Presentation
on
A to Z of Natural Gas & LNG
Oragnized by Petrofed, Lovraj kumar Memorial Trust & PLL

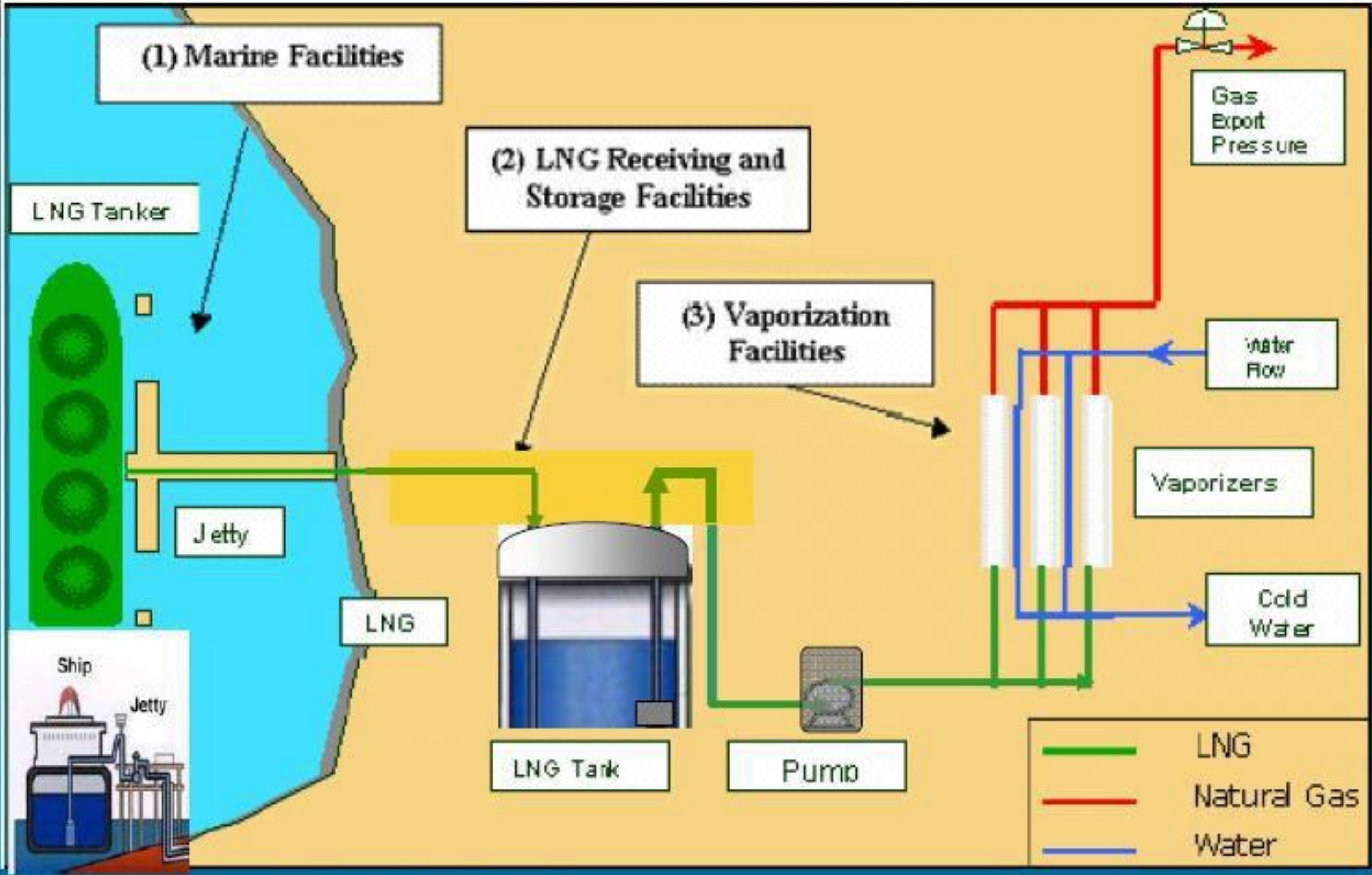
Sham Sunder,

30.04.2015

Presentation on A to Z of LNG

- Various type of Processes & equipments for Regasification terminals

LNG Terminal – A Simple Depiction

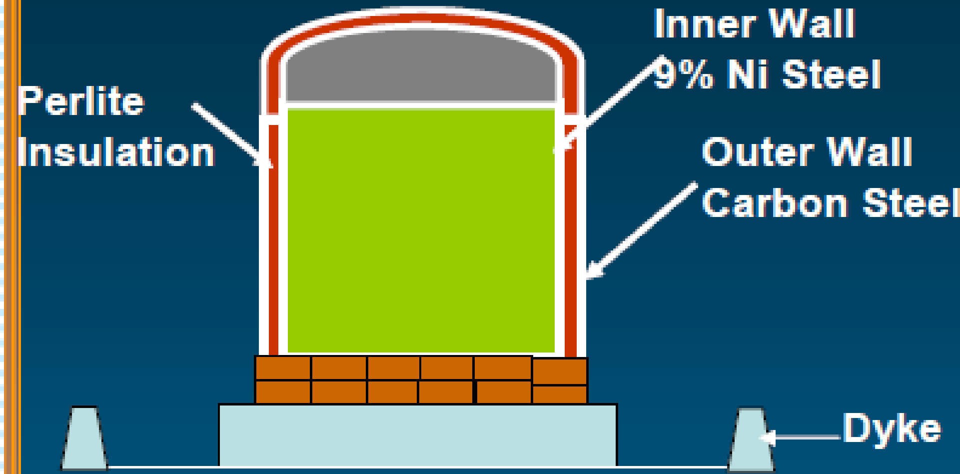


Typical Unloading System

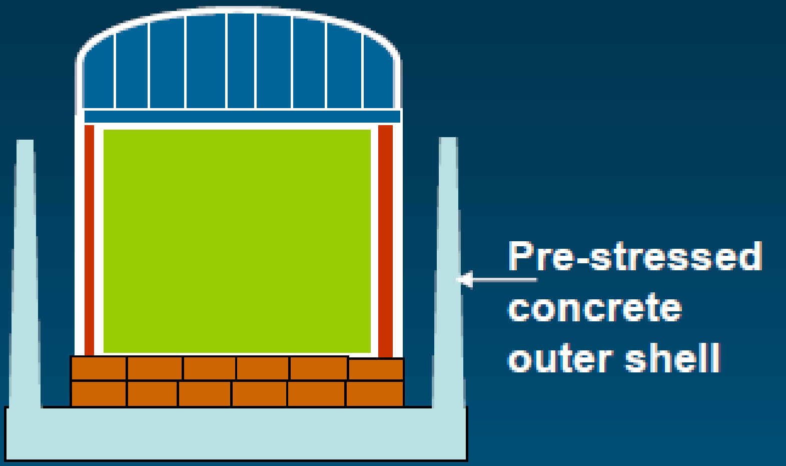
- The most common tanker size is 75,000 to 135,000 M^3 LNG Carriers.
- Industry trend is towards bigger ships upto 265,000 M^3.
- LNG transfer from ship by 2 pumps per cargo tank, 4 tanks.
- Pumping rate - 10000-18000 M^3 /Hr. Unloading time 10-15 hours.
- Loading lines could be two parallel lines of 24" or one line of 30".
- The vapor in storage tanks gets pushed out during filling and is sent to the tanker by vapor return lines.

Types of LNG Storage Tanks

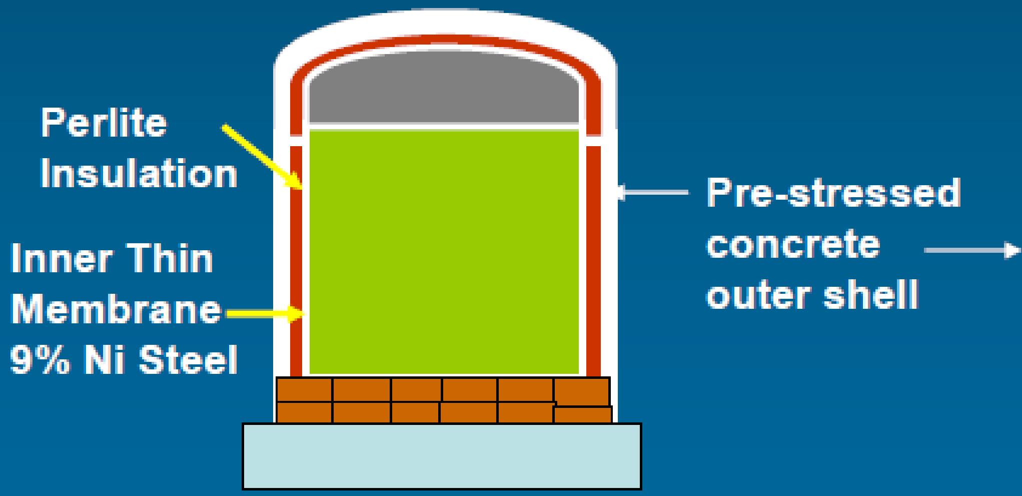
Single Containment



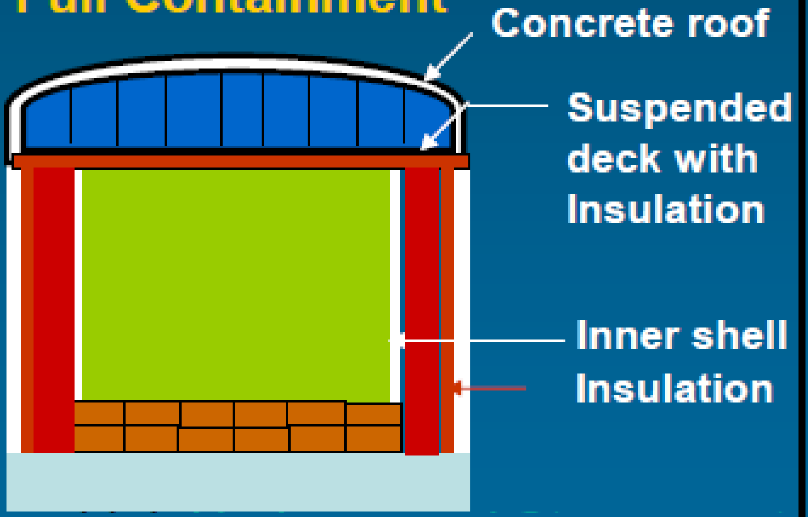
Double Containment



Membrane Tank

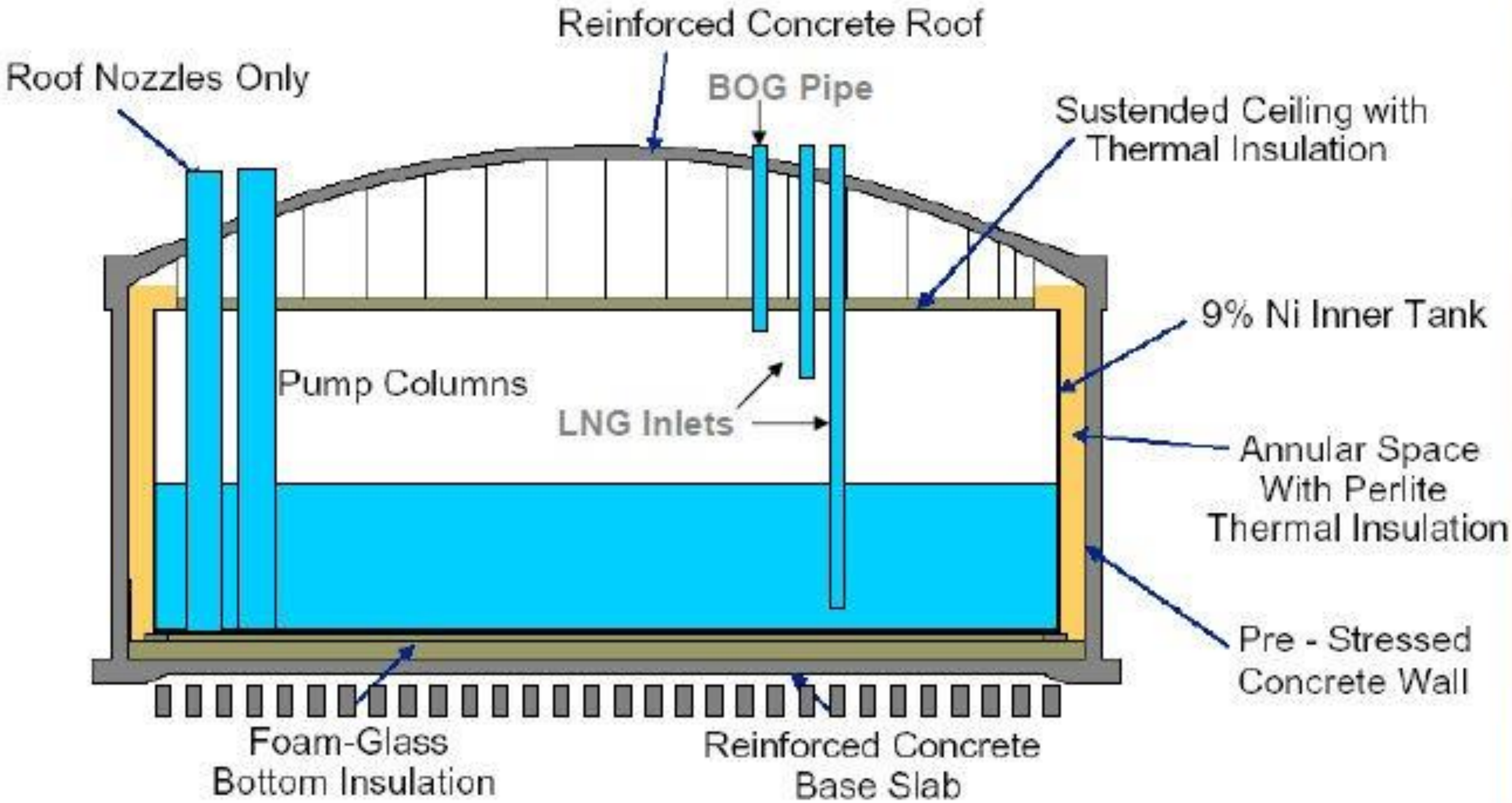


Full Containment

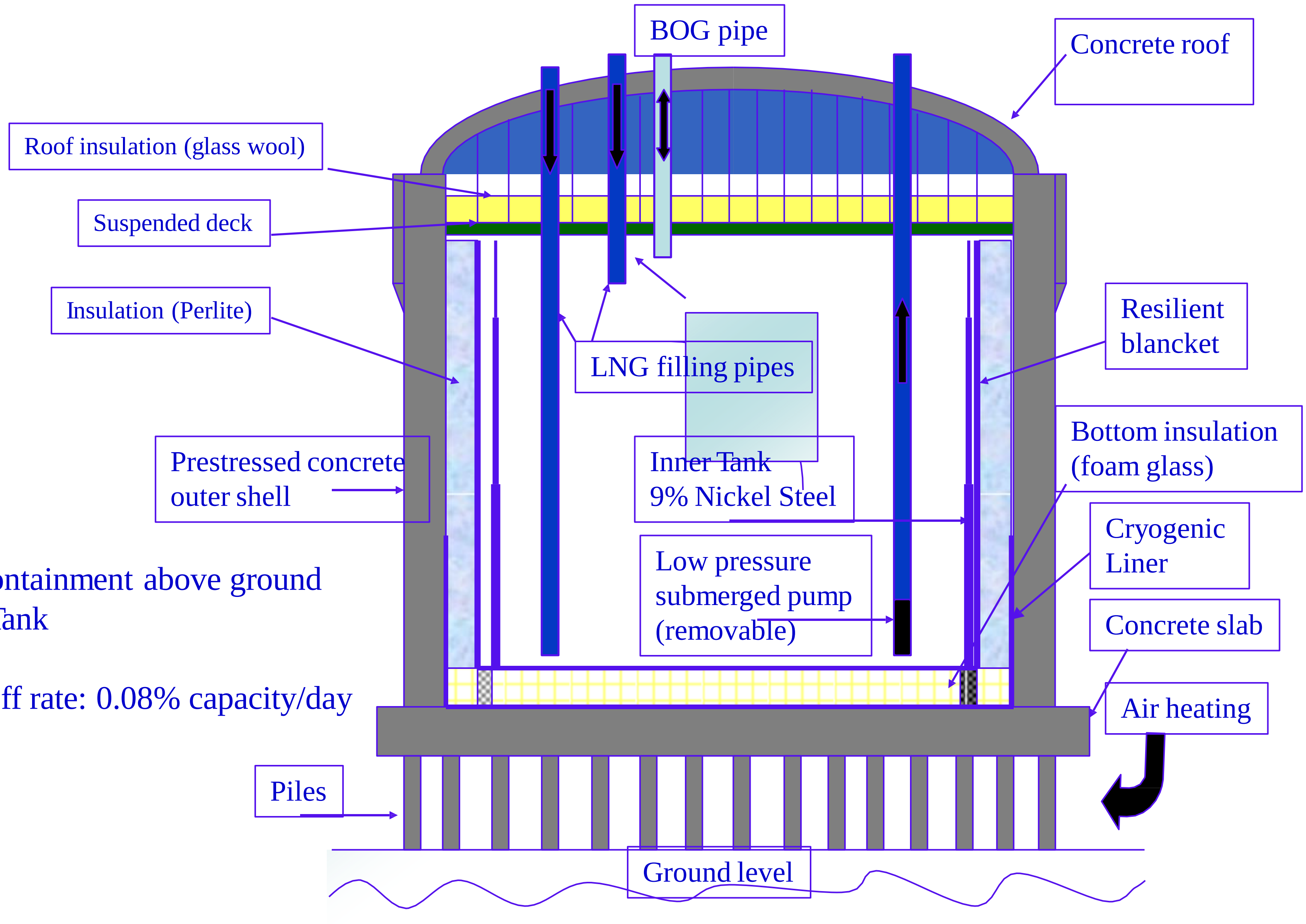


Underground LNG Storage Tanks

Full Containment LNG Tank



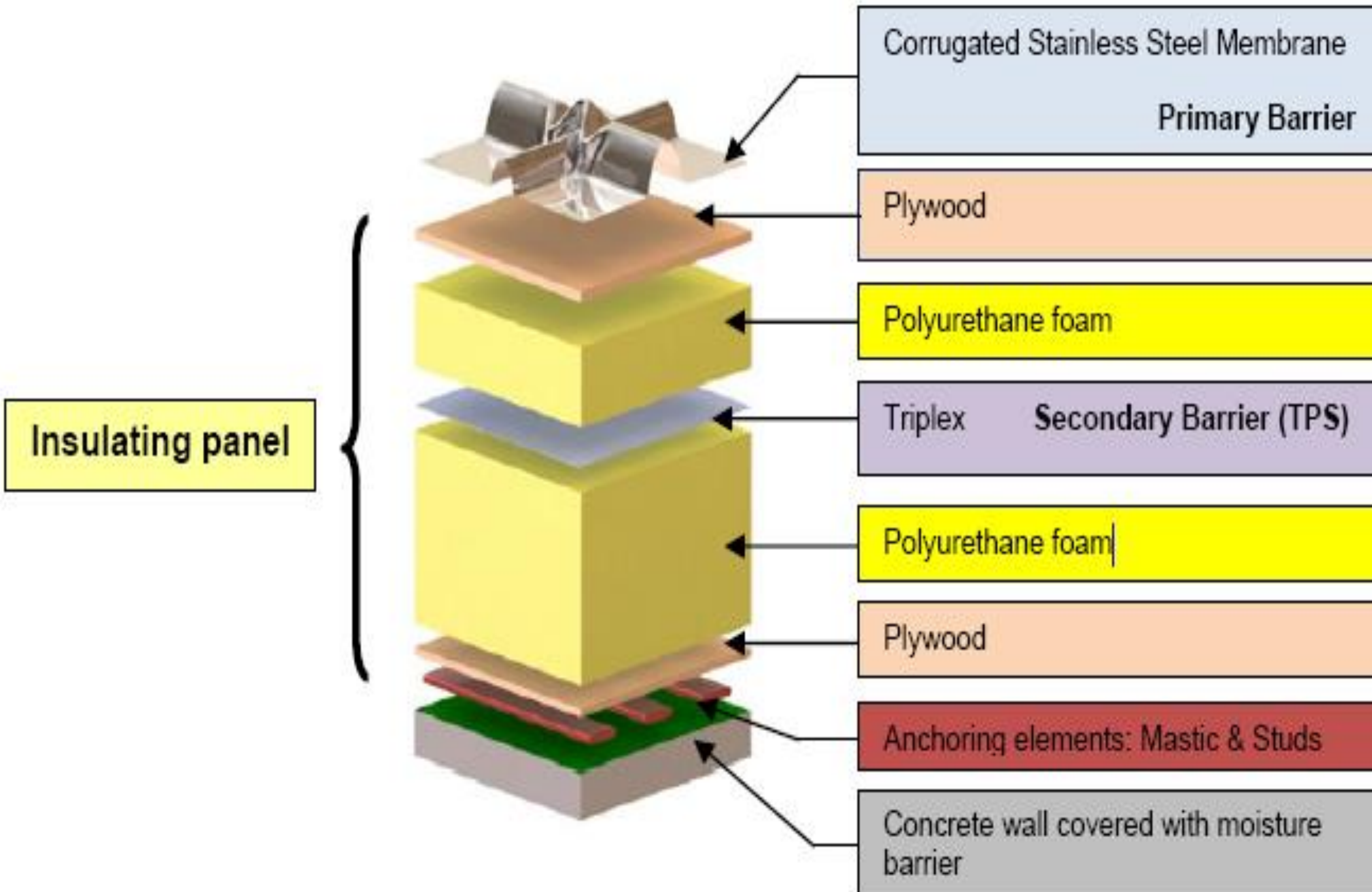
LNG STORAGES TANK-Full Containment



Full containment above ground LNG Tank

Boil Off rate: 0.08% capacity/day

Description of the Membrane Containment System Components



World Scenario for LNG Storage Tanks

- Total Numbers: 610
- Single/Double Containment: 130
- Membrane Type: 105*
- Full Containment: 375

* Mostly in Japan & South Korea

Membrane Storage Tanks
Pros & Cons

- Lower Capital Cost (Only For more than 160000 cubic meter capacity)
- Lower Construction Time
- More Sustainable at high seismic area
- Skilled labour requirement
- Special tools
- Probability of LNG leak frequency is more

Membrane Storage Tanks
Issues in India

- Large space requirement (dyke area)
- Non availability of skilled welders
- Automatic welding machines need to be imported
- Special precaution required for in-tank pumps removal

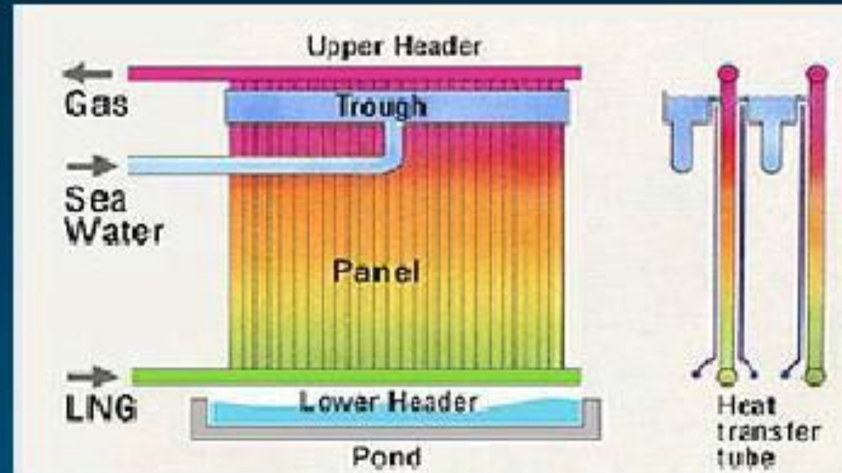
TANK SAFETY

Results of Consequence Modeling

		Containment Type			Remarks
		Single	Double	Full	
Heat flux due to LNG Fire	At Location 1	Acceptable (0.9 Kw/m2)	Acceptable (nil)	No affect outside plant	NFPA 59 A Criteria is 5 KW/m2
	At Location 2	Acceptable (1.2 Kw/m2)	Acceptable (0.1 Kw/m2)	No affect outside plant	Flux causing structural damage estimate is 25 Kw/m2
	5 Kw/m2 distance	700 m	300 m	77 m	Minimum distance to property line
	3 Kw/m2 distance	1200 m	700 m	88 m	
Hazardous Vapour Cloud	Spread	Unacceptable (2500 m to 5600 m)	Unacceptable (1100 m to 1200 m)	Acceptable (57 m)	LEL not to spread outside battery limit

LNG Re-gasification

- LNG vaporization is an energy intensive process.
- Typically, vaporizing 1200 MMSCFD (30 MMSCMD) of LNG requires roughly 750 MM Btu/hr of heat duty.
- This requires 20 MMSCFD (0.5 MMSCMD) natural gas to heat it. Sea Water or air are often used for heating.
- Sea water can be used as heating medium. In the above case, sea water requirement (15 ^{0}F/ 8 ^{0}C rise) will be 100,000 gpm (24,000 M^{3}/Hr).

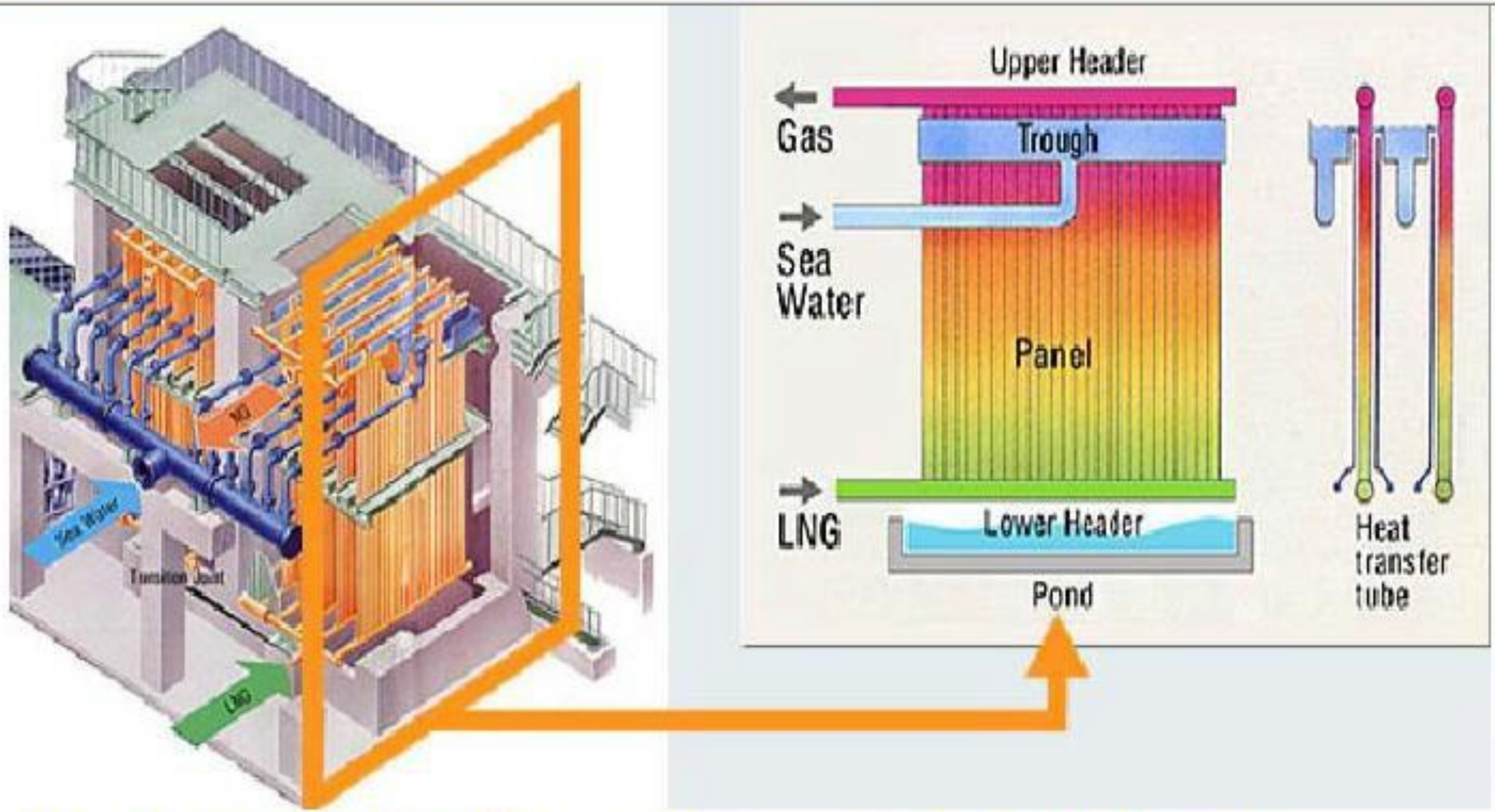


- Energy recovery during vaporization can be done by integrating power plant with LNG facility and using low level heat from power plant.

Types of Vaporizers

- Open Rack Vaporizers (ORV)
- Submerged Combustion Vaporizers (SCV)
- Intermediate Fluid Vaporizers (IFV)
  - Hydrocarbon Mixture (Rankine Cycle)
  - Glycol / Methanol Water System
- Ambient Air Vaporizers (AAV)

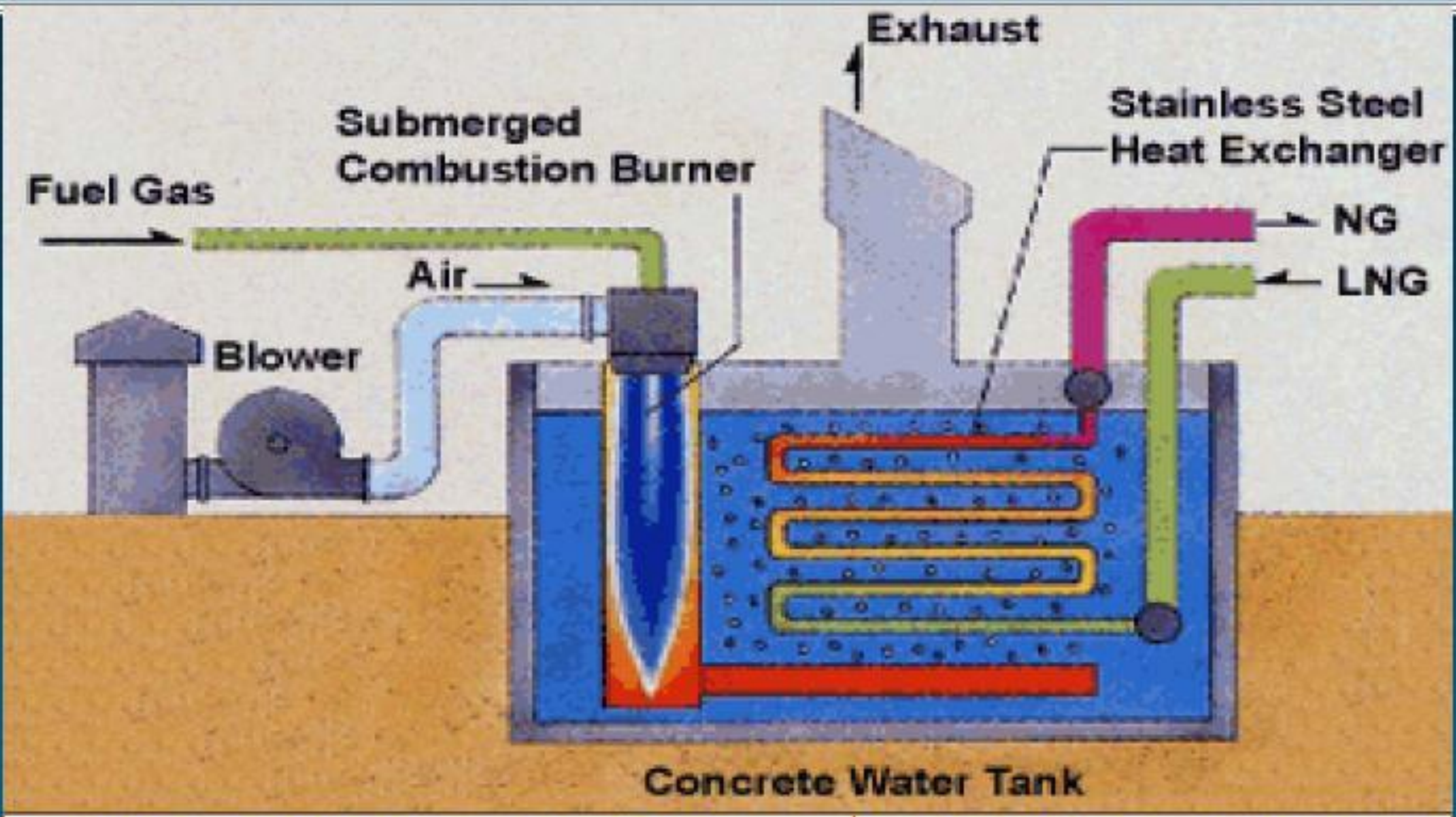
Open Rack Vaporizers (ORV)



- Simple construction & operation.
- No controls, reliable and safe.
- High turndown ratio.

- Capital intensive.
- Environmental issues
- High maintenance.

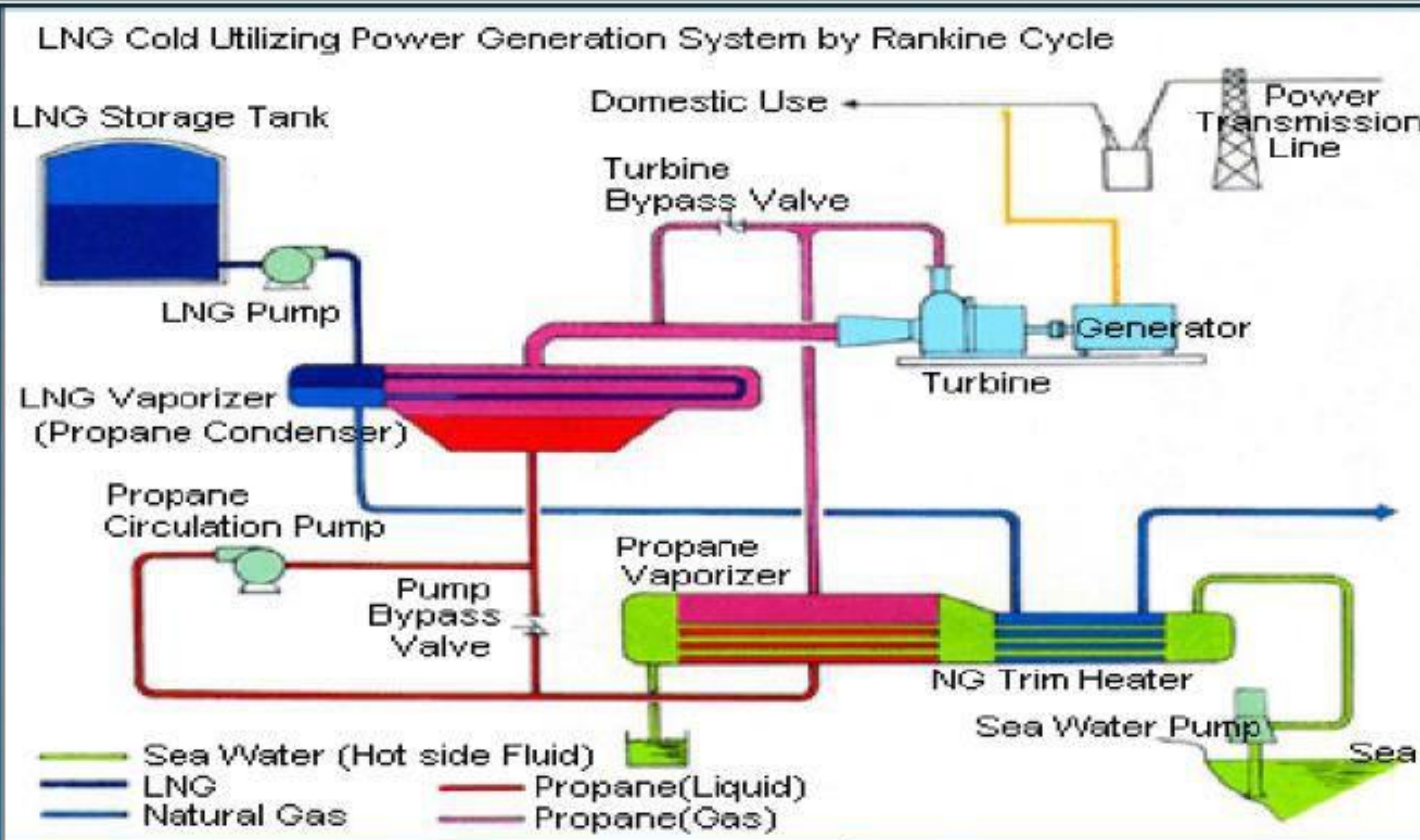
Submerged Combustion Vaporizers (SCV)



- Simple and compact design.
- Large load fluctuations.
- Lower capital cost
- Low ambient temp. application.

- 1.5% fuel consumption
- Green house effect.
- The control is more complex.

Intermediate Fluid Vaporizer (IFV) with Rankine Cycle

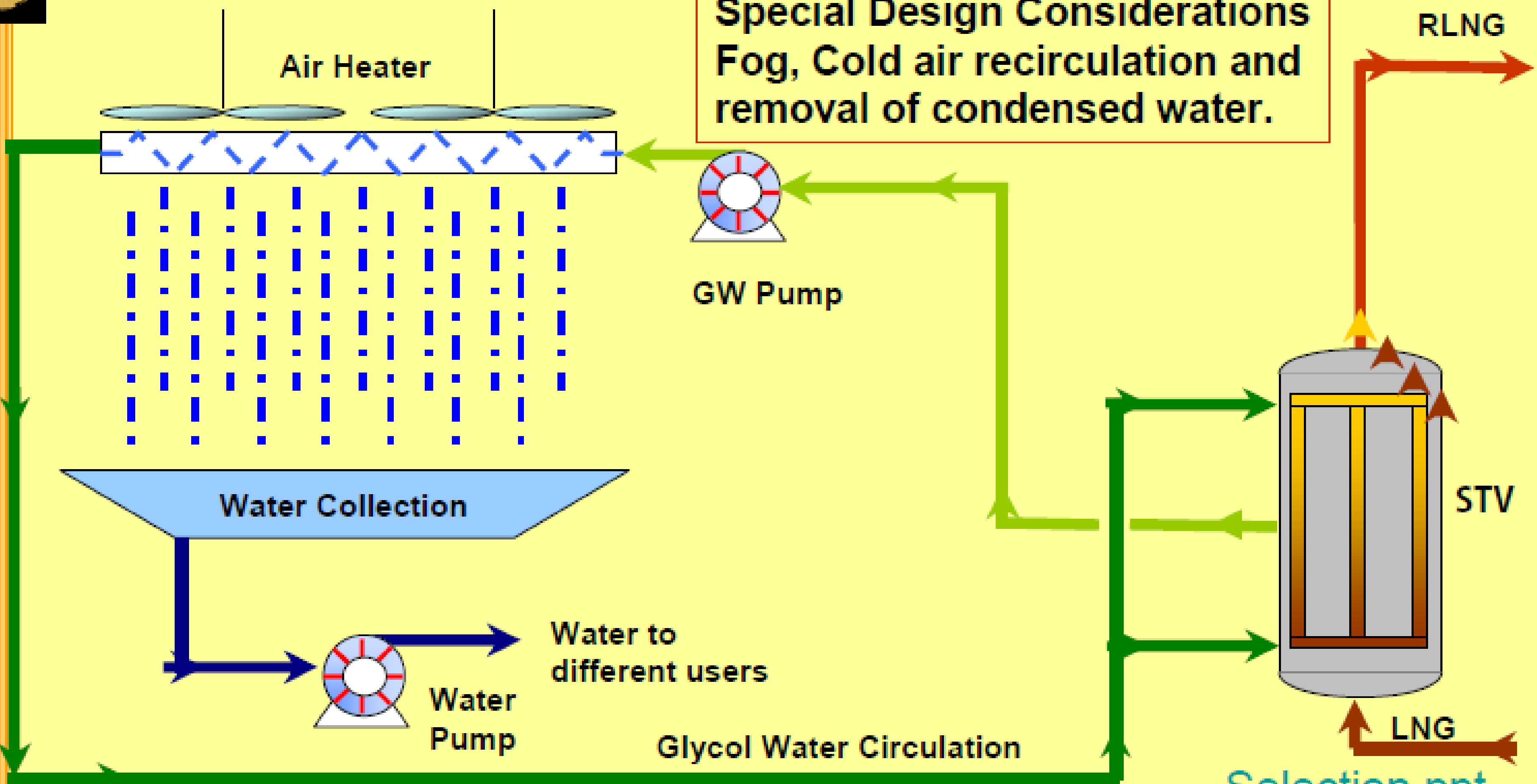


- Cold energy for power generation.
- No greenhouse effect.
- Complex process and controls.

- Higher capital cost
- Turndown ratio limits.
- Longer start-up time.

Glycol-Water Intermediate Fluid Vaporizer

Special Design Considerations
Fog, Cold air recirculation and removal of condensed water.

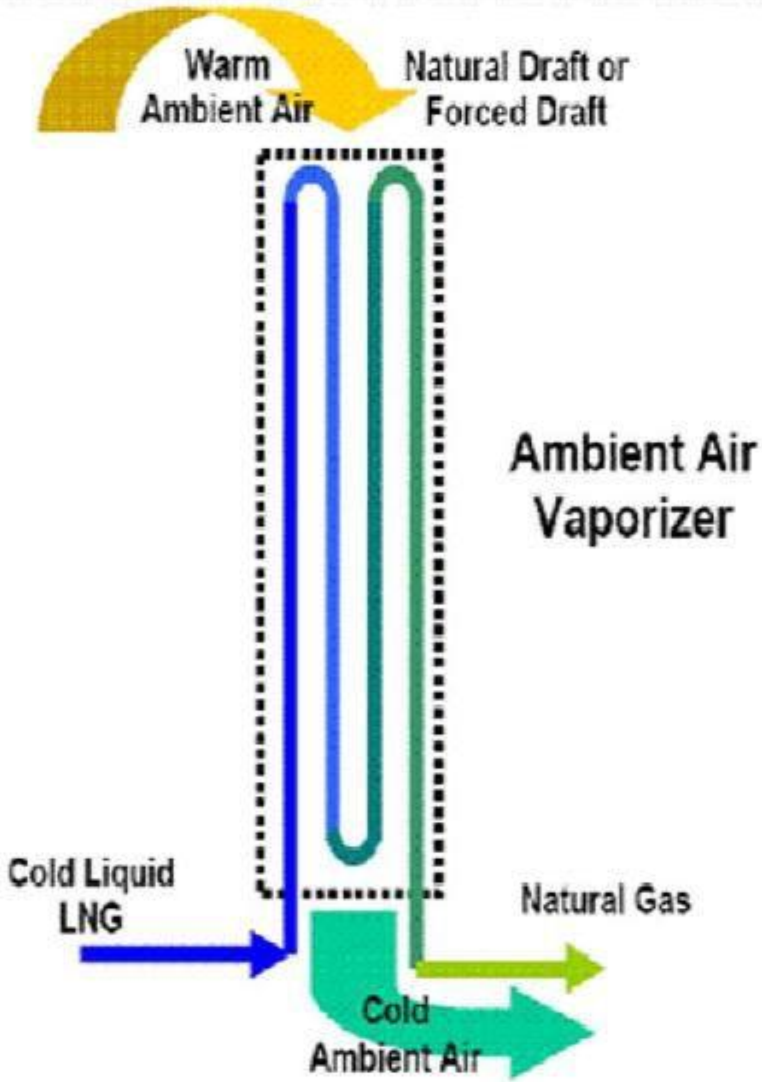


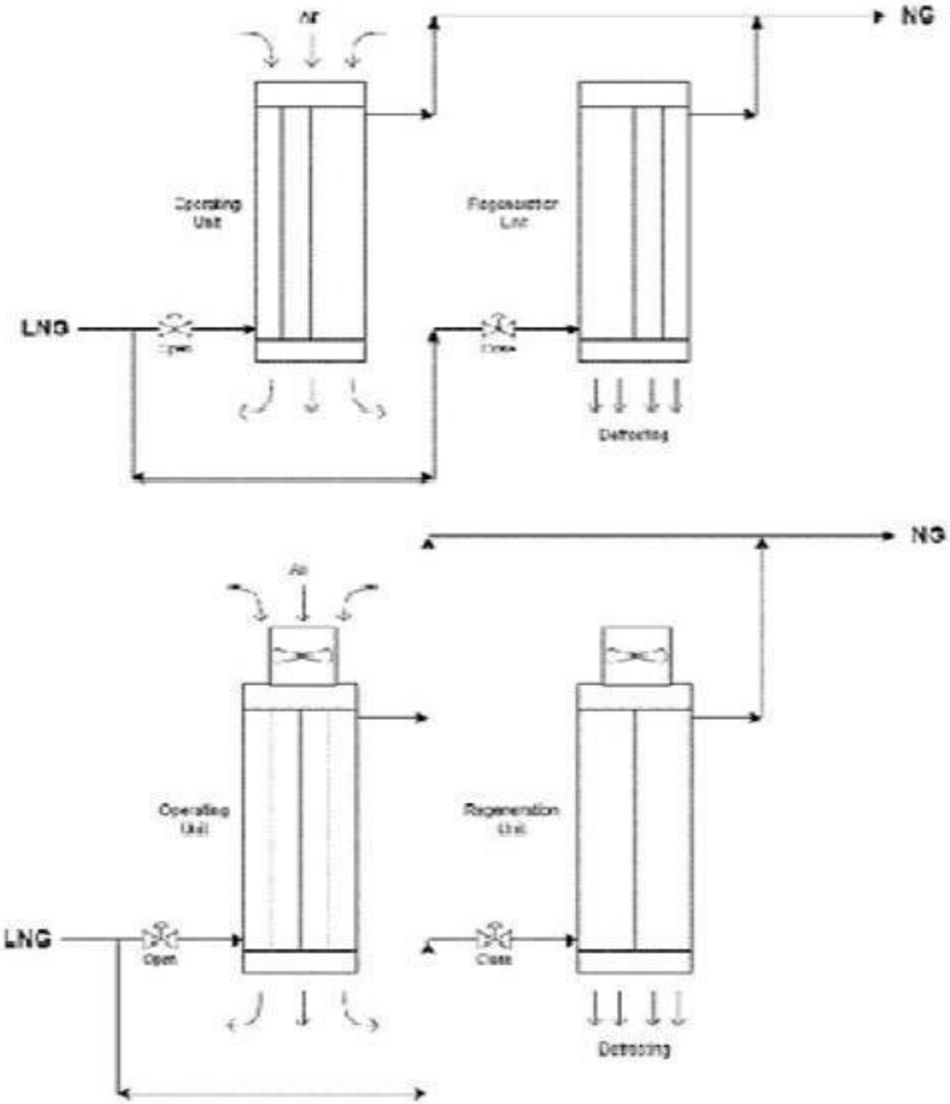
Selection.ppt

- Minimum operating cost.
- Effective at high ambient temp.

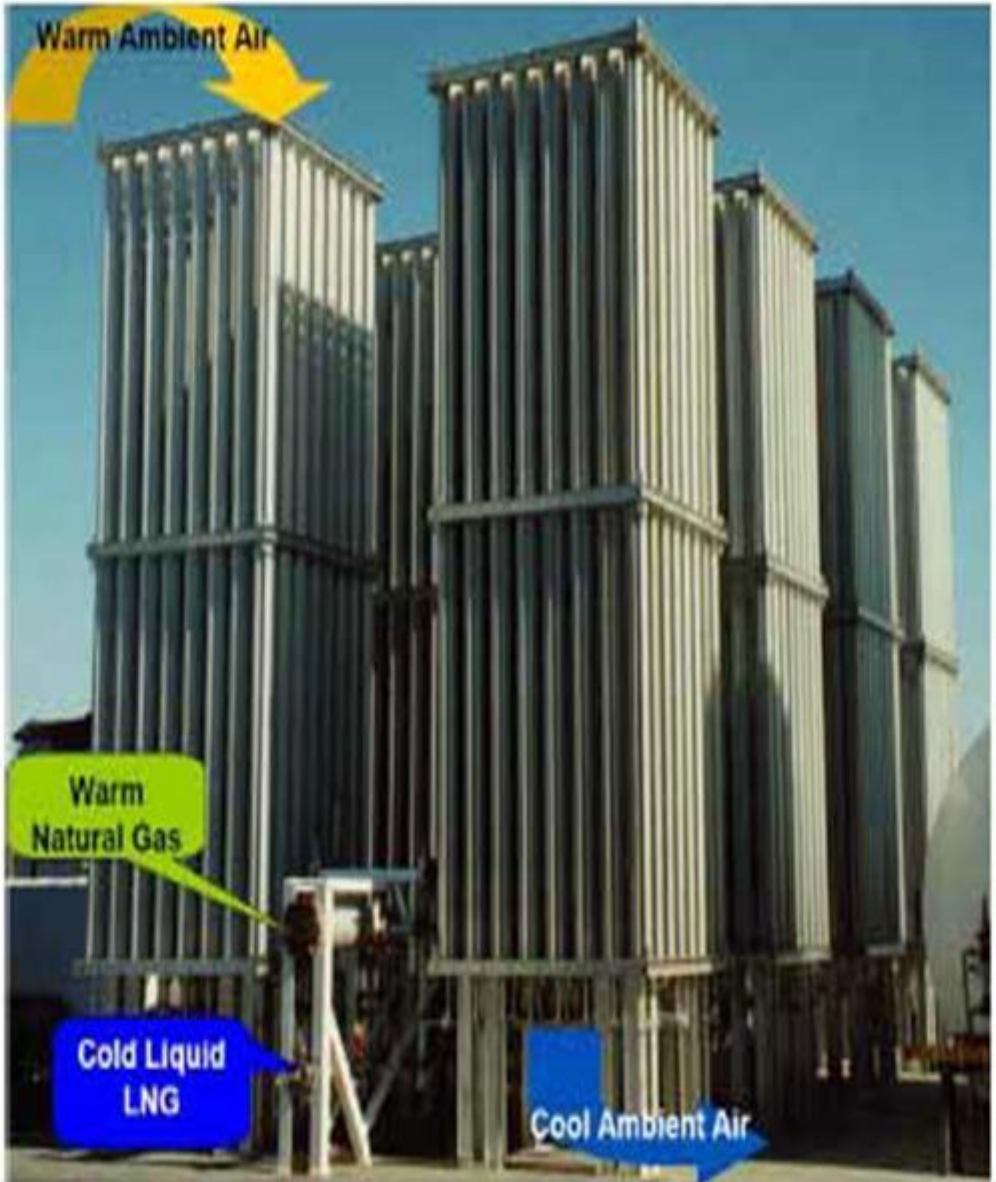
- Capital cost Higher than SCV, lower than ORV.
- Large space requirement.

Natural Draft Direct Ambient Air Vaporizers.





NATURAL DRAFT DIRECT AMBIENT AIR VAPORIZERS



AAV Design

- Natural draft ambient air
- No intermediate fluid
- Direct transfer from air to vaporized fluid
- No power / fuel)
- Wide fin spacing allows for icing design
- Effective to -80 F [-62 C]

Ambient Vaporizers

- **Simplest and most reliable systems**
- **More complex to model**

Consider the following:

- **Simultaneous heat and mass transfer**
- **Diffusion of water vapor**
- **Equilibrium rarely exists**
- **Ambient conditions, not controllable**

Decisions on ambient vaporizer sizing is dictated by prevailing weather conditions, tempered with other considerations based on job specific requirements.

FORCED DRAFT DIRECT AMBIENT AIR VAPORIZERS

FAV Design

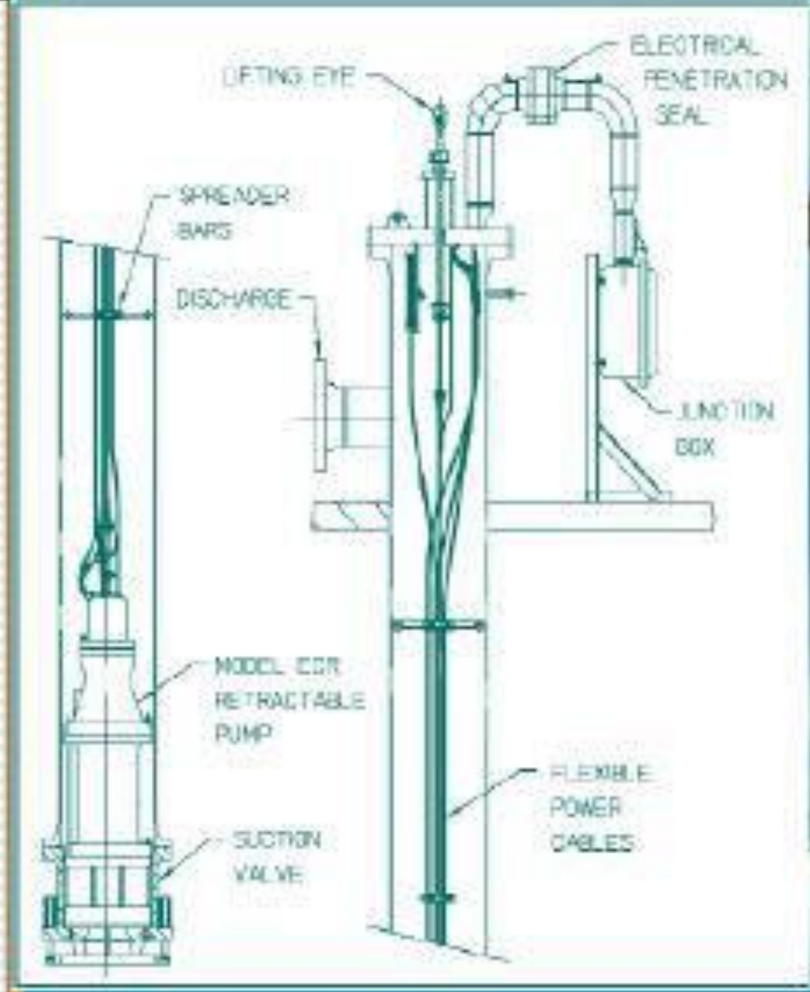
- Fan assisted ambient air
- Increased external coefficient
- Direct transfer from air to vaporized fluid
- Highly efficient, no intermediate fluid
- Wide fin spacing allows for icing design
- Effective to -80 F [-62 C]

Vaporizer Selection Criteria

Local environment – sea water quality, ambient temperature.

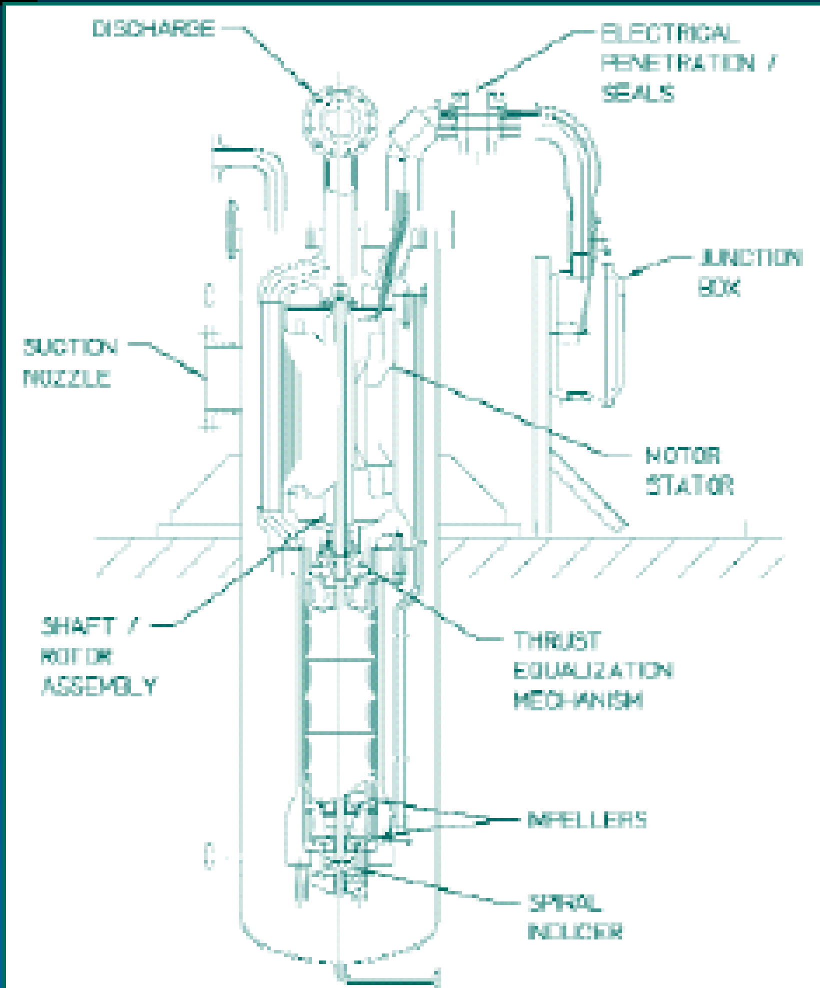
- Environmental Considerations
  - Atmospheric pollution
  - Impact on ocean ecosystem
- Cost – Investment and operating cost
- Space requirement
- Ease of operation
- Maintenance problems

Primary Pump (SEMP)



- Transfers LNG from tank to secondary pumping.
- 200-400 M3 /Hr, 3-8 Kg/sq. cm pressure. 1 or 2 stages.
- Motor and pump with shaft directly submerged in LNG.
- No seal, no leakage of vapor to atmosphere.
- No coupling between motor and pump. No alignment problem.

Secondary Pump

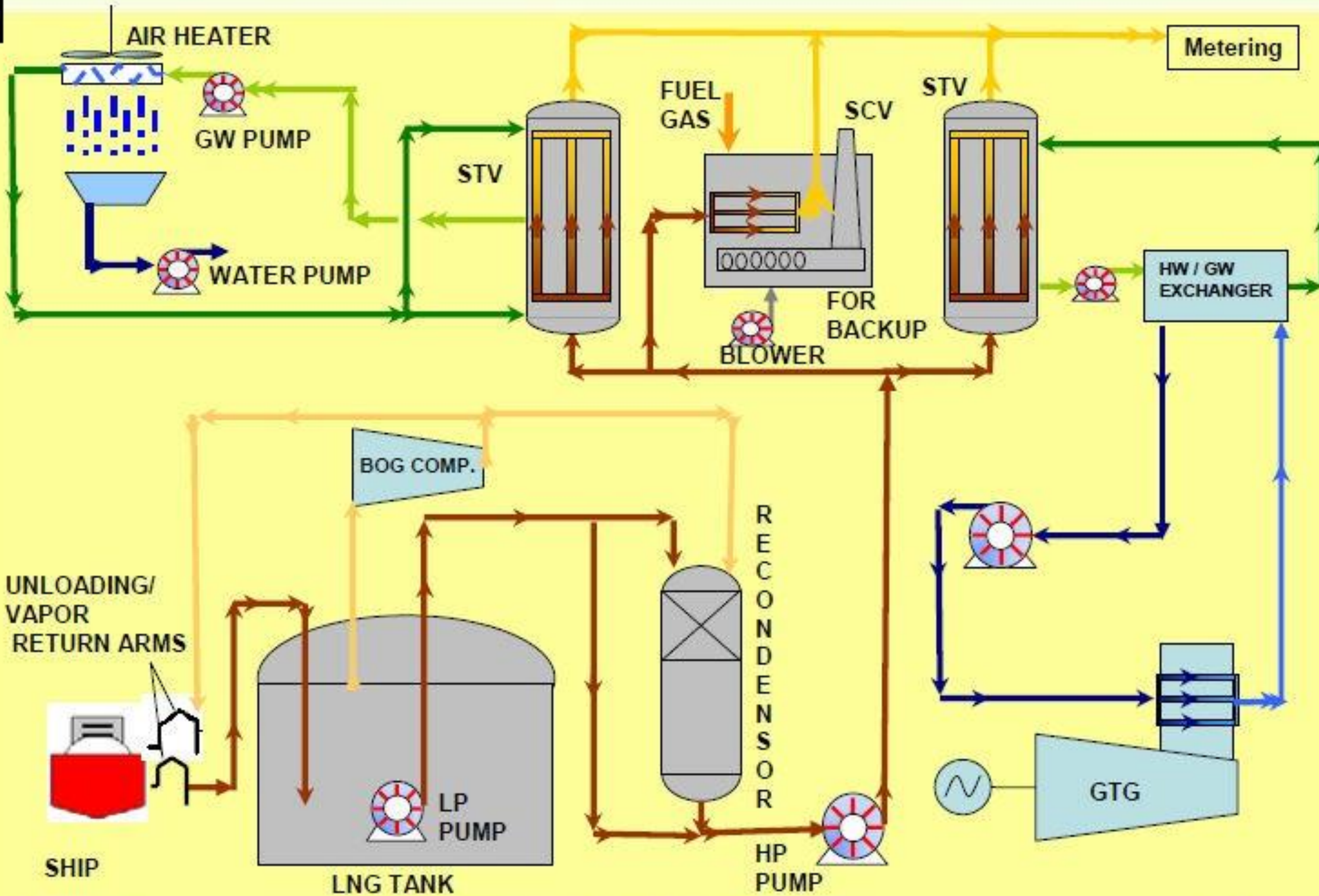


- High pressure (100-140 Kg/ sq. cm) multistage vessel mounted submerged pump.
- Installed in self-contained suction vessel.
- The vessel venting is important.
- Pumps are installed in banks or rows.
- Widely accepted due to inherent safety.

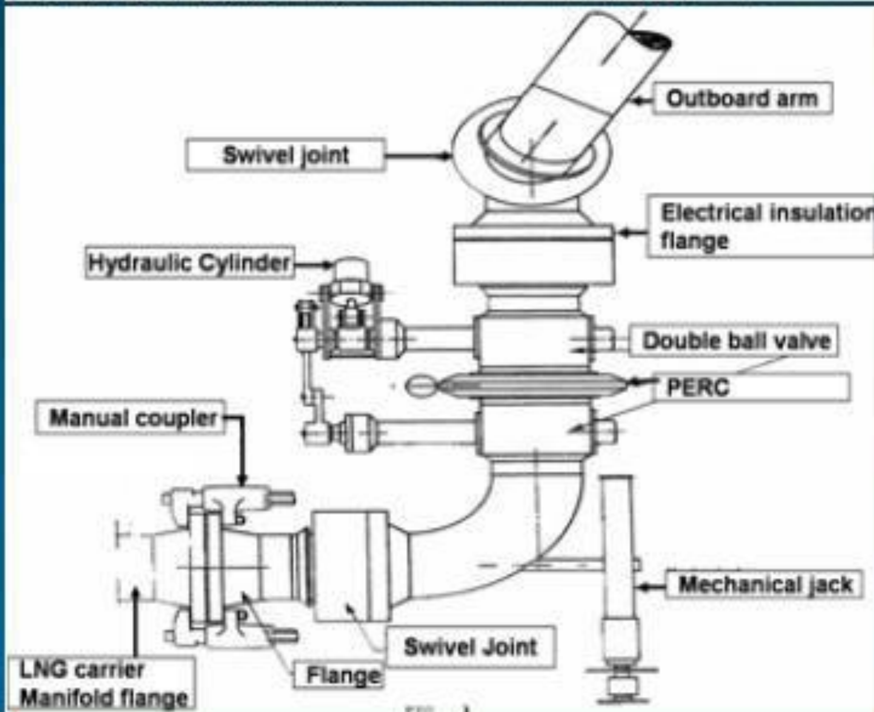
Design Features of LNG Pumps

- Submerged in LNG. No seals, no vapor leakage.
- Common shaft, submerged motor, no air. Explosion proof motor not required, though used for extra-safety.
- Power cables connected at their junction boxes located on or near the head plate of the vessel.
- Primary pumps require 400-440 V power, 50-60 Hz. Secondary Pumps require 4160-6600 V power, 50-60 Hz.

LNG Terminal Dahej



Unloading Arm Safety



- A mooring study is conducted to ensure that the ship can stay in position with the pier during extreme wind speeds.
- Load sensors on the mooring hooks will detect and warn any over or under load.
- Alarm and emergency shutdown system to stop loading.
- The liquid unloading arms will be fitted with Powered Emergency Release Couplings (PERCs).

LNG TRUCK LOADING FACILITY

- Truck Loading facility at Dahej terminal was commissioned in August 07

- Facility can handle 2500 loadings per year

VAPORISATION FACILITIES AT CUSTOMER'S END

EXECUTION OF LNG PROJECTS

- **Pre Project Activities**
  - Surveys & Studies
    - ✓ Land Survey
    - ✓ Collection of ambient data
    - ✓ Bathymetric Study
    - ✓ Topography Survey
    - ✓ Geotechnical Studies
    - ✓ Oceanographic Studies

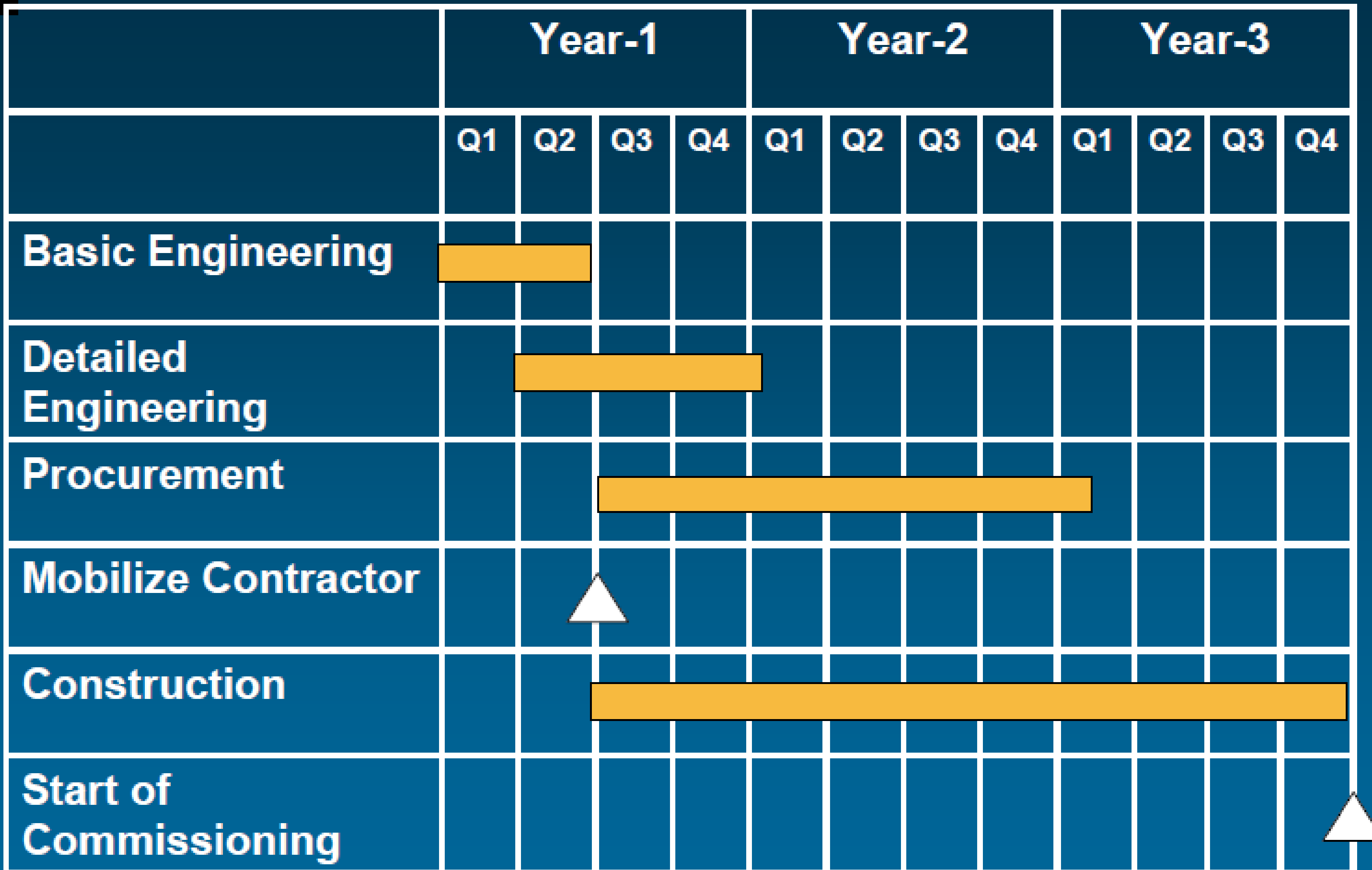
Cont..

- ✓ Marine and Terrestrial Studies (Rapid & Comprehensive)
- ✓ Project Feasibility Study including Mooring analysis & Ship Maneuvering Study
- ✓ Basic Engineering package(FEED)
- ✓ Finalization of Methodology for project execution
- ✓ Techno Commercial Documents for selection of PMC & contractors

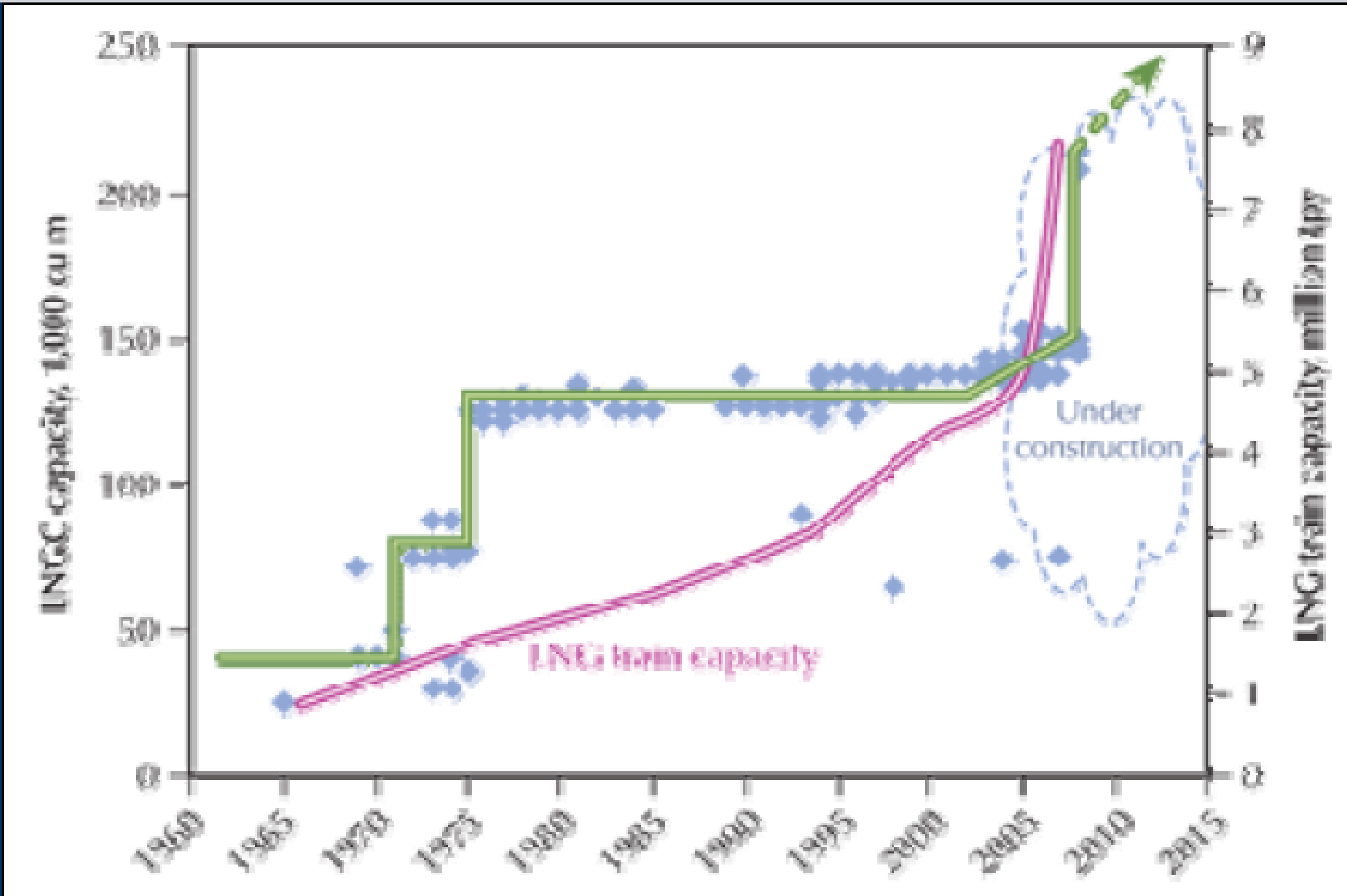
Approvals from Statutory Authorities

- State pollution control
- Costal Regulation Zone (CRZ) approval
- Department of environment & Forest
- Ministry of Environment & Forest
- Chief Controller of Explosives

Typical Project Schedule



LNG Tanker Size Liquefaction Trains



Thank You