STRATEGIES AND CRITERIA FOR SELECTING BUILDINGS FOR ANSS STRONG-MOTION INSTRUMENTATION

J. Carl Stepp

Consortium of Organizations for Strong-Motion Observation Systems (COSMOS)

Abstract

This paper summarizes the conclusions and recommendations of the COSMOS workshop on Strong-Motion Instrumentation of Buildings held in Emeryville, CA, on November 14 and 15, 2001. The recommendations are intended to provide guidance for implementation of the strong-motion element of the Advanced National Seismic System (ANSS) and for strong-motion instrumentation of buildings in general. The guiding objective of building instrumentation should be to gain understanding of the behavior of representative building types in order to improve general predictive models, by: 1) challenging, verifying or calibrating models; 2) calibrating design and retrofit rules (codes); and 3) calibrating post earthquake evaluation rules. National and regional priorities and building selection criteria are needed. The ANSS should take advantage of advances in instrumentation and monitoring technologies and should build partnerships with state and local agencies and private sector companies in order to extend the scope of instrumentation of buildings.

Introduction

Adequate quantitative knowledge about the effects of earthquake ground motion on buildings can be gained only from instrumental measurements of motion both on the ground and in the buildings. The number of strong-motion recordings in buildings that have experienced significant damage in earthquakes is currently far too limited to permit development and validation of generalized predictive models. Currently, 207 buildings have reasonably extensive strong-motion instrumentation as part of the California Strong-Motion Instrumentation Program (CSMIP) and the U. S. Geological Survey National Strong-Motion Program (NSMP) (Huang and Shakal, 2002; Celebi, 2002). An additional approximately 500 buildings located in Los Angeles County have minimal instrumentation as specified by the Uniform Building Code guideline (Savage, 1997). And a few private sector companies have instrumented some of their buildings for the purpose of emergency response and recovery following a damaging earthquake (Otey, 1997). The total number of buildings that currently have adequate strong-motion measurement instrumentation amounts to less than three percent of the estimated 10,000 needed for all measurement purposes, including emergency response and recovery following a damaging earthquake (Stepp ed, 1997).

The Advanced National Seismic System (ANSS), which was authorized by the Congress in 1999, takes a step toward meeting the need for strong-motion response measurements in buildings. The legislation authorized 3000 three-channel instruments for placement in structures of all types (including buildings) and an additional 3000 three-channel instruments for measurement of strong ground motions in urban areas throughout the nation (USGS, 1998). The level of the ANSS authorization for strong-motion instrumentation of all structures falls far short of the estimated need for measurements in buildings alone. Nevertheless, the authorization presents a major opportunity to significantly advance strong-motion measurements. At the same time it presents a significant challenge for the community of earthquake professionals, requiring consideration of tradeoffs and development of implementation strategies that have the highest likelihood for improving earthquake engineering practice and advancing earthquake safety. Implementation strategies must 1) balance national and regional allocation of resources, 2) develop criteria and guidelines for selecting specific buildings in order to obtain recordings in representative building types and for specific measurement objectives, 3) stimulate advancements in instrumentation technologies, 4) identify actions to strengthen coordination between ANSS and building owners aimed at expanding private participation, 5) consider the needs for building health monitoring for emergency response and recovery, and 6) include plans and resources for data archiving and dissemination.

The workshop focused on strong-motion instrumentation of buildings as the priority need for the portion of ANSS resources allocated for strong-motion instrumentation of structures. Emphasis was placed on identification of knowledge gaps with respect to the types of buildings, the types of response measurements, and the national and regional allocation of resources that are together, likely to have the highest payback for advancing earthquake safety practice. Consideration also was given to opportunities for advancing monitoring technologies and to stimulating participation by building owners in strong instrumentation of their buildings. The workshop findings are intended to serve as the basis for development of strategies, criteria, and guidelines for optimally implementing the strong-motion element of the ANSS and for use in general for strong-motion instrumentation of buildings.

Summary of Findings

Building Types and Measurement Priorities

Predictive modeling is at the heart of building engineering. Predictive modeling is central to everything earthquake engineers do from post earthquake investigations to retrofitting buildings, to evaluating buildings, to designing buildings, to performance-based design.

The guiding objective of building instrumentation for response measurements should be to gain understanding of the behavior of representative building types in order to improve general predictive models, by:

- challenging, verifying, or calibrating models;
- calibrating design and retro-fit rules (codes); and
- calibrating post earthquake evaluation rules.

Building response recordings needed to meet this objective and advance earthquake engineering practice should determine measurement objectives for the population of buildings as well as for individual buildings, and should determine the number of instruments required in each building type, and the types of instruments to be installed. These together with consideration of the probability of obtaining recordings in a reasonable time (discussed below), form the basis for establishing criteria and developing guidelines for selecting buildings for strong-motion instrumentation.

The guidelines should require that specific measurement objectives be established for any and all buildings selected for strong-motion instrumentation in the context of filling information gaps to advance safety in earthquakes.

The most important measurement objectives are considered to fall into the following categories.

- Improving modeling of elastic response;
- Improving modeling of nonlinear response;
- Determination of inter-story drift;
- Determination of the torsional deformation;
- Determination of diaphragm deformation; and
- Determination of soil-structure interaction.

Criteria for instrumentation of specific buildings must address how many instruments are required to reasonably assure that a specific monitoring objective will be met. Workshop consensus was that 20 – 50 recording channels are needed, depending on the objective for instrumentation of a building, in order to obtain adequately complete building response measurements. For example, in order to be reasonably sure that sufficient recordings for the determination of inter-story drift will be obtained, placement of instruments on about one third of the building's floors is required. Assuming an average of 30 recording channels per building and three components for each instrument installation location, the currently authorized capital expenditure would permit instrumentation of 300 buildings. The currently authorized ANSS capital funding for 3000 three-component instruments for measuring response of structures, even assuming all of the instruments were placed in buildings, is clearly inadequate to meet the need.

Tradeoffs must be accepted for the development of guidelines and criteria for implementation of the system.

As an initial tradeoff it is recommended that instrumentation of buildings should be given high priority. Other structures – bridges, and other lifeline structures, dams and other critical facility structures – typically have independent requirements for strong-motion measurements. Other tradeoffs, discussed more fully later in this summary, include real-time monitoring of buildings for structural health assessment and for emergency response and recovery. The tradeoffs within the building inventory should take into consideration priority building types (considering current inventory, current construction and future trends), priority response measurement needs, and the likelihood of obtaining useful measurements in a reasonable time. It is recommended that the tradeoffs should emphasize instrumentation of fewer buildings with a scope of instrumentation that is adequate to reasonably ensure that established measurement objectives will be met.

The types of instruments selected for a particular building depend on the building type and on the established measurement objective. For example, displacement response measurements are needed for determination of inter-story drift. Strain measurements are required to determine the deformation of tilt-up wall connections. Other types of response measurements such as connection rotation or building torsion, require pressure gages and/or specific positioning of instruments within a building. Other objectives may require still other types of measurements, types of instruments, instrument configurations, or numbers of instruments.

Criteria for selecting specific buildings for instrumentation should be based on the considerations discussed in the preceding paragraphs. Specifically, selection criteria should be based on: 1) the number and value of the building types rather than on a simple sampling of the distribution of buildings of a given type in a region, 2) occupancy (office, hotel, hospital, and so on), 3) representative retrofitted building types, 4) foundation conditions, and 5) the potential for contributing to the objectives established for the ANSS building instrumentation program. Development of ANSS building selection guidelines should take the CSMIP (Shakal, and Huang, 2002) guidelines as a starting point. ANSS Regional Committees should contribute to development of the guidelines, and the guidelines should have a long time frame, national perspective.

All buildings selected for installation of strong-motion instruments should have a reference strong-motion station (COSMOS, 2001). The reference stations should be part of the additional 3000 urban strong-motion stations authorized as part of the ANSS capital expenditure for strong-motion instruments. This critical need emphasizes the importance of coordinated planning and selection of sites for urban strong-motion stations. The objective should be to optimize the location of strong-motion instruments installed for the purpose obtaining data for development of ShakeMaps that support response and recovery following damaging earthquakes, for example, with the need for building reference stations.

Resource allocation for instrumentation of buildings in different regions of the nation should consider the probability of obtaining recordings, but needs also to cover different building types, construction types, and any regional variations in code strength and ductility requirements. It is considered important that recordings of the responses of some of model building types—different construction types, different levels of strength and ductility – in lower seismic hazard regions also be obtained, if such model building types are sufficiently important and are not available in high seismic hazard areas. Because one model can span many building variations, however, the major consideration should be the probability of obtaining recordings that advance earthquake engineers' general understanding of the performance of building types that make up the building national inventory building.

Data collection, maintenance, archiving and dissemination must be considered key necessary elements of the building instrumentation program. The scope of data collection must include:

- metadata such as relevant information about the building and the site;
- building response recordings; and
- the damage state of the building associated with all recordings.

Real-time recovery of strong-motion recordings for the purpose of assessing building damage immediately following a large earthquake is an important safety objective and has potentially important economic payback. This important use of strong-motion recordings was recognized in the planning for the ANSS, which included consideration of instrumentation to support damage assessments for emergency response and recovery (USGS, 1998). Different points of view were expressed about the scope of instrumentation needed in a building to meet this important monitoring objective. There was agreement however, that to effectively meet this monitoring objective would require instrumentation of a significantly large number of buildings. The required number of strong-motion instruments would greatly exceed the current ANSS capital authorization for instrumentation of buildings. Nevertheless, real-time and near real-time recovery of building response recordings is considered to be a need that should be given continued attention in ANSS planning for the future. Consideration should be given to implementing building health monitoring as a revision of the Uniform Building Code guideline. Another option would be to give building owners incentives in the form of assurance of early resumption of building occupancy following a damaging earthquake. Importantly, continued attention should be given to developments in instrumentation and monitoring technologies in an effort to reduce the cost of strong-motion instrumentation of buildings.

Guidelines for Establishing National Priorities

Considerations for establishing national priorities should take account of the fact that the ANSS is a national program as well as the probability of acquiring useful measurements in a reasonable time frame. Considerations for selecting building types and for measurement priorities discussed in the preceding section generally apply throughout the nation, as any building response recordings obtained in one region will generally be transferable to other regions. This warrants giving higher weight to the probability of obtaining data in the development of an approach for allocating resources. The approach should also give appropriate consideration to the need for response measurements in specific regional model building types, different construction types, and different levels of strength and ductility in low seismic hazard regions. Recognizing that the ANSS is a national program, trade-off is required for a balanced national allocation of funding for instrumentation of buildings. As a long-term program goal, considering that the ANSS is a national program, it is recommended that 30% of the authorized 3000 strong-motion instruments allocated to structures in the ANSS Plan should be distributed equally among all the ANSS regions for instrumentation of buildings, with the exception of the Hawaii Region, discussed later. This allocation should be primarily for the purpose of obtaining response measurements of unique regional building types. The remaining 70% of the capital budget for instrumentation of buildings should be apportioned to ANSS regions based on relative regional seismic hazard/risk measures as discussed below.

Method I – Population Exposure to Seismic Hazard: For the purpose of estimating the amount of instrumentation required to reasonably ensure that adequate sets of measurements would be acquired in densely urbanized areas of the United States for *Hazard Mitigation*, Borcherdt et al., 1997, used population exposure to ground acceleration levels exceeding 0.1g defined by the national seismic hazard maps (Frankel, et al., 1996). The 1990 census was used for this analysis. Assuming that the geographic distribution of population is an approximation for the geographic distribution of the built environment, this approach was used to develop estimates of the number of instruments needed to ensure that the next major damaging earthquake is appropriately recorded. This approach was applied with regional network related weighting factors for purposes of developing the ANSS Plan (USGS, 1998).

The geographic distribution of population exposed to significant seismic hazard as an approximation for the distribution of the built environment, also provides a basis for specifying the geographic distribution of the approximately 300 buildings to be instrumented with the ANSS authorization. Assuming the number of buildings per cell of size 100 square kilometers is directly proportional to the percent of the total population exposed annually to peak acceleration > 0.1g yields the geographic distribution tabulated by state and ANSS region in Table 1. Without further adjustments of this distribution the highest priority region for well-instrumented buildings clearly is Region 1, California. Urban areas in Washington and Oregon, Utah, central United States and New York and neighboring states should be allocated fewer but nevertheless important numbers of instruments for installation in buildings.

***Method II – Annualized Earthquake Loss*:** Method II uses aggregate estimated annual dollar loss to the built inventory due to earthquake damage. FEMA (2001) developed an estimate of annualized earthquake loss (AEL) using HAZUS (1999, SR-1), which is a methodology for the computation of earthquake loss using up-to-date assessments of seismic hazard, building inventories, and building vulnerabilities. This geographic distribution of estimated earthquake losses to the existing built environment is considered more refined than that obtained by the population exposure measure alone.

High values of AEL are indicative of areas that have high seismic hazard and or high values of existing built inventory. The highest AEL is in California due to its high seismic hazard and large exposured built inventory. Other areas such as New York show significant AEL even though the seismic hazard is relatively much lower, because of a large exposed, high value built inventory.

In order to identify areas for which the built inventory, whatever its value, is exposed to high seismic hazard, the FEMA study computed an annualized earthquake loss ratio (AELR). AELR is defined as the AEL normalized by the total replacement value of the exposed inventory. Using the AELR measure gives more weight to hazard, resulting in areas with high seismic hazard, such as Alaska and Hawaii, having a higher index. A higher AELR index can be taken as a measure of a higher probability of obtaining building recordings in any time frame. By this index Alaska and Hawaii rank much higher, reflecting the fact that significantly higher proportions of the building inventories in these states are exposed to high seismic hazard.

The index for establishing the national distribution of instrumentation for building measurements should account for both the national distribution of AEL and the national distribution of AELR. The recommended index for allocating strong-motion instruments per state (assuming an average of 30 channels per building) is

$$Buildings_{30\ channels}/State = Maximum[AEL\%/State{:}0.50ALER\%](0.848)(300),$$

where 0.848 represents the percentage to normalize the index so that the total number of buildings is 300, based on 3000 3-channel instruments in buildings, which is equivalent to 30 channels installed in 300 buildings. The 50 percent applied to the AELR could be increased to place greater emphasis on those areas that have higher seismic hazard but not necessarily a large building inventory. The number of buildings implied by this index aggregated for each ANSS region in Table 1. Application of this index provides an objective method for national allocation of instrument resources. The results seem intuitively correct, based on a general knowledge of the national distribution of seismic hazard, the value of building inventory, and seismic risk. (Estimates of instrumentation for Puerto Rico could not be included, because assessments of seismic hazard had not been completed at the time of the studies by FEMA (Nishenko, 2001) and (Borcherdt et al., 1997). Recent completion of this assessment for Puerto Rico will permit estimates of AEL and guidelines for allocation of building instrumentation there in the future.)

The distribution of instrumented buildings implied by the above index is similar to that implied by the population exposure index, the principal difference being that the number of instrumented buildings implied for California is about 16 percent less than is implied by the population exposure index alone. Consistency between estimates derived using the population exposure index and the combined AEL and AELR index as two different methods provides additional assurance that the geographic distribution derived using either method provides a reasonable basis for assigning national priorities for the instrumentation of buildings. The distribution based on the AEL-AELR index is recommended as the most up-to-date basis for assignment of national priorities.

The consensus recommendation is that 30 percent of the capital expenditure for instrumentation of buildings should be distributed evenly among the ANSS regions in order to insure that regionally important building types can be instrumented. This implies that of the 300 buildings for strong-motion instrumentation, each ANSS region should have about 13 as a minimum. Reviewing the allocation based on the AEL-AELR index (Table 1) shows that the numbers of instruments allocated to each ANSS region meets this minimum number, except the Hawaii Region. Considering the moderate level of hazard and the relatively smaller exposed building inventory in the Hawaii Region, the full fixed percentage allocation is considered to be comparatively, not an appropriate allocation of resources. ANSS region allocations as indicated in Table 1 are recommended.

Guidelines for Establishing Regional Priorities

Guidelines for establishing priorities for allocation of resources within regions must accommodate the general guidance on building types and measurement priorities as well as such locally causative factors as earthquake magnitude, local foundation conditions, local variation of seismic hazard within a region, and local distribution of losses expected in an urban area at risk. The local and regional distributions of expected losses as calculated using HAZUS, provide a quantitative basis for assigning regional priorities and together with these additional considerations, provide the basis for development of criteria and guidelines for selecting specific buildings.

Workshop consensus was that HAZUS results should be used as the basis for establishing regional priorities based on the distribution of regional loss for maximum considered earthquakes in a region. The distribution of loss within regions for these events can be used to define areas and types of buildings most likely to be damaged. The percent of the total loss for each building type multiplied by the number of buildings allocated to the region based on the national priority appropriation provides a quantitative basis for allocation of resources for instrumentation of each building type. Borcherdt, et al., 1997, suggested a similar procedure based on ground motion estimates for a repeat of the San Francisco Earthquake of April 18, 1906 as a means of developing estimates for instrumentation of the built inventory in the San Francisco Bay area. Guidelines provided by this procedure should then be reviewed and interpreted by regional committees as guidance for selecting specific building types and locations and together with other locally causative factors, for establishing a ranking of priority installations.

Table 1. Priorities for national allocation of strong-motion instruments for buildings, by ANSS Region. The number of buildings is based on an average of 30 channels per building and the authorized 3000 3-channel instruments for structures (USGS, 1998).

ANSS Region/(States)	**Number of Buildings**
Region-1: California (California)	186
Region-2: Pacific Northwest (Washington, Oregon)	26
Region-3: Intermountain (Nevada, Utah, Arizona, New Mexico Montana, Idaho, Colorado, Wyoming)	33
Region-4: Mid America (Tennessee, Missouri, Illinois, Kentucky Arkansas, Indiana, Ohio, Mississippi Oklahoma, Texas, Louisiana, Michigan Kansas, Wisconsin, Nebraska, Iowa Minnesota, South Dakota)	13
Region-5: East & Northeast (New York, South Carolina, New Jersey Massachusetts, Georgia, Pennsylvania North Carolina, Connecticut, Virginia Alabama, New Hampshire, Maine Maryland, Vermont, Rhode Island West Virginia, Delaware, Florida District of Columbia)	22
Region-6: Alaska (Alaska)	14
Region-7: Hawaii (Hawaii)	7

Specific building types for consideration in addition to building types and measurement priorities discussed above, especially in high seismic hazard areas such as Anchorage are:

Steel Moment Resisting Frame (10-20 stories),
Steel Braced Frame (10-20 stories),
Reinforced CMU (5-14 stories),
Ductile Concrete Moment Resisting Frame (10-20 stories),
Concrete Shear Wall (10-15 stories),
Timber Building (Shear Wall) (5-stories), and
Special General Buildings (Large, complicated framing system).

Criteria and guidelines for selecting specific buildings should be integrated to the extent practicable with guidelines and criteria for selecting free field sites for strong-motion instrument installation in urban areas. The ANSS authorization allocates 50% of the capital expenditure for strong-motion instruments for installation in structures and 50% for installation in the free field for ground-motion monitoring. This allocation should be viewed as a long-term commitment for the ANSS rather than as a yearly requirement for allocation of resources by region and within regions. ANSS management and each ANSS region should have the flexibility to plan and prioritize resources considering the most urgent instrumentation needs identified by its Regional Committee as long as the 50% - 50% authorized target is met for the Program in the long term. Priority needs are expected to vary from region to region. In addition, each region should have the option to use some ANSS funds for mobile instrumentation for the purpose of conducting structural response studies as necessary. This portion of the instrumentation could be used, for example, to measure basic dynamic characteristics of given classes of buildings during ambient conditions or during small earthquakes that might occur frequently. Such data are lacking outside of California and are potentially important for determining whether certain code provisions, based largely on California data, are applicable to buildings in lower seismic hazard regions which may have different properties and may experience different ground motion characteristics.

In order to ensure that building measurement data needs are met, each ANSS region should appropriately constitute its Advisory Committee with at least a 50% earthquake (structural, and geotechnical) engineers.

Opportunities for Use of New Technologies

An important need is to optimize the costs of instrumentation at any point in time in consideration of the types of response measurements needed and by taking advantage of advances in instrument technologies. With regard to current technology needs for strong-motion accelerometers, discussions in the workshop developed the following recommendations:

1. +/-4g is sufficient for both Reference Station and in building accelerometers;
2. >4g should be considered for special measurements (e.g., impact/pounding, special buildings, equipment);

3. <4g may be sufficient for downhole measurements;
4. When high accelerations are anticipated, sample rate and frequency response must be appropriately increased;
5. 200 SPS is considered minimum for buildings in order to meet the need for higher mode information;
6. 16-bit resolution (sensors + recorder) is considered minimum for structural monitoring and higher resolution would be better.

Consideration of new technologies for building monitoring, as is the case for currently widely used technologies, requires a clear understanding of how the data are to be used in order to determine the appropriate building monitoring system technologies or monitoring configuration. An example already discussed is instrumentation for the purpose of obtaining real-time response measurements for assessment of the damage states of buildings following strong earthquake shaking. The public value of such measurements is sufficiently high to warrant continued investment in the development of effective monitoring technologies that are cost-effective enough to be attractive to individual building owners. In this regard real-time monitoring of some buildings or of some channels in selected buildings should be considered as part of the ANSS. For example, measurement of inter story drift is considered of primary importance. These measurements are not accurately obtained with current building instrumentation deployment. In the short-term, such measurements could be obtained by placing accelerometers or velocity sensors on adjacent floors. In the long-term, research is needed to develop new technologies for direct measurement if inter story drift.

Direct measurement of base rotation is considered to be of primary importance for understanding of soil-structure interaction. Instrumentation technologies for these measurements are currently available and should be installed in selected buildings.

In order to provide more flexibility as well as for reducing cost, it is considered desirable to replace cabled connection systems for instruments in buildings with wireless technology. Currently, however, wireless technologies do not have the distance range to completely replace cabled connections. Continued evolution of this technology is needed before wireless completely replaces cabling in a building monitoring system.

Other strong-motion monitoring technologies together with their potential importance for the short-term (current ANSS planning) and the long-term and are summarized in Table 2.

Table 2. Applicable Technologies for Building Monitoring

TECHNOLOGY	Short-Term Application	Long-Term Application
Lower Resolution Systems (Class B, 16-bit)	**X**	
Direct Rotation Sensors	**X** (low resolution)	**X** (high-resolution)
Soil Pressure Sensors	**X**	
Wireless Communication		**X**
Lower-Cost Accelerometers	**X**	
Strain Sensors	**X**	
Passive Peak Sensors	**X**	
Strong-Motion Velocity Sensors	**X**	
Static Tilt Sensors (SOS)		**X**
GPS Measurements	**X**	

Requirements for instrumentation of buildings for short-term assessments of damage states, coupled with adequately broad real-time data acquisition for purposes of supporting emergency response and recovery would require funding significantly larger than is currently authorized for strong-motion instrumentation. This important need should however, be given continued long-term attention. In particular, the possibility of developing more effective and lower cost instrumentation technologies should be given ongoing attention as part of the ANSS Program. This effort should in addition, target new technologies that can reduce the costs of instrumentation and monitoring while ensuring that the required data are obtained. Importantly, cooperative projects for instrument development should be developed with the NEES Program.

Considerations for Encouraging Private Participation

Private sector building owners assume that their buildings are properly designed and constructed and they are interested in strong-motion monitoring only for protecting their investment and maintaining operation. These essentially operational needs require considerations beyond the needs for building response monitoring. This building owner perspective needs to be engaged before private sector participation can happen. From this perspective, engaging private sector participation must be done in terms of needs and benefits as seen by the owners and operators of the buildings. The data that are collected must be demonstrated to be useful for processes associated with operational decision-making.

In terms of encouraging private sector organizations to get involved, there are some natural allies who can support this effort. First, there are owners who have instrumented their buildings or other structures and have operating experience using response results in decision-making and feel that they have had a successful experience. Second, there are experienced engineers who are advising building owners and have their own practical experiences with successful uses of building response measurements. These organizations/owners and practitioners are considered the best resources for any effort aimed at expanding private participation in strong-motion instrumentation of buildings.

Another important perspective that emerged is that there is a large gap to cross in order to educate private sector users of strong-motion data, as well as the providers of strong-motion data who are trying to meet their needs. Strong-motion monitoring has traditionally focused on providing building response measurements for dynamic modeling purposes. The products that are delivered by the providers respond specifically to the needs of this user group. In order to encourage building owners to invest in strong-motion monitoring, products that the owners can actually use must be provided.

An opportunity considered to have potential for expanding private sector participation involves demonstration projects, including co-funding or CRADA relationships, that get new organizations involved in building instrumentation projects.

Preparation of guidance for use of strong-motion data by building owners is needed and needs to be clearly communicated to the owners in order to bridge the education gap. ANSS should consider providing technical support for private owner participation in building monitoring by serving as recorder and distributor of data that would be collected. The building owner's needs for the data may be as limited as providing a free-field station's data that can go into ShakeMap. If instrumentation of a building meets the national and regional priorities of ANSS and the owner agrees to the use of the data for the public good, then the project would clearly contribute to ANSS goals. There is a range of possible building owner relationships with ANSS that would have to be developed on a case-by-case basis. Any building owner/operator who is engaged in any sense at all in getting and applying earthquake data becomes an advocate for the overall ANSS program.

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