

Exposure Assessment in the Fishing and Seafood Processing Industries in Alaska

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iWorkwise

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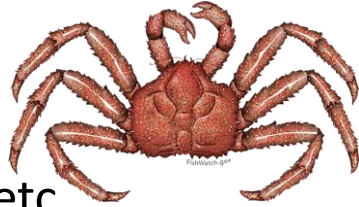
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Introduction to Seafood Industry (Alaska)

- Seafood Types

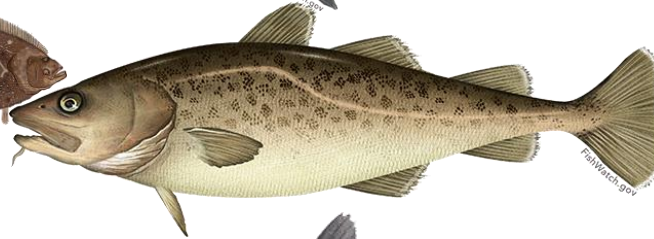
- Shellfish

- Crab, Scallop, etc



- Bony fish

- Salmon
 - Halibut
 - Cod
 - Pollock/hake



- Bony Fish Products

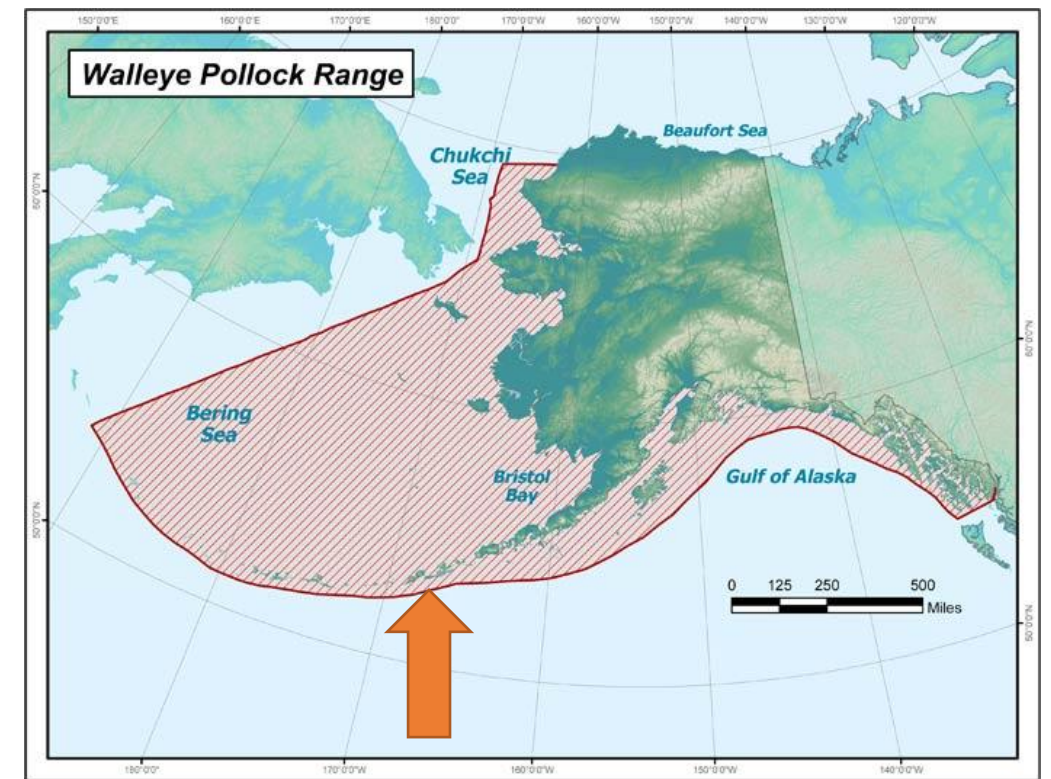
- H&G
 - Fillets
 - Canning
 - Mince (fish sticks)
 - Surimi (imitation crab)
 - Fish meal
 - Fish oil
 - Roe/Milt



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<https://www.fisheries.noaa.gov/species/>

Unalaska, Alaska “Dutch Harbor”



<http://www.adfg.alaska.gov/index.cfm?adfg=walleyepollock.rangemap>



<https://www.ci.unalaska.ak.us/community/page/story-name-unalaska-or-dutch-harbor>

Trawl Deck Mid-water trawl nets and sophisticated electronics are used to target pollock and minimize environmental impacts. New gear technology and voluntary efforts by fishermen are bringing the already low occurrence of bycatch even lower.

Bridge The nerve center of the boat, the bridge controls boat movement and fishing operations. Electronics for navigation, communication, fish finding, and net deployment and operation are controlled here by the captain and the first or second mate.

Observer Office Used by the federal observers while the boat is at sea, at this location you will see the additional products made by the *Alaska Ocean* for specialty markets around the world. These products allow the boat to utilize 100% of the fish it catches.

Flow Scale and Observer Station

All harvested fish are weighed onboard the vessel. The catch of Alaska pollock and any incidental catch of non-target species is documented by federal observers to ensure that the total catch adheres to scientifically set quota levels. Observers also conduct catch sampling to supplement other fishery research used to set the quota each year.

Engine Room The main engine produces 6600 horsepower for propulsion, and three auxiliary engines produce 1500 kW of electricity for operation of all other vessel systems. The *Alaska Ocean* is the only vessel in North America with a CO₂ refrigeration system—the most environmentally friendly system in use today.

Fillet and Surimi Production Fish are sorted by size to increase recovery and then filleted at an average rate of 180 fish per minute. Fillets and surimi are processed and frozen in less than 12 hours from harvest.

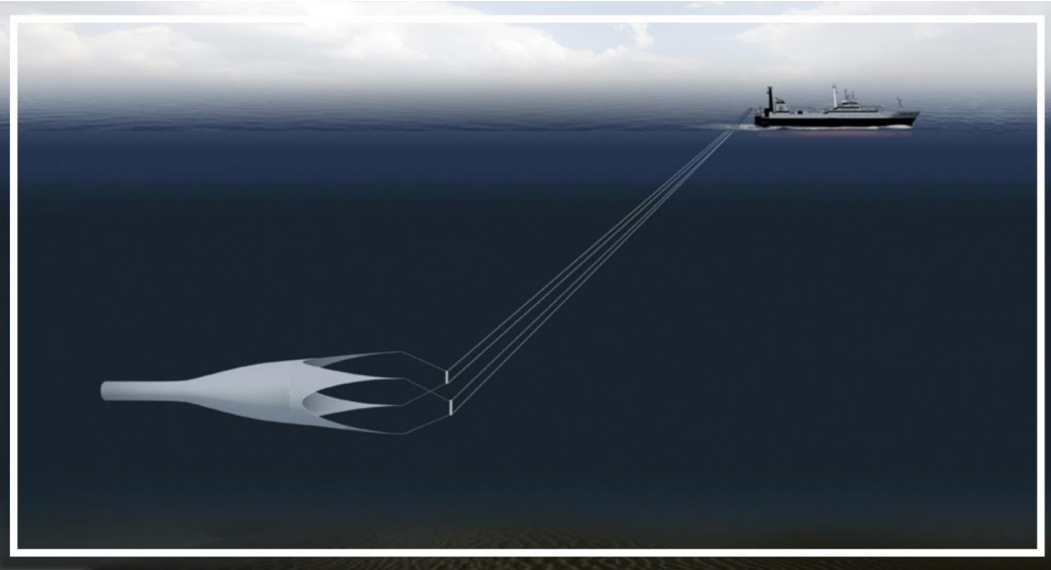
Galley and Staterooms For the 141 people on board, this is home during their time at sea. Rooms, meals, medical services, laundry service, crew lounge, workout area, and email access are provided.

Case-Up Area After freezing, products go through a final inspection before packaging. The production code on each package allows for traceability back to the date and vessel location at the time of harvest.



Pollock Fishing

- Vessels
 - Trawler
 - Catcher-Processor

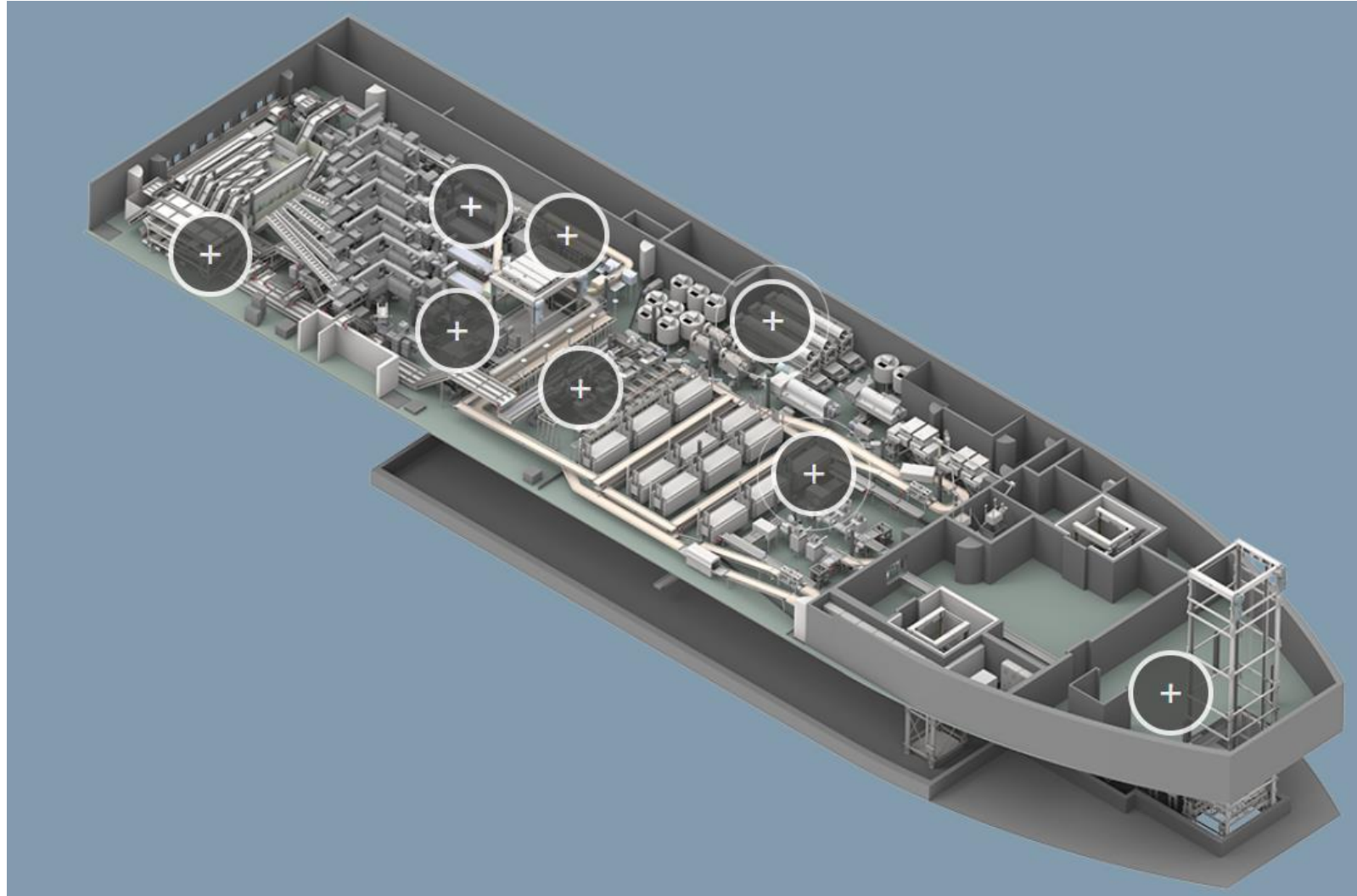


<https://www.youtube.com/watch?v=U3FZ-yY6xGk>

https://www.adfg.alaska.gov/index.cfm?adfg=wildlifeneews.view_article&articles_id=141

Processing Overview

- Sorting
- Filleting
- Inspection
- Mince
- Surimi
- Freezing
- Fish meal/oil
- Roe/milt
- Packing/Storage



Pollock Processing Equipment/Jobs

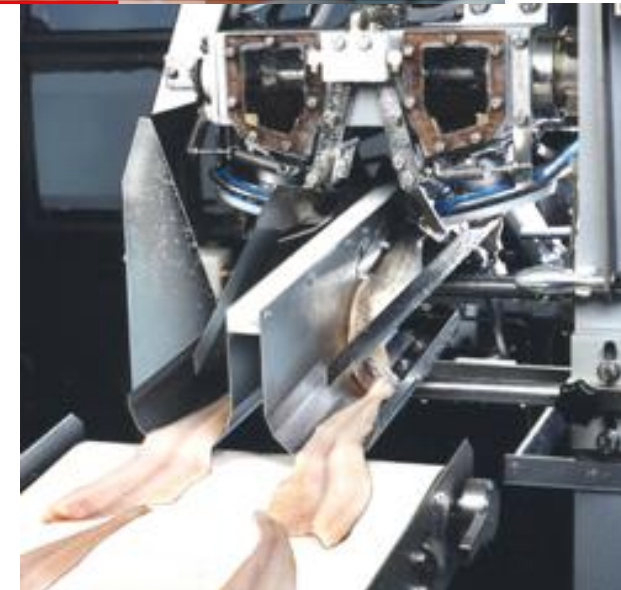
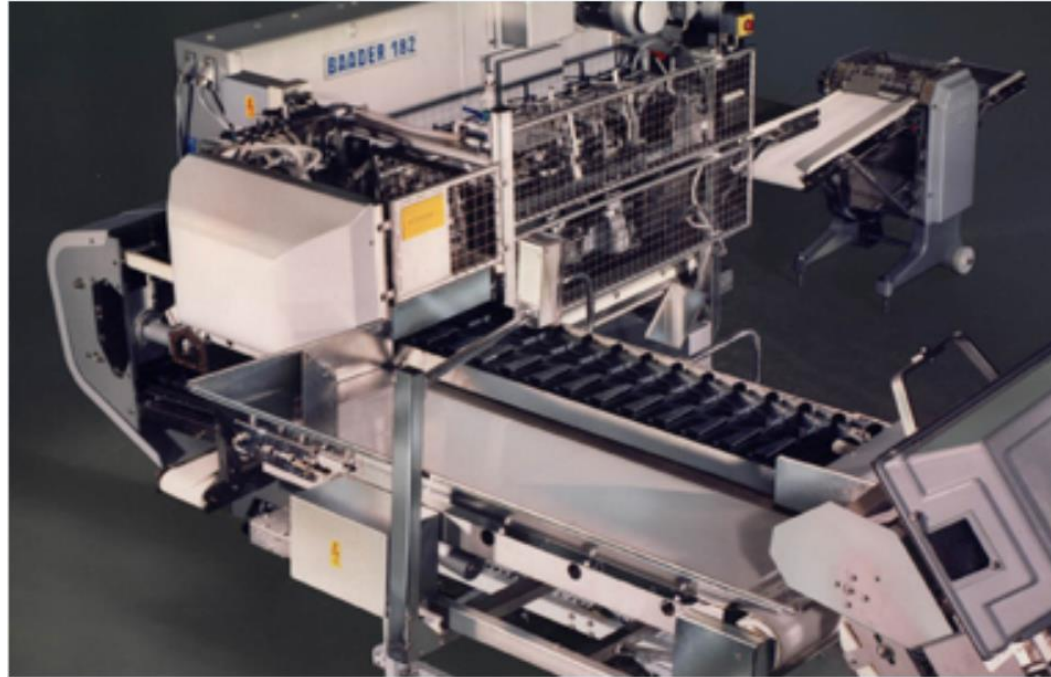
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<https://carsoe.com/seafood-processing/pollock-surimi/>

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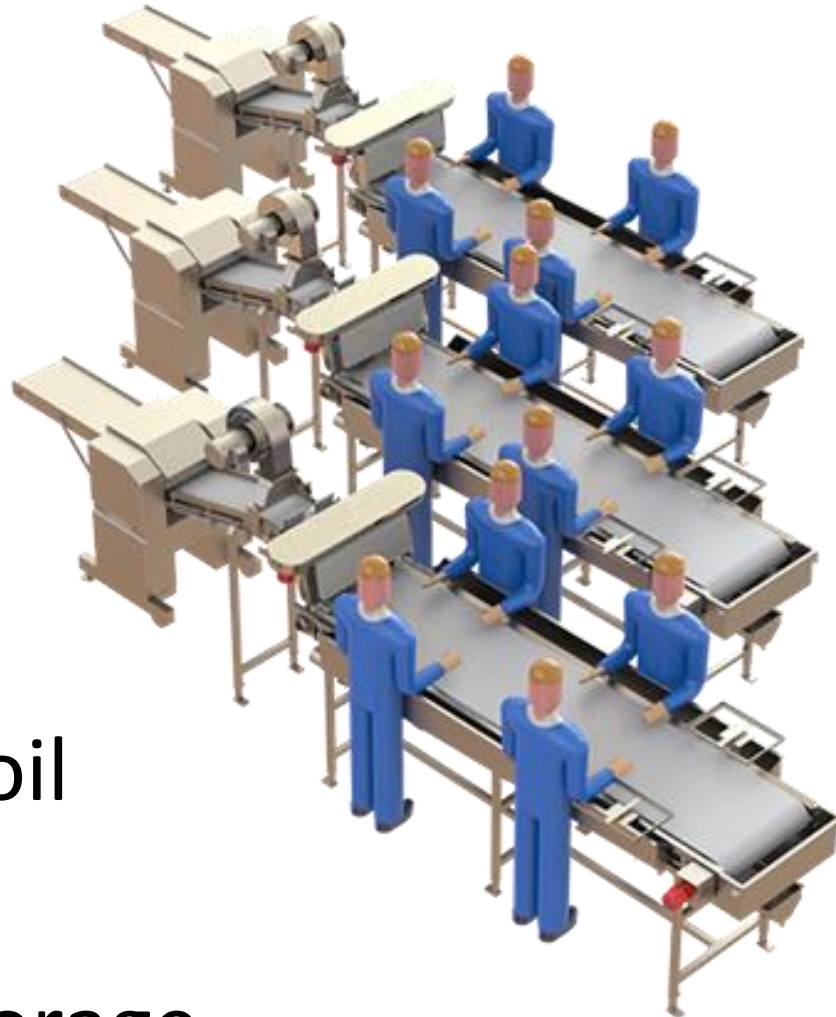




Baader Machine

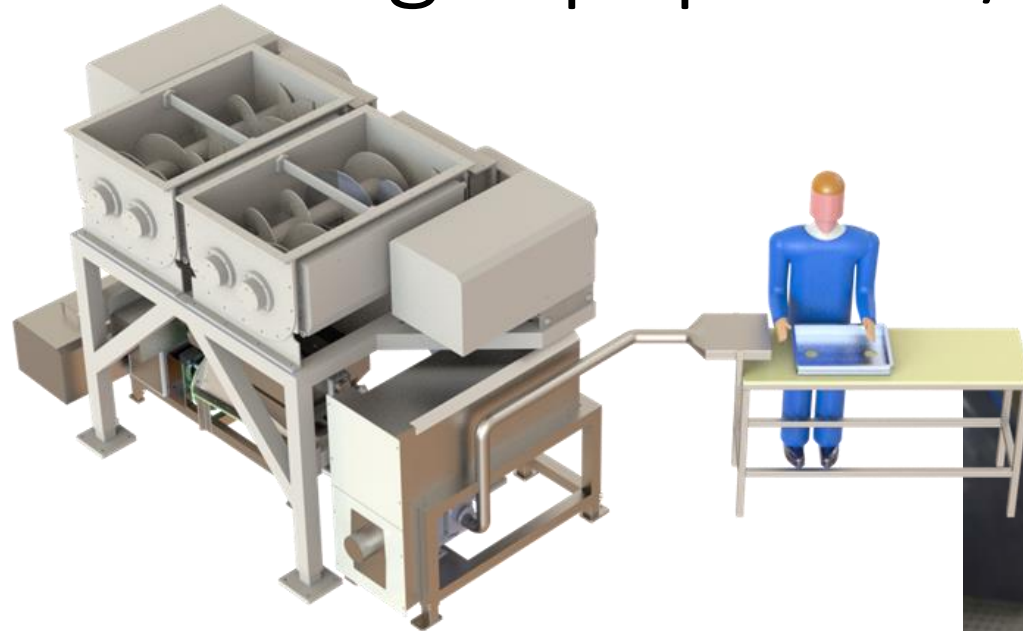
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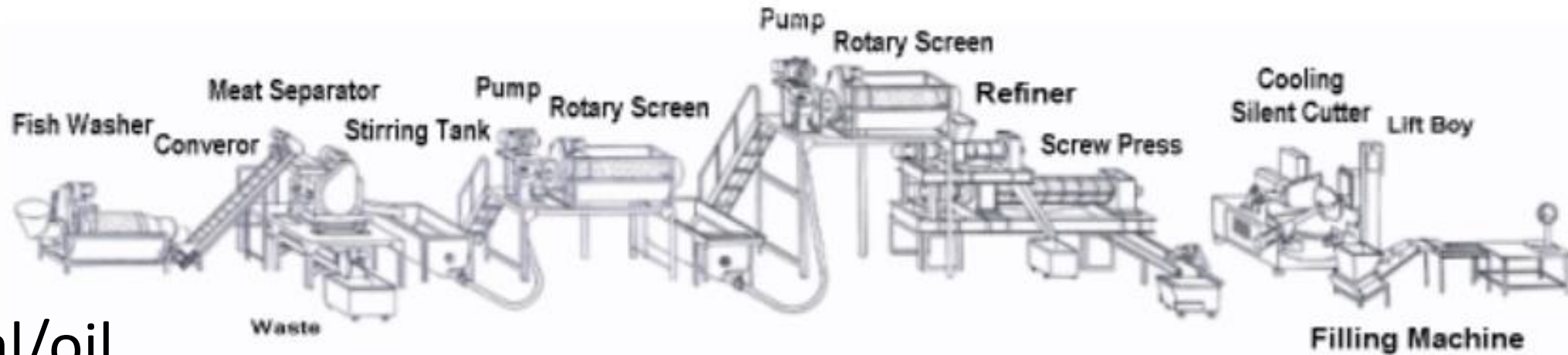
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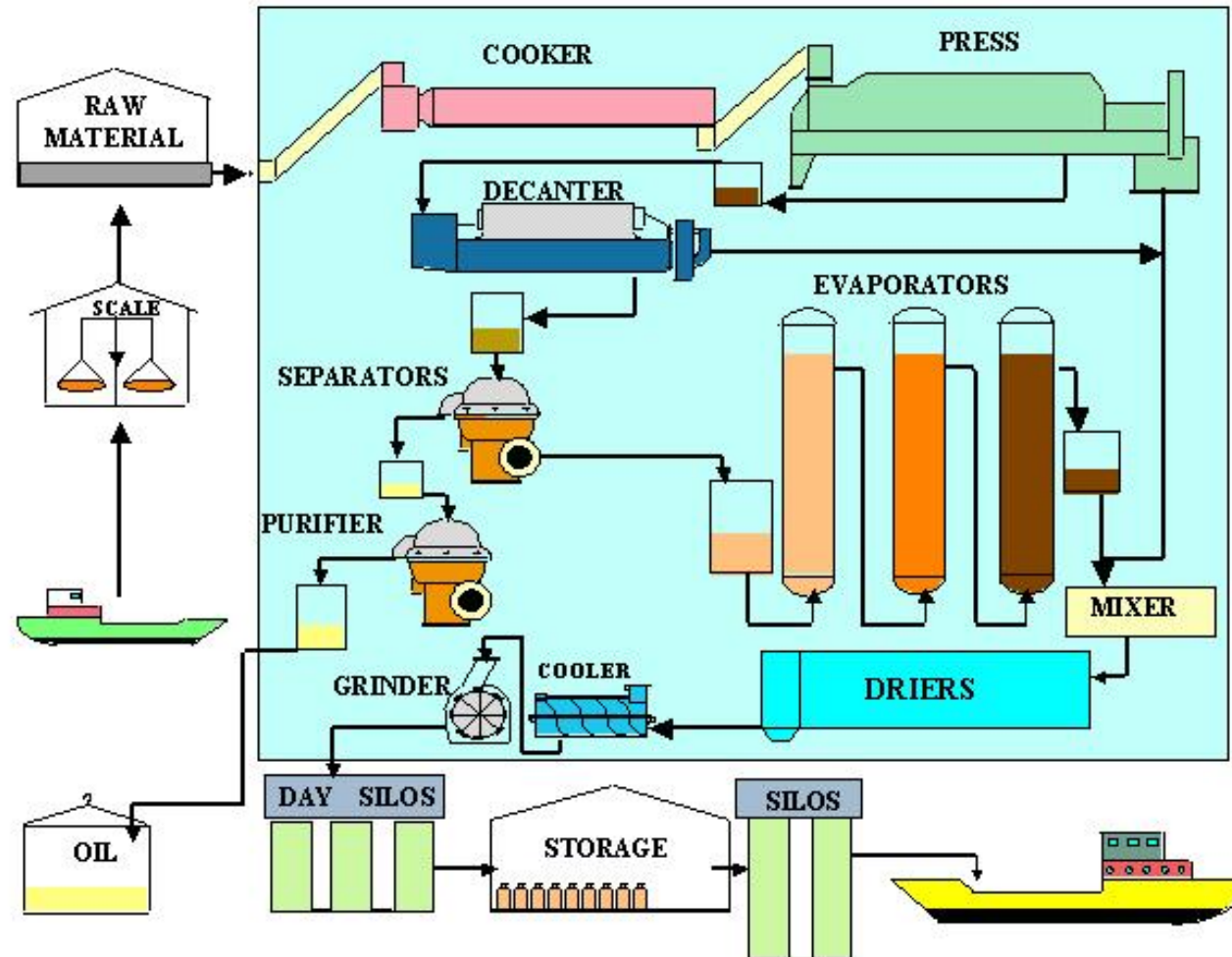
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<https://dsifreezing.com/horizontal-plate-freezers/horizontal-freezer/>

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Health Effects from Seafood

- Immunological IgE-mediated
 - Sensitization
 - Asthma
 - 4%-36% for shellfish
 - 2%-8% for bony fish
 - inhalation or via disrupted skin barrier
- Infections/Flu/Colds

Common to have flu/cold transmission on-board due to wide geographic distribution of arriving workers
- Non-immunological
 - Respiratory Irritation
 - Dermatitis
 - Parasites
 - Anisakis
 - Toxins
 - Ciguatera
 - Marine biotoxin
 - Scromboid poisoning
 - Puffer fish poisoning

Health Effects from Seafood

- High-molecular weight allergens
 - Tropomyosin
 - Mollusks
 - Gastropods (Abalone), Bivalves (Clams, oyster, mussel), Cephalopods (Squid, Octopus)
 - Arthropods
 - Crustacean (crab, lobster, prawn, shrimp)
 - Parvalbumin
 - Chordates/Bony fish (Cod, Salmon, Tuna, Herring, Sardine, Mackerel, Carp, Pollock, Hake)
- Proteolytic enzymes
 - Trypsin – potential to increase airway inflammation
- Other contaminants
 - Endotoxins – most likely related to acute symptoms
 - Total protein levels
 - Whitefish slime/skin
 - Outer shells of crustaceans

Bohlokke, et al (2019); Jeebhay, et al (2019); Jeebhay (2001)



Tale of Two Trips



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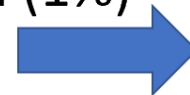
Exposure Assessment

○ IEQ/IAQ

- Carbon dioxide (CO₂)
- Humidity/Temperature
- Carbon monoxide (CO)
- Ventilation

▪ Hypochlorite generation (1%)

- Sea water electrolysis



○ Results

- CO₂ and cfm meet guidelines
 - IMC, 403.3 (10/1000 ft², 15 cfm/person)
- Carbon monoxide DRI
 - 8 ppm – factory onshore
 - up to 75 ppm - processing



Exposure Assessment – Gas/Vapor

- Cleaning/sanitizing

- Sodium hypochlorite,
Potassium hydroxide



- Mid/end of trip

- Hypochlorous acid
- Nitrogen trichloride
- Chlorine gas (DRI)

- Ozone generators



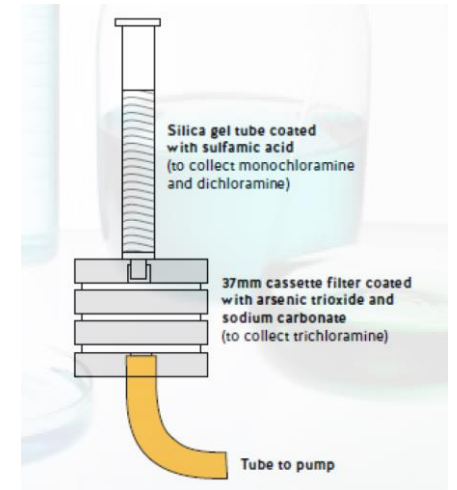
- Ozone DRI

- Refrigeration

- Ammonia
- Freon
- CO₂



- DRI/alarms/interlocks for
freon, CO₂, ammonia



Exposure Assessment – Particulate Matter

- Particulate Matter
 - Inhalable
 - Respirable
- Parvalbumin
 - Thoracic or inhalable
 - ELISA antibody assay (based on cod or pollock)
- Particulate ID
- Particulate Size fractions DRI



Particulate (and Noise) Results

- Results

- Spore trap air samples (factory)
 - No to few spores, no pollen
 - Animal fat cells, salt, soot, diesel exhaust
- Surface/tape samples
 - Animal fat cells, soot
- Particle size DRI
 - Sorting to fillet: $>2.5\ \mu\text{m}$
 - Mince to freezing: $< 2.5\ \mu\text{m}$

- Noise

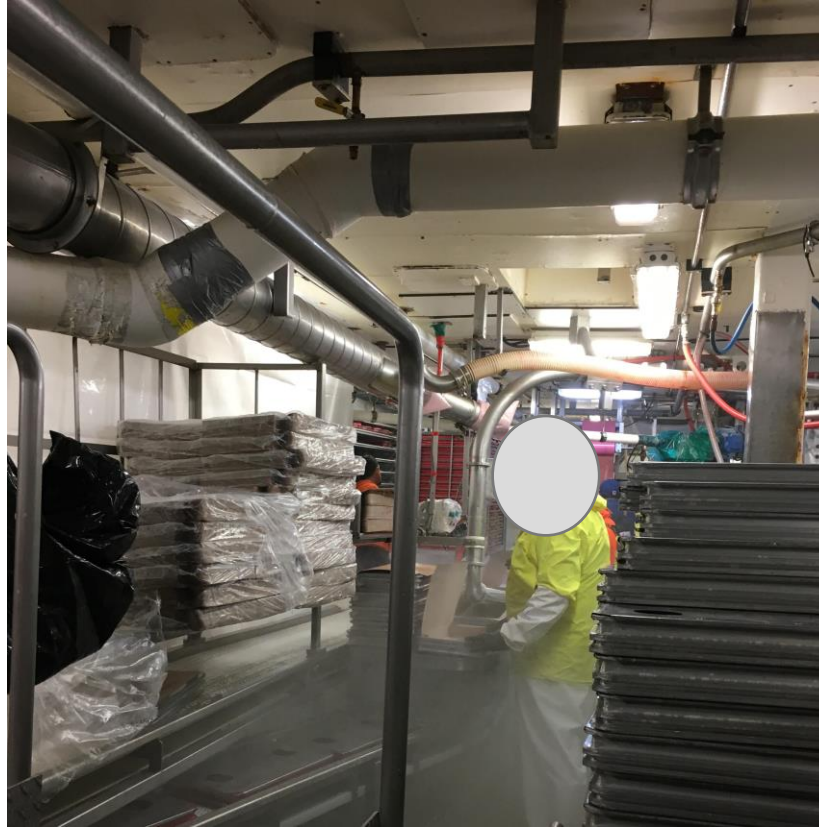
- Work

- Sorting to fillet: 90 to 95 dBA
 - Surimi: 95 to 100 dBA
 - Freezing/packaging: 85 – 90 dBA
 - Pan noise
 - Fish meal: 95 – 100 dBA
 - Engine Room: $> 100\ \text{dBA}$

- Off-shift (24-hour exposure)

- Contribute little to noise exposure

Neitzel (2006), <https://pubmed.ncbi.nlm.nih.gov/16732555/>



Particulate Matter Results

- Sugar room
- Water spray
 - Process water
 - Cleaning tasks
- Stagnant mist



Exposure Assessment Considerations

- Unusual work schedules

- Long shifts (12 - 16 hrs)
- Extended trips (8-14 days)
 - Can be lots of downtime
 - Finding the fish, weather

- OEL adjustment for PM

- 41% - 56%

Guide for the adjustment of permissible exposure values (PEVs) for unusual work schedules



4th edition revised and updated

- Sampling issues

- Lots of water and fish scales
 - Zip-lock bags, plastic belts
- Food quality concerns
 - Belts, sampler and clips (tape)
 - Glass tubes- cover with tygon tubing
- Sample transport/ice
 - Galley freezer/Freezer hold
 - Dutch Harbor, AK to

Anchorage, AK to

Seattle, WA to

HSE in Buxton, UK



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Exposure Controls

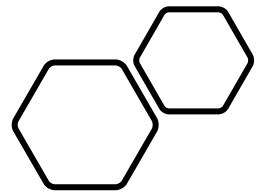
- Reduce water spray
 - Processing
 - Drain extensions
 - Reduce pressure
 - Screens
 - Cleaning
 - Bulk removal 1st
 - Low pressure rinse





Exposure Controls

- Isolation
 - Screens/curtains
 - Plastic sheeting
 - Engineered/machine design

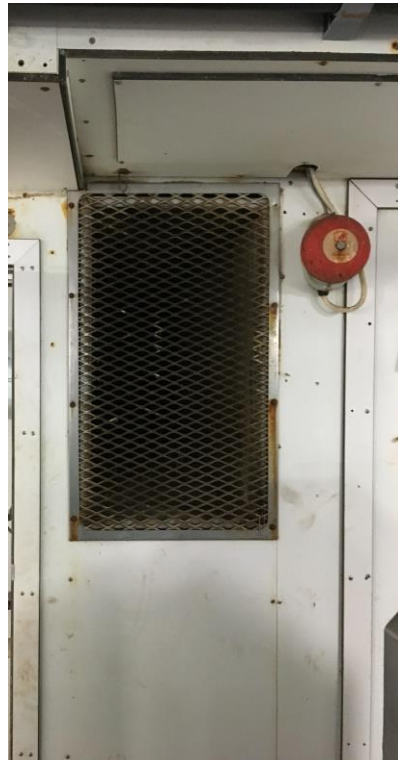


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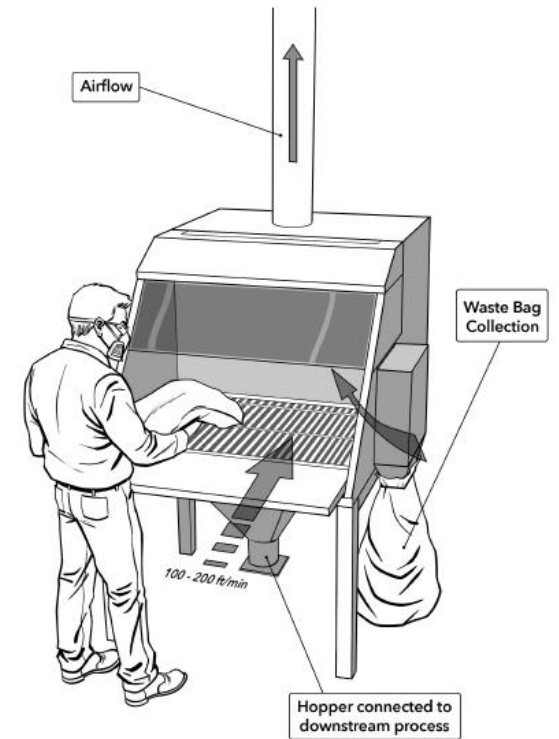


Exposure Controls

- Dilution Ventilation
 - direction
 - temperature

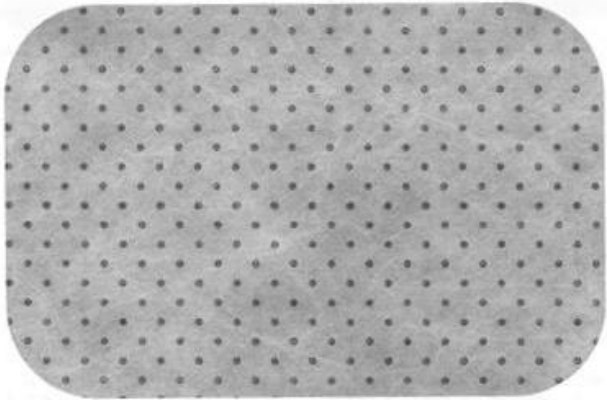


- Local exhaust ventilation
 - little head space
 - sugar room



Exposure Controls

- Respiratory protection
 - N95 FFR
 - ½ face elastomeric
 - PAPR



<https://readimask.com/>



<https://cleanspacetechnology.com/healthusa/>



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Lagnaippe

- Mailing vs. flying with sampling equipment
 - Mail, send with ship ahead of time (weeks), or risk losing during flight
- Sample handling on ship or back home
 - higher blanks on IOM for parvalbumin with on-board processing
 - wall deposits
- Dramamine/Scolpamine
 - Eye muscle relaxation
 - Magnified safety glasses
- Odor

People and their Health Effects

- Examples

- New employees quickly identified as having sensitivity/symptoms
 - Mutual parting of ways
- Long term, invested employees with sensitivity/symptoms
 - Manage with medication
 - Respiratory protection
 - Job change
- Idiopathic pulmonary fibrosis