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# Seismic Safety of Federal Buildings - Intitial Program: How Much Will It Cost?

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## ABSTRACT

This paper provides information on the approximate cost impacts that would arise from implementing an initial program aimed at laying the foundation for achieving the long-term goal of seismic safety in all Federal buildings. The initial program is set forth in a proposed Executive Order titled "Seismic Safety of Existing Federally Owned or Leased Buildings." Information from documents published by the General Accounting Office, Federal Emergency Management Agency, and the National Institute of Standards and Technology were combined with self-reported seismic evaluation and rehabilitation experiences by agencies that have ongoing programs to develop an estimate of the cost of implementation.

The proposed order adopts *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings* as the minimum level for Federal use, and makes mandatory seismic evaluation and, if necessary, rehabilitation under certain conditions, which are identified in the *Standards*. It is estimated that this requirement would result in about $5.3 million per year in recurring annual costs, spread across all agencies of the Federal government, to evaluate and seismically rehabilitate buildings that would not otherwise be addressed. The proposed Executive Order also directs all Federal departments and agencies to, within four years of signing, develop an inventory of their owned and leased buildings, and to estimate the cost of mitigating unacceptable seismic risks in their buildings. Costs to develop the required inventory and cost estimate are expected to be about $116 million, spread across all Federal agencies and over six years.

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# 1. Introduction

A proposed Executive Order titled "Seismic Safety of Existing Federally Owned or Leased Buildings" sets forth an initial program aimed at laying the foundation for achieving the long-term goal of seismic safety in all Federal buildings. This paper identifies direct costs associated with adoption of the proposed Executive Order and develops an estimate of those costs. It does not consider the value of the benefits associated with adopting the proposed order. The estimated costs represent the aggregate impact on the Federal budget. Note that the estimate of that is presented in this paper does not include the costs of continuing already-existing seismic rehabilitation programs, but considers only costs that would be newly imposed on the Federal budget. The values used in developing the estimate are averages, and may not be appropriate for use in developing agency-specific estimates by agencies with atypical building inventories or high seismic performance objectives.

## 1.1 Background of the Proposed Executive Order

The proposed Executive Order was developed by the Interagency Committee on Seismic Safety in Construction (ICSSC) in response to Section 8(a) of Public Law 101-614, the National Earthquake Hazards Reduction Program (NEHRP) Reauthorization Act of 1990, which requires the President to adopt seismic assessment and enhancement standards for Federally owned and leased buildings by December 1, 1994. The legislation directs the ICSSC to develop the standards. Thirty Federal departments and agencies participate in the ICSSC, which was created as a part of NEHRP. The ICSSC brings together representatives from Federal departments and agencies involved in construction to share information and develop guidance on earthquake hazards reduction measures appropriate for Federal use.

The standards were developed with input from the private sector using an ICSSC consensus process, and were published in February 1994 as an ICSSC Recommended Practice, *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings*, hereafter referred to as the Standards [ICSSC RP-4]. As the Standards were developed, the ICSSC considered possible methods of Presidential adoption, and developed the proposed implementing Executive Order for consideration by the President as an adoption instrument. The proposed Executive Order was developed, reviewed and approved using the ICSSC consensus process. A copy of the proposed order can be found in Appendix A of this document.

## 1.2 Summary of the Proposed Executive Order

The proposed Executive Order:

1) adopts the Standards as the minimum level of seismic evaluation and mitigation to be used by Federal departments and agencies, and directs that they be applied, at a minimum, in those situations identified in the Standards as mandating action ("triggers");

2) directs all Federal departments and agencies to, within four years of the signing of the order, inventory their owned and leased buildings, estimate the cost of mitigating

unacceptable seismic risks in their buildings, and report those costs to the Director of the Federal Emergency Management Agency (FEMA);

3) charges the ICSSC with developing, within one year of signing of the order, guidance that is to be used by the affected agencies on inventorying buildings and estimating mitigation costs; and

4) orders FEMA to report to the Congress, within six years of signing, on how an adequate level of seismic safety can be achieved in existing Federally owned and leased buildings in an economically feasible manner.

## 1.3 Scope

Section 2 of this report describes the actions that are required by the proposed Executive Order, and discusses assumptions that are made for the purposes of this cost estimate about the scope of the required actions. Section 3 presents the sources of information about cost and related matters that are used in the estimate. Calculations are shown in Section 4, and the total estimate is tabulated. In Section 5, limitations of the estimate are discussed. Appendix A contains the text of the proposed Executive Order.

## 2. What Information Is Needed to Develop the Cost Estimate?

For the purposes of this cost estimate, the actions required by the proposed Executive Order that will require monetary outlays are grouped as follows:

- Apply minimum level of seismic safety to programs already in place.
- Address the seismic safety of "triggered" buildings (so-called passive program).
- Create an inventory and develop the cost estimate.
- Provide guidance and technical support to some 30 affected agencies, and prepare a final report to the Congress.

Aspects of these required actions that must be determined in order to develop a cost estimate are described below. The sources used as a basis for assigning cost impacts to the required actions are described in Section 3.

### 2.1 Apply minimum level of seismic safety to programs already in place.

Several Federal departments and agencies have active programs in place to improve the seismic safety of their buildings. Because no single source of evaluation and rehabilitation criteria has previously existed in this country, each agency with an active program has established assessment and mitigation criteria that are appropriate for its needs. Adoption of the newly-established Standards by the President as a minimum acceptable level could potentially result in changes being made to agency criteria. The likelihood of significant changes being made in existing programs must be assessed. The impact of the proposed Executive Order on leased buildings must also be determined. These consideration are covered in Section 3.

Note that it is <u>not</u> the intent of the Standards or the proposed Executive Order to require re-evaluation or re-rehabilitation of buildings that have been seismically enhanced under good-faith efforts prior to the development of the Standards, as explicitly stated in the proposed Executive Order, unless some change in the building use or condition occurs that increases the seismic risk associated with it.

### 2.2 Address the seismic safety of "triggered" buildings.

The proposed Executive Order requires that evaluation and, if necessary, mitigation, be performed in those situations identified in the Standards as "triggers." Situations which trigger an evaluation are defined in Section 2.1 of the Standards, and include:

- a change in building function that increases the seismic risk,
- renovation which totals more than 50 percent of the building's replacement value,
- repair of significant damage to the structural system, regardless of the cause of the damage,
- identification by the agency of the building representing an exceptionally high risk, or
- purchase by or donation to the Federal government.

The requirements of this portion of the proposed Executive Order constitute a so-called passive program, "passive" because agencies are required only to react to situations as they arise, and are not required to actively seek out at-risk buildings and improve them.

In order to determine the cost of implementing the proposed Executive Order, an estimate is needed of:

- the number of buildings that will be triggered each year;
- the percentage of the triggered buildings that will be exempt from evaluation because of low regional seismicity, small size, infrequent human occupancy, recent construction or other reason (exemptions are defined in Section 1.3 of the Standards);
- the cost of evaluating the non-exempt triggered buildings;
- the percent expected to be found to have adequate seismic resistance; and
- the cost of mitigating the hazards in the unsafe buildings.

The costs associated with triggered buildings (passive program) will be recurring annual costs until Congress or the Preseident implements a national seismic rehabilitation policy (active program) in response to the conclusions and recommendations of the FEMA report.

### 2.3 Create an inventory and develop the cost estimate.

The ICSSC, in developing the proposed Executive Order, recognized that information available on the cost of assessing and improving the seismic safety of a large population of buildings was not sufficiently reliable to serve as a base for public policy decisions. Consequently, the proposed Executive Order was drafted to include requirements for inventorying and cost estimating in an attempt to develop more reliable information upon which to base an active, comprehensive Federal rehabilitation program. The ICSSC is directed by the proposed Executive Order to develop guidance on how to satisfy these requirements. The ICSSC guidance is intended to ensure that the inventories and cost estimates produced by the agencies include adequate information, and can be compared and combined meaningfully.

Because the ICSSC guidance has not yet been developed, assumptions must be made about the expected scope of that guidance in order to develop an estimate of the cost of implementing the proposed Executive Order. An ICSSC working group was convened on February 14, 1994 to assess available cost data and to begin discussions of the scope of the ICSSC guidance that will be developed. Based on the input from the full ICSSC during development of the Standards and proposed Executive Order, and from the February 14 working group participants, the following assumptions are made about the scope of the inventory and cost estimate effort that will be specified.

- The required inventory will cover all Federally-owned buildings nationwide. It will be of sufficient detail to allow exempt buildings to be identified. The information will be collected in a common-format database, based on existing real property inventories currently maintained by most agencies following General Services Administration guidelines. Verified information on structural system, age, height, occupancy and other topics will be added to the database for each building. The information can be provided by an on-site facility

manager, engineer, or other knowledgeable building personnel; site visits by design engineers will not be required.

- In regions of high and very high seismicity, all non-exempt buildings will be evaluated in order to produce the cost estimate.

- In regions of moderate seismicity, a statistically significant sampling of non-exempt buildings will be evaluated in order to produce the cost estimate. For the purposes of the estimate in this paper, it is assumed that ten percent of non-exempt buildings will be evaluated.

- Information on characteristics of evaluated buildings in regions of moderate, high, and very high seismicity that have been found to pose unacceptable seismic risks will be used to estimate the number of at-risk buildings in regions of low seismicity.

- The rehabilitation costs identified in *Typical Costs of Seismic Rehabilitation of Existing Buildings -- Second Edition* (FEMA 156) will be appropriate for use in developing the cost estimate. Detailed building-specific cost estimates for each at-risk building will not be required.

- Each agency will independently fund (through its normal budgetary process) the work required to develop the inventory and cost estimate for its owned buildings.

### 2.4 Provide guidance, technical support, and a final report.

The proposed Executive Order requires the ICSSC to develop a guidance document, NIST to provide the technical assistance, and FEMA to prepare a report proposing a plan for achieving adequate seismic safety in all Federal buildings (an active program). Information on the expected cost of performing these actions also needs to be developed.

## 3. Sources of Information

The following documents and other sources provided information used in the development of the cost estimate.

### 3.1 *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings*, Diana Todd, editor, NISTIR 5382, ICSSC RP-4, National Institute of Standards and Technology, Gaithersburg, MD 20899, February 1994.

This document presents the Standards which would be adopted by the proposed Executive Order. Information on exemptions, triggers, and the minimum appropriate scope of evaluation and rehabilitation is obtained from this document.

Also extracted from this document is information on the impact of the proposed Executive Order on Federally leased buildings. Standards Section 1.3.2 establishes application criteria for such buildings. These include:

a. no new leases or lease renewals shall be made in buildings that do not comply with these Standards, and
b. existing leases may be held without action until the lease expires.

Based on these criteria, the cost of implementing the proposed Executive Order is assumed to be minimal for Federally leased buildings. It is expected that building owners, not leasing agencies, will pay for the evaluations required to demonstrate compliance for buildings under consideration for Federal leasing. No action, therefore no monetary outlay, is required for existing leases.

### 3.2 *Evaluation and Strengthening Guidelines for Federal Buildings - Assessment of Current Federal Agency Evaluation Programs and Rehabilitation Criteria* and *Development of Typical Costs for Seismic Rehabilitation*, prepared by H.J. Degenkolb Associates, Engineers, and Rutherford & Chekene, Consulting Engineers, NIST GCR 94-650, National Institute of Standards and Technology, Gaithersburg, MD, 1994.

As part of the development of the Standards, a study was commissioned to compare the requirements of the *NEHRP Handbook for the Seismic Evaluation of Existing Buildings* (FEMA 178) to the criteria used by agencies that had rehabilitation programs in place. The results of that study are presented in the report named above (NIST GCR 94-650).

FEMA 178 is the primary technical resource referenced in the Standards. Developed for FEMA by the Building Seismic Safety Council (BSSC), it presents a seismic evaluation methodology that has been reviewed and approved using a consensus process that includes representatives from all sectors of the design and construction community. The comparison study found that the seismic safety level provided by all existing Federal evaluation and rehabilitation programs substantially meets or exceeds the level of seismic safety established in FEMA 178.

The conclusions of the study suggest that the impact of adopting the Standards as a Presidentially-mandated minimum will be negligible on existing rehabilitation programs. Some agencies may choose to restructure their programs to more clearly align their criteria with the approaches presented in the Standards, but the costs of performing evaluations and rehabilitations are not expected to be substantially increased, since all active agency rehabilitation programs already meet or exceed the Standards.

### 3.3 *Federal Buildings -- Many Are Threatened by Earthquakes, but Limited Action Has Been Taken*, U.S. General Accounting Office, GAO/GGD-92-62, Washington, DC, May 1992.

This GAO report identifies regions of very high, high, moderate, and low seismic hazard, and indicates the number of Federally-owned buildings in each region. The following information from the GAO report is used to develop the present cost estimate:

| level of seismic hazard | number of owned buildings |
|---|---|
| very high | 32,000 |
| high | 52,000 |
| moderate | 99,000 |
| low | 234,000 |
| total | 417,000 |

The gross area of the 417,000 buildings is reported in the GAO document as 2,761 million square feet (257 million $m^2$). The average size of a Federally owned building is calculated from these data as 6,600 square feet (615 $m^2$).

### 3.4 *Typical Costs of Seismic Rehabilitation of Existing Buildings -- Second Edition, Volume 1, Summary*, FEMA 156, Washington, DC, publication pending.

Cost information on over two thousand seismic rehabilitation projects was collected in developing the second edition of this report, which is about to be published by FEMA. The database is organized by building structural system, the level of seismic hazard, and other factors.

For the cost estimate on triggered buildings, the average cost of rehabilitation for the entire 2,088 point database is used, $16.50 per square foot ($175 per $m^2$). Because the triggered buildings will be randomly located about the country, and be scattered with regard to structural system, occupancy, age, and so forth, a more precise application of the information in this report is not deemed appropriate.

Note that the costs reported in *Typical Costs* (FEMA 156) are the costs of rehabilitation only. They cover only those costs incurred after the decision to rehabilitate has been made. By design, they do not include the cost of the pre-decision evaluation that is needed to determine whether or not rehabilitation is necessary. Similarly, the report offers no information on what percent of buildings in a given population will be found to present an unacceptable seismic risk.

## 3.5 Other Sources of Information

Needed information that was not available in a published source was solicited from ICSSC member departments and agencies. ICSSC representatives were asked to contribute information from actual seismic evaluation and rehabilitation programs within their agency. At the ICSSC working-group meeting that was held on February 14, 1994, this information was compared and assessed. The representatives present at that meeting concurred on informal guidance about the assumptions to use in developing this cost estimate. The assumptions used and their sources are as follows.

***Numbers of triggered buildings*** - It is assumed that one-tenth of one percent of Federally owned buildings will be seismically evaluated each year outside of established rehabilitation programs.

- The General Services Administration observed that of the 4,412 GSA-owned buildings, nineteen were slated for renovation in fiscal year 1995. Of these, only five projects (or 0.1 percent of the total population of buildings) were of sufficient magnitude to trigger a seismic evaluation, and if necessary, rehabilitation.

- The U.S. Navy reports that it already has a trigger mechanism in place, requiring renovations that exceed ten percent of a building's replacement value to include a seismic evaluation. The Navy, with over 76,000 buildings, is one of the Federal government's largest building owners. However, past experience has shown that only a handful of buildings are evaluated by the Navy each year as a result of this requirement.

A potentially self-defeating feature of triggers that are tied to the value of renovations is that it may be possible for project planners, in an effort to minimize costs, to control the magnitude of a project to avoid triggering a seismic evaluation. This possibility would reduce the number of triggered buildings that otherwise could be expected to occur. Evaluations prompted by change of function, repair of significant structural damage, and other situations are expected to be minimal.

***Percent of a building population that will require evaluation*** - It is assumed that, on average, 15 percent of Federally owned buildings will need seismic evaluation. The other 85 percent will be exempt from evaluation because of year of construction, occupancy, regional seismicity, or other reasons, as described in Section 1.3 of the Standards.

- The U.S. Air Force, in a project initiated and completed in 1993, developed a seismic inventory of their owned buildings in regions of high and very high seismicity. Of 15,641 buildings, 3,134 or 20 percent, were determined to need seismic evaluation.

- A seismic screening program conducted by the U.S. Navy over the past two decades considered roughly 14,000 buildings in regions of high and very high seismicity, and identified about 1,700, or 12 percent, as needing evaluation.

- A U.S. Army screening of their facilities in regions of moderate, high, and very high seismicity identified 3,338 buildings out of 64,575 (five percent) as needing evaluation. A recent U.S. Army screening of buildings at the Presidio in San Francisco, a region of very

high seismicity, found that only 29 of the over 1800 buildings at the site (less than two percent) needed evaluation.

- After the 1971 San Fernando earthquake, the then-named Veteran's Administration (VA) undertook a seismic screening of all 4,891 of its facilities. About 18 percent of VA's buildings (884) were identified as needing evaluation.

- A preliminary review of Department of Energy buildings at a moderate seismicity site showed that 105 of the 374 buildings at the site (28 percent) needed evaluation.

Differences in criteria and procedures used, as well as differences in building locations and populations, account for the range in the building percentages found to require evaluation. The studies cited above, all performed prior to publication of the Standards, were based on agency-established exemption criteria. The exemption criteria in the Standards incorporate many of the same concepts used by these agencies, but the details differ. Procedural differences also contribute to the spread. For example, in the U.S. Army screening procedures, similar buildings (such as a dozen virtually identical barracks buildings on a single base) are grouped and only one of the group is identified as requiring evaluation.

***Costs of inventorying/screening*** - The average cost of developing an adequate seismic inventory is assumed to be $20 per building.

- In the 1993 study of U.S. Air Force facilities in regions of high and very high seismicity, an existing real property database was expanded to include additional seismic information on each building. The new information was verified by site visits performed by in-service personnel. Over 15,000 buildings were inventoried. The U.S. Air Force estimated that the equivalent private sector labor cost for the inventory would have been $300,000, or about $20 per building.

- The U.S. Navy plans to complete screening of its buildings and to add building seismic information to its data base for approximately 9,000 buildings, and has budgeted $170,000 for the project, or about $19.00 per building.

- A U.S. Army inventory/screening of about 65,000 buildings used a "desk-top" analysis. An existing real property inventory was used and no new fields were added to the database. Site visits were not performed to verify data. The 65,000 buildings were screened by in-service personnel at a total equivalent private sector cost of about $20,000, or about $0.31 per building.

***Costs of seismic evaluation*** - The average cost of performing a seismic evaluation is assumed to be $7,500 per building.

- A study prepared in 1990 for the U.S. Postal Service projected that close to $66 million would be required to perform detailed seismic evaluations of the 8,751 Postal Service buildings it had identified as potentially hazardous, or about $7,550 per building.

- The U.S. Army estimates that it will need $19.2 million to evaluate the 3,338 buildings it has identified as needing seismic evaluation. The average evaluation cost per building for this project will be about $5,750.

- The U.S. Air Force expects that $6.1 million will be needed to evaluate the 807 highest priority buildings, and that $13.25 million will be needed to evaluate the 1,764 lower priority buildings. Its estimates are based on an expected average cost of $7,500 per building.

- The Foreign Buildings Office of the State Department reports that in the 1990's, fees that it has paid for detailed seismic assessments have ranged from $0.20 to $4.00 per square foot, with an average cost of $0.60 per square foot (range $2.15 to $43 per $m^2$, average $6.45 per $m^2$). Combining this figure with the average size of a Federal building as calculated from the GAO report (6,600 square feet or 615 $m^2$) leads to a range of $1,300 to $26,400 per building, and an average of $4,000 per building.

All agencies that have experience with seismic evaluation and rehabilitation report that evaluation costs for a single building can be well above the average. The average numbers reported here are appropriate for use only for estimates of the cost of evaluations in the aggregate, and not for estimation of the evaluation costs of any one single building.

***Percent of evaluated buildings that will be found to have inadequate seismic safety*** - Evaluation is expected to reveal that 30 percent of the suspect buildings do have adequate seismic safety, and no further mitigative or rehabilitative action is required. It is assumed that mitigation of unacceptable risks will be necessary in the remaining 70 percent of the evaluated buildings.

- The U.S. Navy has completed assessments of about 1,500 of the 1,700 buildings it has identified to date as needing evaluation. About 1,000 buildings (two-thirds) have been identified as presenting an unacceptable seismic risk and requiring eventual rehabilitation.

- The U.S. Army estimates that two-thirds of the buildings on its evaluation list will eventually require rehabilitation.

- The U.S. Air Force assumes that 35 percent of the buildings in its highest priority evaluation group will need rehabilitation. The Air Force assumes that smaller percentages will need rehabilitation in the lower priority groups.

Unacceptable seismic risks can be reduced through building demolition, reduction of occupancy, rehabilitation, or other means. Rehabilitation is the costliest method of reducing risks. For the purposes of this cost estimate, it is assumed that rehabilitation will be pursued for all buildings identified as posing unacceptable risks.

***Cost of evaluating collected data and preparing cost estimate*** - The actual work of integrating the collected data to prepare a cost estimate is expected to be minor for each affected agency. In order to arrive at an estimate, an agency will need to sort its seismic inventory database into categories that have been identified during the evaluations to establish an estimate of the numbers of buildings in various categories that are expected to require evaluation and rehabilitation. By combining this information with rehabilitation costs extracted from *Typical Costs of Seismic*

*Rehabilitation* and with improved data on the cost of evaluation that is generated during the earlier phases of the project, a cost estimate will be produced. The scope of this work is roughly similar to the database evaluation performed by the U.S. Army to seismically screen its buildings. That study cost about $20,000. For the purposes of this estimate, it is assumed that thirty agencies will spend an average of $20,000 each to produce the required cost estimate, for a total Federal expenditure of $600,000.

***Cost of ICSSC Guidelines, NIST technical assistance, and FEMA report*** - NIST, which provides the Technical Secretariat to the ICSSC, estimates that the required guidance document can be produced for $250,000. NIST anticipates providing $30,000 of technical assistance annually. FEMA expects to spend approximately $1 million to develop the comprehensive report to the Congress on a multi-year, phased program to achieve adequate seismic safety in Federal buildings.

# 4. Estimating the Total Cost

## 4.1 Summary of Pertinent Data and Assumptions

From the discussion in Section 3, following is a summary of key data and assumptions.

| | | |
|---|---|---|
| Number of Federally owned buildings: | | 417,000 |
| by seismicity: | very high | 32,000 |
| | high | 52,000 |
| | moderate | 99,000 |
| | low | 234,000 |
| Average size of Federal building: | | 6,600 $ft^2$ (615 $m^2$) |
| Buildings triggered per year: | | 0.1 percent |
| Cost of creating a seismic inventory: | | $20 per building |
| Buildings requiring evaluation (non-exempt): | | 15 percent |
| Cost of performing a seismic evaluation: | | $7,500 per building |
| Buildings requiring rehabilitation: | | 70 percent of those evaluated |
| Average cost of rehabilitation: | | $16.50 per $ft^2$ ($175 per $m^2$) |

## 4.2 Calculations

Cost estimates for each of the sections of the proposed Executive Order follow.

For Section 1, *Adoption of Minimum Standards*: One-tenth of one percent of the Federal building population, or 417 buildings, are expected to be triggered each year by requirements linked to renovations, repair of damage, or purchase (the passive program). Of these, it is anticipated that 15 percent (63) will have potential seismic deficiencies and will need evaluation, at an average cost of $7,500 per building, ($472,500 for evaluations yearly). It is expected that 70 percent (44) of those evaluated will be found to have problems needing mitigation. Some of those risks will be mitigated in low cost ways such as changing the use of a building (e.g. from office space to storage space), but for the purposes of this estimate, the conservative assumption is made that all deficient buildings will be rehabilitated at an average cost of $16.50 per $ft^2$ ($175 per $m^2$). This leads to an estimate of $4.8 million per year being spent for rehabilitation of unacceptable seismic risks in triggered buildings (distributed across all affected agencies). This is the only recurring annual cost. The calculations are shown below.

417,000 buildings
x 0.001 triggered yearly

417 triggered buildings per year
x 0.15 non-exempt

63 buildings need evaluation

63 buildings
x $7,500 per evaluation

$472,500 for evaluations yearly (recurring)

63 buildings
x 0.70 do not pass evaluation

44 need rehabilitation
x 6,600 $ft^2$ (615 $m^2$) average size

290,400 $ft^2$ (27,060 $m^2$) rehabilitated yearly
x $16.50 per $ft^2$ ($175 per $m^2$)

$4,791,600 for rehabilitations yearly (recurring)

Total annual recurring cost: $472,500 + $4,791,600 = $5.3 million yearly

For Section 2, *Estimating Costs of Mitigation*: The expected cost of developing the ICSSC guidance reported by NIST is $250,000. The anticipated cost of developing a seismic inventory of all 417,000 buildings owned by the Federal government, at $20 per building, is $8.3 million. The task of preparing the cost estimate reports is expected to cost thirty affected agencies an average of $20,000 each, for a total of $600,000.

In regions of high and very high seismicity, all buildings identified in the seismic inventory as potential risks will be evaluated. In regions of moderate seismicity, it is conservatively assumed that 10 percent of the potentially hazardous buildings will be evaluated.

| | | |
|---|---|---|
| Buildings in high and very high seismicity areas: | 84,000 | |
| Percent identified in inventory as at risk (15%): | x 0.15 | |
| Number of buildings requiring evaluation: | 12,600 | |
| Cost of evaluation per building | x $7,500 | |
| | | $94.5 million |
| Buildings in moderate seismicity areas: | 99,000 | |
| Percent identified in inventory as at risk (15%): | x 0.15 | |
| Number of buildings potentially at risk: | 14,850 | |
| Percent to be evaluated (10%): | x 0.10 | |
| Number of buildings selected for evaluation: | 1,485 | |
| Cost of evaluation per building: | x $7,500 | |
| | | $11.1 million |
| Total cost of screening and evaluating: | | $105.6 million |

| | |
|---|---|
| Summation of costs for Section 2: | |
| Develop ICSSC guidance: | $ 0.25 million |
| Inventory Fed. building population: | 8.3 |
| Screen and evaluate buildings: | 105.6 |
| Prepare cost estimates: | 0.6 |
| Total one-time cost of Section 2: | $114.75 million |

For Section 3, *Implementation Responsibilities*: FEMA reports that it expects to spend up to $1 million to analyze the cost data and develop a comprehensive program to eliminate unacceptable seismic risks in Federal buildings. NIST will spend $30,000 per year, for four years, providing technical assistance to the effort, or $120,000.

Total one-time of Section 3 cost: ($1.0 + 0.12) million = $1.12 million.

Total Estimated Cost:

Recurring Annual Costs

Section 1: $ 5.3 million/year

One-Time Costs

Section 2: $114.75 million
Section 3: 1.12
$115.87 million

### 4.3 Timing of Expected Expenditures

The aggregate budget impact of implementing the proposed Executive Order is shown in Table 1. These figures represent the total cumulative budget impact over a six year period on the approximately 30 agencies that will be affected. Figures are presented separately for recurring and one-time annual costs. The table assumes that the proposed Executive Order will be signed on December 1, 1994, the date mandated by the Congress.

The recurring budget impact of evaluating and rehabilitating triggered buildings is expected to be evenly spaced over time. Although buildings will begin to be triggered immediately after the order is signed, because planning for the fiscal year 1995 budget is already well underway, the budget impact will not be felt until fiscal year 1996 at the earliest. The one-time costs vary by year and are expected to peak in the third year of the program, as illlustrated in Table 1.

Table 1. Expected Yearly Budget Impact in Thousands per Fiscal Year

| What | Who | 1995 (Year 1) | 1996 (Year 2) | 1997 (Year 3) | 1998 (Year 4) | 1999 (Year 5) | 2000 and beyond* |
|---|---|---|---|---|---|---|---|
| Evaluate Triggered Buildings* | all agencies | | $ 472.5 | $ 472.5 | $ 472.5 | $ 472.5 | $ 472.5 |
| Rehab Triggered Buildings* | all agencies | | 4,791.6 | 4,791.6 | 4,791.6 | 4,791.6 | 4,791.6 |
| Total Recurring Costs | | | $5,264 | $5,264 | $5,264 | $5,264 | $5,264 |
| | | | | | | | |
| Provide Technical Assistance | NIST** | 30 | 30 | 30 | 30 | | |
| Prepare Guidance Document | ICSSC** | 250 | | | | | |
| Inventory All Buildings | all agencies | | 8,300 | | | | |
| Evaluate Non-Exempt Buildings | all agencies | | 21,120 | 63,360 | 21,120 | | |
| Prepare Cost Estimate | all agencies | | | | 600 | | |
| Prepare Report to Congress | FEMA | | | | | 1,000 | |
| Total One-Time Costs | | $ 280 | $29,420 | $63,360 | $21,720 | $ 1,000 | |
| | | | | | | | |
| Budget Impact Per Year | | $ 280 | $34,684 | $68,624 | $26,984 | $ 6,264 | $ 5,264 |

* Recurring annual costs expected to continue until proposed EO is superseded by Congressional or Presidential mandate. FEMA-generated report will provide information which is expected to be used in developing superseding mandate.

** FEMA funding

# 5. Limitations of the Estimate

Dollar values used in this estimate, which are primarily from the 1990's, have not been corrected for the effects of inflation. Because this estimate is based on averages and assumptions, fine-tuning the estimate for the time value of money was deemed neither appropriate nor necessary.

## 5.1 Section 1

The number of triggered buildings could conceivably increase: one triggering situation not included in the estimate requires agencies to evaluate buildings that, in the agency's judgement, pose an "exceptionally high risk." In developing the seismic inventory required in Section 2, agencies will identify buildings that are potentially hazardous. It is not possible to estimate how many of these will be of significant importance to an agency's function, and/or put such a large number of people at risk that an agency determines that immediate action is necessary. The number of so-identified buildings could be significant depending on the criteria used by the agency to define "exceptional." Because most of these buildings are expected to be identified in the first phase of the program, costs to deal with these buildings will be concentrated in the early years of the program.

Several agencies that already have seismic rehabilitation programs in place have a backlog of buildings which have been identified as needing rehabilitation, but for which funds are not available. The adoption of the proposed Executive Order, with the mandate to take action for buildings posing an "exceptionally high risk," may speed the process of reducing the risk in these buildings, through reprogramming of already budgeted funds or approriation of new funding for the purpose following the affected agency's normal budget process, as required by the order.

When the seismic inventory has been completed, the number of Federally owned buildings may be found to be different from that reported by the GAO. For example, the GAO report states that the U.S. Air Force owns 18,885 buildings in regions of high and very high seismicity. When the Air Force completed its inventory, it determined that it owned only 15,641 buildings in those regions. A counter-example is given by the U.S. Army report that it owns 64,575 buildings in regions of moderate, high, and very high seismicity. The GAO report states that there are only 59,382 Army buildings in those areas. Discrepancies in the definitions used for high, moderate, and low seismicity may account for some of these differences. The GAO-reported figures were used for this estimate because they provided a single authoritative and comprehensive source of information for building ownership by all Federal agencies.

The average size of a Federal building was calculated using the information in the GAO report, and this figure was assumed to represent the average size of the "triggered" buildings. This number may be low, because buildings smaller than 3000 square feet (280 $m^2$) are exempt from evaluation. The seismic evaluations that will be performed over the next four years to develop the cost estimate will provide information on whether the average seismically-deficient building is significantly larger than the "average" building.

During development of the Standards, some agencies expressed concern that the emphasis placed on the safety of nonstructural components by FEMA 178 and the Standards will create additional evaluation and rehabilitation costs. Because tracking of rehabilitation costs to date has not clearly differentiated between structural and nonstructural aspects of a project, this issue cannot be resolved adequately with currently available information. Presumably, the evaluations performed during the four-year data collection effort mandated by the proposed Executive Order will illuminate this issue.

### 5.2 Section 2

The costs to implement Section 2 of the proposed Executive Order could change if the ICSSC-issued guidance differs significantly from the assumptions used in this estimate. Because the ICSSC document will be subjected to a consensus review and approval process, it is difficult to predict the final content of the guidance. Because ICSSC representatives face the same budget pressures that are felt throughout the government, it is likely that any changes in the assumed scope of the guidance will result in smaller, rather than greater, expenditures for each affected agency.

### 5.3 Section 3

The estimates provided by NIST and FEMA on the cost of performing the functions required of them by the proposed Executive Order are based on costs of undertaking studies of similar magnitude and complexity; they are therefore believed to be reliable.

## 6.0 Bibliography

*Cost Projections for the U.S. Postal Service Seismic Program*, ATC-26, Applied Technology Council, Redwood City, CA, U.S. Postal Service, Washington, DC, September 1990.

*Evaluation and Strengthening Guidelines for Federal Buildings - Assessment of Current Federal Agency Evaluation Programs and Rehabilitation Criteria* and *Development of Typical Costs for Seismic Rehabilitation*, prepared by H.J. Degenkolb Associates, Engineers, and Rutherford & Chekene, Consulting Engineers, NIST GCR 94-650, National Institute of Standards and Technology, Gaithersburg, MD, 1994.

*Evaluation and Strengthening Guidelines for Federal Buildings - Identification of Current Federal Agency Programs*, prepared by H.J. Degenkolb Associates, Engineers, and Rutherford & Chekene, Consulting Engineers, NIST GCR 94-649, National Institute of Standards and Technology, Gaithersburg, MD, 1994.

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*NEHRP Handbook for the Seismic Evaluation of Existing Buildings*, FEMA 178, Federal Emergency Management Agency, Washington, DC, June 1992.

*NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings*, FEMA 172, Federal Emergency Management Agency, Washington, DC, June 1992.

*Standards of Seismic Safety for Existing Federally Owned or Leased Buildings*, Diana Todd, editor, NISTIR 5382, ICSSC RP-4, National Institute of Standards and Technology, Gaithersburg, MD 20899, February 1994.

*Typical Costs of Seismic Rehabilitation of Existing Buildings -- Second Edition, Volume 1, Summary*, FEMA 156, Federal Emergency Management Agency, Washington, DC, publication pending.

## Appendix A - Text of the Proposed Executive Order

Proposed Executive Order February 4, 1994

**Seismic Safety of Existing Federally Owned or Leased Buildings**

By the authority vested in me as President by the Constitution and laws of the United States of America, and in furtherance of the Earthquake Hazards Reduction Act of 1977, as amended by P.L. 101-614, which requires the President to adopt "standards for assessing and enhancing the seismic safety of existing buildings constructed for or leased by the Federal Government which were designed and constructed without adequate seismic design and construction standards" (42 U.S. C. 7701 et seq.), it is hereby ordered as follows:

Sec. 1. Adoption of Minimum Standards

The *Standards of Seismic Safety for Existing Federal Buildings*, developed, issued and maintained by the Interagency Committee on Seismic Safety in Construction (ICSSC), hereafter referred to as the *Standards*, are hereby adopted as the minimum level acceptable for use by Federal departments and agencies in assessing the seismic safety of their owned and leased buildings and in mitigating unacceptable seismic risks in those buildings. The *Standards* shall be applied, at a minimum, to those buildings identified in the *Standards* as requiring evaluation and, if necessary, mitigation. Evaluations and mitigations which were completed prior to the date of this order under agency programs that were based on standards deemed adequate and appropriate by the individual agency need not be reconsidered unless otherwise stipulated by the *Standards*.

For the purposes of this order, buildings are defined as any structure, fully or partially enclosed, used or intended for sheltering persons or property, except for the exclusions specified in the *Standards*.

Sec. 2. Estimating Costs of Mitigation

Each agency that owns or leases buildings for Federal use shall, within four years of the issuance of this order, develop an inventory of their owned and leased buildings and shall estimate the costs of mitigating unacceptable seismic risks in those buildings. The cost estimate shall be based on the

exemptions and evaluation and mitigation requirements in the *Standards*. Guidance for the development of the inventory and cost estimates will be issued by the ICSSC no later than one year after the signing of this order. Cost estimates with supporting documentation shall be submitted to the Director of the Federal Emergency Management Agency (FEMA) no later than four years after the signing of this order.

Sec. 3. Implementation Responsibilities

Departments and agencies are responsible for funding the costs of inventorying, cost estimating, and mitigating their buildings as required by this order through their normal budget processes.

The Federal Emergency Management Agency (FEMA) is responsible for (1) notifying all Federal departments and agencies of the existence and content of this order; (2) preparing for the Congress, in consultation with the ICSSC, no later than six years after the issuance of this order, a comprehensive report on how to achieve an adequate level of seismic safety in Federally owned and leased buildings in an economically feasible manner; and, (3) preparing for the Congress on a biennial basis, a report on the execution of this order.

The National Institute of Standards and Technology (NIST) is responsible for providing technical assistance to the Federal departments and agencies in the implementation of this order.

Sec. 4. Updating Programs

The ICSSC is responsible for updating the *Standards* at least every five years, and within two years of the publication of the first edition of FEMA's *Guidelines for Seismic Rehabilitation of Buildings* and *Commentary*.

Sec. 5. Judicial Review

Nothing in this order is intended to create any right or benefit, substantive or procedural, enforceable at law by a party against the United States, its agencies, its officers, or any person.

THE WHITE HOUSE

# Appendix B - ICSSC Working Group on Costs

## ICSSC Working Group on Costs

The following persons participated in the February 14, 1994 meeting of the Interagency Committee on Seismic Safety in Construction Working Group on Costs, or otherwise contributed to this effort. Their efforts are gratefully acknowledged.

| | |
|---|---|
| Krishna Banga | Dept. of Veterans Affairs |
| Ann Bieniawski | Dept. of Energy |
| Charles H. Gutberlet, Jr. | U.S. Army |
| Bruce Hall | General Services Administration |
| James Lafrenz | U.S. Air Force |
| Ugo Morelli | Federal Emergency Management Agency |
| Howard Nickerson | U.S. Navy |
| Steve Sweeney | U.S. Army |
| Diana Todd | National Institute of Standards and Technology |
| Dave Williams | U.S. Army |