

Sample Engineering Cast Study Wind Shutters

Introduction

In an effort to improve the quality of project applications, engineering case studies have been prepared for several common mitigation measures. The engineering cases studies provide focus on the types of information and data needed to ensure completeness of the sections of the project application affecting engineering feasibility. Of particular importance in the engineering review are:

- Scope of Work, including:
 - Problem Description and Proposed Solution;
 - Description of Existing Condition; and,
 - Work Schedule.
- Cost Estimate, including:
 - Conducting the Benefit-Cost Analysis;
 - Anticipated environmental resource remediation or historic property treatment measures;
 - Engineering schematics, detailed engineering drawings, or engineering designs;
 - Other related construction/demolition/relocation costs, such as survey, permitting, site preparation, material disposal; and,
 - Other related acquisition costs, such as appraisals, legal recordation, displacement costs for renters, maintenance.

For each of these sections in the project sub-application, the engineering case studies describe the general type of information that a Sub-applicant should submit. In order to provide additional guidance, the case studies also include sections of a sample project application that present the kind of specific information that the Sub-applicant would need to include in each engineering-related section to support the proposed project. These engineering case studies are not meant to represent complete project applications. Some relevant project information related to historic and environmental impacts, as well as information regarding the project's cost effectiveness may not be included.

One of the most common wind mitigation methods is the installation of wind shutters on structures. Wind shutters installed over windows and other openings protect buildings and contents from the damaging effects of hurricanes and other high wind events; however, shutters are not typically designed to protect buildings against extreme wind events such as strong or violent tornadoes. Typically, wind shutters are constructed of wood, plastic, or metal, and are most effective for facilities along or near the coast that are subject to frequent hurricanes and other high wind storms. Although wind shutter materials and systems can vary, the general information required for a complete grant application is fairly uniform. The following sections describe in detail the information required, and provides samples for each application section.

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Scope of Work

The proposed construction activities should be well-defined and technical documentation should be provided verifying that the scope of work will successfully protect the structures against future high wind damages. Detailed technical information should be provided in the scope of work description, including the following:

- Describe the shuttering technique being employed for each structure to be protected. Also, specify if the entire building, or only parts of the building such as shelter areas, will be receiving shutters.
- Include wind design properties (e.g. Exposure Category, Enclosed building, Importance Factor) and calculations for applicable wind loads.
- State what maximum wind speed or storm class the structure will be designed to withstand.
- State what maximum wind speed the shutters will be designed to withstand, including any applicable standards (e.g. SSTD 12, ASTM E 1996).
- Include any Federal, State or Local building codes or standards that need to be followed (e.g. FEMA 361).

Example Scope of Work

The proposed shutter project will consist of a steel roll-down shutter system covering the entire 1,800 square feet of exterior window area. The shutter system includes electric motors to allow them to be lowered automatically; however, the shutters can still be lowered manually in the event of a power outage. The existing school was designed as an enclosed building with an Importance Factor of 1.15 and Exposure Category C, and the building structure (including all doors) was originally designed and constructed to withstand a 90-mph fastest mile design wind. However, no wind design was incorporated into the design of the building envelope and currently no windows are protected from wind pressures and windborne debris.) The shutter system will be designed to withstand positive and negative wind pressures associated with wind speeds up to 110 miles per hour, and resist debris impact forces in accordance with SSTD 12. An engineering analysis of the existing school building indicates that adding the shutter system will reduce structural wind damages from a Category 2 Hurricane (wind speed range 96-110) by 80 percent and provide partial protection from Category 3 and 4 storm events. (The analysis also confirmed that the building elements around the windows can withstand the forces transferred from the shutter system to the building.) Refer to the attached design calculations for additional details.

Problem Description and Proposed Solution

A detailed written description of the wind hazard potential and past damages that have occurred at the project location should be provided and should include the following information:

- Describe the source of high winds (e.g. hurricanes, tropical storms, etc.) and provide any known explanation of the cause of the hazard (e.g. large windows or other openings, inadequate or no shutter protection, etc.)
- List the history of any previous wind damage events including dates, extent and magnitude of impacts, photos of historic wind events, overall cost of damages, and the estimated frequency of damaging wind events.

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- Provide information on the wind design of the current building, building code at the time of construction, on high wind design requirements for the location (if applicable), and what proposed standards will be met or exceeded.
- Provide the location of the facility, including distance from the coast, and indicate if the facility is located in a FEMA Special Flood Hazard Area (SFHA).
- Briefly state the proposed solution, which will be described in detail in the scope-of-work section.

Example Problem Description and Proposed Solution

The City Middle School is located in the Town. A detailed map, showing the location of the school within the community, is attached. Although the school building is located outside the 500-year floodplain, it has sustained wind damage from several hurricanes and tropical storms due to its close proximity to the Atlantic coast. A list of these windstorm events, along with a description of the damages and actual repair costs associated with each event, is attached.

An analysis of this information indicates that typical wind damages at the school have led to damages of equipment and costly disruptions to school operations. Over the past twenty-five years, the school building has been damaged by high wind events in 1985, 1993 and 2002.

This project proposes to reduce future wind damage at the City Middle School building by installing shutters to prevent contents damage and functional downtime caused by wind-driven rain entering through broken windows.

Description of Existing Conditions

The facility(ies) being protected should be listed. The following information should be included in the property description of the application.

- List the number of properties or facilities are being protected.
- Describe the primary use of the facilities (e.g. single family residential, public library, commercial).
- If residential, state if the property is owner-occupied, rental or seasonal.
- If public, indicate if the facility is used as a hurricane evacuation shelter, and include any State required facility surveys and/or checklists in accordance with American Red Cross Standards (ARC 4496, ARC 3041, ARC Form 6564).
- Provide a detailed description of the facility including: foundation type (e.g. slab-on-grade, crawl space, underground basement), roof type (e.g. flat gravel ballast roof on corrugated metal supported by steel trusses, asphalt shingles on plywood supported by timber trusses, construction type (e.g. engineered or non-engineered wood frame, masonry, manufactured), square footage, age, building construction codes and standards (if any), value of structure, condition, number of stories, etc.
- List the damages that have occurred to the facility for various high-wind events and the costs associated with those damages. Include a history of insurance claims made for each property if possible.

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Example Description of Existing Conditions

The proposed mitigation project is for protection of the City Middle School building; a publicly-owned facility which serves approximately 1,200 students and 100 faculty and staff in the Town of City during the school year. The school also provides summer school classes to an average of 200 students and staff in the greater City area as well as adult education classes on evenings and weekends throughout the calendar year. The City Middle School also serves as a shelter for up to 1,000 local residents in severe storm events. It is important to note, since the building lacks sufficient shutter protection in the designated shelter areas, it does not currently meet the American Red Cross Standards for hurricane evacuation shelters (ARC 4496). A Red Cross Facility Survey (ARC Form 6564) conducted in January 2003 is attached.

The City Middle School building is a two-story, slab-on-grade reinforced masonry structure constructed in 1978. The school was engineered and constructed in with the basic provisions of the Standard Building Code (SBCCI), and a 2002 inspection report by the City Public Works Department indicates that the building is in fair condition. The 14,000 square-foot school building has a flat membrane roof system supported by a corrugated metal deck and steel trusses which are anchored to the reinforced masonry walls. According to the City Department of Education, the City Middle School has an estimated building replacement value of \$2.1 million (not including an estimated \$2 million in contents) and an annual operating budget of \$3.5 million.

The City Middle School has approximately 1,800 square feet of exterior openings that are covered by large plate glass windows. An analysis of damages from the three previous wind events that have impacted the school (in 1985, 1993 and 2002) indicate that the vast majority of wind damages at the school building can be attributed to failure of these windows. A list of these wind storm events, along with a description of the damages and actual repair costs associated with each event, is attached. Typically, broken glass windows have allowed wind-driven rain to enter the school classrooms, resulting in significant damages to contents and equipment and delays in school operations as repairs are made.

Work Schedule

Additional supporting documentation should include a work schedule to:

- Describe the anticipated project schedule.
- Include all phases of the task including: survey, design/specifications, construction, permitting, site inspection and preparation, etc.

Example Work Schedule

The anticipated project schedule for the proposed project is included below. This schedule has been prepared for the structure included in this application. The complete shutter project will be completed within 12 months of project approval with minimal disruption to school operations.

<u>Description of Task</u>	<u>Starting Point</u>	<u>Unit of Time</u>	<u>Duration</u>	<u>Unit of Time</u>
<i>Bid Proposal and Award</i>	<i>1</i>	<i>Month</i>	<i>1</i>	<i>Months</i>
<i>Permitting and Contracting</i>	<i>2</i>	<i>Month</i>	<i>2</i>	<i>Months</i>
<i>Site Inspection and Preparation</i>	<i>3</i>	<i>Month</i>	<i>1</i>	<i>Months</i>
<i>Construction</i>	<i>4</i>	<i>Month</i>	<i>3</i>	<i>Months</i>

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Cost Estimate

- Make sure all anticipated project costs are detailed.
- Provide the source of the estimate (e.g. documented local cost, bids from qualified professionals, published national or local cost estimating guides, etc.)
- Consider the potential future date of construction when compiling the cost estimate.

Example Cost Estimate

CITY MIDDLE SCHOOL SHUTTER SYSTEM PROJECT

Based on the cost estimate listed below, the total project cost for this project is \$77,000, with a federal share of \$57,750.

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT	SOURCE
<i>Mobilization</i>	<i>LS</i>	<i>1</i>	<i>\$4,000</i>	<i>\$4,000.00</i>	<i>Contractor</i>
<i>Roll-Down Metal Shutters</i>	<i>SF</i>	<i>1,800</i>	<i>\$20</i>	<i>\$36,000.00</i>	<i>Manufacturer</i>
<i>Shutter Installation</i>	<i>SF</i>	<i>1,800</i>	<i>\$10</i>	<i>\$18,000.00</i>	<i>Contractor</i>
<i>Electric Motors And Controls</i>	<i>EA</i>	<i>4</i>	<i>\$2,000</i>	<i>\$8,000.00</i>	<i>Manufacturer</i>
<i>Motor And Control Installation</i>	<i>EA</i>	<i>4</i>	<i>\$1,000</i>	<i>\$4,000.00</i>	<i>Contractor</i>
<i>Subtotal</i>				<i>\$71,000.00</i>	
<i>Engineering Design and Construction Inspection @ 10.0%</i>				<i>\$7,000.00</i>	
TOTAL				<i>\$77,000.00</i>	
TOTAL FEDERAL SHARE				<i>\$57,750.00</i>	

Attached supporting documentation includes:

- *Contractor costs for mobilization and installation of roll-down metal shutters, electric motors and controls from Construction Company*
- *Manufacturer costs for furnishing roll-down metal shutters, electric motors and controls from Wind Breaker Shutter Systems, Inc.*
- *Engineering Design and Construction Inspection costs from ASAP Engineering, LLC*