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!

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IFSH BSL-3 Facility

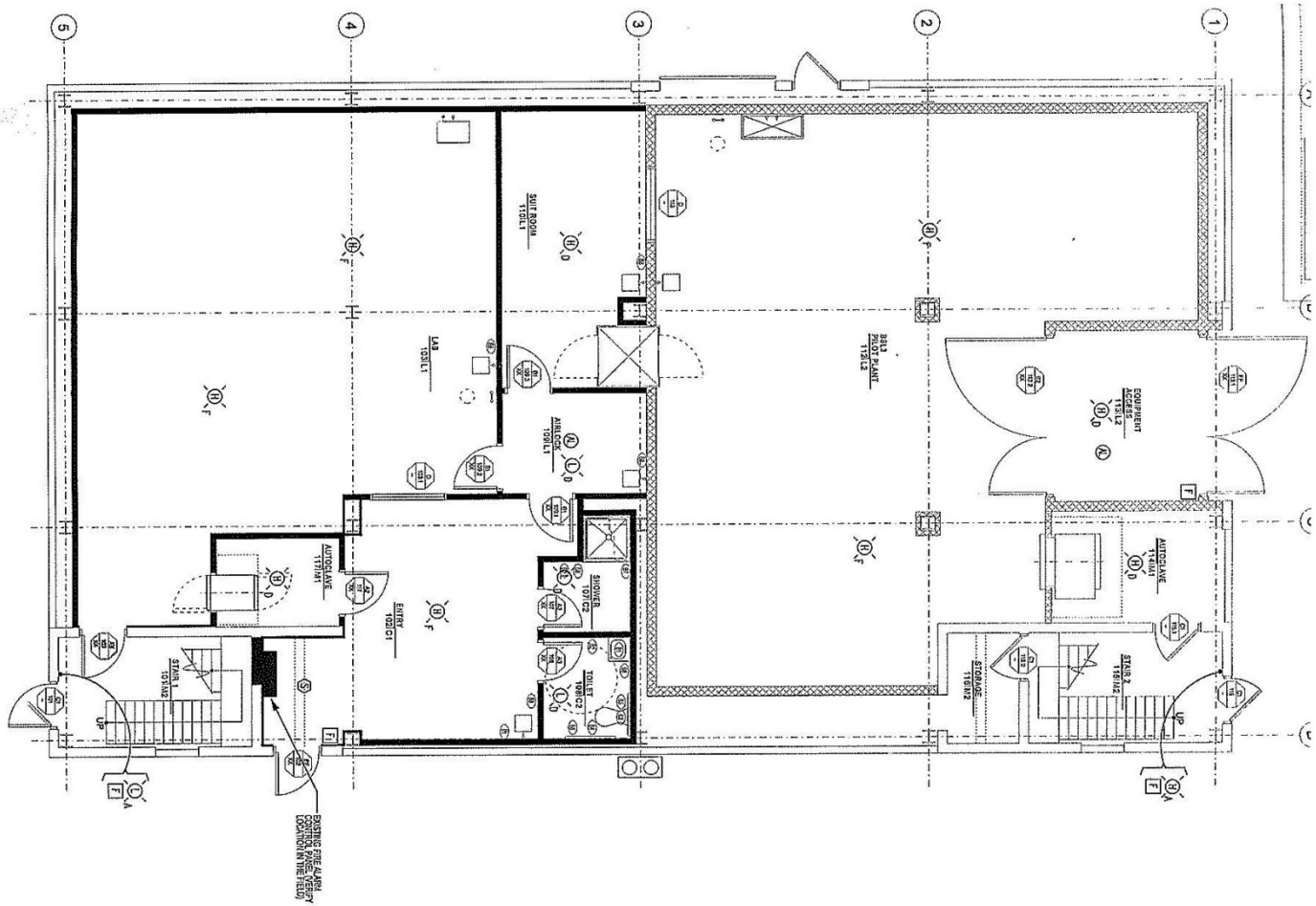
- Designed to allow pilot-scale work on food processing equipment
- Much larger volumes than lab bench
- Can bring in equipment straight from the plant

- 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

First Floor


SUIT ROOM
LAB
AIRLOCK
BSL3 PILOT PLANE
EQUIPMENT ACCESS
AUTOCLAVE
SHOWER
ENTRY
TOILET
STAIR 1
STORAGE
STAIR 2
EXISTING FIRE ALARM CONTROL PANEL (VERIFY LOCATION IN THE FIELD)

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

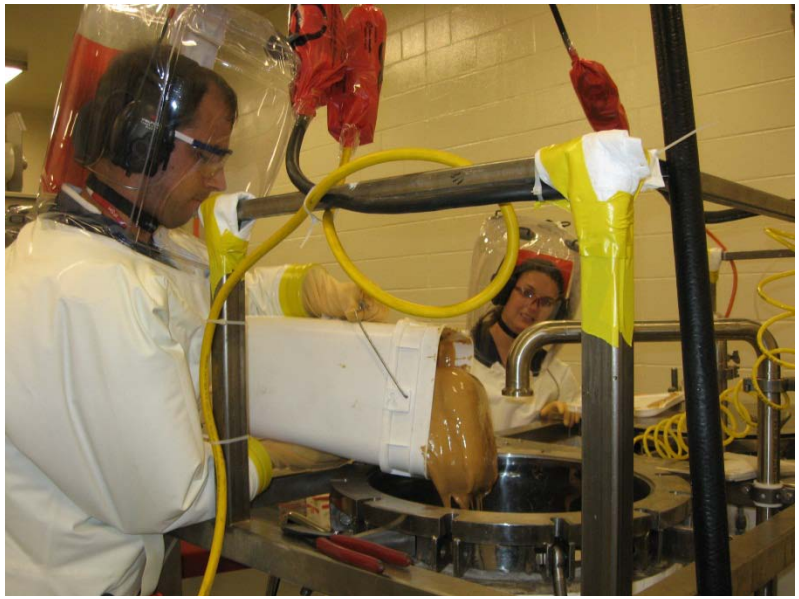
Infectious Materials

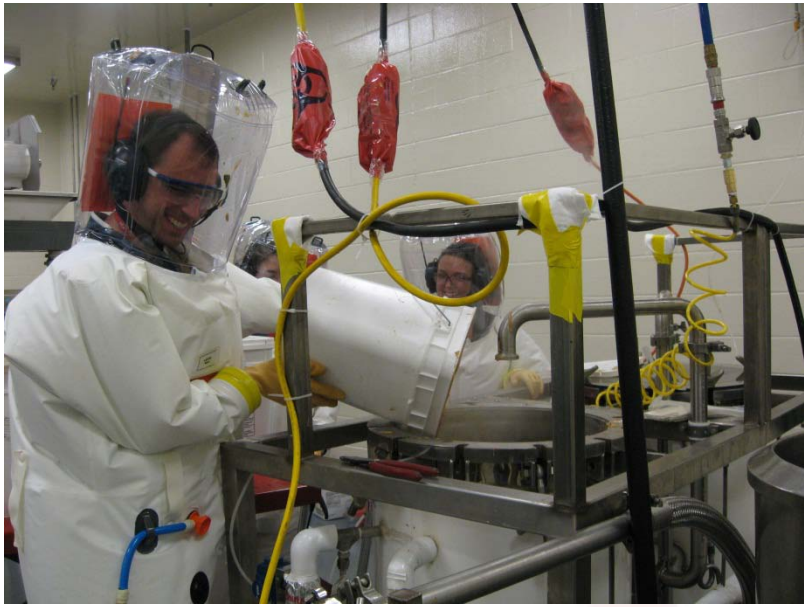
- Food pathogens
  - *Salmonella, Listeria, E. coli* O157:H7
- Select Agents
  - *Bacillus anthracis, Clostridium botulinum* and toxins, ricin, abrin
- Large-volume cultures
  - 150 lbs (68 kg) peanut butter spiked with 10^7 CFU/g *Salmonella*
  - 600 gallons (2300 L) water, spiked with varying amounts 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

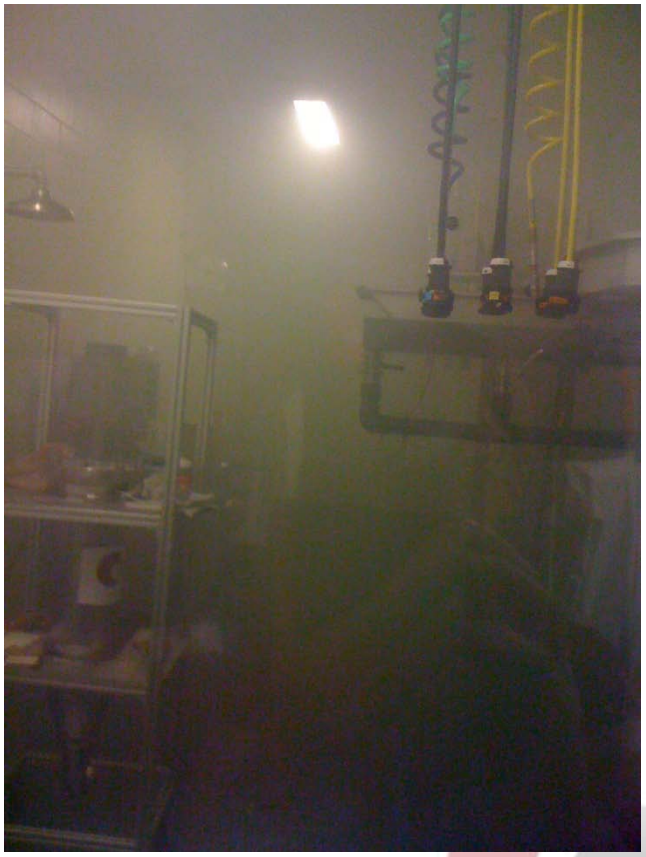
- Facility has been functional for past two years
- Last year has seen increase in use
- How can we increase use while retaining safety?

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
  - ClO_2 penetrates water, so we will run water through equipment to decontaminate the interior piping and pumps
  - ClO_2 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