Pacific Gas and Electric Earthquake Risk Management of Gas and Electric Systems

Kent Ferre, SE
Manager
Geosciences Department

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Earthquake Risk Management Framework
PG&E Infrastructure at a Glance
Understand the Earthquake Hazard and System Vulnerabilities
Earthquake Risk Mitigation Activities
Earthquake Emergency Response and Planning
Earthquake Risk Management Framework
Earthquake Risk Management Framework

• Policy to manage earthquake risks
• Program to understand hazards and system vulnerabilities
• Plan to implement risk mitigation options
• Dedicated staff
• Dedicated budget
• Accountability

• California Seismic Safety Commission/CPUC Safety Branch
Earthquake Risk Management Process

- Evaluate facilities and operations
- Prioritize selected facilities for mitigation
- Implement mitigation
- Establish acceptable level of earthquake risk – enable PG&E management to make risk-informed decisions
PG&E Infrastructure at a Glance
Hydro

- Largest privately owned hydroelectric system
- Total generating capacity of 3,896 MW
- 107 generating units at 68 powerhouses

Fossil Plants

- 3 natural gas fired power plants
- Gateway & Colusa – Modern “F” technology GE 7FA combined cycle plants with over ~1,180 MW output
- Humboldt – 10 Wartsila model 18V50DF reciprocating engines with 163 MW output

Solar

- 152 MW of Photovoltaic (PV) and Fuel Cell facilities
- 9 ground-mounted PV solar stations, 3 small PV generation facilities and 2 fuel-cell facilities

2014 Cap Ex Spend

- Generation - $650 million
Transmission
- ~18,100 circuit miles
- ~90 transmission substations
- ~60 switching stations

Distribution
- ~141,000 circuit miles
- ~600 distribution substations

2014 Cap Ex Spend
- Transmission - $1 billion
- Distribution - $1.9 billion
### Gas

#### Transmission
- ~6,400 miles

#### Distribution
- ~42,400 miles

#### Storage
- 3 underground gas storage facilities
  - McDonald Island, Los Medanos and Pleasant Creek

#### 2014 Cap Ex Spend
- Transmission - $400 million
- Distribution - $700 million
- PSEP - $400 million
Corporate Real Estate

Office Buildings
- Four high rise buildings in San Francisco:
  - 77 Beale – 35 stories
  - 45 Beale – 5 stories
  - 245/215 Market – 15 stories
- One high rise in San Jose: 111 Almaden – 8 stories

Service Centers
- Three new “state of the art” distribution electric control centers in Fresno, Concord, and Rocklin
- ~25 mission critical service centers around bay area serve as operation centers, warehouse facilities, tool shops, and staging areas for emergencies

Seismic Upgrades
- $170M project completed in 1995 which was one of the most comprehensive seismic retrofits of a historic building complex in the U.S.
- Retrofitted ~130 buildings, many to an “IO” performance level, to assure effective emergency response and business continuity.
Understanding the Earthquake Hazard and System Vulnerabilities
Earthquake probabilities

- Likelihood of a magnitude 6.7 or larger earthquake in the next 30 years:
  - Subduction of fault: 20% to 25.9%
  - 15% to 19.9%
  - 10% to 14.9%
  - 5% to 9.9%
  - 1% to 4.9%

Source: USGS

UCERF3
Uniform California Earthquake Rupture Forecast (Version 3)

Three-dimensional perspective view of the likelihood that each region of California will experience a magnitude 6.7 or larger earthquake in the next 30 years. It matches the magnitude of the 1994 Northridge earthquake and 30 years is the typical duration of a horizontal earthquake.

Faults are shown by the rectangles outlined in black. The entire colored area represents greater California, and the white line across the middle defines northern versus southern California. Faults do not include earthquakes on the Cascadia Subduction Zone, a 750-mile offshore fault that extends about 150 miles into California from Oregon and Washington to the north.
Earthquake Risk Mitigation Activities
Electric T&D

• New Equipment
  • IEEE 693 Standard
  • High, Medium, and Low Hazard Zones
  • Use Hazard Maps to determine which bin

• Existing Equipment
  • Replaced 100% of 230kV and 500kV live tank circuit breakers

• Anchorage Retrofits
  • California Building Code

• Substation Buildings
  • Retrofitted 35 substation buildings following ASCE 41 methodology
## Gas T&D

### Gas Transmission

<table>
<thead>
<tr>
<th>Metric</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles of pipeline replaced</td>
<td>9</td>
<td>&gt;155</td>
</tr>
<tr>
<td>Miles of pipeline hydro tested</td>
<td>0</td>
<td>&gt;750</td>
</tr>
<tr>
<td>Miles of pipeline made “piggable”</td>
<td>130</td>
<td>&gt;415</td>
</tr>
<tr>
<td>Automated valves installed</td>
<td>0</td>
<td>235</td>
</tr>
<tr>
<td>Percent system with GPS centerline</td>
<td>0</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Gas Distribution

<table>
<thead>
<tr>
<th>Metric</th>
<th>2010</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles of main replaced</td>
<td>27</td>
<td>&gt;310</td>
</tr>
</tbody>
</table>

- All known remaining CI pipe decommissioned in 2014
- Opened a state-of-the-art Gas Control Center
Iso-Base

Vacaville GCC
Hydro Generation – Earthquake Risk Management

**Dams**

- **Currently Deterministic**
  - DSOD and FERC establish criteria
  - Median for low slip rate faults
  - 1-sigma for high slip rate faults

- **Future PSHA Framework**
  - PG&E fault file
  - SSC and GMC logic tree models
  - Uncertainty is included
Nuclear & Fossil – Earthquake Risk Management

Other Generation

• Nuclear
  • Recent Seismic Hazard Re-evaluation use a PSHA using an updated SSC and GMC as inputs
  • Current Licensing Basis is a M7.5 Hosgri earthquake, 84th percentile ground motions
  • 10,000-year return period ground motions

• New Fossil Power Plants
  • California Building Code
Earthquake Emergency Response
DASH Executive Summary Notification, Event 99900496, Version 1
DASH_Alert_Dev@pge.com

Sent: Sun 2/28/2016 9:35 PM
To: Wolf, Arnold; anyehlers16@gmail.com; arnold.wolfe@gmail.com; Greenberg, Carol; Ferley, Chris; dash_cas@insof.com; ferleych@gmail.com; Guppa, Geanra; Woodell, Kathryn; lock@theexchangeactor.com; Gaur, Mukul; maneesha@insof.com; Satish, Manesh; nukul.gaur@insof.com; Sherman, Rahul; Olson, Ron; Steinberg, Scott M; Keane, Sunny

Executive Summary Notification
Initial Report - Not Reviewed

Event ID: 99900496
Lat/Lon: 38.33/-122.61

Gas Transmission
Action Required

Gas Transmission Stations
Action Required

Gas Distribution
Action Required

Hydro
No Action Required

Visit www/dash for more information.

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Thank You