PhD Proposal 2017

School: CentraleSupélec	
Laboratory: LGI	**Web site: http://www.lgi.ecp.fr/**
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Collaboration with other partner during this PhD: **In France:** Possibly Electricité de France, EDF	**In China:** Possibly Wuhan University of Technology, WUT

Title: Safety and reliability of new marine energy systems
Scientific field: New energy and sustainable development, Safety, Reliability Engineering
Key words: Marine energy systems; New energy systems; Safety assessment; Risk analysis; Reliability

Details for the subject:

Background, Context:

Waterway transportation is the most important way for carrier of freight in terms of rotation volume of goods transport. Depending on growing concerns on energy crises and environmental issues, new energy resources such as solar, wind and hydrogen energy are favoured for possible substitutes to conventional marine fuels in shipping industry. However, the application of new energy is facing many technical challenges. Solar and wind energy are vulnerable to the weather conditions stochasticity while the storage and transportation of the hydrogen remains a challenge. Moreover, shipboard electric propulsion systems experience large power and torque fluctuations on their drive shaft due to propeller rotational motions and waves. Ships are independent systems during voyage, the fault and poor management of the new energy system onboard will cause block out of the whole ship, which should be avoided.

In recent years, the power and energy management strategies aiming at supplying sustainable power are studied. The global optimisation strategy will consider the security constraints and decide the power split to each energy source. However, the safety of the new energy onboard is affected by many aspects. The random power demand, the human operator actions and many other factors will cause faults. In the scenario of technologically and structurally evolving critical infrastructures (CI), understandable concerns are arising on their vulnerability and risk of failure, i.e. on the danger that : 1)The allocated system capacities may not be adequate to support the growing demands in scenarios of greater CI integration and Market deregulation; 2) The safety margins preventively designed may not be sufficient to cope with the expected and, most of all, unexpected stresses arriving onto the systems. What is more, the treatment of uncertainties in practical decision making should be considered too.

Several theories are developed in safety assessment. Typically, event trees (ET) and fault trees (FT) are used in risk assessment. The deterministic analysis methods have been applied to verify criteria that assure plant safety in a number of postulated design basis accident scenarios. These criteria also allow identifying which plant structures, systems and components (SSC) and activities are important to safety. A number of approaches exist for representing and describing the uncertainties in risk assessments, including probabilistic analysis, probability bound analysis, imprecise probability, random sets and possibility theory. The integrated deterministic and probabilistic safety assessment (IDPSA) are under research in recent years.

Research subject, work plan:

The research subject of the proposed thesis concerns the development and improvement of efficient methods for the reliability assessment of marine new energy systems. The target is to achieve the optimal solution to system design and maintenance plan considering the existing uncertainties, complex infrastructure and dynamics. The foreseen work plan of the proposed thesis consists of the following major steps:

1. Conduct an in-depth study of the safety assessment methods and the models available in the literature for new marine energy systems,
2. Model the failure, repair, and maintenance of components of marine new energy systems by reliability models,
3. Develop optimization algorithm(s) for reliable system designs, and
4. Verify the models and algorithms developed on realistic case studies.

The project starts from an in-depth theoretical study of the concepts and methods of reliability modelling, optimization, uncertainty analysis, and control theory. Significant modelling and computational challenges are expected to emerge during the research work.

The thesis work is expected to produce a number of scientific works on peer reviewed, indexed journals (a minimum of two) and of presentations at recognized conferences (a minimum of three).

The educational objective of the proposed PhD thesis is to prepare an expert in the safety and reliability assessment and optimization of marine new energy systems, with the capability of performing advanced analyses and optimizations.