E-beam Treatment of Toxic Wastes;
The Experiences in Pilot and Industrial Scale Plant

BUMSOO HAN / EB TECH Co.

Innovative Technologies for
### Waste Water Treatment and Marine Environmental Protection

Over the last 70 years, we have been benefited from new drugs and other chemical products in our quest for "Better Living through Chemistry".
It is estimated that about 80,000 different chemicals were released into the environment over this period.

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Human Stresses on the Land and Water Resources
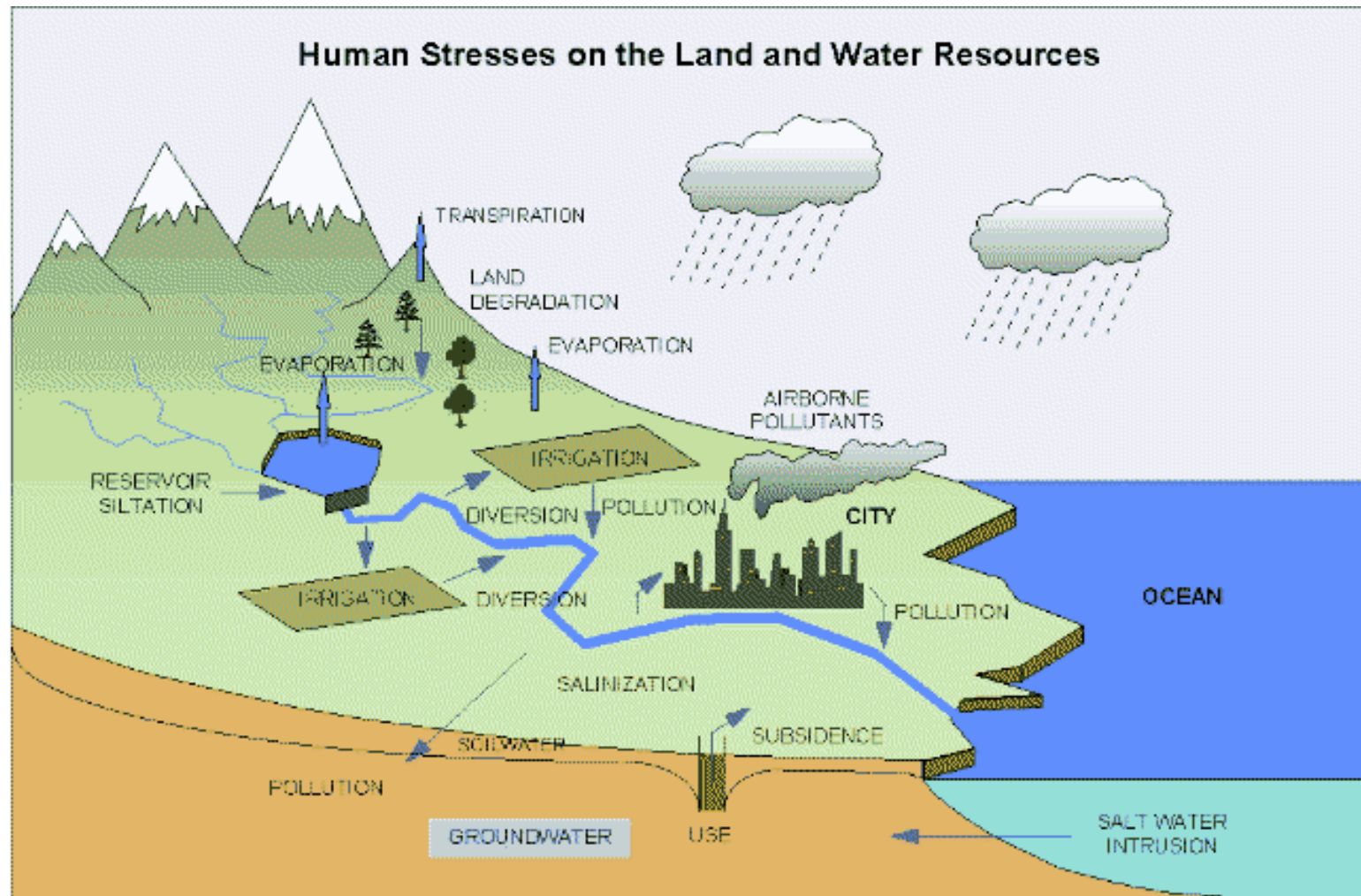
Typical routes to surface and ground water are treated domestic/industrial water, combined sewer overflows, septic tanks, animal feeding.
26 million organic and inorganic substances have been inventoried.

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Pollutants in wastewater :

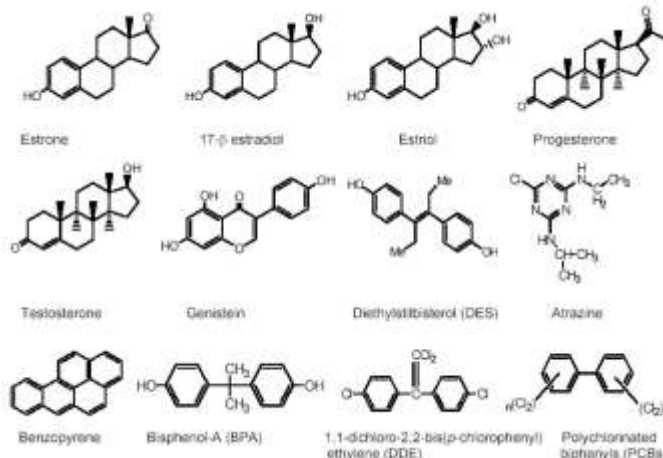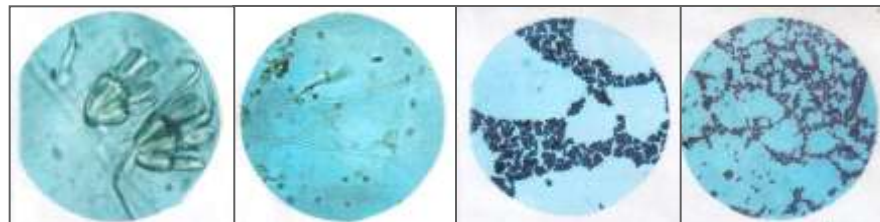**Pathogens**
Oxygen depleting organics
Nutrients (N,P)
Heavy Metals
Chemicals – POPs

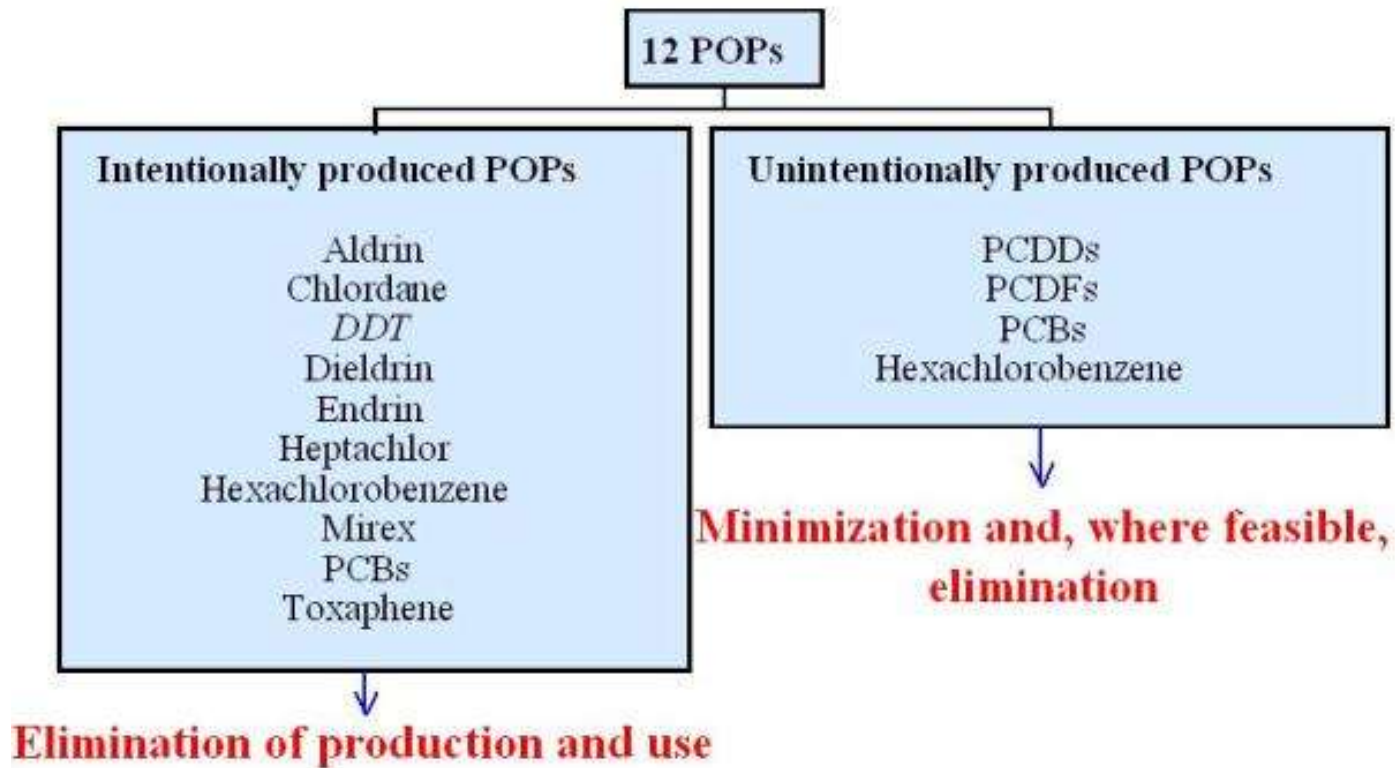   **Endocrine disruptors**
      Pesticide
      Pharmaceutical residues
      Plasticizer etc.

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                      ┌─────────┐
                      │ 12 POPs │
                      └─────────┘
        ┌──────────────────┴──────────────────┐
┌─────────────────────────┐      ┌─────────────────────────┐
│ Intentionally produced POPs │  │ Unintentionally produced POPs │
│                             │  │                             │
│         Aldrin             │  │         PCDDs              │
│         Chlordane          │  │         PCDFs              │
│         DDT                │  │         PCBs               │
│         Dieldrin           │  │    Hexachlorobenzene       │
│         Endrin             │  │                            │
│         Heptachlor         │  └─────────────────────────┘
│     Hexachlorobenzene      │              │
│         Mirex             │               ▼
│         PCBs              │    Minimization and, where feasible,
│         Toxaphene         │            elimination
└─────────────────────────┘
              │
              ▼
Elimination of production and use
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Persistent Organic Pollutants (POPs) : organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bioaccumulation in human and animal tissue, biomagnify in food chains.

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Water Molecule → **Active Radicals** (e_{aq}, OH*, H*, H_2O_2) → **Harmful Organic in Wastewater**

- Complete Decomposition → H_2O, CO_2
- Partial Decomposition ⎤
- Suspended Solid ⎬ → Coagulation
- Monomer to Polymerization ⎦
- Removal of Toxic Group → Bio-Treatment
- Removal of Color, Odor
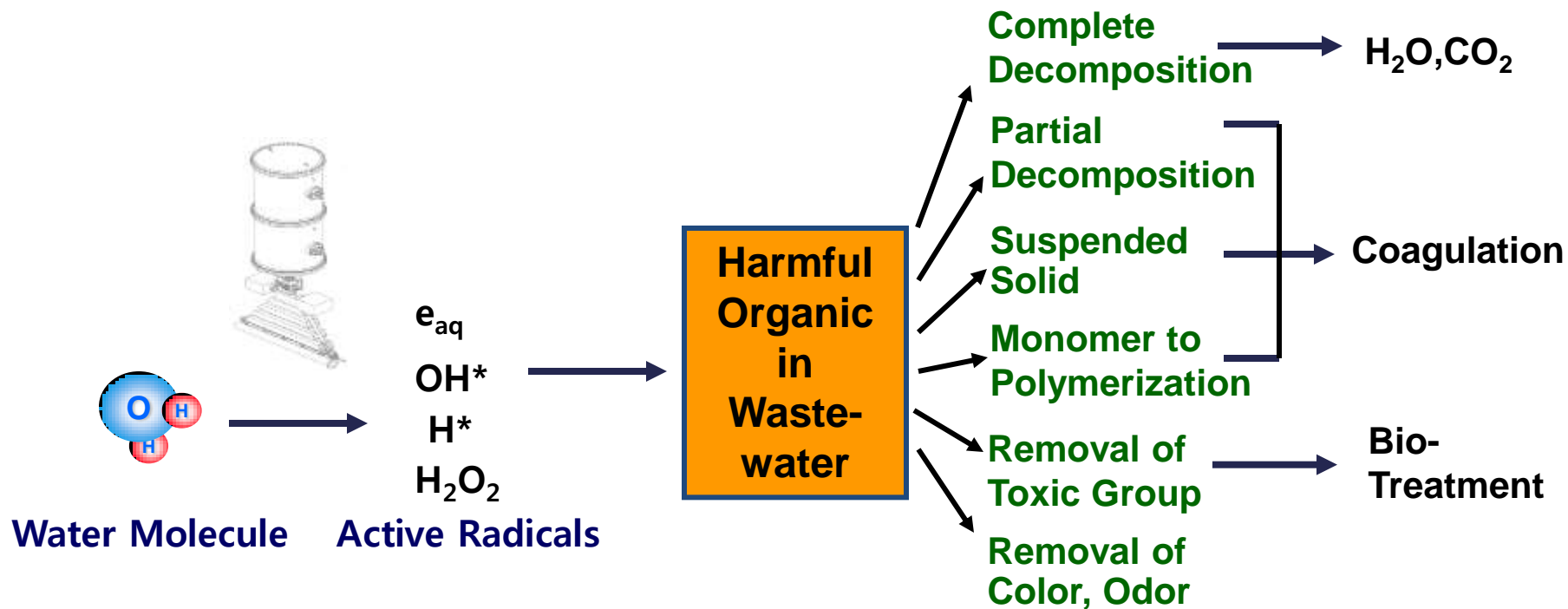
Radiation technologies are effective means of remediation on ecological and economic damage to aquatic ecosystems and are well-proven to practical environmental problems, such as municipal and industrial wastewater remediation and treatment, sludge treatment and reuse. The ionization and excitation of water molecule by high energy radiation produces free radical to treat liquid streams for invasive organisms (in marine ballast water) and trace organics like persistent organic pollutants (POPs), and other trace constituents.

High energy irradiation of aqueous solutions generates highly reactive radicals that can interact with a wide range of pollutants. Laboratory research on industrial wastewaters and polluted groundwater was conducted in the 1970s and 1980s, and in the 1990s several pilot plants, including mobile EB facilities, were built.
The first such full-scale application is combined radiation and biological treatment of textile dyeing wastewater of 10,000 m^3/d using with 1 MeV, 400 kW accelerator.
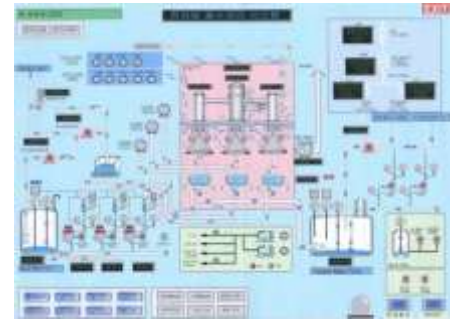
Lab. Scale Experiments (1~50m³/day)

Industrial scale Wastewater Plant (10,000m³/day)

Pilot scale (500~1,000m³/day)

or limited storages

Lab. Scale Experiments (1~10,000Nm³/h)

Industrial scale EBFGT Plant (~600,000Nm³/h)

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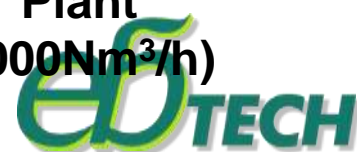
Pilot scale Experiments
(~500m^3/day of water)
(~2,000Nm^3/h of gas)

MOBILE ACCELERATOR
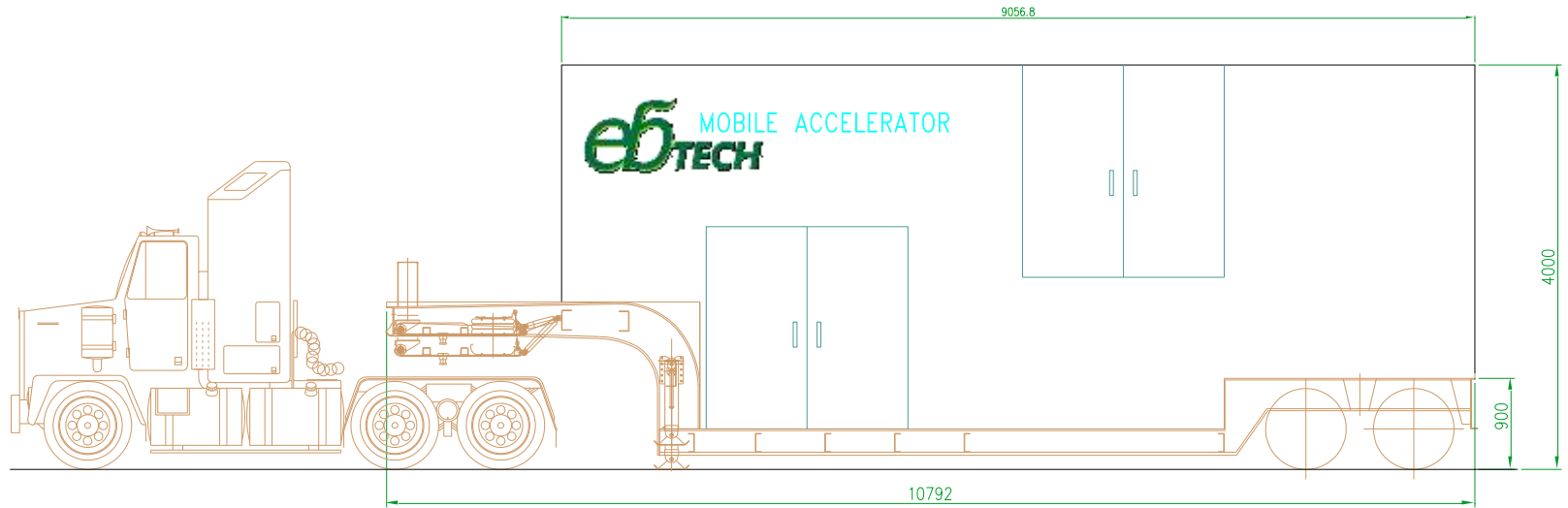
Beam Energy : 0.4~0.7MeV,   Beam Power : 20kW

Self-sustaining system : Self-shielded accelerator

Built-in control and monitoring room

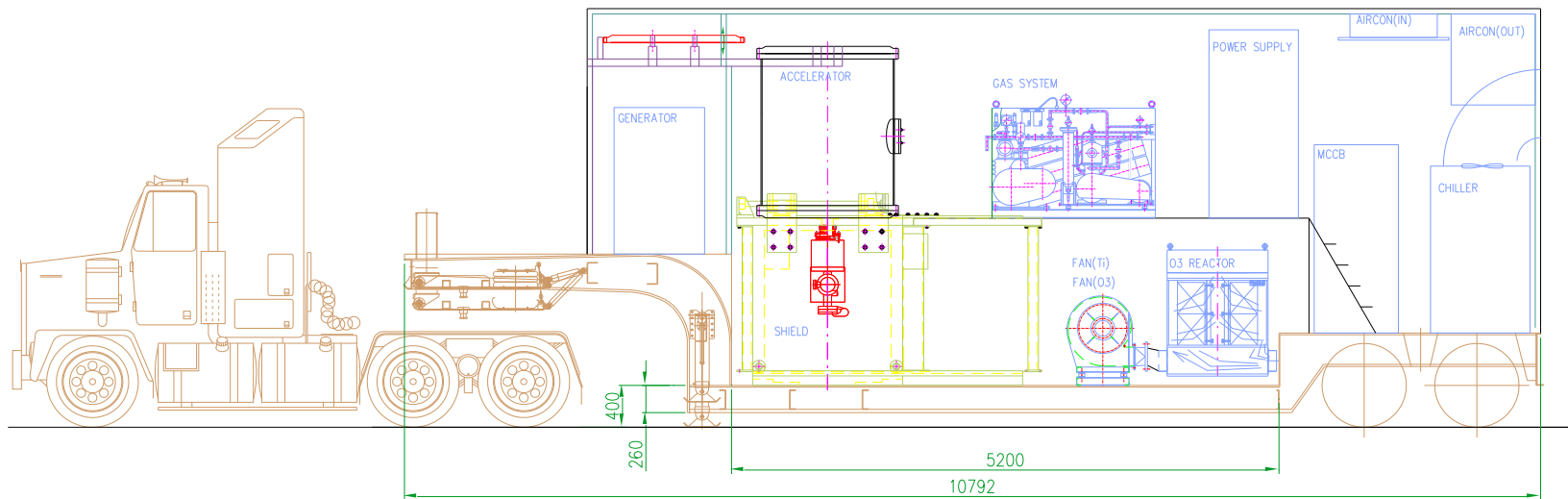**Diesel electricity generator (option)**

Trailer and Shelter : Fit to U.S. and world standard

Total weight : 40 tons (trailer only 30ton)

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Built-in Computerized Experimental & Monitoring System

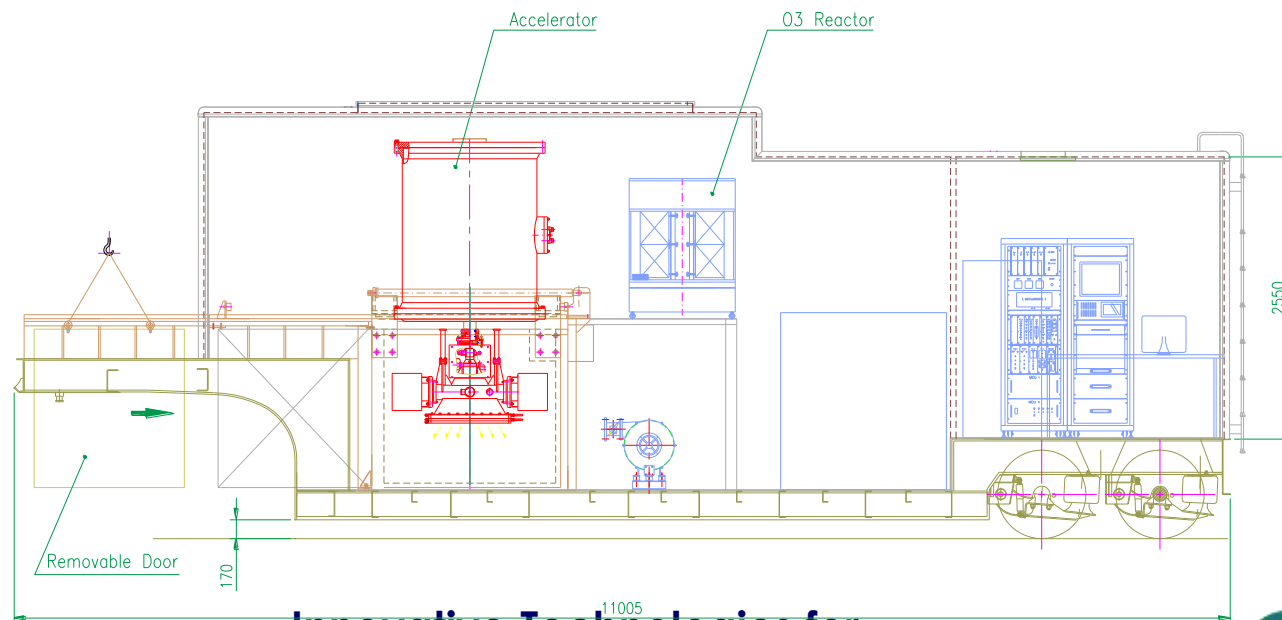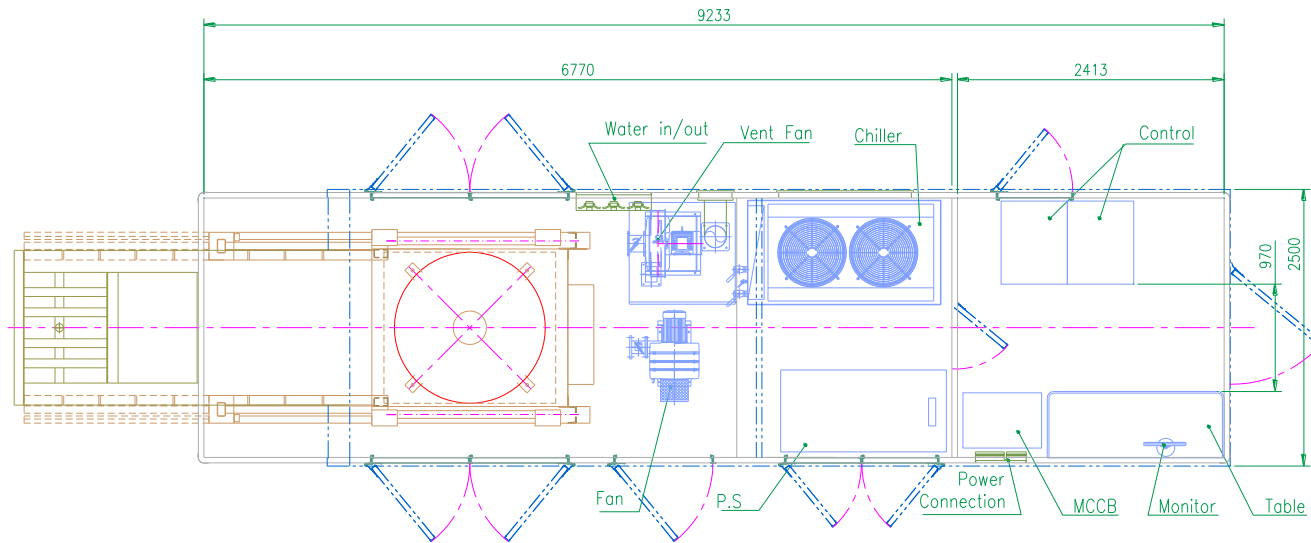**Continuous Treatment of Wastewater/Flue gas on site**

Treatment Capacity : Liquid waste : 500m^3/day   (at max. 2kGy)

Gaseous waste : 2,000Nm^3/h   (at max. 15kGy)

**Innovative Technologies for
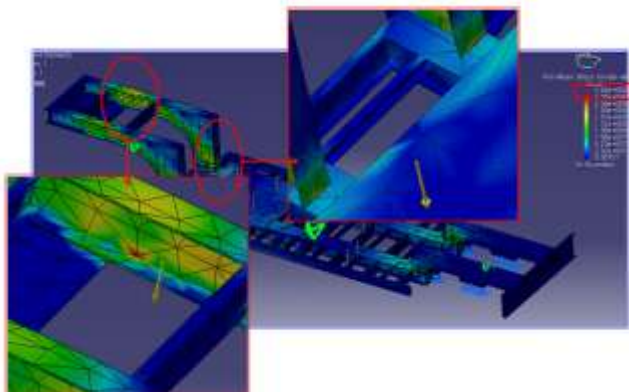Waste Water Treatment and Marine Environmental Protection**

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Waste Water Treatment and Marine Environmental Protection**

-.Structural Analysis and Other calculations

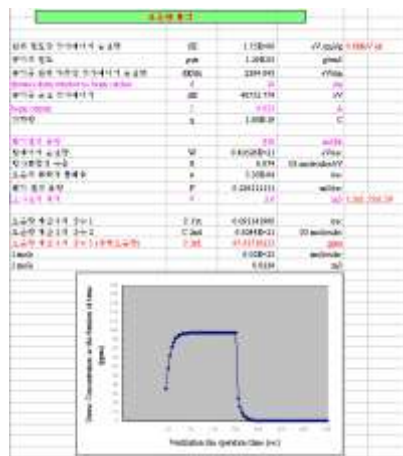Structure stress simulation

fluid calculation

Heat & Cooling calculation

Ozone simulation
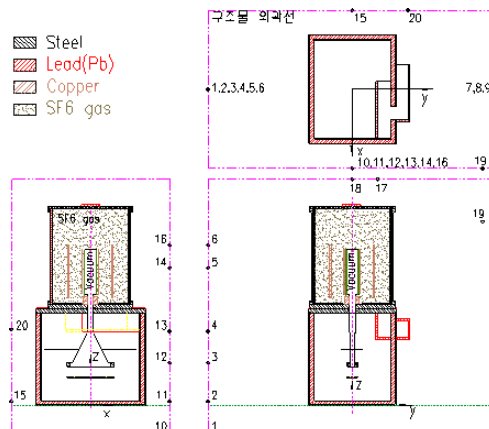
MCNP shielding calculation

Vessel ASME

ETC

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First Barrier—
(Steel+Lead+Steel)

Second barrier—

Polyethylene(PE)10mm-assume for MCNP
(real 50mm: EpoxyGlass+Urethane+EpoxyGlass)

-.Radiation leakage calculation under ICRP with MCNP (Monte Carlo) Simulation

E-E (1:20)

F-F (1:20)

D-D (1:20)

G (1:10)

H (1:10)

N (1:10)

L (1:10)

J (1:11)

K (1:10)

M (1:10)

First Barrier (Steel+Lead+Steel)

Second barrier
Polyethylene(PE)10mm-assume for MCNP
(real 50mm: EpoxyGlass+Urethane+EpoxyGlass)

copper

steel

lead

Specification (Electron Accelerator & Barrier)
+ Electron energy : 0.6MeV
+ Electron beam current : 33mA
+ Max. Power : 20kW
+ Extracton window size : 640mmx75mm
+ Barrier Mat'l : (Steel+Lead+Steel)
+ Length unit : [mm]

DESIGN	CHECK	APPROVE	DATE
WG Kang	SH Kuk	SM Kim	2010-07-05

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TITLE
Accelerator & Barrier layout

DWG NO.	EDIT	file
E03-40-013		Shield

North

North

Coordinate Unit : [cm]

15(-225,260.3,156)

16(-225,0,156)

11(-225,260.3,56)

19(-126,0,56)

12(-225,0,56)

18(0,-344.7,156)

17(-225,-344.7,156)

14(0,-344.7,56)

20(-126,-246,56)

13(-225,-344.7,56)

Ground

Z

5(225,-344.7,156)

9(126,-246,56)

1(225,-344.7,56)

6(225,0,156)

8(0,260.3,156)

10(126,0,56)

2(225,0,56)

7(225,260.3,156)

4(0,260.3,56)

X

Y

Ground

3(225,260.3,56)

DESIGN	CHECK	APPROVE	DATE
WG Kang	SH Kuk	SM Kim	2010-07-02

TTITLE
Detector Coordinate for MCNP

EB tech Co.,LTD.

DWG NO.	EDIT	file
E03-40-022		MCNPDetector

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EUTECH

Trailer

Vessel

Shield   **Innovative Technologies for Shelter**
Waste Water Treatment and Marine Environmental Protection

A MOBILE ACCELERATOR SYSTEM

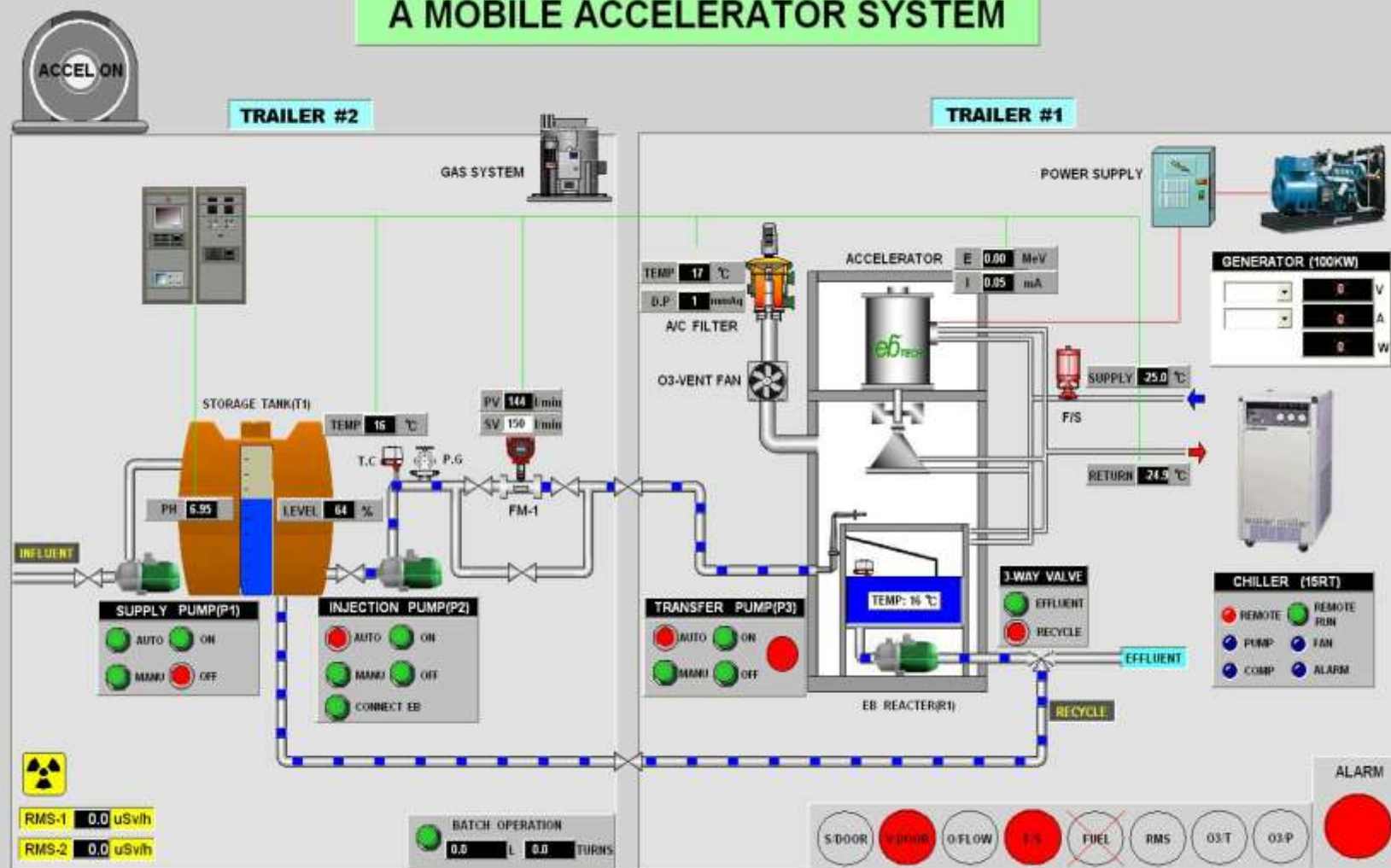**Innovative Technologies for Waste Water Treatment and Marine Environmental Protection**

Mobile e-beam in Flue gas Purification from the oil-refinery in Saudi Arabia

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Mobile e-beam in Flue gas Purification from the oil-refinery in Saudi Arabia

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Summary

Water pollution, by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters, especially wastewater contaminated with chemical contaminants are getting more concerns in recent days. They are toxic and resistant to environmental degradation.

Radiation technology is quite effective for remediation of wastewater contaminated with POPs and other chemicals. When wastewater are irradiated with high energy electron practically all the energy absorbed is deposited in water molecules, and the ionization and excitation of water molecules entail which is known to result in formation of free radical and molecular species to destroy or to convert the harmful chemicals.

In order to avoid the contamination in environment with toxic chemicals, the radiation technologies will be an important role to remove them or to make them less harmful to the environment.

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