Project 17 Planning Issue Summary Ballot Comments

August 7, 2015

Jack Baker, Stanford University

2 Design Value Conveyance--this would be a very useful step towards reflecting the way that many engineers already deal with these maps, would reduce the chance for users to make errors, and would enable a more complete characteristic of seismic hazards (including a number of the later proposals). Moving to an official electronic tool would also make it easier to provide Conditional Mean Spectra that are used in ASCE 7 Chapter 16, and potentially to even provide representative ground motions in the future.

3 Precision vs Uncertainty--I appreciate the issue here, and understand why a mechanism to smooth out the mapped updates may make sense. I would be careful about describing the mechanisms driving changes, however. "Statistical significance" is likely not an appropriate term to use in evaluating the magnitude of changes (no tests of statistical significance are performed on mapped changes that I am aware of, and I am not sure how one would set up such a test if it was desired). Additionally, the ground motion prediction equation dispersion of 0.6 cited in the Description is not a direct driver of the map changes being alluded to (dispersions are generally rather stable from cycle to cycle). I would rather suggest using a more plain language description, such as: "These maps aim to quantify the likelihood of very rare events, and as such are inherently difficult to constrain from observational data. As our knowledge grows, and is reflected in updated models for earthquake occurrences and resulting ground motions, our predictions of rare events are necessarily more affected than our predictions of frequent events. Updated models are generally improved over older models in their ability to explain past observations or their ability to incorporate our understanding of physical processes, but evaluations of newer models versus older models with respect to extreme event predictions is rarely definitive. The issue is whether the maps should aim to reflect our latest understanding of earthquakes, or whether they are more useful as a relatively stable guide for regulations."

4 and 5, Collapse Risk studies--these would be interesting topics for ongoing study, but I hope that the committee is cautious in implementing changes. There is certainly an opportunity to evaluate how closely our modeling assumptions align with the real world, but it's not necessarily for them to align perfectly in order for these maps to be a useful and rational tool. Having too many "knobs to turn" (max direction factors, risk targets, damping levels) may make it difficult to choose a set of parameters for the official maps. Unlike many of the other issues, where there are peer-reviewed models already available, this topic seems somewhat more speculative and in need of some broader education before a change would be well-received.

7 Multi-Period Spectral Values--this would be a nice improvement to model that causes unintended difficulties. I appreciate the challenges in updating simplified analysis methods to utilize this information, but in the long run it seems inevitable that we will move to a more accurate multi-period representation and it would be great to start that transition sooner than later.

8 Duration as a Mapped Parameter--Greg Deierlein and I have been working with a PhD student (Reagan Chandramohan) on this topic and would be happy to share our thoughts and publications with anyone who is interested.

12 and 13 Basin Effects and Simulations--numerical simulations and basin modeling will be important tools for future refinement in hazard maps. Our current models are rather unsatisfactory for dealing with complex basin effects, but the new numerical simulations will need careful vetting to ensure that their insights are not outweighted by their other limitations. Targeted evaluation of one or two special study areas during this cycle would be a great step towards vetting simulation procedures and figuring out what would be needed to adopt them more broadly in future update cycles.

Philip Caldwell, Schneider Electric

I will leave it up to the senior management of the Project 17 planning committee on how to prioritize the issues. Because of the global markets that I have to coordinate for my focus is on the "worst case criteria" globally to use anywhere (except nuclear) without need to assess location or building specific concerns - when I get to that understanding then I am done.

I would like to comment that even in today's earthquake hazard map paradigm it is becoming more of an IT intensive activity to incorporate the map data into the compliance evaluation process. Therefore even if only a few of the Project 17 concepts are carried forward USGS and ASCE will quickly find a dramatic increase in planning and acquiring IT resources to reduce the manipulation of the complex location specific data into a form and context that "the average" design professional can deal with and incorporate into their designs. This is going to require a considerable amount of advance activity with a wide range of stake holders to sort through just the process issues of the IT issues separate from the science of the maps.

An additional comment about stakeholders - something that I first noticed with the publication of the CGS special near field fault maps for California (required for the 1997 UBC), perhaps more non-engineers bought these code maps than practitioners. I am seeing the same trend across the U.S. as I meet with a wide audience of non-practitioners, there is a large user base that goes directly to the latest USGS map updates online that never pick up a copy of the IBC or ASCE/SEI 7 and aren't even aware of the code. Should their needs be examined also?

Rui Chen, California Geological Survey

2017 update of NSHMs may be good idea given the preliminary issues proposed by the Project 17 committee. However, resources required for an update once every 3 years may not be justified. Also, it takes time for the NSHMs user community to catch up with each new edition of maps. Three-year updates may lead to more confusions in the user community. It may also increase the chance of delayed map products.

The advantages of printed maps are for understanding regional variations, not for providing design parameter values. Users already get their design parameters mostly from USGS web-

based tools rather than from printed code maps. Therefore, large amount of printed maps are definitely unnecessary. Digital databases that provide hazard spectra for multiple site conditions and return periods should be the way to go. Developing applications that are designed to reference these databases is a good idea.

Uncertainties in design parameters should affect the use of these parameters. There should be a way to measure statistical significance of fluctuations between different map cycles to justify/explain changes. Statistically insignificant fluctuations should be avoided. Uncertainty should play an important role in the transition from NSHMs to the design maps.
True uniform risk is not achieved even if deterministic cap can be eliminated. There are regional variations in building fragility. Building fragility also varies by building type. Assuming a common fragility curve does not achieve uniform fragility. That said, it is important to account for regional variation in ground motion hazard characteristics, namely the slope of the hazard curve. Perhaps a different term should be used rather than "risk targeted".

There seem to be two conflicting aspects in Issue #5: a) FEMA P-695 (596 must be a typo) made conservative assumptions with regard to the definitions of median collapse capacity and its uncertainty, leading to over-prediction of collapse probability; and b) anticipated seismic reliabilities for code conforming structures are orders of magnitude smaller than those deemed acceptable for failures under other loads, which implies seismic design is less conservatism. Not sure how to explain this inconsistency.

Duration as a mapped parameter is hard to Imagine. However, the effect of duration on building performance should be addressed.

Julie Furr, CSA Engineering

I sit on the Scientific Earthquake Studies Advisory Committee (SESAC) for USGS. While these comments are my own and do not reflect a consensus opinion by SESAC, they are prompted in part by my interaction with SESAC. Most of the planning issues listed require additional USGS resources in terms of research, equipment, and manpower. The USGS, like most federal agencies, is under significant budget challenges and may be unable or unwilling to support some of these initiatives. I would like to recommend a slightly different approach to prioritizing this list in concert with the ballot responses:

<u>My recommendation</u>
Send this list with descriptions as necessary to the USGS and ask them to identify current research projects, ongoing or planned, that would complement these issues. If the research is already in progress on a specific issue, a defined need by Project 17 would be welcome to justify continued funding of that research by providing a specific end use for the data. In return, Project 17 would have a clear direction to proceed on issues already in play, and could focus time and effort to narrowing down the remaining issues.

Sandra Hyde, ICC

All of the project 17 proposed issues will take time and significant manpower.

At the end of the work will be the time to roll out the changes to ASCE 7 and the IBC/IRC. I am focusing my comments on this later timeframe. The comments have been broken down into separate documents by issue. The attached questions and concerns come from a jurisdictional user's perspective – enforcement – rather than an engineer's and this gives the questions/concerns a slightly different focus than an engineer's.

Issue 2 (Design Value Conveyance)
Issue 7 (Multi-period Spectral Design)

Questions:

1. Would the online tool be used in all regions or a map still available for low seismic regions?
2. By what process will you convince building departments that an online tool is a necessary reference to determine the seismic design category (SDC)?

   Discussion of desired changes with jurisdictions will need to begin before ICC Code Development committee hearings for the 2021 or 2024 IBC/IRC (the first hearings will occur in the winter of 2019 or 2020 for the 2021 codes). This will be a paradigm shift. Acceptance of a proposed code change by governmental members is key for the change to pass and become part of the next code edition. Previously only attendees of the hearing could vote on changes, but with the 2018 codes, all registered voting members can vote remotely (online). The Project 17 committee will need to educate members on the changes before the hearings. Currently, the IBC and IRC do not reference any software tool to determine how to design a structure.
3. How do you build trust that a software tool will give the same values for a given location for 10+ years (see static needs below)?
4. For quality assurance, i.e. special inspection, how will the S_{DS}, S_{D1}, new values, etc. be verified in the new schema?

Needs:

1. Static reference values – building officials are primarily concerned about whether mapped values remain static for a specific code edition and its referenced standards. Mapped values must be stable and available for 10+ years so a jurisdiction can access the same values. Maps have worked well for this need. Departments will need reassurance that new values would remain unchanging in a software tool for a given edition of the IBC.

   For example, there are currently jurisdictions adopting the 2012 IBC after use of the 2006 IBC for 6 years. Typical adoptions are a 3 year or 6 year cycle based on adopting a code 1-3 years after it is published. A number of jurisdictions adopted the 2012 IBC in 2015. All of these jurisdictions must be able to retrieve a static S_{DS}, S_{D1} or other value (or simply a SDC) from some location (paper or online) for the next 6+ years – a total life cycle of approximately 10 years.

2. Stability – lack of stability of mapped values and of precision. Regions bouncing between SDC C and SDC D for residential construction have had to deal with an enormous backlash from the community every time the values cross that boundary. Precision becomes an issue because building departments don't know whether a change may be significant. Generally, a department pays attention to the calculated SDC; not whether the mapped values or S_{DS} and S_{D1} values have changed. If the format used to present the seismic forces is simply an SDC or zone, then most departments won't see change (in low seismic regions).

   If they do see changes, whatever format is used to present the seismic force, the following questions must be considered by a building department:
   - How does the building department determine if a new **lower** SDC is 'safe enough'?
   - What are consequences of deciding that a **higher** SDC is required long-term for safety?

   Building departments generally are not concerned about where values come from or what they are based on. Safety and the potential for law suits due to changing seismic design categories are the focus. If a jurisdiction is on an SDC boundary, the department will answer the questions above based on what is easiest for the community and not what a mapped value might be. When a design is conventional, i.e. non-engineered, builders and contractors go to the building department website to determine the SDC to use in their conventional design. Often a department will assign one SDC for the entire jurisdiction if the area is rural or a county.

3. Verification – for special inspection required for a number of larger buildings and buildings in higher seismic design categories, some method of verify a correct S_{DS} and S_{DI} (or other value) needs to exist. Currently, if the USGS tool is used, a quick estimate can be done with the maps plus calculations from either the IBC or ASCE. A process is needed for verification by estimate at a minimum.

Issue 3 (Precision vs. Uncertainty)
Issue 7 (Multi-period Spectral Definition)

Questions:

1. How will the new process differentiate between low seismic and higher seismic regions?
   0. Maintain ELF process? Who gets to use? What would it look like?
      - SDC A = no seismic
      - SDC B + good soil = ELF
      - SDC C + good soil = ELF?
      - SDC B + poor soil (or basin effects?) = ELF?
      - SDC C + poor soil (or basin effects?) = ELF or expanded process?
      - SDC D + good soil – require expanded process?
      - SDC E, F and SDC D + poor soil – always require expanded process? Exceptions?

2. If everyone is not required to go through a multiple-step process, can a low seismic region maintain current design practices for SDC A? SDC B?

3. What about residential & commercial conventional construction?

   This is the most vocal group and the largest sector of buildings built in a given year. Will the IRC maintain a printed map? Would the IBC have a printed map for SDC A, B and possibly C?

   Currently the map in IRC (*International Residential Code*) is the ***ONLY*** item used to determine seismic design category in regions SDC A, B and C. Typically for regions in SDC D_0, D_1 and D_2, knowledgeable building departments (urban areas) will use USGS tool. Rural areas often select the highest SDC on the map in the county and use it for the entire county.

Issue 8 (Duration)

Questions:

1. Is addition of a duration effect variable sufficient to encompass potential failures during a subduction zone earthquake?
2. Is extended vibration likely to change the hysteretic behavior of an elastic material? What about a brittle material designed to remain below the allowable stress elastic limit – what will additional cycles for an extended duration do to the material? Is strain hardening a significant concern? A new testing protocol should be a high priority if answers to these questions are 'we don't know' or 'probably'.
3. Are we considering damage we have seen happen in Japan and Chile? During long duration quakes has there been an increase in damage beyond what would be expected by the codes used for construction of the buildings?

Issue 12 (Basin Effects)

Questions:

1. What happens with basin effects in a traditionally SDC B region? Are effects sufficient to necessitate additional calculations? What about a traditionally SDC C region?
2. For quality assurance, i.e. special inspection, with the complicated process run through an online tool, what rough estimate will be available to estimate, at a minimum, the seismic design category of a building in an area with basin effects?

Marshall Lew, EERI

Issue 2. This issue deals with the future presentation of the building code in what is definitely a changing technological environment. The conveyance of the building code and its provisions presents interesting challenges. One can foresee going entirely digital and perhaps design will be performed by engineers on iPads or even iPhones or whatever new devices are developed and introduced in the future. Perhaps even virtual reality or augmented reality devices would be used. However, my greatest concern is that the movement from traditional "dead tree" format

will lead to further erosion in the design process of understanding and professional judgment. The design process is already becoming more "black box" in approach and could become even more so.

Issue 6. Maximum direction ground motion components is a very important issue to deal with. This has been and continues to be controversial and does not have a true backing by the design community being force fed it in the last code cycle.

Issue 7. Multi-Period Spectral Values are important, but expanding the growing number of maps to cover these additional periods may seem to be convenient, but these would apply to structures of possibly greater importance, economic value, and perhaps exposure to hazard. Do we want to make the design of these structures more "cook book" or require better analysis?

Issue 9. Damping factors. Is this really necessary? It seems like tools to do this are becoming more available. Where different values may be used would be in the more unusual structures requiring more sophisticated analyses anyway.

Issue 12. Basin Effects are important, but this is a huge effort that can drain resources very quickly.

Issue 13. 3-D simulation to develop long period parameters should also include real world calibration and verification to avoid miscalculation that could be either under- or over-conservative.

Jennifer Thornburg, California Geological Survey

If we are serious about having stable seismic parameters over time, we will have to drop most of these proposed issues. We simply cannot continue to change *the nature of the parameters* and expect any type of stability.

I expect that the fundamental decision is whether to design structures to precise seismic parameters. If engineers expect a structure located where S_{DS}=0.61*g* to be designed differently from the same structure located where S_{DS}=0.67*g*, then we will maintain the current style of very detailed design maps, and everyone will likely have to live with continuing changes in the values of seismic parameter. Even if the *definition* of seismic parameters becomes stable, the estimation of the values can be expected to change with each new map version. If stability is more important than the difference in values, then we may need to revert to something like seismic zones where design parameters are more generalized but also more stable over time.
As a second big-picture comment, it seems we are striving to make the general design maps include all possible aspects of ground motion, including elements that have little or no effect on typical structures in most locations across the country. These ideas (e.g., Issues # 6, 8, 9, 10, 12 and 13) are still pretty academic, and a significant research effort is required prior to implementation. Should we expect the more complex analyses to be considered in a site-specific analysis required of the unusual structures, rather than conducting fresh research in time to meet code deadlines in order to create "general procedure" maps for all conditions?