

GLA2011 WORKSHOP SOFREGAZ's experience in tank building and process

JYVÄSKYLÄ – June 7th 2011

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FEW WORDS ABOUT SOFREGAZ



Engineering company specialized in natural gas.

- **Feasibility studies**
- **Basic & Detailed Engineering**
- **Project Management Consulting**
- **Procurement / sourcing**
- **Construction Supervision**
- **Commissioning & start-up**



LNG RECEIVING TERMINAL BILBAO SPAIN

ALL THROUGH THE “NATURAL GAS CHAIN”

Gas treatment (Gas gathering system, Gas Oil Separation Plant, Sweetening, Drying, Extraction, separation and storage of C2+, ...)

LNG

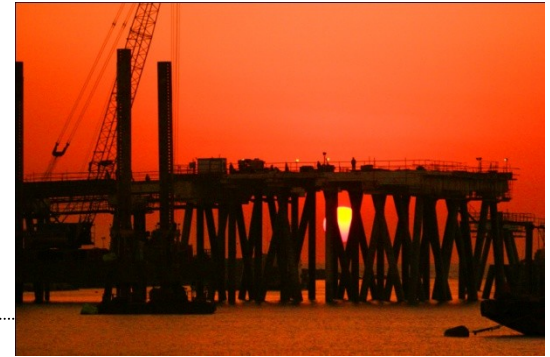
Peak shaving

Small Scale Natural Gas Liquefaction

LNG import terminals

Transmission systems – Pipelines and pumping and compression stations

LNG RECEIVING TERMINAL
HAZIRA INDIA



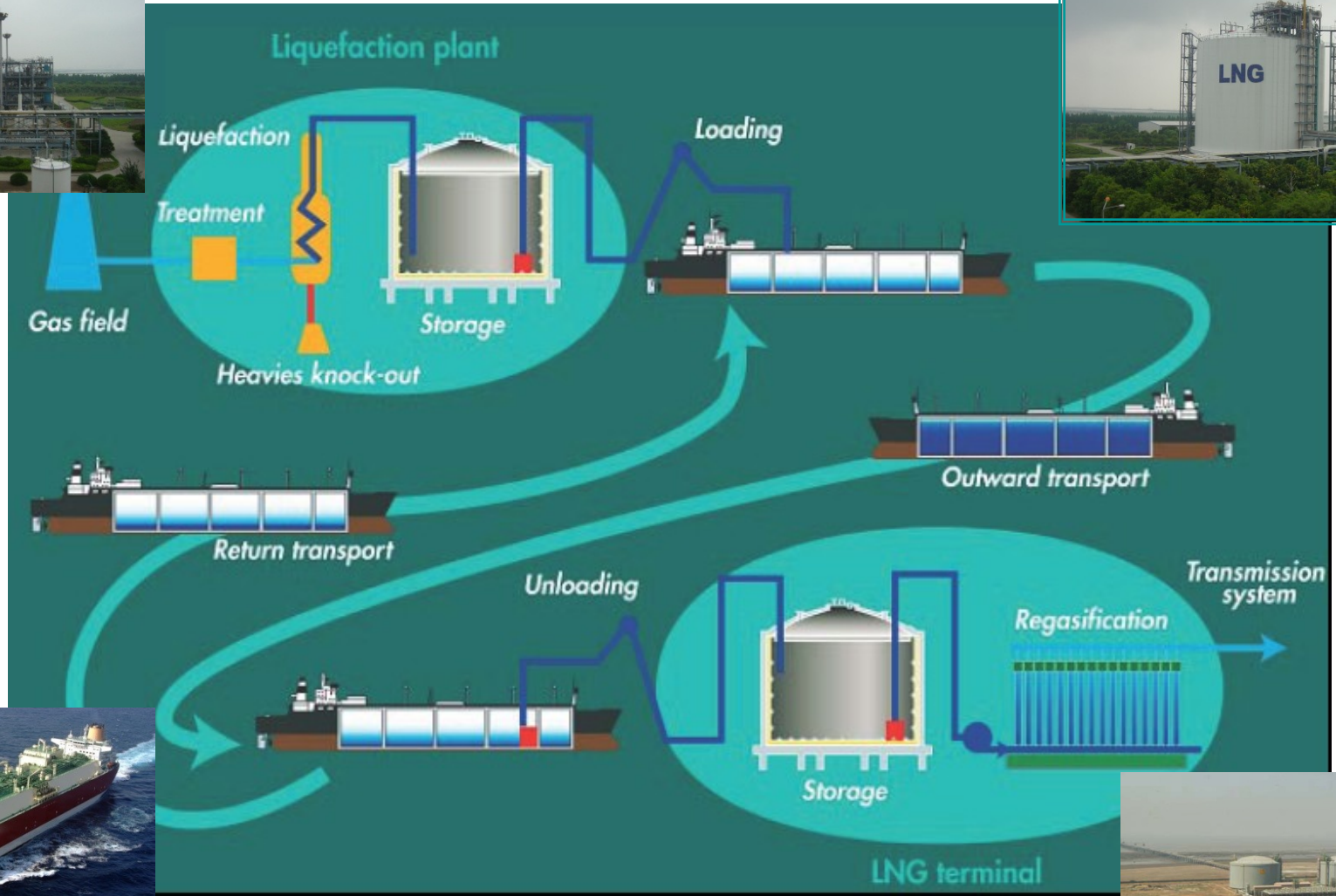
GAS TREATMENT
WAFA LIBYA



COMPRESSION STATION
S3-S6 IRAN



LNG CHAIN



In the last 10 years SOFREGAZ has successfully completed as Joint Venture member 8 EPC contracts including 11 LNG tanks with a cumulated capacity of **1,450,000 m³.**

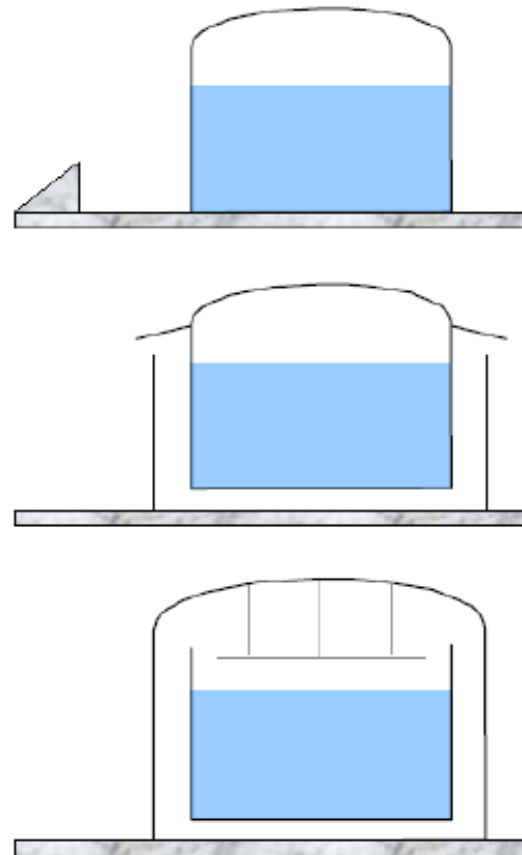
PROJECT	Storage Qty	Unit Vol (m3)	Total Vol (m 3)	Year of completion
SHANGHAI Peak Shaving (China)	1 (Full cont. above ground)	20,000	20,000	2000
BILBAO Rec. Ter. (Spain)	2 (Full cont. above ground)	150,000	300,000	2004
HAZIRA Rec. Ter. (india)	2 (Full cont. above ground)	160,000	320,000	2005
GUANGDONG Rec. Ter.(China)	3 (Full cont. above ground)	160,000	480,000	2006/2007
FOS CAVAOU Rec. Ter. (France)	3 (Full cont. above ground)	110,000	330,000	2009

OVERVIEW ON PROVEN TECHNOLOGIES ON LARGE CAPACITY CRYOGENIC STORAGE (> 60,000 m³)



LNG TANK TYPE

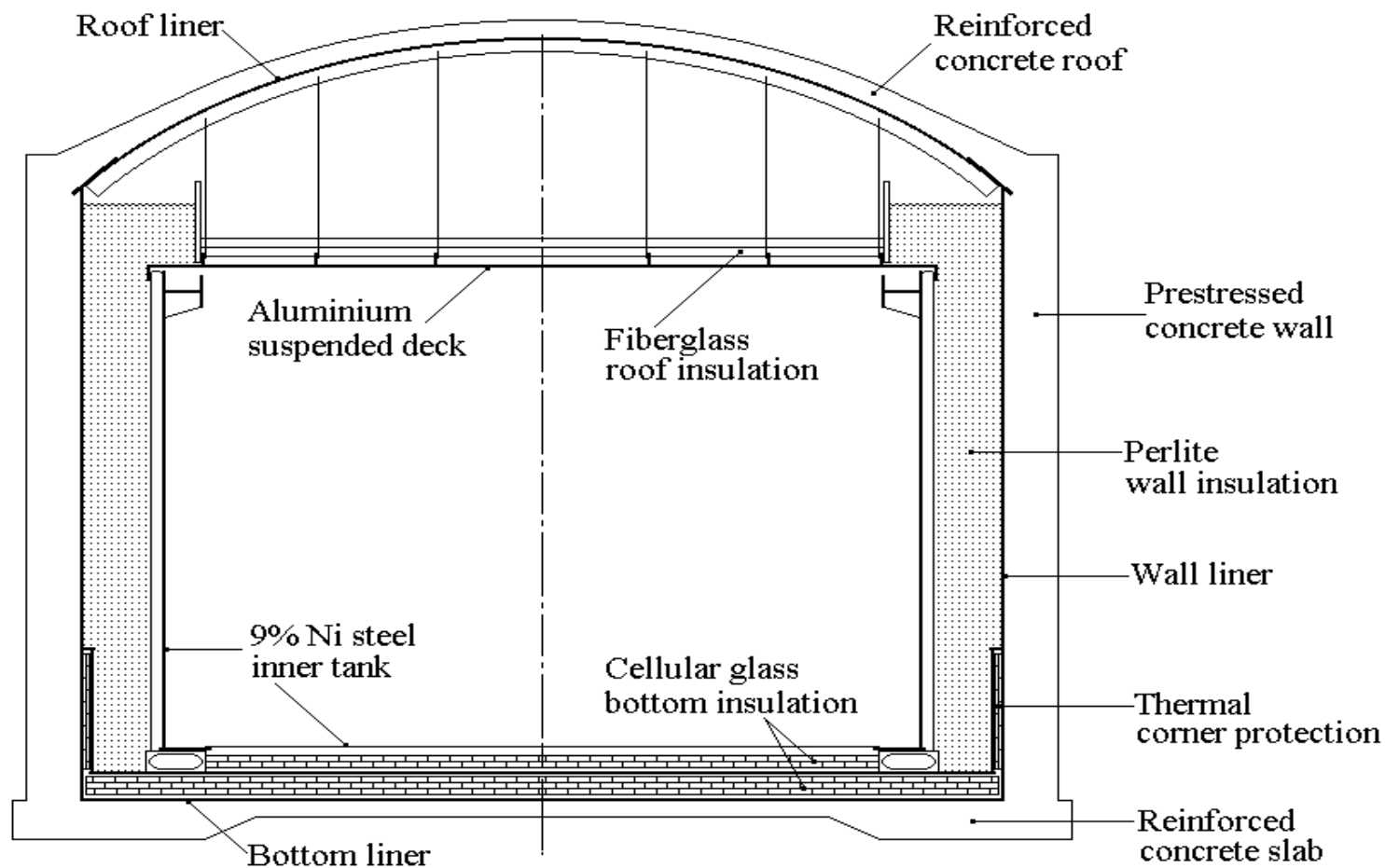
- Single containment
 - Inner shell contains liquid & vapour
- Double containment
 - Inner shell contains liquid & vapour
 - Outer shell contains liquid only
- Full containment
 - Inner shell contains liquid only
 - Outer shell contains liquid & vapour

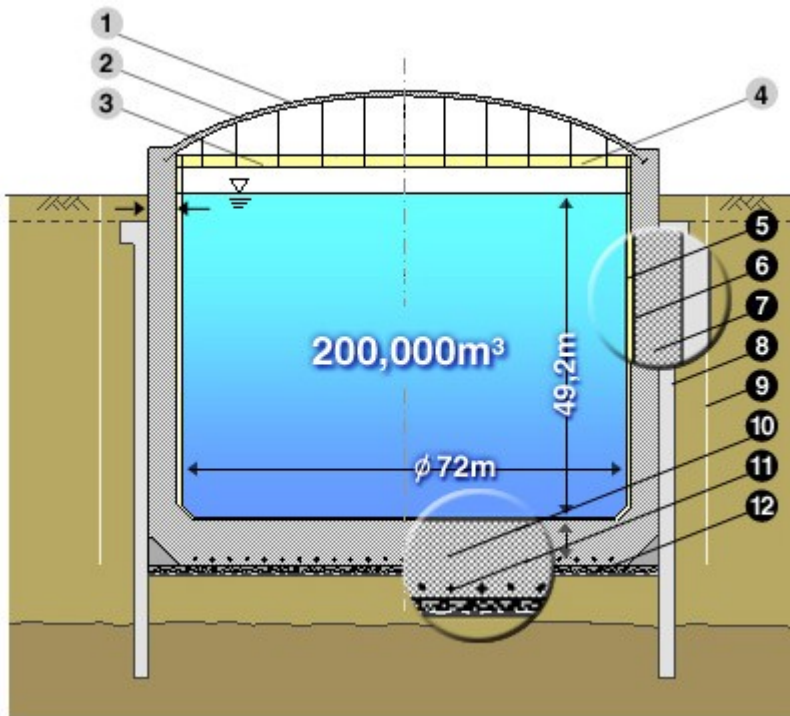


Cove Point Import Terminal, Maryland
Photo courtesy of Dominion © 2003. <http://www.dom.com>

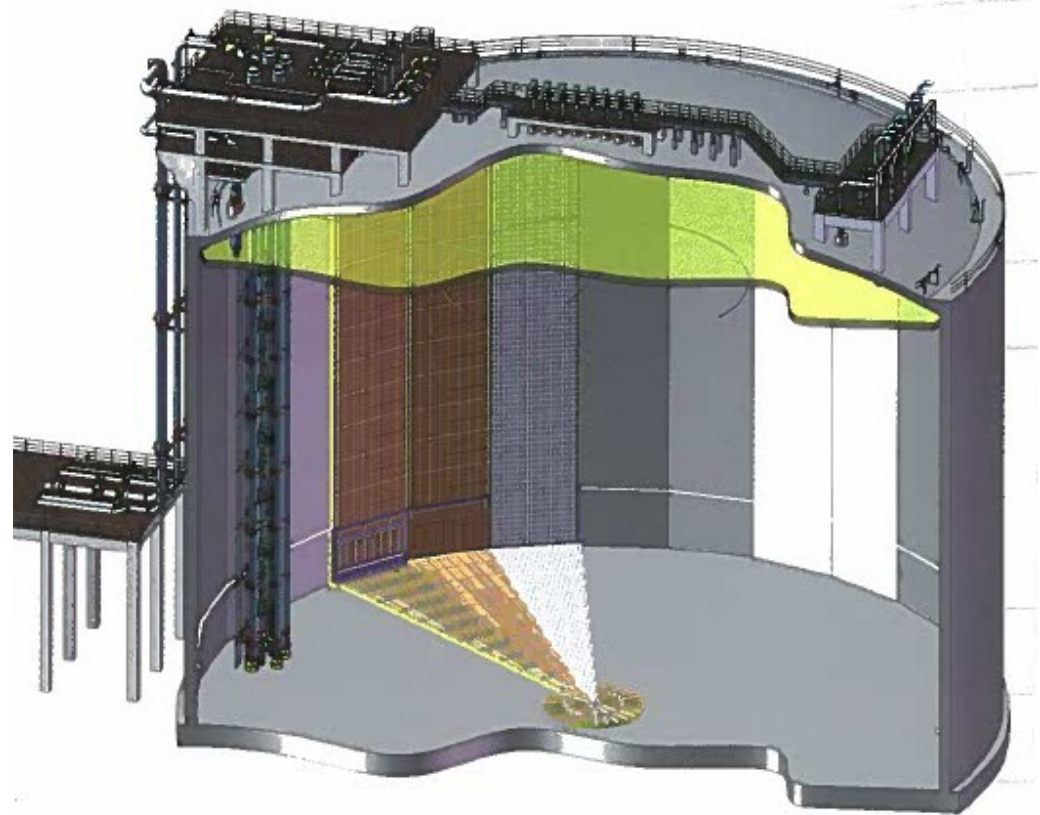
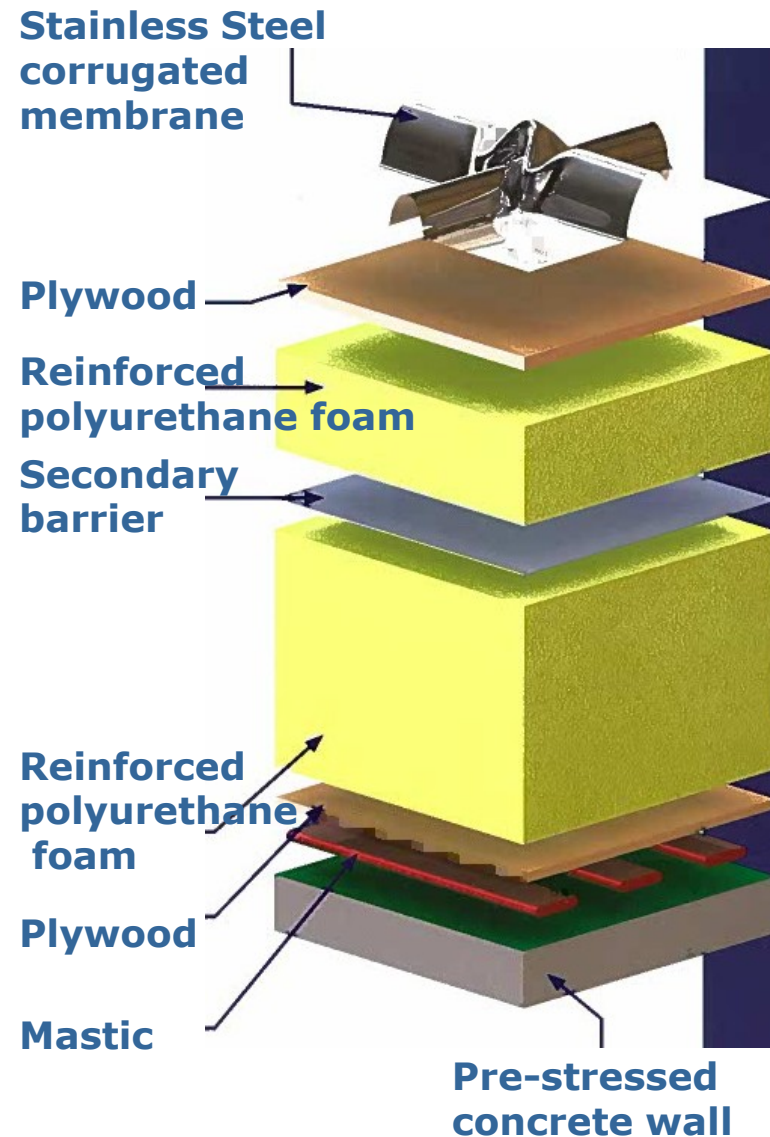


TYPICAL LNG FULL CONTAINMENT TANK





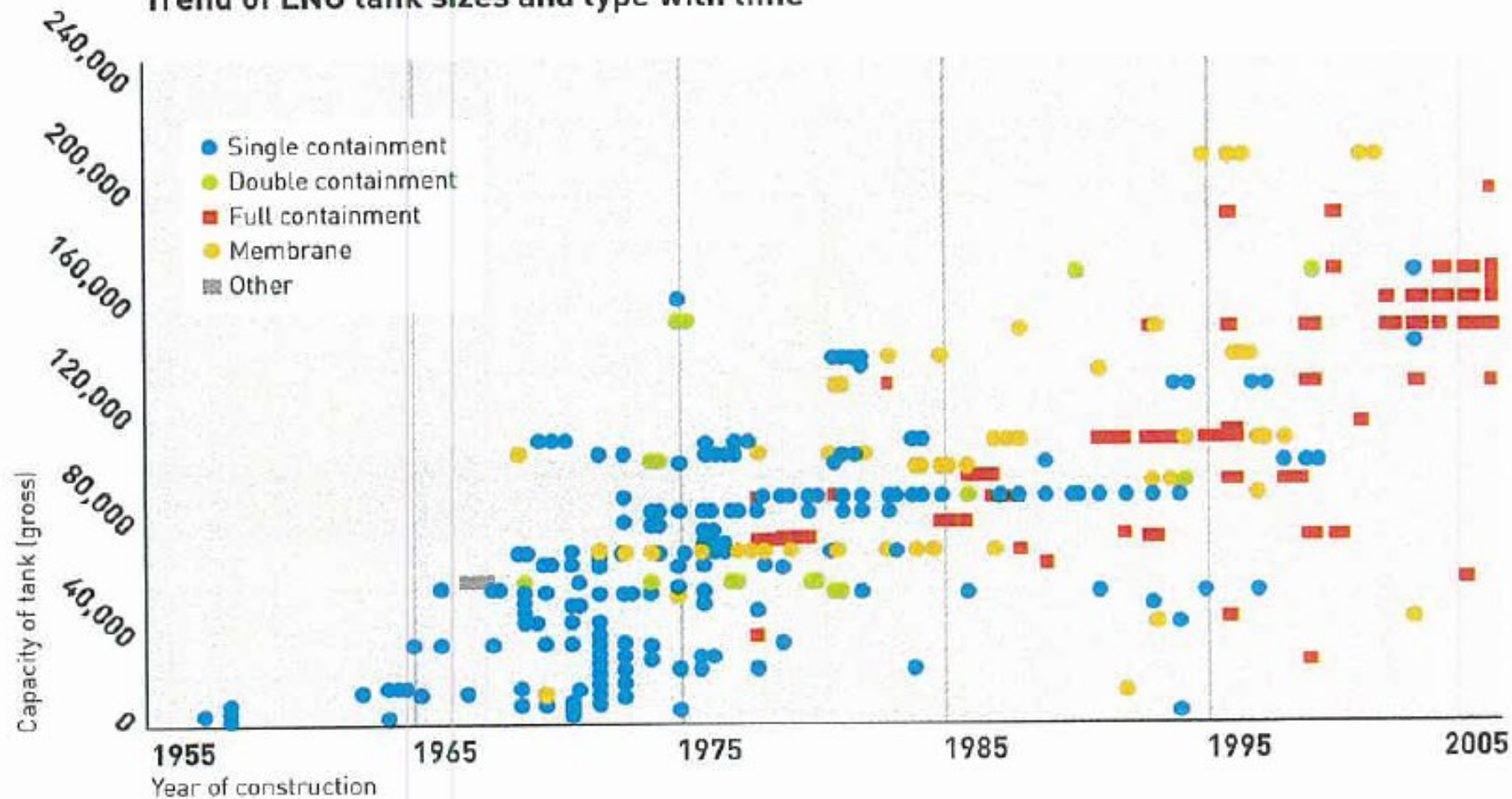
LNG STORAGE: MEMBRANE TECHNOLOGY



Typical GTS
membrane
(GTT license)

LNG TANK TYPE : REFERENCES & TRENDS

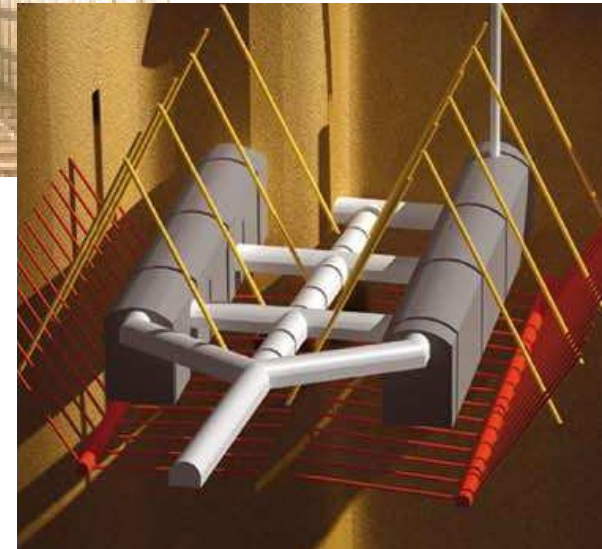
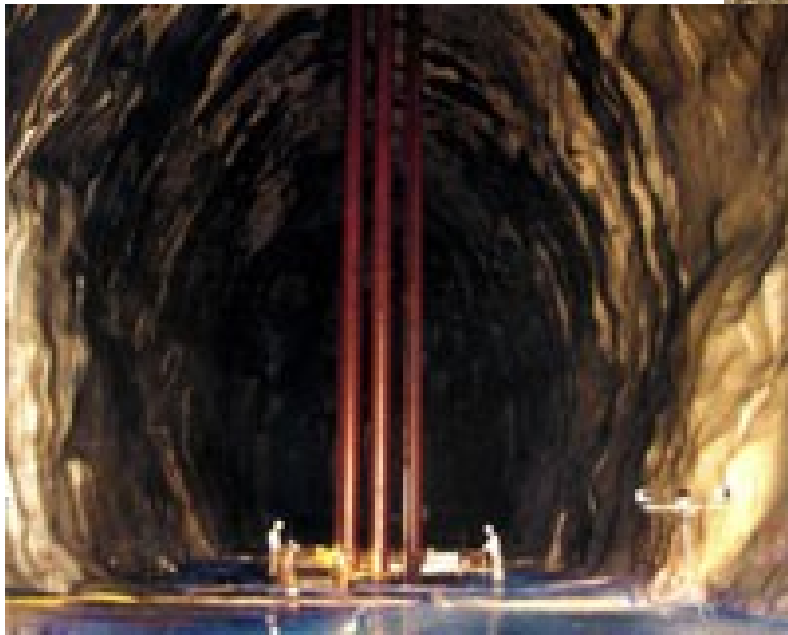
Trend of LNG tank sizes and type with time



LNG STORAGE: DIRECT LNG STORAGE IN MINED CAVERN



- Technology developed by GEOSTOCK - SAIPEM
- Pilot Plant in Pyongtaek in South Korea tested with liquid N₂
- No industrial plant



PRELIMINARY SCHEME OF LARGE BELOW GROUND LIQUID ARGON STORAGE FOR LAGUNA PROJECT



SPECIFIC ASPECTS OF A LARGE LIQUID ARGON STORAGE (100 kt)

❑ STORED PRODUCT: ARGON compared to LNG

	ARGON	LNG
Boiling point at 1 atm (°C)	minus 186	Around minus 160
Liquid density (kg/m3)	1,400	Around 450
Product purity	High purity < 1 ppb	Mixture of N2 (<3% vol), C1 (>90% vol), C2+, CO2 (< 50 ppm)
Operation	One single filling	Cycle of filling and emptying
Safety	Inert gas	Flamable

❑ INTERNAL WALL SURFACE TREATMENT

❑ CONSTRUCTION IN A CONFINED IN AN UNDERGROUND CAVITY

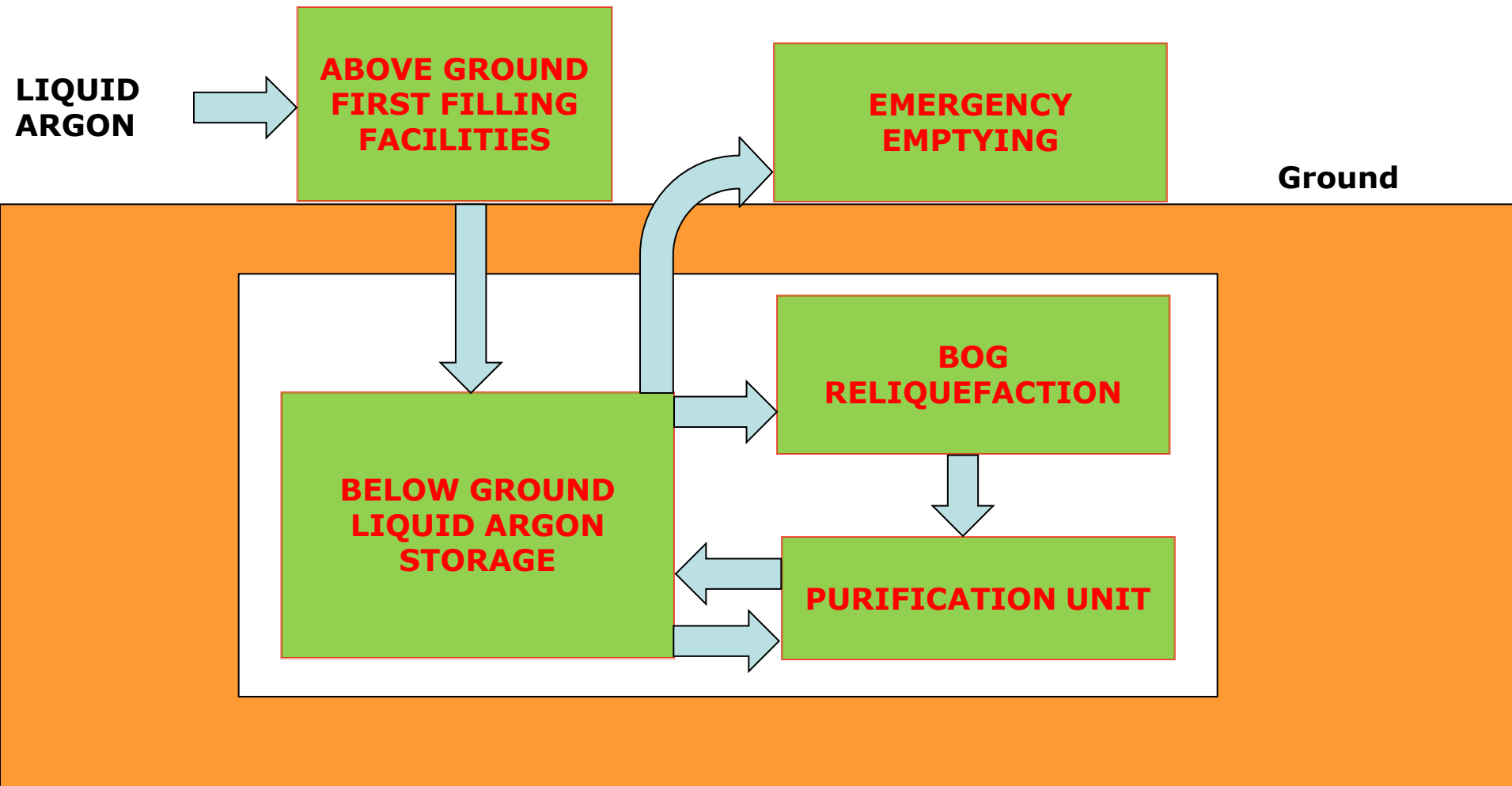
❑ DRYING, FIRST COOLING AND FILLING OPERATION

❑ BOIL OFF GAS HANDLING

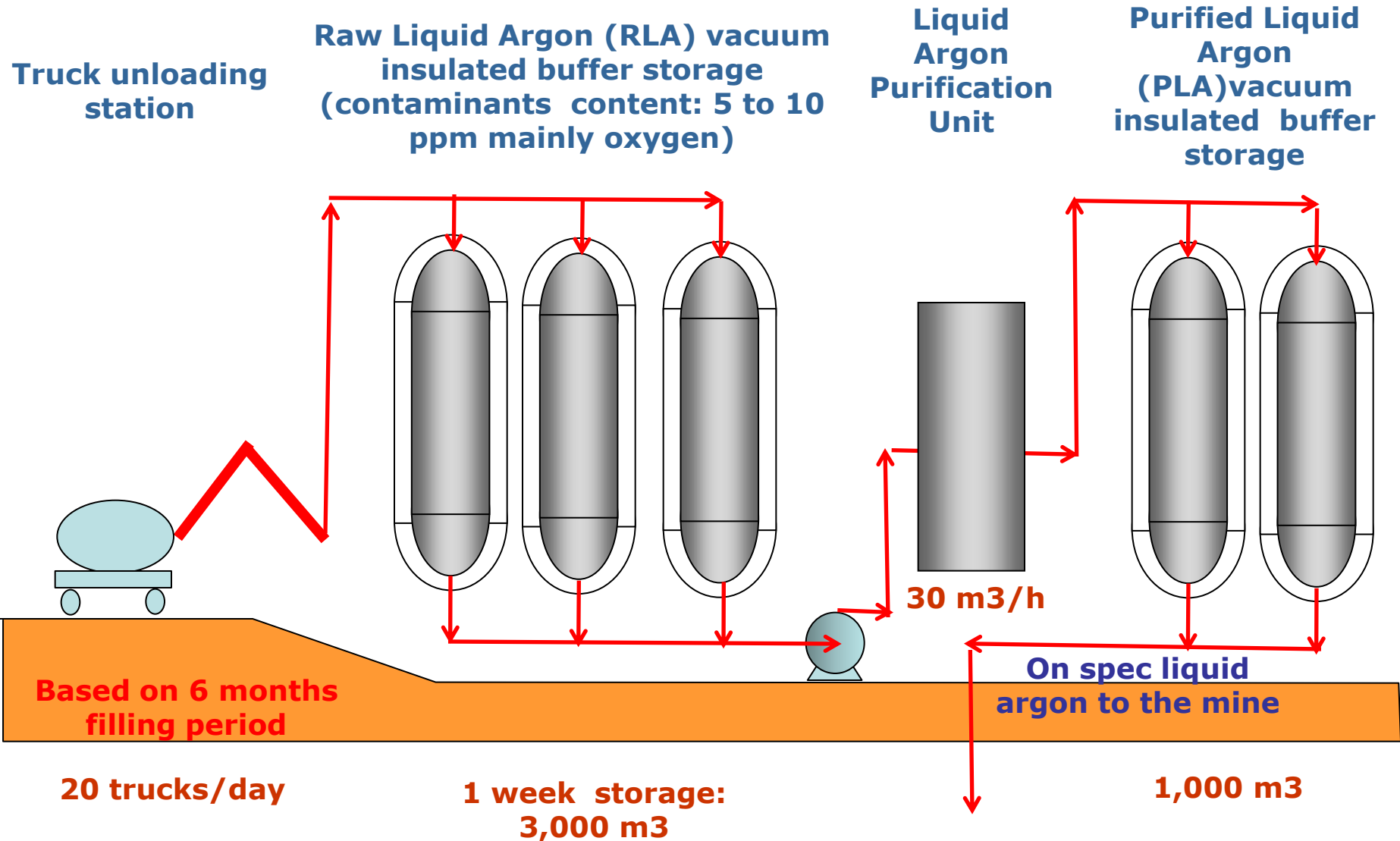
❑ PURIFICATION & FILTRATION

❑ INSTALLATION & MAINTENANCE OF INTERNAL INSTRUMENTATION

PRELIMINARY BLOCK DIAGRAM



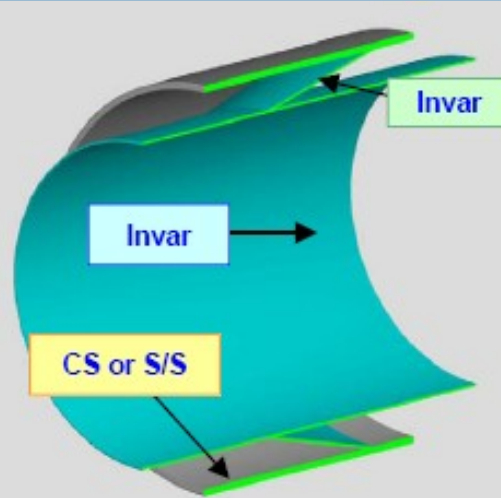
ABOVE GROUND FILLING FACILITIES



TRANSFER LINE FROM GROUND TO BOTTOM

**Pipe in Pipe
Technology:
Invar pipes**

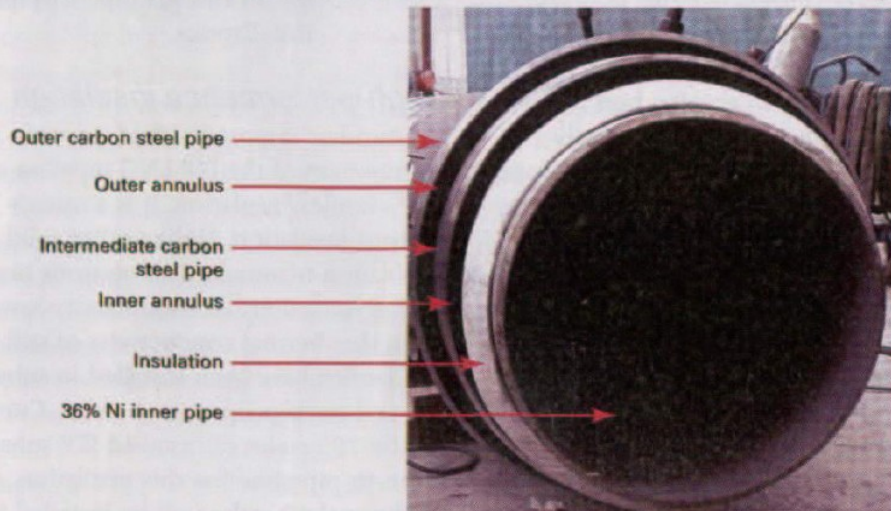
PiP



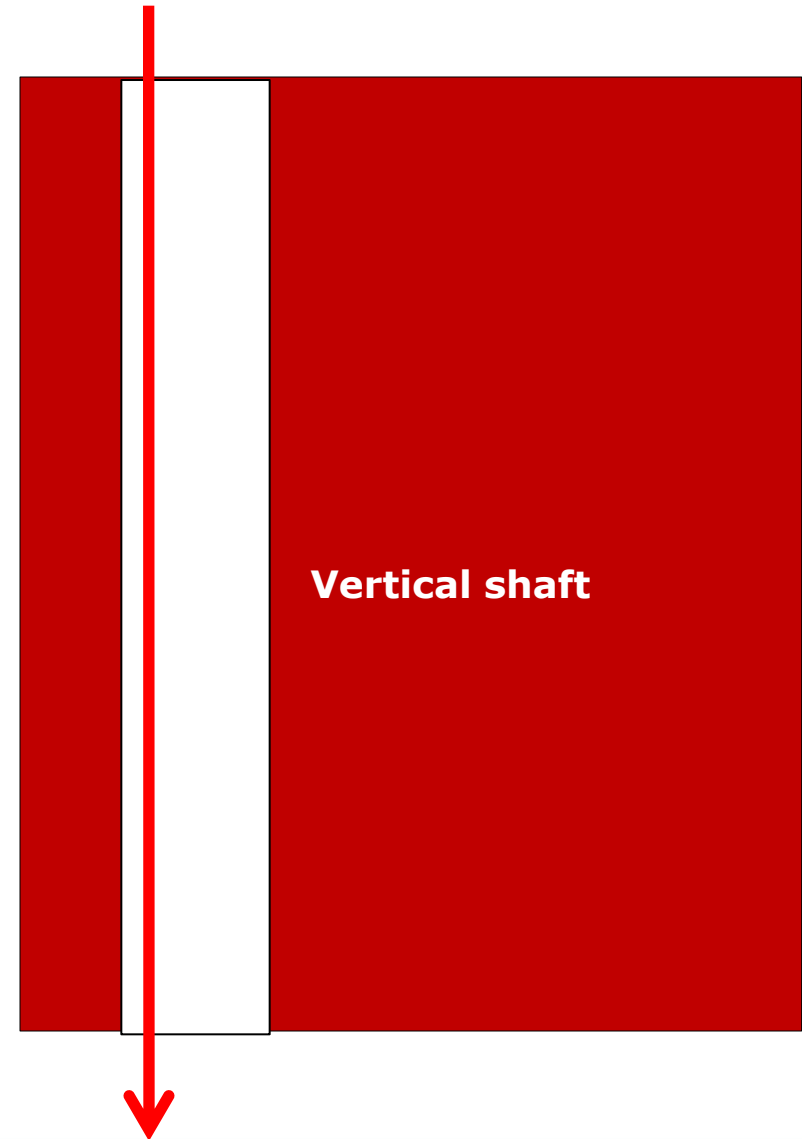
PiPiP

TRIPLE-WALL PIPE-IN-PIPE TEST SECTION

Fig. 1



Main issue: Vertical hanging



IN THE CASE OF FULL CONTAINMENT LIQUID ARGON TANK:

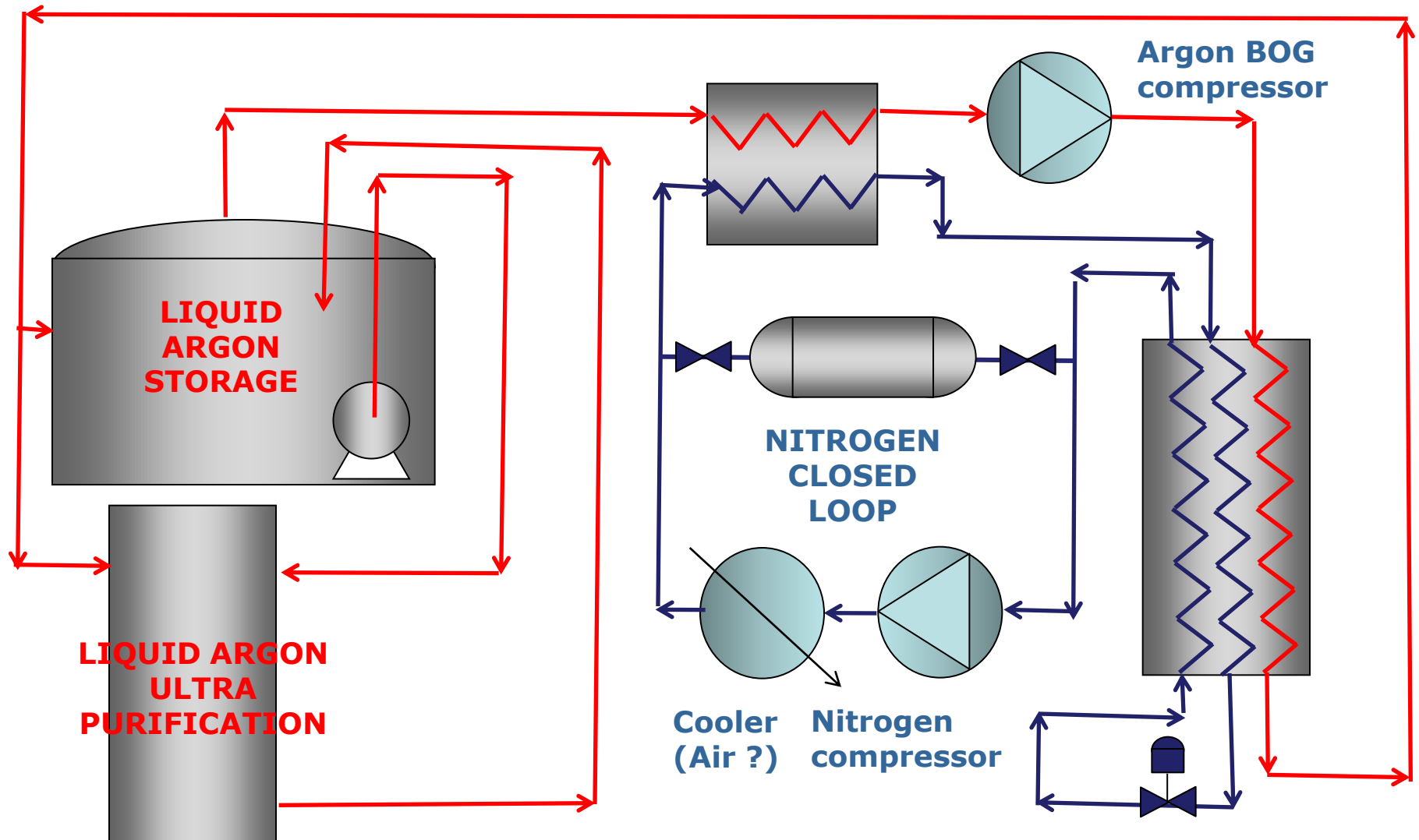
❑ CHOICE OF OUTER TANK DESIGN:

METALLIC (Stainless Steel) SELF SUPPORTING	PRE-STRESSED CONCRETE
Concept not used for LNG for large storage.	Common concept for large LNG storage
Limitation is size of plates (length)	From where concrete will be coming; Inside => location of batching plant Outside => How to transport
More flexible for stop & go problems	Need to be more continuous (jumping or sliding forms)

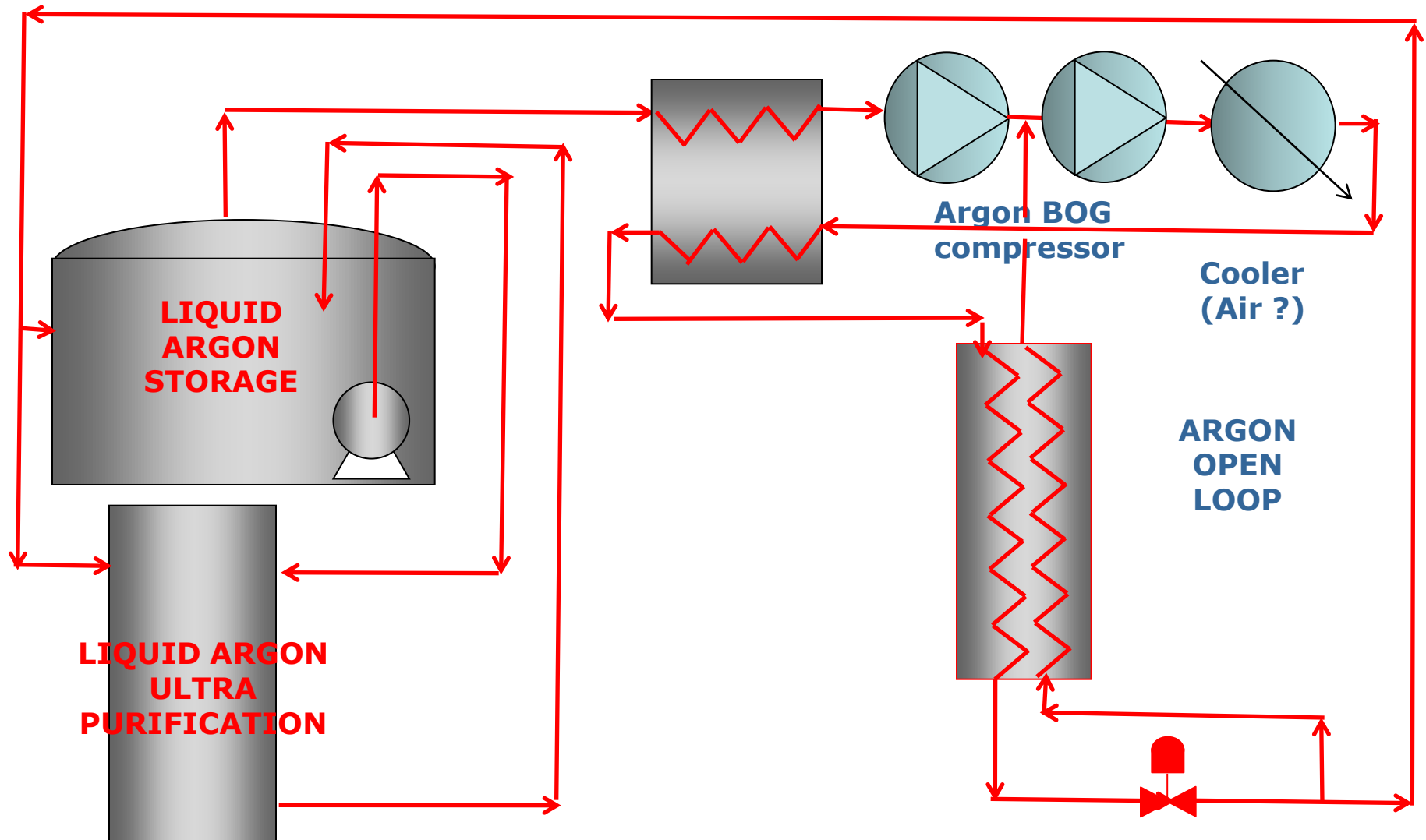
❑ CHOICE OF MAIN CONTAINMENT TYPE:

- ❖ **METTALIC SELF SUPPORTING (Conventional)**
- ❖ **MEMBRANES**

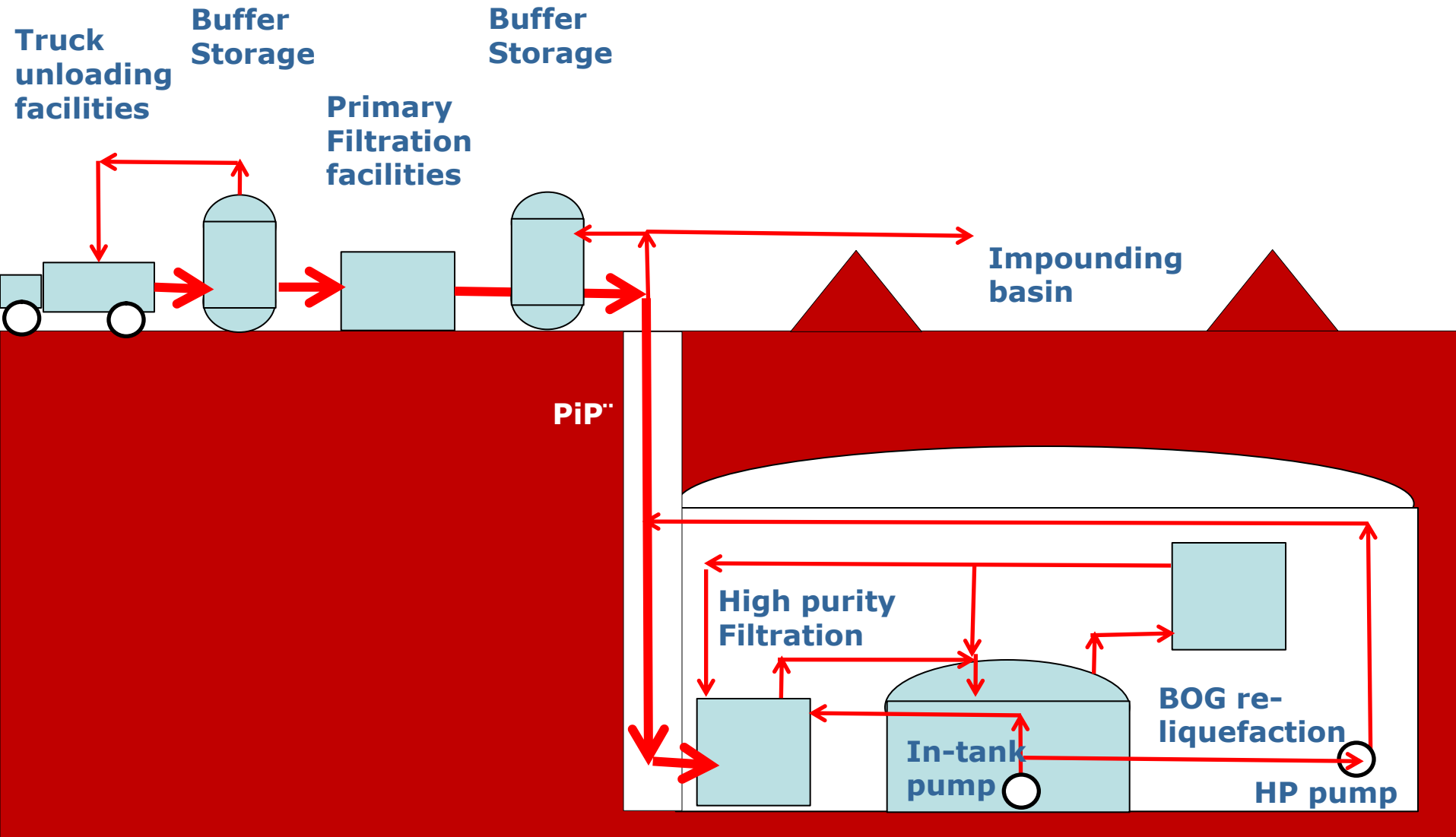
ARGON BOIL-OFF GAS RELIQUIFICATION & PURIFICATION: SCHEME 1



ARGON BOIL-OFF GAS RELIQUEFACTION & PURIFICATION: SCHEME 2



LARGE LIQUID ARGON STORAGE: Auxiliaries

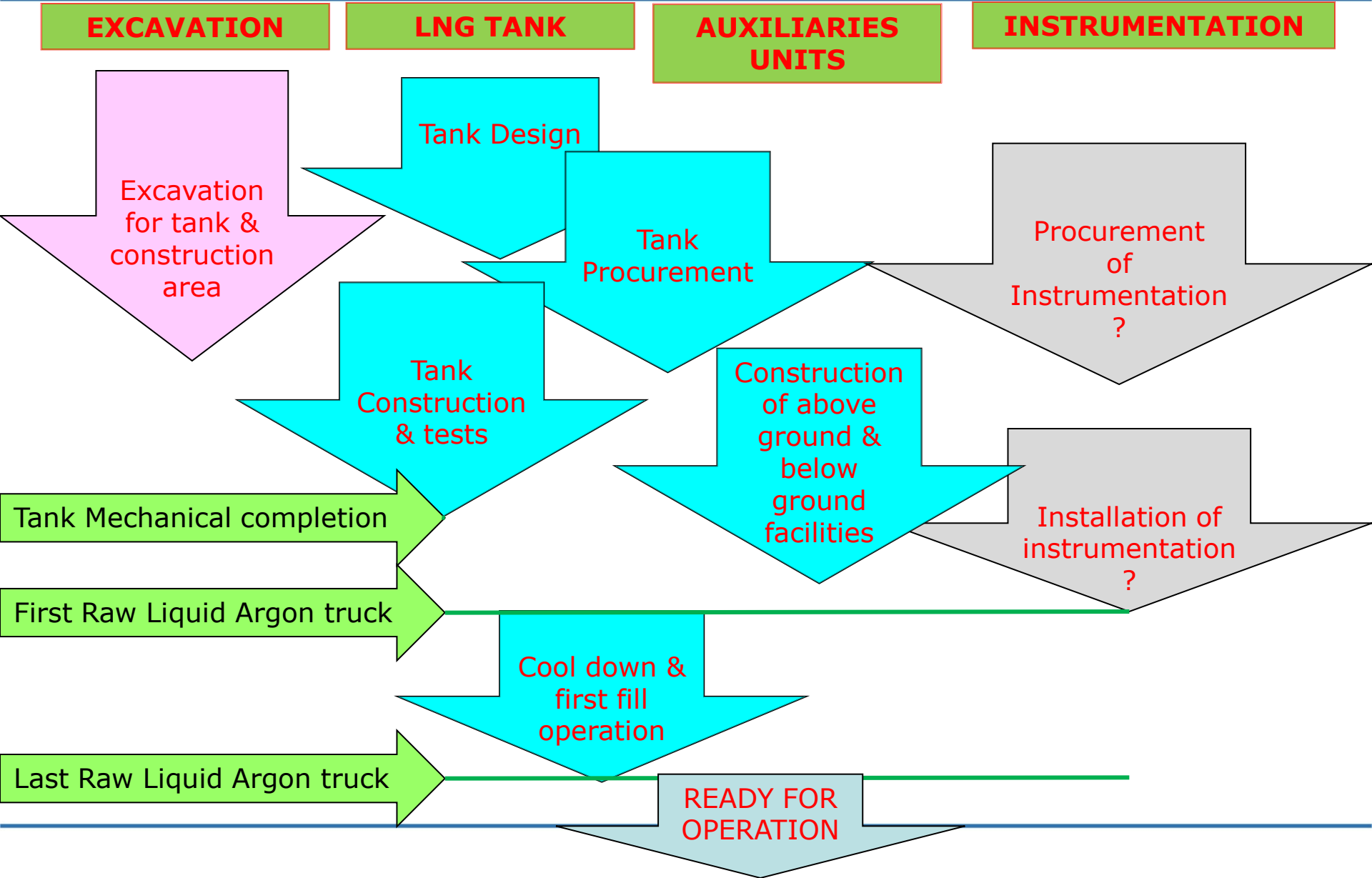


MAIN CONSTRAINTS COMPARED WITH A CONVENTIONAL ABOVE GROUND TANK

- ❑ LIMITATION MAXIMUM ACCESS SIZE & WEIGHT FOR MATERIAL
- ❑ FEW SPACE FOR STORAGE OF MATERIAL AND LIMITED CONSTRUCTION AREA
- ❑ FEW SPACE FOR CRANES
- ❑ VENTILATION & HSE ASPECTS



CONSTRUCTION SEQUENCE



THANK YOU FOR YOUR ATTENTION
