MEETING SUMMARY DISTRIBUTION

Docket 50-206
~~NRC PDR~~
Local PDR
SEP Reading
NRR Reading
E. G. Case
V. Stello
B. Grimes
T. Ippolito
R. Reid
G. Knighton
V. Noonan
D. Eisenhut
A. Schwencer
D. Ziemann
D. K. Davis
G. Lainas
P. Check
T. J. Carter
L. Scinto, OELD
OI&E (3)
H. Smith
R. Fraley, ACRS (16)
T. B. Abernathy
J. R. Buchanan
SEPB Members (10)
J. McEwen, KMC
C. Stepp
H. Canter, Region V
J. L. Crews, Region V
J. Hanchett, Region V
L. Reiter, NRC
D. L. Bernreuter, LLL
D. H. Chung, LLL
R. B. Herrmann, St. Louis Univ.
K. Aki, MIT
S. E. Luco, UCSD
W. C. Moody, SCE
D. E. Nunn, SCE
H. G. Hawkins, SCE
P. J. West, SCE
J. Frazier, TERA/DELTA
R. J. Apsel, TERA/DELTA
S. W. SMith, TERA/DELTA
M. Hauf, TERA/DELTA

7810300068

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

October 16, 1978

MEMORANDUM FOR: D. G. Eisenhut, Assistant Director for Systems & Projects, DOR

FROM: D. K. Davis, Chief, Systematic Evaluation Program Branch, DOR

SUBJECT: SUMMARY OF MEETING WITH SOUTHERN CALIFORNIA EDISON - SITE SPECIFIC EARTHQUAKE PROGRAM

On October 6, 1978, the NRC staff met with its consultants and representatives of Southern California Edison Company (SCE)(attendees listed in Enclosure 1) to discuss technical questions regarding the adequacy of the site specific earthquake model (SSEM)for San Onofre Unit 1. In a pre-meeting caucus, the staff discussed with its consultants the major NRC objectives for the SSEM as it relates to licensing use and summarized the major technical issues that required additional study before any staff position could be established. Although the staff did not expect the SSEM to represent a complete resolution of the near-field problem from a scientific viewpoint, three major areas were identified as requiring additional resolution prior to any meaningful decision of the SSEM's adequacy. These areas are the integration and mesh size, slip functions, and sensitivity and appropriateness of certain parameters.

After this caucus, the meeting with the licensee began with a summary of the issues identified by the staff and its consultants. The licensee indicated its major objectives for the meeting and proceeded with a technical presentation of its proposed program for resolution and progress to date on that program. This presentation is summarized in the information attached (Enclosure 2). The licensee also presented an alternate program aimed at resolving the issues raised by the staff and its consultants through additional verification studies (Enclosure 3). After these discussions, the staff and its consultants caucussed to develop its position on the required technical studies and how they would be used to reach a decision on SSEM for San Onofre Unit 1.

The staff indicated to the licensee a two phase effort for resolving the SSEM for San Onofre Unit 1; a first phase to resolve the three major issues identified above followed by a preliminary staff decision on the SSEM and appropriate site specific spectra for San Onofre Unit 1, and a second phase to confirm the SSEM's adequacy and staff judgments through

additional verification studies. While the staff's need for additional technical studies paralleled that proposed by the licensee in Enclosures 2 and 3, several important changes in scope and direction were identified. After these issues were discussed, the licensee indicated its preference to document its understanding of the studies identified by the staff and its program to resolve the issues identified. The staff would then indicate its agreement or disagreement with this program. The schedule for the two phase effort, staff review of results and staff review of conclusions were discussed as it related to the Systematic Evaluation Program. The staff indicated its belief that these issues could be resolved on a schedule consistent with that set forth for other plants in the SEP.

Don K. Davis, Chief
Systematic Evaluation Program Branch
Division of Operating Reactors

Enclosures:
As stated

ENCLOSURE 1

LIST OF ATTENDEES

D. Davis, NRC
C. Stepp, NRC
H. Canter, NRC, Region V
J. L. Crews, NRC, Region V
J. Hanchett, NRC, Region V
L. Reiter, NRC
D. L. Bernreuter, LLL
D. H. Chung, LLL
R. B. Herrmann, Saint Louis University
K. Aki, MIT
S. E. Luco, UCSD
W. C. Moody, SCE
D. E. Nunn, SCE
H. G. Hawkins, SCE
P. J. West, SCE
J. Frazier, TERA/DELTA
R. J. Apsel, TERA/DELTA
S. W. Smith, TERA/DELTA
M. [illegible]f, TERA/DELTA

SCE/TERA PRESENTATION

SITE SPECIFIC EARTHQUAKE PROGRAM

SAN ONOFRE UNIT 1

OCTOBER 6, 1978

I.	SCE Objectives in Meeting	Wes Moody	(5 min)
II.	Proposed Program to Address Staff/Consultant Comments	Gerry Frazier	(45 min)
III.	Summary of Program Objectives	Stu Smith	(10 min)
IV.	Program Schedule	Gene Hawkins	(5 min)

GROUND MOTION SIMULATIONS:

RESPONSE TO NRC CONCERNS

1. MESH SIZE

   QUANTIFY OR REMOVE ANY APPROXIMATIONS DUE TO MESH SIZE ALONG THE RUPTURE SURFACE.

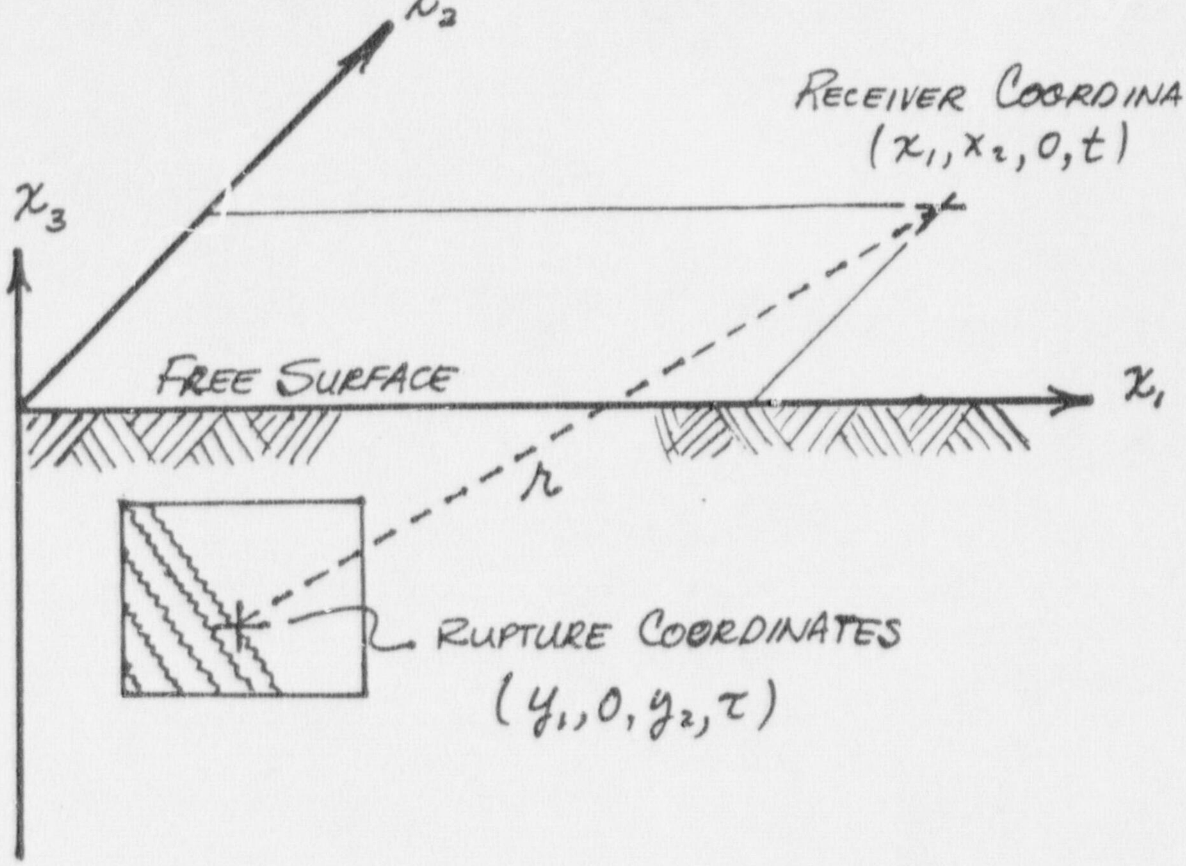
2. SLIP FUNCTION

   EXAMINE ALTERNATE SLIP FUNCTIONS, PARTICULARLY THAT SUGGESTED BY AKI, FOR POSSIBLE IMPROVEMENTS IN ACCURACY OR PLAUSIBILITY.

3. PARAMETER STUDIES

   COMPLETE PARAMETER STUDIES ON THE EFFECTS OF GEOLOGY AND RUPTURE RANDOMNESS. PRESENT PARAMETER STUDIES IN THE FORM OF PROBABILITY DISTRIBUTIONS.

GROUND MOTION EQUATION



$$\begin{pmatrix} \text{GROUND} \\ \text{MOTION} \end{pmatrix} = \begin{pmatrix} \text{SLIP} \\ \text{FUNCTION} \end{pmatrix} \ast\ast \begin{pmatrix} \text{GREEN'S} \\ \text{FUNCTION} \end{pmatrix}$$

$$u(\underset{\sim}{x},t) = \iint_{A} ds(\underset{\sim}{y}) \int_{\tau=0}^{t} d\tau \; s(\underset{\sim}{y},\tau) \; g(\underset{\sim}{x},t;\underset{\sim}{y},\tau)$$

EQUATION MODIFICATIONS

1. SPATIALLY INVARIANT SLIP

$$A(\underset{\sim}{y},\tau) = A(\tau) * \delta(\tau - \tau_R)$$

WHERE $\tau_R \sim \underset{\sim}{y} \cdot \underset{\sim}{n} / V_R$ IS THE TIME OF RUPTURE INITIATION

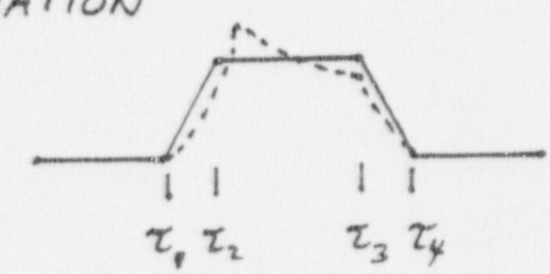
2. LOCALLY SIMILAR GREEN'S FUNCTIONS

$$g(\underset{\sim}{x},t;\underset{\sim}{y},\tau) \approx g(\underset{\sim}{x},t;\underset{\sim}{y}_n,\tau) * \delta(\tau - \Delta\tau_n)$$

WHERE $\Delta\tau_n \sim (r - r_n)/\beta$ IS THE TRAVEL TIME DELAY.

3. LOCAL INTEGRAL APPROXIMATION

$$\iint_{A_n} ds(\underset{\sim}{y})\ \delta(\tau - \tau_R - \Delta\tau_n) \approx$$



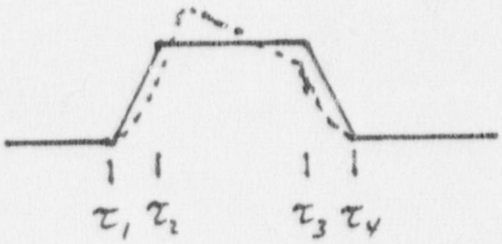
WHERE $\tau_i = (\tau_R + \Delta\tau_n)_i$ IS THE TIME DELAY DUE TO BOTH RUPTURE AND TRAVEL TIME AT THE i^{th} CORNER OF THE RUPTURE SEGEMENT.

CALCULATION METHOD

$$u(\underset{\sim}{x},t) = \iint_A ds(y) \int_{\tau=0}^{t} d\tau \; s(y,\tau)\, g(\underset{\sim}{x},t\,;y,\tau)$$

$$\approx \sum_n \iint_{A_n} ds(y)\; s(\tau) * \delta(\tau-\tau_R) * g(\underset{\sim}{x},t\,;y_n,\tau) * \delta(\tau-\Delta\tau_n)$$

$$\approx \sum_n s_n(\tau) * g(\underset{\sim}{x},t\,;y_n,\tau) * \iint_{A_n} ds(y)\; \delta(\tau-\tau_R-\Delta\tau_n)$$



MESH SIZE

PROPOSED RESOLUTION

1. COMPUTE GROUND MOTION FOR HIGHLY REFINED COHERENT RUPTURE.

2. COMPARE REFINED RESULTS WITH RESULTS FROM REPORTED METHOD TO ASSESS ACCURACY.

3. QUANTIFY RANDOMNESS AND APPROXIMATIONS IN REPORTED METHOD IN TERMS OF RANDOMNESS INTRODUCED INTO COHERENT RUPTURE.

SLIP FUNCTIONS

PROPOSED RESOLUTION

1. COMPARE RESPONSE SPECTRA FOR ALTERNATE SLIP FUNCTIONS.

2. COMPARE RESPONSE SPECTRA FOR PARKFIELD AND IMPERIAL VALLEY EARTHQUAKES USING ALTERNATE SLIP FUNCTION.

3. EXAMINE ALTERNATE DESCRIPTIONS OF FAULT SLIP FOR POSSIBLE IMPROVEMENTS IN:

   (A) ACCURACY

   (B) PLAUSIBILITY

PARAMETER STUDIES

PROPOSED RESOLUTION

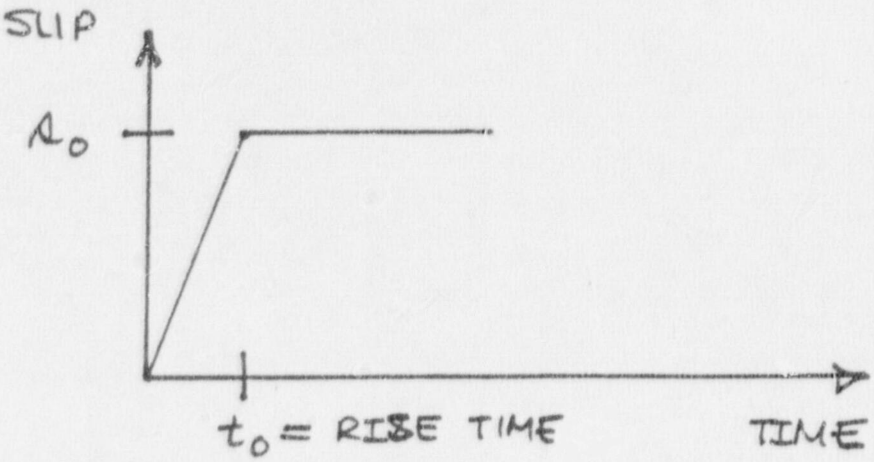
1. QUANTIFY HOW CHANGES IN RUPTURE RANDOMNESS INFLUENCE COMPUTED RESPONSE SPECTRA.

2. QUANTIFY HOW VARIOUS GEOLOGIC PARAMETERS INFLUENCE COMPUTED RESPONSE SPECTRA.

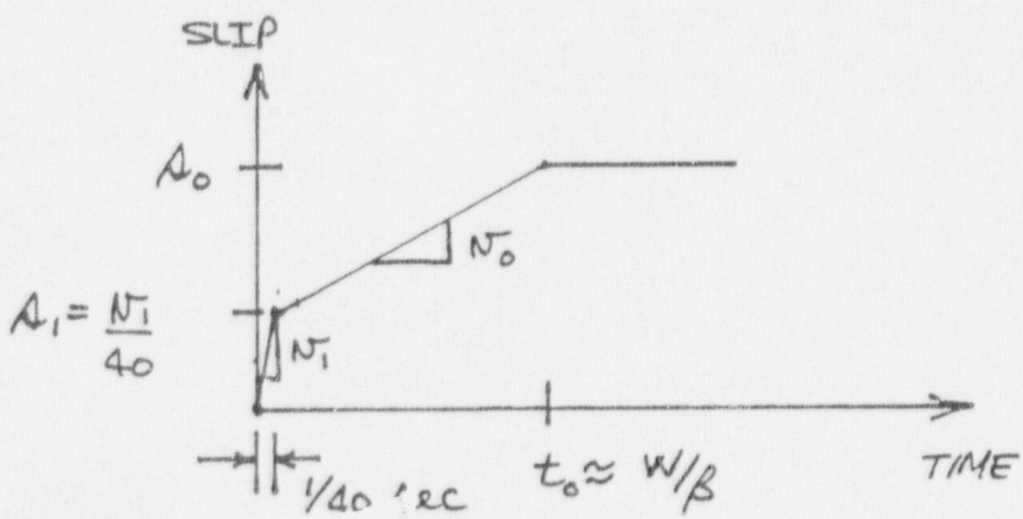
3. COMPUTE THE PROBABILITY DISTRIBUTION FOR RESPONSE SPECTRUM BY ASSIGNING A PROBABILITY DISTRIBUTION TO EACH MODEL PARAMETER.

ALTERNATE SLIP FUNCTIONS

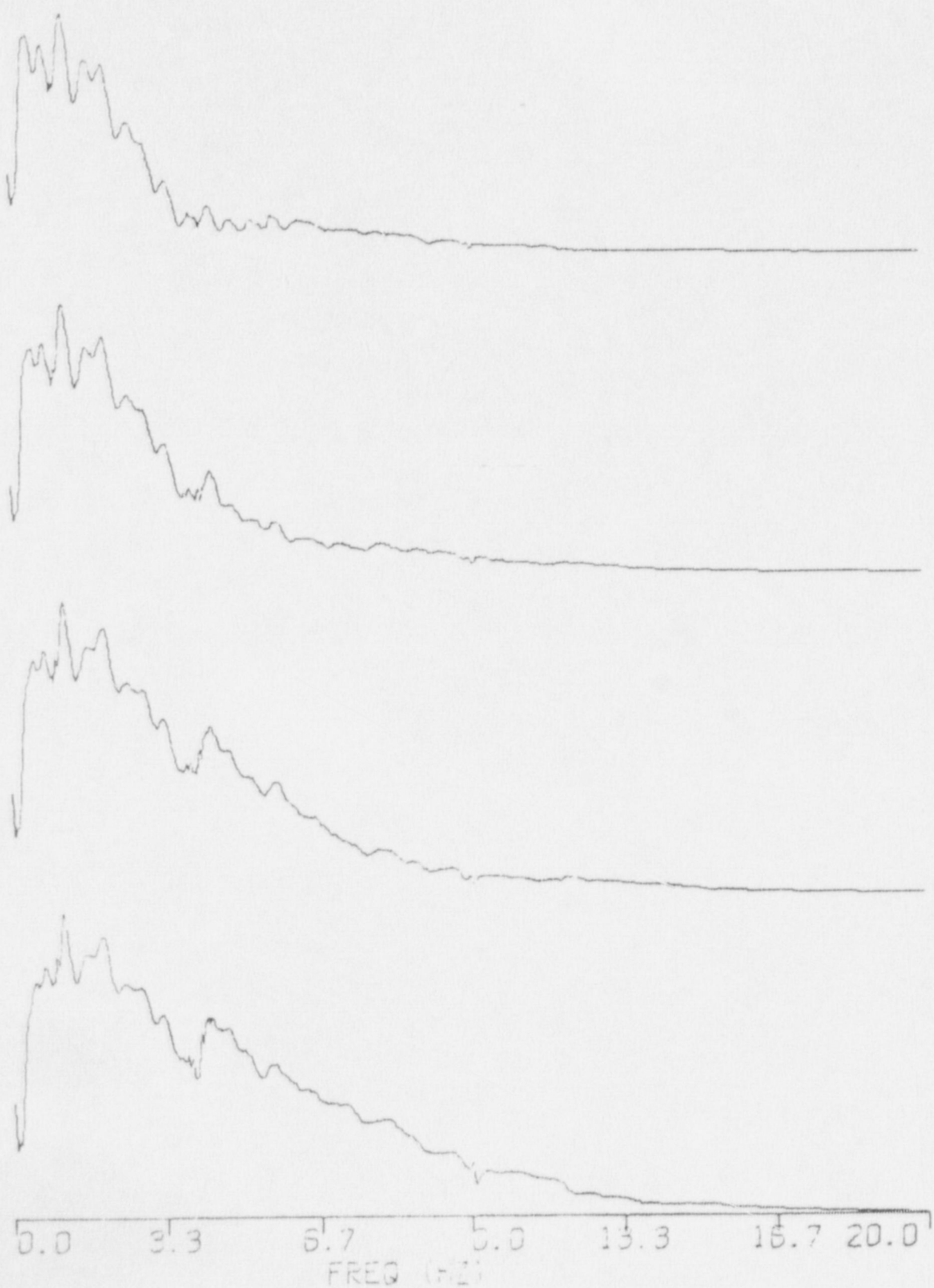
1. TWO PARAMETER (AKI, BRUNE, OTHERS)



2. THREE PARAMETER (DELTA)

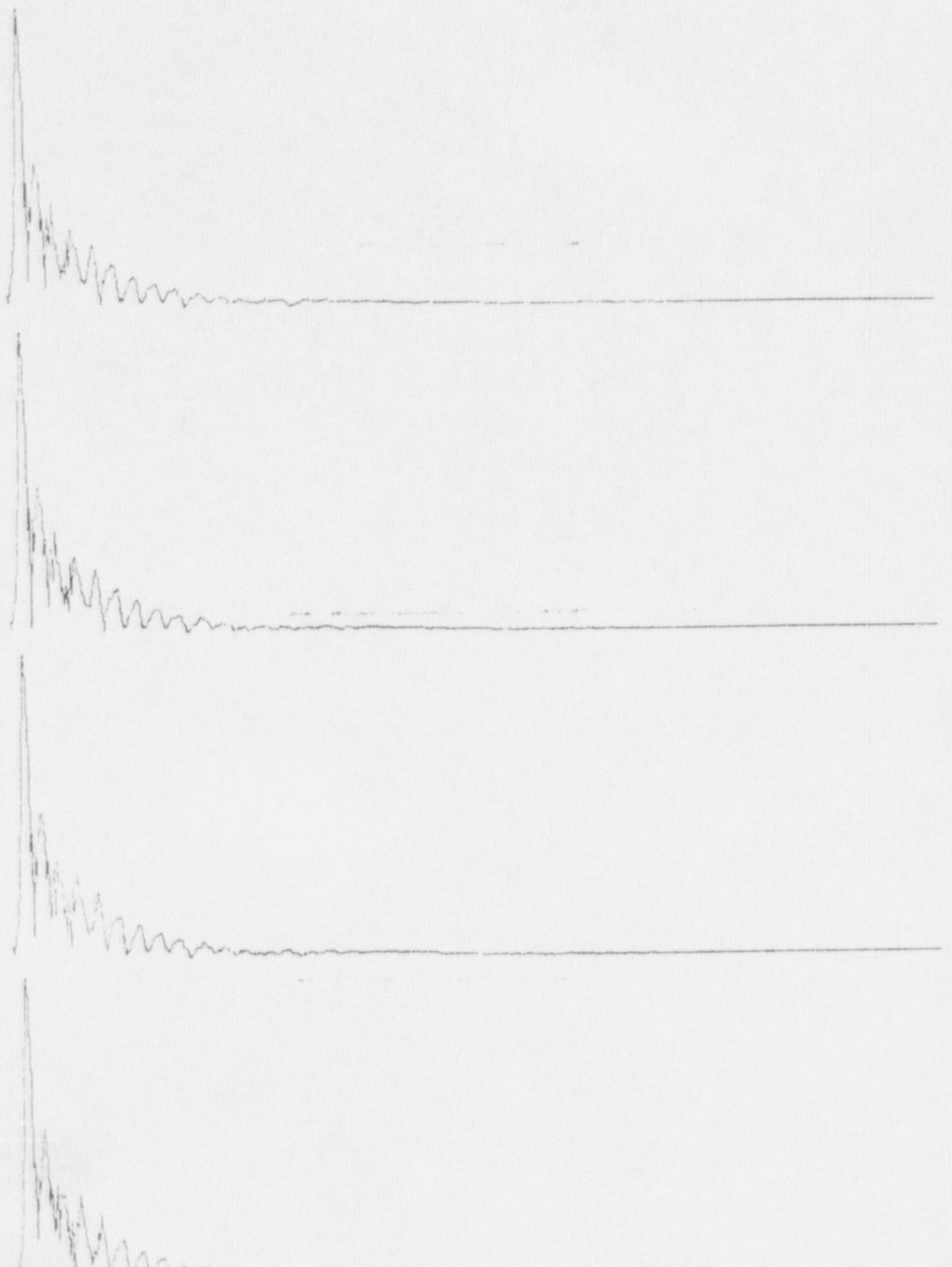



0.0 2.5 5.0 7.5 10.0 12.5 15.0
TIME (SEC)



0.0
3.3
6.7
10.0
13.3
16.7
20.0
FREQ (HZ)


0.0
5.0
10.0
15.0
20.0
25.0
30.0
TIME (SEC)

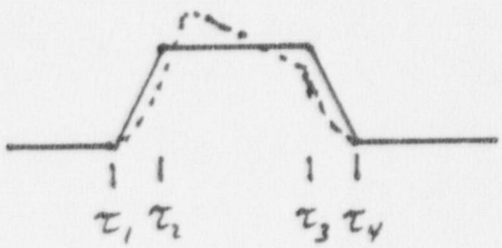

0.0 3.3 6.7 10.0 13.3 16.7 20.0
FREQ (HZ)

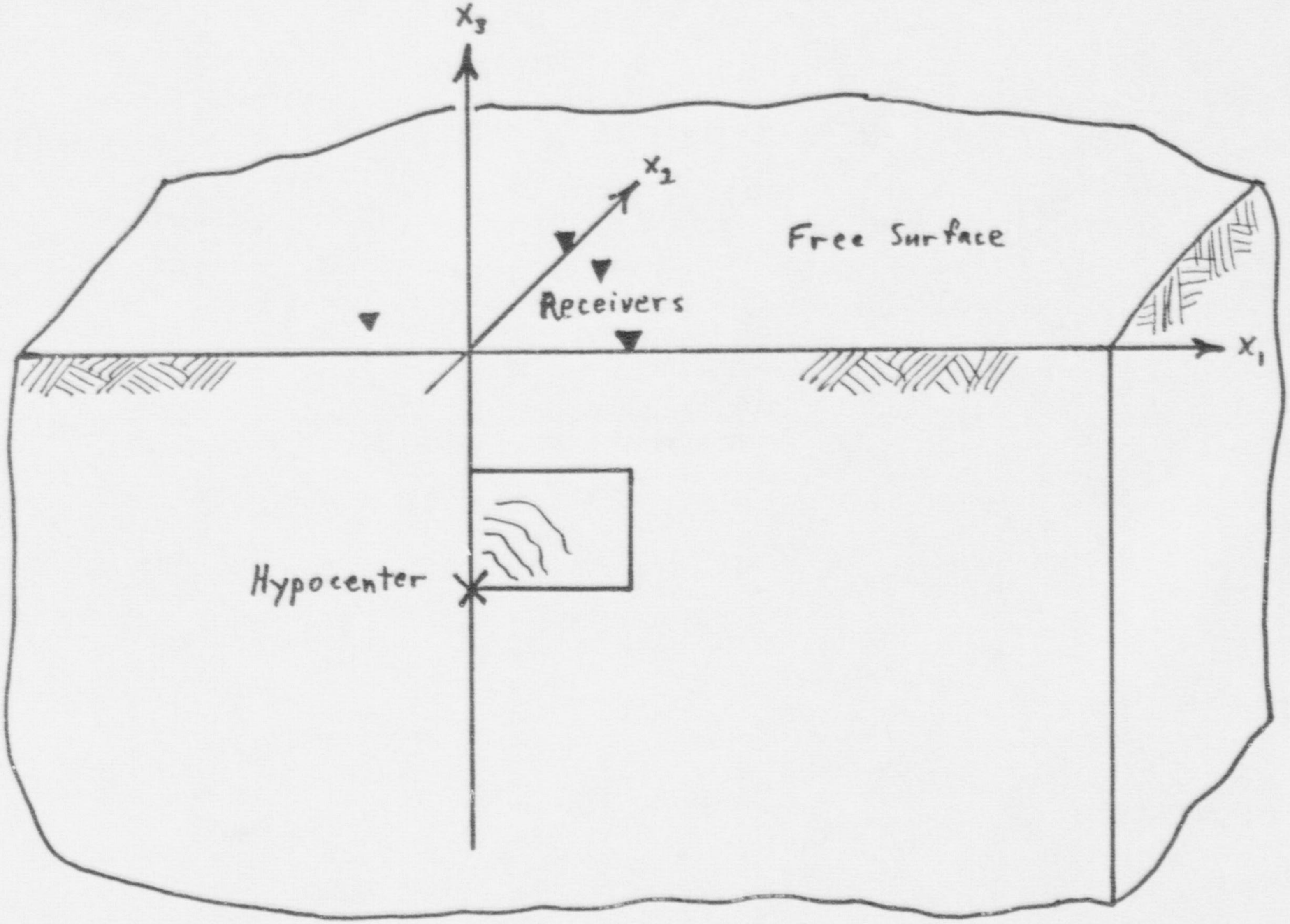
CALCULATION METHOD

$$u(\underset{\sim}{x},t) = \iint_A ds(y) \int_{\tau=0}^{t} d\tau \, s(y,\tau)\, g(\underset{\sim}{x},t;y,\tau)$$

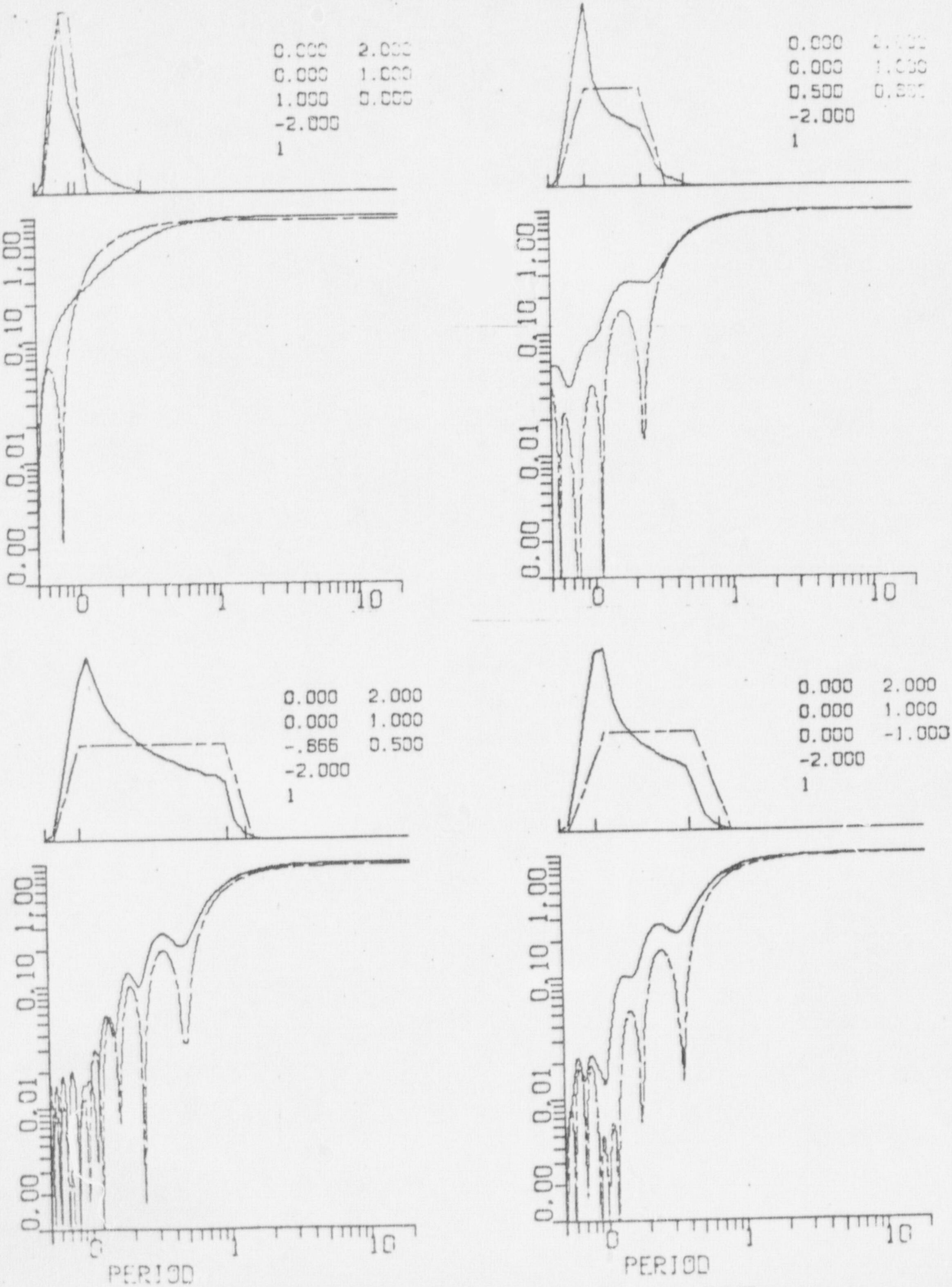
$$\approx \sum_n \iint_{A_n} ds(y)\, s(\tau) * \delta(\tau-\tau_R) * g(\underset{\sim}{x},t;y_n,\tau) * \delta(\tau-\Delta\tau_n)$$

$$\approx \sum_n s_n(\tau) * g(\underset{\sim}{x},t;y_n,\tau) * \iint_{A_n} ds(y)\, \delta(\tau-\tau_R-\Delta\tau_n)$$





x_3
x_2
Free Surface
Receivers
x_1
Hypocenter



0.000 2.000
0.000 1.000
1.000 0.000
-2.000
1
0.00 0.01 0.10 1.00
0 1 10
0.000
0.000
0.500
-2.000
1
0.00 0.01 0.10 1.00
0 1 10
0.000 2.000
0.000 1.000
-.666 0.500
-2.000
1
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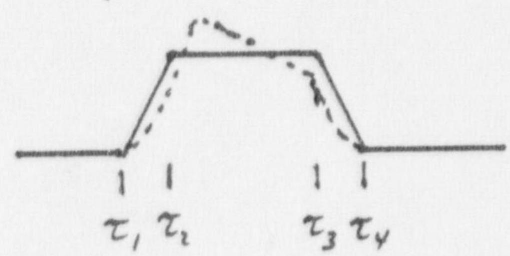
0 1 10
PERIOD
0.000 2.000
0.000 1.000
0.000 -1.000
-2.000
1
0.00 0.01 0.10 1.00
0 1 10
PERIOD

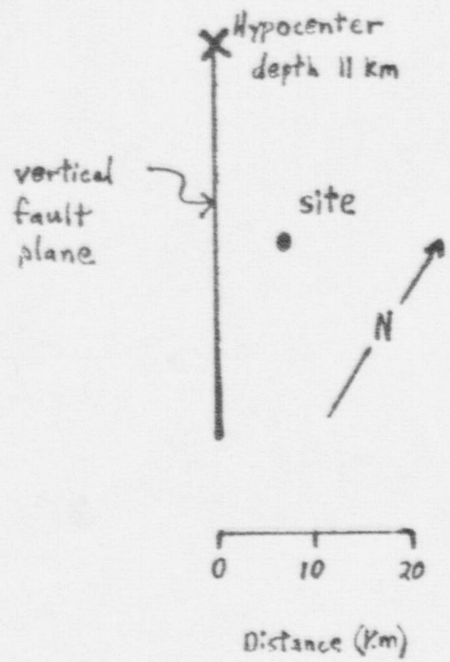
CALCULATION METHOD

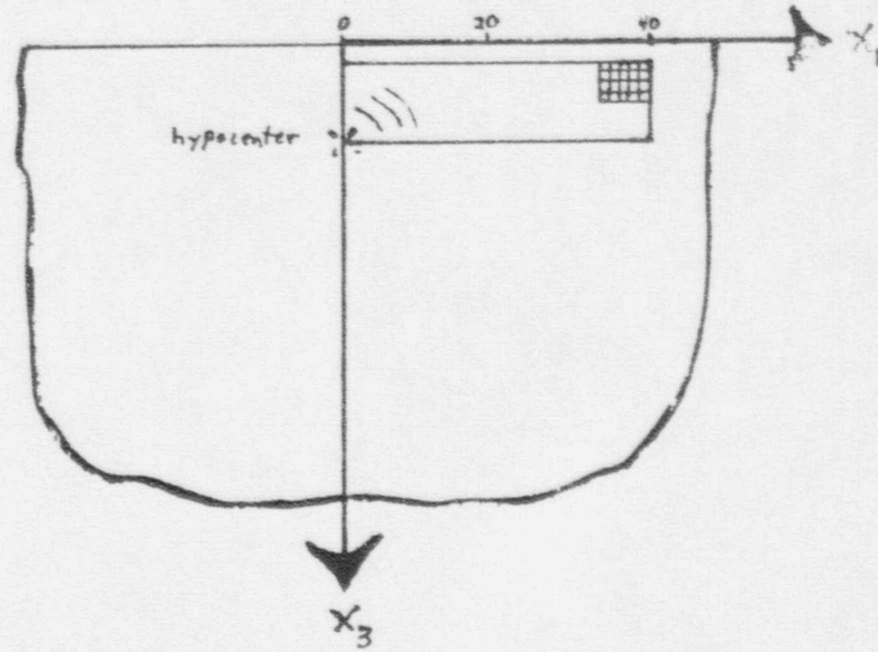
$$u(\underset{\sim}{x},t) = \iint_A ds(\underset{\sim}{y}) \int_{\tau=0}^{t} d\tau \; s(\underset{\sim}{y},\tau)\, g(\underset{\sim}{x},t;\underset{\sim}{y},\tau)$$

$$\approx \sum_n \iint_{A_n} ds(\underset{\sim}{y}) \; s(\tau) * \delta(\tau-\tau_R) * g(\underset{\sim}{x},t;\underset{\sim}{y}_n,\tau) * \delta(\tau-\Delta\tau_n)$$

$$\approx \sum_n s_n(\tau) * g(\underset{\sim}{x},t;\underset{\sim}{y}_n,\tau) * \iint_{A_n} ds(\underset{\sim}{y})\, \delta(\tau-\tau_R-\Delta\tau_n)$$




Hypocenter
depth 11 km
vertical
fault
plane
site
N
0
10
20
Distance (Km)


0
20
40
X_1
hypocenter
X_3

GIVALYEVND. 9/12
earthquake D
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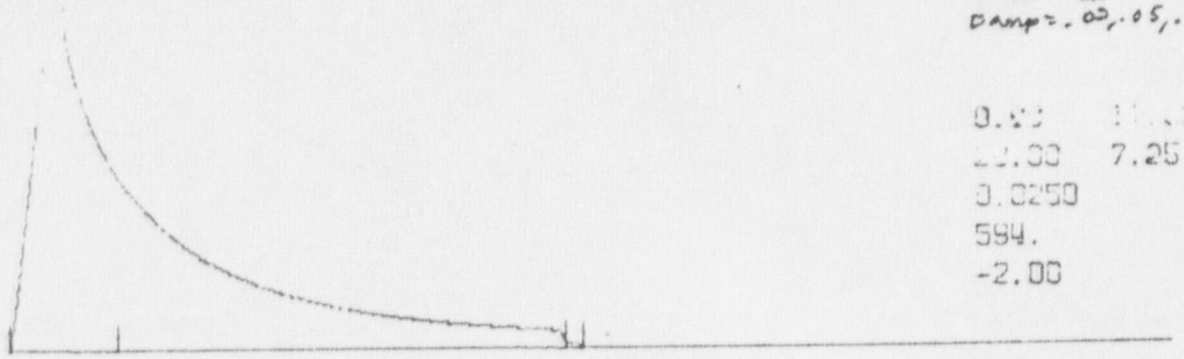

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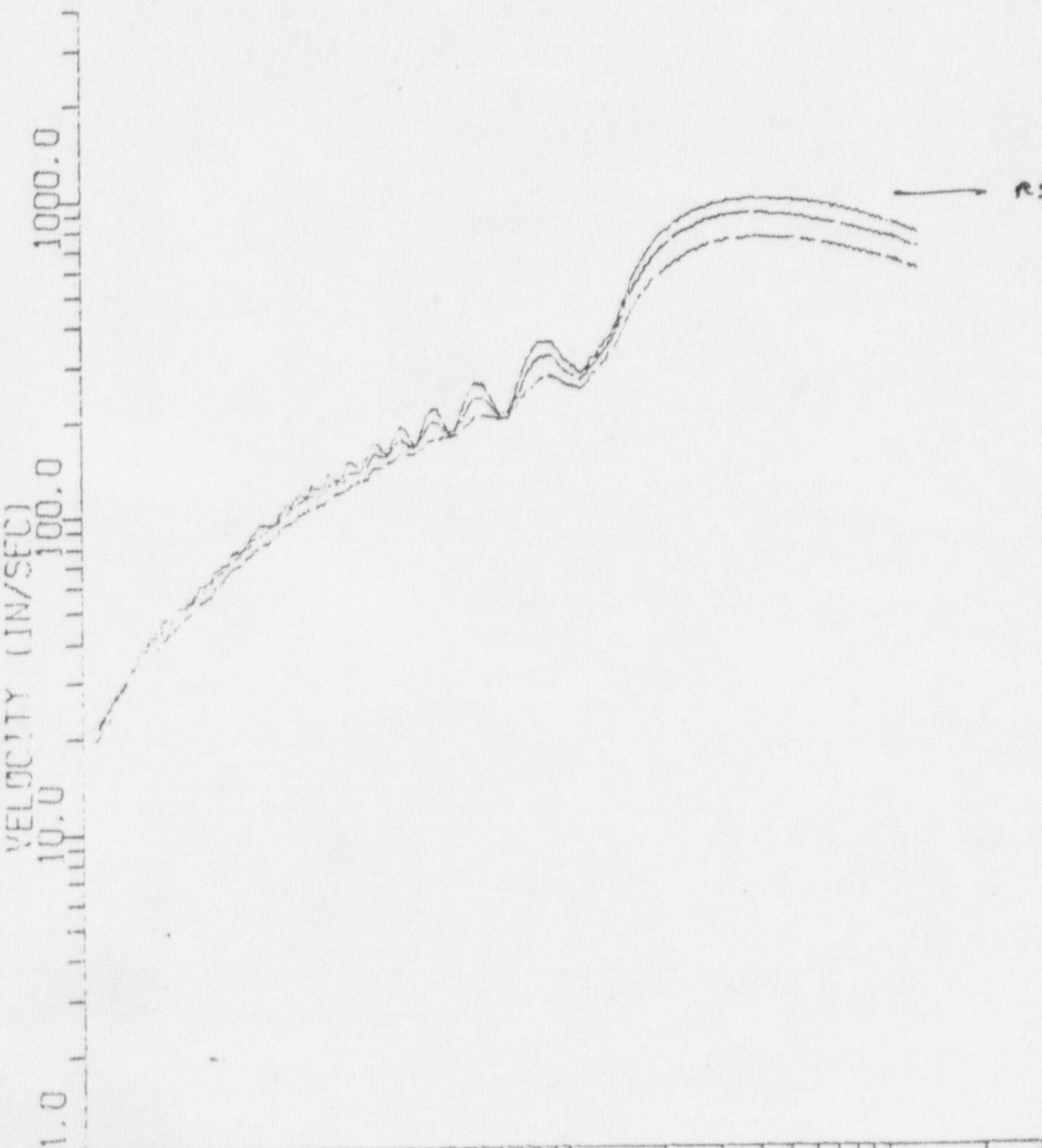
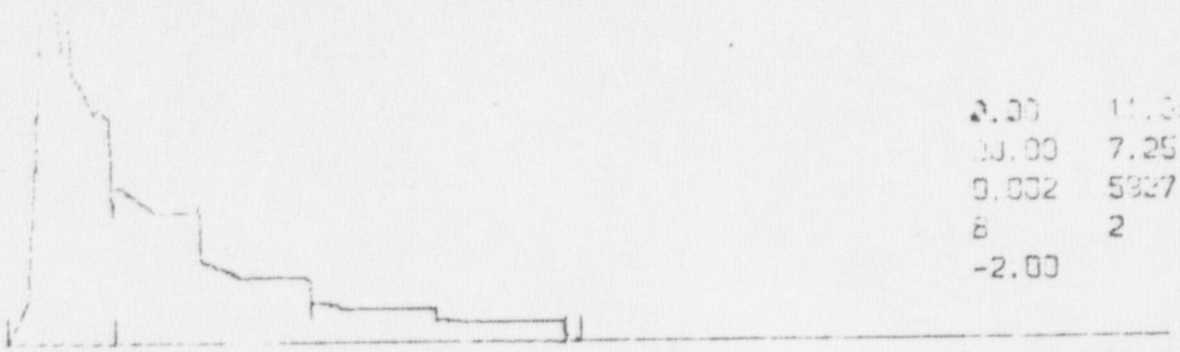
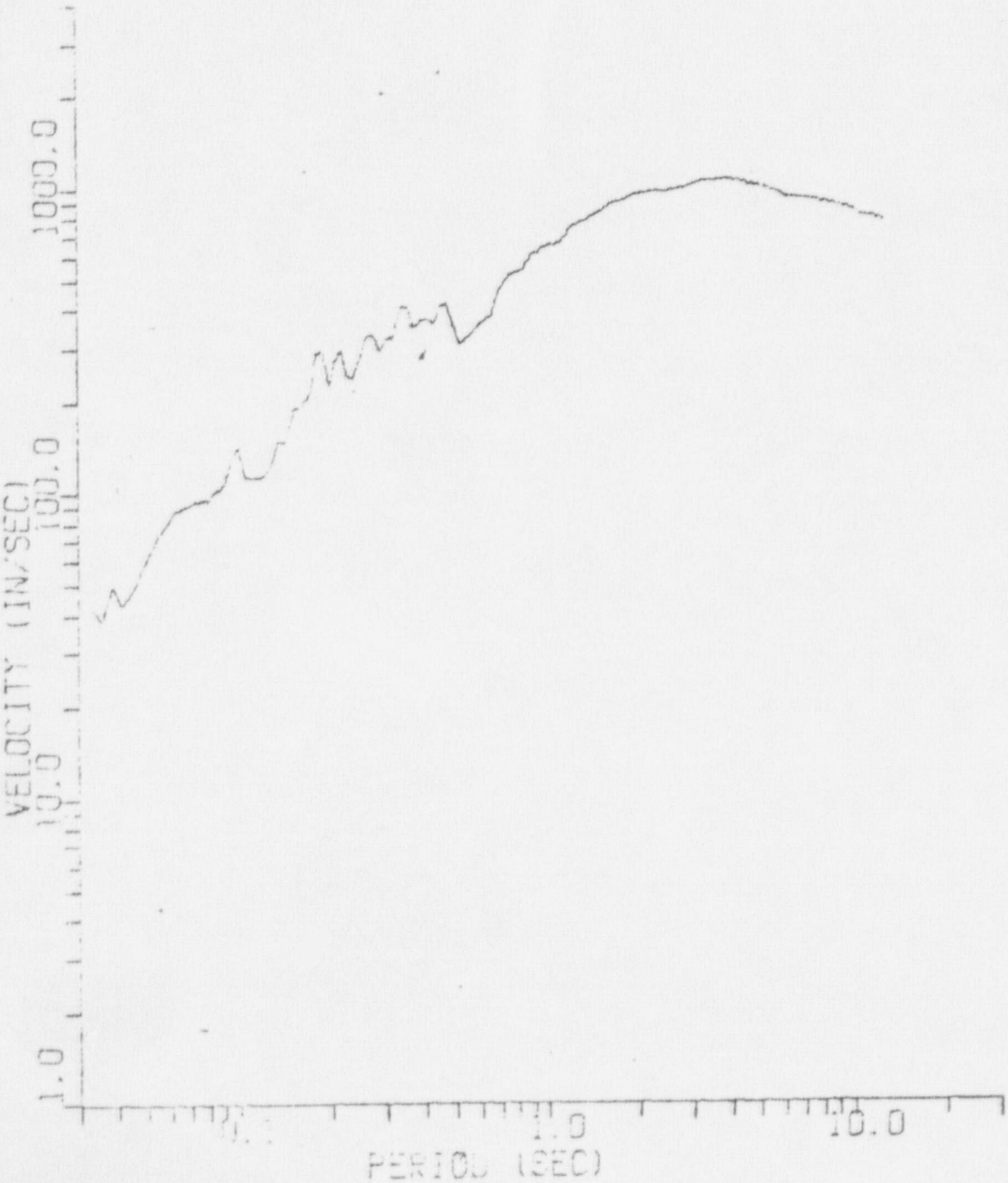



7.25
0.002
2
-2.00


VELOCITY (IN/SEC)
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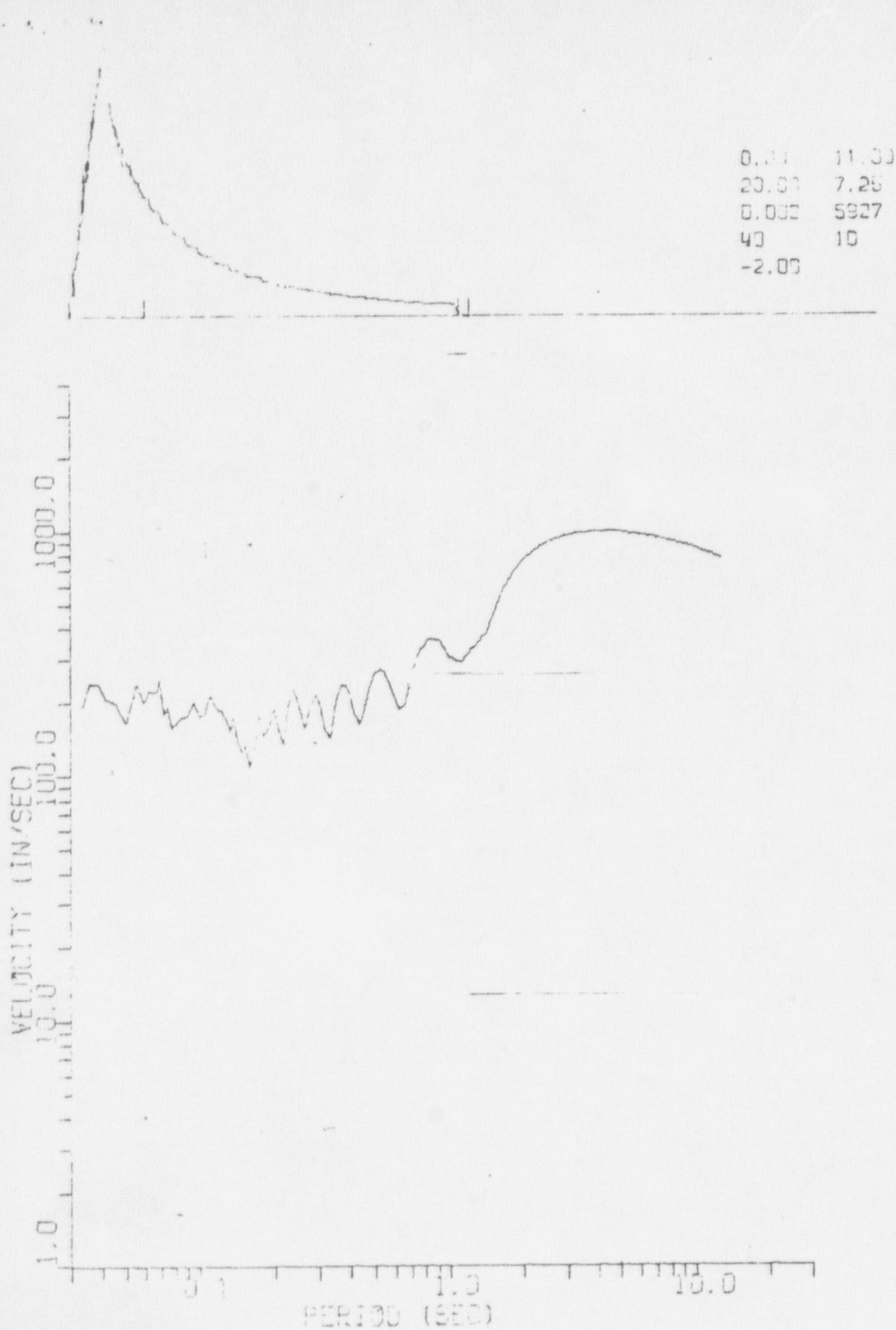
100.0
10.0
1.0
1.0
10.0
PERIOD (SEC)

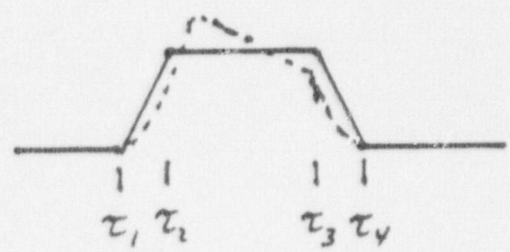

7.25
5927
40
10
-2.00
VELOCITY (IN/SEC)
1000.0
100.0
10.0
1.0
0.1
1.0
10.0
PERIOD (SEC)

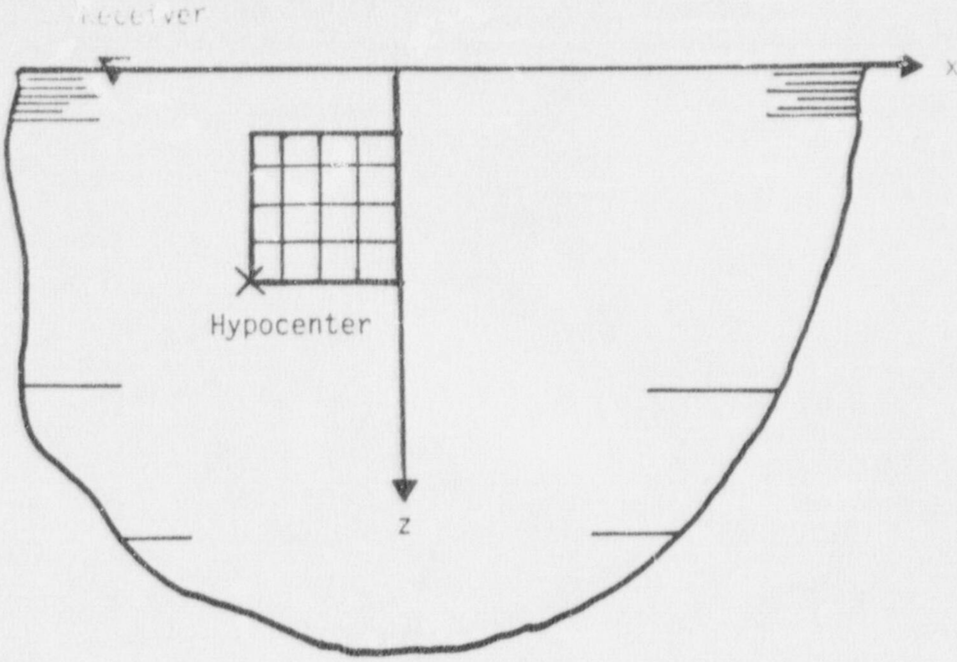
Calculation Method

$$u(\underset{\sim}{x},t)=\iint_A ds(\underset{\sim}{y})\int_{\tau=0}^{t} d\tau \; s(\underset{\sim}{y},\tau)\, g(\underset{\sim}{x},t;\underset{\sim}{y},\tau)$$

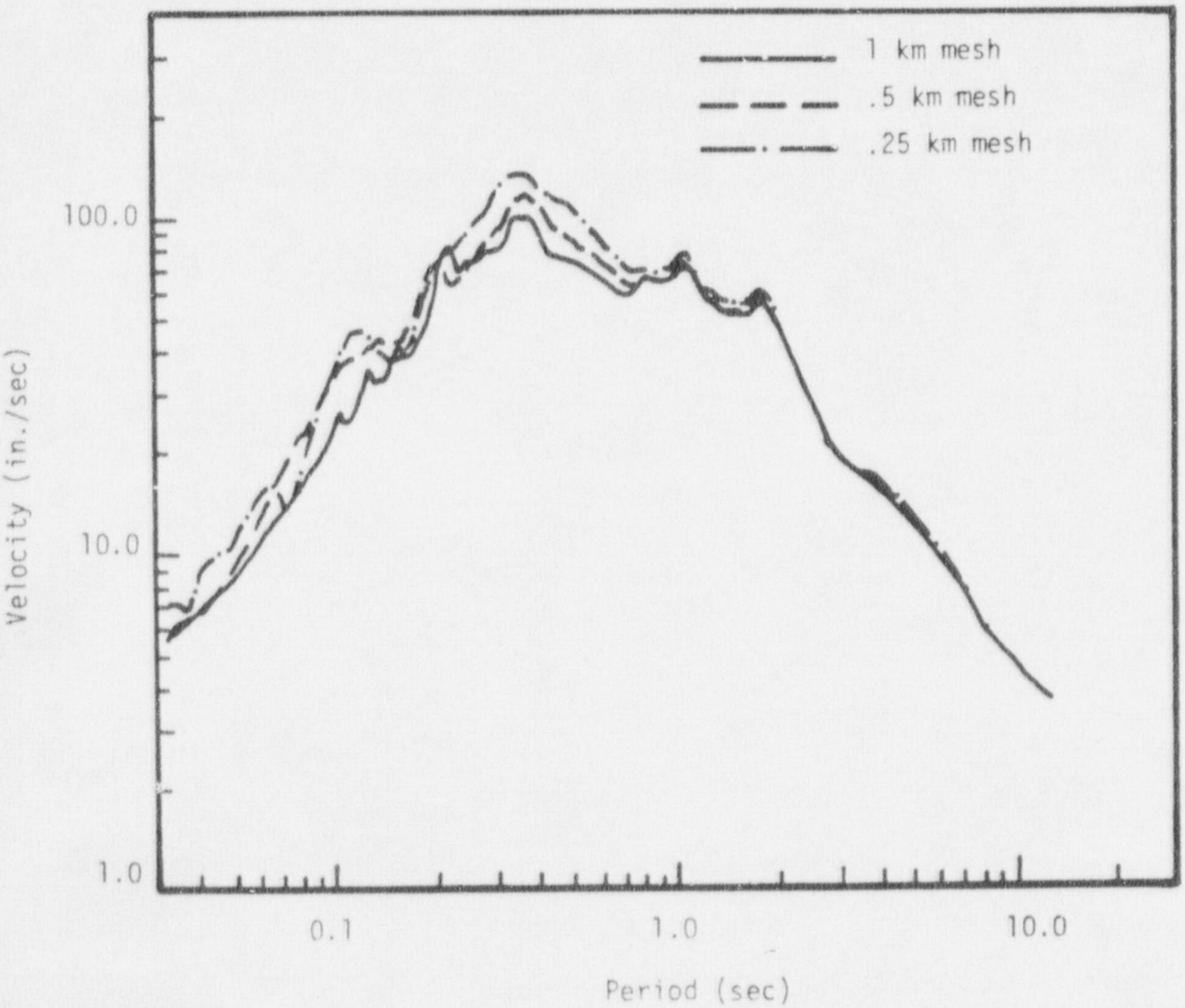
$$\approx \sum_n \iint_{A_n} ds(\underset{\sim}{y}) \; s(\tau) * \delta(\tau-\tau_R) * g(\underset{\sim}{x},t;\underset{\sim}{y}_n,\tau) * \delta(\tau-\Delta\tau_n)$$

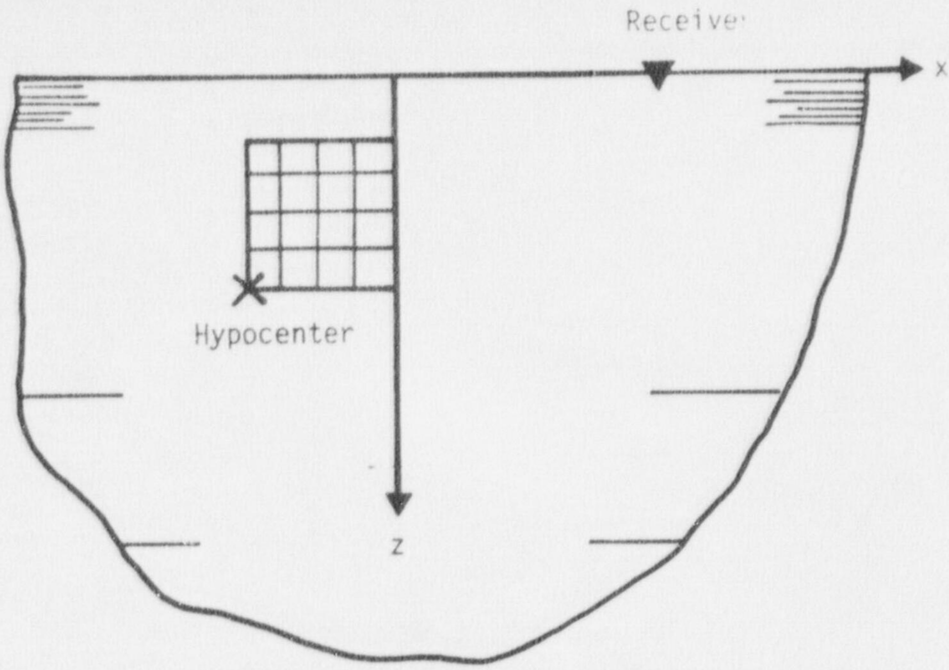
$$\approx \sum_n s_n(\tau) * g(\underset{\sim}{x},t;\underset{\sim}{y}_n,\tau) * \iint_{A_n} ds(\underset{\sim}{y})\, \delta(\tau-\tau_R-\Delta\tau_n)$$



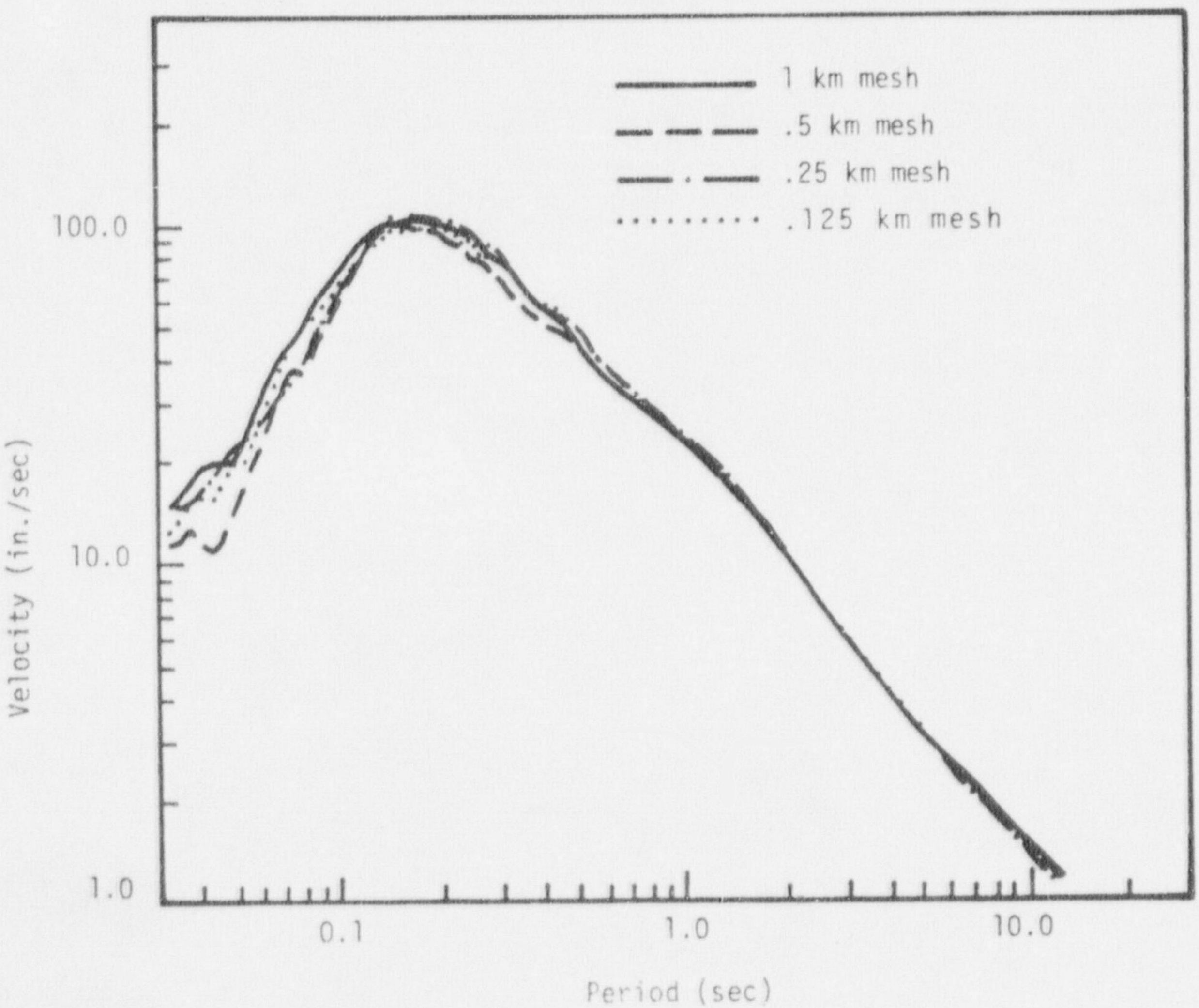


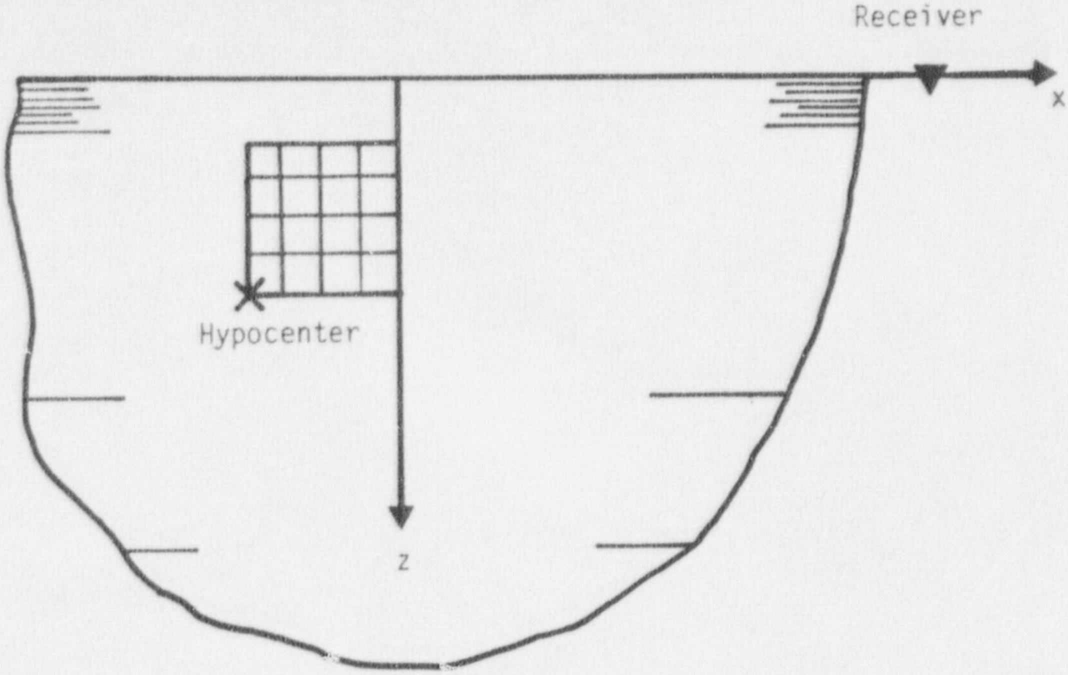
Close In Mesh Size Study (defocussed)



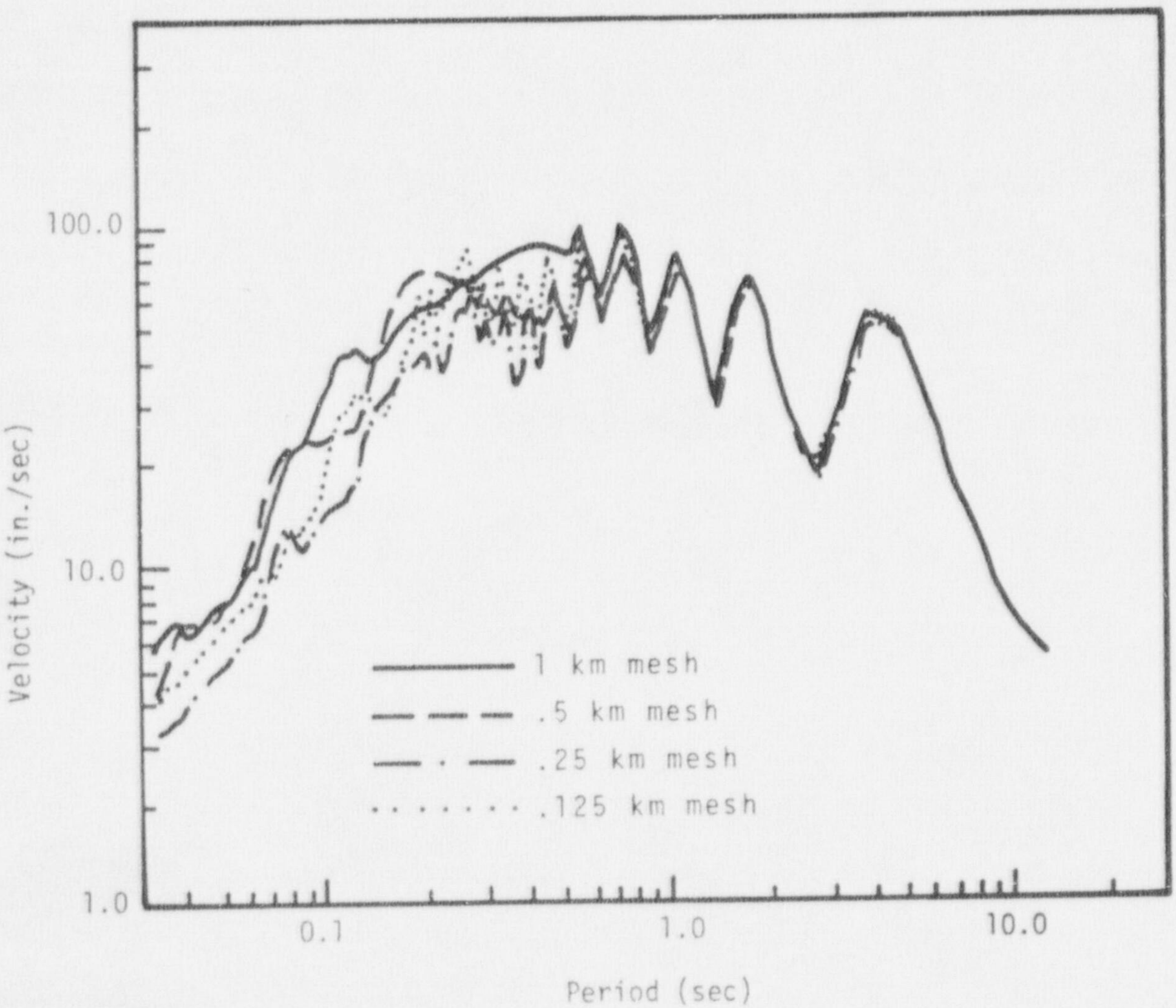


Close In Mesh Size Study (focussed)





Far Away Mesh Size Study (focussed)



GROUND MOTION SIMULATIONS

RESOLUTION SUMMARY

1. Mesh Size

(A) DEMONSTRATE THAT THE EARTHQUAKE MODEL (POSSIBLY REFINED) PRODUCES SMOOTHED RESPONSE SPECTRA THAT ARE WITHIN ± 20% OF WHAT WOULD BE OBTAINED USING INFINITESIMAL MESH SPACING WITH AN IRREGULAR PRESCRIPTION OF FAULT SLIP.

(B) ALTERNATIVELY, DEMONSTRATE THAT THE EARTHQUAKE MODEL (POSSIBLY REFINED) IS SELF CONSISTENT SO AS TO RULE OUT THE POSSIBILITY OF BIAS IN PARTICULAR APPLICATIONS.

2. Slip Function

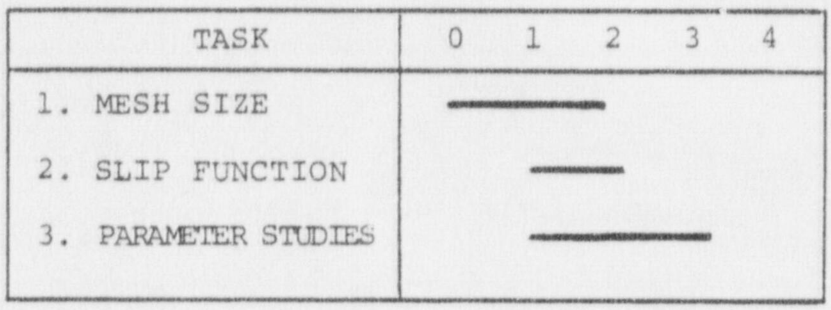
(A) DEMONSTRATE THAT DELTA'S THREE-PARAMETER SLIP FUNCTION IS AT LEAST AS THEORETICALLY PLAUSIBLE AS THE TWO-PARAMETER SLIP FUNCTION AND THAT THE THREE-PARAMETER SLIP FUNCTION SERVES AT LEAST AS WELL FOR MODELLING RECORDED GROUND MOTIONS.

(B) ALTERNATIVELY, IMPLEMENT THE MOST PHYSICALLY REALISTIC SLIP FUNCTION (TWO-PARAMETER, THREE-PARAMETER, OR MODIFIED THREE-PARAMETER) IN THE EARTHQUAKE MODEL.

3. Parameter Studies

(A) COMPLETE PARAMETER STUDIES TO QUALIFY THE EFFECTS THAT IRREGULARITIES IN THE RUPTURE AND CHANGES IN THE EARTH PROPERTIES HAVE ON THE COMPUTED RESULTS.

(B) IN ADDITION, COMPUTE PROBABILITY DISTRIBUTION FOR RESPONSE SPECTRUM BY ASSIGNING A PROBABILITY DISTRIBUTION TO INDIVIDUAL MODEL PARAMETERS.



COST ESTIMATE

TASK SUMMARY SHEET

Task 1 - Mesh Size	$ 53,224
Task 2 - Slip Function	36,863
Task 3 - Parameter Studies	55,583
TOTAL PROGRAM COST	$145,670

VALIDATION STUDIES

PROPOSED RESOLUTION

1. PERFORM ADDITIONAL WORK TOWARD MODELING THE 1940 IMPERIAL VALLEY EARTHQUAKE AND THE 1966 PARKFIELD EARTHQUAKE.

2. COMPUTE GROUND MOTION FOR DISTANCES GREATER THAN 20 KM TO COMPARE WITH EARTHQUAKE DATA AND EMPIRICAL FORMULAE.

3. COMPUTE GROUND MOTION FOR AN ADDITIONAL EARTHQUAKE AND COMPARE WITH RECORDED MOTIONS.

GROUND MOTION SIMULATIONS

ALTERNATE RESOLUTIONS

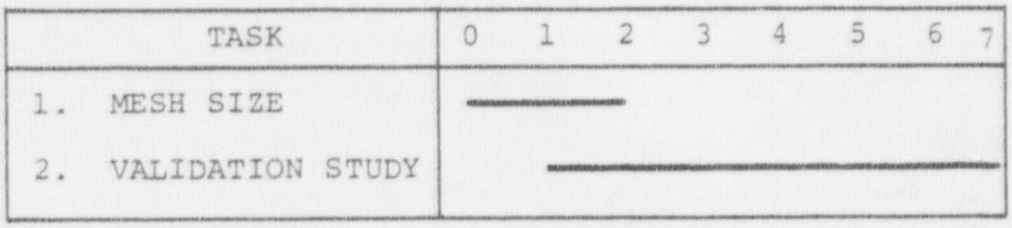
1. MESH SIZE

   DEMONSTRATE THAT THE EARTHQUAKE MODEL (POSSIBLY REFINED) IS SELF CONSISTENT SO AS TO RULE OUT THE POSSIBILITY OF BIAS IN PARTICULAR APPLICATIONS.

2. ADDITIONAL VALIDATION

(A) COMPUTE GROUND MOTIONS FOR DISTANCES GREATER THAN 20 KM AND MATCH EMPERICAL RELATIONSHIPS FOR PEAK ACCELERATION VS DISTANCE AND MAGNITUDE TO WITHIN THE UNCERTAINTY IN THESE RELATIONSHIPS (ROUGHLY A FACTOR OF TWO).

(B) COMPUTE GROUND MOTIONS FOR ONE ADDITIONAL EARTHQUAKE (PREFERABLY THE 1933 LONG BEACH EARTHQUAKE) AND MATCH THE RECORDED MOTIONS (RESPONSE SPECTRA) TO THE DEGREE ACHIEVED FOR PARKFIELD AND IMPERIAL VALLEY.



COST ESTIMATE

Task 1 - Mesh Size	$ 53,224
Task 2 - Validation Study	266,137
TOTAL PROGRAM COST	$ 319,361