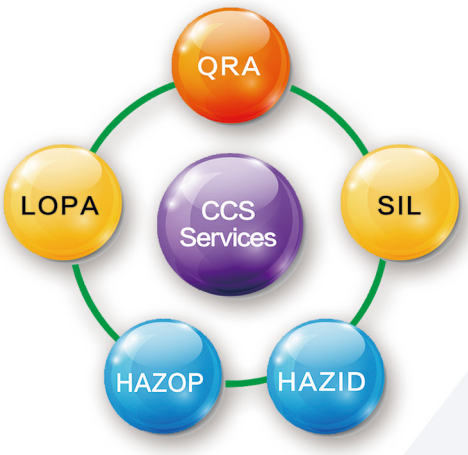


WATERBORNE LNG RISK ASSESSMENT SERVICES

Risk assessments are to help our clients understand potential safety accidents and their consequences, recognize the shortcomings in risk management, and help them better understand the risks they will face and implement effective risk management. To better serve the Administration and the Industry, CCS has developed new products of risk assessments from qualitative to quantitative, including HAZID, HAZOP, LOPA, SIland QRA.

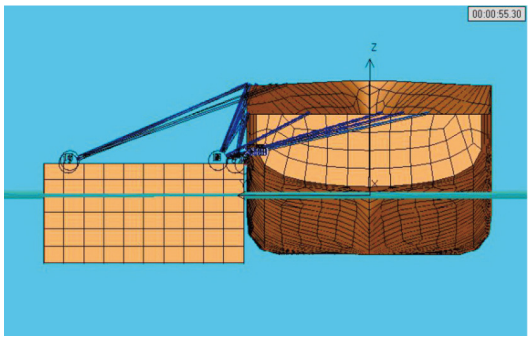


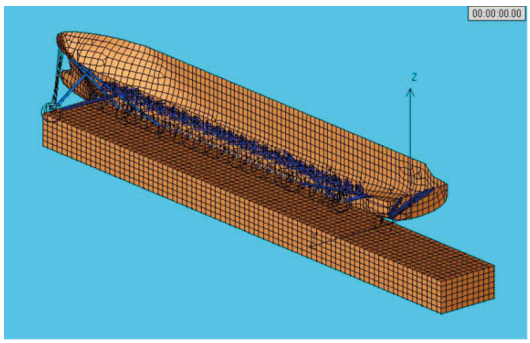


CCS
CHINA CLASSIFICATION SOCIETY
中国船级社

Feasibility Analysis of a LNG Carrier Serving as a Floating Storage Unit (FSU)

CCS has studied the feasibility of a LNG carrier serving as a floating storage unit, aiming at the key issues of HAIYANGSHIYOU 301, such as the techniques, operation and safety issues, and give corresponding risk control measures to guide the safety operation of a LNG carrier serving as a FSU.



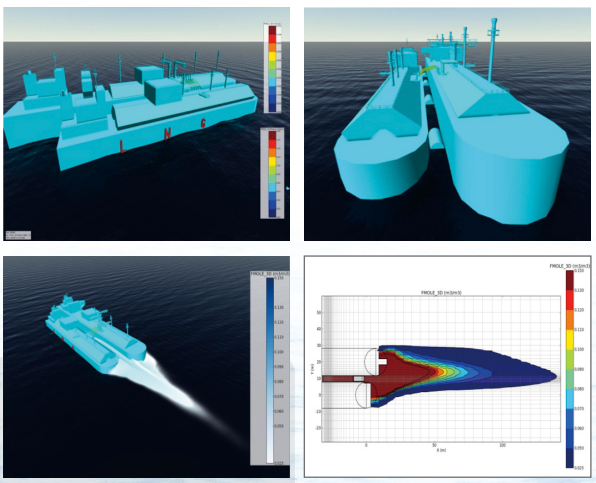


Our services

- Compatibility analysis concerning lightering operation on anchorage
- Analysis of mooring options
- Equipment management and personnel allocation
- Analysis of key technologies of cargo handling
- Risk analysis and the countermeasuresDHAZID, QRAD

Risk Assessment on Ship-to-Ship LNG Transfer Operation

In order to protect the safety LNG transfer of STS operation, CCS has carried out the risk assessment of Ship-to-Ship LNG transfer operation. A quantitative risk assessment on the diffusion range of flammable vapor clouds due to LNG leakage is carried out combined with the evaluation results, and CCS has put forward the corresponding risk control measures for STS operation optimization and provided corresponding suggestions.

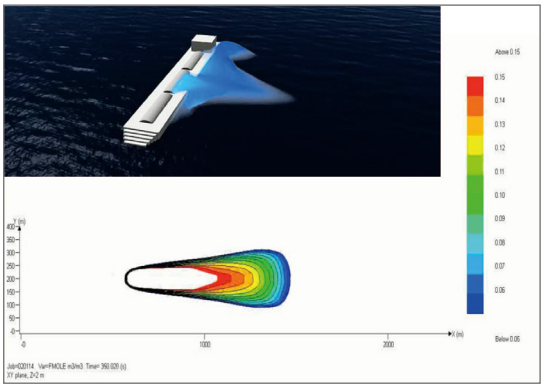


Our services

- Risk assessment on STS LNG transfer operation (QRA, HAZOP, HAZID)
- Simulation and analysis of LNG dispersion after leakage
- Assessment on the safety distance of STS LNG transfer operation
- Assessment on the safety area of STS LNG transfer operation
- Process optimization of STS
- Waters condition and environmental impact assessment of STS LNG transfer operation

Study on Risk Assessment and Preventive Measures of Inland Waterways LNG Carriers

Small-size LNG carriers are very suitable for supplying LNG to LNG fuelled ships, LNG bunkering stations and LNG bunkering pontoons along the Changjiang. However, current standards do not cover inland waterways LNG transportation due to the very strict requirement for safety distance. To solve this problem, CCS has carried out the Study on Risk Assessment and Preventive Measures of Inland Waterways LNG Carriers, a project of the West of China Development sponsored by Ministry of Transport.



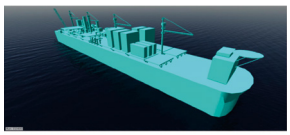
The study focuses on:

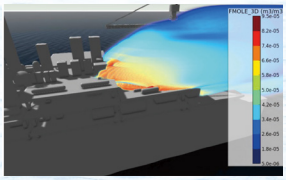
- Risk assessment of small-size LNG carriers navigating from the Changjiang estuary to E'zhou (at middle of the Changjiang), by using the Formal Safety Assessment and Event Tree method.
- Collision-resistant assessment of LNG carriers by numerical simulations and model tests.
- Quantity risk analysis for LNG leakage scenarios.

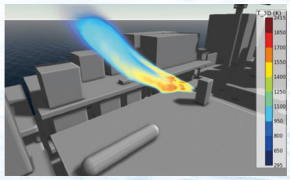
Based on the results of the above studies, CCS has provide a set of steps for risk control, which will form a solid base for developing new safety regulations for sea-to-river LNG carriers.

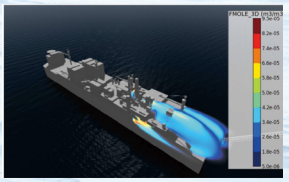
Risk Assessment on FLNG Conceptual Design

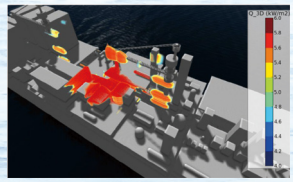
In May 2016, CCS carried out the risk assessment of FLNG Conceptual Design. The evaluation includes the module layout and process flow, which specifically covers the collection, processing, compression, liquefaction, storage and transfer of natural gas.









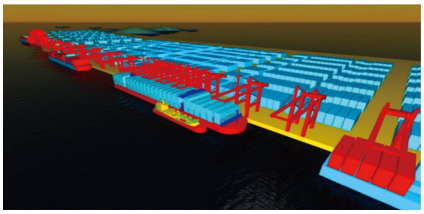


Our services

- Hazard Identification (HAZID)
- Hazard and operability analysis (HAZOP)
- Quantitative risk assessment of accidental consequences (QRA:Gas dispersion and heat radiation)
- Suggestions and measures to risk control

Risk Assessment on LNG Bunkering and Cargo Loading/Unloading Simultaneous Operations (SIMOPS)





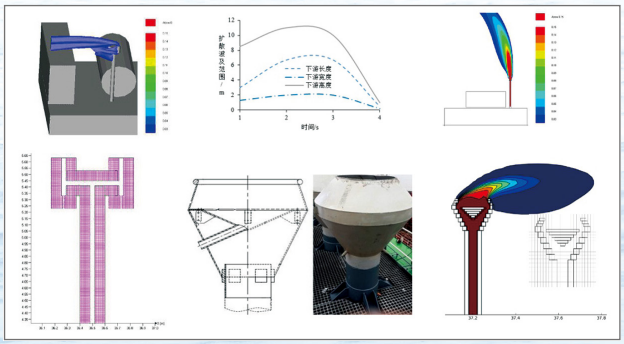
Large-size ship takes a long time for LNG bunkering due to itsc omplexity operations, so sometimes a personalized solution is necessary. For large ships, it is suggested to carry out synchronization between the LNG bunkering and the cargo loading/ unloading to shorten the ship's waiting time. If the loading/unloading area is covered by a flammable cloud in the event of leakage, it may cause a fire. So it is necessary to determine the safety distance of SIMOPS. Based on truck-to-ship (TTS) and shipto-ship (STS) bunkering, CCS has specified the safety distance by quantitative risk assessments for more than 40 dangerous scenarios, then corresponding conclusion and suggestion were given.

Our services

- Risk assessment on LNG bunkering and cargo loading/unloading simultaneous operations (QRA, HAZOP, HAZID)
- Simulation and analysis of LNG dispersion after leakage
- Assessment on the safety distance of bunkering operation
- Assessment on the safety area of STS bunkering operation
- Suggestions on Fisk control of SIMOPS
- Methane emission control solutions
- Process optimization of STS
- Assessment on site selection of LNG bunkering stations and environment and navigation safety assessment

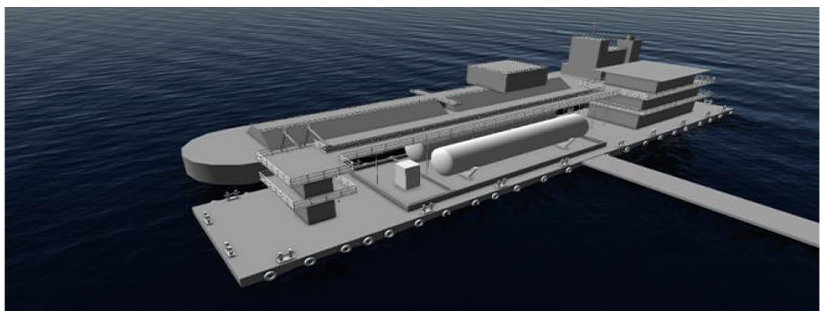
Simulation for Vent Mast Height of Inland LNG Fuelled Ships

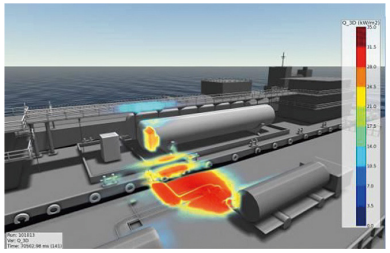
The simulation evaluation for vent mast height of inland LNG Fuelled ships was carried out based on the principle of single failure and method of risk assessment. In accordance with the feature of ship arrangement and sailing condition, combined with the height and type of outlet, total 24 kinds of gas release scenario were selected, the release rate and duration time of gas release were calculated by the ideal gas equation, the range of gas dispersion was simulated by using the three dimensional Computational Fluid Dynamics (CFD) software FLAGS. Based on the criteria of gas dispersion acceptance, the minimum height of vent mast was given for developing the requirement in standard, and the rationality of rules for natural gas fuelled ships issued by China Classification Society was verified. In view of the navigation feature of LNG fuelled ship in Inland River, a new type of vent mast arrangement was recommended.

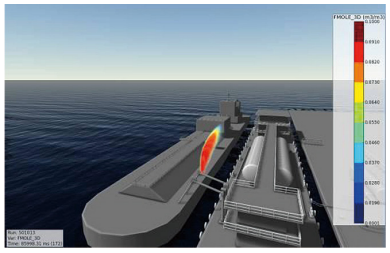


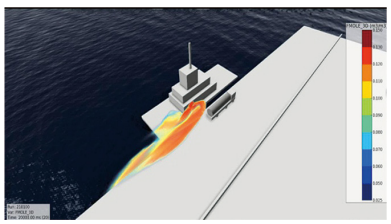
Quantitative Risk Analysis (QRA) of Bunkering from Pontoon to LNG Fuelled Ship

In order to effectively evaluate the risk for LNG bunkering supplied by pontoon, the quantitative risk analysis to the bunkering process for a LNG bunkering pontoon was carried out. Based on three-dimensional computational fluid dynamics(CFD) software FLACS, LNG leakage consequence was simulated and the individual risk values for each dangerous scenario were calculated. According to the recognized individual risk acceptance criteria from national, the safety distance was determined and the risk mitigation measures were advised.



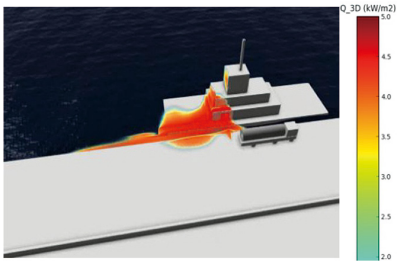


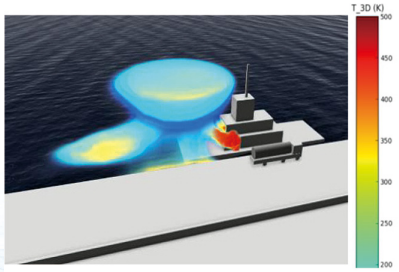




Quantitative Risk Analysis (QRA) of Bunkering from Tank Truck to LNG Fuelled Ship

In order to effectively identify and evaluate the risk with LNG bunkering supplied by tank truck in port, this appraisal to entire LNG bunkering process for one typical LNG fuelled tug was selected and carried out. LNG leakage consequences including cryogenic dense gas dispersion and fire were simulated by using the three dimensional CFD software FLACS, and the individual risk values for each dangerous scene were calculated completely. According to the recognized individual risk acceptance criteria from national or international, the individual risk values were in the acceptable range. The safety distance and heat radiation distance affected from pool fire were proposed for LNG bunkering operation from tank truck to LNG fuelled tug, the risk mitigation measures and management recommendations of LNG bunkering were advised for ship owner.





Our services

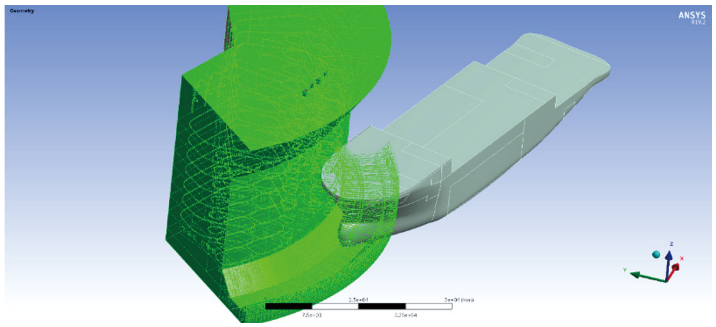
- Risk assessment on LNG bunkering and cargo loading/unloading simultaneous operations (ORA, HAZOP, HAZID)
- Simulation and analysis of LNG dispersion after leakage
- Assessment on the safety distance of bunkering operation
- Assessment on the safety area of STS bunkering operation
- Providing risk elimination on SIMOPS
- Process optimization of STS
- Assessment on site selection of LNG bunkering stations, environment and navigation safety

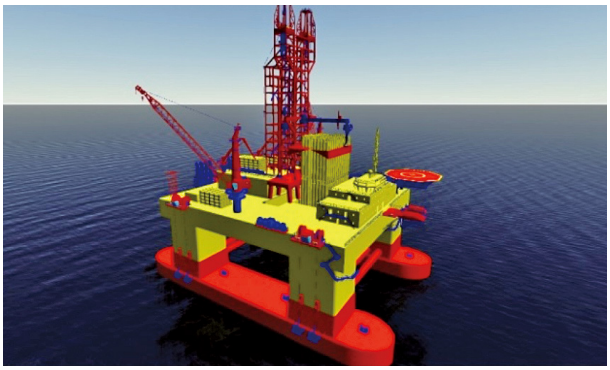
Risk Assessment on FPSO/Rig

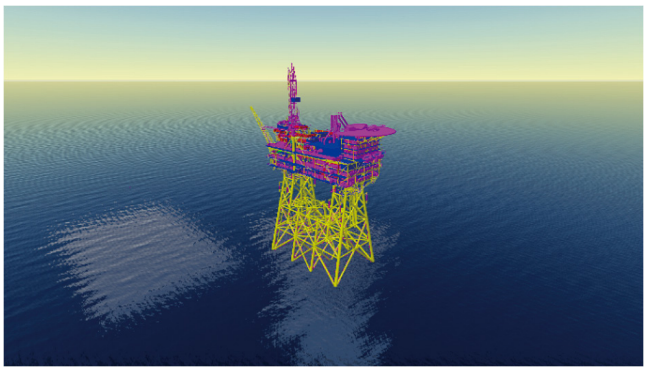
CCS carried out the risk assessment of cylindrical FPSO and Rig. The evaluation includes the module layout，process flow and collision risk.

Our services

- QRA
- Fire and explosion analysis（FEA）
- Smoke diffusion analysis
- Output transfer safety analysis
- Toxicity analysis
- Escape and rescue analysis
- DDT prediction







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