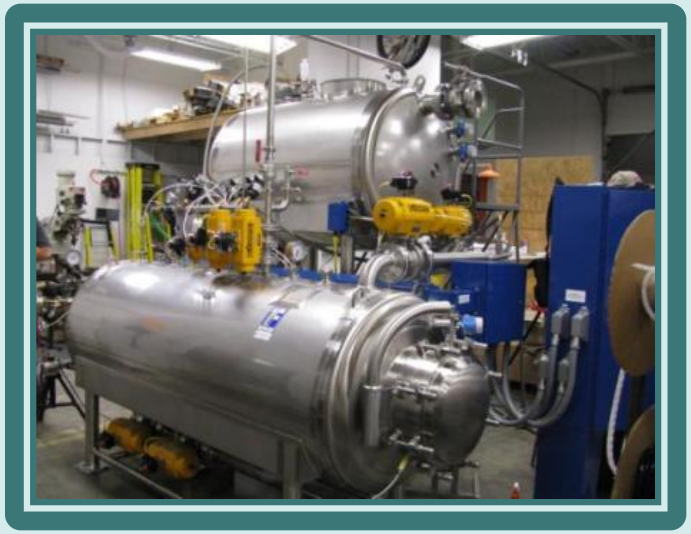
Liquid Effluent Decontamination and Carcass Disposal for Biocontainment Facilities

2011 ABSA Annual Scientific Symposium
November 2, 2011
Anaheim, California
Presented by: Joe Wilson

Today's word is:

Conventional Wisdom Drives High Temperature Batch EDS Selection



But, is this responsible?

Let's discuss.....

Leadership in Energy and Environmental Design

Are we taking this seriously?

If we don't then who will?

In Bio-Containment Facility EDS Specification we're not seeing it!

Effluent Decontamination Systems

EDS

Now is the time for us to think outside the Box!!

Bio-response Solutions

Killing pathogens / select agents in an EDS is easy

- **An EDS is not an Autoclave!**
- **Planning treatment parameters around autoclave parameters could be old school thinking!**
- An EDS is a wet system with a homogeneous environment; an ideal physical environment for rapidly killing pathogens

Let's Take A Closer Look at Some Other Options

Continuous Flow with Energy Recovery

Thermo-Chemical

Chemical

The Basic Batch Chemical EDS

Chemical EDS Options

Chemical
Batch

Continuous
Chemical ! !

Chemical EDS – Sterilization;
------ CAN BE FAST!!

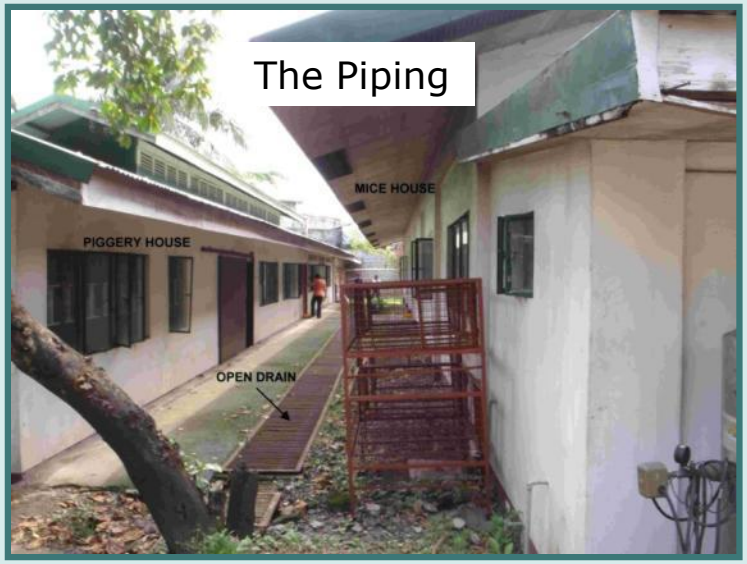
Sample ID (Time = minutes following decontamination)	Seeded Microorganisms Concentration			
	Bacillus subtilis cfu[2] / ml	Bacteriophage pfu[3]/ ml		
		MS-2	FR	PRD1
T=0 Prior to Disinfection	5.7×10^5	4.7×10^6	3.1×10^6	1.8×10^6
T=0 Prior to Disinfection	5.0×10^5	4.9×10^6	2.5×10^6	3.1×10^6
T=0 Prior to Disinfection	7.4×10^5	5.0×10^6	2.7×10^6	2.5×10^6
T=10	<0.1	<1.0	<1.0	<1.0
T=10	<0.1	<1.0	<1.0	<1.0
T=10	<0.1	<1.0	<1.0	<1.0
T=20	<0.1	<1.0	<1.0	<1.0
T=20	<0.1	<1.0	<1.0	<1.0
T=20	<0.1	<1.0	<1.0	<1.0
T=30	<0.1	<1.0	<1.0	<1.0
T=30	<0.1	<1.0	<1.0	<1.0
T=30	<0.1	<1.0	<1.0	<1.0

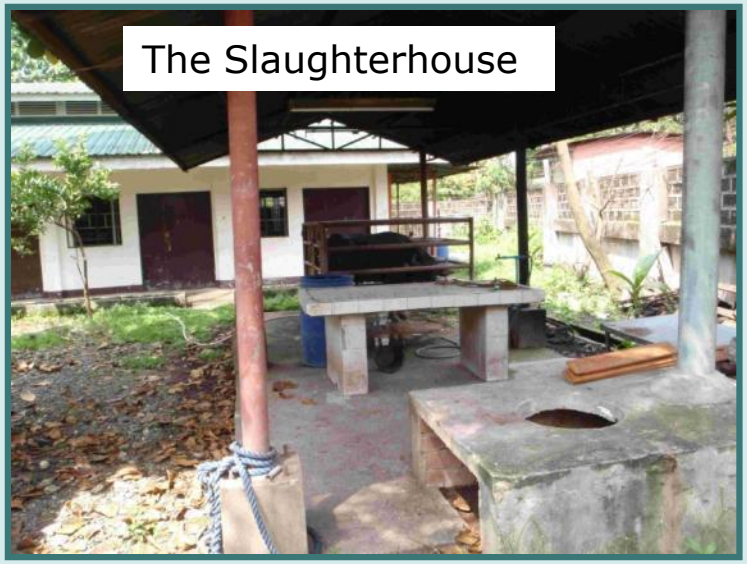
Bio-response Solutions

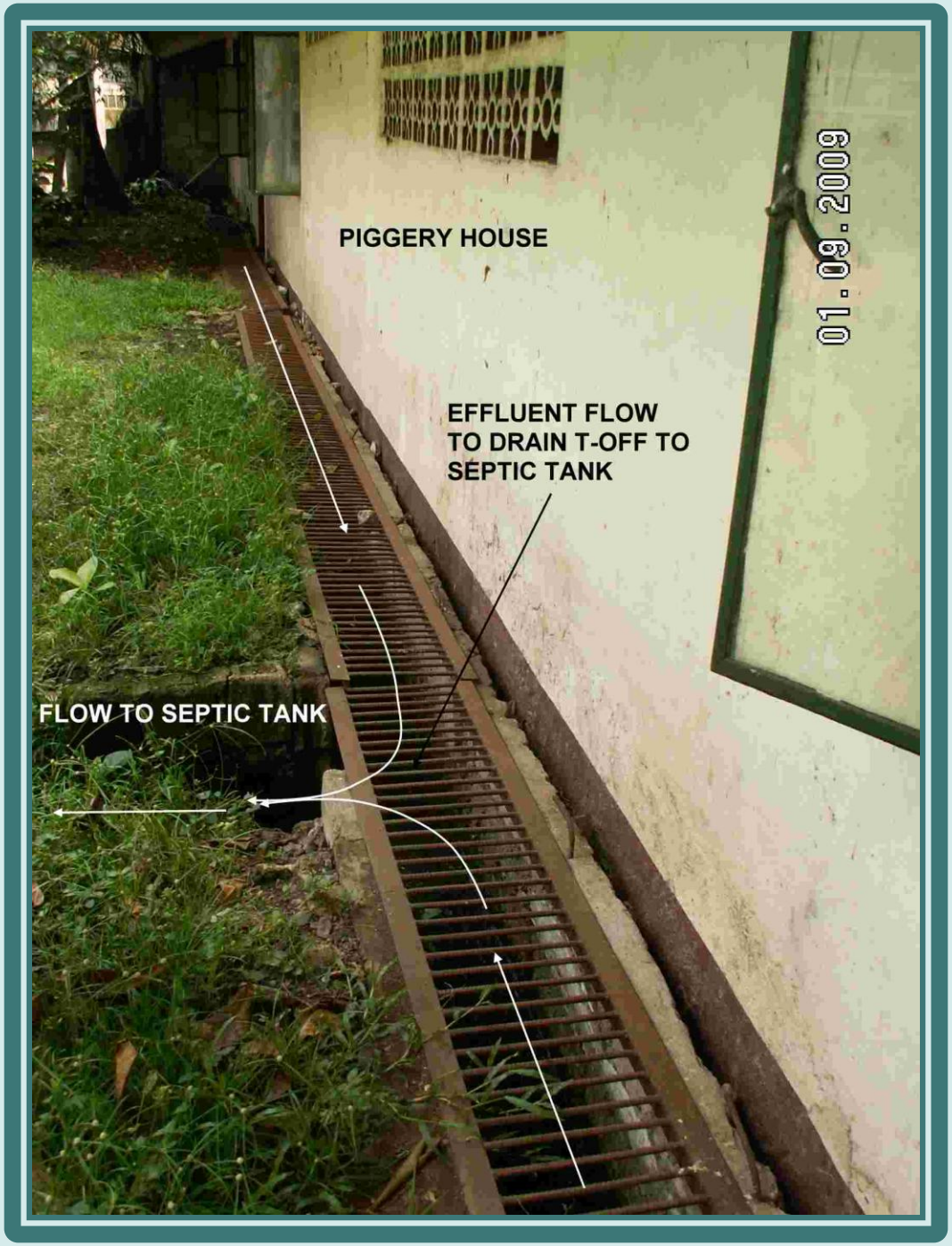
Case Challenge 1:
A Southeast Asia Vaccine Test Facility

- They desired an EDS to replace their current effluent disposition system
- They hired a consultant of our choice to evaluate their situation and the report came back
  - 3,500 lpd wastewater
  - 240 lpd of it is swine manure (high solids, high organic loading)
  - Potable water is “not potable enough” for a steam boiler (in fact it has high turbidity and solids present in the water)
  - They have little money to operate a system
  - They vaccinate animals that they subsequently infect with virulent disease agents to test the vaccines

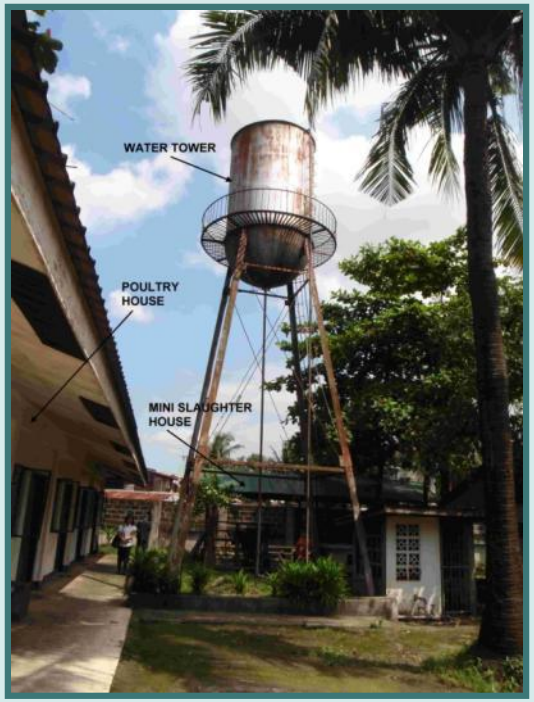
The Dilemma


The Piping
MICE HOUSE
PIGGERY HOUSE
OPEN DRAIN

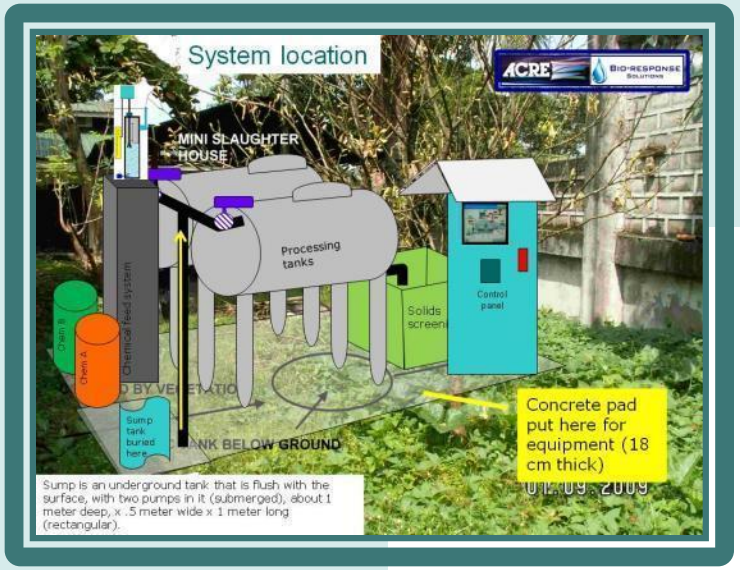

The Slaughterhouse


PIGGERY HOUSE
EFFLUENT FLOW
TO DRAIN T-OFF TO
SEPTIC TANK
FLOW TO SEPTIC TANK
01.09.2009

Could there be an EDS for this situation?



Batch Chemical EDS was the only option they could consider when all factors were understood.



Case Challenge 2:

Modular BSL-3 labs were ordered and in the final phases of construction, but there was no EDS

- **Budgets were constrained**
- **The customer wanted the peace of mind afforded by an EDS**
- **Time was of the essence**
- **Technical resources were virtually non-existant**

The Challenges

Develop an EDS for modular BSL-3 laboratory wastewater with the following attributes:

- **Affordable to acquire**
- **Easy to service by locals; no PLC or Computer**
- **Robust and Reliable**
- **To be located outdoors (in one case with indoor monitoring capability)**
- **Compatible with a variety of corrosive chemicals**
- **Uses minimum energy and no additional water**
- **Could operate on unstable power**
- **Would use reagents that are readily available**

We Knew

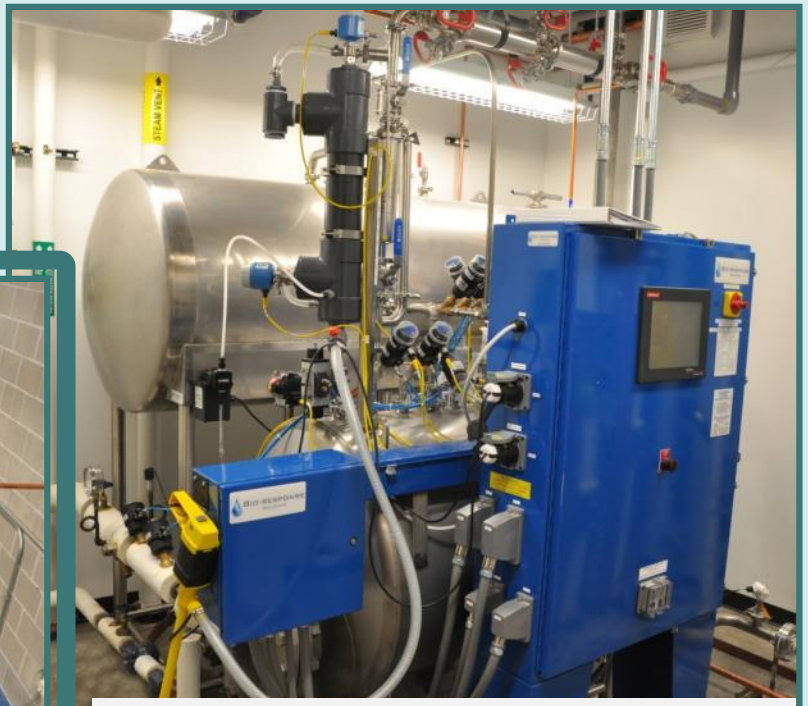
- **Just as there is a need for modular container based laboratories world-wide, so would there be a need for a simple EDS solution**
- **That cost would always be an issue and without affordability they would do without the system**
- **That this could be done effectively with chemicals**

An Answer!!

BIO-RESPONSE SOLUTIONS

Why consider thermochemical?

How about unreliable steam supply for starters?
How about energy reduction?
How about flexibility?



Georgia State University

University of Nebraska

BIO-RESPONSE SOLUTIONS

What is the next big change in EDS?

- **Continuous flow** with **energy recovery and solids handling** capabilities shows great promise
- Uses 1/10 of the energy as thermal batch systems
- Can attain temperatures over 150 degrees C (can sterilize in a 2 minute hold cycle)
- Can be designed for high solids loads
- Cost effective in comparison to batch systems
- Requires much smaller utilities (steam supply)
- Not all continuous flow EDS systems are equal; just as not all incinerators are equal so be very careful to select vendors with the correct experience.
- We have driven this technology to an advanced point; and will now be pushing it into the marketplace.
- **Goodbye Pressure Vessels!!!!**

Continuous Flow EDS Options

A large redundant 150 degree C system with regeneration

A large redundant 100 degree C system with regeneration

Bio-response Solutions

Materials of Construction

Material	Condition	System Cost
316-L Stainless	**Thermal, Low Chlorides (<5 mg/l)**	**$$$**
SAF 2205 Duplex	**Thermal, Low Chlorides (<100 mg/l)**	**$$$$**
SAF 2507 Duplex	Thermal, Medium Chlorides (<250 mg/l)	$$$$$$$
AL6XN Super Austenitic	Thermal, High Chlorides, 20 plus year life (<10,000 mg/l)	$$$$$$$$$!!!!
Hastelloy C22 Super Austenitic	Thermal, High Chlorides, 25 plus year life (<10,000 mg/l)	$$$$$$$$$$$$$!!!!!!!!
Teflon Lined Stainless	Thermal, Very High Chlorides, 30 plus year life (>250 mg/l)	$$$$$$$$
Plastic	**Chemical, Very High Chlorides, 25 year life plus (any chloride concentration)**	**$**

Carcass Disposal Systems

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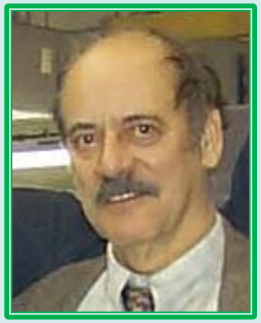
The Carcass Disposal Challenge

Alkaline Hydrolysis Systems

The first commercially installed alkaline hydrolysis system was for human cadaver digestion, and was put into service in 1995 and is still in use today!



Built by the fathers of the modern tissue digester, WR² Founders Dr. Gordon I. Kaye (above L) and Dr. Peter B. Weber (above R)

Owned and operated by:
State of Florida Anatomical Gifts Program

Location: Shands Hospital, University of Florida, Gainesville, Florida

Carcass Disposal Technology Options

- Inside the Containment Barrier Options:
  - Alkaline Hydrolysis (Carcass Digester)
  - Rendering (Cooking / Drying with or without alkali)
  - Autoclaving
- Outside the Containment Barrier Options:
  - Incineration (Starved Air, Pyrolisis, Gasification, etc.)
  - Alkaline Hydrolysis (Carcass Digester)
  - Bulk or Rotary Autoclaving
  - Rendering

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Visual Progression of Alkaline Hydrolysis

A **low temperature** digester allows us to view the progression of the alkaline hydrolysis digestion process. Animals loaded (L) and with dry alkali added (R)

Solbulization / Hydrolysis

Hydrolysis / Saponification

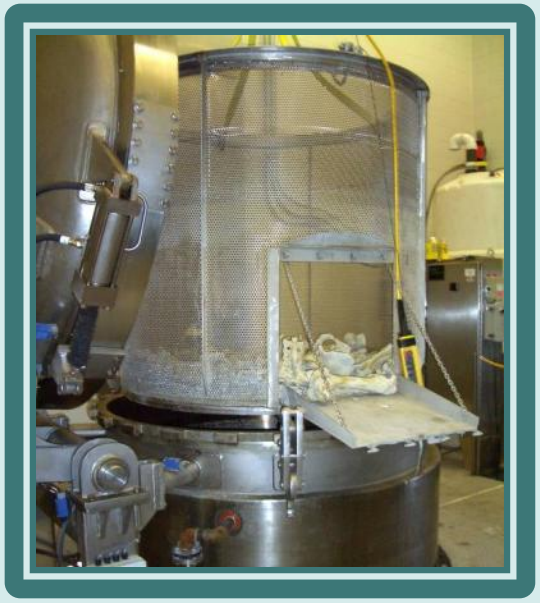
Advancing Hydrolysis

Hydrolysis Complete

BIO-RESPONSE SOLUTIONS

Alkaline Hydrolysis –

Process Complete!!
Residue Safe!!



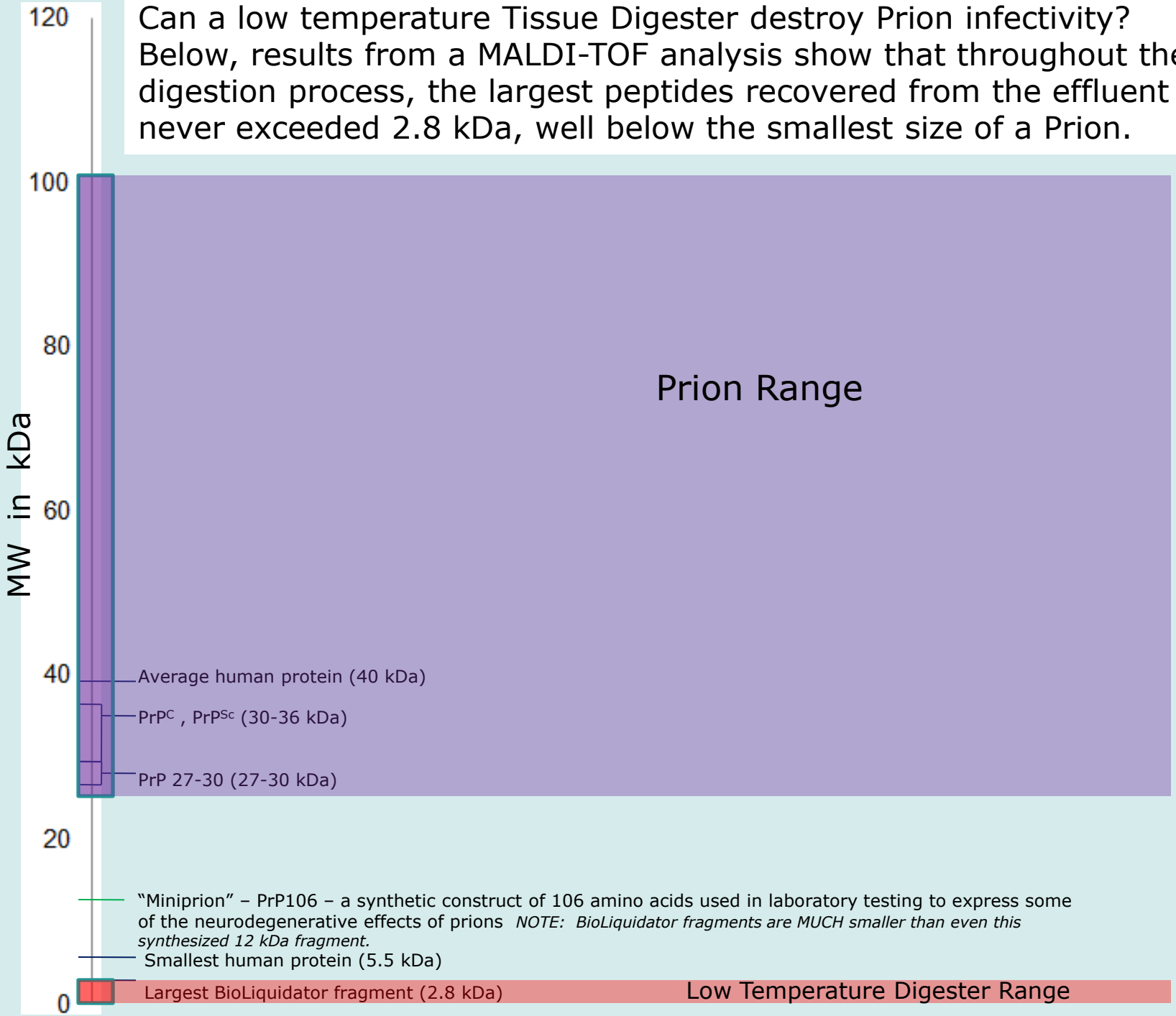
Effluent from Alkaline Hydrolysis

Pounds of Animals Processed	Undiluted Effluent Volume in Gallons	Essential Effluent Characteristics
10	3	BOD~100,000 mg/l COD~160,000 mg/l pH ~12 With CO_2, pH <9 TSS<10,000 mg/l
100	30	
1000	300	
10,000	3,000	

Effluent from Alkaline Hydrolysis

Effluent from Alkaline Hydrolysis is a homogeneous true solution that varies from Yellow and thin (poultry) to light brown and thin (wild animals) to dark brown and thick (sheep) the effluent can vary but the smell of strong ammonia is the same and the other essential properties (BOD/COD, dissolved solids, nitrates, etc. are very similar)

Can a low temperature Tissue Digester destroy Prion infectivity? Below, results from a MALDI-TOF analysis show that throughout the digestion process, the largest peptides recovered from the effluent never exceeded 2.8 kDa, well below the smallest size of a Prion.



Ohio Department of Ag Large Digester

7-28-05 WR^2 Tissue Digester
Ohio Department of Agriculture,
Animal Disease Diagnostic Lab
Reynoldsburg, Ohio, U.S.A.

Ohio Ag Necropsy Facility

Carcasses and a Large Gut Bucket

Large Carcasses Handled by Hoist

All Carcasses Loaded……

Now for the Gut Bucket

Digester Fully Loaded

Digestion Complete; a Clean Process!

A Typical Laboratory Size Digester

System shown, up to 50 kg (110 pounds) per cycle

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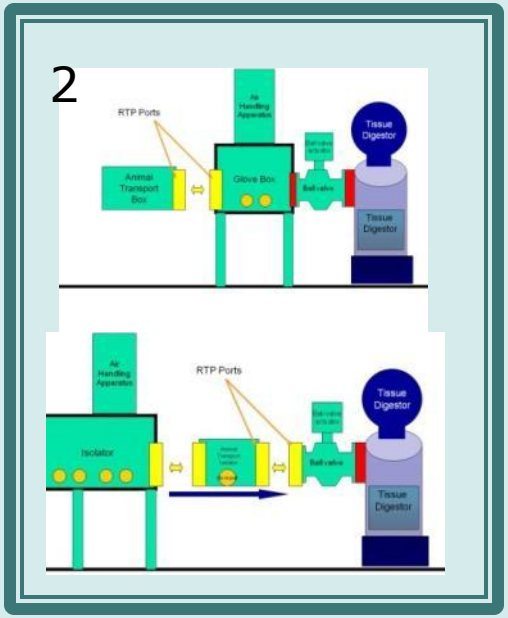
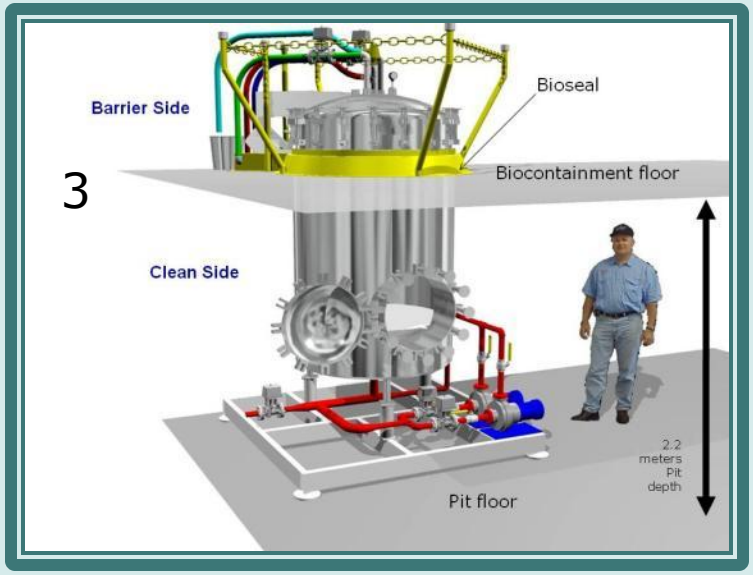
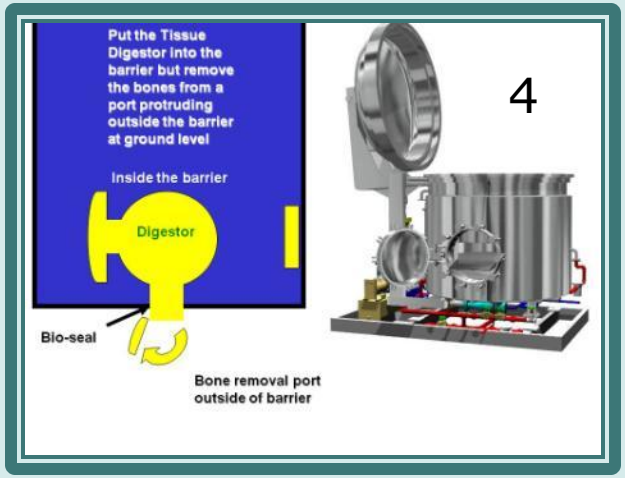
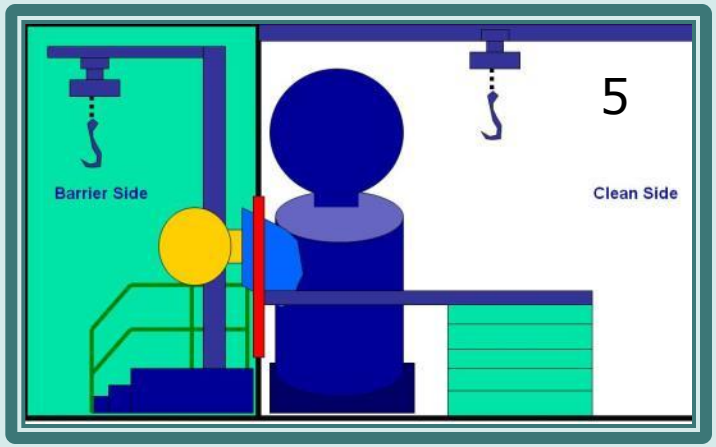
Interfacing with the Barrier

1. Digester in barrier, autoclave bones out
2. Digester with glove box
3. Top of Digester in barrier
4. Digester in barrier, pass bones out side
5. Digester outside barrier with barrier interface









BIO-RESPONSE SOLUTIONS

Jeff Edwards Makes History!

The first commercially sold and operated funeral disposition system in the world;

Edwards Funeral Home, Columbus, Ohio

February, 2011

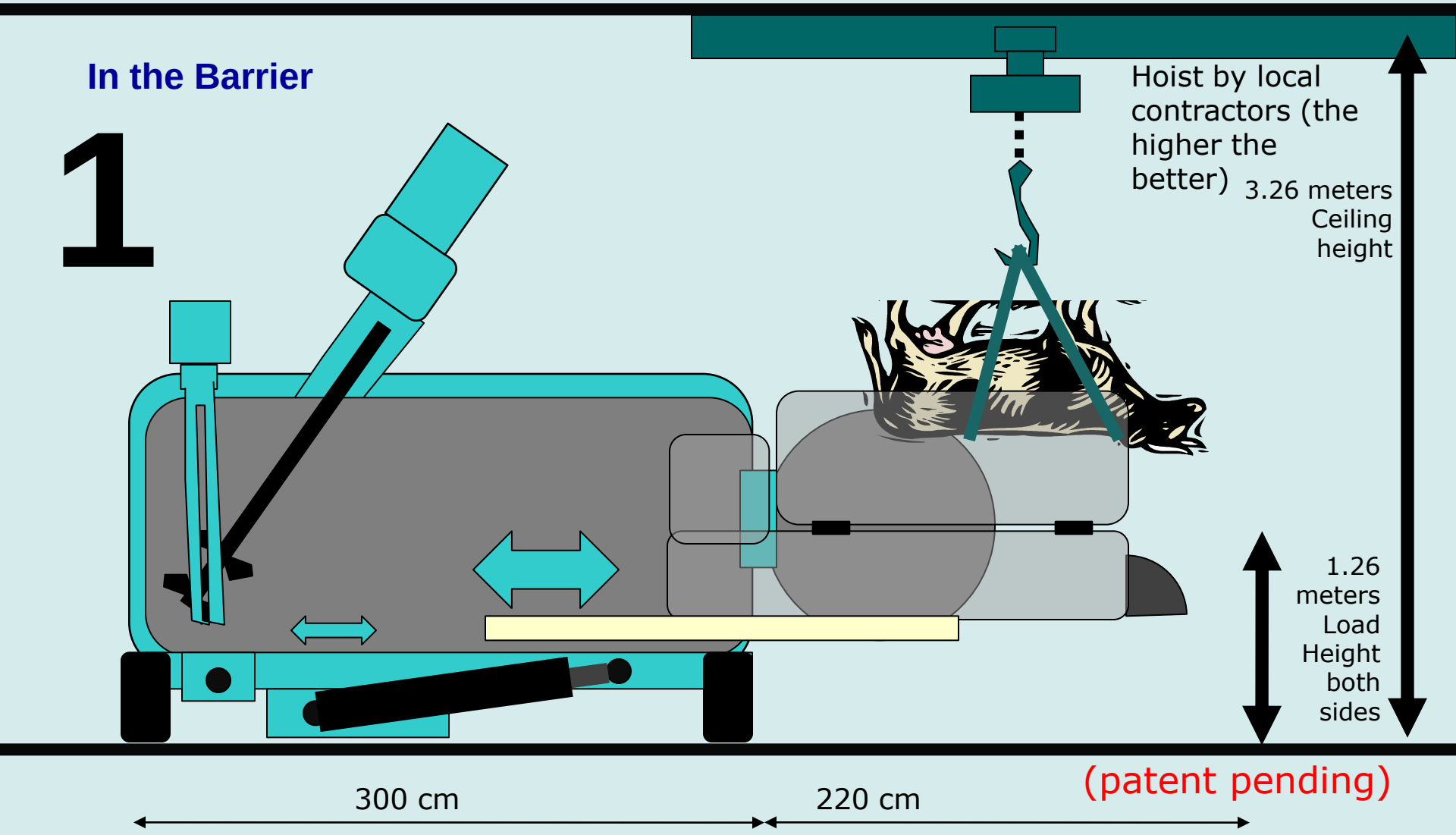
10% of the carbon footprint of cremation

5% of the energy and resource waste as burial

Innovation:
Digester Technology for Facilities with Limited Height

BIO-RESPONSE SOLUTIONS

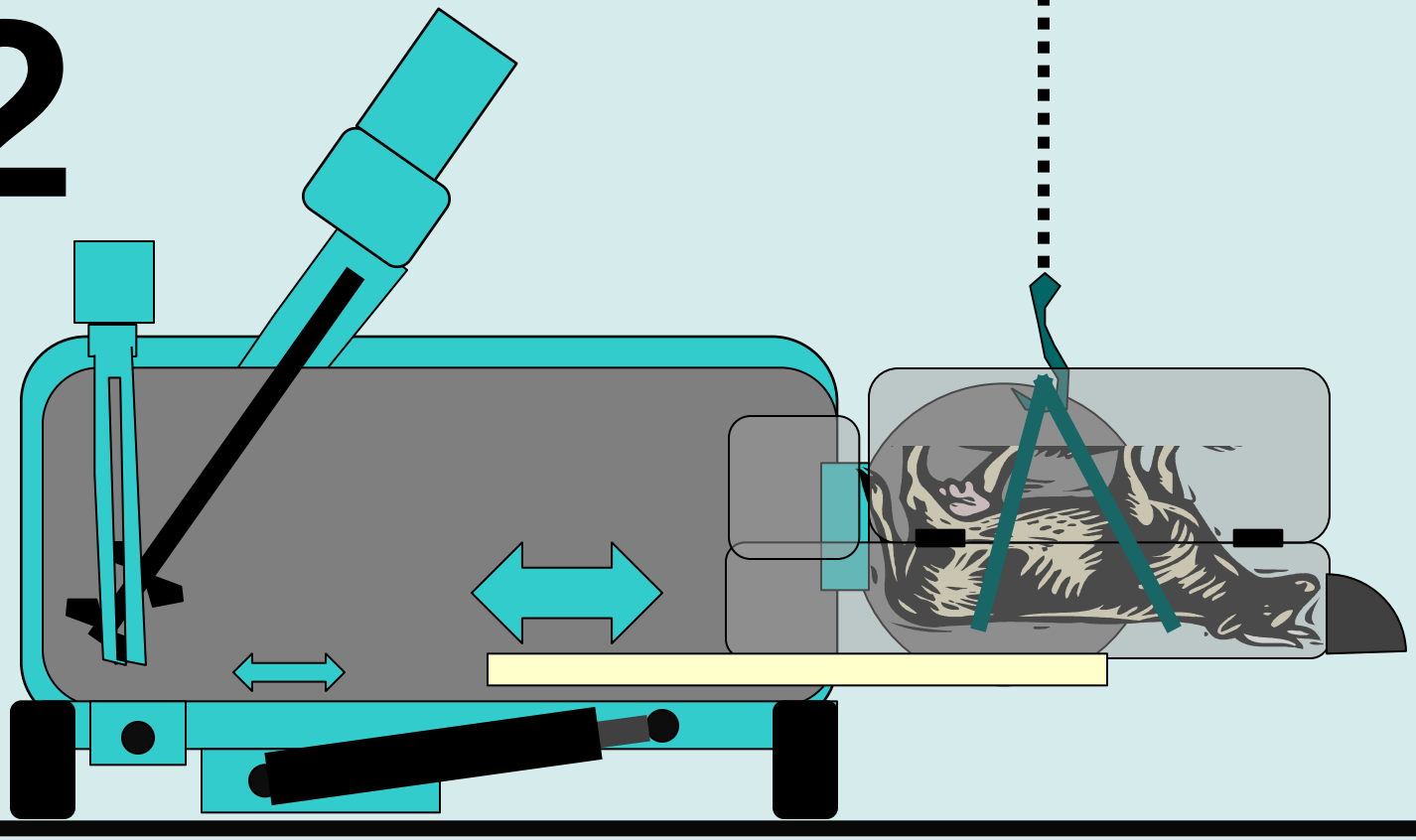
Bringing the Animal from Necropsy



Loading the Animal(s)

In the Barrier

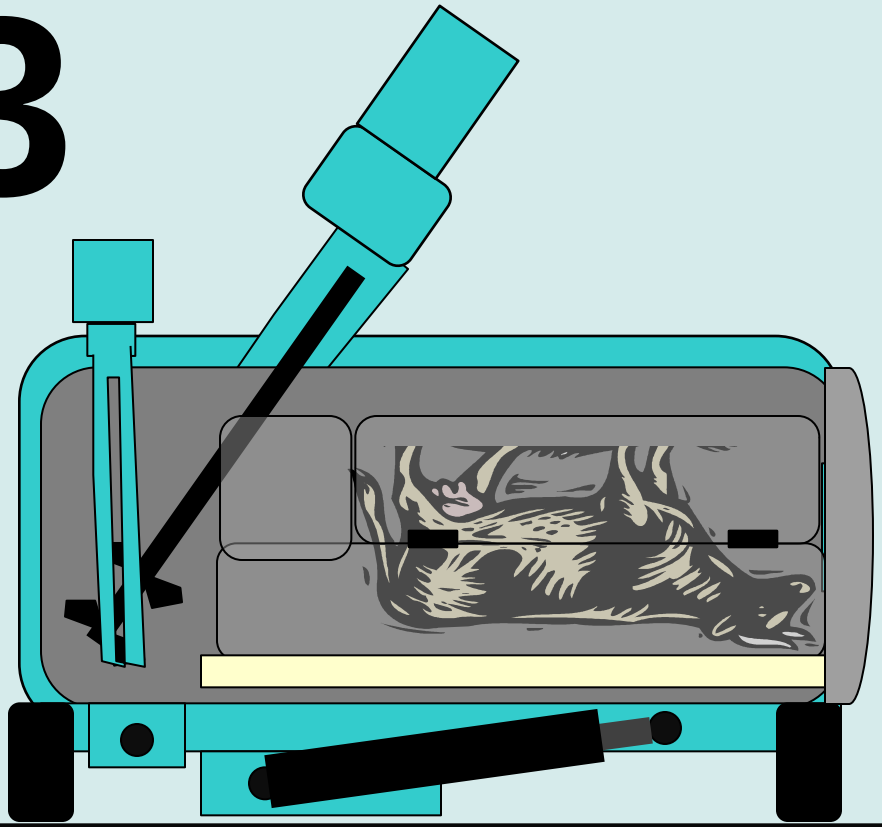
2



Closing the unit

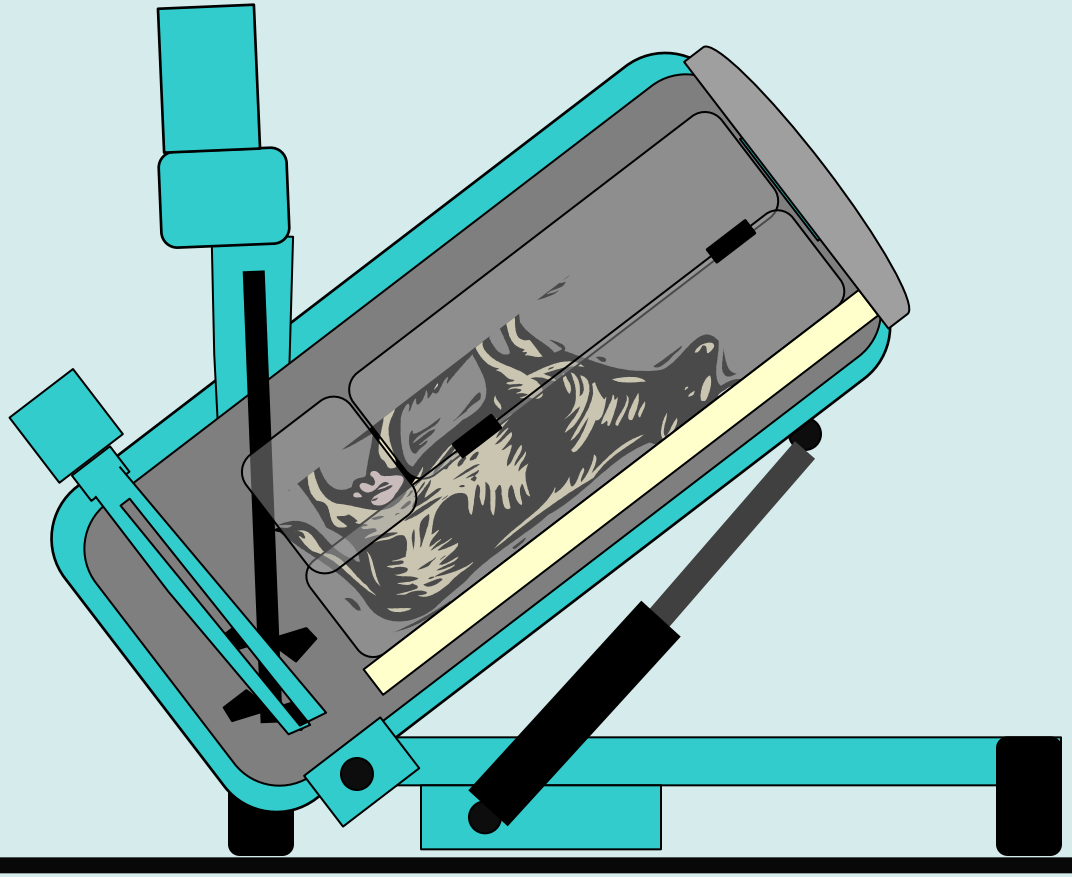
In the Barrier

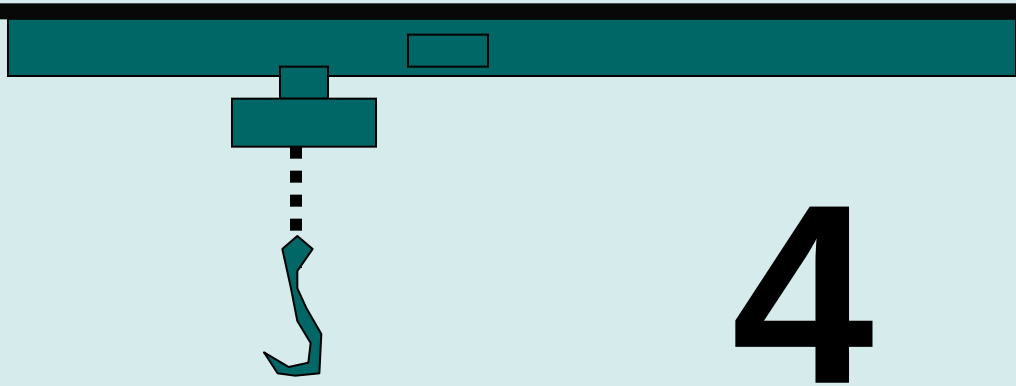
3



Tipping the unit

In the Barrier





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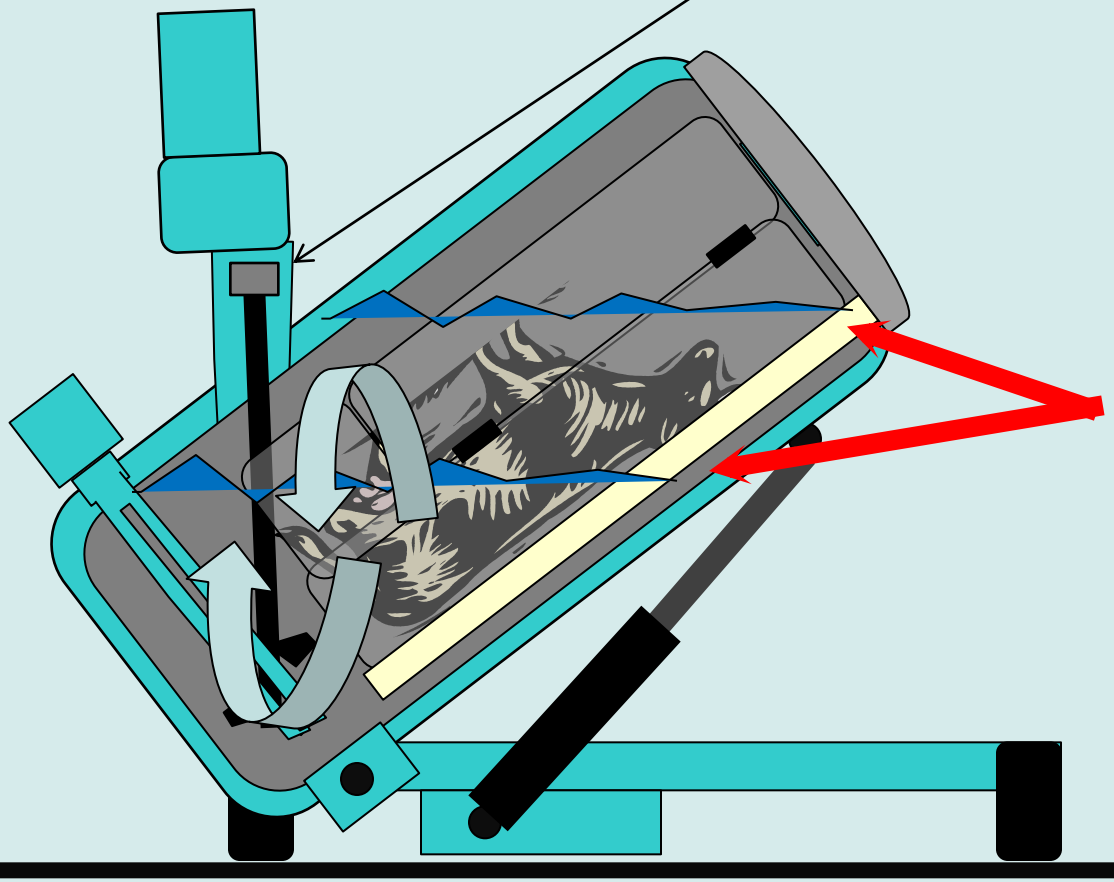
Fill, heat, digest

And the mixer seals are above water at all times; pump seals are the Achilles of alkaline hydrolysis systems

In the Barrier



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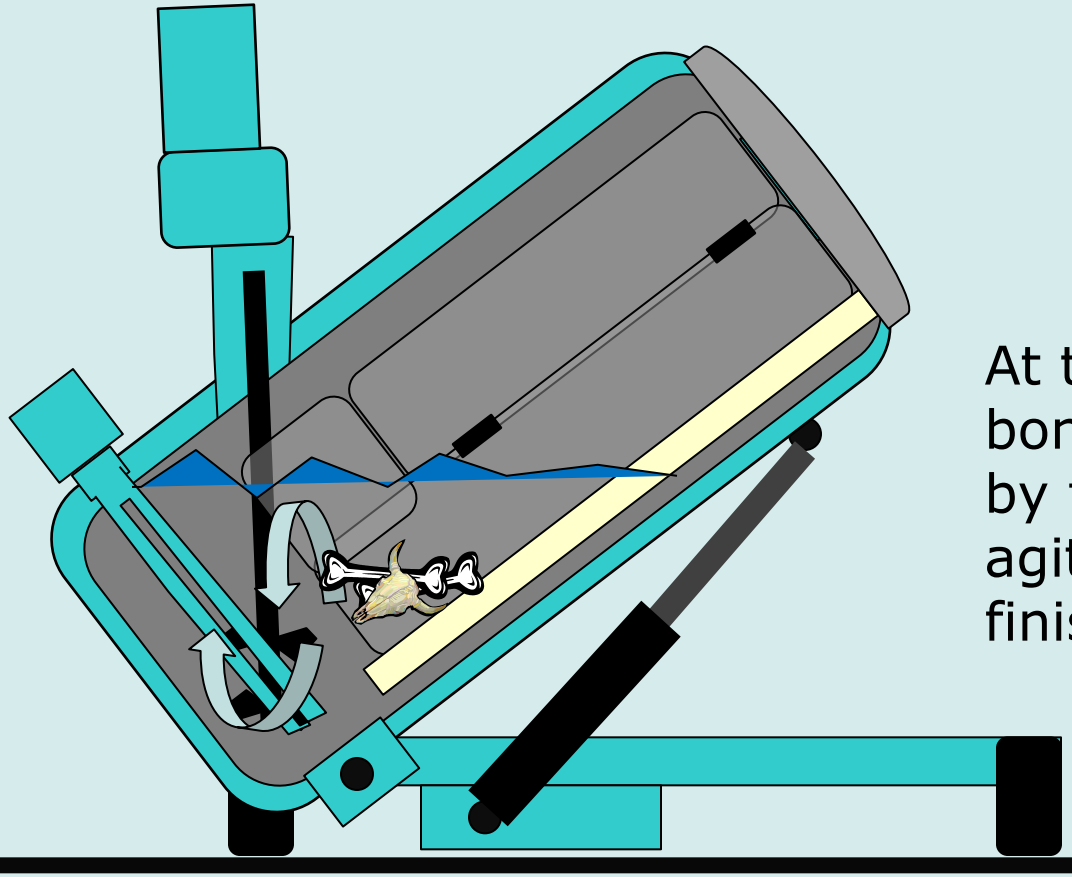
Water level is variable, based on tissue weight

Propeller agitation is dramatic and focuses on the bottom edge of the basket

Drain and rinse

In the Barrier



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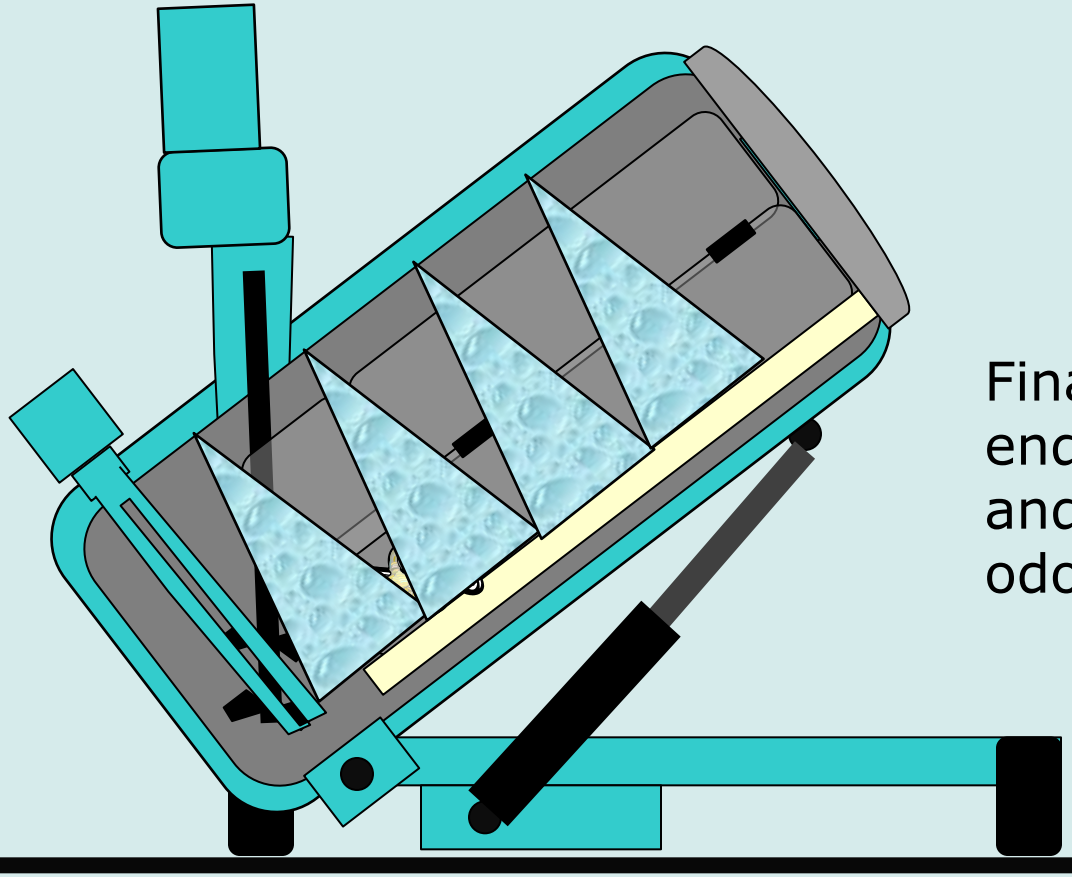
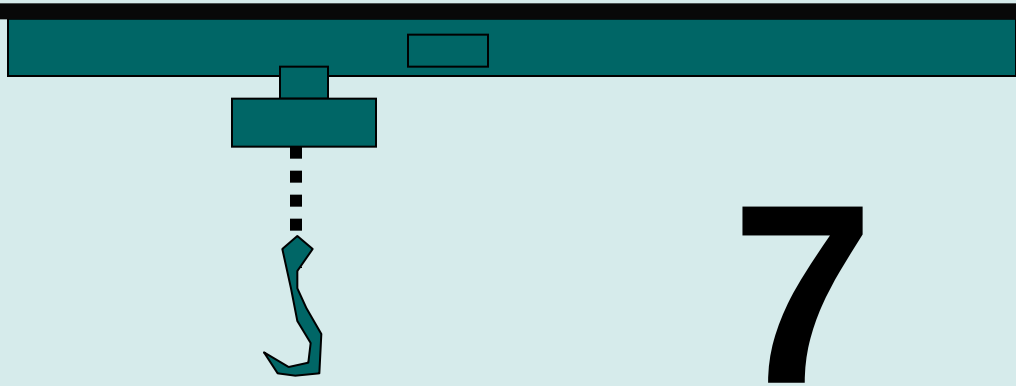
At the end of the cycle the bones are directly impacted by the very close propeller agitation for a complete finish.

Final spray rinse

In the Barrier





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Final spray yields clean, cool end product, a clean basket, and very little if any remaining odor.

Removing the bones

In the Barrier

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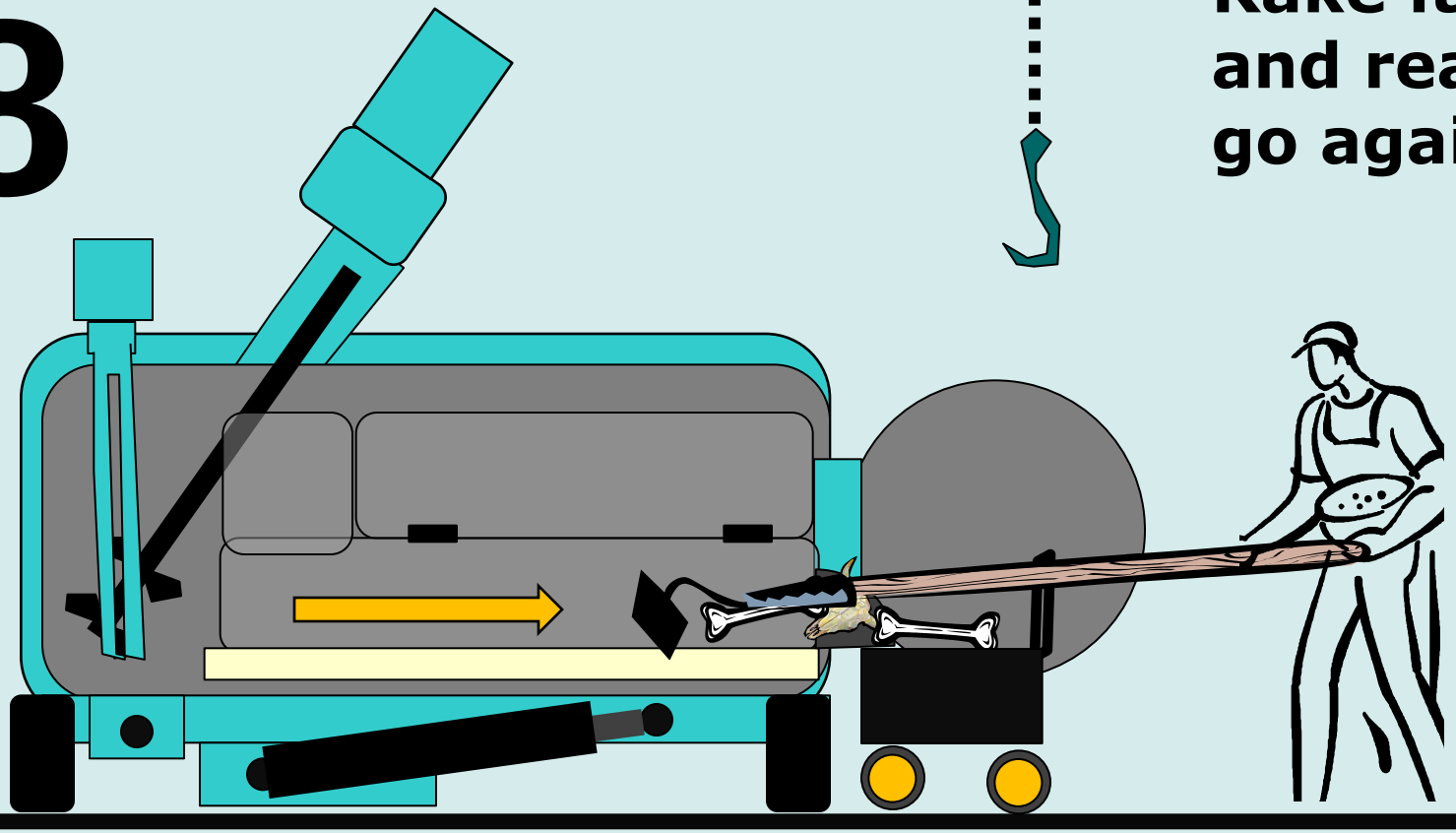
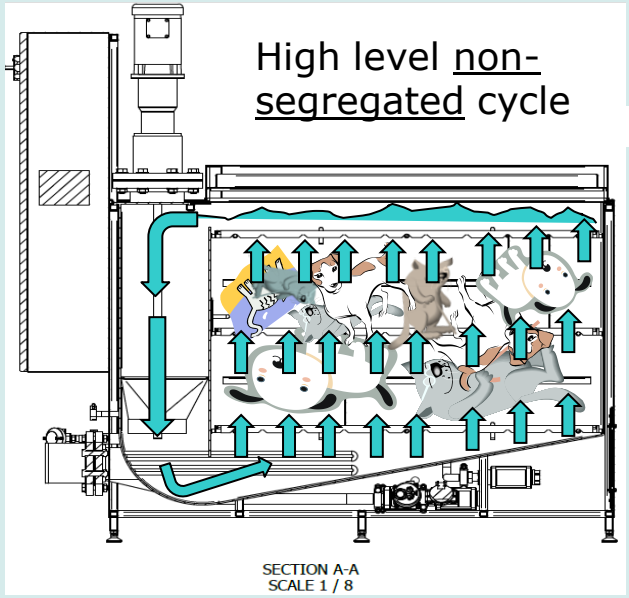


Rake it out and ready to go again!

Something New!! Up to 400 Pound Capacity, low temperature



Patent Pending

BIO-RESPONSE SOLUTIONS


Hey Joe!!
We give up!
Enough is
Enough!!!
Thank You!
BIO-RESPONSE
SOLUTIONS

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