



*INTEGRATED
MULTISTREAM
EXHAUST GAS
CLEANING*

CLEAN MARINE



The pioneer

- First to install full scale hybrid and multistream Exhaust Gas Cleaning System (MV Baru in 2009 and MV Balder in 2012).
- One of the two founders of EGCSA (Exhaust Gas Cleaning System Association).
- Patented and proven technology which has been subject to extensive testing since 2004.



Maritime and process expertise

- Offering turnkey design and project management.
- Ensuring the shortest possible delivery and installation times.
- Skilled network supporting installation, operation, maintenance and service globally.



Full dedication to emission cleaning

- EGCS is the prime business focus of Clean Marine.
- More than 25 MUSD invested in the company by a strong investor base (including major ship owners and other institutional investors).
- A dedicated organization geared to manage all aspects of EGCS installation and operation.

KEY SYSTEM FEATURES



Designed to meet the needs of the maritime industry

- One cleaning system serves all combustion units.
- No trade restrictions.
- One competitive fuel.
- Minimum reduction of cargo capacity.
- Easy to install, operate and monitor.



True multi-stream handling

- One single system is handling all exhaust sources, including boilers.
- No increase in exhaust gas back pressure.
- No blockage risk.
- Built-in gas recirculation and safety bypass.
- No interface requirements between exhaust source and the EGCS.



Efficient, hybrid system

- Seamless operation in sea, fresh and brackish water as NaOH dosing system is boosting cleaning efficiency.
- High trapping of sulfur and particulate matter.
- Vessel can in open loop transit from high to low alkalinity and salinity water without loss of efficiency.
- High pH in effluent water surpassing regulation requirements and being less corrosive.

THE PRODUCT

Efficient gas and liquid interface

A high-speed cyclone (AVC = Advanced Vortex Chamber) is a vital and unique part of our EGC unit. With outstanding separation efficiency it enables our ECGS to operate with very small droplets, creating a large gas-liquid interaction surface. This is a prerequisite for achieving a high sulfur trapping efficiency at minimum cost.

Water boosted with caustic soda (50% NaOH aqueous solution) is injected in the first phase of the cleaning process followed by larger quantities of ambient sea, fresh or brackish water.

This principle of adding caustic soda gives a simple regulation mechanism versus the required cleaning efficiency expressed by the SO₂ (ppm)/CO₂ (%) content of the cleaned exhaust gas. Further, it allows the system to operate in all types of water in either open or closed loop modes.

**Made by
ship owners,
for ship owners.**

Integrated multi-streaming

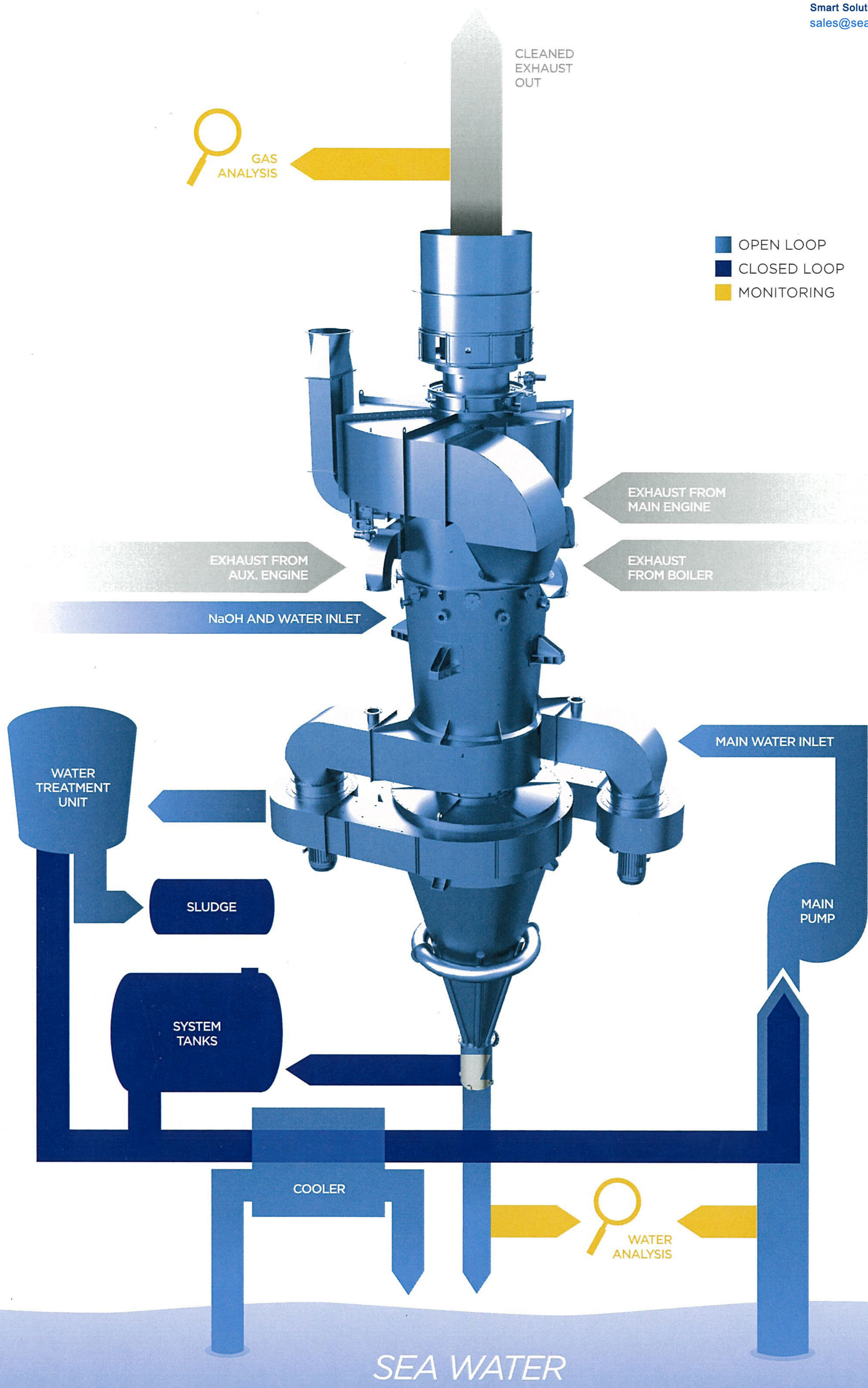
Two fans and a gas recirculation mechanism is integrated in the EGC. This ensures that pressure at the common gas meeting point is maintained at ambient level irrespective the amount of exhaust fed to the system. This feature allows all exhaust sources onboard to be served by one common EGC unit without encountering an increase in back pressure.

Installation of EGCS

The integrated multi-stream features allow the common EGC unit to be sized according to highest practical gas production onboard. The simultaneous production is less than the theoretical amount produced if all exhaust sources were operated at full capacity. Hence, the Clean Marine EGCS is designed to economize on resources (piping, water and power). The installation is also very cost-efficient for vessels with many exhaust sources as the one EGCS unit simultaneously serve all combustion units.

When retrofitting an EGC unit, this may be done adjacent to an existing funnel or inside an enlarged funnel. For a new build ship, the builder will generally incorporate the EGCS into the ship design, with the EGC unit located inside the funnel.

Clean Marine provides all necessary expertise and assistance including naval architects who produce documentation required by class and yards, and personnel who supervise installation and does commissioning.



SEA WATER

OPERATION OF THE EGCS

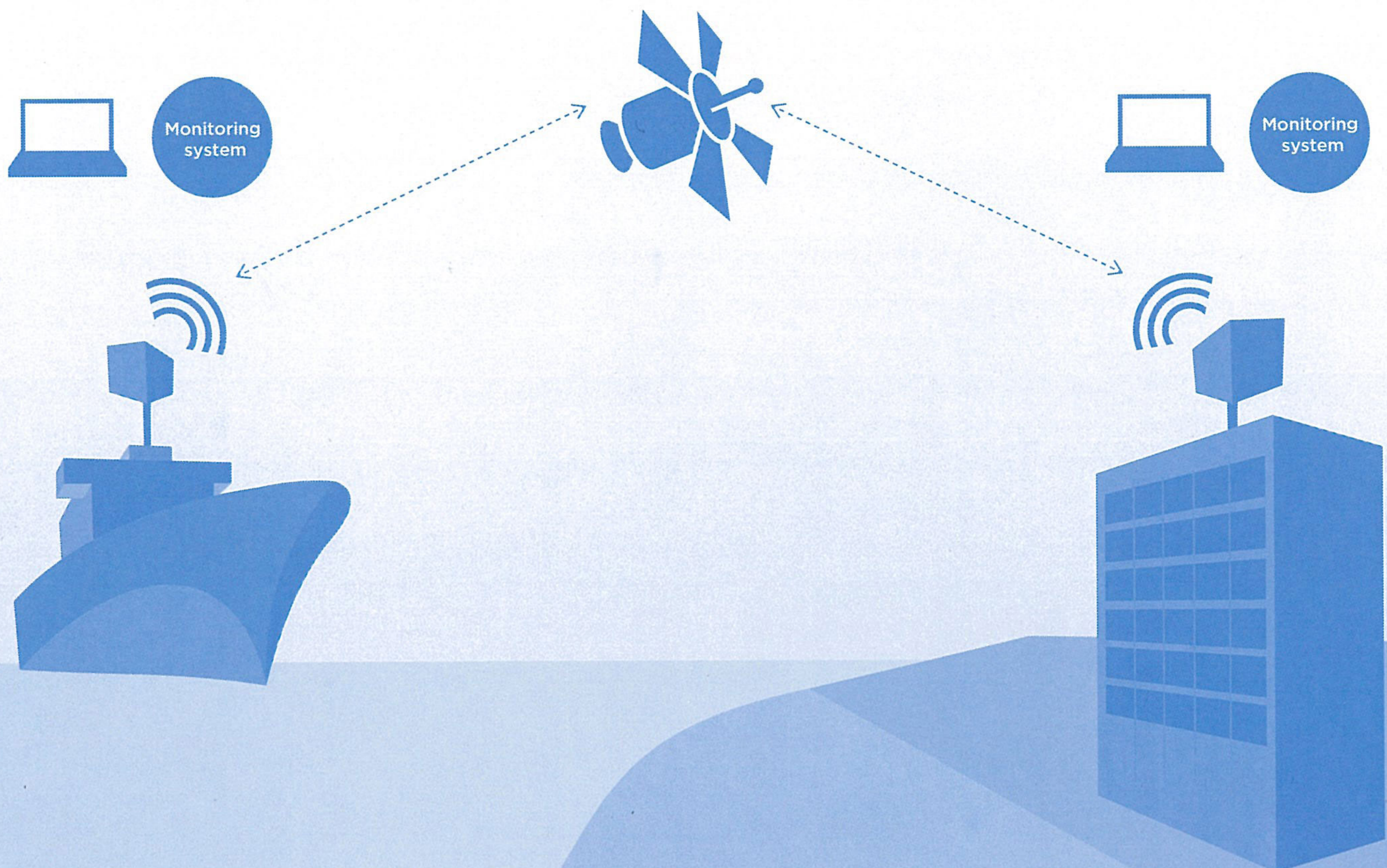
The operator's interface with the EGCS is either a dedicated laptop or the existing machinery control and monitoring system. Through the EGCS GUI, operators can check and operate the complete process. PLC allows activation of the desired operation modes by simple push buttons. For instance, one adapts the EGCS for seagoing full speed operation or for port stay operation by the push of a button.

Clean Marine also offers remote surveillance if supported by the ship's communication system.

During commissioning, the system is tuned to maximum performance through adjustment of frequency drives and other regulating mechanisms.

Since the system works independently of exhaust sources, more complex interfaces are avoided.

The system performs continuous monitoring of emissions and records position, cleaning level, PAH, turbidity and pH, according to the IMO guideline. All emission logs are available for download both onboard and on shore to



HOW TO PROCEED

Clean Marine has the expertise and knowhow to support the ship owners in all aspects of an EGCS installation. As for retrofit projects, Clean Marine proposes a stepwise approach similar to the following:

1

INPUT:

GA, capacity, engine room and funnel/casing plans. Type of machinery and operational profile.

OUTPUT:

EGCS capacity and dimensions. Conceptual layout. Preliminary budget.

The overview of the timeframe and resources required for an EGCS installation combined with an understanding of the technology will ensure useful communications and discussions.

2

INPUT:

Letter of intent or Engineering contract. Onboard inspection. Dialogue with class.

OUTPUT:

Equipment specification, BOM, P&ID, layout, and price. Installation specification.

The Client will now be able to obtain firm quotes from Yards and then place the installation order.

3

INPUT:

EGCS Purchase contract.

OUTPUT:

Final schedules, production drawings and approved class drawings. Prefabrication and erection plans. Equipment delivery, documentation and certification.

Equipment, prefabricated to the extent possible, is delivered to site on time. The yard installation work is conducted under the joint supervision of the Client and Clean Marine. Commissioning is done when the ship is back in service.

A new build installation will follow a different path but will include similar scope of work and involvement.

IT IS TIME TO INSTALL AN EGCS

Clean Marine offers **Exhaust Gas Cleaning Systems (EGCS)**, also known as scrubbers, for the marine industry. The IMO Annex VI sulfur regulation calls for a 0.1% sulfur limit in Emission Control Areas (ECA) by 2015 and a worldwide limit of 0.5% by 2020, or 2025 at the latest.

The Clean Marine Exhaust Gas Cleaning System removes sulfur and harmful particulate matter (PM) from the ship's flue gas. Clean Marine's extensive shipping expertise and years of EGCS R&D comprises the knowledge base for optimal design and installation of EGCS solutions.

Visit our website for more information about Clean Marine's product and services. Clean Marine welcomes the opportunity to install our Exhaust Gas Cleaning System onboard your vessel.



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