A BSL-3 PILOT PLANT FOR FOOD PROCESSING: A Case Study

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Also known as:

THE BSL-3 COOK BOOK
Institute for Food Safety and Health

• Facility dedicated to food protection research
  – Illinois Institute of Technology
  – US Food and Drug Administration
  – Industry Members

• All aspects of food protection
  – Production
  – Processing
  – Packaging
  – Pathogens
Food Safety Modernization Act

Hazard Analysis

• a facility shall identify and evaluate known or reasonably foreseeable hazards (including biological, natural toxins, etc.) that occur naturally, or may be unintentionally introduced; and that may be intentionally introduced, including by acts of terrorism

Preventive Controls

• a facility shall identify and implement preventive controls, including at critical control points, if any, to provide assurances that hazards identified will be significantly minimized or prevented
Current Procedures

• Some industries rely on “the way we’ve always done it."

• Some rely on surrogate pathogens.

• All agree on one problem:
DON’T PUT REAL PATHOGENS IN MY EQUIPMENT!
IFSH BSL-3 Facility

• Designed to allow pilot-scale work on food processing equipment
• Much larger volumes than lab bench
• Can bring in equipment straight from the plant

• Allows validation of actual pathogen on actual equipment, not surrogates
Facility

• Stand-alone building
  – Reconfigured from existing pilot plant
• First floor
  – BSL-3 lab, BSL-3 pilot plant, changing areas
• Second floor
  – Mechanical spaces
• Underground EDS
Biocontainment Pilot Plant

- BSL-3 certified by outside contractors
- Registered to work with Select Agents
- Designed to house pilot/small production scale equipment while containing large volumes of pathogens

- Can handle:
  - Liquids (milk, juice, water)
  - Oils (vegetable oil, butter, nut butters, mayonnaise)
  - Produce (vegetables, fruits)
  - Semi-solids (yogurt, cheese, sauces, jam)
  - Powders (flour, sugar, spices)
  - Meat (cuts, bone-in, ground, poultry)

- Can’t handle:
  - Live animals
  - Carcass processing
Biocontainment Pilot Plant

• Facilities
  – Power: 110V, 208V, 480V
  – Steam supply and condensate return
  – Gas supply: compressed air, nitrogen, carbon dioxide
  – Hot and cold water
  – Floor forklift-rated
  – 18-foot (5.5 m) ceiling
Biocontainment

• Designed for BSL-3 containment
  – Directional airflow
  – HEPA-filtered exhaust air
  – Penetrations sealed
  – Coved floor
  – Pass-through autoclave
  – Effluent Decontamination System
  – Chlorine Dioxide generator
  – Shower out

• Even with all this:
Biocontainment

• Equipment won’t fit in secondary containment
Biocontainment

• So we contain the people
Equipment

• Pilot-scale food processing
• Noisy, smelly, leaky, messy
Produce-Washing Flume

- Straight from field
- 600 gallons (2300 L) of wash water
Peanut-Butter Skid

• Moves hot peanut butter, hot oil
• Approx. 150 lbs (68 kg) of peanut butter/experiment
• Same amount of hot soy or peanut oil
Ultrasound Generator

- Produce washing
- Ultimately plan to scale up for use in flume
Coming Soon

• HTST
  – Pasteurization of liquids
  – Large amounts of very small tubing
  – Holds approx. 3L, cycles 1 L/min
  – Cooling water ~ 4 L/min
Coming Soon

- **Extruder**
  - Raw ingredients in
  - Mixed ingredients out
    - Ready for cooking or shaping
    - Can process up to 660 lbs (300 kg)/hour
      - 165 lbs (75 kg)/hour planned
Known Hazards

• All the hazards of a BSL-3 lab
• All the hazards of a pilot plant/small factory
Infectious Materials

• Food pathogens
  – *Salmonella*, *Listeria*, *E. coli* O157:H7

• Select Agents
  – *Bacillus anthracis*, *Clostridium botulinum* and toxins, ricin, abrin

• Large-volume cultures
  – 150 lbs (68 kg) peanut butter spiked with $10^7$ CFU/g *Salmonella*
  – 600 gallons (2300 L) water, spiked with varying amounts of organisms
Chemical Hazards

- May be biological toxins
- If present, present in high quantity
- Industrial cleaning solutions
  - 70% isopropanol
  - Nitric acid/phosphoric acid
- Remember EDS!
Splash/Spray/Aerosol
Oils Get EVERYWHERE
Splash/Spray/Aerosol
Mechanical Hazards

• Electrical shock

• Heat (steam, hot foods)
Mechanical Hazards

• Moving machinery
  – Also a noise hazard
Mechanical Hazards

• Slip
• Trip
• Fall
Physical Fatigue

• Stress
• Dehydration
• Heavy lifting
• Long-duration experiments
Lessons Learned

• Facility has been functional for past two years
• Last year has seen increase in use
• How can we increase use while retaining safety?
Decontamination

“Clean before decontaminating” has a whole new meaning
- Degrease floors, walls, tools, air lines...
- Clean “fines”
Decontamination

- Minidox M used for equipment and room
  - ClO₂ penetrates water, so we will run water through equipment to decontaminate the interior piping and pumps
  - ClO₂ does not penetrate ½” of peanut butter
Decontamination

- Common sanitizer for food equipment - bleach
- EDS will be ruined by bleach

- Require all researchers to neutralize any bleach before it goes down the drain
BUT...

- Not all “bleach” bottles are the same!
- “Splash-free” bleach has an additive
Fatigue

• Heavy physical labor
  – Lifting devices
• In Sperian suits
  – Fit extremely important
  – Provide chairs!
• Rotating schedule
Heights

• Personnel on ladders
• Cleaning/sampling all parts of equipment
• Loading ingredients into hoppers
Emergency Procedures

• Must plan for injured, trapped personnel
• First responders very receptive
• Hosted HazMat training for 12 local departments
Design Issues

• Autoclaves very small
• No direct pass-through from BCPP to BSL-3 lab
• Lots of shelves in lab, no storage outside lab
• No cold storage
Summary

• Biocontainment Pilot Plant successful
• Able to safely contain large volumes of contaminated food
• Able to house wide variety of food-processing equipment types
• Allows research while protecting researchers
Acknowledgements