REQUEST REPLY BY 3/19/93

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

Taylor
Sniezek
Thompson
Blaha
Knubel
Burkgard
EDO 8640

OFFICE OF THE
COMMISSIONER

March 15, 1993

COMFR-93-002

Speis
Heltemes
Minners
Ader
Jamgochian

MEMORANDUM FOR: The Chairman
Commissioner Rogers
Commissioner Curtiss
Commissioner de Planque

FROM: Forrest J. Remick

SUBJECT: PROPOSED RULE ON REACTOR SITE CRITERIA

In the attached letter from Newman & Holtzinger, P.C., the Commission was requested to extend the public comment period on the subject proposed rule and implementing regulatory guidance from March 24, 1993, to June 1, 1993.

The request identified the difference between the deadline we imposed on domestic comments (March 24, 1993) and the deadline we imposed on international comments (June 1, 1993). I suggest that we extend the comment period for domestic comments to be the same as that imposed on international comments, that being June 1, 1993.

SECY please track.

Attachment:
As stated

cc: OGC
SECY
ACRS

NEWMAN & HOLTZINGER, P.C.

1615 L STREET, N.W.

WASHINGTON, D.C. 20036-5680

202-955-6600

William O. Doub
DIRECT DIAL NUMBER: (202) 955-6742

TELECOPIER: (202) 872-0581

February 26, 1993

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

Attn: Docketing and Service Branch

Re: Proposed Rule on Reactor Site Criteria; Including Seismic and Earthquake Engineering Criteria for Nuclear Power Plants and Proposed Denial of Petition for Rulemaking From Free Environment, Inc. et al. (57 Fed. Reg. 47,802 (October 20, 1992))

Dear Mr. Chilk:

The law firm of Newman & Holtzinger, P.C., on behalf of its clients in the international nuclear community listed below, hereby requests extension of the period for the public to comment on the proposed rule and implementing regulatory guidance from March 24, 1993, to June 1, 1993 for the reasons set forth below. The clients, hereinafter called members of the International Siting Group (ISG), on whose behalf we are requesting the extension are as follows:

Atomic Energy of Canada, Ltd.

Electricité de France

Taiwan Power Company

An extension is necessary and appropriate for several reasons:

(1) The proposed rule presents difficult issues requiring thoughtful and careful analysis if the comments are to be the greatest value to the Commission. In particular, preparation of such comments involves careful consideration of the interplay between the proposed demographic and seismic criteria and the relationship of the proposed criteria to the Commission's Safety Goals, severe accident requirements, and 10 C.F.R. Part 52, as well as preparation of supporting analyses. It is reasonable to extend the public comment period to June 1, 1993, in order to allow all interested persons (and not just members of the international community) adequate time for such consideration.

(2) In its Staff Requirements Memorandum of August 18, 1992, the Commission directed the NRC Staff to obtain the views of the international community by June 1, 1993. Extension of the public comment period until June 1, 1993, will conform the deadline for filing public comments to the Commission's schedule for obtaining comments from the international community and will ensure consideration of all comments received on the proposed rule. In light of the Commission's commitment to obtaining and considering the views of the international community on the proposed rule, the extension would not impact the rulemaking schedule as a practical matter and would enable ISG members (and any members of the international community) to make their views known to the Commission within the context of the public comment period. We believe having one deadline for domestic comments (March 24, 1993) and another for international comments (June 1, 1993) is not desirable. The two should be consistent.

(3) The ISG intends to file comments on the proposed rule. Preparation of the comments is requiring extensive coordination among ISG members in order to develop the comments and supporting information for the views expressed in the comments. Even with the use of facsimile transmissions and courier services to ensure rapid exchanges and coordination, the logistics of such extensive and ongoing communications internationally means that it will be difficult, if not impossible, to complete the ISG comments by the end of the present comment period.

We ask the Commission give urgent attention to this request.

Sincerely,

William O. Doub

cc: Chairman Ivan Selin
Commissioner Kenneth C. Rogers
Commissioner James R. Curtiss
Commissioner Forrest J. Remick
Commissioner E. Gail de Planque

DOCKET NUMBER PROPOSED RULE PR 50, 52 & 100
(57FR 47802)

NEWMAN & HOLTZINGER, P.C.

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Commissioner Kenneth C. Rogers
Commissioner James R. Curtiss
Commissioner Forrest J. Remick
Commissioner E. Gail de Planque

AD93-1
PDR

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

DRAFT REGULATORY GUIDE

November 1992
Division 1
Draft DG-1016

Contact: R. M. Kenneally (301) 492-3893

DRAFT REGULATORY GUIDE DG-1016

(Second Proposed Revision 2 to Regulatory Guide 1.12)
(Previously issued as Draft MS-140-5)

NUCLEAR POWER PLANT INSTRUMENTATION FOR EARTHQUAKES

A. INTRODUCTION

In 10 CFR Part 20, "Standards for Protection Against Radiation," licensees are required to make every reasonable effort to maintain radiation exposures as low as is reasonably achievable. Paragraph (c) of § 50.36, "Technical Specifications," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires the technical specifications of a facility to include surveillance requirements to ensure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions of operation will be met. Paragraph IV(a)(4) of Proposed Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50 would require that suitable instrumentation be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly. Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50 would require shutdown of the nuclear power plant if vibratory ground motion exceeding that of the operating basis earthquake ground motion (OBE) occurs.*

*Guidance is being developed in Draft Regulatory Guide DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions," on plant shutdown criteria.

This guide is being developed to describe seismic instrumentation acceptable to the NRC staff for satisfying the requirements of Parts 20 and 50 and the Proposed Appendix S to Part 50.

Any information collection activities mentioned in this draft regulatory guide are contained as requirements in the proposed amendments to 10 CFR Part 50 that would provide the regulatory basis for this guide. The proposed amendments have been submitted to the Office of Management and Budget for clearance that may be appropriate under the Paperwork Reduction Act. Such clearance, if obtained, would also apply to any information collection activities mentioned in this guide.

B. DISCUSSION

When an earthquake occurs, it is important to immediately assess the effects of the earthquake at the nuclear power plant. State-of-the-art solid-state digital time-history accelerographs installed at appropriate locations will provide time-history data on the seismic response of the free-field, containment structure, and other Category I structures. The instrumentation should be located so that a comparison and evaluation of such response may be made with the design basis and so that occupational radiation exposures are maintained as low as reasonably achievable (ALARA).

Free-field instrumentation data would be used to determine whether the OBE ground motion has been exceeded (see Draft Regulatory Guide DG-1017). Foundation-level instrumentation would provide data on the actual seismic input to the containment and other buildings and would quantify differences between the vibratory ground motion at the free-field and foundation level. Instrumentation is not located on equipment, piping, or supports since experience has shown that data obtained at these locations are obscured by vibratory motion associated with normal plant operation.

The guidance being developed in Draft Regulatory Guide DG-1017 is based on the assumption that the nuclear power plant has operable seismic instrumentation, including the equipment and software required to process the data within 4 hours after an earthquake. This is necessary because the decision to shut down the plant will be made, in part, by comparing the recorded data against OBE exceedance criteria. The decision to shut down the plant is also based on the results of the operator walkdown inspections that take place within 8 hours of the event.

It may not be necessary for identical nuclear power units on a given site to each be provided with seismic instrumentation if essentially the same seismic response at each of the units is expected from a given earthquake.

An evaluation of seismic instrumentation operational experience noted that instruments have been out of service during plant shutdown and sometimes during plant operation. The instrumentation system should be operable at all times. If the seismic instrumentation is inoperable, the guidelines in Appendix B to Draft Regulatory Guide DG-1017 would be used to determine whether the OBE has been exceeded.

Instrumentation characteristics, installation, activation, remote indication, and maintenance are described in this guide to help ensure (1) that the data provided are comparable with the data used in the design of the nuclear power plant, (2) that exceedence of the OBE can be determined, and (3) that the equipment will perform as required.

The Appendix to this guide provides definitions to be used with this guidance.

C. REGULATORY POSITION

The type, locations, operability, characteristics, installation, actuation, remote indication, and maintenance of seismic instrumentation described below are acceptable to the NRC staff for satisfying the requirements in 10 CFR Part 20, 10 CFR 50.36(c), and Paragraph IV(a)(4) of Proposed Appendix S to 10 CFR Part 50 for ensuring the safety of nuclear power plants.

1. SEISMIC INSTRUMENTATION TYPE AND LOCATION

1.1 State-of-the-art solid-state digital instrumentation that will enable the processing of data at the plant site within 4 hours of the seismic event should be used.

1.2 A triaxial time-history accelerograph should be provided at each of the following locations:

1. Free-field.

2. Containment foundation.

3. Two elevations (excluding the foundation) on a structure internal to the containment.

4. Two independent Category I structure foundations (for instance, the diesel generator building and the auxiliary building) where the response is different from that of the containment structure.

5. An elevation (excluding the foundation) on each of the independent Category I structures selected in 4 above.

6. If seismic isolators are used, instrumentation should be placed on both the rigid and isolated portions of the structures at approximately the same elevations.

1.3 The specific locations for instrumentation should be determined by the nuclear plant designer to obtain the most pertinent information consistent with maintaining occupational radiation exposures ALARA for the location, installation, and maintenance of seismic instrumentation. In general:

1.3.1 A design review of the location, installation, and maintenance of proposed instrumentation for maintaining exposures ALARA should be performed by the facility in the planning stage in accordance with Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable."

1.3.2 Instrumentation should be placed in a location with as low a dose rate as is practical, consistent with other requirements.

1.3.3 Instruments should be selected to require minimal maintenance and in-service inspection, as well as minimal time and numbers of personnel to conduct installation and maintenance.

2. INSTRUMENTATION AT MULTI-UNIT SITES

Instrumentation in addition to that installed for a single unit will not be required if essentially the same seismic response is expected at the other units based on the seismic analysis used in the seismic design of the plant. However, if there are separate control rooms, annunciation should be provided to both control rooms as specified in Regulatory Position 7.

3. SEISMIC INSTRUMENTATION OPERABILITY

The seismic instrumentation should operate during all modes of plant operation, including periods of plant shutdown. The maintenance and repair procedures should provide for keeping the maximum number of instruments in service during plant operation and shutdown.

4. INSTRUMENTATION CHARACTERISTICS

4.1 The design should include provisions for in-service testing. The instruments should be capable of periodic channel checks during normal plant operation.

4.2 The instruments should have the capability for in-place functional testing.

4.3 The instrumentation on the foundation and at elevations within the same building or structure should be interconnected for common starting and common timing, and the instrumentation should contain provisions for an external remote alarm to indicate actuation.

4.4 The pre-event memory of the instrumentation should be sufficient to record the onset of the earthquake; for example, it should have the ability to record the 3 seconds prior to seismic-trigger actuation. It should operate continuously during the period in which the earthquake exceeds the seismic-trigger threshold and for a minimum of 5 seconds beyond the last seismic-trigger signal. The instrumentation should be capable of a minimum of 25 minutes of continuous recording.

4.5 Acceleration Sensors

4.5.1. The dynamic range should be 1000:1 zero to peak, for example, 0.001g to 1.0g.

4.5.2. The frequency range should be 0.20 Hz to 50 Hz, or an equivalent demonstrated to be adequate by computational techniques applied to the resultant accelerogram.

4.6 Recorder

4.6.1. The sample rate should be at least 200 samples per second.

4.6.2. The bandwidth should be at least from 0.20 Hz to 50 Hz.

4.6.3. The dynamic range should be 1000:1.

4.7 Seismic Trigger. The actuating level should be adjustable for a minimum of 0.005g to 0.02g.

5. INSTRUMENTATION INSTALLATION

5.1 The instrumentation should be designed and installed so that the vibratory transmissibility over the amplified region of the design spectral frequency range is essentially unity, that is, so that the mounting is rigid.

5.2 The instrumentation should be oriented so that the horizontal axes are parallel to the orthogonal horizontal axes assumed in the seismic analysis.

5.3 Protection against accidental impacts should be provided.

6. INSTRUMENTATION ACTUATION

6.1 Both vertical and horizontal input vibratory ground motion should actuate the same time-history accelerograph. One or more seismic triggers may be used to accomplish this.

6.2 Spurious triggering should be avoided.

6.3 The seismic trigger mechanisms of the time-history accelerograph should be set for a threshold ground acceleration of not more than 0.02g.

7. REMOTE INDICATION

Activation of the free-field or any foundation-level time-history accelerograph should be annunciated in the control room. If there are two or more control rooms at the site, annunciation should be provided to each control room.

8. MAINTENANCE

8.1 The purpose of the maintenance program is to ensure that the equipment will perform as required. As stated in Regulatory Position 3, the maintenance and repair procedures should provide for keeping the maximum number of instruments in service during plant operation and shutdown.

8.2 Systems are to be given channel checks every 2 weeks for the first 3 months of service after startup. Failures of devices normally occur during initial operation. After the initial 3-month period and 3 consecutive successful checks, monthly channel checks are sufficient. The monthly channel check is to include checking the batteries. The channel functional test should be performed every 6 months. Channel calibration should be performed during refueling.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This proposed revision has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified port. of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for construction permits, operating licenses, combined

licenses, or design certification submitted after the implementation date to be specified in the active guide. This guide would not be used in the evaluation of an application for an operating license submitted after the implementation date to be specified in the active guide if the construction permit was issued prior to that date.

APPENDIX

DEFINITIONS

Acceleration Sensor. An instrument capable of sensing absolute acceleration and transmitting the data to a recorder.

Channel Calibration (Primary Calibration). The determination and adjustment, if required, of an instrument, sensor, or system such that it responds within a specific range and accuracy to an acceleration, velocity, or displacement input, as applicable, traceable to the National Institute of Standards and Technology (NIST), or responds to an acceptable physical constant.

Channel Check. The qualitative verification of the functional status of the instrument sensor. This check is an "in-situ" test and may be the same as a channel functional test.

Channel Functional Test (Secondary Calibration). The determination without adjustment that an instrument, sensor, or system responds to a known input, not necessarily traced to the National Institute of Standards and Technology (NIST), of such character that it will verify the instrument, sensor, or system is functioning in a manner that can be calibrated.

Containment - See Primary Containment and Secondary Containment.

Operating Basis Earthquake Ground Motion (OBE). The vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public will remain functional. The value of the OBE is set by the applicant.

Primary Containment. The principal structure of a unit that acts as the barrier, after the fuel cladding and reactor pressure boundary, to control the release of radioactive material. The primary containment includes (1) the containment structure and its access openings, penetrations, and appurtenances, (2) the valves, pipes, closed systems, and other components used to

isolate the containment atmosphere from the environment, and (3) those systems or portions of systems that, by their system functions, extend the containment structure boundary (e.g., the connecting steam and feedwater piping) and provide effective isolation.

Recorder. An instrument capable of simultaneously recording the data versus time from an acceleration sensor or sensors.

Secondary Containment. The structure surrounding the primary containment that acts as a further barrier to control the release of radioactive material.

Seismic Isolator. A device (for instance, laminated elastomer and steel) installed between the structure and its foundation to reduce the acceleration of the isolated structure, as well as the attached equipment and components.

Seismic Trigger. A device that starts the time-history accelerograph.

Time-History Accelerograph. An instrument capable of measuring and permanently recording the absolute acceleration versus time. The components of the time-history accelerograph (acceleration sensor, recorder, seismic trigger) may be assembled in a self-contained unit or may be separately located.

Triaxial. Describes the function of an instrument or group of instruments in three mutually orthogonal directions, one of which is vertical.

REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. The draft regulatory analysis, "Proposed Revision of 10 CFR Part 100 and 10 CFR Part 50," provides the regulatory basis for this guide and examines the costs and benefits of the rule as implemented by the guide. A copy of the draft regulatory analysis is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC, as Enclosure 2 to Secy 92-215.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

DRAFT REGULATORY GUIDE

November 1992
Division 1
Draft DG-1017

Contact: R. M. Kenneally (301) 492-3893

DRAFT REGULATORY GUIDE DG-1017

PRE-EARTHQUAKE PLANNING AND IMMEDIATE NUCLEAR POWER PLANT OPERATOR POSTEARTHQUAKE ACTIONS

A. INTRODUCTION

Paragraph IV(a)(4) of Proposed Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," would require that suitable instrumentation[1] be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly. Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50 would require shutdown of the nuclear power plant if vibratory ground motion exceeding that of the operating basis earthquake ground motion (OBE) or significant plant damage occurs. Proposed Paragraph 50.54(ee) to 10 CFR Part 50 would require licensees of nuclear power plants that have adopted the earthquake engineering criteria in Proposed Appendix S to 10 CFR Part 50 to shut down the plant if the criteria in Paragraph IV(a)(3) of Proposed Appendix S are exceeded.

This guide is being developed to provide guidance acceptable to the NRC staff for a timely evaluation after an earthquake of the recorded

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[1]Guidance is being developed in Draft Regulatory Guide DG-1016, the Second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes," to describe seismic instrumentation acceptable to the NRC staff.

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instrumentation data and for determining whether plant shutdown would be required by the proposed amendments to 10 CFR Part 50.

Any information collection activities mentioned in this draft regulatory guide are contained as requirements in the proposed amendments to 10 CFR Part 50 that would provide the regulatory basis for this guide. The proposed amendments have been submitted to the Office of Management and Budget for clearance that may be appropriate under the Paperwork Reduction Act. Such clearance, if obtained, would also apply to any information collection activities mentioned in this guide.

B. DISCUSSION

When an earthquake occurs, ground motion data are recorded by the seismic instrumentation.[1] These data are used to make an early determination of the degree of severity of the seismic event. The data from the seismic instrumentation, coupled with information obtained from a plant walkdown, are used to make the initial determination of whether the plant should be shut down, if it has not already been shut down by operational perturbations resulting from the seismic event. If on the basis of these initial evaluations (instrumentation data and walkdown) it is concluded that the plant shutdown criteria have not been exceeded, it is presumed that the plant will not be shut down. Guidance is being developed on postshutdown inspections and plant restart; see Draft Regulatory Guide DG-1018, "Restart of a Nuclear Power Plant Shut Down by a Seismic Event."

The Electric Power Research Institute has developed guidelines that will enable licensees to quickly identify and assess earthquake effects on nuclear power plants. These guidelines are in EPRI NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake," July 1988; EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake," December 1989[2]; and EPRI TR-100082, "Standardization of Cumulative Absolute Velocity," December 1991.[2]

This regulatory guide is based on the assumption that the nuclear power plant has operable seismic instrumentation, including the equipment and software required to process the data within 4 hours after an earthquake. This is

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[2]EPRI reports may be obtained from the Electric Power Research Institute, Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303

necessary because the decision to shut down the plant will be made, in part, by comparing the recorded data against OBE exceedance criteria. The decision to shut down the plant is also based on the results of the operator walkdown inspections that take place within 8 hours of the event. If the seismic instrumentation is inoperable, the guidelines in Appendix A to this guide would be used to determine whether the operating basis earthquake ground motion (OBE) has been exceeded.

Shutdown of the nuclear power plant would be required if the vibratory ground motion experienced exceeds that of the OBE. Two criteria for determining exceedance of the OBE are provided in EPRI NP-5930: a threshold response spectrum ordinate criterion and a cumulative absolute velocity criterion (CAV). A procedure to standardize the calculation of the CAV is provided in EPRI TR-100082. A spectral velocity threshold has also been recommended by EPRI since some structures have fundamental frequencies below the range specified in EPRI NP-5930. The NRC staff now recommends 1.0 to 2.0 Hz for the range of the spectral velocity limit since some structures have fundamental frequencies below 1.5 Hz. The former range was 1.5 to 2.0 Hz.

The NRC staff does not endorse the philosophy discussed in EPRI NP-6695, Section 4.3.4 (first paragraph, last sentence), pertaining to plant shutdown considerations following an earthquake based on the need for continued power generation in the region. If the licensee determines that plant shutdown is required by the Commission's regulations, but the licensee does not consider it prudent to do so, the licensee may ask for an emergency exemption from the requirements of the regulation pursuant to 10 CFR Part 50.12 so that the plant need not shut down if the exemption is granted.

Appendix B to this guide provides definitions to be used with this guidance.

C. REGULATORY POSITION

1. BASE-LINE DATA

1.1 Information Related to Seismic Instrumentation

A file containing information on all the seismic instrumentation should be kept at the plant. The file should include:

1. Information on each instrument type such as make, model, and serial number; manufacturers' data sheet; list of special features or options; performance characteristics; examples of typical instrumentation readings and interpretations; operations and maintenance manuals; repair procedures (manufacturers' recommendations for repairing common problems); and a list of any special requirements, e.g., maintenance, operational, installation.

2. Plan views and vertical sections showing the location of each seismic instrument and the orientation of the instrument axis with respect to a plant reference axis.

3. A complete service history of each seismic instrument. The service history should include information such as dates of servicing, description of completed work, and calibration records and data (where applicable).

4. The response spectrum and cumulative absolute velocity (see Regulatory Position 4). These data should be obtained after the initial installation and each servicing of the free-field instrumentation using a suitable earthquake time-history (e.g., the October 1987 Whittier, California, earthquake) or manufacture's calibration standard.

1.2 Planning for Postearthquake Inspections

The selection of equipment and structures for inspections and the content of the baseline inspections as described in Sections 5.3.1 and 5.3.2.1 of EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake," are acceptable to the NRC staff for satisfying the proposed requirements in Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50 for ensuring the safety of nuclear power plants.

2. IMMEDIATE POSTEARTHQUAKE ACTIONS

The guidelines for immediate postearthquake actions specified in Sections 4.3.1 and 4.3.2 (including Section 5.3.2.1 and items 7 and 8 of Table 5-1) of EPRI NP-6695 are acceptable to the NRC staff for satisfying the requirements proposed in Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50.

3. EVALUATION OF GROUND MOTION RECORDS

3.1 Data Identification

A record collection log should be maintained at the plant, and all data should be identifiable and traceable with respect to:

1. The date and time of collection,

2. The make, model, serial number, location, and orientation of the instrument (sensor) from which the record was collected.

3.2 Data Collection

3.2.1 Only personnel trained in the operation of the instrument should collect the data.

3.2.2 The steps for removing and storing records from each seismic instrument should be planned and performed in accordance with established procedures.

3.2.3 Extreme caution should be exercised to prevent accidental damage to the recording media and instruments during data collection and subsequent handling.

3.2.4 As data are collected and the instrumentation is inspected, notes should be made regarding the condition of the instrument and its installation, for example, instrument flooded, mounting surface tilted, fallen objects that struck the instrument or the instrument mounting surface.

3.2.5 For validation of the collected data, a reference signal (see Regulatory Position 1.1(4)) should be added to the record without affecting the previously recorded data.

3.2.6 If the instrument's operation appears to have been normal, the instrument should remain in service without readjustment or change that would defeat attempts to obtain postevent calibration.

3.3 Record Evaluation

Records should be analyzed according to the manufacturer's specifications and the results of the analysis should be evaluated. Any record anomalies, invalid data, and nonpertinent signals should be noted, along with any known causes.

4. DETERMINING OBE EXCEEDANCE

The evaluation to determine whether the OBE was exceeded should be performed using data obtained from the three components of the free-field ground motion (i.e., two horizontal and one vertical). The evaluation may be performed on uncorrected earthquake records. It was found in a study of uncorrected versus corrected earthquake records (see EPRI NP-5930) that the use of uncorrected records is conservative. The evaluation should consist of a check of the response spectrum, cumulative absolute velocity limit, and the operability of the instrumentation.

4.1 Response Spectrum Check

The OBE response spectrum is exceeded if any one of the three components (two horizontal and one vertical) of the 5 percent damped free-field ground motion response spectra is larger than:

1. The corresponding design response spectral acceleration (OBE spectrum if used, otherwise 1/3 of the safe shutdown earthquake (SSE) spectrum) or 0.2g, whichever is greater, for frequencies between 2 to 10 Hz, or

2. The corresponding design response spectral velocity (OBE spectrum if used, otherwise 1/3 of the SSE spectrum) or a spectral velocity of 6 inches per second, whichever is greater, for frequencies between 1 to 2 Hz.

4.2 Cumulative Absolute Velocity (CAV) Limit

For each component of the free-field ground motion, the CAV should be calculated as follows: (1) the absolute acceleration (g units) time-history is divided into 1-second intervals, (2) each 1-second interval that has at least 1 exceedance of 0.025g is integrated over time, (3) all the integrated values are summed together to arrive at the CAV. The CAV limit is exceeded if any CAV calculation is greater than 0.16 g-second. Additional information on how to determine the CAV is provided in EPRI TR-100082.

4.3 Instrument Operability Check

After an earthquake at the plant site, the response spectrum and CAV should be obtained using the calibration standard (see Regulatory Position 1.1(4)) to demonstrate that the system was functioning properly.

4.4 Inoperable Instrumentation

If the seismic instrumentation is inoperable, the criteria in Appendix A to this guide should be used to determine whether the OBE has been exceeded.

5. CRITERIA FOR PLANT SHUTDOWN

If the OBE is exceeded or significant plant damage occurs, the plant must be shut down.

5.1 OBE Exceedance

If the response spectrum check and the CAV limit (performed in accordance with Regulatory Position 4.1 and 4.2) were exceeded, the OBE was exceeded and plant shutdown is required. If either limit does not exceed the criterion, the earthquake motion did not exceed the OBE. The determination of whether or not the OBE has been exceeded should be performed even if the plant automatically trips off-line as a result of the earthquake.

5.2 Damage

The plant should be shut down if the walkdown inspections, performed in accordance with Regulatory Position 2 (Section 4.3.2 of EPRI NP-6695), discover damage.

6. PRE-SHUTDOWN INSPECTIONS

The pre-shutdown inspections described in Section 4.3.4 of EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake,"[1] with the last sentence in the first paragraph of Section 4.3.4 deleted, are acceptable to the NRC staff for satisfying the requirements proposed in Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50 for ensuring the safety of nuclear power plants.

The following paragraph in Section 4.3.4 of EPRI NP-6695 is repeated to emphasize that the plant should shut down in an orderly manner.

> "Prior to initiating plant shutdown following an earthquake, visual inspections and control board checks of safe shutdown systems should be performed by plant operations personnel, and the availability of off-site and emergency power sources should be determined. The purpose of these inspections is to determine the effect of the earthquake on essential safe shutdown equipment which is not normally in use during power operation so that any resets or repairs required as a result of the earthquake can be performed, or alternate equipment can be readied, prior to initiating shutdown activities. In order to ascertain possible fuel and reactor internal damage, the following checks should be made, if possible, before plant shutdown is initiated . . . . "

If the OBE was not exceeded and the walkdown inspection indicates no damage to the nuclear power plant, shutdown of the plant is not required. The plant may continue to operate (or restart following a post-trip review, if it tripped off-line because of the earthquake).

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This draft guide has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for construction permits, operating licenses, combined licenses, or design certification submitted after the implementation date to be specified in the active guide. This guide would not be used in the evaluation of an application for an operating license submitted after the implementation date to be specified in the active guide if the construction permit was issued prior to that date.

APPENDIX A

INTERIM OPERATING BASIS EARTHQUAKE EXCEEDANCE GUIDELINES

This regulatory guide is based on the assumption that the nuclear power plant has operable seismic instrumentation. If the seismic instrumentation is inoperable, the following should be used to determine whether the operating basis earthquake ground motion (OBE) has been exceeded:

1. For plants at which instrumentally determined data are available only at the foundation level, the cumulative absolute velocity (CAV) limit (see Regulatory Position 4.2 of this guide) is not applicable, and a determination of OBE exceedance is based on the response spectrum check described in Regulatory Position 4.1 of this regulatory guide. A comparison is made between the foundation-level design response spectra and data obtained from the foundation-level instruments. If the response spectrum check at any foundation is exceeded, the OBE is exceeded and shutdown is warranted.

2. For plants at which no instrumental data are available, the OBE will be considered to have been exceeded and shutdown to be warranted if one of the following applies:

    1. The earthquake resulted in Modified Mercalli Intensity (MMI) VI or greater within 5 km of the plant,

    2. The earthquake was felt within the plant and was of magnitude 6.0 or greater, or

    3. The earthquake was of magnitude 5.0 or greater and occurred within 200 km of the plant.

3. A postearthquake plant walkdown should be conducted (see Regulatory Position 2 of this guide).

4. If plant shutdown is warranted under the above guidelines, the plant should be shut down in an orderly manner (see Regulatory Position 6 of this guide).

<u>Note</u>:

The determinations of epicentral location, magnitude, and intensity by the U.S. Geological Survey, National Earthquake Information Center, will usually take precedence over other estimates; however, regional and local determinations will be used if they are considered to be more accurate. Also, higher quality damage reports or a lack of damage reports from the nuclear power plant site or its immediate vicinity will take precedence over more distant reports.

APPENDIX B
DEFINITIONS

Design Response Spectra. Response spectra used to design Seismic Category I structures, systems, and components.

Operating Basis Earthquake Ground Motion (OBE). The vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public will remain functional. The value of the OBE is set by the applicant.

Spectral Acceleration. The acceleration response of a linear oscillator with prescribed frequency and damping.

Spectral Velocity. The velocity response of a linear oscillator with prescribed frequency and damping.

REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. The draft regulatory analysis, "Proposed Revisions of 10 CFR Part 100 and 10 CFR Part 50," provides the regulatory basis for this guide and examines the costs and benefits of the rule as implemented by the guide. A copy of the draft regulatory analysis is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC, as Enclosure 2 to Secy 92-215.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

DRAFT REGULATORY GUIDE

November 1992
Division 1
Draft DG-1018

Contact: R. M. Kenneally (301) 492-3893

DRAFT REGULATORY GUIDE DG-1018

RESTART OF A NUCLEAR POWER PLANT SHUT DOWN BY A SEISMIC EVENT

A. INTRODUCTION

Paragraph IV(a)(3) of Proposed Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," would require shutdown of the nuclear power plant if vibratory ground motion exceeding that of the operating basis earthquake ground motion (OBE) or significant plant damage occurs.[1] Prior to resuming operations, the licensee must demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public.

This guide is being developed to provide guidance acceptable to the NRC staff for performing inspections and tests of nuclear power plant equipment and structures prior to restart of a plant that has been shut down by a seismic event.

Any information collection activities mentioned in this draft regulatory guide are contained as requirements in the proposed amendments to 10 CFR Part 50 that would provide the regulatory basis for this guide. The proposed

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[1]Guidance is being developed in Draft Regulatory Guide DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions," to provide criteria for plant shutdown.

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received complete staff review and does not represent an official NRC staff position.

Public comments are being solicited on the draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Regulatory Publications Branch, DFIPS, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555. Copies of comments received may be examined at the NRC Public Document Room, 2120 L Street NW., Washington, DC. Comments will be most helpful if received by March 24, 1993.

Requests for single copies of draft guides (which may be reproduced) or for placement on an automatic distribution list for single copies of future draft guides in specific divisions should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Office of Administration, Distribution and Mail Services Section.

amendments have been submitted to the Office of Management and Budget for clearance that may be appropriate under the Paperwork Reduction Act. Such clearance, if obtained, would also apply to any information collection activities mentioned in this guide.

B. DISCUSSION

Data from seismic instrumentation[2] and a walkdown of the nuclear power plant are used to make the initial determination of whether the plant should be shut down after an earthquake, if the plant has not already shut down from operational perturbations resulting from the seismic event.[1]

The Electric Power Research Institute has developed guidelines that will enable licensees to quickly identify and assess earthquake effects on nuclear power plants in EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake,"[3] December 1989. This regulatory guide addresses sections of EPRI NP-6695 that relate to postshutdown inspection and tests, inspection criteria, inspection personnel, documentation, and long-term evaluations.

C. REGULATORY POSITION

After a plant has been shut down by an earthquake, the guidelines for inspections and tests of nuclear power plant equipment and structures that are specified in Sections 5.3.2 (including Tables 2-1, 2-2, and 5-1), 5.3.3 (includes Table 5-1), 5.3.4, 5.3.5, and the long-term evaluations that are specified in Section 6.3 (all sections and subsections) of EPRI NP-6695 would be acceptable to the NRC staff for satisfying the requirements proposed in Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50.

Coincident with the long-term evaluations, the plant should be restored to its current licensing basis. Exceptions to this must be approved by the Director, Office of Nuclear Reactor Regulation.

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[2]Guidance is being developed in Draft Regulatory Guide DG-1016, the second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes," that will describe seismic instrumentation acceptable to the NRC staff.

[3]EPRI reports may be obtained from the Electric Power Research Institute, Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This draft guide has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for construction permits, operating licenses, combined licenses, or design certification submitted after the implementation date to be specified in the active guide. This guide would not be used in the evaluation of an application for an operating license submitted after the implementation date to be specified in the active guide if the construction permit was issued prior to that date.

REGULATORY ANALYSIS

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AD93-1
PDR

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

FEB 2 3 1993

MEMORANDUM FOR: Lawrence C. Shao, Director
Division of Engineering, RES

FROM: Andrew J. Murphy, Chief
Structural & Seismic Engineering Branch
Division of Engineering, RES

SUBJECT: SUMMARY OF A PUBLIC MEETING ON THE REVISION OF APPENDIX A "SEISMIC AND GEOLOGIC SITING CRITERIA FOR NUCLEAR POWER PLANTS" TO 10CFR PART 100

A meeting was held on February 4, 1993, among the NRC and its consultants, members of the staff of the Nuclear Management and Resources Council (NUMARC) and other representatives from the nuclear industry. A list of attendees is attached as Enclosure 1. The purpose of the meeting was to provide NUMARC the opportunity to present the results of applying its probabilistic seismic hazard analysis (PSHA) methodology (Integrated Seismic Siting Process), a proposed alternative to the NRC staff's revision of Appendix A, to selected sites. A public meeting notice appeared in the Federal Register on January 19, 1993, Vol. 58, No. 11, page 4946. Enclosure 2 is the meeting agenda.

This meeting, scheduled at the request of NUMARC, is a followup of four previous meetings: September 11, July 10, June 17, and April 23, 1992.

Dr. A. Murphy opened the meeting by stating its purpose and providing a summary of the status of the Appendix A Revision Package. Dr. N. Farukhi presented an outline of the presentations that were to be made and introduced the two speakers: Dr. M. McCann of J. Benjamin and Associates and Dr. W. Savage of Pacific Gas and Electric Company.

The presentation was divided into four parts: the goals, which from the NUMARC perspective, are similar to those of the NRC staff; the bases for its Integrated Seismic Siting Process; a summary of the NUMARC methodology, which was described in considerable detail on September 11, 1992; and the application of the NUMARC methodology to sites. Most of the presentation consisted of a discussion of the geological and seismological information about two test sites: a hypothetical site in the Wabash Valley near Vincennes, Indiana and the Department of Energy's Savannah River site in South Carolina; the way this information was incorporated into the decision process of the NUMARC methodology; and the final results. The viewgraphs shown in the presentations are enclosed as Enclosure 3.

NUMARC concluded that these applications of its Integrated Seismic Siting Process demonstrate its stability. A large part of that stability is the result of the broad range of existing eastern U.S. seismic source

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FEB 2 3 1993

interpretations of the LLNL and EPRI PSHA's. NUMARC feels that the exercise also demonstrates the applicability of its program to direct and formal consideration of site specific information in the assessment of the SSE.

The NRC staff will review the NUMARC procedure along with other comments formally submitted during the public comment period for the Appendix A revision package scheduled to end March 24, 1993.

Andrew J. Murphy

Andrew J. Murphy, Chief
Structural & Seismic Engineering Branch
Division of Engineering, RES

Enclosures: As stated

cc w/enclosures:
N. Farukhi, NUMARC
G. Bagchi, NRR
R. Rothman, NRR
P. Sobel, NRR
J. Craig, RES
T. King, RES
C. Ader, RES
N. Chokshi, RES
R. McMullen, RES
R. Kenneally, RES
A. Ibrahim, NMSS
E. Igne, ACRS
PDR

AGENDA
FOR
NUMARC/AHAC - NRC STAFF MEETING
FEBRUARY 4, 1993
8:30AM - 12:30 PM
NICHOLSON LANE SOUTH
CONFERENCE ROOMS A&B

8:30-8:45AM	INTRODUCTION	A. MURPHY
8:45-9:00AM	PURPOSE OF MEETING/ PRESENTATION OUTLINE	N. FARUKHI
9:00-11:15AM	INDUSTRY'S PROPOSED INTEGRATED PROCESS TO DETERMINE SSE GROUND MOTION - PROPOSED PROCESS - PROCESS APPLICATION FOR WABASH VALLEY & SAVANNAH RIVER SITE	M. McCANN/ W. SAVAGE
11:15-12:15PM	QUESTIONS/DISCUSSION	
12:15-12:30PM	WRAP UP	FARUKHI/ MURPHY

ATTENDEES

PUBLIC MEETING
REVISION OF SEISMIC AND GEOLOGIC SITING CRITERIA
(Proposed Appendix B to 10 CFR Part 100 & Draft Regulatory Guide DG-1015)
February 4, 1993
NRC Headquarters, NL/S Building (Conference Rooms A & B)
8:30 AM

NAME	AFFILIATION
Roger M Kenneally	NRC/RES
Nilesh C. Chokshi	NRC/RES
Andrew J. Murphy	NRC/RES
Allin Cornell	CAC Co
Robert J. Budnitz	FRA Inc
Don L Bernreuter	LLNL
DAVE MODEEN	NUMARC
John Craig	NRC/RES
Mike Hayner	CEI/NUMARC
Dick McMullen	NRC - RES
Paul W. Pomeroy	Rondout Associates
GOUTAM BAGCHI	NRC/NRR
ROBERT ROTHMAN	NRC/NRR
CARL STEPP	EPRI
Robert Kennedy	Struct. Mech. Consult.
Phyllis Sobel	NRC/NRR
GUS GIESE-KOCH	NRC/NRR
David Fenster	OCRWM/M&O — Woodward-Clyde
Thomas Rogers	OCRWM/M&O - Woodward-Clyde
Carl Snyder	NUS
John Jacobson	Yankee Atomic
Donald P. Moore	Southern Company Services Inc
MG Phillips	Newman & Holtzinger

ATTENDEES

PUBLIC MEETING
REVISION OF SEISMIC AND GEOLOGIC SITING CRITERIA
(Proposed Appendix B to 10 CFR Part 100 & Draft Regulatory Guide DG-1015)
February 4, 1993
NRC Headquarters, N/S Building (Conference Rooms A & B)
8:30 AM

NAME	AFFILIATION
Hiroaki Yasui	Tokyo Electric Power Co
ARTHUR FRANKEL	U.S. GEOLOGICAL SURVEY
Bob MURRAY	LLNL
JIM TOURTELLOTTE	TAA
Jeff Kimball	DOE
Judith Sikorski	SERCH-LICENSING BECHTEL
Eve Fotopoulos	SERCH Licensing, Bechtel
Ernst Zurflueh	NRC/RES
Bakr Ibrahim	NRC/NMSS
JIM YORK	[illegible]
HOMI MINWALLA	WESTON/JACOBS ENGG GROUP
NAYEEM M. FARUKHI	NUMARC
William U. Savage	Pacific Gas & Electric
Kevin J. Coppersmith	Geomatrix
MARTIN MCCANN, JR	JB&A

Seismic Siting Rulemaking
10 CFR Part 100

Development and Demonstration of Industry's Integrated Seismic Siting Decision Process

NUMARC/NRC Meeting
Rockville, MD
February 4, 1993

SCOPE OF PRESENTATION

- Goals
- Foundation of the industry seismic siting process
- Industry Integrated Seismic Siting Process
- Example Applications

GOALS

- Seismic siting process must be:

    -- predictable and stable

    -- able to account for uncertainty in the assessment of seismic hazards

    -- acceptable to the scientific and engineering community

    -- flexible to support the regulatory process (use of existing, acceptable probabilistic seismic hazard methodologies and new information)

    -- able to provide an information base that facilitates an understanding and review of the assessment of the SSE

FOUNDATION OF THE INDUSTRY SEISMIC SITING PROCESS

- Existing plants are acceptably safe and establish a stable Reference Probability level for determining seismic design motions

- Acceptable seismic hazard methodologies are available

- Accepted seismic source interpretations and parameters can be used to assess a site's SSE in the EUS, unless it is shown that they do not, on a site-by-site basis, accommodate new data

- Integration of up-to-date, site-specific information and accepted seismic source interpretations and seismicity parameters is required

- Establish a measure of the significance of new site-specific information

- Stability of the median seismic hazard curve

ACCEPTABLE SEISMIC HAZARD METHODOLOGIES

- Must permit determination of a Reference Probability (based on existing plants)

- Must be generally applicable to determine hazard at a new site

- Seismic source interpretations and seismicity parameters should be adequately documented

  -- permits examination of data used in developing seismic sources

  -- permits evaluation of new data and existing seismic source interpretations and seismicity parameters

INTEGRATION OF SITE-SPECIFIC DATA

- Systematic framework to:
  - -- examine site-specific data and information available at the time the acceptable methodologies were performed
  - -- evaluate new data and accepted seismic source interpretations
  - -- assess the sensitivity of the site hazard to new information

ASSESSING SIGNIFICANCE OF NEW, SITE SPECIFIC INFORMATION

- Impact of new data on the determination of the SSE is the ultimate determinant

- Changes (increases) in hazard that produce small changes in the SSE level can be accepted within the framework of engineering evaluations, plant margins, and the uncertainty in seismic hazard assessments

WHAT IS A SIGNIFICANT CHANGE IN HAZARD?

Alternative paths can be considered to establish significance:

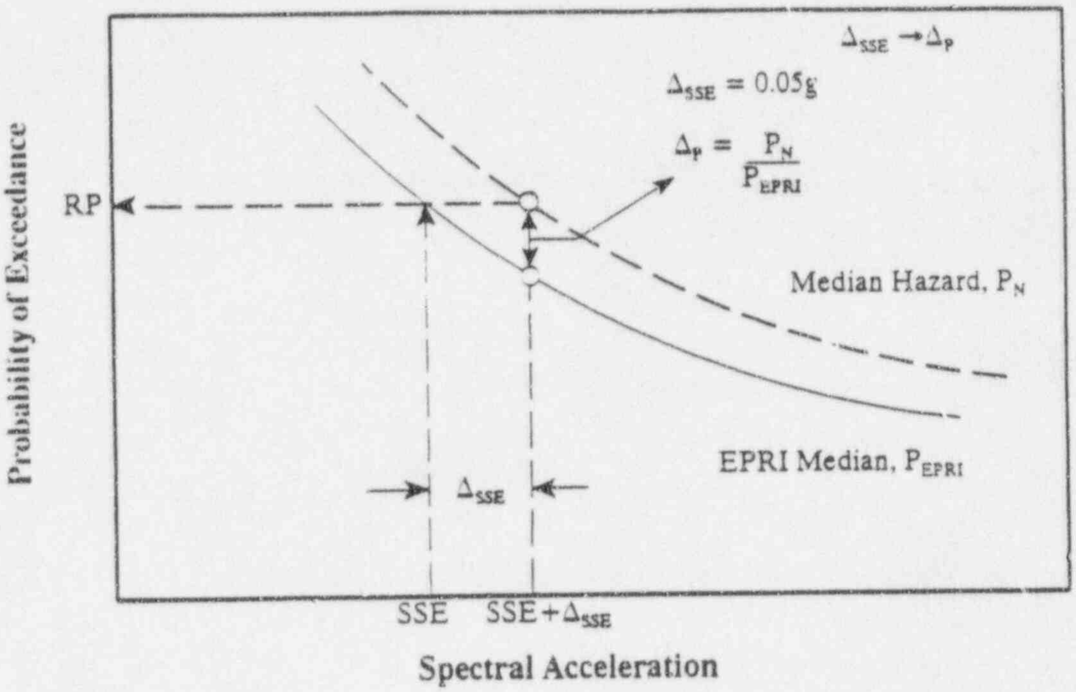
1. Define a change/difference in the SSE, spectral acceleration, that is acceptable and determine the change in hazard that occurs

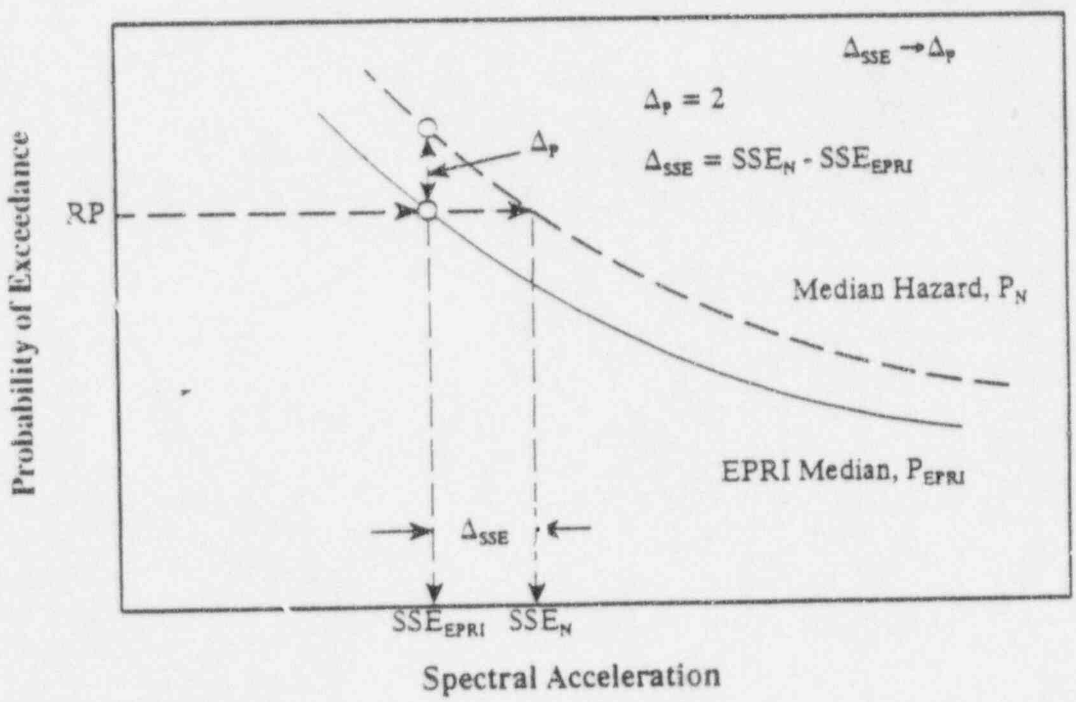
   $\Delta_{SSE} \rightarrow \Delta Hazard\ (\Delta_P)?$

2. Define a change in the hazard that is acceptable and determine the change in the SSE that occurs

   $\Delta_P \rightarrow \Delta_{SSE}?$

ILLUSTRATION OF ALTERNATIVE APPROACHES





SITE Δ_{SSE} RESULTS

Site	Spectral Acceleration - 5 Hz	
	Δ_P	Δ_{SSE}
Limerick	2.0	0.043
Seabrook	2.0	0.071
Zion	2.0	0.019
Millstone	2.0	0.043
Braidwood	2.0	0.023
Sequoyah	2.0	0.040

SITE Δ_P RESULTS

Site	Spectral Acceleration - 5 Hz	
	Δ_P	Δ_{SSE}
Limerick	2.32	.05
Seabrook	1.62	.05
Zion	4.44	.05
Millstone	2.20	.05
Braidwood	3.83	.05
Sequoyah	2.35	.05

ACCEPTABLE CHANGE IN THE SSE AND HAZARD

- Median Ground Motion: $\Delta SSE \leq 0.05g$
  (S_a at 5 and 10 Hz)

- Median Hazard: $\Delta P = \frac{P_{NEW}}{P_{OLD}} \leq 2.0$ (SSE)

ASSESSING THE SIGNIFICANCE OF NEW INFORMATION

New data are not considered significant if:

- *after examination, require no further evaluation,*
- *they require no alternative seismic sources or seismicity parameters, or*
- *result in maintaining or decreasing the site seismic hazard*

FACTORS THAT MAY SHIFT THE MEDIAN HAZARD

- Seismic activity rate
- Maximum magnitude
  - -- recurrence rates
  - -- size of the maximum event
- Identification of new, active tectonic features

INTEGRATED SEISMIC SITING PROCESS

- Accepted seismic source interpretations and seismicity parameters are the basis to determine the SSE

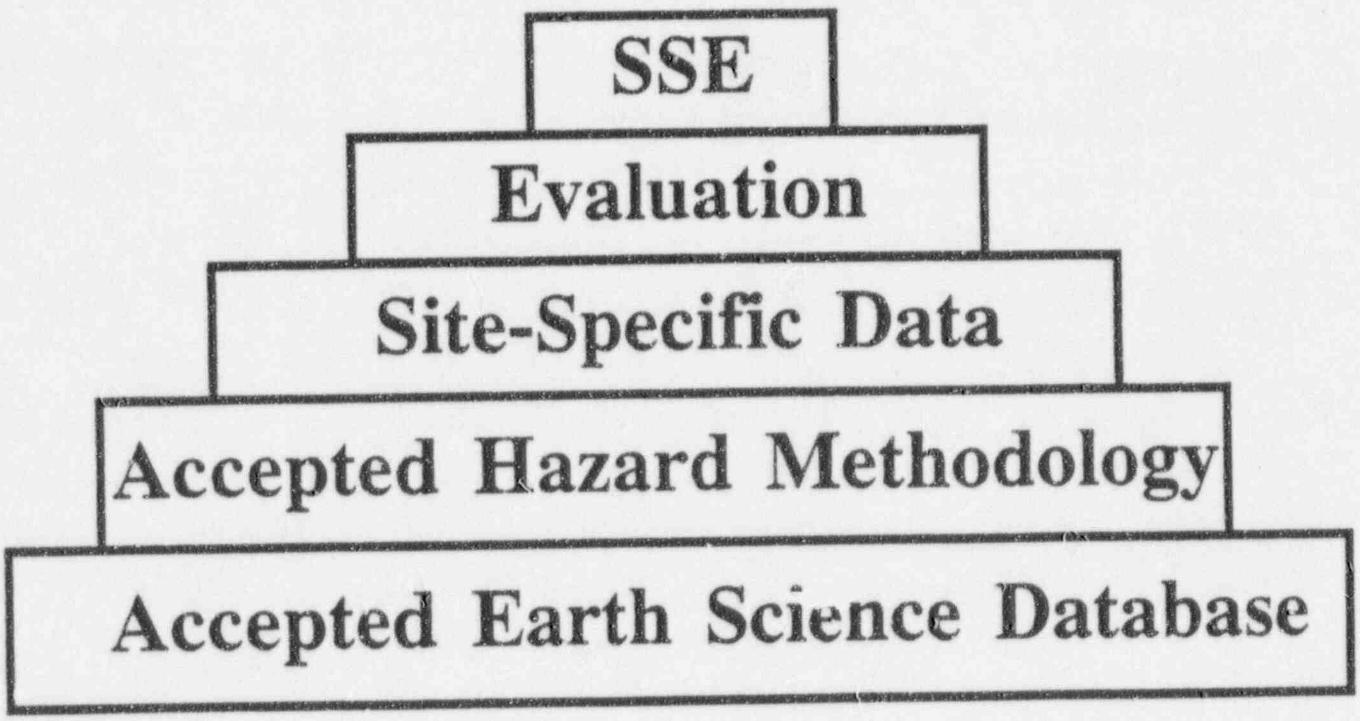
- Given up-to-date, site-specific information, an integrated evaluation is required to determine whether there is a reasonable basis to require a modification of the accepted interpretations

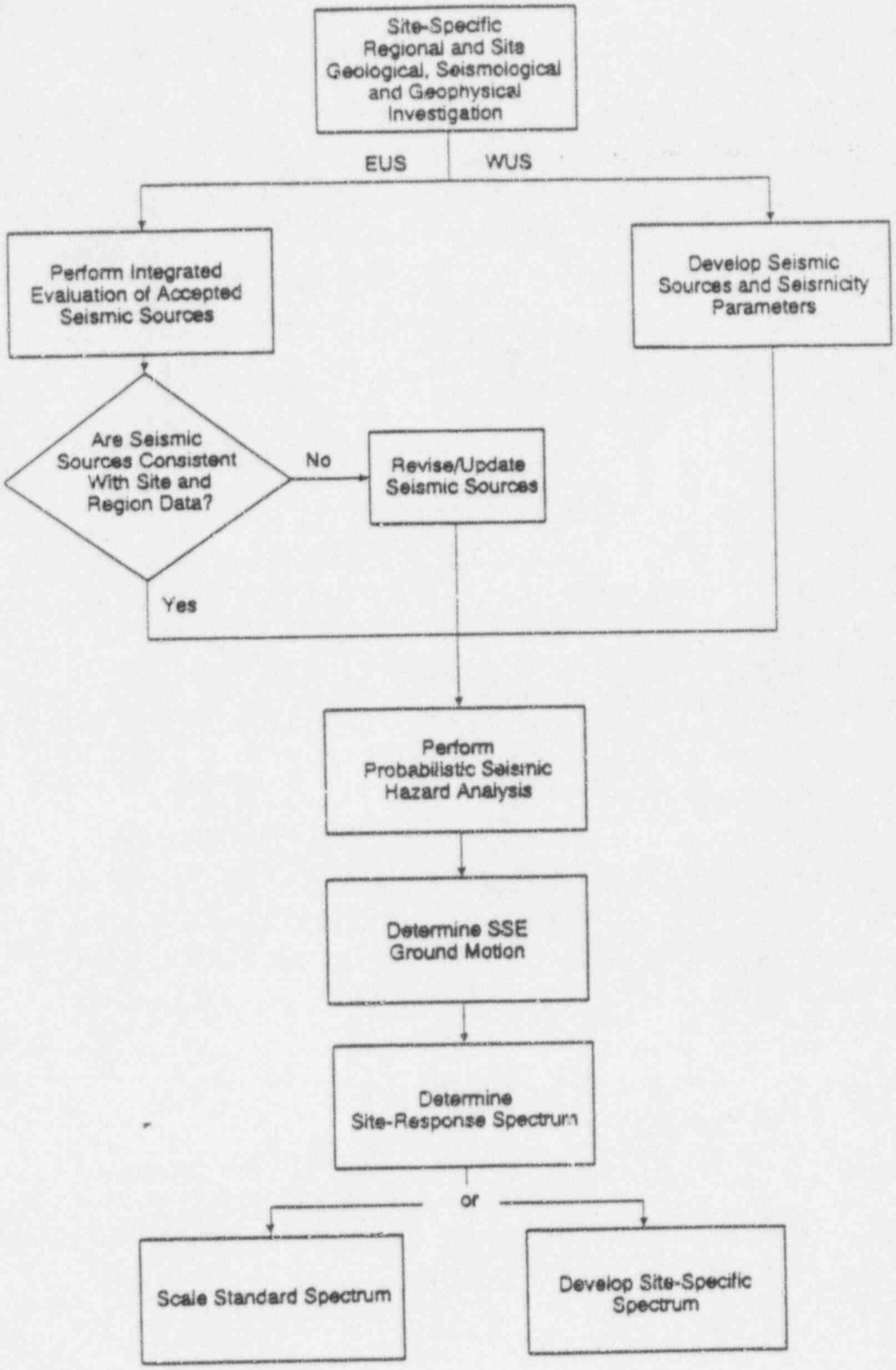
- *Integrated*: systematic evaluation of new geological, seismological and geophysical data within accepted seismic hazard methodologies and seismic source interpretations

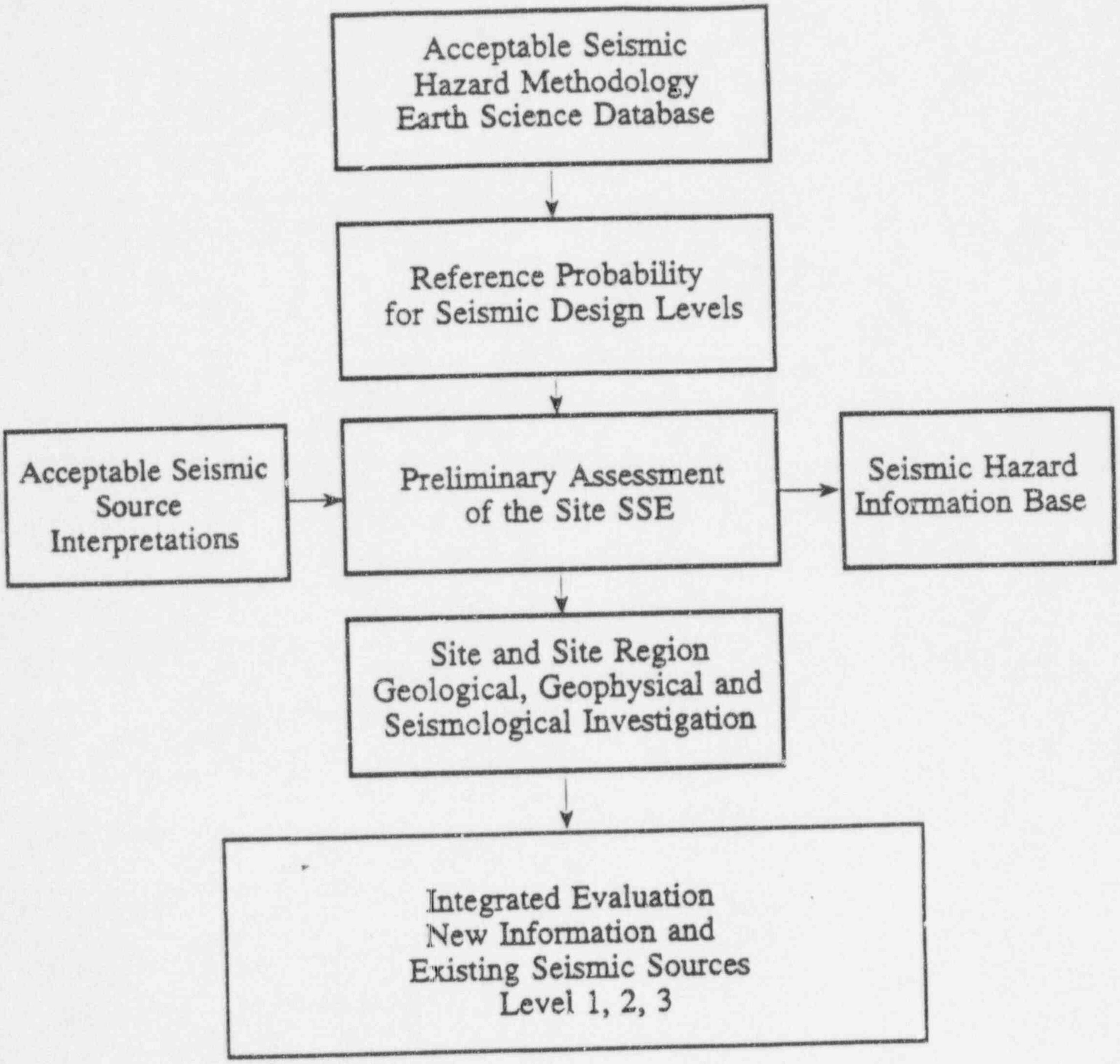
- Seismic siting process incorporates advancements in siting technology in last 10 years

- Efforts have focussed on the examination and evaluation of earth sciences data and the consistency of the accepted seismic source interpretations with new detailed, site-specific information

INTEGRATED SEISMIC SITING PROCESS BUILDING BLOCKS




Site-Specific Regional and Site Geological, Seismological and Geophysical Investigation
EUS
WUS
Perform Integrated Evaluation of Accepted Seismic Sources
Develop Seismic Sources and Seismicity Parameters
Are Seismic Sources Consistent With Site and Region Data?
No
Revise/Update Seismic Sources
Yes
Perform Probabilistic Seismic Hazard Analysis
Determine SSE Ground Motion
Determine Site-Response Spectrum
or
Scale Standard Spectrum
Develop Site-Specific Spectrum


Acceptable Seismic Hazard Methodology Earth Science Database
Reference Probability for Seismic Design Levels
Acceptable Seismic Source Interpretations
Preliminary Assessment of the Site SSE
Seismic Hazard Information Base
Site and Site Region Geological, Geophysical and Seismological Investigation
Integrated Evaluation New Information and Existing Seismic Sources Level 1, 2, 3

SITE-SPECIFIC GEOLOGICAL, SEISMOLOGICAL AND GEOPHYSICAL DATABASE

- Develop a comprehensive, state-of-the-art database for the site
    - -- EPRI database
    - -- Detailed investigations within 8 and reconnaissance within 40 kilometers of the site
    - -- Regional review and update within 200 km of the site

INTEGRATED EVALUATION

- Assess the consistency of new site and site region data and interpretations with existing source characterizations

  -- Level 1: examine the consistency of each site-specific data set with existing data set

  -- Level 2: evaluate the consistency of new data with the range of interpretations incorporated in accepted multiple seismic source characterizations

  -- Level 3: evaluate the consistency of the accepted median hazard with an estimate of the hazard based on seismic sources modified by new data or interpretation

EXAMPLE APPLICATIONS

- Objectives: Apply the industry seismic siting approach; develop guidance for its application

- Sites:

  Wabash Valley (Vincennes, Indiana)

  Savannah River Site

WABASH VALLEY SEISMIC SITING EXAMPLE

- Vincennes, Indiana
- Not a plant site
- In an area of moderate historic earthquakes
- Use EPRI seismic source interpretations and seismicity parameters
- Recent documentation of paleo-liquefaction is new information, not considered in the EPRI study
- Compelling test due to implications regarding seismic sources and maximum magnitude

WABASH VALLEY - APPLICATION

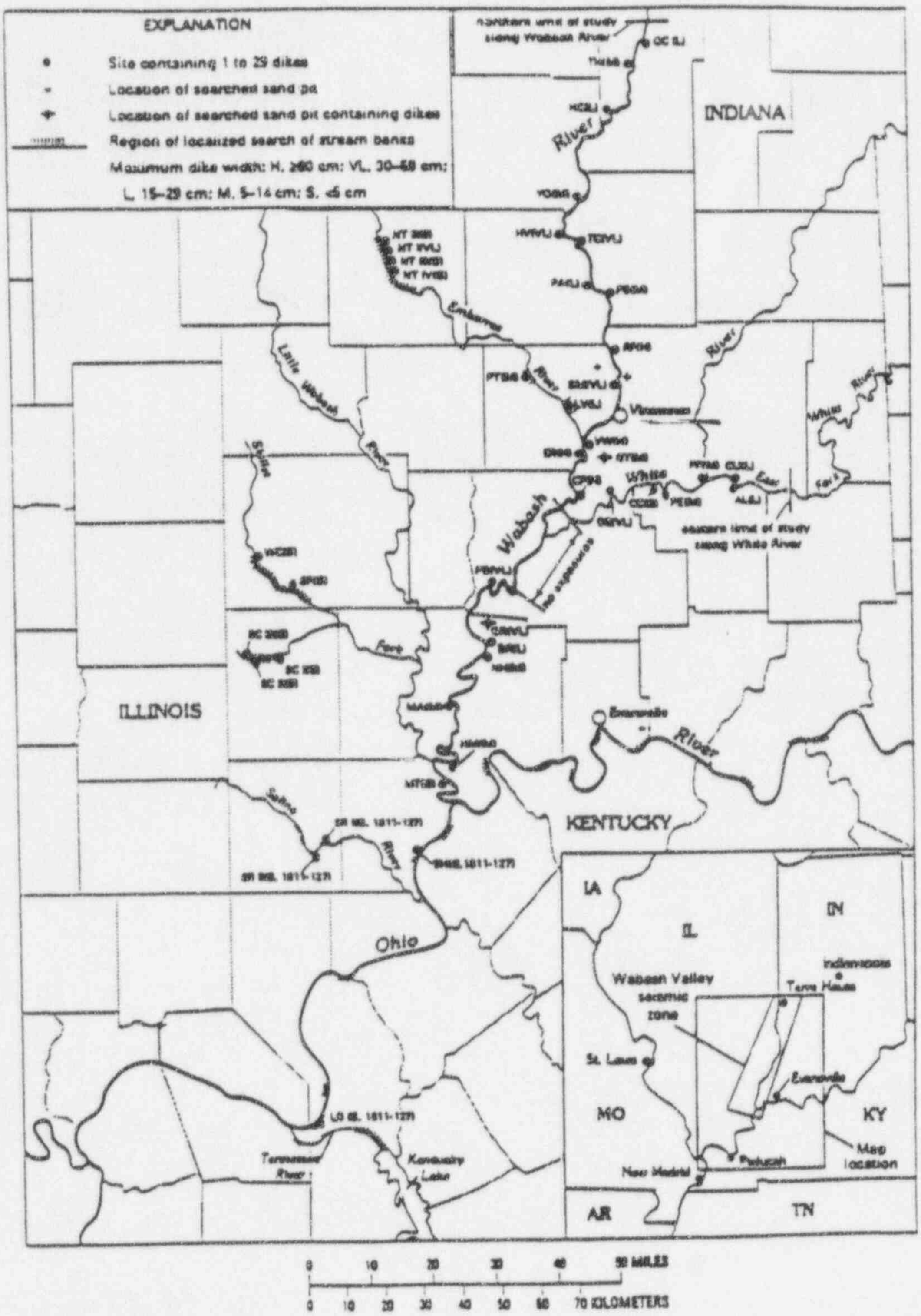
- Level 1 - Examination of new, site-specific earth science information

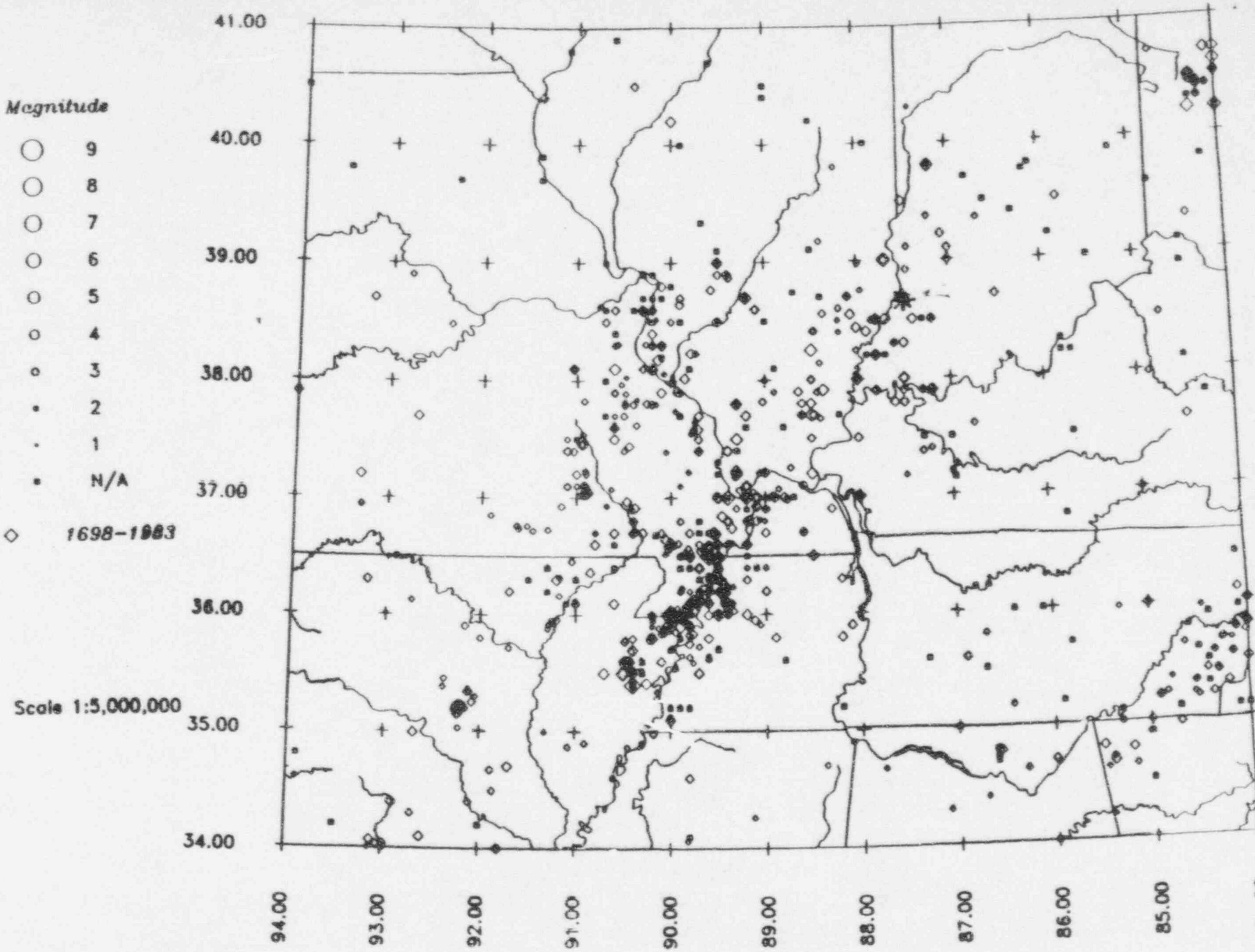
- Summarize new data that requires further evaluation

  - Examine new information; check consistency with the existing data set

  - Determine which data requires further evaluation

WABASH VALLEY





Earthquakes Recorded from 03/1698 to 01/01/83: Vincennes, Indiana

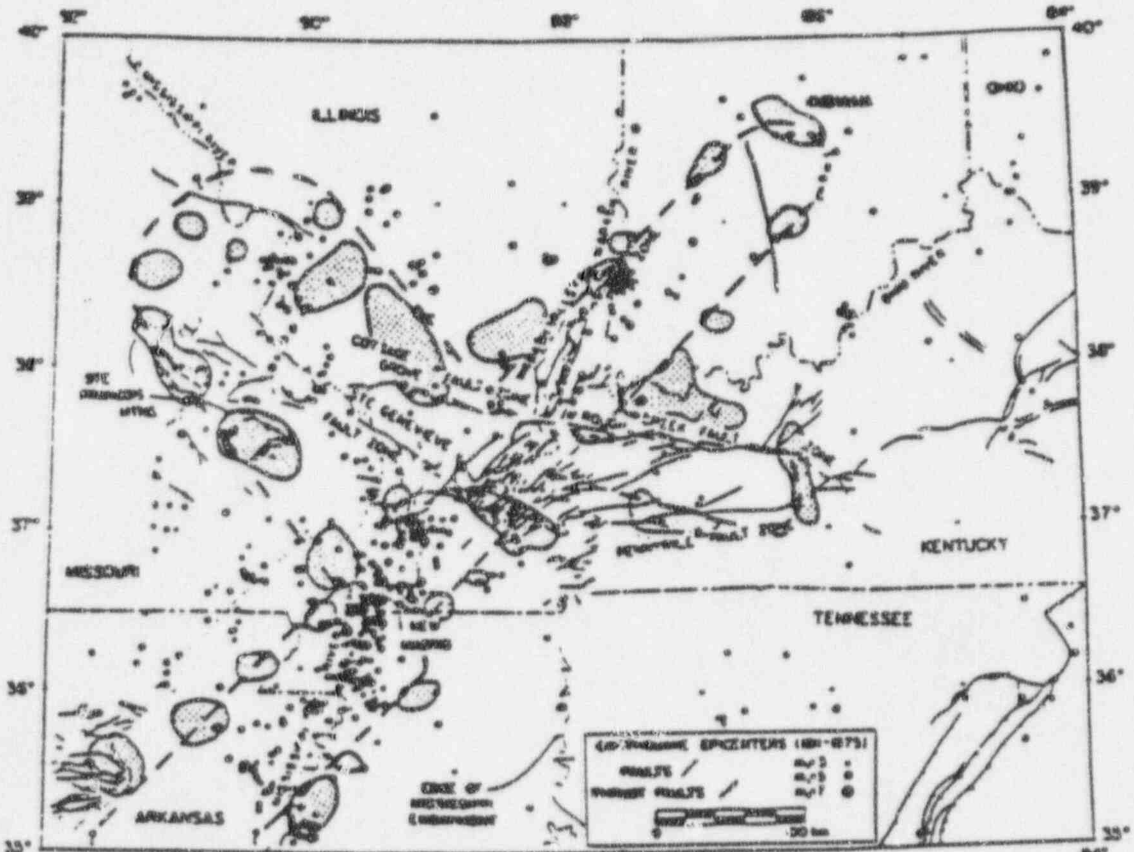
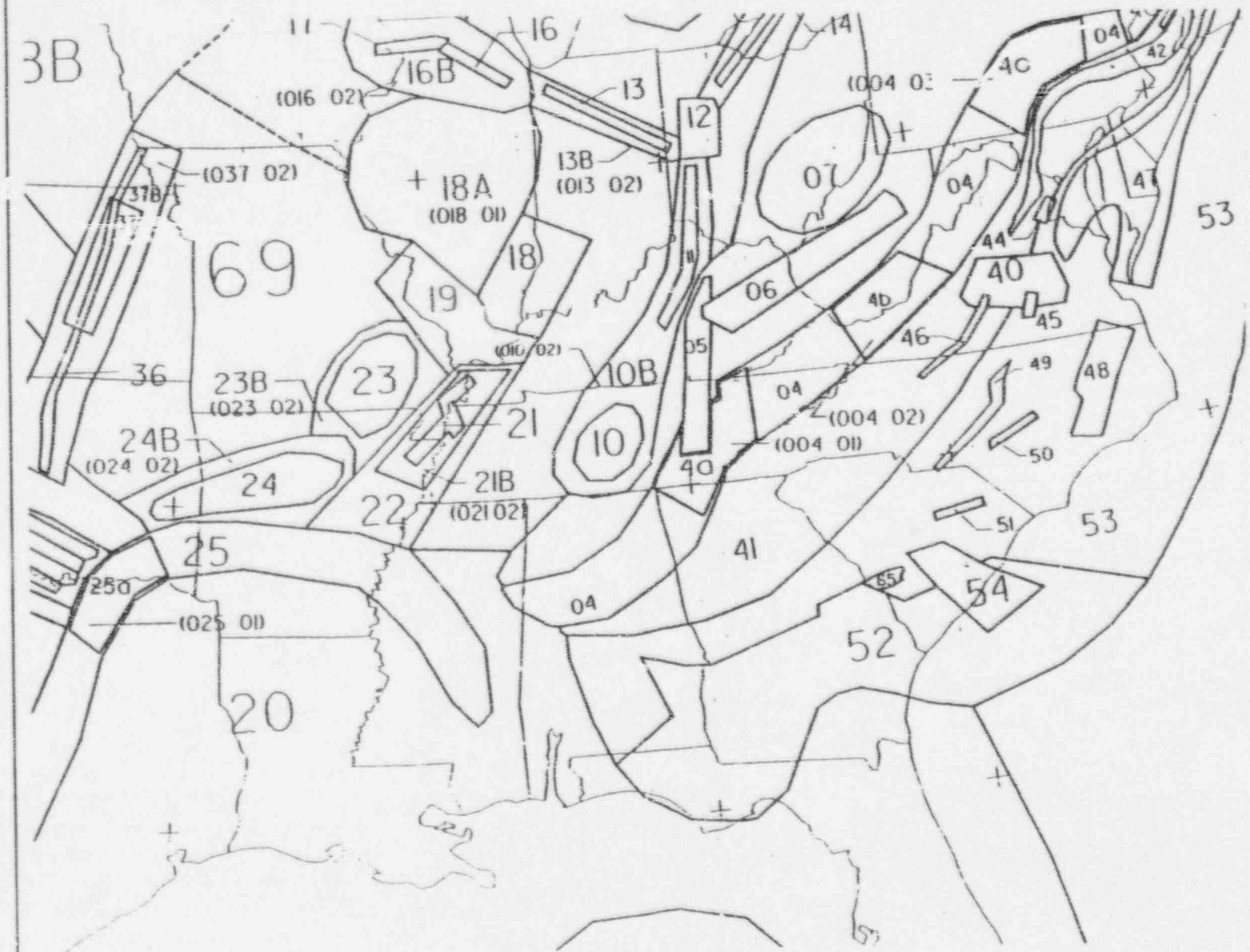
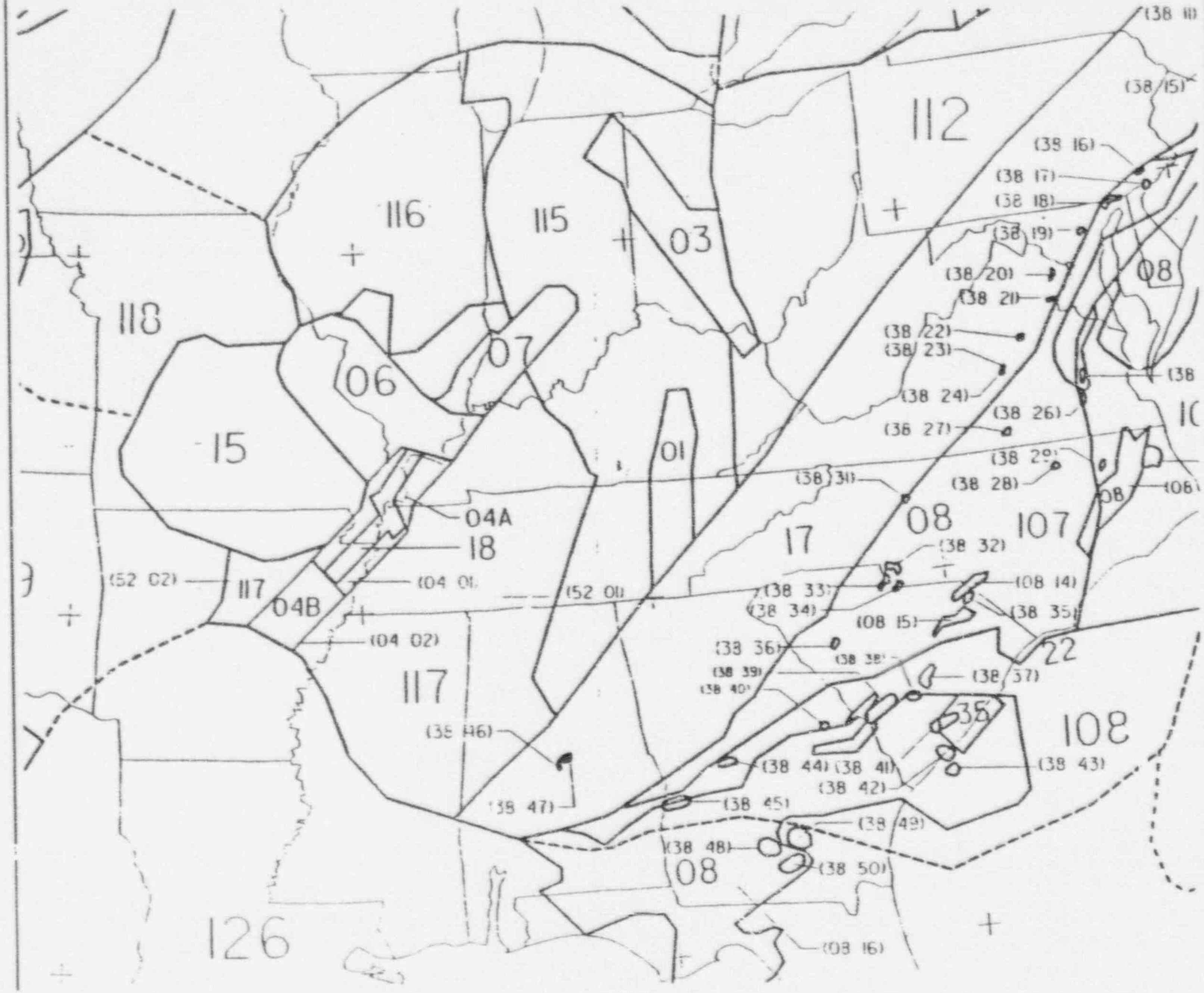


Figure 3-2. Map of inferred rift complex in the New Madrid Area. (Braile, et al, 1982)

DAMES AND MOORE

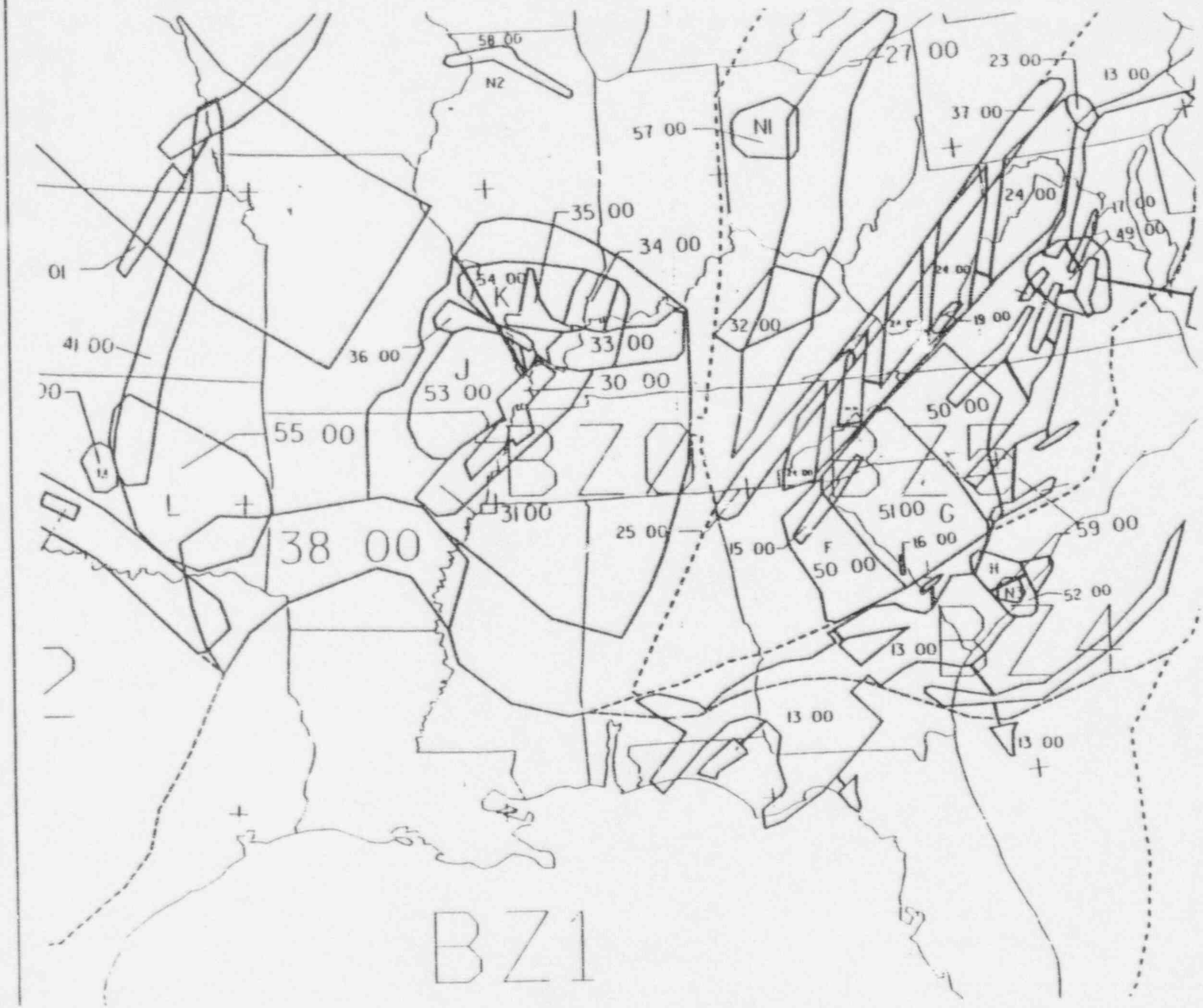


LAW ENGINEERING



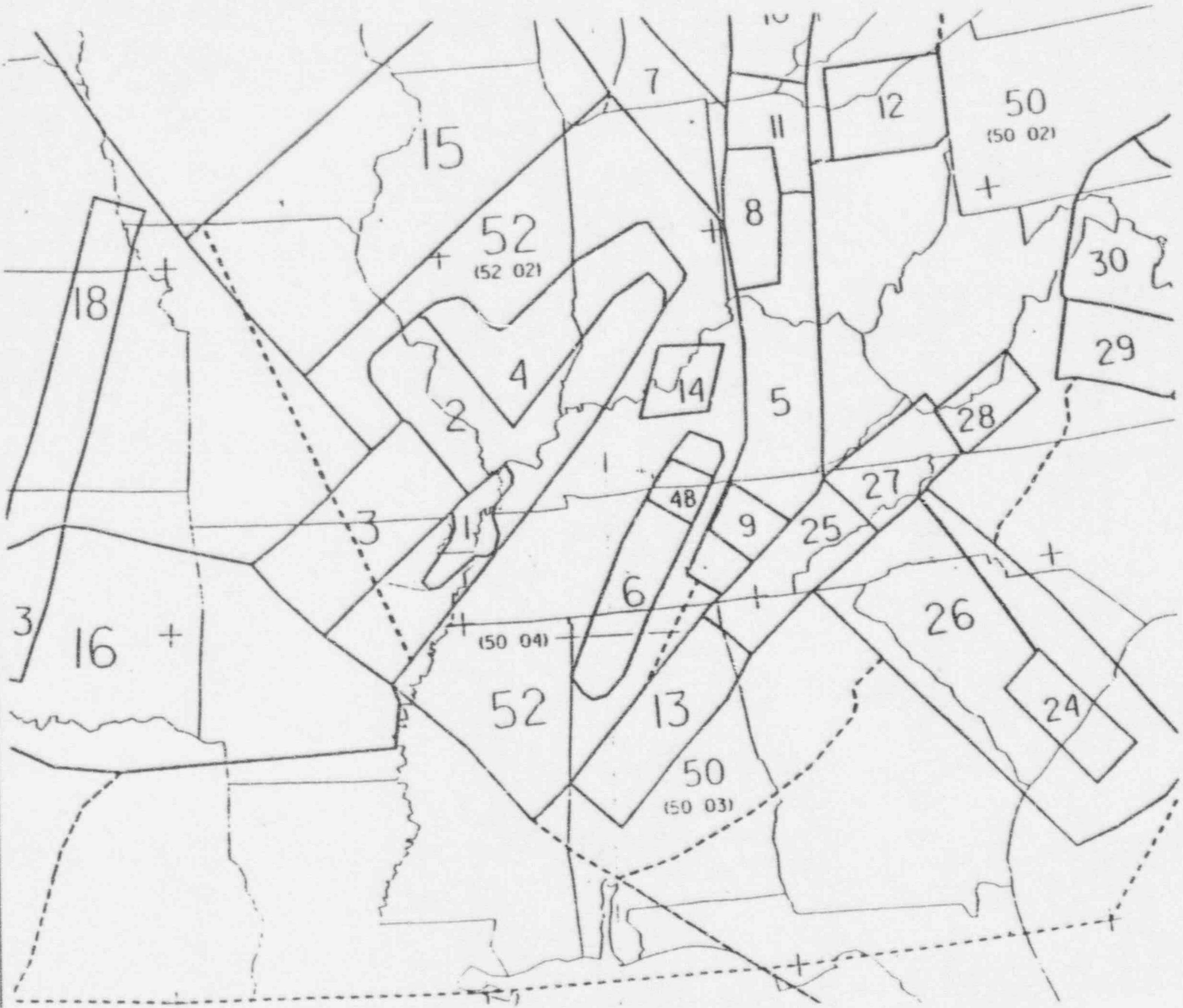
NUMARC

BECHTEL



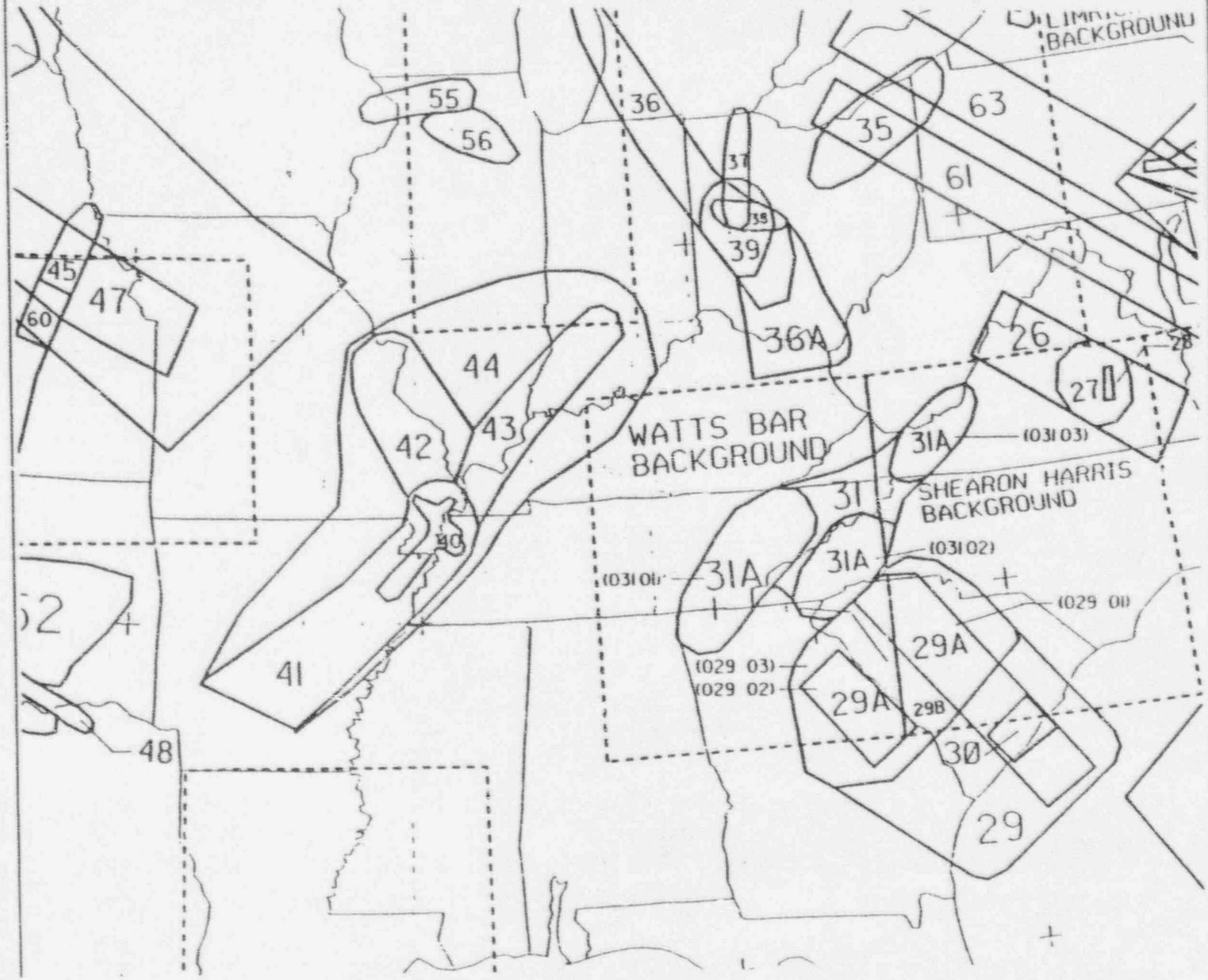
NUMARC

RONDOUT



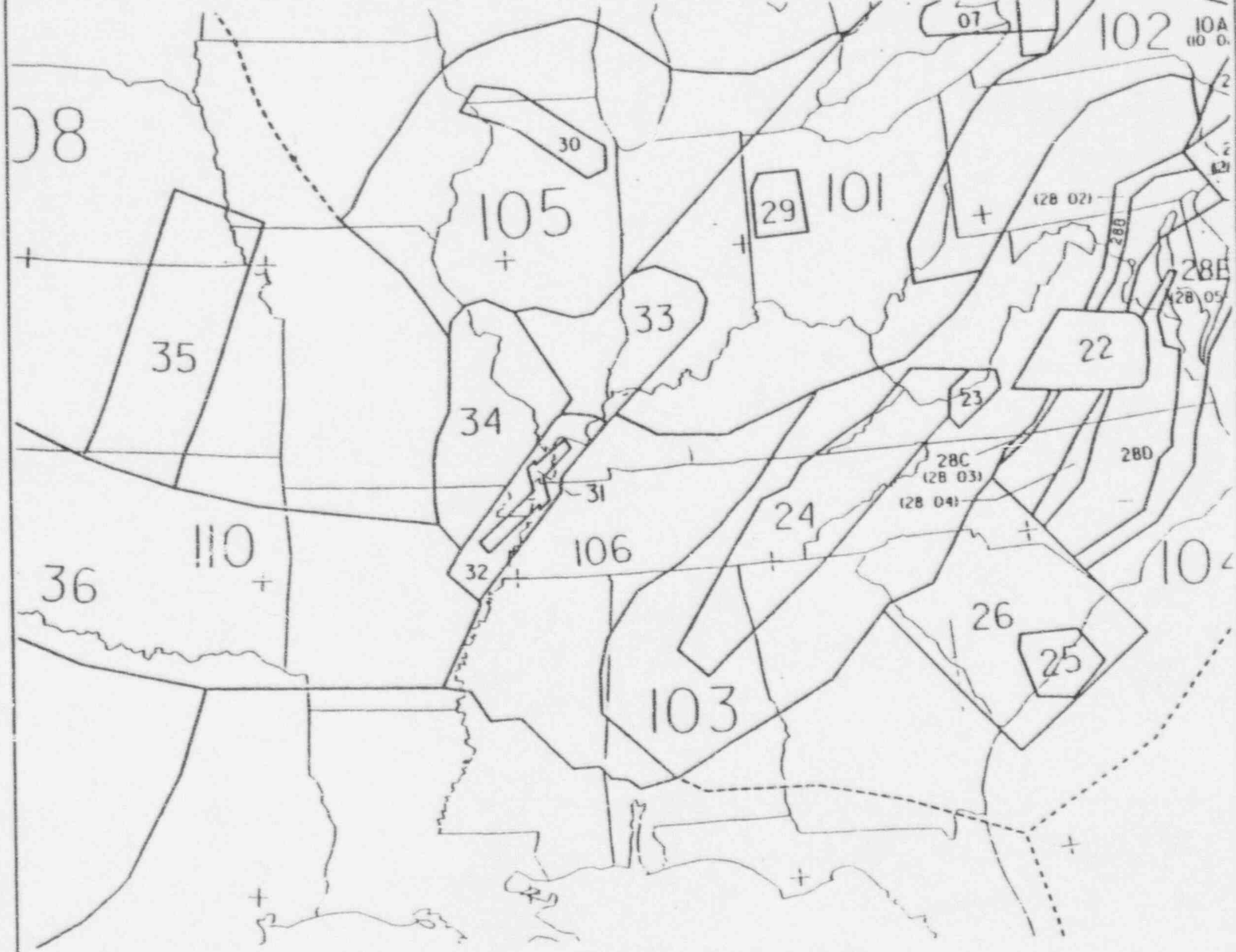
NUMARC

WOODWARD CLYDE



NUMARC

WESTON GEOPHYSICAL



NUMARC

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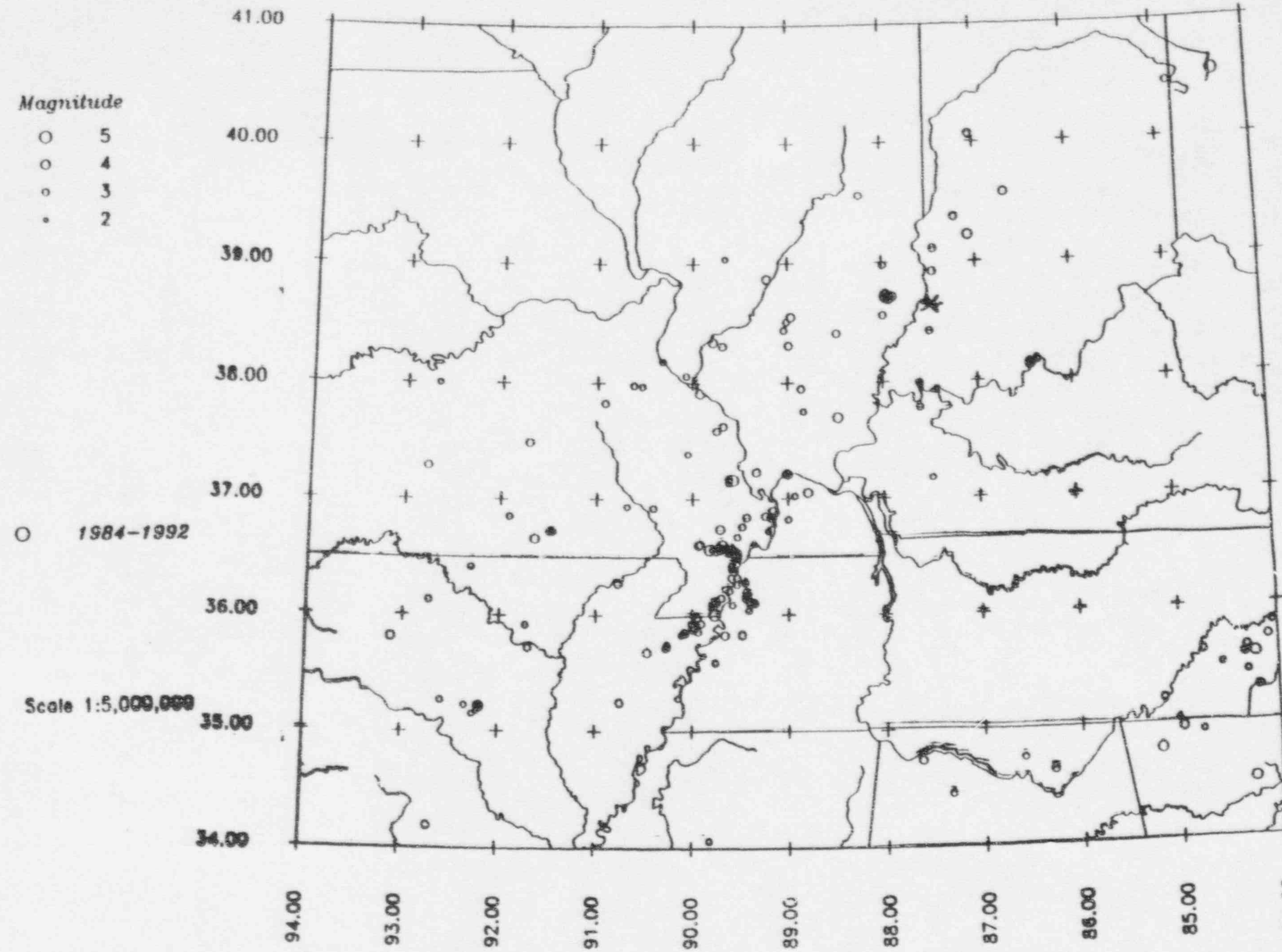
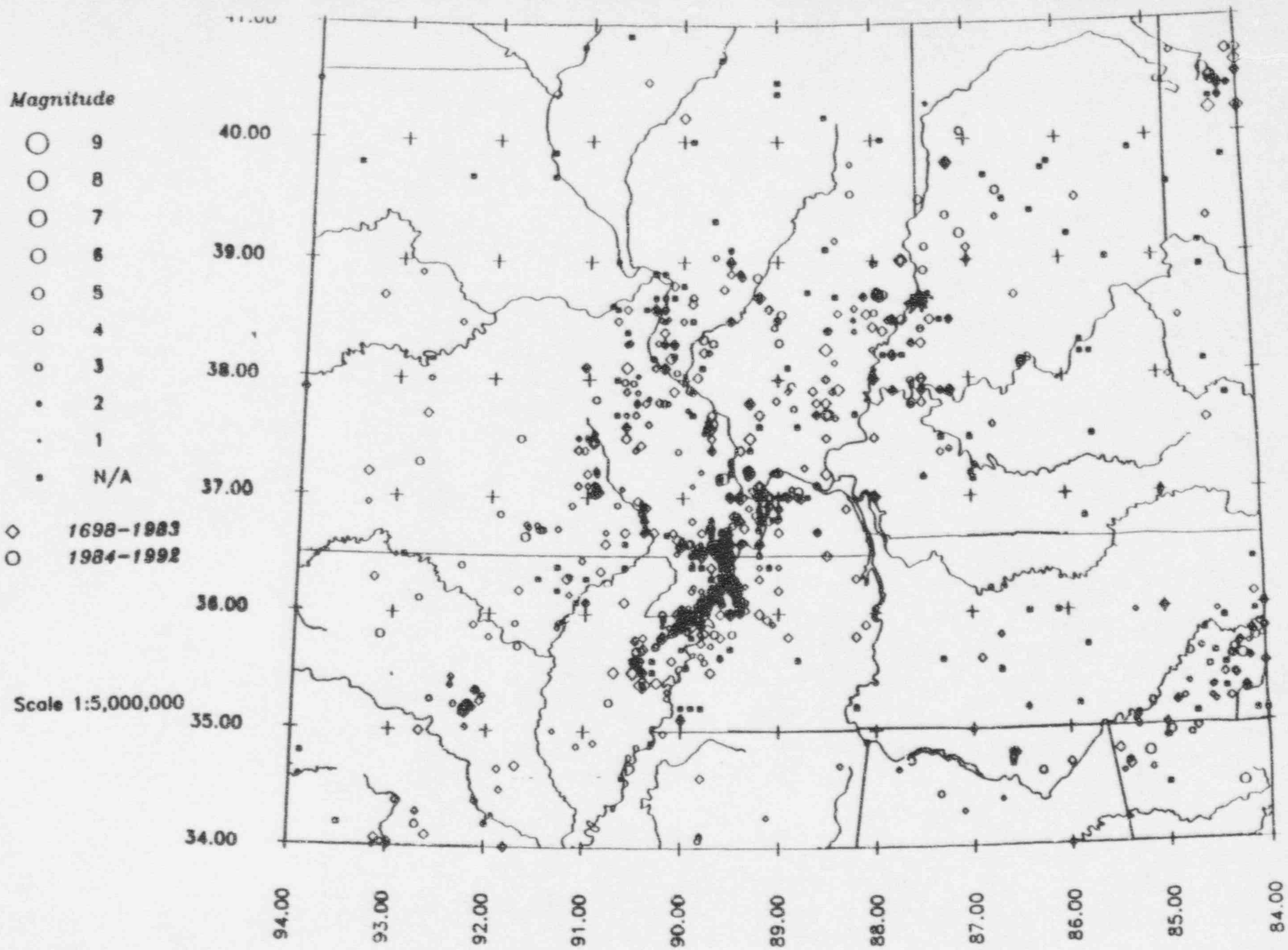


Earthquakes Recorded from 01/01/84 to 10/1/92: Vincennes, Indiana



Earthquakes Recorded from 03/1698 to 10/1/92: Vincennes, Indiana

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(MMI_0) near the upper limit of VI. We expect, however, that catalogs will list the MMI_0 as VII because that level of intensity was indeed present.

The Wabash Valley Seismic Zone

The June 1987 earthquake was the most recent in a series of magnitude ≧ 4.5 shocks to occur in the Wabash Valley seismic zone of southeastern Illinois and southwestern Indiana (Fig. 2). The Wabash Valley zone, as identified by Nuttli and Herrmann (1978) and Nuttli (1979), has a record of seismic activity dating back prior to 1800 that in the last 99 years includes seven shocks with magnitude ≧ 4.5 and MMI_0 = VII. Those earthquakes, which are rather large for the central United States, occur on the average every 16 ± 15 years (see Table 1). Nuttli and Herrmann (1978) and Nuttli (1979) based their identification of the zone primarily on the historical seismicity record, but they also recognized the presence of the north-northeasterly-trending Wabash Valley fault system in the southern half of the 200-km-long zone. Additionally, they noted that the seismicity data were too sparse to determine if there was one continuous zone present or a series of discontinuous smaller zones. Two of the largest historical earthquakes in the mid-continental United States have occurred in the Wabash Valley zone; the m_b = 5.8 (MMI_0 = VII) 1891 event

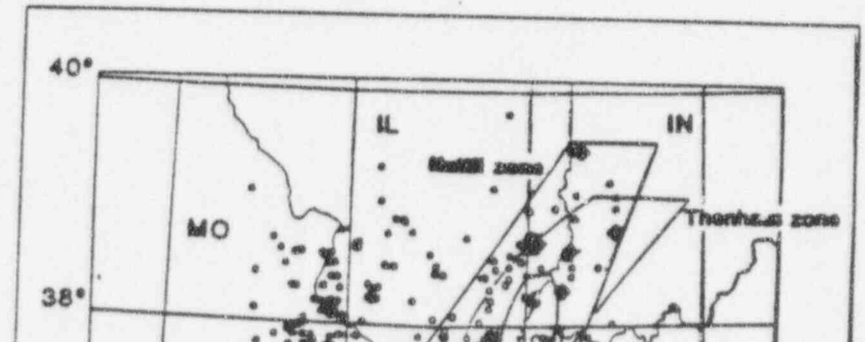

FIG. 2. Map showing boundaries of the Wabash Valley seismic zone as defined by historical seismicity (Nuttli and Herrmann, 1978; Nuttli, 1979) and by geophysical methods (Thenhaus, 1983). Also shown is the areal extent of the Wabash Valley fault zone. Symbols: Open circles are earthquakes of $M < 5.0$; diamonds indicate earthquakes of $M \geq 5.0$; the star slightly east of 88°W longitude line is the 10 June 1987 epicenter; a circle-dot indicates the Griffin, Indiana, probable liquefaction site. (Historical earthquakes from data file compiled by B. G. Reagor and C. W. Stover, U.S. Geological Survey.)

Langer & Bollinger, 1991

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Reelfoot rift (Southern Indiana arm, Fig. 3) on the basis of gravity and magnetic data. The southwest boundary of the northeast-trending Wabash Valley zone was defined geologically by these authors as the east-southeast-striking Cottage Grove-Rough Creek fault zones and geophysically as a prominent east-southeast-trending magnetic lineament. The northeast boundary was set arbitrarily at 39°N latitude, where the gravity and magnetic expression of the zone is lost.

The Wabash Valley fault zone is in the southern half of the seismic zone and, in terms of its geology, is part of the Illinois Basin. The fault zone is about 100 km long, trends north-northeast (Figs. 2 and 3), and is characterized by generally parallel, high-angle normal faults that bound horsts and grabens. The maximum displacement on individual faults is as great as 146 m, with most of the faulting post-Pennsylvanian and pre-Pleistocene in age (Bristol and Treworgy, 1979). Sixty-eight kilometers of seismic-reflection profiles across the

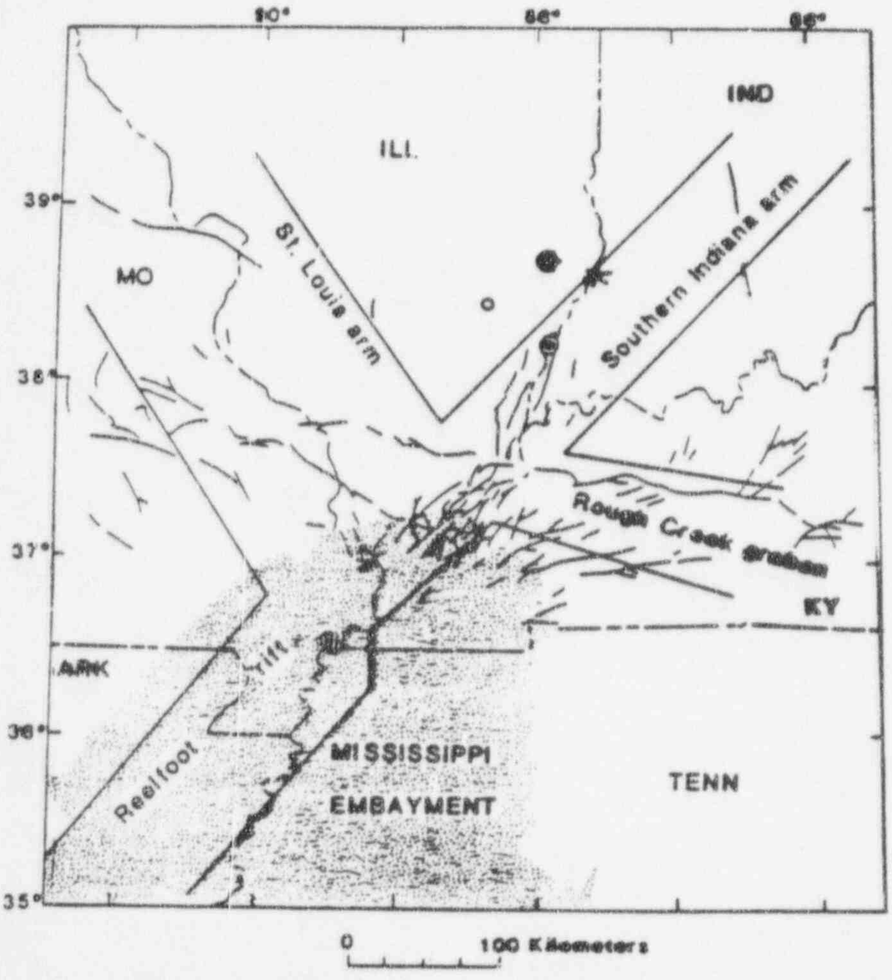

FIG. 3. New Madrid rift complex. After Braile *et al.* (1982a, b) and Soderberg and Keller (1981). Symbols: Star is epicenter of 10 June 1987 earthquake; circle-dot shows Griffin, Indiana, paleoearthquake liquefaction site in Wabash Valley; open circle southwest of main shock epicenter is location of Union Oil Company Cisne Community #1 deep drill hole. Stipple pattern indicates Mississippi embayment; fine lines are regional faults.

Langer + Bollinger, 1991

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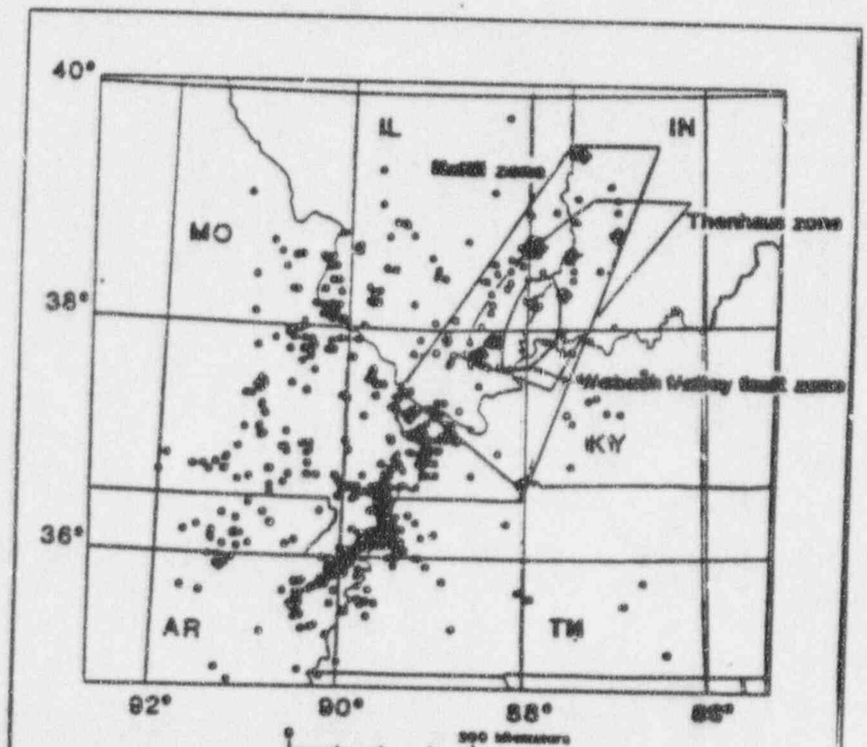

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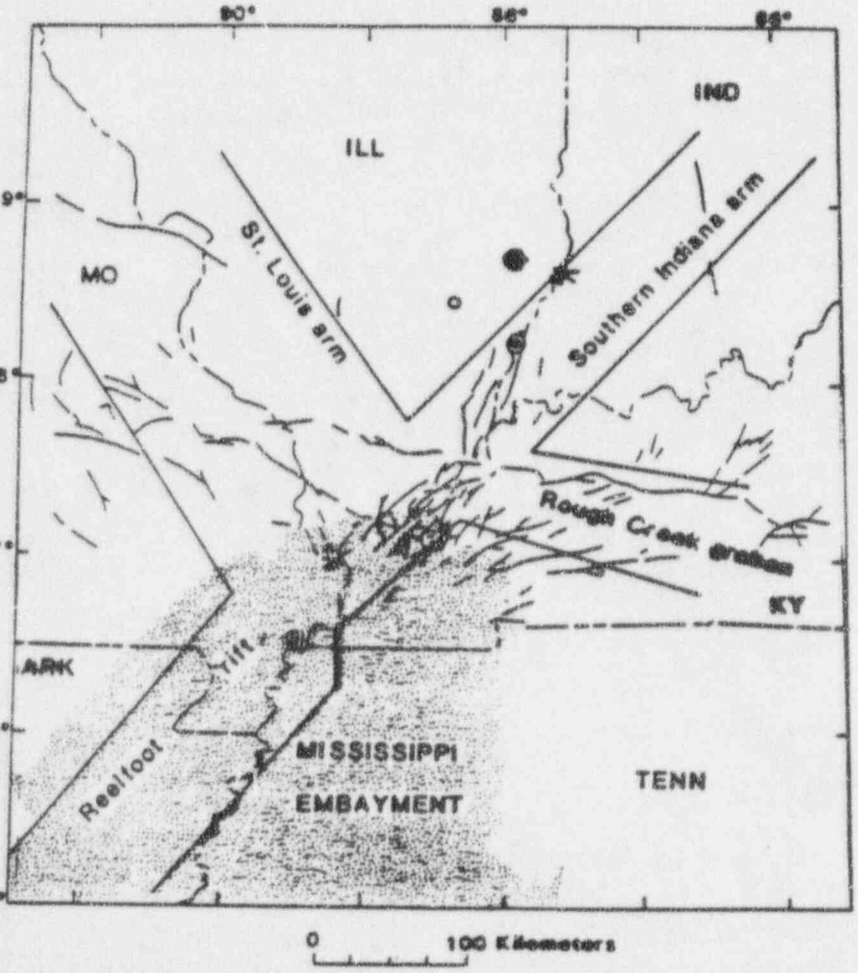

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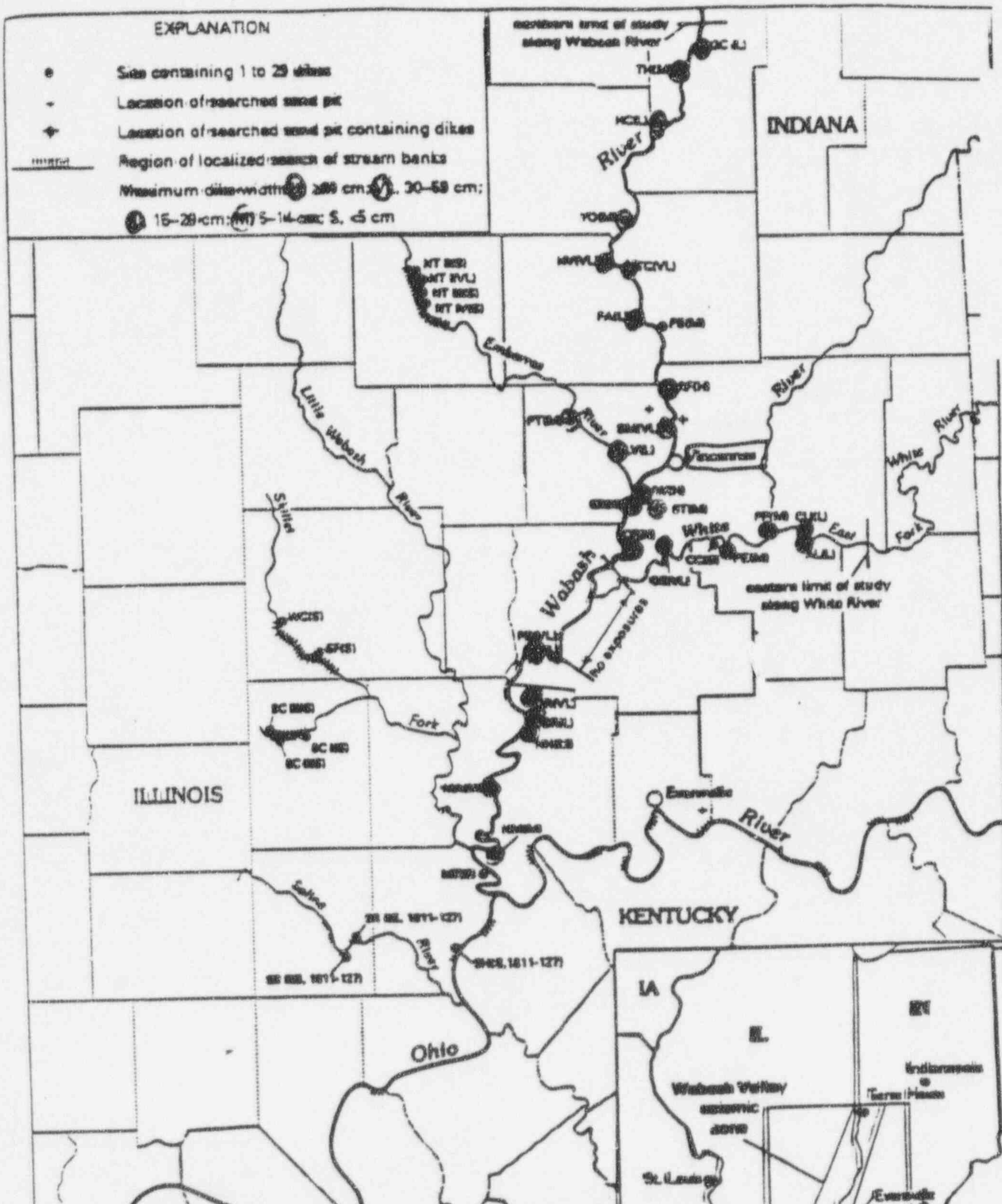
Langer + Bollinger, 1991



0 10 20 30 40 50 MILES
0 10 20 30 40 50 60 70 KILOMETERS

Obermeir et al., 1992

Fig. 1

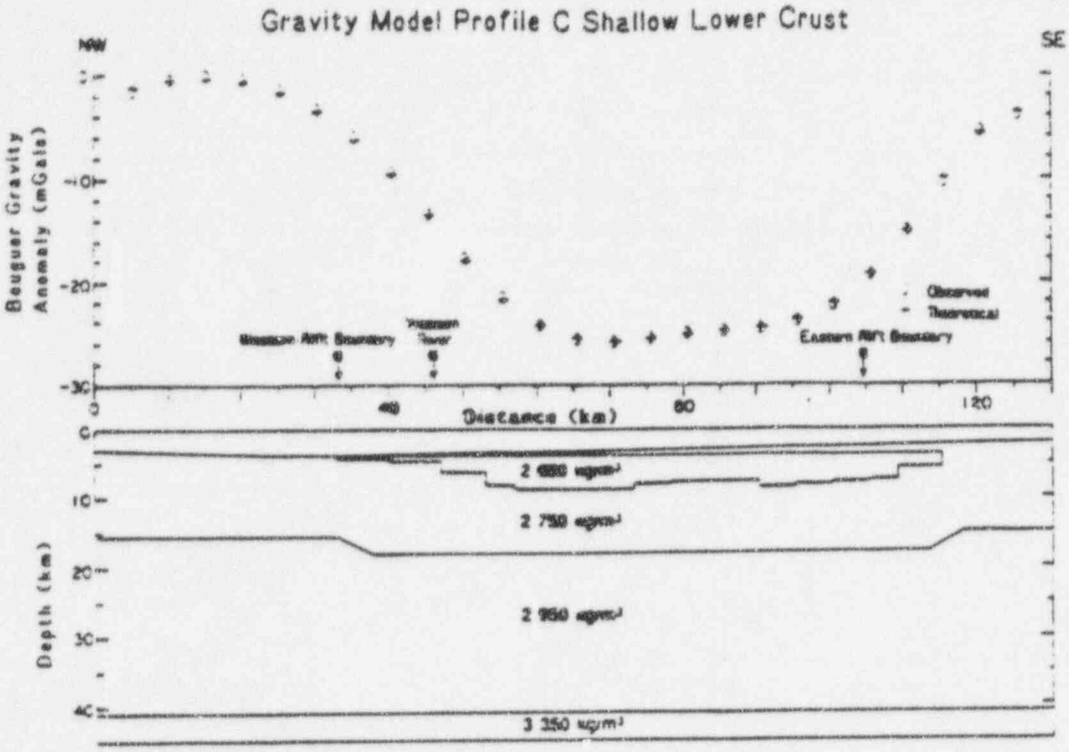


FIG. 19. Gravity model along the northwest-southeast profile C-C' (Figures 1 and 2) showing observed and calculated gravity anomaly values for the model shown in the lower part of the diagram.

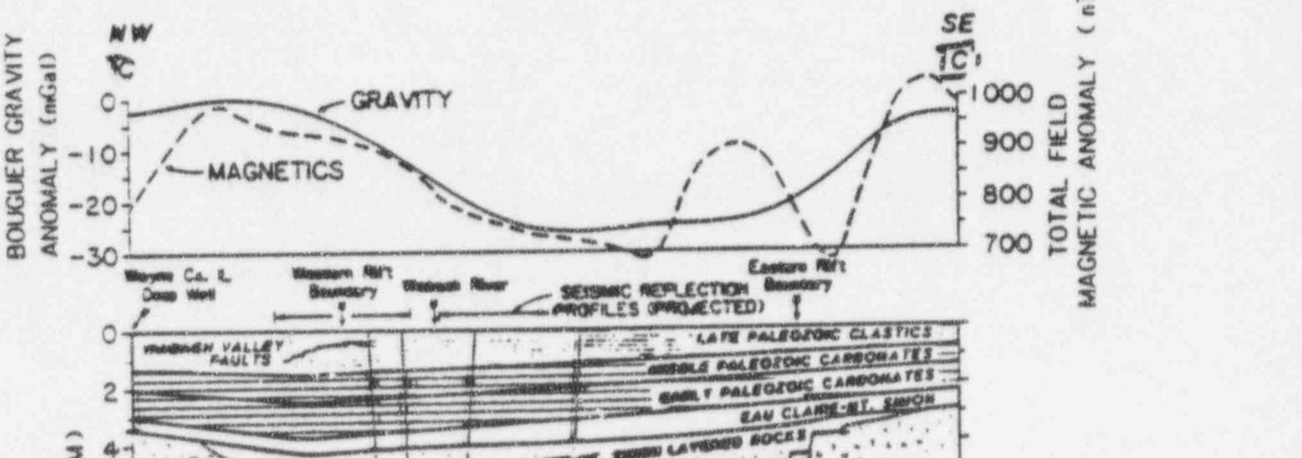


FIG. 20. Schematic model along the northwest-southeast profile C-C' showing the locations of the seismic reflection profiles (projected onto the C-C' line), gravity and magnetic anomaly data. Paleozoic stratigraphic data interpreted from deep drill holes and the seismic reflection record sections, and faulted basement and pre-Mt. Simon layered sequence inferred from the seismic reflection and gravity data.

wrench-fault assemblages, basement-block faulting and drape-folding, compound styles, and basement arches and sags" (Nelson, 1988). More complex localized structures have been observed in the Paleozoic strata, detached from the basement tectonism. The surficial structures of this region can be coarsely divided into two major types, fault systems that dominate the structural style in southernmost Indiana and Illinois, and large fold systems that are pronounced in central Illinois.

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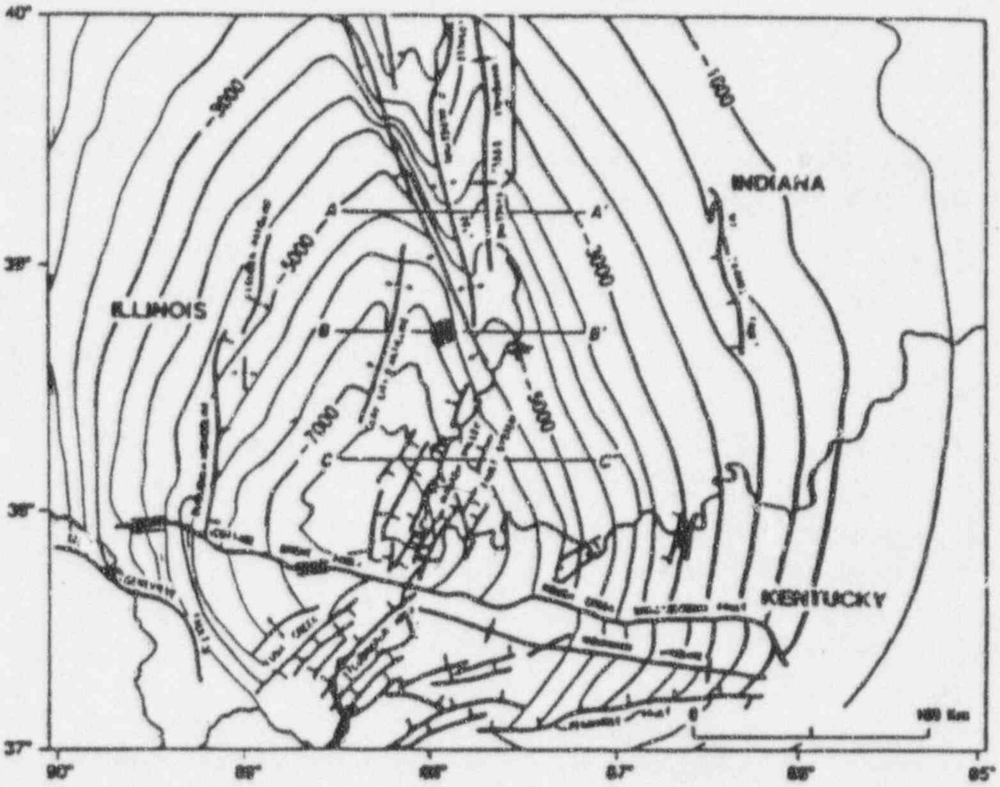


* Vincennes

Fig. 1. Tectonic setting of the June 1987 southeastern Illinois earthquake. Heavy lines denote major structural elements of the region, after Nelson and Bauer (1987); light numbered lines indicate structure contours (in feet) on the top of the Prairie du Chien Group (Lower Ordovician), from Student *et al.*, (1981). East-west lines indicate locations of cross sections shown in Figure 6. Asterisk denotes earthquake epicenter.

Hamburger & Rupp, 1988

LEVEL 1: DATA EXAMINATION SUMMARY

POTENTIALLY SIGNIFICANT DATA AND INTERPRETATIONS

Data/Interpretation	Impact	References
Large (seismically-induced) liquefaction features along Wabash River; associated with ~m 7.5; not New Madrid source	Source configuration Source/tectonic feature activity Maximum magnitude Recurrence (?)	Obermeir et al., 1991 Obermeir et al., 1990
Occurrence of M_w 5 Southeastern Ill. earthquake 10 June 1987 in Wabash Valley area; strike-slip	Source configuration Recurrence (?)	Taylor et al., 1989 Langer and Bollinger, 1991
Interpretation of Wabash Valley fault zone as northerly extension of New Madrid rift complex	Source configuration Source/tectonic feature activity Maximum magnitude Recurrence (?)	Braile et al., 1982 Sexton et al., 1986 Sexton, 1988
New Madrid rift complex does not extend as far north as 1987 epicenter	Source configuration Source/tectonic feature activity Maximum magnitude	Hamburger and Rupp, 1988 Nelson, 1990
Pre-1811 earthquakes not found in Holocene record at New Madrid	Recurrence for New Madrid	Wesnousky, 1992

LEVEL 2: EVALUATION OF NEW DATA AND EXISTING SEISMIC SOURCE INTERPRETATIONS

- Evaluate if new data or new interpretations are accommodated in the accepted seismic source interpretations

- Perform sensitivity evaluations that examine the accepted seismic sources and estimated occurrence rates

LEVEL 2 PARAMETERS

- Seismic source boundaries
- P_A (probability of activity)
- Maximum magnitude distribution
- Earthquake occurrence rates (a- and b-values)

SEISMIC SOURCE BOUNDARIES

- Teams provided alternative interpretations of the tectonic framework and active tectonic features

- Conclusion - Accepted seismic source boundaries accommodate the range of reasonable interpretations

EPRI EARTH SCIENCE TEAMS - SEISMIC SOURCE SUMMARY

Team	Wabash Valley Site				
	Host Source		Probability of Activity	m_{max}	
	No.	Description		Magnitude	$P(m_{max})$
Dames & Moore	18	Southern Illinois, Indiana Fairfield Basin	1.0	6.6 7.2	0.75 0.25
Law Engineering	7	Wabash Valley Arm	0.85	5.5 6.0 6.8	0.20 0.50 0.30
Bechtel	34	Wabash Valley Fault	0.35	5.5 5.8 6.1 6.6	0.10 0.40 0.40 0.10
Rondout	2	Southern Illinois, Indiana	1.0	6.6 6.8 7.0	0.30 0.60 0.10
Weston Geophysical	33	Indiana Arm of New Madrid Rift Complex	1.0	6.0 6.6 7.2	0.68 0.27 0.05
Woodward Clyde	43	Southern Indiana Arm	1.0	5.8 6.6 7.4	0.33 0.34 0.33

WABASH VALLEY - LEVEL 2 EVALUATIONS

Case	Parameter	Description
1	NA	Use EPRI Earth Science Team seismic sources, etc.
2	Probability of activity (P_A)	Change team P_A values for Wabash Valley seismic source to 1.0 →
3	P_A and m_{max}	Same as Case 2, plus team m_{max} values are revised to reflect paleoliquefaction data New m_{max} Distribution for Wabash Seismic Source m_{max} — $P(m_{max})$ 6.0 — 0.05 6.6 — 0.65 7.2 — 0.30

EPRI REGIONAL EARTHQUAKE OCCURRENCE RATES

- Determine team estimates of earthquake occurrence rates within the vicinity of the site

- Occurrence rates are based on

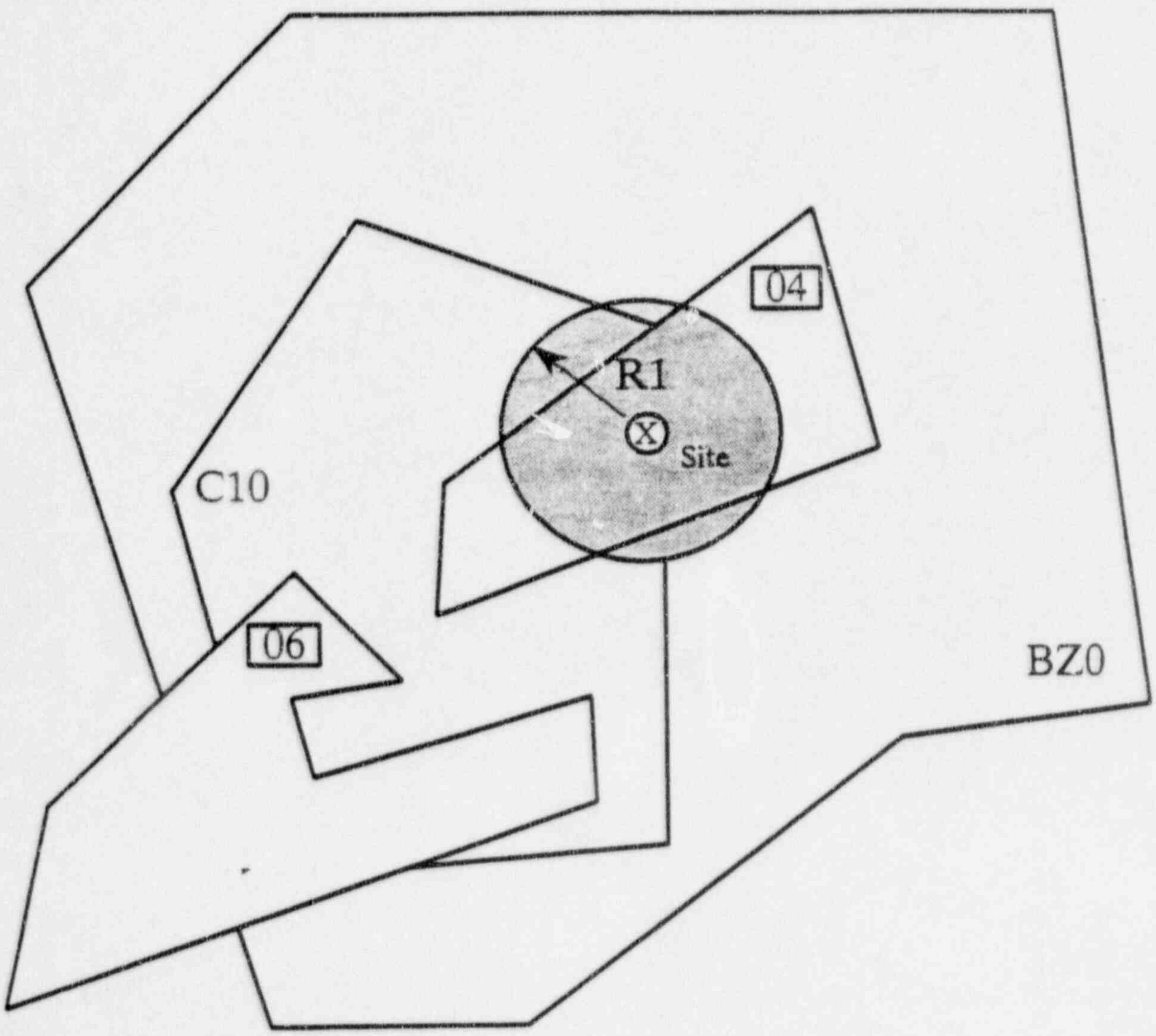
  -- team source combinations (i.e., source probability of activity)

  -- seismicity options

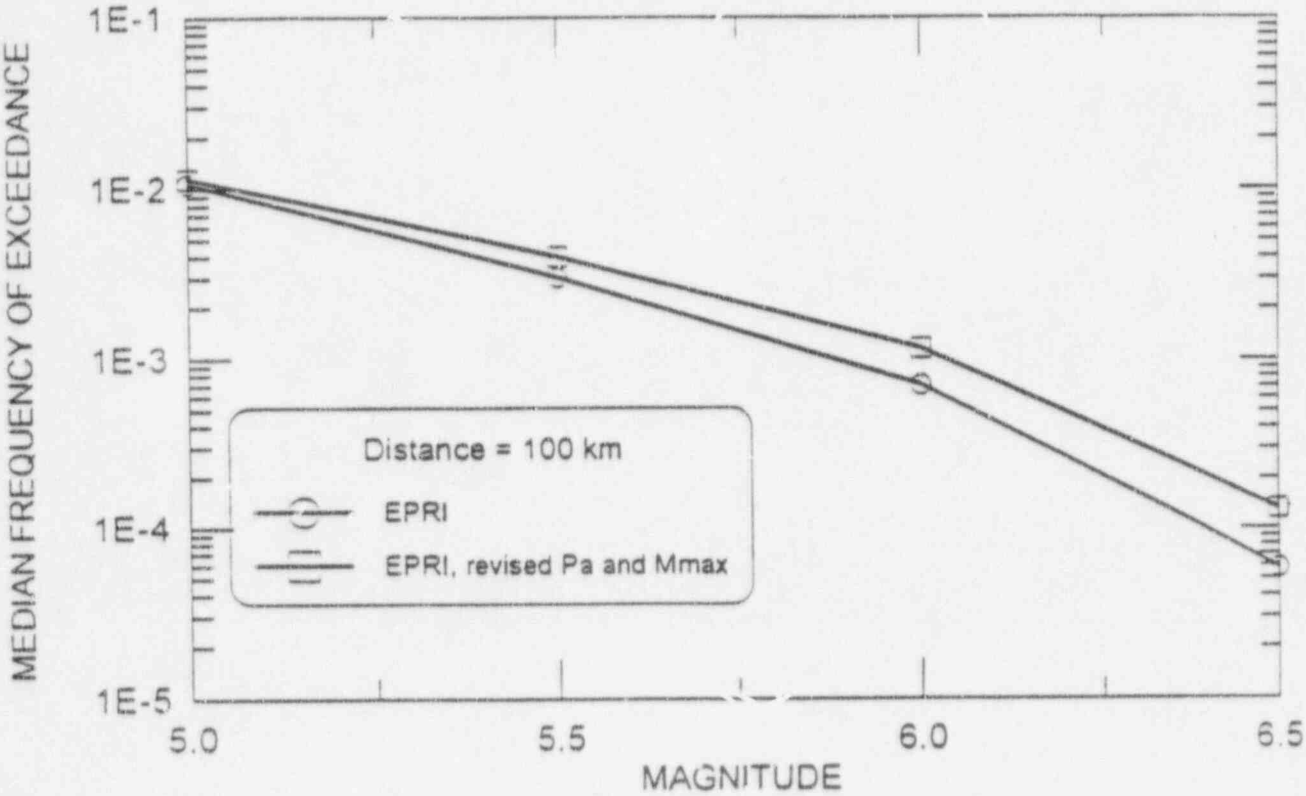
  -- maximum magnitude estimates

- Rates are determined for selected distances from the site

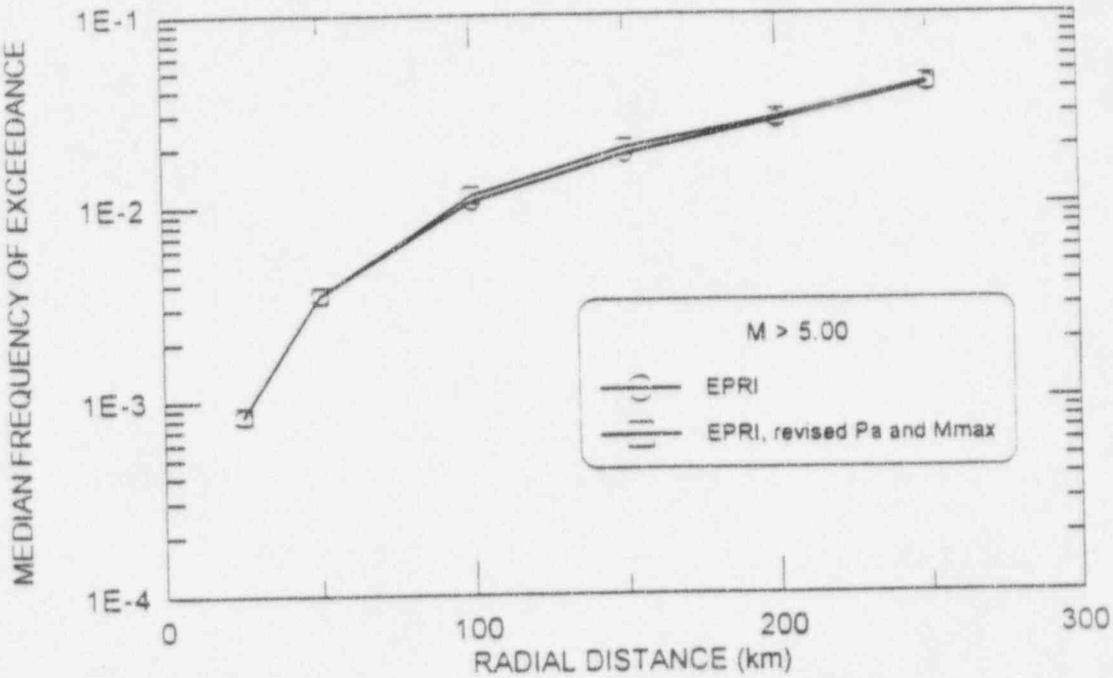
ILLUSTRATION OF PROCEDURE TO DETERMINE EARTHQUAKE OCCURRENCE RATES

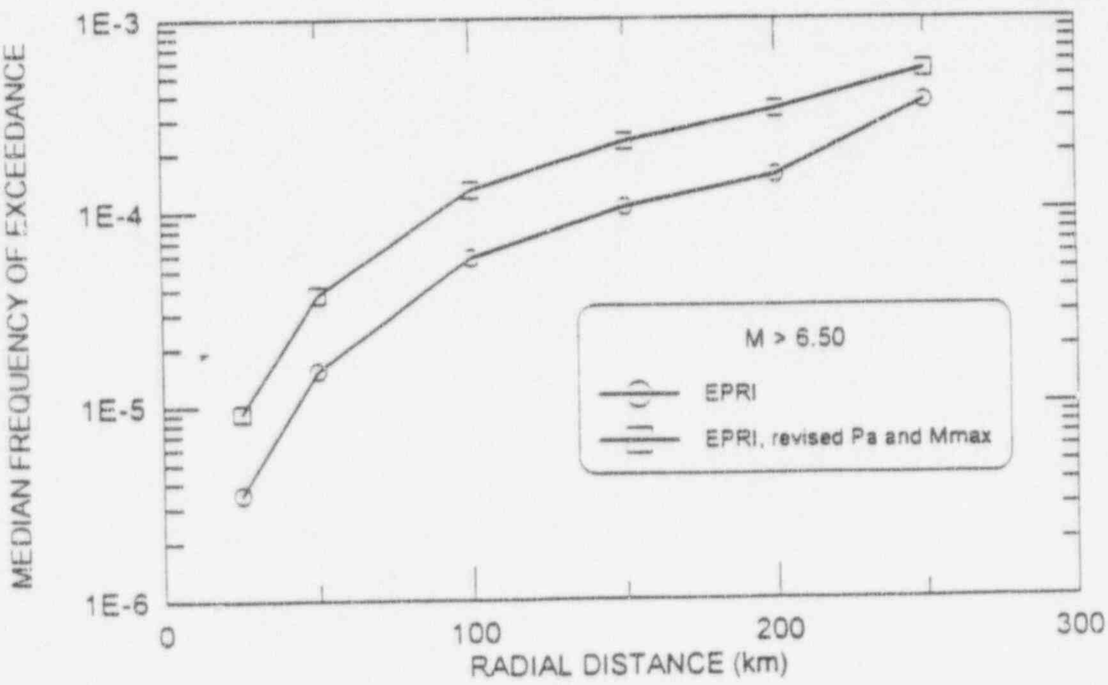


EPRI REGIONAL EARTHQUAKE MEDIAN OCCURRENCE RATES - 100 km



EPRI REGIONAL EARTHQUAKE OCCURRENCE RATES VERSUS DISTANCE





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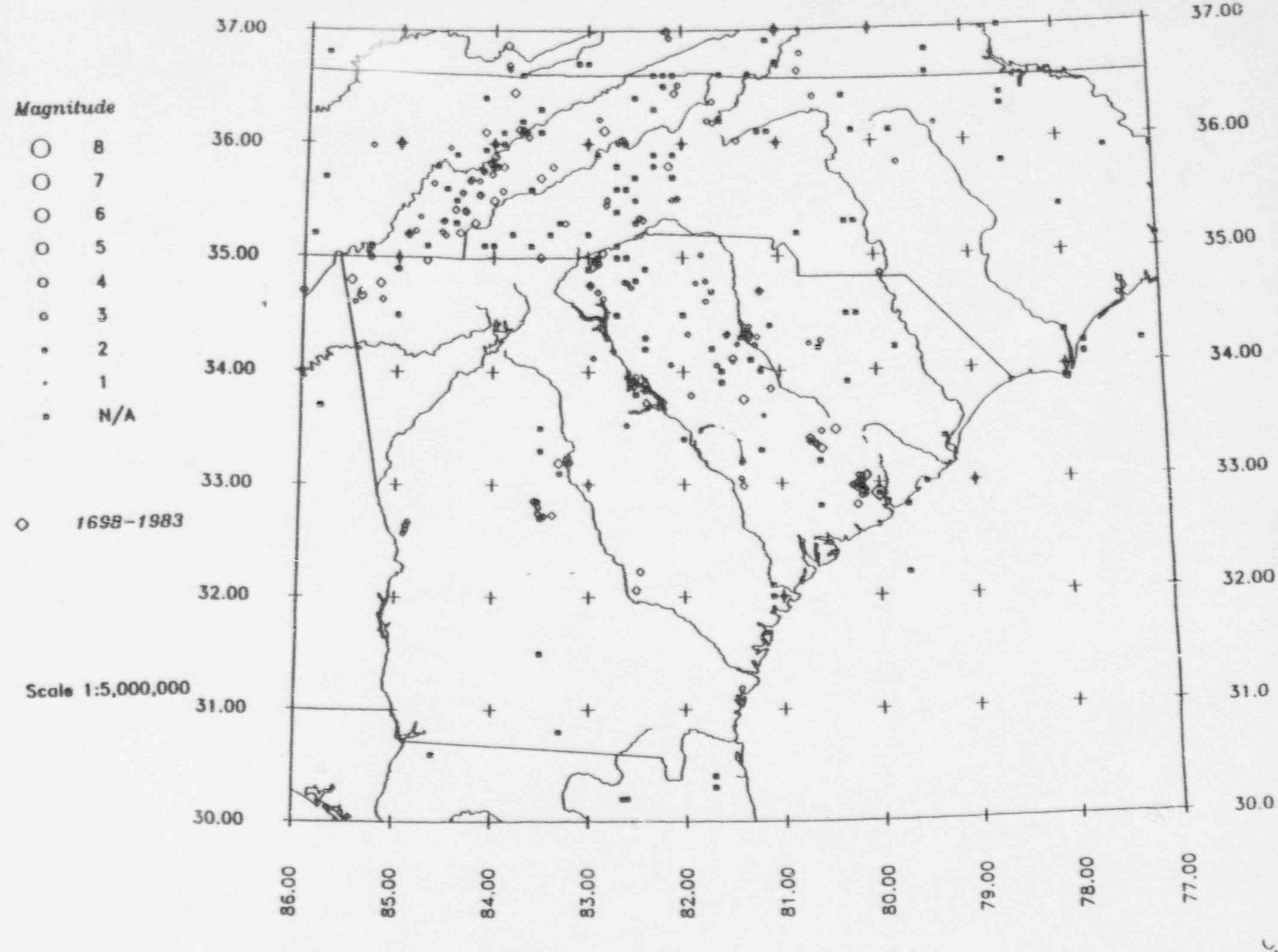
NPR EVALUATION AT THE SAVANNAH RIVER SITE

- NPR - New Production Reactor
- Probabilistic seismic hazard assessment being conducted by LLNL for DOE
- NPR funding was suspended, work has not been completed (ongoing)
- Preliminary results are partially documented

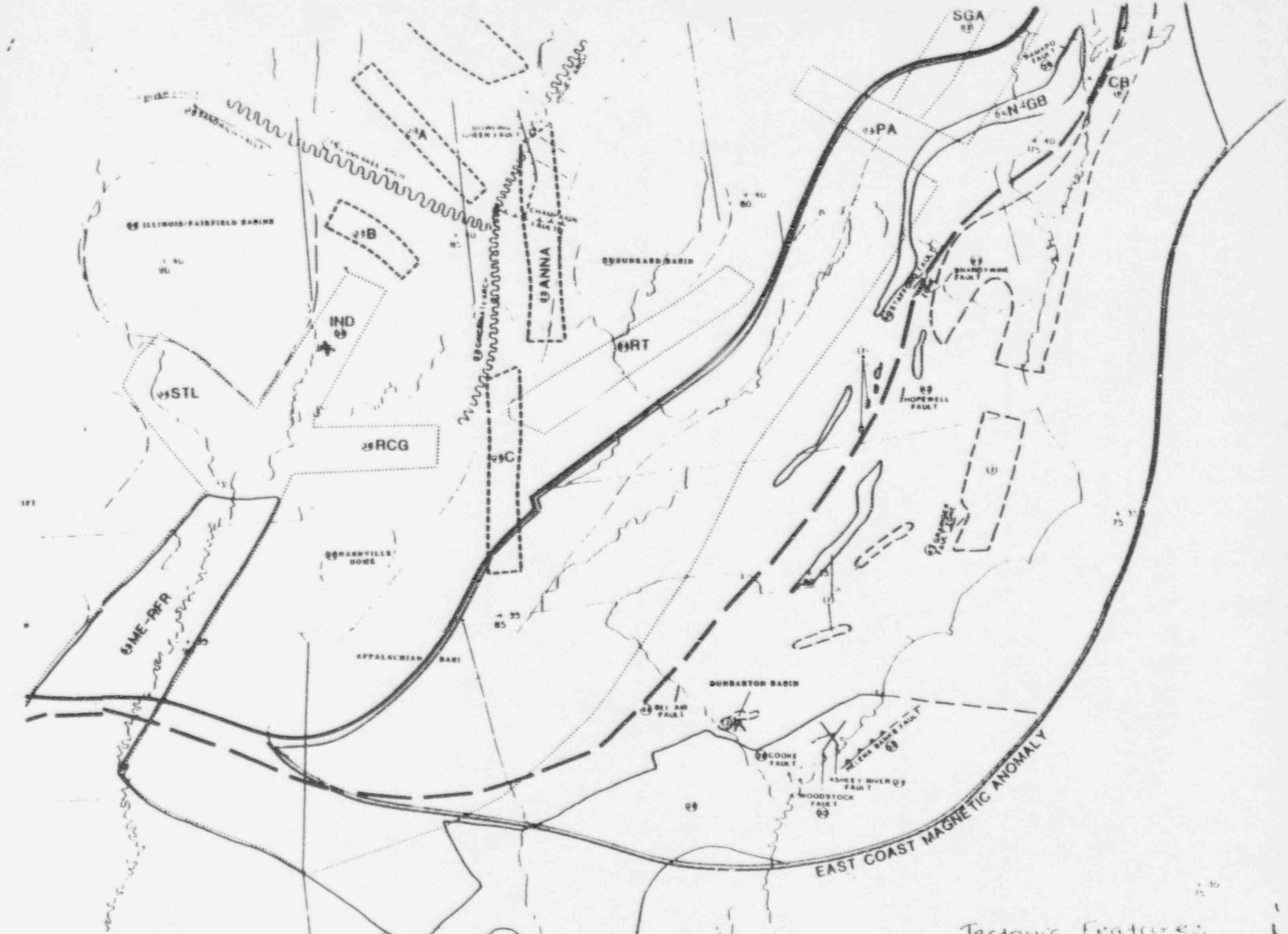
APPLICATION TO THE NPR, SRS

- LLNL (1989) seismic hazard results for the SRS are used

- Level 1 and Level 2 evaluations are not documented in the Earth Science database and seismic source interpretations is not available



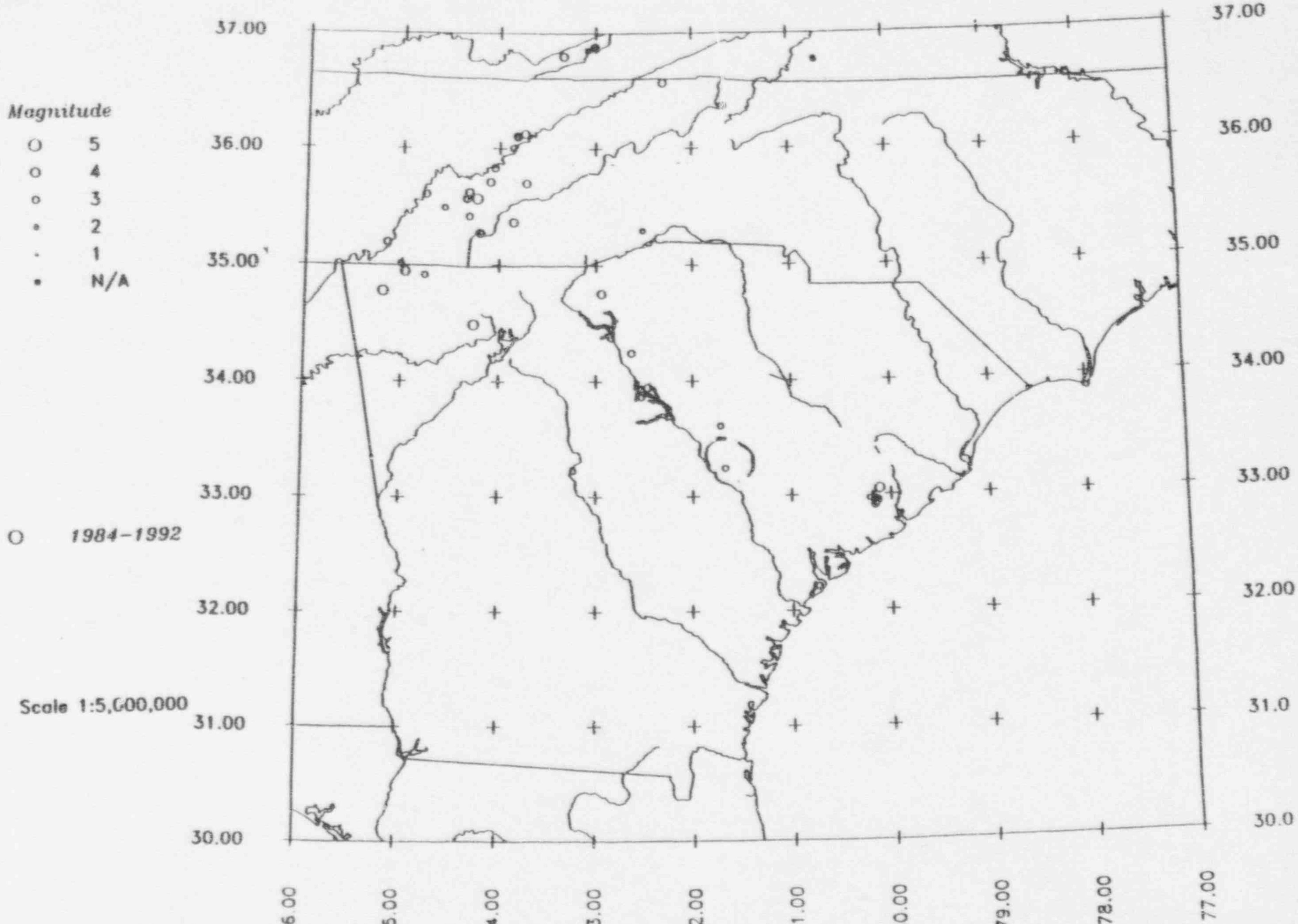
Earthquakes Recorded from 03/1698 to 01/01/84: SRS



Tectonic Features

SAVANNAH RIVER SITE, SOUTH CAROLINA

DATA/INTERPRETATION	POTENTIAL SIGNIFICANCE	REFERENCES
Paleoliquefaction not found outside of SC in coastal deposits from D.C. to Fla.	Source configuration Source/tectonic feature activity	Amick, 1990; 1991 Amick and Gelinas, 1991
Multiple pre-1883 events found in paleoseismic record in Charleston area	Source configuration Maximum magnitude Recurrence	Talwaini and Cox, 1985 Talwani and Collensworth, 1988 Obermeir et al., 1990 Amick, et al., 1990
Evidence for post-Cretaceous reverse/SS reactivation of Helena Banks fault zone	Source configuration Source/tectonic feature activity	Behrendt and Yuan, 1986; 1987
Identification of Woodstock linament in 1886 meisoseismal area	Source configuration Source/tectonic feature activity	Marple and Talwani, 1992
Evidence for post-Cretaceous reverse reactivation of Dunbarton Basin border fault (Pen Branch fault)	Source configuration Source/tectonic feature activity Maximum magnitude Recurrence	Stieve et al., 1991 DOE-SRS reports 1990-1992
Occurrence of small-magnitude earthquakes within SRS	Source/tectonic feature activity	Talwaini et al., 1985
Majority of CEUS focal mechanisms suggest reactivation of preexisting faults in regional stress field	Source/tectonic feature activity	Zoback, 1992



Magnitude
5
4
3
2
1
N/A
1984-1992
Scale 1:5,000,000
37.00
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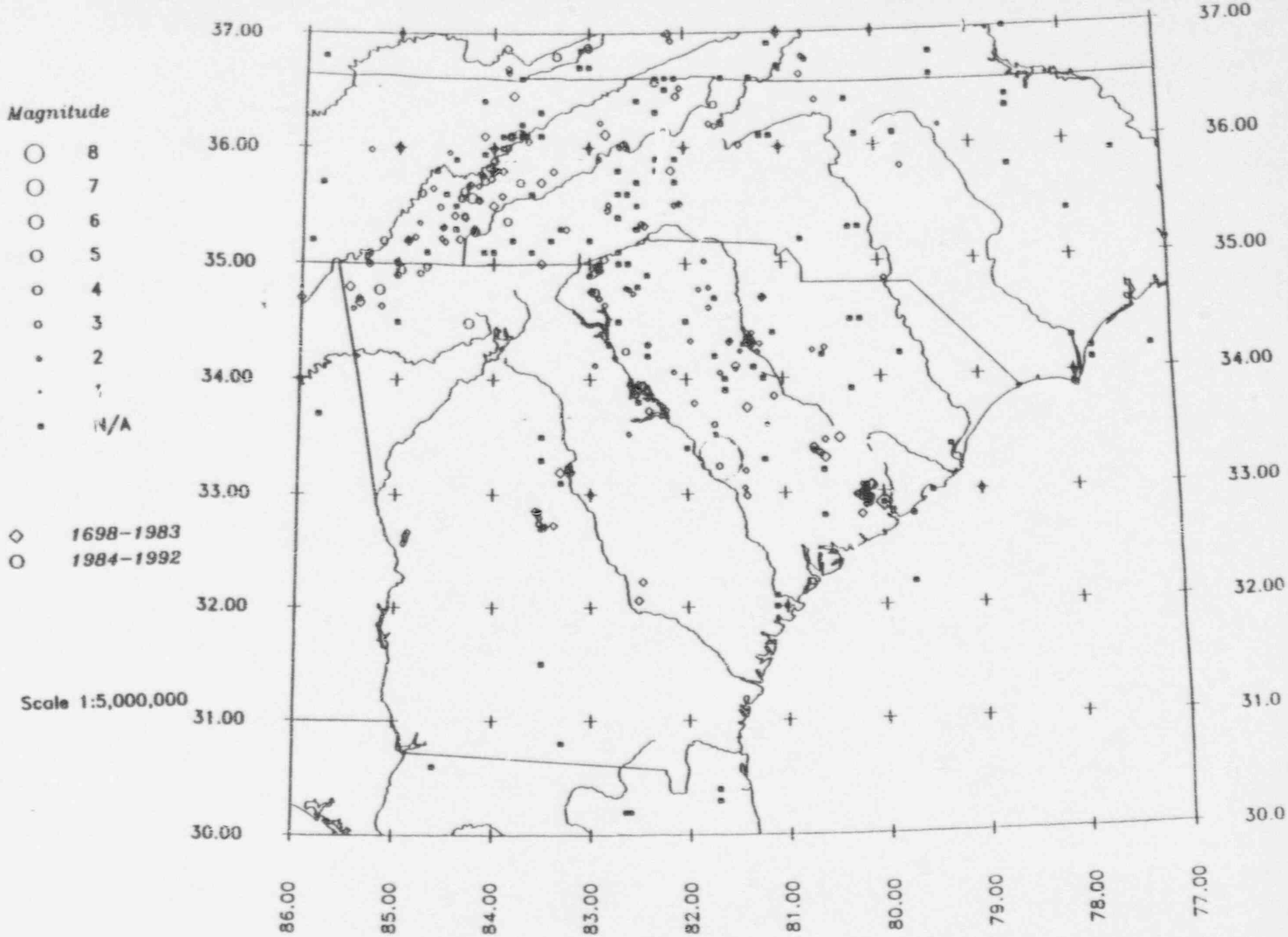
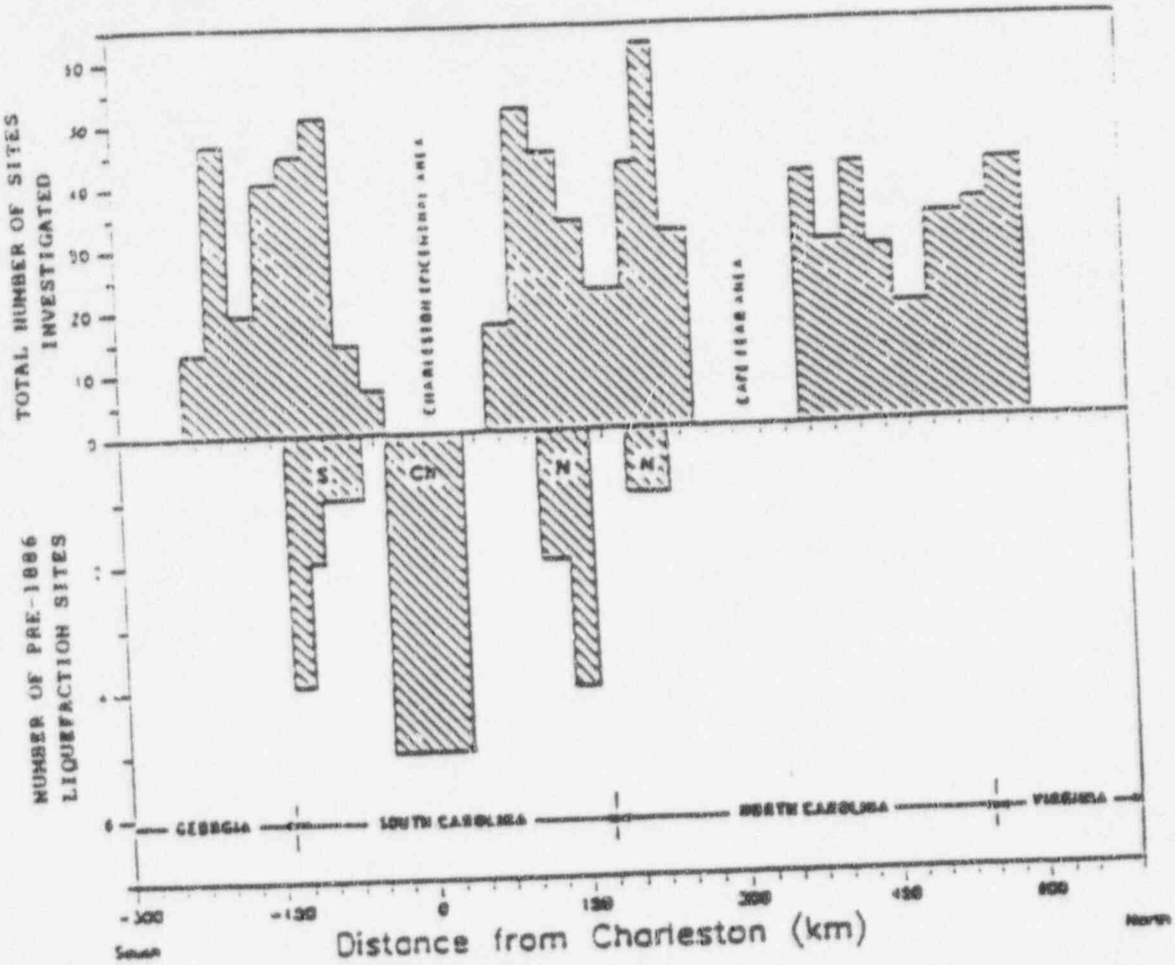


Earthquakes Recorded from 03/1698 to 10/1/92: SRS



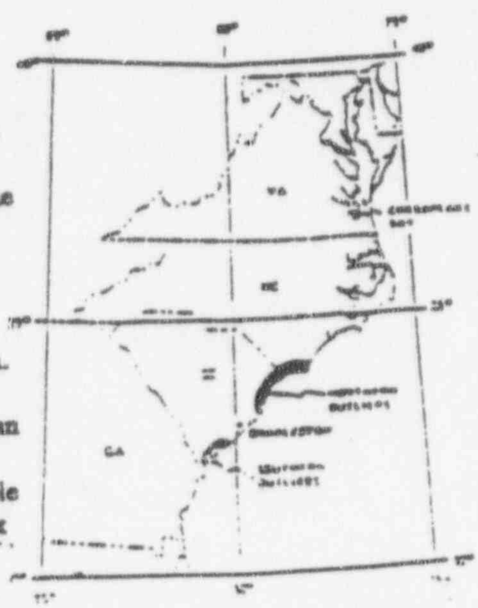


FIGURE 5. Distribution of potential liquefaction sites evaluated along the southeastern Atlantic Seaboard (top) and location of pre-1886 liquefaction sites (bottom) discovered. Sites within the mesoseismal area of the 1886 earthquake are labeled "CH". Outlying liquefaction sites located to the south and north of the 1886 epicentral area are labeled "S" and "N", respectively, (also see insert at right that shows the general location of outlying liquefaction sites with respect to Charleston). The precise number of sites evaluated in the Charleston area has not been shown. However, the total number of sites near Charleston evaluated during our study was significantly less than in other areas. No studies were conducted in the Cape Fear area due to the general absence of suitable deposits over the Cape Fear Arch. (From Amick et al., 1989)

style in this area immediately offshore to be similar to that of the adjacent land area. The objective of this study was to better define the configuration and history of the HBFZ.

Figure 3 shows the location of a fault-bounded Triassic(?) basin reported on the tectonic map of Behrendt and Grim (1983) compiled from the second vertical derivative interpretation of the aeromagnetic survey (Behrendt and Klitgord, 1979; Behrendt and others, 1983) of the Atlantic continental margin. Figure 3 also shows interpretations from Behrendt and others (1983) of seismic-reflection profiles (CH2 and CH5, Fig. 1) over this basin. The HBF appears to lie along this trend.

The present-day tectonic stress field in interior North America is one of east-to-northeast compression (Zoback and Zoback, 1980), although originally Zoback and Zoback (1980), Yang and Aggarwal (1981), and Wentworth and Mergner-Keefer (1983) favored a northwest-trending compressional stress field along the Atlantic seaboard, determined largely from young northeast-striking reverse faults mapped on land (Prowell, 1987) and a few seismic focal mechanisms. Composite seismic focal mechanisms (Tarr and others, 1981; Talwani, 1982; Tarr and Rhea, 1983) for earthquakes recorded since 1974 in the 1886 meizoseismal area, although giving poorly constrained focal planes, demonstrated a northeast-trending compressive stress field for some solutions, however. More recently (in a compilation based on various types of new data including seismic focal mechanisms and drillhole measurements), Zoback (1983) and Zoback and others (1986) stated that the preponderance of evidence now supports a northeast-trending compressive stress field along the Atlantic seaboard as well as in the interior. This change in interpretation raises the question of whether the northeast-striking "reverse" faults determined from reflection profiles in the Charleston area (Behrendt and others, 1981; Hamilton and others, 1983; Schilt and others, 1983) and mapped geologically else-

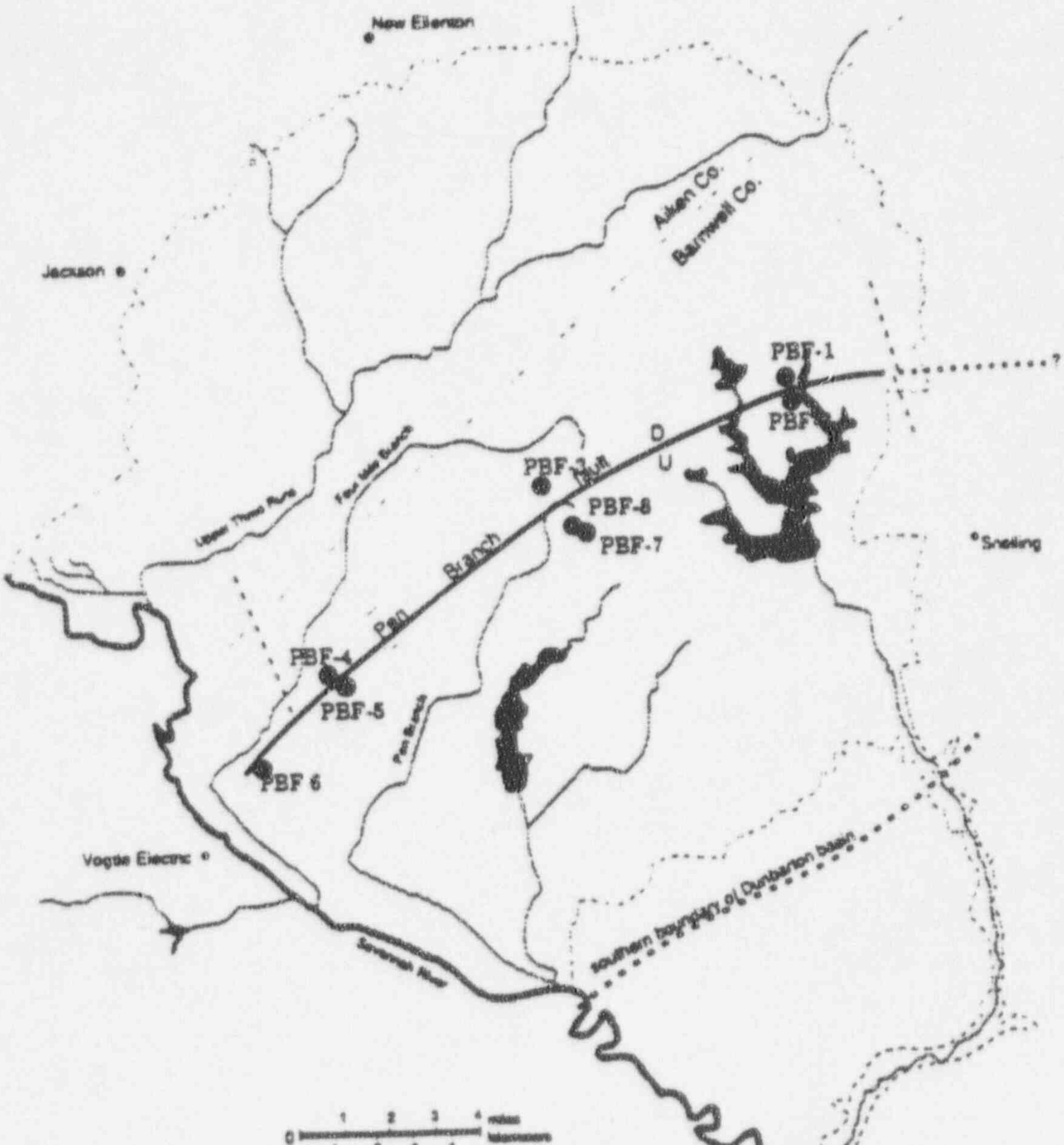


Figure 1. Location of Pen Branch fault at SRS with PBF series shallow coring locations shown as large filled circles. Two other possible north-south trending faults are thought to intersect the Pen Branch fault.

Stieve et al., 1991

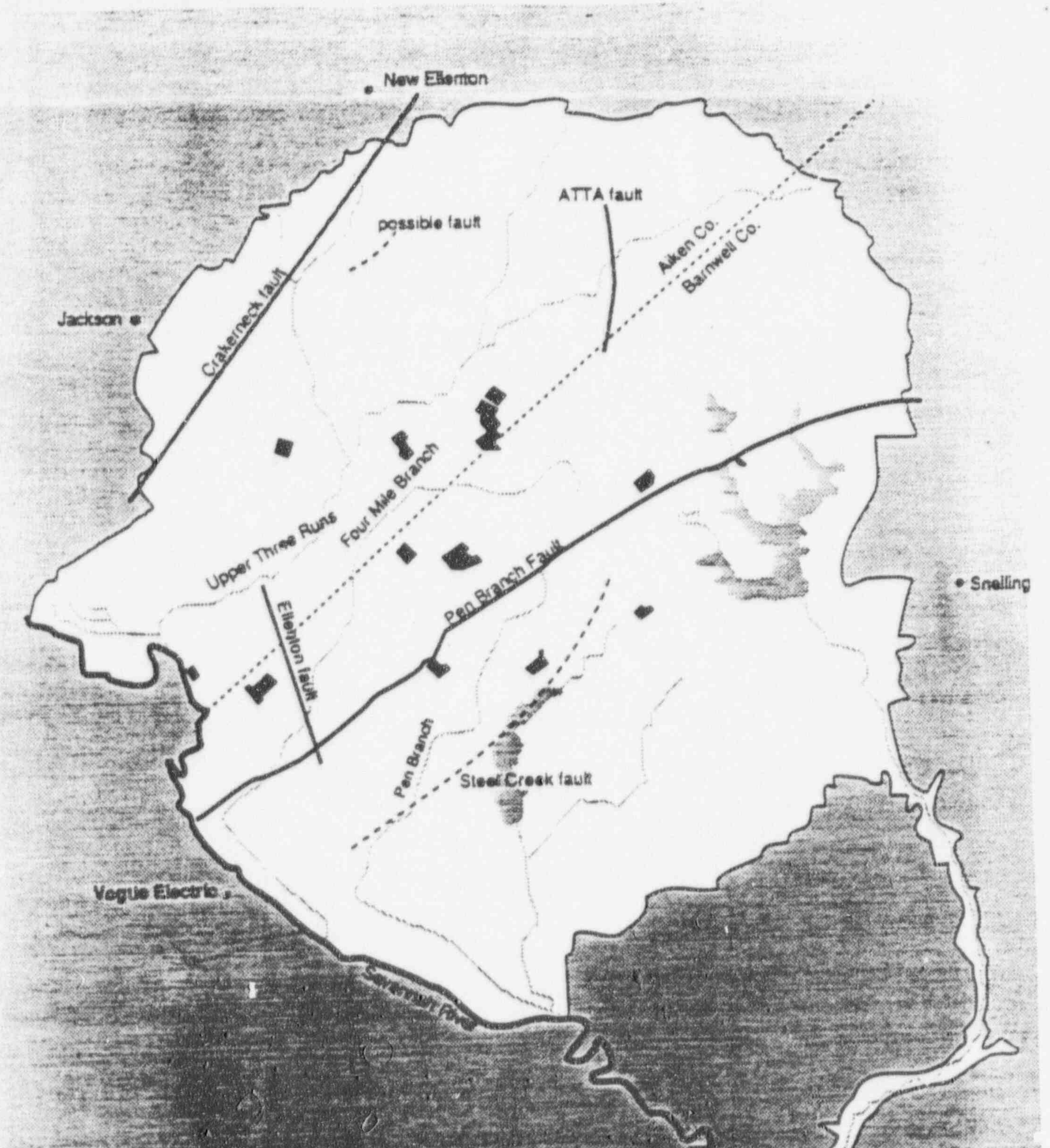


Figure 5. Location map of the Pen Branch fault and other basement faults identified based upon the Seismic Reflection Survey (Conoco, 1987-1988) data. Steel Creek fault was identified at a later date.

Stieve et al., 1991

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Stieve et al., 1991

SUMMARY TO THIS POINT

- There does not appear to be new information that requires further evaluation at Level 2 or 3

- Nonetheless, new seismic source interpretations have been developed that are very different from the interpretations produced in the LLNL study

- The NPR becomes an interesting case to evaluate whether the site ground motion hazard has changed

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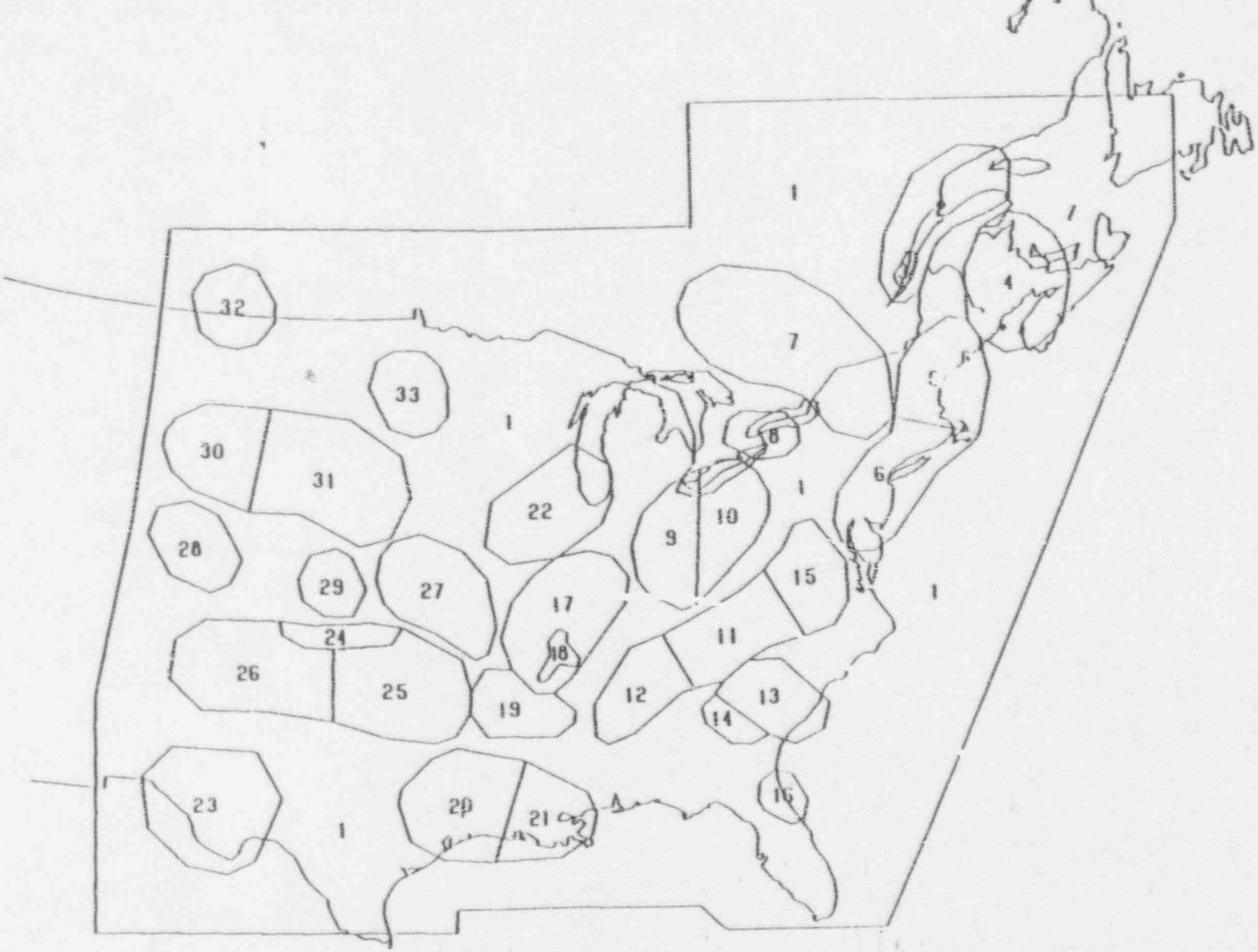
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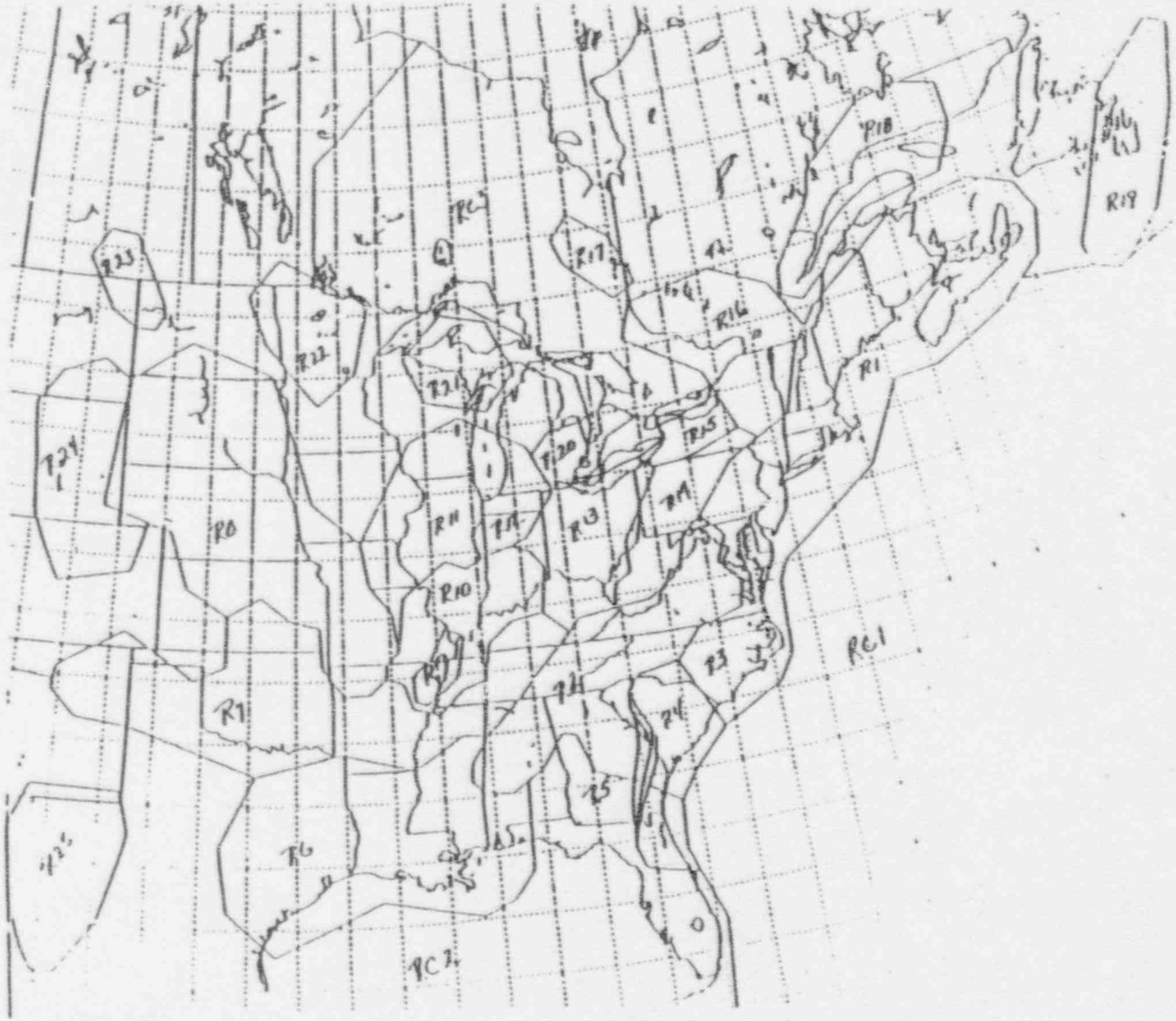
NPR Kafka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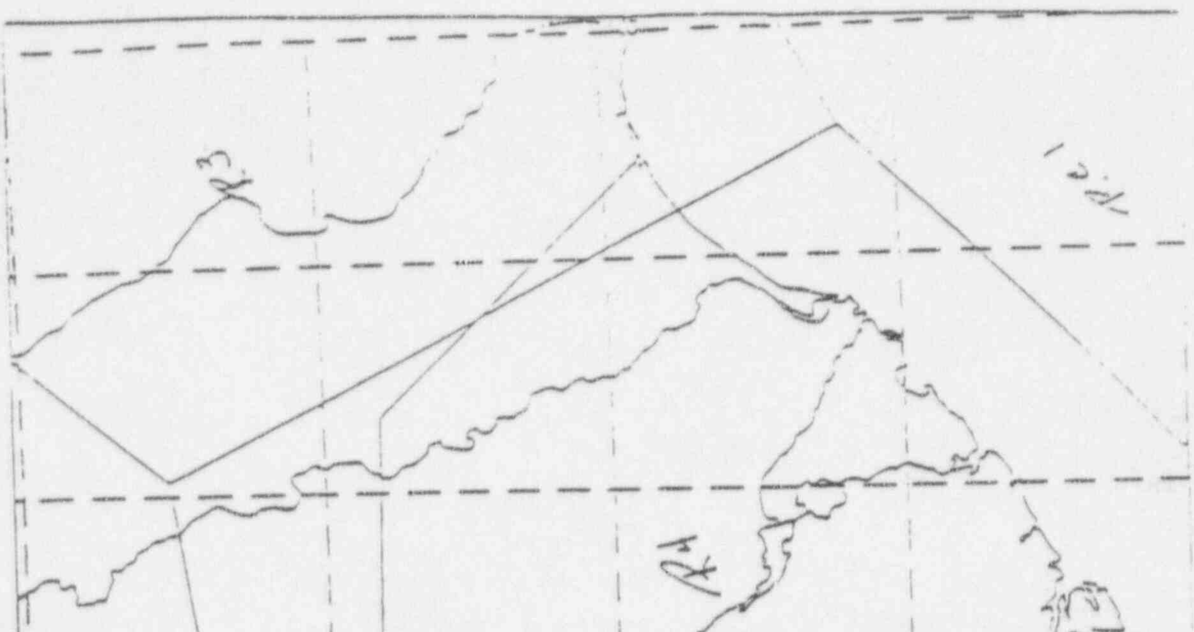
RC2

NPR Kafka



EVALUATION OF NPR SITE

- Level 3: Evaluation of new data and interpretations in terms of the SSE

  -- Evaluate whether expert assessments in NPR study are consistent with original LLNL study results

  -- Some difficulty in making comparisons at PSV 5 and 10 hz

  1. Different attenuation models and soil factors

  2. Lower-bound magnitude of 3.75 rather than 5.0 was used

LLNL/USNRC - NPR COMPARISON FOR SRS

Ground Motion Measure	LLNL 10^{-4} Level		NPR Range
	Average	Std. Dev.	
PGA (g)	0.20	0.05	0.08 - 0.24
PSV - 5 Hz (cm/sec)	11.2	4.6	2.8 - 11.9
PSV - 10 Hz (cm/sec)	4.7	1.54	1.84 - 9.2

NPR SUMMARY

- Each expert represents an applicants assessment of the site SSE. Thus we have 9 trials

- Results - at the 95 percent confidence level

PGA	- 9 experts fall within study results
PSV (5.0 Hz)	- 9 experts fall within study results
PSV (10 Hz)	- 8 experts fall within study results

- Conclude - existing study is consistent with new information

SUMMARY

- Stability of the seismic siting process is derived from:

  - acceptance by the USNRC staff and the industry of the broad range of existing EUS seismic source interpretations

  - use of the median hazard curve as the basis to determine the SSE

- Direct, formal consideration of the significance of site-specific information in the assessment of the SSE