Safety as a First Priority: Evaluating Risk at Composting and Anaerobic Digestion Facilities

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Useful hazard analysis techniques

• Process failure analysis – such as HAZOP; risk mapping

• Job hazard analysis – this can be used as the basis for standard job operating procedures
Consider any and all types of hazards and combinations

- chemical: adverse health effects; reactivity, fire, explosion
- biological: disease, allergy, inflammation
- ergonomic: strains, sprains, over-exertions (acute or cumulative)
- occupational stress: including shiftwork and scheduling
- physical: radiation, thermal, EMF, vibration, noise
- trauma: slips, falls, impact, compression, cuts, amputation
- violence: verbal harassment, threats, physical assaults
- indoor air quality: non-industrial workplaces
Consider…
Operations and Maintenance
Hierarchy of Controls of Hazards

Lower value controls could be used until better, long-term controls can be implemented.
Workplace Health and Safety Program

Rhymes with Orange

THE TEST RESULTS
I recommend garden bed rest.
What is being composted?

Feedstocks: (receiving, tipping floor)
- Yard wastes: leaves, grass, brush, trimmings
- Food wastes
- Agricultural wastes: plants, animals, manure, bedding
- Industrial wastes: paper, food wastes, ????
- Sewage sludge (biosolids)

Bulking agent: wood chips, sawdust, other
Accidents and Trauma Risks

Engulfment
In buildings or from windrows, mists from evaporating moisture might visually obscure workers – run over

Brush chipper accidents
Conveyor belt accidents
Grinders, turners, and mixers
Power take-offs from tractors
Shedding parts; flying debris
Equipment hazards

• Is this equipment manufactured with any guards or interlocks?

• While operating this equipment, something goes terribly wrong. How would you stop this equipment from operating or moving immediately?

• To do maintenance, does this equipment (or a portion thereof) need to be locked-out, blocked, chocked, etc.?
Wood Chipper
Tub grinder

Trommel screen

Figure 4.4
Tractor-assisted windrow turners.

Elevating-face conveyor is adapted with permission from Scat Engineering. Rotary drum turner is adapted with permission from Wildcat Manufacturing.

Tow-behind, PTO-powered rotary drum with flails

Push-type, self-powered (diesel engine) rotary drum with flails

Tractor-towed, self-powered, elevating-face conveyor

Working under Power Lines

Be aware of overhead power lines and the possibility of electrical shock.
The elevated part of the vehicle should be kept a distance of at least 10 feet (3 m) from the power lines to prevent the equipment from becoming energized and shocking the operator.
Check this during the day – lines can expand and sag in hot weather.
Loud equipment…

- wood chipping
- shredding
- grinding
- turning piles

…reported as exceeding 90 dBA.

Shredders reported as high as 98 dBA.

How could noise exposure be reduced?

Common Noise Levels

Compost Fires

Need a supply of water for firefighting. A common cause is spontaneous combustion. Find the hot spot - uncover it and apply water to it.
Routes of Entry
Biological exposures

- **Bacteria**: infectious risk in initial phase of composting; may not be significant risk in final processing if system operates to kill pathogens (possible exception of *C. botulinum*).

- **Fungi**: allergens and toxic products; acute or chronic effects in susceptible people

- **Viruses**: poor survivability in sewage sludge compost (inactivated)

- **Protists** (protozoal parasites)

- **Animals**: worm cysts

- **Prions**

Hygiene Practices

- Hygiene facilities: change rooms, showers, clean-up, lunchroom
- Shower at work and change into clean clothes and shoes. Reserve footgear for use at worksite.
- Wash hands with soap and water before eating or smoking or whenever hands come into contact with compost or feed stocks.
- Wash hands before and after using the bathroom.

Hygiene Practices

• Do not wear work clothes home or outside the work environment.
• Remove excess contaminants from footgear prior to entering a vehicle or a building.
• Thoroughly but gently flush eyes with water if contaminants contact the eyes.
• Care for cuts and abrasions promptly. Keep wounds covered with clean, dry bandages.

Hazard Reduction

Enclosed cabs with air filtration to reduce...

...inhalation
...eye exposure
...impact injuries
Hazard reduction -- PPE

- Respiratory protection for all the dust-generating tasks (particulates); minimum N-95
- Unvented goggles; can add faceshield if impact possible
- Gloves and steel-toed workshoes; for wet feedstocks use heavy duty rubber gloves and boots
- Use protective clothing; moisture-proof for wet feedstocks
- Hardhat
- Hearing protection

Remove contaminated clothing at end of shift. Avoid laundering work clothes at home. If they are cleaned at home, place them in a bag and leave them bagged until they are actually to be placed in the washing machine. Wash separately from other clothing using the hot water cycle. Use chlorine bleach if appropriate for the fabric.

I LOVE THAT NEW COW SMELL.
Unit Operations

Step 1: manure collection

Step 2: addition of other digester feedstocks

Step 3: anaerobic digester

Step 4: solids separation/dewatering

Step 4a: solids storage

Step 4b: liquid storage

Step 5: biogas distribution system

Step 5a: disposal by combustion (gas flare)

Step 5b: electricity and heat generation
Newly-constructed biogas plant in southwestern Germany
Explosion, Dec. 2007
Confined Space
An example of combined hazards

Asphyxiating atmosphere/oxygen deficiency

Explosive atmosphere: gases or dusts

Toxic atmosphere

Mechanical hazard, needing lockout/tagout, line-breaking, or other procedures

Engulfment: drowning, buried alive
Confined Spaces

- raw manure tank
- feedstock tank
- effluent tank
- agitator pits
- digester

These are confined spaces by definition as per 29 CFR 1910.146.
(Note: this OSHA regulation does not apply to agriculture.)

ANSI/ASABE S607 Oct2010 Ventilating Manure Storages to Reduce Entry Risk
RECOMMENDATIONS BY USDHHS/CDC/NIOSH: Manure pits on farms should be treated like any other type of confined space.

• all manure pits should be ventilated,
• the atmosphere within the pit should be tested before entry,
• a standby person should be in constant contact and ready to lift the worker to safety with mechanical lifting equipment (winch, hoist, or pulley), and
• anyone entering a manure pit should wear a safety belt or harness with a lifeline tied to the mechanical lifting device.
Ventilation of Confined Spaces

Ventilate the manure pit as per ANSI/ASABE S607

Source:
Testing a potentially hazardous atmosphere
Tank covers
PREVENTIVE MEASURES

Make covers of a sturdy material to support weight of workers standing or walking across tops of tanks.

- If more than one person stands on the hatch cover at any one time, then the weight of multiple people would dictate the strength needed.

- If a pump is hoisted from a tank and allowed to rest on an adjacent hatch cover, perhaps alongside the operator of the winch, these weights should also be taken into account.
Digester

Figure 6
Biogas piping – no flash arrestor (notice scorching)
Flare

Figure 12
Generator
Noise; electrical hazards; oil on floor.
Still, it would be nice to go out for compost once in a while.