is assumed to be unscathed and the costs are avoided. For any set of real world buildings, the damage would follow more of a sigmoid function where some buildings would suffer more than expected damage at earthquake severities somewhat below the design ground shaking, and some would survive better than expected at earthquakes more severe than $S_r$. Our go, no-go assumption, which for any specific building might be a poor approximation, as applied here to the general class of buildings under consideration, simply assumes that the "tail" of the sigmoid below the design severity balances the "tail" above it.

To continue with the analysis, we need the probability of an earthquake stronger than $S_o$, but not so strong as to exceed $S_r$. Note, however, that while a single earthquake stronger than $S_r$ is assumed to destroy the building and end the possibility of more benefits, the structure might survive several lesser earthquakes of severity $S_e$, where $S_o < S_e <= S_r$ and thus enjoy multiple benefits. How can we estimate the probable number of earthquakes of some intermediate severity $S_e$ when the map gives us only the 90 percent confidence lines of *nonexceedance* of $S_r$?

The upper end of the range is straightforward. The corollary of 90 percent <u>non</u>exceedance is a 10 percent chance of <u>exceeding</u> $S_r$. To use the "urn" analogy beloved of academic lecturers in Probability 101, we have an urn containing a large number of markers labeled with earthquake severity numbers indicating the most severe earthquake that will occur in a year (where many can be zero, of course) and we pull out one for each year. If we randomly pull 50 markers representing 50 years of experience, the contents of the urn should be such that we have a 90 percent chance of <u>not</u> picking a marker with a severity greater than $S_r$ *even once*. That makes the marker for $S_e > S_r$ fairly rare in the contents of the urn just as severe earthquakes are rare. To wind up with a 90 percent chance of not getting at least one $S_e > S_r$ marker in 50 draws, the chance of not getting such a marker on one draw would have to be the 50th root of 0.9, or 0.997895. If the urn had 1 million markers, 2105 of them could be $S_e > S_r$, for a one-year probability of 0.002105.[2]

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[2] Using a million marker urn and expressing probabilities to six decimal places implies a precision considerably greater than the other assumptions of this analysis warrant. As a conceptual device, however, the million marker urn is useful to emphasize earthquake severity as a continuous variable such that there are many possibilities for earthquakes more or less severe than $S_r$. For some earthquake-prone locations like the San Andreas fault, a more appropriate urn analogy might be one where no markers are returned after selection. Such an urn would better represent the case where the "big one" is regarded as inevitable and each year that goes by without having it makes the very severe earthquake that much more likely. By now, there may be few markers left in the San Andreas urn. Once the marker for the "big one" is selected and the severe earthquake occurs, of course, the urn would be replenished to some starting distribution with many low severity markers such that a second severe earthquake immediately after the first becomes very unlikely. Our analysis, however, would not be changed by a non-replacement urn if we can assume the maps are correct for the present time. With a non-replacement urn, as with the real world, the maps will change as time passes and a severe earthquake either occurs or fails to occur.

Strictly speaking, we do not know exactly what is the severity level marked on either the 2105 "greater than" markers or the 997,895 remaining "equal or less than" markers, but in a rational world we could expect a rational urn: one in which the distribution of markers in the urn reflects real world experience with earthquakes. Severe earthquakes are more rare than less severe ones, so if we consider earthquake severity as a discrete variable as the map areas imply, we would expect to find fewer markers for the more severe $S_{r+1}$ than for the design severity, $S_r$, and more markers for $S_{r-1}$. Thus the urn analogy tells us we could expect the probability of $S_{r+1}$ to be less than 0.002105.

The Commentary, Part 2 of *Provisions*, gives the one year probability of exceeding $S_r$ as a discrete variable characterized by a map area and an acceleration coefficient is 0.002, which agrees with our estimate for $S_{r+1}$ from the urn analogy. *Provisions* also tells us that the probabilities of earthquakes in the discrete classes $S_{r-1}$, $S_{r-2}$, etc., are related to $S_r$ such that the logarithm of the probability increases linearly as the map area number decreases. Very roughly, if the probability of exceeding $S_r$ is 0.002, the probability of exceeding $S_{r-1}$ is 0.004 and of $S_{r-2}$ is 0.008, etc. The chance an intermediate earthquake $S_{r-1} < S_e <= S_r$ is roughly 0.002.

Benefit from Saving the Building

The benefit expected in any one year from building to the $S_r$ standard will be based on the expectation in that year of an earthquake more severe than it would have been designed to resist in the absence of the rule, $S_o$, but not above that for which the rule would require it to be designed, $S_r$. One of the benefits the rule is avoiding the loss of the value of the building itself. The value of the building itself may depreciate with time[3]; if we assume straight line depreciation, the remaining value of the building, R, in year, y, of a life, L, is:

$$R = C_i - y \times (C_i - C_s)/L$$

where $C_i$ is the initial cost of the building and $C_s$ its salvage value at the end of a normal life. If we express the salvage value as a fraction of the initial cost, s, where:

$$C_s = s\ C_i,$$

[3] Under normal accounting practice for private sector buildings, it is common to write off as depreciation each year a part of the initial value of the building over an economic lifespan that may or may not coincide with the physical condition of the structure. With good maintenance, a well built building can retain most of its utility for many years and a depreciation write-off may not be appropriate for a public structure that would be covered by this rule. Nevertheless, it is conservative for this analysis to assume some depreciation. Cases for zero and full depreciation are subject to sensitivity analysis.

we get:

$$R = C_i [1 - y (1 - s)/L]$$

If p is the probability of earthquake severity $S_o < S_e <= S_r$ and q is the probability of an earthquake of severity $S_e > S_r$, the expected benefit, b, in that year is:

$$b = p (1 - q)^{y-1} R$$

$$= p (1 - q)^{y-1} C_i [1 - y (1 - s)/L]$$

The $(1 - q)^{y-1}$ term is the probability of not having suffered conditions more severe than the design ground shaking in any of the prior years [i.e. for the 10th year, the term would be $(1-q)^9$]. As noted above, the 90 percent probability of nonexceedance in 50 years criterion leads to a single year <u>exceedance</u> probability of q = 0.002105.

The total expected benefit is:

$$B = NPV \{b\}$$

where NPV indicates the net present value over L years of the yearly benefit discounted back to the first year at a fixed discount rate. In the general case, we do not know $C_i$ explicitly, but earlier cost studies by the Building Seismic Safety Council (BSSC) have developed a relationship between the overall initial cost of the building, $C_i$, and the cost, c, of adding the earthquake reinforcement in the design stage as:

$$c = k C_i,$$

where k was found to average 0.021 for areas where there was no earthquake provision in the local building code, and 0.009 for areas where the local building code already did provide for some measure of earthquake reinforcement[4]. To estimate the expected benefit/cost ratio for the rule, we can substitute $C_i = c/k$ in

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[4] The BSSC conducted a trial design program that covered 52 design case studies for buildings located in various parts of the country. For the 29 trial designs for construction in the 5 cities (Chicago, Ft. Worth, Memphis, New York and St. Louis) whose local building codes had no seismic design provisions, the average projected increase in total building cost was 2.1 percent. For the 23 trial designs conducted in the four cities (Charleston, Los Angeles, Phoenix and Seattle) whose local building codes do have seismic design provisions, the average projected increase in total building cost due to the difference between building code provisions and more stringent NEHRP recommendations was 0.9 percent. While our analysis uses these two percentages, we recognize that they are based on a limited sample and tend to illustrate the tautological case that it costs less to raise the earthquake resistance from an existing building code that already does part of the job than an existing code that does none of the job. As compared to no seismic consideration at all, the first increment of earthquake resistance can be "expensive" if it rules out cheap types of construction like unreinforced masonry. Where the existing building code has already been charged with that expense, adding strength to a more resistant type of construction is cheaper than "starting from scratch."

the benefit equation such that c cancels out and we get an expression that depends only on p, L, s and k:

$$B/c = (p/k)\ NPV\ \{(1 - q)^{y-1}[1 - y\ (1 - s)/L]\}$$

The BSSC study did not attempt a benefit-cost analysis and thus did not compute net present values; however, a FEMA study of building rehabilitation[5] did carry out a benefit cost analysis that used a 4 percent discount rate. The unit NPV at 4 percent over 50 years to a 0.2 residual value is 14.95. From the discussion above, we can assume that the probability of such an earthquake is at least 0.002 for any one of the years of a building life. Thus for a building built where there was no earthquake provision in the building code, we could expect a benefit/cost ratio of at least:

$$B/c = (0.002/0.021) \times 14.95$$

$$= 1.42$$

and for an area where the building code does include earthquake provision k = 0.009:

$$B/c = (0.002/0.009) \times 14.95$$

$$= 3.32$$

Benefit from Persons and Property Saved

The major part of this benefit is in lives saved. If V is the value placed on saving one life, and N is the number of lives that would have been lost in the absence of the earthquake resistance required by this rule, the expected benefit in any one year is:

$$b = p\ (1 - q)^{y-1}\ N\ V$$

Over the life of the building the expected benefit is:

$$B = NPV\ \{p\ (1 - q)^{y-1}\ N\ V\}.$$

Here we are again at a disadvantage with a generic building, since we do not know how people many would be in it if and when the earthquake occurs. As a rough estimate, however, we can attempt to estimate for a government office building. If we let F be the cost per square foot to build the building, then the area of a building costing C is:

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[5] *A Benefit-Cost Model for the Seismic Rehabilitation of Buildings - Volume 1: A User's Manual* - FEMA 227, April 1992, Prepared under Contract No. EMW 89-C-2991 by VSP Associates, Inc., 455 University Avenue, Suite 455, Sacramento, CA 95825.

$$A = C/F.$$

If R is the occupancy rate per 1000 square feet, then the number of people in the building is:

$$N = R\ A/1000 = R\ C/(1000\ F) = 0.001\ RC/F.$$

We can substitute back in our earlier C = c/k relationship and get a generic benefit/cost equation:

$$B/c = 1/c\ NPV\ \{0.001[(p(1 - q)^{y-1}RV/F)(c/k)]\}$$

which, on factoring out the terms that are constant in the NPV process, simplifies to

$$B/c = (0.001\ pRV/kF)\ NPV\{(1 - q)^{y-1}\}$$

where $NPV\{(1 - q)^{y-1}\}$ is the net present value over the life, L, at discount rate, i, for a unit benefit each year if there is no preceding earthquake of severity exceeding the design ground shaking. At the 50 year life and the 4 percent discount rate, $NPV\{(1 - q)^{y-1}\} = 20.074$, so

$$B/c = 0.02074\ pRV/kF.$$

FEMA uses a cost of $80 per square foot to build government office buildings and an occupancy rate of 4 people per 1000 square feet. However, if the building is used only during a standard 40 hour work week, the occupancy rate would be decreased by 40/168 to 0.95. FEMA uses an expected death rate of 0.2 for their worst damage state, which would reduce the number of lives capable of being saved per 1000 square feet to 0.19.

For a building where R = 0.19, and F = 80, located where k = 0.009 and p = 0.002,

$$B/c = 0.0207 \times 0.002 \times 0.19\ V\ /\ (0.009 \times 80)$$

$$= 0.0000109\ V.$$

For V = $1.5 million[6],

$$B/c = 16.38.$$

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[6] For several years the Department of Transportation has used $1.5 million in regulatory evaluations as the dollar value of preventing a transportation accident fatality. While a small part of that amount is an allowance for certain highway costs avoided, most of it is based on the willingness of transportation passengers and other affected participants to pay for reductions in risk. That same willingness should apply to building occupants and may, in fact, be a conservative assumption. The Department is reviewing recent economic studies that indicate that the actual willingness-to-pay may be higher than the value currently being used.

For the region where k = 0.021,

$$B/c = 7.02.$$

The above rough analysis ignores injuries and property loss prevented. FEMA in its analysis allows for two minor and two serious injuries along with each fatality, so the actual personal benefit should be even greater.

Benefit from Function Preserved

Buildings funded by DOT obviously serve a transportation function and the loss of that function is a cost that would be avoided if the building is not destroyed in an earthquake. Once again, the function and its value could be calculated for any specific building, but for the generic building of this analysis, we must make a rough estimate. We start by assuming that the building is economically justified by the transportation function it facilitates. This means that the net present value of the transportation function over the life of the building must equal or exceed the initial cost of the building, or

$$C =< NPV\{ T \}$$

where T is the annual value of the transportation function, assumed constant over the life of the building. Again using the unit NPV concept, we can write:

$$C =< T\ NPV\{1\} \text{ or } T >= C/NPV\{1\}.$$

If we assume for the sake of simplicity that destruction of the building would mean the loss of the transportation function for one year, the expected benefit in any year from avoiding its destruction in an earthquake is at least:

$$b = p\ T >= p\ C/NPV\{1\}$$

The total expected benefit is:

$$B = NPV\ \{ b \}$$

and going through the same set of substitutions used earlier,

$$B/c >= p/k\ NPV\{1 - q)^{y-1}\}/NPV\{1\}$$

Substituting the NPV values, this becomes

$$B/c >= p/k\ (20.74/21.48) \text{ or } 0.966\ p/k$$

For a region where p = 0.002 and k = 0.009, we have

$$B/c >= 0.966 \times 0.002/0.009 \text{ or } >= 0.215$$

and for k = 0.021

$$B/c >= 0.092.$$

Full Benefit of the Rule

The three benefit/cost ratios estimated above are additive, so we can estimate the ratio of the full benefit to cost of the rule as:

$$B/c_{full} = B/c_{structure} + B/c_{persons \& property} + B/c_{function}$$

For the location with current provisions for earthquake reinforcement in the local building code,

$$B/c_{full} >= 3.32 + 16.38 + 0.215 = 19.92.$$

For the location with no provisions for earthquake reinforcement in the local building code,

$$B/c_{full} >= 1.42 + 7.02 + 0.092 = 8.51.$$

Sensitivity Analysis

The above analysis shows that the rule is strongly cost beneficial, principally on the basis of lives saved as intended by the NEHRP and *Provisions*. As a sensitivity analysis, we examine the degree to which any of the assumptions of the analysis might change that conclusion. Wherever possible, the assumptions used were conservative; one assumption that might not have been is the discount rate for computing net present value.

Effect of a 10 Percent Discount Rate

Using a 4 percent discount rate, the rule would be cost beneficial whether or not the locality has earthquake reinforcement already written into its building code. Is that the case with a higher discount rate?

Using the standard OMB 10 percent discount rate,

$$NPV \{(1 - q)^{y-1}[1 - y (1 - s)/L]\} = 8.10$$

$$NPV \{(1 - q)^{y-1}\} = 9.72, \text{ and } NPV \{1\} = 9.91.$$

Applying these numbers to the B/c calculations, for a region with earthquake provisions in the building code:

$$B/c_{full} >= 1.80 + 7.68 + 0.218 = 9.70$$

and for a region without such provision,

$B/c_{full} >= 0.77 + 3.29 + 0.093 = 4.15.$

Although B/c values are lower, the favorable benefit/cost ratio for both cases is retained at the higher discount rate.

Effect of the Depreciation Residual Value Assumption

The depreciation assumption affects only the benefit from saving the building. If the building value had been depreciated to zero over 50 years, the value for NPV $\{(1 - q)^{y-1}[1 - y\ (1 - s)/L]\}$ would have been 13.50 instead of 14.95. This would have changed the finding on $B/c_{structure}$ to 3.00 for the case where the local building code did require earthquake resistance, and to 1.28 for the case where it did not. In neither case, would the overall finding that the rule would be cost beneficial be altered.

If the building value had not been depreciated at all, the value of NPV $\{(1 - q)^{y-1}[1 - y\ (1 - s)/L]\}$ would have been 20.74 instead of 14.95 and the resulting finding for $B/c_{structure}$ would have been raised to 4.61 for the case where the local building code did require earthquake resistance, and to 1.96 for the case where it did not. Again, this alternate assumption would not have changed the overall finding that the rule would be cost beneficial, but it does emphasize the interesting possibility that, for a public building, the rule might be cost beneficial in all areas just on the basis of avoiding the cost of replacing the structure.

Effect of the "Cookie Cutter" Assumption

As noted earlier, the "cookie cutter" assumption really implies that the tails of a sigmoid distribution above and below the design ground shaking will approximately balance each other out. While that might be true of this proposed rule applied to a large number of buildings in different locations, the "cookie cutter" assumption is also implicitly applied to the building that would have been built in the absence of the rule in a place where the building code does already require some measure of earthquake resistance. In our generic building case, we do not know what measure of earthquake resistance the local building code would have required, but our assumption is that the building code requirements could be represented as being similar to the guidelines of *Provisions* except for a somewhat lower design ground shaking.

We also know that the guidelines of *Provisions* are intended to provide resistance to collapse even for earthquakes with severities above the design ground shaking. Thus for the case where $S_o < S_e <= S_r$, it is possible that a building designed for $S_o$ would retain sufficient resistance to have saved some of the lives the analysis has been attributing to a building designed for $S_r$. The saving of lives is a major benefit of the rule, but even for the worst case where all of the life saving benefit would have been attributable to the local building code,

$$B/c_{full} >= 3.32 + 0.0 + 0.215 = 3.54,$$

and the rule would be cost beneficial.

For the case where the local building code contains no requirement for earthquake resistance, the "cookie cutter" assumption has better support. Since adding earthquake resistance adds cost to a building and since cost is a major consideration in the award of contracts for public buildings, we have no basis to assume that earthquake resistance will be included in the building design gratis and less reason to allow for an upper tail to a sigmoid distribution that our "cookie cutter" might have amputated.

If such an upper "tail" exists, it will be the residual effect of some other building code provision, such as allowance for wind loading. Since the most likely places for the building codes to lack seismic provisions are those where earthquakes are infrequent and the design ground shaking is relatively mild, the damage costs the "cookie cutter" analysis assumes the rule would avoid may be too optimistic. Even so, we note that the rule would still be cost beneficial with no benefit counted from lives saved:

$$B/c_{full} >= 1.42 + 0.0 + 0.092 = 1.51.$$

Effect of Assumptions on Earthquake Probability

Based on the assumption that earthquakes would occur only at the discrete severity levels represented by the map areas, we used the value given by *Provisions* of 0.002 as the probability of an earthquake of severity $S_{r-1} < S_e <= S_r$ in any year. However, for the case where the existing building code contains seismic provisions, the equivalent earthquake severity for those provisions, $S_o$, may not be exactly equal to the severity indicated by the map areas. In particular, if the existing code's seismic provisions are more stringent than the rule would require for the next lower map area, $S_{r-1} < S_o$, the interval for $S_o < S_e <= S_r$ will be smaller than $S_{r-1} < S_e <= S_r$ and we would expect the probability of $S_e$ to be less than 0.002.

In the above analysis, the benefit/cost ratio, B/c, is directly proportional to the value assumed for p, the one year probability of an earthquake of severity $S_o < S_e <= S_r$. The estimated B/c for the case of an seismic provisions in the existing building code is so strong (19.92) that the rule would be shown to be cost beneficial if p were as low as 0.0001. In the real world, if the difference between the existing building code and *Provisions* guidelines is small, we would expect the likelihood of an earthquake in the narrow window between $S_o$ and $S_r$ would be low and the expected benefit from requiring use of the guidelines would be small. But by the same token, we would expect the added cost to be small if the guidelines differed only slightly from the existing building code. The significance of a benefit/cost ratio when both numerator and denominator are tending toward zero may be moot. The cost of compliance with the rule of 0.9 percent of the overall cost of the building assumed for the analysis is based on a small number of trial designs. We would hope that comments to the docket for this NPRM would offer added insight into the cost of adding earthquake resistance to buildings.

For the case where the existing building code does not include seismic provisions, the equivalent $S_o$ is not likely to be more severe than $S_{r-1}$, but rather may be <u>less</u> severe. If $S_o < S_{r-1}$, the probability, p, of $S_{r-2} < S_e <= S_r$ would be the difference between the probabilities of exceeding $S_{r-2}$ and $S_r$, or 0.008 - 0.002 = 0.006. Since the benefit/cost ratio is directly proportional to p, we might see the benefits of the rule for locations without seismic provisions in the building code overcome the higher cost so that B/c = 24.69. This potential for the analysis to underestimate p where the local building code lacks seismic provisions may compensate for the tendency of the analysis to be over-optimistic about costs avoided as discussed earlier.

Conclusions

This regulatory evaluation finds that the proposed rule is likely to be cost effective.

Clearly, the value of lives saved is the most important part of the benefit in this analysis, but the value of the building saved is also significant, as may be the value of the transportation function in some cases. Even in the worst case of the high discount rate in an area without earthquake resistance in the current building code, the benefit/cost ratio is 0.86 using only the building construction cost and minimum transportation function without consideration of avoiding fatalities, injuries or loss of property. Only for an unmanned warehouse holding low value goods would the persons and property term be unlikely to add enough benefit to raise B/c to more than unity.

It also must be noted that the assumptions used in the estimate were especially conservative with respect to the value of transportation function. If, for instance, the building housed equipment and personnel that formed the nerve center of a transportation system (e.g. an air traffic control center or the central computer for a rail transit network), loss of the building and contents could impose severe transportation costs over an extended period. It is unlikely that a system would be allowed to remain completely shut down for many days, but it is also unlikely that temporary control "fixes" to get things moving could restore full effectiveness and the system could limp along for months.

The sensitivity analysis shows that the finding that the rule will be cost beneficial is robust. The simplifying assumptions used in the analysis are not biased in favor of the rule and most, in fact, are conservative. It may be concluded that a notice of proposed rulemaking is justified.

## OTHER REQUIRED STATEMENTS

Executive Order 12291 - This proposed rule is not a major rule under Executive Order 12291. Although Federal expenditures run to billions of dollars every year, expenditures for transportation-related buildings are a small fraction of that total and the added cost for earthquake resistance required by this proposed rule would amount to only 1 to 2 percent of that fraction. It is unlikely that the total cost of the rule would exceed $100 million in any one year. The rule is considered to be significant under the DEpartment's Regulatory Policies and Procedures because of potential public interest.

Federalism - This rule would affect state and local entities such as transit authorities to the extent that any buildings they construct with the aid of Federal money might have to comply with more stringent earthquake resistance standards than the local building codes. Building codes, however, are minimum standards and the buildings built under more stringent codes of this proposed rule will be in full compliance with any local codes. Anyone constructing a building or contracting for the construction of a building is at liberty to require strength greater than that required by the local building code. The Department's high priority on safety -- including the occupants of transportation-related buildings -- as well as the mandate of Executive Order 12699 provide ample reason for requiring added earthquake resistance to these buildings. State and local building codes are preempted in only a very narrow sense and for a limited class of buildings. For these reasons, we believe the proposed rule does not have sufficient Federalism impacts to warrant a Federalism assessment under the principles and criteria of Executive Order 12612.

Regulatory Flexibility Act - The Regulatory Flexibility Act of 1980 requires a Federal Agency to review any rule to assess its impact on small businesses. Since this rule applies to buildings built by or for Federal, State or local government entities that are not small businesses, it should have no direct effect on small businesses. Some firms engaged in building construction may qualify as small businesses, but there is no reason why a requirement for added earthquake resistance should affect them adversely. Accordingly, DOT certifies that this rule may not have a significant negative economic effect on small entities.

Paperwork Estimate - This rule requires no added data collection or reporting on the part of any of the entities it affects. It does not add to government-required paperwork.

International Trade Impact Statement - This rule affects primarily domestic buildings and contains no requirement affecting international trade.

Environmental Implications - This rule has no environmental implications except that if an earthquake occurs, it may reduce the amount of rubble produced. Thus its effect on the environment, if any, should be beneficial.

Energy Impact Implications - This rule, while it may affect the way a building is constructed, should have no significant effect on either the amount of energy used in construction or in the amount of energy needed to heat or cool it during its life. To the extent the rule may require the use of more steel in the building design, it may involve somewhat more energy-intensive materials, but this energy impact should not be significant.

# Veterans Affairs

**DEPARTMENT OF VETERANS AFFAIRS**
**Veterans Benefits Administration**
**Washington DC 20420**

NOV 2 3 1992

In Reply Refer To.
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Mr. Gary D. Johnson
Assistant Associate Director
Office of Earthquakes and
National Hazards
Federal Emergency Management Agency
Washington, DC 20472

Dear Mr. Johnson:

We have reviewed the draft copy of the National Earthquake Hazards Reduction Program (NEHRP) Biennial Report to the Congress and wish to comment on an erroneous statement concerning the Department of Veterans Affairs, Loan Guaranty Program.

The statement in the first paragraph on page 27, which indicates that VA's residential program is unaware of the effects of the proposed seismic requirements is incorrect. A member of my Construction and Valuation staff, Mr. Robert Cosgrove, has been a member of an ICSSC subcommittee for several years, and we are fully aware of our responsibilities under Executive Order 12699. Over the years VA's home loan guaranty program and its relationship to the seismic safety objectives of Executive Order 12699 has been discussed with VA's Seismic Safety Coordinator, Mr. Edward Younger, Director, Structural Engineering Service, VA Office of Facilities. Since Mr. Younger's retirement, we had not been contacted by the current agency Seismic Safety Coordinator, until just recently. It appears that facilities staff currently responsible for seismic safety coordination was not aware of the operations of VA's home loan guaranty program and its prior involvement with the ICSSC in seismic safety issues.

Although VA provides loan guarantees to lenders on homes purchased by veterans, and is similar to HUD's single-family home program in many respects, VA does not have a "mortgage insurance" assistance program or provide Federal funds for construction like HUD. VA's loan guaranty program also differs from HUD in that we do not independently establish construction standards which are applied to homes that veterans wish to purchase. Due to our limited technical staff, we neither assist in or regulate the design component of homes purchased by veterans. Historically, VA has relied on HUD in those areas, as appropriate. To be eligible for a VA loan guaranty, proposed construction must comply with local building codes and HUD's Minimum Property Standards, contained in HUD Regulation 24 CFR 200.926. In order to implement the requirements of Executive Order 12699, VA intends to accept HUD's evaluation of the seismic aspect of local codes and incorporate any changes HUD makes to their seismic requirements relating to proposed construction of single-family homes.

We appreciate the opportunity to review the draft copy of the report, and believe the last sentence of the above mentioned paragraph should be rewritten or deleted in its entirety. Please let us know of your actions. Mr. Cosgrove may be contacted at 202-233-2997 should there be any questions concerning this matter.

Sincerely yours,

Keith Pedigo
Director
Loan Guaranty Service

**DEPARTMENT OF VETERANS AFFAIRS**
**DEPUTY ASSISTANT SECRETARY FOR FACILITIES**
**WASHINGTON DC 20420**

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

Dear Mr. Stickney:

I have been asked to reply to your June 30, 1992, letter addressed to the Secretary of Veterans Affairs. The Department of Veterans Affairs Biennial Seismic Activity Report was forwarded to Gary D. Johnson of your office on July 10, 1992. A copy of the correspondence is enclosed.

Sincerely,

Lester M. Hunkele, III

Enclosure

**DEPARTMENT OF VETERANS AFFAIRS**
**DEPUTY ASSISTANT SECRETARY FOR FACILITIES**
**WASHINGTON DC 20420**

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

Dear Mr. Johnson:

I am enclosing the Department of Veterans Affairs submission for inclusion in the National Earthquake Hazards Reduction Program (NEHRP) Biennial Report to the Congress.

Executive Order 12699 does not affect VA's construction program directly because prior mandates from Congress resulted in developing Handbook H-08-8, Earthquake Resistant Design Requirements for VA Hospital Facilities. We design all new VA buildings using the more severe requirements of H-08-8, or the current local seismic code requirements.

Sincerely yours,

Robert L. Neary, Jr.

Lester M. Hunkele, III

Enclosure

**NATIONAL EARTHQUAKE HAZARDS REDUCTION PROGRAM (NEHRP)
BIENNIAL REPORT TO THE CONGRESS
ACTIVITIES FOR FISCAL YEARS 1991-1992
DEPARTMENT OF VETERANS AFFAIRS**

The Department of Veterans Affairs (VA) extensive seismic strengthening program ensures the safety of VA patients and staff through the seismic hardening or replacement of all deficient patient and non-patient buildings in major and moderate risk areas. Since the program's inception in 1971, approximately 130 buildings have been strengthened, are being strengthened, or are presently in the design stage of a construction project to eliminate the seismic risk. The structural seismic strengthening program has made significant progress toward achieving its objectives, although much remains to be done.

Established under the Federal Advisory Committee Act (Pub. L. 92-0463) of October 6, 1972, the Charter of the Advisory Committee on Structural Safety of Department of Veterans Affairs Facilities has been renewed for a two-year period beginning April 23, 1992. One of the major concerns of this committee is earthquake hazards mitigation.

At the time of the Loma Prieta Earthquake, VA had a program for renovation and seismic upgrading of the Martinez Hospital. The earthquake caused no serious damage to the facility because the Amax recorded at the site was relatively low. It did, however, cause VA to look more closely at the existing main building to assess current seismic and program deficiencies. As the assessment revealed the high cost of accomplishing the extensive work that was required, while maintaining operations during the construction period, VA began to doubt the merits of strengthening and renovating the existing facility. A special task force was established to examine new alternatives to meet the medical needs of the Northern California veterans population. The Secretary of the Department of Veterans Affairs examined the recommendations of the Task Force report, considered the serious seismic deficiencies that existed in the building, and determined that the safety and the medical needs of veterans would be best served by closing the facility rather than proceed with an extended construction project. This decision, announced in August 1991, began the process to close the facility.

VA has established a new task force to re-examine several possible options for a new Northern California Hospital. These include three options for renovating and/or rebuilding the Martinez Hospital. Other options include a new hospital at the University of California at Davis, or their Sacramento complex, and a combined smaller hospital at Martinez plus either Davis or Sacramento. In addition, VA is also evaluating a joint operation with the Air Force and expansion of the existing hospital at Travis A.F.B.

At the VAMC, Palo Alto, the main hospital building, building 1, was evacuated following the October 1989 Loma Prieta earthquake. Following a damage assessment, VA determined that the building needed significant reinforcement or replacement. A cost analysis indicated that the most cost-effective solution was to replace the building. It will be replaced with three buildings: a hospital; an administration and research building; and a diagnostic radiology center. Schematic planning began in March 1992; design development starts in July 1992; and construction should start in early 1993, with completion in the spring of 1996. Total project cost will be $180 million. A decision was also made to seismically strengthen building 5, an existing four-story facility. This construction was completed in May 1992 at a cost of about $10 million.

We have begun the process for seismic upgrading the Memphis Medical Center. Several alternate schemes were developed to renovate and strengthen the existing facility. Major considerations were given to the cost and total time of disruption of the hospital in selecting the best approach to correct the seismic deficiency. The least disruptive and least costly scheme is to construct a new patient bed tower adjacent to the existing main building, demolish the existing bed tower from fifteen down to five stories, and seismically strengthen the remaining five-story facility. This approach will allow patients to move into a seismically designed new facility three years earlier than the other schemes.

At VA's Seattle Medical Center, a project is currently under construction for seismic correction and renovation to convert existing building 1 into an office/research complex. This project represents the fourth and final phase of a major construction program that has replaced the old medical center with a new state-of-the-art facility. At this time, the phase-4 project is about 50% complete, and medical center personnel are expected to begin moving into the renovated east section of the building by early fall of this year. This project adds new shear walls and seismic bracing for mechanical and electrical equipment.

At VA's Long Beach Medical Center, the A/E recommended using base isolators to seismically strengthen the main hospital building (#126) as the least disruptive and most cost-effective solution. The design work is essentially complete, and we expect to start construction before the end of 1992.

VA will enter a joint venture project with the Tripler Army Medical Center in Honolulu. Part of the project includes renovating the existing medical center's E-wing. Recent seismic zone changes adopted by the state of Hawaii for the island of Oahu have resulted in the need to seismically strengthen that wing. We are in the process of determining the most appropriate method and cost of the strengthening.

Also included in VA's earthquake hazard mitigation effort is a wide range of programs to:

o Anchor major mechanical and electrical equipment to prevent dislodging or disruption during an earthquake.

o Maintain an emergency radio network to provide direct communication among all VA facilities in the United States.

o Provide emergency utility services, especially water and electric power, in all VA medical centers.

VA Seismic Design Handbook, H-08-8, Earthquake Resistant Design Requirements for VA Hospital Facilities, is under revision. The revision will adopt more of the seismic requirements of the 1991 Uniform Building Code to achieve the benefit of uniformity with national standards and facilitate use of H-08-8 by private-sector structural engineers.