ROGUE WAVES 2000 WORKSHOP

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ROGUE WAVES - DEFINING THEIR CHARACTERISTICS FOR MARINE DESIGH

ABSTRACT for Keynote address by

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Mariners have used phrases like Freak waves, Rogue waves, Walls of water, or even Holes in the Sea. More scientifically, Buckley uses a phrase "Episodic Waves" to characterise elevated and usually steep wave events of limited duration which appear outside of the normal expectations for the prevailing seas. Whatever we call them, I fully support Buckley's early contentions (1978 onwards) and later evidence that such waves often cause extreme damage to ships, and this sometimes leads to their loss. Buckley has more recently defined *Survivability* and *Operability* envelopes of H_s vs T_p for ships. The former agrees within 2% with the 7th International Ship Structures Congress (ISSC 1979) equation for waves of limiting steepness and the latter more nearly corresponds to present day normal design conditions.

Following Buckley's lead, I have since my first formed assessment of the loss of the bulk carrier m.v. DERBYSHIRE (Lord Donaldson, 1995) been advocating an additional *Survival Design* approach for marine structures. This examines responses to a range of sea conditions defined around the survivability envelope with asymmetrical steep elevated waves. The operational risks for example for ships, would include primary structural overload, loss of watertight integrity, capsize, etc. For offshore installations the most serious risks are wave crest impact and platform pushover overloads. In essence, there is sufficient evidence to show that wave models as presently used in ship design do not in general cause serious distress or loss of ships.

Introducing an additional design requirement to provide a ship or offshore installation with some capability to *survive* exceptional extreme seas requires a paradigm shift in thinking. This philosophy was introduced and suggested to the 13th ISSC in Trondheim (1997) and formally extended by Faulkner and Buckley (1997). A UNESCO metocean conference and workshop was held in Paris entitled *Provision and Engineering/Operational Application of Ocean Wave Spectra* in September 1998. As a result, a small working group was set up led by Johannes Guddal. This has just established a three-year multi-disciplinary EC research and application study entitled *MaxWave*. This is aimed at providing designers and operators with more refined environmental wave-related data and models in those regions where trading ships are mostly lost ("graveyards") and those where the most heavily loaded offshore installations exist. In other words, the project should provide a major step toward explicit survival design and operation to offset the present situation of "designing for the unknown" (Smith, 2000).

It follows that much greater discussion and interaction is required between the metocean and the marine design and regulation communities. To this end the author will present:

- photographs of abnormal extreme seas, and their characteristics, and where globally they cause the most damage
- suggested modelling for the type of damage experienced by trading ships and by a recent deep water turret moored offshore FPSO (tanker-like moored vessel) – see Peter Gorf et al
- the author's provisional abnormal wave definitions and modelling of wave heights, crest slopes and crest celerities as used in an attempt to account for such damage
- some surprising results from the recent work for the *DERBYSHIRE* investigations
- an outline of the need for physical wave motion and loading tests for ships in realistic exceptional sea conditions, coupled with related large amplitude non-linear wave modelling for use in time domain studies
- evidence to show that Buckley's operability envelopes approximately correspond to present day normal extreme design sea conditions
- some views of the implicit uncertainties in hindcast wave generation predictions when used forensically for predicting local maxima.

The most important wave conditions for which there is a need for improved knowledge and better data would appear to include: deep ocean steep elevated wave fronts with breaking or near-breaking crests, wave group phenomena, swell effects, wave-wave interactions; events where the concept of wave spectra is strictly not applicable, for example, in rapidly varying extreme cyclonic storm conditions; wave peaks, including such transients as pyramidal waves; wave energy spreading - which gave rise to some quite unexpected levels of deck wetness in the MARIN tests on a 1/65th scale model of the *DERBYSHIRE*.

There is also need for a major improvement in the quality of feedback from operators regarding exceptional sea conditions and the damage it causes. The paper will end with a brief overview of the present position.