Introduction to PLANT PLUS
Plant Diagnosis and Lifetime Improvement Service
What is PLANT PLUS?

• PLANT PLUS is JGC’s Comprehensive Engineering Service which has been developed to support the needs and concerns of the existing plant owners across the world.

• PLANT PLUS is comprised of two core technologies:
  - Computational Fluid Dynamics Technology (CFD)
  - Structural Analysis Technology

• PLANT PLUS can offer a variety of effective solutions for existing plant owners.
  - Improve operational efficiency
  - Reduce and eliminate operational risks
  - Predict defects across the plants
  - Propose plant modification plan in accordance with the most up-to-date technologies and standards
Frequently Asked Questions and Concerns

- Can our plant improve energy efficiency?
- Which improvement plan is the most efficient?
- How can we prevent failures?
- Should we replace our corroded/damaged equipment?
- How can we prevent and/or reduce vibration?

PLANT PLUS can provide solutions!
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**IMPROVEMENT OF PLANT EQUIPMENT**

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## STRUCTURAL INTEGRITY OF PLANT EQUIPMENT

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Q. Is the improvement of plant equipment surely effective?

A. Yes. PLANT PLUS can

1. Model the actual shape of the equipment and simulate various phenomena such as flow in the equipment, heat transfer, chemical reaction, phase change etc.

2. Provide intuitive and easy-to-understand simulation results.

3. Provide the best solution to achieve the improvement.
• PLANT PLUS contributes to pressure drop reduction at intersection of piping, ducts and aggregate stacks which leads to blower power and energy saving.

• Pressure drop of complicated geometry difficult to calculate by manual can be obtained.

EXAMPLE
Pressure drop reduction was achieved by inserting guide vane at appropriate location.
• Insufficient fluid mixing may cause trouble to the downstream side when feed back control was applied.

• PLANT PLUS can estimate pressure, temperature, flow rate, density distribution inside piping and equipment. And then optimal instrument position can be proposed.

EXAMPLE

At thermocouple insertion position (A), fluid temperature was non-uniform. On the other hand, at thermocouple insertion position (C), the fluid temperature become uniform. Thus, suitable thermocouple insertion position (C) was proposed.
• PLANT PLUS can estimate volume fraction of gas and liquid at the outlet nozzle and estimate gas-liquid separation efficiency.

• PLANT PLUS also can be applied any geometry of gas-liquid separator (vertical/horizontal, with baffle plate or/and demister).

**EXAMPLE**

By appropriate direction of the inlet nozzle, inlet gas including mist was separated into gas (blue) and liquid (red) at each exit nozzles with sufficient separation efficiency.
• PLANT PLUS can estimate thermal efficiency, existence of hot spots, coking prediction, flame impingement to furnace tubes, stabilization of burner flame and so on.

• JGC has many experience not only furnaces but also boilers, incinerators, flares and other combustion equipment.

**EXAMPLE**

Estimation for distribution of heat flux and tube surface temperature, leading to best proposal for optimization of the thermo couple position, burner selection and so on.
• PLANT PLUS can estimate mixing performance for mixing vessels by existence of dead space, gas-liquid distribution, mixing time and so on.

• According to estimation results, energy saving because of reduction of power requirement can be archived.

EXAMPLE

Uniform mixing without dead space can be realized by appropriate selection and installation of mixing blades and baffles.

Before stirring  
Stirring  
After stirring
In large-scale chemical reactor, insufficient yield often archives in spite of sufficient yield obtained in the laboratory test.

By estimation the flow pattern and the residence time inside the reactor, the yield may be improved.

**EXAMPLE**

PLANT PLUS revealed dead space and bypass flow inside the chemical reactor, which causes yield reduction. Perforated plates were installed as countermeasure and then the yield was improved.
• If combustible or toxic gas leaks in the building inside the plant area, serious accident occurs. For this reason, quick ventilation is essential.

• By doing simulation based on the leakage scenario, PLANT PLUS can propose the optimum ventilation layout inside the building.

**EXAMPLE**

According to the simulation results for “Before improvement”, toxic gas stagnation was confirmed due to inadequate ventilation. New ventilation was added as countermeasure and then mitigation of the stagnation was achieved.
• Once hot and/or toxic gas discharged from stack reaches the surroundings of human body, it will harm human health and affect plant operation. Thus it is necessary to determine the appropriate height and location of stack.

• By modeling the dispersion of flue gas, PLANT PLUS can provide the proposal for best design.

EXAMPLE

Based on the simulation results of flue gas dispersion, solutions capable of preventing hot and toxic gas from harming human health and affecting plant operation can be proposed.
• Hot Air Recirculation (HAR) can significantly reduce the Air Cooled Heat Exchanger (ACHE) performance.

• PLANT PLUS has much experience in improving the ACHE performance by utilizing the HARview® technologies.

**EXAMPLE**

• HAR CFD analysis is firstly performed to reproduce the current conditions.

• The effect of various mitigations can be evaluated by CFD analysis.

• The most effective and practical mitigation plan will be proposed.
STRUCTURAL INTEGRITY OF PLANT EQUIPMENT

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Q. Would there be any concerns about the structural integrity of the plant equipment?

A. PLANT PLUS can

1. Diagnose from various perspectives such as international design codes, fitness-for-service codes, post construction codes, guidelines that often used in the plant industry, and JGC own company standards.

2. Investigate the root cause of the problem from the site situations and operating conditions.

3. Provide quantitative and easy-to-understand study results and countermeasures using structural analysis techniques such as finite element analysis (FEA).
• PLNAT PLUS can evaluate whether a damaged equipment (metal loss, crack-like flaws, distortions, dents, etc.) can continue operation or should be reinforced, revamped partially, replaced totally.

• JGC has much experience and knowledge of the following Fitness-For-Service codes: API 579-1/ASME FFS-1, BS 7910, WES 2820 (The Japan Welding Engineering Society*), etc.

*JGC is a committee member of this code.
• JGC has much experience of troubleshooting, and can solve vibration troubles promptly and appropriately.

• PLANT PLUS can perform vibration measurement (speed, direction, and dominant frequency of vibration), and study the root cause of vibration.

Vibration measurement record (frequency analysis result)

• PLANT PLUS can deal with the vibration of every facilities.
  ➢ Rotating machines (pumps, compressors, agitators, air fin coolers etc.)
  ➢ Towers, tanks, heat exchangers
  ➢ Piping system, instruments, platforms, foundations
• PLANT PLUS can
  - Refer to the various criteria (ISO, API, JIS or JGC company standards, etc.) according to the vibration level and subjected facility.
  - Evaluate from various viewpoints such as structural integrity of equipment and structure, affect to instruments, work environment, health of workers, etc.
  - Propose the countermeasure to reduce vibration.

**EXAMPLE**

1. Vibration response of pressure gauge
2. Vibration response of rotating machine and foundation
• PLANT PLUS can investigate the root cause, propose the countermeasures, and evaluate whether you can operate continuously.

EXAMPLE

① Flange Leakage
   Analyze deformation amount, generated stress, bolt axial force, gasket surface pressure, thermal expansion/contraction and bolt fastening force

② Deformation of Piping Support
   The magnitude of the load which caused the deformation can be studied by FEA. PLANT PLUS can propose how reinforce against the load mentioned above.

Temperature distribution and deformation of flange
Deformation of support by elastic-plastic analysis
EXAMPLE

③ Deformation of Expansion Joint
Thermal expansion behavior and the load which cause the deformation can be studied by FEA.

Deformed expansion joint

Deformation studied by FEA

④ Abnormal Temperature Rising, Fire Damage
When the trouble such as abnormal temperature rising or fire occurs, PLANT PLUS can study the stress generated on structures and assess the remaining life.

Creep rapture of furnace tube
JGC has much experience and knowledge of the seismic design.

PLANT PLUS can evaluate the existing/aging facilities from the following view points.

✓ Do they satisfy the latest requirements in design code?
✓ What kind of modification and/or reinforcement are necessary?

Object equipment: Tanks, Tower, Piping, Nuclear Equipment, etc.

EXAMPLE

Strength analysis of columns and braces of spherical tank

An integrated analysis model of tower and table top

Deformation by response analysis

Seismic response analysis
If you want to know more, please feel free to contact us.

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