MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

CALCULATION TITLE PAGE

Client: Florida Power

Page 1 of 11

Project: Crystal River 3 Steam Generators

Task No.: 102-071

Title: Statistical Analysis of Defect Depth of SG Tubes

Calculation No.: 102-071-SAB-01

Preparer/Date	Checker/Date	Reviewer/Date	Rev. No.
Scott Bowen 4-6-94	R O Vollmer 4/8/94	W Harrison 4-8-94	0

9406220099 940419
PDR ADOCK 05000302
Q PDR

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

RECORD OF REVISIONS

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bowman	RO'Hanlon	2

Revision	Description
0	Original Issue

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bonnin	R Wellner	3

Purpose:

- To statistically estimate the SG Tube defect depth below which 95% of the defects in the entire steam generator will lie. The analysis is based on a sample of tested tubes and a 95% Confidence level.

- To determine the effect of changes in the % Population cutoff (x% of the population lies below the value) and confidence level on the above analysis

Method:

The calculation is performed using standard statistical techniques outlined in Sections 2-5.3 and 2-5.4.2 of Reference 1.

The values which comprise the statistical sample are listed in the Appendix.

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-5AB01	S. Brown	RC Widmer	4

Results

EFFECT OF %POPULATION
95% CONFIDENCE

%POPULATION	Z pop	MAXIMUM
0.900	1.28	51.2
0.920	1.41	53.3
0.950	1.64	57.1
0.960	1.75	58.8
0.970	1.88	60.9
0.980	2.05	63.7
0.990	2.33	68.3
0.995	2.58	72.4
0.999	3.09	80.9

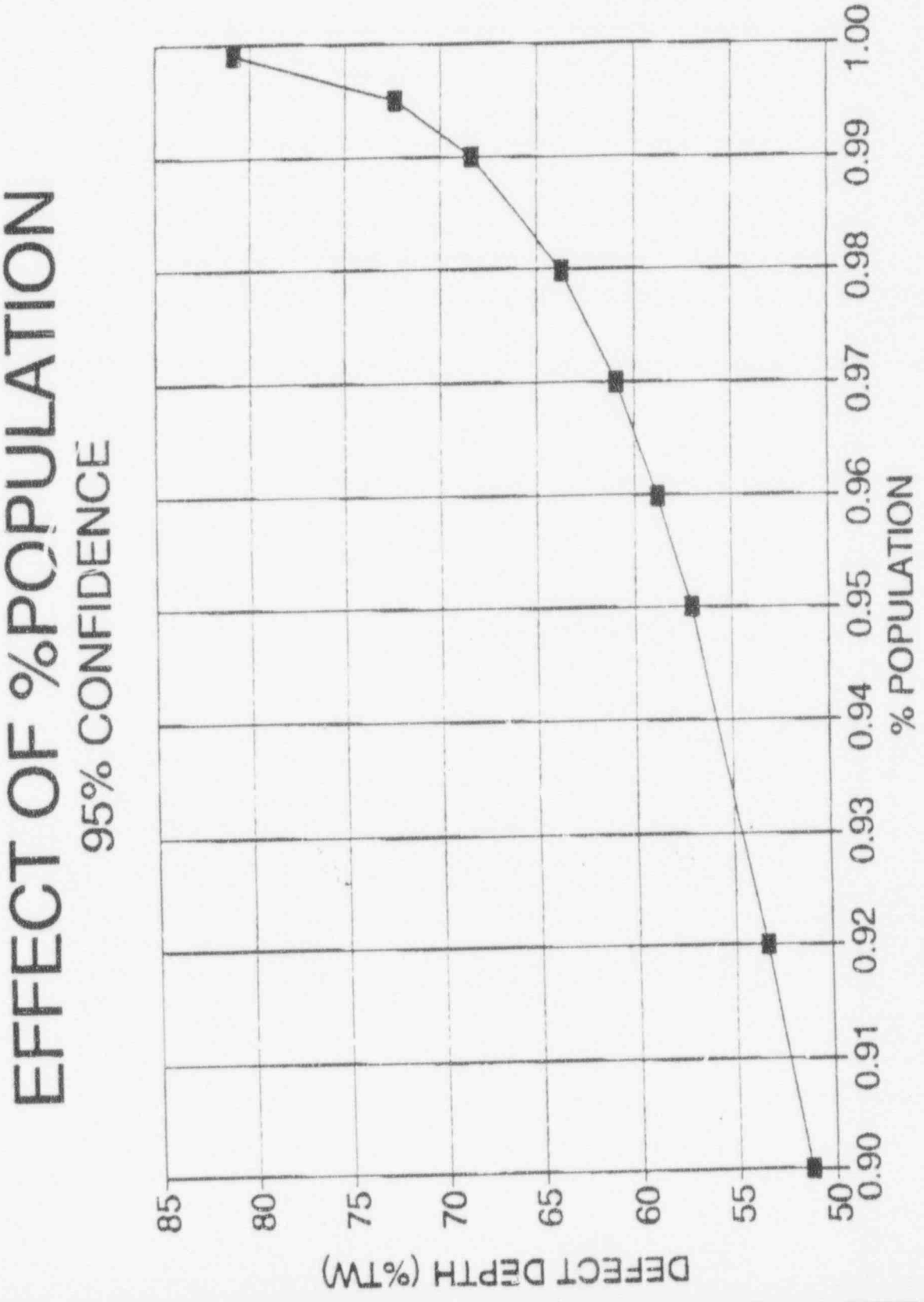
EFFECT OF %CONFIDENCE
95% POPULATION

%CONFIDENCE	Z conf	MAXIMUM
0.900	1.28	56.1
0.920	1.41	56.5
0.950	1.64	57.1
0.960	1.75	57.4
0.970	1.88	57.8
0.980	2.05	58.3
0.990	2.33	59.1
0.995	2.58	59.8
0.999	3.09	61.5

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

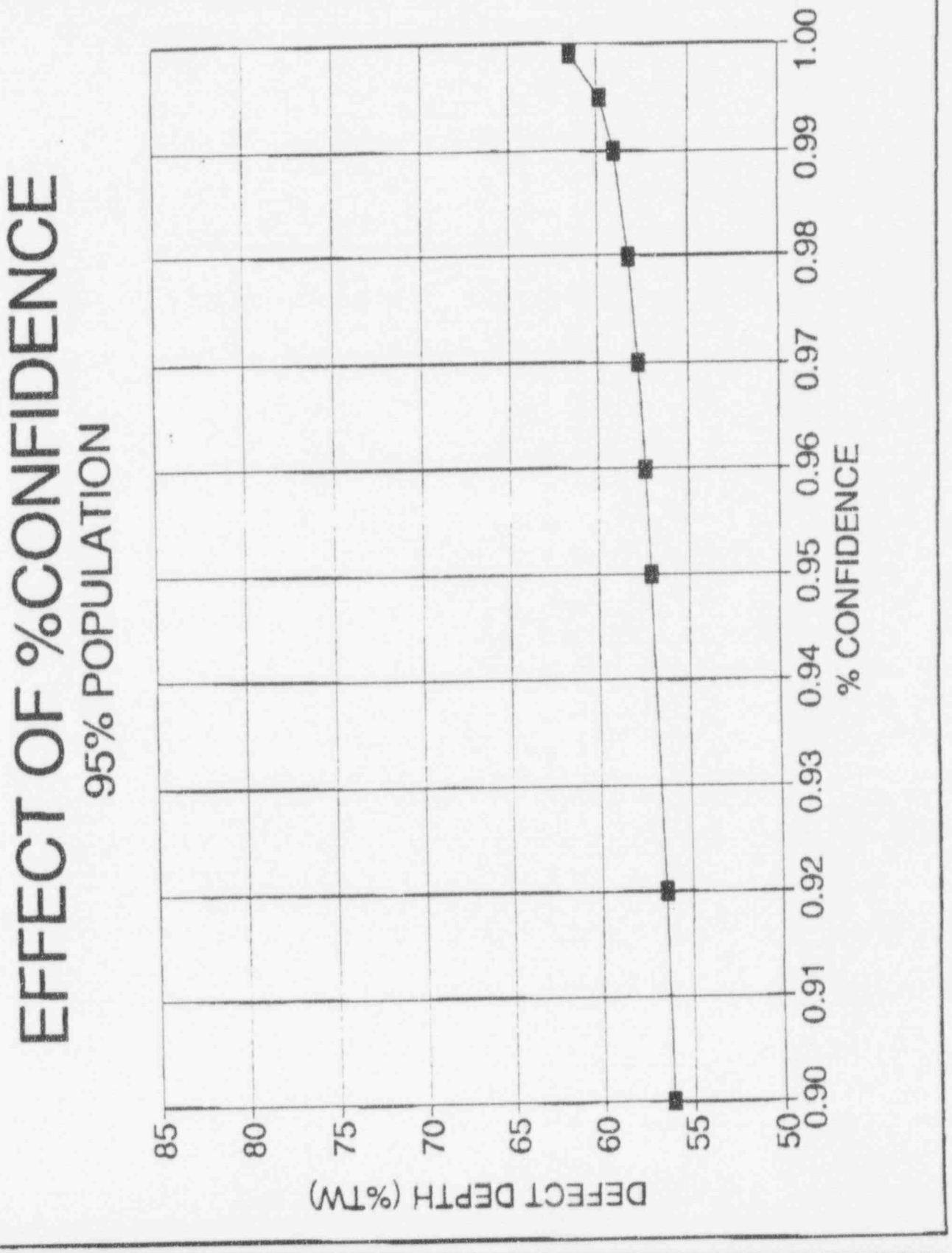
Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bruce	R.O. Vothman	5



MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bo	R.O Vollmer	6



MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bonner	RWWeller	7

Assumptions

In the following calculation it is assumed that:

a) The sample used in the analysis is a representative sample of the entire population (i.e. steam generator)

b) The selection of each element in the sample is independent of the selection of all the other elements.

c) The distribution of samples is reasonably close to a normal distribution. Based on the histogram shown in the Appendix this sample is reasonably close to a normal distribution.

However, the result will also be calculated without assuming a normal distribution to show that this assumption has little effect on the final results.

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bonner	R.O. Vollmer	8

Calculation:

This is a sample calculation performed for the 95% Population, 95% Confidence case. An identical sequence was used for all the other cases summarized in Results. [Ref 1, p 2-14]

P = Probability a defect will be less than calculated depth = 0.95

γ = Confidence level = 0.95

n = size of sample = 100

$\bar{X}$ = Sample Average

$$= \frac{1}{n} \sum_{i=1}^{n} X_i = 28.69 \text{ \%TW} \quad [\text{Ref 1, p 2-2}]$$

X_i = Sample values from Appendix

S = Standard Deviation of Sample

$$S^2 = \frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1} \quad [\text{Ref 1, p 1.-10}]$$

$$S = 14.7 \text{ \%TW}$$

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	J. Brown	R.O'Sullivan	9

$$Z_\gamma = Z_{0.95} = 1.645$$
$$Z_p = Z_{0.95} = 1.645 \quad \text{[Ref 1, Tab A-2]}$$

$$a = 1 - \frac{Z_\gamma^2}{2(n-1)} = .986 \quad \text{[Ref 1, p 2-15]}$$

$$b = Z_p^2 - \frac{Z_\gamma^2}{n} = 2.679 \quad \text{[Ref 1, p 2-15]}$$

$$K = \frac{Z_p + \sqrt{Z_p^2 - ab}}{a} = 1.926 \quad \text{[Ref 1, p 2-15]}$$

X_H = Value below which it is predicted with 95% confidence that 95% of the population values will fall.

$$X_H = \bar{X} + Ks$$
$$= 28.69 + (1.926)(14.77)$$
$$= \underline{\underline{57.1}}$$

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bonnett	RO Uhlmer	10

If the population is not assumed to have a normal distribution, the following procedure [Ref 1, sec. 2-5.4.2] may be used.

For 95% Population
95% Confidence level
100 Sample size (n)

95% of the population will lie below the 2nd largest value [Ref 1, Tab A-31]

Therefore X_H = 54% TW

This value is comparable to the 57.1% TW calculated assuming a normal distribution

MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-07H-SAB-01	S. Bonnett	RO Gallmeyer	11

Reference

1. National Bureau of Standards Handbook 91, Experimental Statistics August 1, 1963.

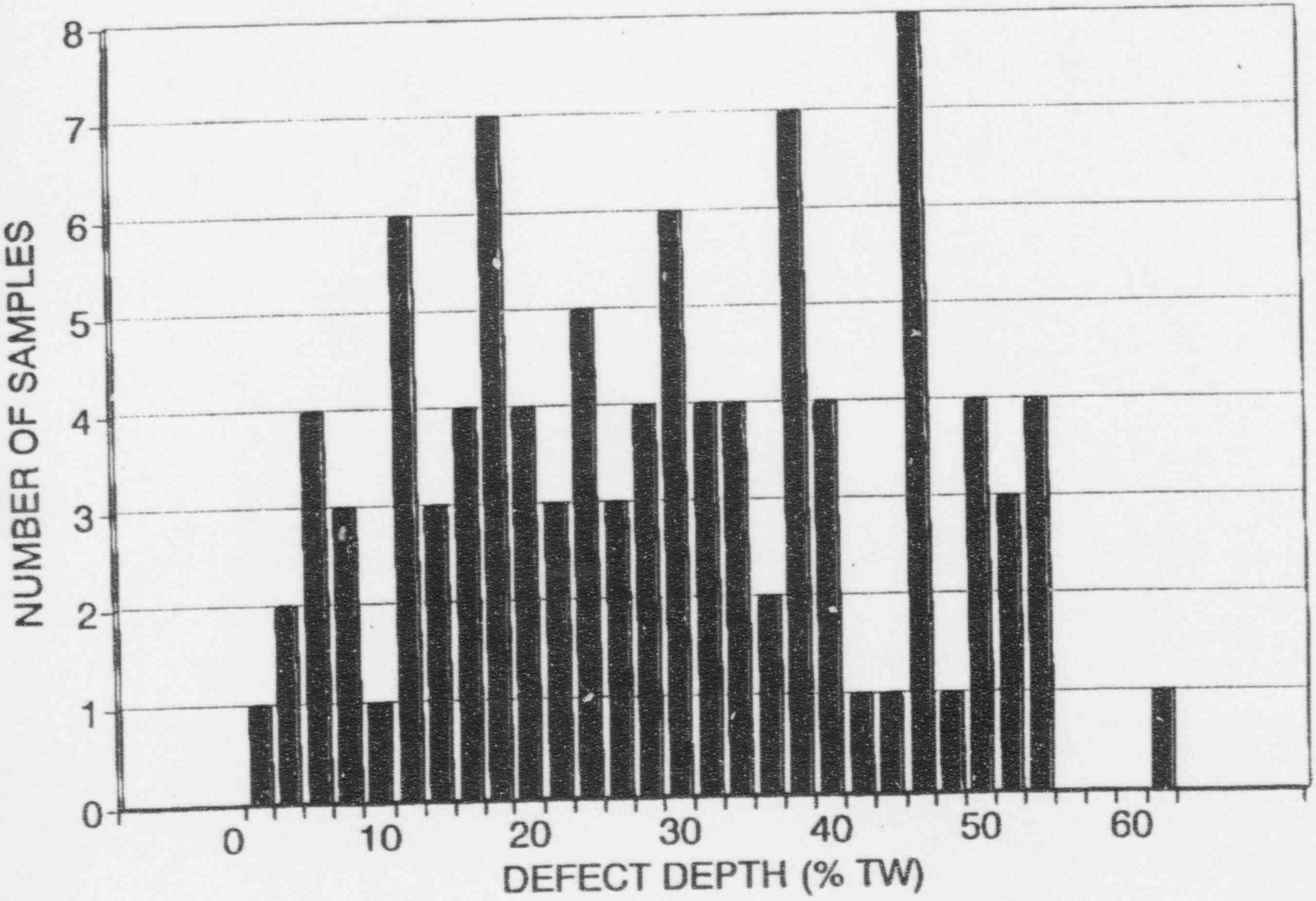
MPR

MPR Associates, Inc.
320 King Street
Alexandria, VA 22314

Calculation No.	Prepared By	Checked By	Page
102-071-SAB-01	S. Bonn	ROWilson	A-1

Appendix

HISTOGRAM -- DEFECT DEPTH



APR-08-1994 15:37 MPR ASSOCIATES INC. 703 519 0224 P.02

ACTUAL MEASURED DEFECT PENETRATION FROM PULLED TUBES

DEFECT DEPTH % TW
38
40
10
8
16
16
16
14
12
22
11
25
36
12
42
24
46
19
31
39
29
32
36
22
20
17
30
31
17
11

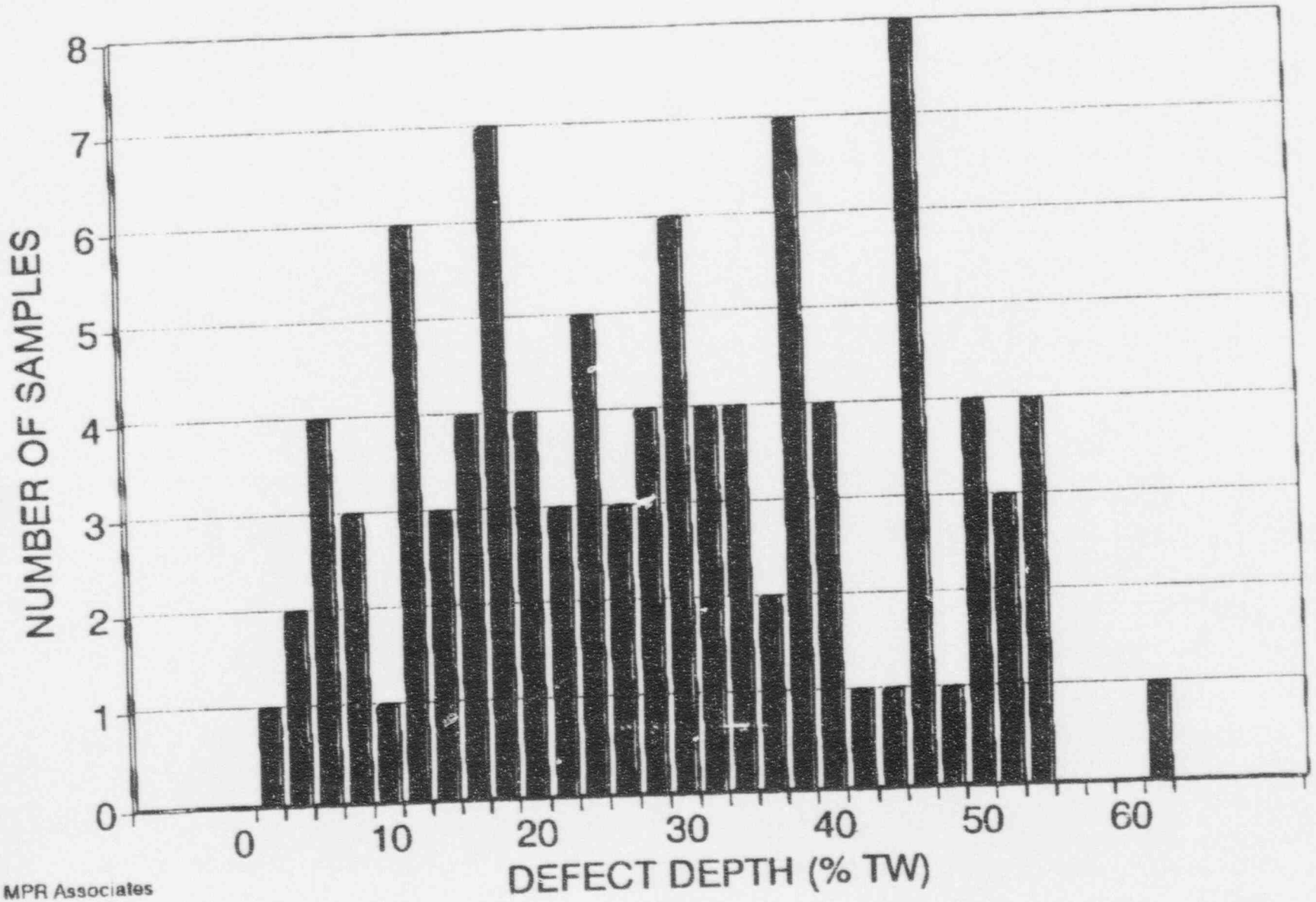
ACTUAL MEASURED DEFECT PENETRATION FROM PULLED TUBES

DEFECT DEPTH % TW
38
38
38
38
38
34
34
28
52
45
19
13
40
19
33
18
33
26
32
12
12
50
53
37
46
18
27
45
45
23
28
46
53
49
46

ACTUAL MEASURED DEFECT PENETRATION FROM PULLED TUBES

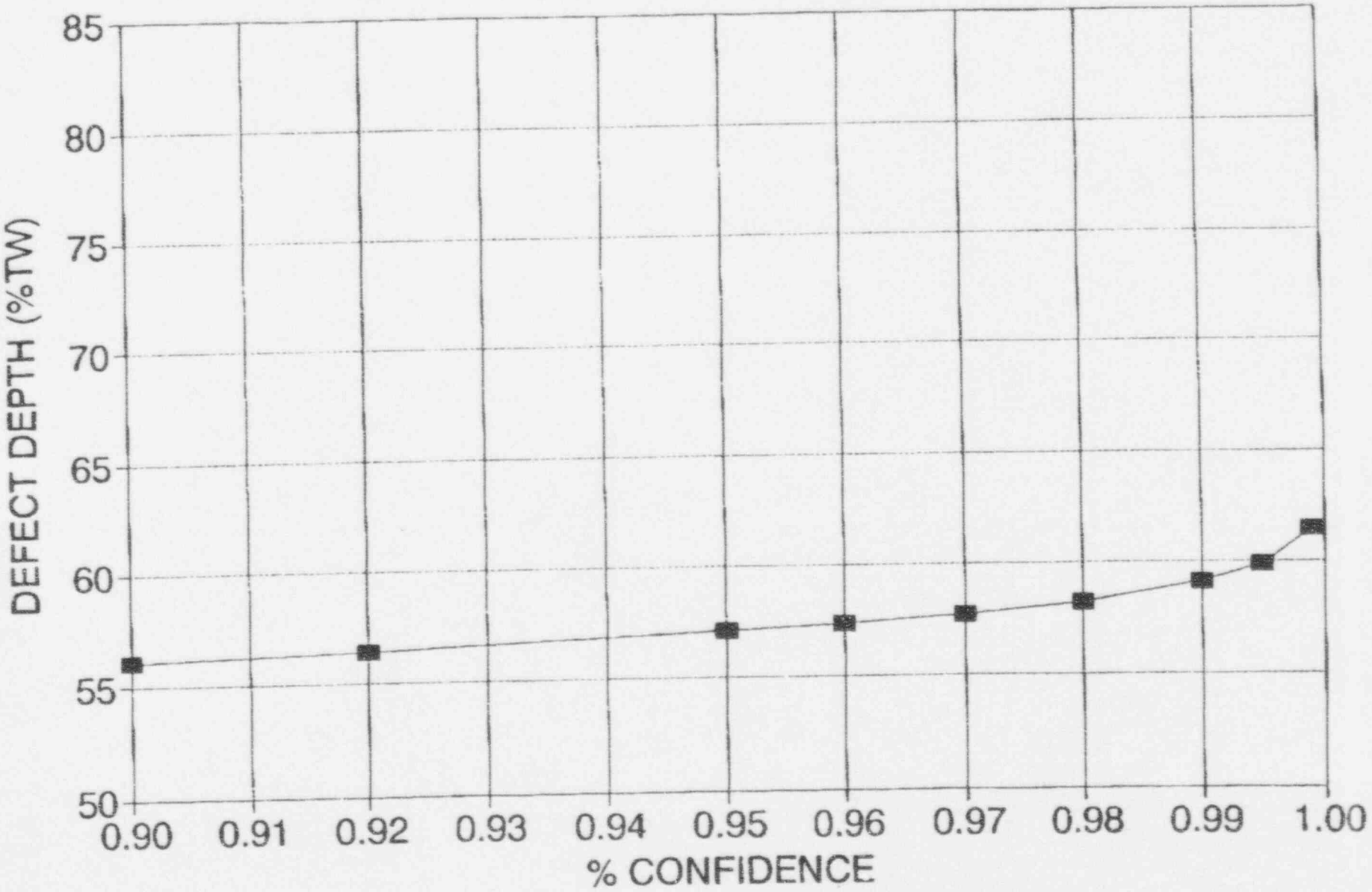
DEFECT DEPTH % TW
62
24
30
30
49
24
51
6
8
5
5
5
4
29
16
54
46
4
1
44
48
54
14
27
49
8
51
17
18
18
22
25
24
40
29

PULLED TUBES
ACTUAL MEASURED DEFECT DEPTH



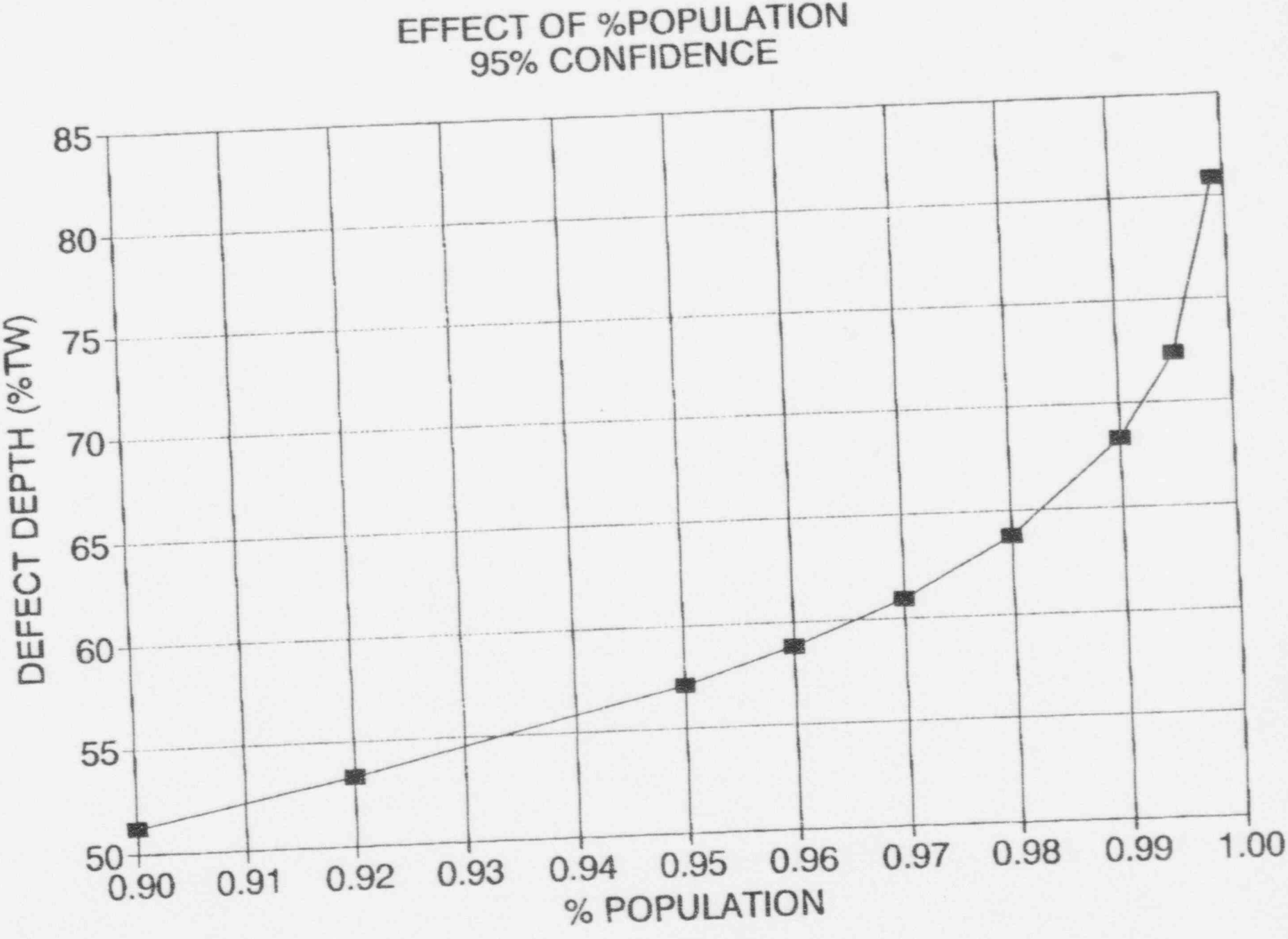
MPR Associates
April 5, 1994

APR-08-1994 15:17 MPR ASSOCIATES INC. 703 519 0224 P.02



MPR Associates
April 5, 1994

APR-08-1994 15:18 MPR ASSOCIATES INC. 703 519 0224 P.04



MPR Associates
April 5, 1994