



# Background Document

## FEMA P-58/BD-3.7.19

# PACT 3.0 Updates to Fragilities

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## **Background Documentation**

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FEMA P-58 Background Documents are a series of reports documenting the technical background and source information for key aspects of the FEMA P-58 methodology and its implementation. This report was developed over the course of the 5-year ATC-58-2 Project funded under FEMA Contract HSFE60-12-C-0243.

Background Documents were developed by consultants, serving at various levels within the project hierarchy, reporting the results of: (1) decisions on technical development protocols; (2) focused studies on the development of key aspects of the methodology; (3) documentation of recommended procedures; and (4) collection of available data for the development of structural and nonstructural fragilities. They were initially intended to serve as a record of the technical state-of-knowledge at the time they were produced, and as resources for the development of the eventual project reports. As such, they represent a snapshot in time, and may, or may not, match the technical content, recommended procedures, or data incorporated into the final methodology and its implementation.

This Background Document is intended for the purpose of providing supplemental knowledge to users of the FEMA P-58 methodology. Information contained herein has not been independently verified for accuracy as a stand-alone document, and may have been superseded in its final implementation within the methodology. Specifically in the case of certain nonstructural component fragilities, the NISTIR fragility classification numbering scheme was modified over the course of the project, and the fragility classification number assigned in this document might be different from numbers assigned in the final fragility database. Users of information in this document assume all liability arising from such use.

## **Notice**

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Cover photograph – Collapsed building viewed through the archway of an adjacent building, 1999 Chi-Chi, Taiwan earthquake (courtesy of Farzad Naeim, John A. Martin & Associates, Los Angeles, California).

**PACT 3.0 Updates to Fragilities  
September 2016**

The following fragility updates were made in response to review team observations of PACT findings. Trivial grammatical changes are not listed. The revisions are included in the September 2016 version of the *Fragility Database*.

**1. Updates to damage states and repair consequences.**

Fragility	Component Description	Notable Changes
B1031.001 B1031.011a B1031.011b B1031.011c B1031.021a B1031.021b B1031.021c	Gravity beam shear tab, steel base plate, and steel column splice	<ul style="list-style-type: none"> <li>• The DS1 damage state was found to generate disproportionately high repair cost.</li> <li>• In response, it was decided to duplicate the DS1 state and introduce a mutually exclusive DS1 / DS2 condition. DS1 results in zero repair and zero cost consequence and represents 95% of events DS1/DS2 mutual exclusive events triggered. DS2 retains the former repair and cost consequence in the remaining 5% of events.</li> <li>• The former DS2 and above remain as renamed subsequent sequential damage states.</li> <li>• DS1 “beta” values are set to 0.25 in order to prevent computational error within PACT.</li> </ul>
B2011.201a	Precast concrete cladding panel – in plane response	<ul style="list-style-type: none"> <li>• The DS1 damage state was found to generate disproportionately high repair cost.</li> <li>• In response, it was decided to duplicate the DS1 state and introduce a mutually exclusive DS1 / DS2 condition where a new DS1 calls for repair equal to 20% of the former DS1 consequence. The new DS2 is equal to the former DS1. The resulting DS1 / DS2 mutual exclusive damage states are given 50% / 50% event probability respectively.</li> <li>• The former DS2 and above remain as sequential states.</li> </ul>

**2. Updates to repair costs**

For the following fragilities, file quantity max and quantity min (\$min & \$max) were edited so that the consequence data are in agreement with the cost unit of the source data. For example, if the source cost data are provided on a per square foot basis, then the economy of scale quantities must also be in square foot units – not in the PACT UNIT which have varying bundled quantities for ceilings, walls, glazing, and distributed mechanical components.

B1044.091 B1044.092 B1044.093 B1044.101 B1044.102 B1044.103 B1044.111 B1044.112 B1044.113	Slender concrete walls.	<ul style="list-style-type: none"> <li>• DS1, DS2, and DS3 median demand, dispersion, and total dispersion (beta) values revised slightly.</li> <li>• Demand parameter revised from “Story drift ratio” to “Effective Drift”.</li> </ul>
B1061.001a B1061.001b B1061.011a B1061.011b B1061.021a B1061.021b	Various cold formed steel walls.	<ul style="list-style-type: none"> <li>• Revised DS1, DS2, and DS3 (where it occurs) to be numeric drift, not percent drift. (e.g. 0.40 revised to 0.004)</li> </ul>
B2011.001a B2011.001b B2011.011a B2011.011b B2011.021a B2011.021b	Various exterior wall cold formed steel walls.	<ul style="list-style-type: none"> <li>• Revised DS1, DS2, and DS3 (where it occurs) to be numeric drift, not percent drift. (e.g. 0.40 revised to 0.004)</li> </ul>
C1011.001a C1011.001b C1011.001c C1011.001d C1011.001e C1011.001f C1011.011a	Various gypsum interior wall partition types.	<ul style="list-style-type: none"> <li>• Reduced from five damage states to three damage states by removal of mutually exclusive DS2 and DS3 to be sequential DS1 through DS3.</li> <li>• Edit to DS1, DS2, and DS3 damage and repair descriptions.</li> <li>• Changes to DS1, DS2, and DS3 median demand and total dispersion (beta) values.</li> <li>• Revision of DS1, DS2, and DS3 cost and time consequences with corresponding changes to reported statistical parameters (mean, CV, p10, p50, p90, and normal / lognormal fit type).</li> </ul>
C3021.001a through C3021.001p	Various generic floor covering types- flooding of floor caused by pipe breakage.	<ul style="list-style-type: none"> <li>• Fragilities redefined to be the flooding of the floor caused by breaking of pipes.</li> <li>• Costs based upon repair of one square foot of flooring.</li> <li>• Seismic design category now by user.</li> <li>• Damage state DS2 (drop joint piping breaks) removed.</li> <li>• Data quality, relevance, and documentation changed to “none”</li> <li>• Changes to DS1 damage and repair text descriptions.</li> <li>• Note added requiring user to supply median demand and total dispersion (beta).</li> </ul>