SMITHSONIAN INSTITUTION
1992 Progress Report to FEMA on Executive Order 12699

1. Introduction:

The responsibilities and jurisdictions of the Smithsonian Institution Seismic Safety program are limited to the facilities designed and constructed under the management and supervision of the Smithsonian Institution. The Smithsonian is not a regulatory agency, nor does it provide Federal loans, grants, guarantees or assistance for the construction of facilities outside of our direct management and supervision.

2. Status of Agency Procedures:

The Office of Design and Construction manages the planning, design development and construction of all new Smithsonian Institution facilities except for the facilities at the National Zoo. The new construction program at the National Zoo is administered by the NZP Office of Construction and Planning. The Smithsonian Seismic Safety Coordinator works with the staff of both offices to assure that they are cognizant of current requlations and requirements.

Since the implementation of Executive Order 12699, the Smithsonian has implemented requirements and procedures which assure design and construction of new facilities in accord with contemporary seismic safety requirements. On June 5, 1991, we issued a revision to the Special Conditions for A/E Services. This document is made a part of every A/E contract and specifies, among other things the codes, standards, and regulations to be used in the design of facilities The revised document requires full compliance with the most recent edition of the *BOCA National Building Code*. The *1992 Supplement to the BOCA Code* is recommended by the ICSSC as providing a level of seismic safety substantially equivalent to that provided by use of the *1988 NEHRP Recommended Provisions*. The A/E Special Conditions document will be updated by August 1992 to include also the *1991 ICBO Uniform Building Code*, and the *SBCCI Standard Building Code with 1992 Amendments,* and, since SI facilities are located in several states, will identify which code will be used for in a particular state.

Following the issuance of the ICSSC *Guidelines and Procedures for Implementation of the Executive Order on Seismic Safety of New Construction,* the Smithsonian Institution appointed Thomas P. Myers, P.E., to be it's Seismic Safety Coordinator. Mr. Myers is a structural engineer, and a member of the ICSSC. Mr. Myers is the single point of contact for the Smithsonian Institution Seismic Safety program. Information relating to seismic safety of the SI building program may be obtained from Mr. Myers.

3. Progress on Implementation Plan

Since enactment of the Executive Order, the Smithsonian Institution has appointed a Seismic Safety Coordinator, and has adopted standards for design of new buildings. The building program at the Smithsonian is very small and centrally located. It is therefore efficient to administer the seismic safety program from a central point of contact within the Office of Design and Construction. All new building projects will be designed and reviewed for conformance with one of the three model codes approved by the ICSSC as providing a level of seismic safety substantially equivalent to the *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings.* Budget requests for new building projects are being evaluated to assure that adequate funds are provided to implement seisimic design & construction requirements. Authorization and allocation of funds will occur through the usual budget process. The SI requested an additional position for the Seismic Safety Coordinator. The incumbent serves from a currently authorized position in the Office of Design & Construction.

4. Impact on Agency Operations.

The steps taken are effective in accomplishing the seismic safety objectives of the SI building program.

It is difficult to quantify the positive impact of the Executive Order on the agency operations. We believe that improved seismic safety will reduce the risk to lives of staff and visitors to the Smithsonian, and to our collections. This is offset somewhat by the increased cost for design and construction of the facilities to resist seismic forces. To date, no data is available to compare the potential savings with the additional cost.

In-house training of staff on the requirements of the Executive Order was accomplished during FY'92, and additional technical training is being sought for architects and engineers on staff.

Department of State

United States Department of State

Washington, D.C. 20520

JUL 16 1992

The Honorable Wallace E. Stickney
Director
Federal Emergency Management Agency
500 C St, SW
Washington, DC 20472

Dear Mr. Stickney:

I am pleased to respond on Secretary Baker's behalf to your letter of June 30, 1992. It is a pleasure to assist FEMA with their requirement to gather information from affected Federal agencies on the status of implementation of the January 5, 1990, Executive Order 12699 (E.O.), "Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction." I am providing this response in accordance with the format suggested in a separate letter dated June 10, 1990 from Mr. Gary D. Johnson, Assistant Associate Director, Office of Earthquakes and Natural Hazards.

1. Introduction

In the Department Of State (DOS), it is through the Office of Foreign Buildings Operations (FBO) that all matters pertaining to the acquisition, design, construction, and maintenance of land and buildings overseas are accomplished. As a facility management organization, FBO has direct control over all DOS overseas properties. FBO issues guidelines for the design of new construction and reviews the designs for conformance.

2. Status of Agency Procedures

FBO is responsible for ensuring that each new DOS building is designed and constructed in accordance with appropriate seismic design and construction standards. It is through FBO policies, procedures, and in particular, the FBO design criteria and guidance documents that the E.O. is executed. The latest edition of the Uniform Building Code (UBC) is the criterion by which seismic design is accomplished.

More specifically, FBO engineering criteria documents have, since 1978, mandated UBC seismic design requirements. The current FBO criteria document, "Architectural and Engineering Design Guidelines and Criteria for New Embassy Buildings", continues to require structural designs in conformance with UBC seismic requirements. This complies with the recommendations of the Interagency Committee on Seismic Safety in Construction publication RP 2.1-A, "Guidelines and Procedures for Implementation of the Executive Order on Seismic Safety of New Building Construction."

With regard to the design of new buildings intended for FBO long term lease, the procedures and criterion described above still apply.

It should be noted that in the context of the Department's worldwide operations in over 250 cities overseas, a determination of seismic risk (i.e. equivalent UBC seismic zonation) of all Diplomatic Posts was completed in 1979 and again updated in 1985. In this regard, FBO is constantly updating the equivalent UBC zonation as appropriate for the particulars of the location and project.

3. Progress on Implementation Plan

The DOS is currently in full compliance with Executive Order 12699, and was in compliance before the order was issued. The Civil/Structural Branch of FBO is responsible for ensuring that the structural designs are in substantial compliance with the seismic provisions of the UBC. Chief of the Branch, Mr. Sedat Asar, serves as the FBO Seismic Coordinator.

4. Impact on Agency Operations

Since FBO had previously addressed seismic design requirements for new construction (1978), the impact of the E.O. on FBO projects has been minimal. Additionally, the unique and special physical security criterion applied to FBO projects typically influences the details of the structural design and structural framing costs to a greater degree than the seismic requirements. Thus the impact on projects costs historically has been minimal.

We hope that this information will satisfy your reporting requirement. If you desire additional information on our seismic program, please do not hesitate to contact our office.

Sincerely,

Jerome F. Tolson, Jr.
Deputy Assistant Secretary
for Foreign Buildings

Tennessee Valley Authority

Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902

November 4, 1992

Dr. Arthur Zeizel
Office of Earthquakes and Natural Hazards
Federal Emergency Management Agency
500 C Street, Southwest
Washington, D.C. 20472

Dear Dr. Zeizel:

As requested in Mr. Gary D. Johnson's October 29 letter, TVA has reviewed the draft assessment of the progress being made in implementing Executive Order 12699. I am enclosing marked-up paragraphs from the text and have the following comments concerning our progress.

Two major changes have occurred within TVA since our initial report to FEMA in July 1992. Through the authority vested in me as the Agency Seismic Safety Coordinator, the TVA Office of the General Counsel has determined that I can issue agency-wide policies and procedures on seismic safety. The TVA Board of Directors will not be required to formally issue a document. Secondly, the TVA Valley Resource Center, which has technical oversight and administrative responsibilities for grant and loan programs, has started "promoting" the use of the model building codes to recipients. It will legally enforce through contract language the provisions of the Executive Order in January 1993 to contractors, loan, and grant recipients for occupiable buildings.

The other changes in the marked-up text are self-explanatory. Note that TVA also funds seismic safety activities through reprogramming of other funds.

My views on the draft assessment are positive; however, are you prepared to state that 50 percent of all buildings will be seismically resistant by the year 2020? It appears to me that the federal agencies are required to have 100 percent of all <u>new</u> buildings seismically resistant after January 1993. Again, the assessment document is a quality piece of work, and I commend you on your efforts.

Very truly yours,

Morris G. Herndon
Agency Seismic Safety Coordinator

Enclosure

July 16, 1992

Mr. Wallace E. Stickney, Director
Federal Emergency Management Agency
Washington, DC 20472

Dear Mr. Stickney:

We are pleased to submit the enclosed report on TVA's progress in the implementation of Executive Order 12699 as requested in your letter of June 30 to Marvin Runyon.

We trust you will find that the report not only provides you with the information you need but also communicates TVA's active involvement and commitment to achieving and maintaining seismic integrity of its structures and lifelines.

TVA's nuclear plants have been designed to stringent seismic standards; active seismic upgrades are underway on our power transmission facilities; and a program is underway to seismically analyze and upgrade our dams through our Dam Safety Program. Now, as the report indicates, new structures will be subject to pertinent seismic construction standards.

If we can be of further assistance, please contact me or TVA's Seismic Safety Coordinator, Morris G. Herndon.

Sincerely,

Norman A. Zigrossi
President
Resources Group

TENNESSEE VALLEY AUTHORITY

1992 PROGRESS REPORT
TO
FEDERAL EMERGENCY MANAGEMENT AGENCY
ON
EXECUTIVE ORDER 12699
ON
SEISMIC SAFETY OF NEW BUILDING CONSTRUCTION

1. Introduction

Briefly describe your agency's seismic safety responsibilities and jurisdictions. If yours is a regulatory agency, describe the authority the agency has to enforce compliance with the Order.

The Tennessee Valley Authority (TVA) is a multipurpose resource development agency located in the seven-state drainage basin of the Tennessee River and its tributaries. TVA owns or leases its facilities which include power plants (both fossil and nuclear), hydroelectric dams and nonpower dams, power distribution systems, office buildings, laboratories, roads, bridges, etc. TVA is responsible for the seismic safety of its owned and leased facilities. Regulatory authority is limited to within TVA for four major groups: Generating, Customer, Resource, and Corporate.

2. Status of Agency Procedures

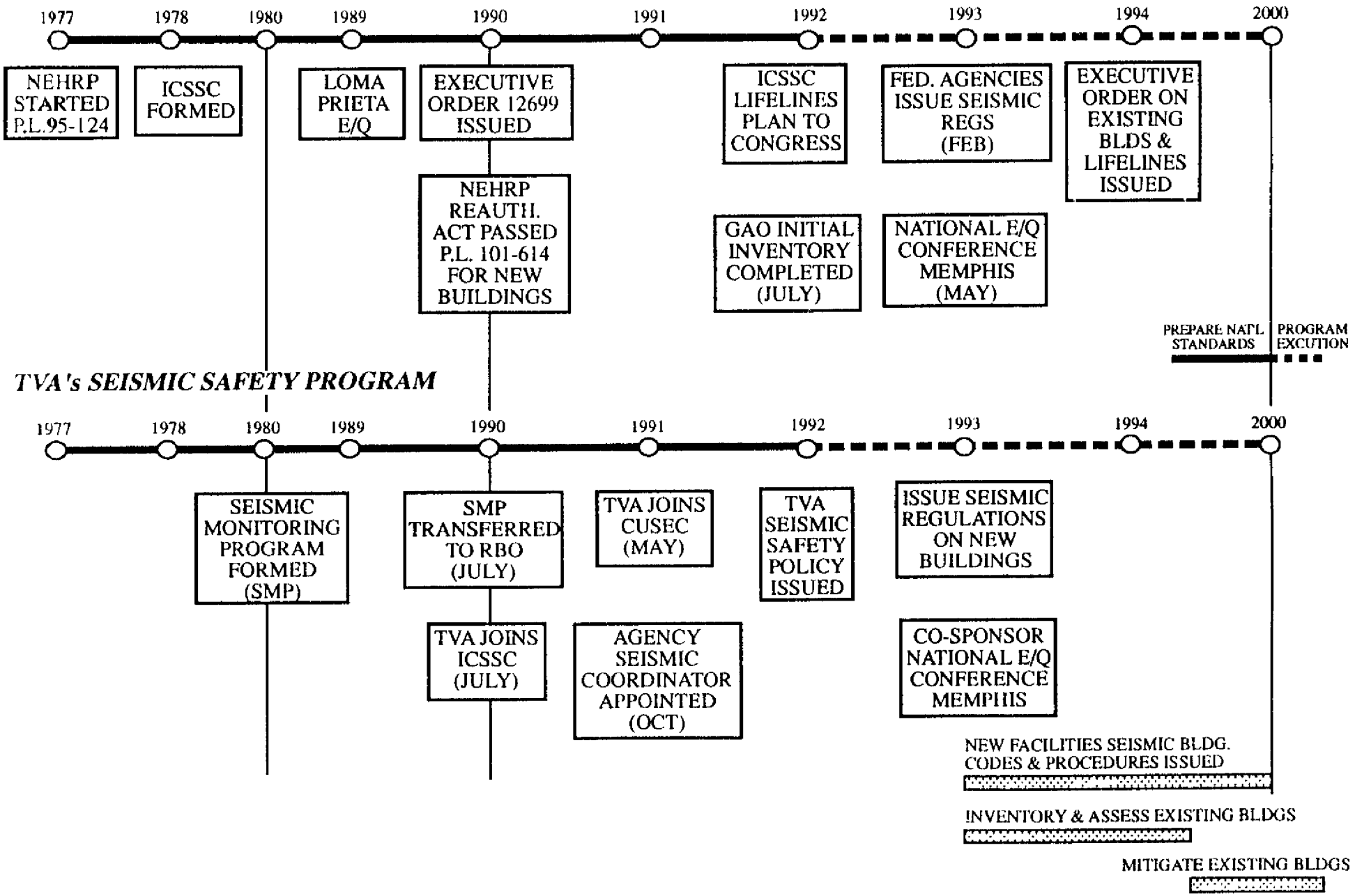
Provide information on the progress on regulations and procedures implementing the Order. What is the planned schedule for having the regulations and procedures in place? Identify Order requirements not implemented and describe impediments to progress.

See the attached TVA schedule for implementing the National Earthquake Hazards Reduction Program (NEHRP). The timeframes set for TVA's Seismic Safety Program parallel the National program. The TVA seismic safety policy will be formally approved by our Board of Directors in fiscal year 1992, and specific seismic regulations will be in place prior to February 1, 1993. Executive Order requirements not implemented are seismic safety requirements for domestic assistance programs for Federal grants and loans to the private sector. The three-year rule to implement contractually will occur in January 1993.

Describe actions taken in response to the July 1991 Guidelines and Procedures for Implementation of the Executive Order on Seismic Safety of New Construction, prepared by the Interagency Committee on Seismic Safety in Construction.

The Interagency Committee on Seismic Safety in Construction (ICSSC) recommended Procedure 2.1 (Guidelines and Procedures for Implementation of the Executive Order on Seismic Safety of New Construction) was received by TVA, reviewed by the General Counsel, and issued internally for information and use by TVA designers and builders. The Agency Seismic Safety Coordinator formally introduced the publication to the five TVA subcommittees that were organized for seismic safety.

NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM



What procedures are in place for collecting, and documenting agency seismic safety information and for assessing and providing the information to FEMA When necessary?

Seismic Safety Program management in TVA is organizationally located with the Dam Safety Department in the Resource Group, since seismic evaluations of TVA dams have been promulgated in that department since the Federal Guidelines for Dam Safety were issued in 1979. Collecting, documenting, assessing, and reporting to FEMA is centrally coordinated through the department. Procedurally, instructional memoranda are issued by the Agency Seismic Safety Coordinator from the Dam Safety Department.

Has your agency adopted seismic safety design and construction standards for agency use? If so, how are they used?

Yes. TVA uses the 1991 ICBO Uniform Building Code, the 1992 Amendments to the SBCC Building Code, and the Nuclear Regulatory Commission's regulatory guides. They are used internally by TVA designers, and external contractors are required to meet our code specifications.

3. Progress on Implementation Plan

Report the progress of your agency in implementing the Order from its enactment on January 5, 1990, to the end of Fiscal Year 1992 (i.e., September 30, 1992). Are responsibilities clearly assigned?

Since enactment of the Order, TVA has joined the Interagency Committee on Seismic Safety in Construction; appointed an Agency Seismic Safety Coordinator; formed five subcommittees for ongoing activities (Standards for New and Existing Buildings, Lifelines, Evaluation of Site Hazards, Federal Domestic Assistance Programs, and Post Earthquake Response); adopted model building codes; and is identifying agency programs that are affected by the Executive Order.

Describe changes within the agency in the administration of the seismic safety program, policy, budget, organizational, and staff changes. Has a viable administrative framework been established for implementation of the requirements of the Order and for addressing the substantive and procedural steps set out in the Guidelines?

As stated, the Seismic Safety Program has been established under the Agency Seismic Safety Coordinator in the Dam Safety Department of the Resource Group. Agency policy is being developed for Board of Directors' approval, and funds for program activities are presently derived from organizational overheads and training funds. The Seismic Safety Staff in TVA includes the Agency Coordinator, a civil engineer, and a seismologist. Support organizations within TVA have technical professionals who attend committee activities and supply support services to the Seismic Safety Program. Bimonthly coordination meetings are held to discuss program implementation progress throughout TVA.

Describe your agency's plan for implementation of the Order through the usual budget process.

TVA's plan for implementation throughout the normal budget process is to continue to study and mitigate seismic modifications to dams through the Dam Safety Program, inspect and mitigate transmission system facilities' vulnerability to seismic movement, and continue to design and build nuclear power plant facilities in accordance with the Nuclear Regulatory Commission's procedures. Meetings and committee activities are funded through Agency overhead accounts and training funds. TVA plans to request new initiative funding from the Office of Management and Budget after the President reports to Congress in 1994 on how the standards could be supplied to Federally assisted and regulated existing buildings.

Report on the provisions made to ensure that the seismic safety actions being taken are technically sound.

TVA uses a recognized Hydro Board of Consultants to evaluate its recommended new seismic modifications to dams and appurtenance structures. The Engineering Department contracts with nationally recognized firms for seismic analyses of hydro facilities. Internally, the Seismic Safety Staff has a seismologist and a civil engineer to ensure that seismic safety actions are technically sound. The Engineering Departments in Hydro, Nuclear, and Transmission Facilities all employ professional engineers, geologists, and geo-technical specialists. The Model Building Codes incorporating seismic provisions are used in the Agency and by contractors.

4. Impact on Agency Operations

Assess the impact of the agency changes on the effectiveness of accomplishing seismic safety objectives.

The impact to TVA operations has been that a Presidential Executive Order has required TVA to reassess its seismic safety efforts and centralize its focus. Prior to and immediately after the issuance of the Executive Order, TVA quickly organized the Seismic Safety Program, appointed the Coordinator, formed five subcommittees, started attending national workshops, and held frequent coordination meetings. After joining the ICSSC, TVA became a co-sponsor to a regional organization named Central United States Earthquake Consortium (CUSEC), held several workshops on seismic awareness, and is helping to sponsor the National 1993 Earthquake Conference in Memphis, Tennessee.

Provide information on the impact of the Order on agency operations, both positive and negative. Beneficial impacts can be expressed by reduced risk to lives of building occupants, improved capability of critical buildings to function during and after an earthquake, and reduced potential for damage losses. Negative impacts can include such aspects as excessive additional costs, or major time delays in construction, regulatory approval or provision of Federal financial assistance.

Since the Order, TVA has structurally modified Beech Dam in middle Tennessee because of high seismic vulnerability of failure in an urban location; stabilized 93 transmission system facilities against seismic movement; assessed three large dams for maximum credible earthquake (MCE) loads; is conducting a regional MCE study; and evaluated a major office building for seismic hazards. On the negative side of the issue, TVA has been unable to require contractors to use updated seismic criteria to be used in leased or Federally assisted construction through the grants program until January 1994 per directives in the Executive Order.

Report on agency seismic safety training and education activities which your agency has performed or supported. Identify actions being taken to strengthen these activities.

TVA has sponsored and participated in three earthquake hazard reduction overview seminars. TVA has also hosted informational sessions with media representatives to explain the transmission of earthquake information to the public. TVA has issued several seismic articles in internal newsletters emphasizing seismic safety. ICSSC subcommittee members attend workshops and seminars at the national level.

Describe special initiatives and accomplishments of your agency in achieving improved seismic safety.

TVA is very active in conducting studies and initiating seismic safety activities. Listed below are the efforts TVA has taken to be proactive in seismic programs on a regional and national scale.

<u>Studies Related to Major Facilities</u>

Specific ongoing TVA studies relating to earthquake hazards reduction at major facilities include ground-motion studies for hydro facilities, investigations of transmission system vulnerability to earthquakes, bridge investigations, nuclear plant designs, and fossil plant designs. An inventory of over 500 TVA buildings is underway.

Seismic Studies Related to Dam Safety

TVA has 54 dams and continues to make seismic evaluations to determine seismic compliance with the Federal Guidelines for Dam Safety. Preliminary studies identified nine dams for additional seismic evaluation. Studies to evaluate seismically induced loss of strength (liquefaction) in embankment foundations at Fort Loudoun, Kentucky, and Beech Dams have been completed. In-depth studies to evaluate liquefaction of foundations of Guntersville, Tellico, Pickwick, Chickamauga, and Watts Bar Dams are scheduled through Fiscal Year 1994. Studies to evaluate the seismicity of the hydraulic fill embankment at the Blue Ridge Dam have been completed.

TVA continued to develop and maintain Emergency Action Plans (EAPs) for 47 of its 54 dams. These plans include procedures to identify potential safety problems resulting from earthquakes (or other sources) and notify appropriate local emergency management agencies should failure appear likely. In Fiscal Years 1991-92, TVA upgraded the EAPs and reissued copies to State, Local, and Federal organizations; hydro plant managers; internal TVA users; and emergency management agencies in seven states. Operations and Maintenance (O&M) manuals are being prepared for issuance in the near future.

Seismic Studies Related to Fossil Facilities

TVA evaluated, using model building codes, seismic loads in the design of a Flue-Gas-Desulfurization Project, combustion turbine maintenance facilities, and two emission stacks. Seismic loads were also considered in the rehabilitation of a hyperbolic cooling tower that was constructed of reinforced concrete.

Seismic Studies Related to Nuclear Facilities

TVA is a participating member on the Nuclear Management and Resources Council (NUMARC) advisory committee for the revision of the Nuclear Regulatory Commission's (NRC) Appendix A to 10 CFR Part 100, "Seismic and Geological Siting Criteria for Nuclear Power Plants," and its related regulatory guides. These regulations and guides will apply to future nuclear generating facilities such as the Standardized Advanced Reactor designs.

Seismic Studies Related to Bridge Safety

All new TVA bridges will be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Seismic Design of Highway Bridges. Existing bridges were not designed for seismic loading. In Fiscal Year 1993, TVA plans to implement a program to seismically evaluate retrofitting existing bridges.

Seismic Studies Related to Transmission Facilities

TVA's Transmission organization has continued to identify electrical equipment at TVA substations that are especially vulnerable to earthquakes. The potentially dangerous effects of earthquakes on power transformers and lightning arresters are of primary concern.

Inspections of TVA substations revealed that the transformers are not sufficiently anchored to their foundations and that the electrical connections do not have enough slack for seismic movement. Switch-houses will be inspected for seismic loading in the near future.

TVA has anchored twenty-three 500-kV and seventy 161-kV transformers to its foundations for seismic loading in the New Madrid Seismic Zone (western Tennessee and Kentucky) which presents the greatest source of seismic hazard to TVA's transmission system.

TVA has a minimum of one emergency earthquake drill per year involving engineering and maintenance operation personnel. These drills involve potential safety problems, local emergency agencies, repair procedures, and evaluations of the drill.

Interagency Cooperation

TVA participates in the Interagency Committee on Seismic Safety in Construction (ICSSC); the Interagency Research Coordinating Conference (IRCC), which reviews research projects in seismology and earthquake engineering; and the Interagency Committee on Dam Safety (ICODS), which oversees compliance with the Federal Guidelines for Dam Safety, including guidelines for the seismic safety of dams. TVA exchanges seismological data with other Federal agencies, including the U.S. Geological Survey (USGS), the U.S. Department of Energy (USDOE), and the U.S. Army Corps of Engineers (USACE). TVA is a member of the Central United States Earthquake Consortium (CUSEC) that focuses on earthquake hazard reduction in the central and eastern United States.

Participation in Industry Research

TVA is a contributing member of the Electric Power Research Institute (EPRI). EPRI's earthquake research program includes seismic hazard and ground motion studies, seismic evaluation and qualification, and seismic design and analysis. TVA is a primary sponsor of the 1993 National Earthquake Conference, which is an activity of the Decade for Natural Disaster Reduction and has been designed to provide state-of-the-art information in five topic areas: Hazard Assessment; Mitigation of Damage; Preparedness, Awareness, and Public Education; Emergency Response; and Socioeconomic and Public Policy Impacts.

Seismic Monitoring Efforts

Fiscal Year 1992 marked the eleventh year of TVA's Seismic Monitoring Program whose objectives are to accumulate a regional earthquake database to characterize the seismic hazard of the Tennessee Valley, and to provide continuous, prompt information on earthquake occurrences in and near the Tennessee Valley.

TVA records data from 19 microearthquake monitoring stations in Tennessee, Alabama, Georgia, and Kentucky. Strong-motion instrumentation is located at each of TVA's three nuclear plants, one fossil plant site in the Mississippi Valley region, and one office building in east Tennessee.

TVA disseminates earthquake information to organizations and citizens throughout the Tennessee Valley in four ways: (1) through an earthquake notification network; (2) through participation in and sponsorship of earthquake workshops and seminars; (3) through a TVA semi-annual seismic bulletin; and (4) through the Southeastern United States Seismic Network Bulletin.

TVA has sponsored and participated in three earthquake hazard reduction overview seminars (in conjunction with CUSEC) during the past two years. TVA has hosted an informational session with media representatives to explain the transmission of earthquake information.

The TVA Seismic Monitoring Program is primarily a TVA-funded project; however, USDOE via Martin Marietta Energy Systems and USGS via Memphis State University are also sponsors. TVA's partnership with Memphis State University and USGS is a result of the formation of the Southern Appalachian Cooperative Seismic Network (SACSNet) which also includes Virginia Polytechnical Institute and the University of North Carolina.

Department of Transportation

U.S. Department of Transportation
Office of the Secretary of Transportation

400 Seventh St., S.W.
Washington, D.C. 20590

JUL 21 1992

Mr. Gary D. Johnson
Assistant Associate Director
Office of Earthquakes and Natural Hazards
Federal Emergency Management Agency
Washington, D.C. 20472

Dear Mr. Johnson:

This is in response to your request to gather information from Federal agencies on their progress in implementing Executive Order 12699, "Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction."

We have prepared a draft rulemaking and it is currently circulating for comments throughout the Department. We have also prepared a Preliminary Regulatory Evaluation (PRE) which assesses the overall costs and benefits of the rule, and demonstrates that it has reasonable justification. There are three forms of benefits that fall under the analysis: the benefit expected in any year from avoiding the loss of the value of the building itself, because it has been built to new higher standards; the benefit of the lives saved in the building because the building has withstood the ground shaking; and the benefit of the function preserved, because the building is able to protect the mission it houses.

In the PRE, these benefits have been monetized, using a statistical analysis. The benefits were assessed for the conditions where the expected incidence of earthquake ground motion acceleration are greater than that for which a building built to an earlier code would not have survived, but less than the maximum acceleration shown on the NEHRP contour maps, which have a 90 percent probability on non-exceedance in 50 years.

When the benefits are aggregated for the lives saved, the preservation of the building, and the continued functioning of the transportation mission housed in that building, the rule is cost beneficial.

Sincerely,

Donald R. Trilling
Director, Office of Transportation Regulatory Affairs

Attached is the Preliminary Regulatory Evaluation performed by the Department of Transportation for a Notice of Proposed Rulemaking that would implement Executive Order 12699 for buildings under the responsibility of that agency. Any preliminary regulatory evaluation is intended to examine the impacts of a proposed rule and, in particular, to determine whether the benefits to be expected from the rule will justify the costs it may impose on the nation. This analysis by DOT addresses the difficult issue of estimating and comparing both benefits and costs of seismic reinforcement of as yet undesigned buildings to protect against the widely varying earthquake threat in different parts of the country. The finding is that, over the 50 year economic life of a public building, the expected benefit in terms of lives saved, injuries prevented and property damage reduced will exceed the cost of including earthquake resistance in the design. The finding holds for all parts of the country, although the expected benefit/cost ratio may be more favorable in localities where the rule reinforces existing building codes that already require some measure of seismic strengthening and rule out low cost, but less shake-resistant, construction types. The DOT analysis will be reviewed widely as public comments are received on the proposed rule; its findings are not limited to transportation-related biuldings, but are applicable to public buildings in general.

PRELIMINARY REGULATORY EVALUATION FOR THE PROPOSED RULE IMPLEMENTING EXECUTIVE ORDER 12699: SEISMIC SAFETY OF FEDERAL AND FEDERALLY ASSISTED OR REGULATED NEW BUILDING CONSTRUCTION

31 August 1992

Robert D. Nutter
Office of Regulatory Affairs
U.S. Department of Transportation

PRELIMINARY REGULATORY EVALUATION FOR THE EARTHQUAKE RULE IMPLEMENTING E.O. 12699

The purpose of any Preliminary Regulatory Evaluation (PRE) is to show that there is a reasonable justification for proposing the rule. While this rule implements an Executive Order and might rely on the strength of that order as sufficient justification, it is still useful to examine whether, in the case of the Department of Transportation, the rulemaking meets the three basic criteria:

Is there a problem?

Is rulemaking the best solution?

Will this rule be cost effective -- will it have a benefit greater than its cost?

The Problem

The underlying problem is that a significant seismic risk exists for most of the United States, but in many localities buildings are not constructed to be earthquake resistant or sufficiently resistant to withstand the severity of earthquake that might occur. Thus, there are widespread, often underestimated, risks to life and property. While earthquakes can neither be prevented nor accurately predicted, it is possible to greatly reduce the threat to life and property by following certain recognized building construction practices. Whether such practices are followed or not can make the difference between suffering tens of casualties or thousands of casualties in a serious earthquake. The problem at hand is how to ensure that buildings do have the requisite earthquake resistance.

Is Rulemaking the Best Solution?

In general, building codes, which are the bases for all private construction, are set by local jurisdictions and not Federal edict. Getting earthquake resistance written into local building codes is mainly a matter of persuasion and the encouragement of Federal example. For those buildings built by or for the Federal government, or those built with or with the assistance of Federal funds, the Federal government is in a position to mandate the construction code. Executive Order 12699, "Seismic Safety of Federal and Federally-Assisted or Regulated New Building Construction," requires all Federal agencies to ensure that new Federal buildings are designed and constructed in accord with appropriate seismic design and construction standards. The Order pertains to any new building that is federally-owned, leased, assisted, or regulated. A building is defined as any structure, fully or partially enclosed, used or intended for sheltering persons or property.

The process of public rulemaking is most appropriate for the Department to use in implementing the Executive Order. The rule provides the vehicle for making known how the overall Federal requirement should be applied to buildings under the jurisdiction of the Department of Transportation. The Department has long recognized transportation safety as one of its highest priorities; the extension of the same concern for safety to people and goods in transportation-related buildings is consistent with that priority. By publishing the proposed rule in the Federal Register and asking for public comment, as is done with other transportation safety rules, we ensure the broadest possible applicability and acceptability for the final rule.

Is the Proposed Rule Cost-Effective?

The proposed rule would require that all new DOT-owned or leased buildings as well as buildings built or leased with DOT grant money and those regulated by DOT to be earthquake resistant according to standards equal to, or substantially equivalent to, standards and practices recommended by the National Earthquake Hazards Reduction Program (NEHRP). Since the severity of earthquakes that might be expected varies greatly in different parts of the country, the design ground shaking guidance is keyed to seismic ground acceleration maps prepared by the U.S. Geological Survey for the 1991 Edition of the NEHRP Recommended Provisions for the Development of Seismic Regulations for new Buildings (*Provisions*). These maps (Maps 1 through 4) show the coefficient of effective peak acceleration (A_a) and coefficient of effective peak velocity-related acceleration (A_v) with a 90 percent probability of nonexceedance in 50 years. Maps 1 and 2 show map areas with acceleration measures color coded in terms of whole counties, while maps 3 and 4 show "contour" lines for these same two acceleration coefficient measures[1], where the contour lines may cut through counties shown in outline. In the East, where counties are small and the contour lines tend to be widely spaced, maps 1 & 2 may be more convenient. In the West, where counties are large and contour lines crowd close together in earthquake-prone areas, maps 3 & 4 may be more accurate.

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[1] In maps 1 through 4, the coefficient A_a is a dimensionless parameter related to acceleration in gravity units, such that if the acceleration is 0.2g, then the coefficient is 0.2; the coefficient A_v is similarly dimensionless and related to velocity as follows:

in./sec.	A_v
12	0.4
6	0.2
3	0.1
1.5	0.05

Provisions also includes preliminary spectral response acceleration contour maps for the maximum 0.3 second spectral response acceleration and the maximum 1.0 second spectral response acceleration with a 90 percent probability of nonexceedance in 50 years. While these new measures have not been reviewed and accepted by the building construction community and should not be used for design at this time, all of the discussion regarding costs and benefits of this proposed rule would be equally applicable to use of these maps.

For the Seismic Hazard Exposure Group appropriate for usage proposed for a given building and the levels of A_a and A_v given by the maps for that building's location, the architect can determine the applicable Seismic Performance Category. There are three Seismic Hazard Exposure Groups (I through III); five Seismic Performance Categories; and seven levels of the acceleration coefficients, A_a and A_v, plotted as colors and referred to as "Map Areas" on maps 1 and 2, where:

Map Area	A_a or A_v
7	0.40
6	0.30
5	0.20
4	0.15
3	0.10
2	0.05
1	<0.05

Thus, although earthquake severity and building strength are both continuous variables, the rule considers earthquake severity and applies building resistance in somewhat discrete increments. In the ensuing discussion, we use the symbol S_r to denote the earthquake severity in terms of design ground shaking determined by the map coefficients and the local soil and other characteristics.

Provisions gives design guidance for earthquake resistance in each category that can be used, along with other factors like the soil type, to construct a building able to resist the preponderance of earthquakes expected for the area. The principal aim is to ensure life safety, but it is expected that structural damage should be repairable for a building so designed and constructed in earthquakes no more severe than those given by the map contours. For earthquakes more severe, there may be some loss of life and irreparable damage, but buildings designed to the codes recommended by *Provisions* should not completely collapse unless the ground shaking is considerably worse than the map indication. This will reassure the architect, the purchasers and the users of the building, but it is less helpful for making a cost-benefit analysis of the rule.

Where a Benefit Can be Expected

We have to assume that, even in the absence of the rule, any building located where earthquakes are considered a threat would most likely be built to meet a local building code that already requires some degree of seismic resistance. For purposes of analysis, we assume that the protection offered by the local building code can be expressed in terms of the protection *Provisions* for an earthquake severity, S_o, that might be less severe than the level, S_r, that the rule would require. Benefits of more stringent standards will consist of costs avoided if an

earthquake occurs and the building has been properly designed and constructed:

- loss of the remaining value of the building itself at that point in its economic life if it had been damaged beyond repair (less, of course, the cost of repairs needed to restore the surviving building to full capacity),
- any loss of life and injury to people if the building had collapsed as well as loss of goods or equipment located in the building,
- loss of the transportation function of the building as well as secondary losses in activities dependent on the function of the building.

To realize such a benefit from designing to survive S_r, there must, during the expected life of the structure, actually be an earthquake of severity less than or equal to S_r, but greater than S_o. If there is an earthquake more severe than S_r, the structure may be severely damaged with loss of life, property and function, as well as injury to occupants. The loss in an earthquake more severe than S_r may be nearly as great as it would have been if the building had been designed only for S_o and there may be little or no benefit to count. On the other hand, if there is no earthquake more severe than S_o (or no earthquake at all -- the case in most years in most localities), then the building would have stood up just as well without the strengthening and again there is no countable benefit from the more stringent requirement of the proposed rule.

For any specific building in any specific location, we would know what the local building code requires for earthquake resistance. The same data base that created the contour maps for 90 percent nonexceedance could presumably tell us the probability of an earthquake exceeding the building code requirements during the life of the building. Then, knowing the cost and function of the building, how many people will be using it and how many activities are dependent on its function, we could estimate the benefits and costs of using NEHRP recommended provisions as opposed to the local building code. But for an *a priori* PRE, we must deal with generic buildings at unspecified locations that might be affected by the requirement of the rule. Can we make a generic estimate of benefit and cost in that case?

Estimating Earthquake Probability

To simplify discussion and analysis, we will assume a "cookie cutter" or "go, no-go" earthquake damage function: if there is a quake with severity above its design criterion, the building is damaged irreparably, with all the attendant costs; otherwise it