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Whakararanga Iwi

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Minimum Fitness Recommendations for Rural Fire Personnel

SCION
July 2014

The physically demanding nature of forest and rural firefighting requires firefighters to be physically fit to minimise fatigue and work competently. In some parts of the world firefighting agencies employ physical competency tests to determine if firefighters are fit for duty. A requirement of the National Rural Fire Authority (NRFA) is that Rural Fire Authorities ensure personnel can carry out the tasks required of them in a safe manner, including being adequately equipped and trained physically for the most demanding tasks.

The research was conducted using interviews of Rural Fire Officers (RFOs) and volunteer firefighters; and looking at the physiological requirements of firefighting in case studies.

The aim of this research was to identify what is the current level of acceptance to, and application of, health and fitness programmes and standards as developed by the NRFA within New Zealand Volunteer Rural Fire Forces; and then to provide the NRFA with recommendations on the minimum standards for health and fitness that can be applied to volunteer rural firefighters, based on the actual tasks performed.

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Minimum Fitness Recommendations for Rural Fire Personnel

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EXECUTIVE SUMMARY

The physically demanding nature of forest and rural firefighting (Budd 2001; Gaskill 2002; Heil 2002; Ruby, Shriver et al. 2002; Parker 2010), requires firefighters to be physically fit to minimise fatigue and work competently (Phillips, Petersen et al. 2011). In some parts of the world firefighting agencies employ physical competency tests to determine if firefighters are fit for duty.

A requirement of the National Rural Fire Authority (NRFA) is that Rural Fire Authorities ensure personnel can carry out the tasks required of them in a safe manner, including being adequately equipped and trained physically for the most demanding tasks. In New Zealand the NRFA has introduced an industry best practice programme for Rural Fire Authorities to implement. The programme is optional and it is the decision of each Rural Fire Authority to consider how they individually meet their legal requirements under the Health and Safety in Employment Act 1992 (NRFA 2009).

The New Zealand NRFA voluntary Guidelines (NRFA 2009) known as the “Guidelines for Managing a Rural Fire Health & Fitness Programme” present three levels of testing:

- High level pack test (also known as the pack hike test, or arduous test) – walk 4.8 km, 20.5 kg load, 45 minutes for crew leaders, and front-line firefighters.
- Moderate level pack test (also known as the field walk test) – walk 3.2 km, 11.3 kg load, 30 minutes for fire management personnel and support firefighters
- Low level walk test – walk 1.61 km, no load, 16 minutes.

This study reports on the suitability of the current fitness Guidelines, assesses tasks and work demands for volunteer rural firefighters and recommends an appropriate minimum fitness level for New Zealand Rural Fire Volunteers.

Australia does not enforce any physical fitness requirements on rural fire volunteers. Other emergency services personnel in New Zealand are moving towards task-oriented fitness assessments (NZ Police and Army), and have contracted Otago University medical researchers to provide recommendations around suitable tasks and fitness levels. Ambulance NZ is considering regulating their services personnel, and may introduce a physical fitness test, although this is unlikely to be a requirement for volunteers.

Aerobic fitness is known to be important for firefighter work performance. The combination of the analysis of firefighter tasks and expert opinion reveals the most important tasks are building a fireline with hand tools, working under adverse conditions, hiking with light loads and lifting and carrying light loads (Sharkey, 1999). Construct validity of the pack test asks the question ‘does the pack test actually measure the characteristics that are important for the successful completion of the tasks of wildland firefighting?’

The physiological workload of New Zealand rural firefighters has been measured in a number of field studies over recent years (Parker et al. 2008; Parker 2010). In the recent New Zealand firefighter studies heart rate was recorded with a data-logging heart rate monitor and Global Positioning System (GPS) location by a data logging device. The heart rate of firefighters at real fires can be high for extended periods of time if they are engaged in physically demanding work. Carbon monoxide (CO) has a significant effect on physical performance because it reduces the

amount of oxygen that can be carried by the blood. Therefore the heart must pump more blood to maintain oxygen to the tissues.

The fitness tests used in New Zealand (i.e. NRFA 2009 Guidelines) have not been validated against the tasks New Zealand rural firefighters are normally engaged in. New Zealand studies of firefighters have shown them to only walk relatively short distances to the fire, not carry much gear on their backs and use a mixture of hand tools and water. In this way they differ from both United States and Australian firefighters. However, there is a lack of data for firefighters at initial attack and in difficult or steep terrain where workload will be higher. The pack test also appears to discriminate against shorter, and more burly, firefighters.

Where heart rates have been measured on New Zealand rural fire fighting personnel, we have found most firefighters did not exhibit extremely high heart rates over prolonged periods. Self-pacing of firefighters is probably a highly significant factor when examining workload and heart rate in the presence of CO. Firefighters will work more slowly, if they can, under conditions of high physiological workload. The stability of the firefighter's heart rate is explained by the self-pacing of work and by the wearing of clothing that allows unrestricted evaporation of sweat. However, a gap remains around the need to capture heart rate recordings from firefighters at initial attack, especially on steep and difficult terrain to determine whether or not they self pace. Additional recording of heart rates of personnel undertaking moderate duties such as operating pumps or running out hoses is also required to validate any physical tests aimed at a lower level of heart rate capacity.

Sixty-eight Rural Fire Officers (RFOs) were interviewed across 36 Rural Fire Authorities (RFAs) in New Zealand to discuss the steps being taken in their area to ensure crews were physically fit to respond to callouts. The assessment sought to discover what was occurring with regards to physical fitness assessments in RFAs where the NRFA Guidelines are voluntary. The majority of RFAs interviewed were therefore purposely skewed towards territorial authorities and forest-based areas, rather than Department of Conservation (DOC), due to the requirement by DOC for staff to undertake the pack test anyway.

The interviews focussed on the type of callouts crews were typically responding to, the main occupation of people who were currently in the crews, and whether the crews were being asked to complete any formal assessment of fitness based around the guidelines of the National Rural Fire Authority (NRFA) booklet "Guidelines for Managing a Rural Fire Health and Fitness Programme" (2009).

Rural Fire Officers were also asked for their opinion around the suitability of the Guidelines as a means of assessing fitness for being part of a rural fire crew, and whether they would support any minimum fitness level being introduced. The difference in type of personnel and the RFA they are attached to impacts heavily on the likelihood of the RFA conducting a formal physical fitness test like the pack test.

Forty-four percent of RFAs interviewed are using the NRFA Guidelines to assess physical fitness of their crews, to some degree. Those not using formal assessment methods were all using some degree of personnel management technique (either at RFO or Crew Leader level) to informally assess fitness and assign people to tasks that were suitable for their level of fitness.

Only five RFAs interviewed were running all three pack test levels as per the NRFA Guidelines. The low level walk test did not seem very popular amongst RFAs running the pack test. Two thirds of RFOs interviewed were not conducting any formal physical assessments on their

volunteers (including contractors). However they were physically assessing those being deployed overseas or outside the district as NRFA Rural Fire Response Team Firefighters. Four RFAs are looking to bring in more formalised physical testing for volunteers in the near future.

The positive aspects seen in the pack test is that it is simple to conduct, and easy to assess as a pass/fail. There is minimal equipment needed, and the pack test was recognised by most as being based on sound research, and possibly the best measure currently available to assess heart work rates. It was seen as significant also that both DOC and international rural fire crews in Australia and the United States had adopted the test as best practice. Most RFOs believed it to be a good indicator of a person's overall fitness, but the majority (70%) disagreed that it was an adequate indicator of fitness to the task of rural firefighting. The main concerns were threefold:

- Concerns about the test procedure and suitability of the test in determining fitness for task
- Concerns about the non-representative nature of the test to real-life physicality
- Concerns about the need for physical testing if not in a physically demanding role.

RFOs did not turn away volunteers due to lack of physical fitness, instead people were reassigned to different roles that more suited their abilities. Regrettably, eight RFOs mentioned they were aware of a firefighter staff member that was seriously injured during a fire event. All but two RFAs had debrief procedures available for members who had been involved in a traumatic callout.

There was definite support to continue undertaking the high level pack test for those being deployed internationally, and also for rural firefighters in the NRFA Rural Fire Response Teams. There was also a good level of support to require an arduous pack test for DOC high country volunteer crews, and those fire crews likely to be responding to steep slope and gully fires. Many RFOs did not see the need for any physical testing for crews called out to mainly flat land vegetation fires or where the majority of callouts are roadside fires or urban assists.

There was a clear indication that the majority of RFOs thought medical test assessments gave them the best indications of heart and lung capacity risk, and most supported this as a necessary step for all rural fire force personnel. The majority of RFOs supported a minimum fitness level for those firefighters conducting frontline rural firefighting tasks (58%), but it was not clear what this level should be. Most did NOT support the need for any formal physical testing beyond an annual medical test for those doing pump operating, running out hoses, driving and running supplies or administrative tasks. There was a unanimous desire to cater for people who don't want to be frontline firefighters but still make a valuable contribution to the Volunteer Rural Fire Force (VRFF) crews. There was almost no support amongst RFOs for the low level walk test.

Almost unanimously, RFOs felt that if a minimum fitness level was applied across the board to all volunteers, it would result in at least half of their personnel leaving the VRFF. This included areas where it was felt that most of the personnel could easily pass the test. The concerns are therefore both that the older and less fit members would be excluded from being members of the VRFF, resulting in a loss of critical mass in small rural areas. Additionally, there would be a rebellion on principle by many of the fitter members of the VRFF force, due to the mandatory nature of the fitness test being implemented, and they would also leave. Others feared considerable loss of knowledge and experience, making for a much more vulnerable and less capable national VRFF. The force may also become very unbalanced—a lot of physically capable people, but none very willing to man the pumps or supply the scones or drive the tanker etc. In short the community morale and spirit of the crews would be lacking.

Recommendations

A three - tier minimum fitness recommendation:

Tier 1	Medical testing by GP or other medical professional	Voluntary and provided at no cost to firefighters at intervals as laid out in the Guidelines	All firefighters
Tier 2	Moderate pack test Walk 3.2 km, 11.3 kg, 30 minutes	Voluntary	For all front line firefighters and pump operators
Tier 3	Arduous pack test Walk 4.8 km, 20.5 kg, 45 minutes	Compulsory	For all NRFA Rural Fire Response Team firefighters (paid), and internationally deployed rural firefighters
		Voluntary	For all other frontline fire fighters.

Tier 1

More formal medical testing by a GP verifies any issues that individuals may be already aware of, as well as highlighting unknown medical conditions that could potentially cause the person difficulty during VRFF duties. The NRFA Medical test checklist would need to be completed and discussed with a medical professional prior to assessment. It is recommended to keep this voluntary due to the concern from some RFAs around funding for staff to be assessed by a GP, however, certain RFAs will still be required to undertake medical testing of some volunteers for health insurance purposes (not fitness assessments).

Tier 2

A number of RFAs are interested in conducting the pack test, and around half of the RFOs have introduced some level of the NRFA fitness Guidelines. However, only a third felt the pack test was a good indicator of fitness for their crews and their situations. In recognition of the desire by RFOs for some form of fitness testing, we recommend the medium level pack test for frontline fire fighters and pump operators who are not being deployed, or who are not willing to undertake the full pack test. This would be voluntary, and could be used as a training-night exercise.

Tier 3

The arduous level pack test as outlined in the NRFA Guidelines would be retained, and is recommended for all frontline fire fighters. The arduous pack test should remain a mandatory requirement for all fire fighters involved in NRFA Rural Fire Response Team (paid) firefighters and those deployed internationally. Provision should also be made within RFAs for other frontline fire fighters to complete the arduous pack test on a voluntary basis where personnel want to complete the test.

It is recommended that personnel undertaking Tiers 2 & 3 also complete the Tier 1 medical test prior to conducting either the moderate or arduous pack test.

We suggest the NRFA support these minimum fitness recommendations by:

- Encouraging RFOs to train crew leaders in recognising the signs of fatigue and physical fitness limitations in personnel, and for crew leaders to hold dialogue about self-awareness of physical fitness levels and health limitations with their crews.
- Continuing to encourage: RFAs to maintain the fitness ; and RFOs to consider implementing a higher tier as a minimum level within their crews.
- Continuing research to fill gaps in knowledge around real time productivity and maximum heart /lung capacity for a variety of fire-fighting tasks. Of particular benefit would be to include heart rate monitoring for pump operators, and mop-up operations, and to ensure an increased dataset for real-time firefighting activities across age-groups, and during the initial attack phase.

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Introduction

The need for fitness recommendations

Forest and rural firefighting can be very physically demanding (Budd 2001; Gaskill 2002; Heil 2002; Ruby, Shriver et al. 2002; Parker 2010), requiring firefighters to be physically fit to minimise fatigue and work competently (Phillips, Petersen et al. 2011). In some parts of the world firefighting agencies employ physical competency tests to determine if firefighters are fit for duty.

There is a requirement from the NRFA for Rural Fire Authorities to ensure personnel can carry out the tasks required of them in a safe manner, including being adequately equipped and trained physically for the most demanding tasks. In New Zealand the NRFA has introduced an industry best practice programme for Rural Fire Authorities to implement. The programme is optional and it is the decision of each Rural Fire Authority to consider how they individually meet their legal requirements under the Health and Safety in Employment Act 1992 (NRFA 2009).

The Health & Safety in Employment Act 1992 states that the employer must take all practicable steps to ensure the safety of employees at work. The Act also requires Rural Fire Authorities to ensure volunteer firefighters are treated and provided for in the same way as paid employees of the RFA. This includes being responsible for their health, safety and welfare.

New Zealand Rural Fire Authority “Guidelines for Managing a Rural Fire Health & Fitness Programme 2009”

The New Zealand Rural Fire Authority “Guidelines for Managing a Rural Fire Health & Fitness Programme 2009” will be referred to as the “Guidelines” in this document. As stated (NRFA, 2009, p 7) “These guidelines provide Rural Fire Authorities with the tools to undertake a health and fitness programme for their rural fire personnel. The guidelines will help the Rural Fire Authority to:

- put in place medical screening
- identify work capacity recommendations
- specify the fitness levels required for fire personnel to safely undertake fire-fighting tasks; and
- encourage fire personnel to acquire the appropriate levels of fitness.”

The NRFA Guidelines comprise:

- Consent to participate
- Medical screening
- Pack test
- Support
 - Getting fit enough to pass
 - Guidance material on a fitness training programme.

Project brief

Forest and rural firefighting can be extremely demanding, requiring firefighters to be physically fit to maintain safety, minimise fatigue and work competently. Just how fit and how to measure fitness is a question New Zealand's Fire Service Commission would like answers to.

In New Zealand there are One-Hundred and Ninety Three (193) registered Volunteer Rural Fire Forces (VRFF's) with approximately 3,400 Volunteers as members being Rural Fire Fighters. A number of these VRFF's have been in existence since the late 1980's when with the demise of the NZ Forest Service the structure of managing rural fire in New Zealand changed to being more inclusive of Local Territorial Authorities taking responsibility for managing rural fire within their jurisdictional areas. Since then the number and resourcing capability of VRFF's around the country has increased, with small and isolated rural communities becoming more reliant on self protection. The average age range of Volunteer Rural Fire Fighters is understood to be in the 45-55 year band. In 2005 the National Rural Fire Authority (NRFA) in conjunction with the rural fire sector, developed a set of "Guidelines for Managing a Rural Fire Health & Fitness Programme", which were later revised in 2009 with an updated version being published.

This study reports on the suitability of the current NRFA fitness Guidelines (2009), assesses tasks and work demands for volunteer rural firefighters and recommends an appropriate minimum fitness level for New Zealand Rural Fire Volunteers.

The project objectives were to:

- Identify the current level of acceptance and application of health and fitness programmes and recommendations as developed by the National Rural Fire Authority (NRFA), within the New Zealand Volunteer Rural Fire Forces.
- Review and characterise tasks, task frequency and work demands for volunteer rural fire fighters, compare with relevant international requirements and review associated international prescribed fitness requirements.
- Provide recommendations on the minimum recommendations for health and fitness that can be applied to volunteer rural firefighters, based on the actual tasks performed.

This work contributes, from a New Zealand perspective, to the body of knowledge that already exists on rural firefighter task load and performance and associated fitness requirements. To date, the literature has been dominated by the United States and Australian rural fire communities who differ in some respects to New Zealand fire suppression methods, fuels and topography. This work provides science and evidence from a New Zealand perspective that can then be applied with confidence to New Zealand rural fire forces.

PART 1: FITNESS REQUIREMENTS FOR EMERGENCY SERVICES PERSONNEL

Rural Fire Fitness Tests

New Zealand fitness tests for rural fire personnel

Rural fire agencies use physical competency tests such as the Pack Hike Test (PHT) which involves a 4.83 km walk over level terrain carrying a 20.4 kg pack, or more commonly a weighted vest, within 45 minutes. The test is designed to challenge an individual's muscular endurance, strength and cardio-respiratory fitness and was devised to mirror the physiological strain of wildland fire suppression using handtools (DeLorenzo-Green and Sharkey 1995).

A less arduous version of the PHT is the Field Walk Test (FWT) – a 3.2 km walk over level terrain carrying an 11.3 kg pack within 30 minutes (McLennan and Birch 2004). Lord et al. (2012) report that they are not aware of any validation tests of the FWT and the 11.3 kg vest and 3.2 km walking distance in 30 minutes appear to be arbitrarily assigned.

The NRFA call for volunteer rural firefighters on their website mentions both a “pack test” and a medical test as pre-requisites¹. The forms for medical assessment are provided in Appendix A. In New Zealand the NRFA voluntary Guidelines (NRFA 2009) present three levels of testing for the “pack test”:

- High level pack test (Pack hike test) – walk 4.8 km, 20.5 kg load, 45 minutes for crew leaders, and front-line firefighters. The test is intended to assess fitness for arduous work that applies mainly to operational functions.
- Moderate level pack test (Field walk test) – walk 3.2 km, 11.3 kg load, 30 minutes for fire management personnel and support firefighters (drivers, pump operators, mop up other than hill-country fires). These personnel are often in stressful roles and working extended hours.
- Low level walk test – walk 1.61 km, no load, 16 minutes for non-fireground positions (incident management support) mainly involving office-type work. This type of work may involve working extended hours in a moderately stressful situation.

The NZ Rural Fire Authority “pack test” measures the participant's cardiovascular fitness, strength and muscle endurance, rather than their ability to fight hill-country fires.

In 1965 the metabolic, cardiovascular and thermal demands of United States wildland firefighting were measured in the field. These tests showed that aerobic fitness was important for firefighter work performance (Sharkey, 1999). From 1975 to 1998 the United States wildland fire agencies used the five minute step test to determine firefighters fitness for duty (Sharkey, 1999). However, the step test was not considered job related and

¹ <http://www.nrfa.org.nz/OurPeopleAndOrganisation/Pages/Volunteer-as-a-rural-firefighter.aspx>

effort was put into developing a job related test. The combination of the analysis of firefighter tasks and expert opinion revealed the most important tasks were building a fireline with hand tools, working under adverse conditions, hiking with light loads and lifting and carrying light loads (Sharkey, 1999).

Applicability of tests

Peterson et al. (2010) in a study of the validity and relevance of the PHT, to Australian firefighters, concluded that the test displays content validity for the work demands of hand tools using United States wildland firefighting. They considered the 45 minute cut off time had no scientific basis and appeared to have been based on a linear regression between PHT finishing time and a maximal oxygen uptake (VO_{2max}) of 45 ml/kg body weight per minute (Sharkey and Rothwell, 1996). This is a very high workload and was calculated from a job task analysis in 1973 which found the average energy expenditure of United States wildland firefighting tasks was 22.5 ml/kg per minute (Sharkey, 1999). This value was doubled and set as the minimum requirement for wildland firefighters. Peterson et al. (2010, p 1278) explain that “*This doubling was based on the notion that workers typically cannot sustain more than approximately 50% of their VO_{2max} during day-long work (Sharkey, 1999). This approach is problematic, however, as 22.5 ml/kg per minute was the average for firefighting tasks and does not include periods of rest between those tasks.*” Ruby et al. (2002) calculated an average energy expenditure of 8.4 ml/kg per minute including rest periods for wildland firefighters. Peterson et al. (2010, p 1279) concluded that, “... *the minimum energy expenditure required for satisfactory wildland firefighting has not been investigated. Until this is determined the construct validity of the PHT cannot be verified.*” Construct validity of the PHT asks the question ‘does the PHT actually measure the characteristics that are important for the successful completion of the tasks of wildland firefighting?’

The PHT also appears to discriminate against shorter firefighters. In an evaluation of 5000 firefighters, individuals under 1.60 m had a pass rate of 67% which was significantly less than for all firefighters (Sharkey, 1999). Petersen et al. (2010, p 1278) state “...*this is possibly due to the reduced maximum walking speed of shorter individuals who may struggle to achieve the required walking speed.*”

Australia

Lord et al. (2012) report “*Most volunteer bushfire firefighters in Australia do not undertake “fit for duty” (FFD) testing before they are deployed to the fireground (McLennan and Birch, 2004)*”. The only volunteer firefighting force to use a FFD test is the Australian Capital Territory Rural Fire Service (ACT RFS). The ACT RFS uses the PHT to test firefighters before they are allowed to go on interstate bushfire deployments. For deployment within ACT the ACT RFS uses the less demanding FWT to physically screen firefighters.

British Columbia Forest Service

All British Columbia Forest Service wildland firefighters are required to perform a national standard fitness test known as the WFX-FIT test². The test replaces pack test and all crew personnel are required to pass the WFX-FIT in its entirety to be eligible for firefighting.

The test comprises:

- To simulate the weight of gear a weighted belt is worn instead of a chest pack, hard hat and hiking boots.
- Carry a medium pump on back over the ramp 8 times for a distance of 160 metres.
- Carry a medium pump in hands around the ramp a distance of 80 metres (no ramp).
- Carry hose pack on back over ramp 50 times (1km).
- Pull simulated charged hose 80 metres (no ramp).



Ramp used in British Columbia Forest Service test

² <http://bcwildfire.ca/employment/firefighter/fitness.htm>

Other Emergency Services in New Zealand

NZ Police

Fitness tests used

There are three basic tests as requirements for physical health assessment outlined on the NZ Police website (Anon 2013b):

- The Physical Appraisal Test (PAT) used to assess fitness during entry into the police academy (Table below). This test involves running 2.4 km, and also assesses the ability to jump vertically and a grip test (needed to operate a firearm if required; and to restrain and handcuff individuals). Body Mass Index (BMI) and waist to height ratio are also measured, to advise applicants if they should consider undertaking a weight reduction programme.
- The Physical Competency Test (PCT) requires completing a 400m obstacle course with 10 key tasks, within a certain timeframe (depends on age and gender). The PCT is aimed to represent tasks a police officer may need to do in the course of police work. Exertion on duty is usually in short bursts, intense, high cardio—this test aims to duplicate that. All police officers are required to complete and pass the test every two years in order to be deployed on duty. The tasks involve:
 - Pushing a car trailer 10m
 - Carrying a car wheel assembly 10m
 - Running 200m
 - Walking along a one-metre high, 5m long, right-angle beam
 - Jumping a 1.8m long jump
 - Running around cones and under and over hurdles for 30m
 - Climbing through a 1m high window
 - Scaling a solid 1.8m high wall
 - Dragging a 75kg body 7.5m
 - Climbing a 2.2m high wire fence.
- A Swimming Certificate of completeness. This is a requirement for entry into the Police Academy, and requires being able to:
 - Swim 50 metres in 54 seconds
 - Tread water for 5 mins
 - Duck dive 3m to retrieve a rubber brick.

	Run 2.4kms	Grip Strength*	Vertical jump
Males			
Under 20	10 min 51 sec	>96kg	48cm
20-29	10 min 15 sec	>96kg	48cm
30-34	10 min 50 sec	>96kg	48cm
35-39	11 min 30 sec	>96kg	48cm
40+	12 min 15 sec	>96kg	48cm
Females			
Under 20	12 min 54 sec	>52kg	40cm
20-29	11 min 50 sec	>52kg	40cm
30-34	12 min 25 sec	>52kg	40cm
35-39	13 min 10 sec	>52kg	40cm
40+	14 min 10 sec	>52kg	40cm

*For both hands combined total

(Source: NZ Police website: www.newcops.co.nz)

New Zealand Police Physical Appraisal Test

History of physical fitness testing in the NZ Police Force

The 1981 Springboks tour raised concerns that not all police were adequately fit and able to maintain order and enforce law (Broun 2010). Many police “suffered debilitating injuries” during Springbok riots (Anon 2012a). Police were at this time not required to complete any physical training or assessment after graduating. As a result, the Physical Competency Test (PCT), based on the California Highway Patrol’s physical test (Anon 2012c), was introduced in 1986 as a requisite fitness test for New Zealand police officers (Anon 2013a). During the 1980’s and 1990’s, the PCT had minor reviews, the most important change being that police officers aged over 50 were no longer required to go over the wall during the PCT, just to touch it (Anon 2012c). The PCT was also made not compulsory for officers above the rank of senior sergeant. Physical fitness was highly encouraged however, as fitness makes it easier to do the job, and also provides better recovery times from injuries sustained on the job. Police officers were given three days leave to train for the PCT, and circuits and strength work were often used by Physical Education Officers to help police staff to pass (Anon 2012a,c).

Entry requirements for the New Zealand Police Academy (PAT tests) were found to have more strenuous requirements than those of the Army, and in July 2006, revised standards were brought in that were both more comparable with other Australasian emergency agencies, and also now better account for age and gender (Police 2006). In particular the PAT run times (implemented 1 Jul 2006) were changed to recognise peak fitness at age 20 to 29 years. The PAT grip test was changed to account for different hand sizes, and the BMI was no longer a failing point for the PAT, just used as a guideline for future weight reduction. Medical standards were also relaxed: People who wore glasses and hearing aids, or were colour blind were now eligible for Police Academy training, but still had to pass eye and hearing tests; Asthmatics were also now considered for Police Academy training. The PCT test was also made easier for recruits —they had to scale a 4ft (1.2 m) wall, not a 6ft (1.8 m) wall to gain academy entry (though would need to scale a 6ft wall prior to graduating).

During 2009, the Police Association commissioned the University of Otago Medical School to undertake a review of the PCT. Several media reports during 2009 and 2010 (Broun 2010) state that a large proportion (up to 21%) of police officers did not hold a current pass for the PCT, and the physical training allowance (PCT leave time of 3 days a year to train) was revoked in place of a \$1390 incentive for passing the PCT. Official Information Act data from 2010 showed ‘dozens’ of police staff suffering serious injury as a result of completing the PCT test —damaged kneecaps, sprains, muscle and tendon damage, dislocations and fractures (Broun 2010). A 54 year old Whanganui police officer failed the PCT during 2010, and had a fatal heart attack on the second attempt. The Coroner recommended that police staff undergo an active preventative injury fitness programme, which was rejected by the Police Association as it had been tried previously and found to be an “ineffective use of time and resources” (Anon 2012a).

The University of Otago Medical School report (Handcock and Dempsey 2010) provided recommendations for a revised PCT test, following research on 71 healthy and uninjured people 50 years and under, half of whom were police staff. The study found the PCT was overall a good measure of fitness of police for role, however older members were advantaged as they were using less of their maximum capabilities during the test (Anon 2012b).

From 1 March 2013, constabulary staff (constables, sergeants and senior sergeants) must hold a current PCT pass in order to be operationally deployed (Anon 2013a). The Police Association also accepted the University of Otago recommended reduction in wall height for the PCT from 2m to 1.8m, but the reports' recommended modifications regarding completion times for the course were not adopted (Anon 2013a; McNeilly 2013). The proposed new times from the University of Otago, compared with old times, would result in five hundred staff failing the PCT (Anon 2012a). But the majority would fail by only a few seconds. Of greater concern was that reducing completion times for the older aged staff may increase anxiety in older members about the PCT test (Anon 2012), and they may choose to default if possible (take leave that day etc.); the fit members of the older age bracket would also lose their P1 pass to a P2 grade pass, which could prove demoralising as high test results are a badge of honour (Anon 2012c). Allowing younger police longer timeframes to complete the test may also result in some in the 20-29 bracket no longer taking the test seriously. A 3News report from 29th May (Anon 2013c) shows that the new PCT test regime and an increased biennial incentive payment for passing PCT of \$1408 has resulted in 97% of police officers having a valid PCT test pass.

Routine police work is not considered (by University of Otago Medical School) strenuous enough nor active enough that police can maintain physical fitness to the level required for all policing tasks (Handcock and Dempsey 2010). Of note is that police officers are now required to carry more equipment while on duty—about 7kg more than in 1981— as they now have a stab-resistant vest and duty belt. Additional loading has been found to significantly decrease task performance, balance, and to increase landing stress while running (Dempsey 2012). The average age of police officers has risen to 42 years old, and may be due to the removal of the requirement for police officers to retire at 55 years (Anon 2012c).

NZ Armed Forces (Army)

The Army have now implemented an evidence based, task-oriented physical test, to replace the Battle Efficiency Test (BET). The test's purpose is to determine the physical readiness of personnel to perform required tasks at Directed Level of Capability, and also to identify areas of weakness for injury prevention and further physical training (Anon 2012).

The new test was devised by the University of Otago Medical School and launched in January 2013 following a trial rollout during May-Oct 2012. Input into this new recommended fitness requirement included a team comprising subject matter experts from all military trades,

Defence Technology Agency (DTA) exercise specialists, personnel advisors and military chain of command. Whereas the Battle Efficiency Test was a 12km run with equipment, the new physical test consists of:

- Jerry can lift and place
- Simulated CASEVAC drag
- Simulated CASEVAC stretcher carry
- Fire and manoeuvre
- Tactical move by foot.

In addition, Army recruits must pass entry physical and medical requirements (Table 2). The entry physical fitness requirements consist of a 2.4km run, curl-ups and press-ups. Certain medical conditions (coeliac disease, asthma and eyesight) and height, weight and

BMI assessment outside of an average range may restrict applicants from recruiting, or being deployed on certain missions (NZDF 2013). The main rationale for this requirement is that army equipment, uniform and diet is designed for the average frame, and that personnel may be stationed in a location where a non-coeliac diet is not available, or the medical condition places unacceptable risk to the operation (NZDF 2013). Fitness level requirements increase for various roles within the Armed Forces.

Males:

	Run 2.4kms	Curl-ups	Press-ups
Entry fitness level	12 minutes	45	15
Required fitness level 2	10.5 minutes	60	28
Required fitness level 1	10 minutes	66	30
100 Club	8 minutes	130	55

Females:

	Run 2.4kms	Curl-ups	Press-ups
Entry fitness level	14 minutes	35	8
Required fitness level 2	12 minutes 20sec	50	14
Required fitness level 1	11 minutes 50sec	55	15
100 Club	10 minutes 5 sec	118	36

(Source: Defence Careers website)

Height, weight and BMI recommended guidelines:

- Height between 153-193cm
- Weight less than 125kg
- BMI 18-34.

Ambulance/ Paramedics

At present, there is no required fitness testing for Ambulance NZ personnel, and fitness is self-declared and by reference. St John event volunteers require “*physical strength, fitness and good health (you need to demonstrate you could carry an 80kg person)*”³.

Ambulance NZ (an umbrella group for numerous emergency medics – see www.ambulancen.z.co.nz) is currently considering regulating the services personnel, and have applied for regulation under the HPCA Act 2003 for both Defence medics and Paramedics. Regulation would require physical qualification via some kind of fitness testing.

Australian St John volunteers and paramedics in Western Australia require the passing of a functional capacity test which consists of:

- Step test
- Blood pressure and heart rate within normal limit
- Muskulo-skeletal review – medical history and injury history
- Pushups
- Strength tests
- Core- situps and trunk rotation
- Demonstrate hamstring flexibility
- Power lifting tasks – lifting loads up to 30kg and carrying them while manoeuvring into offload positions.

Such a test could be introduced for Defence medics and Paramedics when Ambulance NZ regulation occurs, but is unlikely to be a requirement for volunteers.

³ <http://www.stjohn.org.nz/What-we-do/Event-Services/Become-a-Volunteer-at-Events/>

PART 2: SUMMARY OF FITNESS ASSESSMENTS AND ISSUES EMERGING

Rural Fire Officer Interviews

Sixty-eight Rural Fire Officers were interviewed across thirty-six Rural Fire Authorities (RFAs) in New Zealand to discuss the steps being taken in their area to ensure crews were physically fit to respond to callouts (refer Appendix B). The assessment sought to discover what was occurring with regard to physical fitness assessments in RFAs where the NRFA Guidelines are voluntary. The majority of RFAs interviewed were therefore purposely skewed towards territorial authorities and forest-based areas, rather than DOC, due to the requirement by DOC for fire fighting staff to undertake the pack test anyway.

The interviews focussed on the type of callouts they were typically responding to, the main occupation of people who were currently in the crews, and whether the crews were being asked to complete any formal assessment of fitness based around the guidelines of the NRFA booklet “Guidelines for Managing a Rural Fire Health and Fitness Programme” (2009).

Rural Fire Officers (RFOs) were also asked for their opinion around the suitability of the pack test guidelines to assess fitness for being part of a rural fire crew, and whether they would support any minimum fitness level being introduced (refer Appendix B).

History behind the NRFA Guidelines

A number of theories were suggested by RFOs around the origins of the pack test introduction into New Zealand. These included that the test originated from Australasian Fire Authorities Council (AFAC) tests, and was brought into New Zealand in association with the Department of Conservation (DOC); that it was a hangover from the forestry company days in the 1990s, when Carter Holt Harvey Limited and latterly Rayonier ran a test involving carrying a pack, climbing fences and running 100 metres; and also that it was a requirement for overseas deployment and had been adapted from the Canadian firefighter fitness test— one RFO remembered a test involving a 25 kg pack and running up 180 steps. As some RFAs have been running a version of the pack test for up to 12 years, there may well be several origins.

The introduction of the NRFA Guidelines came about in the following manner⁴:

- Due to a high incidence of heart attacks in rural firefighting, and an unacceptable proportion of fatalities following heart attack, the United States introduced a fire fighter fitness programme in the early 1990s.
- The fitness programme adopted by the United States was developed in league with medical experts who developed three levels of pack test, combined with a comprehensive medical assessment prior to the pack test, and a post-performance recovery assessment immediately following the completion of the pack test.
- The pack test as introduced into the United States was found later to not reduce the number of heart attack incidents, but they were now occurring mainly during the

⁴ Pers. Comm from one of the members of the team that developed the NRFA Guidelines

pack test, rather than on the fire grounds. The major reason for this was that when the United States first introduced the Pack Test, they did not require medical assessment prior to undertaking the physical test.

- As a result of the later research finding the number of heart attack incidents had not fallen, a full medical assessment prior to the pack test was then made a compulsory component of the United States test.
- The year 2000 saw the first deployment of New Zealand Rural firefighters to the United States, and the United States required from New Zealand evidence of completion of the pack test. It was at this point that the NRFA management and other stakeholders (DOC, NZ Defence, and Local Government agencies) set up a working group to discuss the merits of the pack test and to develop some guidelines.
- New Zealand also had an agreement with Australia for deployment, with similar physical fitness test requirements. It appears the Australians had modified the United States pack test for their purposes, and the New Zealand working group decided to do the same.
- Alongside the United States pack test, the working group investigated the Australian, Canadian and also other emergency service physical testing, and developed the 2006 NRFA Guidelines, later updated in 2009.
- One main difference of the NRFA Guidelines is that the United States post-performance evaluation is not currently compulsory. This consists of checking the heart function and lung capacity prior to the test, immediately after finishing, and in order to test recovery, again 5 and 30 minutes after completion.

Callout types

Crews are responding to mainly vegetation fires. Any other callouts (vehicle accidents, rescues, structural fires etc.) depend on the local terrain and the proximity to an urban Fire Service brigade as to whether the VRFF crew is first responder or backs up the New Zealand Fire Service (NZFS).

Crews from small rural communities often have the same or similar personnel who respond to a variety of emergencies, and hence may wear various ‘hats’ at an incident. Many VRFF crews also back up urban NZFS personnel in supplying water for structural fires, helping with traffic control, or taking over from initial fire brigades on vegetation fires.

Volunteer types

The types of people responding to a callout also vary throughout the RFA areas. This reflects how fire authorities are managing the need for rural fire crews and sourcing personnel. Pumicelands, for example, source rural fire personnel from within the silvicultural and harvesting contracting staff of the forestry companies. The New Plymouth District Council have contracted Fulton Hogan roading contractors to undertake rural firefighting duties for their area, and other regions have advertised for paid VRFF personnel. In smaller isolated communities, most of the rural fire crews comprise of rural workers, and people with a strong desire to serve their local communities.

One RFO interviewed listed six different possible volunteers he could get responding to a callout situation: Agency fire fighter; contract firefighters/ local contractor crews; first responders or Urban Search and Rescue members; VRFF crews; NZFS support crews; members of public who turn out to help (usually used as logistical support).

The difference in type of firefighter personnel and the RFA they are attached to impacts heavily on the likelihood of the RFA conducting a formal physical fitness test like the pack test. The majority of those using contractors (particularly forestry based) are not undertaking formal assessments, and are unlikely to in future. These RFOs rely on the company medical and drug testing regime of the contractor organisation, and their day to day working requirements, as an indicator of suitability for the role of a rural firefighter. Where there is a mixture of crews, some with paid contractors and some crews of rural or urban local people, the need to complete a formal assessment becomes rather complicated. Some RFOs have stated they have attempted to implement the pack test on volunteers, but were advised not to for legal reasons, and other RFOs (DOC-based) state the territorial authority considers their volunteers to be staff, and therefore they must complete the pack test as the DOC staff do. The legal opinion from Human Resources for one Council-based RFA was that it would be illegal to impose a fitness level on volunteers, and if this cannot be undertaken on volunteers, it was not to be used to assess physical fitness for any staff, as volunteers are staff. Another RFO in a forestry-based contractor crew stated that as the test is voluntary, the pack test score cannot be used by the contractor company to restrict day to day duties of staff not passing the test, but wondered about the daily duty implications for contractors if the test became mandatory. One RFO stated the Council required its volunteers to complete the pack test because they were sometimes called out to fires on DOC land, and it was a DOC health and safety requirement for fire personnel to have passed a pack test. The matter is further complicated in that most volunteers are not being paid to undertake VRRFF duties, but some fire authorities hire contractors on short-term contracts if a large fire event occurs, and can compensate out-of-district NRFA Rural Fire Response Team volunteer firefighters. There doesn't appear to be any clear legal or standard policy position across fire authorities on the requirements for volunteers to meet a formal physical assessment for OSH requirements.

Steps being taken to ensure firefighters are physically capable to fight fire

Forty-four percent of RFAs interviewed are using the NRFA Guidelines to assess physical fitness of their crews, to some degree (refer Appendix B). Those RFAs using the NRFA 2009 Guidelines saw the main benefits in doing so to be:

- It is a good benchmark, that provides a fair assessment across the whole crew – everyone could participate in the test, and the test was the same for all in that role.
- The pack test was a low-impact fitness test, and the risk of injury was reduced compared to a task-oriented or equipment-based obstacle course.
- Providing the volunteer with confidence in their ability to fight fires at the level they were at, as it shows what they are capable and not capable of doing.
- Providing confidence between crew members of their colleague's ability to fight the fire alongside them (They would have their back).
- Providing credibility when paired to support NZFS crews.

Of those running the voluntary NRFA Guidelines, most RFOs were running the tests annually within their own areas, usually before the fire season began, and tested all personnel (i.e. both deployment and volunteer frontline) passing the medical on the arduous level test. Those who did not pass the arduous test were usually given a further chance, or encouraged to complete some further fitness training. Most frontline personnel who were undertaking the arduous pack test passed the test. One RFO stated that people in

his crews who had struggled to pass would also only be selected as a last resort for frontline tasks, and were encouraged to improve fitness.

Only five RFAs interviewed were running all three pack test levels as per the NRFA Guidelines. Four ran just the arduous, and seven ran two levels. Of those running two levels, four ran the arduous for the majority of staff, and the field walk test for a few members or those unable to complete the arduous; and three ran the arduous and the low level test for support staff. One RFA had modified the low level test to include a 1.6km walk with a weighted 20.1kg pack, for those not completing an arduous test.

The low level test did not seem very popular amongst RFAs running the pack test. Those offering to test this level were doing so due either:

- a) To complete a company policy that all staff have a minimum fitness level (e.g. DOC)
- b) As RFAs who had adopted the voluntary NRFA Guidelines in full.

Informal assessments

Two thirds of RFOs interviewed were not conducting any formal physical assessments on their volunteers (including contractors), other than those being deployed overseas or outside the district as NRFA Rural Fire Response Team Firefighters. Four RFAs are looking to bring in more formalised physical testing for volunteers in the near future.

The main reasons for not conducting any formal assessment such as the NRFA Guidelines include:

- Lack of time – Personnel usually need to take time off work or during free time to undertake the testing, and are not compensated for the time taken. One enlarged Rural Fire district had planned to conduct both the medical and pack test on the same day, but ran out of time to do the pack test once the medical assessments had all been completed. They will now be conducting a day for medicals, and another for the pack test, which will require a second day of leave for personnel.
- Volunteer resistance or refusal – Some RFOs had attempted to introduce the NRFA Guidelines, but failed to gain uptake or acceptance by local crews. Two RFOs stated they had also found initial resistance to running any formal physical assessment, but a majority of their crews are now participating in the assessments when offered.
- Not seeing the pack test as necessary – A few RFOs regarded the NRFA Guidelines as bureaucratic rather than a useful indicator of fitness for duties. Some rural RFAs with farm or forestry sourced staff saw the pack test as superfluous, both due to a lack of income for staff while completing the test, and also as their personnel had a higher level of fitness from day to day working activities than what the arduous level required. Others interviewed felt that people should know their own physical limits and would act accordingly on a fire ground. Personal responsibility for injury and safety was seen by some RFOs to be being devolved to an organisational level with the pack test.
- Not seeing the pack test as a good indicator of fitness – Some RFOs were cynical of the pack test, due to their awareness that personnel in other RFAs were training for the test, rather than maintaining a good level of fitness throughout the year. Due to the voluntary nature of the Guidelines, the tests are not being applied consistently

across RFAs, and some felt that certain people in the local area that had passed the pack test from neighbouring crews were not people they would want to put into a frontline role, and they would stand them down. A number of RFOs had an issue with the way the pack test was constructed, and did not feel it was representative of the broad range of tasks in the New Zealand VRFF situation.

- Lack of funding – The issue of who pays for the medical assessments and the travel costs and lost work opportunities from participating in the pack test assessment needs addressing.

Those not using formal assessment methods were all using some degree of personnel management technique (either at RFO or Crew Leader level) to informally assess fitness and assign people to tasks that were suitable for their level of fitness. Informal assessment techniques included:

- Managing person to task. This was by far the most common means of assigning people to roles, and underpinned the need for crew leaders to have excellent people management skills. One RFO noted there was a fine line between assigning people to task, and offending people. The majority of local community fire crews were assembled over time, with the crew leader building a team based on the skills that were available. There was not the luxury of selecting skilled members, and it was felt the pack test was no match for knowing the staff personally and what they were physically capable of. There was also recognition that pressure can mount with no increase in physicality, and fire officers need to know who can manage the pressure and keep a cool head. Most rural crews could also manage callouts by calling neighbouring crews for backup of fitter members, if needed.
- Recruitment. Many RFOs required a trial period for new recruits, and nearly all were conducting ‘behind the scenes’ research into the people using in-house knowledge from VRFF personnel about the characteristics of the applicants and suitability for the role of rural firefighting. Some Fire Authorities required medical testing prior to recruitment, and some also indicated it was an expectation that new fire personnel recruits would need to complete a pack test once a year. Most recruits who failed to become part of a crew did so due to drug testing or police checks, or decided themselves to leave fairly quickly on discovering the tasks were beyond their physical capacity. Only two RFOs indicated they had had to turn away a recruit due to lack of physical fitness.
- Medical tests. Most of the RFAs (69%) undertook medical testing with some of their crew members. Many of the RFOs were relying on medical testing for the older members of the crews. A number of Council-based RFAs indicated they required a medical test for all personnel over 65 years, for insurance purposes. DOC undertake a self-assessment health form for staff to identify potential medical issues, and these are passed to the DOC medical personnel. If the issue is considered serious, they are required to get a doctors certificate before completing the pack test. One DOC RFO stated that the DOC guidelines are ‘ageist’, requiring a medical yearly for over 55 years, every 3 years for those aged 40-55, but only 5 yearly for personnel under 40 years. One PRFO noted forms used in the NRFA Guidelines for medical testing were not user friendly, requiring multiple entry of similar information, and suggested adopting the NZFS medical forms instead. He also noted that some VRFF personnel had taken the wrong forms (i.e. the NZFS ones) along to the doctor.

- Drug testing. Forestry contractor companies and also certain Territorial Authorities require drug testing for rural fire personnel.
- Police checks. A number of RFOs stated that they required police checks prior to recruitment, and this could sometimes highlight drug and alcohol related issues that may restrict people's ability to be deployed outside the area, even if they passed the pack test.
- Training nights. Most Fire officers were using training nights as the basis for assessing the physical abilities of their personnel. Some RFOs said they used the training nights to check the ability of staff to lift and carry pumps, and one also stated they had run the field walk test as a training night exercise, which all the crew had enjoyed. It provided an indication of fitness to the crew leaders. This RFO felt that the personnel would not have readily participated had it been run as a formal assessment, however.
- Self-assessment. There was a strong feeling among the RFOs that people themselves were the best indicator of whether they were able to conduct certain tasks, and that most would either not volunteer or would step back from duties that they felt were too demanding. One RFO stated that he had been in both the Police and Army, and that the same macho culture was not present in the Fire Service, so there was limited risk of someone pushing themselves physically beyond their limits. He felt the culture within the VRFF was of no shame in stepping into less active duties. Other RFOs supported this view, with only three having had to ask staff to come off the front line or stand someone down from the task they were doing due to physical failure to undertake the task.
- Dialogue and talking about fitness. RFOs regularly discussed exercise as preventative injury with crews, and talked through with particularly the older personnel what they were capable of undertaking. Most less-fit personnel were encouraged onto support roles, or only allowed a certain distance from the fire truck or pumps.

Attitudes to the pack test

The pack test is seen as simple to conduct, and easy to assess as a pass/fail. There is minimal equipment needed, and the pack test is perceived as being based on sound research, possibly the best measure currently available to assess heart work rates. That both DOC and international rural fire crews in Australia and the United States had adopted the test as best practice gave RFOs confidence in its merit for assessing those suitable for international deployment. Most RFOs believed it to be a good indicator of a person's overall fitness, but the majority (70%) disagreed that it was an adequate indicator of fitness to the task of rural firefighting.

The main concerns were threefold:

- a) Concerns about the test procedure and suitability of the test in determining fitness for task

Upper body strength is not seen to be adequately measured through the pack test. This is an essential physical requirement for personnel carrying and operating pumps and undertaking hand tool work to cut a firebreak in particular. One RFO questioned if some personnel who passed the pack test could lift down and turn on the pump. Another had seen people struggling to cut fire breaks who had passed the arduous pack test, whereas those who had failed the arduous level were cutting fire breaks with ease, due to greater upper body strength. The test was seen to unfairly disadvantage shorter and also stockier (more burly) members of the crews, and advantage those with longer legs.

The present guidelines are a pass/fail. The pack test is designed in such a way that it provides a measure of physical capacity and exertion, and the time, distance and weight guidelines are used to ensure the heart is being worked to an appropriate level. The test, though walking, is not designed to assess walking ability; however, this point does not seem to have been made adequately clear enough to the Rural fire community. Some RFOs would support a more graduated scale, so that personnel complete the full arduous pack test, but the time band completed would determine what roles personnel can and can't undertake. The pack test is not designed for this type of determination however, and further shows that RFOs do not understand why the pack test is designed the way it is.

- b) Concerns about the non-representative nature of the test to real-life physicality

A number of RFOs questioned how representative the test was to real call-out situations, particularly those who were not operating in steep country. A couple of RFOs said they would be running out a maximum of 1-2 hose lengths before calling in a helicopter, and that personnel did not need to walk for miles with a fully loaded hose or pump. In more remote and steeper country areas helicopters are being used to transport both personnel and equipment to the fire ground, negating the need to walk in with equipment. The pack test did not seem to challenge people in the same manner as a real life situation, with many RFOs indicating they felt it was a "test to see if you could walk fast with a hose pack", and therefore questioned the relevance to their area.

Other concerns included:

- Accounting for adrenalin loading – when personnel receive a page or notification of callout, their heart rate is already elevated due to adrenalin, so the real-time load on the heart is higher than in the pack test situation at initial attack stage.
- The most difficult challenges to overcome at the fire ground are dealing with the heat, steep hills and carting equipment around. This requires additional physical pressures beyond heart and lung capacity. Some RFOs stated that it was not a good indicator of stamina, and that they also needed to ensure people had the mental willpower to continue fighting fires for very long stretches of time, if they were part of the NRFA Rural Fire Response Team or deployed overseas. One RFO familiar with international deployment stated 30% of those passing the arduous pack test would not cope in a 10-14 day deployment. He instead looks for people who are 'work fit' by doing a similar very physical job day in and day out, as well as those who are undertaking regular sustained exercise regimes when selecting for NRFA Rural Fire Response Team members or for international deployment. Those

lacking stamina tended to take shortcuts and make bad decisions. One RFO noted that at a major NZ wildfire event, some of the personnel he had expected to cope well struggled with the day in, day out nature of fire suppression, and it had surprised him.

- Much of the work involved in rural firefighting occurs in uneven loads, with short bursts of very hard activity, and periods of lesser activity where rest can occur. The pack test was seen to be unrepresentative of the stop-start nature of load on the heart and lungs during rural firefighting.

c) Concerns about the need for the physical test if not in a physically demanding role.

Fire Officers questioned the need for personnel not on frontline duties to be formally tested in the manner of the pack test.

Turning away volunteers due to physical limitations

RFOs did not turn away volunteers due to lack of physical fitness, instead people were reassigned to different roles that more suited their abilities. Usually this would mean older and less fit crew members were no longer frontline firefighters, but were still operative as pump operators and drivers. One RFO felt that a “Jack/Jill of all trades” regardless of fitness was more useful to a VRFF crew than someone who was ultra-fit. This RFA was not fighting many vegetation fires, however, and had a large number of first responder and urban fire assists.

Incidences of collapse and serious injury during firefighting

Regrettably, eight RFOs mentioned they were aware of a fire fighter staff member that was seriously injured during a fire event. Four of these involved the collapse or heart attack of NZFS personnel assisting a rural fire operation. One RFA had a VRFF collapse during a major escape fire, and another RFA had a VRFF staff member with a heart attack resulting in fatality. Another RFA mentioned that a crew member had succumbed to heat stress, and on a positive note, a DOC RFO stated their medical screening had revealed someone at imminent risk of heart failure, who was due to be deployed. A number of RFOs also stated they were aware of fatalities from heart attack amongst urban brigade members while attending fires.

Dealing with heat, dehydration and fatigue are necessary elements of firefighting. RFOs stated they were always looking for signs that personnel were not coping, either physically or mentally, and needed to be relieved during fire suppression activities. There is perhaps a need for training at the RFO and Crew leader level to recognise symptoms, and also for a higher level of self-awareness amongst firefighters of the signs of fatigue and dehydration. One RFO was concerned at the high use of energy drinks to rehydrate among younger members of his crews, and wondered about their impact.

Debriefs following traumatic callouts

The NRFA Guidelines emphasise the need for both physical and psychological fitness for duty. Two RFOs mentioned the Fire Service Health and Safety Officer presentation on this topic at the 2013 Forest and Rural Fire Association of New Zealand (FRFANZ) conference. Many rural fire crews are attending motor vehicle accidents (MVA) and assisting with first response situations, sometimes as first to scene. Two RFAs have had particularly large rural escape burns that ended in traumatic outcomes. All but two RFAs had debrief procedures available for members who had been involved in a traumatic callout. Some were informal, but most followed the NZFS Incident Management and Critical Stress team guidelines, or provided St John counselling service or in-house chaplaincy. At present, it is not mandatory for the NZFS to offer their counselling service to VRFF assisting in urban fire callouts and rescues. One RFO felt the role of providing a debrief or counselling was beyond the NRFA duties of rural firefighting, and this was the role of the District Health Board or New Zealand Police, should they want VRFF crews to assist in MVA and first response.

Do RFOs feel a minimum physical fitness test should be introduced?

There was definite support to continue undertaking the pack test for those being deployed internationally, and also for rural firefighters in the NRFA Rural Fire Response Teams. Most RFOs felt there was a need to encourage the young and keen crew members to maintain physical fitness, and to encourage them to become part of the NRFA Rural Fire Response Teams. NRFA Rural Fire Response Team Firefighters are often employed on contract by the local territorial authority, and this might get around the legal ability to test 'volunteers'.

There was also a good level of support to require an arduous pack test for DOC High Country volunteer crews, and those fire crews likely to be responding to steep slope and gully fires. Many RFOs did not see the need for any physical testing for crews called out to mainly flat land vegetation fires or where the majority of callouts are roadside fires or urban assists.

There was a clear indication that the majority of RFOs thought medical test assessments gave them the best indications of heart and lung capacity risk, and most supported this as a necessary step for all volunteer rural fire personnel. However, some RFOs questioned the "ageist" requirement in the Guidelines of different timeframes for medical assessments depending on age. A number of RFOs also mentioned they had older members who could possibly physically outwork younger members of the crews.

Most RFOs supported a minimum fitness level for those firefighters conducting frontline rural firefighting tasks (58%), but it was not clear what this level should be. Many felt that the pack test was a good guideline, where some regarded it as the international standard benchmark.

Most did NOT support the need for any formal physical testing beyond an annual medical test for those doing pump operating, running out hoses, driving and running supplies or administrative tasks. There was a unanimous desire to cater for people who don't want to be frontline firefighters but still make a valuable contribution to the VRFF crews. Many of the crew members are not motivated by the physical nature of firefighting, but by doing something for their communities and belonging to a VRFF team.

There was almost no support amongst RFOs for the low-level walk test.

Some RFOs would like to see a more rigorous medical assessment and no pack test as a minimum physical level. Such an assessment should include blood pressure and heart and lung capacity testing.

A number of RFOs suggested some task-oriented testing procedures that could be used during training nights to assess stamina and upper body capacity. These included:

- Pulling a loaded hose through thick vegetation
- Walking up a steep slope (or stairs) with a hose pack
- Carrying a pump to a water source, and starting it
- Lifting a hose pack and a pump off the side of a truck.

Impacts on VRFF if a minimum fitness level was introduced

A clear message was that the volunteer rural fire forces attract volunteers by making it a fun and inclusive place to be, and a minimum level for all personnel would negatively change the culture of the VRFF.

Volunteer motivations

Almost unanimously, RFOs felt that if a minimum level was applied across the board to all volunteers, it would result in at least half of their personnel leaving the rural fire force. This included areas where it was felt that most of the personnel could easily pass the test. The concerns are therefore both that the older and less fit members would be excluded from being members of the VRFF, resulting in a loss of critical mass in small rural areas to continue the rural fire team; and also that there would be a rebellion in principle by many of the fitter members of the VRFF force, due to the mandatory nature of the fitness test being implemented, and they would also leave. Most cited the introduction of the unit standards as an example of what would likely occur. One RFO lost 47% of his personnel from the unit standards introduction, and felt there were already enough restrictions on VRFF volunteers. This agrees with the Heathrose Research findings that compliance and administration issues were the least liked aspect of being involved in the VRFF (Alkema et al., 2013).

Loss of rural fire support

Should a large percentage of volunteers leave, this would result in considerable loss of knowledge and experience, making for a much more vulnerable and less capable national Volunteer Rural Fire force. The force may also become very unbalanced—a lot of physically capable people, but none very willing to man the pumps or supply the scones or drive the tanker etc. In short the community morale and spirit of the crews would be lacking.

The closure of VRFF crews from some small communities would leave them especially vulnerable, given the long distances to the nearest rural firefighting crew. While most RFOs felt ex-volunteers would still ‘Be there’ for their community if an incident occurred, this would be in an unofficial capacity, and may lead to an unco-ordinated command strategy amongst those responding. VRFF crews are an important part of rural communities, both socially and economically—a Pricewaterhouse Coopers report (2009)

estimated the economic impact of vegetation fire in small remote communities at \$2.2 million.

At present, some callouts are only being responded to by a handful of members, usually older, due to younger crew members working during the daytime. Regions experiencing dairy conversions are also failing to get younger recruits, as it is harder for share milkers and herd managers to take time off to respond to callouts.

Guidelines seen as industry standard

A couple of RFOs feared that the NRFA Guidelines are in danger of becoming seen by Department of Labour as the industry standard anyway, even though they are a voluntary code of practice. Some felt that a minimum fitness level could be gradually introduced, so that for new recruits it would be mandatory, but voluntary for existing personnel. One RFA has already done this since 2009.

Some RFOs were concerned that personnel might see that passing the pack test was a qualification for frontline duty, whereas the RFOs took other aspects of suitability into consideration besides fitness, and assigned the best personnel available to different tasks. This could add to the risk on a fire ground if people feel they should be doing more than they are asked to, based on pack test scores.

Cost implications

Some RFOs were very concerned with the additional costs of implementing and administering a minimum level physical test. Who would cover the cost of the medicals? Or cover the days leave from work to do the pack test and medical, etc.? Many of the forestry and contractor personnel are employed on wages rather than as salaried staff, and would lose significant income if not reimbursed.

Volunteer Rural Firefighter Interviews

Twenty VRFF personnel were interviewed to ask their opinions on the pack test. All had completed the arduous pack test (walk 4.8 km with a 20.5 kg load in 45 minutes) at some stage in the last two years. The firefighters ranged in rural fire experience from 1 year to 35 years. They had all attended fires as frontline firefighters.

The firefighters were asked:

- Do you train especially for the pack test or just maintain your fitness levels all year?
- In your experience, how hard is the PHT compared with the exertion of a rural fire call out?
- Do you feel there should be some minimum fitness standard across all VRFF?

Their responses are summarised in the table below.

	Yes	No	Maintain fitness
Special training for the pack test?	1	5	14
Exertion similar in arduous pack test vs fires?	3	17	-
Does there need to be some minimum fitness standard?	20	-	-

Training

Most respondents (70 %) do no special training for the pack test but do strenuous physical activity for recreation such as regularly going to the gym, cycling, touch rugby, squash, tramping, hunting and vigorous walking. One person trained specifically for the pack test by walking regularly with a weighted backpack before testing. The remaining three respondents did no additional physical exercise other than their normal lifestyle but they were younger firefighters who felt they led an active lifestyle.

Arduous pack test vs fire ground work

Only three firefighters reported being in situations at rural fires that were as physically demanding as the arduous pack test. They were all very experienced firefighters who had a very extensive range of fire experience. They recalled situations where there were very high workloads - "Steep terrain, carrying fuel and chainsaw", "Long uphill climbs". Most (85 %) firefighters had not experienced fire situations that were as physically demanding as the arduous pack test. One commented that during the pack he gets shin splints because he has to walk so fast. "I never get shin splints at fires". Other comments were "...the pack test is over the top", "Never had to work as hard as the test", "It is an unnatural walking speed", "I would run if I had to go that fast normally".

Need for a minimum fitness level

All firefighters questioned were firm that there needed to be some form of minimum fitness level. Particularly because firefighters work together as a team and need to be able to rely on their fellow crew members if they need assistance. Most firefighters reported that they maintained their health and fitness because they did not want to be a liability to others on the fireground.

PART 3: RURAL FIREFIGHTING TASKS AND THEIR PHYSICAL REQUIREMENTS

Physiological Impacts of Rural Firefighting

The physiological workload of New Zealand Rural Firefighters has been measured in a number of field studies over recent years (Parker et al. 2008; Parker 2010). There is a great interest in the fitness testing requirements for rural firefighters because of the perceived physical demand of the firefighting tasks. This review summarises the available complete physiological workload data sets that have been collected under New Zealand operational (as opposed to simulated) firefighting conditions.

Monitoring of NZ firefighters on the job

Up until recently the workload of firefighters was estimated or measured in indirect ways (e.g. Ruby et al. 2002). Studies had estimated workload (e.g. Heil, 2004) and productivity (e.g. Murphy & Quintilio, 1979; Murphy, Quintilio & Woodard, 1989) from simulated rural fires and some had asked the firefighters to estimate workload and/or productivity from memory (e.g. Schmidt & Rinehart, 1982; McCarthy, Tolhurst & Wouters, 2003). An ongoing New Zealand study since 2007 aims to gain better data through video exposure monitoring, to record aspects of the environment and physiological response of firefighters to that environment at real rural fires (Parker, 2010).

Video exposure monitoring

Video exposure monitoring involves the combination of real-time monitoring instruments, usually for gases/vapours and dust, with video of the worker's activities (Rosén, Andersson, Walsh, Clark, Säämänen, Heinonen, Riipinen & Pääkkönen, 2005). In the New Zealand firefighter studies heart rate was recorded with a data-logging heart rate monitor and GPS location by a data logging device.

Real-time occupational health monitoring equipment became widely available in the 1980s. The National Institute for Working Life in Sweden linked a real-time paint fume monitoring instrument with a concurrent video recording of the spray painters in a woodwork factory (Rosén & Lundström, 1987). Having a video record of the workers activity, while simultaneously viewing the concentration of paint fumes, enabled the researcher and the workers to see the effects of different work activities on paint fume exposure. *“The value of this arrangement for the occupational hygienist as well as for the worker was immediate and obvious”* proclaimed Rosén et al. (2005, p. 202).

When used for task analysis, video exposure monitoring allows the investigator to determine exactly what task the subject was engaged in and the associated exposure concentration. For example a study of glass fibre reinforced plastic application in waste water tanks showed 46% of the total exposure to styrene was explained by activities undertaken in only 10% of the working time (Andersson & Rosén, 1995).

Visual exposure monitoring supplies solutions, and a way to test those solutions, to occupational exposure problems. Rosén (2002, p. 4) stated in his invited editorial in the *Annals of Occupational Hygiene* that “*Visualisation acted as a catalyst for productive communication between process experts and occupational hygienists, and became the key to a systematic problem-solving process.*” The same methods can be applied to the studies of firefighters, identifying physically demanding tasks.

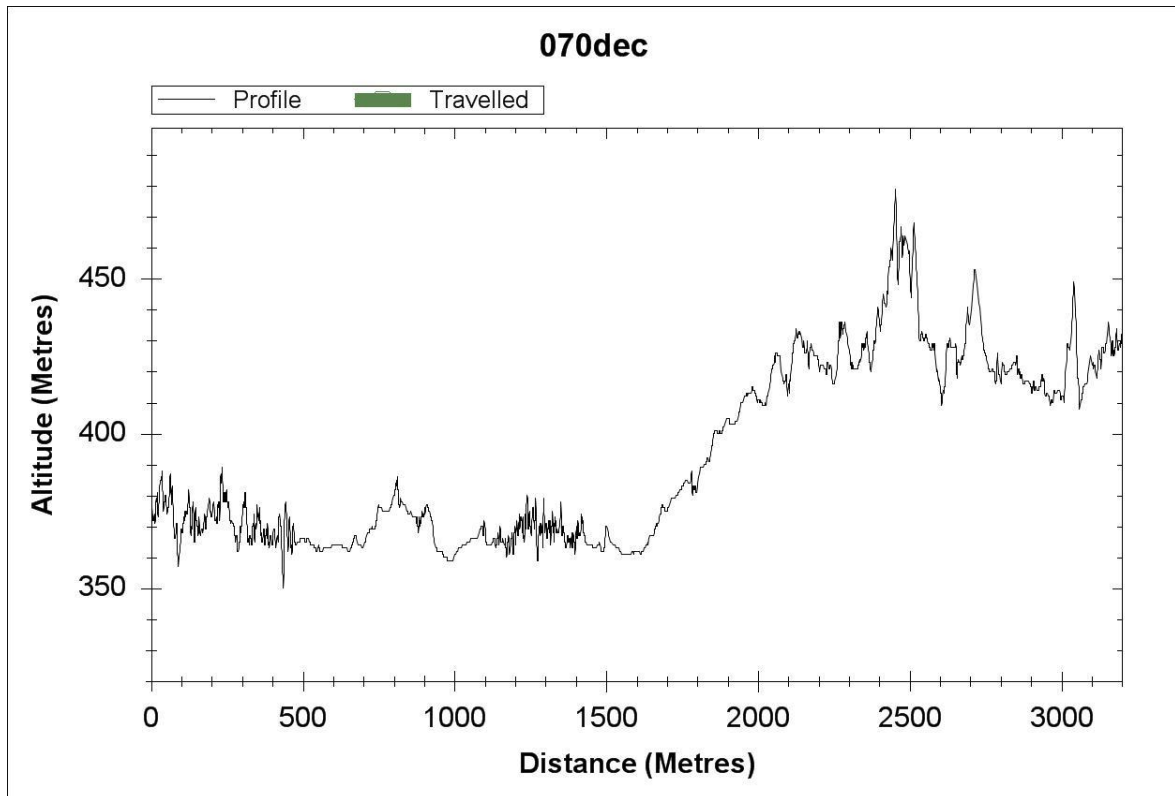
Rural firefighter response under workload

The following scale has been proposed by Rodahl (1989) to give estimates of workload from heart rate:

Heart rate (beats / minute)	Physiological workload
Less than 90	Light
90 – 110	Moderate
110 – 130	Heavy
130 – 150	Very heavy
150 - 170	Extremely heavy

All firefighting tasks except observation of fire can be classified as “Heavy” resulting in average heart rates between 110 and 130 beats per minute (bpm). These results are similar to New Zealand forestry tasks where average heart rates between 115 and 130 bpm are common. Examination of detailed heart rate traces indicated the intermittent nature of fire suppression tasks. To maintain a high average heart rate the firefighters take brief rests by changing tasks.

The heart rate of firefighters at real fires can be high for extended periods of time if they are engaged in physically demanding work. The steepness of the terrain has a very big influence on the physiological workload of the firefighter. In the figure below the vertical and horizontal displacement of the firefighter were recorded by a miniature GPS data logger. He was fighting a fire in pine trees on steep terrain.



Vertical (altitude) and horizontal (distance) movement of a firefighter in initial attack

The firefighter traversed 3100 metres and climbed from 360 metres above sea level to 480 metres in the two hour recording period. He had numerous journeys up and down hill as can be seen in the figure.

Average heart rate for the firefighter on steep terrain during the observation period was 145 beats/minute. This compares with Budd (2001) who reported that Australian rural firefighters, at ‘realistic’ experimental bush fires, exhibited average heart rates of 152 beats/minute. He concluded that the stability of the firefighter’s heart rate is explained by the self-pacing of work and by the wearing of clothing that allows unrestricted evaporation of sweat. However the higher heart rates found by Budd did not include rest periods and conversation which was recorded in the New Zealand study by Parker (2010).

Carbon monoxide exposure

Carbon monoxide (CO) has a significant effect on physical performance because it reduces the amount of oxygen that can be carried by the blood. Therefore the heart must pump more blood to maintain oxygen to the tissues.



Recent work by Scion (Parker et al., 2010) measured the exposure of firefighters to CO. Self-pacing of firefighters is probably a highly significant factor when examining workload and heart rate in the presence of CO. An Australian study on occupational fitness and work strain (the adopted level of individual ‘effort’) in bushfire firefighting (Budd, 2001) found that firefighters paced themselves at similar levels of strain (relative to their own abilities) regardless of the wide range of levels of fitness in the crews. Performance/productivity therefore differed widely but ‘effort’ did not. In the earlier studies on which the 2001 paper was based, Brotherhood et al. (1997) concluded that “*perceived exertion and ventilatory threshold (the upper limit of comfortable breathing) provided the cues by which firefighters pace themselves at sustainable work rates that balance their fireline productivity against its physiological cost*”. Heart rate increased linearly with productivity, whereas perceived exertion and ventilatory threshold increased curvilinearly, rising steeply at fast work rates. Therefore firefighters will work more slowly, if they can, under conditions of high physiological workload.

Applicability of tests

The fitness tests used in New Zealand have not been validated against the tasks New Zealand rural firefighters are normally engaged in. However, some validation work has taken place in Australia by Matt Phillips and others. Phillips et al., (2011) state the Pack Hike Test (PHT) was based on North American wildland firefighting data (Sharkey, 1999) and has only been validated with North American firefighters (Sharkey and Davis, 2008). They explain that Australian rural firefighters do not undertake the prolonged load carriage duties (Phillips et al., 2008) typical of United States wildland firefighters (Sharkey and Davis, 2008). *“As load carriage is the core component of the PHT (Sharkey, 1999) the applicability to Australian volunteer firefighters may be questioned”* (Phillips et al., 2011, p 412). They go on to state that most Australian volunteer firefighters use different fire suppression techniques (spraying water) compared with United States wildland firefighters who use handtools (i.e. raking fireline). Lord et al., (2012, p 192) state *“... wildland firefighters in the United States primarily use handtools (i.e. rakes and axes) and hike to and from the fireground carrying these tools (Sharkey and Davis, 2008). In contrast, Australian volunteer firefighters (including ACT RFS personnel) generally strive to extinguish bushfires using hoses connected to fire trucks or ‘tankers’ (Aisbett and Nichols, 2007)”*.

To date, New Zealand studies of firefighters have shown them to only walk relatively short distances to the fire, not carry much gear on their backs and use a mixture of hand tools and water. In this way they differ from both United States and Australian firefighters. However, there is a lack of data for firefighters at initial attack and in difficult or steep terrain where workload will be higher.

Measurement of firefighter physiological workload

Jermier, Gaines and McIntosh (1989, p. 16) state *“A dangerous setting is one in which a physically and/or psychologically harmful event has some probability of occurring.”* Certainly rural firefighting can be considered as a dangerous activity. It is difficult and dangerous for investigators to be present to collect data from workers in dangerous situations. The investigator is seen as an extra firefighter who can be utilised in the emergency situation and may be requested to carry equipment or help with fire suppression. In these circumstances it is difficult to collect data and any work data collected will not be representative of normal work.

But it is often difficult to get access to workers undertaking dangerous work. The researcher must have a background in that work or undertake training to enter the fire ground. More often, research investigating people working in dangerous occupations has been limited to interviews with workers after the work or from simulation of dangerous work. For example, the estimation of rural firefighter ‘productivity’ has been an active research area for many years because fire managers need estimates of productivity to plan the allocation of firefighters to a fire. Too many firefighters at a location is wasteful, too few firefighters may not control the fire. However, collection of data from real fires is extremely difficult. Of fourteen English language papers written on rural firefighter productivity in the period 1970 to 2003, only two used data from real fires (Lindquist, 1970; Quintilio, Van Nest, Murphy & Woodard, 1988). The remainder used ‘expert opinion’ (e.g. Fried & Gilles, 1989; Schmidt & Rinehart, 1982), simulated fires (no fire

present) or experimental fires (where additional resources were available if the fire got out of control) to determine firefighter productivity.

Few studies, in the English literature, have measured rural firefighting work at real fires (Parker, Ashby, Pearce & Riley, 2007). Those studies that have measured fire suppression productivity (area of fire extinguished per unit time) at real fires have not measured the physiological workload on the firefighter (Parker, et al. 2007). A considerable amount of research involving firefighters at real rural fires has been carried out in Chile but published in Spanish (Apud, Meyer & Maureira, 2002).

Scientist as firefighter

The most recent data collected (Birdlings Flat Fire and Rakia River Fire) are actually from the firefighting activities of the first author of this report (Richard Parker). There had been difficulties in the past getting complete datasets from firefighters at fires. The fragile electronic cameras and sensors often failed. Greater understanding of the physiological workload of firefighting is achieved when the researcher is also a trained firefighter embedded in a normal fire crew. Problems with data recording equipment can be rectified in the field and recollection of events and activities during the fire have the extra dimension of 'being there'. Work is currently underway with Scion and the Human Interface Technology Laboratory (HITLab) to develop a firefighter helmet which records all relevant data without the need for training or careful operation.

Case study datasets

Summary of data sets collected

Fire	Kaingaroa Forest	Sala St Rotorua	Mahia	Birdlings Flat	Blenheim	Rakaia River
Fuel	Young pine plantation	Eucalyptus trees and undergrowth	Yong pine plantation	Coprosma	Bailed hay	Matagauri
Task	Initial attack	Mop up	Mop up	Mop up	Mop up	Mop up
Role	Firefighter & Crew Leader	Firefighter	Firefighter & Crew Leader	Firefighter	Firefighter	Firefighter
Tools	Hand tools	Hose	Hose	Hose and backpack pump	Hand tools	Hand tools
Maximum heart rate (bpm)	185	144	168	145	138	154
Average heart rate (bpm)	145	119	109	97*	120*	123
Age (years)	28	38	33	53	42	53

*Includes rest periods

Field data collected from real fire operations

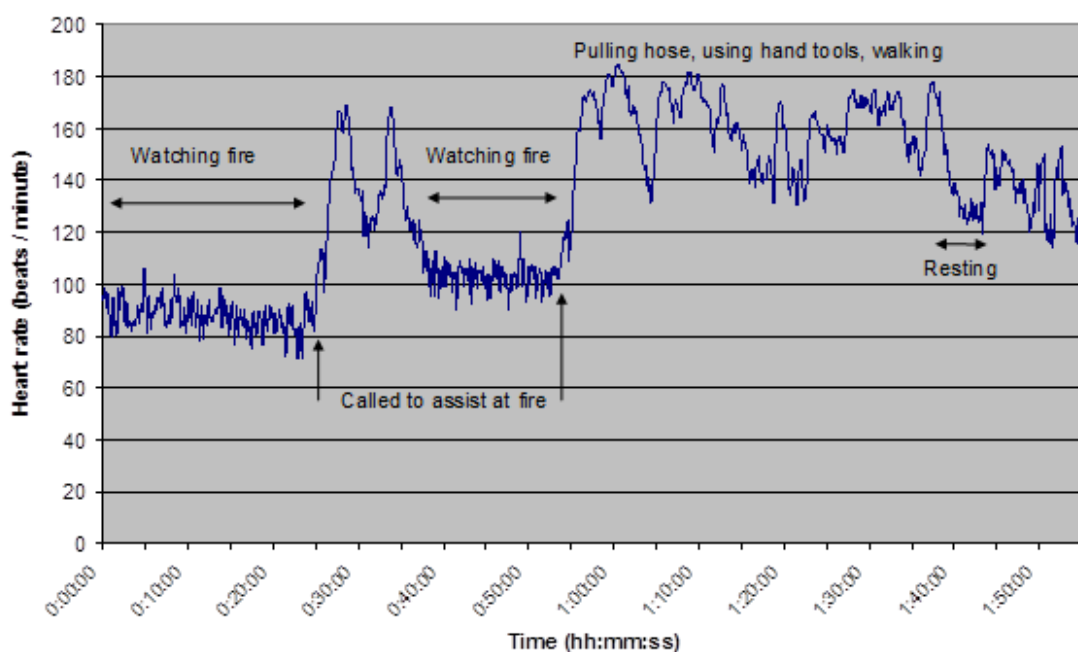
The preceding summary data sets are a unique collection of heart rate records collected from firefighters under real operational conditions. Because data collection is secondary to fire suppression tasks these data sets are, in some cases, an incomplete record of the firefighters true physiological workload on the day. Data collection equipment may fail and cannot be replaced, batteries go flat, data collection equipment gets broken or lost. For example, the firefighter at the Rakaia Fire has a heart rate record for approximately 3 hours of work (1500 hours to 1800 hours) . However, he actually worked for 7 hours (to 2000 hours) but the heart rate monitor had run out of battery power.

Overall the data records present a picture of generally heavy workload. These are all mopping up operations and we have not yet been able to measure heart rate at initial attack operations when workloads are expected to be higher. Also, these records are from predominantly flat terrain.

Kaingaroa Forest Fire

Initial attack on hilly terrain in a young radiata pine plantation.

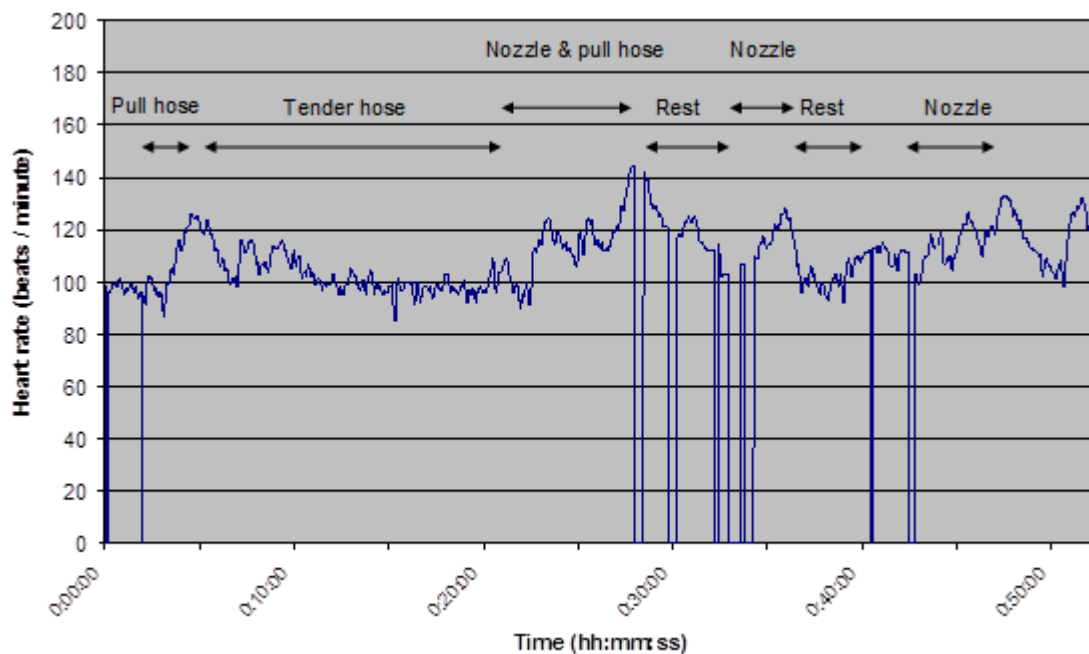
The firefighter's heart rate was low while he was watching the fire being ignited by a helicopter. He was standing still watching the progression of the fire and ensuring flames did not spill over the firebreak he was protecting. At 25 minutes he got a radio call that one of his team members was overcome with smoke and he walked and ran up the hill to assist her. He then returned to the road and watched the fire burn and continued to monitor the fire break. At 55 minutes he was called on the radio for assistance at the site where the fire had spilled over into standing trees. He ran up hill to the fire and worked with a hose crew and monitored his crew members.



Sala Street, Rotorua

Mopping up on flat terrain at a fire in a eucalyptus plantation with understory vegetation.

The firefighter was engaged in two main tasks – tending the fire hose or holding on to the hose nozzle directing water at the fire. Occasionally he would pull the hose along the ground to reposition it. His heart rate would climb rapidly when repositioning the hose, would remain constant when tending the hose and climb gradually when on the nozzle. Holding the nozzle and directing the flow of water is physically demanding because the firefighter has to hold the nozzle against the reactive force of the water.



Mahia Fire

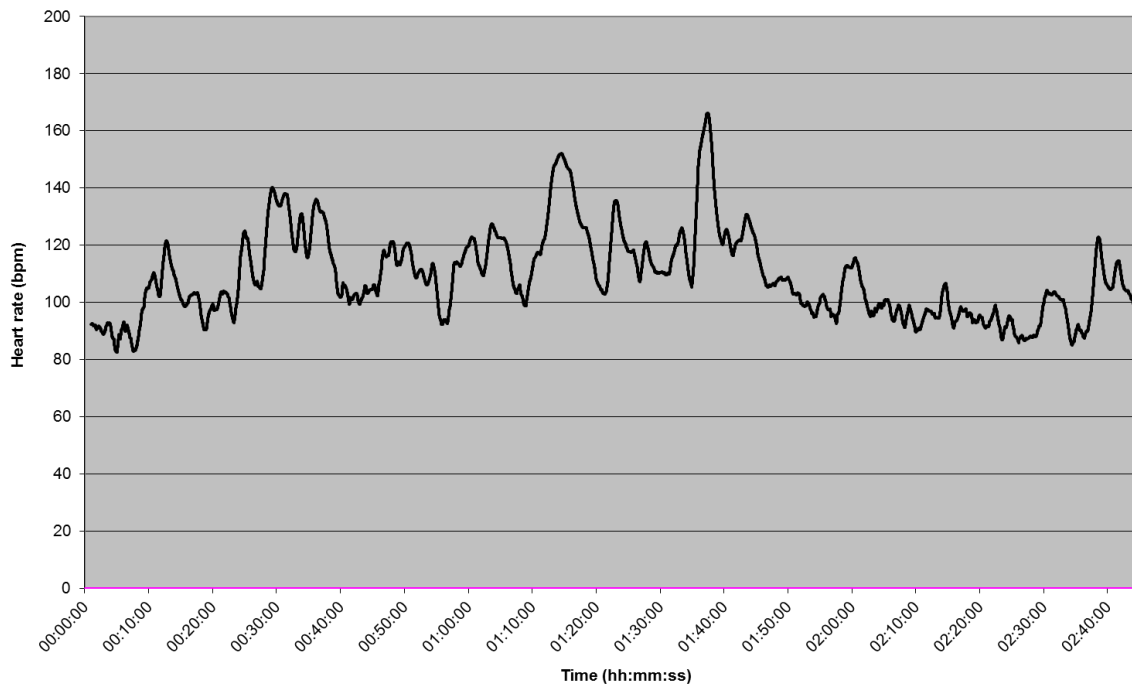
Mopping up in a young pine forest in sand dunes on predominantly flat terrain.

The firefighter walked on flat land to the mop up area. He then was engaged in carrying hose packs, hosing applying water from a hose to burning vegetation, rolling up hoses, working on a Wajax pump. In addition were the usual radio and face to face communication activities.

Maximum heart rate was 168 beats per minute, for a brief period. This was achieved when pulling hoses along the ground.

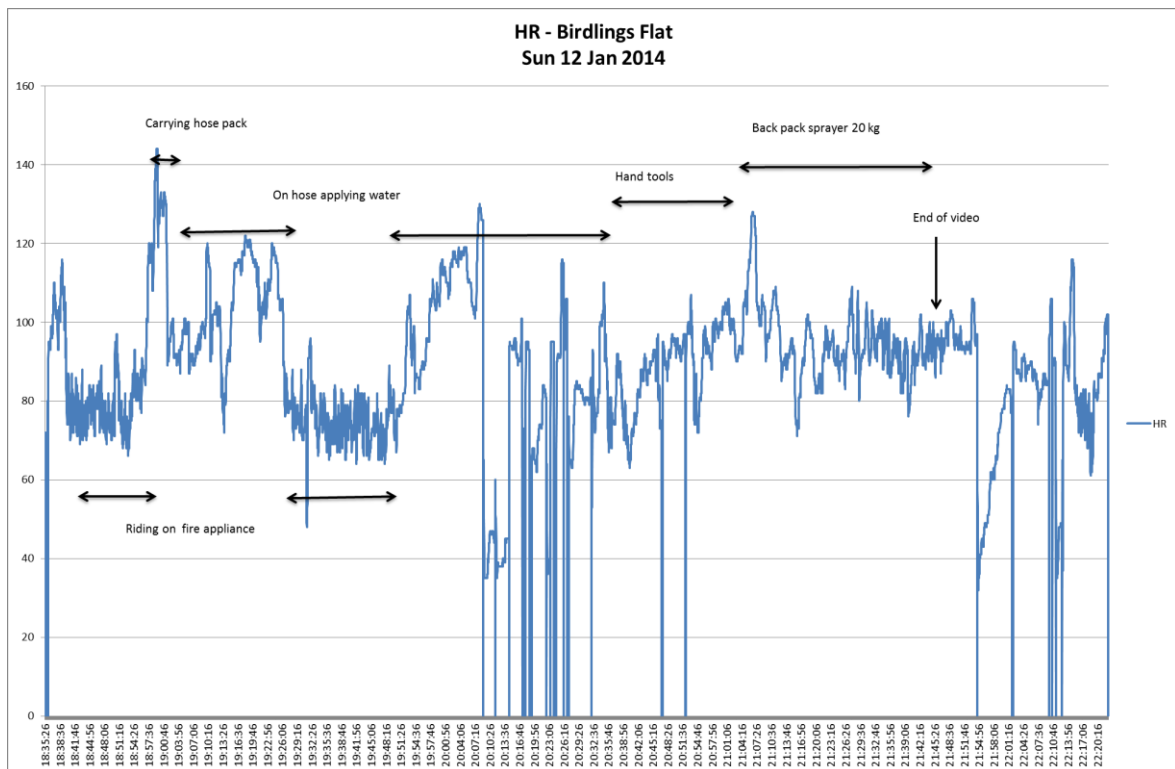


The firefighter is applying water to vegetation – helmet camera view



Birdlings Flat Fire

Mopping up on flat terrain among burnt coprosma bushes. Using mostly water from a tanker and occasional hand tool use. Maximum heart rate was 145 beats per minutes when running out a hose pack. There were periods of rest when riding on a fire appliance.

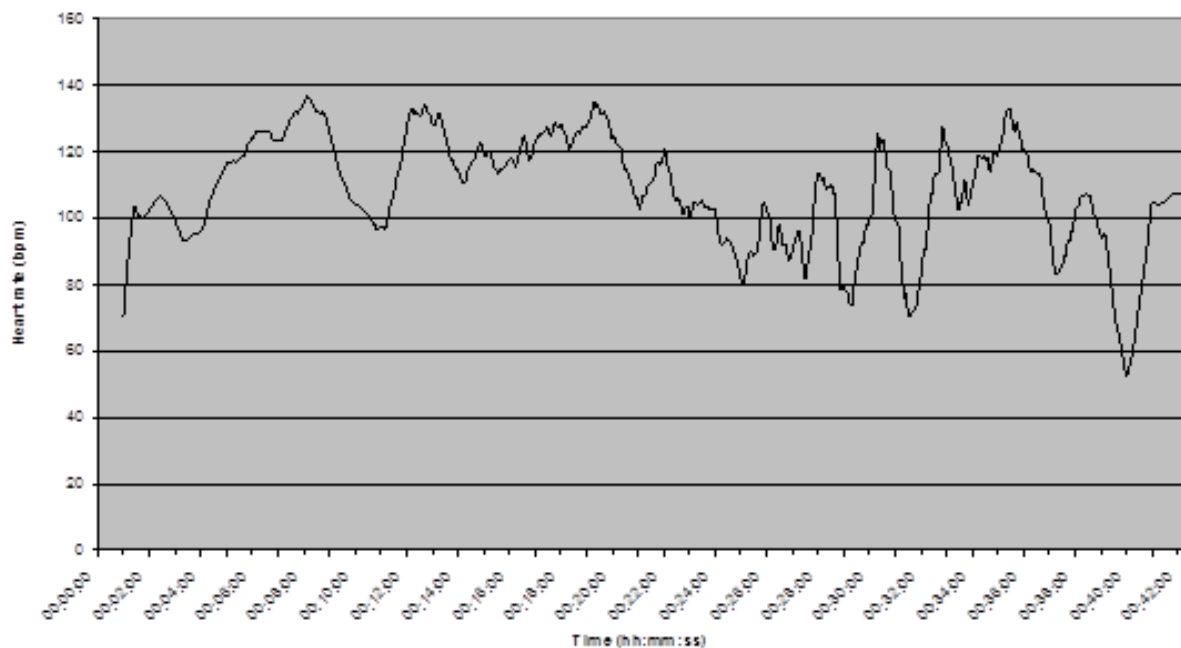


Blenheim Fire

Fire suppression and mopping up of a hay barn fire with the raking out of hay and removal of covering roofing iron.

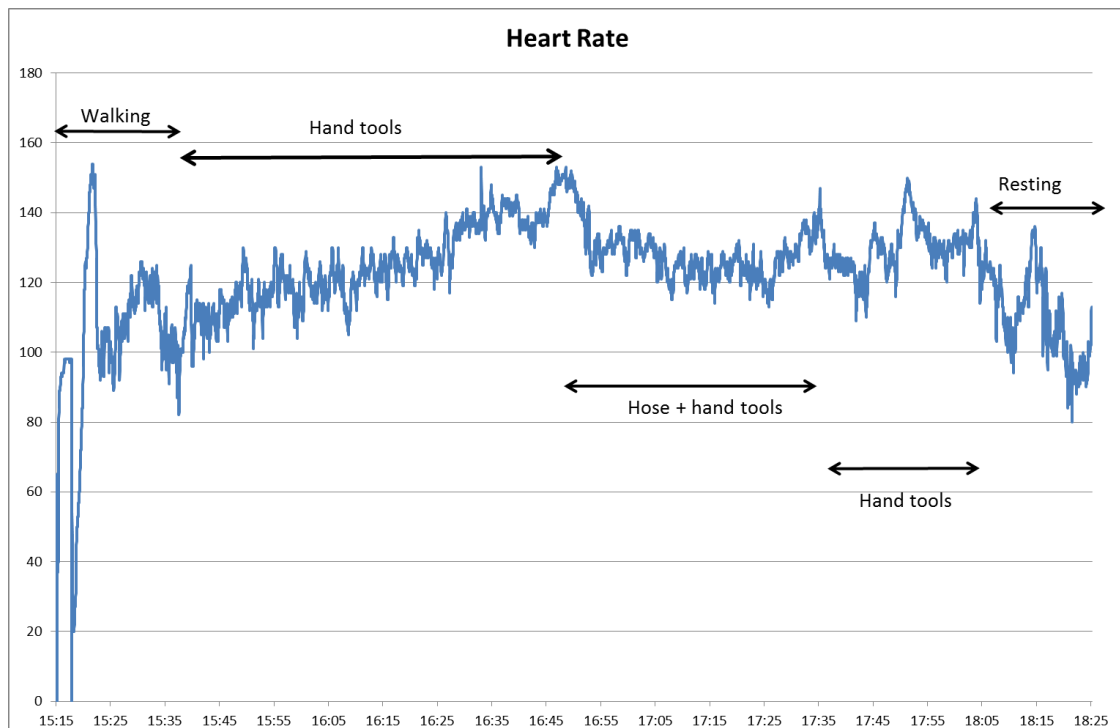
The firefighter was working on flat ground and was able to drive to the fire. He was using hand tools and a hose from the appliance.

Maximum heart rate was less than 140 beats per minute with a 7 minute and 10 minute period of heavy work (above 110 beats per minute).



Rakaia Fire

The firefighter was predominantly using hand tools during the measurement period. The terrain was sloping at approximately 15 degrees and very loose soil underfoot. Average heart rate was 123 beats per minute. Heart rate progressively increased as fatigue accumulated.



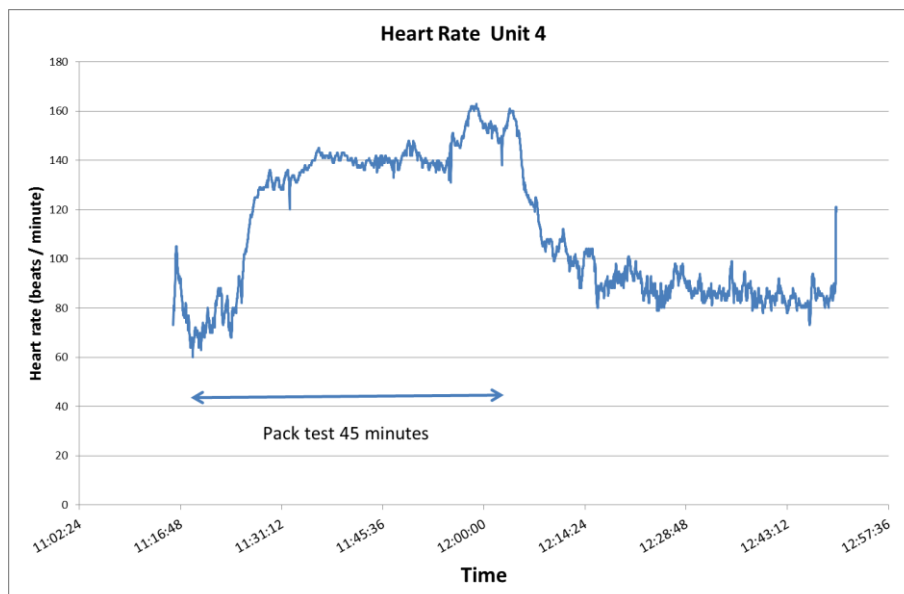
Self-pacing of firefighters

From the field studies at real fires presented here, most firefighters did not exhibit extremely high heart rates over prolonged periods. The firefighter at the Kaingaroa Forest Fire did have three 10 minute periods of intense activity above 160 bpm in support of colleagues engaged in initial attack. In ‘non-attack’ situations people tend to work at a ‘comfortable’ level of exertion knowing they may have to work for many hours. Budd (2001, p. 381) nicely put it that: “*Contrary to the findings of laboratory studies heart rate (and rectal temperature) were not changed by variations of 36-217 min in work duration; 406-630 W in energy expenditure; 15-34 degrees C in wet-bulb globe temperature (WBGT), 7-27% in body fat content; or 31-63 ml min⁻¹ kg⁻¹ body mass in maximum oxygen uptake (VO₂max)*”. He concluded that the stability of the firefighter’s heart rate is explained by the self-pacing of work and by the wearing of clothing that allows unrestricted evaporation of sweat.

We will be working hard to capture heart rate recordings from firefighters at initial attack, especially on steep and difficult terrain. Do they self pace? These are situations where work fitness will be important.

Heart rate during the pack test

The pack test raises heart rate to a relatively constant level as is seen in the figure below. However, other than a burst of effort near the end of the test, heart rate is relatively constant. Compare this with the heart rates of firefighters presented earlier. At real fires the data collected showed considerable variation over time with periods of working hard interspersed with periods of resting or working less hard. If the work was steady (e.g. Rakaia Fire) heart rate climbed slowly as fatigue increased.



Heart rate of a successful participant in the arduous pack test

PART 4: RECOMMENDED MINIMUM FITNESS REQUIREMENTS FOR NEW ZEALAND VOLUNTEER RURAL FIREFIGHTERS

Summary of findings

- The NRFA Guidelines have been used by around half of the RFAs we spoke with, however, only a third of RFOs felt the pack test was a good indicator of fitness for rural fire fighting.
- New Zealand rural fire fighting differs from international experiences in that it is more stop-start in nature, and thus there are more short bursts of highly intense activity, with rest periods between. The average heart rate for fire fighters we have monitored is 115-130 beats per minute, however, higher heart rates of between 120-180 beats per minute can be experienced for short intense activities, particularly hand tool work. New Zealand fire fighters also have shorter hose lengths to run out, and rely on helicopters for aid in difficult terrain..
- The pack test is perceived by most RFOs as a robust international standard, however, it appears there is a lack of validation of the applicability of the pack test to New Zealand fire-fighting conditions. The United States (where the test was developed) do more prolonged load carriage duties, and have different fire suppression techniques. In New Zealand there is a mix of suppression techniques used, and it appears more tasks requiring upper body strength for frontline duties than just walking in carrying a hose pack.
- Heat, carbon monoxide and steepness of terrain are the major aspects which impact on the ability to maintain physical fitness during fire fighting.
- The ability to recognise the signs of fatigue and physical limits in both yourself and fellow team members is critical to fire ground safety.
- There is evidence that rural fire fighters use the stop-start nature to rest and also self-pace their work effort. However, there have unfortunately been incidences where physical fitness limitations have caused collapse, in some cases fatal.
- The importance of medical testing to uncover or raise awareness of pre-existing medical conditions has been highlighted in the United States experiences of rural fire fighting. Medical testing rather than self-assessment can highlight unknown medical conditions before they become an issue during firefighting tasks on a fire ground.
- The majority of RFOs as well as those VRFF personnel interviewed undertaking the pack test support the need for a minimum fitness requirement for frontline personnel.
- A clear message was that the volunteer rural fire forces attract volunteers by making it a fun and inclusive place to be, and a minimum level for all personnel would negatively change the culture of the VRFF.

Recommendations

A three - tier minimum fitness recommendation:

Tier 1	Medical testing by GP or other medical professional	Voluntary and provided at no cost to firefighters at intervals as laid out in the Guidelines	All firefighters
Tier 2	Moderate pack test Walk 3.2 km, 11.3 kg, 30 minutes	Voluntary	For all front line firefighters and pump operators
Tier 3	Arduous pack test Walk 4.8 km, 20.5 kg, 45 minutes	Compulsory	For all NRFA Rural Fire Response Team firefighters (paid), and internationally deployed rural firefighters
		Voluntary	For all other frontline fire fighters.

Tier 1

More formal medical testing by a GP verifies any issues that individuals may be already aware of, as well as highlighting unknown medical conditions that could potentially cause the person difficulty during VRRF duties. The NRFA Medical test checklist would need to be completed and discussed with a medical professional prior to assessment. It is recommended to keep this voluntary due to the concern from some RFAs around funding for staff to be assessed by a GP, however, certain RFAs will still be required to undertake medical testing of some volunteers for health insurance purposes (not fitness assessments).

Tier 2

A number of RFAs are interested in conducting the pack test, and around half of the RFOs have introduced some level of the NRFA fitness Guidelines. However, only a third felt the pack test was a good indicator of fitness for their crews and their situations. In recognition of the desire by RFOs for some form of fitness testing, we recommend the medium level pack test for frontline fire fighters and pump operators who are not being deployed, or who are not willing to undertake the full pack test. This would be voluntary, and could be used as a training-night exercise.

Tier 3

The arduous level pack test as outlined in the NRFA Guidelines would be retained, and is recommended for all frontline fire fighters. The arduous pack test should remain a mandatory requirement for all fire fighters involved in NRFA Rural Fire Response Team (paid) firefighters and those deployed internationally. Provision should also be made within RFAs for other frontline fire fighters to complete the arduous pack test on a voluntary basis where personnel want to complete the test.

It is recommended that personnel undertaking Tiers 2 & 3 also complete the Tier 1 medical test prior to conducting either the moderate or arduous pack test.

We suggest the NRFA support these minimum fitness recommendations by:

- Encouraging RFOs to train crew leaders in recognising the signs of fatigue and physical fitness limitations in personnel, and for crew leaders to hold dialogue about self-awareness of physical fitness levels and health limitations with their crews.
- Continuing to encourage: RFAs to maintain the fitness; and RFOs to consider implementing a higher tier as a minimum fitness level within their crews.
- Continuing research to fill gaps in knowledge around real time productivity and maximum heart /lung capacity for a variety of fire-fighting tasks. Of particular benefit would be to include heart rate monitoring for pump operators, and mop-up operations, and to ensure an increased dataset for real-time firefighting activities across age-groups, and during the initial attack phase.

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Appendix A: NRFA medical test forms

Health Monitoring Programme: Fitness for Fire-fighting Consent Form

The Health and Safety in Employment Act 1992, Section 10(2) refers.

Firefighter Name: _____

Rural Fire Authority: _____

Is committed to best practices of occupational safety and health and is committed to meeting its obligations under the Health and Safety in Employment Act 1992. Section 10(2) requires the employer to monitor an employee's exposure to known hazards and to take all practicable steps to obtain the employee's informed consent to monitor their health in relation to their exposure to hazards.

Consent includes an agreement to undertake a medical assessment as well as participate in a task-based fitness test.

If passed suitable by a doctor you will be required to undergo a task-based test of your fitness to undertake fire-fighting duties specific to your fireground position. An information pack about the testing regime and process will be given to you with this form. You should read this material and seek answers to any questions before giving your consent to undergo a medical examination and a task-based fitness test.

By law, the _____ Rural Fire Authority is required to obtain consent to undertake any form of occupational health monitoring.

We have explained the importance of and need for Employee Health Monitoring. It is important you know your interests are protected under the Health and Safety in Employment Act 1992, the Privacy Act 1993 and the principles of the Health Information Privacy Code 1994.

For the purposes of the Rural Fire Health and Fitness programme the authority will:

- Collect only the information needed to implement the programme.
- Keep the Rural Fire Health and Fitness programme information about you secure.
- Use the information only for the purposes of which it was collected.
- Observe all the laws and regulations regarding the release of information collected.

Consent

To indicate your consent to participate in the Rural Fire Health and Fitness programme and to the collection of relevant health information in terms of Section 10(2) of the Health and Safety in Employment Act, please sign below where indicated.

I consent to participate in the _____ Rural Fire Authority Rural Fire Health and Fitness programme, and to the collection of relevant health information about me by a doctor.

Signed (Firefighter): _____

Date: _____

Medical History Checklist

Firefighting is potentially a hazardous and physically demanding activity. Firefighting is also a safety-critical activity where the actions of the firefighter can affect their own and others' safety. The firefighter is required to be both mentally and physically fit to do their job safely and without putting others at risk.

A candidate for the Rural Fire Health and Fitness programme should fill in this form and give it to the doctor at the time of their medical check. The form provides the doctor with a snapshot of the firefighter's medical history that will help the doctor to evaluate the candidate. Completing this form is optional.

Medical History Checklist *(To be completed by the Firefighter)*

Firefighter Name: _____

Rural Fire Authority: _____

Intended test level: High Moderate Low

This questionnaire is to identify any health problems that may affect your ability to safely work as a firefighter or to participate in the task-based fitness test. The information will help your doctor who is conducting a medical assessment.

Please Provide details if you answer 'Yes' to any question.

Q1	Do you know of any health problems that would affect your ability to safely work as a firefighter or undertake the pack test?	yes/no
Q2	Have you ever had heart disease, heart surgery, heart attack (MI), blood pressure problems, chest pains (angina) or palpitations (an irregular or rapid heartbeat)?	yes/no
Q3	Do you have persistent or recurrent muscle, bone, joint, ligament or tendon problems, e.g. arthritis, tendonitis, broken bones or joint injury?	yes/no
Q4	Do you have persistent or recurrent back pain or any sort of back or neck problems?	yes/no
Q5	Have you ever had a stroke of any sort or ever experienced sudden tingling, numbness or loss of feeling in your arms, hands, legs feet or face?	yes/no
Q6	Have you ever had any episodes of loss of consciousness, dizziness, vertigo, fainting, fits, turns or seizures or serious head injury of any sort?	yes/no
Q7	Do you have diabetes, asthma, epilepsy or other long term health problems?	yes/no
Q8	Do you regularly take any prescription or non-prescription medication?	yes/no
Q9	Do you have any problems with your vision or hearing?	yes/no
Q10	Do you regularly exercise for more than 30 minutes three times per week?	yes/no
Q11	Do you smoke?	yes/no

Further details:

Question No.	

Signed (Firefighter): _____

Date: _____

Appendix B: Regional summary of physical assessments undertaken

Region	RFA	How is the RFA managing physical fitness?	Medical tests being conducted?	Pack test conducted?	Is the pack test a good indicator of fitness for RFF?	Is a minimum fitness standard required?
NORTH ISLAND						
<i>Northern NI</i>	Thames	Rely on people knowing their limits, and monitor people's physicality at training nights.	y	n		y
	Whakatane	All do the arduous pack test	y	y	y	y
	Whangarei	pack test every 2 years for volunteers, and yearly for paid contractors	y	y	n	
	Far North DC	Assign people to appropriate tasks. Crew self manage fitness levels and pull out if not up to it.	y	n	n	y
	Opotiki	Tried to bring in pack test, volunteers wouldn't do it.	y	n		n
	Auckland	Volunteers run pack test with DOC Staff	y	y	y	n/y
<i>Central NI</i>	Gisborne	Annually pack test for those who want to	y	y	n	n
	Waikato	Annual pack test, 3 levels. Build a team based on community abilities, and expect people not to put themselves into situations they can't handle.	y	y	n	n
	South Waikato	No volunteers – using contractors				
	Taranaki DOC	Annually as part of std ops for DOC	y	y	y	n
	Taranaki DC	Use rural contractors for District Council	n	n	n	y
	Sth Taranaki DC	Screen thoroughly on recruitment, and pack test every 15-18mths	y	y	n	y
	New Plymouth	Joining with Sth Taranaki as an enlarged RF district	y	y	n	y
	Pumicelands	Undertake pack test annually only for Seasonal guys	y- deployed	y	y/n	n/y
	Lake Taupo	Try to keep crews from silviculture together, and know forestry worker capabilities are high	y	n	n	n
	Bay Forests	Refresher training, and using forestry personnel, so fit anyway. Self management of fitness	n	n	y/n	y
	Otorohanga	No volunteer crews, just use NZFS	n	n		n
	Waipa	The Pirongia RFF is looking to amalgamate with the NZFS, and older members mean this RFA may close.	n	n		
	Wairoa	Older crew member knowledge of community	y	n		n
	Western Bay	Rely on people's own self-knowledge of their capabilities	n	n	n	n
<i>Southern NI</i>	Porirua	No volunteers				
	Tararua	By knowing the people on the crew- and assigning accordingly	n	n	n	n
	Hastings	Self-awareness of limits, and ongoing physical drills at training	n	n	y	n/y
	Central Hawke's Bay	Draw volunteers from farming community so all at a high physical level anyway	y	n		n
	Wellington	Everyone does the pack test annually	y	y	y	y
	Wairarapa	pack test offered to all on voluntary basis	y	y	n/y	y
	Wanganui	Annual pack test	y	y	y	y
	Horizons	Started training for pack test, but didn't get picked up by crews	y	n	n	y
	Palmerston Nth	Run all through the arduous pack test, 90% pass this. Compulsory for new recruits to pass arduous since 2009	y	y	y	y

Region	RFA	How is the RFA managing physical fitness?	Medical tests being conducted?	Pack test conducted?	Is the pack test a good indicator of fitness for RFF?	Is a minimum fitness standard required?
SOUTH ISLAND						
<i>Northern SI</i>	Hurunui	Taking older people off onto lighter duties, people self-managing their health and fitness	y	n		n
	West Coast	Based on fire chief's assessment of fitness for role.	n	n	n	y
<i>Central SI</i>	Waitaki DC	Only running pack test for those who want to do it, seasonal and deployment	y	y		n
	Christchurch	No longer running pack test	n	n	n	y
<i>Southern SI</i>	Dunedin	Only running pack test for those who want to do it- weyjax competitors and seasonal, also running field walk test for IMT staff who want to do the pack test	y	y	n	y/n
	Southern Rural	Yes, for anyone who wants to. Annually for 50+ yrs and bi-annually for those under 50	y	y	y/n	y/n
	Queenstown Lakes	Know the people in community and what they are capable of	n	n	n	n
	Clutha	Discussed bringing in pack test once with on crew --much resistance; another fire crew is now starting to bring in pack test	y/n	n	n	n
	Central Otago	Encourage each other to train and maintain fitness		n	n	y