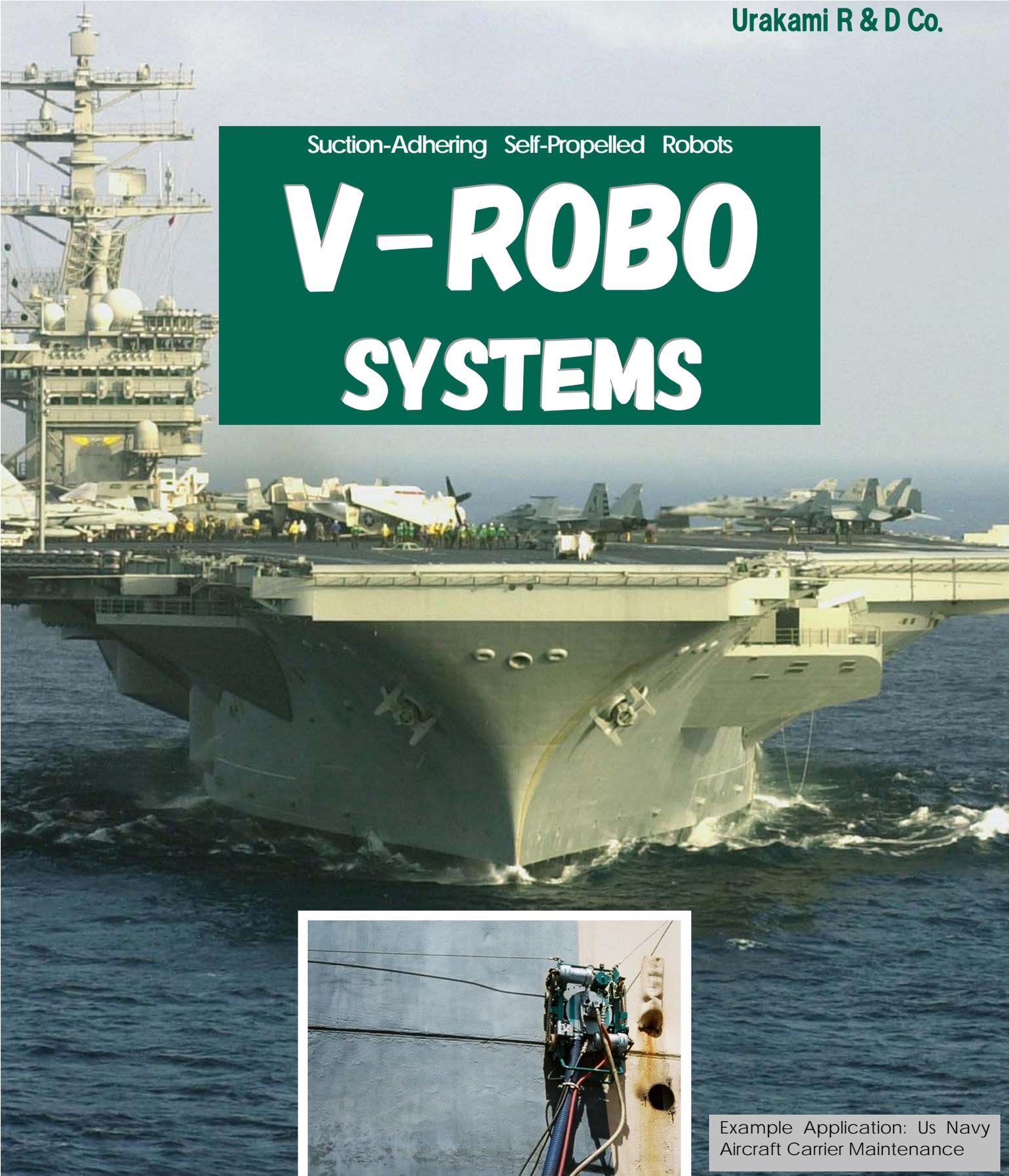


Suction-Adhering Self-Propelled Robots

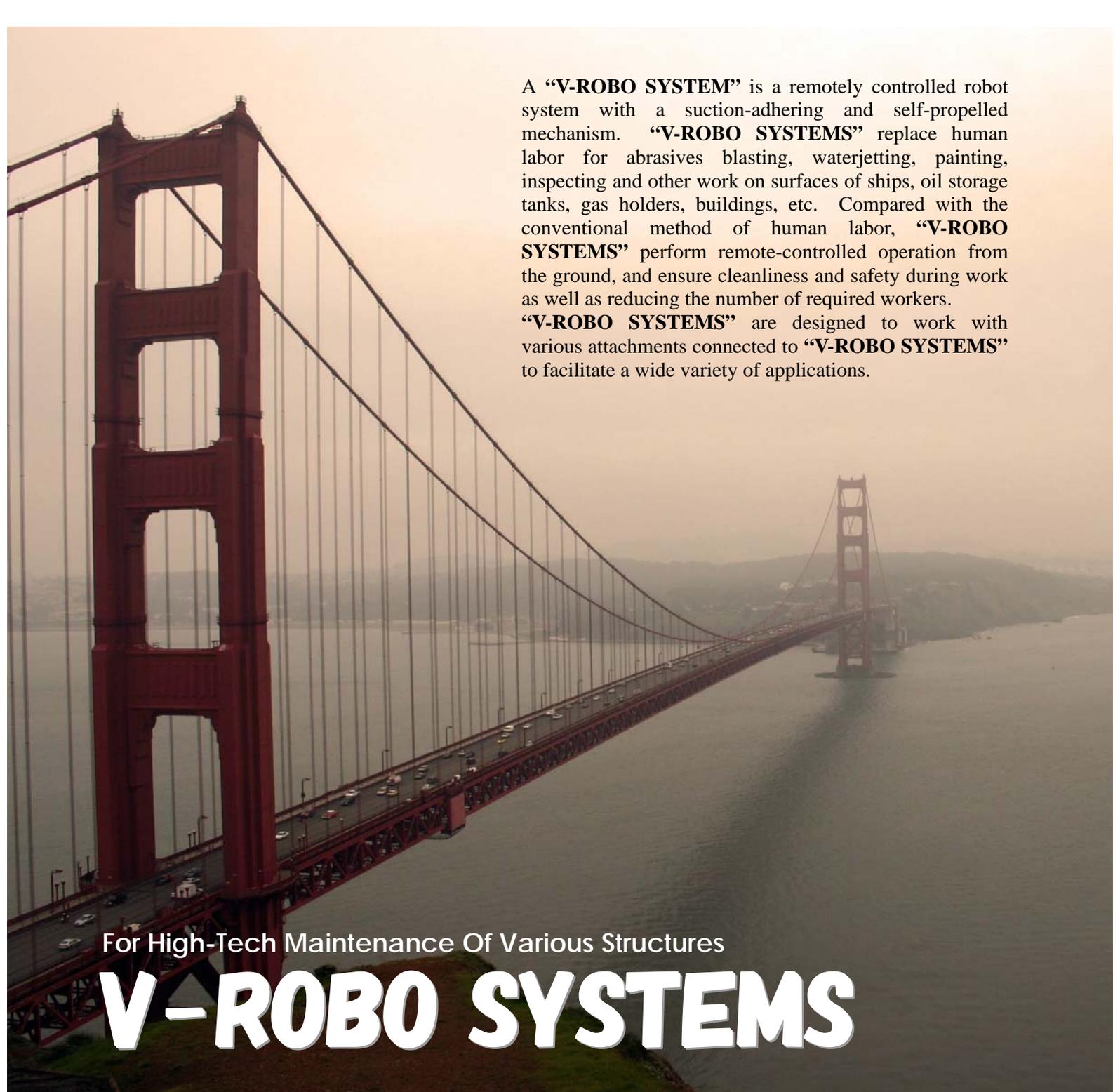
# V-ROBO SYSTEMS



Example Application: Us Navy Aircraft Carrier Maintenance

Ultra-High Pressure Waterjet Robot

Evolution Underway To Become  
The World'S Standard



A **“V-ROBO SYSTEM”** is a remotely controlled robot system with a suction-adhering and self-propelled mechanism. **“V-ROBO SYSTEMS”** replace human labor for abrasives blasting, waterjetting, painting, inspecting and other work on surfaces of ships, oil storage tanks, gas holders, buildings, etc. Compared with the conventional method of human labor, **“V-ROBO SYSTEMS”** perform remote-controlled operation from the ground, and ensure cleanliness and safety during work as well as reducing the number of required workers. **“V-ROBO SYSTEMS”** are designed to work with various attachments connected to **“V-ROBO SYSTEMS”** to facilitate a wide variety of applications.

For High-Tech Maintenance Of Various Structures

# V-ROBO SYSTEMS

Various structures, such as:

- petroleum and gas storage tanks
- electric power plants
- ships, bridges and roads

are invaluable assets to our daily life and the basis for industry and economy. They provide energy, transportation and distribution of goods to support our lives.

We need to take good care of these extremely important structures so that they may function well for many years to come.

**“V-ROBO SYSTEMS”** were created just for that purpose of maintaining the social infrastructure we have built while preserving the environment not only for mankind but also for all the living things on earth.



The World's First Thermal-Spraying Robot

## Greetings From The Inventor / Developer Of V-ROBO SYSTEMS

**Urakami Research & Development Co.** succeeded, for the first time in the world, in the invention and practical use of a robot that adheres to, by way of negative pressure suction, and travels along, the surface of a structure. **Since the latter half of the 1990's**, the suction-adhering self-propelled ultrahigh-pressure water-jetting robots we invented and developed have been widely used in the United States and Europe for exfoliating deteriorated paint and resultant rust on the surface of large structures, such as U.S. Navy's nuclear aircraft carrier George Washington and other ships and major international petroleum companies' storage tanks. **HydroCat** by Flow International Corp. is one of the robots developed with the technology provided by Urakami Research & Development Co.

**Suction-adhering self-propelled robots** are designed to create negatively-pressurized space within, which allows them to adhere to and travel along the surface of a structure. **There is** a wide variety of applications of these robots, both on land and underwater, all operated with remote controls. **Exfoliating and cleaning work**, for example, of the surface of a structure by ultrahigh-pressure waterjetting within the space completely sealed from the exterior environment prevents soiled water or noise from escaping into the environment. **The robots** are thus excellent protectors of the environment, as well as the health and safety of workers.

**Another example** of the evolution of our suction-adhering self-propelled robots is the approach of filling the space within with other decompressed gasses other than decompressed air or with decompressed water for use on land. **The latter case** has such applications as ultrasound cleaning and ultrasound flaw detection on the surface of structures. **In the age** of ultrasound washing machines that do not require laundry detergents, the evolution of our suction-adhering self-propelled robots allows us to wash floors, walls and ceilings with ultrasound.

**For the use** of our robots underwater, the negatively-pressurized space may be filled with other decompressed fluids other than decompressed water or with a decompressed gas, such as air. **The latter case** has such applications as underwater abrasives blast cleaning and polishing and underwater thermal spraying of anti-corrosive alloys. **Unlike painting** with the life of less than 10 years, thermal spraying provides anti-corrosive film of the life of scores of years instantly, again unlike painting which requires time to dry. **This superior coating method** is already in use with an aluminum-magnesium alloy on offshore oil rigs in the North Sea off England.

**Traditionally**, it has cost enormous expenses, time and labor to maintain giant structures, such as petroleum storage facilities, long large bridges and nuclear power plants. **The application** of our suction-adhering self-propelled robots achieves much lower-cost maintenance together with environmental protection and safer workplace.

**The application** of our revolutionary technology of suction-adhering self-propelled robots to underwater coating with anti-corrosive alloys for the first time in history for the maintenance of giant underwater structures enables us to prolong the lives of the valuable assets we have built.

**We are** constantly making efforts toward further evolution of our robots and toward further revolution of maintenance technology of large structures.



Conventional Thermal Spraying Method



Fukashi Urakami  
President  
Urakami Research & Development Co. Ltd.

# V-ROBO SYSTEMS

## Various Applications



Ultra-High Pressure Waterjet Robot



Abrasive Blast Robot For Maintenance Work



Abrasive Blast Robot For Shipbuilding Work



Grinding Robot



Underwater Cleaning Robot



Spray Painting Robot



Roler Painting Robot



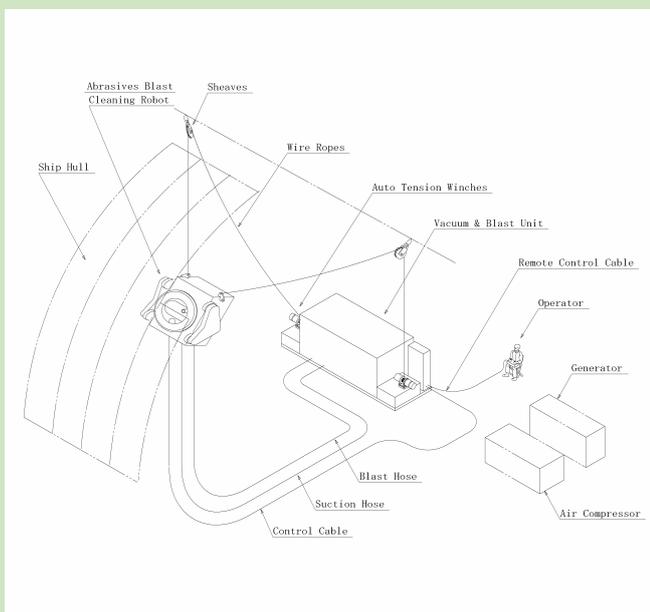
Window Cleaning Robot

## Embodiment Examples

Case 1

# On Shore

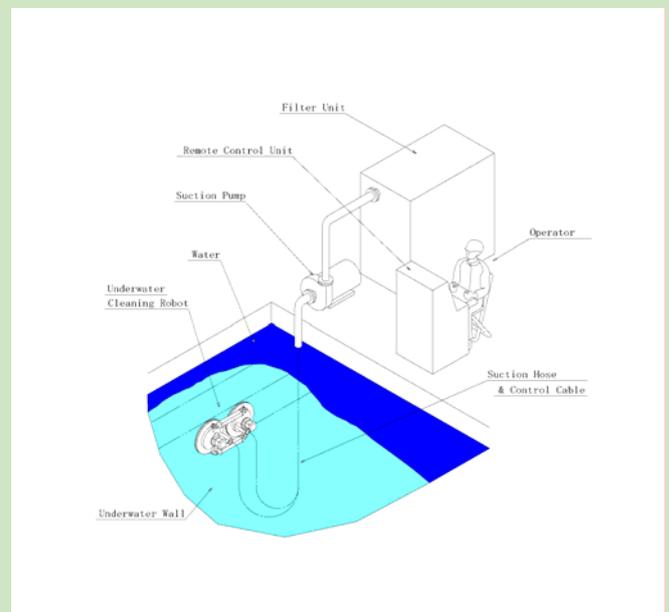
Abrasive Blast Robot



Case 2

# Underwater

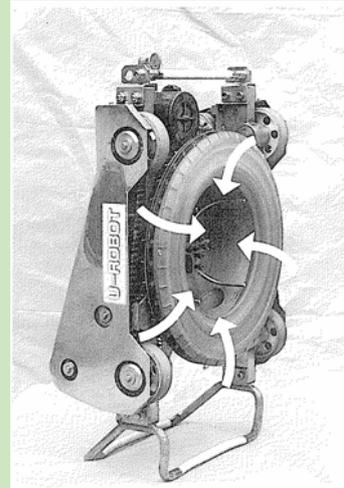
Cleaning Robot



# Major Functions Of V-ROBO SYSTEMS

## 1. Vacuum Suction

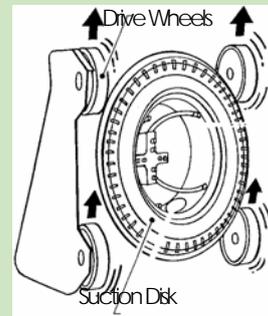
A robot that can adhere to and travel along various wall surfaces! The major challenge in our development efforts centered around the materialization of a highly durable suction disk sealing mechanism indispensable for stable adhesion and propulsion. A suction disk sealer works to prevent external air from entering the suction disk. When a robot travels along a wall surface, the suction disk sealer is kept in contact with the surface and must, therefore, be highly durable in wear and tear. Also important is that the sealer does not become turned up at any level difference (welding lines, concrete jointings, etc.) but rides smoothly. Developed at the same time was a highly safe auto-tension winch to prevent the robot from falling in case of a power failure. To make doubly sure, the robot is equipped with a safety device that instantaneously activates a brake on the winch by detecting vacuum loss within the suction disk with a pressure sensor.



High velocity air flows into the inside of Suction Disk and cleans the dirt on the surface of structures.

## 2. Suction Cleaning

Prioritizing excellence in wear and tear of the suction disk sealer led us to a larger area of the gap between the suction disk sealer and a wall surface, increasing the flow rate of the outside air into the suction disk, creating a high-speed air current, enabling more efficient suction recovery of materials removed from the wall surface. This provides the merit of preventing environmental pollution as dust and dirt removed from the wall surface are sucked into a suction hose instead of scattering outside the suction disk. Furthermore, the high-speed air current is used to dry the wetted wall surface. Wall surfaces underwater are also cleaned effectively without polluting the surrounding water as exfoliated materials are recovered by the robot.



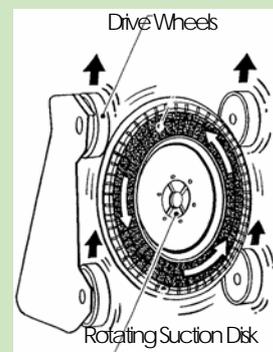
Suction Disk adheres to the surface of structures and travels on the surface by four-wheel-drive.

## 3. Self Propulsion

Our robots slide along a wall surface while keeping contact with it. There are 3 methods of propulsion that allow the robots to travel.

### ■ Propulsion By Drive Wheels

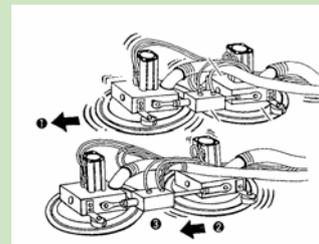
The suction disk consists of a suction disk and a suction disk sealer. Wheels are fixed onto the suction disk with a frame and are driven to allow the robot to travel along a wall surface while the distance between the wall surface and the suction disk is kept constant. Revolving the suction disk sealer with abrasive cloth attached thereon enables polishing work of the wall surface.



In the Grinding Robot, Suction Disk with Polishing Cloth rotates and roughens the surface of structures before painting.

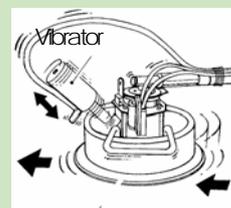
### ■ Propulsion By Looper-Like Crawling

Installing 2 suction disks, with each suction disk equipped with a roller movable in the direction of a wall surface and with an air cylinder between the 2 suction disks to continuously increase and decrease the distance between the two enables the robot to make scaling movements. This method is advantageous in that all the suction disks are given self-propulsion while adhering to a wall surface. Because the 2 suction disks are connected to each other with a swivel joint, allowing any relative angles between the two, the robot can adhere to and travel along a surface of a smaller curvature such as the exterior or interior surface of a pipe.



### ■ Propulsion By Vibrating

Simply installing a piston vibrator perpendicular to the suction disk gives the robot self propulsion while adhering to a wall surface. This method is simple in configuration and has the advantage of a small and light design.



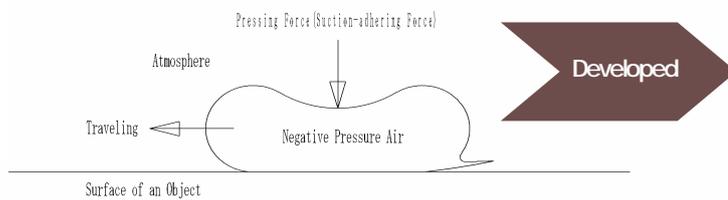
# Fluid Space Surface -Crawling Technology

V-ROBO SYSTEMS Are Evolving To  
The Fluid Space Surface-Crawling Technology.

## 4 Modes Of The Fluid Space Surface-Crawling

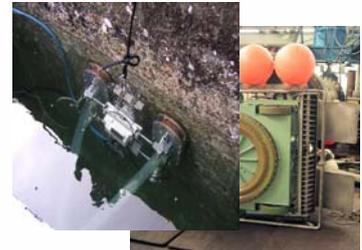
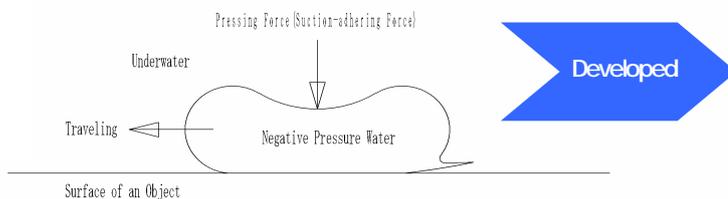
### Abrasives Blasting / Waterjetting / Thermal Spraying

1



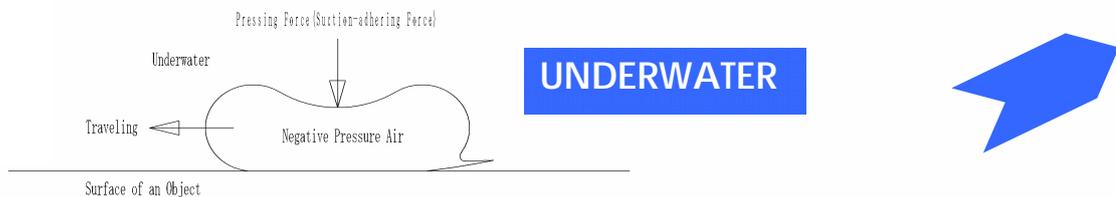
### Underwater Cleaning / Ultrasound Inspecting

2



### Underwater Abrasives Blasting / Thermal Spraying

3



### Ultrasound Inspecting / Washing / Cleaning

4



# -Advanced-

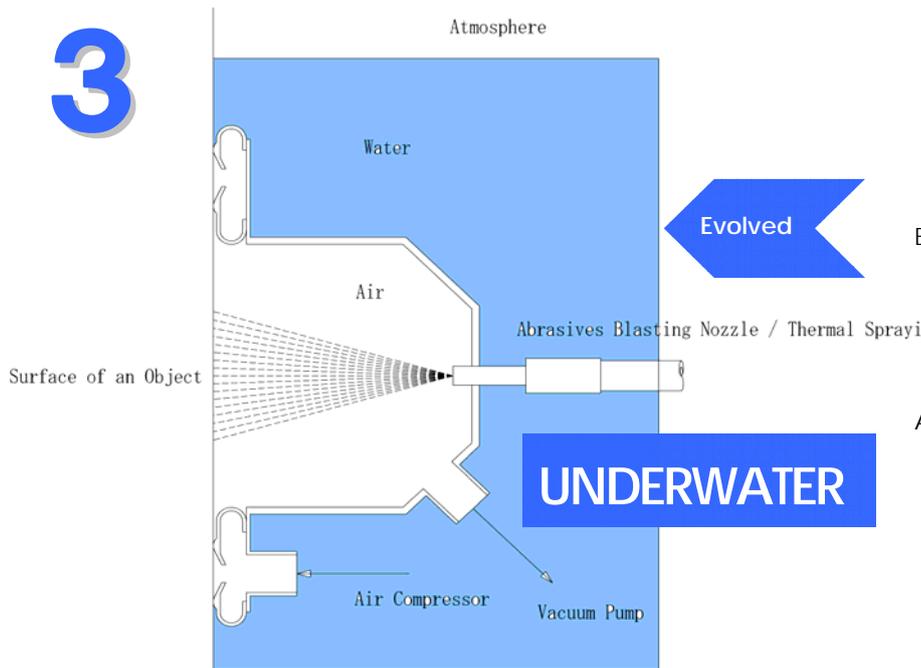
## Fluid Space Surface-Crawling Technology

### Case 3

#### Underwater Abrasives Blasting / Thermal Spraying

↓ Basic Technologies

# 3



Barnacle Removing Robot



Abrasives Blast Robot



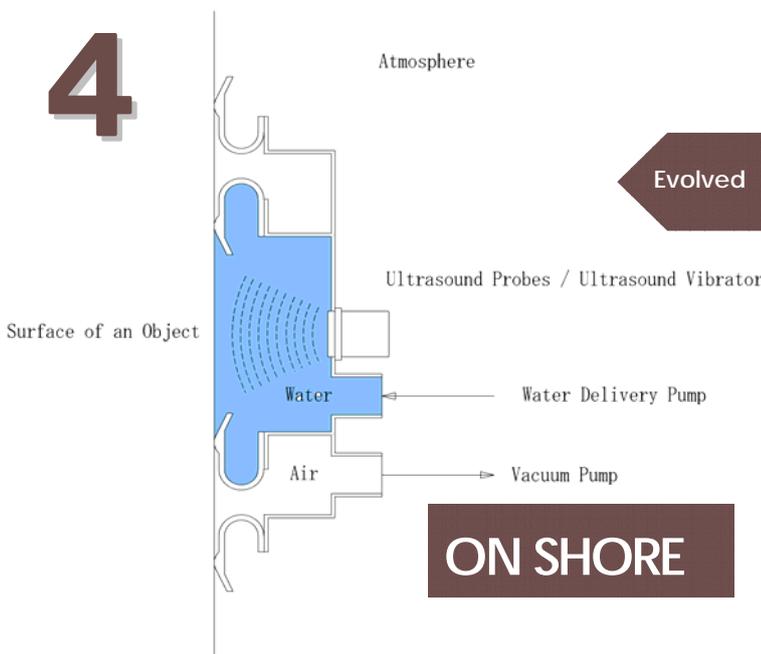
Thermal Spray Robot

### Case 4

#### Ultrasound Inspecting / Ultrasound Cleaning

↓ Basic Technologies

# 4



High Performance Vacuum Unit



Porous Pavement Cleaner



After / Before Cleaning

## Ultra-High Pressure Waterjet Robot

# TYPE VB

Steel structures such as ships, petroleum storage tanks, bridges and concrete structures such as building exteriors require periodical re-painting work. City gas holders periodically go through non-destructive tests on welded seam lines. Exfoliation of old coating is needed in preparation for the re-painting work and the non-destructive tests.

If the coating is not deteriorated over time but is still active, complete exfoliation takes a long time and, in some areas, overblasting occurs, damaging the surface material.

Additionally, the operation is extremely dangerous as it requires work at high places, and is exhausting to workers as they must be wearing dust protective masks and coveralls, making it difficult to secure workers who are willing to work in such an environment.

Remote-controlled suction-adhering self-propelled water-jetting robots perform water-jet cleaning while vacuum-adhering to, and traveling along the wall, ceiling or floor of a structure.

Inside the robots' vacuum suction disks, ultrahigh-pressure water of over 2,500 kg/cm<sup>2</sup> is jetted out to speedily exfoliate the coating, and soiled water is all sucked into the system for recovery.

The robots prevent environmental pollution, provide labor shortage solution, and contribute to operation time shortening, cost reduction and safer work environment.



Conventional Waterjet Method



# Ultra-High Pressure Waterjet Robot



## The Latest Model: VB400X

VB400X Was Developed As The Latest Model Of Our VB400 Series. VB400X Has Characteristics Of High-Performance Mobility And Advanced Adaptability To Curved Surfaces.

## Applications

Surface Preparation Before Painting Or Inspection Of Steel Structures Or Concrete Structures Such As Ships, Tanks, Gas Holders, Water Gates, Bridges, Buildings, Etc.



Vacuum Unit (Type: 55 Kw)



Type: VB400 At Gas Holder



Ultra-High Pressure Waterjetting



Type: VB600

## Characteristics

### ■ Suction Adhesion And Self Propulsion

Vacuum suction disk allows tight adhesion to worked surface and free self propulsion.

### ■ Old Coating Exfoliation

Coating is speedily exfoliated by the action of ultrahigh-pressure water of over 2,500 kg/cm<sup>2</sup> jetted out of a revolving-type water-jetting nozzle located inside the vacuum suction disk.

### ■ Soiled Water Recovery And Surface Drying

Soiled water is powerfully sucked in and recovered by the action of the high-speed air current sucked into the vacuum suction disk, and the processed surface is dried. This makes it unnecessary to add a rust preventive material, which causes water tainting, to the ultrahigh-pressure water.

### ■ Prevention Of Environmental Pollution

Soiled water is powerfully sucked in and recovered by the action of the high-speed air current sucked into the vacuum suction disk. This prevents environmental pollution with the scattering of the soiled water.

### ■ Safer Work Environment

All the operation is remote-controlled and scaffoldings are no longer necessary to work at high places. This provides safer work environment.

### ■ Reduced Work Load

Workers no longer have to wear dust preventive masks and coveralls and fight against high-pressure water jet while holding heavy nozzles. This reduces work load.

### ■ Fall Preventive Measures

A fall preventive measure is installed for safety in case of a power failure stopping the operation of the vacuum pump. Fall preventive devices available in the market for safety of workers working at high places may be used. If the weight of the robot exceeds the allowable load of such a fall preventive device (if the robot is a larger model of 80 kgs or heavier) however, the highly safe auto-tension winch developed particularly for our robots can be used.

### ■ Type Of Surface Material Not Questioned

Our robots use vacuum suction disks for suction adhesion. The surface can be magnetic steel plates, stainless steel plates, concrete, glass, plastic, tiles, rubber lining, etc. The robots will adhere to and travel along these surfaces while performing designated tasks.

### ■ Certain Surface Irregularities Not Questioned

Our robots can suction-adhere to certain surface irregularities, such as welding lines, tiles and concrete jointings.

### ■ Reduction Of Exposure To Radiation

Application of our robots to nuclear facilities reduces workers' risk of exposure to radiation.

### ■ Wall, Ceiling Or Floor Surfaces Not Questioned

Our robots may be used on wall, ceiling and floor surfaces.

## Abrasives Blast Robot

# TYPE VA / VR

Steel structures such as ships, petroleum storage tanks, bridges and concrete structures such as building exteriors require periodical re-painting work.

Abrasives blasting is needed in preparation for the re-painting work.

The operation is extremely dangerous as it requires work at high places, and is exhausting to workers as they must be wearing dust protective masks and coveralls, making it difficult to secure workers who are willing to work in such an environment.

Remote-controlled suction-adhering self-propelled abrasives blasting robots perform blast cleaning while vacuum-adhering to, and traveling along the wall, ceiling or floor of a structure.

Inside the robots' vacuum suction disks, abrasives is jetted out to remove rust or old coating from surface of the structure and to create "**ANCHOR PATTERN**" on the surface, and used abrasives and dust are all sucked into the system for recovery and recycling of the abrasives.

The robots prevent environmental pollution provide labor shortage solution, and contribute to operation time shortening, cost reduction and safer work environment.

Conventional Sand Blast Method



# Abrasives Blast Robot



Type: VA600 ( Air Blasting )



Type: VR700 ( Wheel Blasting )

## Applications

Surface Preparation Before Painting, Thermal Spraying Or Inspection Of Steel Structures Or Concrete Structures Such As Ships, Tanks, Gas Holders, Bridges, Buildings, Etc.



Vacuum & Blast Unit  
( Type: 90 Kw )



Type: VA600 with Cart



Type: VAC400 for CORNER



Type: VAV250 for a Handy Tool

## Characteristics

### ■ Suction Adhesion And Self Propulsion

Vacuum suction disk allows tight adhesion to worked surface and free self propulsion.

### ■ Removal Of Rust And Old Coating / Formation Of "ANCHOR PATTERN"

Rust and old coating are removed from surface of a structure and "Anchor Pattern" is created on the surface by the action of abrasives jetted out of an air-blasting nozzle located inside the vacuum suction disk.

### ■ Prevention Of Environmental Pollution

Used abrasives and dust are powerfully sucked in and recovered for recycling of abrasives by the action of the high-speed air current sucked into the vacuum suction disk.

This prevents environmental pollution with the scattering of the used abrasives and dust.

This also reduces air-jet noise during abrasives blasting.

### ■ Safer Work Environment

All the operation is remote-controlled and scaffoldings are no longer necessary to work at high places.

This provides safer work environment.

### ■ Reduced Work Load

Workers no longer have to wear dust preventive masks and coveralls and fight against abrasives jet while holding heavy nozzles. This reduces work load.

### ■ Fall Preventive Measures

A fall preventive measure is installed for safety in case of a power failure stopping the operation of the vacuum pump. Fall preventive devices available in the market for safety of workers working at high places may be used. If the weight of the robot exceeds the allowable load of such a fall preventive device (if the robot is a larger model of 80 kgs or heavier) however, the highly safe auto-tension winch developed particularly for our robots can be used.

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### ■ Certain Surface Irregularities Not Questioned

Our robots can suction-adhere to certain surface irregularities, such as welding lines, tiles and concrete jointings.

### ■ Reduction Of Exposure To Radiation

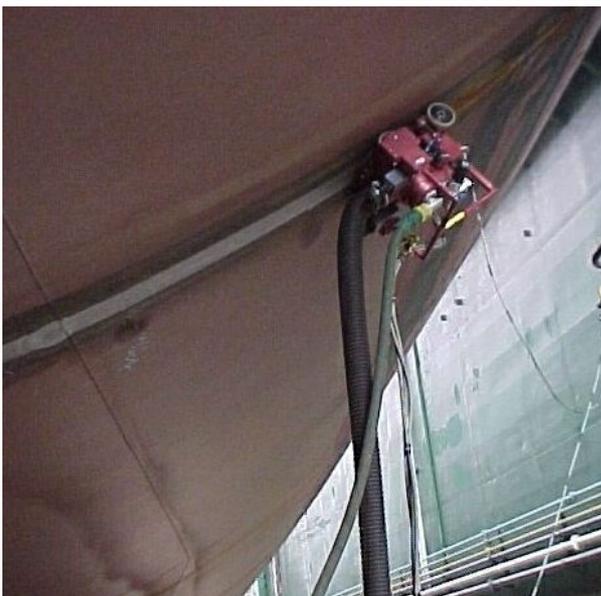
Application of our robots to nuclear facilities reduces workers' risk of exposure to radiation.

### ■ Wall, Ceiling Or Floor Surfaces Not Questioned

Our robots may be used on wall, ceiling and floor surfaces.

## Abrasive Blast Robot For Shipbuilding

# TYPE VAL



Type: VAL250 ( Air Blasting )



Working At Dry Dock



Vacuum & Blast Unit ( 90 Kw )

### Conventional Grinding Method



### Applications

Abrasive Blasting  
After Welding For  
Steel Structure Such As  
New Ships, Tanks,  
Gas Holders, Etc.

Newly built ships undergo grinding work on **welded seam lines** before they are painted. Often times, the finish grade of the grinding work is inadequate because “**Anchor Patterns**” – surface roughness – are not formed by the grinding work. Welded seam lines need **Anchor Patterns** for high quality painting.

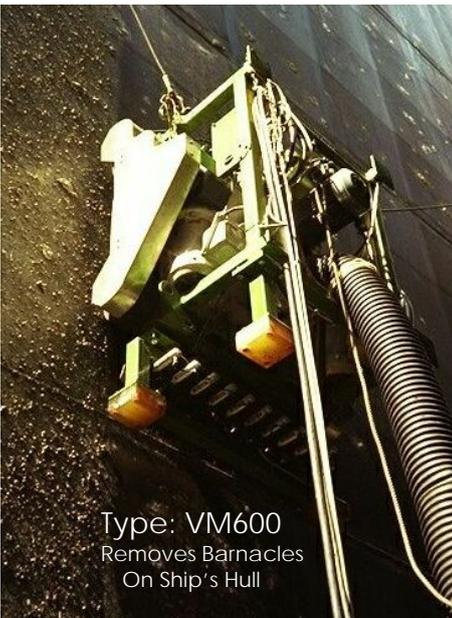
**V-ROBO Type VAL250** was developed at the request of **Samsung Heavy Industries Corp.** Five sets of VAL250 are now playing active roles in the forefront of the world of Samsung shipyards.

VAL250 blasts abrasive and forms **Anchor Patterns** on welded seam lines, and does not cause environmental pollution because of its self-contained recovery system.

VAL250 also removes heat stress and residual hydrogen from welded seam lines.

## Grinding Robot

# TYPE VM

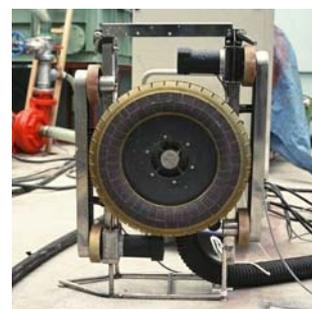


Type: VM600  
Removes Barnacles  
On Ship's Hull



Type: VM400  
Paints The Interior Of CV. Of  
Nuclear Reactor

### Conventional Grinding Method



VM400  
with Rotating  
SuctionDisk with  
Polishing Tips

## Applications

Surface Preparation Before Painting Of Steel Structures Or Concrete Structures Such As Ships, Tanks, Containment Vessel Of A Nuclear Reactor, Etc.

V-ROBO Type VM's main unit adheres to and moves along the wall while the support unit remains on the ground.

The main unit consists of a suction disk with many "Polishing Cloth Tips" fastened by means of pieces of Velcro, and four drive wheels.

The support unit consists of a Roots type vacuum pump unit, a bag filter unit, two auto-tension winch units and an electronic control unit.

For efficient pre-painting work on surfaces, the suction disk of the main unit rotates and polishes the surface.

## Inchworm Movement Robot

# TYPE VD

V-ROBO Type VD's main unit adheres to the surface of structures by vacuum and self-propels. Its support unit is installed on the ground.

The main unit is equipped with two suction disks and moves like an inchworm, adhering to the surface while both disks are always kept in vacuum.

The support unit consists of a vacuum pump unit, a filter unit, an electronic control unit and a pneumatic control unit.

Type VD is remotely controlled by an operator on the ground.

The suction disks scrub the surface vigorously and efficiently remove the dirt from the surface.

Type VD is designed to thoroughly clean and polish the surface in order to prevent it from fouling.



Underwater Cleaning Robot  
Type: VD250

### Conventional Cleaning Method



# Inchworm Movement Robot

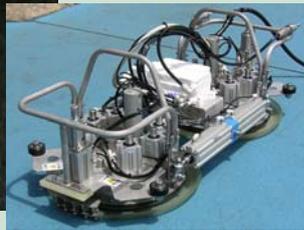
## Underwater



Type: VDG300 Cleaning Sludge

## Applications

Underwater Cleaning Of Cooling Waterways, Ducts, Water Tanks, Pools Of Nuclear Facilities, Sewage Treatment Plants, Aquarium, Oil Tanks, Etc.



Type: VDG300



An Example Of Vacuum Pump For Sludge Recovery

## Conventional Vacuum Recovery Of Sludge



## Characteristics

■ The suction disks have three functions which work at the same time: **adhering** function, **scrubbing** function and **vacuum cleaning** function.

■ The dirt on the surface is powerfully absorbed and collected by the high-speed air flow which is absorbed into the suction disks of the main unit.

■ The robot is equipped with a simple self-propelled mechanism which uses air cylinders. It is small, light-weight and quite easy to maintain.

■ The two suction disks are connected by universal couplings. The robot can adhere to and travel on surfaces of small curvatures.

■ The robot can adhere to and self-propel along the surface of any material such as steel plate, stainless steel plate, concrete, glass, plastic and tile.

■ The robot can work on wall, ceiling surfaces and floor surfaces.

■ All the operation is remote-controlled and scaffoldings are no longer necessary to work at high places. This provides safer work environment.

## On Shore



## Applications

- Cleaning Of Air-Conditioning Ducts, Boiler Tubes, Windows, Etc.
- Drying Of Wet Surface



Type: VD200

**V-ROBO Type VD Is "The Most Suitable Method" For Decontamination Of Nuclear Facilities!**

V-ROBO SYSTEMS reduce workers' risk of exposure to radiation.

# V-ROBO SYSTEMS

## Applications

On Shore	Abrasives Blasting	Ships, Oil Tanks, Gas Holders, Pipe Lines, Oil Rigs, Power Plants, Chimneys, Bridges, Water Tanks, Water Gates, Nuclear Facilities, Pools, Bioler Tubes, Etc.
	Water-Jetting	
	Grinding	
	Thermal Spraying	
	Painting	
	Cleaning	Ducts, Tunnels, Windows, Etc.
	Cleaning	Welding Seams, Coatings, Tunnels, Etc.
	Drying	Bottom Plates Of Oil Tanks, Etc.
Underwater	Abrasives Blasting	Ships, Oil Storage Tank Ships, Oil Rigs, Power Plants, Pipe Lines, Bridges, Water Tanks, Nuclear Facilities, Pools, Etc.
	Water-jetting	
	Thermal Spraying	
	Painting	
	Cleaning	Cooling Water Ducts, Aquariums, Etc.
	Cleaning	Welding Seams, Coatings, Etc.
	Inspecting	Nuclear Facilities, Etc.
	Decontaminating	

## "V-ROBO SYSTEMS" Actively Participating In Various Job Sites

"V-ROBO SYSTEMS" Have Numerous Patents And Proprietary Technologies.



Bridges



Oil Storage Ships



Oil Rigs



Ships



Power Plants



Nuclear Facilities



Tanks



Aquariums

- Agency -

**V-robo**®

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