Safety and Health Risks Associated with Growing and Processing Legal Cannabis

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General Business Overview – “Legal” Cannabis

- Legal cannabis manufacturing for medicinal and/or recreational use is now widespread in the US. Production operations range from a few plants being grown by medical marijuana caregivers to very large scale (square kilometers) greenhouse complexes in Canada and some US states.

- Cannabis is not legal at the federal level in the US. It is still a “Schedule 1” drug, as is heroin, LSD, magic mushrooms, etc. This presents significant issues of finance, legality, security, and scale.

- Generally smaller growers/businesses in the US vs. Canada. Exceptions exist, of course.

- Cannabis is now broadly legal in Canada (recreational and medical). Scale is much larger, with more traditional safety/health risk control application and resources. In Canada, you are more likely to observe large corporate H&S involvement, and more involvement of the government safety/health (and environmental) regulators.
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Overview – Cultivation, Extraction, and other Support Processes

- Cultivation and Extraction are two of the main processes of safety and health interest.
- Other processes of safety/health interest include packaging, maintenance of facilities and equipment, transportation, and security.
- Laboratory safety is also important, as QC lab work (GC/GCMS, ICAP, optical microscopy, etc.) is a big part of cannabis QC and production.

Let's visit the cultivation process itself . . .
Growing Process Map

Process Flow Chart for Cannabis Cultivation

Contained Structure (adapted from 7CFR334.1 definitions): A (fully enclosed) physical structure designed to minimize release of plant materials into the outdoor environment and/or prevent unauthorized access to plant materials contained within the structure. Examples of contained structures include, but are not limited to, laboratories, greenhouses, storage facilities, bioreactors, and fermenters.

Outdoor Setting: Areas that are not considered contained structures, including partially-enclosed structures that are used outdoors (e.g., hoop houses, lathe houses, screenhouses).

Post-Harvest Operations: Activities occurring after commodity is harvested from plant (usually in an enclosed or semi-enclosed structure dedicated for post-harvest use).
Cannabis Industry: Manufacturing Flow Chart

Cannabis Industry: Manufacturing Flow Chart

Cultivation (assumed to end at Harvest)

Drying

Bud Curing
1. Freeze dry
2. Water Cure
3. Dry-Ice Cure

Safety Inspection

Chopping & Stem Removal

Wash

Shred/Strain

Decarboxylation

Infusion
1. Alcohol
2. Oil
3. Butter
4. Honey

Processing

Non-Solvent Extraction
1. Dry Sieve
2. Water
3. Rosin Tech
4. Ice Water

Solvent Extraction

Packaging

Pre-Rolls

Buds: Sativa, Hybrid, & Indica

Concentrate, Extracts, Topical, Wax

Edibles & Drinks

QA/QC & Distribution
### Boiling Points of Cannabinoids & Terpenoids:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Boiling Point</th>
<th>Medicinal Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>THC</td>
<td>315 °F</td>
<td>Anti-inflammatory, analgesic, antidepressant</td>
</tr>
<tr>
<td>THC-A</td>
<td>220 °F</td>
<td>Sedative, antitumor, anti-nausea, antidepressant, anti-epileptic</td>
</tr>
<tr>
<td>CBD</td>
<td>356 °F</td>
<td>Antipsychotic, anti-inflammatory, anti-oxidant, anti-seizure, pain relief</td>
</tr>
<tr>
<td>CBN</td>
<td>365 °F</td>
<td>Analgesic, antispasmodic, anti-insomnia, sedative</td>
</tr>
<tr>
<td>CBC</td>
<td>428 °F</td>
<td>Antibacterial, anti-inflammatory, anti-anxiety, bone-growth stimulant</td>
</tr>
<tr>
<td>Caryophyllene</td>
<td>246 °F</td>
<td>Anti-inflammatory, antidepressant</td>
</tr>
<tr>
<td>Limonene</td>
<td>349 °F</td>
<td>Antidepressant, immunity booster</td>
</tr>
<tr>
<td>Myrcene</td>
<td>334 °F</td>
<td>Antibiotic, anti-inflammatory, antitumor</td>
</tr>
<tr>
<td>Linalool</td>
<td>388 °F</td>
<td>Insomnia and chronic-pain relief</td>
</tr>
<tr>
<td>Pinene</td>
<td>311 °F</td>
<td>Anti-asthmatic, anti-inflammatory, bronchodilator, stimulant</td>
</tr>
<tr>
<td>Cineole</td>
<td>349 °F</td>
<td>Antibiotic, antiviral, stimulant, increases blood flow</td>
</tr>
</tbody>
</table>

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Cultivation - UV Light

- Takes place in greenhouses and/or indoors.
- Very controlled growing conditions. Lighting cycles are varied throughout the growing period. All designed to maximize yield.
- UV lighting – high-intensity skin/eye exposures. Generally mitigated by UV-resistant clothing (covering all skin), UV glasses, enclosures, reflectors directing UV light to plant areas only.
Cultivation – Atmospheric Hazards

- Increasing the CO2 level inside the greenhouse/growing room will increase the yield. CO2 is supplemented with gas from storage tanks or generators.
- CO2 levels can reach (and sometimes exceed) the TLV of 5000 ppm. The CO2 STEL is 30,000 PPM.
- Ammonia (aqueous and/or anhydrous) may become more popular in large-scale operations as a fertilizer.
- Controls include fixed and portable oxygen, NH3 and CO2 monitors with alarms, and good process safety management.
Cultivation – Pesticides

- Bugs like cannabis! Growers don’t like bugs!
- Pesticides are commonly used in commercial growing operations.
- Some growers are organic (no pesticides), but this may result in more expensive cannabis.
- Worker Exposure Controls – Registered pesticides (EPA and Health Canada), selected carefully and used appropriately by trained (and where required – licensed) applicators, wearing suitable PPE.
- Residue testing on products will likely gain in importance as the legal cannabis marketplace expands.
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Cultivation – Mold

- *Optimal growth conditions for cannabis are also near-optimal growth conditions for mold.*
- Cultivation piping systems and water storage tanks can be breeding grounds for Legionella bacteria.
- Controls for mold include regular visual inspections, careful monitoring of humidity, use of hydroponic metered watering techniques vs. open water spraying, good drainage of soils and other production areas.
- *Monitor workers for mold sensitization.* PPE (respirators) when needed.
- Controls for Legionella include regular water line flushing and testing, avoiding ferrous plumbing, and avoiding aerosol creation.
Cultivation – Ergonomic Risks

• Harvesting and trimming of cannabis is manual and labor intensive. Ergonomic risks include bending, over-reaching.

• Manual handling of heavy materials, including fertilizers, CO2 tanks, potting soils, etc. may occur.

• Trimming of dried cannabis flowers (buds) is a very manual task, performed with tiny scissors/trimmers. Risks include chronic hand soreness and/or carpal tunnel syndrome.

• Controls may include appropriate material handling equipment, mobile scaffolds, and for bud trimming, job rotation and ergonomically-designed trimming scissors.

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Cultivation – Heat Stress

- Optimal growing conditions for cannabis include warmth and humidity.
- Combined with other PPE for UV, mold, pesticides, etc., heat stress is a significant risk.
- Controls include appropriate work/rest cycles, acclimatization, hydration, training, cooling stations, PPE (ice vests) Humidex/WBGT monitoring, and co-worker monitoring.
- 40 Humidex = 104 F dry temp

<table>
<thead>
<tr>
<th>Humidex 1 – Moderate physical work, unacclimatized worker, OR Heavy physical work, acclimatized worker</th>
<th>Response</th>
<th>Humidex 2 – Moderate physical work, acclimatized worker, OR Light physical work, unacclimatized worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 - 29</td>
<td>supply water to workers on an “as needed” basis</td>
<td>32 - 35</td>
</tr>
<tr>
<td>30 - 33</td>
<td>post Heat Stress Alert notice</td>
<td>36 - 39</td>
</tr>
<tr>
<td>34 - 37</td>
<td>• notify workers that they need to drink extra water  • ensure workers are trained to recognize symptoms</td>
<td>40 - 42</td>
</tr>
<tr>
<td>38 - 39</td>
<td>• work with 15 minutes relief per hour can continue  • provide adequate cool (10 - 15°C) water  • at least 1 cup (240 mL) of water every 20 minutes  • workers with symptoms should seek medical attention</td>
<td>43 - 44</td>
</tr>
<tr>
<td>40 - 41</td>
<td>• work with 30 minutes relief per hour can continue in addition to the provisions listed previously</td>
<td>45 - 46</td>
</tr>
<tr>
<td>42 - 44</td>
<td>if feasible, work with 45 minutes relief per hour can continue in addition to the provisions listed above</td>
<td>47 - 49</td>
</tr>
<tr>
<td>45 or over</td>
<td>only medically supervised work can continue</td>
<td>50&quot; and over</td>
</tr>
</tbody>
</table>

Source: Occupational Health Clinics for Ontario Workers (OHCCOW) – “Humidex Based Heat Response Plan”
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Cultivation – Other Safety/Health Risks

- Working at Heights – tall plants, overhead lights, greenhouse louver systems, etc.
- Electrical Safety – cannabis production equipment uses lots of electricity. Wiring needs to meet electrical codes, especially in high humidity/wet areas, and areas where flammable vapors may be present.
- Security/Workplace Violence – very high value crop, very easy to convert to cash. In the US, cannabis-related business transactions are often done in cash. Armed guards, video monitoring, physical security, alarms, etc. are common.
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Extraction – What is it?

- Cannabis oils (terpenes) contain THC, CBD, and possibly other medicinal compounds. Cannabis oils are also used medically and recreationally in foods, and can be smoked.

- Buds are ground up, and a solvent is used to extract the terpenes from the buds, then the solvent from the terpenes.

- Safety/health risks in extraction processes are many, and relate to the extraction processes used. Steam, flammable solvents like ethanol, “supercritical CO2”, and other extraction methods are available. Each has unique safety/health hazards and operational benefits.

- **Process safety is a must with extraction processes.** Adopting process safety management (PSM) elements from OSHA and other recognized safety organizations would be a good practice when utilizing extraction processes. **Need to do good PHAs on extraction processes.**

- Engineering control examples include atmospheric monitors, electrical installations suitable for flammable atmospheres, pressure-relief devices, and other controls specific to the extraction methods used.
Extraction Process – Supercritical CO2

Goal of process is to extract terpenes as quickly and efficiently as possible.

Safety/Health:

High Pressures
Cryogenic Temperatures
Asphyxiant gas (CO2)
Line Breaking (pressure)
Extraction Process – Flammable Solvents

Goal of process is to extract terpenes as quickly and efficiently as possible.

Safety/Health:

High Pressures
Line Breaking (pressure)
Flammable liquids and gases
Toxicity of vapors and gases

Environmental – Waste products
Extraction Processes - Summary

- Oils can be separated (“extracted”) from the plant products (primarily buds/flowers) using a variety of means.
- Extraction is two processes – (1) separate the oil from the plant, and (2) separate the solvent from the oil.
- Some of the solvents used are flammable. Examples include alcohols, ethers, and fuels like propane and butane.
- Some of the solvents used are toxic (alcohols, ethers).
- Some of the solvents used are cryogenic liquids (super-critical CO2) and are toxic and/or asphyxiants.
- Most of the industrial-scale processes are enclosed, monitored and controlled. But . . .
- Legal cannabis is a new industry. Process safety management and safety culture is immature in many respects. Much can go wrong in this area.
- *The application of proven process safety management tools in this area is vital.*
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Safety/Health “Culture” in the Legal Cannabis Industry

- Cannabis growing/processing “roots” (no pun intended) are counter-culture and tend to be insular. There is not a history of collaboration with the safety/health community and regulators until very recently.

- The controlled growing of high-value crops is a new and competitive industry. Safety/health best practices are not readily being shared at this point.

- We are seeing this start to turn around in states like Colorado and Washington, with successful safety/health outreach efforts made by state OSH organizations.

- *Much opportunity for safety and IH professionals to influence this emerging industry.*
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Summary –

- Industrial Hygienists and Safety Professionals are currently providing safety and health support to workers and employers in the legal cannabis industry.
- Aside from some of the extraction technologies, there is nothing particularly exotic about this industry. There are many traditional IH/safety risks, for which our knowledge, skills, and abilities can help protect worker safety/health.
- Excellent sources of safety/health information can be found by Googling “cannabis safety health Colorado” or “cannabis safety health Washington”. Both Colorado and Washington have very knowledgeable state-plan industrial hygiene and safety professionals supporting worker safety for their legal cannabis industries.

Disclaimer – All of the information presented pertains to the legal cannabis industry. This presentation should not be construed as an advocacy or enticement for the use, manufacture or distribution of cannabis contrary to law.

Questions?