

Best Practices Guide for Hop Processing

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In conjunction with: Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) and the United States Department of Agriculture

Introduction

This guide was authored for the sole purpose of providing robust, *minimum* standards for hop processors regarding food safety, product quality, personnel, and proper data collection and retention. Practices outlined in this manual are borrowed from other similar industries as well as crafted specifically with smaller hop processors in mind.

The Guide is divided into 16 sections detailing necessary steps for the processor to show control of all aspect of hop processing and food safety. The Guide is by no means a complete accounting for all aspects of a food processing business and the processor shall retain all liabilities therein.

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Facilities

- 1.1 CONSTRUCTION AND MAINTENANCE; GENERAL.
 - 1.1.1 Buildings shall be of sound construction, permanently sealed within reason from weather and pests and capable of restricting access to unauthorized personnel.
 - 1.1.2 Building must be composed of materials resistant to the local weather and not permit the habitation of pests or other vermin and be maintained to prevent such.
 - 1.1.3 Structures attached to existing buildings in which processing shall occur must be isolated from the main structure in such a manner to limit access.
 - 1.1.4 All framing shall be enclosed.
 - 1.1.5 All insulation shall be encapsulated such that no friable particulates or other contaminants may be released.
- 1.2 EXTERIOR PREMISES. The premises surrounding a hops processing plant shall be well drained and shall be kept in a clean and orderly condition. The premises shall be kept free of accumulations of trash, garbage, and other potential health nuisances. Driveways and parking lots shall be surfaced or maintained to minimize airborne dust and dirt.
- 1.3 DOORS AND WINDOWS. Doors, windows, skylights, transoms and other openings to the outside shall be tight-fitting, free of breaks, and effectively screened or protected against the entry of rodents, insects, birds and other animals. External doors, other than overhead doors in delivery areas, shall be self-closing. External doors shall be kept closed when not in use.
- 1.4 ACCESS AND SECURITY. Processing structures shall exhibit controlled access on all entries and exits such as keyed deadbolts, key-pad access, magnetic ID cards. Overhead doors shall be controlled by either keyed entry or remote keypad access.
- 1.5 CONTROL OF PESTS. Effective measures shall be taken, as necessary, to control insects, rodents and other pests in a hops processing plant. Pesticides and other hazardous substances shall not be stored or used in a manner which may contaminate hops, or which may constitute a hazard to employees or the public. Pesticides shall not be stored, handled or used in a manner inconsistent with label directions, or in a negligent manner.

- 1.6 VENTILATION. There shall be adequate ventilation in all areas where hops is processed or handled, in all areas where equipment or utensils are cleaned or sanitized, and in all dressing rooms, locker rooms, toilet rooms, employee break rooms, and garbage or rubbish storage areas.
 - 1.6.1 Ventilation shall be adequate to remove excessive heat, steam, condensation, vapors, obnoxious odors, smoke and fumes. Ventilation systems shall be positioned so that exhaust air is not vented onto exposed hops, or onto clean hops packages, equipment or utensils.
 - 1.6.2 Intake fans shall be equipped with filters that are readily removable for cleaning and replacement.
 - 1.6.3 Intake filters shall be capable of removing at least 85% of particulate matter that is 5 microns or larger in size.
 - 1.6.4 Exhaust fans, intake fans, ventilation ducts and filters shall be kept clean and in good repair, and shall be screened or louvered to prevent contamination of hops by dust, dirt, insects or other contaminants.
 - 1.6.5 Ventilation systems, if used to ventilate any area of a hops processing plant, shall be capable of maintaining positive pressures in that area.
- 1.7 LIGHTING. Lighting in every area of a hops processing plant shall be sufficient for the purpose for which the area is used.
 - 1.7.1 Artificial lights in processing areas shall be equipped with protective shields or shatter resistant bulbs.
 - 1.7.2 There shall be not less than 215 lux of illumination on all processing surfaces as measured 3 feet from the floor.
 - 1.7.3 Supplemental task lighting shall be equipped with enclosed bulbs
- 1.8 FLOORS, WALLS AND CEILINGS. Floors, walls and ceilings in processing areas shall be:
 - 1.8.1 Constructed of smooth, easily cleanable, non-porous materials such as ceramic tile, FIP (fiberglass impregnated panels), sealed concrete, or stainless steel. This does not prohibit the use of easily cleanable anti-slip floors.
 - 1.8.2 Gypsum board may be used as a wall and ceiling material and coated with a light colored, high-gloss, industrial finish promoting easy cleaning only in areas not directly adjacent to

- hop processing activities or wash-down areas.
 - 1.8.3 The junctions of walls and floors in processing areas shall be coved to facilitate cleaning and sealed to both the wall and floor to prevent water seepage behind cove material.
 - 1.8.4 Floors on which water or fluid wastes are discharged shall have an adequate number of floor drains and be adequately sloped to ensure proper drainage to the floor drains.
 - 1.8.5 At least one service sink or curbed floor drains shall be provided for mop and floor cleaning tools and general janitorial activities within the immediate processing area but not directly adjacent to the processing equipment as to prevent any cross-contamination.
- 1.9 PLUMBING SYSTEM AND SEWAGE DISPOSAL. Sewage and waste materials from hops processing plant shall be removed in a sanitary manner, in compliance with applicable state and local regulations. All plumbing, plumbing fixtures and equipment shall be designed, installed and maintained to prevent backflow, back-siphonage and cross-connections.
- 1.9.1 Floor drains shall be installed with sloping floor to convey waste water and prevent standing puddles.
- 1.10 OPERATIONS WATER. Operations water shall be obtained from a source that complies with local municipal water quality standards or county well water standards. Water shall be available in consistently adequate quantity, and shall comply with the health related drinking water standards for any given municipality.
- 1.10.1 If a hops processing plant operator obtains operations water from a privately owned water system, the operator shall sample that water at least once annually. The operator shall have each sample tested by a certified laboratory for compliance with the microbiological standards under Appendix A of this document or municipal standards, whichever is stricter.
 - 1.10.2 A hops processing plant operator shall keep on file, for at least one year, the results of all microbiological and other tests conducted on operations water sampled at the hops processing plant.
 - 1.10.3 Non-potable water shall not be used in any operation

- 1.11 ELECTRICAL CONNECTIONS. All electrical connections to equipment and outlets shall be installed and maintained to the minimum building code requirements for the municipality.
 - 1.11.1 Main disconnects shall be capable of lock-out, tag-out and located within line-of-sight and appropriate distance to machinery to be shut off in the event of an accident.
 - 1.11.1.1 Power shut-offs or safety stops shall be installed on equipment where circuit panel connections are not line-of-sight
 - 1.11.2 All surface-mounted electrical connections and circuits shall be enclosed in metal or plastic conduit and sealed with water-tight fittings
 - 1.11.3 Any floor mounted conduit must use seal-tight connectors and be connected in such a manner to permit cleaning on all surfaces and not retain debris.
- 1.12 PROCESSING AREA SEPARATED. Hops processing areas shall:
 - 1.12.1 Be separated by partition or be located at an adequate distance from other operations which may contaminate unpackaged hops, so that contamination is effectively eliminated.
 - 1.12.2 No processing may be conducted in a room used as living, sleeping quarters, or office space.
 - 1.12.3 If a hops processing area shares one or more walls with adjacent non-processing areas, processing operations shall be separated by a tight-fitting, latching door.
- 1.13 CLEANING FACILITIES. If equipment, utensils or containers are manually cleaned or sanitized, the hops processing plant shall be equipped with wash and rinse sinks which are suitable for all manual cleaning and sanitizing operations.
 - 1.13.1 Each sink shall be constructed of stainless steel or other approved materials.
 - 1.13.2 Each sink shall have at least 3 compartments for washing, rinsing and sanitizing equipment and utensils.
 - 1.13.3 All sink compartments shall accommodate the immersion of at least 50% of the largest item to be cleaned or sanitized in the sink and shall be served by hot and cold running water, cleaned prior to each use.
 - 1.13.4 Drain boards shall be provided in connection with every sink and large enough to accommodate soiled equipment and

utensils prior to washing, and clean equipment and utensils after they are sanitized. Mobile prep carts are acceptable for this purpose.

- 1.13.5 Brushes and cleaning tools shall be kept clean and in good repair and constructed of non-rusting materials. Single service disposable towels may be used in place of re-usable cloths if they are discarded after each use.

2 Personnel Standards.

- 2.1 **CLEANLINESS.** A high degree of personal cleanliness shall be maintained and good hygienic practices shall be observed during working periods.

- 2.1.1 Persons engaged in hops processing shall wash their hands before beginning work and upon returning to work after using toilet facilities, eating, smoking or engaging in other activities which may contaminate the hands.
 - 2.1.2 Persons engaged in hops processing shall keep their fingernails clean and neatly trimmed, and shall not wear fingernail polish unless they wear sanitary gloves at all times when handling hops.

- 2.2 **HAND CONTACT WITH HOPS.** Individuals engaged in hops processing or handling may not contact processed hops with their bare hands but shall use suitable hops handling aids such as deli-tissue, spatulas, tongs, single-use gloves, or dispensing equipment to avoid bare-hand contact.

- 2.2.1 Individuals may contact processed hops with bare hands if it is reasonably necessary, and does not contaminate hops.

- 2.3 **CLOTHING AND JEWELRY.** Persons in hops processing areas or handling unpackaged hops shall wear garments in accordance with the following:

- 2.3.1 Clean, washable outer garments and effective hair restraints, including effective hair restraints for beards longer than 1/2 inch.
 - 2.3.2 Hair restraints may include hair nets, caps and snoods, but do not include hairsprays, visors or headbands.
 - 2.3.3 Persons working in hops processing areas or handling unpackaged hops shall remove all jewelry from their hands and fingers before having any direct manual contact with hops or hops contact surfaces.

- 2.3.4 Jewelry shall not be worn in a manner which creates a risk of hops contamination. This subsection does not apply to plain band wedding rings.
 - 2.3.5 Loose clothing, long sleeves, shirt tails shall not be permitted when operating equipment that could pose an entanglement hazard.
- 2.4 EMPLOYEE HEALTH. No person who by medical examination or supervisory observation has or is reasonably suspected of having any of the following conditions may work in a hops processing plant in any capacity that may result in the contamination of hops, or in the contamination of equipment or utensils used to process or handle hops:
 - 2.4.1 A communicable disease.
 - 2.4.2 Any symptom of an acute gastrointestinal illness.
 - 2.4.3 A discharging or open wound, sore or lesion on the hands, arms or other exposed portions of the body.
- 2.5 CONSUMPTION OF FOOD, BEVERAGES, AND TOBACCO. There shall be no consumption of food, beverages or tobacco in any hops processing area, in any area where hops processing equipment or utensils are cleaned or stored. Sanitary water fountains in a processing area are exempt from this section. Food, beverages or tobacco shall be consumed only in designated areas separated from hops processing areas.
- 2.6 TOILET FACILITIES. Sanitary toilets shall be conveniently located and available to all employees as per state and local regulations.
 - 2.6.1 Processing facilities connected to living quarters shall have their own toilet facilities separate from any living quarters.
 - 2.6.2 Toilet rooms shall be completely enclosed and secured, well-lighted and equipped with tight-fitting, latching doors.
 - 2.6.3 Fixtures shall be easily cleanable and kept clean and in good repair and comply with the following sections:
 - 2.6.3.1 Shall be separately vented to the outside;
 - 2.6.3.2 Shall be equipped with an exhaust fan capable of creating a negative pressure within the toilet facility; and
 - 2.6.3.3 Shall not open directly into a hops processing area.
 - 2.6.3.4 Hand washing facilities shall be located in or adjacent to every toilet room and include hot and cold running water, soap in a soap dispenser, and a sanitary single-

service means of drying the hands. A sign directing employees to wash their hands shall be prominently posted in every toilet room used by employees.

2.6.3.5 The facility shall be served by hot and cold running water provided through a mixing valve or combination faucet, or by potable tempered water.

2.6.3.6 An easily cleanable covered trash receptacle and an adequate supply of toilet tissue shall be available in every toilet room at all times.

2.7 LOCKER AND LINEN FACILITIES. Lockers or comparable facilities may be provided for clothing and similar personal items of employees should specific gowning requirements be required.

2.7.1 Personal items (clothing, etc.) shall not be stored in any hop processing areas.

2.7.2 Protective clothing worn during processing shall be stored in an orderly and sanitary manner.

2.7.3 If disposable garments are utilized in the processing area, they shall be of single use and disposed of when suitably soiled or otherwise deemed ineffective.

2.8 HAND WASHING FACILITIES FOR PROCESSING AREAS. Hand washing sinks with hot and cold running water shall be provided processing areas. The sinks shall be unobstructed and kept clean. Supplies shall be provided in accordance with hand washing in toilet facilities and comply with the following:

2.8.1 It shall be located in the processing area.

2.8.2 It shall be served by hot and cold running water provided under pressure through a mixing valve or combination faucet, or by potable and tempered water.

2.8.3 Hand washing sinks may not be used to clean, sanitize, or store equipment or utensils.

2.9 GARBAGE AND REFUSE DISPOSAL. Garbage and refuse shall be removed as often as necessary to maintain the premises in a clean and sanitary condition.

- 2.9.1 Garbage storage areas shall be constructed and maintained so that they do not attract or harbor insects, rodents or other animals.
- 2.9.2 Garbage and refuse shall be held in durable, leak-proof, easily cleanable, and pest-resistant containers.
- 2.9.3 Containers shall be kept covered with tight-fitting lids, and shall be cleaned when necessary to prevent insanitary conditions.
- 2.9.4 Garbage and refuse shall not be burned on the premises, except in compliance with state and local laws.

3 Equipment and Utensils.

- 3.1 CONSTRUCTION AND MAINTENANCE; GENERAL. Equipment and utensils shall be of sanitary design and construction. Equipment and utensils shall be readily accessible for cleaning and inspection and shall be constructed so that they can be easily cleaned. Equipment and utensils shall be kept clean and in good repair.
- 3.2 HOPS CONTACT SURFACES. Hops contact surfaces of equipment and utensils shall:
 - 3.2.1 Be constructed of stainless steel or other materials which are smooth, impervious, nontoxic, noncorrosive, nonabsorbent and durable to solvents such as denatured alcohol.
 - 3.2.2 Be easily cleanable, and shall be free of breaks, open seams, cracks or similar defects.
 - 3.2.3 Not impart any odor, color, taste or adulterating substance to hops.
 - 3.2.4 Be readily accessible for manual cleaning.
 - 3.2.5 Joints and fittings shall be of sanitary design and construction.
- 3.3 LOCATION AND INSTALLATION OF EQUIPMENT. Equipment which cannot be easily moved shall:
 - 3.3.1 Be installed in a manner which prevents liquid or debris from accumulating under or around the equipment.
 - 3.3.2 Equipment shall be installed so that there is adequate clearance on all sides for cleaning and maintenance. This does not apply to that portion of a tank or container which is designed and installed to protrude into or through the wall or ceiling of a hops processing plant.

- 3.3.3 Air intake vents for ingredient storage containers and hop processing areas shall be filtered to prevent dust and debris contamination from forced-air ventilation systems.
- 3.4 MEASURING DEVICES AND CONTROLS. All freezer and cold storage compartment used to store or hold hops shall be equipped with a thermometer and relative humidity meter which accurately indicates the conditions in the compartment. Data should be accessible either electronically or physically for record retention purposes.
- 3.5 LUBRICATION. Equipment shall be designed and constructed so that gear and bearing lubricants do not come in contact with hops or hops contact surfaces. Only food grade lubricants may be used in equipment if incidental hops contact may occur.
- 3.6 CLEANING AND SANITIZING EQUIPMENT AND UTENSILS; GENERAL. All hops contact surfaces of equipment and utensils shall be cleaned and sanitized after each day's use, and prior to any change in use that may cross-contaminate hops with major hops allergens or other contaminants.
 - 3.6.1 Sanitizers and methods used to sanitize equipment and utensils shall comply with state food safety standards.
 - 3.6.2 The processor may apply to its governing body for alternative cleaning and sanitizing procedures.
 - 3.6.3 Containers used to store hops or ingredients shall be cleaned and sanitized whenever the hops processing plant operator empties those tanks or more often if necessary.
 - 3.6.4 Paragraph 3.6 does not apply to the following equipment, provided that the hops processing plant operator cleans and sanitizes the equipment according to manufacturer specifications:
 - 3.6.4.1 Drying equipment.
 - 3.6.4.2 Cloth-collector systems.
 - 3.6.4.3 Dry product packaging equipment and storage containers.

4 Sanitizers and Sanitizing Methods.

- 4.1 SANITIZING METHODS. All returnable or multi-use hops packages, and all hops contact surfaces of equipment and utensils used to handle hops,

shall be sanitized prior to each use by one of the following sanitizing methods:

- 4.1.1 Immersion for at least 30 seconds in clean water at a temperature of at least 170°F (77°C).
 - 4.1.2 Immersion for a period of at least 2 minutes in a sanitizing solution containing at least 100 ppm of available chlorine, and having a pH not higher than 8.3, at a temperature not less than 75°F (24°C) nor more than 110°F (44°C).
 - 4.1.3 Immersion for a period of at least one minute in a sanitizing solution containing at least 12.5 ppm of available iodine, and having an acid pH not higher than 5.0, at a temperature of not less than 75°F (24°C) nor more than 110°F (44°C).
 - 4.1.4 Immersion in a caustic sanitizing solution
 - 4.1.5 Application, according to manufacturer's instructions, of a nontoxic chemical sanitizer or sanitizing method which has been demonstrated to be equally effective for sanitizing purposes
- 4.2 **SANITIZERS; MAXIMUM CONCENTRATIONS.** Sanitizers and cleaning compounds used on hops contact surfaces:
- 4.2.1 Shall not be used in a way that leaves a toxic residue on the hops contact surface.
 - 4.2.2 Sanitizing solutions shall not exceed the maximum concentrations established by the food and drug administration, United States department of health and human services, under 21 CFR 178.1010.
 - 4.2.3 A test kit or other device that measures the concentration of sanitizing solutions in parts per million shall be used as necessary to ensure compliance with this subsection at all times.

5 Water supply

- 5.1 **INGREDIENT WATER.** Ingredient water shall comply with the health related drinking water standards.
- 5.1.1 If ingredient water for bottled drinking water or soda water beverages is obtained from a privately owned water supply, that water shall also comply with the health related enforcement standards.
 - 5.1.2 If a hops processing plant operator obtains ingredient water from a privately owned source, the operator shall sample that

ingredient water at least once annually. The operator shall have each sample tested by a certified laboratory for compliance with the microbiological standards.

- 5.1.3 If a hops processing plant operator obtains ingredient water from a municipal source, the operator shall do all of the following:

5.1.3.1 Use current good manufacturing practices in handling that water, including safe and sanitary equipment, utensils, production controls and process controls that conform to good public health practice.

5.1.3.2 Provide documentation to the department, at the department's request, that the water complies with the microbiological standards. Documentation may consist of information provided by the municipality.

5.1.3.3 A hops processing plant operator shall keep on file, for at least 5 years, the results of all microbiological and other tests conducted on ingredient water sampled at the hops processing plant. The operator shall make the records available for inspection.

6 Hops Handling and Storage.

- 6.1 **GENERAL.** Hops shall be protected from contamination and decomposition while being processed, handled, conveyed or held at a hops processing plant.

6.1.1 Hops shall be processed and held in a manner which keeps the hops in a safe, wholesome and unadulterated condition.

6.1.2 Potentially hazardous hops shall be processed and held at temperatures, or in a manner, which minimizes the potential for growth of undesirable microorganisms.

- 6.2 **HOPS STORAGE.** Hops storage areas shall be maintained in a clean, sanitary and orderly condition, free from conditions which may result in the adulteration of hops. Potentially hazardous hops shall be stored at safe temperatures. Storage areas shall be constructed and maintained so that waste water and other waste liquids do not drain into, or accumulate in any storage area. Hops shall not be stored in a manner which may tend to attract or harbor pests.

- 6.3 **BULK PNEUMATIC HANDLING SYSTEMS.** Pneumatic systems using storage bins constructed of semi-permeable cloth material are exempt from the

requirement that surfaces be smooth and nonabsorbent, provided the surfaces can be effectively cleaned.

- 6.3.1 Attachment mechanisms for holding inspection port covers, access doors, delivery pipe caps or other removable accessories shall have no loose parts.
- 6.3.2 Delivery pipe caps shall be kept in place, and secured against removal. Outside installations shall be watertight or suitably covered to prevent entry of water and foreign material.
- 6.3.3 Intake air used in pneumatic handling systems shall be filtered to exclude particles of 50 microns or larger. Air discharged from the system shall be filtered so that no visible dust is permitted to escape. Filters shall be readily removable for cleaning or replacement.

6.4 RAW INGREDIENTS AND FINISHED PRODUCTS; SEPARATE HANDLING. Effective measures shall be taken to prevent cross contamination between raw ingredients and finished hops products. Raw ingredients shall not be handled simultaneously with finished products in any part of a hops processing plant if either the raw materials or the finished products are uncovered or unprotected, and if the handling may result in contamination.

6.5 SALVAGING DISTRESSED HOPS.

- 6.5.1 "Distressed hops" means processed hops exposed to a fire, flood, transportation accident, refrigeration breakdown or other unusual condition which may affect its safety or suitability for human consumption. This subdivision does not include hops or hop packages damaged during normal conditions product handling, transit or storage.
- 6.5.2 "Reconditioned hops" means packaged distressed hops which are distributed or offered for sale for consumption after its package is repaired or relabeled without being opened.
- 6.5.3 "Reprocessed hops" means hops otherwise damaged and subsequently processed in accordance with the requirements under this chapter and distributed or offered for sale with the intention of human consumption
- 6.5.4 A hop processing plant operator shall identify distressed hops as such, and shall separate them from pre or post processed hops. No operator may store distressed hops in a processing

area, or under conditions which may lead to the contamination of other hops, equipment, utensils or packaging materials.

6.5.5 No hops processing plant operator may do any of the following:

6.5.5.1 Reprocess or attempt to reprocess hops that may have been contaminated or adulterated.

6.5.5.2 Sell, offer to sell or distribute hops in packaging that is damaged or otherwise impinged upon, such as packages with leaking seams, ruptures, fractures, openings which may have exposed hops to contamination.

7 Hops Packaging and Labeling

7.1 GENERAL. Hops packages

7.1.1 Shall be of sanitary design and construction, so as to protect hops contents from reasonably foreseeable risks of contamination.

7.1.2 Hops packages shall be clean, sanitary and free of any extraneous or deleterious substance.

7.1.3 Hops shall not be sold or distributed in packages which are damaged to the extent that hops contents may be adulterated as a result of the damage.

7.1.4 A sealed hops package is damaged within the meaning of this subsection if the package or seal is broken or bulged.

7.2 HOPS PACKAGE LABELING. Packaged hops shall be packaged and labeled according to all of the following, as applicable:

7.2.1 Packaging containing hops shall report:

7.2.1.1 Vendor name

7.2.1.2 Hop variety

7.2.1.3 Alpha acid content expressed as a percentage

7.2.1.4 Total oil content expressed as ml/100g

7.2.1.5 Lot number pursuant to section 10 of this document

7.2.1.6 Barcode or other inventory tracking mechanism

7.2.2 External packaging such as cardboard box or other material shall display a label reporting the following information:

7.2.2.1 Vendor name

7.2.2.2 Hop variety

7.2.2.3 Lot tracking information

- 7.2.3 Labels shall be composed of materials suitable for prolonged cold without negative impact on adhesive such that the labels are easily removed from the container
- 7.2.4 Labels shall be printed using thermal transfer, laser, or other method indelible against condensation, fading.

8 **Recall Plan.**

- 8.1 **PLAN REQUIRED.** A hops processing plant operator shall have a written plan for identifying and recalling hops produced at that plant, should a hops recall become necessary. The operator shall update the plan as necessary, and shall make it available to the department for inspection and copying upon request.
- 8.2 **PLAN CONTENTS.** A plan shall do all of the following:
 - 8.2.1 Identify key individuals or positions that are responsible for planning, approving and implementing recalls on behalf of the hops processing plant operator.
 - 8.2.2 Identify key individuals or entities to be contacted or consulted in connection with a recall.
 - 8.2.3 Include procedures for the routine identification, dating and tracking of hop production lots, to distinguish affected lots from unaffected lots in the event of a recall.
 - 8.2.4 Include procedures to enable routine identification, dating and tracking of hop shipments from the hop processing plant. Tracking shall identify shipment recipients and contents, cross-referenced to production lots, so that recipients of affected lots can be contacted in the event of a recall.
 - 8.2.5 Include procedures for determining the nature and scope of a recall, including affected hop production lots, shipments and shipment recipients.
 - 8.2.6 Include procedures for identifying and communicating with affected persons, including suppliers, hops shipment recipients, down-line buyers, consumers, government agencies and others.
 - 8.2.7 Identify potential target audiences for recall information, including consumers, distributors and government agencies.
 - 8.2.8 Identify potential methods for communicating with target audiences under par. 8.2.7.
 - 8.2.9 Identify key information, including the identity of the affected hops, the reason for the recall, and suggested actions to be taken

by impacted recipients that may require action to be taken in the event of a recall.

9 Receiving Hops

- 9.1 GENERAL. Receiving hops at the processing facility consists of 3 stages; Pre-receipt and sampling, Pending receipt, and Disposition.
- 9.2 Pre-Receipt consists of lot number assignment, initial data entry, chain-of-custody provision, and hop quality sampling. No guarantees of acceptance are given and the grower must sign a chain-of-custody waiver acknowledging this fact.
- 9.3 Pending Receipt is the period during which the hop lots are evaluated for quality. Pending lots must be stored in climate controlled conditions described later in Section 14.
- 9.4 Disposition assigns either an ACCEPT or REJECT label to hop lots in Pending status based on quality criteria and/or any other contract obligations.
 - 9.4.1 ACCEPTED lots may proceed to pre-processing status and storage location
 - 9.4.2 ACCEPTED WITH CONDITIONS lots may proceed to pre-processing but lot will be noted for review
 - 9.4.3 REJECTED lots must be clearly marked as such and isolated from Pending and Accepted lots.
 - 9.4.3.1 Lots Rejected for high moisture content should be removed from the facility as they pose a fire risk. REJECTION disposition options are covered in chapter 13.

10 Lot Number Generation

- 10.1 GENERAL. Lot numbers shall consist of a unique numerical or alphanumerical code containing the following information:
 - 10.1.1 Hop variety
 - 10.1.2 Grower identity
 - 10.1.3 Date received
- 10.2 PURPOSE. Lot numbers do not presume acceptance or rejection, provide

processing status or stage, or are intended to identify finished goods. They are only intended to be a means of traceable identification through the pre-processing steps. Lot numbers will later be linked to inventory control batch numbers.

- 10.3 NOMENCLATURE. It is recommended that lot number nomenclature contain enough information for educated personnel to interpret the lot number with minimal effort so obvious differences can quickly be identified. For instance, a lot number might include a 3 letter abbreviation for the variety, number code for the grower, and the date:
CAS.012.091213
- 10.4 NON-ALPHANUMERIC CHARACTERS. Hyphens, slashes, decimals help break up the code so it is easier to read. In this example a worker can easily see that this bale belongs to Grower 12, Cascade is the variety, and it was received on September 12th, 2013. It is not necessary for the worker to know the identity of Grower 12, only that the Cascade hops belong to that farm.
- 10.5 BARCODING. Tagging hop lots with barcodes assist with automatic inventory movements and transactions, such as moving a lot from pending to accepted status, without re-labeling.
 - 10.5.1 Barcode data should contain all of the pertinent information as alphanumeric codes but are capable of holding much more information.
- 10.6 SOFTWARE COMPLIANT NOMENCLATURE. Prior to instituting lot numbering nomenclature, identify the ability of the software system to accept the numbering format. Most electronic inventory management software allow between 15-25 characters in the lot number however some will not accept non-alphanumeric icons such as hyphens, dots, or spaces.
- 10.7 TAGGING AND LABELING. Lot numbers must be securely affixed to each grower parcel in a manner that ensures:
 - 10.7.1 Clearly legible coding
 - 10.7.2 Large enough to be easily read in low light
 - 10.7.3 Be easily affixed to the parcel via adhesive or other non-metallic mechanical means
 - 10.7.4 Labeling material and ink are suitable for cold storage and non-

smudging

10.7.4.1 Thermal transfer and laser printers are acceptable for lot label printing.

10.7.4.2 Inkjet printers are not acceptable as they are not indelible.

10.7.4.3 Label stock should be of a material that resists moisture and does not lose adhesion in cold temperatures or due to rapid temperature changes.

10.7.4.4 Labels shall be minimally coated. Raw paper labels are not acceptable unless protected by a moisture resistant cover or pouch.

11 Receipt Inspection

11.1 GENERAL. Receipt inspection is the process of qualifying hops for quality, integrity, and other criteria per the processor's material specifications.

11.1.1 Receipt inspection criteria must be clearly defined and measureable (e.g. discoloration, debris contamination, moisture content) and any batch rejections must be justified with empirical data. This section describes the receipt inspection process and details the minimum criteria upon which hops may be accepted or rejected.

11.2 USDA HOP INSPECTION HANDBOOK. Hop physical quality parameters measured to determine acceptance by the processor shall include, at a minimum, the parameters set forth by the USDA Hop Inspection Handbook at the time of this manual's publishing ([Appendix KA](#)). The Handbook is intended to be used as Standard Operating Procedure for USDA inspectors however most small hop processors do not have access to USDA inspectors therefore these procedures should be the responsibility of the processor. Records should be made available for review. Further guidance on proper sample handling and data recording are detailed in Appendix J.

12 Receiving Activities

12.1 GENERAL. Incoming hops shall be assigned unique pre-processing lot numbers that link grower, variety, field, harvest, etc.

12.1.1 Hops staged for inspection shall be segregated from accepted lots by distinct physical means (bins, racks, section, etc).

12.1.2 Rejected lots shall be removed from the immediate area.

12.2 RECEIVING ACTIVITIES. The processor shall make every attempt to perform preliminary receipt inspection on the same day as delivery to the processing facility.

12.2.1 Receiving personnel shall refer the USDA Hop Inspection Handbook, Chapter 2, Section 2.6 when determining sample number and frequency.

12.2.2 If the lot is comprised from numerous small, loose bags (non-baled, uncompressed) it is permissible to combine the smaller parcels of the same variety into a composite unit for baling by the processor.

12.2.3 Sub-samples shall be placed into a secure container made safe against contamination or spillage. The container shall have the lot number clearly marked in indelible ink.

12.2.4 Lots shall be moved to PENDING status per section 9.2.1

13 Documenting Rejection

13.1 GENERAL. Rejection of a hop lot constitutes a raw material non-conformance and requires documentation. A non-conformance report should contain the following information:

13.1.1 Non Conformance Report number

13.1.2 Lot Number

13.1.3 Date of inspection

13.1.4 Reason for rejection

13.1.5 Rejection codes should consist of similar categories:

13.1.5.1 Physical contamination

13.1.5.1.1 Leaf/stem debris

13.1.5.1.2 Seed content

13.1.5.1.3 Foreign matter (stones, animal parts, twine, etc)

13.1.5.2 Moisture content (high/low)

13.1.5.3 Chemical composition (alpha/beta acid content, pesticide residue, etc)

13.1.5.4 Physical degradation (mold, discoloration, insect damage, etc)

13.1.6 Action (lot destroyed, returned to grower, etc)

13.1.7 Inspector Name and Signature

13.1.8 Supervisor Name and Signature.

13.2 REPORT RETENTION. Non-conformance reports shall be retained for 5

years and reviewed annually for reoccurrences.

14 Pre-Processing Hop Storage

- 14.1 GENERAL. Once hops are received and have a disposition assigned they must enter controlled storage to wait further processing.
- 14.2 STORAGE FACILITIES. Storage facility must be structurally sound, free from leaks, standing water, dampness and constructed from easily cleaned and sanitized materials as in section 6.2
- 14.3 CLIMATE CONTROL. Storage facilities must be climate controlled for temperature and relative humidity and traceable for record keeping. See Appendix B for equilibrium storage charts.
 - 14.3.1 STORAGE TEMPERATURE. Ambient temperature in hop storage facilities shall be set between 34 and 45 degrees Fahrenheit
 - 14.3.2 RELATIVE HUMIDITY. Hops shall be stored at such relative humidity that appropriate equilibrium moisture content is reached and held in the hops of no less than 8% and no more than 12%.
 - 14.3.3 ENVIRONMENTAL MONITORING. Storage conditions shall be electronically monitored, recorded, and traced to finished goods batch numbers for records review and in the event of a product recall. Storage data should be retained for a minimum of 3 years on a rolling update.
- 14.4 STORAGE ORGANIZATION. Storage facilities must have discrete storage locations with unique identifiers to distinguish physical hop storage location within the climate controlled warehouse.
 - 14.4.1 LOCATION RECORD. When hops are received and assigned a disposition per section 9 their physical location within the storage area must be recorded on a manifest and linked to the lot number. This is the location record. No more than one lot may be assigned to any single location record number.
 - 14.4.2 STORAGE MANIFEST. Storage manifest is the physical record of each hop lot in controlled storage. It should include the physical address of the lot within the facility and all movements into and out of other locations as to provide a complete movement history

15 Hop Analysis

15.1 CHEMISTRY

15.1.1 All hops shall be tested in accordance with the American Society of Brewing Chemists protocols for the following attributes:

15.1.1.1 Alpha/beta acid content – ASBC Method HOPS 6

15.1.1.2 Total oil content – ASBC Method HOPS 14

15.2 MOISTURE CONTENT

15.2.1 Total moisture content shall conform to the oven dry method in which a sample of known weight is dried using heat or microwave (as per standard forage moisture content analysis). Oven dry weight compared to the original weight determines actual moisture content of the hop sample

15.2.2 Hops must contain no more than 12% moisture for safe storage. Higher moisture content can lead to composting and potential spontaneous combustion of hop bales.

15.3 PHYSICAL ANALYSIS

15.3.1 All hop physical analyses shall conform to the American Society of Brewing Chemists protocols for the following attributes:

15.3.1.1 Stem and leaf debris

15.3.1.2 Seed content

15.3.1.3 Insect content

15.4 DATA RECORDS

15.4.1 Laboratory data should be clearly linked to the incoming pre-process lot number consistent with Section 10.

15.4.2 Data shall be made readily available to any inspector or customer at any time

15.4.3 Data shall be retained for a duration of 5 years in accordance with good documentation practices

15.4.4 See Appendix C for example of a sample database

16 Hop Processing

16.1 GENERAL – The hop processing area or “processing floor” consists of 8 specific manual and automated tasks; Pre-sorting and Staging, cone

conveyance, size reduction, pelletizing, conditioning, packaging, pre-shipping and consolidation, and shipping/storage. Some of these steps may be combined or absent depending on the processing design.

- 16.2 PROCESSING FLOOR. The floor, or area encompassing the physical processing activities, shall comply with the facilities requirements set forth in sections 1 and 3. The flow of the processing system should be such that the path of physical movement of hops in the system is unbroken and does not double back over itself creating potential for confusion of product. Every effort should be made to limit the number of steps requiring a worker to physically handle the product. The processor should make use of conveyors, augers, flow chutes, etc. wherever possible. Ideal systems are those that limit manual movement of product from one processing operation to another and utilize separate doors for incoming raw material and outgoing finished goods
- 16.3 PRE-SORTING AND STAGING. Once hops are released from storage they first are held in a staging area for lot blending.
 - 16.3.1 The lot movements shall be tracked per section 14.4.2.
 - 16.3.2 Allow ample room in the facility for staging as this will likely be the most cumbersome activity and tight and cluttered spaces will add to potential lot confusion.
 - 16.3.3 Allow ample room between staged lots or provide physical partitions.
 - 16.3.4 Clearly identify the lots to be processed to the operator and record all lot numbers contained with the blended group. This blended group is now known as a BATCH (see Appendix D for more detail on blending)
- 16.4 CONE CONVEYANCE. Once the batches are organized the cones must be conveyed to the particle size reduction station.
 - 16.4.1 Before the cones are reduced they must be screened for foreign debris, ferrous and non-ferrous metals, etc.
 - 16.4.1.1** Hops shall ideally pass over or through a means to remove or otherwise identify foreign materials such as a density gap, magnets, metal or x-ray detection, etc.
 - 16.4.2 BALE BREAKERS.
 - 16.4.2.1** Facilities that utilize dense bales requiring loosening a bale for conveyance to the hammer mill.

16.4.2.2 Bale breakers must have a gross screening capability to prevent any large debris from passing into the conveyance system.

16.4.3 DENSITY GAP.

16.4.3.1 Pneumatic conveyance systems where cones are sucked through low pressure pipe the system makes use of a gap between the hop cone feed and the vacuum tube. This gap allows for very dense items such as rocks/stones, larger metal debris, plastic debris, etc.

16.4.4 BELT CONVEYANCE.

16.4.4.1 Conveyor belt systems shall be constructed in such a manner as to limit the ability of hop and debris to build up under the belt and in other hard-to-reach areas.

16.4.4.2 All hop contact surfaces shall be constructed of easy-to-clean materials and/or food grade materials.

16.4.5 AUGER CONVEYANCE.

16.4.5.1 Transfer auger systems shall be constructed of easy-to-clean material and kept free of rust (steel) and be equipped with appropriate safety guards to prevent injury.

16.4.6 OPERATOR. It is a matter of vigilance by the station operator to visually screen debris before it might cause issues downstream. Items like plastic fabric, dead animals, paper or other contaminants must be screened at this stage. Ideally the hops pass through a wide grate platform to screen the largest potential contaminants from a height into a receiving hopper prior to conveyance.

16.5 SIZE REDUCTION. In the simplest terms, size reduction grinds, hammers, or otherwise pulverizes the cones to a specific size (or narrow range) prior to pelletizing. This is a potentially dangerous operation as it involves heavy instruments rotating at high speeds. Proper precaution must be taken to minimize any potential injury should malfunction occur.

16.5.1 MILL CONSTRUCTION.

16.5.1.1 Size reduction mills should be constructed from robust, rigid materials and resistant to corrosion that would otherwise contaminate product.

16.5.1.2 Stainless steel, coated carbon steel, aluminum are

suitable materials.

16.5.1.3 Mills should be constructed in such a manner as to facilitate complete disassembly and cleaning purposes and assembled in such a manner to minimize joints, intersections, welds that may harbor debris.

16.5.1.4 Should coated carbon steel be used it should be free from corrosion and loose coating and coated in such a manner that contact with food product is acceptable.

16.5.1.4.1 Food contact approved liner materials should be considered.

16.5.2 FERROUS CONTAMINATION. The processor shall make every effort to isolate and remove ferrous debris prior to milling and pelletizing.

16.5.2.1 The use of magnets to trap ferrous debris is acceptable. Provisions should be made for the operator to monitor and clear the trap periodically during production.

16.5.3 FERROUS ENTRAPMENT. Should any ferrous material be passed into the hammer mill the mill exit shall be fitted with magnetic apparatus to trap any ferrous fragments prior to pelletizing.

16.5.3.1 The Magnet traps shall be constructed and installed in such a manner as to allow the monitoring and easy removal/cleaning of the trap during production.

16.5.4 DUST CONTROL. Mills shall be constructed to minimize dust evolution and move material either directly into the pellet mill or into another conveyance with minimal losses.

16.5.4.1 Feed systems into the mill shall be under positive force or pressure or contain a back flow prevention device to minimize dust ejection.

16.5.4.2 Should pneumatic conveyance be used the system must contain either an integral dust filtration device cleaned via backflow or a separate dust scrubbing unit (bag-house)

16.5.4.3 Operators shall be protected from fugitive dust by appropriate breathing safety devices as determined by the state in which the processing is taking place.

16.5.4.4 Workers shall be protected from airborne particulates by a minimum of N95 particle respirators

16.5.5 TRANSFER TO PELLET MILL. Conveyance device shall comply with standards described in section 16.4.

16.5.5.1 In addition the device shall be covered to prevent

accidental contamination and to control dust.

16.6 **BLENDING.** Some processors may find it necessary to blend different hop batches to obtain a more uniform chemistry. In such cases the processor may either blend whole cones or milled powder. There is no preference as to the blending method however the process should be designed to avoid the introduction of foreign debris and other contaminants.

16.6.1 The blending container should be designed with fitted lids, hatches, or other means of eliminating dust evolution and external contamination.

16.7 **PELLETIZING.** Milled powder shall be immediately pelletized. Pelletizing is the act of densifying the milled powder and may be achieved by a number of methods and machinery. Regardless of the device the following topics must be addressed.

16.7.1 **MILL CONSTRUCTION.** The pellet mill shall be constructed from high durability materials such as cast iron, steel, stainless steel with well-fitting parts, free from cracks, splinters, or other defects that may introduce metal fragments into the pellets. Moving parts should be precisely machined to prevent excess mill powder build-up that could otherwise degrade and contaminate the final pellet product.

16.7.2 **MILL DIE AND ROLLERS.** The mill die and rollers shall be constructed of high strength, heat treated steel or stainless steel.

16.7.2.1 All die and roller fasteners shall be designed as to minimize interference with the pelletizing process, be of sound structural nature to prevent any contamination by metal fragments, and be easily cleaned and sanitized.

16.7.3 **MILL CHAMBER.** The mill chamber shall be enclosed for operator safety, dust control, and debris/contamination control.

16.7.4 **PELLET OUTPUT.** Pellets shall be deposited into a container or device approved for food contact.

16.7.4.1 The device shall be enclosed or shielded to prevent contamination.

16.7.4.1.1 If a cooling tunnel is utilized it shall be easily disassembled for cleaning and restrict foreign object from entering the pellet stream.

16.7.4.1.2 A shaker grate or other means of separating

loose fines from formed pellets should be employed.

16.7.4.1.3 Separated fines may be reintroduced to the pellet mill only if they are collected in a manner consistent with the procedures in section 16.

16.7.5 PELLET CONVEYANCE. Pellets may be conveyed away from the immediate milling area using devices consistent with section 16. All contact surfaces must be food grade materials, i.e. stainless steel, approved composites, plastics, etc.

16.8 PELLET PACKAGING. Pellets should be vacuum-packaged immediately after cooling to avoid potential contamination and reduce oxidation.

16.8.1 PACKAGING DEVICES. Vacuum packaging devices must be equipped with the following options:

16.8.1.1 Retractable snorkel made from stainless steel and removable for cleaning and inspection

16.8.1.2 Gas purge function to flood the packaging with inert, food grade gas

16.8.1.3 Food-grade, coated heat sealing bars

16.8.1.4 Physical structure manufactured from stainless steel or other easily cleaned and sanitized material.

16.8.1.5 Controls for adjusting heat sealing duration, vacuum duration, and gas purge duration

16.8.1.6 Minimum of 3/16" heat sealed area

16.8.2 PACKAGING MATERIAL. Pellets and whole hop cones must be contained within packaging comprised of materials approved for food contact.

16.8.2.1 Water vapor transmission rate should be equal to or less than $< 0.0003 \text{ gr./100in}^2 / 24 \text{ hrs}$ (Federal Standard 101)

16.8.2.2 Light transmission rate should be less than or equal to 0.01% (ASTM 1003-77)

16.8.2.3 Packaging must contain an aluminized foil layer in accordance with light transmission rates listed in 16.8.2.2

16.8.3 LAMINATION INTEGRITY. Barrier foil material shall conform to standards acceptable to the processor and compliant with brewer specifications.

16.8.3.1 Processor shall have a written protocol for testing barrier materials to ensure proper function, i.e. no leaking,

tearing, etc.

16.8.4 Barrier foils shall be tested for seal integrity after heat sealing.

16.9 Leak Testing, Pillow Packs

16.9.1 Pillow packs are defined as hops packed in barrier foil but have a slight inflation of inert gas (i.e. nitrogen) instead of a hard vacuum.

16.9.2 Pillow packs shall be tested for leaks by either low pressure chamber or water submersion

16.9.3 See Appendix H for testing parameters

16.10 Leak Testing, Hard and Soft Pack

16.10.1 Hard pack is defined as hops packaged in barrier foil and subject to a hard vacuum prior to sealing such that the hop pellets are compressed into a hard mass

16.10.2 Soft pack is defined as hops packaged in barrier foil and subjected to moderate vacuum such that the majority of the inert gas is removed but not so much that the hops are free to move within the package under moderate pressure

16.10.2.1 Vacuum shall be strong enough that seal failure is evident by bag expansion

16.10.3 Hard and soft packs shall be tested for seal integrity by simple inflation over time.

16.10.4 See Appendix H for testing parameters

APPENDIX A *(borrowed from WI DATCP Food Processing CR)*

Distribution system microbiological contaminant maximum contaminant levels. The following are the maximum contaminant levels for coliform bacteria applicable to public water systems.

(1) MCL FOR COLIFORM BACTERIA. The maximum contaminant level (MCL) for coliform bacteria is based on the presence or absence of total coliforms in a sample.

(a) For a public water system which collects at least 40 samples per month, if no more than 5.0% of the samples collected during a month are total coliform-positive, the public water system is in compliance with the MCL for total coliforms.

(b) For a public water system which collects fewer than 40 samples per month, if no more than one sample, including routine and repeat samples, collected during a monitoring period is total coliform-positive, the public water system is in compliance with the MCL for total coliforms.

(2) MCL FOR FECAL COLIFORM OR E. COLI. Any fecal coliform-positive repeat sample or E. coli-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or E. coli-positive routine sample constitutes a violation of the MCL for total coliforms.

(3) DETERMINING COMPLIANCE. The water supplier for a public water system shall determine compliance with the MCL for total coliforms in subs. (1) and (2) for each monitoring period in which the public water system is required to monitor for total coliforms.

(4) CORRECTIVE ACTION. The water supplier shall initiate action to identify the cause of the positive bacteriological sample results and to eliminate potential health hazards which may exist in the public water system when monitoring pursuant to sub. (1) or (2) shows the presence of any coliform organisms.

(5) HETEROTROPHIC BACTERIA LIMITS. If heterotrophic bacterial plate counts on water distributed to the consumer exceed 500 organisms per milliliter, the

department shall determine if the bacterial count is of public health or nuisance significance and may require appropriate action.

(6) BEST AVAILABLE TREATMENT TECHNIQUES. Any of the following are best technology, treatment techniques, or other means available for achieving compliance with the maximum contaminant level for total coliforms in subs. (1) and (2):

(a) Protection of wells from coliform contamination by appropriate placement and construction.

(b) Maintenance of a disinfectant residual throughout the distribution system.

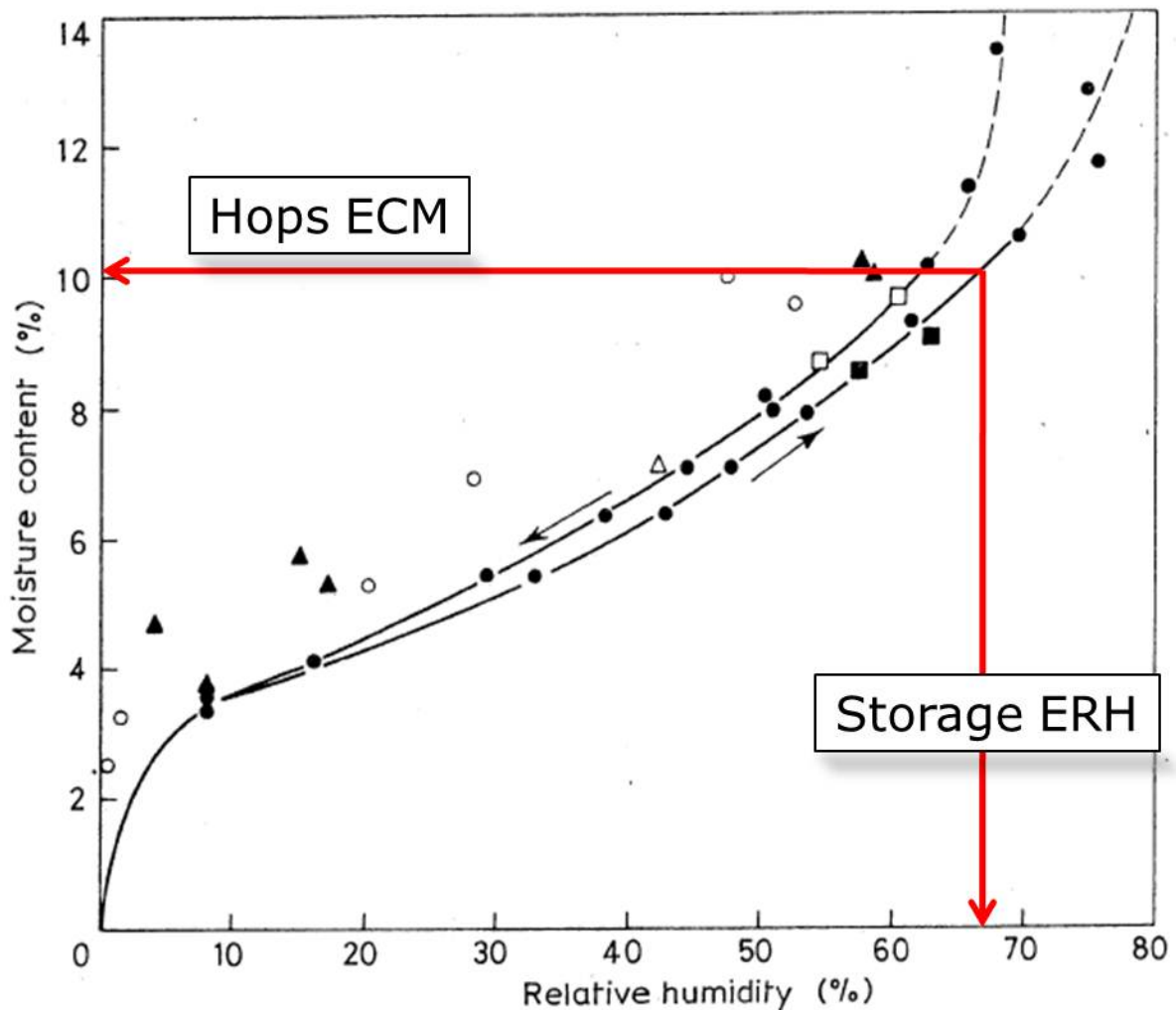
(c) Proper maintenance of the distribution system including appropriate pipe replacement and repair procedures, main flushing programs, proper operation and maintenance of storage tanks and reservoirs, and continual maintenance of positive water pressure in all parts of the distribution system.

(d) Filtration and disinfection of surface water, or disinfection of groundwater using strong oxidants such as chlorine, chlorine dioxide or ozone.

(e) The development and implementation of a department-approved wellhead protection program.

Appendix B – Equilibrium Moisture Content for Hop Storage

- EMC = Equilibrium Moisture Content
 - Moisture level of hop
- ERH = Equilibrium Relative Humidity
 - RH of air
- For every EMC there is a corresponding ERH
 - Graphing this out gives us an isotherm diagram for the hop



Source: *J. Agric. Eng. Res*, Henderson 1973

Appendix C – Hop Sample Database

[illegible]

Appendix D – Instructions on how to calculate the optimized blending of hops for processing to minimize variability of alpha in one or more lots

This document is geared toward hop processors that wish to blend hops of a single variety from multiple sources in order to achieve acceptably uniform chemistry in the blend. Typically this is done if a processor has more hops of a single variety that can be physically blended before processing, but not enough hops that a single grower's hops of that variety would take up an entire processing lot (see definitions).

In this document we will refer to units of hops using the terms defined below. Each lot will be given a unique number to aid identification, tracking, recall and other activities related to the hops.

Definitions

Receiving Lot (RL): All hops of a single variety delivered by one grower on the same day. All bales in a receiving lot are assumed to have the same chemistry. If the grower indicates there are two or more groups of hops that might have different chemistry, these should be given different RL numbers. Hops of the same variety from the same grower delivered on a different day will be assumed to have different chemistry and should be given a different RL number.

Processing Lot (PL): A processing lot is a group of hops of the same variety from one or more growers blended together and processed during the same day/shift/etc. The size of a processing lot is determined by the processor and can include factors such as length of employee shift, total mass/volume, equipment cleaning/breakdown, or other factors.

Processing Batch (PB): A processing lot consists of one or more processing batches. A PB is the amount of hops that can be successfully blended to achieve a uniform chemistry value. If the processor has an infinite mixing capacity, the PB is the same as the PL. In practice, however, the PB is assumed to be smaller than the PL, and a sequence of PBs will be run through the processing system for each PL.

Goal

The goal for blending is to achieve a uniform product (hop pellets). The processor should decide what metrics will be used to optimize blending to achieve uniformity. This document uses the percent alpha for each RL as the metric for optimization. Other metrics can be substituted, such as oil content, color, percent beta, etc. If the processor wishes to optimize using more than one metric, this is a more complex problem, which will not be solved in this document. However, using the techniques described here serially or in a nested fashion would work well. We will also assume the processor will be batch blending at the beginning of the processing stream – blending the raw material. Blending can also be done at the end of the processing stream – the pellets – however excessive manipulation of pellets causes them to break and crumble, resulting in an inferior product.

Questions to be answered first

There are several questions the processor must answer before optimizing. Below are the questions along with some discussion as to how these questions can be answered. We assume here that the processor has already established limits on debris, moisture, alpha, color, etc. and that those limits have been used to reject RL of hops that do not meet the quality standards. All RLs used will be assumed to be acceptable for processing. We also assume that at the time of optimization, all RLs have been weighed and analyzed for alpha (the optimization metric used in this document). Batch or lot size can be volume or mass, however since the two are closely related and batch calculation uses mass to compute the means, this document strictly refers to mass when discussing batch or lot size.

1. What are the maximum and minimum sizes of RLs? The processor may wish to break up large RLs into 2 or more smaller RLs if the RL approaches or exceeds the size of the PL.
2. What are the maximum and minimum sizes of PLs? The processor may wish to set the smallest PL size so that the optimization does not result in an excessive number of PLs. The processor should also set the maximum PL size so that in the case of the need to issue a recall on a PL, an acceptable amount of material will be affected. Also, in the case of enough mass in the RLs for a single variety, the processor can consider creating various grades

of PLs, for example, high alpha PLs and low alpha PLs. Extremely large PLs will hinder this.

3. How many PLs can a single grower's RLs be in? It is preferable to keep a single grower's hops in as few PLs as possible while meeting other constraints in order to minimize losses due to a recall. For example, if it is determined that Grower Q sprayed a pesticide on his Chinooks that is not registered for hops (a food product), you will need to recall and possibly destroy all Chinook PLs that contain Grower Q's hops. If Grower Q hops are in every Chinook PL, you will need to recall all of your processed Chinooks. If Grower Q's hops are only in a portion of your Chinook PLs, you will still be able to sell some of your Chinooks.
4. What is the maximum or optimum size of the PB? How much material can physically be blended before entering the processing "pipeline"? Making this as large as possible will assist in creating a more uniform PL.
5. For each PL, what is the acceptable difference between PB mean metric and PL mean metric? It is assumed that the blend of hops in each PBs will vary somewhat in mean alpha for example, but the difference will be acceptably close to the target mean alpha for the PL. The larger the acceptable difference, the easier the optimization problem will be to solve, however, the PL may be less uniform. The accuracy of your mean alpha test (or other blending metric) will influence your acceptable difference between PB and PL means. For example, if your alpha test is accurate to within $\pm 0.2\%$, then it does not make sense to have an acceptable mean difference less than $\pm 0.2\%$.

Calculating Batches: Simple Method

The simplest way to calculate processing batches is to enter all the data for the receiving lots into a spread sheet, calculate the mean alpha of all RLs (weighted by mass), sort the RLs by alpha, and then compute PBs by alternately selecting high and low alpha RLs until the total mass is near the optimum PB size and the batch alpha is acceptably close to the mean. This is most useful when the total volume of hops to be processed is low. It becomes less practical as the volume of hops to be processed is very large.

Consider the following data for cascade hops:

Receiving Lot	Grower	Number of Bales	Variety	Mass Lbs	Alpha %
11003092012	A	2	Cascade	73.6	5.1
11033092012	B	2	Cascade	69.5	1.7
11009092012	C	1	Cascade	8.1	4.6
11010100112	D	2	Cascade	80.8	5.3
11001092012	E	1	Cascade	35.1	3.2
11013092012	F	1	Cascade	17.4	3.6
11016100112	G	1	Cascade	1.8	5.6
11017092012	H	3	Cascade	133.6	3.6
11017100112	H	4	Cascade	144.6	4.7
11022092012	I	1	Cascade	41.6	4.7

There are 9 growers and 10 receiving lots. The receiving lots have unique identifiers (RL identifiers should be created by the processor to encode variety, grower, receiving date, and other pertinent information). Notice grower H has 2 lots with different alphas. We can calculate the mass-weighted mean alpha of all bales by computing for each RL the mass multiplied by the alpha (mass*alpha), summing all these numbers, and dividing by the total mass. The table below contains the mass*alpha (labeled Total Alpha) and the mean bale mass in the last two columns. The last row contains the total mass (606.0 lb) and the total of Total Alpha (2494.4 lb %). The mean alpha for the all the cascades, then is $2494.4/606.0$, which is 4.1%.

Receiving Lot	Grower	Number of Bales	Variety	Mass Lbs	Alpha %	Total Alpha	Mean Bale Mass
11003092012	A	2	Cascade	73.6	5.1	375.4	36.8
11033092012	B	2	Cascade	69.5	1.7	121.0	34.8
11009092012	C	1	Cascade	8.1	4.6	37.3	8.1
11010100112	D	2	Cascade	80.8	5.3	431.3	40.4
11001092012	E	1	Cascade	35.1	3.2	112.3	35.1
11013092012	F	1	Cascade	17.4	3.6	62.5	17.4
11016100112	G	1	Cascade	1.8	5.6	10.0	1.8
11017092012	H	3	Cascade	133.6	3.6	476.7	44.5
11017100112	H	4	Cascade	144.6	4.7	672.2	36.1
11022092012	I	1	Cascade	41.6	4.7	197.8	41.6
total				606.0		2494.4	

The next step is to sort by alpha and compute the batches. Let us assume our optimal processing batch size is 200 lb and our maximum processing lot size is 2000 lb. All the cascades add up to 606 lb, which is less than our maximum PL size, so these can all go into one processing lot. We can expect to create three processing batches of approximately 200 lb each. We believe our test for alpha is accurate to within $\pm 0.2\%$, so we will accept a departure twice that, or mean alpha that is within $\pm 0.4\%$ of the entire mean alpha. If we can get closer, of course that is better.

Row	Receiving Lot	Grower	Number of Bales	Variety	Mass Lbs	Alpha %	Total Alpha	Mean Bale Mass
1	11016100112	G	1	Cascade	1.8	5.6	10.0	1.8
2	11010100112	D	2	Cascade	80.8	5.3	431.3	40.4
3	11003092012	A	2	Cascade	73.6	5.1	375.4	36.8
4	11022092012	I	1	Cascade	41.6	4.7	196.8	41.6
5	11017100112	H	4	Cascade	144.6	4.7	672.2	36.1
6	11009092012	C	1	Cascade	8.1	4.6	37.3	8.1
7	11013092012	F	1	Cascade	17.4	3.6	62.5	17.4
8	11017092012	H	3	Cascade	133.6	3.6	475.7	44.5
9	11001092012	E	1	Cascade	35.1	3.2	112.3	35.1
10	11033092012	B	2	Cascade	69.5	1.7	121.0	34.8

Starting with the RLs with the highest and the lowest alphas, we sum the total alphas and sum the masses for a number of RLs until we have about 200 lbs and the mass-weighted mean alpha is near the mean alpha of the entire amount of cascades. Rows 1 and 10 add up to only $(1.8+69.5)=71.3$ lb and have a mean alpha of $(10.0+121.0)/71.3=1.8\%$. This mass is too low, so we will be adding more to the batch. We add a high or low RL depending on whether the previous mean alpha was too high or too low. 1.8 is too low, so we add the second highest alpha RL. For rows 1, 2, and 10, the mass is now $(1.8+69.5+80.8)=152.1$ lb and the mean alpha is now $(10.0+121.0+431.3)/152.1=3.7\%$. This is within the criterion for an acceptable batch alpha, however, the mass is below the optimum batch size and the batch alpha is below the mean, so let's try adding another high RL to the batch. Rows 1, 10, 2, and 3 add up to $(1.8+69.5+80.8+73.6)=225.7$ lb and the mean alpha is $(10.0+121.0+431.3+375.4)/225.7=4.2\%$. This is very close to the mean so we will call this batch 1. The farther away from the mean each of the first batches is

will cause at least one of the rest of the batches to be farther away from the mean on the opposite side. Notice our batch size is a little higher than our optimum batch size, but it exceeds it by less than one average bale, so we are willing to accept that. Notice thus far we have used all bales included in each RL. We have the ability to split RLs across batches if needed, which is why we have calculated the mean bale mass. If bales vary greatly in mass and you believe you will be splitting bales in single RLs across multiple batches, you should have the actual bale weights available for your calculations instead of the averages.

Row	Receiving Lot	Grower	Number of Bales	Variety	Mass Lbs	Alpha %	Total Alpha	Mean Bale Mass	Batch
1	11016100112	G	1	Cascade	1.8	5.6	10.0	1.8	1
2	11010100112	D	2	Cascade	80.8	5.3	431.3	40.4	1
3	11003092012	A	2	Cascade	73.6	5.1	375.4	36.8	1
4	11022092012	I	1	Cascade	41.6	4.7	196.8	41.6	2
5	11017100112	H	4	Cascade	144.6	4.7	672.2	36.1	?
6	11009092012	C	1	Cascade	8.1	4.6	37.3	8.1	?
7	11013092012	F	1	Cascade	17.4	3.6	62.5	17.4	?
8	11017092012	H	3	Cascade	133.6	3.6	475.7	44.5	?
9	11001092012	E	1	Cascade	35.1	3.2	112.3	35.1	2
10	11033092012	B	2	Cascade	69.5	1.7	121.0	34.8	1

Now to calculate the second PB, we repeat the same exercise starting with a high and a low alpha RL. Lines 4 and 9 are $(41.6+35.1)=76.7$ lb and have a mean alpha of $(196.8+112.3)/76.7=4.0$ %. This is very close to the mean alpha, but the mass is very small. Let's add more to the batch. Note however, that adding all of the next high alpha RL will drive the mass over the optimal limit and increase the alpha by quite a bit. Fortunately there are several bales in each of the next highest and lowest RLs, so let's pick two of the bales from the next highest (line 5) and lowest (line 8) RLs and see if that gets us close to the requirements. Here we will use average bale weights instead of total in the calculation. The mass is $(41.6+35.1+2*36.1+2*44.5)=237.9$ lb and the mean alpha is $(196.8+112.3+2*36.1*4.7+2*44.5*3.6)/237.9=4.1$ %. Right on the nose! Notice in the calculation of mean alpha the equation has number of bales times mean bale mass times alpha for lines 5 and 8 where we are not using the entire RL. Now we can put all the rest of the bales from lines 5 and 8 plus the bales from lines 6 and 7

in the last batch because we know that we only need three batches. The total mass of batch 3 will be $(2*36.1+8.1+17.4+44.5)=142.2$ lb, and the mean alpha is $(2*36.1*4.7+37.3+62.5+44.5*3.6)/142.2=4.0\%$. Here's how our final batches look:

Row	Receiving Lot	Grower	Number of Bales	Variety	Mass Lbs	Alpha %	Total Alpha	Mean Bale Mass	Batch
1	11016100112	G	1	Cascade	1.8	5.6	10.0	1.8	1
2	11010100112	D	2	Cascade	80.8	5.3	431.3	40.4	1
3	11003092012	A	2	Cascade	73.6	5.1	375.4	36.8	1
4	11022092012	I	1	Cascade	41.6	4.7	196.8	41.6	2
5	11017100112	H	4	Cascade	144.6	4.7	672.2	36.1	2(two),3(two)
6	11009092012	C	1	Cascade	8.1	4.6	37.3	8.1	3
7	11013092012	F	1	Cascade	17.4	3.6	62.5	17.4	3
8	11017092012	H	3	Cascade	133.6	3.6	475.7	44.5	2(two),3(one)
9	11001092012	E	1	Cascade	35.1	3.2	112.3	35.1	2
10	11033092012	B	2	Cascade	69.5	1.7	121.0	34.8	1

Our alphas in batch order are 4.2%, 4.1%, and 4.0%. If you want to get even better mean alphas while processing, you could process the batches in an order such that an above-mean batch would be followed by a below-mean batch. Because you get some mixing across batches in the processing stream, running high, low, high, low, etc. batches will even out the PL alpha even more. In our example here, we could process, batch 1, then 3, then 2 to get the PL alpha closer to the mean.

Calculating Batches: More Complex Method

The first method we used is suitable for small volumes of processing. When the number of growers and the amount of hops get large, however, the problem is best solved in a more automated way. The problem also becomes somewhat different, as the large volume will likely require different machinery, work flow, and constraints. That means re-assessing your optimum batch and processing lot sizes, allowable difference from mean alpha, etc. And last but not least, you will want to use some optimization algorithm to select batches.

This type of optimization problem – selecting which set of processing lots to include in a batch for blending to have the smallest mean alpha “error” – is well suited to linear programming. We set up the problem in the following way:

We have n RLs and m batches. The mean alpha for all RLs together is α . The alpha for RL i is a_i and the mass of RL i is W_i . We create a matrix X_{ij} whose elements are 1 if we include RL i in batch j , and zero otherwise.

Each RL can only be in one batch (if we wish to split RLs, each bale for the RL will be considered a separate RL), so that summing all over all batches (j), $\sum X_{ij} = 1$ for $i=1, 2, 3, \dots, n$.

The total alpha for each RL is T_i , where $T_i = W_i * a_i$, and we want to optimize for each batch j , summing over all RLs i ,

$\sum (T_i X_{ij}) / \sum (W_i X_{ij}) - \alpha \leq \varepsilon$, which can be rewritten as

$\sum [T_i - (\alpha + \varepsilon) W_i] X_{ij} \leq 0$, for $j = 1, 2, 3, \dots, m$. Let's call this part $[T_i - (\alpha + \varepsilon) W_i] = t_i$.

If the optimum (we will use maximum here) batch mass is M , our constraints on batch mass are

$\sum W_i X_{ij} \leq M$, for $j = 1, 2, 3, \dots, m$

We want to solve for integer values of X_{ij} , but in practice, it is much easier to allow X_{ij} to be between 0 and 1 (non-integer solutions are much faster), so we will just end up rounding up/down to 0 and 1:

$0 \leq X_{ij} \leq 1$.

Depending on what linear programming solver you use, you will set up the matrices as needed. X becomes a vector with $m*n$ elements (because we need to solve for $m*n$ combinations of bale and batch). We are going to put our inequality equations $\sum [T_i - (\alpha + \varepsilon) W_i] X_{ij} \leq 0$ and our constraints $\sum W_i X_{ij} \leq M$ into the form

$A X \leq b$, where there are $m*2$ lines – the first m lines contain t_i for each of the m batches and the last m lines the W_i for each batch. In this example A below, 0_n refers to n zeroes, m is equal to 3...

$$A = \begin{array}{c|ccc} t_i & 0_n & 0_n & 0_n \\ 0_n & t_i & 0_n & 0_n \\ 0_n & 0_n & t_i & 0_n \end{array}$$

$$\begin{matrix} W_i, 0_n, 0_n \\ 0_n, W_i, 0_n \\ 0_n, 0_n, W_i \end{matrix}$$

and $b = [0_m, M_m]'$. Vector b (‘ means transpose) has m zeroes and m Ms.

Next we set up a similar matrix $A_{eq} X = b_{eq}$ for the equalities. In this matrix we have $m*n$ columns and n rows. We use it to require each bale to be used only once. For each bale i we will have a line of the matrix expressing the fact that the sum of $X_{i1} + X_{i2} + X_{i3} + \dots + X_{im} = 1$. A_{eq} becomes

$$\begin{matrix} A_{eq} = 1_m, 0_{n*(m-1)} \\ 0_n, 1_m, 0_{n*(m-2)} \\ \dots \\ 0_{n*(m-1)}, 1_m \end{matrix}$$

and $b = [1_n]'$.

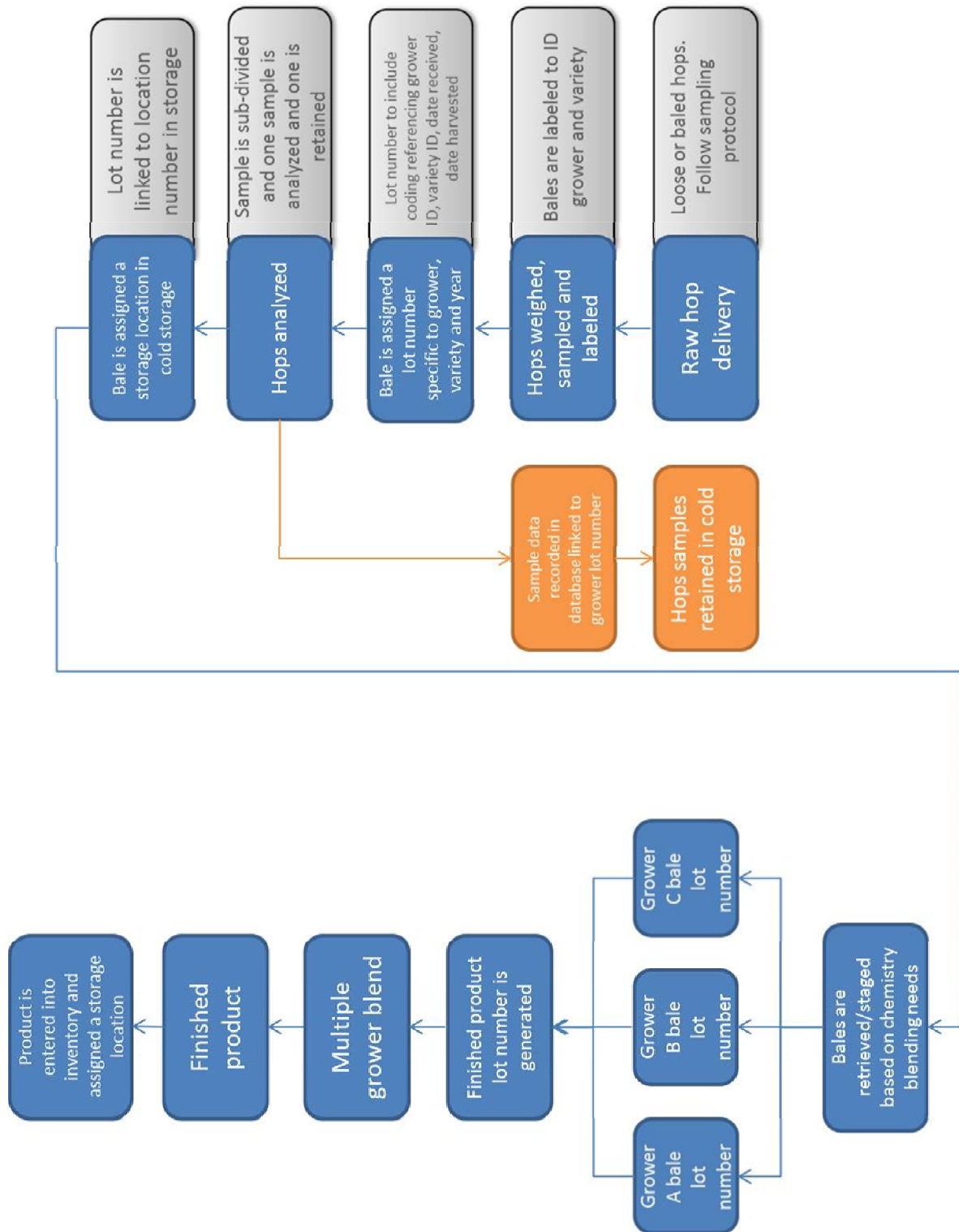
The last steps are to create lower and upper bounds for X , which will be vectors of $m*n$ zeroes and ones, and the objective function, which can just be another $m*n$ vector of ones. These vectors and arrays should be loaded into the solver in the correct order. After solving, our only task is to round the elements of X up or down to 0 or 1 in order to decide whether or not to include bale i into batch j . There may be situations in which allowing X to be a non-integer gives unreasonable results. In that case, a more rigorous solver that forces an integer solution can be used.

For very large numbers of bales and batches, even this method can become unwieldy. The problem should then be split into several smaller problems to make it more amenable to this type of solution.

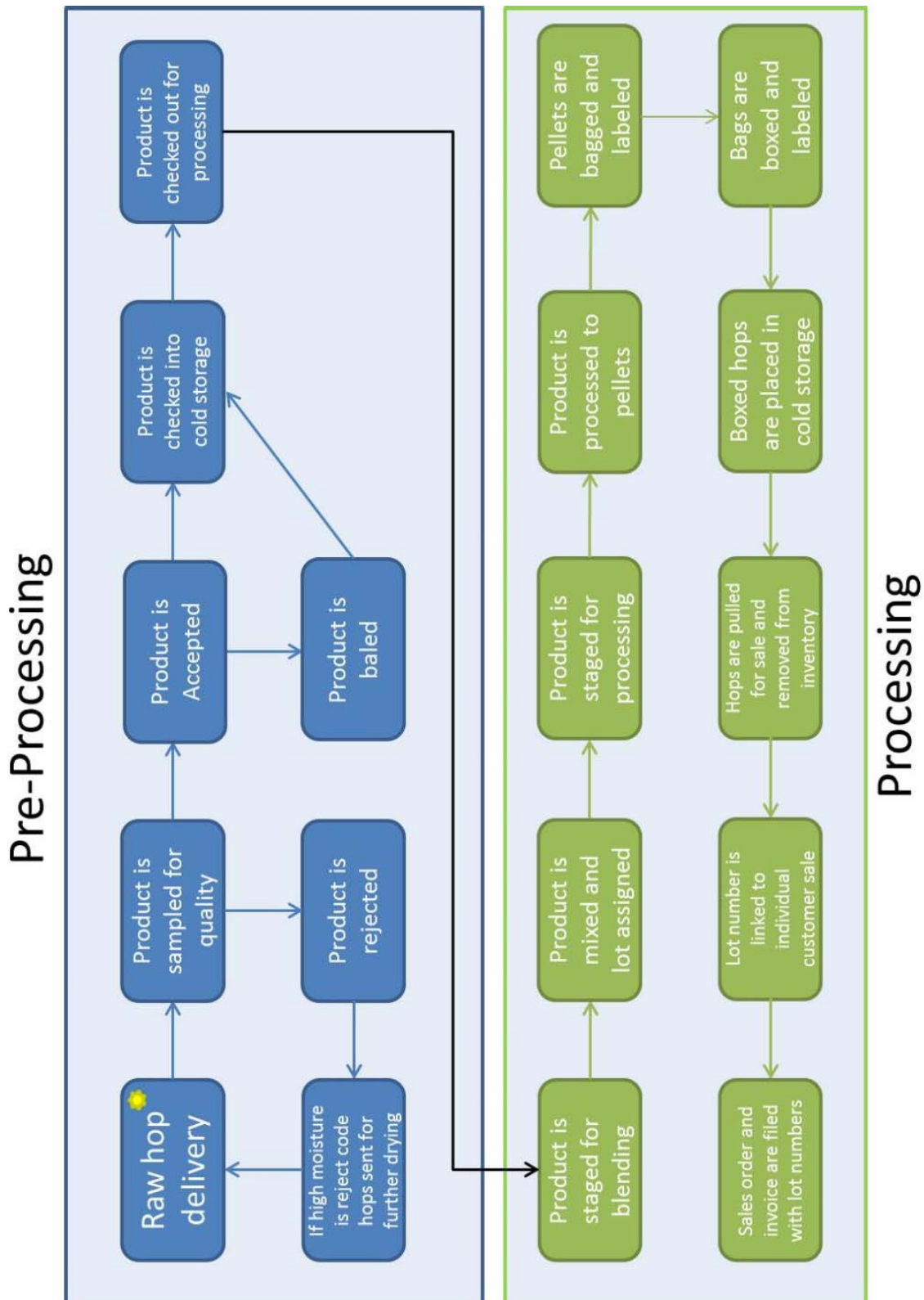
Conclusions

Calculating batches for processing can be done using either simple or more rigorous methods, depending on the size of the problem. The most important part of the process is deciding what will be used as a metric for the batch calculation and what the constraints of the problem are. Once those are decided on, hand calculations or packaged linear optimization software can be used

Appendix E – Receiving Logistics Flowchart



Appendix F – Processing Flowchart



Appendix G – Sample Nonconformance Report

Nonconformance Report

Report #

Grower: _____ Lot#: _____ Date: _____

Inspector: _____

Rejection Codes

- | | | |
|--|---|--|
| <input type="checkbox"/> Stem Debris (SD) | <input type="checkbox"/> Alpha Acid (AA) | <input type="checkbox"/> Mold/Mildew (MO) |
| <input type="checkbox"/> Leaf Debris (LD) | <input type="checkbox"/> Beta Acid (BA) | <input type="checkbox"/> Foreign Matter (FM) |
| <input type="checkbox"/> Seed Debris (SeD) | <input type="checkbox"/> Hop Storage Index (HI) | <input type="checkbox"/> Insect Debris (ID) |
| <input type="checkbox"/> Moisture Content (MC) | <input type="checkbox"/> Discoloration (DC) | <input type="checkbox"/> Pest. Residue (PR) |

List Reason Code and Disposition

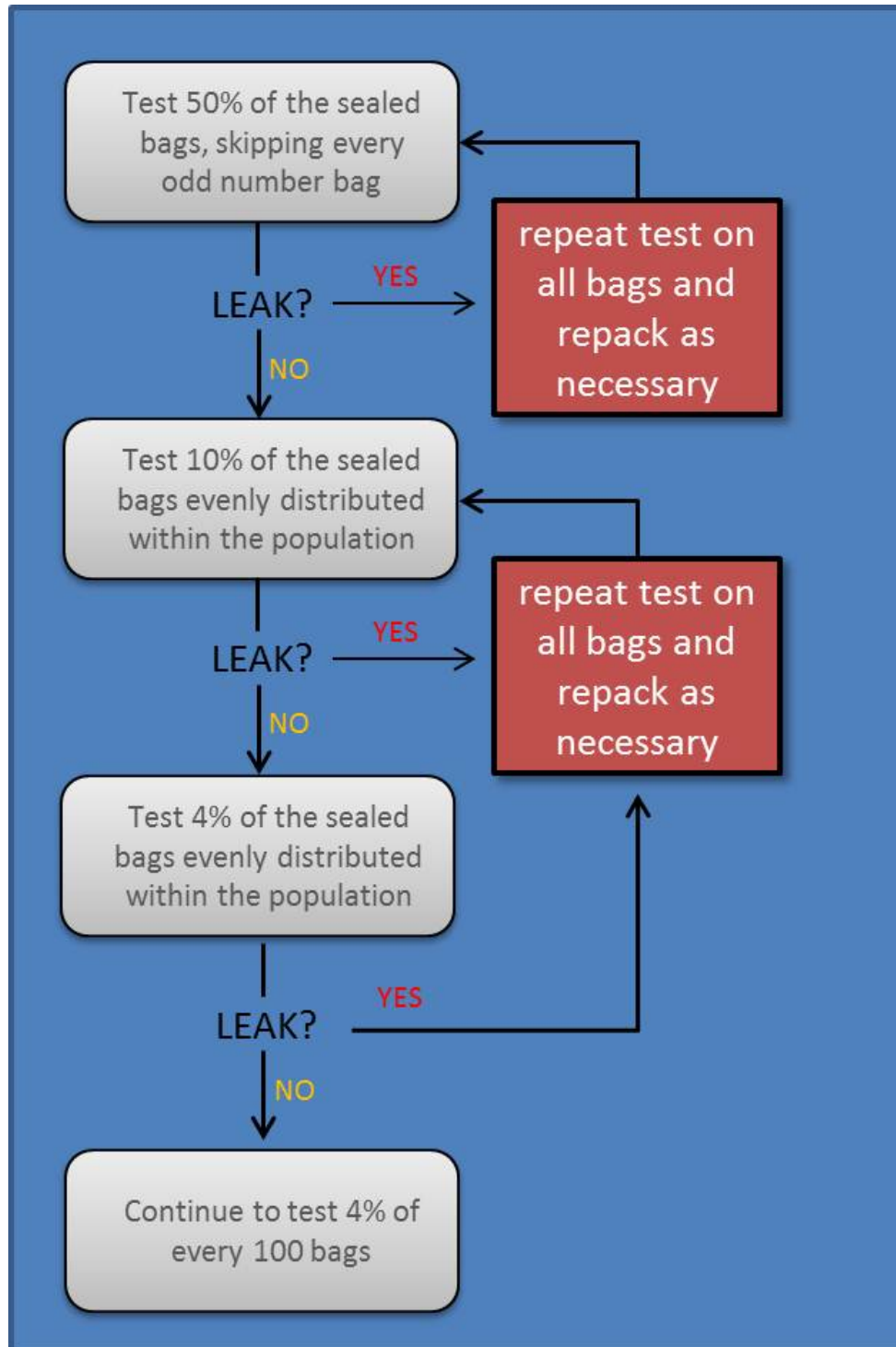
Action ☐ Return to Grower ☐ Destroy ☐ Hold ☐ Rework

Inspector Signature: _____

Supervisor Signature: _____

Appendix H – Barrier Foil Testing

- A. Barrier Foil Integrity Testing. Barrier materials shall conform to Section 16.8.2 at a minimum. For each new lot of barrier material the following testing procedure shall be performed:



Appendix I - Inventory Control for Hop Processing

This document is geared toward hop processors who wish to track hops from multiple sources, through different processing streams, and to different customers. Each processor's inventory system will need to reflect the specific needs of that processor, so the discussion here is in general terms.

Inventory Purpose

The purpose in creating inventory control is to be able to track a physical unit, such as a single bale of hops from source to customer. Why is this important? There are several reasons. Firstly, being able to uniquely track bales of hops allows the processor to create an organized inventory of what material is in stock, allowing the processor to estimate things such as required processing time and labor, amount of processing-related materials to order, amount of product available for sales, amount of predicted income/profit, and so forth. Secondly, an inventory system allows traceability, that is, knowing which producer's hops went into which product. It can be important from a processing standpoint, such as being able to batch blend or create different product streams based on quality or source. It is also extremely important from a food safety aspect. If it is later discovered that Grower Y used a pesticide not approved for hops, the processor can recall all product that contains Grower Y's hops. Or if a product is later discovered to be inferior or contaminated in some way, the processor can attempt to trace back all the way back to the grower, if needed, to discover the source of the problem. Traceability may be also important to the buyer (I want pellets that contain hops from Grower X but not from Grower Z). Traceability may actually be required for your business by your local, state, or federal regulatory agency.

An inventory system will allow the processor to fulfill all the tracking needs in an organized and transparent way.

Inventory Categories

The processor will likely require more than one set of inventory numbers. Inventory numbers will need to uniquely represent sources, forms, processing, and possibly destinations of hops. The processor should analyze each phase of the entire operation to determine where physical units may be mingled, split, or altered

in form. These types of changes can indicate where a new kind of inventory number should be assigned.

Example 1:

Hops of multiple varieties are received from multiple growers on multiple dates. An inventory number of hops received should allow the processor to trace at the very least, the variety, grower, and date combination.

Example 2:

Hops of a single variety received from multiple growers on multiple dates are blended together and pelletized during several processing shifts over a span of days. The inventory number of the processed hops should allow tracing to the variety, grower blend, processing shift (traceable to specific employees) and processing day.

Example 3:

Hops from a single processing batch are split into two different products streams, one of which remains in the same form and one which receives further processing. The inventory number should allow tracing to the variety, the source processing batch, shift/day, and the type of further processing.

Example 4:

Hops from a single processing batch are packaged in different sizes or types of packaging for specific customers. The inventory number should allow tracing to variety, source batch, shift/day, package size/type, and possibly customer.

As you can see, the types of information you wish to track with an inventory control system changes depending on what phase of the process the inventory number represents. At the very least, each subsequent inventory number in a processing stream should allow the processor to trace up or down the “tree” of product mingling, splitting, and transformation.

Generating Inventory Numbers

It is not necessary to come up with a complicated scheme to generate inventory numbers as long as each inventory number is unique. One could just start with 0

and each subsequent inventory number (for any part of the process) could be incremented by 1. In practice, however, it is very helpful to encode much of the information in the inventory number itself so that the number itself conveys variety, date, grower, customer, form, etc. that is readable without looking it up in a spreadsheet.

Inventory numbers can be strictly numeric (digits 0 through 9 only) or alphanumeric (numbers and letters). Keep in mind some types of information are more easily read in either numeric or alphanumeric form, but you might have only a certain number of digits available in your inventory number.

You may wish to encode some of the information in a form not easily decipherable so that you may track the information, but the worker or customer cannot. This is useful if you would like to either add layers of privacy (for growers for example) or confidential information (proprietary processing steps). You may also wish to encode the information so that the inventory numbers sort in a specific way.

Example: CAS00120130915

This number encodes variety, grower, and receipt date for hop bales into a single number, with the first three characters representing variety (cascade), the next three representing grower number (001), and the last 8 representing receipt date (2013, Sep 15). If it is more important for your business to track first by grower than variety, you might wish to have the grower number first, i.e., 001CAS20130915. This number would not work, however, if you have another variety beginning with the letters CAS, if you have more than 1000 growers, or if you ever receive more than one shipment of the same variety from the same grower on the same day. In those cases, changing the encoding is needed. You could add characters to the variety or encode it as a number. To handle more growers you could increase the number of digits or use letters in as additional numbers (e.g., after 999 comes A00). You could add time of day to the date or add an additional lot number. Keep in mind, the shorter the number, the more readable and the less likely there will be transcription errors when entering numbers by hand.

Issues to consider when deciding on inventory number form: How many unique items can I have in each category? Can I have unique inventory numbers year after year (preferred) or will I need to recycle numbers after a period of time (less

desirable)? Can I use characters other than numbers and letters, such as dashes and punctuation? Should I generate a unique inventory number for each physical item (such as hop bale) or should I generate one inventory number to describe a group of items that are the same (all bales in one received lot)? Should numbers be sequential or should I reserve ranges for certain things?

You will probably find that the types of information you wish to track changes as your business grows and changes. If you do not max out the numbers of digits available you will have the freedom to use those later when you wish to track more information.

Inventory Software

If you are using off-the-shelf inventory control software, you may need to use the forms of inventory numbers accepted by your software. As a bare minimum, whatever inventory software you use must allow you to generate unique values, and enough of them to track all individual items that you wish to track. These numbers must then be associated with some data base into which you will enter all the pertinent information needed to track.

Other useful features for inventory software would include bar/QR code generation and scanning, label printing, numerous simultaneous users allowed, interface with your purchasing system, interface with your customer relations management software (e.g., sales), and so forth. If off-the-shelf software does not suit your operation, custom software can be written, but may be quite costly. Maintenance of integrated systems should also be considered when deciding what to purchase – you don't want something so complicated or unwieldy that you need to hire specialized manpower to run it. A flexible inventory system will grow with you, whereas you may quickly outgrow a very rigid inventory system.

Conclusions

Inventory control is an essential part of your business, as it allows tracking of all items through the processing stream and allows other business requirements to be calculated. Traceability is extremely important when it comes to food safety. Whether you use an off-the-shelf or custom designed system will be determined by the types of information you need to track and how you need it to integrate with

other parts of your business flow. Anticipating how your business will grow and change will help you design an inventory numbering system that will last longer than a season or two.

Appendix J – Hop Sampling Protocol

HOP SAMPLING – SAMPLE SIZE

Hop samples shall be taken from bulk farm deliveries in accordance with statistical sampling procedures to ensure robust confidence of analytical results.

- a. Confidence Level should be a minimum of 95%
- b. Confidence Interval (+/- margin of error) should be no more than 20
- c. Population Size can be considered the entire yield (weight) of a given lot

Using these numbers a grower can determine the number of samples required to be 95% confident that the final chemistry numbers represent the overall chemistry of the lot.

See [the USDA Hop Inspectors Handbook](#) for more details

