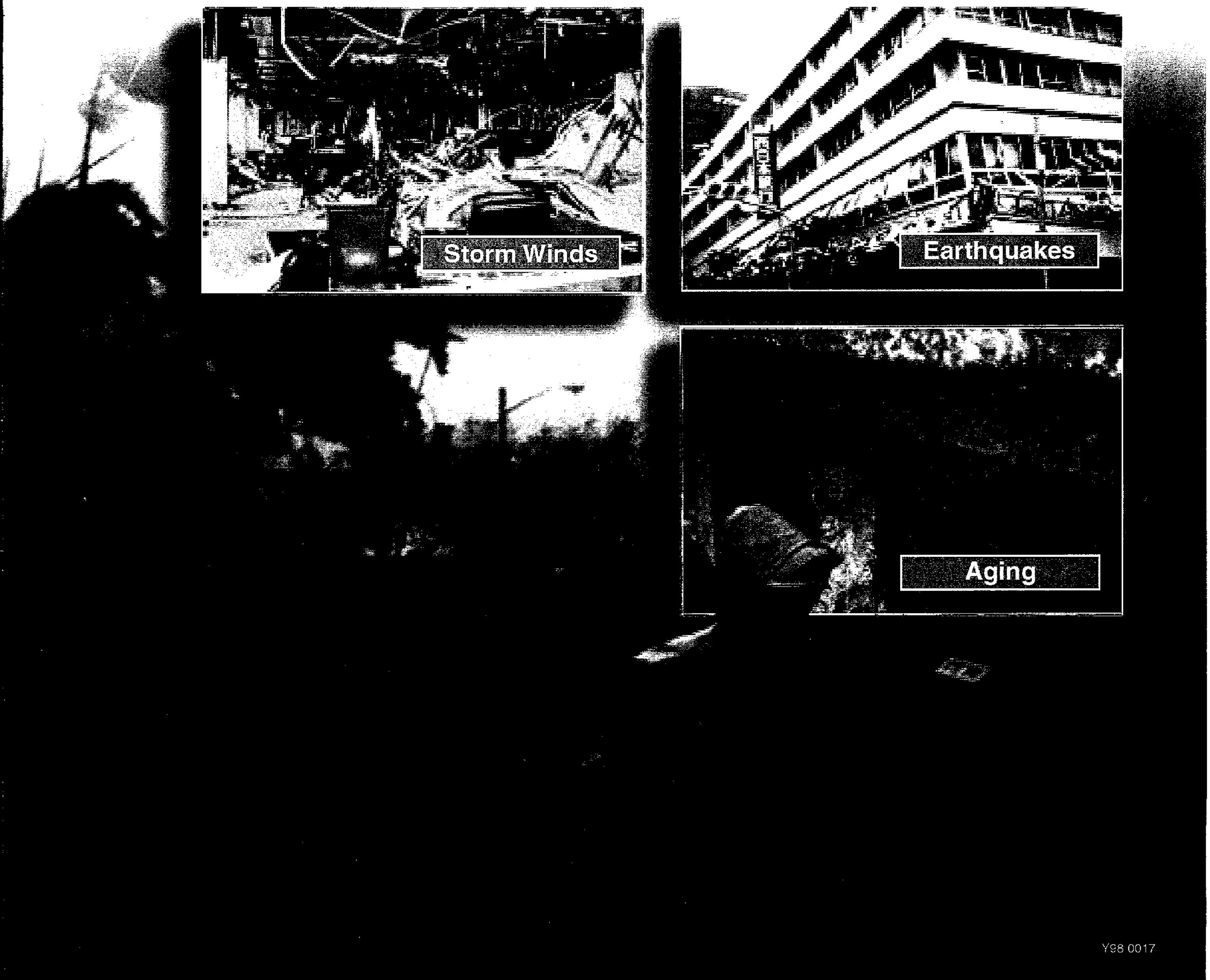
INEEL/EXT-98-00213

Program Plan

for

The Partnership for Natural Disaster Reduction



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Partnership for Natural Disaster Reduction Program Plan

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February 1998

Partnership for Natural Disaster Reduction Program Plan

Revision 0

This document describes an effort to bring together many organizations and individuals to reduce the loss of life, property damage, and disaster costs resulting from the effects of natural hazards on man-made structures.

As the Partnership continues to grow, this document will change and expand to reflect the input of many participants. This document will be publicly posted electronically and comments will be incorporated. Revisions will occur on four month intervals.

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The Partnership for Natural Disaster Reduction

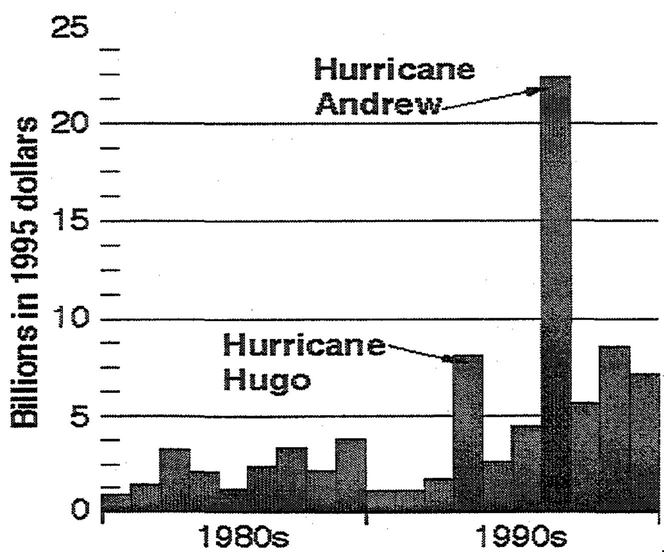
1. INTRODUCTION

Worldwide, economic disaster damages have tripled in the past 30 years.

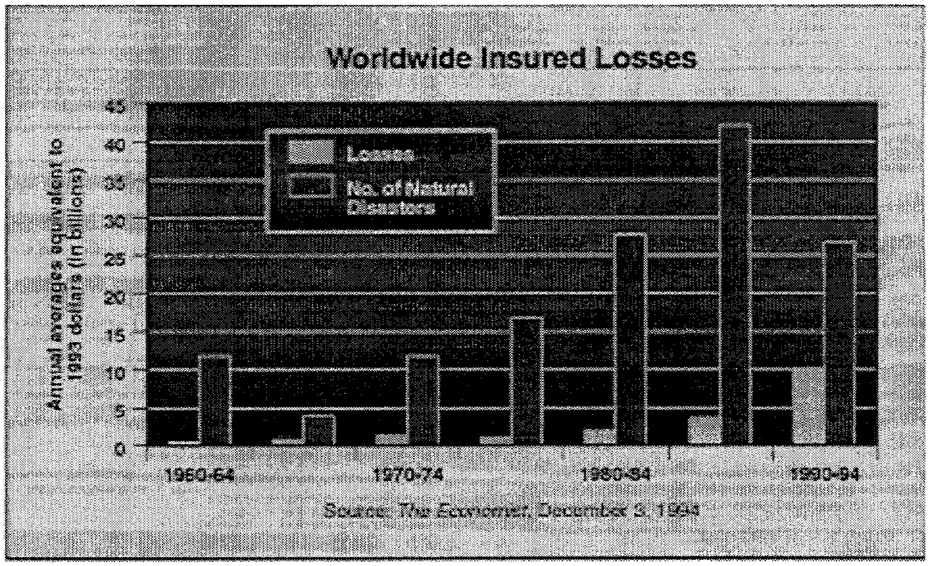
Over the last decade, nearly 90% of the property losses have resulted from windstorms and about 4% from earthquakes.

In a matter of minutes, a natural disaster completely changes people's lives. For example, 9,750 lives were lost in the 1993 Latur, India earthquake, 106,000 homes were destroyed in the 1995 Hanshin-Awajii (Kobe) Japan earthquake, and over 8000 jobs/businesses were either disrupted or terminated during Hurricane Andrew. Worldwide, economic disaster damages have tripled in the past 30 years — rising from $40 billion in the 1960's to $120 billion in the 1980's. Potential losses and recovery costs continue to rise because of rapid population growth, urban expansion, and increased new construction concentrated in high-risk areas.

In the U.S., economic losses from 1989 to 1994 resulting from hurricanes and earthquakes exceeded more than $100 billion. With the exception of floods, severe windstorms annually cause more damage than earthquakes because they occur more frequently. On average, 350 lives are lost every year as a result of windstorms. Over the last decade, nearly 90% of the property losses have resulted from windstorms and about 4% from earthquakes. The unexpected vulnerability of many homes, the high number of pay-outs by insurance companies, and the resulting difficulties of getting affordable insurance coverage following Hurricane Andrew in Florida further emphasized the need for the United States to aggressively put more efforts into wind-related pre-disaster mitigation. Everyone shares the burden of recovery in the form of increased taxes for federal assistance and higher insurance premiums.



U.S. wind-related losses are increasing at an alarming rate.



> *The Partnership will: develop, validate, and implement pre-disaster mitigation technologies.*

In response to these critical national and international needs, the Partnership for Natural Disaster Reduction (the Partnership) is defining a national program which has the mission to develop, validate, and implement technologies that will reduce damage to structures, buildings, and infrastructure elements resulting from windstorms, earthquakes, and aging processes. The Partnership was created by the Federal Emergency Management Agency (FEMA) and the U.S. Department of Energy's (DOE) Idaho National Engineering and Environmental Laboratory (INEEL). Its vision is to reduce the loss of life, property damage, and disaster costs resulting from the effects of natural hazards on man-made structures. Industrial partners, universities, national and international organizations, and United States federal and state government agencies are sharing leadership of this public-private partnership, each contributing crucial expertise to address the critical needs faced by this nation and other nations in the destructive path of natural disasters.

Industry, universities, international organizations, and government, each contribute crucial expertise.

The Partnership is focusing its first efforts on reducing heavy losses and damage associated with severe windstorms such as hurricanes or typhoons. In the future, it will also address reducing the damage caused by earthquakes and weathering and deterioration processes which age structures. The Partnership will find and develop affordable damage reduction technologies, validate their success by testing under repeatable, controlled, actual hazard conditions, and implement these proven affordable mitigation technologies worldwide. Each is required to successfully achieve the best and most cost-effective, reliable, hazard mitigation solutions in the shortest amount of time.

Affordable technologies must be developed. Structural failures must be understood.

Develop New Designs and Technologies — Recent disasters revealed that structures can fail in unexpected ways. Structural failures must be understood to reduce the vulnerability of the nation's multi-trillion-dollar inventory of homes, office buildings, schools, hospitals, government facilities, industrial complexes, lifelines, and communication systems. Affordable and cost-effective mitigation technologies must be developed.

As part of this effort, the Partnership will collect and analyze past disaster observations and data to acquire a comprehensive understanding of structural failures. The expertise of the members in the Partnership will facilitate developing the affordable mitigation technologies.

The Partnership, through the DOE and INEEL, is funding several projects in support of developing mitigation technologies:

- Texas Tech University is working with Clemson University to design and build wind measurement instrumentation stations on trailers that can be deployed in the path of a storm.
- University of Wyoming is developing engineering design tools for mobile home-type structures using laboratory investigation and full-scale field test data.
- Washington State University is developing non-linear models of metal fastener/wood connections.
- M.I.T. is assessing material degradation mechanisms on residential roofing to determine how the rate and effects of aging can be evaluated.
- University of Utah is developing and testing methods for reinforcement of concrete joints with carbon fiber composites for durability and earthquake resistance.

Validate New Designs and Technologies — Mitigation technologies, structural designs, construction practices and modeling tools must have their effectiveness validated prior to being considered for implementation. Testing is essential to provide a technical baseline upon which to prove the value and effectiveness of the products for commercialization and implementation.

Mitigation technologies, structural designs, construction practices and modeling tools must be validated.

To address this need, the Partnership will validate mitigation technologies by testing small-scale infrastructure elements and full-size structures at university, government, and industry laboratories. Eventually, computer simulation will replace some of the physical testing as advances are made in software tools. Because adequate full-size test facilities do not exist now, the Partnership is pursuing the development of a "user" facility known as the Disaster Prevention Center (see Section 3.). The Disaster Prevention Center is being developed in three phases:

Phase 1 — The Windstorm Simulation Center will subject full-scale two-story buildings (or equivalent structures) to category 5 hurricane winds.

Phase 2 — The Preconditioning and Aging Center will focus on weathering and deterioration processes.

Phase 3 — The Earthquake Simulation Center will simulate ground shaking like that observed near an earthquake fault.

Public educational or news media programs will broadcast the tests as they occur. One of the purposes for the media demonstration of the tests is to motivate the public to take an active role in protecting homes and other facilities before a hurricane or earthquake occur. Also, following a full-size test, disaster response personnel can safely practice rescue operations in damaged structures or building code inspectors and insurance adjusters can safely observe the resulting damage.

Currently, the Partnership has completed (and peer-reviewed) a conceptual design report for the Windstorm Simulation Center. For development of the concept, Clemson University has performed tests on a conceptual a bench scale model and the INEEL is constructing a 1/20th scale model. Additional work for development includes a thorough evaluation of the power requirements and aerodynamic design to optimize flow characteristics.

Several customers have expressed a willingness to test their products or to use the test center for other purposes. For example, New Necessities has expressed interest in testing fiber wrap products and the American Red Cross is interested in using the facility for disaster response training.

Results must be implemented in a significant fraction of homes. Only affordable and proven designs, retrofit approaches, and construction practices will be implemented.

Implement New Designs and Technologies — Affordable and proven mitigation technologies must be put into use (or implemented) by many communities to reduce the suffering and losses currently experienced as a result of natural disasters. Nearly half of the United States is vulnerable to severe windstorms and other areas are vulnerable to earthquakes. Projected losses are quickly becoming unmanageable (e.g., $75 billion estimated loss if a hurricane impacts Miami).

The Partnership will put into use the affordable proven pre-disaster mitigation technologies through the Partners at community levels, by technology deployment centers like those envisioned by Centers for Protection Against Natural Disasters (CPAND), and through agencies specializing in public education such as FEMA. Validated technologies, such as proven designs, retrofit approaches, and construction practices will be provided to the private sector and advocated for incorporation into codes. They will be provided to communities taking actions to protect themselves against natural disasters such as currently offered by the Federal Emergency Management Agency under "Project Impact."

Validated products will motivate the public to take an active role in protecting homes and other facilities.

Currently, the Partnership is educating engineering professionals, national organizations, and the public about its capabilities. Several (e.g., Centers for Protection Against Natural Disasters —CPAND; State of Florida Department of Community Affairs; American Public Works Association; American Red Cross; and the Applied Technology Council) have expressed a willingness to use or disseminate the affordable proven fixes.

The Partnership — At this time, those who are contributing time, resources, and expertise to the Partnership include:

AON Group
Factory Mutual Research Corporation
Integrated Structural Engineering Consultants, Inc.
Federal Emergency Management Agency
Department of Energy
National Oceanic and Atmospheric Agency
Idaho National Engineering and Environmental Laboratory
National Roofing Contractors Association
Florida State University System
International Hurricane Center
Clemson University
Colorado State University
CPAND
Georgia Institute of Technology
Louisiana Tech University
Massachusetts Institute of Technology
Mississippi State University
Texas Tech University
Texas A&M University
University of Alaska
University of New Orleans
University of Notre Dame
University of Utah
University of Wyoming
Washington State University

The Partnership is coordinating support for the national program from industry, U.S. federal agencies, national and international organizations, and universities. Industrial and university partners are providing in-kind support to the Partnership, contributing resources for activities ranging from program development to design of test facilities. Several industries have expressed interest to augment existing resource allocations by the federal government and other institutions to develop mitigation technologies. U.S. federal agencies and international organizations will support validation activities through testing of both small-scale infrastructure elements and full-size structures at university, government, and industry laboratories. Products of the Partnership (i.e., validated technologies) will be implemented by state and local communities, industry, federal agencies, and international organizations.

The Partnership will provide the necessary tools to affordably and reliably decrease the vulnerabilities to natural disasters.

The Partnership, through its national program, will provide the necessary tools to cost-effectively and reliably decrease the vulnerabilities of the nation's multi-trillion-dollar infrastructure inventory to natural disasters. Developing and validating pre-disaster mitigation technologies will result in:

- Proven upgrade techniques and retrofit practices
- Direct correlation of windstorm and earthquake intensities to the resulting structural and contents damage
- Refinement of computer simulations and design tools
- Improvement of standardized product evaluation procedures
- Development of proven designs for new construction
- Validation of building codes and construction practices
- Affordable proven hazard-resistant products
- Public demand for use of proven mitigation methods

Implementing the affordable, proven, pre-disaster mitigation technologies in all communities will:

- Save lives
- Reduce damage to homes, buildings, and structures
- Shorten recovery times
- Decrease business interruptions
- Improve risk data
- Reduce economic burdens
- Simplify design codes
- Energize public support

2. HOW THE PARTNERSHIP IS ORGANIZED AND OPERATES

2.1 Overview

The vision and mission of the Partnership address the national and international efforts to reduce the impacts of natural disasters.

Vision – Reduce loss of life, property damage, and disaster costs resulting from the effect of natural hazards on man-made structures.

Mission – Develop, validate, and implement new designs and technologies that will reduce damage to structures, buildings, and infrastructure elements resulting from windstorms, earthquakes, and aging processes.

The Partnership is organized with a Governing Council, a Director, an Advisory Committee, and six working groups (See Figure 2.1) operating as a non-legal entity under a multi-agency agreement between DOE and FEMA. The Governing Council will be comprised of representatives of the Partners (See Section 2.2) and will appoint one of its members as the Director to serve for a one-year term. The Advisory Committee will be comprised of representatives of the Partners and world-class technical advisors.

Using data from natural disasters compiled by the Partnership's Technical Information Group, the Director and Governing Council will identify general problem areas relating to the failure of structural and nonstructural systems during severe windstorms and earthquakes that require resolution. Using this general guidance, technical representatives from the Partnership's members will propose projects to be undertaken by the Partnership to resolve these structural failures. These proposals will be submitted to the Advisory Committee for review. The Committee will provide a prioritized list of recommended projects to the Director for implementation. The Director will consider the recommendation of the Committee and approve proposals for funding and implementation by the Partnership. The approved proposals may be managed by a principle investigator from one of the members of the Partnership or, for large projects, may have a project manager assigned from the Project Management Group of the Partnership.

A detailed project plan will be developed by the manager and approved by the Director and Governing Council prior to project execution. The project plan may include a combination of evaluation of an existing technology, data generation, applied research, engineering development of a hardware and/or software product, test and evaluation, and technology implementation. The project plan may also include methods of

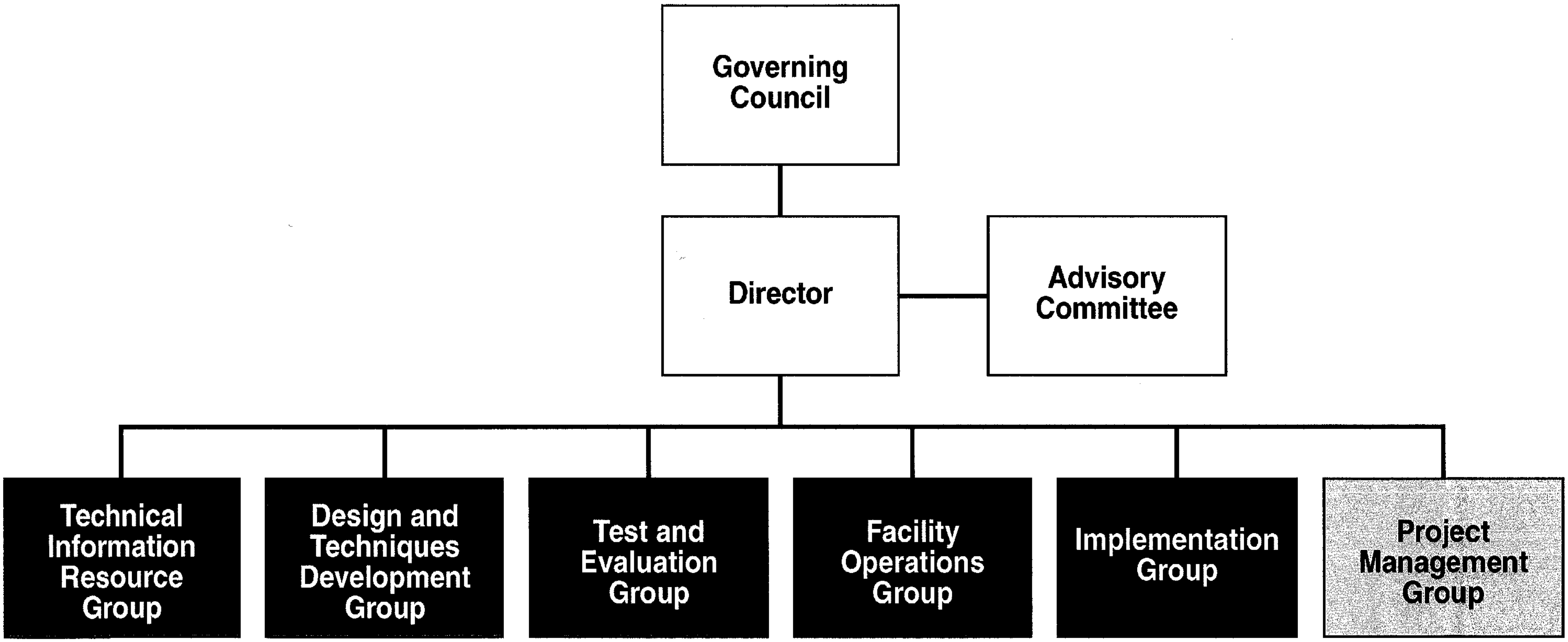


Figure 2.1. Organization Chart for the Partnership

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accomplishing the project such as subcontracts solicited through requests for proposals, collaborations between Partners, or the use of full-time staff of the Partnership.

If the objective of the project is mitigation technology, the technology must be validated through laboratory testing or field testing. The method used to validate the technology will be determined in the project plan. The validation can either be performed at Partner facilities, the Partnership's Disaster Prevention Center, or other locations. Proven, validated technologies will also be evaluated for cost/benefit. If technologies are viable, an implementation plan will be developed. The Partnership must approve the implementation plan before it is executed.

Funding for Partnership projects will be the responsibility of the Governing Council. Sustained funding will be required for program development and administrative costs and will cover many of the specific technical projects. There may be situations where the Partnership management raises funds for a single specific project of interest to only a subset of the Partnership.

The Partnership organizers anticipate that the Governing Council will modify the organization described here to meet the needs of the partners. Also, a formal operating Partnership charter will be developed when the Governing Council is established and funded. For continuity, a small permanent staff of 30–50 personnel will eventually be required for operation of the Partnership. Most functions will be carried out by employees from the Partners who serve part or full time for the duration of specific projects. The management staff of the six working groups will be held to a minimum (1-3 personnel each) and will have the primary task of ensuring that the work carried out by the Partnership team is fully integrated.

The six working groups carry out the work defined by the Director. These groups operate under the titles of Technical Information Resource, Design and Techniques Development, Test and Evaluation, Facility Operations, Implementation, and Project Management. They are described more fully below.

2.2 Setting Up The Partnership

The United States Department of Energy and the Federal Emergency Management Agency created the Partnership to reduce loss of life, property damage, and disaster costs resulting from the effects of natural hazards on man-made structures. The Partnership brings together industry, academia, and federal, state, and local government to share in developing proven and cost-effective hazard mitigation measures. The primary Partnership categories are as follows:

- **Sustaining Partners**
  - Provide the sustaining financial or in-kind support to engineer, design, build, operate, and maintain the Partnership mission including the Disaster Prevention Center test facilities.
  - Expected to be large federal agencies such as Department of Energy and Federal Emergency Management Agency (primarily agencies specifically chartered to reduce the effects of natural disasters), foreign and domestic major industries, and the States.
- **Contributing Partners**
  - Provide financial or in-kind support (such as technical personnel, test hardware, or equipment) for Partnership operations or for specific projects.
  - Expected to be federal and state agencies, private sector entities, and other partners such as insurance companies and the housing industry.
- **Associate Partners**
  - Non-funding participants that advance the Partnership mission.
  - Expected to be universities, humanitarian agencies, building code committees, research organizations, technical societies, and individuals.
  - May be funded to collaborate on Partnership projects, e.g., university faculty performing problem specific research.

2.3 Policy Setting and Organization of the Partnership Administration

The organization, roles, and responsibilities of the Partnership are summarized in Figure 2.2. Details of the functions of the Partnership are available in Appendix A.

2.3.1 Governing Council

The Governing Council is the controlling body of the Partnership. The Council is comprised of representatives from the Partners. The Council sets policy, determines goals and objectives, guides the direction of the Partnership, and approves the annual operation plan. The Council elects one Council member to serve as the Director.

2.3.2 Director

The Director is responsible for the organization and successful operation.

The Director is appointed by the Council. He/she is responsible for the successful organization and operation of the Partnership and its facilities. The Director is the principal point of communication and interaction with the Governing Council, the Advisory Committee, and all

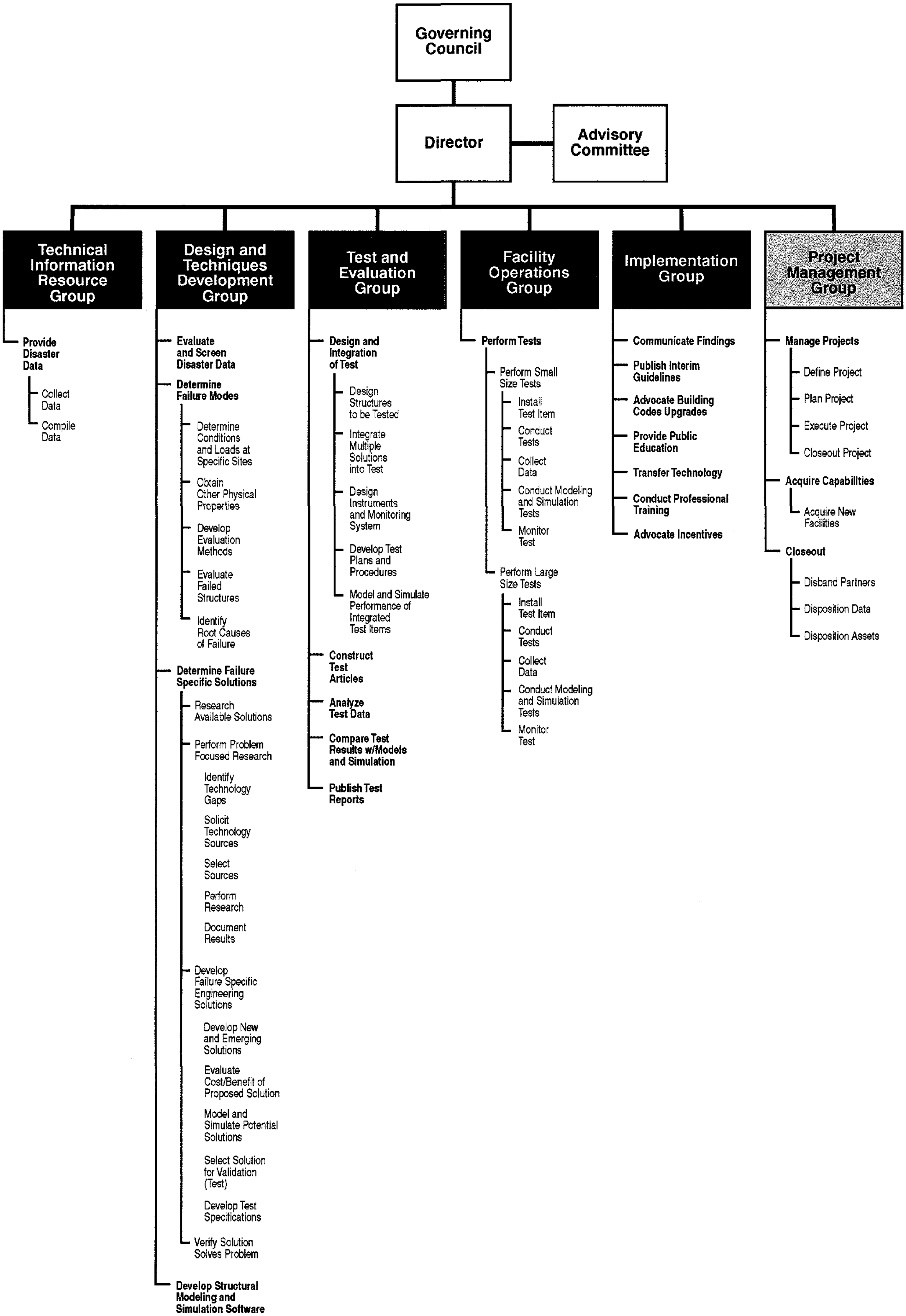


Figure 2.2 Partnership Roles and Responsibilities

agencies/ organizations external to the Partnership. Responsibilities include:

- Developing and managing the implementation of the Partnership Strategic Plan incorporating the policy and meeting the objectives as defined by the Governing Council.
- Submitting an annual operating plan to the Governing Council for approval.
- Approving and implementing the projects to be conducted by the Partnership.
- Appointing the members of the Advisory Committee.
- Managing the approved cost, schedule, and technical performance baselines.
- Maintaining interaction with the technical community.

2.3.3 Advisory Committee

The Advisory Committee is comprised of Partner representatives and world-class technical advisors invited by the Director. The Committee advises the Director and Governing Council on technical development and implementation of projects. They perform independent technical peer reviews for technical proposals, documents, and reports as requested by the Director. They also advise the Director and Governing Council on implementation of policy and project operational elements.

2.4 Organization of the Six Working Groups

2.4.1 Technical Information Resource Group

The Technical Information Resource Group collects, stores, and compiles disaster research and test data. From this central repository, the group provides on-line data search and retrieval capabilities.

2.4.2 Design and Techniques Development Group

The Design and Techniques Development Group is the technical projects group who recommend projects to mitigate disaster risk. Responsibilities include:

- Determining the root causes of structural component failures.
- Developing potential failure-specific solutions.
- Identifying and overseeing problem-specific research.
- Developing structural modeling and simulation software
- Verifying solutions solve the identified problem.

2.4.3 Test and Evaluation Group

The Test and Evaluation Group designs the test project, integrates the project with the test resources, and constructs the test. Responsibilities include:

- Analyzing test data and publish results.
- Comparing test results with modeling and simulation results.

2.4.4 Facilities Operations Group

The Facilities Operations Group responsibilities include:

- Performing all tests at the Disaster Prevention Center
- Maintaining and upgrading all Disaster Prevention Center facilities.

2.4.5 Implementation Group

The Implementation Group communicates Partnership findings, including interim guidelines, to groups, publications, or other entities whose function is to implement changes in construction techniques. Their responsibilities include:

- Advocating building code upgrades.
- Providing public education.
- Licensing developed techniques and software.

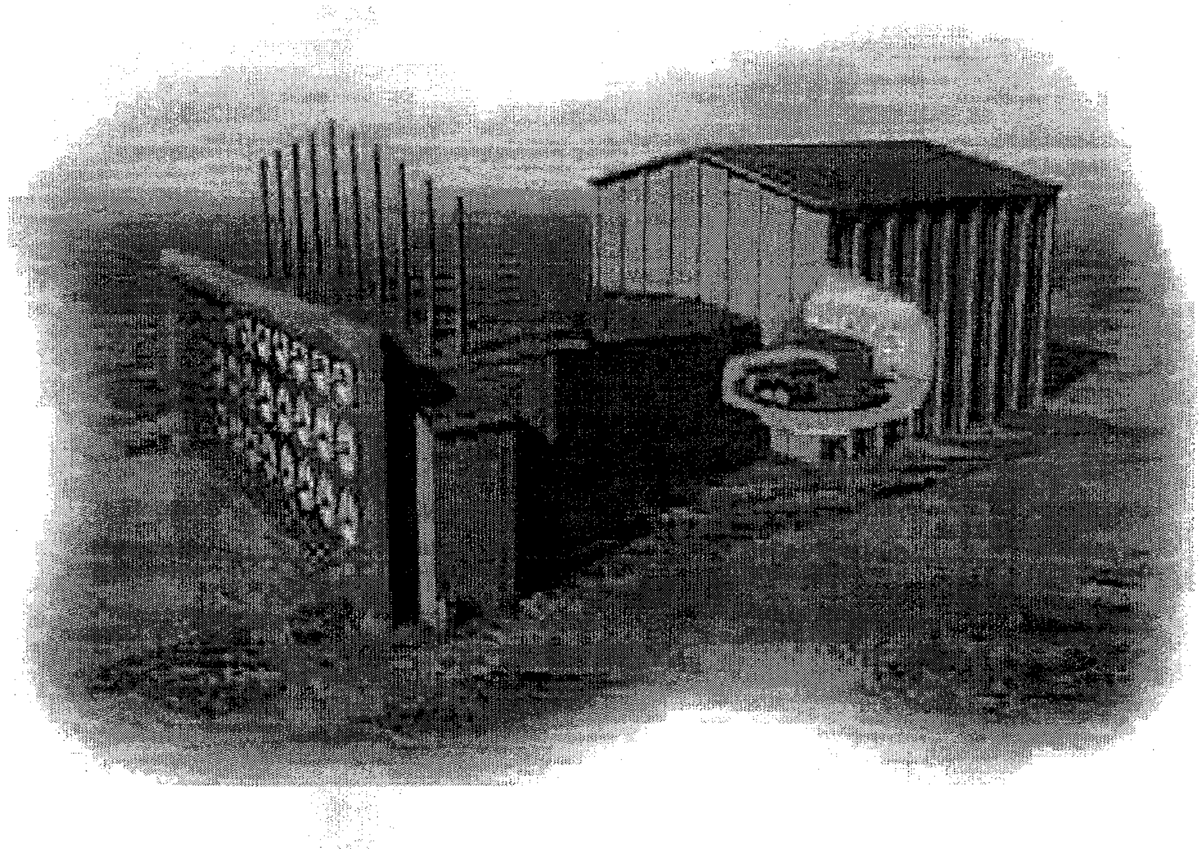
2.4.6 Project Management Group

The Project Management Group responsibilities include:

- Managing construction of the Disaster Prevention Center facilities.
- Managing specific project design, verification, and implementation.
- Managing disposition of the Partnership assets when no longer needed.

3. PARTNERSHIP FACILITIES

The Disaster Prevention Center



Mitigation technologies, structural designs, construction practices and modeling tools must have their effectiveness in reducing damage resulting from windstorms, earthquakes, and aging processes validated prior to being considered for implementation. Testing is essential to provide a technical baseline upon which to prove the value and effectiveness of the products for commercialization and implementation.

To address this need, the Partnership will validate mitigation technologies by testing small-scale infrastructure elements and full-size structures at university, government, and industry laboratories. Eventually, computer simulation will replace some of the physical testing as advances are made in software tools. Because adequate full-size test facilities do not exist now, the Partnership is pursuing the development of a "user" facility known as the Disaster Prevention Center. The Disaster Prevention Center is being developed in three phases:

HomeSaver: testing homes under hurricane conditions.

Phase 1 — The Windstorm Simulation Center (shown above) will subject full-scale two-story buildings (or equivalent structures) to sustained winds up to about 155 miles per hour and gusts up to 200 miles per hour with realistic turbulent gust structures and injection of water at up to 8 inches per hour. One of the first Partnership projects will focus on testing homes under hurricane conditions and is referred to as the "HomeSaver Project."

Phase 2 — The Preconditioning and Aging Center will focus on weathering and deterioration processes and their effects on structural integrity. The center will have the capabilities for temperature cycling, humidity control, replication of marine environments, ultraviolet exposures, and chemical attacks on large-size structural elements and materials.

Phase 3 — The Earthquake Simulation Center will simulate ground shaking like that observed near an earthquake fault.

The Control and Data Acquisition Center will be the hub for pretest simulations, control of tests, collection of test data, post-test analyses, and dissemination of results for all the testing centers. During all phases, components of the Control and Data Acquisition Center will be developed.

The Disaster Prevention Center will be managed by the Partnership so that Partnership projects will have priority access. However, the Disaster Prevention Center will be open to any organization interested in purchasing test time and space. It is envisioned that the Disaster Prevention Center will have a wide variety of applications beyond testing buildings and structures such as validating energy efficiency technologies in real world environments.

The National Research Council stated, "The resistance of small structures, such as wood frame buildings, small office buildings, and masonry buildings to wind loads is currently difficult to predict. Model versions of these structures cannot duplicate their complicated failure modes. Physical modeling facilities are needed in which simulated wind loads can be applied to full scale models of such smaller structures." A 1995 workshop brought together insurers, wind engineers, and wind researchers who confirmed the need for full-scale wind testing. The Workshop participants defined initial performance requirements, recommended types of tests, and identified specific products and applications for a windstorm simulation center. These requirements were refined through two open meetings in 1996 and 1997.

The Windstorm Simulation Center with the Control and Data Acquisition Center are the highest priority for new facilities because wind damage mitigation is urgent in the United States. Insurance industries estimate that 90% of losses due to natural disasters is related to wind while only about 10% of research money is allocated to wind-related technologies. It is expected that the United States government will fund this facility.

A brief description of the Windstorm Simulation Center and the Control and Data Acquisition Center follows:

3.1 Windstorm Simulation Center

The Windstorm Simulation Center will subject one- or two-story buildings (or structures within these dimensions) to winds encountered in a category 5 hurricane. This translates to turbulent storm winds with gusts up to 200 miles per hour, pelting rain up to 8 inches per hour, and airborne debris (airborne debris is not included in phase 1 but will be added later). Test structures will be mounted on a turntable to enable testing of wind damage to all sides, or to simulate the passage of a hurricane eye wall. Supporting infrastructure for the facility includes visitor and observation areas, test specimen construction pads, a maintenance/materials storage warehouse, and posttest display and tear down pads. Design and construction will allow future expansion of the facility to simulate hail, snow, ice storms, and tornadoes.

3.2 Control and Data Acquisition Center

A Control and Data Acquisition Center will include control systems for the test centers, data acquisition, test data analysis, and simulation activities. It will provide office space and training facilities. It functions as the nerve center for all planned phases of the full-scale testing programs. By electronic link with the Control and Data Acquisition Center, technology centers and universities will be able to participate in and observe the full-scale tests.

3.3 Non-INEEL (Existing) Facilities

Existing facilities provide capabilities for scale modeling, simulation, and component testing. The Partnership will use existing facilities whenever possible. The Partnership will identify existing facilities and their capabilities and enter into agreements with their owners/operators to use these facilities to meet Partnership validation needs. Selection or decision to use existing capabilities is project specific. The intent is to integrate all capabilities to maximize effectiveness at the least possible cost.

4. INTERNATIONAL RELATIONS

International participants are encouraged to become Partners. Active participation of leading scientists from around the world will facilitate the development of the full potential of the Partnership. A primary international objective for the Partnership is to share the benefits and the responsibility of the development, construction, and operation phases of the Partnership programs and the Disaster Prevention Center. This will be achieved in a manner that is commensurate with the international partner's scientific and engineering strengths and resources. Formal relationships between the Partnership and international partners will be developed on a individual basis and in accordance with government-to-government agreements

PNDR major milestones can be accomplished in nine-months – be ready to start detailed design.

5. PROGRAM SCHEDULE

The program schedule presents the major milestones for establishing the Partnership. Since the schedule is determined by funds availability, the schedule shows periods of time between milestones. Construction and operation of the facilities are single events in this schedule but will have more detailed schedules in the facilities plan. Figure 5.1 lists milestones.

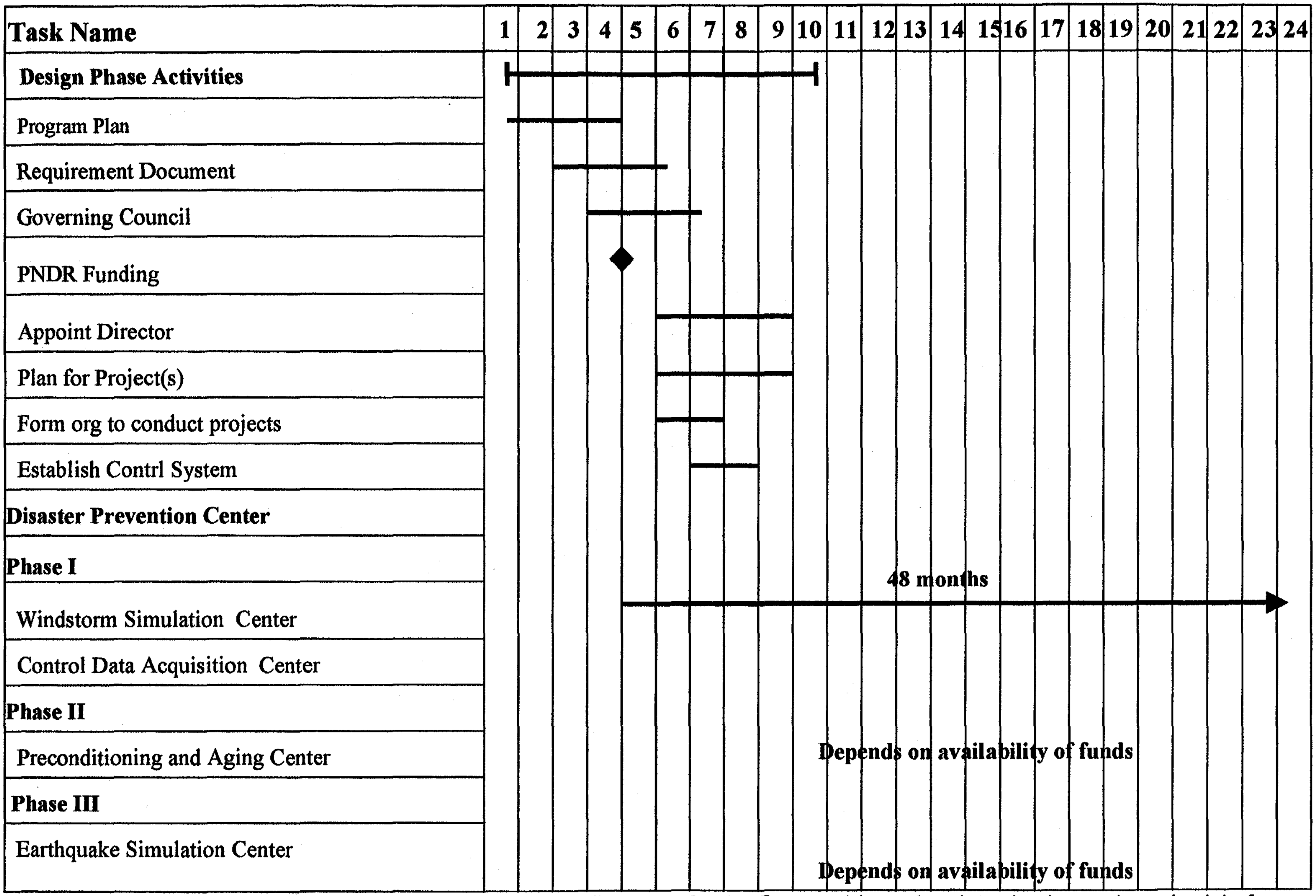


Figure 5.1. Schedule. The schedule depicts the major milestones for the Partnership and an introduction to the schedule for Phase I, the Windstorm Simulation Center.

Partners are using discretionary funds to plan, but serious funding is required to be ready for detailed design.

6. PROJECT COST ESTIMATE

Funding for the initial program activities such as program documentation, technical planning meetings and proposals is borne by the initial members of the Partnership. The Partnership is guiding the use of funds to universities and researchers to provide technical data to be used in determining alternatives and selecting the preferred alternative. Substantial funding from government partners is necessary to establish the Partnership and to begin design of Phase I, the Windstorm Simulation Center and the Control and Data Acquisition Center.

A preliminary cost estimate was developed to support Phase I construction. The Conceptual Design Report contains the cost estimate of $181 million for the Windstorm Simulation Center, the Control and Data Acquisition Center, and the supporting infrastructure. The Data Acquisition Center and infrastructure will also support Phase II, the Preconditioning and Aging Center, and Phase III, the Earthquake Simulation Center. The cost estimate serves as a point of comparison for alternatives to be analyzed.

7. PROJECT CONTROL SYSTEM

The Director has the authority and responsibility to develop and maintain management planning, measurement and control criteria, and applicable procedures.

7.1 Baseline Management Approach

The Partnership will use a baseline management approach, in-process technical reviews of the project design and development, and approval of key specifications and program documents. The Project Management Group will develop and document project baselines that address technical, cost, and schedule parameters. Proposed changes to the cost, schedule, and technical baseline will be reviewed and approved through the change control process prior to implementation in accordance with the configuration management and change control procedures discussed in Section 8.0 of this plan.

7.2 Monitoring Of The Baseline

Monitoring of the baseline will be performed using the following tools and processes:

- Cost and Planning System
- Projected and expended costs comparison curves
- Monthly performance measurement data

7.3 Work Authorization

A work authorization may cover research and development, engineering design, procurement, construction, or a combination of these. Prior to commencement of work by subcontractors, the Partnership will issue a written work authorization that provides a definitive statement of work. This description will state form, fit, and functional requirements, budget, and schedule (start and complete dates as a minimum, interim milestones are preferable). The final step is approval or notice to proceed authorizing the expenditure of funds.

8. CONFIGURATION MANAGEMENT, DOCUMENTATION, CHANGE CONTROL, AND STATUS REPORTING

8.1 Configuration Management

Configuration Management is the discipline to be utilized for managing the technical, cost, and schedule baselines of the Partnership, including specifications, drawings, fabrication instructions, test requirements, test procedures, installation instructions, and training modules that either describe or are a part of the products produced by the Partnership. These products include those resulting from both mitigation projects as well as the development of the facilities necessary to support the mission of the Partnership. The Partnership will apply Configuration Management principles to ensure that the baselines are properly identified, changes to the baselines are controlled, the status of the implementation of changes is recorded and available to members of the Partnership, and changes to the documentation are reflected in the products.

The requirements for Configuration Management within the Partnership will be defined in a Configuration Management Plan (CMP). The Director will be responsible for the successful implementation of Configuration Management within the Partnership although the day-to-day execution of Configuration Management will be delegated to the Configuration Manager within the Project Management Group. Managers of projects undertaken by the Partnership will be responsible to the Director for implementation of Configuration Management within their individual projects.

8.2 Documentation

Documentation requirements for projects implemented within the Partnership will be established by the Director. The methods to be used for the development, review, control, and publication of these documents will be addressed in the project plan for each project. A central document control center for storage and access to the Partnership's documents will be established and maintained.

8.3 Change Control

The Director, with the assistance of the Configuration Manager, will establish and conduct the change control board for the Partnership. This board will normally review and approve/disapprove changes to the cost, schedule, or technical performance requirements of the projects. Change control board and change approval authority will be delegated to the managers of projects for changes not impacting the cost, schedule, or technical performance requirements of their individual projects.

8.4 Status Reporting

An on-line status reporting system will be utilized by the Partnership to provide up-to-date information concerning the status of the cost, schedule, and technical baselines and the documentation used to describe them. This reporting system will be accessible to all Partners via the Internet.

9. ACQUISITION STRATEGY

Several diverse types of acquisitions will occur during the course of the Partnership, including procuring equipment and facilities to perform tests, subcontracts and equipment purchases to support the construction of test specimens. The Partnership will contain diverse groups that may have different procurement policies and requirements. A final acquisition plan will be developed that combines procurement policies and requirements from each Partner to generate an all-encompassing plan, which addresses compliance issues and ensures competitive procurement practices.

10. SYSTEMS ENGINEERING AND INTEGRATION

The Partnership will use the systems engineering process, which considers all aspects of system requirements from the earliest stages of design through development, testing, and operation. The process supports project management by ensuring that adequate data is available to make informed decisions. The systems engineering process was used to prepare this program plan and will be used throughout the program to ensure that requirements are identified, the project design satisfies the requirements, alternatives are analyzed for the best solution, and the solutions are verified to meet the requirements. The process will ensure that the requirements are traceable and that the solutions are defensible.

A systems engineering management plan will be developed to include sections on technical planning and control, systems engineering process, and engineering integration. The plan will discuss risk assessment, the technical design review process, and technical performance measures.

11. REFERENCES

1. Partnership for Natural Disaster Reduction (Partnership) Test Complex, Phase I, Conceptual Design Report, May 7, 1997, Idaho National Engineering Laboratory.

12. DEFINITION OF TERMS

BASELINE – A reference point for cost, schedule, and technical performance from which to control changes.

CHANGE CONTROL – A documented process applying technical and management review and approval of changes to technical, cost, and schedule baselines. This process represents the way in which the project baseline is modified in a disciplined manner during the conduct of a project.

CHANGE CONTROL BOARD – A group of representatives from the Partnership organizations who review changes to the technical, cost, and schedule baselines and recommend to the Director, approval or disapproval of proposed change(s).

CONFIGURATION MANAGEMENT – The formal process for managing (including change control) technical, cost, and schedule baselines including hardware and technical documentation for the Partnership.

CONTINGENCY – A portion of the total project budget withheld to cope with the risks that may emerge during conduct of the project. Risks including items overlooked in the development of the cost estimate or project design requirements resulting from new technical input data.

DISASTER PREVENTION CENTER – A full-scale state-of-the-art test complex operated by the Partnership and consisting of the following facilities listed in order of construction:

WINDSTORM SIMULATION CENTER – A test facility capable of subjecting full-scale representative two story houses to category 5 hurricane force winds and rain.

CONTROL AND DATA ACQUISITION CENTER – A facility to control and collect data during tests in the windstorm and earthquake simulation center.

PRECONDITIONING AND AGING CENTER – A facility for preconditioning full-scale structures prior to tests in the Windstorm and Earthquake Simulation Centers. Aging effects (up to 30 years) representative of the environments being considered for the wind and earthquake tests will be simulated.

EARTHQUAKE SIMULATION CENTER – A test facility capable of subjecting full-scale representative five story buildings to near-field impulse and far-field ground motion expected in a large seismic event.

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) – The federal organization responsible for the nation's system of emergency management.

MANAGEMENT RESERVE – A portion of the budget used to fund program changes.

MILESTONE – Defined events in a project schedule that constitute task start, task completion, or accomplishment of an objective. Milestones are measurable.

PARTNERSHIP for NATURAL DISASTER REDUCTION (Partnership) - The Partnership created by the Department of Energy (DOE) and the Federal Emergency Management Agency (FEMA) to reduce loss of life, property damage, and disaster costs resulting from the effects of natural hazards on man-made structures. The Partnership brings together industry, academia, and federal, state, and local government to share in the investment, leadership, and coordination of developing proven and cost-effective hazard mitigation measures.

APPENDIX A

PARTNERSHIP FUNCTIONS

PARTNERSHIP FUNCTIONS

This appendix provides details of the Partnership functions shown in Figure A.1. The colors of the blocks on the functional chart relate to the colors on the organization chart, Figure 2.1. The functions of the Partnership encompass the life cycle of the program from startup through closeout. The life cycle of the Partnership is defined by four elements: managing, acquiring, operating, and closeout of the Partnership below.

A.1 MANAGE THE PARTNERSHIP PROGRAM

The two elements of management functions are to manage the Partnership and to manage the Partnership projects.

A.1.1 Manage the Partnership

The management function must consider each of the life cycle elements from initiation through funding, maintenance, and close out. Managing the Partnership has six functional elements.

A.1.1.1 Define the Partnership

The Partnership consists of principals who have or share natural disaster problems; industries, universities, and laboratories who have or are working on solutions; international, federal, state, and local agencies who implement codes to ensure hazard reduction; and, all who participate in the planning, reduction, or financial impact after a natural disaster. The Partnership is illustrated by the organizational chart and described by the organizational responsibilities (see Section 2).

A.1.1.2 Plan the Partnership

This document provides the Program Plan for the Partnership. It is based on a Partnership requirements document. The Program Plan is a living document to be continuously revised to fit the needs of the Partnership. It will be accompanied with annual operating plans in order for the Partners to share a common vision of Partnership activities.

A.1.1.3 Execute the Partnership

The Partnership will be implemented through a charter signed by the major sponsoring agency and two or more sustaining Partners. The Partnership focus on developing, validating, and implementing constructive techniques/solutions to problems may include adding new facilities to perform the validation task. In parallel with identifying existing or new facilities, the Partnership will conduct a problem-solution analysis of existing data to prepare for efficient and effective use of testing facilities.

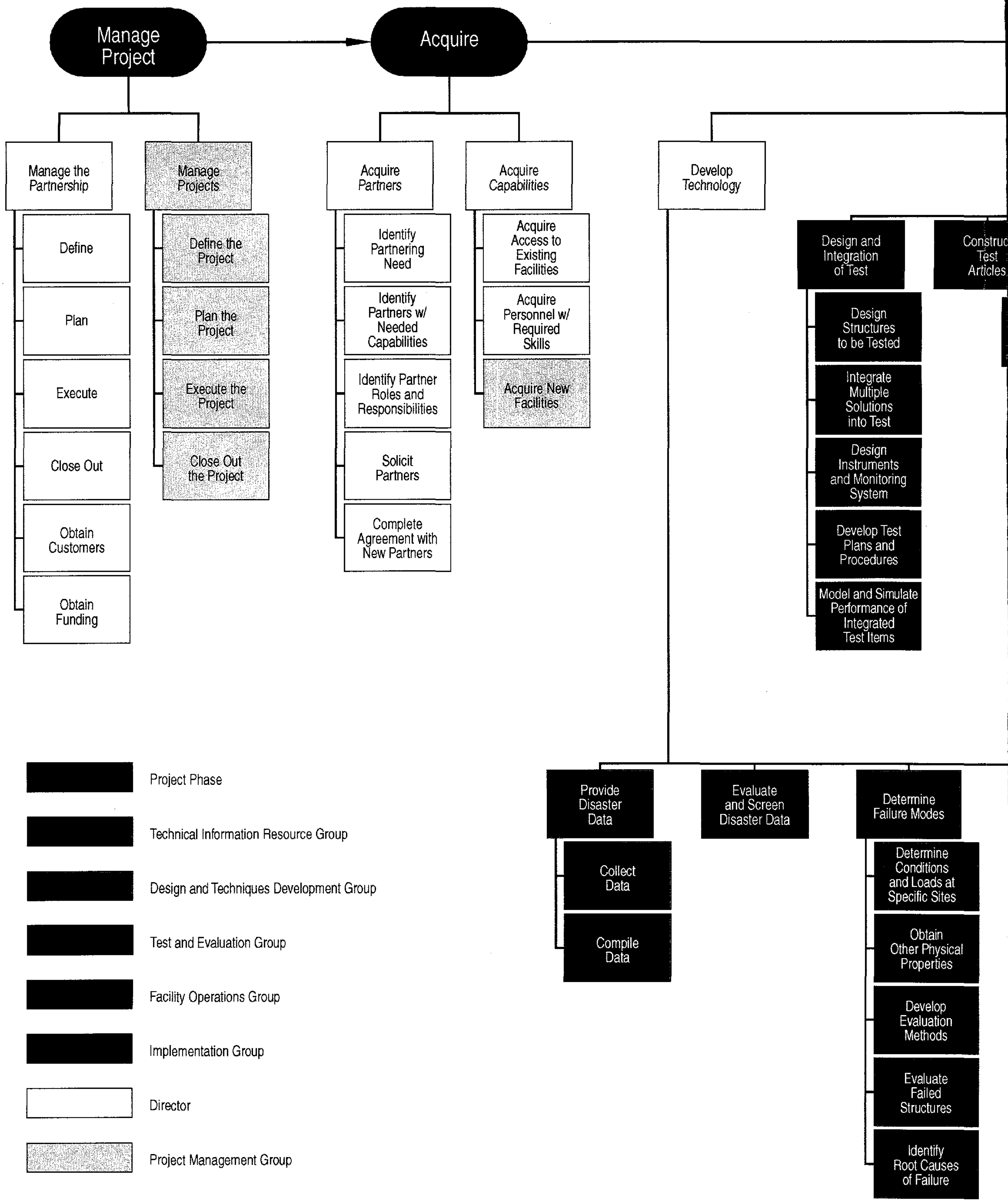


Figure A.1. Functions of the Partnership

A.1.1.4 Close Out

Once the Partnership reaches the end of its operational life-cycle phase, the Partnership will be systematically terminated. The Partnership's roles and responsibilities may be assumed by another organization, or it may simply cease to exist as an operating entity. This function effectively manages the tasks necessary to accomplish closing out the Partnership (as described in Section A.4), whether through transfer or elimination of its roles, responsibilities, and assets.

A.1.1.5 Obtain Customers for the Partnership

While the Partnerships activities will consist of the development, validation, and implementation of technologies defined by the Partners acting through the Governing Council, some activities may be undertaken at the request of organizations outside the Partnership. This function actively seeks technology development, validation, and implementation activities and the necessary funding to support these activities from customers outside the Partnership. These tasks will be undertaken on a non-interference basis with the tasks sponsored by the Partnership and are aimed at obtaining maximum utilization of the expertise and facilities of the Partnership.

A.1.1.6 Obtain Funding

The sustaining financial support (initial funds, capital funds, and operating funds) for Partnership activities, projects, and facilities, will be provided primarily through federal agencies such as the Federal Emergency Management Agency and Department of Energy. A priority of the Partnership leadership will be to obtain funding from a broad base of federal agencies that also have mitigation interests, responsibilities, and expertise. State governments, manufacturing and insurance industries will be encouraged to contribute funding. By investing in the Partnership, industry will feel ownership and ensure that their needs and concerns are addressed through Partnership programs and projects.

It is anticipated that there will be projects of interest to specific industries that may not be in the main stream of Partnership goals. An example of such a project would be evaluation of a particular product such as a joist system or shutter. Another function of the Partnership leadership will be to identify and form consortiums to fund specific projects, protecting proprietary information when needed.

A.1.2 Manage the Partnership Projects

A project is one of many elements of the Partnership program. A project may cost multi-million dollars such as construction for Phase I of the Disaster Prevention Center, the Windstorm Simulation Facility, or be as small as testing a component such as a window frame. Also, data collection and assimilation, and modeling and simulation are projects. Every project requires management attention. The amount of attention will be proportional to the size and complexity of the project. Four elements of management are applied to each project.

A.1.2.1 Define the Project

The project is defined in the project plan. Each project plan will describe the type of project and the documentation that identifies the technical, cost, and schedule baselines of the project. The Partnership will use the project plan to integrate the project into the overall Partnership program plan.

A.1.2.2 Plan the Project

The project plan will identify the resources, including funding, facilities, personnel and equipment, needed to conduct the project. Each project may use its own resources or the resources of the Partnership. The Partnership will use the project planning to integrate the project into the overall Partnership planning.

A.1.2.3 Execute the Project

The project will be executed upon the approval of the project plan by the Partnership Director. Whenever possible, the Director will integrate the project with other projects to be efficient and conserve resources.

A.1.2.4 Closeout the Project

The technical phase of the projects will be closed by publishing a final report. Data collected will be analyzed, stored, or disseminated in accordance with the approved project plan. The findings will be forwarded for cost/benefit analysis and implementation.

A.2 ACQUIRE THE PARTNERSHIP

The focus of the Partnership is to satisfy the needs of the Partners. The Partnership will acquire Partners and acquire capabilities.

A.2.1 Acquire Partners

Participants will include insurers; the housing and construction industry; international, federal, state, and local government agencies; universities; research organizations; and the general private sector. Participants will join the Partnership in a variety of partner categories (see Section 2 of this Program Plan), each with specifically defined roles, responsibilities, and expectations.

A.2.1.1 Identify Partnering Needs

Partnering needs include funds, management, technical skills, technical integration, test facilities, interaction with building code committees, and research and development.

Each of these needs will be translated into measurable requirements that direct the design, validation, and implementation of construction techniques for the functions, operations, tasks, and facilities associated with the Partnership. The Partnership must be prepared to offer incentives for implementation. For example, the Partnership may pay the cost of rewriting and publishing code manuals.

A.2.1.2 Identify Partners with Needed Capabilities

Partners will be solicited that have the capabilities needed to address all functions and requirements of the Partnership. Expertise in areas such as building performance, economic, planning, atmospheric sciences, sociology, engineering, construction, and risk management are vital to success.

A.2.1.3 Identify Partner Roles and Responsibilities

The roles and responsibilities of the Partnership are defined in Section 2. The roles and responsibilities for construction and operation of the facilities will be defined in the facilities operation plan.

A.2.1.4 Solicit Partners

Potential Partners will be formally solicited from the list of potential partners that possess needed capabilities.

A.2.1.5 Accept Partners

The Governing Council will formally accept new Partners into the Partnership.

A.2.2 Acquire Capabilities

The Partnership, in order to achieve its vision, must acquire the capabilities to develop, validate, and implement designs. These capabilities may be in the form of a facility or a number of facilities to test and validate solutions using personnel who possess the knowledge and skills required to develop new engineering techniques. Three functions are associated with acquiring capabilities.

A.2.2.1 Acquire Access to Existing Facilities

Existing facilities provide capabilities for scale modeling, simulation, and component testing. The Partnership will use existing facilities whenever possible. The Partnership will identify existing facilities and their capabilities. Selection or decision to use existing capabilities is project specific. The intent is to integrate all capabilities to maximize effectiveness at the least possible cost.

A.2.2.2 Acquire Personnel with Required Skills

The Partnership will employ only a minimum staff for continuity of projects and maintenance of Partnership operated facilities. Technical expertise for development, validation, and implementation will be drawn primarily from the membership. For example, existing data and natural disaster data analysis may be accomplished by government agencies; modeling and simulation may be accomplished by academia; and, implementation may be guided by industry and controlled by state and local entities.

A.2.2.3 Acquire New Facilities

The Windstorm Simulation Center with the Control and Data Acquisition Center are the highest priority for new facilities because wind damage mitigation is urgent in the United States. The United States government will fund this facility. Follow-on phases include expanding the windstorm facility by adding the Preconditioning and Aging Center followed by the Earthquake Simulation Center. These facilities are of high value not only to the United States but also to the world. The technology for the design of these centers will take more time to develop than will the windstorm facility.

Brief descriptions of the Windstorm Simulation Center and the Control and Data Acquisition Center are available in Section 3.

A.3 OPERATE THE PARTNERSHIP

Operating the Partnership includes developing design and construction techniques, validating the techniques, and implementing the techniques.

A.3.1 Develop Technologies

Developing loss prevention technologies consists of providing disaster data, determining the failure modes, and developing technologies to prevent structural failure.

A.3.1.1 Provide Disaster Data

A key element of the Partnership will be the collection and compilation of disaster data. The Partnership will link to existing databases such as Earthquake Engineering Research Institute (EERI) and build new databases necessary to satisfy the requirement for storing, compiling, or analyzing the data. The data collection and compilation serves as an active international library of disaster information stored in searchable formats, accessed on-line via the internet, and continuously updated as data becomes available. The data will be stored and retrieved as field data, test and technology research results, references published by universities and other research organizations, and other data specific to windstorms, earthquake, and aging effects on man-made structures. The functions of providing disaster data are to collect data and compile data.

A.3.1.1.1 Collect Data

The Partnership will collect all data useful for the identification of loss prevention techniques that will reduce damage resulting from windstorms, earthquakes, and aging processes. Data collection includes the following:

- **Collect Historical Data.** The Partnership will collect historical natural disaster data providing a general background of world wide disaster conditions and effects. This information will be necessary; (1) to characterize wind storms, earthquakes, and the environmental conditions that cause aging, and (2) to identify any generic trends in the failure of structures under similar conditions. Examples of historical data include wind speed and duration measurements from past hurricanes, newspaper accounts, types of structures most damaged, types of structures undamaged, photos, damage surveys, technical reports, maps of damaged areas, dates and frequency of occurrence, effects on infrastructure and life lines, and the causes of casualties.

- **Collect Site-Specific Data.** The Partnership will collect site specific data to help identify the conditions present at locations that either have had significant natural disasters or have been identified to have a high risk. Examples of site-specific data include damage data in south Florida - perhaps as the result of multiple events, common housing types, current and past building codes and practices, common material and connection data, common soil profiles, locations of dunes, and shoreline depth profiles.

- **Collect Event-Specific Data.** The Partnership will collect event-specific data for significant wind storms and earthquakes. Examples of event specific data include damage data for Hurricane Andrew, wind speed and duration data, seismic ground motion data, common types of failures, types of structures that did not fail, estimates of loads on structures due to a specific event, technical reports, engineering studies, etc.

- **Collect Technical Data.** The Partnership will collect technical data specific to the Partnership activities and from studies conducted by other organizations. Examples of technical data include the identification of component failures, test procedures and results, interim guidelines, current building codes and practices, and recommended mitigation methods.

A.3.1.1.2 Compile Data

The Partnership will compile all disaster and test data in searchable formats allowing for user-friendly remote access by the Partnership, other research/engineering organizations, and the general public. The Partnership will also compile and safeguard proprietary technical and test data as required. Compiling data includes the functions as follows:

- **Reduce Data.** The Partnership will reduce all data to common readily usable formats. Disaster data will include field data where applicable, sources, locations, and references to related documents. Test data will include raw data, instrument calibrations, and the reduced data (removing from the raw data the effects of transducer calibration and offsets).

- **Input Data.** The Partnership will provide a data input service using an archive system specifically designed for this task. All data will be referenced in a continuously updated searchable database.

- **Store Data.** The Partnership will electronically store the data and provide a reliable archive system.

- **Retrieve Data.** The Partnership will provide a remotely accessible data search and retrieval system. Data access control will be as defined by the Partnership. Electronic copies of all Partnership test and technical reports will be available. Some voluminous historical data will be in the database but may only be available through inter-library loan.

A.3.1.2 Evaluate and Screen Disaster Data

Disaster data will be processed to identify specific failures in houses and other structures, and to determine if they can/should be evaluated by the Partnership. Screening will include determination of the significance of the identified failure, searching of available technologies to address the failure, determining whether the failure has been previously investigated, etc.

A.3.1.3 Determine Failure Modes

The Partnership will investigate failures resulting from natural disasters and make root-cause determinations for those component failures/failure mechanisms the Partnership determines to be significant. Evaluation criteria may include loss of life, economic factors, impact on other failures, etc.

A.3.1.3.1 Determine Conditions and Loads at Specific Site

Actual environmental factors applied to failed items will be determined. This may be as simple as using direct measurements taken proximate to the structures under consideration, interpolating between known data points, physical testing of material collected at the site, or calculation based upon failure of known quantities gathered at the site.

A.3.1.3.2 Obtain Other Physical Properties

Examples of sources to be used to determine other physical properties are: building codes of record, building inspection records, industry standard practice at the time of original construction, modification history, etc.

A.3.1.3.3 Develop Evaluation Methods

The Partnership will determine whether computer modeling, scale testing, calculations, etc. will adequately lead to accurate conclusions regarding failure causes.

A.3.1.3.4 Evaluate Failed Structures

The Partnership will perform evaluation of failed structures per appropriate evaluation methods.

A.3.1.3.5 Identify Root Causes of Failure

Utilizing all data obtained and determined, the Partnership will identify the root cause of failure. They will provide this information to the "determine failure specific solutions" function.

A.3.1.4 Determine Failure-Specific Solutions

Some of the functions that may be performed to reach a solution are (1) researching currently available solutions, (2) performing problem focused research, and (3) developing failure specific engineering solutions.

Evaluation criteria for selecting failure-specific solutions include loss of life, economic factors, and impact on other failures.

A.3.1.4.1 Research Available Solutions

To reach a solution for a problem such as shingle tear-off, a comprehensive search of available solutions may find an existing solution already implemented, an existing solution that may not be implemented because of expense or impracticalities, or that no solution exists. If the solution falls in the latter categories, the Partnership will develop a new solution, or assist in the development of emerging solutions.
Potential solutions will be modeled and simulated and results predicted. Out of the many potential solutions, a number will be selected for validation or testing based on recommendations of the Advisory Committee. Requirements for testing and validation of these potential solutions will be developed into test specifications.

A.3.1.4.2 Perform Problem-Focused Research

In some cases, the failure of structures may be attributed to the lack of knowledge about the "problem". For example, failures of structures due to hurricanes may stem from a lack of knowledge on how hurricane force winds interact with the structure and how they should be applied for design. This technology is not related to a "specific failure" like a shingle or shutter, but rather a "technology gap" in how we find solutions or design structures.

This "problem-focused" technology development may include the identification of technology gaps, the solicitation and selection of sources for technology development (such as universities), researching solutions, and documenting results. Identification of technology gaps and possible solutions in this problem-focused approach may benefit from state-of-the-art techniques in data mining and knowledge extraction. Techniques currently exist for extracting knowledge (i.e., developing modeling and predictive tools) from large data sets using heavily automated statistically based algorithms derived from cybernetic principles. Development and application of such tools would serve to narrow the technology gap search space and could help address experimental data analysis needs as well. These functions are:

- **Identify Technology Gaps** - Determine the gaps, areas where no technologies are available to provide solutions to the problem. These technology gaps become the basis for engineering a viable solution to structural failures.

- **Solicit Technology Sources of Potential Solutions** - Sources of potential technologies to fill the identified technology gaps are solicited for participation in problem focused research projects.

- **Select Sources** - Sources of potential technologies to fill the identified technology gaps are selected from those responding to the previous solicitation for participation in problem focused research.

- **Perform Research** - Research is performed in the selected potential technologies to fill the identified technology gaps. These technologies provide the engineered solutions to the root cause of structural failures.

- **Document Results** - Research performed in the selected technologies is documented in a technology research report.

A.3.1.4.3 Develop Failure-Specific Engineering Solutions

Examples of failure-specific solutions are shingle failure, connection failures, and foundation failures. The functions associated with developing failure-specific engineering solutions are:

- **Develop New and Emerging Solutions**: Existing solutions, resulting from researching available technology solutions, that require further engineering to become viable and potential technology solutions from problem focused research are engineered prior to being submitted for validation.

- **Evaluate Cost/Benefit of Proposed Solution:** The cost to benefit ratios of proposed solutions will be evaluated to aid in selecting solutions to be pursued under the sponsorship of the Partnership. Solutions that have high cost to benefit ratios will be eliminated in favor of proposed solutions that have lower cost to benefit values. This process will be continuously updated as the development continues to ensure that the product remains an effective solution for the problem.

- **Model and Simulate Potential Solutions**: Modeling and simulation are used for selecting solutions before being submitted for validation.
- **Select Solution for Validation (Test):** Results of modeling and simulation, pre-validation, are used for selection of solutions submitted for validation.
- **Develop Test Specifications**: Test specifications are developed for all solutions submitted for validation.

A.3.1.4.4 Develop Structural Modeling and Simulation Software

In activities undertaken by the Partnership will be the need to model the performance of various structural elements found in homes, buildings, and infrastructure elements exposed to the elements. The Partnership will use readily available modeling and simulation software where available for this purpose. Where adequate modeling and simulation software is not available or the need for improvement is observed, the Partnership will undertake the development of these tools for use within the Partnership and for licensing to others outside the Partnership.

A.3.2 Validate Technologies

Validating design and construction technologies involves: designing and integrating the test based on pre-test prediction modeling, constructing structures for the test, performing the test, analyzing the test data, comparing the test results with modeling and simulation results to validate models, verifying that the solution(s) solved the problem, and publishing the test report.

A.3.2.1 Design and Integration of Test

The test must be designed and integrated before performing the actual tests. The design and integration consists of the following functions: design structures to be tested; integrate multiple solutions into the test; design the instrumentation and monitoring systems; develop test plans and procedures; and model and simulate performance of the integrated test items.

A.3.2.1.1 Design Structures to Be Tested

The structures to be tested will be designed and fabricated. Design drawings and specifications will be documented and filed.

A.3.2.1.2 Integrate Multiple Solutions into Test

In some cases, due to the expense of running a test and the variety of solutions, it may be cost effective to conduct two or more tests simultaneously. In this case, the multiple solutions will be integrated into one test design. The test planner must ensure that the tests are mutually exclusive such that the effects of the test on one test article does not affect the results of the test on a different test article.

A.3.2.1.3 Design Instrumentation and Monitoring System

Each test will be unique and will require different instrumentation equipment and monitoring systems. The test objectives will be reviewed to identify the parameters to be measured during the test. Engineers will integrate the test article(s) with the instrumentation and monitoring systems. The data acquisition system may need to be put on-line for viewing real-time test results from off site.

A.3.2.1.4 Develop Test Plans and Procedures

The project will develop a test plan and test procedure. A thorough test plan will ensure that resources are identified and available to conduct the test and useful, quantified data are collected. The test plan(s) will be submitted to a project committee from the Partnership for approval prior to test initiation. The committee will consist of engineers and scientists as well as experts in safety, quality, regulatory requirements, and operations.

Each test plan will address, at a minimum, the following: organization and responsibilities; description of test (including objectives); sequence of activities; sampling and data; document/disc control (including test plan changes); analytical methods; data reduction, validation, and verification; quality assurance; equipment and instruments; supplies, utilities, and facilities; health and safety; and residuals management. Procedures for conducting the tests will also be submitted, including detailed operating procedures, standard operating procedures, and any other special test specific procedure such as an emergency procedure.

A.3.2.1.5 Model and Simulate Performance of Integrated Test Items

Before testing, all test articles may be modeled to simulate the performance of the items during the tests. The model and simulation algorithm may result in a need to modify the test design to ensure all tests will result in qualified data and be performed safely. This prediction tool will constantly be updated as actual test results are received and compared to the model.

A.3.2.2 Construct Test Articles for Test

Test articles will be thoroughly inspected by an independent inspector and verified that they meet specification. During the construction, changes will be formally approved through the change control process. Instrumentation installed on the test structure will only be installed by qualified instrumentation personnel and will follow the same requirements for inspection and change as did the construction of the test article.

A.3.2.3 Perform Test

The functions of performing the test are to perform full-scale tests and perform small-size tests.

A.3.2.3.1 Perform Full-Size Tests

The test team will conduct the tests in a facility appropriate for the test article to be tested. The functions of performing full-scale tests are as follows:

- **Install Test Item.** Develop a procedure to install the test article on a test stand without degrading the article to be tested. The procedure will be reviewed and approved. The test article will be installed on the test stand per the procedure.

- **Conduct Full-Size Tests.** Tests will begin with a thorough inspection of the newly installed test article to verify that there was no damage that would invalidate the test to follow. All instrumentation will be terminated, and a validation/baseline of the instrumentation will be conducted. The test will be conducted using the approved procedure. An independent inspector will observe the test and verify that the procedure is followed.

- **Collect Data.** Data will be collected on a real-time basis from the instrumentation installed on the test article. This data will be stored electronically for retrieval, data reduction, and analysis.

- **Conduct Modeling and Simulation.** Research and test data will be used to develop and verify simulation(s). The goal of modeling and simulation is to be able to accurately predict the response of structural components and the structure itself to the forces of hurricane force wind, aging, and earthquake.

- **Monitor Test.** During the test, personnel will monitor the test instruments and the test article to ensure that anomalies or failures are noted and recorded that may affect test results.

A.3.2.3.2 Perform Small-Size Test

Small test articles, e.g., components, may be tested in facilities around the world that are of sufficient capacity and are available at the time of test. While test plans and test procedures are different than for full-scale tests, the functions of the full-scale test also apply to small-size tests.

A.3.2.4 Analyze Test Data

Data will be reduced and analyzed. All equations used for data reduction or analysis will be documented and validated. The data will be evaluated to see if the test results fulfilled or did not fulfill the data quality objectives and if they supported the test hypothesis and customer needs as defined in the test plan.

A.3.2.5 Compare Test Results with Modeling and Simulation Results

The data obtained from the tests will be compared to the predictions made by the model and simulation techniques. If modeling or simulation techniques are not validated, analysts will determine if the model or the test requires modification. If either the model or the test is changed, the test may have to be conducted again.

A.3.2.6 Publish Test Report

The purpose of developing a test report is to ensure that data is analyzed, compared with modeling and simulation results, evaluated for recommendations and conclusions, and documented. Each test report will address the following: technology description; test objectives; experimental design and procedures; quality assurance; test results; problems and issues identified through testing; recommendations; and conclusions. Arrangements will be made to accommodate proprietary data.

A.3.2.7 Verify Solution Solves Problem

The next step is to verify that the solution(s) solved the problem(s) based on the requirements to be satisfied. The verification that the solution is valid may require integration of the results and analysis.

A.3.3 Implement Loss Prevention Techniques

Before the public realizes any savings in disaster mitigation costs, the validated design and construction techniques must be implemented. The functions of implementing design and construction technique solutions.

A.3.3.1 Communicate Findings

Findings will be communicated through television media (e.g., NOVA, Discovery), newsletters, press releases, journals, and technical reports to the general public, universities, and technical and professional societies.

A.3.3.2 Publish Interim Guidelines

Solutions directly relating to an improved method of structural design or building construction methods and materials may warrant the publishing of “interim guidelines” to communicate current information and provide recommendations which may help design professionals mitigate building damage due to natural phenomenon.

A.3.3.3 Advocate Building Codes Upgrades

The results of the solution testing and research performed by the Partnership will generate new engineering knowledge suitable for incorporation into building codes. The Partnership will take an active role in transferring the knowledge gained into upgraded building practices.

A.3.3.4 Provide Public Education

The Partnership, in cooperation with the Federal Emergency Management Agency, National Association of Home Builders, and others, will play a role in educating the public on the value of mitigation technology.

A.3.3.5 Transfer Technology

The Partnership has three main objectives for technology commercialization and implementation. The first objective is to transfer existing and emerging technology from industry, universities, and other federal agencies into the development of new technologies and/or techniques. This is called Technology Infusion and is often referred to as partnering. The second objective is sharing the technologies with other partners by performing simulations and/or tests. This is called Technology Adoption. The final objective is transferring the technologies and/or techniques from the Partnership to private industry. This is called Technology Diffusion and is referred to as commercialization.

The resources the Partners bring to the Partnership, including but not limited to the INEEL Office of Research and Technology Applications, will be used to improve and implement technology transfer mechanisms, including cooperative research and development agreements, cost sharing agreements, program research and development announcements, memorandum of understanding, small business innovation research programs, and licenses.

Some of the resulting products from performing the tests are new and improved modeling and simulation algorithms and design and construction techniques that can withstand earthquakes, high winds, and/or aging. Some of these products may result in intellectual property. In this instance, the product will be patented. Once a patent is obtained, the product(s) will be marketed and licensed as appropriate (nationally and internationally). The Partnership, specifically the Governing Council, will own the patent and will reinvest the benefits from the patents into operations of the Partnership.

A.3.3.6 Provide Professional Training

The Partnership, in cooperation with the Federal Emergency Management Agency, National Association of Home Builders, and others, will play a role in educating the design and construction professions in the implementation of design and construction techniques developed and validated by the Partnership.

A.3.3.7 Advocate Incentives

The results of the activities of the Partnership will reduce the susceptibility of homes, buildings, and other structures to damage from its environment. This reduced susceptibility should cause a corresponding reduction in the cost of insuring these structures against damage from natural disasters. The Partnership will provide information concerning the performance of the technologies developed and validated under the Partnership's direction to the insurance industry and will advocate incentives for the use of these techniques in applicable structures.

A.4 CLOSEOUT THE PARTNERSHIP

When the Partnership reaches the end of its useful life, the Partnership will be disbanded, the physical assets disposed, and the land will be reclaimed. The closeout functions are discussed below.

A.4.1 Disband Partners

Upon completion of all Partnership activities, the Partnership will cease to exist. The Governing Council will determine the procedure for dismantling the Partnership and the process of disposing of physical assets.

A.4.2 Disposition of Test Data

The Governing Council will determine what will be done with data generated by the Partnership. Since most of the funding was provided by federal entities, it is assumed that data will be stored in federal archives.

A.4.3 Disposition of Assets

All physical assets of the Partnership will be sold, salvaged, demolished, or otherwise disposed of. An attempt will be made to identity new uses for all assets, by the Department of Energy, the Partnership, other federal agencies, or through new programs. Assets consist of test specimens, facilities and equipment, and land.

A.4.3.1 Disposition of Test Specimens

Test specimens may be placed on display at the Disaster Prevention Center subsequent to testing. If not placed on display, it is the test sponsor's responsibility to promptly remove the test specimen and all debris generated during the test. All test facilities will be returned to the original, pre-test condition.

A.4.3.2 Disposition of Facilities and Equipment

All above-ground facilities, including utility services, will be removed at such time that no further use can be identified for them. This includes services like power, aerial communications equipment, street and parking lot lighting, fences and gates, sewage treatment facilities, water and fuel storage facilities. Buried utilities such as water service piping, duct banks containing power or communications cables and sewer lines, will generally be abandoned in-place. At no time will it be acceptable to abandon any facility that contains any hazardous material, or other material that may be harmful to animals, plants, or the environment.

Upon completion of the Partnership functions, all equipment possessed by the Partnership will be equitably distributed among the Partners, either in parsing out of the actual equipment or by funds generated through the sale of the equipment. Some of the equipment may be donated to universities for further research in the reduction of natural hazards.

A.4.3.3 Reclaim Land

Reclamation of all land possessed, used, or disturbed by the Partnership will be in accordance with the approved environmental documentation for the activity conducted upon that land.