UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 4 1989

MEMORANDUM FOR: Distribution

FROM: Roger M. Kenneally
Seismic Subcommittee
External Events Steering Group

SUBJECT: SUMMARY OF SEPTEMBER 21, 1989 MEETING WITH NUMARC

On September 21, 1989, the Seismic Subcommittee, External Events Steering Group met with representatives of NUMARC and their consultants. The purpose of the meeting was for the subcommittee to discuss seismic issues related to individual plant examination for external events (IPEEE). In particular, the subcommittee wanted to be briefed on (a) industry's approach to determining the review level earthquake ground motion, and (b) industry's interim procedures to address high-frequency ground motions in seismic margin assessments. Enclosure 1 is a list of meeting attendees.

James Whitcraft, NUMARC, gave a short introduction about the industry's presentation which would highlight material from a draft report given to the subcommittee prior to the meeting. Dr. Robert Sewell discussed the review level earthquake issue; however, discussions on the high-frequency issue were deferred since Dr. John Reed could not be present. A meeting on that subject could be arranged later if the subcommittee wanted one.

Mr. Whitcraft inquired about the current schedule for issuing the external event generic letter. He was informed that a draft generic letter would be given to Mr. Shao, External Events Steering Group (EESG) Chairman on September 28, 1989. The EESG and their subcommittees would meet with the ACRS and CRGR during October or November. It is anticipated that the generic letter would be published by the end of this year.

Dr. Leon Reiter, Seismic Subcommittee Co-Chairman, questioned Mr. Whitcraft about the September 8, 1989 IPEEE presentation by NUMARC's William Rasin to the ACRS. Mr. Rasin told the ACRS that NUMARC is separating the Charleston earthquake issue from the IPEEE. Dr. Reiter explained that the approach being taken by the subcommittee is that while resolution of the "Charleston Issue" as such may be seperate, any action stemming from that resolution would be integrated into the IPEEE.

Dr. Sewell gave an update on industry's July 20, 1989 presentation to the subcommittee on review level earthquake determination (Enclosure 2 is a copy of the presentation material used). Industry's approach to the seismic aspect of the IPEEE is to reduce plant risk to the point that the resulting plant safety level is generally consistent with the NRC Safety Goal. They are assuming Safety Goal applicability at the plant level. NUMARC staff and their consultants were reminded by the subcommittee that the Safety Goal provides targets for generic regulatory requirements and not criteria for individual

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licensing decisions. In addition, they were informed that the application of the Safety Goal to existing plants has not been determined by the Commission although a core damage frequency of IE-05 for advanced reactors has been cited by NRC management.

The graphics on Dr. Sewell's presentation material used numbers rather than names to reference the various plant sites. The staff strongly recommended that NUMARC provide a cross-reference between number and site. This would enable a comparison between staff and industry proposed criteria for determining the review level earthquake. Mr. Whitcraft, acknowledging the usefullness of that information stated it was unavailable per the request of some utilities.

Next, Dr. Sewell briefly described the industry program to integrate containment performance into the IPEEE. They are recommending that the IPEEE should critically examine components that support containment cooling and containment isolation in addition to core cooling. They were informed that their approach is quite similar to the one being developed by the subcommittee.

During the concluding discussions, the subcommittee recommended a follow-up meeting to discuss the high-frequency ground motion issue with Dr. Reed. A second topic that should be discussed at that meeting is how to specify the spectrum for an IPEEE seismic margins evaluation. Should it be site specific, NUREG/CR-0098 or something else? Mr. Whitcraft will try to arrange a meeting in early October.

Roger M Kenneally

Roger M. Kenneally
Seismic Subcommittee
External Events Steering Group

Enclosures:
1. Meeting Attendees
2. Review Level Earthquake Motions for Resolution of Seismic Severe Accident Issues

OCT 4 1989

Distribution:

L. C. Shao
R. W. Houston
T. M. Novak
J. E. Richardson
G. Bagchi
A. J. Murphy
L. Reiter
J. Chen
N. Chokshi
D. Jeng
G. Kelly
T. Y. Chang
C. Stepp, EPRI
R. T. Sewell, Risk Engineering
J. Whitcraft, NUMARC
R. Rothman
D. Guzy
C. Seiss, ACRS
E. Beckjord
D. Ross
T. Speis
T. Murley
F. Miraglia
PDR

Enclosure 1

September 21, 1989

NRC/NUMARC MEETING

Roger Kennewlly	NRC/RES	301 492 3893
Nilesh Chokshi	NRC/RES	301 492 3947
CARL STEPP	[redacted] EPRI	415 855 2103
Robert T. Sewell	Risk Engineering	303 278 3800
ROBERT L ROTHMAN	NRC/NRR	301 492 0844
Dan Guzy	NRC/RES	301-49[illegible]
Andrew Murphy	NRC/RES	301-492-3860
JOHN T. CHEN	NRC/RES	301-492-3919
Leon Reiter	NRC/NRR	301-492-0891
Jim WHITCRAFT	NUMARC	202-872-1280

Enclosure 2

REVIEW LEVEL EARTHQUAKE MOTIONS FOR RESOLUTION OF SEISMIC SEVERE ACCIDENT ISSUES

Prepared By:

Robert T. Sewell
Robin K. McGuire

RISK ENGINEERING, INC.

Presented At:
NRC/NUMARC Meeting
Washington D.C.

September 21, 1989

TOPICS

- **BACKGROUND:** SEISMIC SEVERE ACCIDENT ISSUES
- **APPROACH:** PROBABILISTIC SAFETY-GOAL BASIS
- **METHOD:** REVIEW LEVEL EARTHQUAKE (RLE) SPECTRUM DETERMINATION
- **RESULTS:** RLE SPECTRA AND INDUSTRY-WIDE IMPLICATIONS
  - EPRI Hazard Input
  - LLNL Hazard Input
- **DISCUSSION:** ADDITIONAL ASPECTS OF SEISMIC SEVERE ACCIDENT POLICY

— BACKGROUND —

NRC PROGRAM FOR INTEGRATED CLOSURE OF SEVERE ACCCIDENT POLICY (SAP)

SIX MAJOR ELEMENTS:

1. IPE — Individual Plant Examination.
   - Systematic examination of existing plants for severe accident vulnerabilities.

2. CPI — Containment Performance Improvements.
   - Develop generic improvements for major containment types.

3. IPO — Improved Plant Operations.
   - Develop improved NRC and utility programs for plant operations.

4. SARP — Severe Accident Research Program.
   - Research on severe accident processes.

5. EEP — External Events Program.
   - Identify external events requiring severe accident examination.
   - Develop procedures to conduct Individual Plant Examinations for External Events (IPEEEs).

6. AM — Accident Management.
   - Develop and implement plant-specific, severe-accident management plans.

— BACKGROUND —

SEISMIC SEVERE ACCIDENT ISSUES

- SEISMIC SEVERE ACCIDENT POLICY (SSAP) HAS SAME OBJECTIVES AS SAP FOR INTERNAL EVENTS — SEISMIC EVENTS FOLDED INTO SAP INTEGRATED RESOLUTION PLAN.

- PRIMARY FOCUS HAS BEEN ON DETERMINING PROCEDURES FOR INDEPENDENT PLANT EXAMINATIONS FOR SEISMIC EVENTS (IPESE or IPEEE–SEISMIC).

— BACKGROUND —

OBJECTIVES OF IPESE

S–A. Develop an appreciation of severe accident behavior resulting from seismic initiators.

S–B. Understand the most-likely seismic severe accident sequences that could occur at the plant.

S–C. Gain a more quantitative understanding of the seismic probabilities of core damage and fission-product releases.

S–D. Reduce plant risks, if necessary, by appropriate modifications to procedures and hardware that would help prevent or mitigate severe seismic accidents.

- The resulting plant safety levels should be generally consistent with NRC safety goals.

S–E. Coordinate the IPESE effort with other NRC seismic safety programs (e.g., A–46 and Seismic Margins) and with the overall systematic examination IPE program.

— APPROACH —

PROBABILISTIC RISK-ACCEPTANCE BASIS

- USE NRC SAFETY-GOAL-CONSISTENT CRITERIA TO DEFINE ADEQUATE OVERALL PLANT SAFETY LEVELS.

- SEISMIC SAFETY GUIDELINES ARE DERIVED FROM GENERAL SEISMIC FRACTION OF TOTAL RISK OBTAINED IN PAST PRAs.

- PROBABILISTIC SEISMIC HAZARD RESULTS ARE USED WITH SEISMIC SAFETY GUIDELINES TO DETERMINE A REVIEW-LEVEL EARTHQUAKE (RLE) SPECTRUM.
  - The RLE is the plant HCLPF capacity needed to satisfy the seismic safety guideline, in face of the site seismic hazard.

- THE RLE SPECTRUM DETERMINES THE TYPE OF IPESE TO PERFORM. IF THE IPESE SHOWS A CAPACITY GREATER THAN OR EQUAL TO THE RLE SPECTRUM, THEN THE PLANT HAS A GENERALLY ACCEPTABLE LEVEL OF SEISMIC SAFETY.
  - This approach for determination and use of the RLE satisfies (at least partially) IPESE objectives [S–C] and [S–D].
  - This approach is consistent with the intended use of safety goals in resolving SAP (Stello, 1988).

— APPROACH —

PROBABILISTIC SAFETY GOALS

NRC STAFF PERSPECTIVES ON SAFETY GOALS:

- Safety Goals are "targets" for regulatory requirements but not criteria for individual licensing decisions.

- A general hierarchical approach, as suggested by the ACRS should be followed.

- Large release should be defined as one with a potential for causing an offsite early fatality. Quantitative surrogate: a release that results in at least one early fatality.

- Mean frequency of core damage (i.e., loss of core cooling) should not exceed 1.0×10^{-4}/r-yr (for all internal and external events, excluding sabotage).

— APPROACH —

PROBABILISTIC SAFETY GOALS

ACRS HIERARCHY:

- Level 1: The August 4, 1986 qualitative safety goals.

- Level 2: The 1986 quantitative safety goals.

- Level 3: The 10^{-6} mean frequency of large release performance (consequence mitigation) guideline.

- Level 4: The following performance objectives:

  - Accident Prevention: 10^{-4} Mean frequency of core damage.
  - Accident Mitigation: 10^{-1} chance of large release given any of the family of core-damage sequences.
  - Plant Operations: Undetermined criteria related to performance of safe plant operation.

- Level 5: Existing body of regulations, in end, modified to be consistent with safety guidelines.

LEVELS 2 TO 5 ARE MORE PRACTICAL SURROGATES (WITH INTENDED INCREASING CONSERVATISM) TO THE QUALITATIVE GOALS.

LEVEL 5 DEPENDS ON EVOLUTION OF REGULATIONS AND IS INAPPLICABLE, AT PRESENT, AS A PRACTICAL SURROGATE.

— APPROACH —

RLE SAFETY CRITERION

- RLE APPROACH USES SEISMIC SAFETY GUIDELINES AT ACRS LEVEL 4
  - Implies least effort in IPESE analyses.
  - Implements conservative and absolute safety comparison based on mean core-damage frequency.
  - Requires demonstration of accident mitigation capabilities in IPESE or IPE.

— APPROACH —

RLE SAFETY CRITERION

- SEISMIC SAFETY GUIDELINE IS BASED ON SEISMIC FRACTION OF TOTAL RISK, AS OBTAINED IN PAST PRAs (e.g., SEE NUREG–1150):

Plant	Mean Seismic Core-Damage Frequency (Per R-Year)	% of Total Core-Damage Frequency
Zion 1 & 2	5.6×10^{-6}	3
Indian Point 2	4.8×10^{-5}	30
Indian Point 3	2.5×10^{-5}	1
Limerick 1 & 2	4.0×10^{-6}	–
Millstone 3	9.4×10^{-5}	68
Seabrook 1 & 2	2.9×10^{-5}	13
Oconee 3	6.3×10^{-5}	25
Surry 1 & 2	2.5×10^{-5}	32
Peach Bottom 2 & 3	3.1×10^{-6}	11

- RLE COMPUTATIONS USE A MEAN SEISMIC CORE-DAMAGE SAFETY GUIDELINE OF 2.0×10^{-5}.

— METHODOLOGY —

STEPS IN RLE SPECTRUM DETERMINATION

1. SEISMIC HAZARD DESCRIPTION

   - Mean seismic hazard curves for 5 and 10-Hz spectral acceleration.

2. SEISMIC CAPACITY DESCRIPTION.

   - Core-damage fragility-curve families based on 5 and 10-Hz spectral acceleration (S_a).
   - Shape of fragility families are defined by generic parameters: $\beta_R = 0.22$ and $\beta_U = 0.24$.
   - 5 and 10-Hz S_a HCLPF capacities are used to scale the fragility shapes to obtain absolute core-damage fragility-curve families for 5 and 10-Hz S_a.

3. MEAN SEISMIC CORE-DAMAGE FREQUENCY ASSESSMENT.

   - Discretize hazard curves.
   - Numerically integrate the product, discretized hazard × fragility.
   - Obtain mean core-damage frequency by appropriately weighting each hazard/fragility combination.

— METHODOLOGY —

STEPS IN RLE SPECTRUM DETERMINATION (CONTINUED)

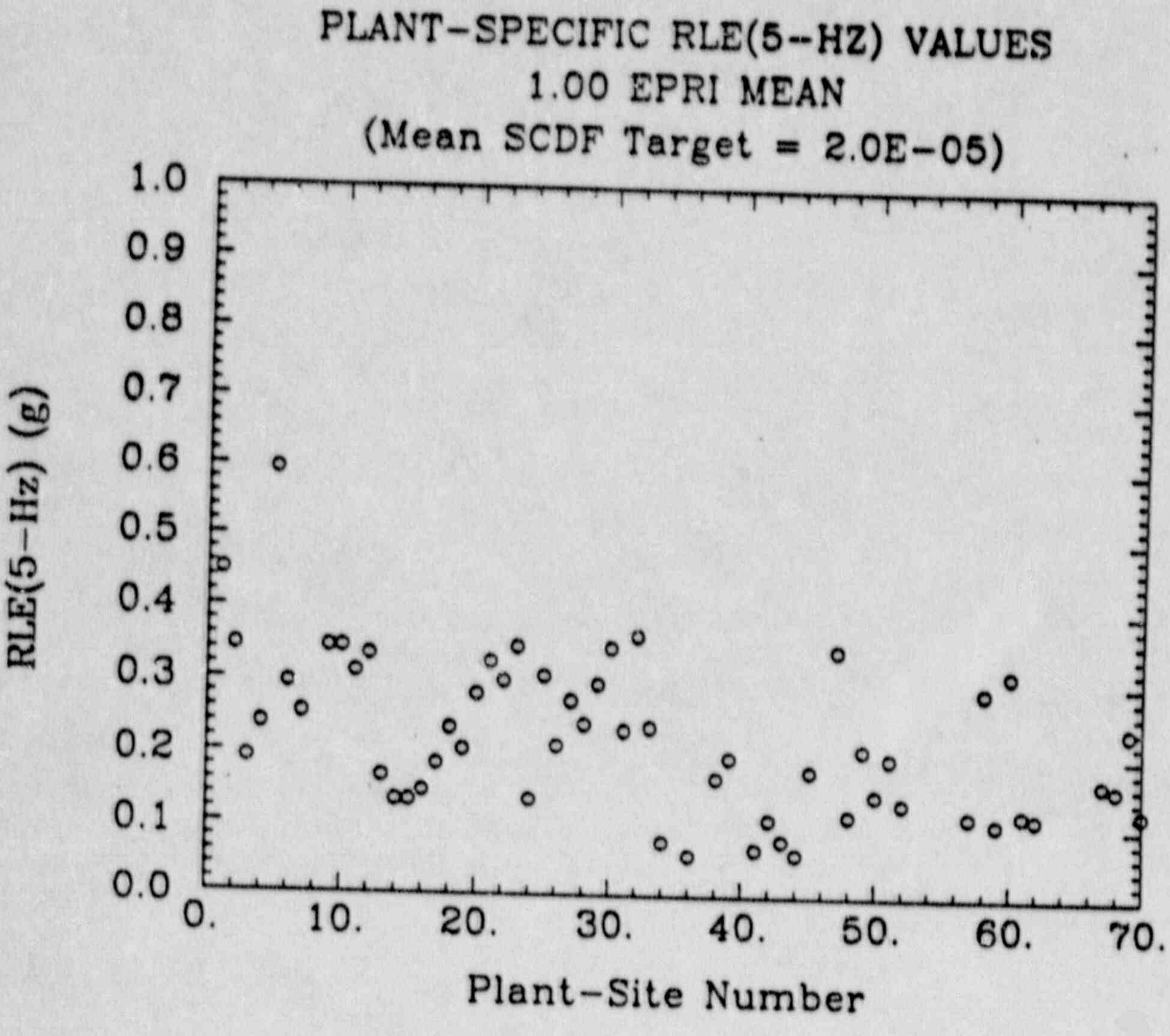
4. ITERATIVE DETERMINATION OF RLE VALUES.

   - By iteration, find RLE_{5-Hz} as the value of 5-Hz S_a HCLPF that results in a mean core damage frequency of 2.0×10^{-5}.
   - Repeat to find RLE_{10-Hz} as the 10-Hz S_a minimum required HCLPF.
   - Convert 5 and 10-Hz S_a HCLPFs from 50% to 84% non-exceedance probability HCLPFs by applying the factor $e^{\beta_{U}} \approx 1.2$.

5. DETERMINATION OF RLE SPECTRUM.

   - Find mean hazards $\overline{H}(RLE_5)$ and $\overline{H}(RLE_{10})$ by evaluating the mean 5 and 10-Hz S_a hazard curves, correspondingly, at values of RLE_5 and RLE_{10}.
   - Average the values $\overline{H}(RLE_5)$ and $\overline{H}(RLE_{10})$.
   - Obtain the RLE Spectrum as the site mean uniform hazard spectrum (UHS) anchored to the above average level of hazard.

— RESULTS —



PLANT-SPECIFIC RLE(5-HZ) VALUES
1.00 EPRI MEAN
(Mean SCDF Target = 2.0E-05)
RLE(5-Hz) (g)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
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20.
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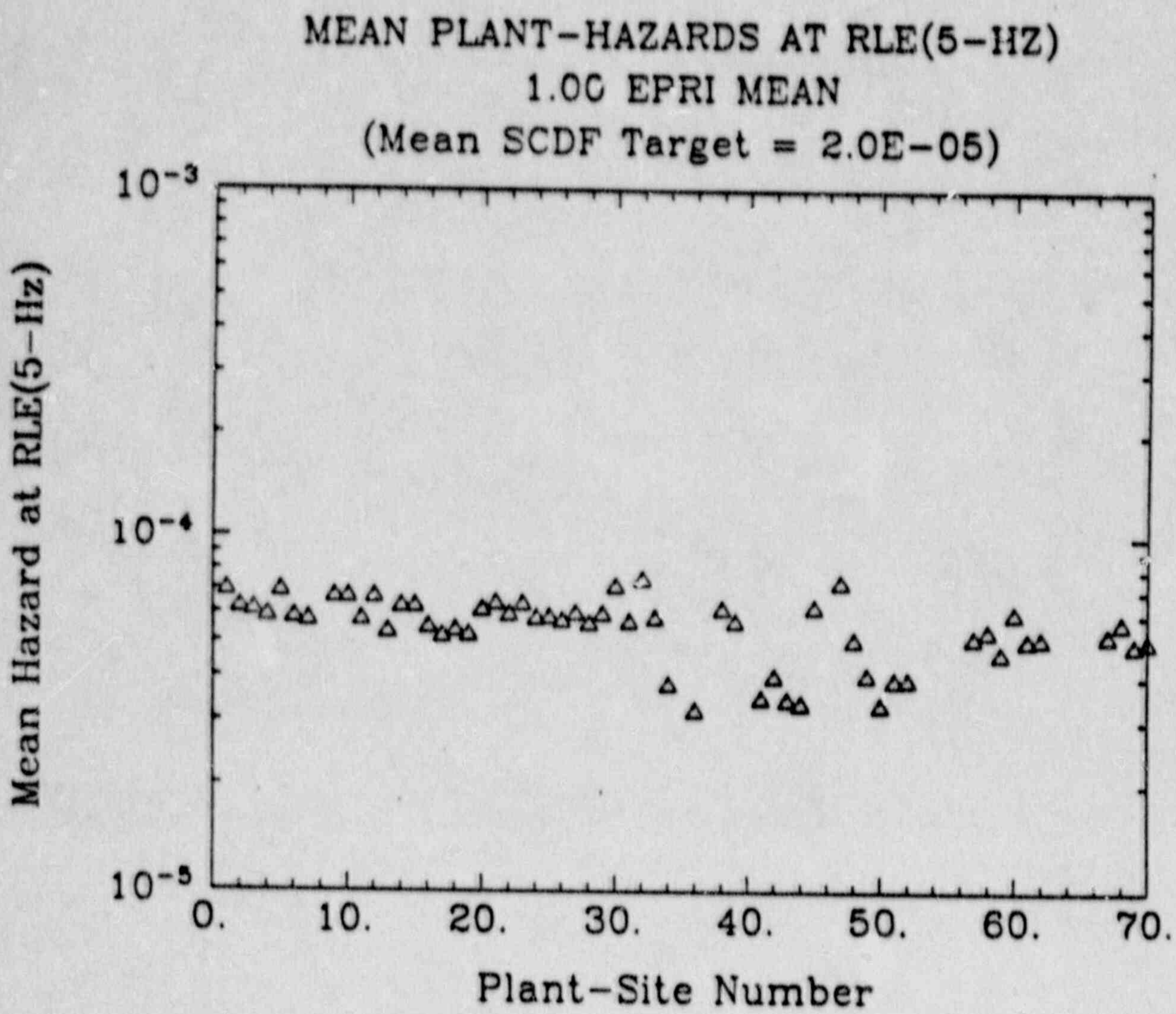
40.
50.
60.
70.
Plant-Site Number

— RESULTS —



MEAN PLANT-HAZARDS AT RLE(5-HZ)
1.00 EPRI MEAN
(Mean SCDF Target = 2.0E-05)
Mean Hazard at RLE(5-Hz)
10^{-3}
10^{-4}
10^{-5}
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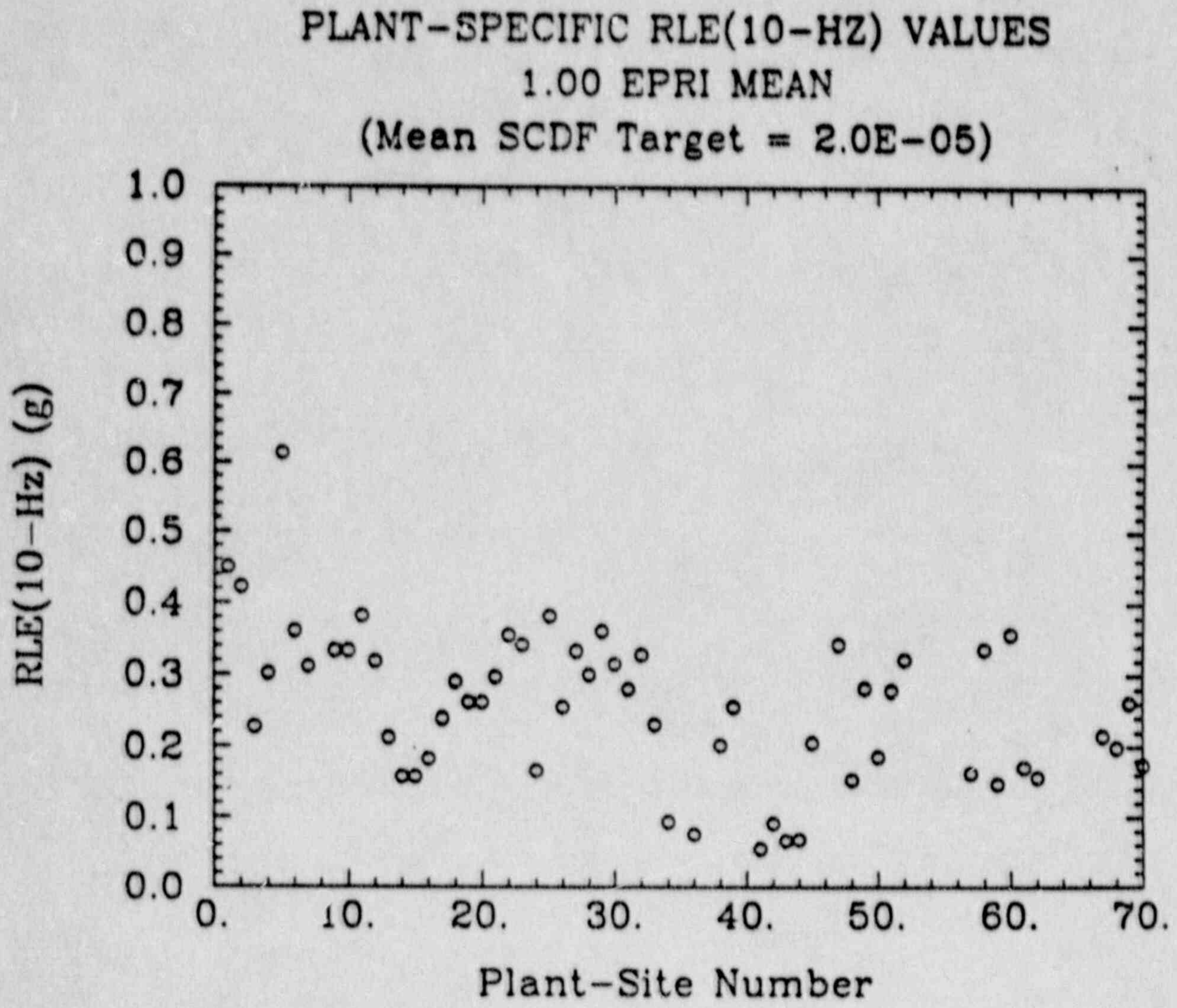
Plant-Site Number

— RESULTS —



PLANT-SPECIFIC RLE(10-HZ) VALUES
1.00 EPRI MEAN
(Mean SCDF Target = 2.0E-05)
RLE(10-Hz) (g)
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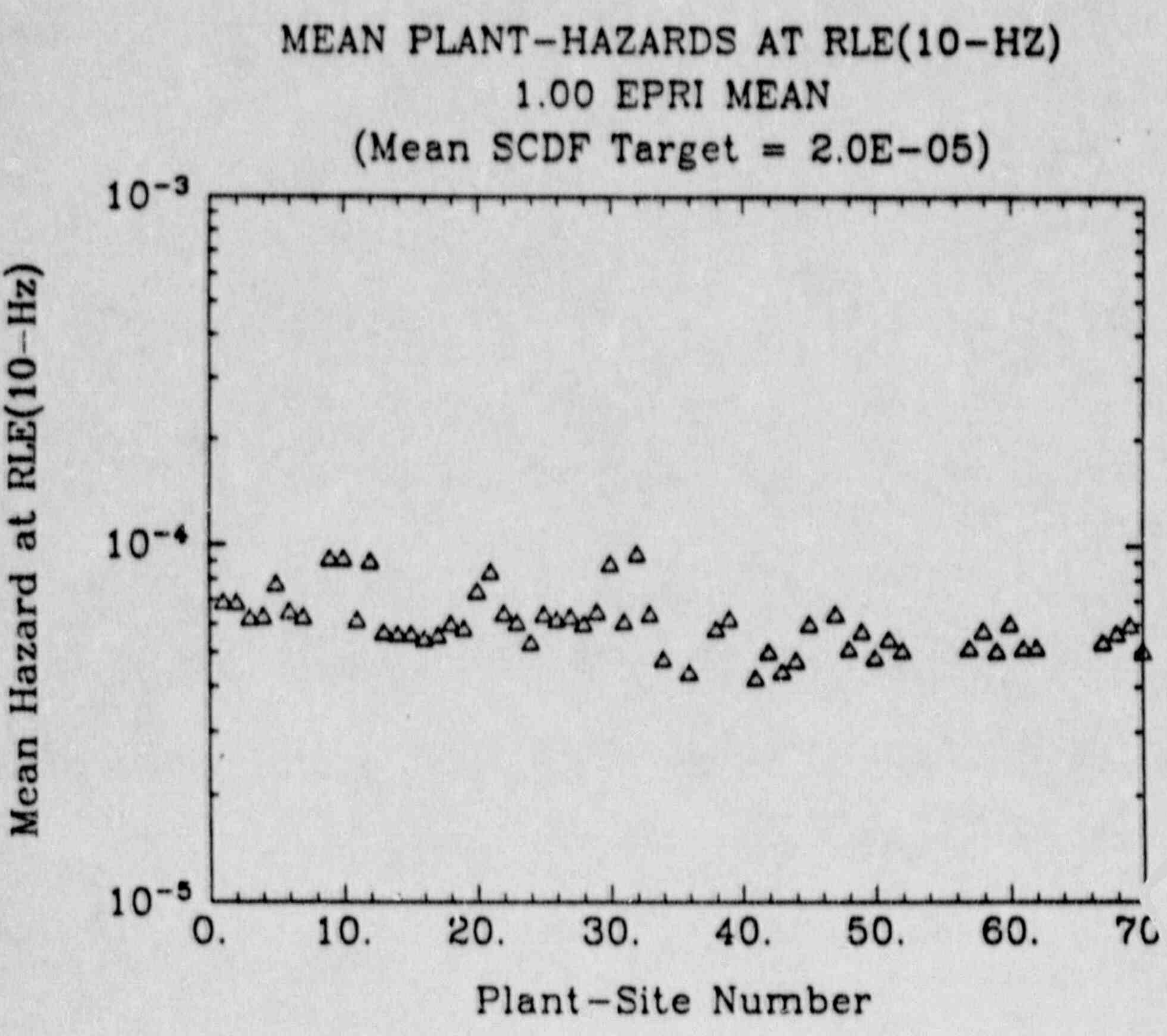

MEAN PLANT-HAZARDS AT RLE(10-HZ)
1.00 EPRI MEAN
(Mean SCDF Target = 2.0E-05)
Mean Hazard at RLE(10-Hz)
10⁻³
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10⁻⁵
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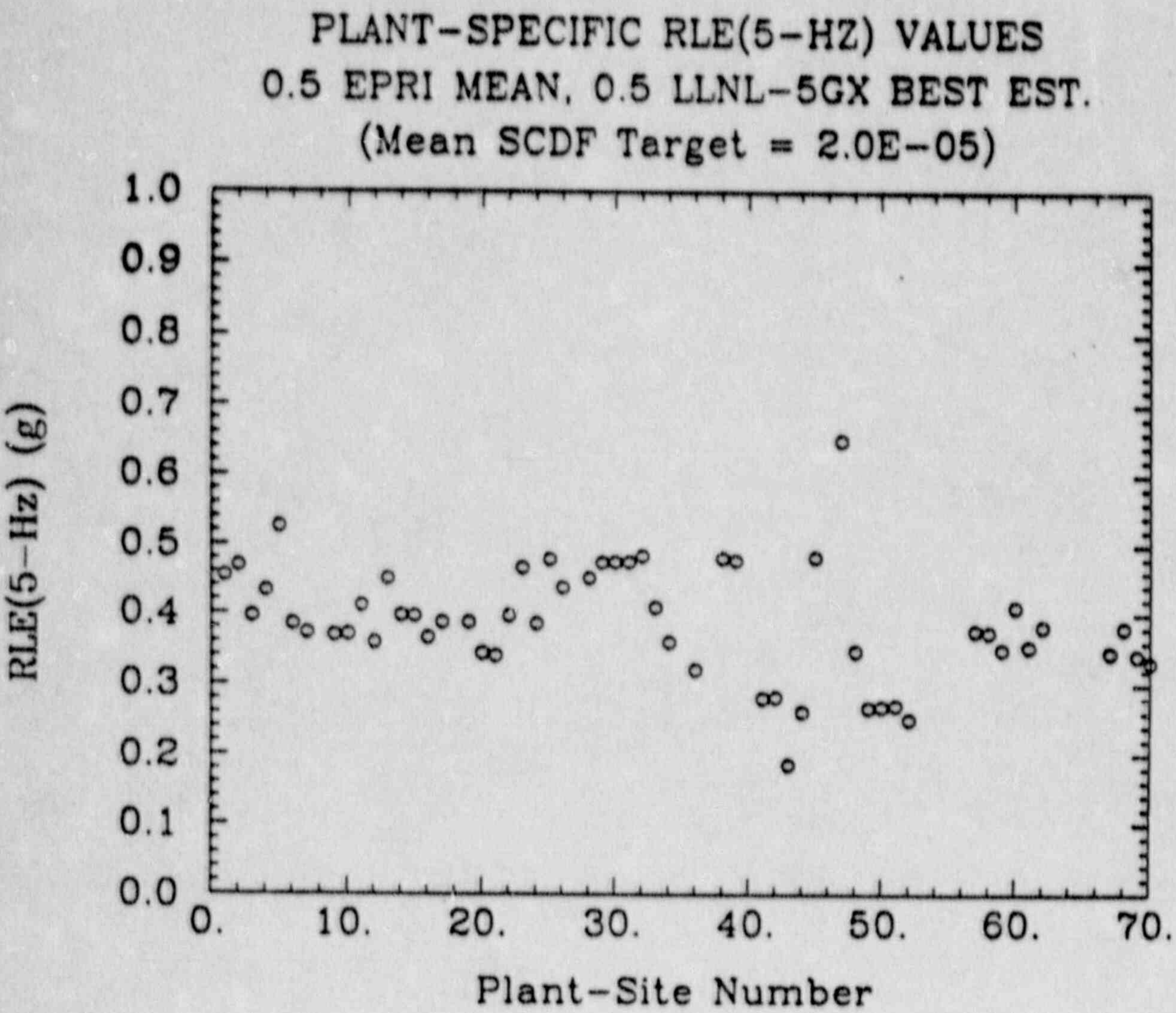
Plant-Site Number


PLANT-SPECIFIC RLE(5-HZ) VALUES
0.5 EPRI MEAN, 0.5 LLNL-5GX BEST EST.
(Mean SCDF Target = 2.0E-05)
RLE(5-Hz) (g)
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Plant-Site Number

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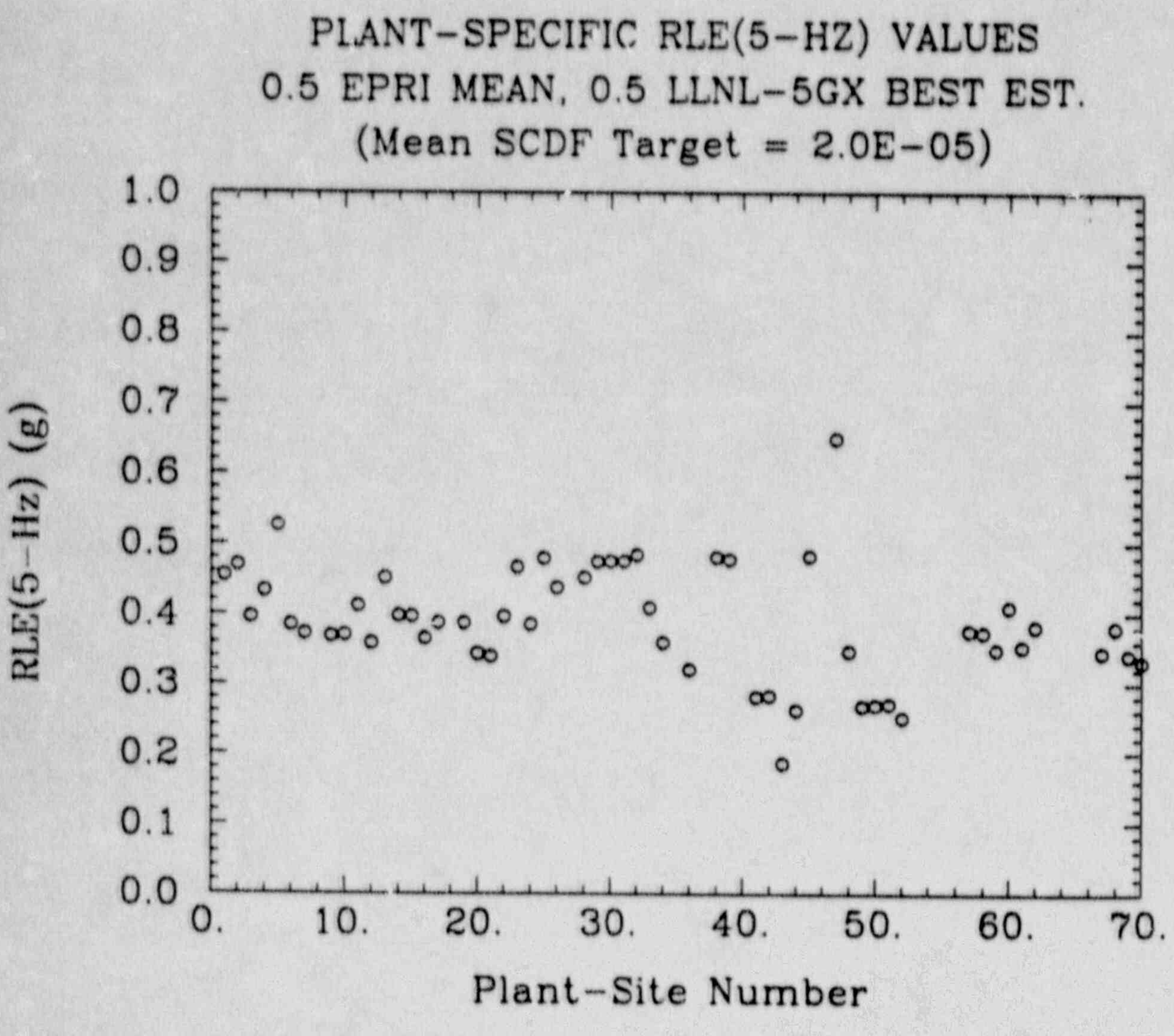

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Plant-Site Number

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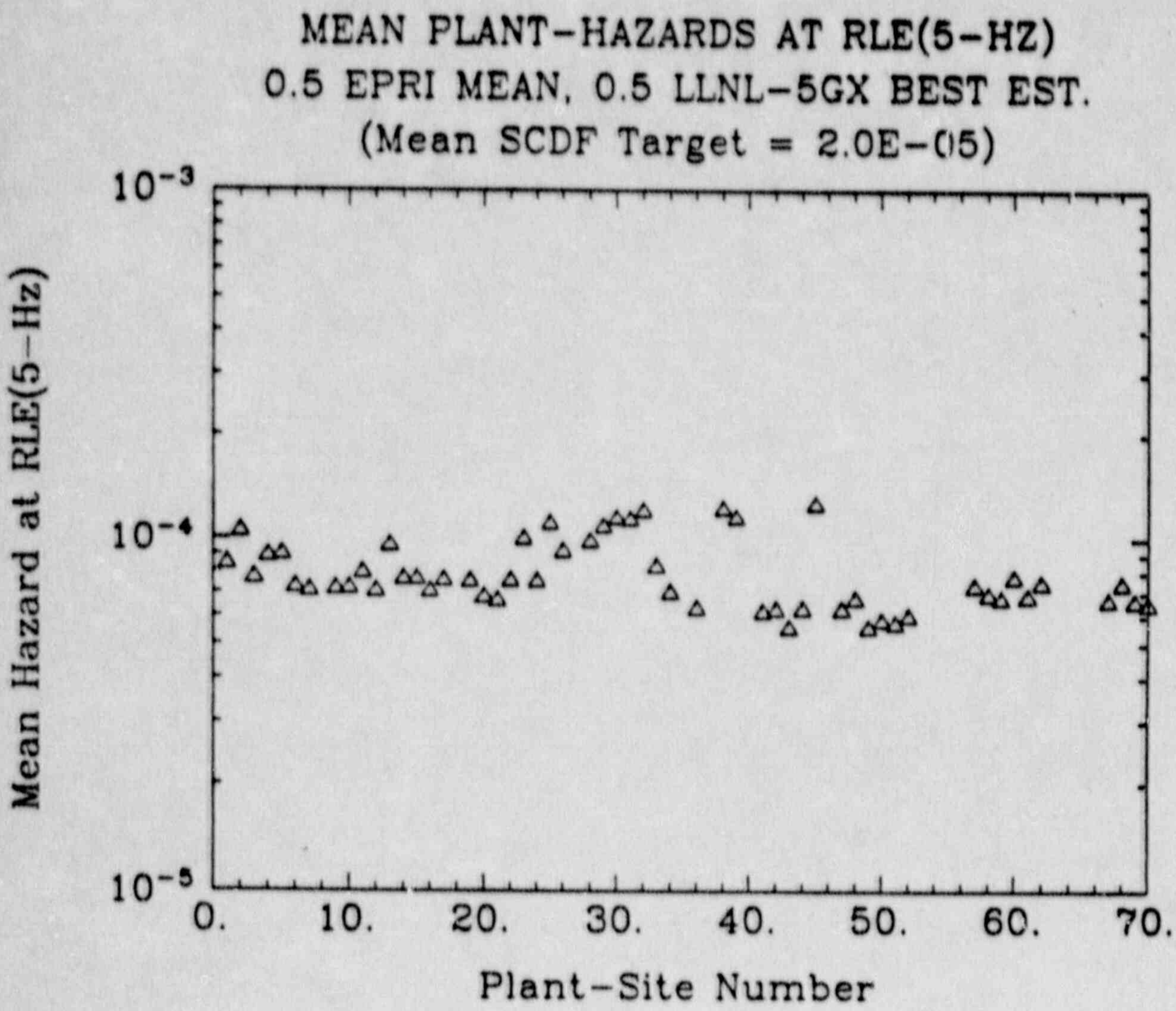
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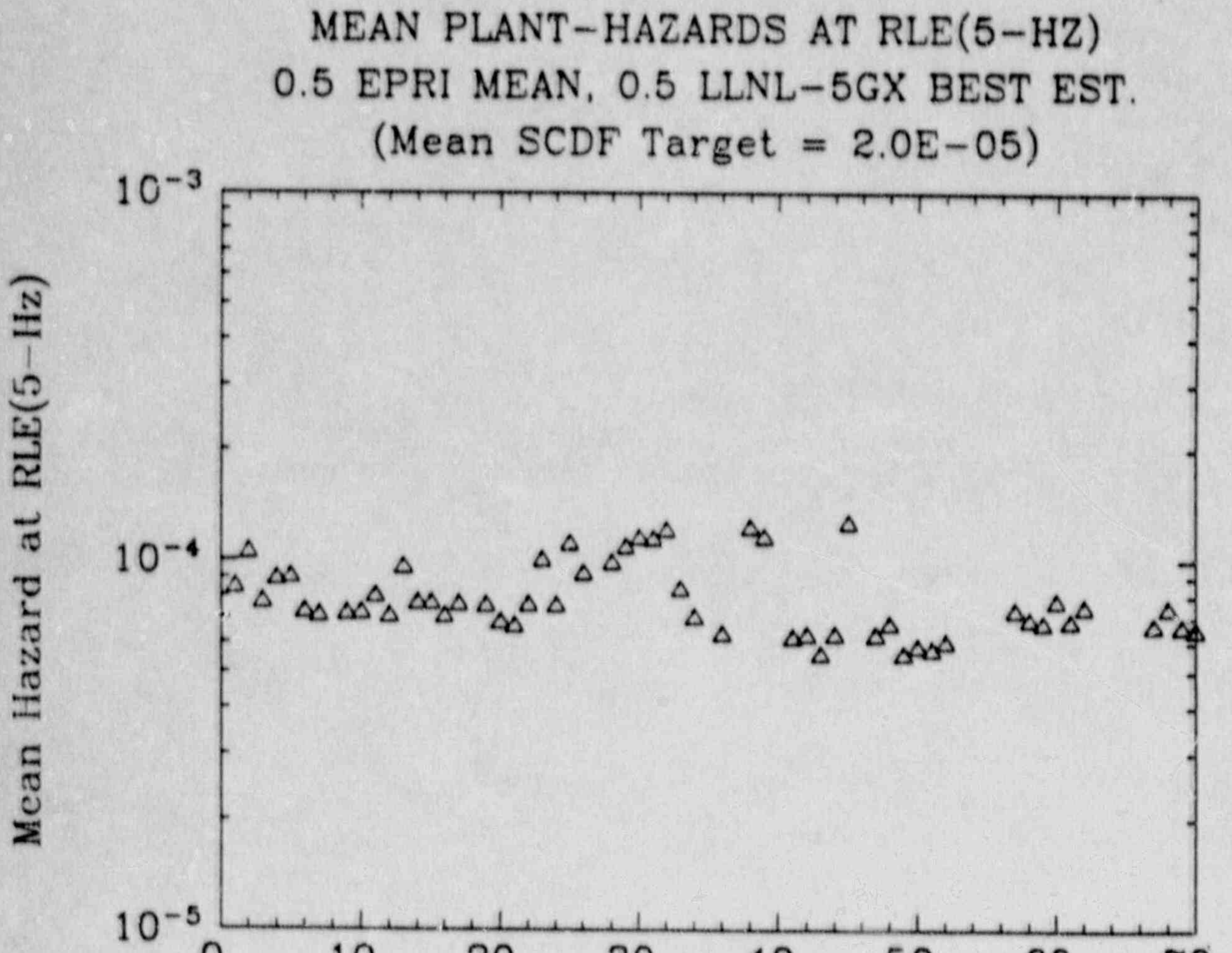
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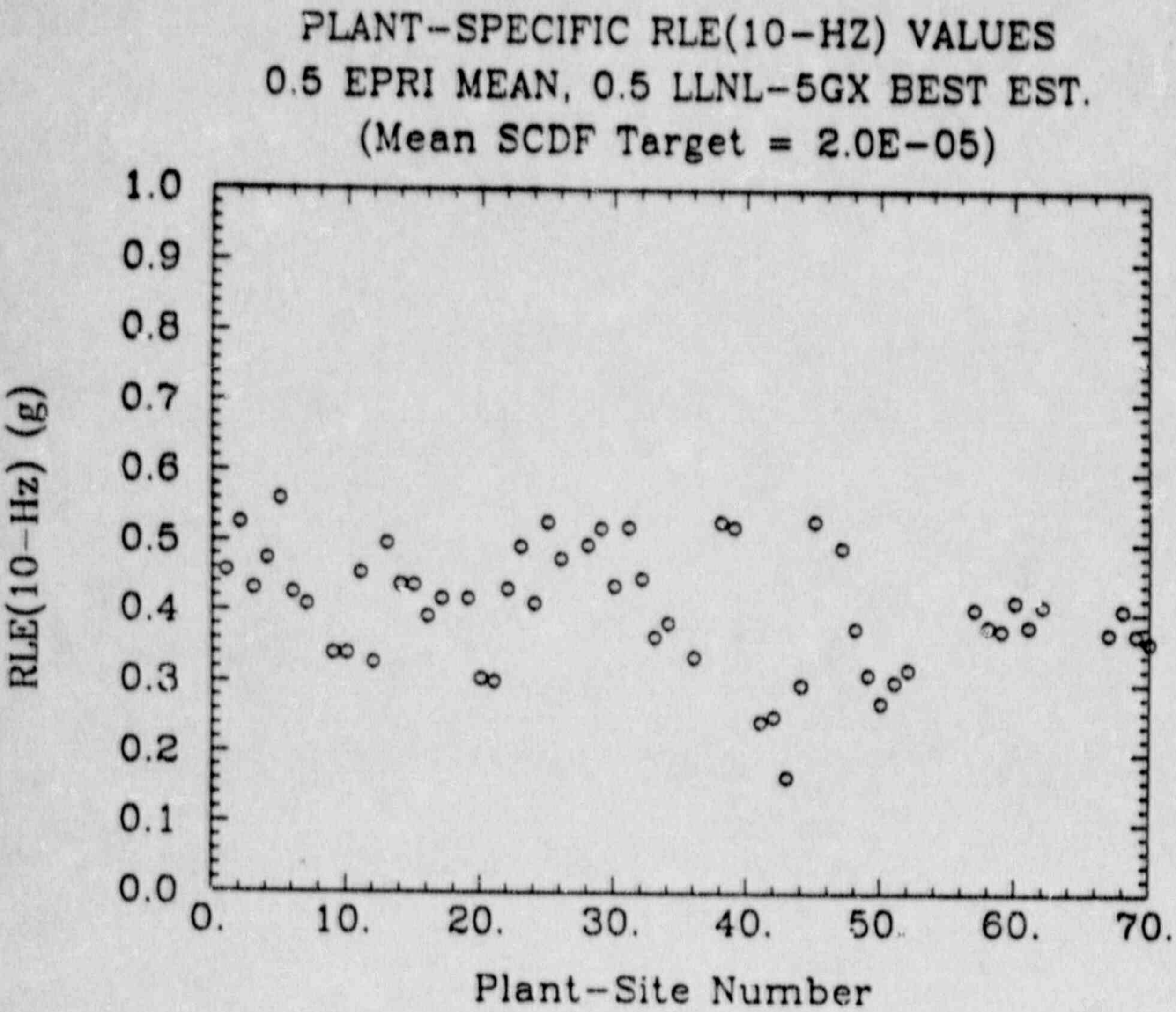

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Plant-Site Number

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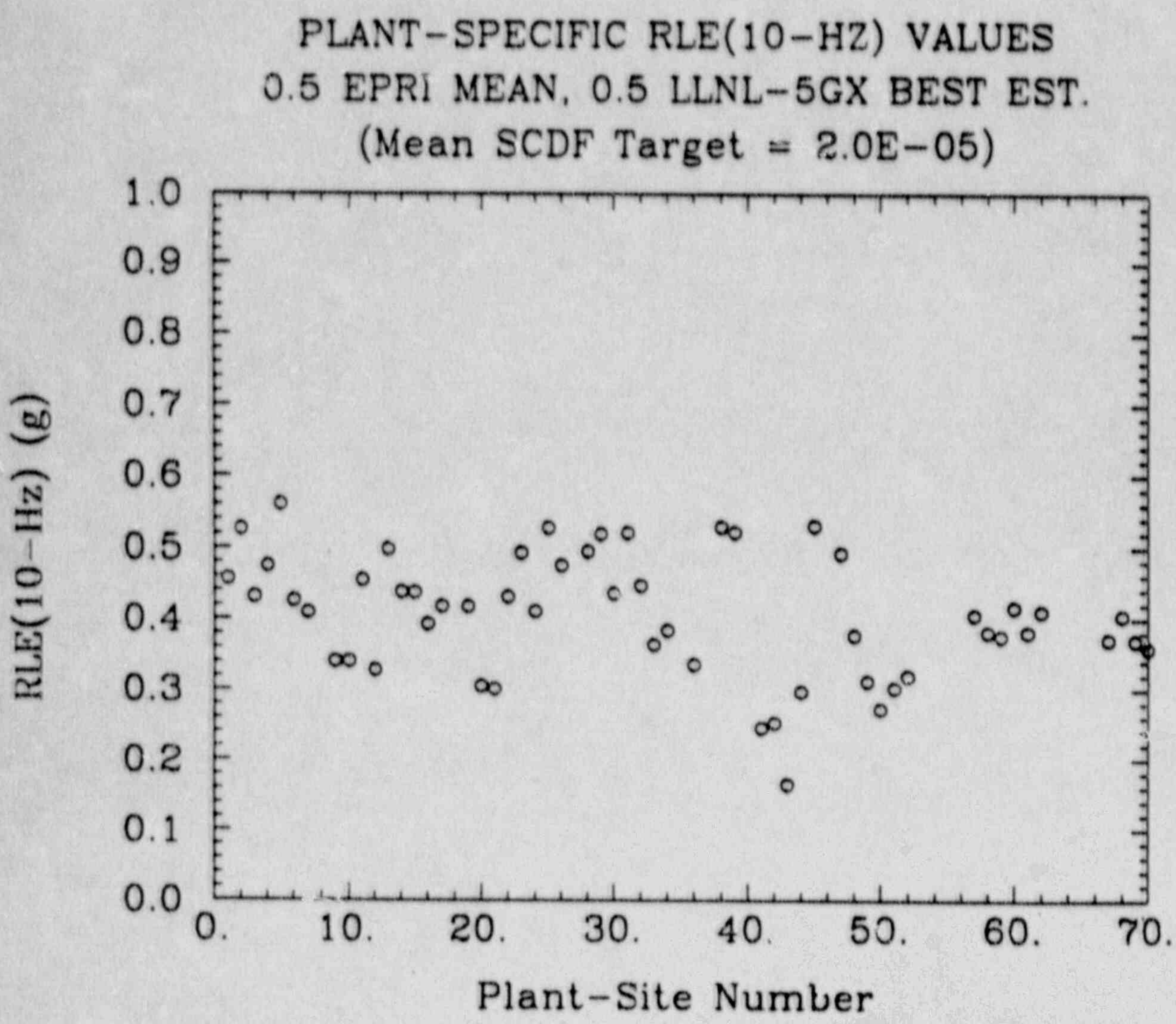

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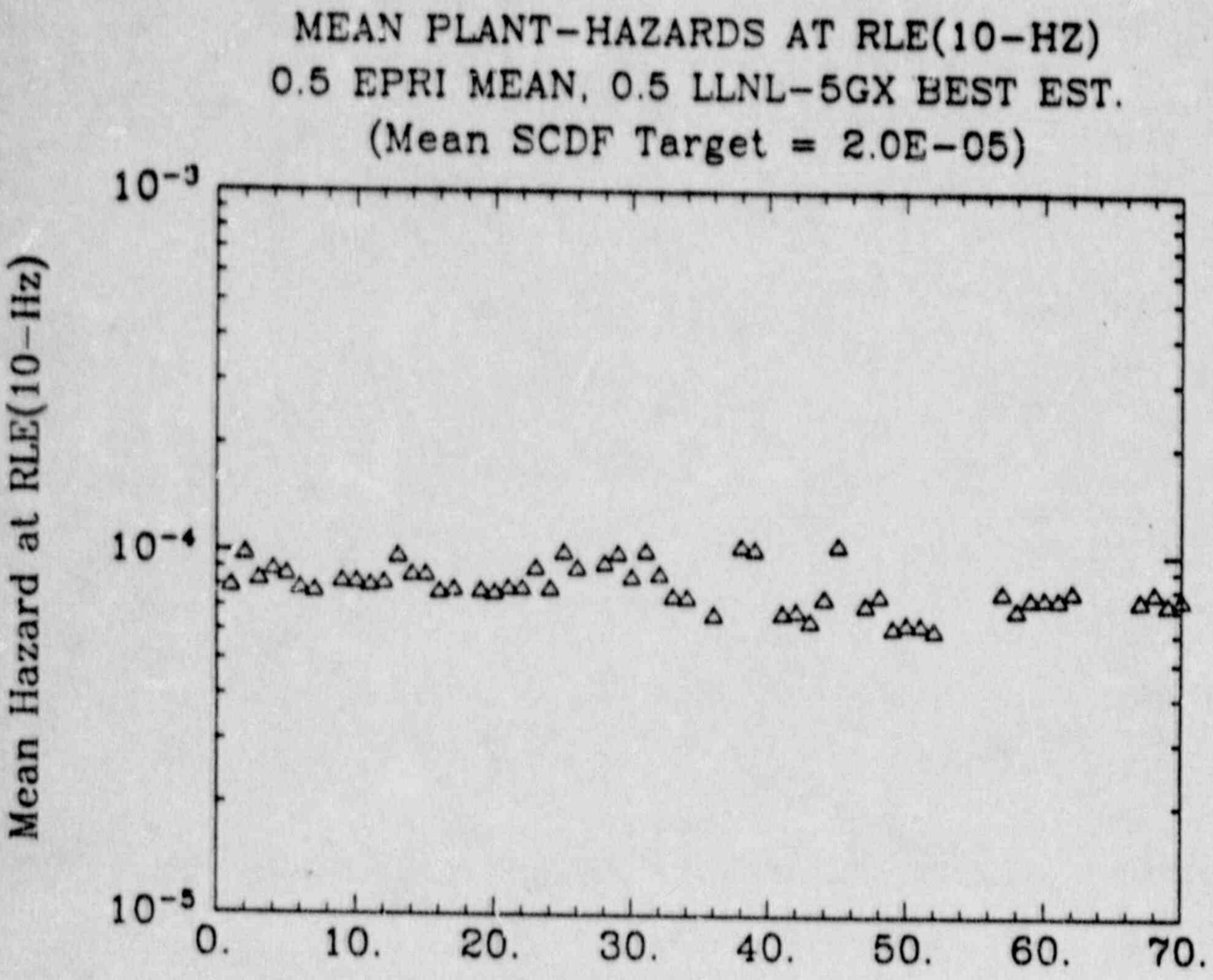
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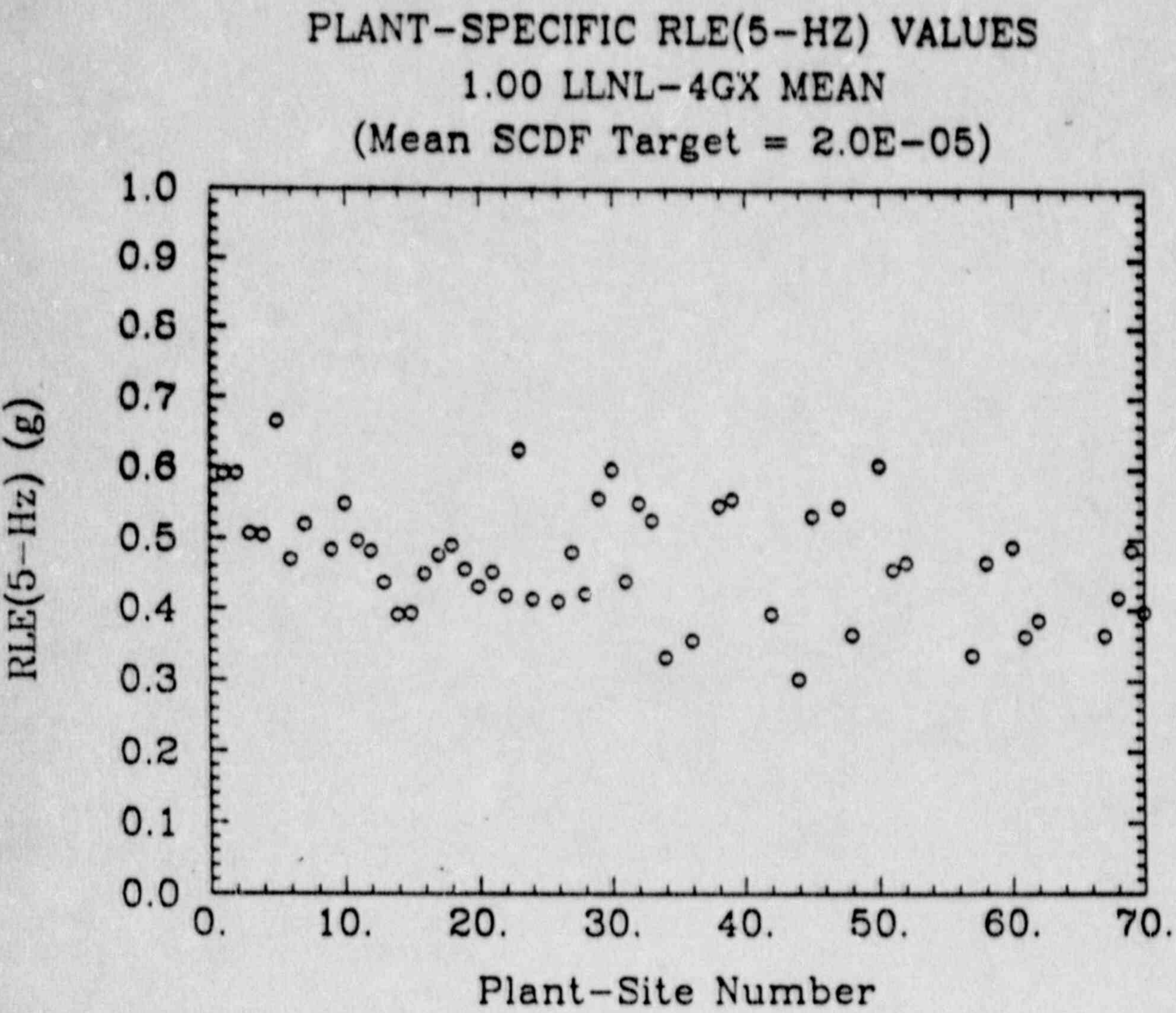
— RESULTS —



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1.00 LLNL-4GX MEAN
(Mean SCDF Target = 2.0E-05)
RLE(5-Hz) (g)
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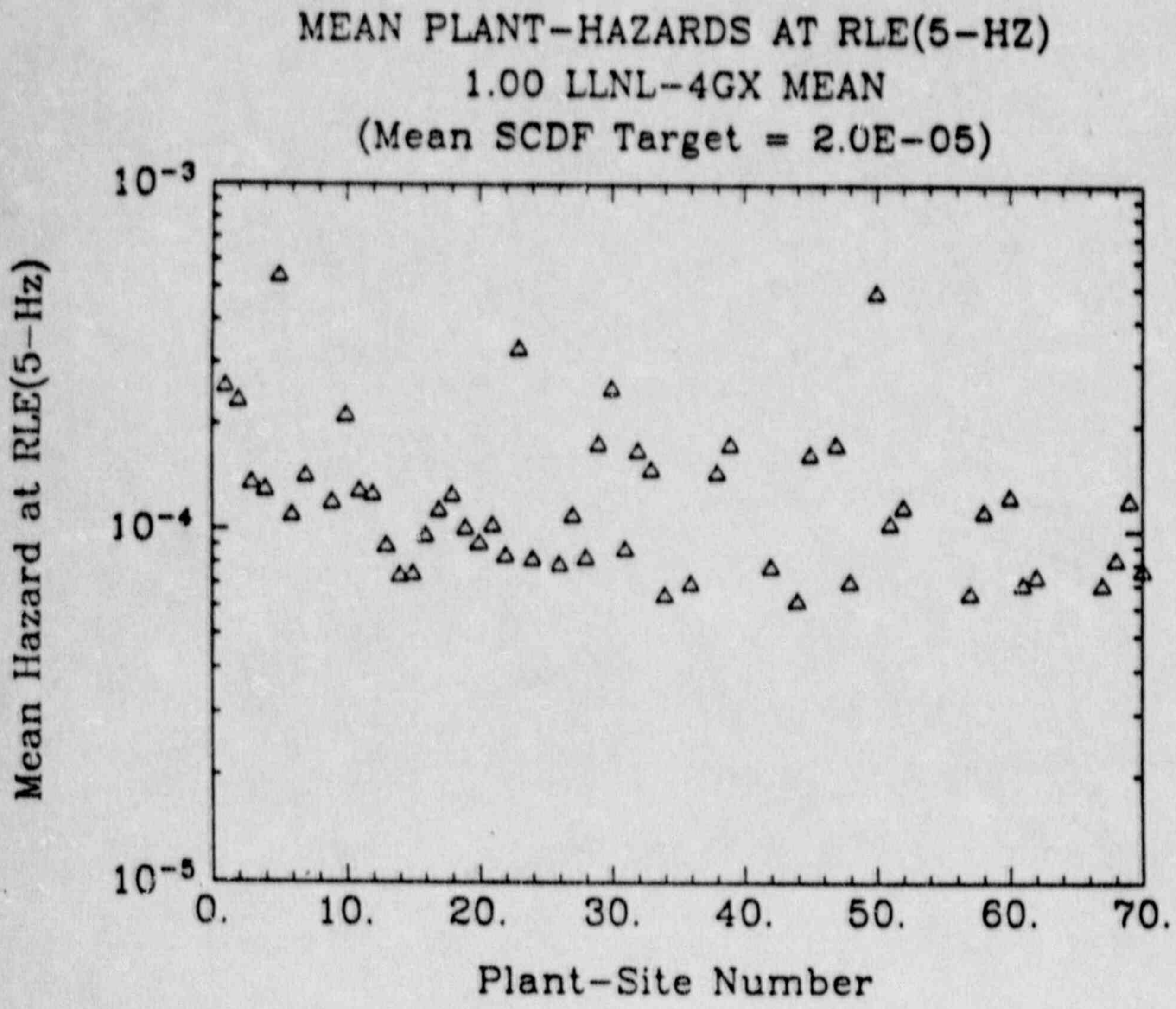

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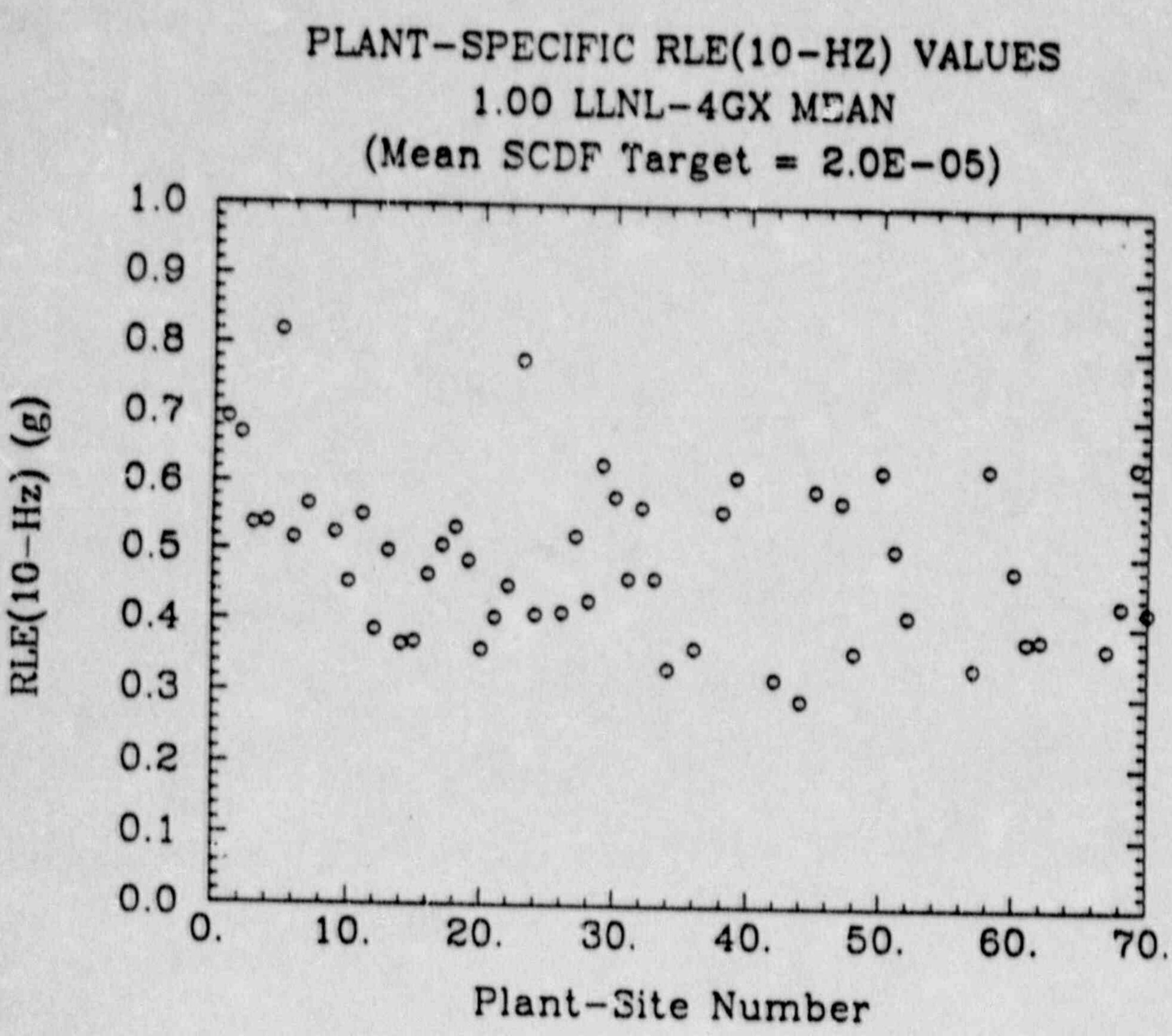

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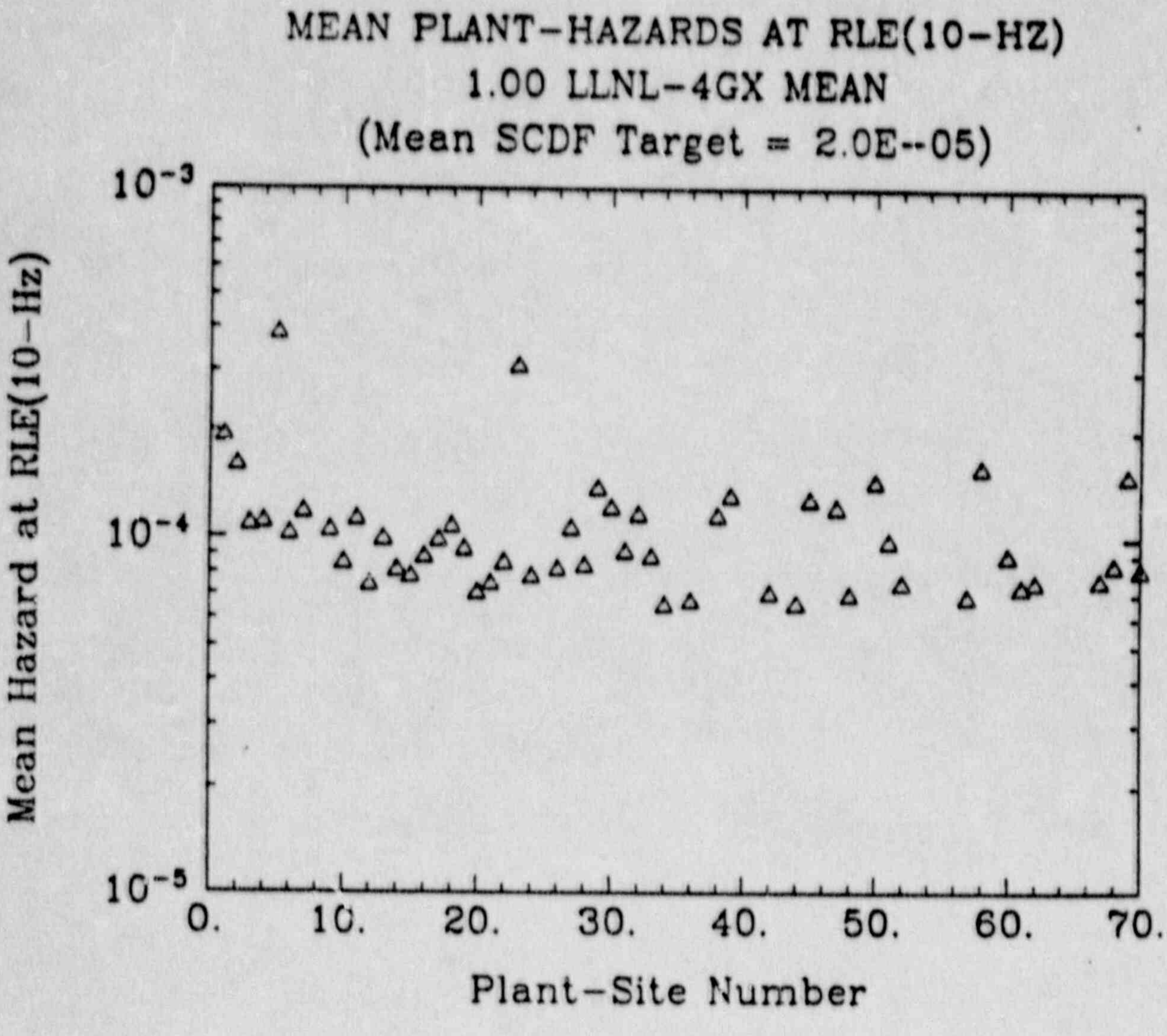

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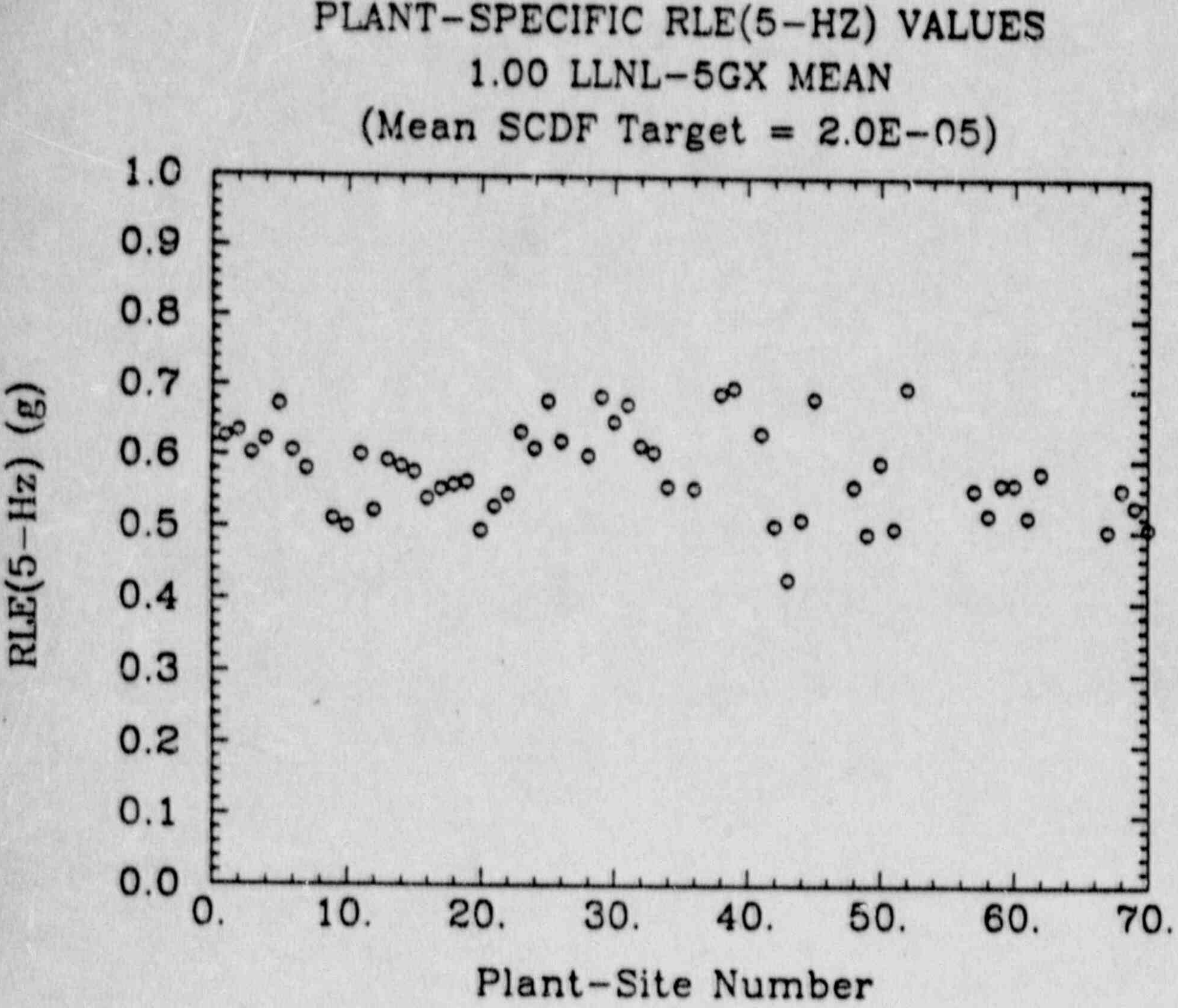

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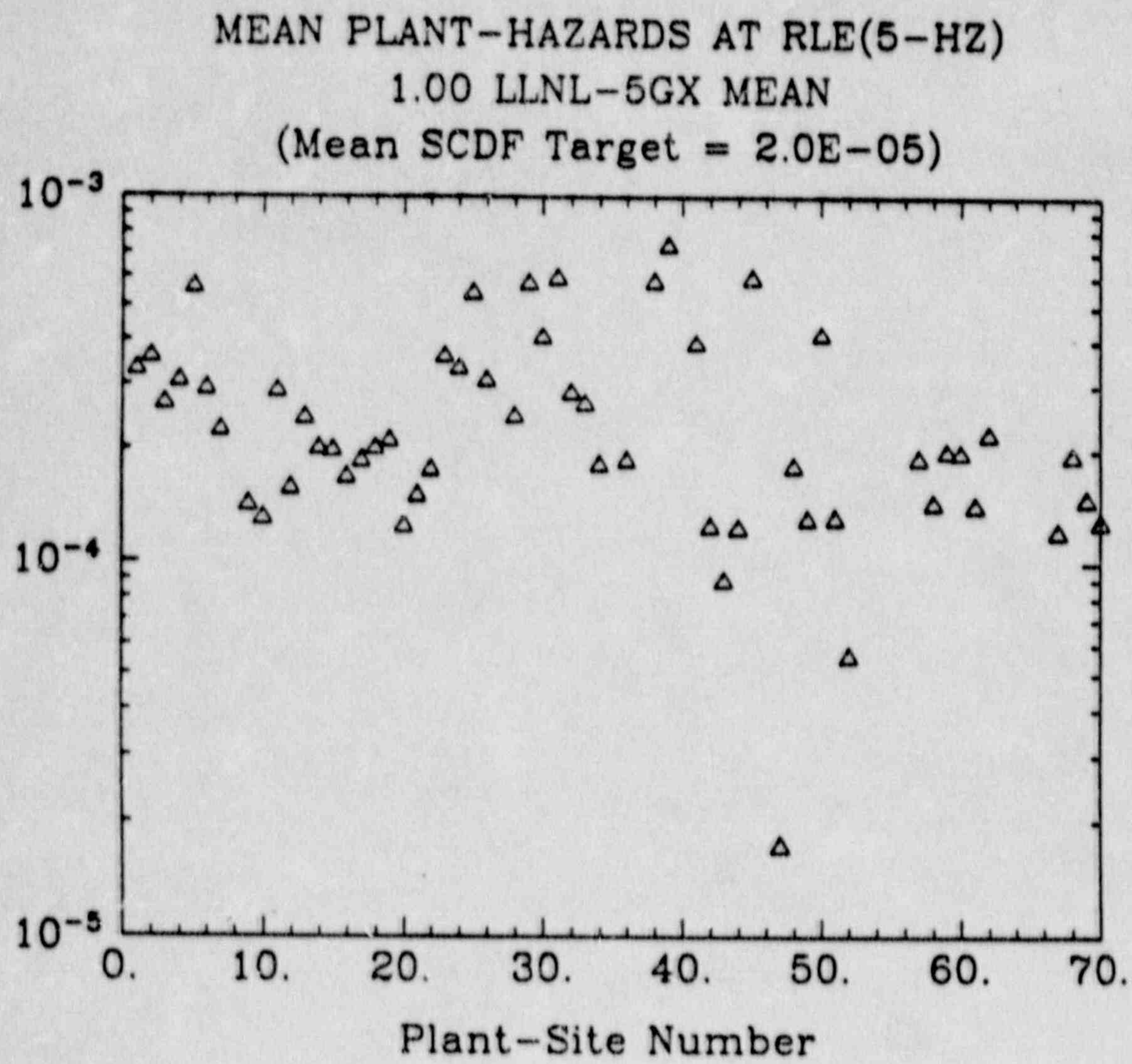

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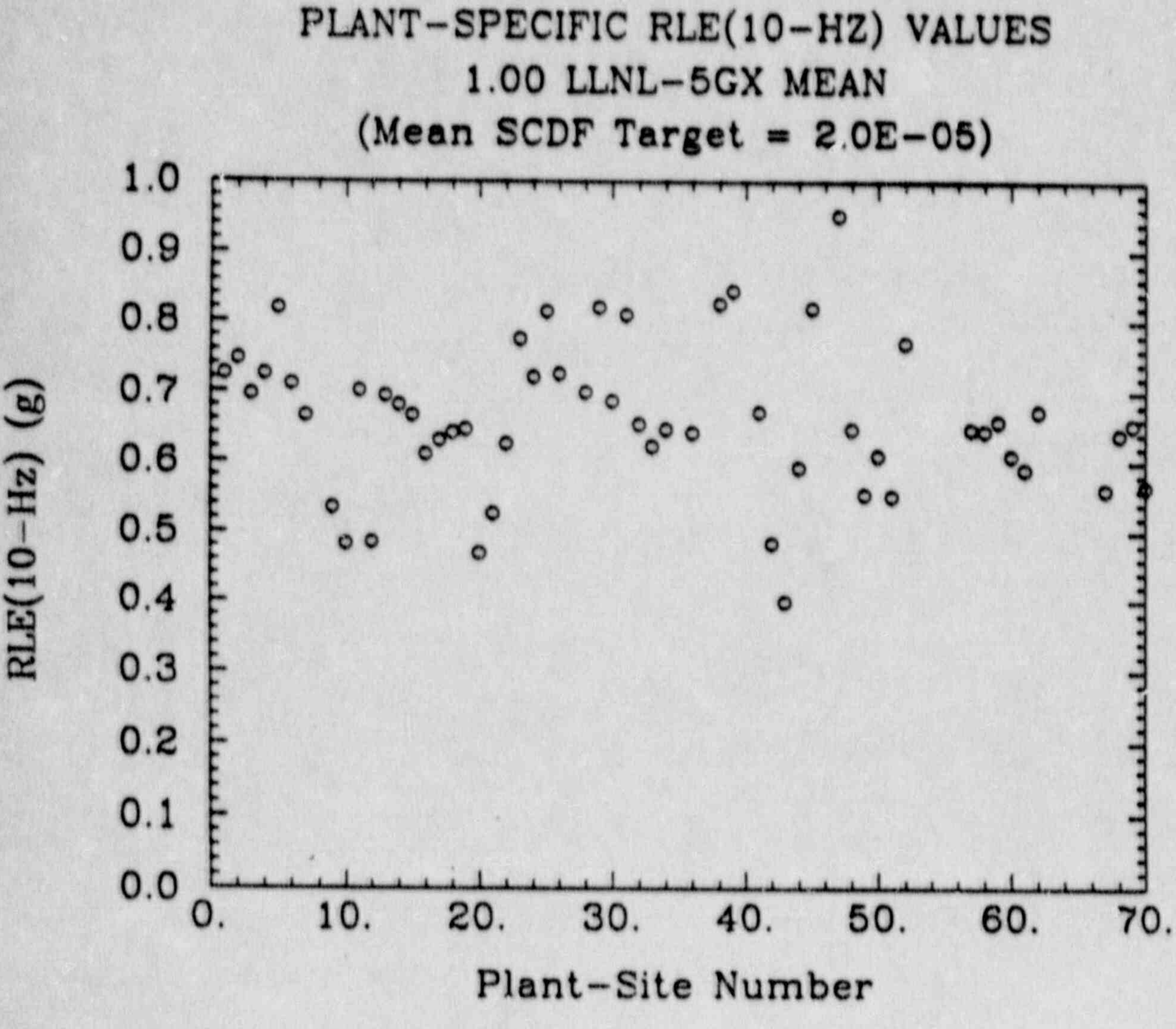

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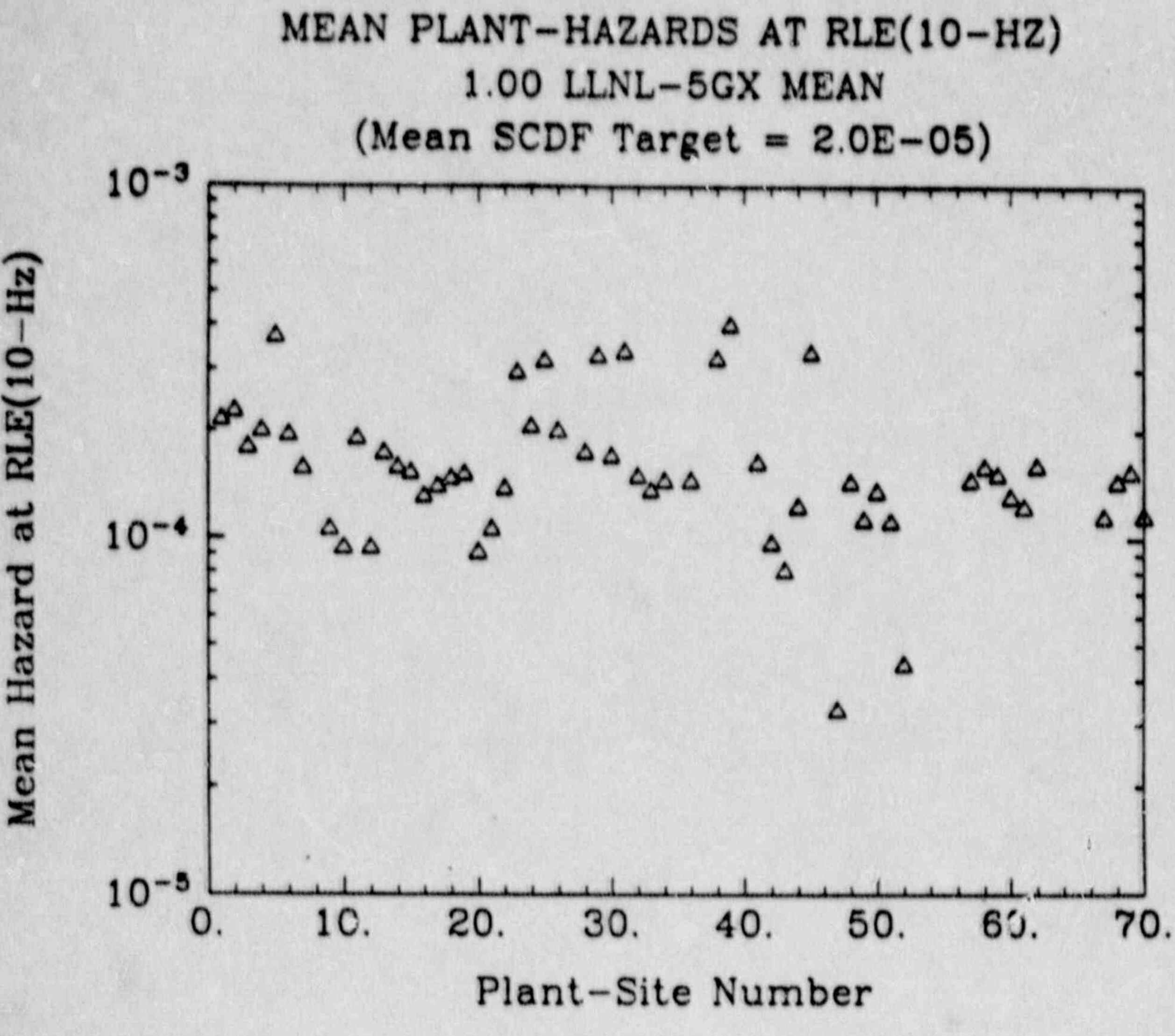
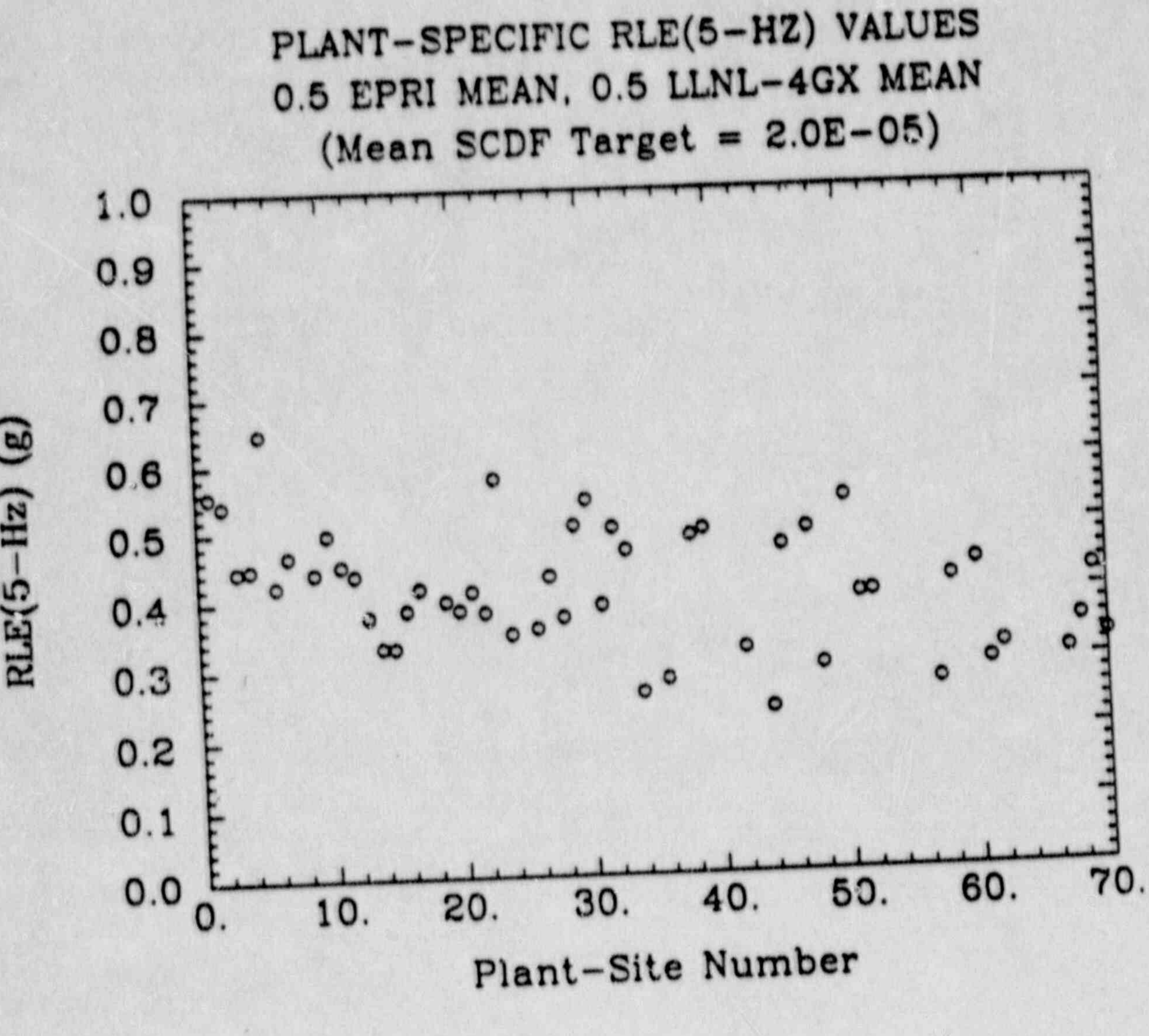
0.6
0.7
0.8
0.9
1.0
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

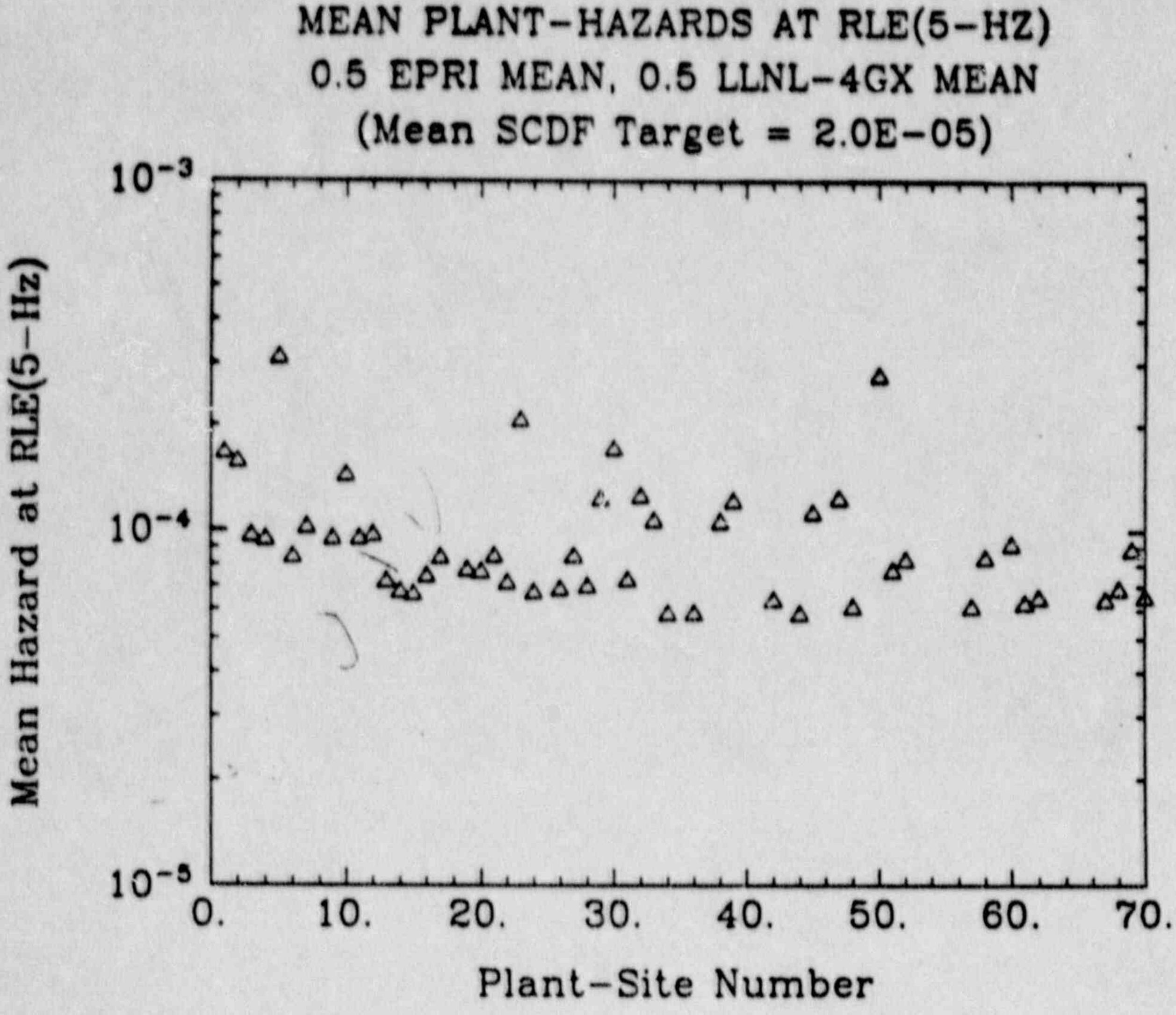
— RESULTS —


MEAN PLANT-HAZARDS AT RLE(10-HZ)
1.00 LLNL-5GX MEAN
(Mean SCDF Target = 2.0E-05)
Mean Hazard at RLE(10-Hz)
10^{-3}
10^{-4}
10^{-5}
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

-- RESULTS —

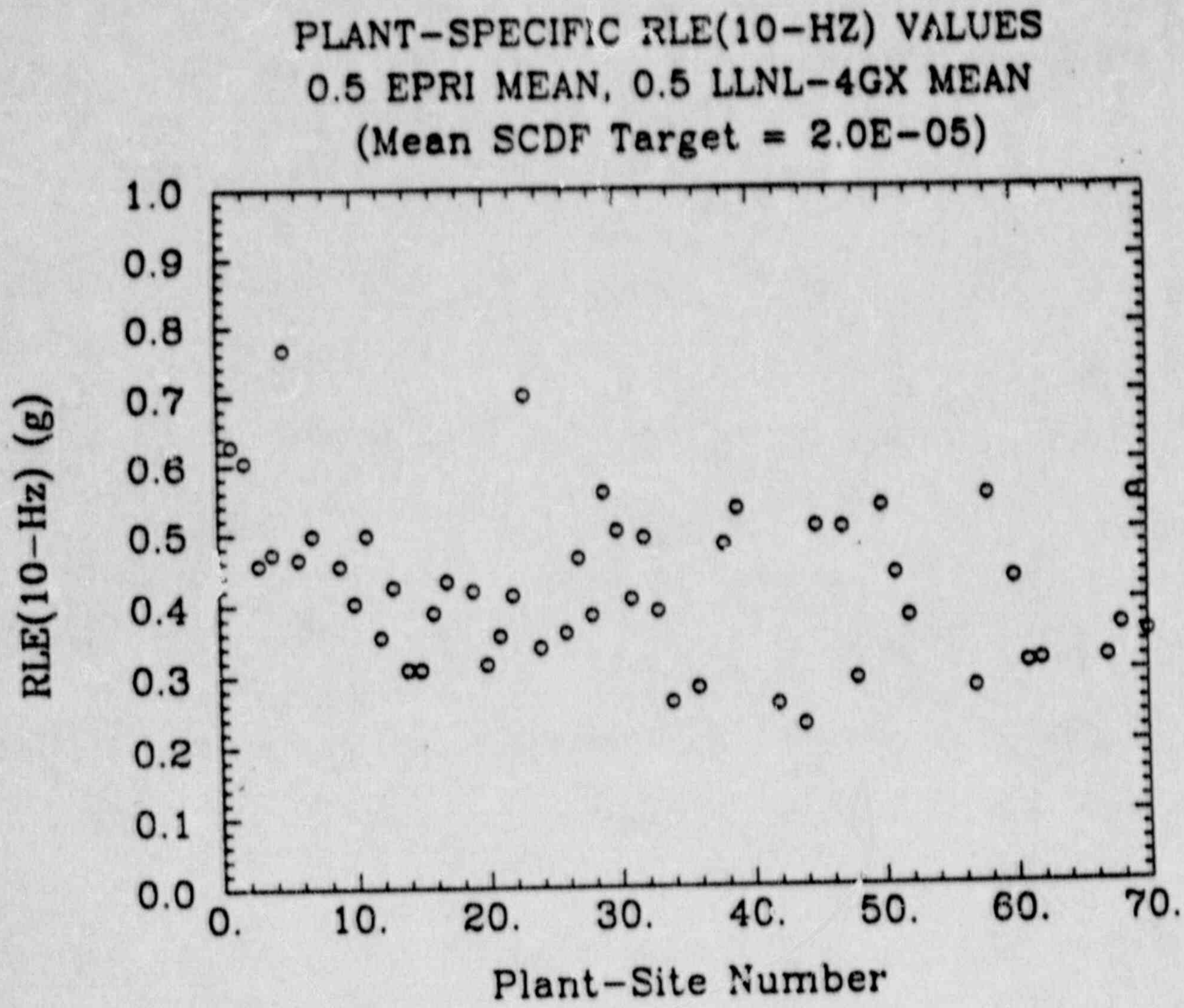

PLANT-SPECIFIC RLE(5-HZ) VALUES
0.5 EPRI MEAN, 0.5 LLNL-4GX MEAN
(Mean SCDF Target = 2.0E-05)
RLE(5-Hz) (g)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

— RESULTS —



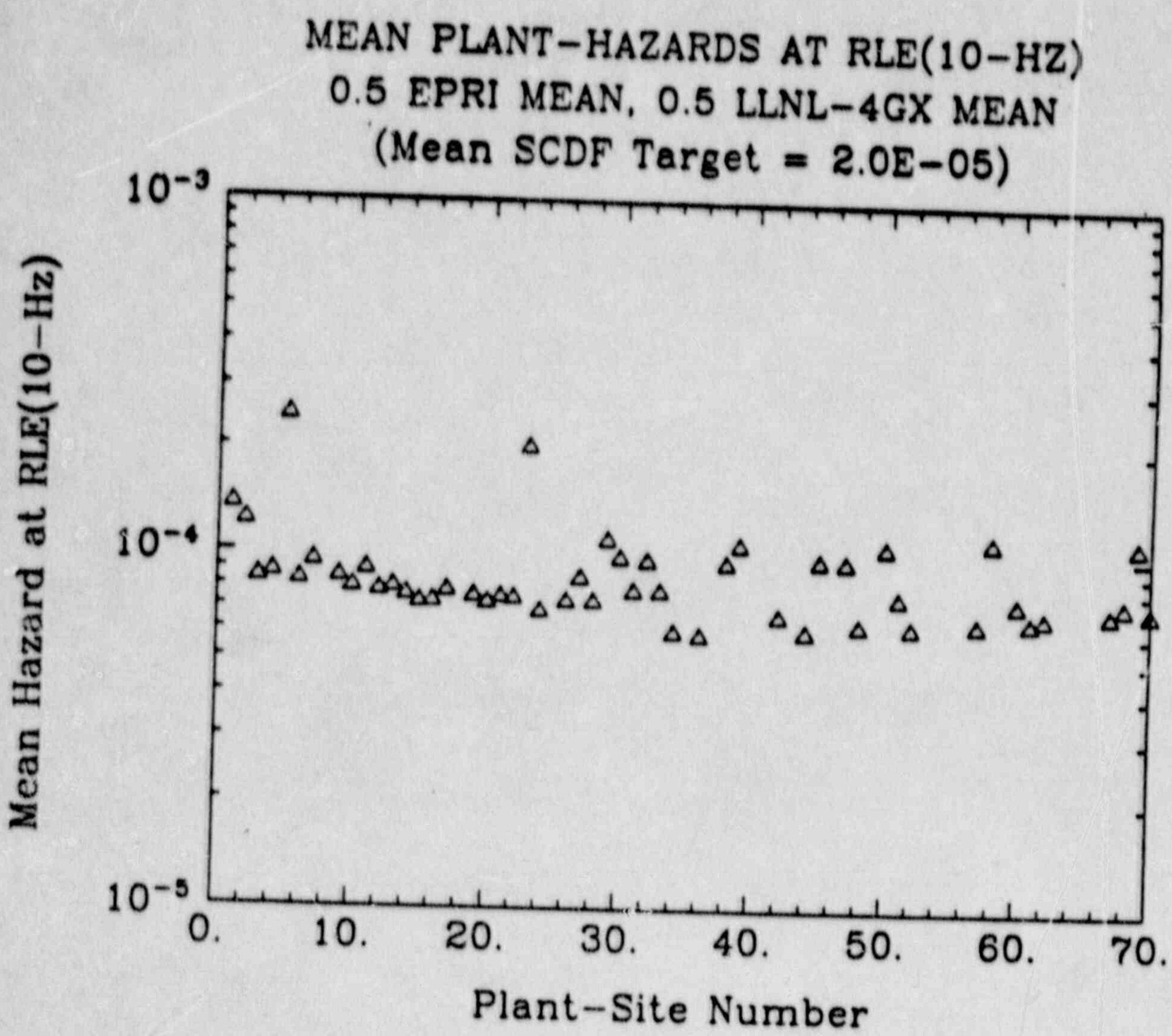
MEAN PLANT-HAZARDS AT RLE(5-HZ)
0.5 EPRI MEAN, 0.5 LLNL-4GX MEAN
(Mean SCDF Target = 2.0E-05)
10^-3
10^-4
10^-5
Mean Hazard at RLE(5-Hz)
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

— RESULTS —



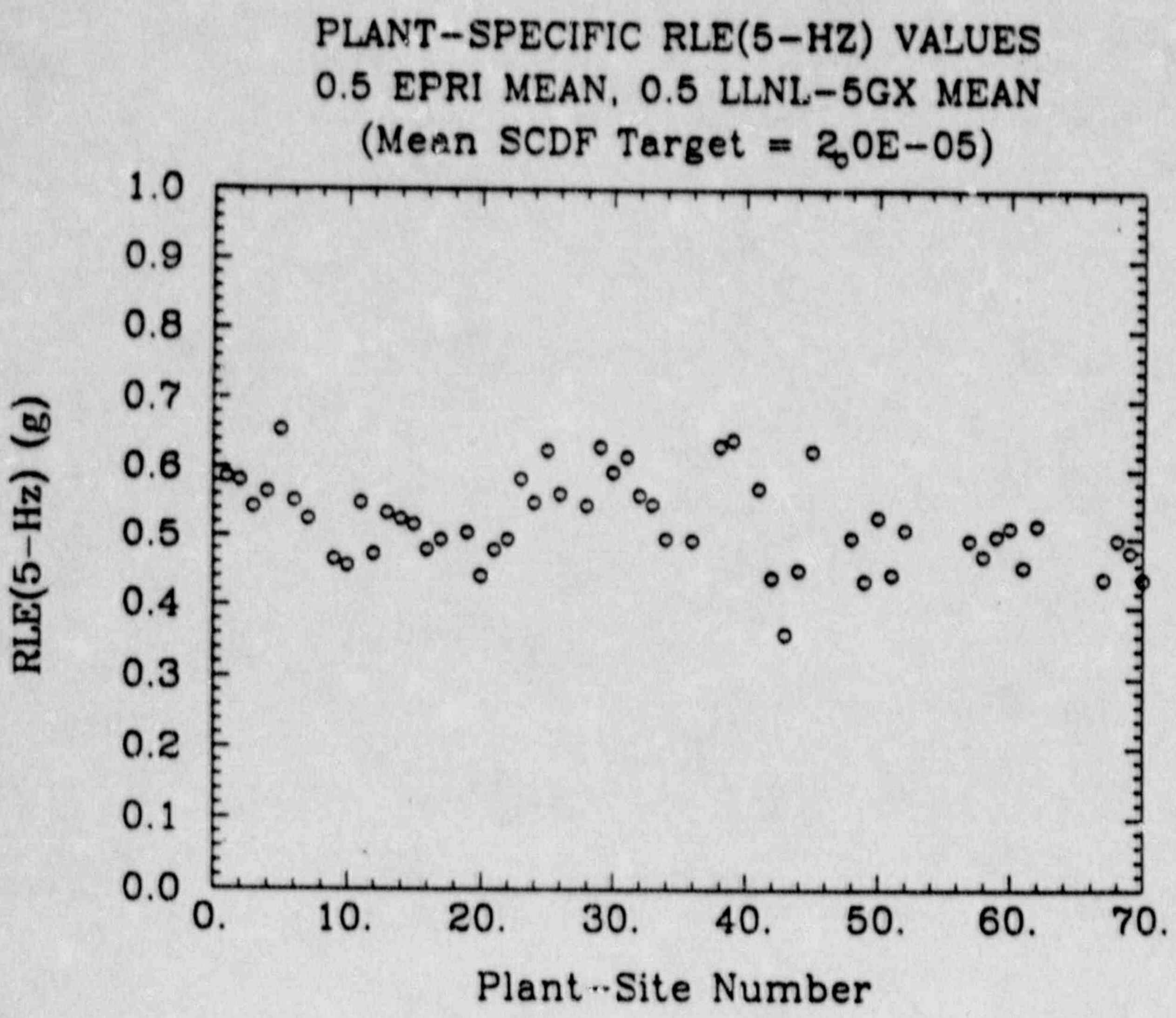
PLANT-SPECIFIC RLE(10-HZ) VALUES
0.5 EPRI MEAN, 0.5 LLNL-4GX MEAN
(Mean SCDF Target = 2.0E-05)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
RLE(10-Hz) (g)
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

— RESULTS —



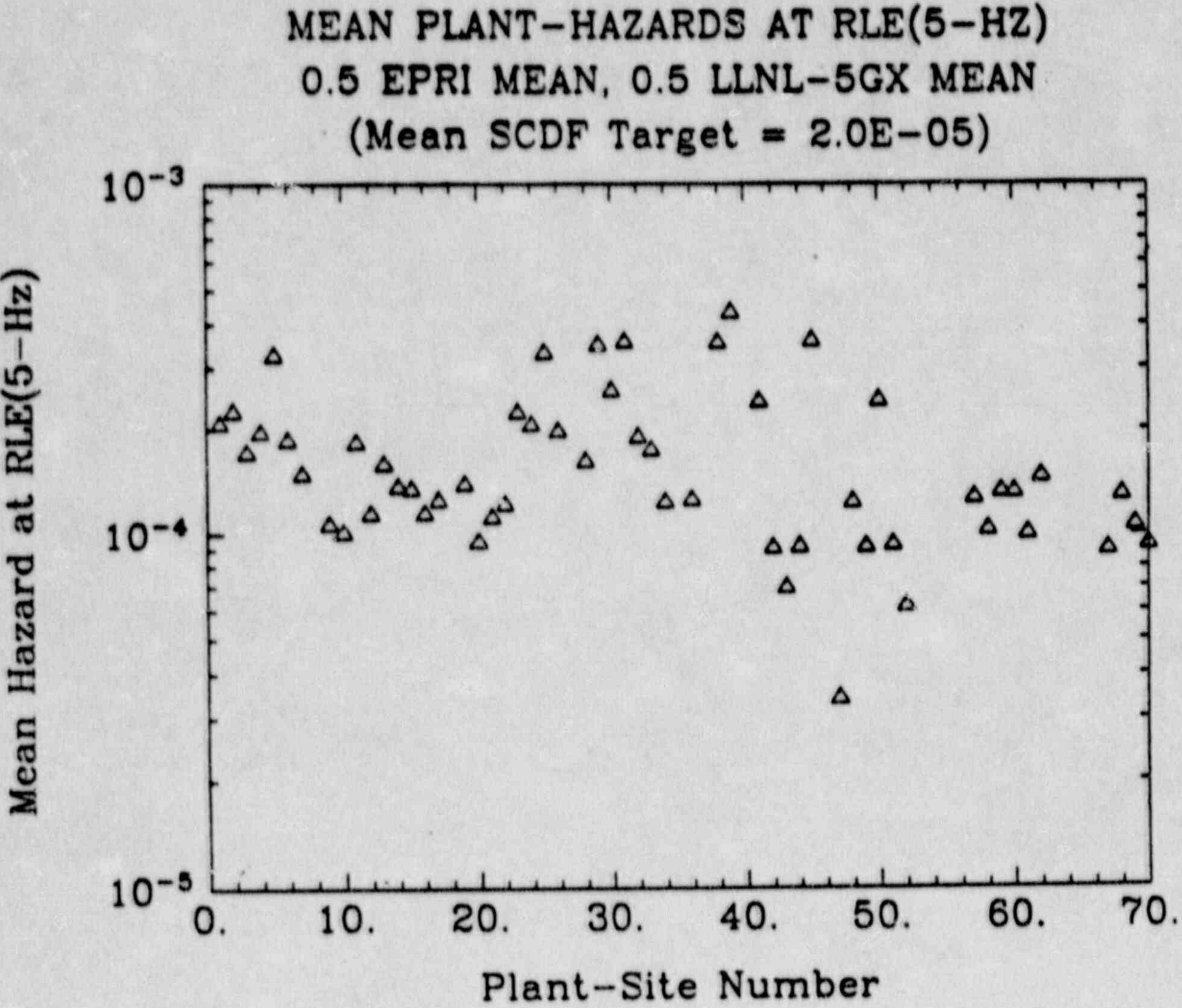
MEAN PLANT-HAZARDS AT RLE(10-HZ)
0.5 EPRI MEAN, 0.5 LLNL-4GX MEAN
(Mean SCDF Target = 2.0E-05)
Mean Hazard at RLE(10-Hz)
10⁻³
10⁻⁴
10⁻⁵
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

— RESULTS —



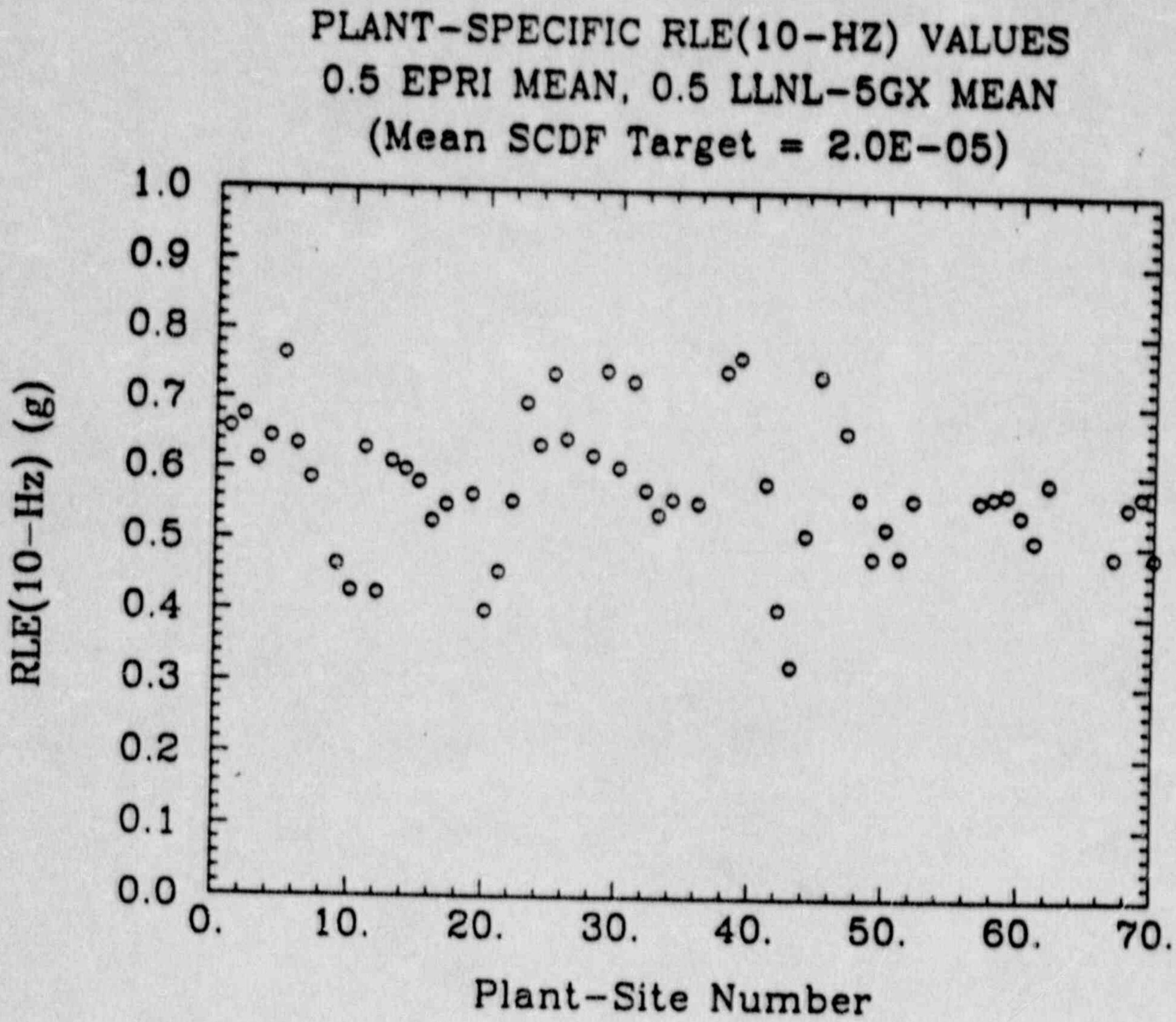
PLANT-SPECIFIC RLE(5-HZ) VALUES
0.5 EPRI MEAN, 0.5 LLNL-5GX MEAN
(Mean SCDF Target = 2.0E-05)
RLE(5-Hz) (g)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

— RESULTS —



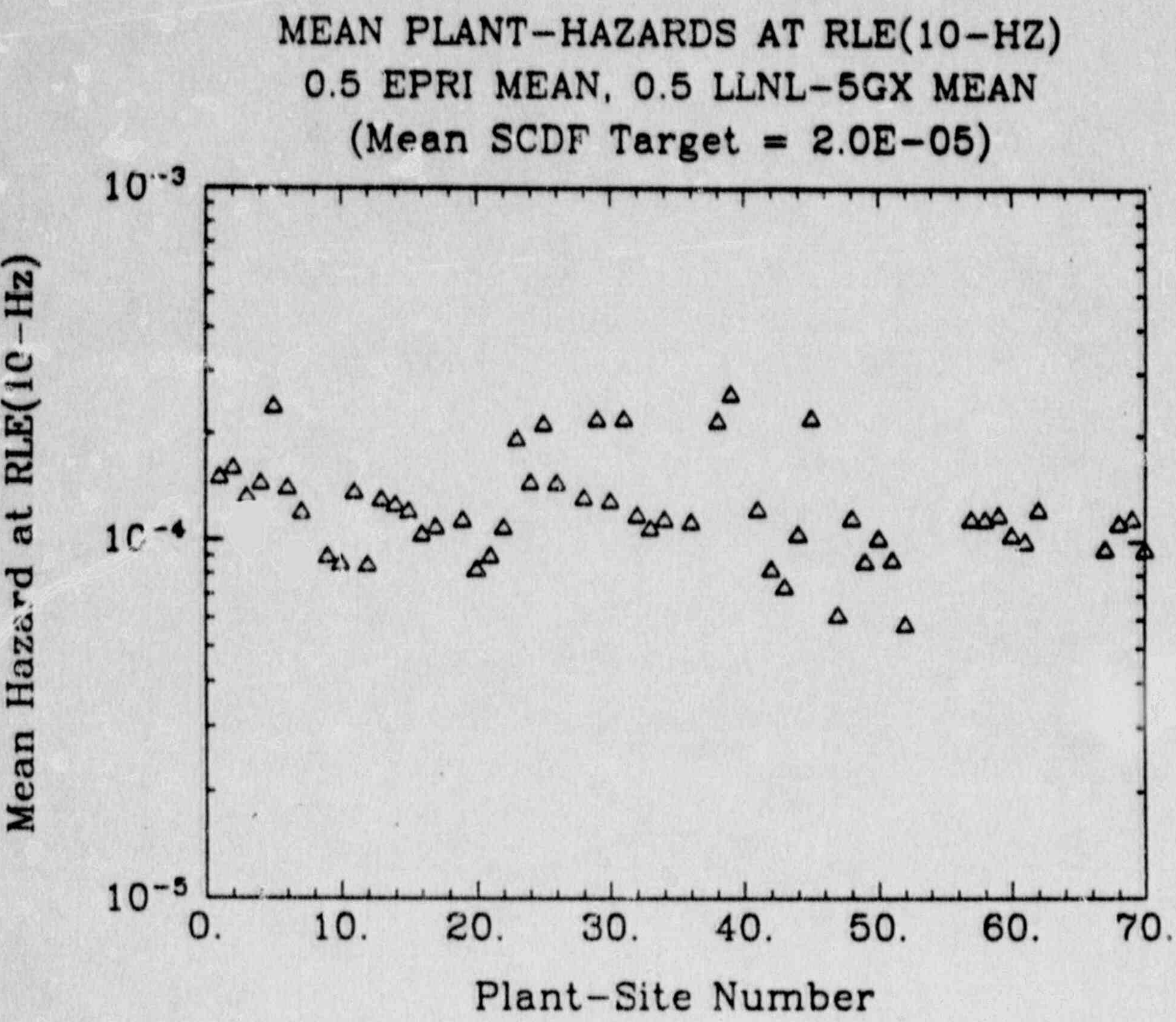
MEAN PLANT-HAZARDS AT RLE(5-HZ)
0.5 EPRI MEAN, 0.5 LLNL-5GX MEAN
(Mean SCDF Target = 2.0E-05)
Mean Hazard at RLE(5-Hz)
10^{-3}
10^{-4}
10^{-5}
0. 10. 20. 30. 40. 50. 60. 70.
Plant-Site Number

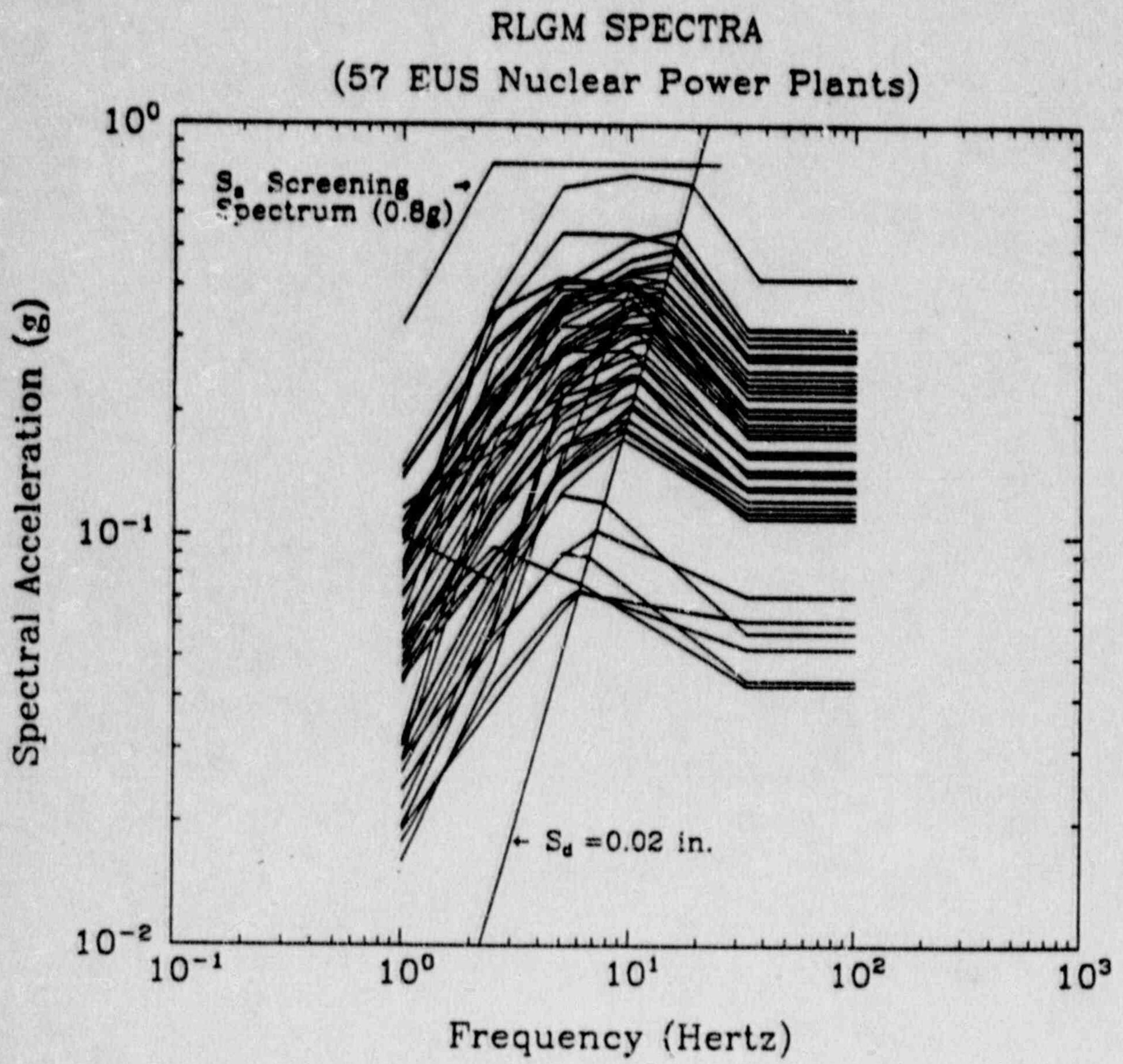
— RESULTS —



PLANT-SPECIFIC RLE(10-HZ) VALUES
0.5 EPRI MEAN, 0.5 LLNL-5GX MEAN
(Mean SCDF Target = 2.0E-05)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
RLE(10-Hz) (g)
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number

— RESULTS —


MEAN PLANT-HAZARDS AT RLE(10-HZ)
0.5 EPRI MEAN, 0.5 LLNL-5GX MEAN
(Mean SCDF Target = 2.0E-05)
Mean Hazard at RLE(10-Hz)
10^{-3}
10^{-4}
10^{-5}
0.
10.
20.
30.
40.
50.
60.
70.
Plant-Site Number


RLGM SPECTRA
(57 EUS Nuclear Power Plants)
S_a Screening Spectrum (0.8g)
S_d =0.02 in.
Spectral Acceleration (g)
Frequency (Hertz)
10^0
10^{-1}
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3

4c

SEISMIC IPEEE AND SQUG REVIEW IMPLICATIONS FOR 57 EUS NUCLEAR POWER PLANTS

Site No.	SMA Type	SQUG Plant	Site No.	SMA Type	SQUG Plant
01	2 or less	√	31	2 or less	
02	2 or less		32	2 or less	
03	2 or less	√	33	2 or less	√
04	2 or less	√	34	2 or less	√
05	2 or less	√	36	2 or less	√
06	2 or less	√	38	2 or less	√
07	2 or less	√	39	2 or less	
09	2 or less	√	41	2 or less	
10	2 or less		42	2 or less	
11	2 or less	√	43	2 or less	
12	2 or less	√	44	2 or less	
13	2 or less	√	45	2 or less	√
14	2 or less	√	47	2 or less	
15	2 or less	√	48	2 or less	
16	2 or less		49	2 or less	√
17	2 or less	√	50	2 or less	√
18	2 or less	√	51	2 or less	√
19	2 or less	√	52	2 or less	√
20	2 or less	√	57	2 or less	√
21	2 or less	√	58	2 or less	√
22	2 or less	√	59	2 or less	√
23	2 or less	√	60	2 or less	√
24	2 or less		61	2 or less	
25	2 or less	√	62	2 or less	
26	2 or less	√	67	2 or less	√
27	2 or less	√	68	2 or less	√
28	2 or less		69	2 or less	√
29	2 or less		70	2 or less	
30	2 or less	√			

— SUMMARY/DISCUSSION —
ADDITIONAL SEISMIC SEVERE-ACCIDENT TOPICS

- NEED TO CLARIFY THE ROLE OF SEISMIC PRA IN IPESE PROCESS.
- NEED TO DEVELOP STRATEGIES TO COORDINATE EFFORTS OF IPE AND IPESE PROGRAMS.
- NEED TO DEVELOP PROCEDURES FOR IPESE IDENTIFICATION OF VULNERABILITIES IN SEISMIC PLANT CONTAINMENT SYSTEMS.
  - What are the specific requirements in extending SMA procedures to examine seismic containment systems?
  - What is the minimum plant-specific HCLPF capacity of the seismic containment system needed to meet safety-goal accident and consequence mitigation criteria?

RESULTS: IMPLICATIONS FOR IPESEs

Site No.	10 Hertz RLE (g)	10 Hertz H(RLE)	5 Hertz RLE (g)	5 Hertz H(RLE)	UHS Hazard	SMA Type†	SQUG Plant
01	0.450	0.681E-04	0.450	0.691E-04	0.687E-04	2 or less	✓
02	0.423	0.679E-04	0.346	0.619E-04	0.650E-04	2 or less	
03	0.227	0.617E-04	0.192	0.610E-04	0.614E-04	2 or less	✓
04	0.302	0.623E-04	0.239	0.586E-04	0.605E-04	2 or less	✓
05	0.614	0.767E-04	0.595	0.689E-04	0.729E-04	2 or less	✓
06	0.361	0.643E-04	0.295	0.582E-04	0.613E-04	2 or less	✓
07	0.312	0.622E-04	0.254	0.572E-04	0.598E-04	2 or less	✓
09	0.334	0.905E-04	0.346	0.665E-04	0.786E-04	2 or less	✓
10	0.334	0.905E-04	0.346	0.665E-04	0.786E-04	2 or less	
11	0.[illegible]83	0.610E-04	0.312	0.576E-04	0.593E-04	2 or less	✓
12	0.319	0.889E-04	0.336	0.666E-04	0.778E-04	2 or less	✓
13	0.213	0.562E-04	0.168	0.531E-04	0.547E-04	2 or less	✓
14	0.158	0.555E-04	0.134	0.626E-04	0.591E-04	2 or less	✓
15	0.158	0.555E-04	0.134	0.626E-04	0.591E-04	2 or less	✓
16	0.183	0.539E-04	0.148	0.547E-04	0.543E-04	2 or less	
17	0.239	0.552E-04	0.186	0.517E-04	0.535E-04	2 or less	✓
18	0.291	0.596E-04	0.235	0.537E-04	0.567E-04	2 or less	✓
19	0.262	0.577E-04	0.206	0.520E-04	0.549E-04	2 or less	✓
20	0.262	0.733E-04	0.282	0.612E-04	0.673E-04	2 or less	✓
21	0.298	0.831E-04	0.327	0.63[illegible]E-04	0.735E-04	2 or less	✓
22	0.356	0.635E-04	0.300	0.595E-04	0.615E-04	2 or less	✓
23	0.343	0.601E-04	0.348	0.636E-04	0.619E-04	2 or less	✓
24	0.16[illegible]	0.528E-04	0.136	0.581E-04	0.555E-04	2 or less	
25	0.383	0.633E-04	0.308	0.584E-04	0.609E-04	2 or less	✓
26	0.255	0.612E-04	0.212	0.571E-04	0.592E-04	2 or less	✓
27	0.334	[illegible]	0.274	0.597E-04	0.611E-04	2 or less	✓
28	0.391	0.595E-04	0.242	0.561E-04	0.579E-04	2 or less	
29	0.362	0.644E-04	0.297	0.596E-04	0.621E-04	2 or less	
30	0.316	0.878E-04	0.348	0.712E-04	0.796E-04	2 or less	✓
31	0.281	0.605E-04	0.234	0.566E-04	0.586E-04	2 or less	
32	0.329	0.936E-04	0.364	0.748E-04	0.842E-04	2 or less	
33	0.231	0.635E-04	0.239	0.583E-04	0.609E-04	2 or less	✓
34	0.094	0.474E-04	0.078	0.378E-04	0.426E-04	2 or less	✓
36	0.076	0.433E-04	0.059	0.318E-04	0.376E-04	2 or less	✓
38	0.203	0.577E-04	0.169	0.616E-04	0.600E-04	2 or less	✓
39	0.256	0.616E-04	0.198	0.569E-04	0.593E-04	2 or less	
41	0.055	0.418E-04	0.069	0.345E-04	0.382E-04	2 or less	
42	0.092	0.497E-04	0.111	0.398E-04	0.448E-04	2 or less	
43	0.067	0.437E-04	0.081	0.342E-04	0.390E-04	2 or less	
44	0.069	0.469E-04	0.062	0.333E-04	0.401E-04	2 or less	
45	0.206	0.595E-04	0.180	0.625E-04	0.610E-04	2 or less	✓
47	0.344	0.635E-04	0.348	0.734E-04	0.685E-04	2 or less	
48	0.154	0.508E-04	0.118	0.504E-04	0.507E-04	2 or less	
49	0.283	0.569E-04	0.211	0.401E-04	0.485E-04	2 or less	✓
50	0.186	0.479E-04	0.147	0.330E-04	0.405E-04	2 or less	✓
51	0.279	0.539E-04	0.199	0.388E-04	0.464E-04	2 or less	✓
52	0.323	0.501E-04	0.135	0.390E-04	0.446E-04	2 or less	✓
57	0.163	0.509E-04	0.118	0.514E-04	0.512E-04	2 or less	✓
58	0.337	0.570E-04	0.201	0.535E-04	0.553E-04	2 or less	✓
59	0.148	0.500E-04	0.108	0.465E-04	0.483E-04	2 or less	✓
60	0.358	0.599E-04	0.315	0.602E-04	0.601E-04	2 or less	✓
61	0.171	0.510E-04	0.121	0.506E-04	0.508E-04	2 or less	
62	0.157	0.510E-04	0.116	0.511E-04	0.511E-04	2 or less	
67	0.215	0.529E-04	0.166	0.523E-04	0.526E-04	2 or less	✓
68	0.199	0.560E-04	0.159	0.566E-04	0.563E-04	2 or less	✓
69	0.261	0.591E-04	0.239	0.491E-04	0.542E-04	2 or less	✓
70	0.174	0.498E-04	0.124	0.504E-04	0.501E-04	2 or less	

† Preliminary, based on RLE values for 5 and 10-Hz S_a.

— SUMMARY/DISCUSSION —

ROLE OF SEISMIC PRA (SPRA)

- ADVANTAGES OF SPRA VERSUS SMA FOR IPESE ANALYSIS
  - SPRA results facilitate comparison with safety goals.
  - SPRA results facilitate decision making (e.g., cost-benefit basis for upgrade decisions).
  - SPRA facilitates identification of vulnerabilities in seismic containment systems.
  - SPRA is of same (likely) format as the IPE (i.e., a Level 1 internal-events PRA).
    - Facilitates coordination of SPRA-IPESE with PRA-IPE.
    - PRA-IPE plant modeling includes seismic sequences.

- ADVANTAGES OF SMA VERSUS SPRA FOR IPESE ANALYSIS
  - SMA can be managed within a utility with minimal outside consulting.
  - SMA has more-comprehensive, efficient walkdown procedures.
  - SMA HCLPF evaluations are simpler, more cost-effective than SPRA fragility assessments.
  - Many seismic engineers, for various reasons, feel more comfortable with SMA and believe SMA gives a more robust measure of plant seismic capacity.

— SUMMARY/DISCUSSION —

COORDINATION OF IPESE AND IPE

- IPESE WILL BE CONDUCTED ON A LATER SCHEDULE THAN THE IPE.
  - May preclude coordination of IPE AND IPESE walkdown efforts
- IPE WILL INCLUDE THOROUGH MODELING OF PLANT SYSTEMS AND ACCIDENT SEQUENCES.
  - Need to investigate how SMA–IPESE can best use the IPE plant modeling effort to avoid redundant systems analysis.

— SUMMARY/DISCUSSION —

SEISMIC CONTAINMENT SYSTEMS

- CONTAINMENT COOLING AND CONTAINMENT ISOLATION SYSTEMS SHOULD BE EXAMINED IN IPESE.
  - Containment responses outside cooling and isolation functions are considered to be primarily phenomenological behaviors that are insensitive to the magnitude of seismic load.
- SEISMIC VULNERABILITY OF CONTAINMENT COOLING AND ISOLATION FUNCTIONS OCCURS IN SUPPORT SYSTEMS.
  - Direct failures of containment cooling and isolation components (e.g., containment sprays, fan coolers, isolation valves) should be checked in IPESE, but in general, are not the vulnerable elements.
  - Loss of power, failure of solid-state protection system, etc. likely dominate the failure of containment cooling and isolation systems.
- SMA–IPESE SHOULD CRITICALLY EXAMINE COMPONENTS THAT SUPPORT CONTAINMENT COOLING AND ISOLATION (IN ADDITION TO CORE COOLING).

— SUMMARY/DISCUSSION —
SEISMIC CONTAINMENT SYSTEMS
(CONTINUED)

- REVIEW LEVEL USED IN EXAMINING SUPPORT SYSTEMS SHOULD BE BASED ON ACCIDENT-MITIGATION SAFETY-GOAL GUIDELINES.
  - Is the core-damage RLE spectrum adequate as a containment-cooling and containment-isolation review level?
- OPTIONS TO ELIMINATE OR MITIGATE SEISMIC CONTAINMENT VULNERABILITIES
  - Make containment cooling and isolation functions fail-safe with respect to support systems (e.g., change the type of isolation valves).
  - Insure adequate seismic capacity of support systems.
  - Consider potential operator mitigative action.