DOCKETED

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CEC Research Area:
Natural Gas Infrastructure Safety and Integrity

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1

Proposed Research

1. **Develop seismic design models and mitigation options specifically for natural gas pipelines Transmission and Distribution pipelines**
   Note: Pipeline Research Council International (PRCI) guideline used in Gas industry. Water/Oil industries use flexible connection, not used in gas industry.

   » 1.1 Design - Angle of crossing over fault
   - Compression vs Tension
   - Bending and shear in pipe
   - Location of the bend

   » 1.2 Non-Linear Finite Element Analysis (FEA)
   - Software such as ANSYS widely used in the Gas industry

   » 1.3 Different backfill materials
   - Low Friction materials
   - New materials and technologies should be tested and evaluated in labs

   » 1.4 Performance Based Design and Failure Mitigation Strategies
   - Automatic Shut-Off Valves

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Proposed Research

2. Seismic fault rupture displacement models for Transmission and Distribution Pipelines

» 2.1 Deterministic Analysis vs Probabilistic Analysis

- California Building Code/International Building Code use probabilistic models, Oil and Gas uses deterministic models

» 2.2 Advancing Hybrid Analysis

- Published[1] approach by SoCalGas, PG&E, and Scott Lindwall

» 2.3 gathering data such as slip rate and information on probabilistic analysis

- Calibrating new models by measuring the seismic parameters needed

[1] *Fault Displacement Hazard Analysis Methods and Strategies for Pipelines;*11th U.S. National Conference on Earthquake Engineering Integrating Science; Engineering & Policy; June 25-29 2018; Los Angeles California

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Proposed Research

3. Design and mitigation for soil movement during flood or earthquake

- » Current activities
  - Updating maps of faults and floods.
  - Hydrology analysis
    - such as Army Corps software HEC RAS
  - Developing design and mitigation guidelines for rock falling events
    - Rock Falling example – Montecito land slides
    - Lateral Spreading example - Northridge earthquake
- » 3.1 Identifying risks and updating maps for landsliding, mud-sliding, rock falling and lateral spreading
- » 3.2 Mitigation plan for rock falling and design criteria
- » 3.3 New techniques such as FEA analysis for landsliding and lateral spreading and mitigation design.

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Questions?