


Inspection Activities					
Test No.	Task Description	Condition/Steps	Results	Notes	Unexpected Result Comments/Changes made to equipment during inspection
Section 1 - Routine Inspections					
The purpose of Section 1 is to determine the condition of the machine for the safety of the test team as well as to create a baseline understanding of the pre-inspection condition.					
Any unexpected conditions or deficiencies will be documented and reviewed before further inspections are conducted.					
Other Questions:					
Why is the joystick function the way it is? - The joystick functions ergonomically for the "normal" operation. That is, travel forward then tamp a tie (cycle). This is forward, then backward, on the joystick, maybe thousands of times per day.					
Is it consistent with other manufacturers? - Still undetermined.					
1.1 - Daily Items (Operations Manual 7-6)					
1.1.1	Check Air Pressure with Engine Running	Should maintain 120 PSI	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		
1.1.2	Check Hydraulic Oil Level.	3/4 full	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		
1.1.3	Inspect Hoses and Fittings for Leaks.	No Leaks, hoses with outer cover worn through or damaged are defective	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		
1.1.3.1	Note the location of hoses installed post-accident	*Limited to workhead areas. *Is evidence consistent with the condition being non-causative, and not detrimental to further inspection?	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	<ul style="list-style-type: none"> o Right front workhead hyd hose had ruptured due to workhead being lowered while the machine was in motion. It was a #12 hose approximately 5' long. o Left lower step had been removed to extract the injured employee. Step was returned to service. o Middle lower window broken during incident. No window replacement on hand.
1.1.3.2	Note the location of hoses removed pre-accident	*Limited to rear hydraulic motor area *Is evidence consistent with the condition being non-causative, and not detrimental to further inspection?	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	<ul style="list-style-type: none"> o Rear travel motor had a leaking output shaft seal on 1/30 that required replacement WOH# 40624494. o Mechanic also opened a WOH# 40624514 to check hyd pressures and fix hyd leak with reference to the motor. o Mechanic replaced rear motor with in stock motor. o Replacement hyd motor started leaking ¼ mile after replacement. Mechanic didn't have another replacement so the motor chain was removed and the lever for the rear motor was disengaged and removed from service.
1.1.4	Check Hydraulic Oil Return Filter Indicator when running	Oil to top of sight gauge, clear, not dark, and not milky colored	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		
1.1.5	Check Hydraulic Oil Pressure Filter Indicator when running		<input type="checkbox"/> - Expected <input checked="" type="checkbox"/> -Unexpected		<p>The No. 1 filter indicator had two dark lights. Normally either "clean" or "bypass" should be lit.</p> <p>The no. 2 filter indicator had the "bypass" light lit, indicating a blocked filter or faulty sensor/light.</p> <p>The No. 2 pressure differential sensor was replaced, with no effect.</p> <p>The high pressure filters themselves were removed and inspected. There was no blockage, and very little filtered material. This is consistent with a fairly recent maintenance overhaul with oil changed, prior to the accident.</p> <p>The working group determines there is either (1) a problem in the light bank itself or (2) because the filters used by UP are twice as restrictive as Nordco's original filters (UP = 5 micron, Nordco = 10 micron). This could possibly cause a sensor error.</p> <p>The mechanical working group determines a hydraulic oil analysis by a lab is necessary to determine oil quality and contamination levels.</p>
1.1.6	Inspect Electrical Connections/Harnesses for Tightness	harness to controllers, operator control boxes, footswitches, and main control cabinet must have proper connection otherwise problems in starting or stopping may occur.	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		Electrical cabinets and harnesses are in excellent condition with no dirt, debris, corrosion, or other unexpected wear noted.
1.1.7	Drain Air Tanks, checking for excessive water or oil.		<input type="checkbox"/> - Expected <input checked="" type="checkbox"/> -Unexpected	*From Monthly List "If Water in Air tanks, Check Air Dryer desiccant. "	At some point, the air tank drain pull tab was replaced with a more robust valve piped to the side of the machine. This device is capable of blowing water from the bottom of the air tank. It is non-standard, but effective.
1.1.8	Inspect wheels, wheel nuts, brake shoes, and check gap between brake shoes and wheels.		<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	As noted in the prior inspections, the brakes were out of adjustment. The standard is for the brakes to release no more than 1/8th inch from the wheel when released. The average of the top and bottom gaps are measured. The group noted that all wheels had at least some portion of the brake/wheel gap larger than 1/8th inch. However, because prior brake testing had already been completed and the vehicle was known to stop safely in an 'as-is' condition, the protocol was continued without further inspection or work to the brake system.

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1.1.9	Check all brake chamber for caging bolts.		x - Expected <input type="checkbox"/> -Unexpected		
1.1.10	Check machine for cracks or other structural damage.		x - Expected <input type="checkbox"/> -Unexpected	*An unexpected result may limit further testing *See also, Section 3 regarding work head damage inspection	
1.1.11	Check that all lights (brake, marker, work, travel, strobes) are functioning.		x - Expected <input type="checkbox"/> -Unexpected	*Unexpected results may require repair before continuing for employee safety.	
1.1.12	Clean (Inspect for) debris/trash from machine.		x - Expected <input type="checkbox"/> -Unexpected	*Unexpected results may require repair before continuing for employee safety.	
1.1.13	Check oil level in vibrators	Should be 1/2 to 3/4 in sight glass	x - Expected <input type="checkbox"/> -Unexpected		
1.2 - Weekly Items (Operations Manual 7-11)					
1.2.1	Adjust and oil (Inspect) Propulsion Chains, Adjusting screw and yoke threads (Front & Rear)		x - Expected <input type="checkbox"/> -Unexpected		As noted in the prior inspection, the front travel chain was out of adjustment and riding on the vehicle frame. The rear chain was removed prior to the accident. Neither condition prevents further testing.
1.2.2	Check Oil Level in Pump Drive		x - Expected <input type="checkbox"/> -Unexpected		
1.2.3	Visually Inspect Hydraulic Tank Air Breather for COLOR change		x - Expected <input type="checkbox"/> -Unexpected		
1.2.4	Check tamping tool tightness and wear		x - Expected <input type="checkbox"/> -Unexpected		
1.2.5	Check brake shoes for wear	Condemning limit is a pad < 3/8" thick	x - Expected <input type="checkbox"/> -Unexpected		
1.2.6	Grease Inspect Brake Lever Pivot		x - Expected <input type="checkbox"/> -Unexpected		
1.2.7	Remove & Inspect BOTH Suction Strainer Elements		<input type="checkbox"/> - Expected <input checked="" type="checkbox"/> - Unexpected	*Skip. Tests in 1.5 instead. See Ops Manual page 86.	Not conducted.
1.3 - Monthly Items (Operations Manual 7-15)					
1.3.1	Ensure engine mounts, fuel tank mounts and hydraulic tank mounts are secure		x - Expected <input type="checkbox"/> -Unexpected		
1.3.2	Check Fan, Alternator, and Generator Belts		x - Expected <input type="checkbox"/> -Unexpected		
1.3.3	Check hydraulic hoses on machine for wear and leaks		x - Expected <input type="checkbox"/> -Unexpected		
1.3.4	Check hydraulic cylinders for leaks and/or damage		x - Expected <input type="checkbox"/> -Unexpected		
1.3.5	Check hydraulic valves for leaks and/or damage		x - Expected <input type="checkbox"/> -Unexpected		
1.3.6	Inspect Hydraulic Tank Top Off for Damage/Cleanliness		x - Expected <input type="checkbox"/> -Unexpected		
1.3.7	Check both implement pump pressures.	Oil Temp 100F Should be 2700 psi	x - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	Hydraulic system checks: o System Pumps ☑ P1 rear pump 2750 PSI ☑ P2 front pump 2669 PSI ☑ Pump system pressures are to be set @ 2700 PSI o Travel motor cross over reliefs ☑ Front 2910 PSI ☑ Reverse 2950 PSI ☑ Motor crossover reliefs are to be set @ 2900
1.4 - Quarterly Items					
1.4.1	Test hydraulic oil cleanliness, replace filters as necessary.	Inspect for contaminants, water, etc.	x - Expected <input type="checkbox"/> -Unexpected		As noted elsewhere, the high-pressure and return filters (4 total) were removed and inspected. The filters were very clean, with very little debris noted. One return filter had a failed O-ring which was captured in the retention spring and did not contaminate the hydraulic fluid. It was noted that the filters were all 5 micron filters.

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1.4.2	Inspect hydraulic tank breathers and filler screens	Including hydraulic tank air dryer cartridge Including both hydraulic tank return filters Including hydraulic tank top off filter if equipped (pg. 7-27) Items should be free of contamination and damage.	x - Expected <input type="checkbox"/> -Unexpected		The breather was inspected and found to be in like-new condition. This is consistent with a recent maintenance cycle being completed prior to the accident.
1.4.3	Check all wiring for wear and/or damage		x - Expected <input type="checkbox"/> -Unexpected	*Especially [Work/Travel], [Auto/Manual], Joystick and Foot switch wiring	All wiring (including the foot pedal) was in good operating condition with no wear or corrosion.
1.4.4	Check switches and contacts for tightness.		x - Expected <input type="checkbox"/> -Unexpected	*Same as above	
1.4.5	Check terminal strips for tightness		x - Expected <input type="checkbox"/> -Unexpected		
1.5 - 6/12 Mth Items					
1.5.1	Drain and inspect hydraulic tank		<input type="checkbox"/> - Expected <input checked="" type="checkbox"/> -Unexpected	*AFTER Dynamic testing, filter the oil that is removed.	These tests were determined to be unnecessary by the group. First, the hydraulic oil filters were inspected for contamination or evidence of debris. None was found. Second, the oil itself was sampled at three different tank locations and sent to a lab for analysis. (Results pending) and Finally, a hydraulic schematic review was conducted. During this review it was determined that a "runaway" due to hydraulic causes could only occur if debris was lodged in three separate valves simultaneously. The oil condition is not consistent with a failure like that. Finally, if the hydraulic system were to experience runaway propulsion, the brake system would also have to fail to induce movement. It was demonstrated in subsequent testing that the brake system is in working order and capable of holding the machine in place against tractive effort.
1.5.2	Inspect both suction strainer elements	Including Magnetic separator	<input type="checkbox"/> - Expected <input checked="" type="checkbox"/> -Unexpected		
Section 2 - Normal Operation					
The purpose of this section is to determine if the machine operates normally under the conditions known, or assumed, to have existed at the time of the accident. Any unexpected conditions or deficiencies will be documented and reviewed before further inspections are conducted.					
2.1 Start up/ Warm up	To be completed as described in Ops. Manual Section 6 (pages 6-1 to 6-3)		x - Expected <input type="checkbox"/> -Unexpected		The battery condition required a portable jump-start device
2.2 Stop Tests	Done on 0.73% uphill grade, with rear motor cut out		x - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	
2.2.3	Work Mode - Top Speed, emergency	Top Speed: 9mph Emergency Stop Button: Stopped at 23'	x - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	
2.2.4	Work Mode - Top Speed, Release Joystick to Stop	Top Speed: 9mph Release joystick: Stopped at 21'	x - Expected <input type="checkbox"/> -Unexpected	Results from UP Testing Feb. 2-3, 2021	

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2.2.5 - Travel Top Speeds	Low Travel - 14mph	Over what distance?	x - Expected ☐-Unexpected	Results from UP Testing Feb. 2-3, 2021	Machine travel speeds w/ stop ☒ Low travel 14mph - 55' The machine reached top speed in 1/8th mile, traveled additional 1/8th mile before brake application
2.2.6 - Travel Top Speeds	High Travel - 17mph	Over what distance?	x - Expected ☐-Unexpected	Results from UP Testing Feb. 2-3, 2021	Machine travel speeds w/ stop ☒ High travel 17mph - 47'-59' The machine reached top speed in 1/8th mile, traveled additional 1/8th mile before brake application
2.2.7 - Feb. 2 "Reenactment"			x - Expected ☐-Unexpected	Results from UP Testing Feb. 2-3, 2021	Time/Distance traveled ☒ Tie 1 – Tie 5 - 3:53 seconds ☒ Tie 5 – Impact (start at tie 1) - 9:33 seconds ☒ Tie 1 – Tie 5 applying E-stop - 11'
2.3 - Mar. 24 "Reenactment"	a. Machine is stopped at a tie to be worked b. Operator tamps the tie while in [Work] and [Manual] mode using the joystick c. Operator uses the joystick to "skip" 5 ties (about 10-feet) d. Operator attempts to stop by releasing the joystick and "sliding" into the sixth tie. e. Reverse and repeat 5 times	a. What maximum speed does the machine reach? b. What is the distance traveled between 'Joystick release' and 0-mph(stopped). c. Do all brakes function as expected? d. Is the stopping distance consistent?	x - Expected ☐-Unexpected		a. The speed was not recorded b. Approximatley 2.5 ties (~5') c. Yes d. Yes
2.4 – Emergency Stop Button	a. Machine is stopped as if tamping a tie had been completed b. Travel forward until the maximum speed from 2.2 is reached c. Press the Emergency Stop mushroom switch. d. record the stop distance			Discussion to accept UP stop testing (2.2.7) in place of this test	
Section 3 - Investigative Scenarios					
The purpose of this section is to explore the Working Group's theories and scenarios. What conditions may have contributed to an unintended acceleration, or failure to decelerate? Any unexpected conditions or deficiencies will be documented and reviewed before further inspections are conducted.					
3.1 - Horn Test	a. While stopped operator should demonstrate the operation of the horn b. Record observations about mechanical/tactile operation from the operator (Is the cord obstructed, hard to reach, etc.?) c. Record qualitative observations about horn sound (no decible requirement exists)		x - Expected ☐-Unexpected		The horn operates normally and at an expected volume. The cable is not difficult to reach from the operator's normal position.
3.2 – Emergency Stop Button	a. Machine is stopped as if tamping a tie had been completed b. Travel forward until the maximum speed from Test No. 2.2 is reached c. Press the Emergency Stop mushroom switch. d. record the stop distance and time to full stop			Discussion to accept UP stop testing (2.2.7) in place of this test	

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2.2 - Baseline- Stop Tests with recorded speed	(*) Review previously conducted UP tests, otherwise, construct test plan for stop distance testing at 2, 5, 10 mph				
				Discussion to accept UP stop testing (2.2.7) in place of this test	
3.4 - Dynamic Test	a. Situate cab in normal operating condition, including [Work] Mode and [Manual] Mode. b. Travel forward at ~3mph with joystick c. Depress foot switch and hold it down (to simulate debris or an electrical fault) c1. Release Joystick. Observe vehicle behavior and then stop safely	Operators have stated that the [work/travel] switch may be inadvertently toggled when reaching over-shoulder for another switch or item. They describe the change in operation very noticable, especially engine speed noise and a <u>slowing</u> of the machine. This test is intended to give investigators insight with <u>this</u> machine.	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		With the machine set to [Work] and [Manual], the foot pedal is disabled by design as explained elsewhere.
3.4.2 - Dynamic Test 2	a. Situate cab in normal operating condition, including [Work] Mode and [Manual] Mode. b. Travel forward at ~3mph with joystick c. Toggle from [Work] to [Travel] d. Record speed changes, engine noise changes, and 'jerk'	It has been stated that the foot switch does not operate as intended on this machine. Can the anomaly be quantified and can a determination be made as to why the foot switch does not work?	<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		There are no noticable changes in 'jerk', or engine speed, when this is done. The vehicle continues to travel normally. The vibrators do stop. The hydraulic pressure holding the work heads up is reduced. The work heads were observed to not drop a noticable ammount in 1-minute but after several minutes they do begin to reach tie height and need to be reset.
3.5 - Foot switch			<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		[UP 2/2/21] Foot pedal for workhead cycle was inoperative — bad switch in the pedal The foot pedal works as designed as described above
3.6 - Motor failure		Two drive motors on the rear axle failed in rapid succession. Can the investigative team determine any reason, other than low quality remanufactured motors, for these failures. Could these reasons be causative?			The group discussed the possibilities. It was agreed that the motors require frequent maintenance, are not as reliable as Nordco would like, and fail with some regularity due to no fault of the rest of the machine. No causative link to the accident could be established for further investigation.
Other observational tests	a. Travel 5' tie lengths and use the service brake. B. Travel 5' tie lengths and use the parking brake c. Travel 5' tie lengths and use the emergency brake		<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		a. The machine comes to a complete stop within 5' b. The machine comes to a complete stop within 5' c. The machine comes to a complete stop, and the engine shuts down, within 2.5'
Other observational tests	Starting in work mode, push foot pedal and hold it, then switch to travel mode.		<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		The machine doesn't do anything in work mode, but travels as soon as travel is selected
Other observational tests	Attempt to travel with (a) Service brake applied (b) Parking brake applied		<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		a. No movement b. No movement
Other observational tests	With machine in work mode and auto mode, press foot pedal		"As designed"		Machine completes one tamping cycle and travels forward so long as the pedal is held down.

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Other observational tests	With machine in work mode and auto mode, press foot pedal and joystick simultaneously, release joystick but not foot pedal		"As designed"		Machine completes one tamping cycle and travels forward so long as foot pedal is held down.
Section 4 - Component Removal					
The purpose of this section is to remove, inspect, and retain and components needed for further study.					
Any unexpected conditions or deficiencies will be documented and reviewed before further inspections are conducted.					
*Ensure all static/dynamic tests are complete					
4.1	Remove and inspect hydraulic propel valve (front motor)	Signs of wear, damage, debris, etc.?			The mechanical working group determines that external observations and oil analysis are sufficient to eliminate these tests from the protocol.
4.2	Remove and inspect joystick control	Signs of wear, damage, debris, etc.?			
4.3	Remove and inspect foot pedal	Signs of wear, damage, debris, etc.?			
4.4	Remove and inspect switches (Work/Travel), (Auto/Manual)	What diagnostics might be needed?			
4.5	Microprocessor controls to be reviewed by Nordco, team		<input checked="" type="checkbox"/> - Expected <input type="checkbox"/> -Unexpected		PLC controller was observed and noted to be in normal working order. The delay between joystick release and brake application was 0.2 seconds, as set from the factory. The service brake application valve was noted to be in working order.
Section 5 - Wrap Up					