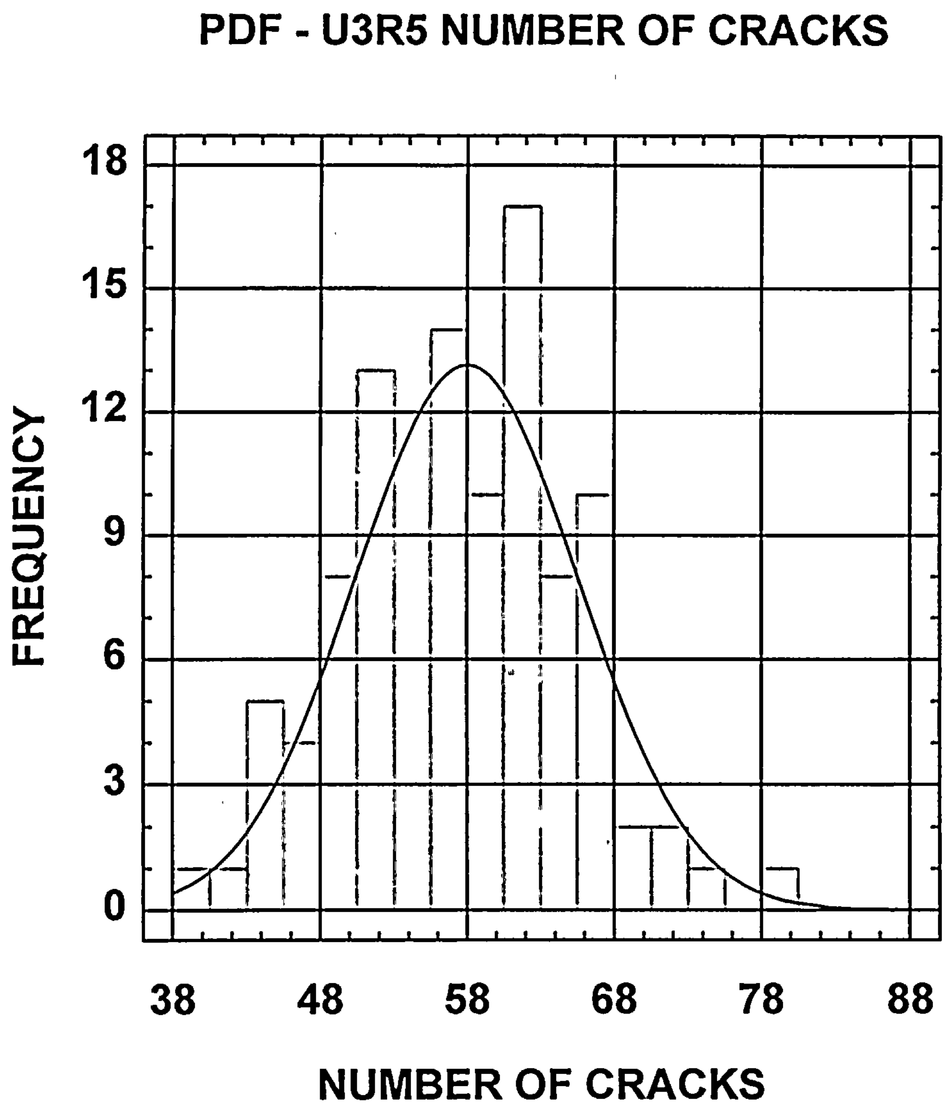
PDF U3R5 NUMBER OF CRACKS

PREDICTED FOR PLUSPOINT INSPECTION



U3 UPPER 95 GROWTH RATES

Figure 3



Prediction presented to NRC Staff July 12, 1995
Prediction based on MRPC POD curve and without Weibull setback optimization

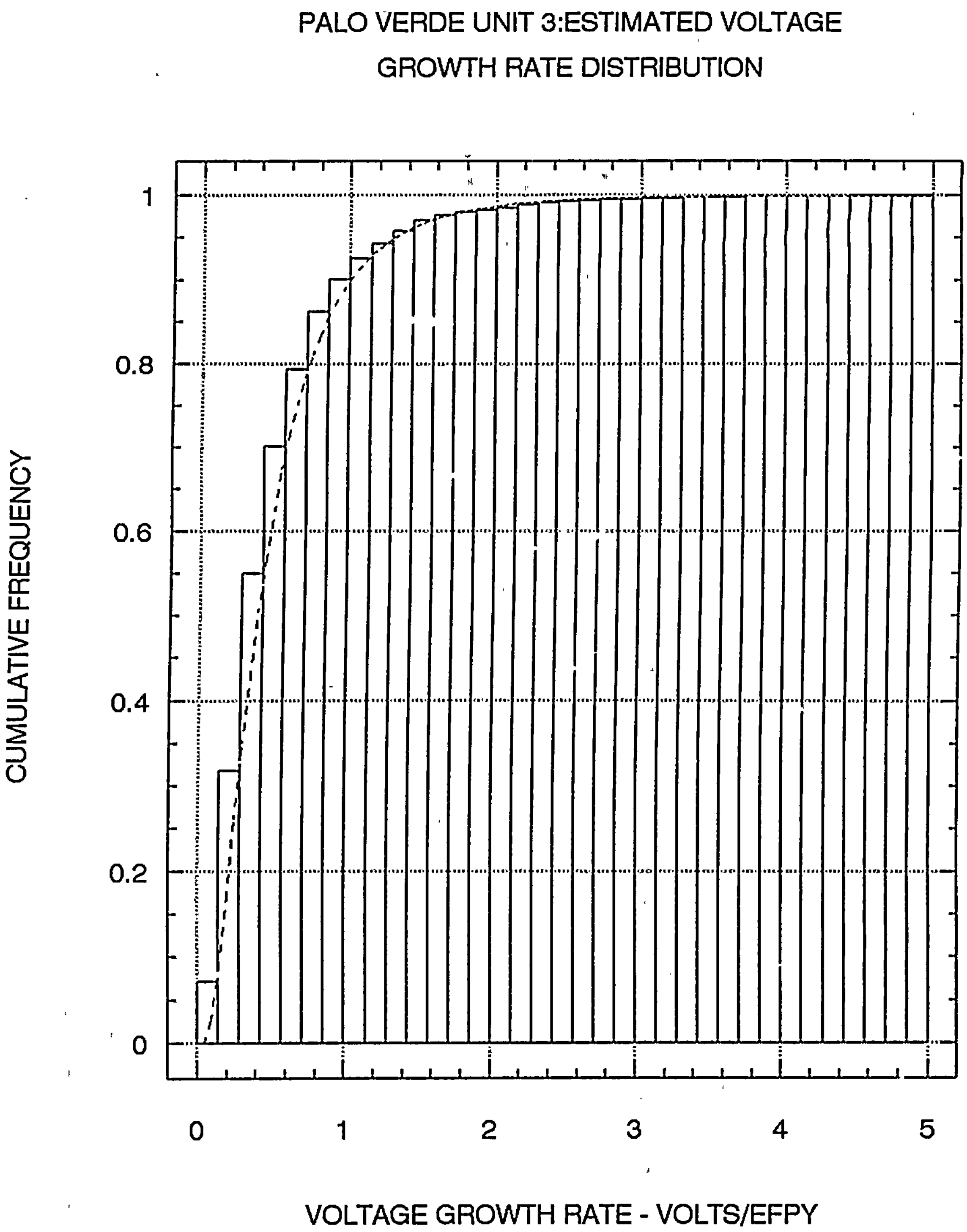

PALO VERDE UNIT 3:ESTIMATED VOLTAGE
GROWTH RATE DISTRIBUTION
CUMULATIVE FREQUENCY
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
VOLTAGE GROWTH RATE - VOLTS/EFPY

FIGURE 4

U3R5 Voltage Growth Summary

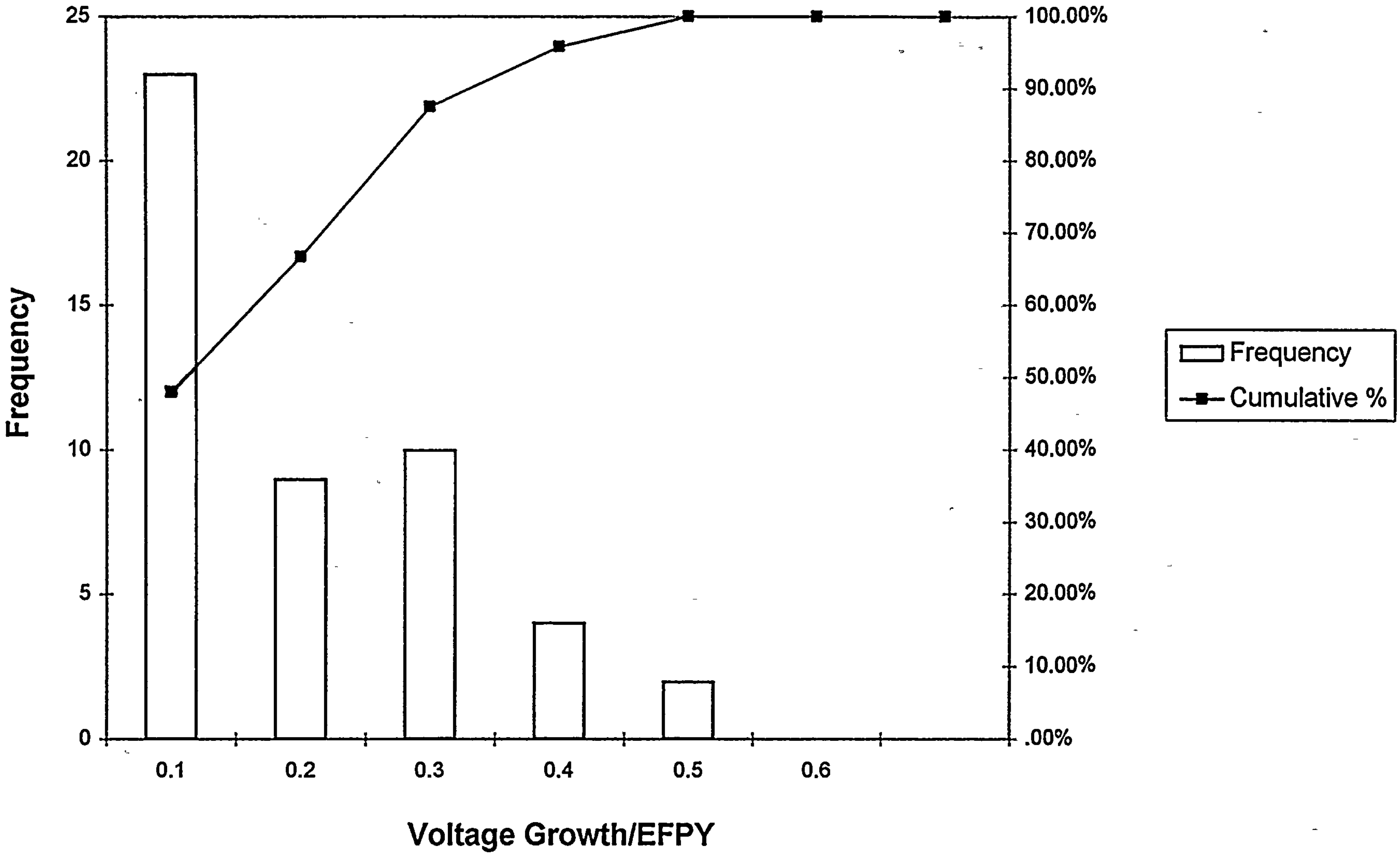
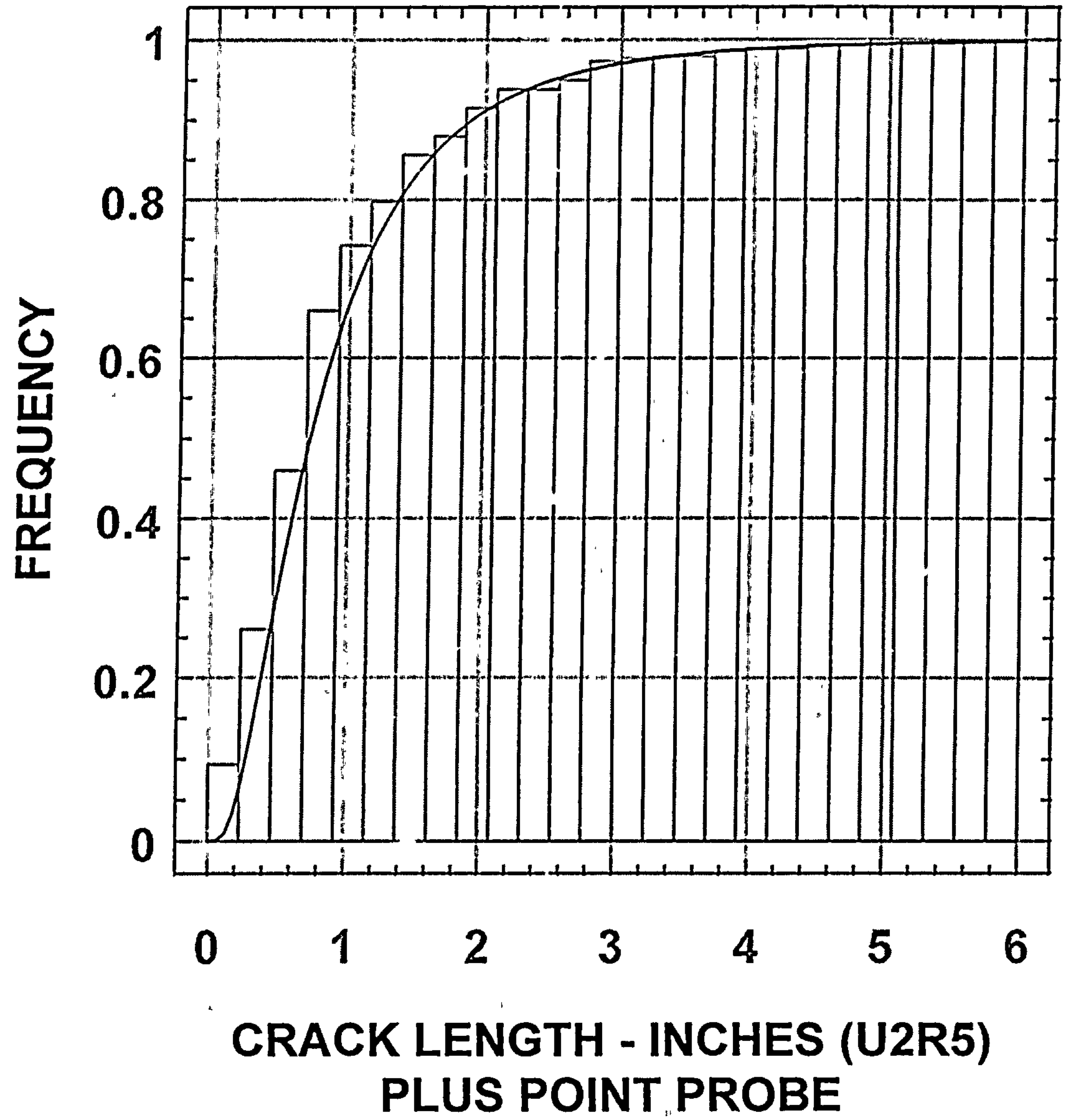


Figure 5



DISTRIBUTION OF U2R5 CRACK LENGTHS

FIGURE -6

U3R5 Crack Lengths

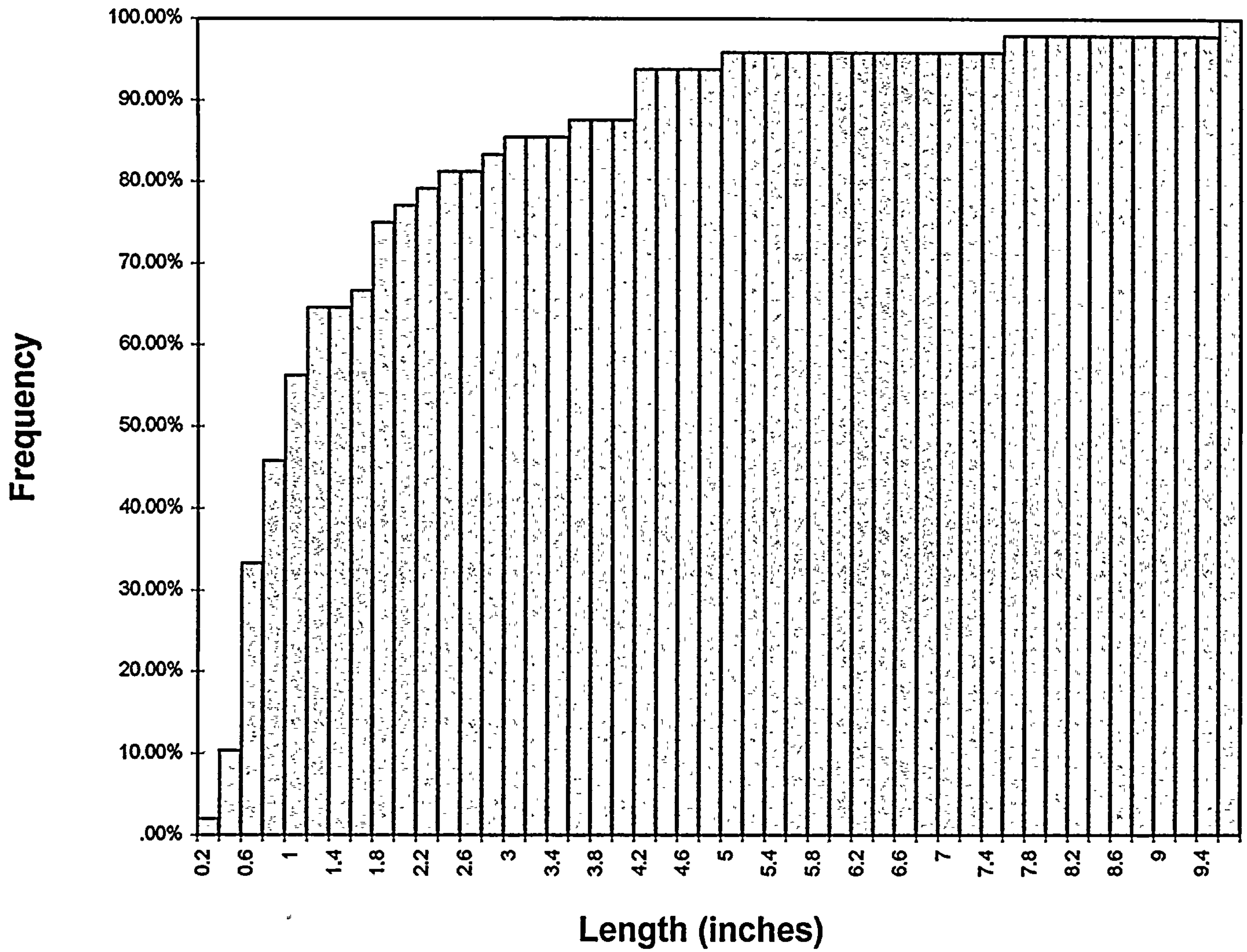


Figure 7