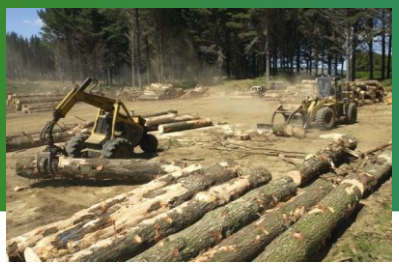

HARVESTING TECHNICAL NOTE

HTN13-02
2021

Machine Maintenance Non-Injury Events: Analysis of IRIS data

Summary

This report summarises a total of 191 non-injury incident reports related to harvesting machine maintenance supplied to the New Zealand forest industry Incident Recording Information System (IRIS) database from January 2016 to December 2020. The most common agency involved in the non-injury events was the door of the machine. Machine doors are heavy and have considerable inertia, so are difficult to stop once they start moving. Doors swung closed on operators or trapped their appendages. Doors were also damaged when left open when the machine was moved. Incidents related to hydraulic fittings and fluid were the next most frequently reported. High pressure hydraulic fluid is a potential hazard that requires special care during machine maintenance. As the industry increases its levels of mechanisation the function of machinery maintenance will remain a focus area for safety improvements.

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Introduction

This report focuses on non-injury events in machine maintenance tasks in the New Zealand forest harvesting sector. Non-injury events include contact, near hit and property damage incidents. A companion report examined injury causing events which occurred during forestry machine maintenance (Parker *et al.* 2020).

This study is part of the "Forestry Work in the Modern Age" Primary Growth Partnership (FGR, 2018), one of the drivers of which is to make harvesting and log logistics operations safer. Analyses of incident reports will provide a baseline of event types, situations and causes from which any improvements in safety due to interventions such as new technology (or other innovations) on the log landing developed in the FGR programme can be measured.

Figure 1:Maintenance of forestry machinery Source: R Prebble.

Methods

The New Zealand forest industry's Incident Recording Information System (IRIS) database includes records for both injury events (lost time, medical treatment and minor injury) and non-injury events.

There are three non-injury types recorded in the IRIS database:

Contact - No Injury - Contact with an object or energy source where first aid treatment was not sought. The contact may have resulted in minor bruising and/or abrasions or PPE has prevented more serious injury.

Near Hit - An event that given similar circumstances, could have resulted in injury or property damage. A near hit may be a warning that control measures may not be working as intended or management of a hazard is absent.

Property Damage - Unintentional damage to property or machinery as a result of operational activity. No threat to personal safety.

IRIS data were selected for the period January 2016 to December 2020. The criteria for selection of data for analysis on non-injury events (Table 1) were:

- ACTIVITY = Harvesting
- OPERATION = All operations
- TASK = Maintenance

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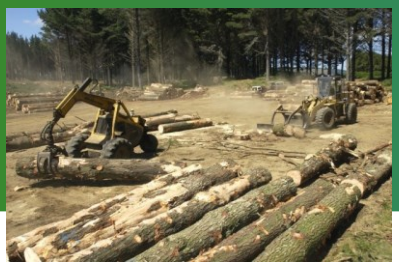

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Table 1: Variables used in the analysis of non-injury events

Variable	Examples[1]
Incident type	Near hit, Contact – no injury, Property damage
Agency	Door, Hydraulic, Fall from machine, Cutting chain, Spanner, Diesel, Live harvester head, Rope, Slew, Hammer, Welding

[1] Not an exhaustive list of examples used in the database

Results

There were 191 maintenance-related non-injury incident reports to the IRIS database in the period January 2016 to December 2020. Table 2 shows the types of maintenance work related non-injury events. Most reports were for near-hit events (40% of total). The number of near-hit reports has fluctuated from a peak of 28 events in 2017. While there have been fewer contact and property damage events, they follow a similar pattern of fluctuation year-by-year. The trends in non-injury event types are plotted in Figure 2.

As shown in Table 3 clearfell mechanical harvesting operations contributed the greatest number of non-injury events reported to the IRIS database of the last five years (56% of total events). This is to be expected for two reasons: firstly, mechanised operations have more machines on site and therefore have greater maintenance requirements than motor-manual operations, and secondly, there has been a significant increase in mechanisation of harvesting operations over the last decade (Visser 2019).

Table 2: Maintenance work related non-injury event types reported to the IRIS database

Event type	2016	2017	2018	2019	2020	Total
Contact - No Injury	13	24	3	15	6	**61**
Near Hit	18	28	6	13	11	**76**
Property Damage	10	12	7	13	12	**54**
Total	**41**	**64**	**16**	**41**	**29**	**191**

Table 3: Maintenance work non-injury events by operation

Operation	2016	2017	2018	2019	2020	Total
Clearfell Mechanical stems/Logs	17	36	9	24	21	107
Clearfell Motor Manual Stems/Logs	7	13	2	1		23
Hauler Stems/Logs	16	12	5	16	8	57
Road Line salvage	1	3				4
Total	41	64	16	41	29	191

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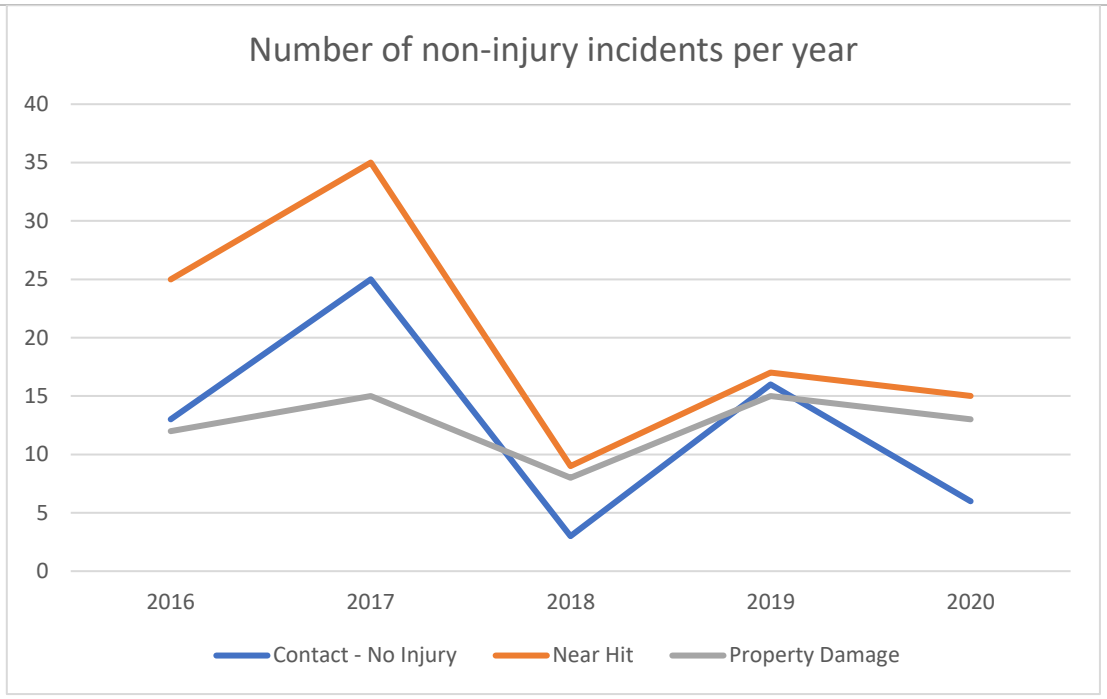

Figure 2: Trends in the type of maintenance-related non-injury incidents

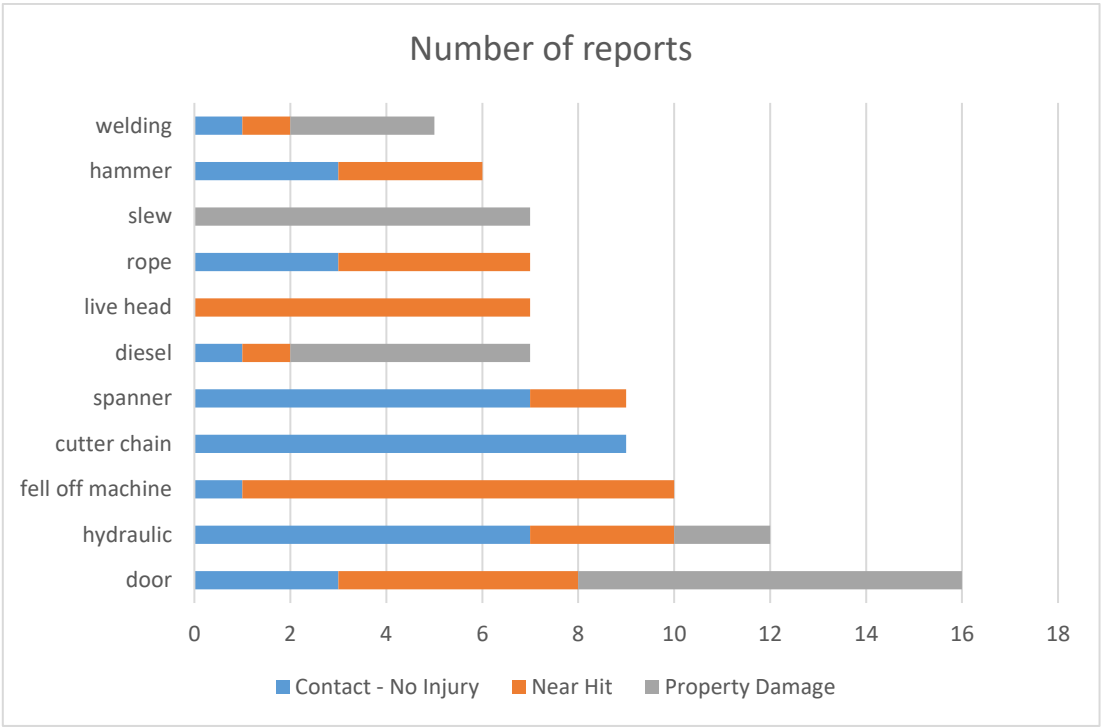

Figure 3: Non-injury reports by agency and event type

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Reports by agency

The most common agencies involved in the non-injury events is presented in Figure 3.

Doors

There was a total of 16 non-injury incidents involving doors on machines. Machine doors are heavy and often the machine is not parked on level ground so the door can be difficult to open or can swing shut unexpectedly with gravity or the wind. Eight incidents resulted in the door closing unexpectedly, in seven cases hitting workers, and in one case breaking the window in the door. On four occasions a machine was moved while a door was inadvertently left open – resulting in the door colliding with an object and being damaged. On one occasion a door came off its hinges narrowly missing a mechanic.

Verbatim reports of interest:

- "The door handle is very tight and hard to open on occasions. I pulled it harder and strained / pinched a nerve in my shoulder blade."
- "He was straightening out the toolbox door below the cab. As he put the door back on the hinges, he jammed his thumb between the door and handrail."
- "Door of diesel tank fell and hit worker's knee."
- "Hauler door jammed fingers: We were putting the hauler guard back on the hauler. I was holding the guard when the hauler door swung around and jammed my finger."
- "Carriage door slammed closed on arm while doing maintenance."
- "A feller was filling up fuel/oil from the tank container, when the wind caught the door and swung it round striking his helmet."
- "A machine operator and a mechanic were working on a machine. They needed to open the door to look at the diesel filter. The door came off its hinges and nearly hit the mechanic's arm."
- "Got grease gun out from the side door to grease the grapple. Put grease gun back but didn't shut the door properly. Door opened and hit log stack damaging door."
- "Processor parked off edge of road for repairs, truck backing in backed into door and broke off the hinge."
- "A service mechanic opened the hydraulically operated bonnet of the harvester but forgot to close the machine's side door. This resulted in the side door being ripped off its hinges."
- "Completed my morning pre-start checks and forgot to close the small side door to the engine bay. I began to lift the blade, which got hooked up on the small door and bent it badly."

Hydraulics

Twelve non-injury events were reported involving hydraulics. There were seven events reported where workers doing maintenance on hydraulic systems were sprayed with high pressure fluid. One fire was reported when a fitting failure caused oil to spray on the exhaust manifold. Three other events were: accidently pouring 20 litres of engine coolant into the hydraulic oil tank; almost forgetting to release tank pressure when changing hydraulic oil filters and slipping on spilt hydraulic fluid.

Verbatim reports of interest:

- "Checking hose fitting which had just been fixed when it let go and sprayed hydraulic fluid in the worker's face."
- "Hydraulic hose under pressure. Went to change the O-ring and hose blew off just missing my head."
- "A loader had a hydraulic oil leak inside a housing and the operator asked the QC to inspect the machine for its source. When the QC approached, the machine was operated to replicate the leak and oil spurted out and onto the QC's face."
- "Pressure from hydraulic cylinders was not released and oil hit operator in face."
- "When trying to find a leak in a hydraulic hose, I was squirted in the face with hydraulic fluid."
- "Hydraulic pipe loaded up with pressure when operator went to loosen the bolts the hydraulic oil burst out."
- "Taking ram off Waratah. After it was off, we thought we would get oil out of the ram before sending it in to get fixed. As he pushed the

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shaft in, oil sprayed out of the fitting with the odd spot of oil hitting him in the face. Eye protection was being worn."

- "Replaced water brakes on hauler, applied revs to check for leaks, hose blew off hydraulic fitting causing oil to spray on to exhaust manifold, causing a flame momentarily which extinguished itself. Extinguisher was not needed."

Fell off machine

The third most frequent non-injury event type was falling off a machine or falling while working on a machine (10 incidents in total). There were seven non-injury events where the worker slipped on the metal surface of the machine or catwalk. A further two events where the worker tripped and fell, and one event where a mechanic was hit by the grill and subsequently fell from the machine.

Verbatim reports of interest:

- "Getting grease gun out of the side box of 548 (skidder) when I slipped off the catwalk and fell to the ground."
- "Putting grease gun away and went to jump off track of digger to avoid mud puddle. Slipped on track as went to jump."
- "Was about to fill water up on the hauler and slipped over on the hauler by the radiator. Had spiked boots on but no injury."
- "Cleaning windows on skidder and there was grease where I was standing on the back of the skidder, and I slipped but caught balance again."
- "Operator slipped while getting out of harvester."
- "Working on a leaking fitting in the back of 909 (feller buncher). Had a bit of rain mixed with oil and slipped on the catwalk, was holding hand holds so didn't fall off."
- "Slipped on hauler while putting new rope on. PTO shaft was uncovered and could have caused injury if fallen on it."

Chainsaw Chain

There were nine incidents involving chainsaw chain of either a processor or a harvester. All of these incidents were "Contact – No Injury" type events. Four of the events reported were during the process of changing the chain on the cutter bar and another two events were during chain sharpening.

Figure 4: Chain maintenance. Source: R. Prebble

Verbatim reports of interest:

- "Sharpening chainsaw and a piece of metal flicked off and got into eye."
- "Extracting branch out of felling head when hand slipped off saw bar and hit edge of the saw box."
- "Hand slipped while pushing the release button on Waratah chain release system. Thumb hit chain cutting through end of fingernail."
- "Changed chain on Waratah, pulled chain tight over tip of bar, cut finger on small slither of steel on chain's drive link. Gloves were provided but not worn."
- "Harvester operator sharpening chain without gloves and cut thumb."
- "Carrying sharpened Waratah chain from ute to machine toolbox. When dropping the chain into the toolbox operator cut finger."
- "Picking up tools off work bench and cut finger on a Waratah chain left lying under rags on the bench."
- "Taking chain off harvesting bar, chain was still on the sprocket end, rest of loop dropped onto leg and made a very small cut."

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- "Didn't wear gloves when changing chain on processor. Cut palm of hand."

Spanner

In all nine spanner or nut related non-injury events the spanner slipped, and sudden movement has resulted in the worker hitting an adjacent object.

Verbatim reports of interest:

- "Spanner slipped off nut causing a graze/small cut to cheek."
- "Tool slipped while performing maintenance and operator hit elbow on grapple."
- "A worker was undoing a bolt on the main saw chain of the processor when the spanner slipped, and his hand hit the chain resulting in a cut to the finger."
- "Fitting a hydraulic hose, spanner freed up suddenly causing forearm to hit sharp steel point with force."
- "Changing wheel on forwarder - socket was not on nut properly, while holding socket extension I put pressure on socket to undo - it slipped pinching finger between rim and extension."
- "While undertaking maintenance on processing head, socket slipped off nut that was being tightened and operator slipped over striking a steel plate with his face."
- "Harvester operator was tightening bar nut and slipped hitting hand on side of harvest head."
- "A spanner slipped off a bolt and then bounced back and hit the worker in the forehead. The worker was operating in an awkward position and did not have a spanner extender to assist him."
- "Changing chain on felling head and hand slipped off spanner and hit chain cutting glove."

Diesel Fuel

Diesel related activities resulted in 7 non-injury reports. In two cases people were squirted with diesel. Other diesel-related events included spilling fuel on the ground when the hose came out of tank, forgetting to put diesel cap back on and crushing it when moving off, a small fire started when diesel leaked from fuel system, and a diesel tank trailer flipped over when it came loose while being moved.

Verbatim reports of interest:

- "While trying to prime diesel tank from being empty to pick up the diesel and get rid of air lock, the lid on pump came off and squirted diesel over person."
- "Turned the revs up and it blew the cap off sprayed diesel everywhere. Worker got soaked and motor caught fire. Put out with extinguisher."

Discussion and Conclusions

Non-injury reports provide an additional source of information on potential injury risks to workers involved in machine maintenance in the New Zealand forest industry. The non-injury events described are often overlooked by conventional 'injury' analysis because they seem trivial at the time. The events can be as simple as almost falling, forgetting to perform a task or skinning knuckles while using a spanner.

Of the four most common agencies involved in these non-injury incidents (doors, hydraulics, falls, and cutter chains) the following interventions are recommended:

1. Door restraints to prevent doors swinging open or closed unintentionally.
2. Eye protection when working with hydraulic fittings and hydraulic fluid.
3. Non-slip surfaces to reduce slip type incidents.
4. Better fitting gloves to encourage use when maintaining chainsaw chain.

Overlaid on the larger volume of injury reports from similar maintenance tasks (Parker *et al.* 2020) a comprehensive picture of the risks during machine maintenance emerges. Maintaining and repairing machinery is a very physical activity requiring access to awkward spaces with the risk of entrapment or falling from height. Maintenance workers are at risk from sharp edges (e.g., cutter chains, metal fittings) and high-pressure hydraulic fluid. Hand tools are used to remove or place mechanical parts and often there is little

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space around those parts. Workers hands are exposed to potential injury, particularly if they must remove protective gloves for improved dexterity.

These data provide a useful baseline of types of injury and non-injury, frequency and severity, situations and causes, to compare against in the future. Changes in non-injury statistics related to maintenance work due to increases in mechanisation of harvesting operations and changes in technologies (and other innovations) developed as part of the Primary Growth Partnership "Forestry Work in the Modern Age" will continue to be monitored.

Acknowledgements

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