

# Appendix S

## VALIDATION AND QUALITY CONTROL

### S.1 External Quality Control

In a highly visible public project, multiple modes of quality assurance are desirable. One mode that is especially desirable is the formation of a review committee that is independent of the actual investigations undertaken. The Project Management Committee (PMC) of the Multihazard Mitigation Council (MMC) provided this external oversight management function. In this multi-disciplinary setting, the PMC included representatives of such disciplines and topics as natural hazards risk assessment, land-use planning, community studies, economics, and sociology.

In practice, the ongoing reviews by the PMC provided critical perspectives on the project in progress. These began with the development of the “Parameters” document that provided important guidelines, definitions, goals, and bounds during the undertaking of this project. During the course of this project, additional instances of the PMC critical assistance included:

- Posing challenging questions that required clarification of definitions and methods,
- Referring the project team to important advances in the literature,
- Assisting in resolving points of controversy among project participants,
- Acting through the PMC Project Manager to facilitate access of the project team to FEMA field offices, grantee staff, and data, and
- Providing feedback on such notions as spin-offs that are accelerations, and the procedures to be used in their quantitative evaluation.

### S.2 Internal Quality Control Procedures

Two main types of internal quality control procedures were used in this project: the formal and the informal.

*Formal procedures* consisting of a variety of internal checks and a report form that was used by the Track A<sup>145</sup> team to check the work of Track B<sup>146</sup> and vice versa.

This Quality Control (QC) review form (Table S-1) was included as part of each internal report. A report passed the QC check if the reviewer was satisfied with each of the 13 points listed in the form. Final reports were not delivered to MMC until the report passed the QC check. Interim reports have been provided with the caveat that the QC procedure had not yet been applied.

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<sup>145</sup> Benefit-cost analysis of FEMA hazard mitigation grants

<sup>146</sup> Community studies

The Track A co-leader acted as reviewer of Track-B reports at the draft and final stages. The Track B co-leader performed similar QC checks of Track-A reports.

**Table S-1 QC Form (Track B reports)**

Reviewer: \_\_\_\_\_  
 Report: (Title) \_\_\_\_\_  
 Date of review: \_\_\_\_\_

Tests: (explain any “no” responses in comments section, below)	Satisfactory
1. All important assumptions clearly stated & justified?	
2. All data sources clearly referenced, all bibliographic references complete & verified?	
3. All important study parameters clearly defined?	
4. Clear statement of study objectives?	
5. Clearly document data-collection procedures?	
6. All relevant data presented & summarized?	
7. All math clearly documented with numbered equations, no skipped steps?	
8. All conclusions supported by well documented data and analysis?	
9. Assess sensitivity of results to important alternative assumptions?	
10. Clear & complete statement of study limitations?	
11. Spot checks: calculations, selection of track-B communities, selection of track-A samples, and result tables. (List calcs & results tables checked in “comments” section.)	
12. Acceptable grammar, style, and organization?	
13. Response to prior QC commentary?	
<b>Summary: does the report pass QC? (Yes if the answer to all of the above is yes)</b>	

The QC form referred to “important” assumptions, limitations, study parameters, and relevant data. Track A provided to Track B, and vice versa, a draft document listing these important assumptions, limitations, etc.; the QC person also reviewed this document. Thus, QC attention was not paid to parameters, assumptions, and the like, that were unlikely materially to affect the study results.

These formal procedures were originally designed chiefly to fit situations in which mature risk evaluation tools, namely, HAZUS for specific types of wind, earthquake, and flood risks, were used. In these cases, parameters dominating outcomes were considered to be fairly well understood, and modification of inputs for sensitivity evaluations were likewise fairly mechanical. Greater ambiguities in the application of these formal procedures were believed to arise when the grants under consideration could not be evaluated through the use of these mature tools. In these cases, parameters and assumptions potentially dominating benefit estimates may be poorly understood. Absent extensive new research, assessment of the uncertainties in these benefit estimates may remain subjective.

Informal procedures included:

- The use of subject-matter specialists to review approaches and draft documents on matters pertaining to their specialties,
- Project team members reviewing general drafts of data, reports, analyses, and proposed approaches written by other project team members, and
- The technical project manager and project Track leaders reviewing all documents pertinent to their general charges.

These more informal procedures were continuously exercised no less than weekly and often more frequently in the course of this project.

### **S.3 Internal Project Review Team (IPRT) Input**

Independent review of the project was provided by the periodic review and input of ATC's Internal Project Review Team (IPRT). The IPRT consisted of six experts, all of whom are nationally recognized experts in their respective fields. They all have long-term experience in working with FEMA and in hazard mitigation. They were selected to provide independent, broad, consensus-based input to the ATC Project Team. This broad input was extremely important to the success of this project, in order to keep the Project Team focused on the big picture, while they performed very detailed data collection and analysis tasks. This balance of long-term experience, coupled with the breadth and depth of expertise resident on the IPRT and project team, allowed the Project Team to make technical recommendations and draw conclusions based upon the best available science and expert judgment. The IPRT was composed of the following individuals:

- William Petak (Chair) – policy analysis
- David Brookshire – economics/non-market impacts
- Dennis Mileti – social science
- Doug Plasencia – flood hazard mitigation
- Zan Turner – building code implementation
- Stephanie King – loss estimation modeling.

These six experts provided input in the areas of benefit-cost analysis, social science research, economics, policy analysis, implementation of hazard mitigation programs at the local level, and on earthquake, flood, and wind hazard issues. All major deliverables were reviewed by the IPRT before delivery to the PMC. Their input was solicited via conference calls, documented in minutes, and disseminated to the Project Team.

### **S.4 Validation of Costs**

For Track A, validation of costs was relatively straightforward, consisting chiefly of using RS Means (Means, R.S., 2002) to spot-check construction costs given facility type and geographic location. Track A also gathered secondary field data in order to substantiate costs.

Track B gathered cost data at the federal, state, and local levels, and so was not restricted to secondary data. Data gathered in the field provided corrections to secondary data. As a result, cost data for Track B had potentially greater certainty than cost data in Track A.

For both Track A and Track B, FEMA grants with multiple objectives were believed to have the potential for posing special cost estimation problems. For one thing, it was believed that costs of pertinent activities may need to be broken down for these grants. For another thing, some costs may not be pertinent to this project (e.g., grants for activities not pertaining to natural hazards mitigation).

## S.5 Validation of Benefits

For situations in which HAZUS tools are mature, Track A had the following procedures to check primarily inputs to HAZUS.

**Spot-check samples.** Some parameters were spot-checked and some were checked for the entire population. Samples for performing spot checks were selected from the Track A study samples as follows. Track A examined three project-type mitigation efforts from each of three hazards and three hazard levels, and three process-type activities from each of three hazards (3 project samples  $\times$  3 hazards  $\times$  3 hazard levels + 3 process samples  $\times$  3 hazards = 36 mitigations, less empty strata). In particular, the samples from each stratum were those selected from the 1<sup>st</sup>, 12<sup>th</sup>, and 25<sup>th</sup> fractile of cost.

- *Hazard assignment.* Track A checked hazard assignment for the wind and earthquake population by mapping each project location and its associated hazard level. Track A produced one map for each hazard. Track A visually compared project hazard-level assignments for earthquake and wind with the FEMA 154 (2002) earthquake-hazard-level map and ASCE-7 windspeed map. Track A performed spot checks for flood projects, taking stream order and stream distance as given, and checked one property from each sample project to ensure that, given stream order and stream distance, the highest-hazard property in the project actually met the project definition of flood hazard.
- *Project location.* Track A spot-checked the address stated in NEMIS with the address stated in the grant application. Track A used online geo-location tools (e.g., MapQuest) to check general agreement with FEMA's geo-location. Mitigation efforts with a precise address had to agree within  $\pm 0.01^\circ$  of latitude and of longitude. Mitigation efforts with imprecise location (e.g., processes applicable to a county) had to agree within  $\pm 0.1^\circ$  of latitude and of longitude.
- *Mitigation type.* Track A spot-checked to ensure that the grant-application description agreed with HAZUS input data, which agreed with the FEMA project-type coding.
- *HAZUS coding.* Track A spot-checked pre- and post-mitigation HAZUS structure type, value, location, and all other parameters listed in the data-collection form, compared the data-collection person's assessments with that of either another data-collection person or of the Track A co-leader, based on a hardcopy of the hazard mitigation grant application or considered internal consistency. Approximately 1,500 changes were made to coded project data. Most were minor but there were obvious transcription or typographic errors such as data from one field entered in an adjacent one or incorrect state abbreviations. Many were

critical data missing from one field that could be readily inferred from another, such as HAZUS's code for occupancy type being inferred from the project description. Some critical additions were made to address, geolocation, occupancy, number of stories, etc., using data available on the Internet and via mapping software. Some systematic checks were also performed, such as checking that the ratio of building value to square footage or the ratio of content value to structure value was within reason.

In similar situations in which HAZUS was considered a suitable mature risk evaluation tool, Track B used field data at various levels of completeness but generally more complete than those used in Track A. These were geo-coded with sometimes very precise longitudes and latitudes, with clear designations of the mitigation type and the hazard type, respectively.

Greater challenges in QC arose when the available risk tools for quantitatively evaluating benefits were less mature. In these cases, non-linearities in benefit estimates were believed to arise as a result of parameters not well-understood. For instance, a risk evaluation tool that did not have a category for commercial-industrial-institutional buildings with and without shutters would likely require the substitution of another building category to develop any benefit estimates for a mitigation consisting of installing shutters. In these cases, it was expected that Track A and Track B would clearly document the relative credibility of risk evaluation tools, assumptions used, and their limitations.

