

Periodic Deep Cleaning Study of Harvesting Equipment

Coordinated by Harvester Sanitation & Design Working Group, later called Harvest Forward Coalition

Original date of issue December 1, 2021 (updated May 20, 2024)

Update From Harvest Forward Coalition includes.

- *Cleaning and Hygienic Design Expectations with KPIs (page2) for tracking improvement*
- *Hygienic Design review checklist (page16) specifically for Harvest Equipment.*

Participating Organizations include:

Processors: Bonduelle Fresh Americas, Dole Food Company, Fresh Express, McEntire Produce, Taylor Farms.

Harvesting Companies: Automated Harvesting, Foothill Packing, Fresh Harvest, Smith Packing, Seco Packing

Trade Associations: Leafy Greens Marketing Agreement (LGMA)

Facilitated by Commercial Food Sanitation (CFS) - Additional questions – contact Joe Stout, Founder Commercial Food Sanitation Joe.stout@cf-san.com

Overview

Leafy greens represent a food category with consumption > 12#/per capita annually. These widely distributed products, which are not subject to a full lethality treatment in field pack or processing operations, have been implicated in several significant outbreaks with subsequent product recalls. While root cause to many of these recent outbreaks has not been fully determined, investigations and enhanced scrutiny to field practices have taken center stage.

While attention has focused on water quality and harvest practices, effective cleaning of harvesting equipment is difficult in a field environment exposed to the elements. This is compounded by frequent movement from field to field where cleaning procedures and sanitization occurs. A group of produce growers, shippers, processors, and harvesting organizations, facilitated by Commercial Food Sanitation (CFS), recognized these challenges, and initiated a working group in 2019 to further assess existing practices as well as the impact of equipment design on effective cleaning and sanitization of harvesting equipment.

The purpose of this study and white paper was to establish a data-based approach to a combination of Periodic Equipment Cleaning (PEC) and hygienic redesign of Harvest equipment. PEC is a protocol which schedules and completes disassembly, cleaning, and sanitization of hard to clean niche areas in process equipment for RTE foods. Routine cleaning of harvesting equipment is completed daily but does not allow for PEC execution because of the time needed for disassembly to allow access. PEC activities are well developed in food processing facilities for produce and other food categories, but not developed in the areas of harvest equipment. The approach of using PEC activities will ensure equipment niche areas are cleaned effectively at the appropriate frequency to prevent microbiological cross-contamination between harvesting events or between harvesting different commodities, fields, lots etc. In the long term, hygienic design improvements will eliminate niche areas and allow for effective routine cleaning. The information and microbiological data collected during this study illustrate the need for a combination of PEC cleaning and Hygienic Design improvements. In combination this will allow for effective and efficient cleaning of harvesting equipment.

As sanitation and hygienic design programs for harvesting equipment are not mature in field harvesting environments, the group organized detailed PEC cleaning of different models of equipment from multiple harvesting firms, locations, and seasons. Visibly clean observations, ATP, and microbiological data were collected from predetermined PEC sites not easily

accessible, or areas not cleaned during daily sanitation. Samples were taken prior to and after deep cleaning between January and July 2021. Existing data shows that product contact surfaces (zone 1) can be cleaned with appropriate execution of routine (daily) sanitation procedures. This study focused on near-product (zone 2) locations which could be a source of micro cross contamination once the harvest equipment is in operation for several hours.

This Periodic Equipment Cleaning assessment detailed both common and unique areas associated with specific models. Each harvesting machine was disassembled, tested, cleaned, and subsequently re-tested prior to reassembly. Sampling, analysis, and reporting protocols were established to enable consistency across each sampling event. In some cases, the same harvesting unit was revaluated in a different geographic area and season (Salinas vs. Yuma). The same test design was used in all situations. Data was assembled by Commercial Sanitation and graphed blindly. The data conclusions were the same regardless of the season or geography.

Data Overview

Analysis identified common niche locations across different equipment models with elevated microbial loads. Most of the elevated coliform and APC counts were from sample sites showing visible soil after PEC disassembly. Visible soil and microbial counts were eliminated or significantly reduced after the PEC activities. In all cases, swab samples for Generic *E. coli*. were negative before and after deep cleaning.

Conclusions:

The harvesting units evaluated in this study were not hygienically designed and therefore are not easily accessible for routine or PEC. Many Zone-2 harborage points showed visible soils and microbiological activity in the study. Periodic teardown and deep cleaning at a predetermined frequency are necessary to address the areas of concern identified in this study in addition to other niche locations. PEC is and will continue to be a burden to execute given field cleaning of the equipment and out of service time needed. The strategic solution is to elevate industry focus on hygienic design enhancements using the high-count failure sites as a starting point to transition failed sites from PEC sites to routine cleaning sites to enable daily cleaning without dis-assembly.

PEC / Hygienic Design Focus areas:

Some locations are model specific, however in general common areas as noted below require periodic disassembly/deep cleaning and/or modification based on observations and data. Hygienic design improvements could remove these as at-risk areas.

- Wear strips under belts (difficult to remove)
- Difficult to reach locations (incline belts, cog wheels)
- Sandwich spots (adjoined laminated flat surfaces) (support strips, flaps to chlorine tunnels...)
- Hidden surfaces (cutting board attachments, framework)
- Mechanical drive and support rollers
- Bearings

Cleaning and Hygienic Design Expectations with Key Performance Indicators for Continuous Improvement

- Each equipment unit has a Hygienic Design review twice annually. Recommend at the start of each half year production cycle. (**KPI metric #1** - Rating calculation is % Satisfactory and Acceptable of items on the HD check list. (HD list to be maintained with harvest unit or be available electronically).
- Periodic equipment cleaning tasks (PECs) are scheduled and completed. (KPI metric - less than 90% of PECs complete = incomplete) Maintain in MSS with Harvest Unit or available electronically.

- Organize and execute cleaning following the 7-step process using a check list to document completion and effectiveness. **KPI metric #2-** % expected / acceptable) for each cleaning event. Maintain in MSS with Harvester or electronically.
- Cleaning chemicals used / concentrations / usage are documented for each cleaning event. Maintained in MSS with Harvester or electronically. **KPI metric #3** – tests / % passed (first pass)
- Pre-op inspections, verification data (ATP / APC / visual inspection) of zone 1 surfaces. Target is based on industry / company expectations. Visual inspections are to occur and pass prior to ATP and APC swabbing. **KPI metric #4** Visual inspection points observed / passed % (first pass) **KPI metric #5** -ATP / APC taken / passed % passed maintained in MSS with Harvester or electronically.

Next Steps:

This study identified common areas which require PEC development and execution. Additional dialogue, training, and partnership is needed with harvesting and equipment manufacturing representatives regarding sanitation, maintenance requirements, and improved design opportunities. Further testing and coordination with harvesting operations and manufacturers is planned to enhance hygienic design and sanitation processes.

This will be a continuous improvement initiative which will require a collaborative approach from all parties (Harvesters, Processors, Customers, Original Equipment Manufacturers (OEMs), Trade Groups and Regulatory) for the situation to advance from existing status.

Appendixes,

Appendix A Periodic Equipment Cleaning (PEC) -overview and instructions

Appendix B. Swab Sites & PEC swab data

Appendix C. Priority Sites for re-design

Appendix D SSOP Guidance developed by this team in 2019.

Appendix E Hygienic Design check list

Appendix A - PEC overview

Periodic Equipment Cleaning (PEC) Overview

Periodic equipment cleaning is the dis-assembly and cleaning of equipment at defined frequencies and is a critical component of a sanitation program. Some examples of items evaluated include:

- Removal of conveyor belts
- Inner framework
- Wear strips
- Sprockets
- Sandwich joints

Periodic Equipment Cleaning Assessment Process:

A PEC assessment is initiated after routine sanitation has been completed to assess soil and micro loads in locations that are not typically accessible. Steps include:

- Disassemble equipment to expose niches and sandwiched surfaces
- Inspect and swab selected areas that have been exposed through disassembly
- Rinse and clean equipment and parts that have been fully disassembled to remove exposed soils.
- Inspect and swab the same sites that were evaluated at the disassembly step.
- Sanitize all surfaces of the disassembled equipment and parts.
- Re-assemble disassembled parts / equipment and fully clean equipment.

Equipment and Locations

Three point hitch and self-propelled equipment are primarily used in the harvest of iceberg and romaine lettuces; PEC assessments conducted in Yuma, Santa Maria, and Salinas

Harvester PEC Assessment Design and Data Collection:

- Harvester units cleaned using existing protocols in field prior to disassembly and evaluation.
- PEC assessments performed in an area protected from elements, equipped for disassembly and cleaning
- Each supplier and Harvest team coordinated activities with a designated Harvester
- Visual comments, and swabs (ATP, APC, coliform, and generic E coli) collected for each (of 9) preidentified locations upon disassembly and reassembly after deep cleaning submitted to CFS for entry into database.

Appendix B Swab Sites & Data

Swab sites: (Focused on zone 2 locations)

Sites chosen to reflect items that apply to majority of units.
Approximate 4" x 4" area (as feasible) swabbed per designated technique.
Results entered CFS tabulation form to facilitate analysis.

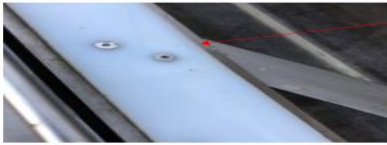
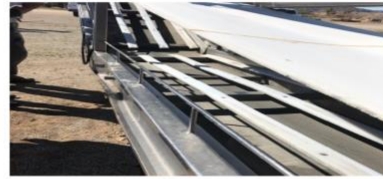
- 1) Guide Strips under Main Conveyer belt (pull strips, swab underneath)
- 2) Bearing(s) at conveyer drive
- 3) Cog wheel(s) under Incline belt slide and swab under unexposed areas
- 4) Support rollers – (often hollow, swab caps and surrounding areas)
- 5) Mechanical drive and idle rollers – slack belt and swab beneath areas
- 6) Tunnel flap – sandwich connections
- 7) Sprayer nozzles – external hose and connections
- 8) Cutting boards – remove and swab unexposed areas and connection points
- 9) Sandwich joints – choose depending on model and design

Appendix B – Swab sites

UMHW Guide Strips (1)



Pull off strips;
swab underneath

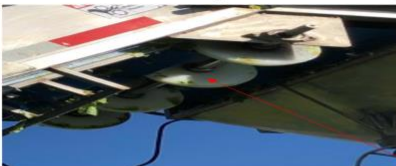


Bearings (2)



Swab bearings at conveyor drives

Conveyor Cog Wheels (3)



Remove covers and
keys; slide wheels;
swab unexposed
areas



Support Rollers (4)



Typically hollow; tip and swab at edges. Swab inside if there is an extra roller

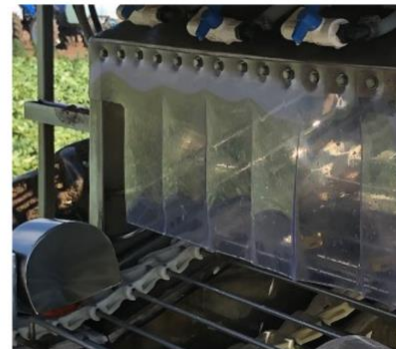


Mechanical (Drive and Idle) Rollers (5)



Remove or slacken belt; swab roller and bearing/bushing

Tunnel Flap Connections (6)



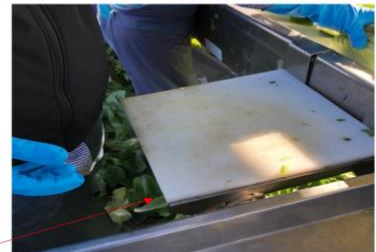
Swab sandwich connections

Sprayer (Tunnel) Nozzles (7)



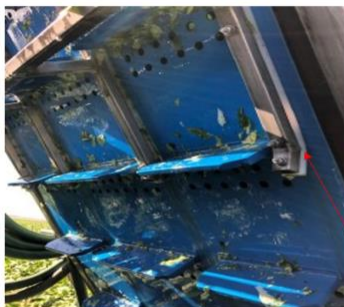
Swab external hose and connections

Cutting Board Attachment (8)



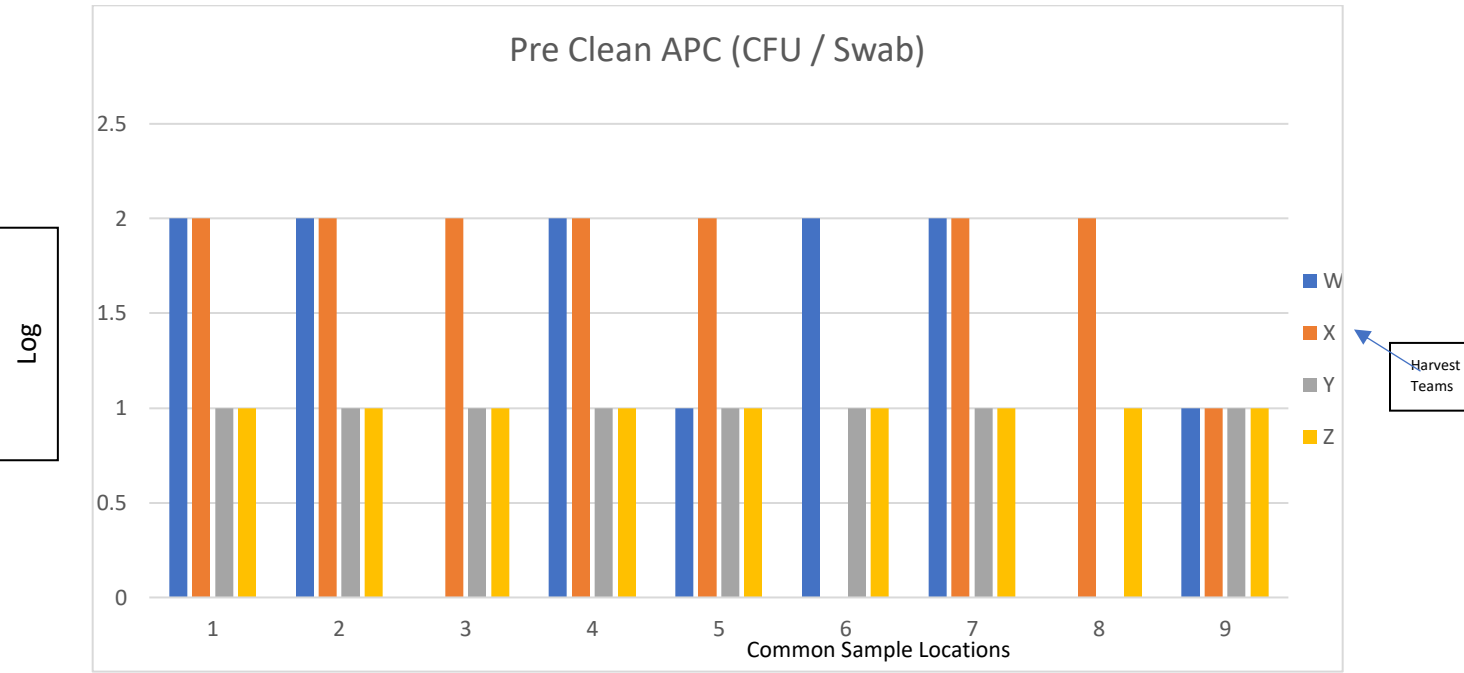
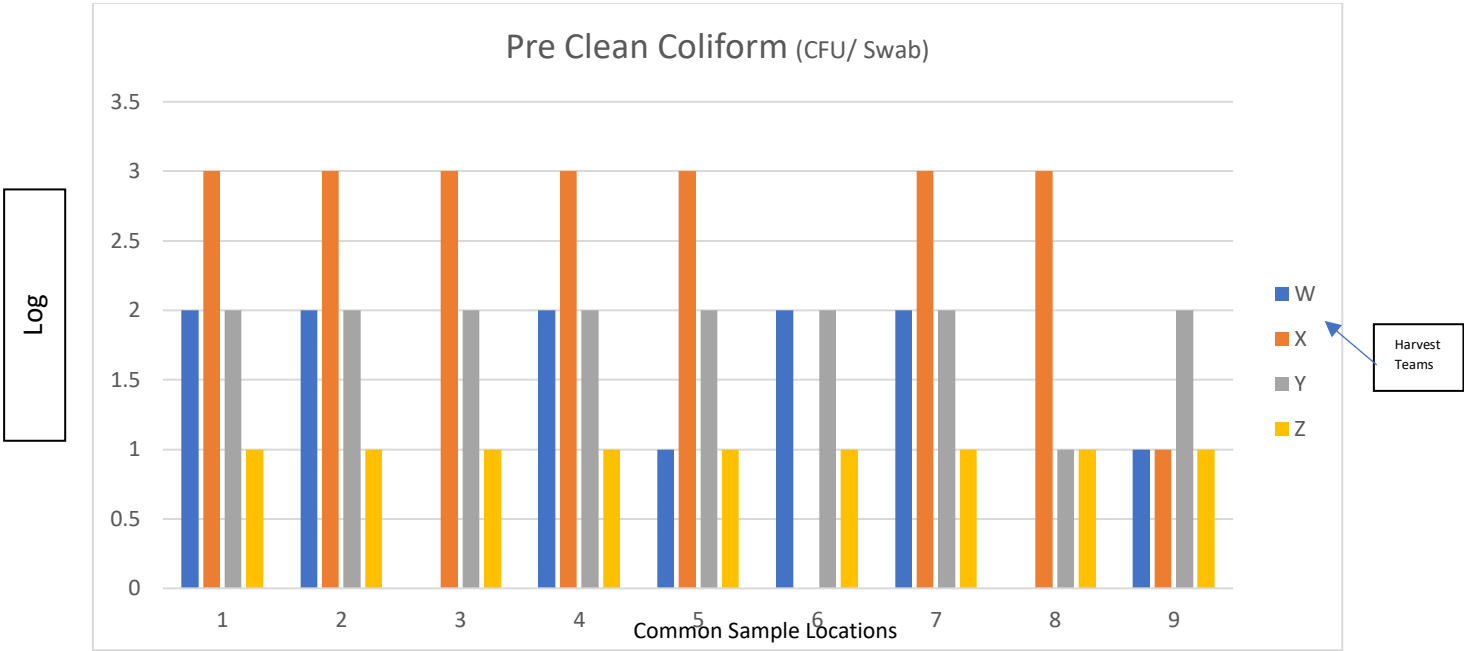
Remove boards; swab underside and connect points

Sandwich Joints (9)

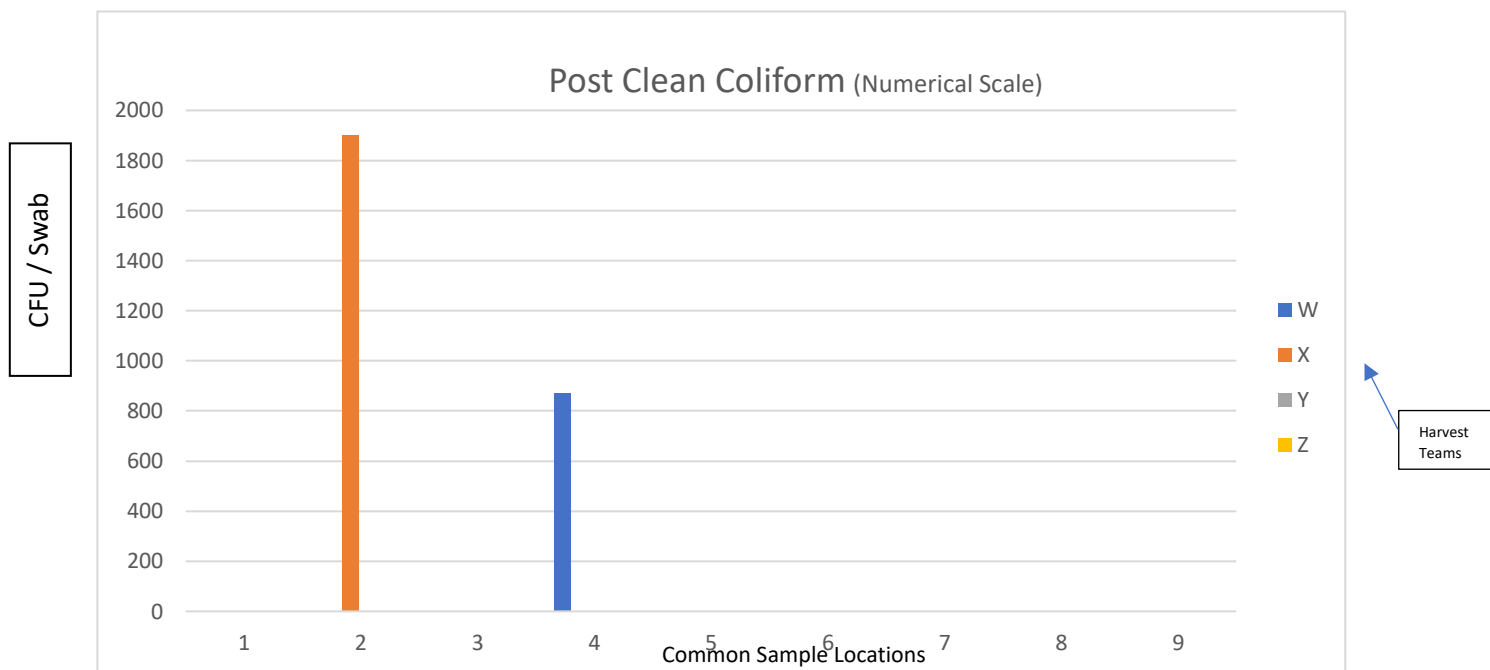
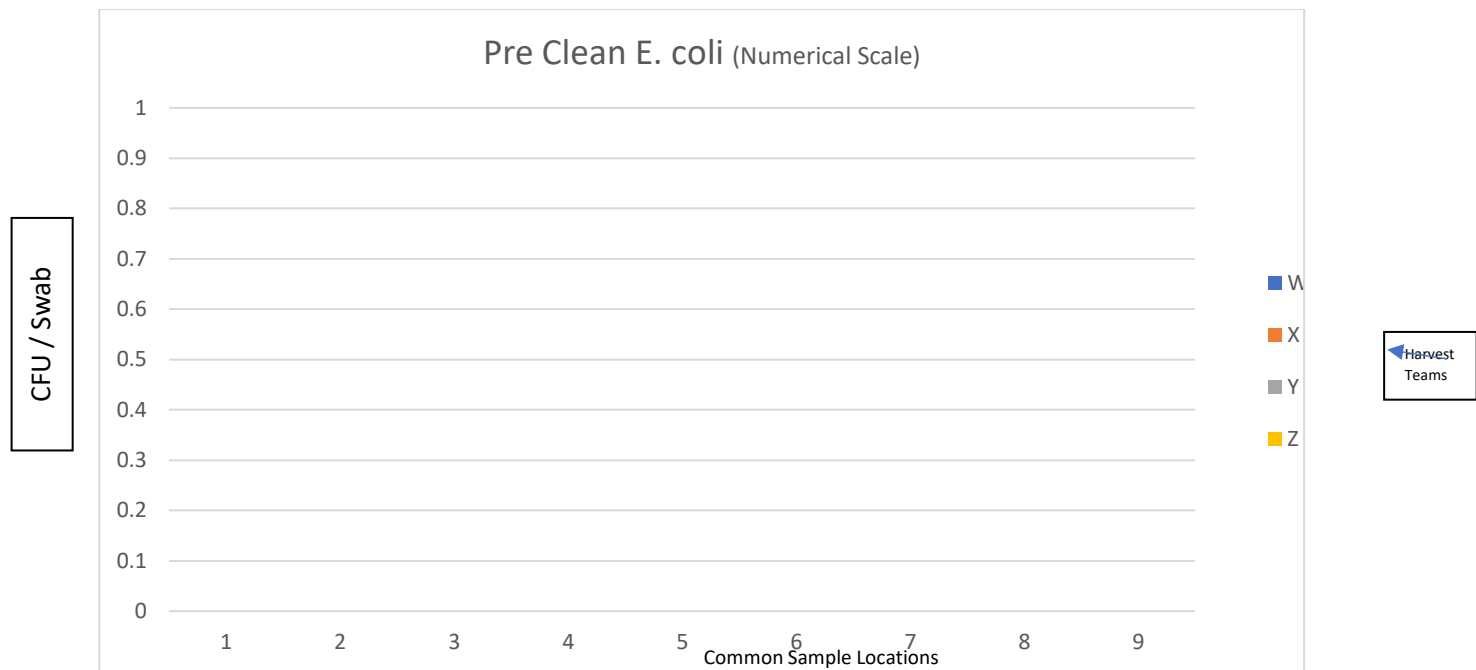


Depending on model/design multiple sandwich joints at zone 2 interface. Pick 1 or 2












Appendix B - PEC Data



Generic E coli was not identified in any trial



Appendix C Priority Sites for re-design

Harvester Hygienic Design					
Example		Priority	Principle	Option	Option
Guide Strips		High	Niche	Notched Design	Stand-off
Hollow rolls		High	Niche	Solid urethane rollers	Sealed rollers
Sandwich Points		High	Niche	Removal	Spacers
Belt clips		High	Niche	Thermolace	Endless belting
Fiber Backed Belts		Med.	Niche	Monolithic Belts	
Bearings		Med.	Niche	Spacers	Sealed Bearings
Welds		Med.	Niche	Full welds vs tack welds	Polishing
Hollow Framework		Med.	Niche	Angle Iron / I Channel	
Cutting boards		High	Accessibili	Removable (slides, clips)	
Bundled Conduit		Med.	Niche	Brackets	Pigtail or O Rings
Air Hoses		Low	Niche	Translucent vs. Opaque	
System Cleaning		High	Access	Retro System with Spray Bars	Bring in CIP truck
Pressure Cleaning Damage		High	Niche	Brushes vs Pressure	Spray System Cleaning

Appendix D – SSOP






Routine Cleaning SSOP Guidance







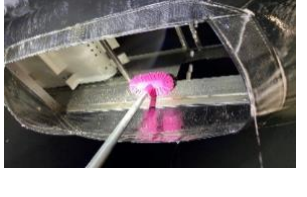
These guidelines have been written by Commercial Food Sanitation experts as well as multiple processors and trade groups for the benefit of harvesters. This document provides guidance that companies may decide to use part or all of. All final cleaning procedures need to be verified and validated through analytical results by the company utilizing them.





Process Requirements	
Requirements and Qualifications:	Clean PPE adhering to designated safety requirements — Boots, Wet Suits, Gloves, Hairnets, Eye Wear etc. Employees should be trained and adhere to Good Harvest and Sanitation Practices
Equipment / tools:	Color Coded Brushes, Single Use Scrub Pads, Buckets, Portable Foamers, High Pressure Washers, Waste Containers etc.
Utilities:	Adequate Supply of LGMA Type A Water
Cleaning / sanitizing chemicals:	Detergent Sanitizer (200 ppm chlorine) or equivalent


Points of Interest			
<u>CLEAN DIFFICULT TO ACCESS AREAS:</u>			
Under belts			
<u>CLEAN DIFFICULT TO ACCESS AREAS:</u>			
Under incline conveyer Incline guide rollers			
<u>CLEAN DIFFICULT TO ACCESS AREAS:</u>			
Undersides/hard to reach areas Drop shoot			
<u>CLEAN DIFFICULT TO ACCESS AREAS:</u>			
Chlorine tunnel and nozzles Tool storage			

7-Step Sanitation Process

Step	Sanitation Process Details	Photos
Sanitation Preparation	<p>Ensure clean PPE and tools are available.</p> <p>Move harvester to an open location away from cross-contamination and run-off. Cleaning and sanitizing chemicals should not reach growing areas.</p> <p>Enable safe access to all equipment components for cleaning</p> <p>Never walk or step on equipment</p> <p>Ensure proper lighting for cleaning</p> <p>Do not complete cleaning during excessive rain or dusty conditions</p> <p>Identify and report abnormal conditions prior to cleaning and follow-up as necessary</p>	  
Step 1 Removal of Gross Soils	<ul style="list-style-type: none"> a) Remove product, supplies and waste from equipment and cleaning area. b) Loosen assembly, incline and other belts for cleaning top, bottom surfaces, sprockets, and rollers. c) Rinse cutting boards, tables, and tarps d) Remove gross soils and place into waste containers e) Wipe excess grease from motors and bearings f) Do not place equipment or parts on the ground g) Jog conveyers to aid in removal as necessary 	 

<p>Step 2 Pre-rinse; Remove Visible Soils (~ 100% particulates)</p>	<ul style="list-style-type: none"> a) Lift belts to rinse upper and lower belt surfaces, framework, guides, rollers etc. b) Remove majority of visible soils and debris (top down), using ladders, trucks, or other approved means to access incline shoots and other difficult to reach locations. c) Rinse cutting boards, tables, and tarps d) Take precautions to avoid cross-contamination from high-pressure water sprays e) Minimize use of water to avoid creation of excess mud f) Jog conveyers to aid in removal of debris during rinsing as necessary g) Pay close attention to “hard to reach areas” 	   
<p>Step 3 Detergent Application: Enable Removal of Remaining Soils</p>	<ul style="list-style-type: none"> a) Prepare cleaning solution to manufacturer’s recommendations. b) Apply cleaning solutions to ensure coverage of contact and adjacent (zone 1 & 2) surfaces. c) Include hoses, nozzles, cutting boards, tables, undersides of equipment, belts, rollers. d) All areas should be scrubbed with hygienic color-coded brushes or single use scrub pads. e) Do not allow cleaning solutions to dry before scrubbing or rinsing. 	  

Step 4 Post Rinse: Removal of Detergents and Remaining Soils	<ul style="list-style-type: none"> a) Rinse equipment top down in the order detergents were applied. b) Be sure to rinse undersides of belts and equipment frames c) Jog conveyers to aid in removal of debris during rinsing as necessary d) Avoid spraying on ground and splashing solutions onto clean equipment e) Visually inspect all surfaces; no chemical or soil residues should be evident f) Reclean soiled areas as necessary 	 
Step 5 Inspection and Release for Transport	<ul style="list-style-type: none"> a) Prior to putting cleaning materials away, operator or lead should self-inspect equipment b) Remove soils that have been identified and re-clean (scrub) with detergent and rinse as necessary c) Document cleaning time, date, equipment identification and inspection results d) Reassemble conveyers and any other components e) Clean, wrap and store hoses f) Store cleaning equipment and supplies in designated location. g) Release equipment for transport. 	 
Step 6	<ul style="list-style-type: none"> a) Reference GHP/PPE requirements 	

<p>Pre-operational Inspection and Approval</p> <p>NEXT DAY</p>	<ul style="list-style-type: none"> b) Visually inspect equipment in accordance with pre-op procedures c) Reclean soiled areas if identified. d) Identify any damage or items that may need further maintenance (frayed belts, table condition, hoses, corrosion, chipping paint, excessive lubricants...) for leadership follow-up e) Document deficiencies and corrective actions including recleaning and follow-up inspection results f) If any items represent a food safety risk, equipment shall not be placed back into service until corrected g) Release equipment for sanitizing when visual results and equipment conditions are acceptable 	
<p>Step 7 Sanitize:</p> <p>NEXT /DAY</p>	<ul style="list-style-type: none"> a) Verify strength of solution. b) Thoroughly sanitize contact and adjacent (zone 1 & 2) surfaces c) Upon completion, place cleaning tools and supplies in assigned locations d) Complete remaining sanitation documentation e) Release equipment for harvesting 	

Appendix E

Harvest Equipment Design Review Checklist

	Harvest Company _____				
	Reviewer _____ Date _____				
	Harvester type ID _____ Unit # _____				
RATING		S	A	M	U
<u>#</u>	<u>Item</u>	-	-	-	-
1	Food contact surfaces are non-reactive, non-corrosive, non-contaminating, non-absorbent, cleanable and adequately maintained.	1			
2	Food contact surfaces are easily accessible to facilitate cleaning and maintenance activities.	1			
3	Product zone (proximity of contact surfaces) areas are accessible for cleaning and inspection or equipped for tool-free or limited disassembly. Ladders/platforms, if used, are safe and facilitate full accessibility to all components and surfaces.	1			
4	Equipment can be dismantled and reassembled to enable effective routine sanitation and maintenance			1	
5	Single filament conveyor belting (not fibrous or lacing material) used. Belts are easily cleaned.		1		1
6	All belting is easily removable, or belt tension is slacked easily without tools enabling surfaces underneath to be cleaned.			1	
7	Carry and return rollers on conveyers are solid or with welded end caps vs. hollow tube roller or press fit.		1		
8	Bearings are not located in food contact areas; bearings are sealed or capped and mounted on stand offs in product zones (close to food surfaces). Material is resistant to corrosion associated with operation and sanitation.		1		
9	Surfaces are pitched away from zone 1 areas in wet areas to avoid water and product accumulation.	1			

10	Product zones are free of joined surfaces (sandwich areas) that cannot be taken apart.				1
11	Food contact equipment welds are smooth to the touch and free of pits, cracks and corrosion. Lap joints were not observed.		1		
12	Welds (non-contact zones) are smooth and free of corrosion	1			
13	Internal angles to food contact areas are formed (non-welded) with an angle to facilitate cleaning (3/16" minimum; 1 " preferred)	1			
14	Product contact areas or zones are free of threaded bolts, nuts or other fasteners which present foreign material or micro harborage risk. Lock nuts vs. open threads are used.			1	
15	No penetrations into hollow areas (product surfaces, zones or framework) which can entrap water and debris. Frame components are free of skip or spot welds and/or laminations			1	
16	Lubricants are not observed within or above food contact areas.	1			
17	Drives or components are mounted on cleanable supports not located above contact surfaces or zones without sufficient shielding to protect product and contact surfaces.		1		
18	Conduit, cabling, and process piping is mounted via sanitary stand-offs and routed to avoid drip, drain, or diffusion into Zone 1 areas. No zip ties. Adequate stand offs for cleaning.		1		
19	Conduit and supply lines are not located above contact surfaces or zones and separated to enable cleaning.				1
20	Piano hinges, knurling, braided covers, or socket head cap screws are not used.	1			
21	Components and safety features (guards, enclosures...) are constructed to enable disassembly and effective cleaning and inspection.			1	
22	Catch pans are accessible or removable for cleaning and sloped away from contact surfaces.		1		

23	Underside of equipment is separated by at least 6 inches from the crop to be harvested to prevent direct contact with food product.	1			
24	Platforms above exposed product or contact areas are solid and do not allow water or soil to drop to product or contact surfaces. Kick plates of sufficient height (> 6") in place to prevent incidental contamination.		1		
25	An overhead barrier is used to prevent birds droppings from landing in food product or on contact locations.			1	
26	An design review has been completed. At risk designs are communicated to maintenance for repair or shared with sanitation to add to PEC list. Actions were taken to resolve issue.	1			
27	Detailed assembly and disassembly instructions are available to facilitate routine and periodic cleaning and maintenance.		1		
28	Preventive maintenance programs are developed and followed - 90% completion rate.		1		

Totals **10 10 6 3**

Perfect Score 28 **28**

Total S & A **20**

S&A % **71%**

DEFINITIONS:

S- Satisfactory – Meets stated requirement

A - Adequate – Does not meet stated requirement; but is managed with a PEC or routine sanitation.

M-Marginal – Does not meet stated requirement; modification or PECs need improvements.

U - Unsatisfactory – Does not meet stated requirement; not being managed

