Safety and Efficacy of Continuous Effluent Decontamination

Presented to: Chesapeake Area Biological Safety Association

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www.wr2.net

WR²

Waste Reduction by Waste Reduction, Inc.

Offers engineered, patented technologies for the safe decontamination and disposal of effluent, clinical, and animal carcass wastes

When you are building a world class biocontainment facility, the last thing you need to worry about is whether the Effluent Decontamination System (EDS) or Carcass Disposal System (Tissue Digestor) will service your facility safely, and reliably, for decades to come.

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Biocontainment facilities have three basic categories of effluents

- Air
- Solid Wastes
  - –Contaminated Waste
  - –Animal Carcasses
- Liquid Effluent

Some sources of liquid effluent

- Sinks
- Toilets
- Showers
- Floor Drains
- Animal Areas
- Autoclaves
- Other Equipment

Some solids that may be present

- Animal Food
- Bedding Residues
- Feces with grass (animal and lab worker)
- Paper / Toilet Paper
- Sand (from primate biscuits, animal faeces)
- Soil (from animal feces)
- Hair
- Other Various Items Inadvertently Flushed (paper clips, screws, plumbing parts, mop string, wedding rings, etc.)
- Solids can be minimized with screen traps in containment but must also be considered in EDS system design

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Some chemicals that may be present

- Chlorides (from bleach, hydrochloric acid, etc.)
- Acids – most are damaging (including phosphoric, hydrochloric {muriatic}, and other harmful acids)
- Alkali's are beneficial (KOH, NaOH, CaO, etc.)
- Detergents / Soaps
- Disinfectants (quats, phenols, chlorine compounds, peroxide, aldehydes, ammonia, etc.)
- Formalin / Formaldehyde / Glutaraldehyde
- Reagents
- Chemicals that are damaging to EDS systems are dramatically more so at elevated temperatures (Ahrennius' law)

All Effluent Decontamination Systems (EDS) should be viewed as Continuous

Some EDS designs can produce sterile effluent, and some EDS designs can produce only disinfected effluent.

Some EDS designs handle solids well, and some do not.

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What type of EDS do you need?

- What size of EDS do you need (maximum total gallons per day, and maximum gallons per minute flow rate)?
- What solids will be present in the effluent and in what quantity?
- What chemicals will the EDS see and in what concentrations (net)?
- What are your cost constraints?
- Is redundancy (24/7/365 operation) important? In other words, can you shut down your liquid flow from your lab for a few days if necessary to repair a failed EDS system?
- What would happen if your system failed and backed up contaminated water into your lab? Where would if flow once it breached containment?
- Would you attach your EDS to emergency power?
- Is sterilization important (what is the most dangerous organism you are working with)? What is the likelihood of working with prions in the future?
- Must you validate sterilization with continuous parametric monitoring or periodic biological testing, or both?
- Is disinfection adequate for your needs?

Types of EDS Systems

Yellow systems sterilize, Green systems disinfect

- Multi-Vessel, High Temperature, Continuous Batch, Self Cleaning EDS with circulation and solids handling features (Alkaline Hydrolysis option Available)
- Multi-Vessel, High Temperature, Continuous Batch EDS with destratification design (no pump)
- Single or Multi-Vessel, High Temperature, Continuous Batch EDS with collection/grinding/feed tank (can double as a Tissue Digestor)
- Continuous Flow, High Temperature, EDS
- Continuous Flow, Thermo-Chemical EDS
- Continuous Batch Chemical EDS

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Multi-Vessel, High Temperature, Continuous Batch, Self Cleaning EDS with circulation and solids handling features (Alkaline Hydrolysis option Available). **This is our premier recommended system.**

Pros:

- Uniform temperature throughout
- Uniform effluent sample possible
- Can use integral solids basket
- Can use a grinder pump for heavy solids applications
- Self cleaning (no buildup)
- Heats faster
- Anti-corrosive physics of flow
- Allows alkaline hydrolysis feature
- Can pump to drain
- More process monitoring criteria
- Less steam jacket complexity
- Can use a heat exchanger for heating
- Reliable

Cons:

- Pumping system requires maintenance

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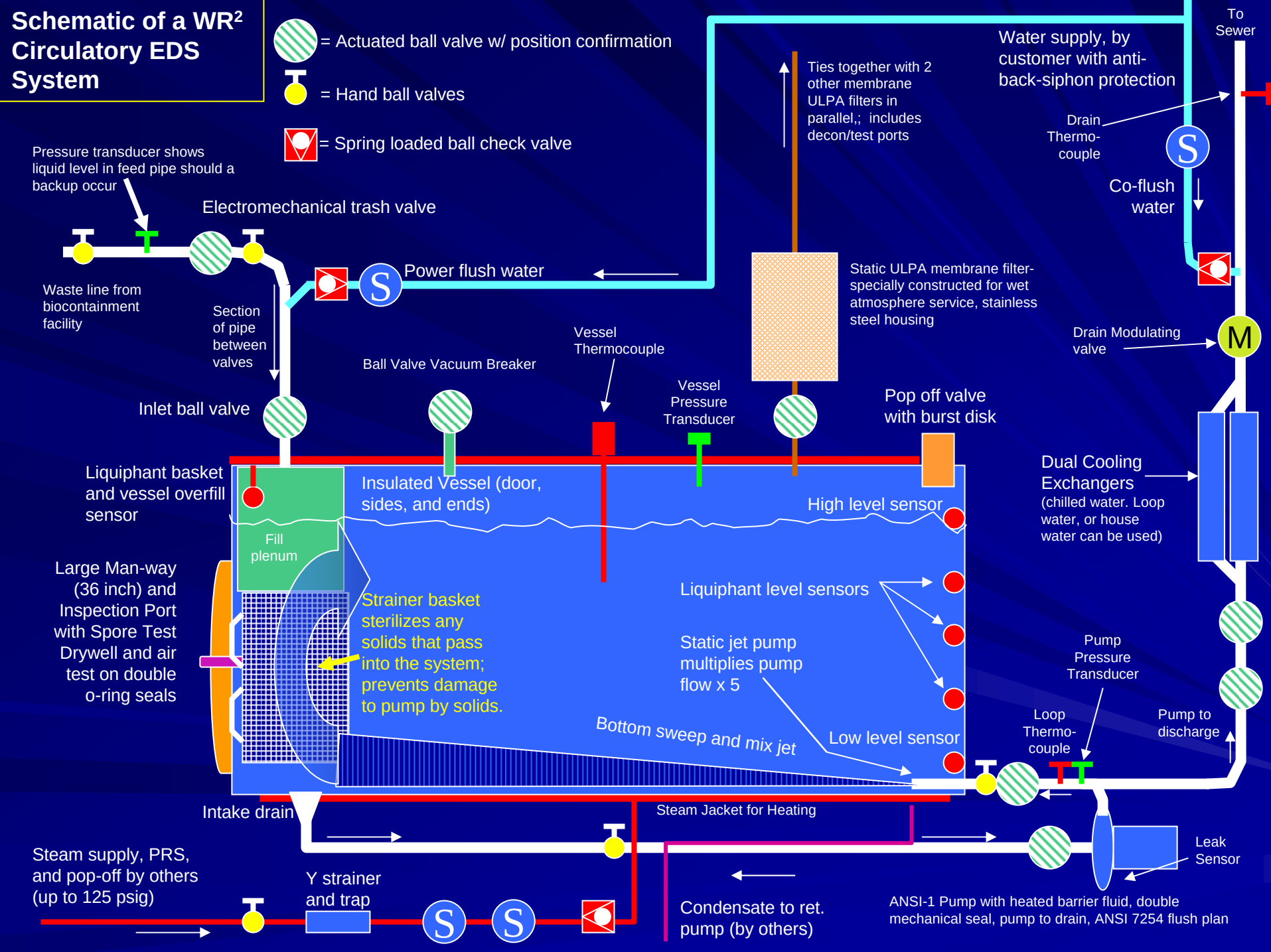
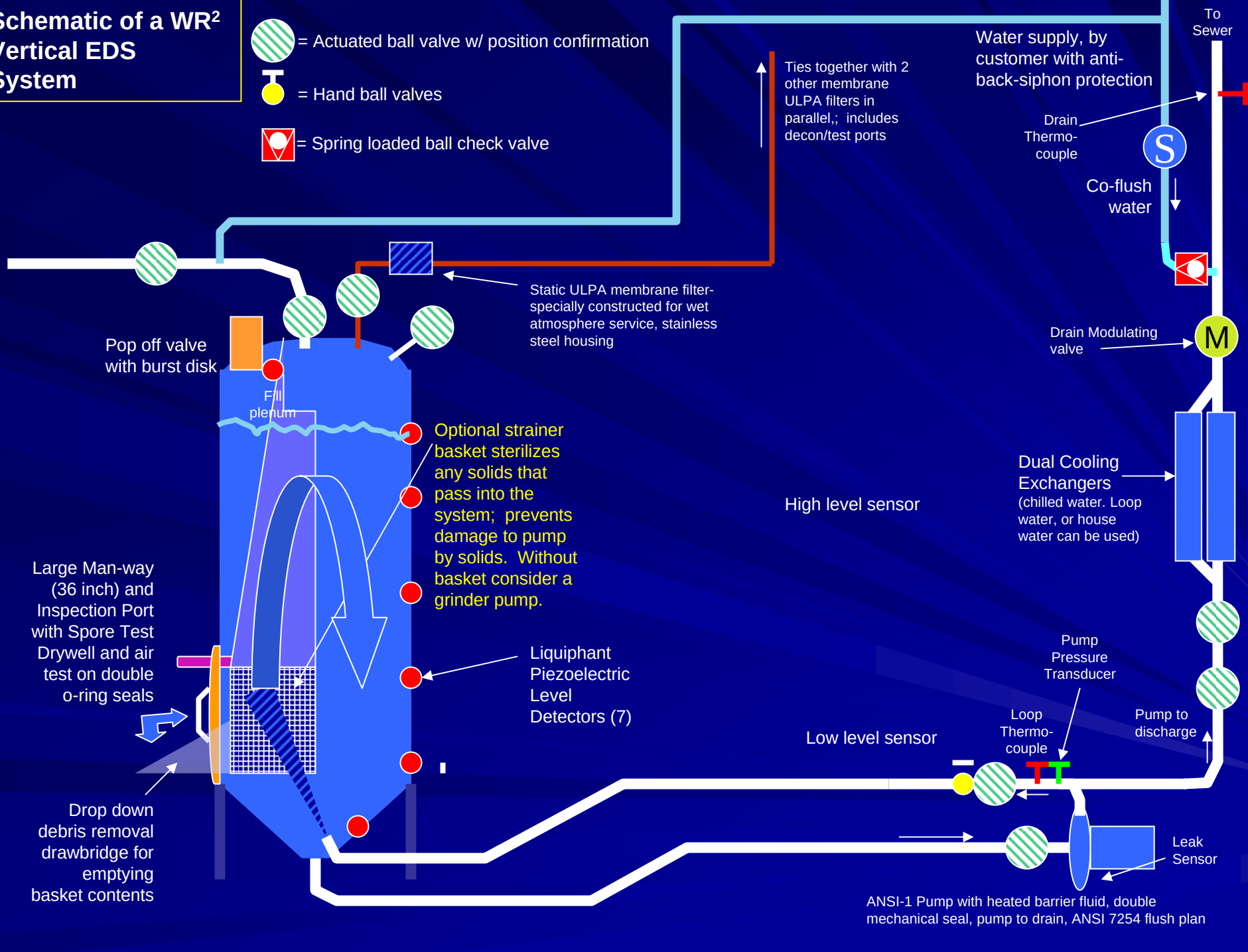
Schematic of a WR² Circulatory EDS System



Schematic of a WR² Vertical EDS System



Multi-Vessel, High Temperature, Continuous Batch EDS with destratification design (no pump)

Pros:

- No pump to fail
- New technology takes destratification to a new level of sophistication and performance
- Reliable

Cons:

- Solids can build up; requires periodic cleaning (some automated, some not)
- Cannot use integral solids basket
- Slower to heat; cannot use heat exchanger for heating
- More prone to pitting corrosion
- Drip leg ball valve vulnerable
- Must run at higher temperature to assure treatment in lowest parts of system
- Non-uniform effluent (sampling is not representative cross section of contents)
- Hot drip leg and double drip leg ball valves a must
- More steam jackets required / more steam feed valves

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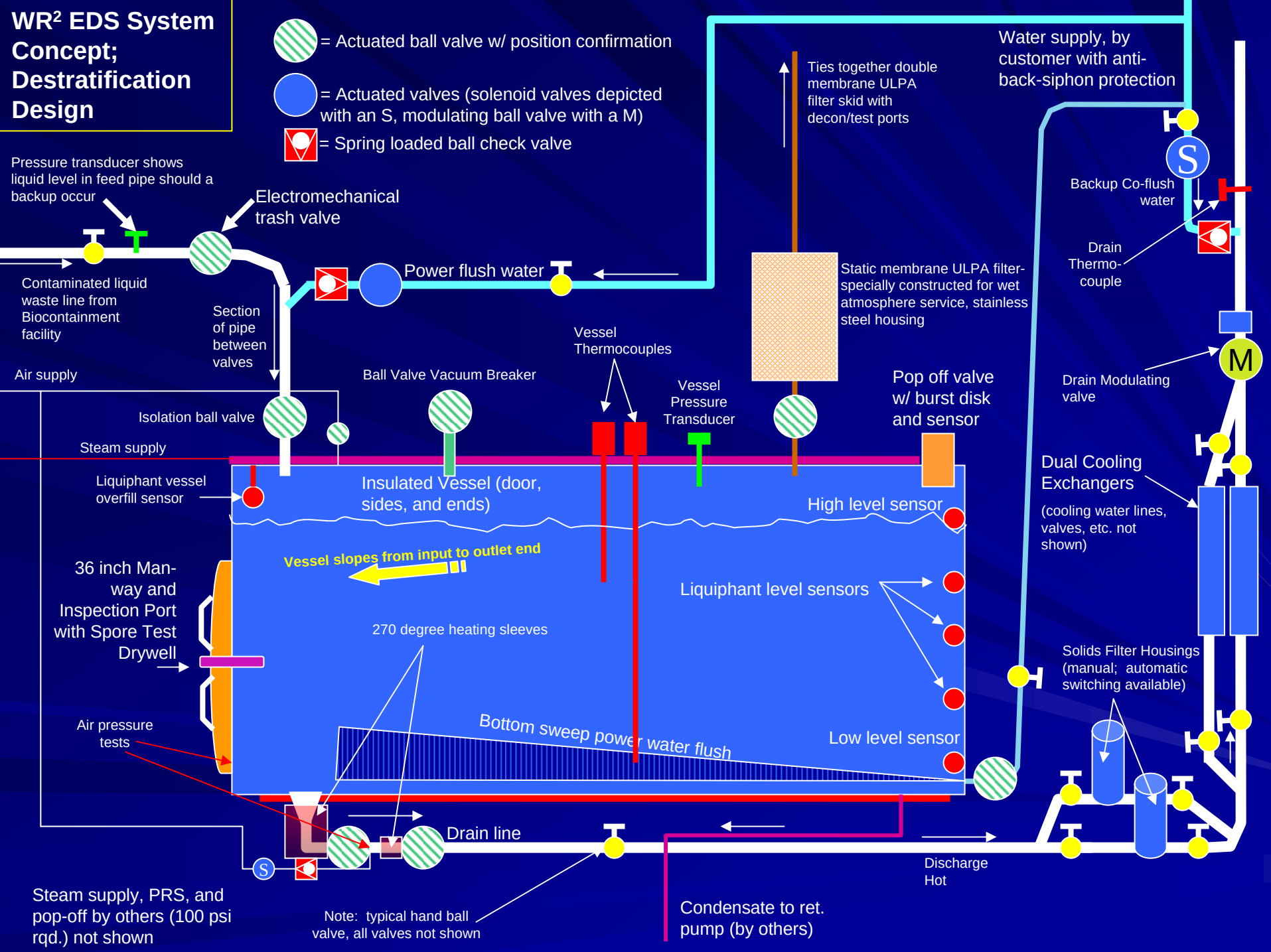
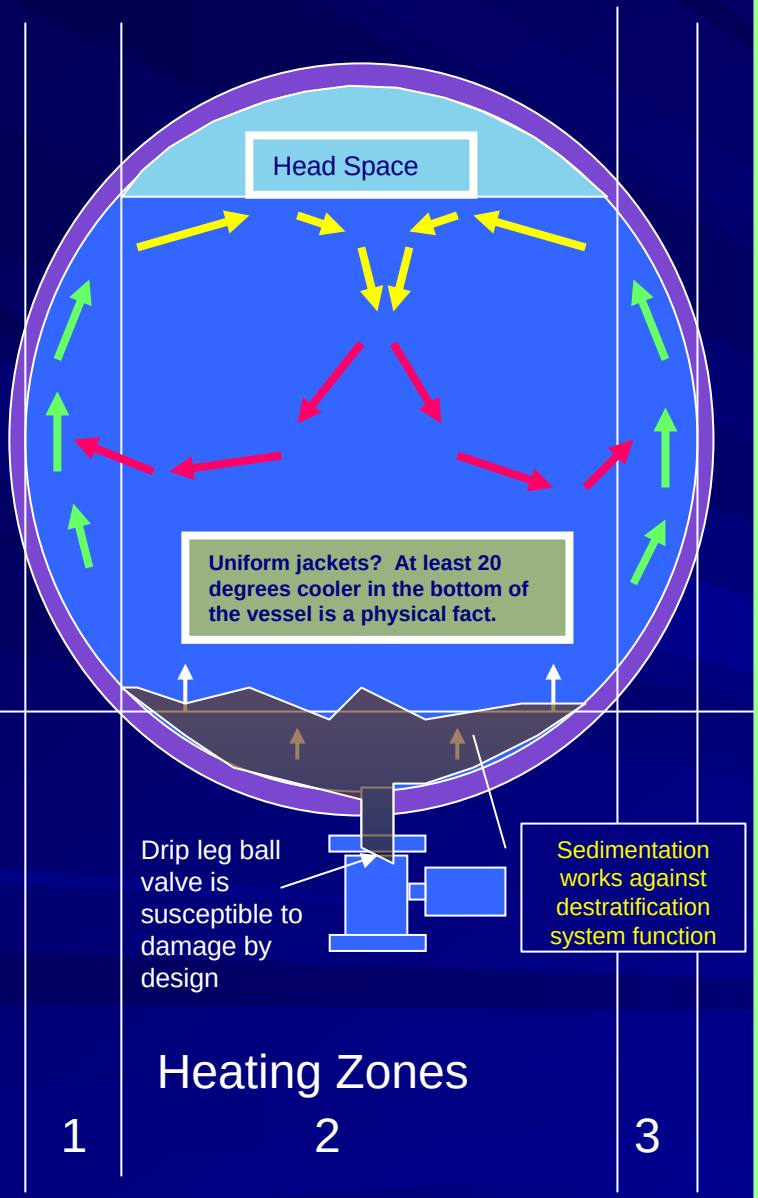
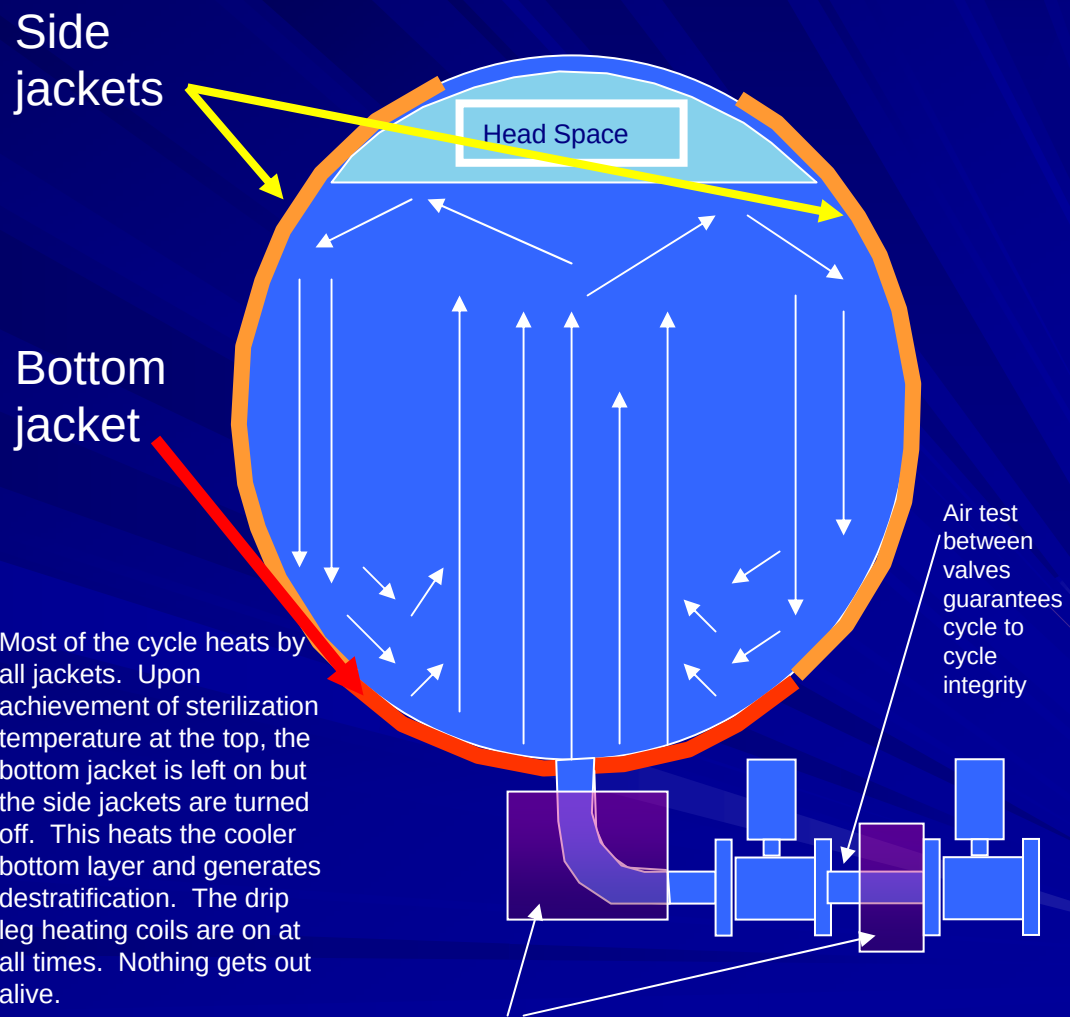
WR² EDS System Concept; Destratification Design



Typical Destratification Scheme Results in Stratification by design



WR² Destratification Scheme Results in Uniform Temperature Throughout the Vessel



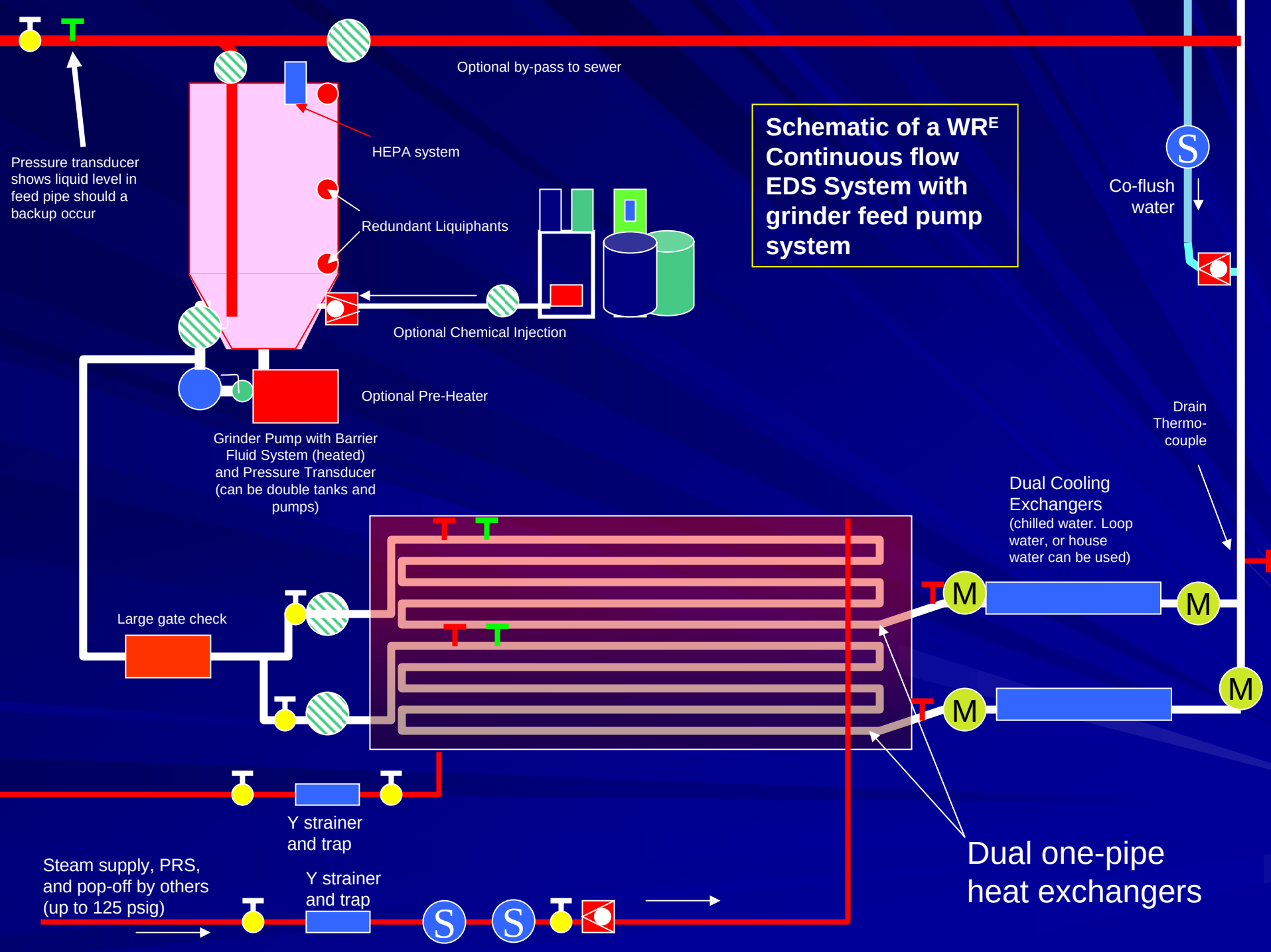
Continuous Flow High Temperature or Thermo-Chemical EDS

Pros:

- Continuous operation
- Always hot / always ready
- Can be done thermally, or thermo-chemically
- Suitable where sterilization failure is not as critical
- Can incorporate chemicals
- Small systems can be more cost effective than small batch systems, especially if thermo-chemical
- Thermal enhancement to chemical treatment improves chemical activity by over 100 fold (Ahrennius again)

Cons:

- May to be redundant (parallel systems)
- Only as good as the motive force (pump) and the modulating valve (backforce)
- Requires a feeding tank to do it correctly
- Flow through pipes is not uniform; must be considered in design
- Less secure than continuous batch systems, failure results in contaminated release to sewer
- Solids can cause problems in the modulating system (should be pre-ground in a grinding / feeding tank)
- Difficult to validate but not impossible


Schematic of a WR^E Continuous flow EDS System with grinder feed pump system
Optional by-pass to sewer
HEPA system
Pressure transducer shows liquid level in feed pipe should a backup occur
Redundant Liquiphants
Optional Chemical Injection
Co-flush water
Optional Pre-Heater
Grinder Pump with Barrier Fluid System (heated) and Pressure Transducer (can be double tanks and pumps)
Drain Thermo-couple
Dual Cooling Exchangers (chilled water. Loop water, or house water can be used)
Large gate check
Y strainer and trap
Steam supply, PRS, and pop-off by others (up to 125 psig)
Y strainer and trap
Dual one-pipe heat exchangers

EDS Materials and Ratings

- In the past EDS components have been made from carbon steel or type 304 stainless steel. These are not an option; they will not hold up to the chemicals used in today's laboratories
- Type 316-L stainless steel is the minimum standard for vessels, and would normally suffice if care is taken with the types and amounts of chemicals to be processed. Type 316-L stainless steel is the material that is most used on EDS systems.
- More expensive super-austenitic stainless steel may be required for vessels and pipes if excessive chlorides or specific acids are to be a routine part of the effluent stream
- High pressure systems should be 125 psig vessels

What Should You Expect from Your EDS System Provider?

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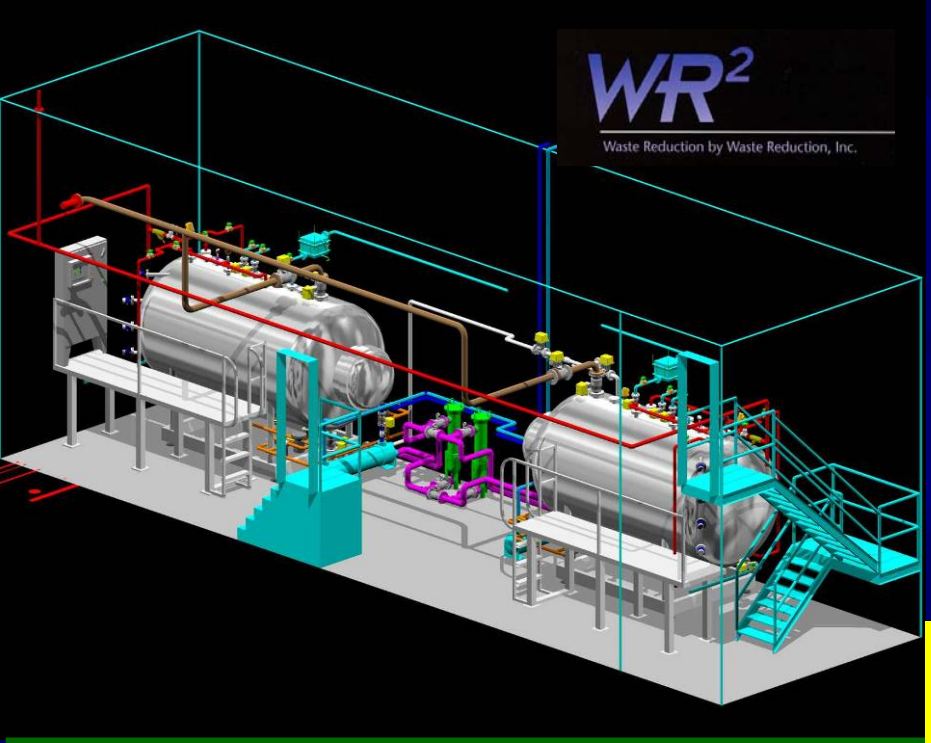
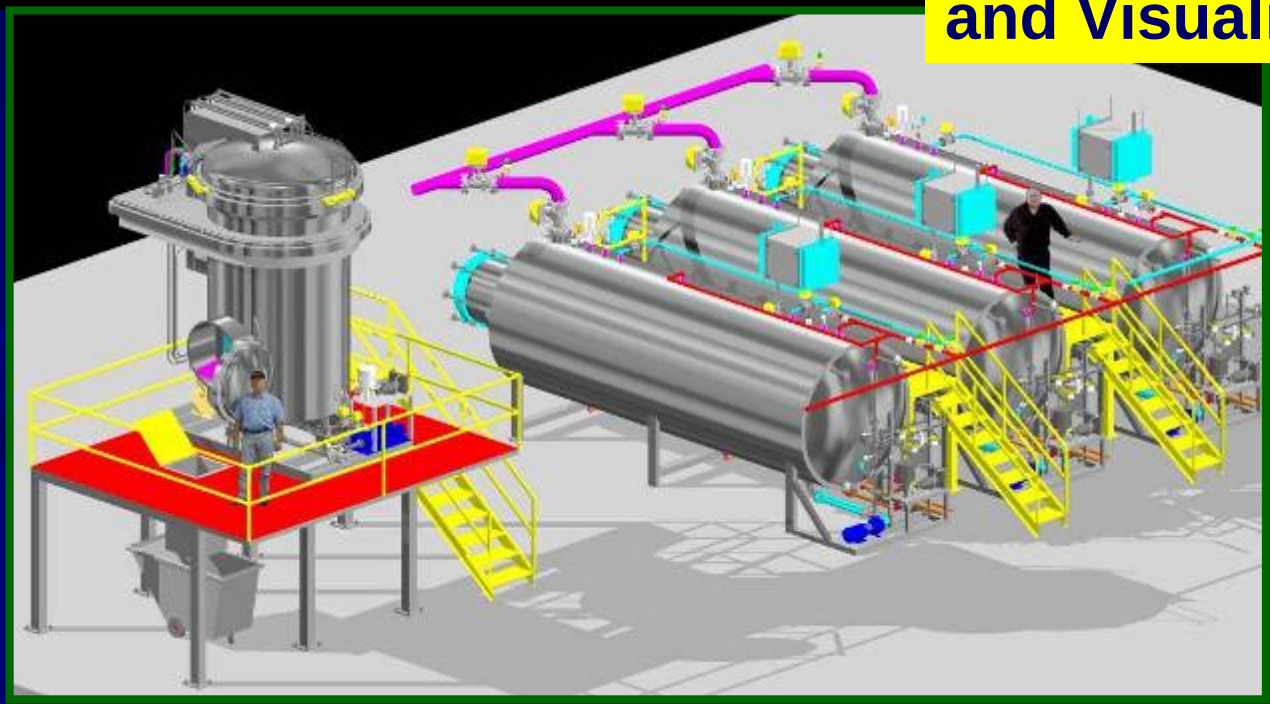
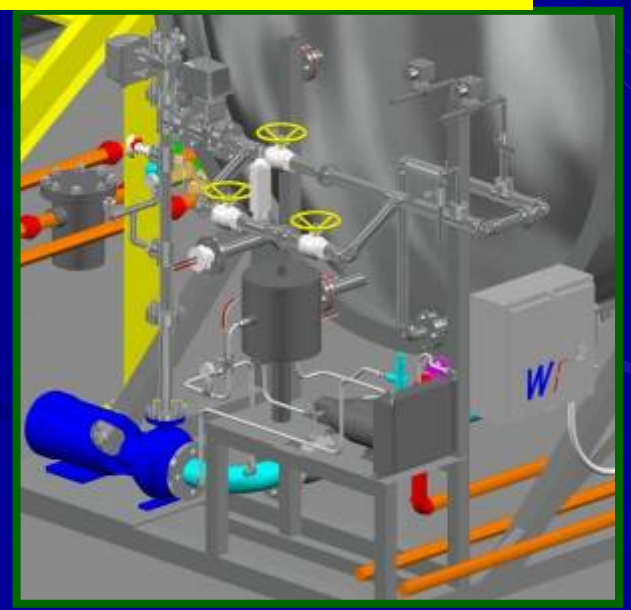
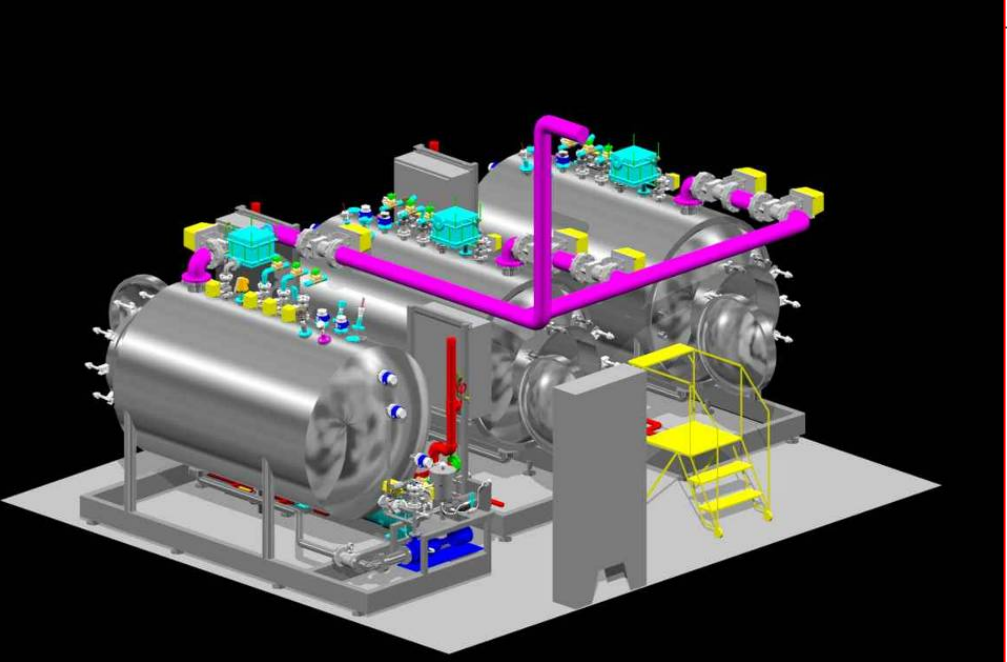
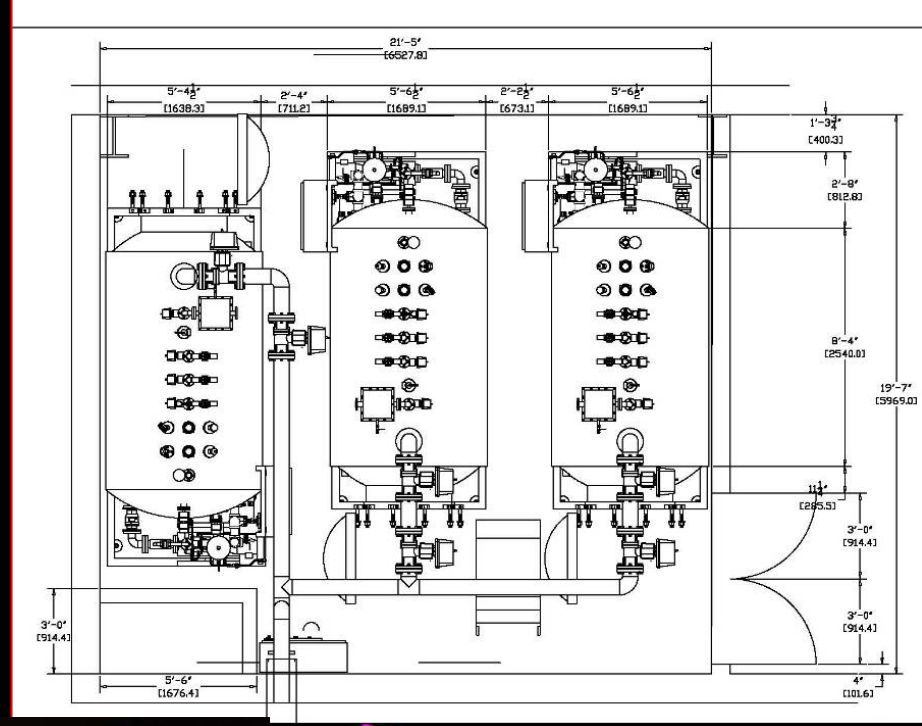


EDS Design Assistance and Visualiazation

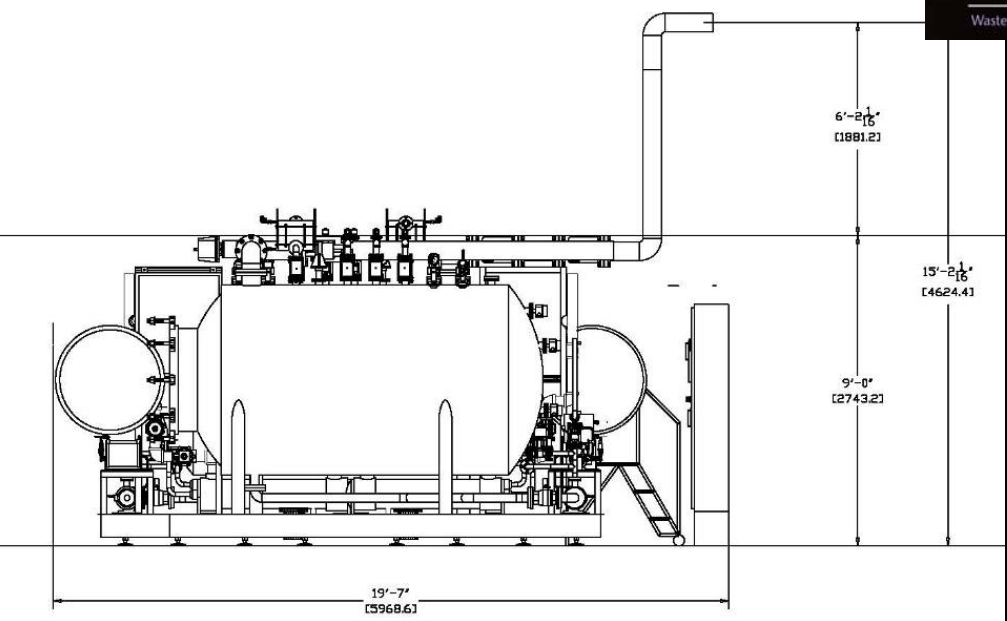








EDS Layout in your space



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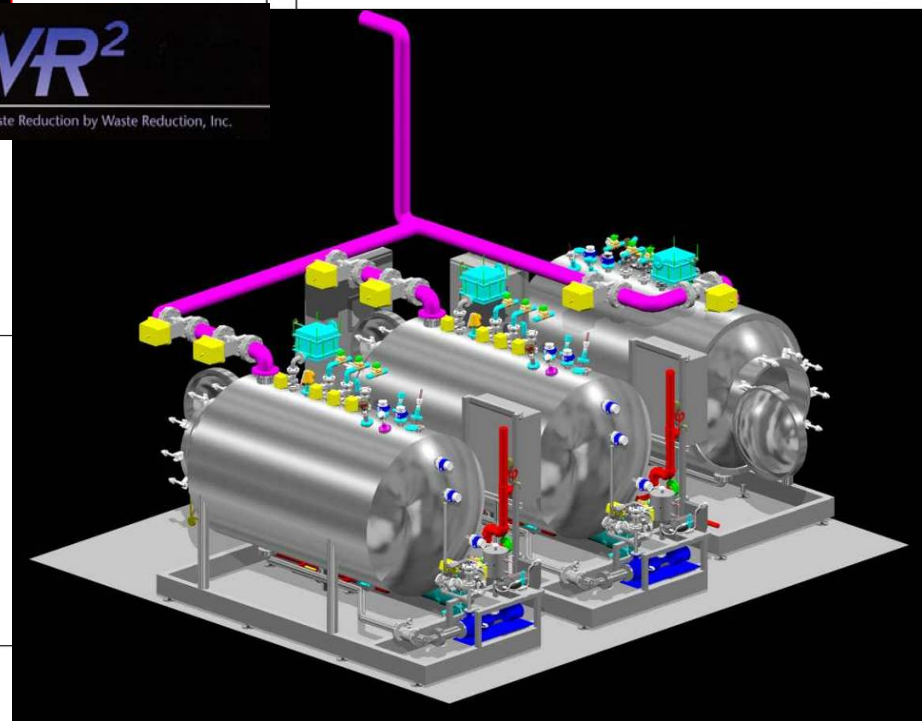
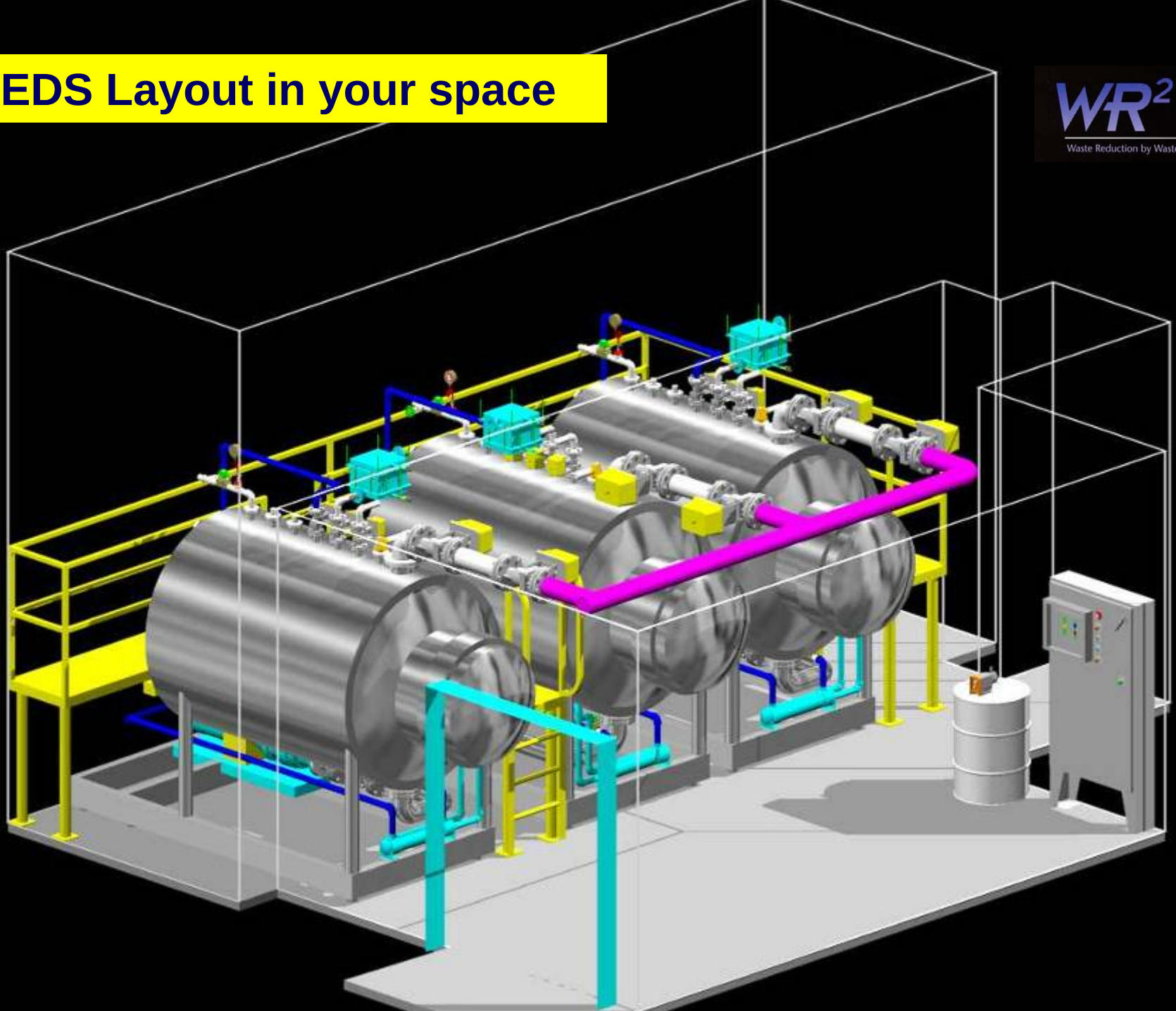


EDS Layout in your space



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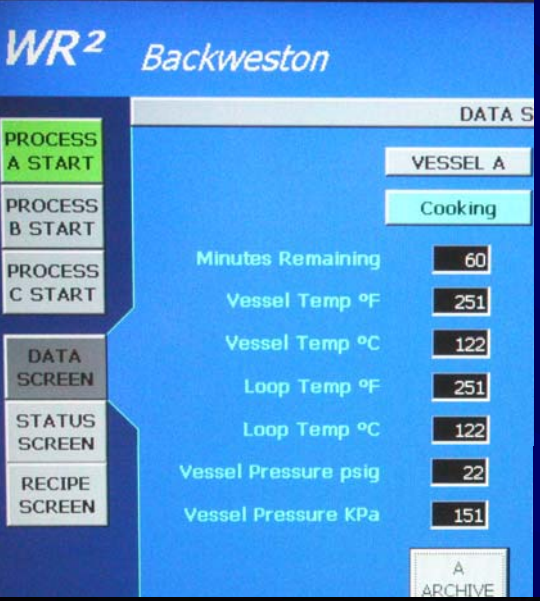
EDS Manufacturing



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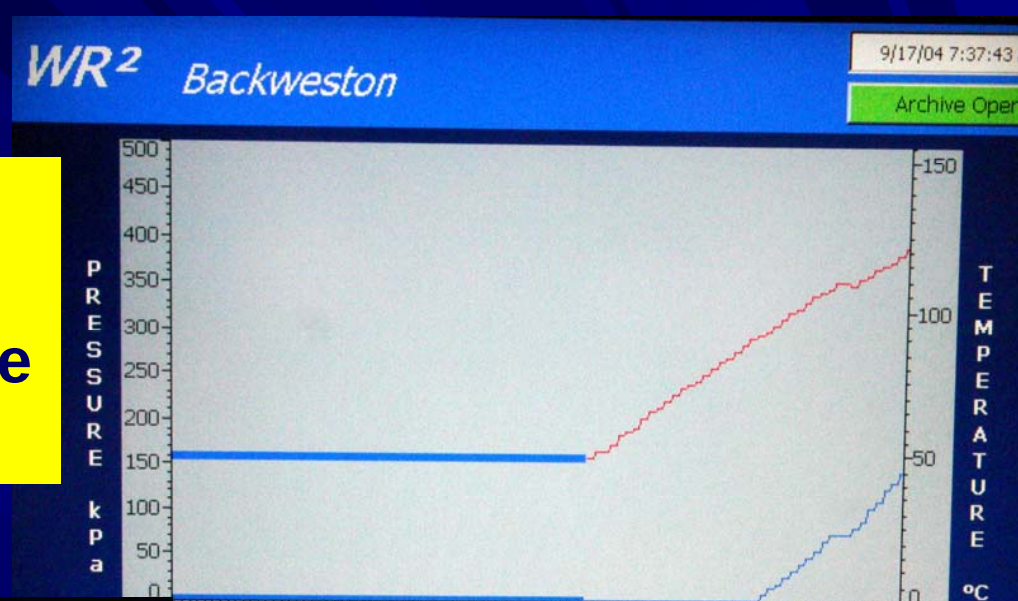
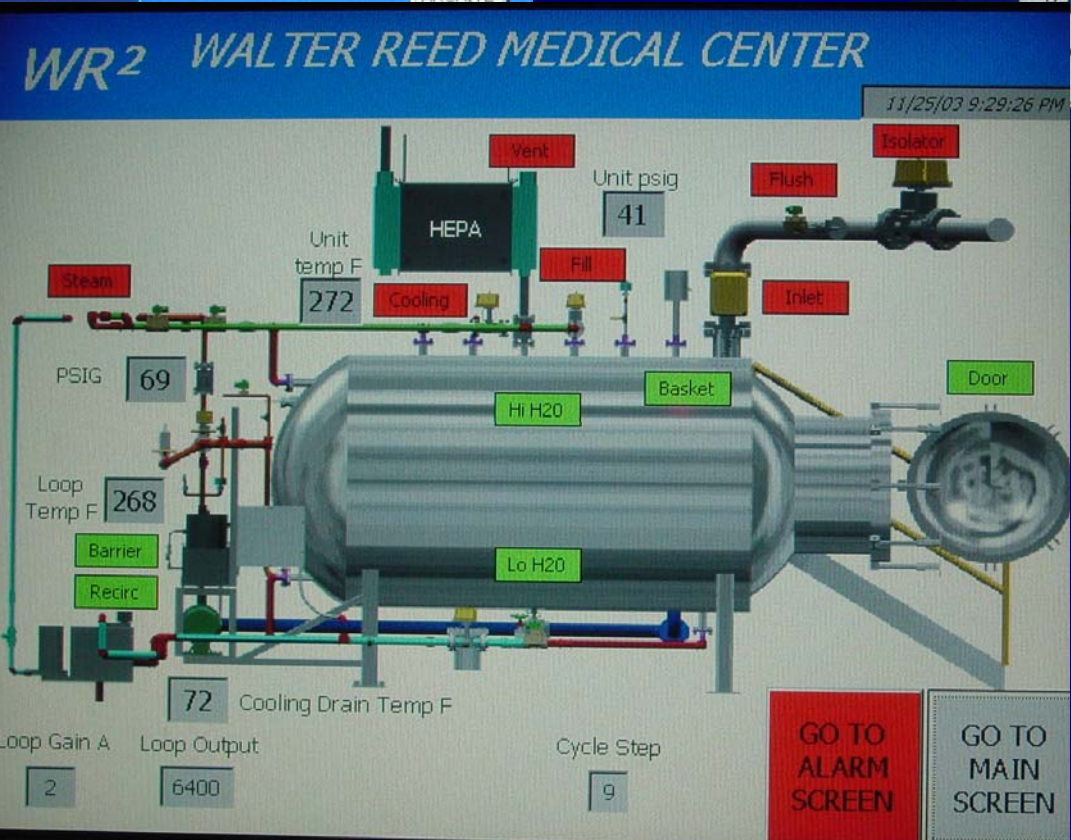
EDS Factory Acceptance Testing





EDS Delivery

EDS Installation

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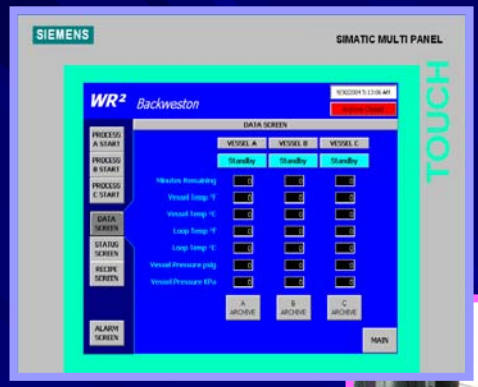
EDS Commissioning



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Cutting Edge Features

Effluent Decontamination System at Armed Forces Institute of Pathology, Walter Reed

If you must, a Pre-Grinder / Feed tank up to the task

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All stainless construction, and NO LOAD CELLS!

Wire runs between units limited to a data cable

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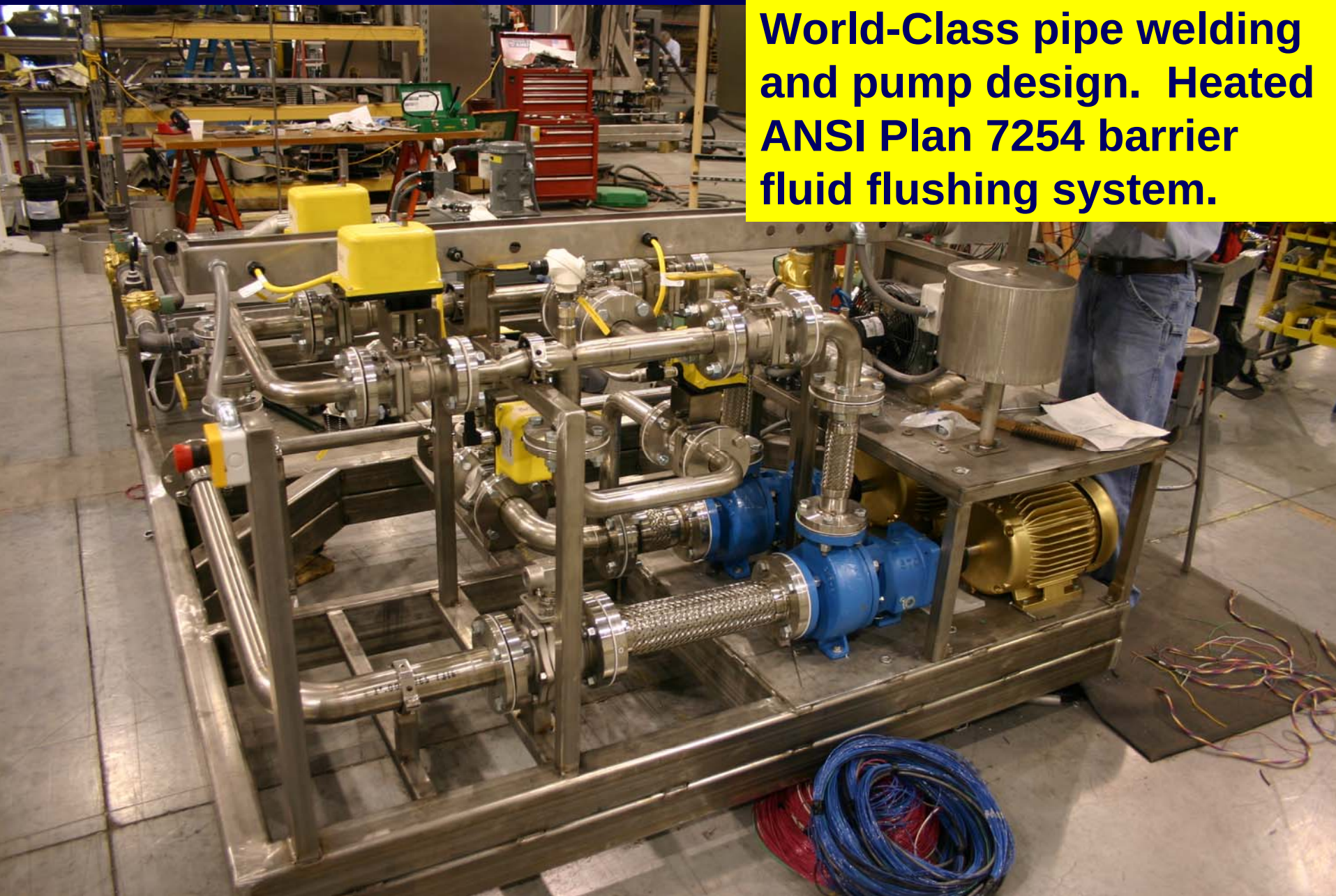

World-Class pipe welding and pump design. Heated ANSI Plan 7254 barrier fluid flushing system.

Intuitive, Automated System Control with On-line Diagnostics and Programmability

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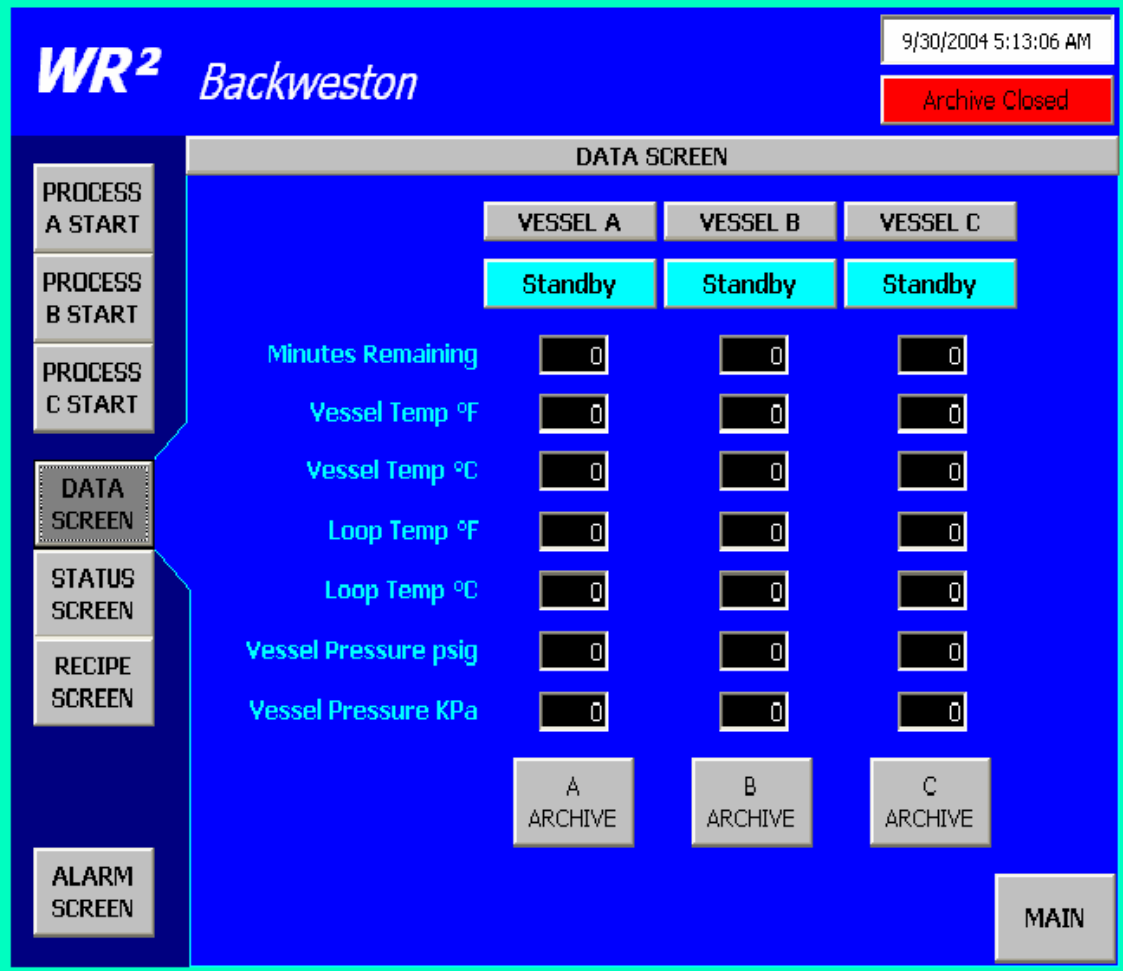
SIEMENS

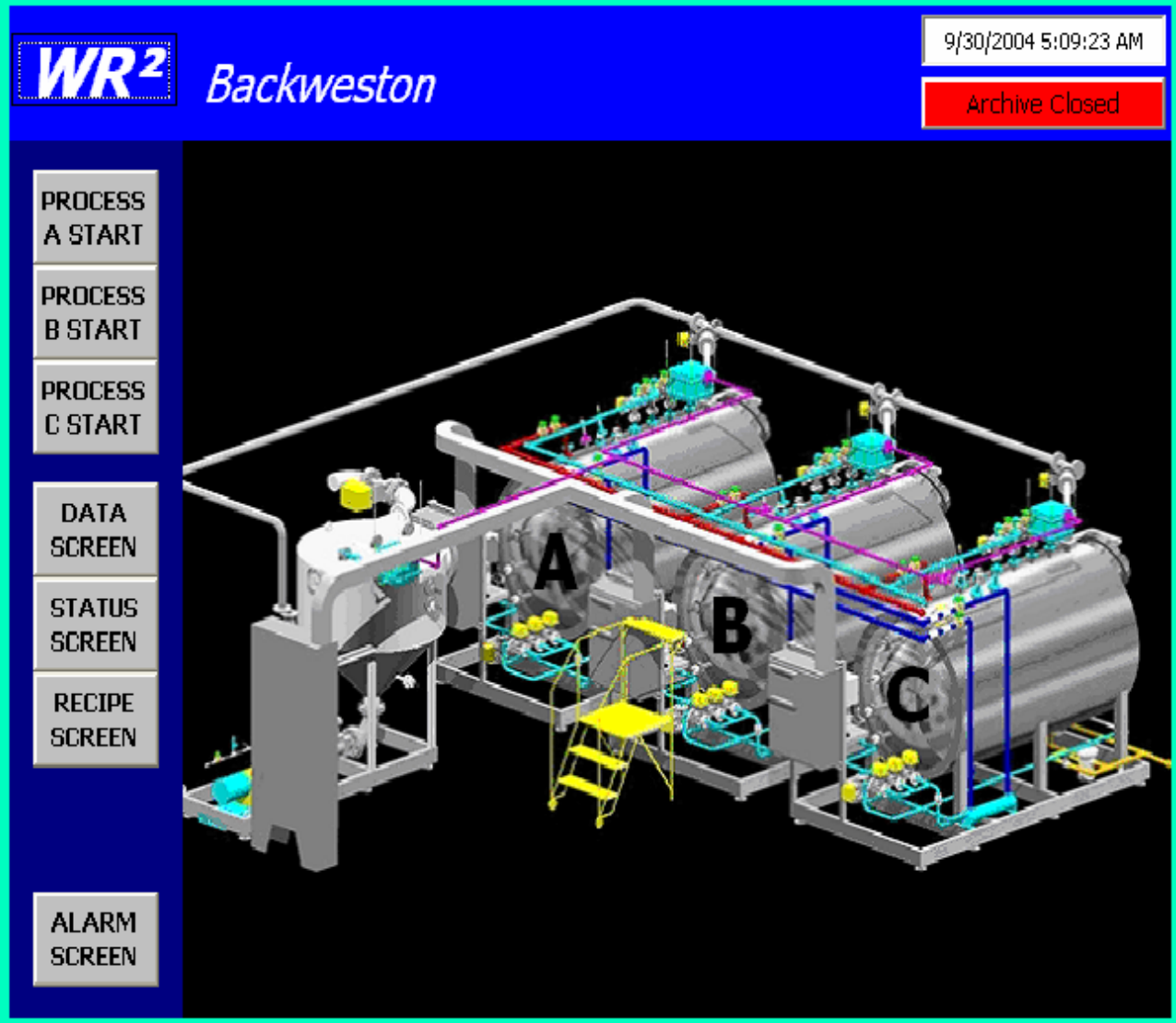
SIMATIC MULTI PANEL



SIEMENS

SIMATIC MULTI PANEL

Siemens Controls; The World Standard



TOUCH

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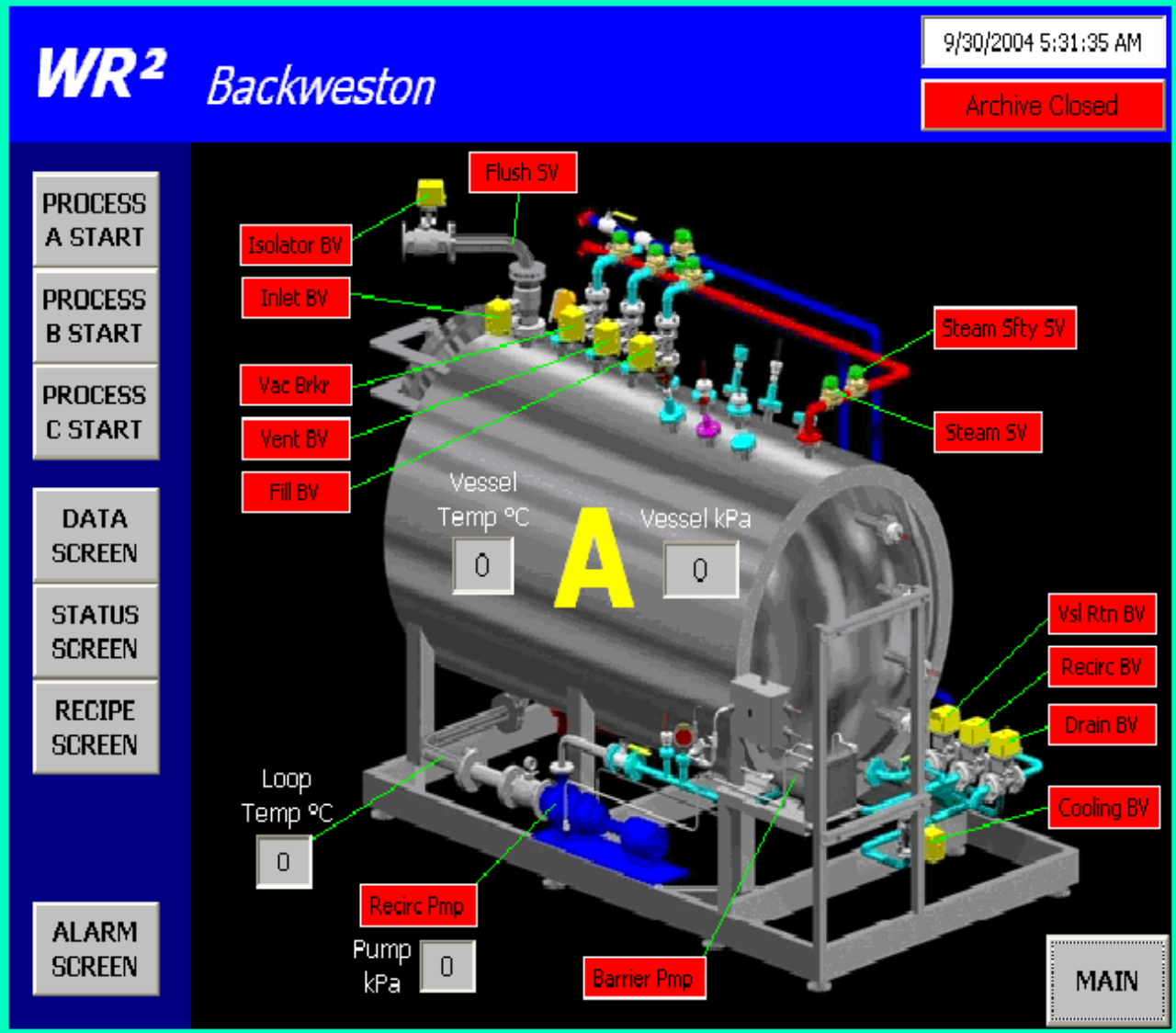
Screens that tell you what is going on

SIMATIC MULTI PANEL

TOUCH



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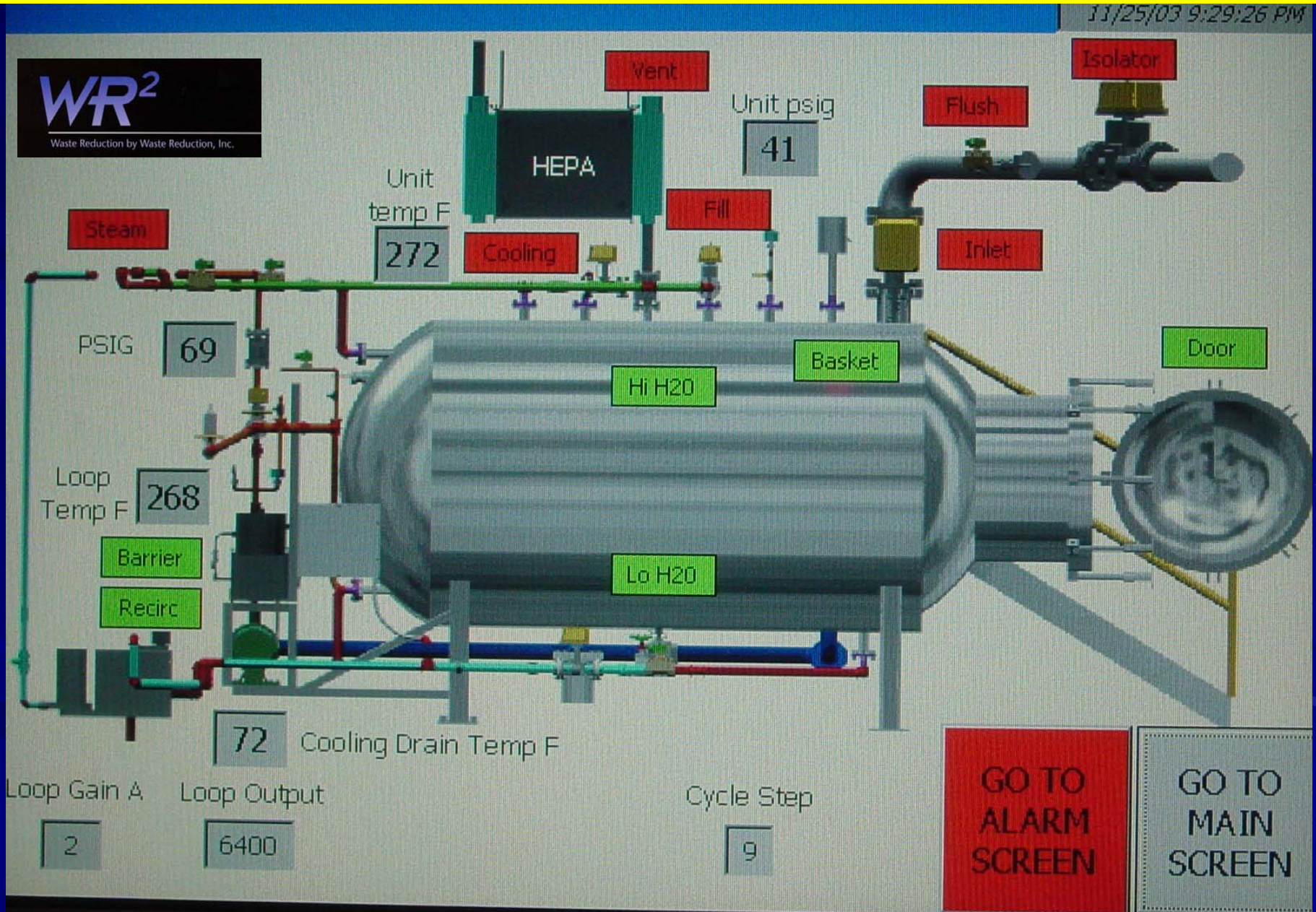
Controls that can interface with building systems and/or can notify appropriate officials if a Category 1 alarm is generated by the system

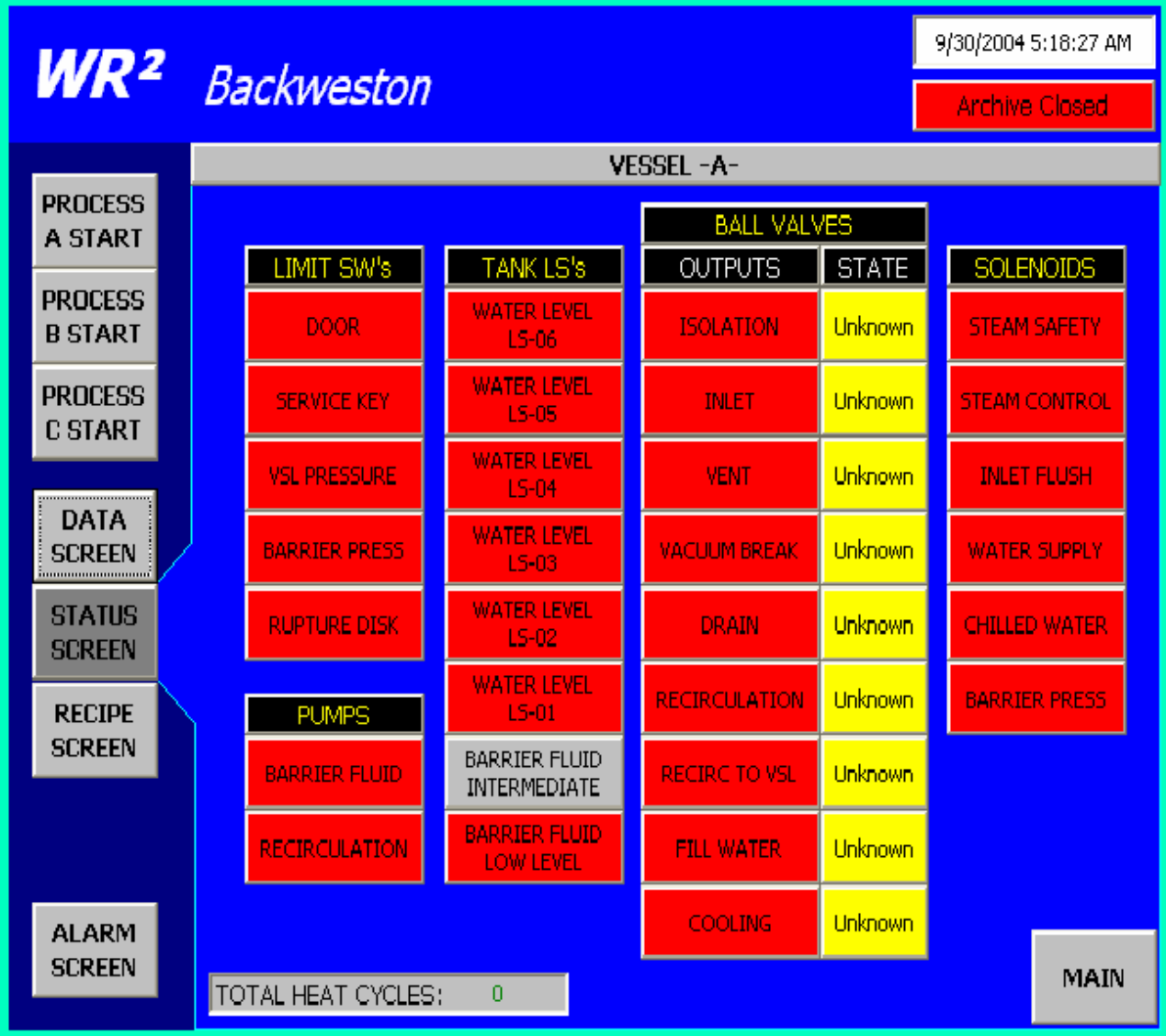


SIEMENS

System Confirmation Screens

SIMATIC MULTI PANEL

TOUCH



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Easy Access for Inspection
Barton Malo
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Some Key Philosophies for Obtaining the Best System Design for your Facility:

- Today you can purchase, from more than one manufacturer, a standard engineered package EDS system tailored to your performance requirements. The advantages to you over a custom system are price, performance, and ongoing serviceability
- You should define a **"performance specification"** rather than a "design specification". State what you want the system to achieve, and what conditions it will face, then let the system producers give you their best answers. A "**design specification"** can result in a customized hybrid system; not an optimized engineered design
- The submitting vendors owe you all of their experience, know-how, and consultation to assist you in making the best choice for your application
- Bio-safety design knowledge is essential, and must be applied throughout the design process
- You require a system that is safe to own, operate, and maintain
- It is ok to request a custom feature as long as the feature does not defy physics or compromise safety or integrity
- Standardization of controls and components is essential for long term service and support from the system provider
- All systems should be built and tested at the producers factory, under your scrutiny (this is called a Factory Acceptance Test), then disassembled into skid mounted components for shipping, delivery, rigging, and fast installation in the field
- Choose a stable producer so that they are likely to remain profitable and stay in business to serve your service and technical needs over the long haul
- Your vendor of choice should design, develop, program, and build the equipment (as opposed to subcontracting all of these functions) and they should maintain the technical engineering / servicing staff to be able to troubleshoot and fix any problem quickly. Who do you call for help at 3:00 a.m. on Sunday morning? Is a 24/7/365 technical assistance provision available from your vendor of choice?

A simple performance specification

- Sterilization required; 270 degrees F for 30 minutes, minimum cycle parameter
- Redundant parametric monitoring with spore test drywell available on each vessel
- Overpressure set at minimum125 psi
- 100 psig steam supply available; specify flow required
- 1,000 gallon per day requirement at 10 gallons per minute maximum inflow rate
- Solids handling capability
- Self-cleaning (no buildup of sediment)
- Redundant system design
- Must fit our space envelope (drawings provided)
- Must discharge to 20 feet above system level

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EDS Mistakes we have seen

- Vacuum breakers used on EDS vessels
- Load cells used for volume determination
- Pneumatic valves used (as opposed to electromechanical)
- Single waste line feed valve with no flush provision
- Air pressure test feature on entire vessel
- No pump circulation and resulting sediment problems
- Small man-ways; not made to open and close routinely if desired
- No solids handling provisions
- No water fill / flush provisions
- Pop-off routed through contaminated HEPA filter system (system fill vent system)
- Aluminum vessel skins; galvanized steel substructures
- NaOCl decontamination of feed tanks then going to cook tanks
- Inadequate alarms matrix and reporting system

EDS Mistakes (continued)

- Carbon steel EDS vessels
- Type 304 stainless steel vessels
- Drip leg ball valve
- Unheated drip leg
- Lots of NaOCl used in laboratories for drain decontamination and wash-down
- Too much insulation on critical valves, pipes, and joints
- Specification for rapid heating and rapid cooling when unnecessary
- Underestimating time to heat through a heavy type 316-L stainless steel vessel
- Autoclave jacket condensate going to EDS, and cooling the condensate if it is routed to the EDS
- Pre-vac sterilizers using eductors to generate the vacuum
- Wrong incoming pipe material (Carbon steel, PVC)
- And many more

Additional pointers

- The time and temperatures required for sterilization are not just for the effluent being decontaminated, but are for achieving sterilization in the coldest spot in the processing system
- Pressure vessel head space should be 25%
- Do not undersize system, do not over size system (1 cycle per tank per day is best, 2 cycles per tank per day is acceptable)
- All block valves should be electromechanical, 3-piece, Teflon sealed design
- All block valves have position verification switches
- All vessel stubs are short, and are insulated
- All vessel stubs are at least 1-1/2 inches in size and have only one valve, instrument, or sensor (no trees)
- Vacuum breaker is a block valve (ball valve)
- Man-way seal is a double o-ring with air pressure seal test verification
- Exit ball valves are doubled with air pressure seal test verification

Pointers (continued)

- Pump seal has a shroud, and leak test, tied to incoming and outgoing electromechanical ball valves
- Install system in sub-containment if possible
- Have a redundant vessel if you can
- Have sufficient isolation valves and decontamination ports to anticipate any situation
- Entire system including feed lines should be decontaminated with hot alkali; never a chloride disinfectant
- Consider alkaline hydrolysis for prion capability, system decontamination, and corrosion prevention particularly where chlorides are involved
- Barrier fluid system for pump seals are heated (proprietary)
- Small systems, like fully featured small cars, are very pricey for capacity
- You can keep the receiving vessel hot while receiving (e.g., 180 degrees F)
- Have an effluent shut-down plan for the facility

Other Types of EDS Systems

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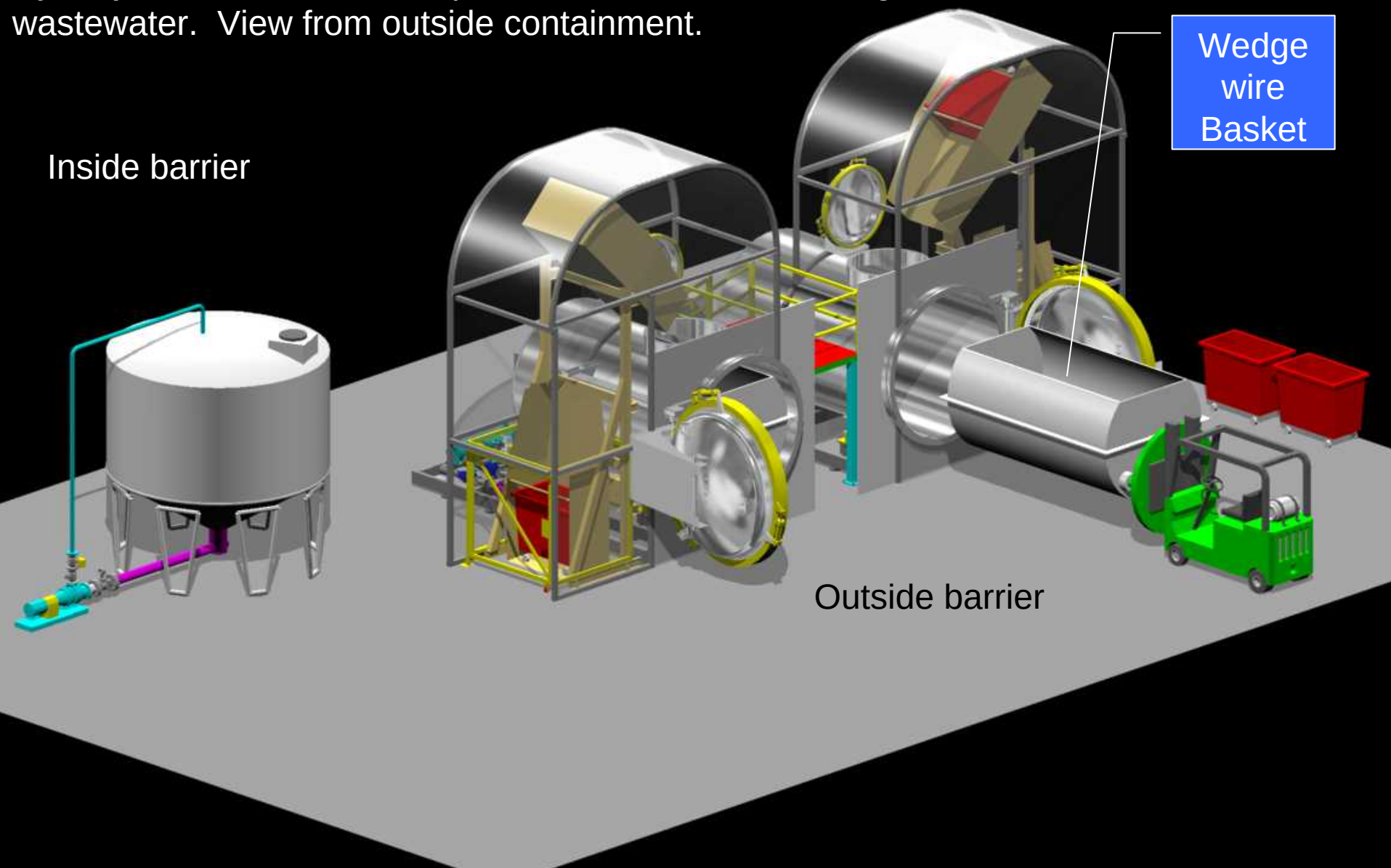
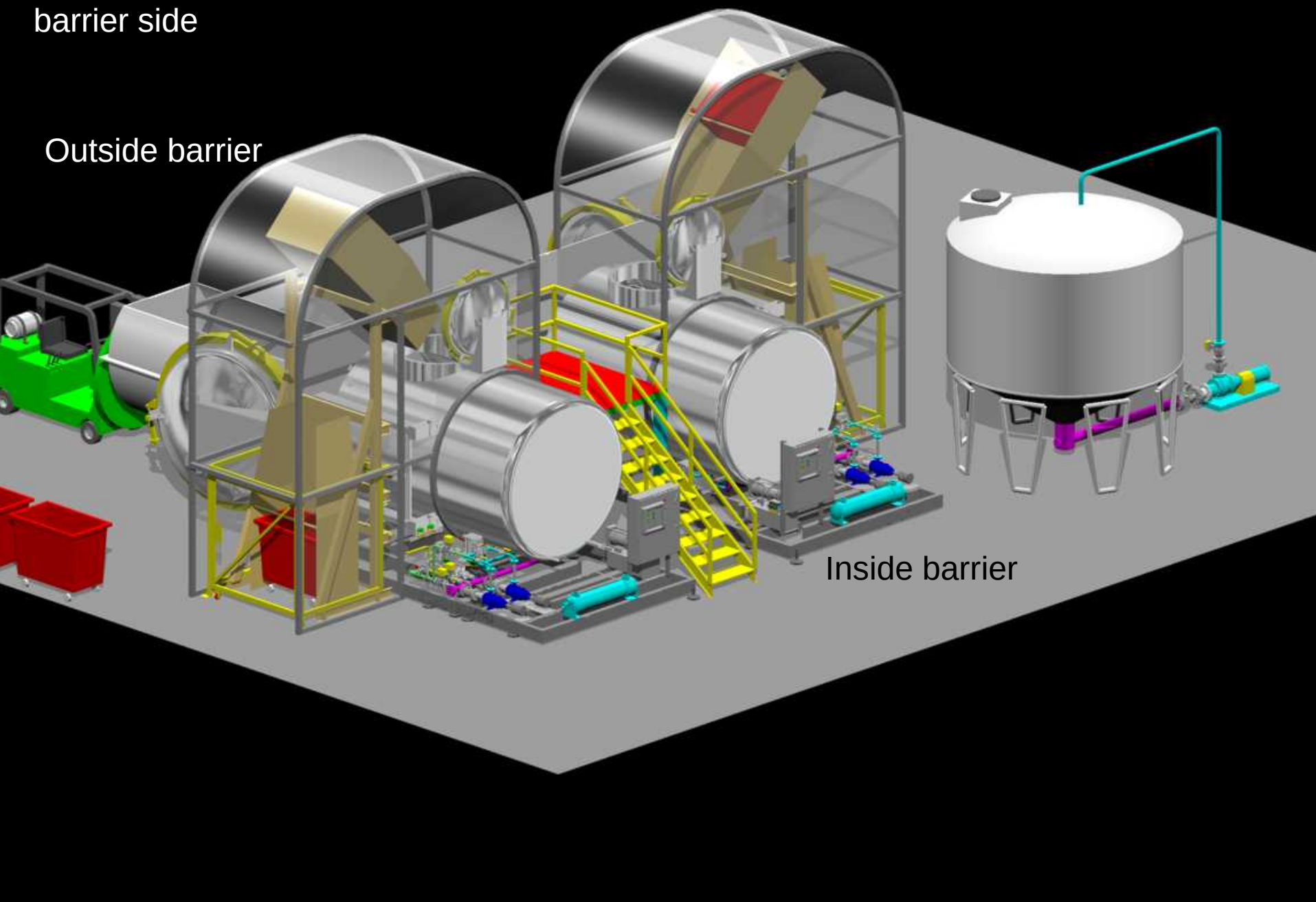
Mass Animal Bedding Sterilizer / Tissue Digestor / EDS System for handling all bedding, urine, feces, washwater, carcasses, and other contaminated wastewater from a large animal research facility. Features patented Alkaline Hydrolysis for destruction of prions in carcasses, bedding, feces, and wastewater. View from outside containment.



Mass Animal Bedding Sterilizer / Tissue Digestor / EDS System viewed from the barrier side

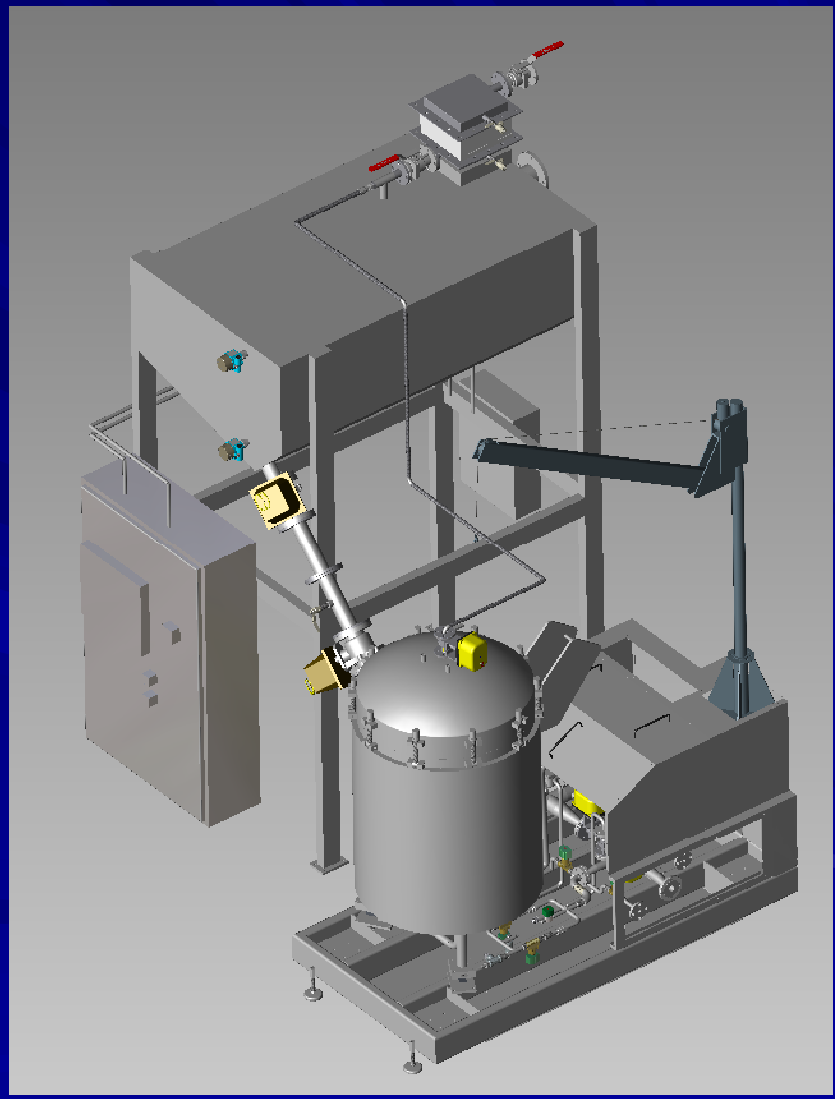


An EDS / Tissue Digestor can be substantially less expensive than a small EDS alone. This system is being built for Penn State University.

Shown:

- 250 gallon collection tank
- 90 gallon EDS
- 280 pound (tissue capacity) Tissue Digestor
- Model 100-30-31 EDS/TD

- Available:
- 500 gallon collection tank
- 150 gallon EDS
- 500 pound (tissue capacity) Tissue Digestor
- Model 100-34-38 EDS/TD



Features prion capability as alkaline hydrolysis is a standard feature with this system

Integral basket collects and sterilizes any solids

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A small, relatively inexpensive package EDS is available for small facilities(100 gallon collection tank / 50 gallon single cook tank)

If you have questions, contact us at 317.484.4200
We are happy to meet with you to discuss your potential EDS or Tissue Digestor needs.

www.wr2.net