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EMERGENCY ALARM SYSTEM FOR FALLERS

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INTRODUCTION

Felling is one of the most hazardous occupations in logging. Over half of the fatalities that occurred in New Zealand exotic forest harvesting from 1968 to 1987 were the result of tree felling accidents (Gaskin, 1988). Fallers often have to work alone and are frequently out of sight of other workers so serious accidents can go undetected for some time. This can mean the difference between life and death.

The Safety Code for Bush Undertakings Part 3 - Logging, states that "No faller shall work on his own beyond calling distance of another worker". Implementation of this clause however can become difficult and at times unworkable in broken terrain or where other noises could drown out a call for assistance.

Some companies require two workers to be involved in the felling during clearfelling operations, one to act as an observer while the other works. Those employing the extra man find this an expensive but necessary precaution. In operations where all of the trimming and crosscutting is done on the landing however, there is often need for only one faller in the bush.

Similar problems with faller isolation exist in other countries where clearfelling of large trees takes place, e.g. Australia, United States and Canada. At the request of member companies and with the assistance of Talkie Tooter (Canada) Limited, MacMillan Bloedel Limited, Fletcher Challenge Canada Limited and the Science Council of British Columbia, the Forest Engineering Research Institute of Canada (FERIC) initiated a project to develop a radio alarm system for fallers (Ewart, 1990).

Figure 1 - The Safety Link Alarm attached to the faller's belt

This Technical Release explains the development process and describes some range testing and noise level tests carried out in New Zealand.

DESIGN CRITERIA

After reviewing state-of-the-art communications technology and interviewing potential end users, the following requirements were identified:

- The alarm had to be lightweight, robust and waterproof.
- It should be worn on the faller's belt and not obstruct his normal movement.
- An operating range of 500m was essential, even under adverse conditions.
- The unit had to be sensitive to motion so that the alarm would activate automatically if the faller was disabled.
- Sensitivity needed to be such that false alarms were not transmitted during normal work activities.
- The faller had to be able to disarm the motion detector during breaks and yet still continue to monitor any incoming signals from the other worker.
- The facility to manually activate the alarm signal was necessary.
- The receiving unit had to emit an alarm loud enough to alert a fellow worker using a chainsaw and wearing hearing protection.
- The alarm from the sending unit also had to be audible to rescuers looking for the injured worker.
- The battery charge had to last more than just one shift.
- The system had to be self monitoring so that accidentally going out of range or a low battery charge could be detected.
- It had to be functional in all weather conditions and reasonably priced.

A beeping alarm tone was preferred over voice communication because of its compatibility with both manual and automatic initiation.

EQUIPMENT DEVELOPMENT

To address the above requirements and ensure all of the criteria was met, the development of the safety link followed seven distinct component phases.

Transmitter and Receiver

The carrier frequency had to be exclusive to the system to eliminate interference from other radio signals. Ultra High Frequency (UHF) could satisfy this need and enable the use of short compact antenna but it required costly components and special licensing. The Industrial, Scientific and Medical (ISM) frequency of 40.68MHZ (VHF) was selected because it did not require licensing.

Antenna

The location and design of the antenna on the unit was important for range and efficiency. Early trials with concealed antenna resulted in limited range capabilities and the exposed antenna was too easily broken. The final configuration of a partially protected antenna is a compromise between the requirements for both range and durability.

Motion Sensor

The motion sensor is a tiny mercury switch which is designed to monitor movement and trigger the alarm after a predetermined period of inactivity. The sensor will initiate a signal if the safety link device remains motionless for longer than one minute when in the work mode.

Alarms

Both the sending and receiving units emit a warning signal of 90 dBA. The intermittent signal from the receiving unit is supposed to be loud enough to alert a fellow worker wearing hearing protection and operating a chainsaw. The alarm from the sender unit has a continuous signal and it is designed to guide rescuers to the injured worker. Other variations of the alarm signal are

used to warn of low battery power or being out of range of the other transceiver.

Encoder and Decoder

The unit's data encoder and decoder is a logic programme on a memory chip which controls the response to any signal from; the receiver, the motion sensor, or from manual activation. The programme also identifies the units operating status prompting the appropriate signals to emergency alarms, low battery power or being out of range.

Power Supply

The rechargeable battery is the heaviest component in the unit. Several types of power supply were tried in an effort to minimise weight and maximise power. The production units have nickel-cadmium 0.45 ampere-hour batteries.

Housing

The housing was designed to meet the containment, protection and functional requirements of the other components within realistic price limits. Special shielding of some componentry was necessary to eliminate induced interference.

OPERATION

The Safety Link system functions like a "buddy system" where two transceivers constantly monitor the operational status of each other. If one of the two units remains motionless for more than a minute, it emits an intermittent series of chirps for five seconds before initiating a full alarm transmission to the other unit. The system is fail safe because it relies on the units monitoring each other and when no signal is received from the buddy unit, an emergency signal is given. It is primarily designed for a pair of fallers who may be working independently of each other but in the same block.

The designed maximum range of the Safety Link device is 500m, even in adverse conditions. If the fallers are out of range for more than two minutes or if the unit fails to function properly, it emits a slow beep and the warning light will flash slowly. This will continue until the fallers move back within range.

A fully charged battery will last 9 to 12 hours in environments ranging from -30°C to +60°C. When one hour's life remains in the battery, the unit will emit a chirping sound every five seconds. A special battery charger is supplied with each system and a full charge requires 14 hours.

The control panel of the Safety Link unit is illustrated in Figure 2. When starting the day, each faller turns his unit on by rotating the switch to the work position. The system can be tested by one of the pair pressing the manual alarm button. Turning both units off and on again will clear the alarm. A signal light flashes every two seconds on each of the companion Safety Link unit as long as they are within range and functioning normally.

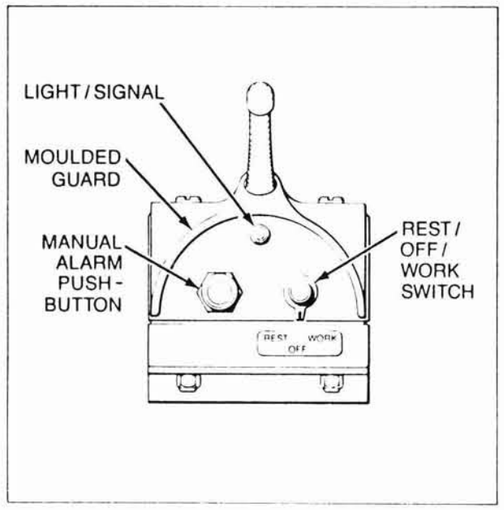

Figure 2 - Location of controls on Safety Link emergency alarm system

If an alarm is initiated either by pressing the alarm button or by having the unit remain motionless for more than a minute while in the work mode, the sending unit emits a series of interrupted chirps which continue until the switch is turned into the off position. This function allows cancellation of an accidental activation of the system. There is a five second delay between the sending unit signalling an alarm and the receiving unit reacting to it. The receiving units alarm is a continuous rapid cadence which can only be stopped by turning the device off.

To verify an incoming alarm, the faller receiving the transmission should turn his work switch off and then on. If the sound resumes the alarm is valid and he should turn his unit off and move towards the sound of the sending unit.

A faller can take a break from work without activating the alarm by turning the switch to the "rest" position. The Safety Link will still monitor incoming signals from fellow workers and the manual alarm button can still be used if a wild pig comes racing towards him. A warning beep will sound every five minutes reminding the faller that his unit is in the rest mode.

FUNCTIONAL TESTING

A pair of Safety Links were imported to New Zealand for appraisal and a series of range tests and noise level tests were conducted.

The range tests involved turning the pair of Safety Links on and walking apart, stopping at 300, 400, 500 and 600m intervals to test the alarm signal. The Safety Link alarm could be triggered with the two units 600m apart. If the receiving unit was located directly behind a tree at that range (right up against the trunk) then the alarm may not be triggered. The presence of trees between the two devices did not otherwise appear to affect performance. Range tests were not conducted on broken terrain.

In New Zealand where there may be only one faller working, the best place to monitor a faller alarm would be inside the cab of a loader. To test this concept, one of the pair was placed inside a vehicle 1000m away from the sending unit. The vehicle was driven towards the activated sending unit until the alarm was received. The distance from that point to the sending unit was measured at 300m. Obviously the presence of large or metallic objects directly in front of the Safety Link device does affect performance.

To be successful, the Safety Link alarm must be audible over the sound of other equipment being used in the logging operation. The BOP Area Health Board undertook a sound level survey of the alarm using a Bruel and Kjaer 2234 sound level meter. The noise level of a 268 Husqvarna chainsaw was also tested at the same time, the results are shown in Table 1.

Table 1 : Noise Level Readings from Safety Link and Chainsaw

Location		*Leq**
Safety Link	*- Directly at source*	*105*
	- At workers ear	*91*
268 chainsaw	*- At idle***	*89*
	*- Maximum load***	*101*
	*- Normal working***	*98*

* *Leq takes into account all bursts of noise and converts them to an equivalent level for a continuous eight hour period.*

** *These measurements were taken at the source.*

A recent survey undertaken by the Area Health Board showed the average Leq rating for chainsaws was higher than that recorded in Table 1. The results of that survey are shown in Table 2.

Table 2 : Average Leq Rating for Chainsaws

Speed of chainsaw	*Leq*
At idle	*97*
Racing	*113*
Under load	*111*

It appears from the results of the survey that the Safety Link alarm could be drowned out by the noise of a chainsaw under normal working conditions.

USER TRIALS

Workers from two contract crews in Tasman Forestry Limited, Murupara, co-operated in user trials to test the Safety Link under working conditions. The results of these trials were as follows:

Crew A - Clark 668 Grapple Skidder Operation

One Safety Link unit was worn on a faller's belt and the other was located inside the cab of the rubber-tyred front end loader. In this set up however, the units kept giving off the malfunction alarm. The receiver unit in the loader was transferred to the skidder but the result was still the same.

A second trial was conducted with a trainer holding the receiver unit and observing from a distance. The alarm apparently triggered frequently and it appeared to happen when the faller was inserting the backcut. That pair of transceivers has been returned to the manufacturer for inspection.

Crew B - Cat 528 Grapple Skidder Operation

Further tests were done with one of a pair of Safety Links inside a vehicle and repeatedly the malfunction signal was activated. It was concluded that having the receiving unit located in a machine or vehicle was not a viable option.

Range tests were also done during these trials using a vehicle but holding the transceiver outside. At a range of 2000m (unsighted) and with both sets on work, the unit with the vehicle was kept motionless and after one minute the alarm went off. One minute later the fallers alarm was triggered.

Operational trials were done with a skiddy wearing one unit and the faller the other. At no time did the out of range signal go off, even with distances as great as 800m. The alarm when activated was easily heard over the noise of three chainsaws and a loader. The workers found the alarm was very distinctive and could be readily identified amidst the other noises.

The faller was impressed with the unit, commenting that the size and weight did not cause any problems. He felt more secure in the knowledge that the alarm would be quickly raised if he were to be badly injured. The workers also found the Safety Link handy as a signalling device to alert the faller for smokos, etc.

Once familiar with the operation of the Safety Link alarm system the crews were quite happy to use it and were positive about the results of the trials. Tasman Forestry Limited is considering buying a set for the Murupara district and ultimately hopes to encourage all of its contractors to purchase their own sets.

DISCUSSION

The Safety Link alarm system is a valuable safety device that could prove to be a life saver where fallers traditionally work alone. The main advantages of the system are:

- Response to an accident will be quicker.
- The alarm will activate automatically if the victim is unconscious or incapacitated.
- The units are specifically designed for logging conditions being robust in construction and yet not too bulky.
- They are simple to operate and have built in facilities to inform the user/wearer of their operational status i.e. low power, out of range, etc.

For a capital outlay of little over NZ$4,000 (1990 price) the Safety Link alarm can provide a safer environment for fallers to work in. In single faller, clearfelling operations where traditionally an observer may be required, the savings to the contractor could be substantial. For further information on the Safety Link system, contact Taupo Rigging Services, Telephone (074) 84-754 Taupo.

LIRA NOTE

Since the trials described in this Technical Release, work has started on a base station concept capable of monitoring a number of remote units. New sets now have a motion sensor delay of 90 seconds because too many accidental alarms have been triggered with the 60 second delay. Replacement chips are available for existing systems with 60 second delays.

REFERENCES

Gaskin, J. (1988) : "Analysis of Fatal Logging Accidents - 1968 to 1987". LIRA Brief Report Vol. 13 No. 20.

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