APPENDIX G. SEISMIC RISK ASSESSMENT METHODOLOGY AND DEMONSTRATION PROJECT

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Seismic Risk Assessment Methodology and Demonstration Project

Introduction

The City of Seattle, using a grant funded through FEMA's Pre-Disaster Mitigation Grant Program, recently completed a seismic risk assessment for a representative set of City-owned buildings as a demonstration project. This effort was intended to be a systematic, efficient, and cost-effective risk assessment methodology that could be applied not only to city-owned buildings, but also to other public, non-profit, and private buildings. The City's goal was to develop a practical screening methodology that can be utilized city-wide to evaluate seismic risks, prioritize mitigation actions, and reduce seismic risk over time. A more detailed explanation of the process follows.

Methodology

The assessment followed six steps:

1) Define seismic performance objectives
2) Establish criteria for exclusion from further study
3) Pre-screen candidate structures using criteria established in Step 2
4) Perform seismic evaluations (based on ASCE 31-03[1]) and rough order of magnitude (ROM) cost estimates for candidate structures that passed the pre-screening process in Step 3
5) Based on the results of Step 4, select candidate structures for more detailed seismic evaluations (based on ASCE 31-03 and ASCE 41-06[2]) and preliminary cost estimates
6) Prioritize retrofits based on evaluation results

Each step is explained in further detail below.

The first step was to define the seismic performance objectives for the facilities. These performance objectives were based on post-seismic event requirements and included a range of operational expectations consisting of Collapse Prevention, Life Safety, Immediate Occupancy, and Operational. The challenge of this step was to identify an appropriate objective that balanced safety and operational needs with budget constraints. In the case of this demonstration, Immediate Occupancy was chosen for facilities that house first responders (Fire, Police), while Life Safety was chosen for all other facilities.

The second step of the process was to establish criteria for exclusion from further study. The goal of the process was to make deliberate decisions about what facilities should be studied. For this step, an existing Critical Facilities Index (CFI) was used to assist in the decision-making process. This index was a weighted average of 5 scores for each facility (Life Safety Index, Lifeline Systems Index, Time Dependency Index, Business Function Index, and Risk Index) that was a useful baseline for the facilities.

[1] American Society of Civil Engineers, ASCE 31-03 Seismic Evaluation of Existing Buildings
[2] American Society of Civil Engineers, ASCE 41-06, Seismic Rehabilitation of Existing Buildings

It was then determined that all facilities with the lowest Risk Index (which reflects low seismic damage potential) would be excluded, and the remaining facilities would be ranked based on their CFI scores.

The third step of the process was to pre-screen the candidate structures using the process we determined in step 2. Starting with the list of all facilities, we removed those with a low Risk Index and then ordered the remaining facilities by highest to lowest CFI. The 12 facilities with the highest CFI (most critical) were selected for the first phase of seismic evaluation. The 12 identified facilities were:

1. Airport Way Center Building B - FAS Shops,
2. Airport Way Center Building E - Water Quality Lab,
3. Charles Street Fire Garage,
4. Charles Street Vehicle Maintenance,
5. Charles Street Traffic Meter Shop,
6. Charles Street SDOT Engineering,
7. Charles Street Tire Shop,
8. Haller Lake Vehicle Maintenance,
9. SPD Harbor Patrol Office,
10. Sunny Jim SDOT Sign Shop,
11. SFD Headquarters, and
12. SPD South Precinct.

The fourth step was to have a structural engineer perform ASCE 31-03 Tier 1 assessments of the candidate buildings and provide ROM cost estimates for the upgrades each facility would need to meet the stated performance objective. The deliverable from this step resulted in the Phase 1 report and was used to inform decisions made in the next step.

The fifth step was to review the Phase 1 report and select two of those facilities to have more detailed studies (ASCE 31-03 and ASCE 41-06) and cost estimates created for them. This step involved consideration of not only the CFI, but also departmental short- and long-term plans, and other departmental considerations for the facilities in question. Specific details about the physical conditions of the facilities such as building age, square footage, and details from the Phase 1 report were also considered. Upon receiving the selection of the two facilities for further study, the consultants were able to conduct more in-depth reviews and produce the Phase 2 report. The specific methodology of the Phase 2 evaluation is detailed in the report; however one item to note in particular is that the consultant was able to use a 2-dimensional (hand calculation) analysis for the rectilinear Charles Street Vehicle Maintenance Garage, but used a 3-dimensional analysis (using structural analytical software) for the South Precinct due to its complex geometry.

The sixth step was to prioritize retrofits based on evaluation results. It is our understanding that in order for an upgrade to be effective, the structural engineer's recommended seismic retrofits within a building would need to be completed in their entirety. The goal of any seismic retrofit is to establish a continuous lateral load path, whereas piecemeal fixes to only a few lateral-resisting elements while leaving other deficient elements as-is does not accomplish this objective. Because the Phase 1 and

Phase 2 reports identified retrofits that require a large capital investment that cannot easily be broken up, the retrofits will be prioritized in combination with other departmental considerations including long-term plans for the facilities, criticality of the operation within the facility (CFI), and budget availability. The prescriptive retrofit recommendations for each facility will also be evaluated in conjunction with other known, non-seismic deficiencies in order to capture efficiencies where possible.

Integration into Hazard Mitigation Plan

The last element of the grant requirements is to integrate the results of the report and methodology into the City of Seattle's Hazard Mitigation Plan. At this time, this integration process has just begun and will be completed by the consultant that has been hired and managed by the Office of Emergency Management (OEM). In addition, this methodology will be presented to the public at a Project Closeout Workshop presenting the final adopted Hazard Mitigation Plan.

Summary

This study has helped the City of Seattle by developing a methodology to evaluate seismic risks, prioritize mitigation actions, and reduce seismic risk over time. By breaking down the process of assessing the risk of facilities into six steps, the methodology can be reapplied to the remainder of the buildings in our department's portfolio. It may also be applied to facilities in other City departments, other public agencies, and non-profit and private buildings.

An important issue that was identified by going through this process was the need to more closely evaluate the seismic performance objectives from the first step of the methodology. The technical definitions of the performance objectives should be more closely aligned with the organization's performance expectations of the facility after a seismic event occurs. One key component of this is to properly educate the decision makers on the real-world implications of one performance level over another. This is important not just to manage expectations of performance, but also because the performance level can have significant cost impacts on the actual retrofit, as well as the assessment itself.

This study has provided the City of Seattle the long term benefit of identifying specific gaps between how our facilities will perform during a seismic event in their current condition and how we expect them to perform. The Phase 1 and Phase 2 reports explicitly determine what actions are needed to mitigate these gaps. Having this information will allow the City of Seattle to plan for seismic upgrades and provides the framework to determine other facilities in our portfolio that require seismic assessments. This will allow the City to identify steps needed to meet expectations of performance and continue to serve the constituents of the City when an event does occur.