THE APPLIED TECHNOLOGY COUNCIL: AN HISTORICAL PERSPECTIVE

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ABSTRACT:
Since its incorporation in 1973, the Applied Technology Council (ATC) has evolved into a major player in the United States for the advancement of engineering applications and resources for mitigating the effects of natural and man-made hazards on the built environment. The impetus for the organization's founding was the 1971 San Fernando earthquake, which demonstrated the need for rapid improvement in seismic design standards and hazard mitigation strategies. Over the last three decades, ATC projects and resulting reports have effectively defined the technical basis for earthquake engineering practice in the United States for both buildings and bridges. Widely accepted and used by the profession, these publications address (1) seismic design of new buildings and bridges; (2) rapid screening of buildings for potential seismic hazards; (3) detailed seismic evaluation of buildings; (4) seismic upgrade (rehabilitation/retrofit) of buildings; (5) earthquake damage prediction for buildings and bridges (and other structures); (6) safety evaluation of buildings after earthquakes; and (7) detailed evaluation and repair of earthquake damaged buildings. The reasons for ATC's success in defining earthquake engineering practice in the United States relate to a variety of factors, including the process by which the documents are developed; the funding made available by government agencies and other sources; the availability of technically qualified specialists; strict quality control measures; and careful editing and attention to report format and content attributes that make the reports easy to use and follow by intended users. Projects now underway will have significant effects on future earthquake engineering practice.

KEY WORDS:
Seismic engineering applications

1. INTRODUCTION

Since its incorporation in 1973, the Applied Technology Council (ATC) has evolved into a major player in the United States for the advancement of engineering applications and resources for mitigating the effects of natural and man-made hazards on the built environment. The organization's success is the result of a variety of factors, including strict adherence to the project development strategies adopted at the organization's founding, generally ample funding from state and federal agencies, and strong support by the structural engineering practice and research communities.

The following sections describe the founding, mission and organizational structure of ATC, trends in public financial support to ATC for transferring academic research into active engineering practice, the ATC projects and resulting reports that have effectively defined earthquake engineering practice in the United States for both buildings and bridges, and new projects and developments that will affect structural and earthquake engineering practice in the coming decades.

2. FOUNDING, MISSION AND ORGANIZATION OF ATC

The Applied Technology Council was founded in 1971 through the efforts of several key individuals within the Structural Engineers Association of California. The impetus for the organization's founding was the significant damage to engineered buildings and bridges caused by the 1971 San Fernando, California, earthquake, which clearly demonstrated the need for more rapid improvement in seismic design standards and hazard mitigation strategies. Up until that time, improvements in design practice and proposed code changes came primarily from voluntary efforts by committees of the Structural Engineers Association of California (SEAOC), an effective but slow and arduous process. In recognition of the need to circumvent the barrier caused by the natural slowness of voluntary work, a key principle in the founding of ATC was to create an organization and structure that would pay consultants to conduct work to advance the practice and technology of structural engineering, as opposed to relying on voluntary service.

In 1973, the organization was officially established as a non-profit corporation in the State of California. The exploratory committee of SEAOC members that developed and promoted the initial concept of ATC consisted of Roland Sharpe, John Wiggins (representing Southern California) and Steve Johnston (representing Northern California). William Giles served as the initial Executive Secretary, Roland Sharpe as the first Executive Director, and William Moore as the first President of the Board of Directors. These gentlemen were instrumental in establishing the mission and organization of ATC. In the words of Roland Sharpe, the organization was "formed to seek funding to review research, decide what was useful, and convert it to a format readily useable by the practicing engineer." To this end, a critically important framework for the organization was established at the outset. This framework stipulated that (1) detailed technical work on projects be carried out by the best available technical consultants from private design practice and the research community; and (2) that their work be reviewed and guided by an advisory "blue-ribbon" Project Engineering Panel, consisting of leading specialists from structural engineering practice, the academic/research community, and the regulatory community. This framework has served ATC extremely well for more than 30 years.

Over the years the mission has evolved and it currently reads as follows: "The mission of ATC is to develop state-of-the-art, user-friendly engineering resources and applications for use in mitigating the effects of natural and other hazards on the built environment." The mission supports a loftier vision, which is "to achieve and maintain excellence in advancing science and engineering technology to protect life and property" (ATC Board of Directors Strategic Plan, January 1998). To execute this mission and vision, ATC conducts seminars and workshops, identifies and encourages needed research, and develops guidelines and manuals containing consensus opinions and broad perspective on structural engineering issues, all in a non-proprietary format. ATC is not a code development organization, although ATC project reports frequently serve as resource documents for the development of codes, standards and specifications. ATC thereby fulfills a unique role in funded information transfer.

Since its incorporation in 1973, ATC has been guided by a Board of Directors consisting of leading structural engineering and design professionals. In the early years, the Board consisted largely of representatives from the Structural Engineers Association of California, along with one representative from the American Society of Civil Engineers (ASCE) and one representative from the Western State Council of Structural Engineers Associations. Since then, as the funding environment has matured and the scope of ATC activities has widened, the Board has been reformulated to include one representative appointed by the American Society of Civil Engineers, three representatives appointed by the National Council of Structural Engineers Associations, one representative appointed by the Structural Engineers Association of New York, four representatives appointed by the regional associations of the Structural Engineers Association of California, one representative appointed by the Western Council of Structural Engineers Associations, and four at-large representatives concerned with the practice of structural engineering. Each director serves a three-year term.

Project management and administration are carried out by a full-time Executive Director and support staff, now consisting of a Director of Projects, Director of Wind and Flood Hazard Mitigation, Director of Business Development, Research Applications Manager, Operations Manager, Information Technology Manager, and Administrative Assistant.

2. PROJECT FINANCIAL SUPPORT AND TRENDS

Funding for ATC projects is obtained from government agencies and from the private sector in the form of tax-deductible contributions. In recent years, the principal funding source for ATC projects has been the Federal Emergency Management Agency (FEMA), through its earthquake hazard mitigation program. Historically, ATC has also obtained funding from the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), and the U. S. Geological Survey (USGS), which constitute (along with FEMA) the principal agencies of the U. S. National Earthquake Hazard Reduction Program (NEHRP), as well as from other Federal agencies, such as the Federal Highway Administration, the U. S. Postal Service, and the Department of Housing and Urban Development. In addition to the Federal government, funding has also been provided by a variety of other government agencies, including the Italian Department of Civil Protection (Rome, Italy), the California Department of Transportation, the California Geological Survey, the California Office of Emergency Services, the California Office of Statewide Health Planning and Development, the California Seismic Safety Commission, the Department of Building and Safety of the City of Los Angeles, and the Department of Building Inspection of the City and County of San Francisco. Funding has also been provided by private sector organizations, such as the Institute for Business and Home Safety, and the Charles Pankow Foundation.

In 1988, ATC established the *Henry J. Degenkolb Memorial Endowment Fund*, named for a dedicated structural engineer and international leader in the development of structural engineering technology who gave outstanding technical support to the Applied Technology Council and its projects. The purpose of the *Endowment Fund* is to support projects of critical interest to structural engineering design practice, for which funds are not available from traditional funding sources. Initially the fund grew very slowly, but in recent years it has benefited immensely by a very active Endowment Committee and a major fund raising activity associated with the 100th Anniversary of the 1906 San Francisco Earthquake.

While robust at the present time, the financial support for the types of projects conducted by ATC has fluctuated significantly since ATC's inception, a reflection of the historically tentative support for technology transfer projects in natural hazard mitigation. This trend in financial support for ATC project development is reflected in Figure 1, which shows fluctuations over the last three decades of the ATC Operating Reserve and the ATC Endowment Fund Balance. As indicated in Figure 1, ATC has experienced several occasions when the Operating Reserve dropped precipitously, most recently following the attacks on the World Trade Center Buildings in New York City in 2001. Fortuitously, the Operating Reserve has rebounded to acceptable levels following each downturn.

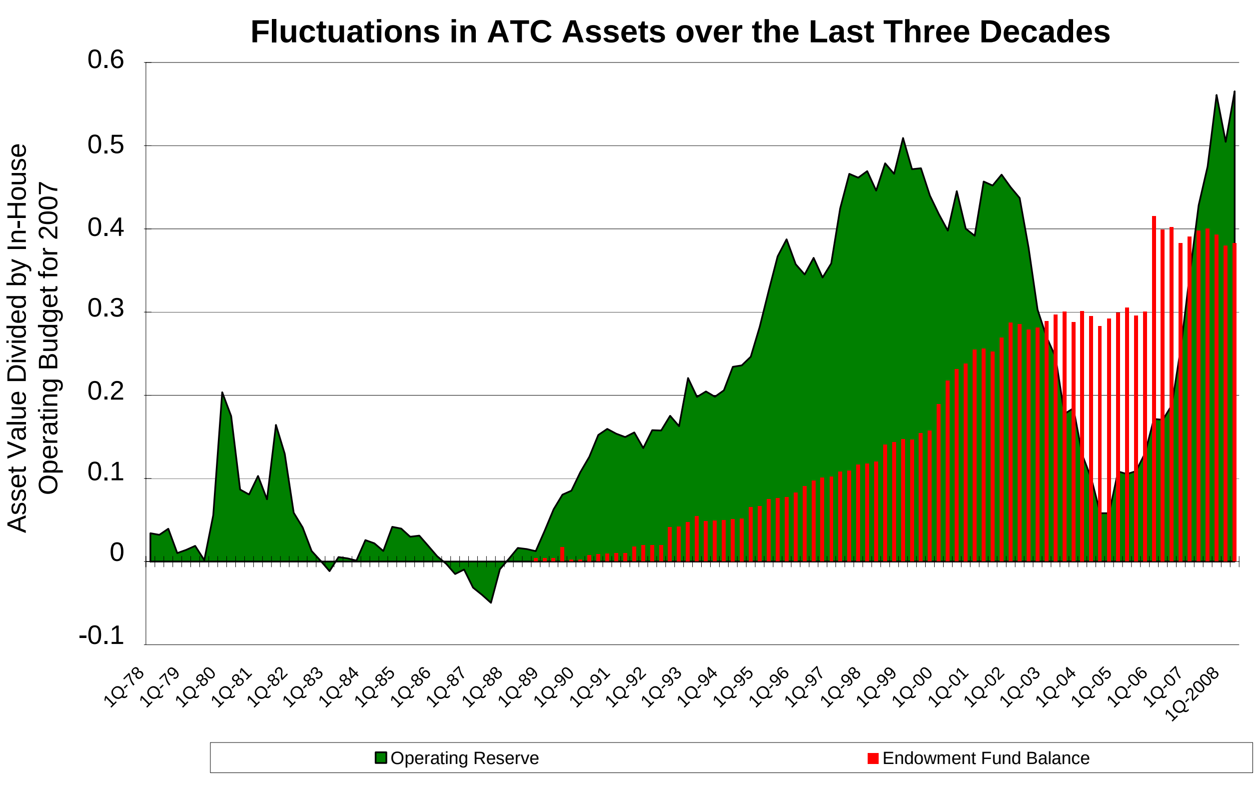

Figure 1: Fluctuations in ATC Operating Reserve and Endowment Fund Balance over the last three decades, expressed as a percentage of the ATC In-House Operating Budget for 2007.

3. ATC PROJECTS AND REPORTS: DEFINING U. S. EARTHQUAKE AND STRUCTURAL ENGINEERING PRACTICE

The Applied Technology Council conducts projects that meet the following criteria:

1. The primary audience or benefactor is the design practitioner in structural engineering.
2. A cross section or consensus of engineering opinion is required to be obtained and presented by a neutral source.
3. The project fosters the advancement of structural engineering practice.

Since its incorporation in 1973, ATC has completed more than 60 major technical projects. Until the mid 1990s the projects focused on earthquake engineering issues, but since then the scope of ATC has broadened to include projects in wind engineering, coastal engineering, and blast-resistant design. ATC projects and resulting reports have effectively defined the technical basis for earthquake engineering practice in the United States for both buildings and bridges. Widely accepted and used by the profession, these procedures address: (1) seismic design of new buildings and bridges, (2) rapid screening of buildings for potential seismic hazards, (3) detailed seismic evaluation of buildings, (4) seismic upgrade (rehabilitation/retrofit) of buildings, (5) damage prediction, (6) safety evaluation of buildings after earthquakes, and (7) detailed evaluation and repair of damaged buildings.

The reasons for ATC's success in defining earthquake engineering practice in the United States relate to a variety of factors, including (1) the process by which the documents are developed, using paid consultants working under the review and guidance of blue-ribbon advisory panels; (2) extensive quality control measures, which are implemented by ATC staff; (3) generally ample funding from federal, state, city, and private-sector agencies; (4) the availability of technically qualified specialists who are willing to work at the pay scales and under the conditions typical of ATC projects; and (5) careful editing and attention to report format and content attributes that make the reports easy to use and follow by the intended users.

Following are brief descriptions of several key ATC earthquake engineering projects and reports that now serve as the technical basis for current U. S. earthquake engineering practice.

3.1 Tentative Provisions for the Development of Seismic Regulations for Buildings (ATC-3)

Work on the ATC-3 project, development of *Tentative Provisions for the Development of Seismic Regulations for Buildings*, commenced in 1974 with funding from the National Science Foundation and the National Bureau of Standards (NBS). Encompassing four years of effort and the involvement of 85 nationally recognized experts in earthquake engineering, the final document (ATC, 1978) embodied a then-new new seismic design approach for buildings, including newly introduced response reduction factors, otherwise known as R-Factors, new ground motion maps, and other innovative features. In 1979 the Building Seismic Safety Council (BSSC) was established to gain wide acceptance of the ATC-3-06 *Tentative Provisions* and to provide a national group to address the complex regional, regulatory, technical, social, and economic issues involved in developing and promulgating technically improved seismic design regulations.

Since the late 1980s the document has been updated regularly by BSSC approximately every three years. The most recent version of the document was published in 2003 as the FEMA 450 report, *NEHRP Recommended Provisions for the Development of Seismic Regulation for New Buildings and Other Structures, Part I: Provisions,* and *Part II: Commentary*. In addition, the provisions now serve as the technical basis for the seismic provisions of the 1988 and subsequent issues of the *Uniform Building Code* and its successor document, the *International Building Code*.

3.2 Seismic Design Guidelines for Highway Bridges (ATC-6)

In 1978 the Federal Highway Administration awarded a contract to ATC to (1) evaluate then-current criteria used for the seismic design of highway bridges, (2) review available seismic research findings for design applicability and use in new specifications, (3) develop new and improved seismic design guidelines for highway bridges applicable to all regions of the United States, and (4) evaluate the impact of these guidelines and modify them as appropriate. In the resulting ATC-6 project, ATC developed a set of nationally applicable guidelines that were comprehensive in nature and embodied several new concepts, which represented significant departures from then-existing design provisions. The guidelines document, published by ATC in 1981 as the ATC-6 report, *Seismic Design Guidelines for Highway Bridges*, includes the recommended provisions as well as an extensive commentary documenting the basis for the guidelines, an example illustrating their use, a summary of the results from seismic redesigns of twenty-one bridges carried out to assess the practicability, and cost impact information.

In 1983 the ATC-6 *Guidelines* (ATC, 1981) were adopted by the American Association of State Highway and Transportation Officials (AASHTO) as a *Guide Specification*. In 1991 they were adopted as seismic provisions within the AASHTO *Standard Specifications for Highway Bridges* as Division I-A. Since then they have been used for the seismic design of all federally funded bridges.

3.3 Earthquake Damage Evaluation Data for California (ATC-13)

The 492-page ATC-13 Report, *Earthquake Damage Evaluation Data for California* (ATC, 1985), has been characterized as the "seminal" report on earthquake damage and loss estimation (Ugo Morelli [FEMA Program Officer, retired], oral communication). Funded by FEMA to provide data to estimate the economic impacts of a major California earthquake on the state, the surrounding states, and the nation, the ATC-13 report includes damage probability matrices for 78 types of representative California facilities, estimates of the time required to restore damaged facilities to their pre-earthquake usability, and estimates of expected death and injuries, expressed as a function of percent damage (repair cost divided by replacement value) and building mass.

While FEMA never completed the implementation of the originally planned economic analysis using the ATC-13 data and methodology, largely as a result of the development of the Hazards US (HAZUS) software, the ATC-13 report has been widely used nationwide for earthquake insurance portfolio analysis. Because the ATC-13 damage probability matrices are based on Modified Mercalli Intensity (MMI), and while they are based solely on expert opinion, the damage probability matrix (DPM) data are ideally suited for use in rapid damage estimation using ShakeMaps, which provide regional distributions of MMI on a real time basis (without the aid of human kind) for California and other regions of the United States. The DPM data would benefit, however, from updating to include structural damage information gathered from areas impacted by earthquakes occurring since the publication of ATC-13 in 1985.

3.4 Evaluating the Seismic Resistance of Existing Buildings (ATC-14)

In 1987, the Applied Technology Council (ATC) published the ATC-14 Report, *Evaluating the Seismic Resistance of Existing Buildings*. The document provides comprehensive practical procedures, applicable nationwide, for evaluating existing buildings to determine potential earthquake hazards and identify buildings, or components of buildings, which present unacceptable risk to human life. Included in the ATC-14 Report are a state-of-practice review; seismic loading criteria; general methodology for the evaluation of existing buildings; model building definitions and procedures for seismic evaluation of each of the model building types; procedures for seismic evaluation of nonstructural elements; illustrative examples of the use of the methodology; and field data sheets and abbreviated evaluation checklists for model building types in areas of high seismicity.

Since its publication in 1987, the document has evolved into the nation's current standard for seismic evaluation of existing buildings (ASCE 31). The evolution commenced with the publication in 1989 of the FEMA-funded ATC-22 Report, *A Handbook for Seismic Evaluation of Existing Buildings (Preliminary)* (ATC, 1989a), which underwent consensus review by the Building Seismic Safety Council, resulting in the publication of the FEMA 178 *NEHRP Handbook for Seismic Evaluation of Existing Buildings* in 1992. In 1998 the document was revised by ASCE and published as the FEMA 310 report, *Handbook for the Seismic Evaluation of Buildings – A Prestandard*. In 2003 the document was formally accepted as a national ASCE standard and published as ASCE 31, *Seismic Evaluation of Existing Buildings* (ASCE, 2003). The current procedures and model building types are refined and expanded versions of those originally introduced in ATC-14. The ATC-14 document remains a resource on the technical basis for the current procedures.

3.4 Procedures for Postearthquake Safety Evaluation of Buildings (ATC-20)

In 1989, two weeks before the Loma Prieta earthquake in the San Francisco Bay area, ATC released the ATC-20 report, *Procedures for Postearthquake Safety Evaluation of Buildings* (ATC, 1989b), and the companion ATC-20-1 *Field Manual: Postearthquake Safety Evaluation of Buildings* (ATC, 1989c). The timely distribution of the documents provided a critically needed resource for hundreds of volunteer structural engineers, building inspectors, and structural engineers from city building departments and other regulatory agencies, who were required to make on-the-spot evaluations and decisions regarding continued use and occupancy of buildings damaged by the Loma Prieta earthquake.

Since the introduction of the ATC-20 procedures in 1989, the procedures have been used after every major earthquake in California (on tens of thousands of buildings). The report is now considered the *defacto* national standard, and its wide-spread use has spawned the development of a series of reports and products designed to enhance and facilitate postearthquake safety evaluation of buildings. These include the ATC-20-2 report, *Addendum to the ATC-20 Procedures for Postearthquake Safety Evaluation of Buildings* (ATC, 1995); the ATC-20-3 report, *Case Studies in Rapid Postearthquake Safety Evaluation of Buildings* (ATC, 1996a); the ATC-20-T Postearthquake Safety Evaluation of Buildings Training CD (ATC/FEMA, 2002); the ATC-20i *Mobile Postearthquake Building Safety Evaluation Data Acquisition System* (ATC, 2003), a personal digital assistant application of the ATC-20 procedures; and most recently, the updated ATC-20-1 *Field Manual: Procedures for Postearthquake Safety Evaluation of Buildings, Second Edition* (ATC, 2005).

3.5 FEMA 154, Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook (ATC-20)

Published in 1988, the FEMA 154 Report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook* (ATC, 1988), was developed to provide a methodology, based on a sideway survey, to assign buildings to one of two categories: those acceptable as to risk to life safety or those that may be seismically hazardous and should be studied further. The methodology uses a Data Collection Form to document a building's attributes, as collected in pre-field work or observed from the street by the surveyor. The Form enables the inspector to document the number of stories, soil type and other physical attributes, identify the primary structural lateral load resisting system of the building, and assign a Basic Structural Hazard (BSH) Score for that building type and seismicity region; modify the BSH Score based on observed features that affect seismic performance; and make a determination, based on the final score, as to whether the building is potentially hazardous and needs to be further evaluated by a professional engineer experienced in seismic design.

The handbook was updated by ATC in early 2000 and published as the FEMA 154 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook, Second Edition* (ATC, 2001a). The *Second Edition* is based on feedback from users of the methodology, new data on the performance of buildings in earthquakes, and new seismic hazard mapping information, and uses a revised scoring system that is based on fragility curves embodied in FEMA's HAZUS loss estimation software. As of the year 2000, the procedure had been applied on more than 70,000 buildings nationwide (ATC, 2001b).

3.6 FEMA 273 NEHRP Guidelines for the Seismic Rehabilitation of Buildings (ATC-33)

Prepared by ATC, under contract to the Building Seismic Safety Council, involving a team of more than 60 consultants from various organizations and regions of the country, the FEMA 273 *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* were developed to serve as a tool for design professionals, a reference document for building regulatory officials, and a foundation for the future development and implementation of building code provisions and standards. The *Guidelines* enable users, on a voluntary basis, to rehabilitate buildings to meet specified performance levels (Collapse Prevention, Life Safety, and Immediate Occupancy), and performance ranges (Limited Safety and Damage Control) at specified levels of ground shaking. The

Guidelines also contain significant new features, including a Simplified Rehabilitation method, which can be applied to certain simple, regular buildings that do not exceed specified height restrictions; a Systematic Rehabilitation method (the main body of the *Guidelines*), which can be applied to any type of building at any location; new Linear Static and Nonlinear Static Procedures for analysis; procedures for determining acceptability of existing components and seismic elements; procedures for incorporating the emerging technologies of seismic isolation and energy dissipation; and procedures for seismic rehabilitation of nonstructural components and systems.

Following their publication in 1997, the FEMA 273 *Guidelines* were upgraded to prestandard status in a process carried out by ASCE and published as FEMA 356, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* (ASCE, 2000). Subsequently the document was balloted, revised, accepted as a national ASCE standard and published as ASCE 41, *Seismic Rehabilitation of Existing Buildings* (ASCE, 2006).

3.7 FEMA 306/307/308 Evaluation and Repair of Earthquake-Damaged Concrete and Masonry Wall Buildings (ATC-43)

Developed under the ATC-43 project by 26 nationally recognized specialists in earthquake engineering, the reports, *Evaluation of Earthquake-Damaged Concrete and Masonry Wall Buildings, Basic Procedures Manual* (FEMA 306), *Evaluation of Earthquake-Damaged Concrete and Masonry Wall Buildings, Technical Resources* (FEMA 307), and *The Repair of Earthquake Damaged Concrete and Masonry Wall Buildings* (FEMA 308)**,** provide field investigation techniques, damage evaluation procedures, methods for performance loss determination, repair guides and recommended repair techniques, and an in-depth discussion of policy issues pertaining to the repair and upgrade of earthquake damaged buildings with primary lateral-force-resisting systems consisting of concrete bearing walls or masonry bearing walls, and vertical-load-bearing concrete frames or steel frames with concrete or masonry infill panels. Published in 1998, the documents are intended for an audience that includes design engineers, building owners, and building regulatory officials.

4. CURRENT PROJECTS AND FUTURE DEVELOPMENTS

In recent years ATC has commenced a variety of new projects that will also have lasting impact on earthquake engineering practice. One of the major new efforts is the ATC-58 Program, under which ATC is developing, with FEMA funding, *Next-Generation Performance-Based Seismic Design Guidelines for New and Existing Buildings.* Another major new effort, which commenced in 2007, is a multi-year research and development project in earthquake engineering funded by NIST and carried out by the NEHRP Consultants Joint Venture, a partnership of ATC and the Consortium of Universities for Research in Earthquake Engineering (CUREE). In addition, ATC is conducting a variety of other projects for FEMA under two recently awarded multi-year Seismic and Multi-Hazard Technical Guidance Development and Support Contracts. These efforts include a major project (ATC-63) to develop a methodology for computing building system performance and response parameters (R factors and other design variables), a major project (ATC-64) to develop design guidance for special facilities for vertical evacuation from tsunami (completed in 2008), and a series of training, planning, and public outreach efforts on building seismic hazard mitigation methods and issues. Following are brief descriptions of the ATC-58 Program and NEHRP Consultants Joint Venture efforts.

4.1 Next-Generation Performance-Based Seismic Design Guidelines for New and Existing Buildings (ATC-58)

The long-term project to develop next-generation performance-based seismic design guidelines for new and existing buildings, commenced in 2001. The project is expected to require up to 15 years to complete and is being conducted in several phases, as resources become available. During the initial 5-year funding phase, ATC completed the first major program product, the FEMA 445 *Program Plan for Development of Next-Generation Performance-Based Seismic Design Guidelines for New and Existing Buildings*, and commenced development of *Guidelines for Seismic Performance Assessment of Buildings*, the second major project product. The assessment procedures will enable design professionals to estimate the potential earthquake casualty, economic, and occupancy losses associated with an existing building, or the proposed design for a new building, in a variety of formats useful to building owners, lenders, insurers, tenants, and other decision makers. Loss functions will be provided for three basic stakeholder-identified parameters: casualties, repair cost (dollars), and/length of time of lost service or occupancy (downtime). The products of this first phase will be directly useful to improving current seismic design practice and producing more loss-resistant construction.

The second phase of the ATC-58 Program will focus on the development of engineering design guidelines for design professionals and performance decision tools for stakeholders. The decision tools will assist decision makers to select appropriate performance criteria for individual buildings and broad classes of buildings, consider-ing the costs of providing enhanced or more reliable protection against loss and the benefits of future avoided losses. The engineering guidelines will assist design professionals to select appropriate design strategies and preliminary designs, which can then be refined using the performance assessment tools developed in the first phase.

4.2 NEHRP Earthquake Structural and Engineering Research (ATC-CUREE Joint Venture)

Work on the NEHRP Earthquake Structural and Engineering Research program, which commenced in late 2007 and is being carried out under an indefinite delivery/indefinite quantity task order contract, will be based on a "roadmap" for implementing a problem-focused research and development program in earthquake engineering that was developed by representatives of the design and construction industry, under ATC's leadership. The roadmap and its basis are described in the ATC-57 Report, *The Missing Piece, Improving Seismic Design and Construction Practices* (ATC, 2003). The roadmap emphasizes two program areas, with a total of five Program Elements:

- *Systematic support of the seismic code development process.*

  Program Element 1 Provide technical support for the seismic practice and code development process.

  Program Element 2 Develop the technical basis for performance-based seismic engineering by supporting problem-focused, user-directed research and development.

- *Improve seismic design and construction productivity.*

  Program Element 3 Support the development of technical resources (e.g., guidelines and manuals) to improve seismic engineering practice.

  Program Element 4 Make evaluated technology available to practicing professionals in the design and construction communities.

  Program Element 5 Develop tools to enhance the productivity, economy and effectiveness of the earthquake resistant design and construction process.

To date under the program NIST has funded task orders for four projects: (1) two projects to conduct beta testing of the ATC-63 procedures for determining structural system specific R Factors; (2) a project to develop Technical Briefs on the seismic design of moment resisting concrete frame buildings and steel moment frame buildings; and (3) an initial (phase 1) project to develop seismic design guidelines for port and harbor facilities.

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