STATE TRANSPORTATION AGENCIES PARTNER TO DEPLOY & ENHANCE SHAKECAST

Loren Turner & Nathan Newall, Caltrans
Daniel Slosky, David Wald, Kuo-Wan Lin, U. S. Geological Survey
Overview: What is ShakeCast?

• **Open-source USGS software**; user installs (or USGS hosts).

• **Automatically** retrieves ShakeMap & compares shaking levels with unique facility fragilities.

• Generates & delivers report of inspection priorities (hierarchical lists of facilities likely impacted).

• Sends notifications & reports to specified personnel/responders.

• Raises post-earthquake situational awareness in first min. to hrs. following an earthquake.
ShakeCast: Sample Critical Users

**Agencies**
- U.S. NRC
- U.S. Fish & Wildlife Service
- US Army Corps of Engineers
- Montana Department of Natural Resources & Conservation
- Idaho Department of Environmental Quality
- United States Department of Veterans Affairs
- California Energy Commission
- International Atomic Energy Agency
- Idaho Transportation Department
- Oregon Department of Transportation
- DOT

**Transportation**
- Caltrans
- WSDOT
- Nevada DOT
- LA Metro

**Business**
- Walmart
- TRAVELERS
- Target
- Boeing
- Amazon

**Lifelines/Utilities**
- Alameda County Water District
- Edison
- Southern California Edison
- Public Works
- San Francisco Water Power Sewer
- Raytheon
- East Bay Municipal Utility District
- Los Angeles Department of Water & Power
- Sempra Energy

**Critical Facilities**
- FERC
- Federal Energy Regulatory Commission
- Department of Energy
- Hanford
- OSHPD
- Sandia National Laboratories
- Jet Propulsion Laboratory
- California Institute of Technology

**Emergency Management**
- Utah Emergency Management

**Engineering**
- Degenkolb
- U.S. Resiliency Council
- Infra Terra
- Port of Long Beach
- THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS
## Managing In-house ShakeCast System

<table>
<thead>
<tr>
<th>Key Person</th>
<th>Role</th>
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<tbody>
<tr>
<td><strong>Project/Program Manager</strong></td>
<td>Oversee the ShakeCast project and coordinate activities regarding research, implementation, and operation of the ShakeCast system at the user organization</td>
</tr>
<tr>
<td><strong>Server System Administrator</strong></td>
<td>Administer the host server for ShakeCast and configure system components for the machine</td>
</tr>
<tr>
<td><strong>Security/Firewall Policy Administrator</strong></td>
<td>Administer user account, account privileges, firewall settings, and network interconnectivity (USGS web server and user’s SMTP server)</td>
</tr>
<tr>
<td><strong>ShakeCast System Administrator</strong></td>
<td>Install ShakeCast software; administer ShakeCast database inventory on facilities, earthquakes, groups, and users; maintain the ShakeCast system</td>
</tr>
<tr>
<td><strong>USGS ShakeCast Team</strong></td>
<td>Provide training and technical support on the ShakeCast system</td>
</tr>
</tbody>
</table>

*Ref. Caltrans ShakeCast V3 IMPLEMENTATION RECOMMENDATION*
### Study Detail View

Connecting the DOTs: Implementing ShakeCast Across Multiple State Departments of Transportation for Rapid Post-Earthquake Response

#### General Information

<table>
<thead>
<tr>
<th>Study Number: TPF-5(357)</th>
<th>Lead Agency: California Department of Transportation</th>
<th>Status: Cleared by FHWA</th>
<th>Contract/Other Number:</th>
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<tbody>
<tr>
<td>Contract Start Date:</td>
<td></td>
<td>Est. Completion Date:</td>
<td>Last Updated: May 10, 2018</td>
</tr>
<tr>
<td>Solicitation Number: 1406</td>
<td></td>
<td></td>
<td>Contract End Date:</td>
</tr>
<tr>
<td>Partners: CA, ID, MO, MS, OK, OR, SC, TX, UT, WA</td>
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<td></td>
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</tr>
</tbody>
</table>

#### Contact Information:

**Lead Agency Contact(s):**

Nathan Newell  
nathan.newell@dot.ca.gov  
Phone: 916-227-8763

**FHWA Technical Liaison(s):**

Sheila Duwadi  
Sheila.Duwadi@fhwa.dot.gov  
Phone: 202-493-3106
SHAKECAST TFP TRELLO WEB SITE: PROJECT ROADMAP

Task 1 – Establish Operational ShakeCast Systems for DOT Partners

Task 2 – Expand ShakeCast Functionality

Task 3 – Long-Term Roadmap

Task 4 – Final Report

ShakeCast Excel Workbook

U.S. Department of Transportation
Federal Highway Administration

NIB-to-ShakeCast Conversion Tool

Add a card...
Ten U.S. State Dept. of Transportation Partners implementing ShakeCast

- NBI2SC_XML. Converts National Bridge Inventory (NBI) to ShakeCast input XML.
- Uses Hazus Methodology
- Still requires QA/QC for a few percent of bridges (each state has thousands or 10’s of thousands.)
- Done for all 50 states & Puerto Rico.
SHAKECAST STATE PDF REPORT EXAMPLES

State of Oklahoma
Department of Transportation

ShakeCast Report
National Earthquake Information Center (NEIC)

Magnitude 4.4 - OKLAHOMA

Version 2
Latitude: 36.75480 Longitude: -98.07650
Depth: 5 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions related to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.

Type | ID | Name | Epicentral Distance | PGA (g) | PGV (cm/s) | PSA 1s (%g) | MMI | Vs30 (m/s)
--- | --- | --- | --- | --- | --- | --- | --- | ---
BRIEGE | 40_098290000000000 | 098290000000000 - SALT FORK | 4.63 | Below Threshold | 23.37 | 4.1 | 1.08 | V | 453.86
BRIEGE | 40_231610000000000 | 231610000000000 - ARKANSAS RIVER CREEK | 3.58 | Below Threshold | 20.4 | 2.3 | 1.36 | V | 262.284
BRIEGE | 40_288420000000000 | 288420000000000 - SAND CREEK | 5.45 | Below Threshold | 19.98 | 2.29 | 1.55 | V | 253.23
BRIEGE | 40_306700000000000 | 306700000000000 - WAGON CREEK | 3.64 | Below Threshold | 18.01 | 1.89 | 1.11 | V | 238.542
BRIEGE | 40_167030000000000 | 167030000000000 - CREEK | 5.77 | Below Threshold | 17.97 | 1.9 | 1.24 | V | 343.206
BRIEGE | 40_293770000000000 | 293770000000000 - SAND CREEK | 6.05 | Below Threshold | 18.86 | 2.26 | 1.52 | V | 232.26
BRIEGE | 40_307060000000000 | 307060000000000 - CREEK | 6.27 | Below Threshold | 15.94 | 2.26 | 1.02 | V | 321.146

BRIEGE: 18845

State of Idaho
Department of Transportation

ShakeCast Report
National Earthquake Information Center (NEIC)

Magnitude 5.3 - SOUTHERN IDAHO

Version 3
Origin Time: 2017-09-02 23:56:52 GMT
Latitude: 42.62440 Longitude: -111.39050
Depth: 9.2 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions related to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.

Type | ID | Name | Epicentral Distance | PGA (g) | PGV (cm/s) | PSA 1s (%g) | MMI | Vs30 (m/s)
--- | --- | --- | --- | --- | --- | --- | --- | ---
BRIEGE | 16_000000000000000 | 000000000000000 - BATTLE RIVER | 16.37 | Below Threshold | 6.5 | 6.27 | 4.09 | V | 363.906
BRIEGE | 16_00000000022301 | 0000000022301 - BEAR RIVER | 35.02 | Below Threshold | 4.54 | 5.54 | 4.05 | V | 190.403
BRIEGE | 16_00000000016695 | 0000000016695 - BEAR LAKE CANYON | 35.51 | Below Threshold | 6.14 | 5.68 | 4.08 | V | 198.041
BRIEGE | 16_00000000032325 | 0000000032325 - BEAR RIVER | 10.82 | Below Threshold | 7.81 | 5.85 | 3.89 | V | 398.643
BRIEGE | 16_00000000015340 | 000000015340 - UTILITY, IDAHO SPRINGS, ID | 15.44 | Below Threshold | 7.07 | 5.16 | 3.38 | V | 387.539
BRIEGE | 16_00000000032320 | 0000000032320 - BEAR RIVER | 15.48 | Below Threshold | 6.72 | 4.98 | 3.24 | V | 381.205
BRIEGE | 16_00000000017258 | 000000017258 - BATTLE RIVER | 16.48 | Below Threshold | 6.05 | 4.97 | 3.04 | V | 392.204
We would like to welcome you to try the new Amazon ShakeCast V3 AMI! Your Amazon account now has access to our private stable-release AMI.

The links provided below will aid in the installation and configuration of your instance:

- [Cloud Installation Guide](#): Describes the process of starting ShakeCast through Amazon Web Services
- [ShakeCast Inventory Workbook](#): Organizes your inventory and generates XML files which are readable by ShakeCast
- [User Guide](#)
- [System Configuration](#): WARNING Inventory management schemas are outdated -- Use inventory workbook instead
- [HAZUS Model Building Types and modifications](#)

A couple things to note:
1) In the AWS Console, if you cannot see the Private AMI, check in the upper right corner, making sure the location is set to N. Virginia.
2) The V3 AMI image is accessible by your server's public DNS. Your URL will look similar to:
   ec2-###-###.compute-1.amazonaws.com
3) In order to view the admin console you will need to log in using the initial scadmin user credentials (username:scadmin password:scadmin)
4) Application build location, /usr/local/shakecast

BETA ShakeCast V4 (pyCast) is now available on AWS. If you are interested in testing this software, please let us know.
The ShakeCast Excel Workbook

Easily input Facility, Notification Group, and User Information and export ShakeCast readable XML files

- Start
- Take a Tutorial
- Workbook Info
# Notification Worksheet

## Spreadsheet Information

**Facility Type**: Select the facility type from the drop-down list.

**Monitoring Region**: Polygon defining the latitude/longitude boundaries of the area being monitored. Must contain more than 3 points separated by semi-colons where the last point is the same as the first point.

**Notification Type**: Notifications can be sent for new earthquakes (NEW EVENT) or if there is ground shaking parameter at a facility (DAMAGE).

**Notification Priority**: Each GREEN, YELLOW, ORANGE, and RED level is defined individually. This field is only required for DAMAGE notifications.

**Minimum Magnitude**: Minimum magnitude for a notification to be sent. This field is only required for NEW EVENT notifications.

**Event Type**: Type of event that will trigger notifications: ALL, ACTUAL, TEST, SCENARIO, or HEARTBEAT.

## Options

**Notification Format**: Notification product delivery format.
### User Worksheet

<table>
<thead>
<tr>
<th>Username</th>
<th>User Type</th>
<th>Password</th>
<th>Full Name</th>
<th>Email Address</th>
<th>Phone Number</th>
<th>Notification Group</th>
<th>Pager Delivery</th>
<th>What email address would you like your PAGER emails to be sent to?</th>
<th>Which email address would you like your EMAIL messages to be sent to?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex1</td>
<td>USER</td>
<td>pass</td>
<td>Test User</td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
<td></td>
<td>CAL_BRIDGES</td>
<td></td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
</tr>
<tr>
<td>Ex2</td>
<td>USER</td>
<td>pass</td>
<td>Test User</td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
<td></td>
<td>CAL_BRIDGES:DU</td>
<td></td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
</tr>
<tr>
<td>Ex3</td>
<td>ADMIN</td>
<td>pass</td>
<td>Test User</td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
<td></td>
<td>CAL_BRIDGES:SCENARIO</td>
<td></td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
<td><a href="mailto:example@example.com">example@example.com</a></td>
</tr>
</tbody>
</table>

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**Spreadsheet Information**

- **Username**: Enter a username that does not contain any spaces.
- **User Type**: Users are either USER or ADMIN.
- **Password**: Enter the full name of the account user.
- **Full Name**: The email address of the account holder. This address will be used to send you non-alert messages.
- **Email Address**: Required for admins, but not general users.
- **Phone Number**: Notification or DRP/UP the user is subscribed to.
- **Pager Delivery**: Which email address would you like your PAGER emails to be sent to? Which email address would you like your EMAIL messages to be sent to?

**Options**

- Export XML
- Export Master XML
- Update Worksheet
- Unlock Data
- Import CSV
- Clear All Data
# SHAKECAST WORKBOOK: FACILITIES

## Facility Fragility Parameters

| Hazard Type | PGA | DPA | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM | IM |
|-------------|-----|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Concrete Frame Low | 0.02 | 0.04 | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | 0.16 | 0.18 | 0.20 | 0.22 | 0.24 | 0.26 | 0.28 | 0.30 | 0.32 | 0.34 | 0.36 | 0.38 | 0.40 | 0.42 |

### Facility Attributes

Facility Attributes allow you to group and filter facilities. This field also allows you to further personalize your facility information.

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### Notes

- Select from library of default HAZUS models to auto-populate fragility parameters, or enter fragility parameters manually.
- This field is automatically populated based on the HAZUS Model Building Type Label field selection.
What’s new in ShakeCast?

- **V4 development ("pyCast")**
  - Complete code refactoring to modern technologies for sustainability (Python, Angular). SQLite database & pure Python web server to ease the install process.
  - Automatic updates
  - V4 ShakeMap compatibility
  - Full HAZUS AEBM integration
  - Scenario & Atlas integration
  - USGS Ground Failure product integration

- **ShakeCast Support**
  - Support for scores of critical users; V3 to V4 upgrades.
  - *ShakeCast Workbook* facilitates creating inventory.
  - USGS cloud hosting for VA, NRC, others.
ShakeCast Fragility Models

**Hazus-based Fragility Function**

- Fragility Curves for Facility 34249
  - Event: ncsanandreas 2 se scte-1

- Distribution of Probability
  - Best Estimate: 28.428

**Customized Damage Function**

- ShakeCast damage state implementation for HAZUS high-code model building types.

**Hazus AEBM Function**

- Performance Point Calculation and Intersection of Upper and Lower Bound Demand and Capacity Curves

- Structural Damage State Probabilities
  - None
  - Slight
  - Moderate
  - Extensive
  - Complete

**Exceedance of Regulatory Levels**

- SL1/OBE Exceedance
- SL2/SSE Exceedance
- RG 1.166A Exceedance
- Magnitude/Distance Check
- Felt (M>6.0 & MMI II) Check
- Felt on Site (MMI IV) Check
ShakeCast-Related R&D

- **Scenario & Atlas ShakeMap Collections**
  - >800 scenario for U.S. available to ShakeCast
  - >6,000 global earthquake ShakeMaps for significant historical earthquakes

- **Landslide/liquefaction product integration**
U.S. ShakeMap Scenarios (>800 from BSSC catalog)

Multiply-weighted, GMPEs, consistent with USGS NSHM’14
M 7.0 Scenario Earthquake - Gore Range frontal fault

2017-05-12 20:14:13 UTC | 39.826°N 106.216°W | 9.0 km depth

This event is a scenario (it did not occur) and should only be used for planning purposes.

More information about scenarios
Event-specific Landslide & Liquefaction Estimation

- Ground failure is currently triggered initially by the same triggers as PAGER (authoritative ShakeMap, M>4 US, M5.5 world).
- Core of product = suite of geospatial models
Ground Failure (GF) Products

Landslide Map

M 6.9 - 1km W of Day Valley, California
1989-10-18 00:04:15 (UTC) | 37.038°N 121.880°W | 17.2 km depth

- Probability type is areal coverage
- Logarithmic bins to better visualize range of typical values
- Saturates at probability of 0.2, which equates to severe ground failure. Neither model ever reaches values much higher than 0.2.
- Same colorbar bins for both models

Kate Allstadt & Eric Thompson, USGS

Liquefaction Map

M 6.9 - 1km W of Day Valley, California
1989-10-18 00:04:15 (UTC) | 37.036°N 121.880°W | 17.2 km depth

- Topographic layer leaves terrain and infrastructure visible
- Can add other earthquake layers, like shaking contours and population
Ground Failure

Contributed by USGS last updated 2018-05-06 18:48:30 (UTC)

☑️ The data below are the most preferred data available
☐ The data below have NOT been reviewed by a scientist.

Impact

Landslides

Estimated Area Exposed to Hazard

- Little to no
- Limited
- Significant
- Extensive

Landslides triggered by this earthquake are estimated to be limited in number and spatial extent.

Estimated Population Exposure

- Little to no
- Limited
- Significant
- Extensive

The approximate number of people living near areas prone to landslides triggered by this earthquake is low, but landslides damage or fatalities are still possible in highly susceptible areas. This is not a direct estimate of fatalities or losses due to landslides.

Contributors

Due to local factors and model limitations, ground failure may still occur when alert levels indicate little to no hazard. Refer to Ground
SHAKECAST DOCUMENTATION & SOFTWARE ON USGS GITHUB

usgs.github.io/shakecast