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AUTH. NAME AUTHOR AFFILIATION
TUCKER, H. B. Duke Power Co.
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SUBJECT: Forwards short-duration mass-point testing termination criteria re containment integrated leak rate testing for review, per 870212 meeting w/NRC in Bethesda, MD. Criteria also to be used to satisfy Paragraph 7.6 of ANSI-N45.5. Fee paid.

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DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
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TELEPHONE
(704) 373-4531

September 17, 1987

U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
McGuire Nuclear Station
Docket Nos. 50-369, -370
Catawba Nuclear Station
Docket Nos. 50-413, -414
Containment Integrated Leak Rate Testing
Short Duration Mass-Point
Testing Termination Criteria

Gentlemen:

On February 12, 1987, a meeting was held in Bethesda with members of NRC Staff and Duke Power Company to discuss Containment Integrated Leak Rate Testing (CILRT). One of the topics of discussion was termination criteria for CILRTs of less than 24-hour duration. It was agreed that Duke would develop a set of criteria and submit them to the Staff. Accordingly, attached for your review are Short-Duration Mass-Point Testing Termination Criteria.

Please note that these criteria will be used to satisfy Paragraph 7.6 of ANSI-N45.5, i.e., demonstrate "to the satisfaction of those responsible... that the leakage rate can be accurately determined during a shorter test period". This letter does not supercede or alter any of the positions presented in H. B. Tucker's letter of September 1, 1987, which requested that a backfit analysis be performed on the current Staff position on 10 CFR 50 Appendix J.

Also attached is a check in the amount of $150.00, pursuant to 10CFR 170.21.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

SAG/132/sbn

Attachment

A017
w/check $150
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xc: Dr. J. Nelson Grace, Regional Administrator
U.S. Nuclear Regulatory Commission - Region II
101 Marietta Street, Suite 2900
Atlanta, Georgia 30323

Executive Director for Operations
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. K.N. Jabbour, Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Ms. Helen Pastis, Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Darl Hood, Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. P.K. Van Doorn
NRC Resident Inspector
Catawba Nuclear Station

Mr. W.T. Orders
NRC Resident Inspector
McGuire Nuclear Station

Mr. J.C. Bryant
NRC Resident Inspector
Oconee Nuclear Station

ATTACHMENT I
DUKE POWER COMPANY
REDUCED DURATION CONTAINMENT INTEGRATED
LEAKAGE RATE TESTING TERMINATION CRITERIA

INTRODUCTION

The mass point technique for data analysis described in ANSI/ANS 56.8-1981 is the preferred industry standard for reduction of integrated leakage rate test data. Several methods for performance of reduced duration mass point leak rate tests have been proposed in recent years, one of which was offered for comment in the supplemental draft Regulatory Guide, MS 021-5. Considering the preferred standard and the provision allowing for test durations less than 24 hours clearly stated in ANS N45.4-1972, the mass point termination criteria described by this policy will be adopted by Duke Power Company for all future CILRT's conducted in less than 24 hours.

REDUCED DURATION TERMINATION CRITERIA

1. **ANSI/ANS 56.8 Criteria**

   a. The mass point 95 percent upper confidence limit (UCL) leak rate shall be less than 75 percent of the maximum allowable leakage (L_a).

   b. The test duration shall be a minimum of eight hours.

   c. The test shall be of sufficient duration to satisfy the Instrumentation Selection Guide (ISG) as described in Section 4.0 of ANSI/ANS 56.8.

   Basis - The mass point data reduction technique as described by ANSI/ANS 56.8 is the preferred standard for statistical analysis of CILRT test data. Exceptions allowing for the mass point technique are included in each station's technical specifications. The proposed Appendix J refers to draft Regulatory Guide MS 021-5, which cites 56.8 for details on testing technique and analyses. Referencing 56.8 reflects the improvements in test methods due to advances in computer and instrument technology; therefore, all test duration requirements specified by 56.8 are included in this policy.

2. The **"Limit on Data Scatter"** (inequality 2.1) presented in draft Regulatory Guide MS 021-5 shall be satisfied. Algebraically, this condition is satisfied when the ratio of the left hand side of inequality 2.1 over the right hand side of inequality 2.1 is greater than 1.0.

Basis - The limit on data scatter criterion ensures a tight fit of the test data about the linear least squares fit regression line; thereby, providing additional confidence in the validity of the final test result.

3. The **"Predictor Criterion"** as outlined in T.M. Brown's and L.F. Estenssoro's paper, "Suggested Criteria for a Short Duration ILRT ", shall be satisfied. This condition is met when the predictor equation result is less than 25 percent.

   Basis - Satisfying this criterion ensures that the measured leakage rate (L_{am}) and the 95 percent upper confidence limit (UCL) leakage rate are converging. In addition, the predictor equation will provide reasonable assurance that the leakage rate reported following test termination will result in the verification test meeting its acceptance criterion.

4. **One-Half Maximum Window Leakage Criterion** - the measured leakage rate (L_{am}) for all time intervals equal to one-half of the test duration shall be less than 0.75 L_a. This criterion is accomplished by passing a window equal to one-half of the test duration through all data from time zero, and recording the value of the maximum leakage. As the test duration increases in time, the window duration correspondingly increases. The time at which the maximum value of the window leakage is less than 0.75 L_a is the point where this criterion is met.

   Basis - The draft Regulatory Guide MS 021-5 introduces a statistical test, Condition 1, which sets a limit on curvature. Condition 1 is satisfied when one of the inequalities, equation 1.1 or 1.2 is met. Extensive comments prepared by Bechtel Power Corporation concerning the "Extended ANSI Acceptance Criteria" were submitted to the NRC on January 9, 1987. The results of this analysis for 14 cases shows the erratic behavior of inequalities 1.1 and 1.2 with no observable trending. An analysis documented by the April 21, 1987 Duke Power Company draft Regulatory Guide comments yields similar results.

   Based on the erratic behavior of inequalities 1.1 and 1.2, it was concluded that the proposed limit on curvature was unreasonable. As an alternative to Condition 1, Bechtel proposed the maximum window leakage criterion. When analyzing leak rate data for several CILRT's, Bechtel noticed that the leak rate results often moved in and out of acceptability, depending on the start time chosen and the duration of the leakage rate analysis. The maximum window leakage criterion was adapted from a methodology for "Goodness of Fit

Significance Tests" from the book, Probability, Statistics and Decision for Civil Engineers (Benjamin, Jack R. and C. Allen Cornell, McGraw Hill Book Co., N.Y., 1970, pp. 459-461).

Employing the window criterion for sequential time intervals equal to t/2, starting from time zero provides the following safeguards:

a. Assurance that the leakage rate for the chosen time period is not the only acceptable time period for the test.

b. Assuming that the leakage path area remains constant throughout the test period, the mass change in containment should decrease linearly. This criterion will not be satisfied until twice the time interval at which the measured leak (L_{am}) crosses the .75 L_a acceptance line; thereby, providing a conservative safety margin.

c. If another leakage path develops later in the test, the earlier mass points will not mask the maximum window leakage calculation for the later test periods. The window calculation will force a longer test duration as a result of a leak developing later in the test. This characteristic provides an additional check for nonlinear intervals of test data.

TEST CASE RESULTS

Attachment II, Table 1 presents the results of the application of the mass point termination criteria to data files obtained from five Duke Power CILRT's. Attachment III presents plots of the termination criteria for each of the test cases.

ONS1 and ONS3 require a 24 hour test duration due to failure to meet the maximum window leakage criterion. For ONS3 the test was started before complete mass stabilization was achieved, even though the temperature stabilization criterion of 56.8 was met. If the start time is moved forward eight hours, the window criterion is met in 9.8 hours; however, the data scatter criterion becomes the limiting condition since it requires 10.8 hours. For ONS1, the measured leak, L_{am} does not cross the 0.75 L_a acceptance line for 19.5 hours; consequently, the window criterion cannot be met in less than 24 hours. MNS1 and MNS2 meet all termination criteria in 9.2 hours and 10.0 hours respectively. For both MNS1 and MNS2, the UCL leak rate crosses the acceptance line in such a short time period that the predictor criterion becomes the limiting condition.

CNS1 requires 18.0 hours before all termination criteria are met.

Table 2 of Attachment II presents a comparison of the reduced duration UCL leak rate with the 24 hour UCL leak rate for those test cases where the termination criteria for reduced duration testing are satisfied. In all cases the reduced duration leak rate is greater than the 24 hour leak rate result.

The measured CILRT leakage approaches an asymptotic value of leak rate after a sufficient time period has elapsed. The purpose of the CILRT is to ensure that the leak rate value measured at test termination is **less than** the maximum allowable leakage, not to determine the absolute leak rate. By ensuring that the leak rate value is less than 75 percent of the maximum allowable leakage and by placing a statistical upper bound on the true leakage rate adds considerable conservatism to the final test result. Each of the four termination criteria addresses specific concerns that provide additional safeguards to ensure that the leak rate value determined is indeed less than the maximum allowable leakage.

REFERENCES

ANSI/ANS 56.8 - 1981, Containment System Leakage Testing Requirements, American Nuclear Society, La Grange Park, Il., 1981.

ANS N45.4 - 1972, Containment System Leakage Testing Requirements, American Nuclear Society, La Grange Park, IL., 1972.

Bechtel Corporation, "Comments on the 'Extended ANSI' Acceptance Criteria of Proposed Regulatory Guide MS 021-5", prepared for USNRC Docketing Service Branch, January 9, 1987.

Bechtel Corporation, Topical Report BN-TOP-1, Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants, Revision 1, November 1, 1972.

Benjamin, Jack R. and C. Allen Cornell, "Goodness of Fit Significance Tests", Probability, Statistics and Decision for Civil Engineers, McGraw Hill Book Co., NY, 1970.

Brown, Ted and Louis Estenssoro, "Suggested Criteria for a Short Duration ILRT", Proceedings of Reactor Operation Division Workshop, American Nuclear Society, San Diego, Ca., January 18-19, 1982.

US Nuclear Regulatory Commission, Draft Regulatory Guide and Value/Impact Statement, "Containment System Leakage Testing", Task MS 021-5, Division 1, October, 1986.

Young, Larry R., "Methods for Determining Integrated Leakage Rate Test Duration - Case Studies", Proceedings of the Third Workshop on Containment Integrity NUREG/CP-0076, prepared for USNRC by Sandia National Laboratories, August 1986.

ATTACHMENT II
DUKE POWER COMPANY
TABULATION OF RESULTS

Table 1
Mass Point Termination Criteria Test Cases

(Time in hours at which each criterion is met.)

Station	Test Date	UCL	Max Window	Data Scatter	Predictor	All Criteria Satisfied
ONS3	3/87	17.0	* NS	12.2	12.8	NS
ONS1	4/86	20.2	* NS	4.8	6.0	NS
MNS1	8/86	5.7	8.4	6.6	* 9.2	9.2
MNS2	5/86	5.0	7.7	8.5	*10.0	10.0
CNS1	1/84	10.0	*18.0	14.5	13.7	18.0

NS - Never Satisfied
* - Limiting Condition

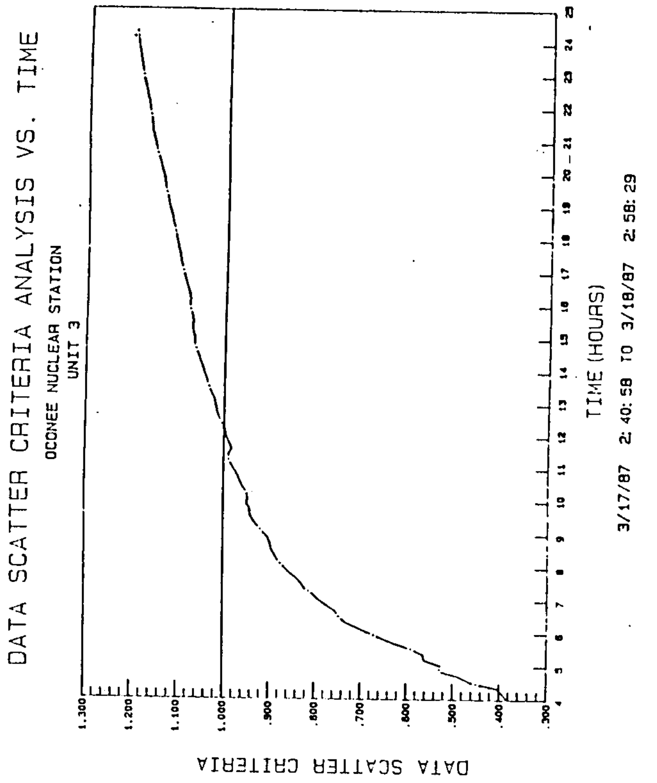
Table 2
$UCL(t_t)$ / $UCL(t_{24})$ Comparison

Station	$.75L_a$ (wt %/day)	t_t (hrs)	$UCL(t_t)$ (wt %/day)	$UCL(t_{24})$ (wt %/day)	% Difference
ONS3	0.132	N/A	-	0.10474	-
ONS1	0.187	N/A	-	0.17366	-
MNS1	0.225	9.2	0.15349	0.15276	+ 0.5%
MNS2	0.225	10.0	0.12154	0.08293	+46.6%
CNS1	0.150	18.0	0.11165	0.10991	+ 1.6%

where: $UCL(t_t)$ = UCL when all termination criteria are met.
$UCL(t_{24})$ = UCL at 24 hours.
t_t = time when all termination criteria are met.

$$\% \text{ Difference} = \frac{UCL(t_t) - UCL(t_{24})}{UCL(t_{24})} \times 100\%$$

mah-01, tilrt.txt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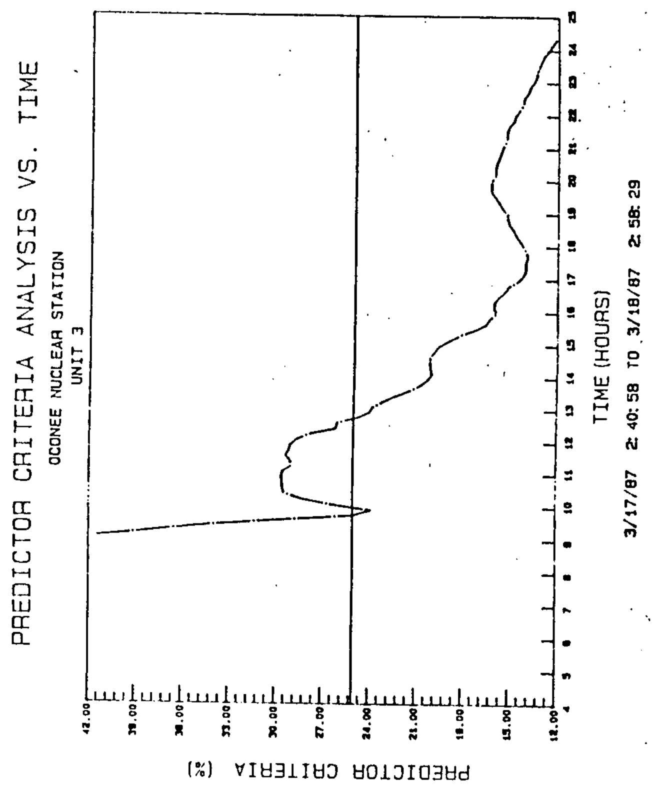
DATA SCATTER CRITERIA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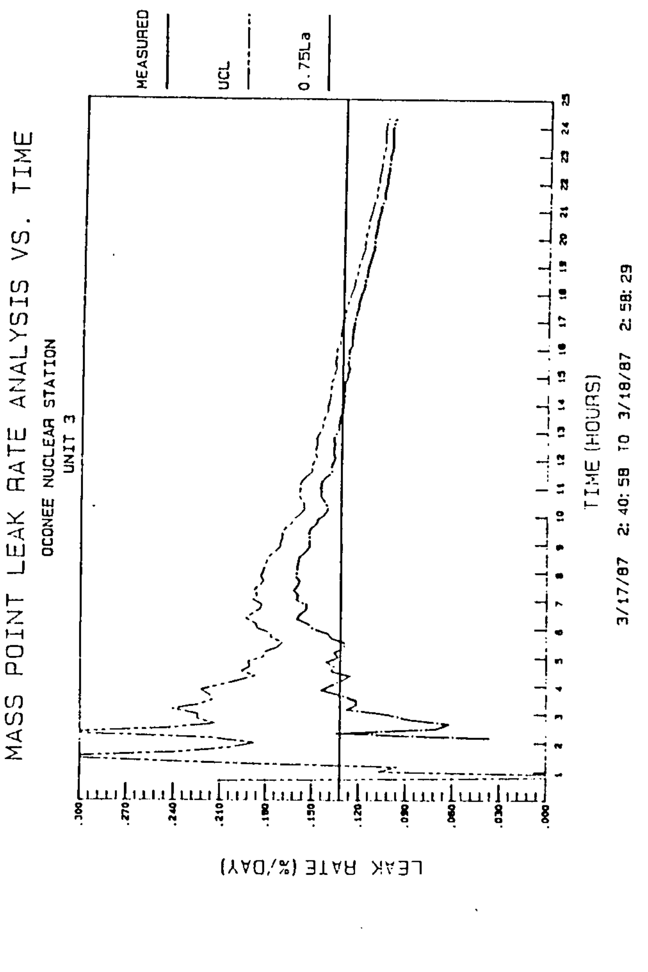
PREDICTOR CRITERIA (%)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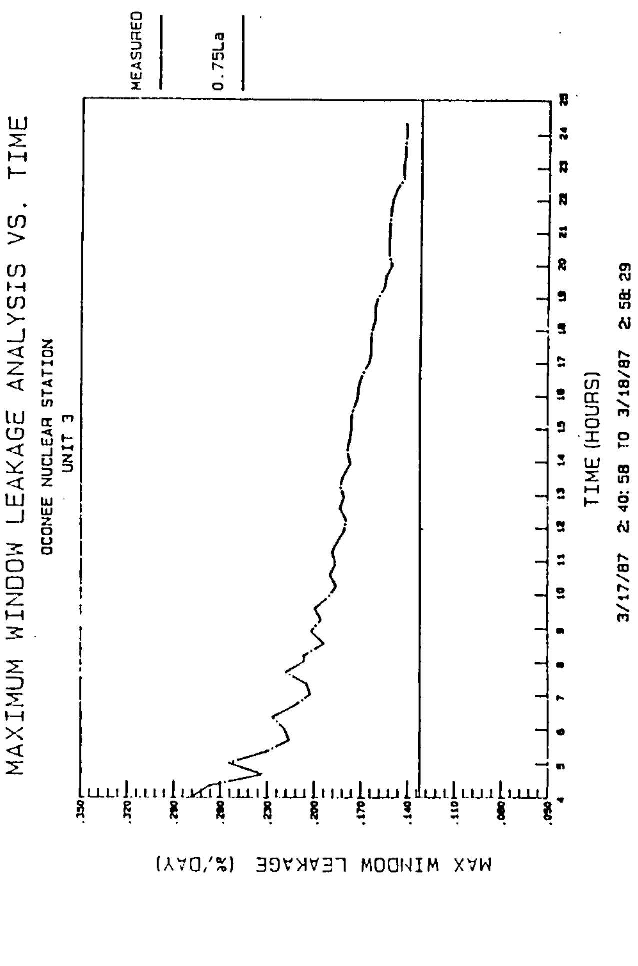
LEAK RATE (%/DAY)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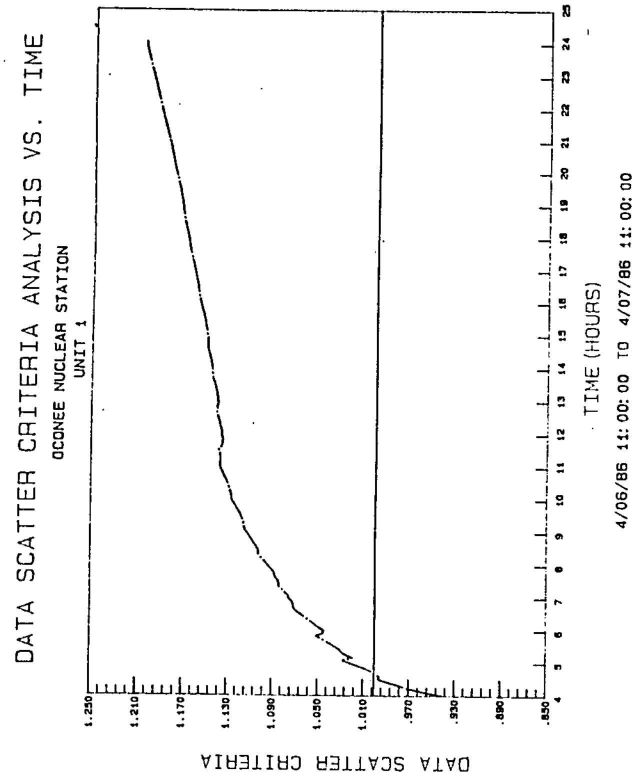
MAX WINDOW LEAKAGE (%/DAY)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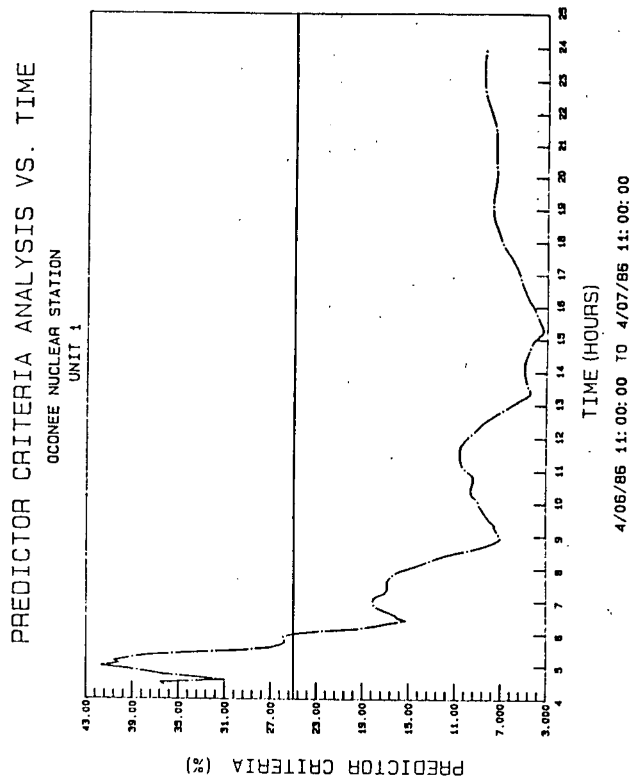
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PREDICTOR CRITERIA (%)
TIME (HOURS)
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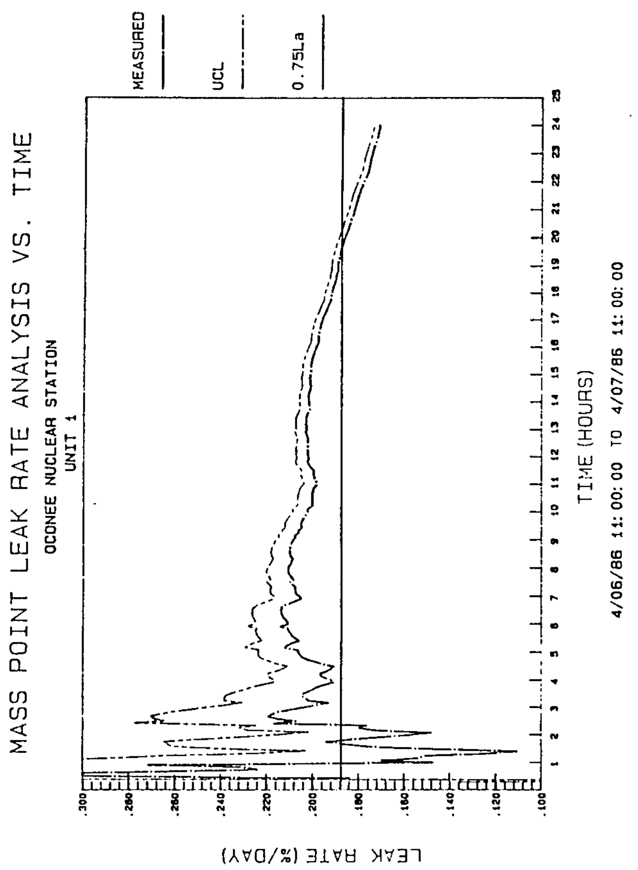
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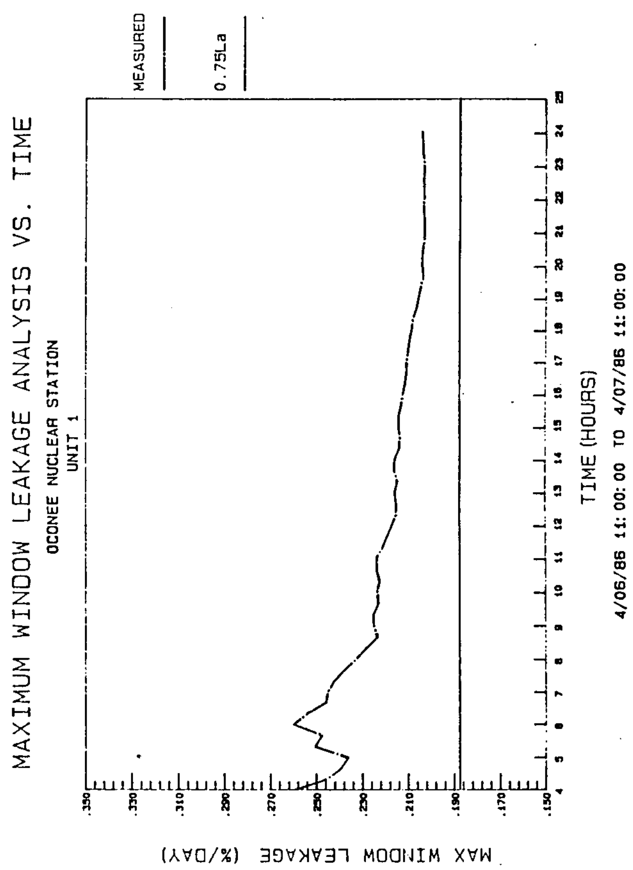
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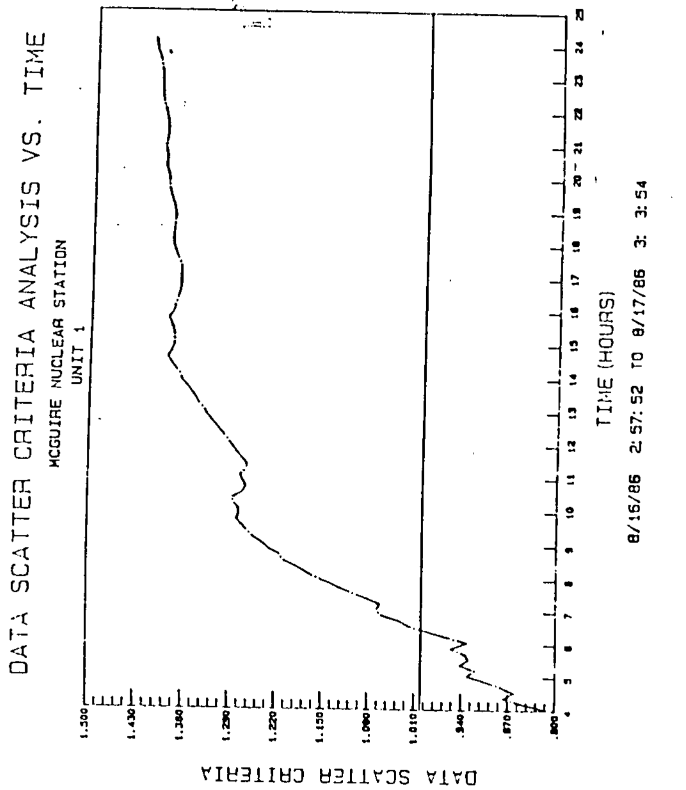
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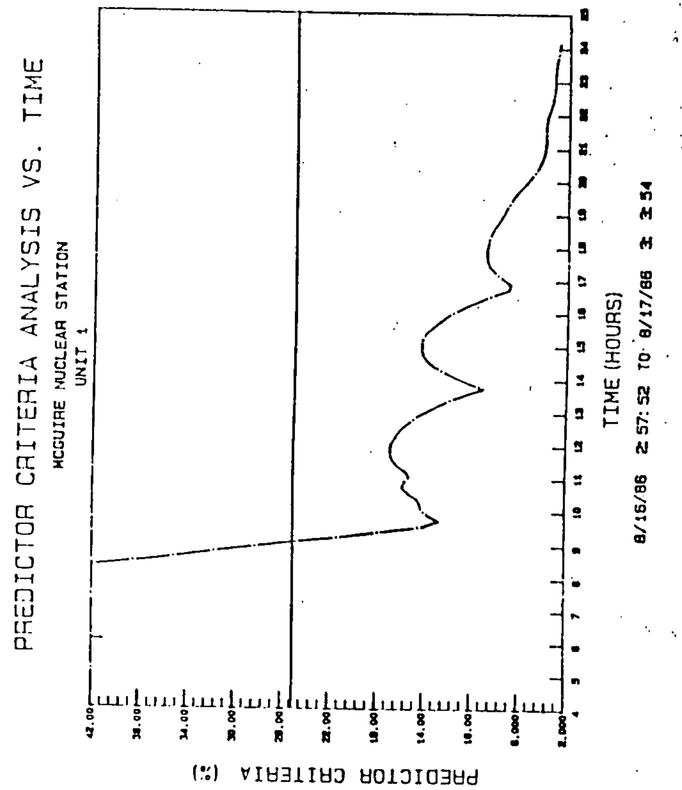
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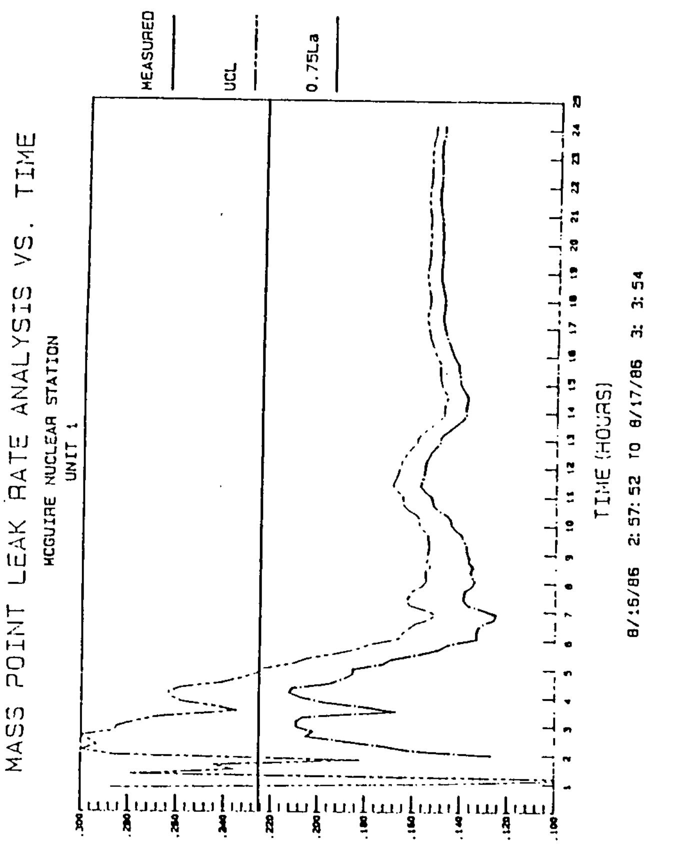
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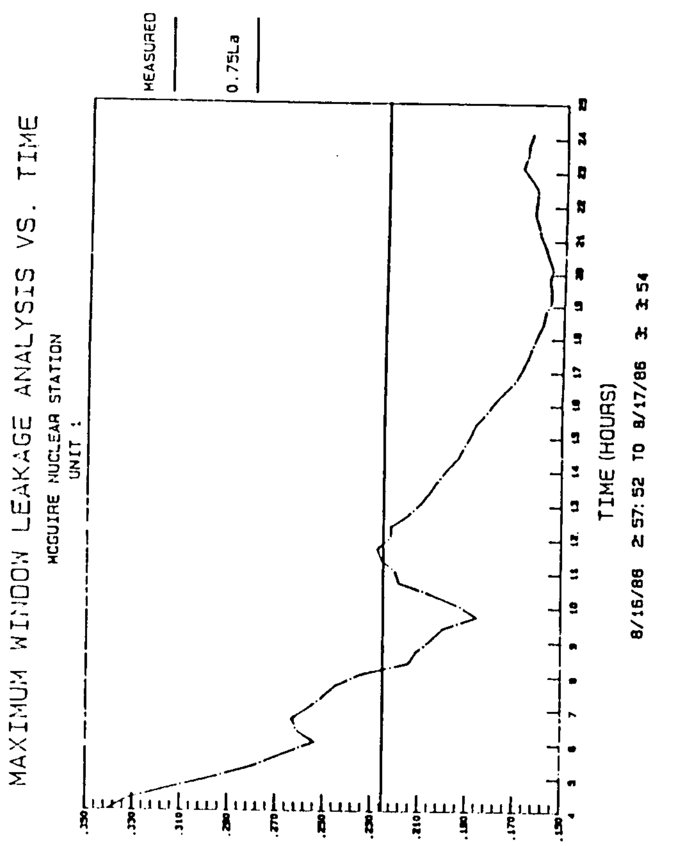
LEAK RATE (%/DAY)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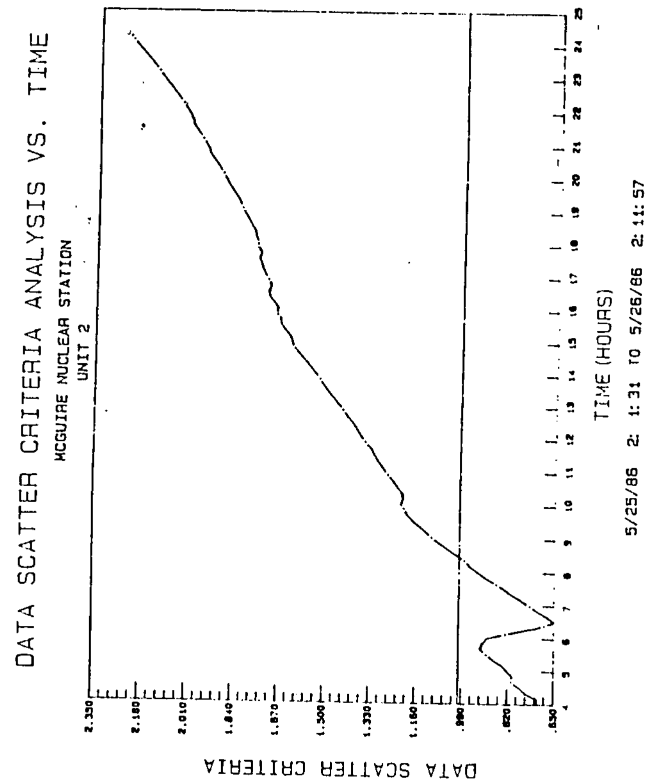
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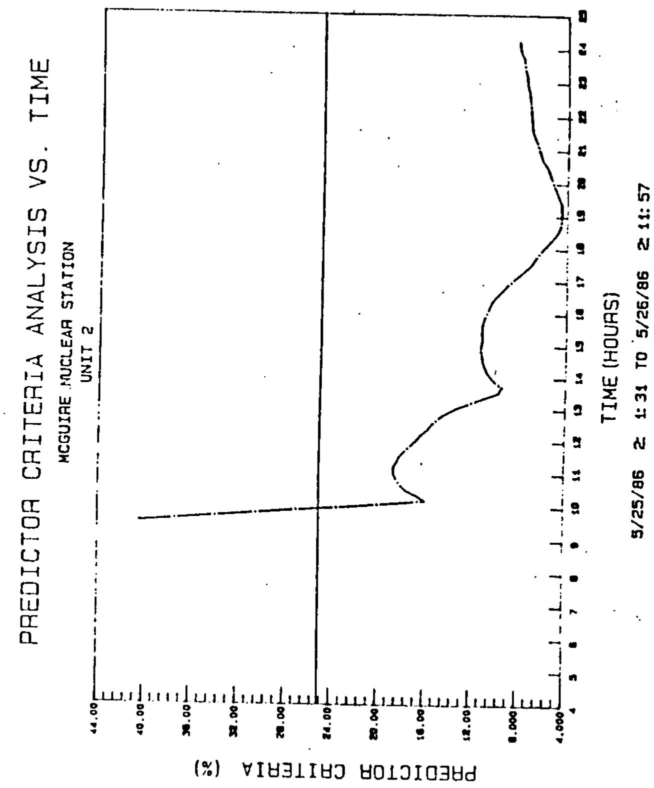
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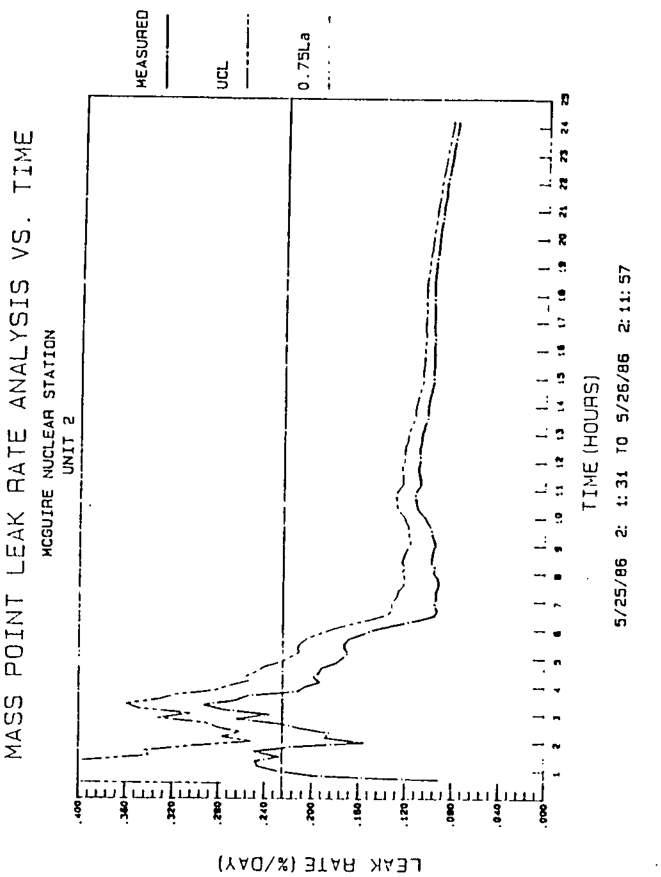
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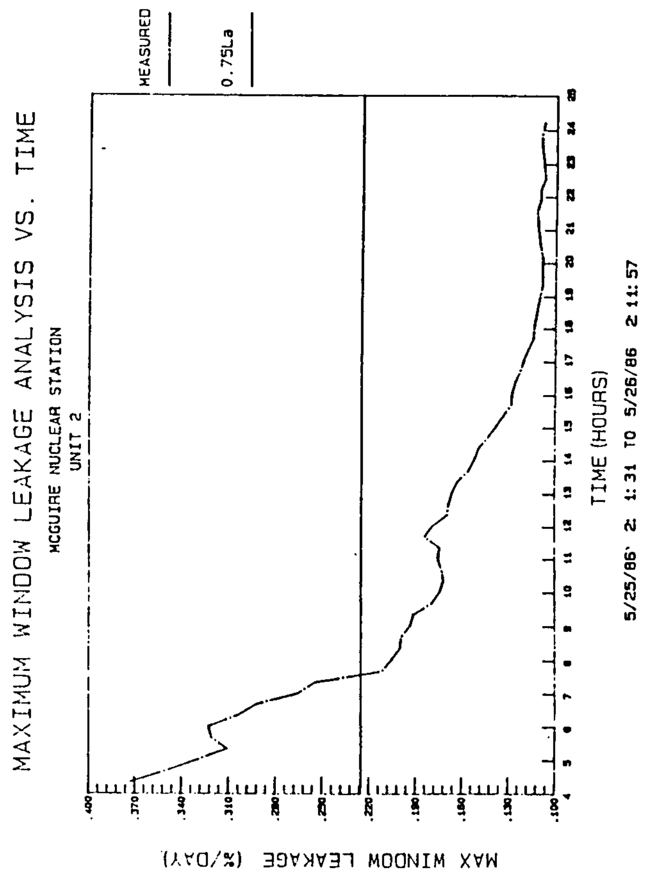
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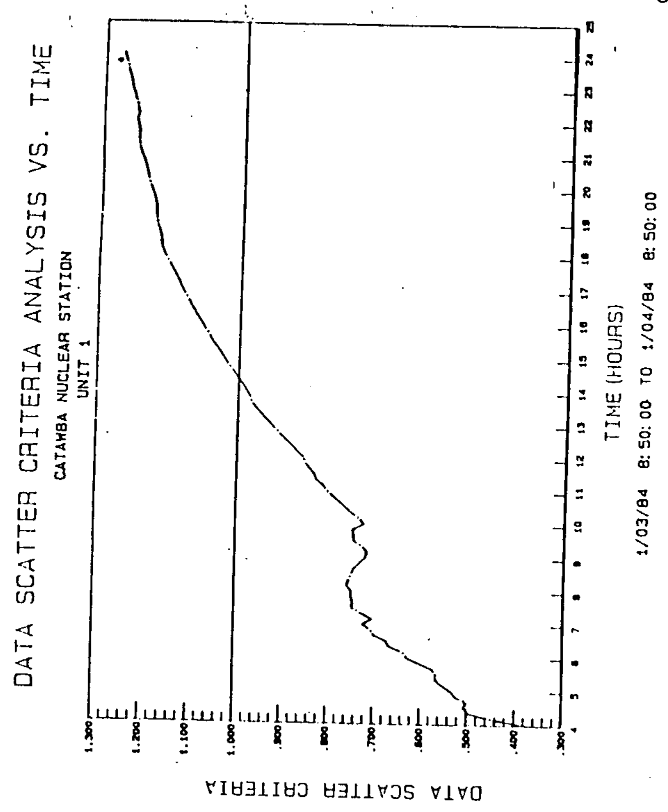
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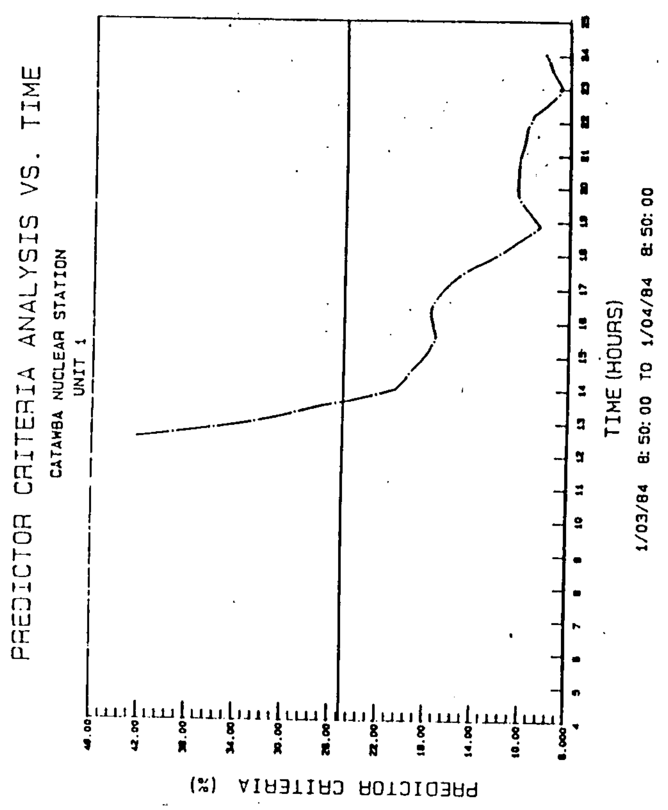
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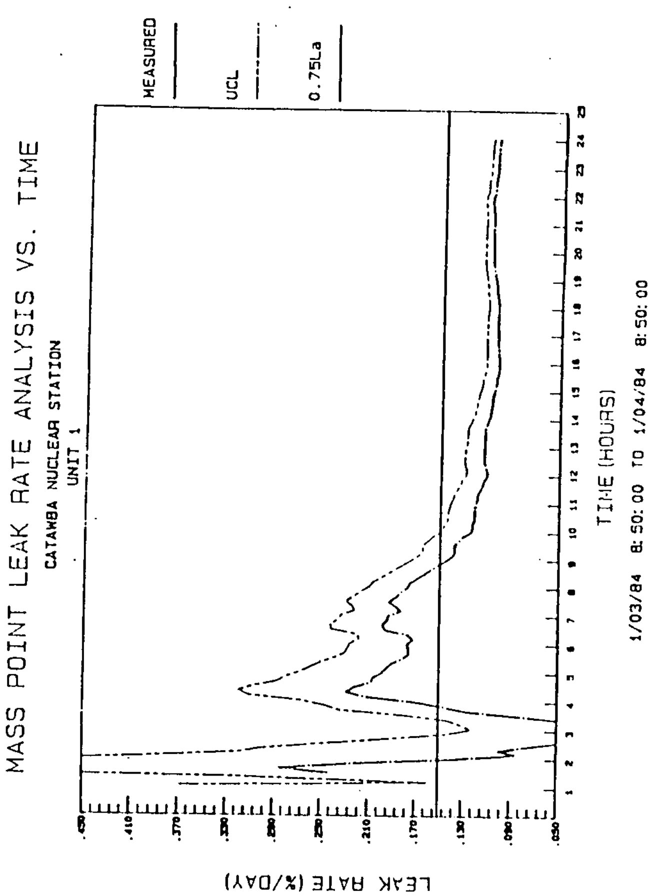
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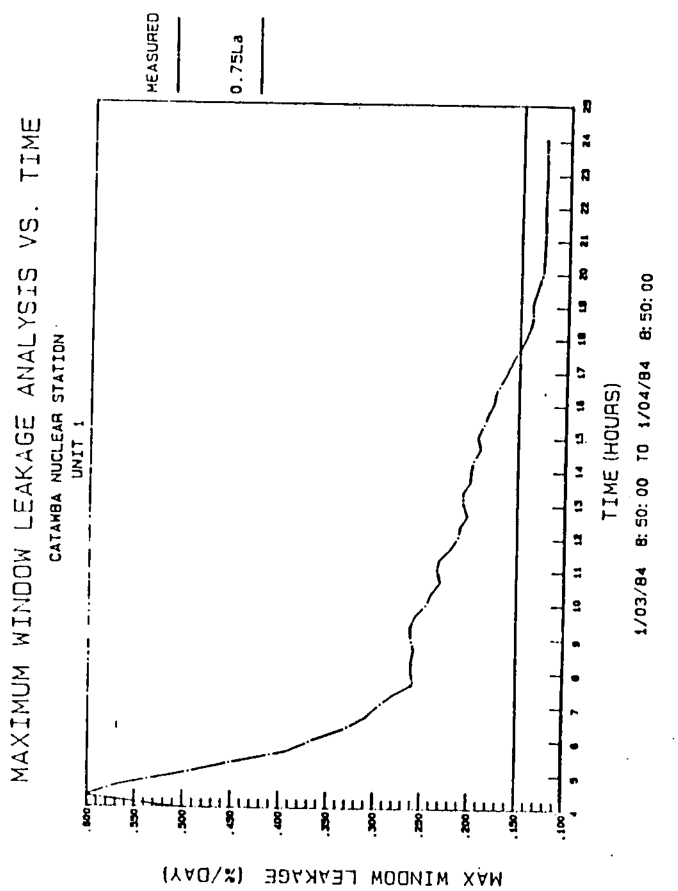
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