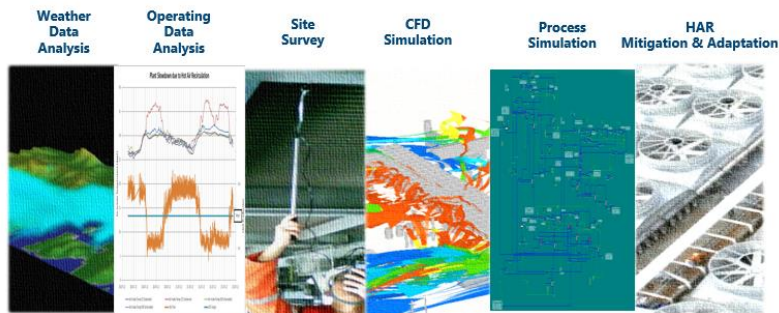
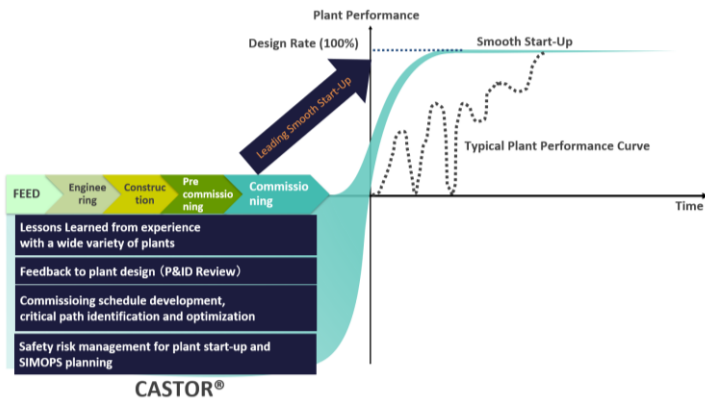


Operation

Our engineers have a wealth of plant engineering experience and channel their expertise through cutting-edge engineering tools to provide profitability improvement services and plant automation program. Additionally, we provide expert consultations and recommendations for commissioning and startup, utilizing our extensive knowledge and experience from numerous EPC projects.



Key Activities of AIRLIZE LNG®



High-quality Commissioning & Startup Planning Based on a Wealth of Experience

Service Menu

◆ Profitability Improvement Program

LNG Cube (Engineering Consultation Service)

AIRLIZE LNG®
(Diagnoses services for HAR^(*) optimization)

◆ Plant Operation Automation Program

Automatics Operation

◆ Operations Readiness & Assurance Program

Operations Readiness & Assurance

◆ Predictable Startup Program [See Details](#)

CASTOR®
(Commissioning & Startup Transient Operability Review)

Commissioning Safety

Commissioning & Startup for
FLNG/FPSO/Module

(*)HAR : Hot Air Recirculation



Operational Excellence Services

Operation

LNG Cube  LNG³



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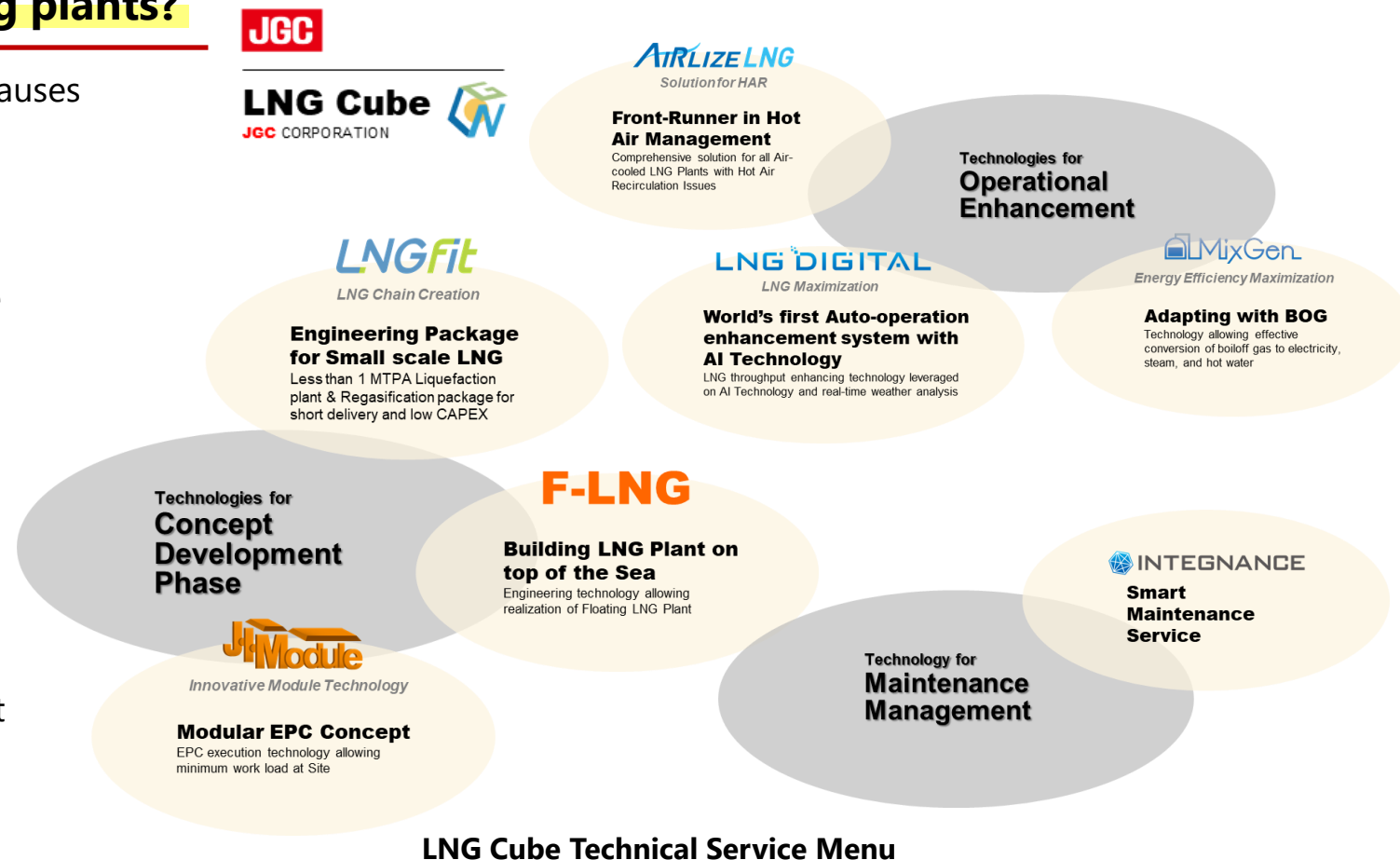
 <https://www.jgc.com/en/business/epc/operation-maintenance/service/>

Do you have any needs in your operating plants?

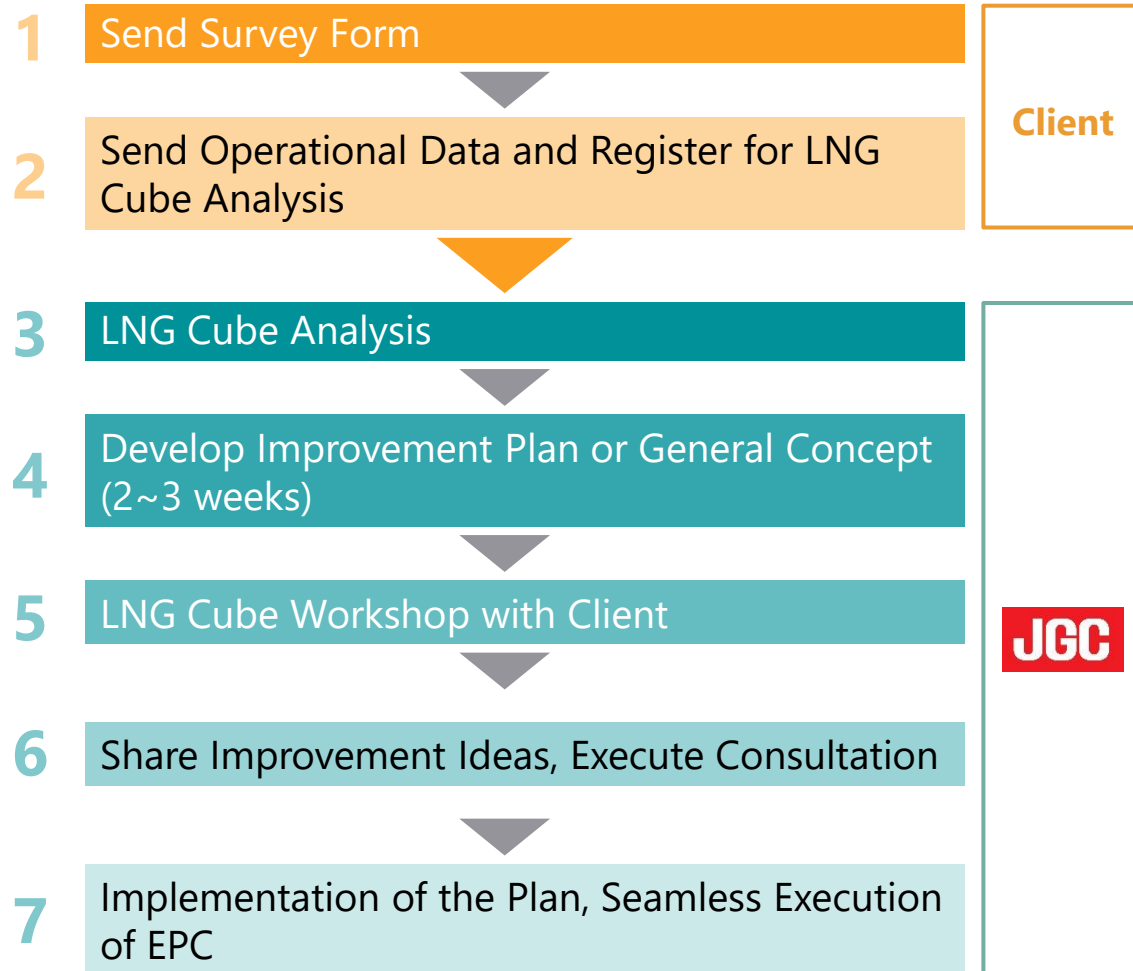
- Sudden shutdown of the plant with unknown root-causes
- Frequent malfunction of equipment
- Unachieved production corrective planning
- Flare minimizing
- Smooth startup operation and flawless maintenance

What is LNG³ ?

- LNG Cube is a comprehensive technical service package related to LNG plants
- LNG Cube starts from Workshop and Consulting by the world's leading LNG specialists
- Analysis and Consulting leveraged on lessons learnt and operational database from past engineering, construction and operational experiences
- LNG Cube technical services are not limited to existing plants but can be applicable to grassroots plants



Workflow & Results



Our Strengths

- Abundant experience in commissioning and startup
- Speedy solutions leveraged on numerous of Lessons Learned from past commissioning and startup experience
- Consulting by Project Manager and Study Manager with extensive site experience and EPC execution experience

Our Experiences

Client	Year	Region	Activity
A Company	2017 - 2019	South East Asia	- LNG Cube Workshop (Development of New Digital Solutions) - Feasibility Study for the implementation of the Digital Solution - Implementation of the Digital Solution
B Company	2018 - 2019	South East Asia	- LNG Cube Workshop (Development of Efficiency Improvement Ideas) - Proposal for Advanced Control System Installation - Feasibility Study of the Advanced Control System Installation (Planned)
C Company	2018 - 2019	South East Asia	- LNG Cube Workshop (Development of Production Enhancement Ideas) - Business Case Study for LNG Production Enhancement
D Company	2018 - 2019	Europe	- LNG Cube Pre-Workshop (Development of New LNG Technology) - LNG Cube Workshop



Operational Excellence Services

Operation

AIRLIZE LNG® *AIRLIZE LNG*



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HAR^(*) causes loss of LNG production

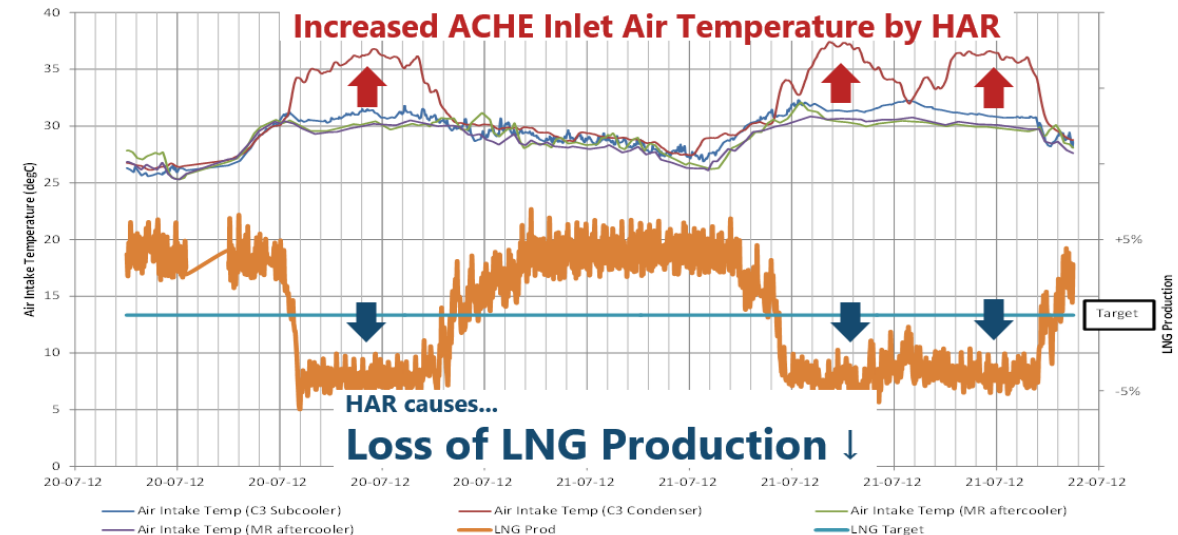
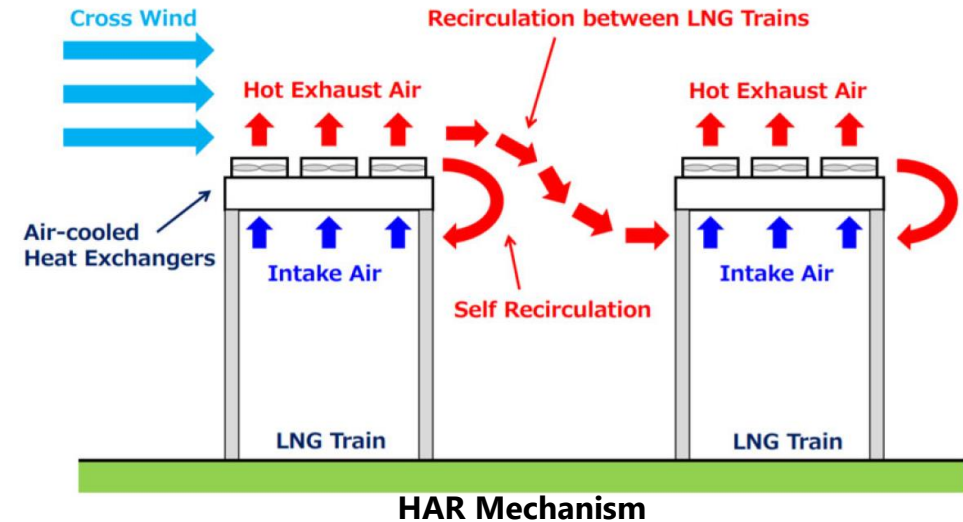
(*) Hot Air Recirculation

- ☹️ **Process performance degradation due to HAR**
- ☹️ **Increased ACHE^(**) inlet air temperature due to HAR**
- ☹️ **It is difficult to identify HAR mitigation plan or adaptation plan**

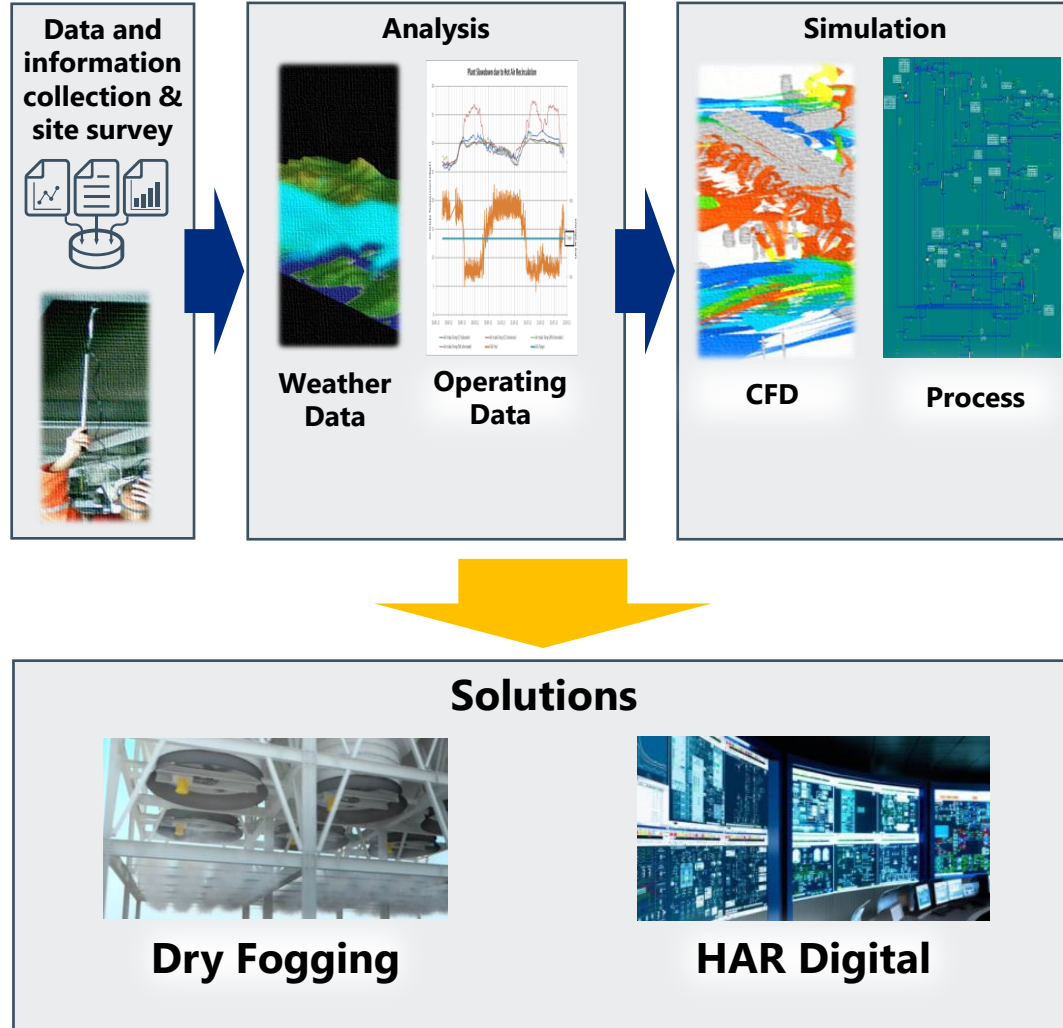
(**) Air Cooled Heat Exchanger

What is AIRLIZE[®] ?

- AIRLIZE LNG[®] is JGC's Comprehensive Life Cycle Support Services for Air-Cooled LNG Plants
- Diagnoses and Analysis services for HAR optimization



Workflow & Result



Our Strengths

- **Real-time Weather Monitoring System:** Introduction of advanced systems for real-time weather monitoring.
- **Advanced Analytical Capabilities:** Expertise in process big data analysis, CFD (Computational Fluid Dynamics) simulation, and rigorous process simulation.
- **Extensive Experience:** JGC's extensive experience in LNG processes and Hot Air Recirculation (HAR) analysis.
- **Comprehensive HAR Management Solutions:** JGC offers two types of solutions for HAR management:
 - Dry Fogging
 - HAR Digital

Our Experiences

20+ Projects

Contributed to over 20 projects in various phases of Project/Plant Life Cycle (FS, Pre-FEED, FEED, EPC, Revamps)



What is Dry Fogging?

Dry Fogging enhance the performance of ACHE by implementing simple water mist system.



The water mist helps lower the air inlet temperature of the ACHE.



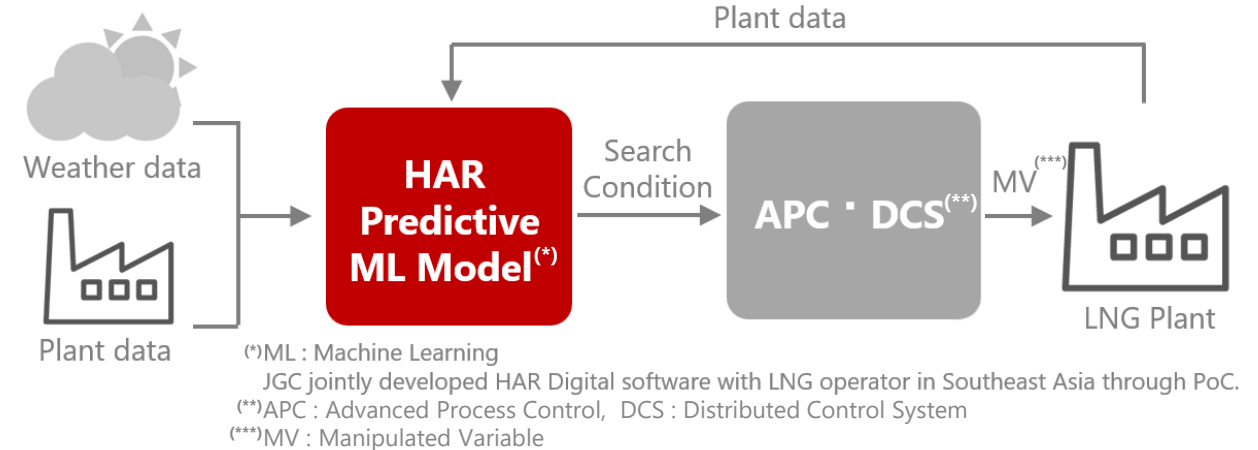
Improves the overall performance of the ACHE.

Advantage of Dry Fogging

- **Increased LNG Production:** By enhancing cooling performance with minimal capital investment, LNG production can be increased by up to 2%.
- **Quick Delivery Time:** From design to installation, the system can be delivered within a year.
- **No Equipment Damage:** The fine water mist ensures no damage or scale formation on the equipment.
- **Simple System and Easy Operation:** The system consists of only pumps, piping, and fogging nozzles, making it easy to operate.

What is HAR Digital?

HAR Digital is an automated control system powered by Artificial Intelligence (AI).



Advantage of HAR digital

- **Increased LNG Throughput:** The feed-forward process control system, powered by a HAR predictive machine learning (ML) model, can increase LNG throughput by up to 2% without any major modifications.
- **Stable Operation:** Achieves stable operation by adjusting in advance.
- **High Performance:** High performance operation can be achieved by maintaining proximity to the operating limit while HAR does not occur



Operational Excellence Services

Operation Automatics Operation



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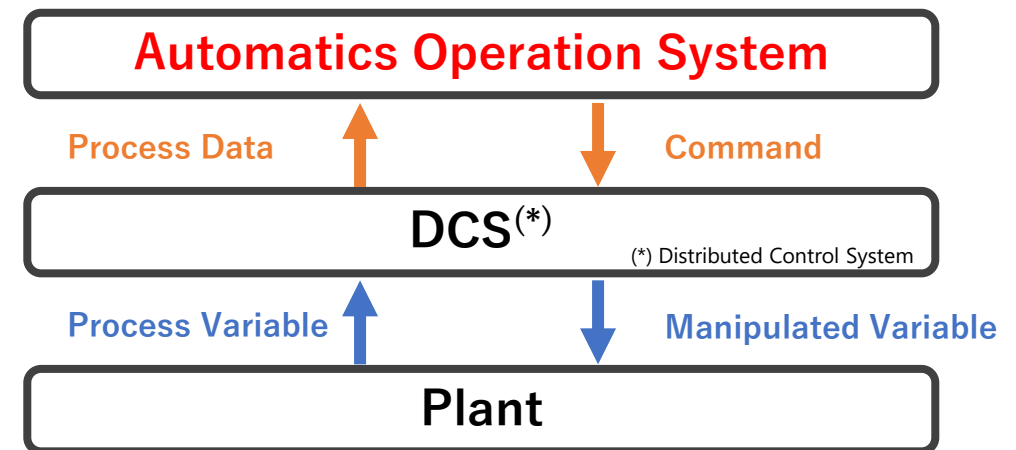
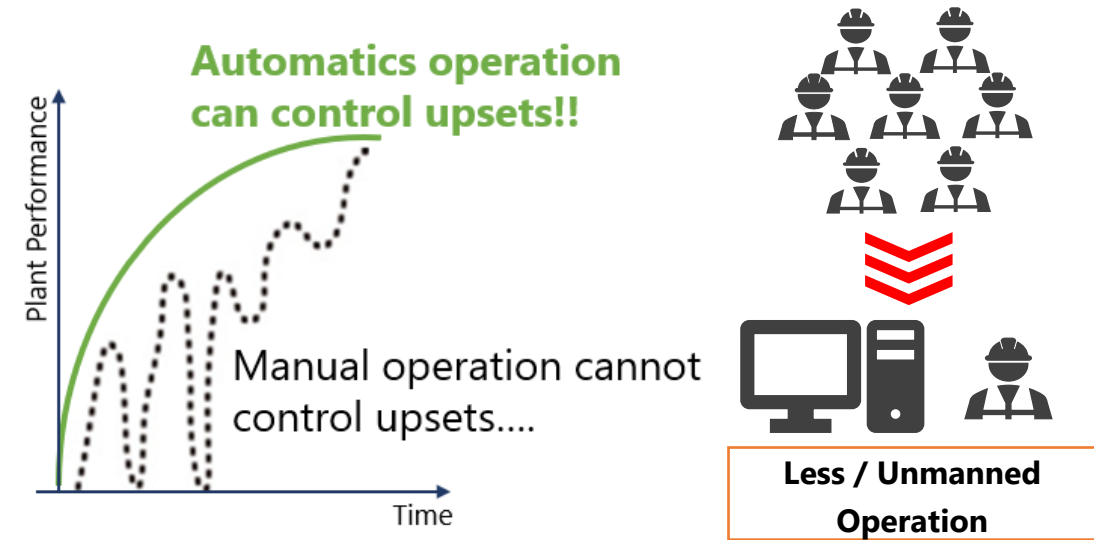
Automatics Operation

Advantages of Automatics Operation

- 👍 **Stabilizing facility performance by reducing process upsets during process operation**
- 👍 **Prevention of equipment damage due to mistakes**
- 👍 **Minimizing transient operation time**
- 👍 **Standardization of transient operation sequence**
- 👍 **Assistance for operators with limited experience.**

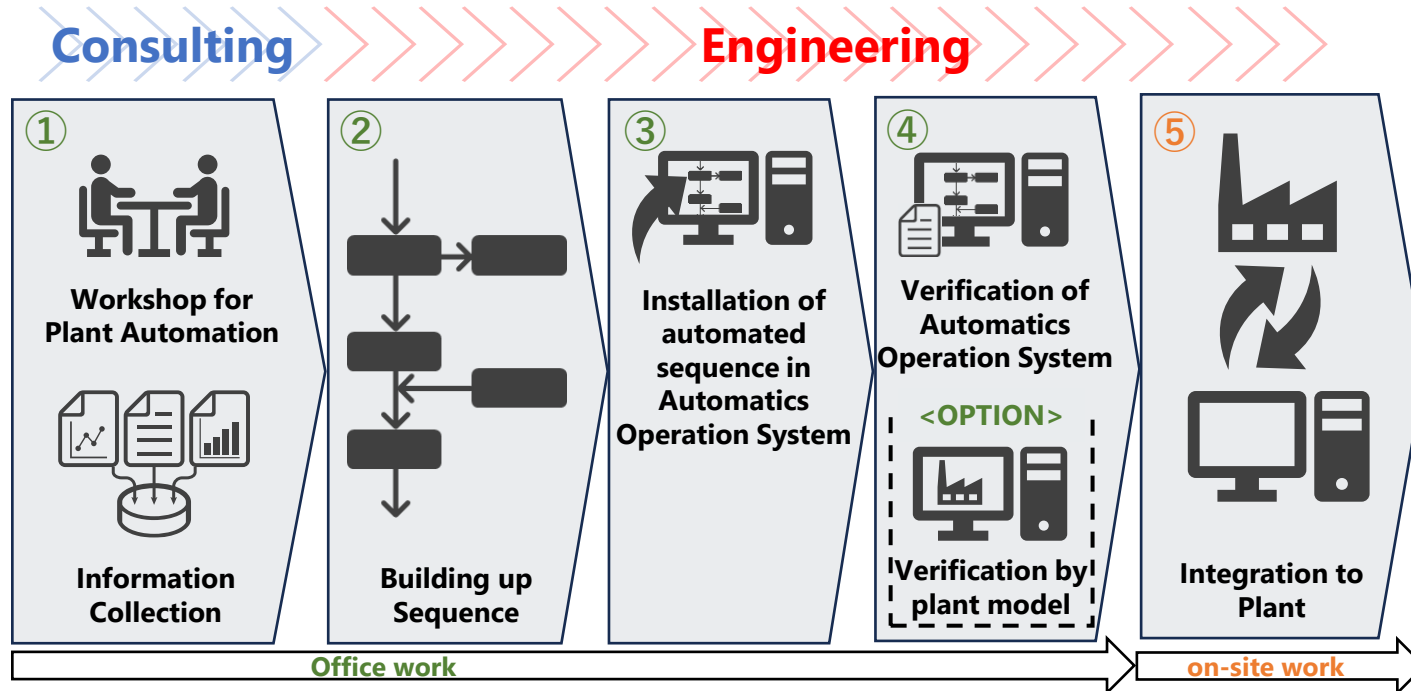
What is Automatics Operation ?

- Automatics Operation achieves an automated operation for numerous types of plant and equipment (upstream, midstream, downstream).
 - Plant Startup and Shutdown
 - Transient Operation (ramp-up/down, etc.)
 - Process Upset (adjusted for stable operation)
 - Package System Startup and Shutdown (Compressor, Expander, etc.)
- JGC provides consulting and engineering services to implement Automatics Operation for existing plants.



Automatics Operation

Workflow for Implementation



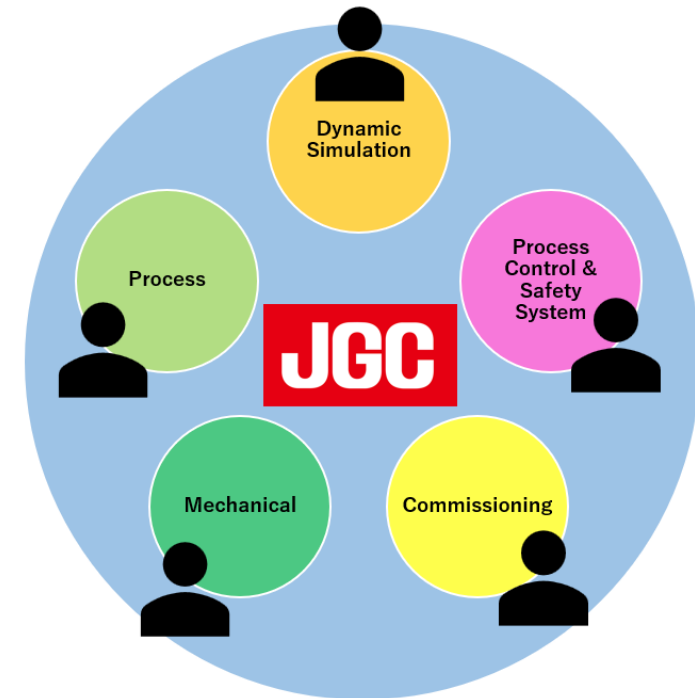
Our Experience

- LNG, Ammonia, Power Plant, etc.
Automation for plant startup and shutdown in various types of plants.
- MCHE^(*) Cooldown, Compressor change-over, etc.
Automatic sequences for startup and shutdown of many types of package system

(*) Main Cryogenic Heat Exchanger

Our Strengths

- Experience in EPC and O&M of many types of facilities in many locations around the world
- Specialist Engineering Team consisting of various experts in JGC to deliver Automatics Operation



Case Study : Success of Automated Startup/Shutdown in IGFC(*)

- Plant owner: Osaki Coolgen Corporation <<https://www.osaki-coolgen.jp/en/>>
- Process: CO2 Capture and Recovery Facility in the IGFC
- Requirement: Fully automated plant startup/shutdown operation

(*) Integrated Coal Gasification Fuel Cell Combined Cycle

Approach

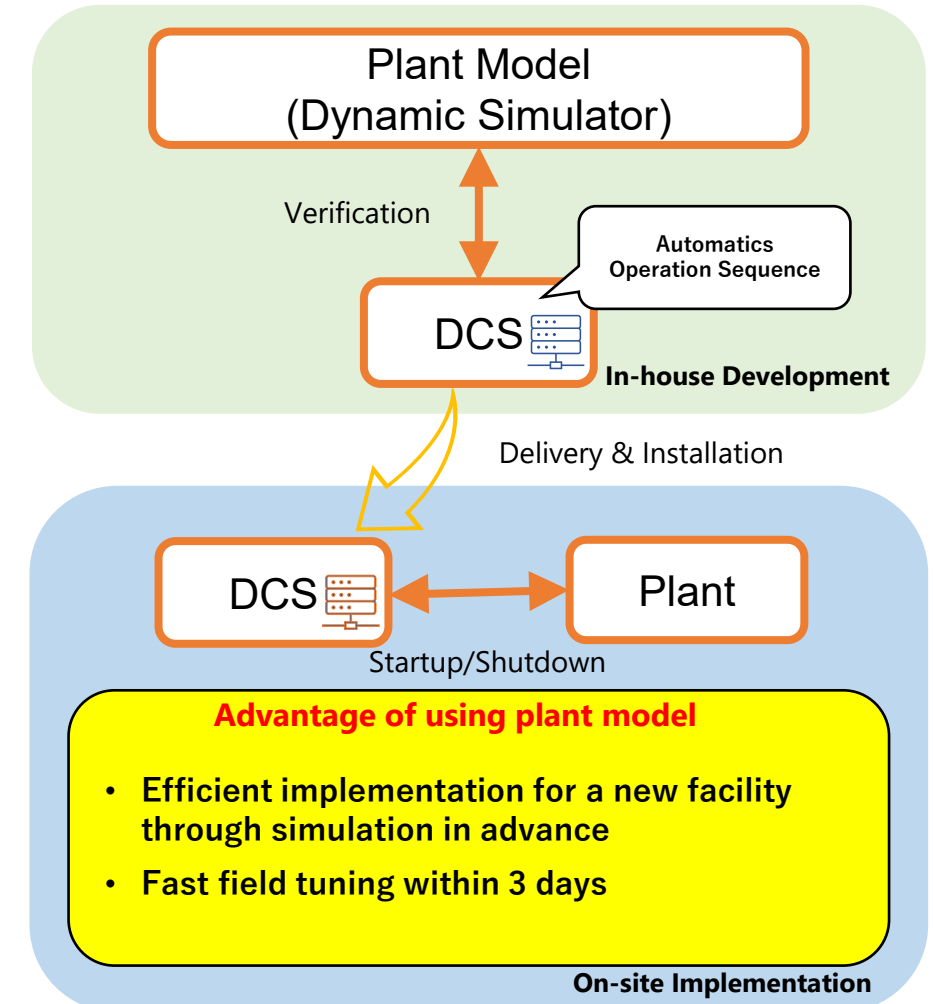
- Developed Plant Model to validate Automatics Operation Sequence for minimizing tuning work during on-site implementation
- Implemented Automatics Operation sequence into DCS according to system configuration at existing unit

Achievement

- Quick startup/shutdown operation by automating over 1000 steps in the procedure
- Safe startup/shutdown operation without any human error and any failure of an equipment



Provided by Osaki Coolgen Corporation



Implementation by using plant model



Operational Excellence Services

Operation

Operations Readiness & Assurance



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Operations Readiness & Assurance

Do you have any of these issues?

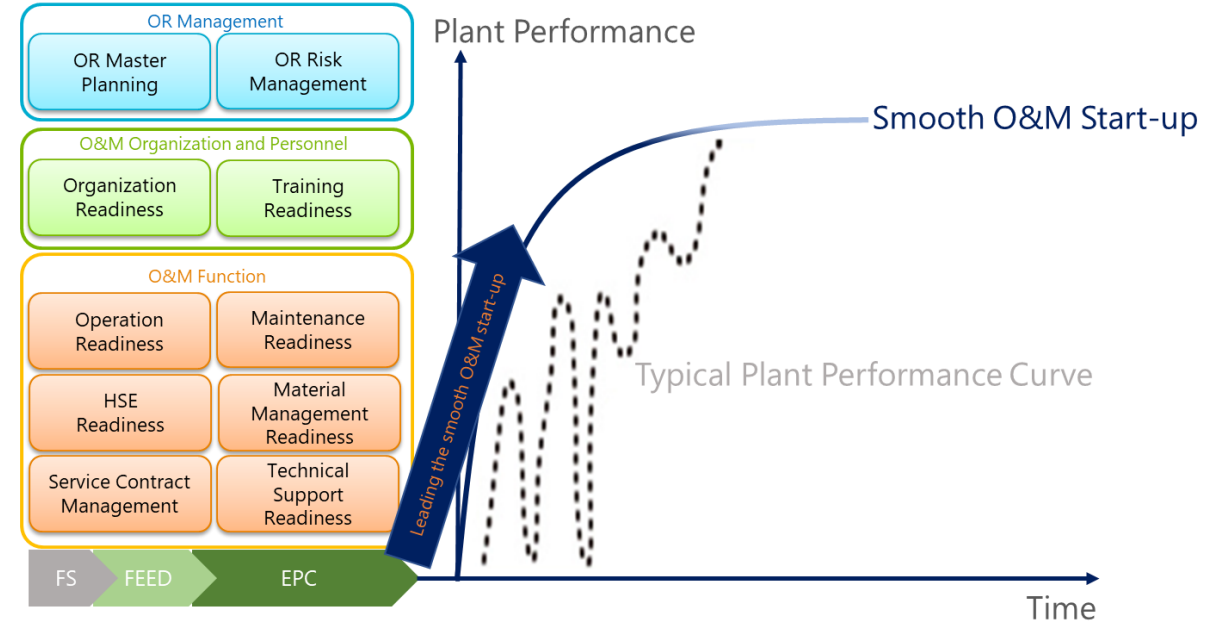
- ☹️ **Concern of safe and smooth startup of O&M**
- ☹️ **High total cost of ownership**
- ☹️ **Potential areas of concerns and its mitigations in OR^(*)**

OR&A Solution

- Execute Operations Readiness & Assurance program for all OR key components of facilities^(**) by expert team
- Assess OR plan and progress and reporting with findings and mitigations
- Follow up prioritized mitigation actions to reduce OR risk and to minimize the facility total cost of ownership

^(*)OR : Operations Readiness

^(**)facilities : Onshore and offshore O&G plant, chemical plant etc.



Operations Readiness & Assurance

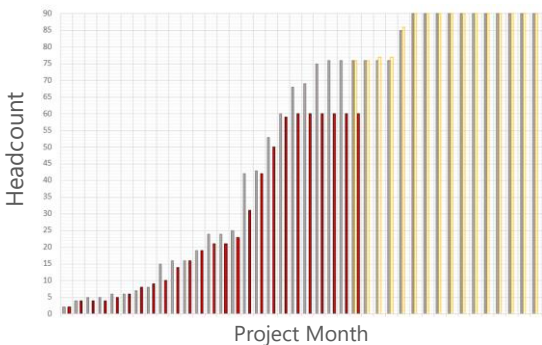
Workflow & Result

A) Operations Readiness & Assurance Planning Phase

- 1. Verification of overall OR schedule
- 2. Define OR elements
- 3. Establish OR progress and KPI tracking system

B) Assurance Phase

- 1. Monitor OR activities
- 2. Assess the progress and risk for OR activities (Health Check)
- 3. Report and follow up mitigation actions



Recruiting Progress Tracking

OR Components	Business Processes	Status	Plan	Forecast	Actual
Organization Readiness	Recruiting for O&M personnel	Completed	🟢	🟢	🟢
Training Readiness	Competency Assessment	Completed	🟡	🟢	🟢
HSE Readiness	PTW	Completed	🟢	🟢	🟡
HSE Readiness	LOTO	In progress	🟢	🟡	
HSE Readiness	Emergency Response	In progress	🟢	🟡	
HSE Readiness	Spill Prevention	In progress	🟡	🟢	
HSE Readiness	Waste Management Plan	Not Started	🔴	🟢	
Operation Readiness	Production Reporting	Not Started	🔴	🟡	
Operation Readiness	Laboratry Analysis	In progress	🟢	🟢	
Operation Readiness	Crew Change	Completed	🟡	🟢	🟢
Maintenance Readiness	Maintenance Management (Work Process)	Not Started	🟡	🟡	

Business Process Progress Tracking

Sample Progress and KPI tracking system

Our Strengths

- Standardized Operations Readiness & Assurance program based on FLNG project
- Expert O&M engineers with experiences in operating companies
- Utilization of global project management experiences from over 20,000 FEED and EPC projects

Our Experiences

- Operations Readiness & Assurance program execution for FLNG O&M
- Operations audit for FPSO in West Africa
- O&M and Training readiness planning and execution for various EPC projects



Operational Excellence Services

Operation Predictable Startup Program



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Predictable Startup Program

Do you have any of these issues?

- ☹️ **Reliability of current Commissioning Plan**
- ☹️ **Lack of experience in planning**
- ☹️ **Unfamiliar equipment/unit**
- ☹️ **Resource for unfamiliar countries**



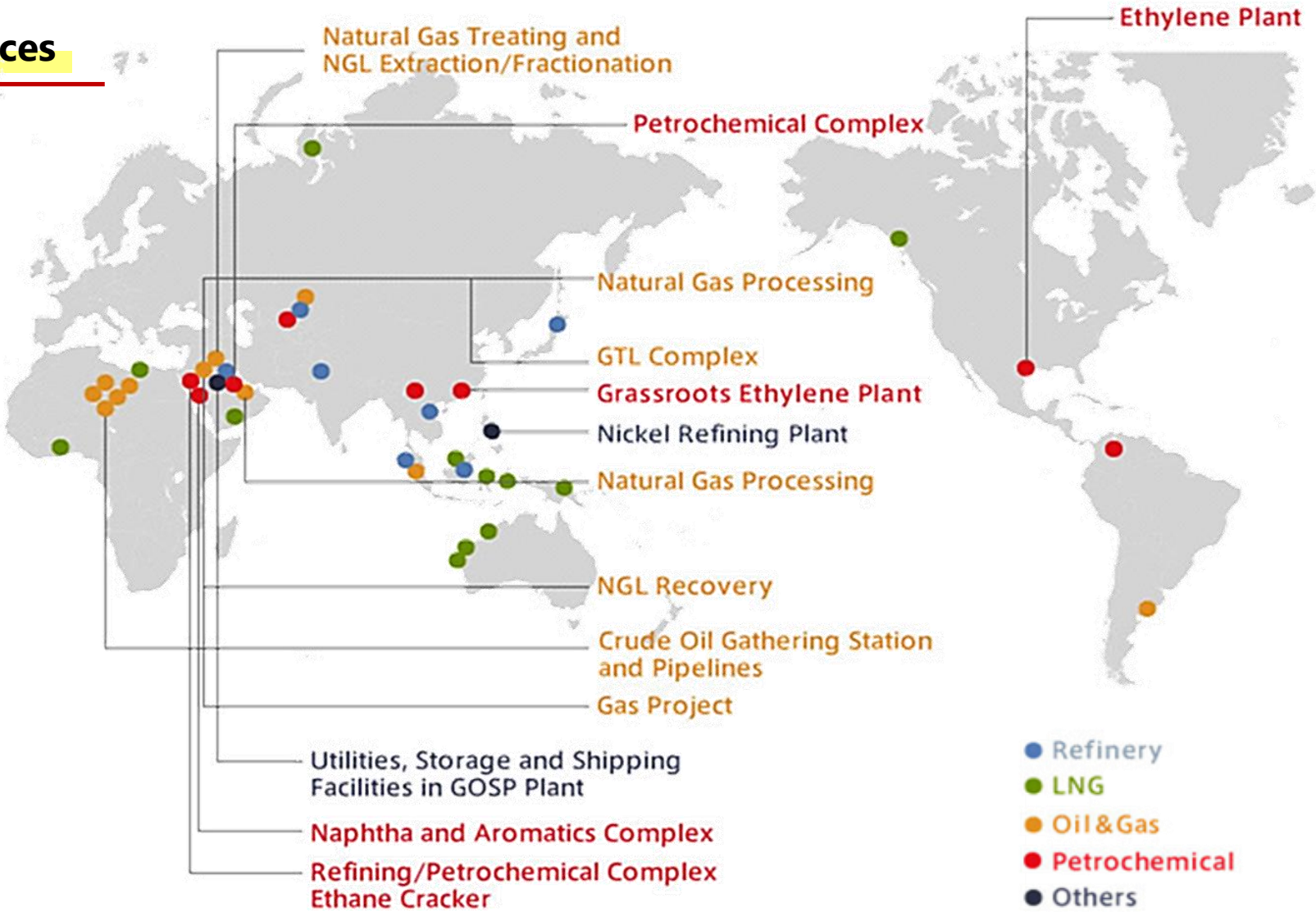
Our Solution

Provide consultation, recommendations and/or improvements for the following items on the following plans/topics:

- **Commissioning HSE Plan**
- Commissioning Execution Plan
- **Plan and/or procedure with CASTOR®**
- Completion Plan includes Systemization and/or RFSU Blocks
- **Commissioning & Startup for FLNG/FPSO/Module**
- Design/Engineering Considerations
- Benchmark Schedule and/or manning against projects completed
- Contractor Strategy (SOW, Technical evaluation, Selection)
- Identifying Commissioning Risks and Mitigation

Our Strengths and Experiences

Extensive experience in commissioning of refinery, LNG, Gas and petrochemical plants for a variety of clients around the world.





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Operation
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CASTOR[®] (Commissioning and Startup Transient Operability Review)

Do you have any of these issues?



Concerns on Commissioning and Startup Plan



Lack of (or No) Experience in Plant Startup



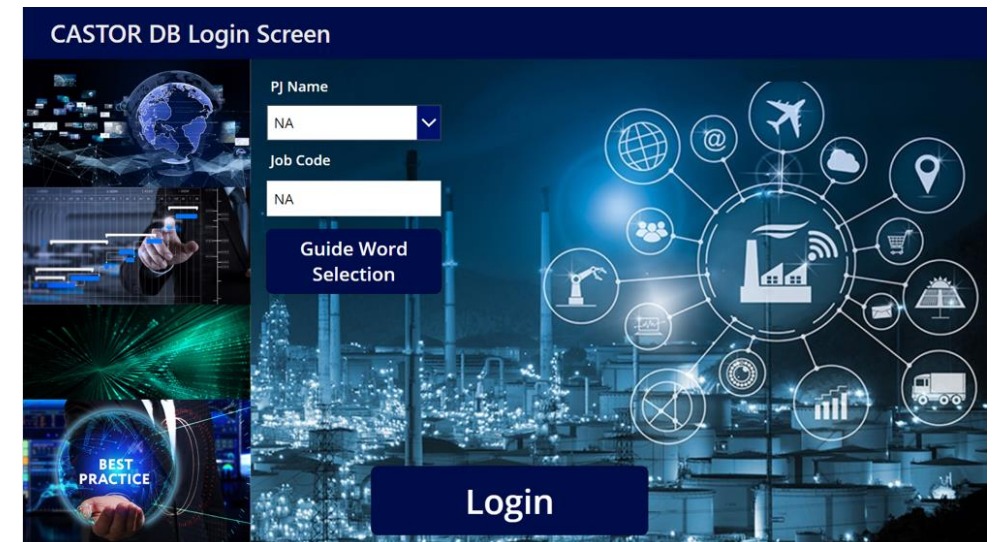
Introduction of Unfamiliar Equipment/Unit

Asset Domains	Failure Processes	Catastrophic modes	Thermal	Pressure	Specific Emission	Non-Intrusive/Tactile	Valving Domains	Recommendation, Tests	Recommendation/ Tests	Start-up Tests/Alarms
Environmental/Sea temperature	Water process time	Cat activation	Thermal expansion/contract	Recycle modes	Product Load mode	Recycle modes	Heavy rotation	Equipment thermal test	Pre-run test	Exhausted pumps/Signifies test
Over temperature	Main control lines	Cat de-activation	Control on manual	Flow removal-gas/Shell	Product feed mode	Cryostat mode (static)	Cryostat mode	Pre-run test	Pre-run test	Single tests on compressed
Overfill	Leak in container. Leaks (structure)	Cat Regen	Heavy retention	Other feed flow Modes	Drain mode / rein-trip mode	Cylinders	Chemical	Instrument Loop test	Chemical circuit run	Pressure tests not able to test on benign fluid
Over pressure	Control feedback (e.g. flow control)	Reactor switch	Trial/Warning/Alarms	Distillation mode	Other feed quality Modes	Steam out mode	Water / water	Major test	Cat Clean test	Valves expansion tests
Back flow	Feed exchanger failure (overfilling/Backflow through)	Cat Circulation	Cyclonuclear storm	Equipment bypass / Inhibit mode		Firing modes	Gas	Start Up / Activation	Cat Start Up / Activation	Compressor tests not able to test on benign
Vapour breakthrough	Insufficient failure	Coking/Decoking	Cold water / Distillation	Wiping & reduction mode		Depressure-down / Inhibit mode	Feed/ Night swing	Energize	Heating	Equipment test not able to test on benign fluid
Vacuum filth/emptying	Internal failure	Stripping	Day-Night swing	Control dry	Regen. Mode	Cryopic modes	Flows (flood side)	Lock out/ Flush cleaning (Steam, Pumps)	Emergency/High test at MCP	Equipment test not able to test on benign fluid
Plant integrity	Feeding/Intrinsics	Cat make up/repair	Human error	Steam out mode	Drifts/Naating / clean tests	Pigging mode	Lightning strike	Arrows (per system)	Comprehensive/Isolated test at High pressure test at MCP	Old tests
Impurity/Toxic	Cracking/Intrinsics	Offstream/Reactor modes	Competence	Depressure/download mode		Welding mode	Water (run for 30min/30min)	Water (run for 30min/30min)	Water (run for 30min/30min)	Measuring tests
Off-spec product	Failure	PHA/Extrinsics	PHAs	Depressure/download mode	Welding mode	Welding mode	Heat/Smoke/Dust storm	Heat/Smoke/Dust storm	Heat/Smoke/Dust storm	Measuring tests
Composition different	Loss of NO	Feed not in spec / PIP	High inventory	Off-spec (products)	Special Start Modes	Test modes e.g. pre-ED/ED tests	High humidity	Special cleaning (Loop, back removal)	Special cleaning (Loop, back removal)	Other tests not able test on benign fluid
Hydrates/corrosion-outlet	Loss of heating	Coke Feed/Regen		High inventory	Drifts routine maintain. Modes	Manual modes	NO / Air run	NO / Air run	NO / Air run	Turndown test
Water ingress	Loss of cooling	Cat/Reactor issues (e.g. temperature/pressure/through)			Cat changout	Chemical changout	Cat loading	Cat loading	Chemicals run	Performance test
Oil Ingress e.g. vacuum tank	Loss of FGD	Backflow issues			Cat changout	Chemical changout	Preservation	Preservation	Special circulation run	Other tests
ph issues	Loss of steam	Incompatible components			Chemical changout	Chemical changout	Low pressure Leak test	Low pressure Leak test	Electrical test	NO Liquid/MR Turbine Start-up
Water/Steam/Plug/ingress	Loss of water	Cat plugging			Preservation mode	Preservation mode	PSV test	PSV test	Heat func. Test	
Thermal	Loss of chemicals	Cat Regen issues			Special Inspections	Special Inspections	Large bore pipe cleaning	Large bore pipe cleaning	Complete complete loop test	
Special/Deposits	Unexpected start-up	Unexpected start-up			Special cleaning / decom tests	Special cleaning / decom tests	Other tests	Other tests	Special tests	
Vacuum during start-up	Loss of oil/gas	Reaction cover, Loss			Cat change	Cat change				Old tests
Loss of H2/AC	Loss of products	Pre-emption			Pre-emption	Pre-emption				PS/G tests
Electrostatic spark	Loss of H2/AC	Pre-emption			Pre-emption	Pre-emption				Pre-emption/Chem. Decom
Excessing RV	Loss of Power	RV design for upset cases			Pre-emption	Pre-emption				Pre-emption
Americ issues (degrad, test)	Loss of Air	Catalyst with loaded batches			Pre-emption	Pre-emption				PSID trip tests
Flaring	Loss of heating	Cat start-up			Pre-emption	Pre-emption				Other tests
Load curve over	Loss of Unit	Cat start-up			Pre-emption	Pre-emption				
Conversion	Loss of Unit	Cat start-up			Pre-emption	Pre-emption				
Unbalanced water flow/pressure	Loss of Unit	Cat start-up			Pre-emption	Pre-emption				
High/low	Loss of Unit	Cat start-up			Pre-emption	Pre-emption				
Unit up/down / Full	Loss of Unit	Cat start-up			Pre-emption	Pre-emption				
Water, contract	Loss of Unit	Cat start-up			Pre-emption	Pre-emption				

CASTOR Guideword Template (General)

CASTOR® Solution

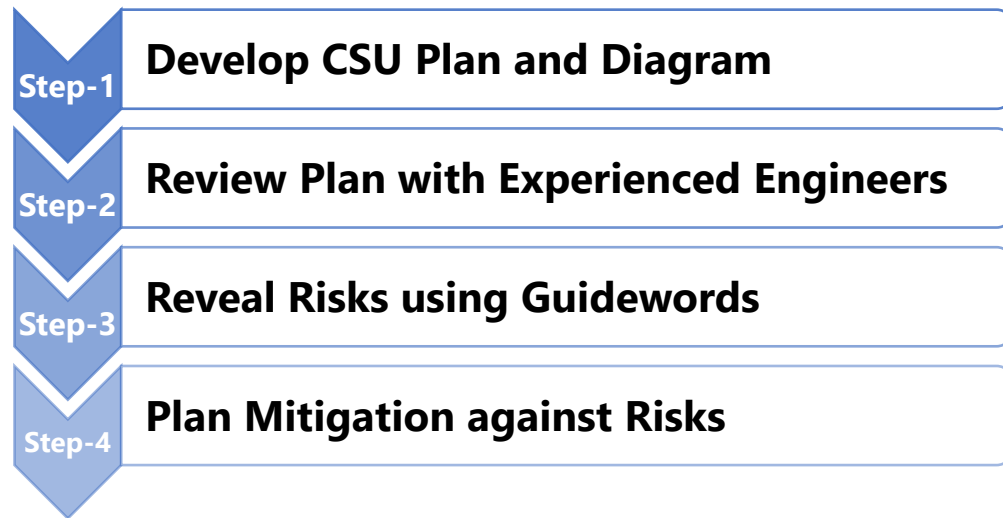
- Reveal risks during transient state operation at commissioning and initial startup phase
- Plan mitigation actions against risks
- Increase likelihood of successful commissioning and plant startup
- Minimize downtime due to trouble
- Eliminate risks of schedule delay



CASTOR Database

Workflow & Results

Workflow of CASTOR®



- Develop Commissioning and Startup (CSU) Plan and Diagram
- Review CSU Plan and Diagram with highly experienced engineers
- Reveal risks related to transient operation during Commissioning and Startup using Guidewords and experiences of engineers
- Plan mitigation actions against revealed risks
- Improvement of Operation Manuals, Procedures (SOP), Training Programs and updating of procedures for existing plants

Our Strengths

- Professional Process & Commissioning Engineer Teams
- World-class experiences and expertise in Plant Commissioning and Startup as an EPC Contractor
- A wealth of Lessons Learned about Commissioning and Startup
- Experiences in various types of plant like LNG, Refinery, NGL, GOSP, Floating LNG, Chemical, etc.

Our Experiences

- CASTOR® for LNG, NGL, GOSP, Floating LNG, Ethylene, etc.
- Not only for EPC but also for FEED projects
- Long history of startup review as the predecessors of CASTOR®

== > **CASTOR Database**



CASTOR®
Since 2015
15 Cases



Operational Excellence Services

Operation
Commissioning Safety



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Commissioning Safety

Do you have any of these issues?

☹️ **Introduction of hazardous material in areas where construction is still in progress**

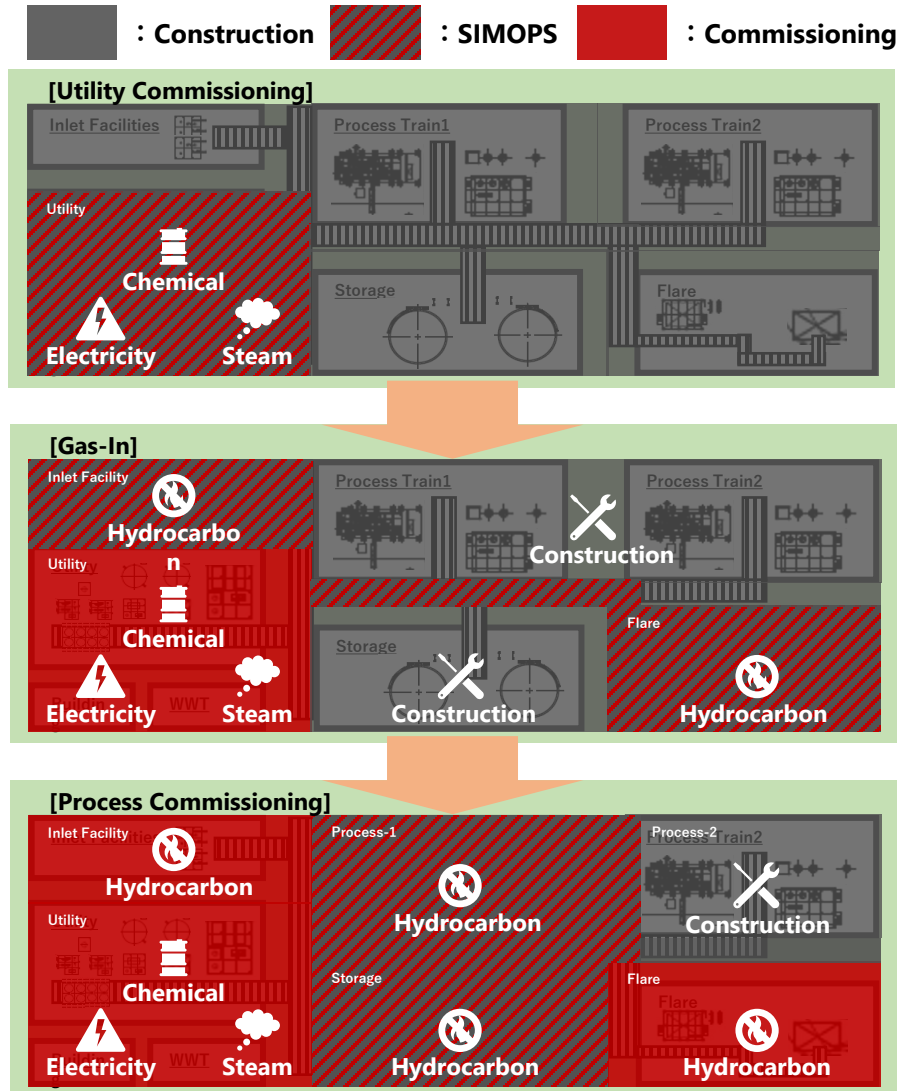
- ✓ **Electricity**
- ✓ **Chemicals**
- ✓ **Steam**
- ✓ **Hydrocarbon**

Our Solution

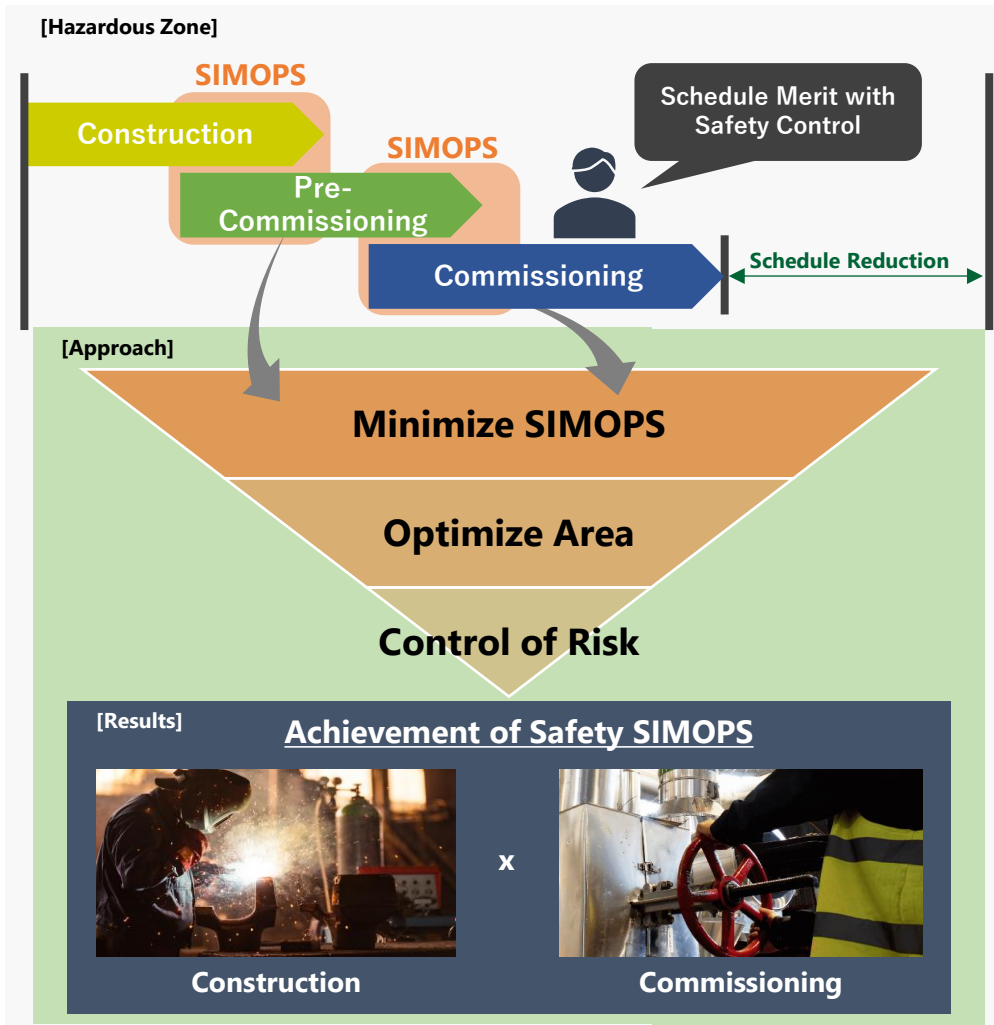
Provide consultation on the following plans/topics:

- Completion Plan
- Systemization
- Identify Safety Risks and Prepare Risk Mitigation (SIMOPS Study)
- Design/Engineering Considerations (Additional Isolations)
- QRA Study with Technical HSE Engineering

SIMOPS Study



Workflow & Result



Our Strengths

- Professional Process & Material Engineer Teams
- Top global results and performances on Degradation Assessment, Inspection Planning, On-site Inspection.
- Use of big data that integrates customer plant operating data and JGC design data to forecast future plants' needs
- Collaboration between overseas EPC-capable group companies and local maintenance companies.



Our Experiences

- CSU planning using system definitions since early 1990s
- SIMOPS study since early 2000s
- Continued to ensure commissioning safety in recent larger and more complex projects.



Operational Excellence Services

Operation

Commissioning & Startup for FLNG/FPSO/Module



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Commissioning & Startup for FLNG/FPSO/Module

Do you have any of these issues?



What shall be conducted at each location??

- ✓ At Module Fabrication Yard
- ✓ At Shipyard / Onshore
- ✓ At Offshore (both Pre-RFSU and Post-RFSU)



What shall be prepared at each phase??

- ✓ Manning (POB Plan/ Flotel)
- ✓ Spare Parts/Special Tools/ Temporaries/Consumables
- ✓ Logistics/Onshore Base/Storage Area
- ✓ Startup Procedure/Training, etc.

Solution based on actual FLNG EPCIC experiences



Provide consultation on the following topics:

- ✓ Project Completion Plan
- ✓ Design/Engineering Considerations
- ✓ Commissioning Execution Plan
- ✓ Startup Plan, Procedure and Operator Training
- ✓ Manning including Offshore Training
- ✓ Logistics Strategy and/or Material Arrangement etc.



Commissioning & Startup for FLNG/FPSO/Module

[Return to
Operation menu](#)

Workflow & Result



Our Strengths

We are one of leading companies for Modularized Project & FLNG and have several experiences of actual project execution.

- Executed several Modularized Projects for both Onshore and Offshore
- Accumulated know-how to work with Module Fab Yard and Shipyard
- Executed two (2) FLNG EPCIC Project (see below photos)
- Executed Construction Management and Completion Support Service for Prelude FLNG Project

Our Experiences

