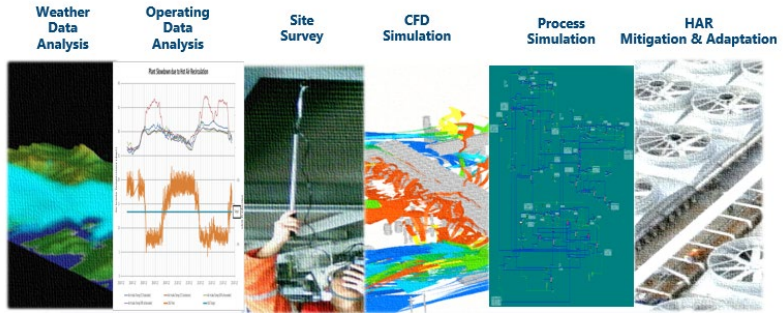
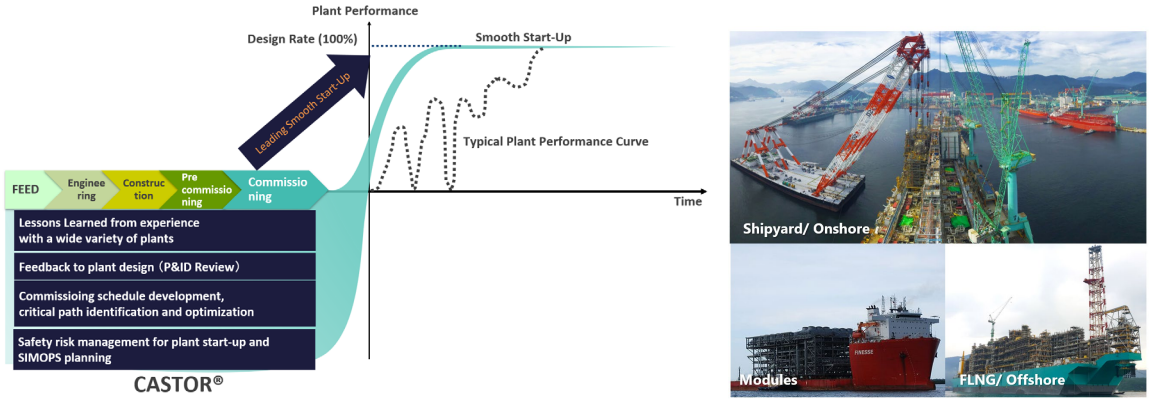
Operation

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

Return to OE Service menu

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 (OR&A)
- **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

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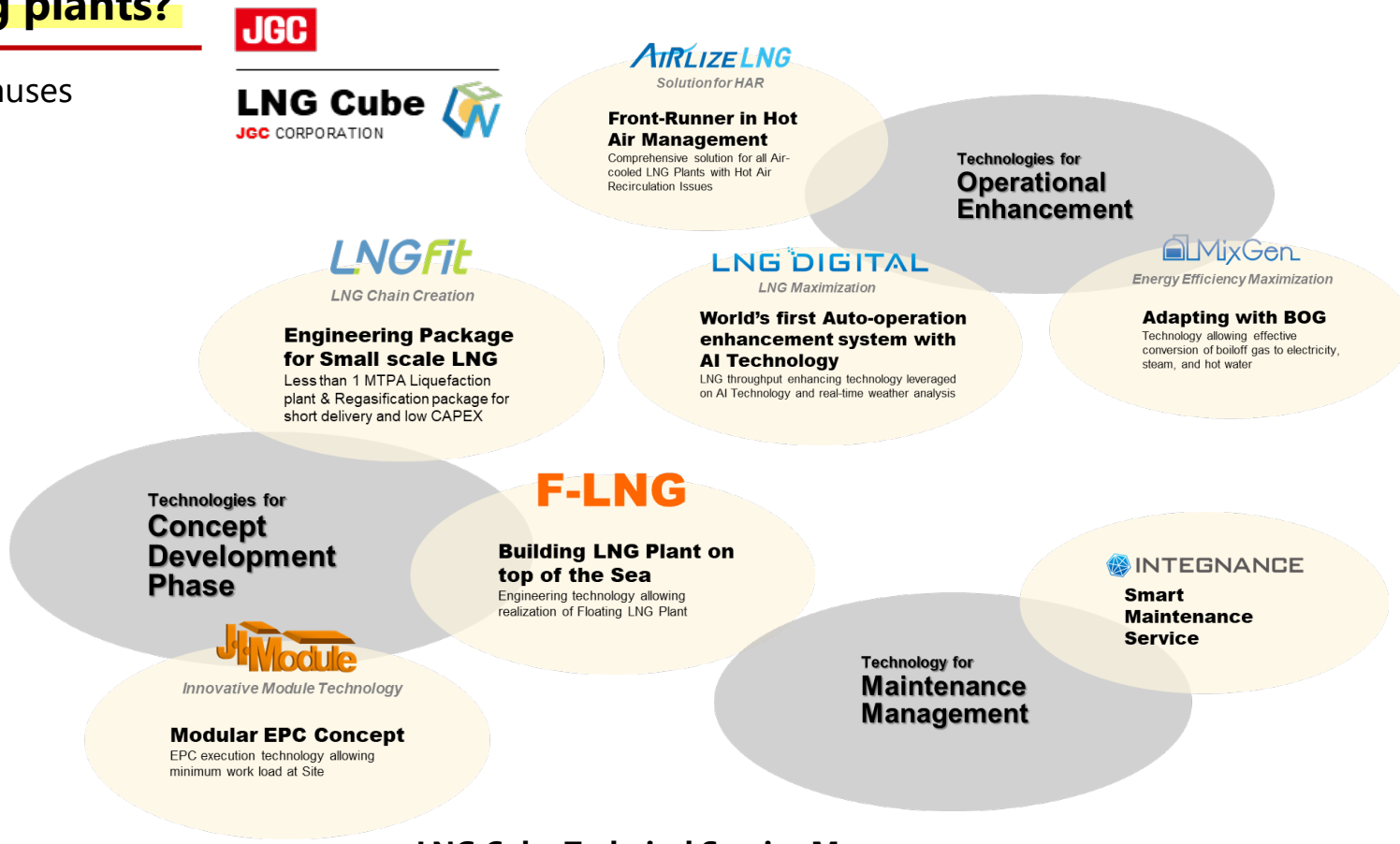
LNG³ (Engineering Consultation Service)

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



LNG Cube Technical Service Menu

LNG³ (Engineering Consultation Service)

Return to Operation menu

Workflow & Results

1. Send Survey Form
2. Send Operational Data and Register for LNG Cube Analysis

Client

3. LNG Cube Analysis
4. Develop Improvement Plan or General Concept (2~3 weeks)
5. LNG Cube Workshop with Client
6. Share Improvement Ideas, Execute Consultation
7. Implementation of the Plan, Seamless Execution of EPC

JGC

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

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AIRLIZE LNG®

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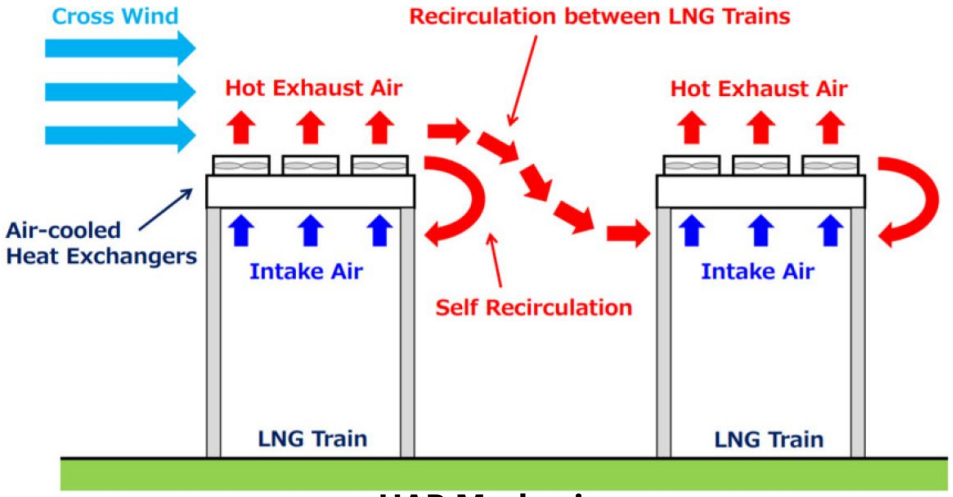
HAR(*) causes loss of LNG production

(*)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**

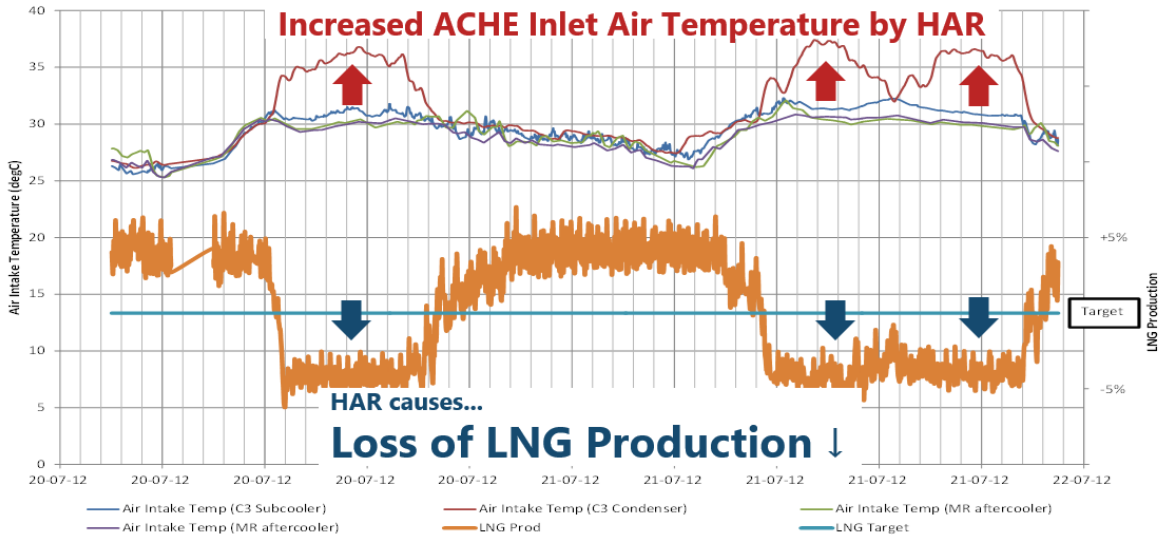
(**)Air Cooled Heat Exchanger



HAR Mechanism

What is AIRLIZE® ?

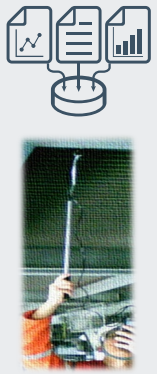
- AIRLIZE LNG® is JGC's Comprehensive Life Cycle Support Services for Air-Cooled LNG Plants
- Diagnoses and Analysis services for HAR optimization



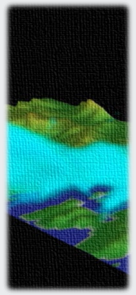
AIRLIZE LNG

Workflow & Result

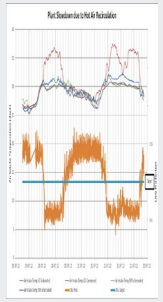
Data and information collection & site survey



Analysis

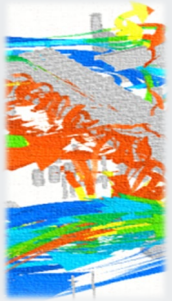


Weather Data

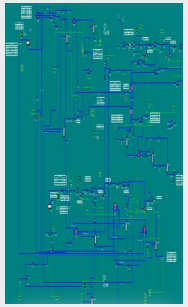


Operating Data

Simulation



CFD



Process

Solutions

Dry Fogging

HAR Digital

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)

TANGGUH LNG · PETRONAS LNG 9 · Ichthys PROJECT INPEX · MOZAMBIQUE LNG · DONGGI SENORO Liquefied Natural Gas · YAMAL LNG · GORGON AUSTRALIAN LNG · Kitimat LNG · Jordan Cove LNG VERESEN · Golden Pass LNG ExxonMobil · Cameron LNG · Lake Charles LNG

What is Dry Fogging?

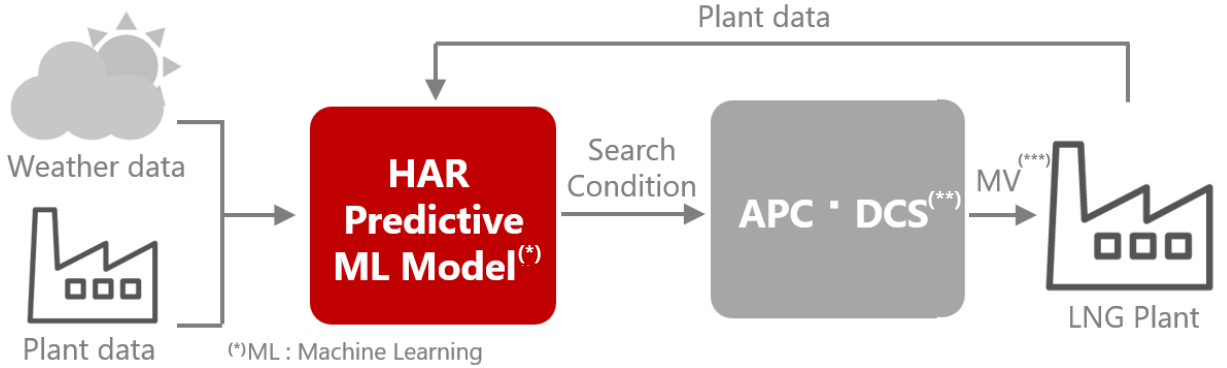
Dry Fogging enhance the performance of ACHE by implementing simple water mist system.

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

Improves the overall performance of the ACHE.

What is HAR Digital?

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



(*)ML : Machine Learning
JGC jointly developed HAR Digital software with LNG operator in Southeast Asia through PoC.
(**)APC : Advanced Process Control, DCS : Distributed Control System
(***)MV : Manipulated Variable

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.

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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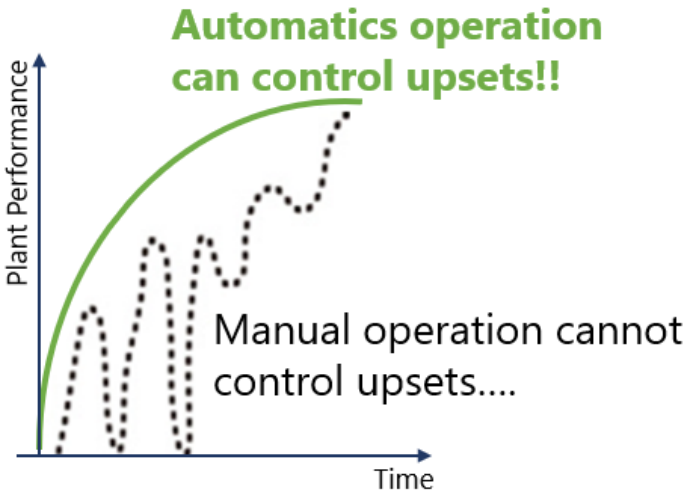
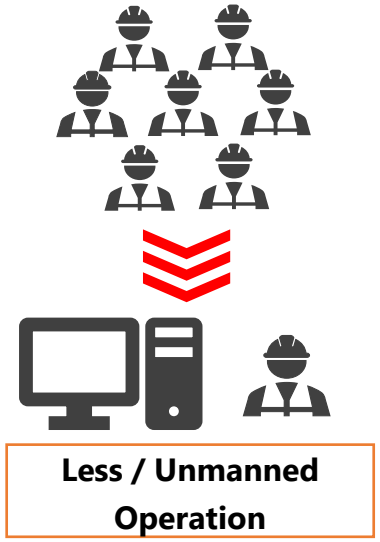
Automatics Operation

Advantages of Automatics Operation

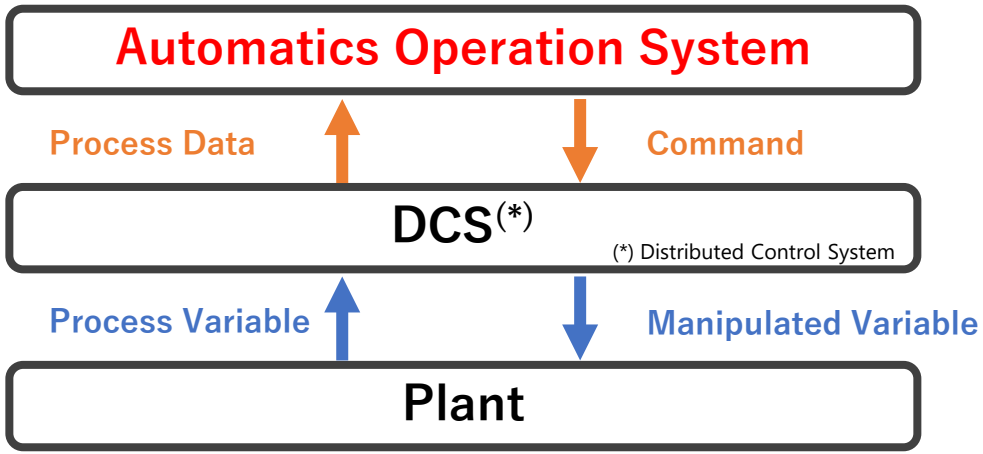
- **Stabilizing facility performance by reducing process upsets during process operation**
- **Prevention of equipment damage due to mistakes**
- **Minimizing transient operation time**
- **Standardization of transient operation sequence**
- **Assistance for operators with limited experience.**





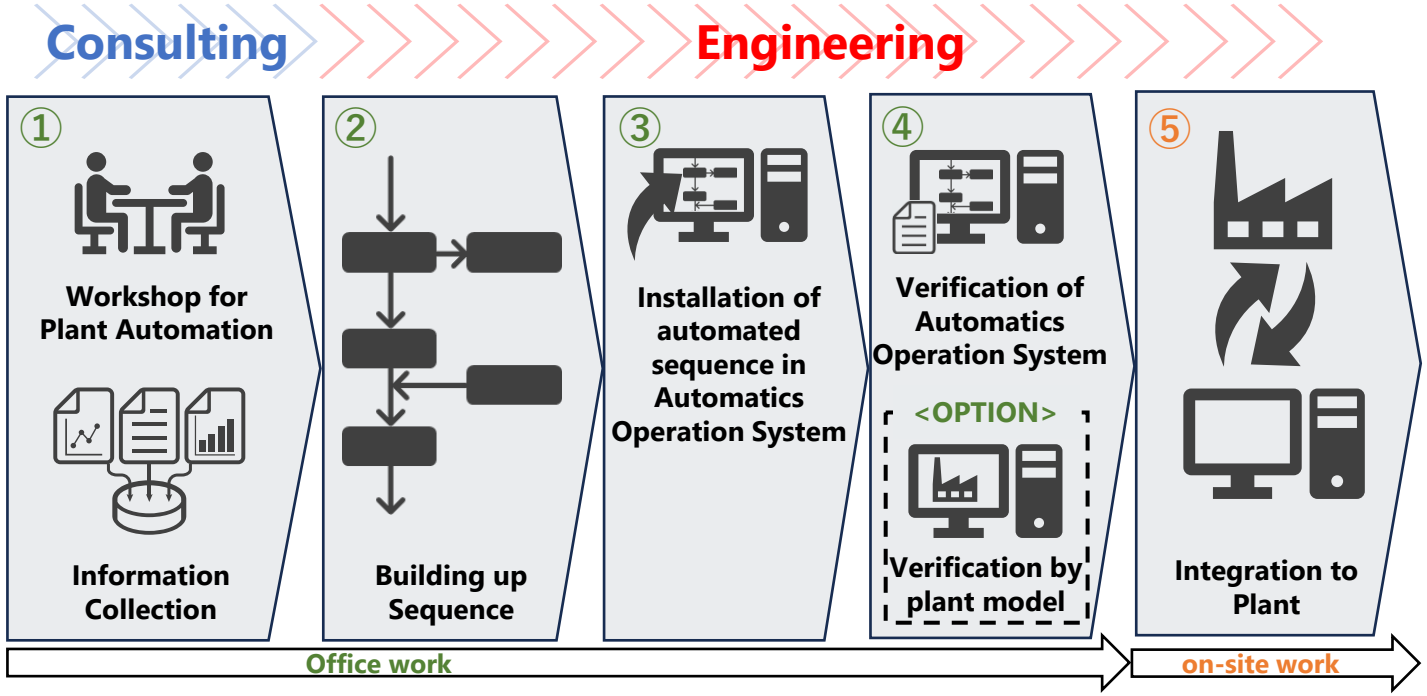
What is Automatics Operation ?

- 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.



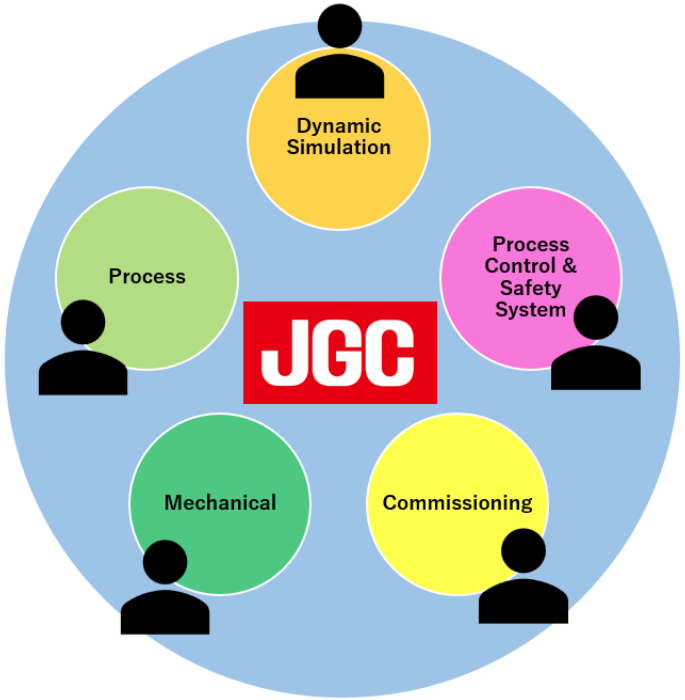
Automatics Operation

Workflow for Implementation



Our 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



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

Automatics Operation

Return to Operation menu

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

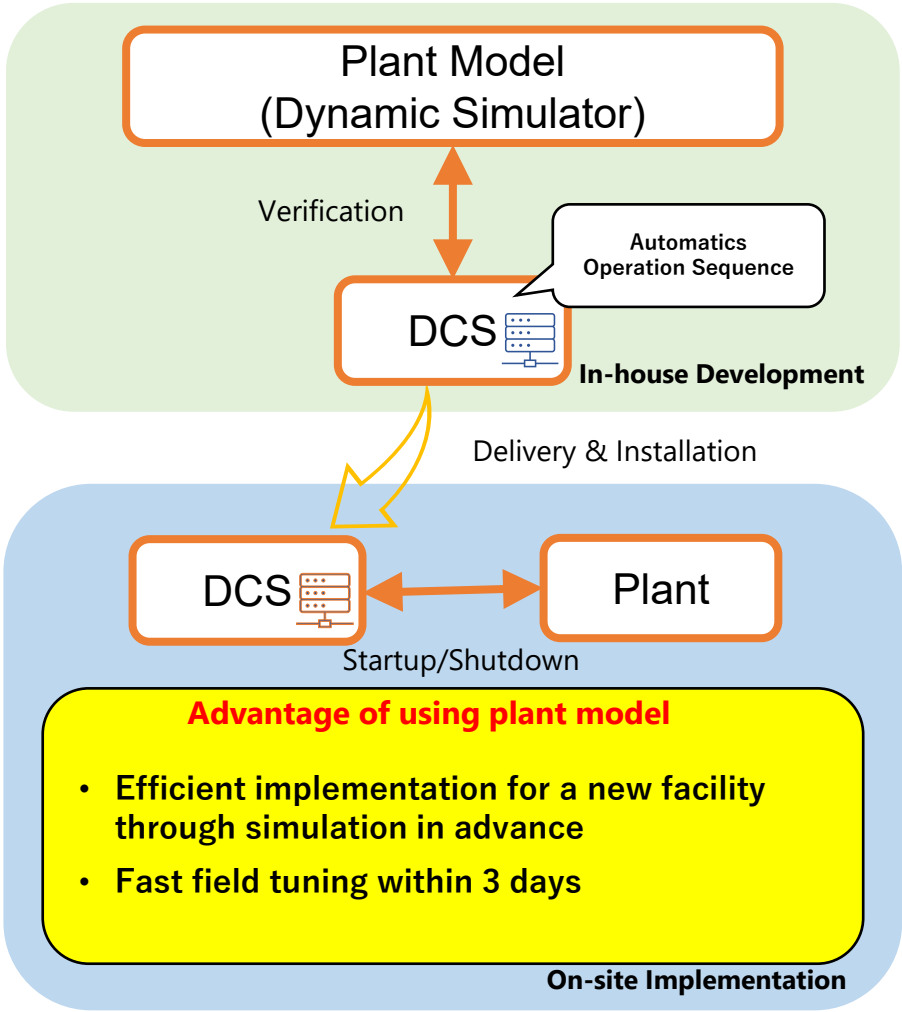
Approach

- 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

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Operation

Operations Readiness & Assurance (OR&A)

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Operations Readiness & Assurance (OR&A)

Do you have any of these issues?

☹ **Concern of safe and smooth startup of O&M**

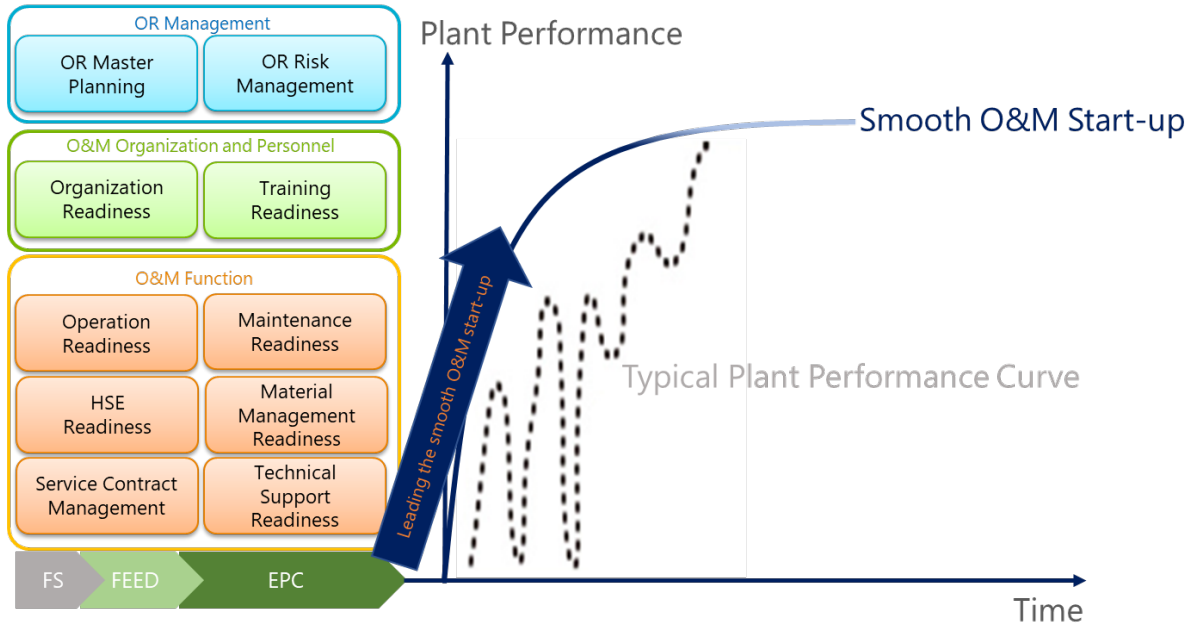
☹ **High total cost of ownership**

☹ **Potential areas of concerns and its mitigations in OR(*)**

OR&A Solution

- Execute OR&A 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 (OR&A)

Operations Readiness & Assurance (OR&A)

Return to Operation menu

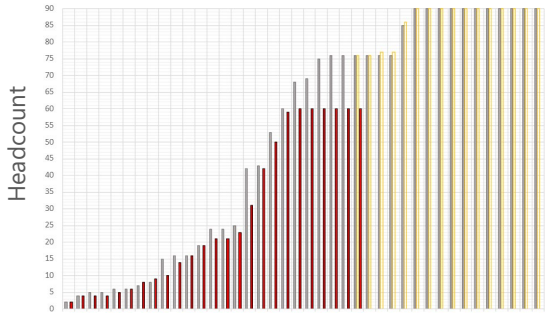
Workflow & Result

A) OR&A 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	Recruting 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 OR&A 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

- OR&A 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

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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:

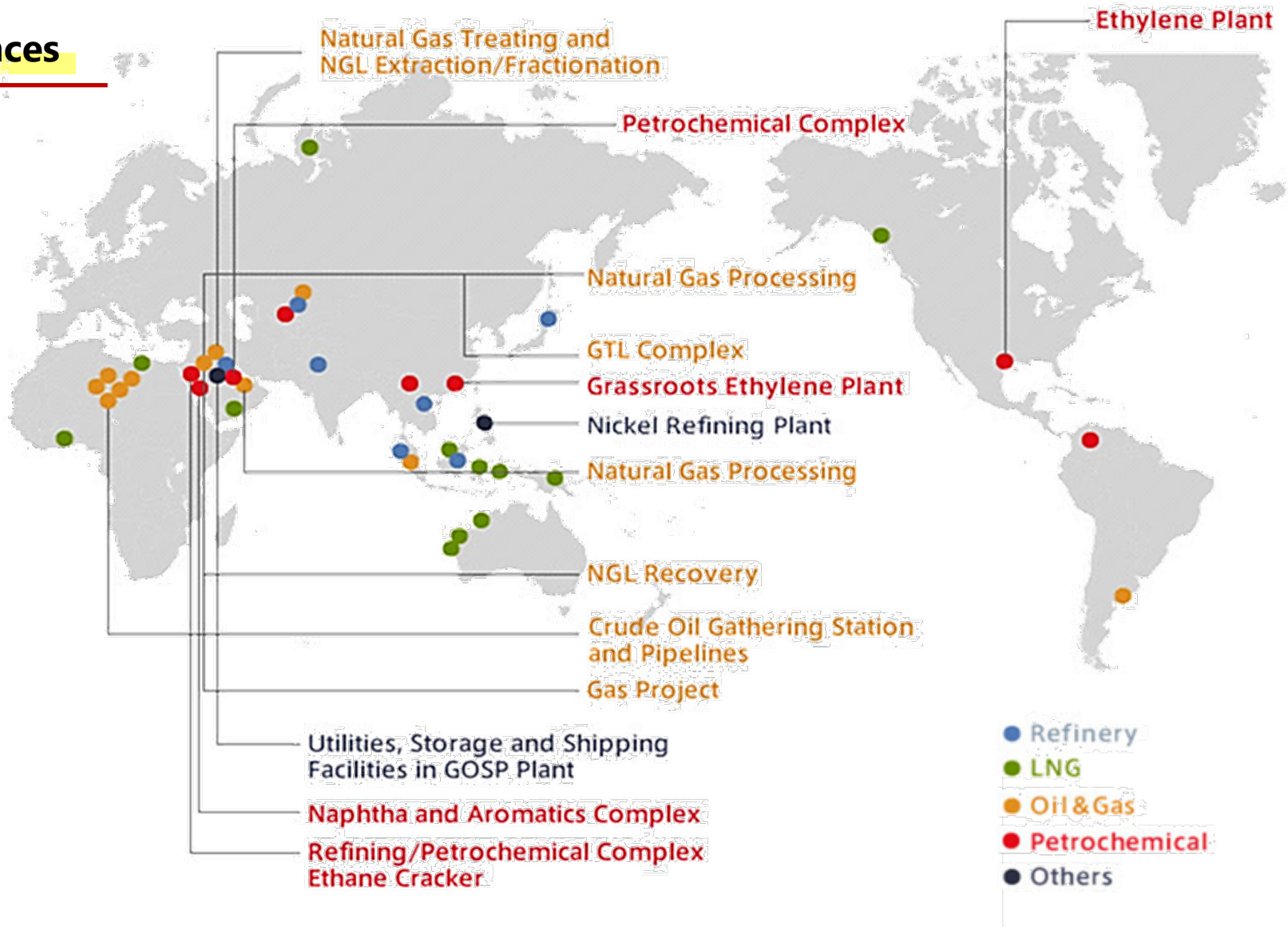
- **Commissioning HSE Plan**
- Commissioning Execution Plan
- **Plan and/or procedure with CASTOR®**
- Completion Plan includes Systemization and/or RFSU Blocks
- **Commissioning & Startup for FLNG/FPSO/Module**
- Design/Engineering Considerations
- Benchmark Schedule and/or manning against projects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

Predictable Startup Program

Return to Operation menu

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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CASTOR® (Commissioning and Startup Transient Operability Review)

Do you have any of these issues?

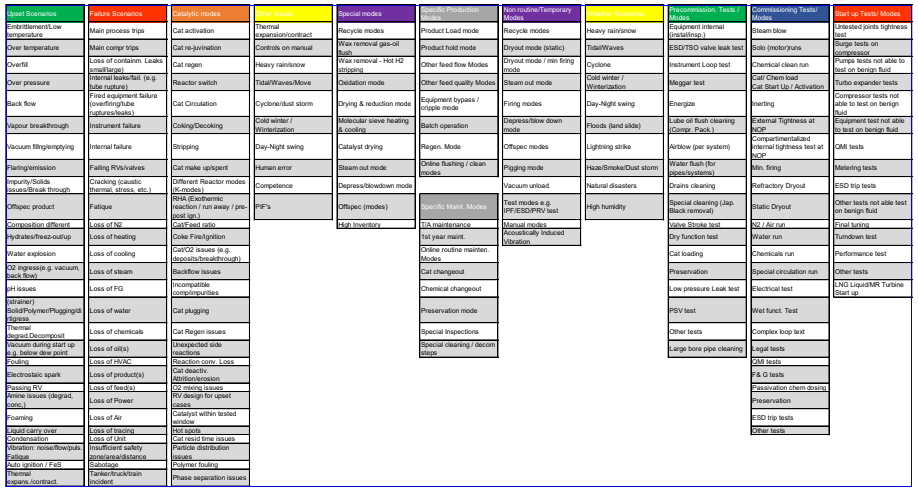
☹ **Concerns on Commissioning and Startup Plan**

☹ **Lack of (or No) Experience in Plant Startup**

☹ **Introduction of Unfamiliar Equipment/Unit**

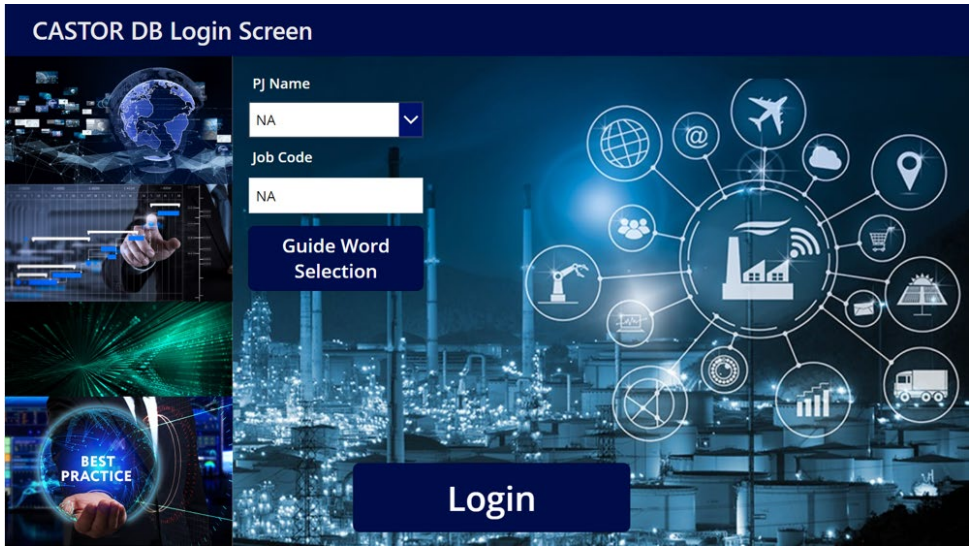
CASTOR® Solution

- 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



Upset Scenarios	Failure Scenarios	Catalytic modes	Slow modes	Special modes	Specific Production Modes	Non routine/Temporary Modes	Weather Scenarios	Precommission. Tests / Modes	Commissioning Tests/ Modes	Start up Tests/ Modes
Embrittlement/Low temperature	Main process trips	Cat activation	Thermal expansion/contract	Recycle modes	Product Load mode	Recycle modes	Heavy rain/snow	Equipment internal (install/insp.)	Steam blow	Untested joints tightness test
Over temperature	Main compr trips	Cat re-juvination	Controls on manual	Wax removal gas-oil flush	Product hold mode	Dryout mode (static)	Tidal/Waves	ESD/TSO valve leak test	Solo (motor)runs	Surge tests on compressor
Overfill	Loss of containm. Leaks small/large)	Cat regen	Heavy rain/snow	Wax removal - Hot H2 stripping	Other feed flow Modes	Dryout mode / min firing mode	Cyclone	Instrument Loop test	Chemical clean run	Pumps tests not able to test on benign fluid
Over pressure	Internal leaks/fail. (e.g. tube rupture)	Reactor switch	Tidal/Waves/Move	Oxidation mode	Other feed quality Modes	Steam out mode	Cold winter / Winterization	Meggar test	Cat/ Chem load	Turbo expander tests
Back flow	Fired equipment failure (overfiring/tube ruptures/leaks)	Cat Circulation	Cyclone/dust storm	Drying & reduction mode	Equipment bypass / cripple mode	Firing modes	Day-Night swing	Energize	Cat Start Up / Activation	Compressor tests not able to test on benign fluid
Vapour breakthrough	Instrument failure	Coking/Decoking	Cold winter / Winterization	Molecular sieve heating & cooling	Batch operation	Depress/blow down mode	Floods (land slide)	Lube oil flush cleaning (compr.,Pack.)	Inerting	Equipment test not able to test on benign fluid
Vacuum filling/emptying	Internal failure	Stripping	Day-Night swing	Catalyst drying	Regen. Mode	Offspec modes	Lightning strike	External Tightness at MOP	Airblow (per system)	OMI tests
Flaring/emission	Failing RVs/valves	Cat make up/spent	Human error	Steam out mode	Online flushing / clean modes	Pigging mode	Haze/Smoke/Dust storm	Compartimentalized internal tightness test at MOP	Min. firing	Metering tests
Impurity/Solids issues/Break through	Cracking (caustic, thermal, stress, etc.)	Different Reactor modes (IK-modes)	Competence	Depress/blowdown mode		Vacuum unload.	Natural disasters	Water flush (for pipes/systems)	Refractory Dryout	ESD trip tests
Offspec product	Fatigue	RHA (Exothermic reaction / run away / pro-/post ign.)	PIF's	Offspec (modes)	Specific Maint. Modes	Test modes e.g. IPF/ESD/PRV test	High humidity	Drains cleaning	Static Dryout	Other tests not able test on benign fluid
Composition different	Loss of N2	Cat/Feed ratio		High Inventory	T/A maintenance	Manual modes		Special cleaning (Jap. Black removal)	N2 / Air run	Final tunings
Hydrates/freez-outup	Loss of heating	Coke Fire/Ignition			1st year maint.	Acoustically Induced Vibration		Valve Stroke test	Water run	Turndown test
Water explosion	Loss of cooling	Cat/O2 issues (e.g. deposits/breakthrough)			Online routine mainten. Modes			Dry function test	Chemicals run	Performance test
O2 ingress(e.g. vacuum, back flow)	Loss of steam	Backflow issues			Cat changeout			Cat loading	Special circulation run	Other tests
pH issues	Loss of FG	Incompatible comp/impurities			Chemical changeout			Preservation	Electrical test	LNG Liquid/MR Turbine Start up
Catalyst(r) Solid/Polymer/Plugging/dp/press	Loss of water	Cat plugging			Preservation mode			Low pressure Leak test	Wet funct. Test	
Thermal degrad.Decomposit	Loss of chemicals	Cat Regen issues			Special Inspections			PSV test	Complex loop test	
Vacuum during start up e.g. below dew point	Loss of oil(s)	Unexpected side reactions			Special cleaning / decom steps			Other tests	Legal tests	
Fouling	Loss of HVAC	Reaction conv. Loss						Large bore pipe cleaning	QMI tests	
Electrostaic spark	Loss of product(s)	Cat deactiv. Attrition/erosion							F& G tests	
Passing RV	Loss of feed(s)	O2 mixing issues							Passivation chem dosing	
Amine issues (degrad, conc.)	Loss of Power	RV design for upset cases							Preservation	
Foaming	Loss of Air	Catalyst within tested window							ESD trip tests	
Liquid carry over	Loss of tracing	Hot spots							Other tests	
Condensation	Loss of Unit	Cat resid time issues								
Vibration: noise/flow/puls Fatigue	Insufficient safety zone/area/distance	Particle distribution issues								
Auto ignition / FeS	Sabotage	Polymer fouling								
Thermal expans./contract.	Tanker/truck/train incident	Phase separation issues								

CASTOR Guideword Template (General)



CASTOR Database

CASTOR® (Commissioning and Startup Transient Operability Review)

Return to Operation menu

Workflow & Results

Workflow of CASTOR®

- **Step-1** Develop CSU Plan and Diagram
- **Step-2** Review Plan with Experienced Engineers
- **Step-3** Reveal Risks using Guidewords
- **Step-4** Plan Mitigation against Risks

- 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
7 Cases

Operational Excellence Services

Operation

Commissioning Safety

Contact Us

Technology Inquiries | Contact Us | JGC HOLDINGS CORPORATION

Access to Our Homepage

https://www.jgc.com/en/business/epc/operation-maintanance/service/

Commissioning Safety

Do you have any of these issues?

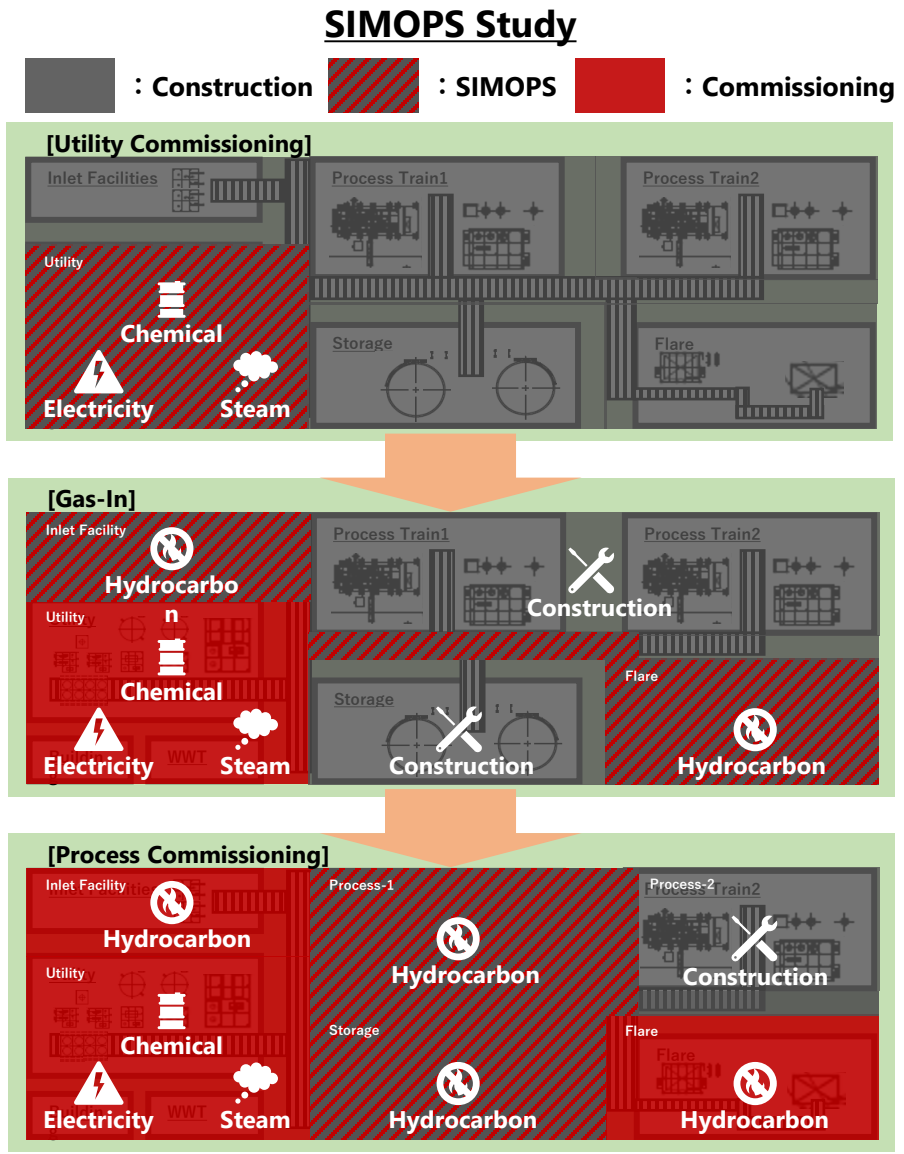
☹ **Introduction of hazardous material in areas where construction is still in progress**

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

Our Solution

Provide consultation on the following plans/topics:

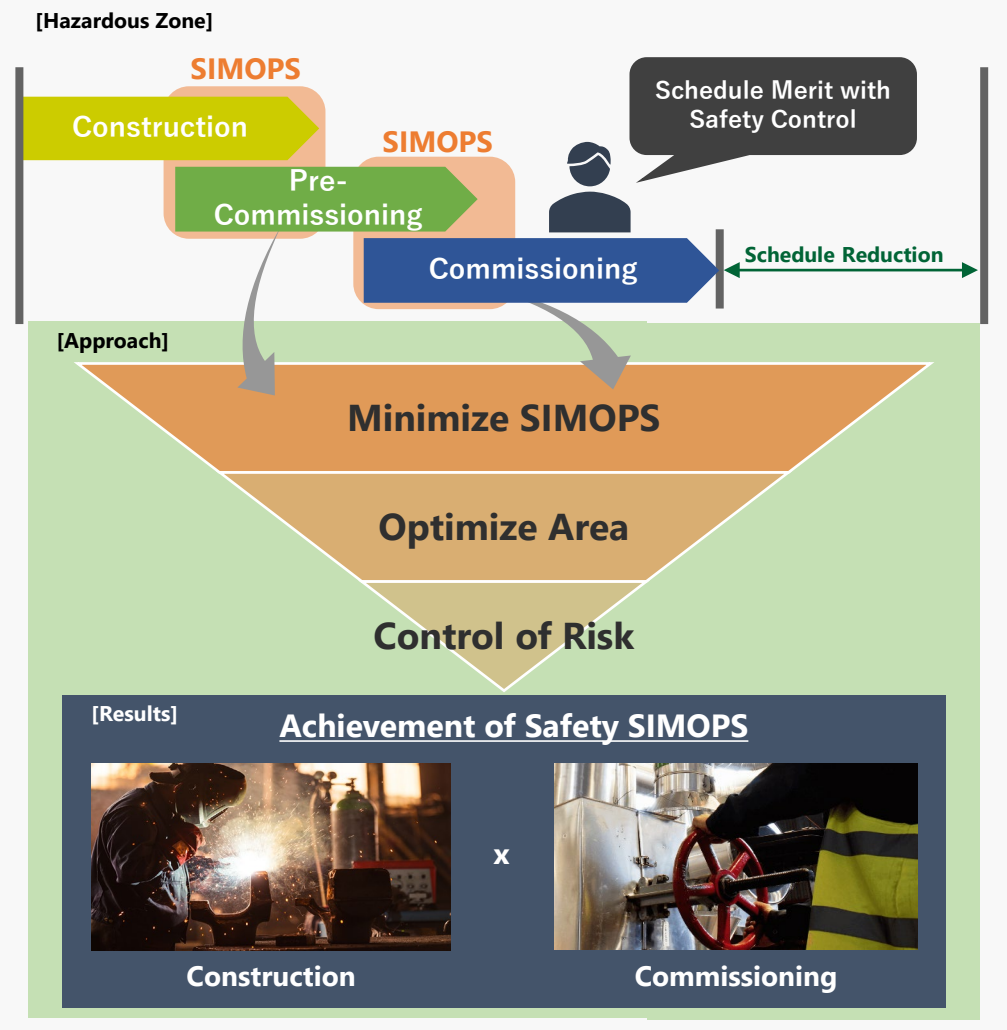
- Completion Plan
- Systemization
- Identify Safety Risks and Prepare Risk Mitigation (SIMOPS Study)
- Design/Engineering Considerations (Additional Isolations)
- QRA Study with Technical HSE Engineering



Commissioning Safety

Return to Operation menu

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 oversea 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)

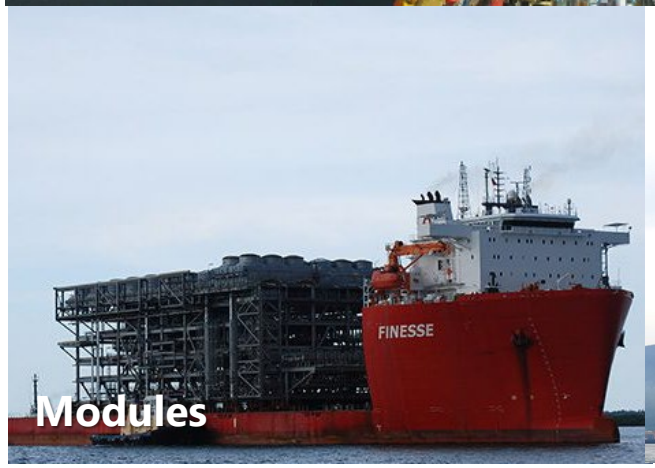
☹ **What shall be prepared at each phase??**

- ✓ 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

Engineering
- Establish Project Completion Plan
- Establish Commissioning Execution Plan

Module Yard
- Pre-commissioning (Clean & Tight)
- Preservation

Shipyard
- Maximize Commissioning (Minimize Offshore Works)
- Preparation for Offshore (Materials/Manning etc.)

Towing
- Hull & Marine Operation
- Preservation

Pre-RFSU Offshore
- Offshore Installation
- Reverification of Onshore Works & PSSR

Post-RFSU Offshore
- Smooth Startup as per SOP
- Ramp up & Performance Test

🙂 **Successful Project Completion**

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


Petronas FLNG-2 EPCIC


ENI Coral FLNG-2 EPCIC