



Solutions for Integrating FLNG & FSRUs: How Does Class Fit In?

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Agenda

- FSRUs, FLNGs and Floating Power Generation – Class and Regulatory Requirements
 - Approaches for classing
 - FLNG history & class
 - Classing FSRU
 - Classing Power Generation, possibly with regasification
 - The role of the class society in FSU, FSRU, FLNG & LNG floating LNG to power projects

Classification Approaches

- Marine Class
 - Ship
 - Barge
- Offshore (Permanent Facility) Class

FLNG



Offshore LPG Solutions

- 1997 - Escravos LPG FSO
 - First purpose-built
 - LPG FSO Offshore Nigeria
 - (Classed by ABS)
- 2005 - Sanha LPG FPSO
 - First LPG FPSO
 - (Classed by ABS)



Complex FPSO With Cryogenic Gas Processing

- ConocoPhillips-Belanek Natuna FPSO
- Existing comprehensive offshore gas solution
- ABS classed Floating Offshore Installation
- 100,000 BOPD, 500 MMSCFD gas, 23,000 BPD LPG
- 1 mm bbl oil storage, LPG FSO, offshore Indonesia
- 30 Years Field Life: Start up in 2004



FLNG: Combination of 3 Industries



Offshore Production

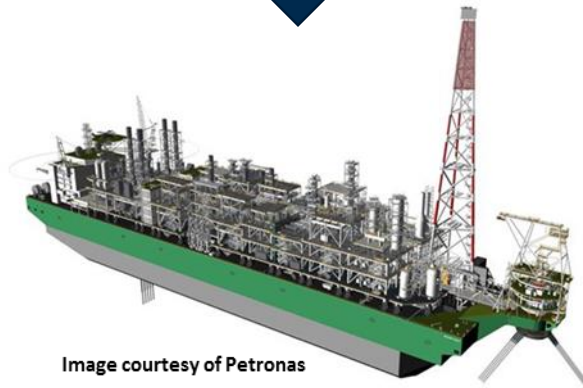


Image courtesy of Petronas

Floating Offshore Liquefied Gas Terminals



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Onshore LNG



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LNG Shipping



Specific Design Challenges for Floating LNG

- Establish basis for Rules and Standards
- Address FLNG specific safety concerns
 - Potential for gas leaks and explosions (NG, LPG)
 - Cryogenic spills
- Cargo containment systems
 - Requirement for unrestricted partial filling
 - Offshore maintenance (no dry-docking)
- Topsides
 - Restricted footprint available
 - Motions and accelerations (incl. transit)
 - Marinisation of process equipment
- Offloading
 - Side-by-side offloading
 - Tandem offloading (dedicated ships)
- Environmental standards

FLNG Rules & Standards

Process Plant

- API, ASME, ANSI, ...
- NFPA
- IMO IGC
- SIGGTO
- ABS Facilities Rules
- ABS Offshore Terminal Guide
- ABS Steel Vessel Rules

Offshore Cargo Transfer

- IMO IGC
- SIGTTO, OCIMF
- EN (1474)
- IACS Requirements
- ABS Steel Vessel Rules
- ABS Offshore Terminal Guide
- SOLAS, MARPOL
- CFRs

Hull and Cargo Structure

- ABS Steel Vessel Rules
- ABS MODU Rules
- ABS Offshore Terminal Guide
- ABS Facilities on Offshore Installation rules
- DLA, SFA

Risk Based Approach

- FSA,QRA
- HAZID, HAZOP, FMEA, FERA, ...
- Novel Concept Guidelines
- ABS Guidance Noted on Risk Assessment Application for the Marine and Offshore Oil and Gas Industries
- Special Studies etc...
- Define Risk Acceptance Criteria
- ALARP

Containment and its Support

- Design Code for Containment Systems
 - IMO IGC
- ABS Offshore Terminal Guide
- Continuous Monitoring of Cargo Containment and Structurally Critical Components

Accommodation, Machinery, Propulsion etc.

- ABS Steel Vessel Rules
- ABS MODU Rules
- IMO IGC
- IACS Requirements
- SOLAS, MARPOL
- ILO
- CFRs

Turret SPM

(Single Point Mooring)

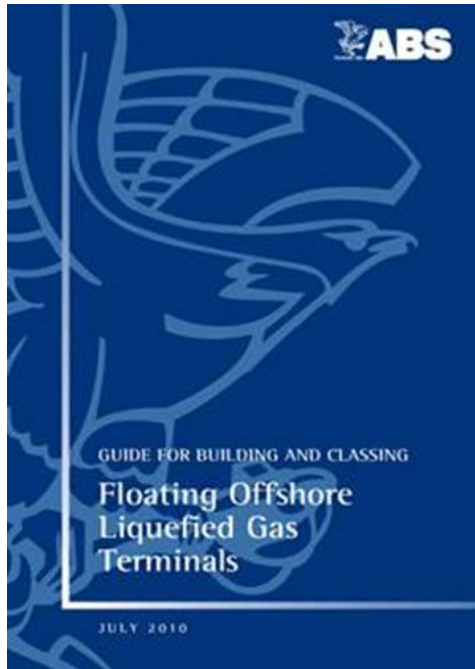
- ABS SPM Rules
- ABS Facilities on Offshore Installation Rules
- ABS Steel Vessel Rules

Standard

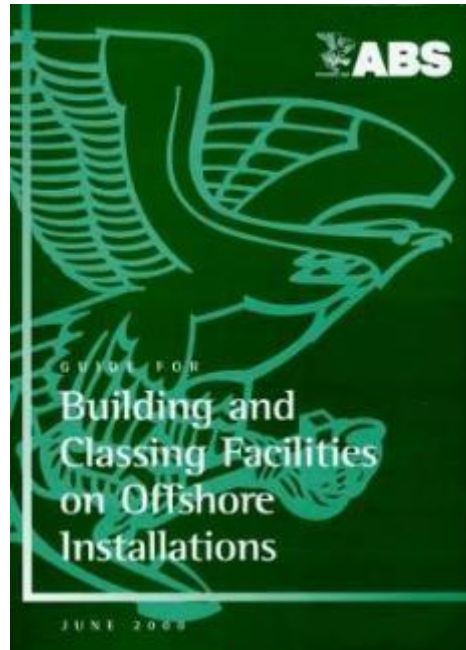
Extension

Novel

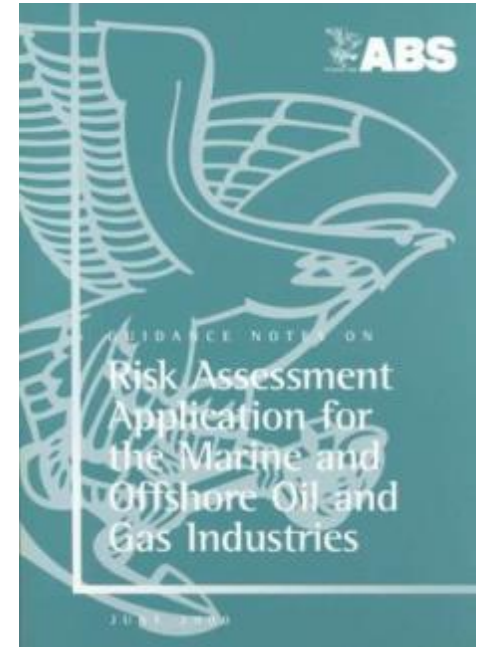
ABS Rules & Guides for FLNG



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Industry Standards
API, ASME, NFPA, etc.

Risk-based
alternatives

FLNG Unit Classification (ABS notations)

✠A1, Offshore Liquefied Gas Terminal, F(LNG) T

- Structure
- Storage
- Accommodations
- Hull Machinery
- Safety Functions (incl. Topside Essential Safety functions)
- Position Mooring
- Export Systems

✠A1, Offshore Liquefied Gas Terminal, F(LNG) PLSO

- Gas Processing
- Liquefaction

✠A1, Offshore Installations – Offshore Pipelines

✠A1, Offshore Installations – Offshore Risers

Gravity Based Unit Classification (ABS)

✘A1, Offshore Liquefied Gas Terminal, G(LNG) T

✘A1, Offshore Liquefied Gas Terminal, G(LNG) PLSO

- Gas Processing
- Liquefaction



FSRU

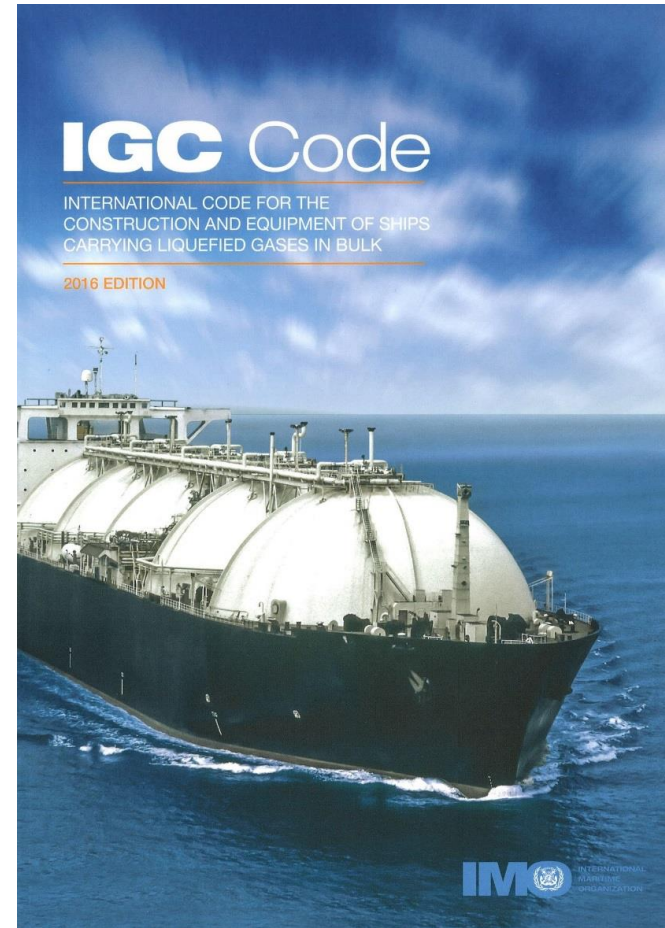


Floating regasification – Key issues

- Define Main objectives:
 - Tie into existing networks that need increased capacity
 - Develop new markets with minimum local infrastructure
 - Provide seasonal supply
- Main Challenges
 - Regas technology selection
 - Flexibility vs Cost
 - Sloshing & Motions (offshore)
 - Permanent mooring requirements
 - LNG transfer (offshore or at the jetty)
 - Boil off Gas management
 - Safety
 - Environmental requirements
 - Use of sea water
 - Air emissions

Hazards Covered by International Gas Code

- As an LNGC:
 - Gas release from cargo containment/cargo transfer system
 - Overpressure/underpressure of cargo containment system
 - Low temperature
 - Hull structural failure from thermal shock
 - Arrangements and survival
 - Hull penetration/cargo containment, collision, grounding
 - Fire
 - Toxicity
 - Reactivity
 - Corrosion



New IGC specifically addresses FSRUs

1.1.10 *When a ship is intended to operate for periods at a fixed location in a re-gasification and gas discharge mode or a gas receiving, processing, liquefaction and storage mode, the Administration and port Administrations involved in the operation shall take appropriate steps to ensure implementation of the provisions of the Code as are applicable to the proposed arrangements. **Furthermore, additional requirements shall be established based on the principles of the Code as well as recognised standards that address specific risks not envisaged by it.***

Such risks may include, but not be limited to:

- .1 fire and explosion;*
- .2 evacuation;*
- .3 extension of hazardous areas;*
- .4 pressurised gas discharge to shore;*
- .5 high-pressure gas venting;*
- .6 process upset conditions;*
- .7 storage and handling of flammable refrigerants;*
- .8 continuous presence of liquid and vapour cargo outside the cargo containment system;*
- .9 tank over-pressure and under-pressure;*
- .10 ship-to-ship transfer of liquid cargo; and*
- .11 collision risk during berthing manoeuvres.*

ABS Approach

- Floating gas project makes use of **existing technology, simply a new application** (common to most new design approaches)
- **Traditional risk assessment** approaches are well suited to evaluation and improvement of risk and reliability characteristics of FSRUs
- **HAZID, HAZOP, FMEA** appear to be the most beneficial to the project at hand:
 - HAZID and HAZOP will benefit the project through systematic identification and evaluation of hazards inherent to the system and its operational environment
 - FMEA is likely the most beneficial to actual reliability of the system. Not only considers intended function, but also the unanticipated effects of component failure

Ship Class or Offshore Class Approach?

- **Ship Classification**

- FSRU constructed as per standard shipbuilding practice
- IGC is governing regulation, Hull structure based on worldwide trading
- Statutory requirement for dry-docking every 5 years, however UWILD (underwater inspection in Lieu of drydocking) may be accepted subject to flag state acceptance
- Applied for most FSRU projects to date

- **Barge Classification**

- As per shipbuilding standards, but not self-propelled

- **Offshore Classification**

- FSRU constructed as per offshore industry standards
- Offshore price structure from shipyards may be less attractive
- Site specific assessment may allow lower scantlings
- UWILD common practice

FSRU Unit Classification

ABS Notations

Ship Rules Approach:

✕A1, Liquefied Gas Carrier (LNG) R

Barge Rules Approach:

✕A1, Liquefied Gas Tank Barge, (R),
(Site Specific Location)
(Duration on Site)

Offshore Approach:

✕A1, Offshore Liquefied Gas Terminal,
F(LNG) RSO

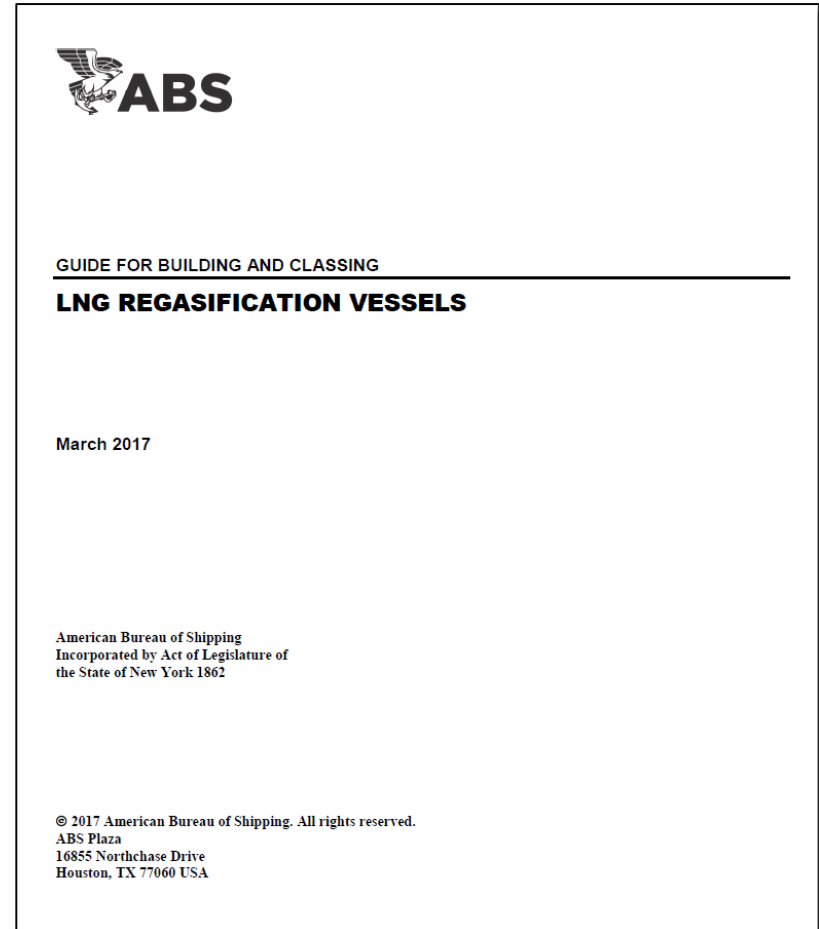
- Structure
- Storage
- Accommodations
- Hull Machinery
- Safety Functions
- Regasification System
- Position Mooring
- Export Systems



ABS Guide For Regasification Vessels

New Guide for LNG Regasification Vessels

- Consolidated ABS requirements based on Steel Vessel Rules and latest IGC requirements.
- Circulated to industry for comments Q1 2017
Final version to published April 2017
- Provides guidance on addressing risks not envisaged by the IGC
 - Guidance to Risk Assessment
 - Alternative Industry standards
- Incorporates provisions for extending dry-docking intervals



Floating Power Generation



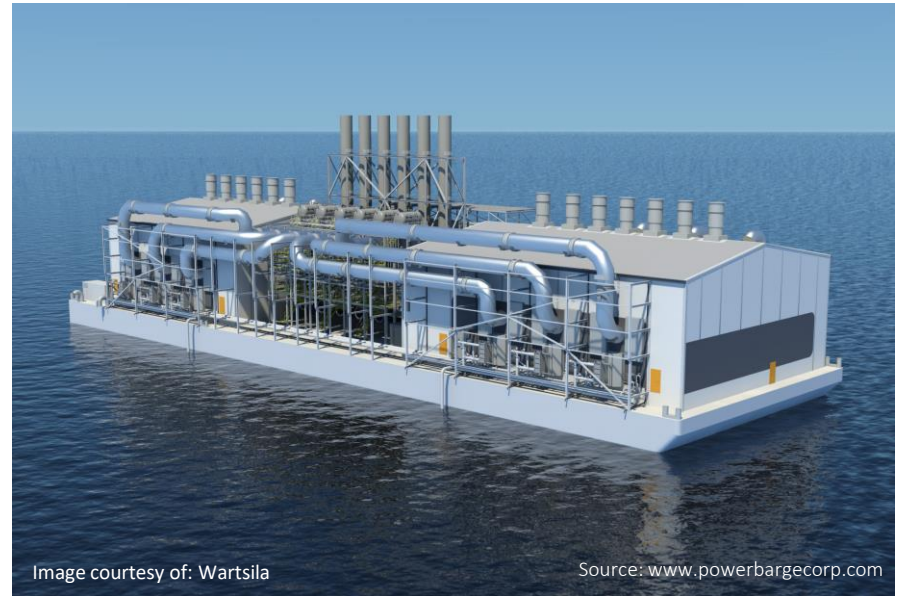
Power Barge Characteristics and Types

- Typical Notations:
 - ⚡A1 Barge, River and Harbor Service
 - ⚡A1 Offshore Installation – Electric Generating Plant
 - ⚡A1 Liquefied Gas Tank Barge
- Rule Sets
 - ABS Rules for Building and Classing Steel Barges
 - IMO IGC Code

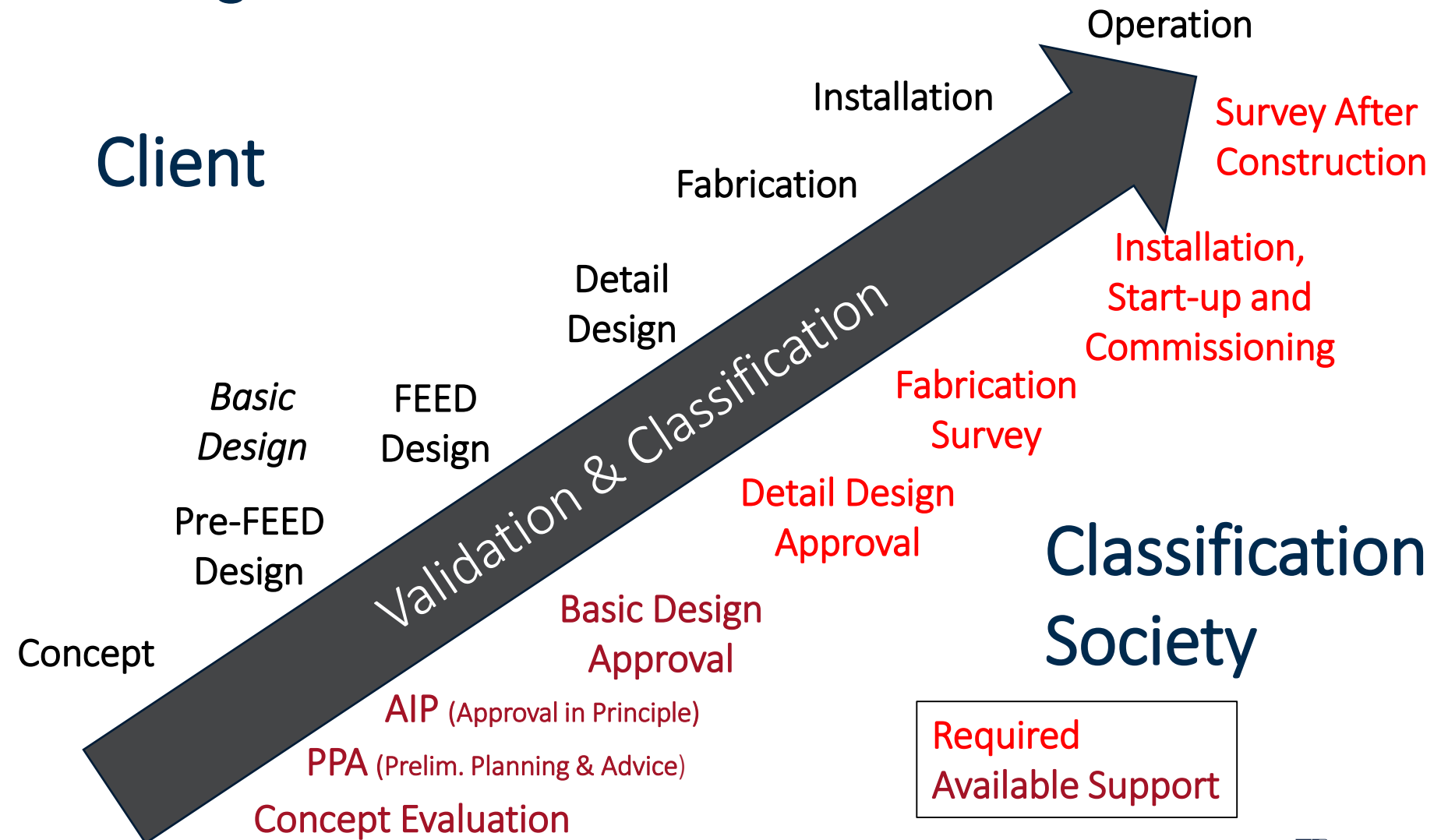


Power Barge Characteristics

- ⚓ A1 Deck Barge
- Power Generation excluded from Class
- Structures / Loadline
- Accommodations
- Ship's services
- Shell penetrations
- Fire and Safety Plan
- Fire protection and fire detection



Design Process & Class Role





Thank You

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