33rd ANNUAL GIRO CONVENTION
Hilton Vienna Hotel, Am Stadtpark

ELLA Working Party

Energy Large Loss Analysis Team Members
Franck Allaire
Stephen Burr
Justyn Harding
Tom Jowett (chair)

Areas of Study
- Modelling Energy losses
- Wave damage vs Wind damage
- Rogue or Freak waves
Modelling large losses

- Relyed on Willis database – special data extract for this study
- 1985 to 2005
- Data is revalued using the IChemE rebuild index
- Threshold > $5m on a revalued basis

Willis Database Background

- Idea conceived 1994
- Recognition of general lack of industry information
- Marine & aviation losses well reported but energy losses are not unless they are major and/or involve death or injury
- "This is a unique facility"

The Database

- Only for losses of US$ 1,000,000 or more
- Information captured is from 1972 to date
- Mainly property related losses - does not include personal injury in isolation
- Losses are upstream and downstream, onshore and offshore
- Currently contains in excess of 6,800 records valued at over US$98,000,000,000 and is constantly updated
- All figures are 100% ground up except B.I.
The Database - Types of Property

- Offshore - Upstream
  - Rigs
  - Platforms
  - Pipelines
  - Storage & offloading systems

- Onshore - Downstream
  - Refineries, petrochemical plants etc.
  - Loading terminals, tank farms
  - Power Stations
  - Gas plants, transmission stations

Types Of Report

- Summary: No. of incidents, agg. & avge. $
  - by year
  - by geographical area, country or location
  - by cause
  - by property type
  - by month (seasonal trends)
  - by cost bandwidths
  - by well depth
  - any combination of the above

- Listings of individual losses by date or value
The Willis Database

- At the moment it is not possible to extract claims data and model it as the working party has.
- For actuaries this makes the database harder to use
- But worth the effort

Modelling large losses

- Different fitting methods and curves available
- Data contains nat cat losses
- Data not developed for IBNR
- Not necessarily accurate or complete
- Understand your data & make your own selection
Classification of the losses

Summary Tables 1

<table>
<thead>
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<th>Cause</th>
<th>L. Other</th>
<th>L. Plant</th>
<th>L. Ref</th>
<th>L. Wells</th>
<th>O. Other</th>
<th>O. Platf</th>
<th>O. Wells</th>
<th>Total</th>
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Summary Tables 2

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<td>2,638</td>
<td>8,969</td>
<td>21,588</td>
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</table>

- Fire is the largest claim category with 37% of the loss cost
- Cat wind losses amount for 25% of all energy losses in the WDr ($17.7bn / $71bn)
Curve Fits to some of the data

- There is enough data to fit curves for some of the classifications
- No single distribution fitted all the data
- Which index to use when revaluing old claims is always an issue
- Fitting to the tail of the distribution is subjective

Offshore Platform - Wave v Wind

1. Offshore Platform Windstorm Losses
2. 2005 Hurricanes
3. Offshore structures design
4. Freak Waves
5. Cat models
6. Conclusion
Offshore Platform Windstorm Losses

<table>
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<th>Percentage</th>
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<td>50</td>
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</tr>
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<td>13</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

- Windstorm is the main peril for offshore platform (50% of losses)

2005 Hurricanes - Wind damage

- Built in 1996, Shell Mars Tension Leg Platform was designed to withstand waves of 71 ft (22 m) and winds of 140 mph (62 m/s)
- The Helmerich & Payne 201 derrick was lost, during Katrina, with major damage to the rig floor and substructure.

2005 Hurricanes - Wind damage

Article on WorldOil.com

- Wind damage refers to rigs getting blown off platforms or the damage to topsides facilities, as occurred on Shell's Mars platform after Katrina.
- "When I look at all of it, I think our current standards are good. However, I think that some people have gotten sloppy in their operations. The tie-downs, for instance, weren't good enough." Ken Arnold Senior Executive Vice President at AMEC Paragon, one of the industry's most respected experts
2005 Hurricanes - Wave damage

- Operators have lost platforms in these storms, because wave heights were greater than engineers would have expected, and that is the puzzlement.

- Arnold suggests the following contributing factors:
  - limited understanding of wave crest elevation
  - "rogue waves" within a storm
  - model error for deep water
  - lower security loading
  - better modelling of stresses lead to a less cautious attitude
  - economical pressure pushed for more tight designs

Should these wave heights have been unexpected when there is so much information in the public domain? We summarise a little on the next few slides.

Offshore structures design - ISO 19901

Table C.2: Indicative extreme values - GOM Area II and III for water depths greater than 300m. ISO/FDIS 19901-1:2005(E) - GOM, 2005-04-01

<table>
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<tr>
<th>Return period</th>
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<th>100</th>
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<tr>
<td>Wind - 3 s gust wind speed (m/s)</td>
<td>28.4</td>
<td>41.0</td>
<td>46.9</td>
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<tr>
<td>10 minute mean wind speed (m/s)</td>
<td>26.6</td>
<td>31.3</td>
<td>37.1</td>
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<tr>
<td>Waves - Maximum wave height (m)</td>
<td>15</td>
<td>22.0</td>
<td>25.9</td>
</tr>
<tr>
<td>Significant wave height (m)</td>
<td>8.5</td>
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<td>14.3</td>
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<tr>
<td>Spectral peak period (s)</td>
<td>12.3</td>
<td>13.3</td>
<td>14.3</td>
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<tr>
<td>Significant wave height (m)</td>
<td>1.71</td>
<td>1.77</td>
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<tr>
<td>Incidence</td>
<td>1.16</td>
<td>1.16</td>
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</tbody>
</table>
Freak Waves – Non Observed Sea States

In a badly behaving problem, a 1.3 load factor does not protect at the 10,000 year return period any longer.

Freak Waves – Problem?

Freak waves will mainly represent a problem if their crest hits a structural element which is not designed for wave loads.

Occurrence of freak waves is dramatically increasing in non-linear sea states.
Freak Waves - Camille & the New Year Wave

- "The analysis of data from the North Sea and Gulf of Mexico indicates that the difference between the characteristics of the individual freak waves do not seem to be significant, although the Camille waves tend to have a lower ratio of maximum crest to significant wave height."

- "However these conclusions must be considered with care as the length of records and the number of abnormal waves considered is not very large."

Freak Waves – Experimental Relationship with Wind Speed

- "Both experimental and numerical results are in quite qualitative agreement. It is shown experimentally and numerically that the effect of the wind is twofold: (i) it increases slightly the amplification of the envelope of the short group containing the rogue wave and more importantly (ii) it increases the time of existence of this group."

Freak Waves – So what?

- Platforms not designed for wave impact at the freak wave height
- Damage function of cat models only relies on wind speed.
- Waves are a significant factor too
- Especially if wave heights do not behave in a linear way.
- Increasing property damage and uncertainty
Cat Models

- Onshore models
  - Emphasis on wind speed
- Offshore models
  - Wave wind relationship based on average?
  - Or based on linear wave model?
  - Or (more likely) an implicit relationship assumed
  - Damageability function ignores impact of freak waves?
  - Calibration, GOM suggests high level of uncertainty?
  - Underestimation of the severity of extreme events?
  - Possible adjustments factors?
  - Actuaries need to take more account of the uncertainty?

Concluding thoughts

- Discussion with M&E engineers suggest a 80% Wind 20% Wave split rule of thumb
  - But this is not data tested and we think is a post Andrew statistic
- Recent hurricanes and scientific research on freak waves suggest that their occurrence in rough sea conditions have been underestimated
- Offshore platform design criteria may not be as safe as had been assumed
- Do Cat models make enough allowance for freak waves in extreme conditions?
  - Does the damage function allow for enough variability?
- Pricing actuaries take care

Appendix
Wind vs Wave References

WorldOil.com article on US GOM structures standards  

Sverre Haver (Statoil, Norway) - "Freak Waves - A Suggested Definition and Possible Consequences for Marine Structures"  
www.ifremer.fr/web-com/stw2004/rw/presentations/haver.ppt

C. Guedes Soares, and E.M. Antão (IST, Portugal) - "Comparison of the characteristics of abnormal waves on the North Sea and Gulf of Mexico"  

Wind speed and Rogue Wave:  
Searching for rogue waves with Radar:  
http://www.esa.int/esaCP/SEMOKQL26WD_index_0.html

ella.wikispaces.com ……..look it up

Data Sources

Willis Data  
http://www.willis.com/Adviser.aspx

OPL Data  
http://www.oilpubs.com/wofdg

My Giro 2005 workshop handout  
Gulf of Mexico offshore energy

IFREMER Rogue Waves 2004 Seminar  
OSG International Association of Oil & Gas Producers  
http://www.oagle.org.uk
- Metocean Committee  
http://www.galbraithconsulting.co.uk/iso/19901-1/ISO_19901-1_FDIS_SUBMITTED_2.pdf

RMS GOM Offshore Model  
- Web page  
www.rms.com/Catastrophe/Models/OffshorePlatforms.asp
- Flyer  
www.rms.com/Publications/OPR.pdf
- Analysis of Katrina  
www.rms.com/Publications/KatrinaReport_LessonsandImplications.pdf

Blowout statistics  
- http://www.sintef.no/content/page1____4649.aspx
- www.hse.gov.uk/research/rrpdf/rr095.pdf