



First Enerquip Trash Rake

Bringing Nordic ties to the PNW



Dennis France, ME
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Welcome and thank you for the opportunity. Give brief background and job description.

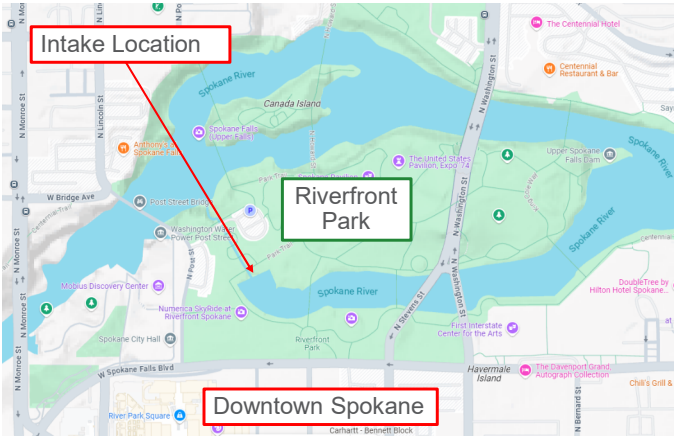
Agenda

- Existing Equipment & Reason for Upgrade
- Equipment supplier decision
- Equipment and Project Design
- FAT, Install, & Commissioning
- Operation Since Installed



Upper Falls Intake Structure

- Constructed in 1921 in downtown area of Spokane, WA
- Located within Riverfront Park
- 43' wide intake
- 3 intakes merge to a single penstock for 10 MW Vertical Francis unit
- 29 feet deep at intake

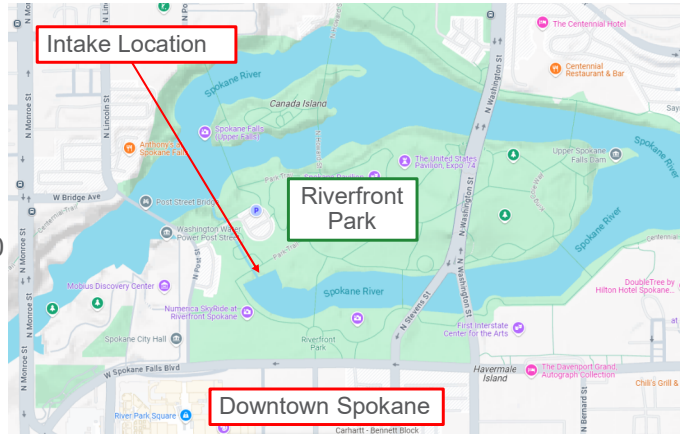


The map shows the Spokane River flowing through downtown Spokane, WA. The intake location is marked with a red box and a red arrow pointing to a spot on the river. The Riverfront Park is marked with a green box. The downtown area is marked with a red box. Various landmarks and streets are labeled on the map.

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AVISTA

- Constructed in 1921 in downtown area of Spokane, WA
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Upper falls is located in the heart of riverfront park, created for expo 74'. This poses many challenges with being in plain site of the public and poses challenges for operation and construction of projects.

Existing Equipment

- Existing trash rake and knuckle boom equipment from 1993



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Trash rake primarily was for smaller items as it just had small fingers and capacity. Had a narrow head and took a long time to clean entire rack length. Knuckle boom was for larger items, but lacked the ability to reach all the way across intake and would have to manually use pie poles to pull a log over to the boom. Sometimes would have to have operators near water to place a chocker around debris with knuckleboom. Rack Replaced in 1999

Reason for Upgrade

- Existing rake undersized for pulling logs
- Safety concerns with conveyor system and knuckle boom use
- Asset condition, maintenance costs rising year to year on existing equipment
- Looking to condense from two pieces of machinery to one

Requirements of New Rake

- Ability to clean entire rack from top to bottom
- System must reduce operator interaction
- System must be able to transport debris to two separate dumpsters without use of conveyor
- System must be able to remove large logs from intake area
- System must have a maintenance position not over the water
- System should have option for cab or wireless remote operation
- System shall have the ability to operate in manual, semi-auto, or fully automatic cleaning mode

Equipment Supplier Options

- Atlas Polar
- Kuenz*
- Muhr
- Enerquip*
- Cross Machine
- Misc. other Suppliers



We talked with multiple suppliers, but really narrowed the pool for the RFP down to between Kuenz and Enerquip. Other suppliers either could not meet the functional requirements we were asking for or we were not familiar with. Some of the other suppliers were machine or fab shops that had built something for another dam owner at one time or another.

Equipment Comparison

Kuenz HCRM-200



Kuez		Enerquip
Yes	Service in US	No
Bottom-up	Cleaning Method	Top-down
Yes	Pressure against rack	No
8 ft	Rake Head Width	4'-11"
4,500 lbs	Lifting Capacity	3,300 lbs
25,000 lbs	Machine Weight	13,700 lbs
30 ft.	Machine Height	15 ft
80 ft/min	Traversing Speed	98 ft/min
65ft/min	Lifting Speed	98 ft/min
1.5 deg/sec	Rotating speed	3 deg/sec
No	Telescoping Arm	Yes
AB/ Siemens	PLC	Siemens
Glavanized	Coating	Epoxy Paint
yes	Remote service	yes
2 yrs	Warranty	3 yrs

Enerquip Medium TRCM



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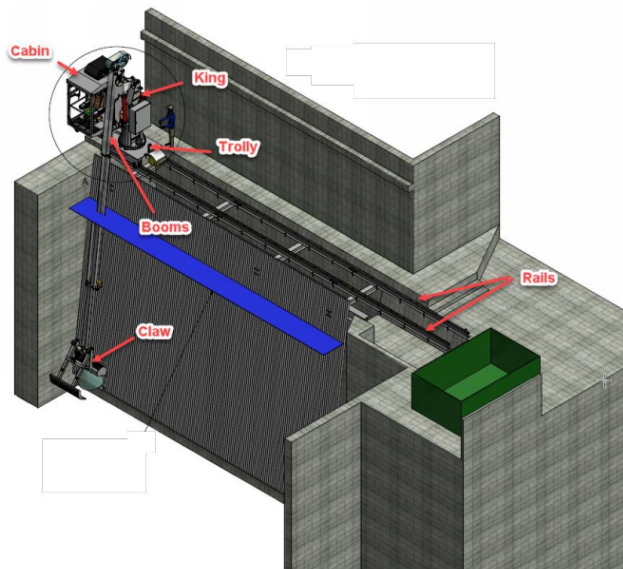
We have a Kuenz machine at our Nine Mile facility and have had many issues with programming and the machine alarming and having to reset alarms or not being able to operate the unit. We spoke with another dam owner who had purchased some H200's and they had similar issues with the automatic mode and alarms. In the end, it really came down to the unit efficiency, size and weight. This smaller unit we thought would fit our smaller intake better. We developed a memo to send to our steering committee for them to make the final decision. Kuenz did have a say, lead time, that added some complications. We received info from Enerquip to reach out to other owners that had these units installed. One in Laos and one in Sweden. Both had good things to say and we felt the risk to purchasing this rake was quite minimal.

Why we chose Enerquip

- We felt it was a better overall design and fit to our smaller intake in the center of a park.
- We really liked the top-down cleaning method as something they have been doing for years.
- We liked a custom design tailored to our specific intake structure and operational preferences
- We liked the use of hydraulics for control of machine and simplicity of the electrical system.
- Based on the amount of these machines currently installed and the what the references had to say, we felt the benefits outweighed the risk of being the first in US.
- We also figured being a flagship unit in the US would help us in the short term because Enerquip would want this unit to be in pristine condition as part of our agreement was allowing visits from their potential clients in the US.

Design of Rake

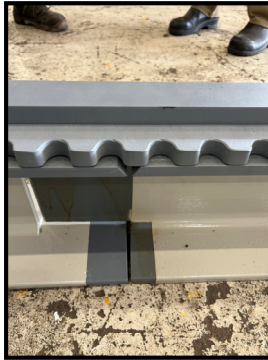
- Enerquip 3D Layout
- Gripper Head designed to Rack dimensions
- Extended rails
- Designed to Norsok Standards



Point out existing intake house as well as rack and dumpsters. The design we asked for that was different than normal was the increase in capacity from 1000 kg to 1500, joysticks in the cabin, 480V instead of 400V, added drain plug to bottom of hyd. tank instead of on the side, oil cooler added. Noise survey completed and unit is less than 80 db when running.

Enerquip Rails

- Similar to crane rails
- Custom Rack & Pinion
- Hold down bearings ride on underside of flanges
- Heat tape full length of rail



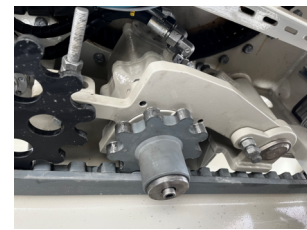
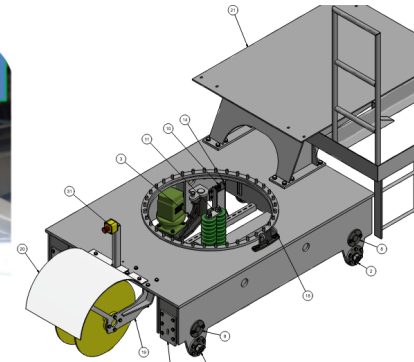
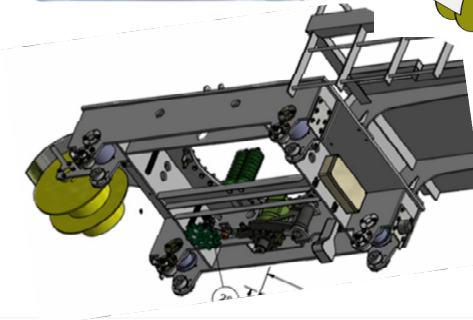
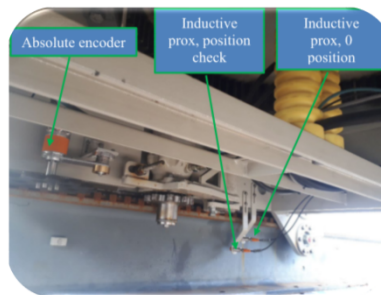
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- Have surface to ride on like crane rails
- Rack and pinion mounted on front rail for trolley travel and position
- Hold down bearings ride on underside of rail

Trolley and Drive

- Hydraulic drive with sprocket
- Absolute encoder with sprocket
- Inductive prox. sensors
- Cable reel

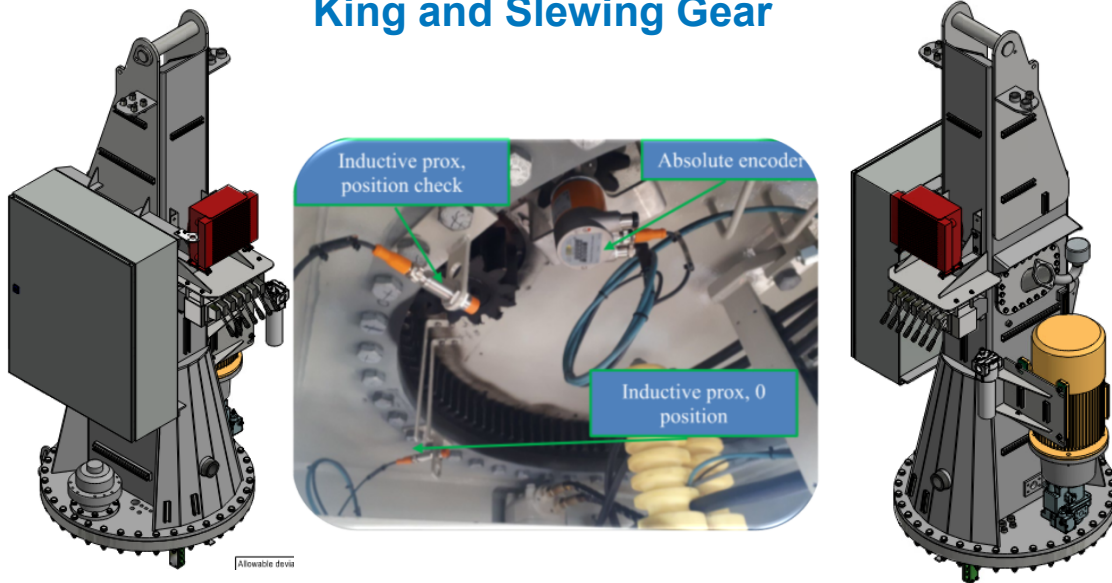


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- Fully and continuously welded construction
- 8 hold down bearings. These are eccentric to adjust within 2 mm of rail.
- Inductive prox. One to check encoder, one for park position
- Cab mounted to trolley
- Flanges on wheels

King and Slewing Gear

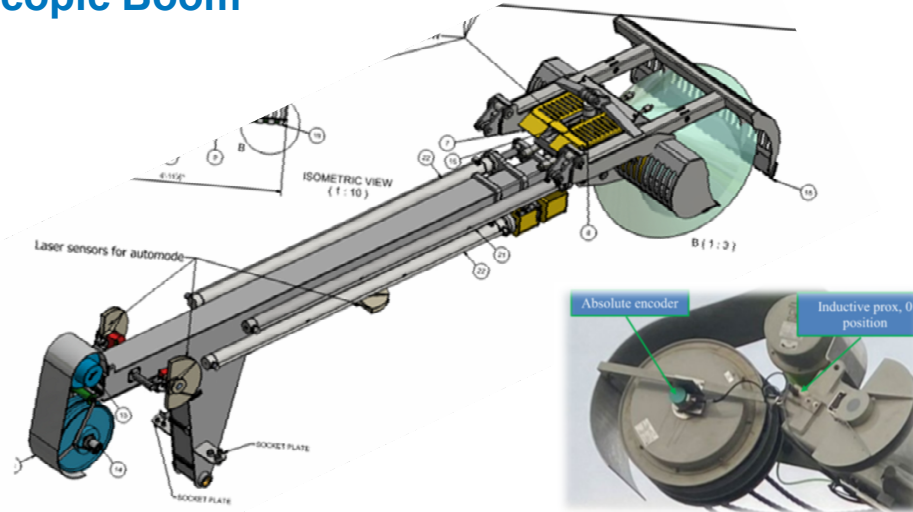


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- Main structure of the rake
- Fully and continuously welded construction
- Includes main slewing gear and hydraulic motor with pinion gear for full machine rotation limited by hydraulic hoses
- King serves as hydraulic tank and pin connection to telescopic boom
- Most of hydraulic system is mounted to the king as well as the main control panel for the unit.
- Hydraulic pump is mounted to the King
- Has rotary position indication using slewing gear
- Inductive prox. sensors to check rotary sensor and for parked or "0" position

Telescopic Boom

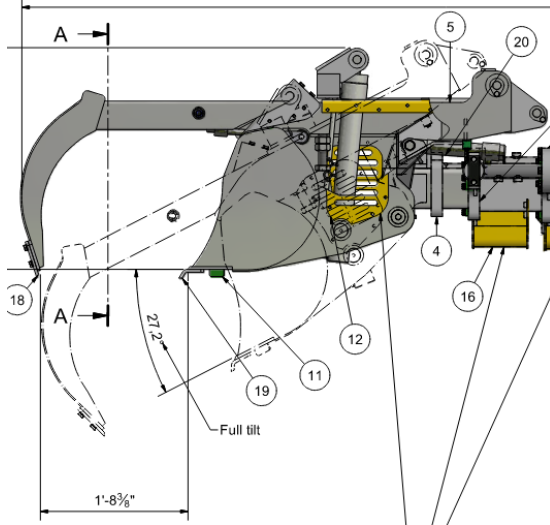


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- Made up of three individual sections
- Largest section is welded, the other two are square tubing
- Hydraulic hose drum mounted to end
- Rotary encoder mounted on hydraulic hose drum
- Laser sensors for larger debris during auto mode
- Prox sensor to check rotary position
- 3 double acting cylinders

Gripper Claw



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- Main claw with scraper teeth to fit in slots of rack
- Single cylinder to open/close the claw
- Two double acting cylinders for telescopic upper claw portion
- Has tilt function for main claw to grab debris that may be of awkward geometry
- High quality camera and flood light mounted in claw

We thought the camera may have use for trash rack inspection or being able to see what articles we may be picking up on the bottom.. Can do a general inspection of rack with camera, but not detailed. If we were to buy another rake, we will have a camera on it.

Hydraulics

- Proportional control
- Pressure sensor for lifting
- Pressure sensing for gripper
- Volume sensing
- Oil Heater & Cooler
- Overcenter valves on all functions
- Small Accumulator for gripper



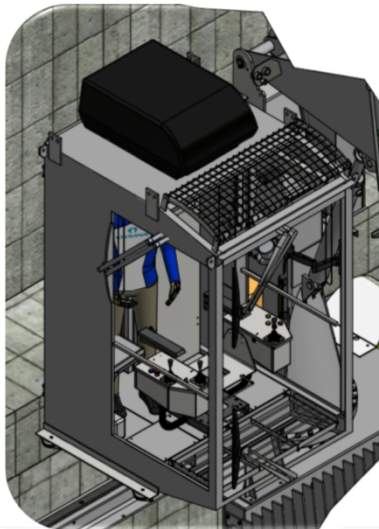
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- All functions controlled with proportional valves with pressure sensing
- Low-noise, LS regulated variable piston hydraulic pump powered by electric motor to control flow and pressure to individual or multiple functions
- Pressure sensor for lifting load mounted directly on lift cylinder
- Pressure sensor for gripper claw
- Volume sensing for individual operations calculated for leak detection on hydraulic system
- System incorporates both an oil heater and cooler for large swing of temperatures in the northwest (the cooler was not standard in Norway)
- Synthetic, biodegradable, environmentally acceptable oil used
- Added valve for reservoir drain
- Both Slewing and Trolley hydraulic drive includes brake and positioning
- Telescoping, boom, trolley, slew, and tilt functions include an overcenter valve acting similar to counterbalance valve for safe operations
- There is a small accumulator included

Not common for oil cooler in Norway. They suggested a Texaco product that met Scandinavian standards, though we requested a Shell Panolin product the USACE has been using.

Operators Cabin

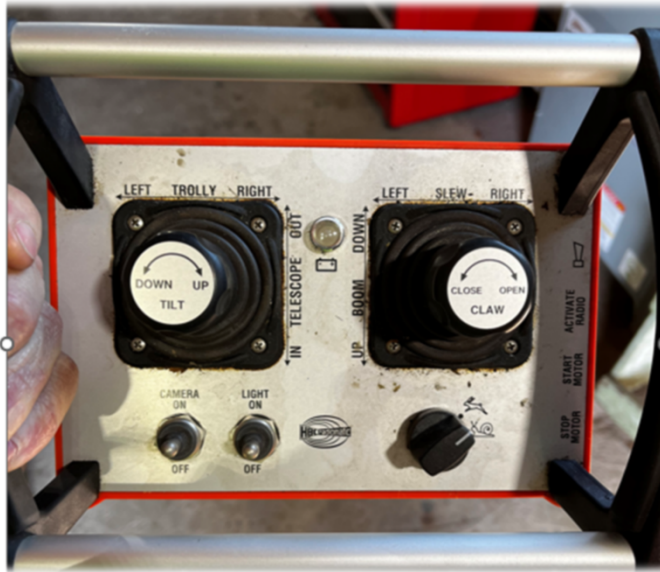


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- Joystick operation option in cab
- HMI screen in cabin
- Tablet for viewing camera from cabin
- Climate controlled with radio
- Air ride seat
- Glass in floor on front portion so operator can see down the rack when operating

Radio Controlled

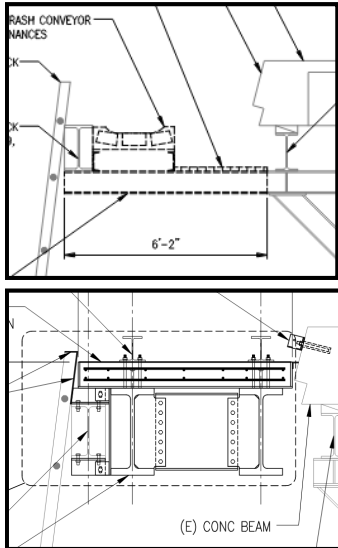


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HBC radio “belly box” style with joysticks for manual operation of all 6 proportional functions

Design of Rake Foundation



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- Had an engineering firm design the support structure and electrical in the existing intake structure for the new trash rake.
- Most difficult part of the design was mounting the Enerquip rails with a concrete deck that could support weight on front rail and uplift on back rail.
- Designing for the allowable deflection of 5 mm on span of rails between wheelbase

It would have been better if we had had mass concrete to bolt our rails down to, but we did not. This made it so we had to have W24 beams span the entire intake and then weld studs to them to accept the Enerquip Rails.

Factory Acceptance Test Trip

- Manufacturing facility located in Eiken, Norway.
- Equipment setup on test rail and ran through functional tests
- Toured 4 other hydro facilities during visit.



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AVISTA

Followed FAT document and through all tests. Reviewed all of their quality documentation and sign-offs during manufacturing. Only one of the units we visited in Norway had a cab, it was the Large Unit. Other units were run in automatic. They also had a conductor bar system instead of the cable reel, which I liked more. Enerquip did not suggest this for us since our intake was so narrow and the travel was short. Tested each hydraulic function to calculate oil volume for each operation for leak detection in PLC. Amotsfoss- facility built in 2021, only run it in automatic unless large debris, remote operated facility

Installation

- Set trolley and king in place
- Set cabin on trolley
- Pin boom onto king and lift cylinder
- Attach hydraulic hoses and electrical power feed



Cleaning Modes

- Manual
- Automatic
- Surface cleaning mode
- Deep Cleaning mode
- Ice Scraping mode
- Surface and Deep Cleaning Mode

The screenshot displays the AVISTA control interface with the following sections:

- Cleaning Mode Selection:** Includes buttons for 'Waterlevel Mode', 'Waterlevel + Deep Clean Mode', 'Deep Clean Mode', and 'Ice Scrape Mode', each with an 'Enable' button.
- Clean All Or Grid No.:** Includes buttons for 'G1', 'G2', and 'G3', each with an 'Enable' button.
- Start On Timer:** Includes buttons for 'Enable', 'Disable', and 'Setup'.
- Sequences per Activation:** Includes buttons for '1', '2', and '3'.
- Enable Remote Start Signal:** Includes an 'Enable' button.
- Select Dump Location:** Includes buttons for 'Position1' and 'Position2'.
- Analog Inputs & Position Feedback:** Includes fields for 'LS Pressure' (000 PSI), 'Oil Level' (000%), 'Claw Open', 'Claw Close', 'Travel pos' (0000 Inch), 'Telescope pos' (0000 Inch), 'Boom pos' (000.0°), and 'Slew pos' (0000.0°).
- Bottom Navigation Bar:** Includes icons for Home, Alarms, Power/Interface, Accessories, Laser Sensor, Operation View, Service, Log On, and a help icon.

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Semi automatic mode - When autosequence is running is possible to activate «Semi Auto», then the speed of all functions is limited by the “Trolley” joystick. So the operator can adjust the speed of the autosequence. Mostly used for fault finding.

Automatic modes

- Waterlevel : Only waterlevel clean
- Waterlevel + Deep clean : First water level clean then deep clean
- Deep clean: If waterlevel is checked for large object the deep clean can be selected, only available for one sequence
- Ice Scrape: Run claw up/down the grid without dumping, to remove icing on the grid.

Commissioning

- Configured Laser sensors
- Set slewing positions
- Programmed dumpster locations
- Split Rack into 3 zones
- Set depth
- Tested ice, shallow and deep clean modes
- Performed load test



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- Configured Laser sensors to our site
- Set slewing position constraints to protect machine and onsite structures
- Tested all e-stops
- Programmed machine to parking position and emptying position for both dumpster locations
- Set machine to 3 cleaning zones on rack, 3 swipes in each zone
- Set max telescope position
- Tested ice, shallow and deep clean modes
- Ran machine in auto multiple times, started in multiple zones, timed full duration without interruptions (44 minutes)
- Performed load test with concrete block and large debris
- Experienced internal leakage on slew brake, repaired onsite and spare brake shipped to Avista
- Small leakage on telescoping cylinder seal inside packing box, new seal kit sent and repaired at a later date in a timely manner.

Operation Since Installation

- PLC issue, locked out
- Temp. sensor alarm
- Small oil leak on fitting, tightened fitting



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- PLC issue with being locked out one time, turned off the machine and back on and have not had an issue since
- Had a temperature sensor alarm that was confirmed false, Enerquip remoted into machine to bypass alarm for operation. Found a loose terminal connection for sensor.
- Small oil leak on fitting, tightened fitting

Operational staff has enjoyed the ease of use of this machine and likes the cab with joystick controls

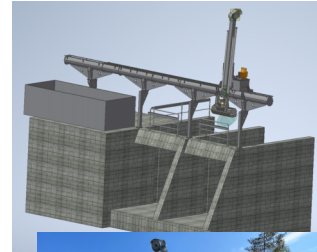
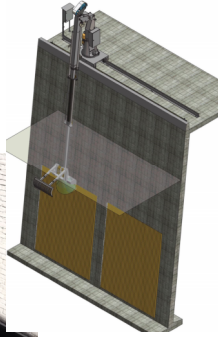
Machine has performed flawlessly during our high debris leaf seasons

There has not been any log or large debris the machine has not been able to remove from the intake

Leaf season posed task that filled both dumpsters and then had leaves sitting on the ground. The machine was able to pick the leaves out of the pile to place in dumpster after both were empty and cleanup was a breeze. Large debris such as logs can be held over dumpster and cut to smaller length to fit and then repositioned. The task before for this was to set on the ground and perform task. This new way is much better ergonomically and safety wise.

Other Enerquip Installations

- <https://www.enerquip.no/>
- Partnered with Embertech out of Canada for North American Service



Questions or comments?



23 Optional footer for data sources, etc.

