Seismic PSA – A PSA Modeller’s Perspective

Presented by:
Mike Zammett
Senior Consultant
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Introduction

• Seismic PSA has been performed internationally for many years;
• Technique constantly evolving and covers many disciplines:
  - Geology,
  - Seismology,
  - Civil Engineers,
  - Mechanical Engineers
  - PSA Engineers.

(Artist’s Impression)
Introduction

- Therefore Seismic PSA has the potential to get a little complex...
Seismic Events

What happens?
Seismic Events

What happens?
Seismic Events
Small event
Seismic Events
Large event
Seismic Events

‘In betweener’
Seismic Events

‘In betweener’
Seismic Events

‘In betweener’ – other effects
## Seismic Events

### How serious a problem are they?

<table>
<thead>
<tr>
<th>Location</th>
<th>No. per annum</th>
<th>Strongest (Richter Scale)</th>
<th>Typical Annual Strength (Richter Scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>&gt;1.00E06</td>
<td>9.5 (Chile 1960)</td>
<td>8.0</td>
</tr>
<tr>
<td>US</td>
<td>20,000</td>
<td>9.2 (Alaska 1964)</td>
<td>6.9</td>
</tr>
<tr>
<td>Japan</td>
<td>1500</td>
<td>9.0 (Honshu 2011)</td>
<td>6.3</td>
</tr>
<tr>
<td>UK</td>
<td>&gt;100</td>
<td>6.1 (North Sea 1930)</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Modelling

The past – deterministic (essentially)
Modelling

The past – deterministic (essentially)
Modelling
The past – deterministic (essentially)
Modelling
The present – probabilistic (sort of)
Modelling

The present – probabilistic (sort of) – with uncertainty
Modelling

The future? - Components
Modelling
The future? – seismic correlation

- How do we quantify the likelihood of both components failing following a seismic event?
Modelling

The future? – CCFs & Operator Actions
Modelling

Past
- Simple
- Aligns with safety case
- Quick implementation
- Short analysis run time
- Diminished risk insights
- No minimal cutsets
- Overly conservative?
- Invisible?
- Uncertainty?

Present
- Seismic minimal cutsets
- Risk insights (some)
- Quick implementation
- Short analysis run time
- Visibility
- Uncertainty represented
- Dependent on data
- More expensive
- System level only
- Conservative?

Future
- Seismic minimal cutsets
- Risk insights (detailed)
- Best estimate
- Visibility
- Uncertainty represented
- Dependent on data
- More expensive
- Longer implementation
- Longer analysis run time
Modelling

• Fragility – are we certain?
Modelling

• Fragility – are we certain?
Modelling

The future? – back to reality

• Aftershocks?
• Consequential hazards?
• Long term issues:
  ▪ Operator Fatigue/stress
  ▪ Offsite incidents
  ▪ Fuel storage
Closing Remarks

• Assessment of seismic events complex;
• Original PSA modelling deterministic in nature;
• PSA modelling increasing in complexity;
• ‘Realistic’ PSA modelling getting closer;
• Future developments need to balance ‘realism’ vs ‘complexity’.
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