



## **Mines Rescue FCE Physical preparation for Brigadesman**

# Mines Rescue FCE – Physical preparation for Brigadesmen

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The information in this document is adapted from the book “Physical Performance Optimisation – A handbook for fire fighters” by Herb Groeller and Nigel Taylor. It has been specifically modified for Mines Rescue Brigadesmen and developed to assist in the physical preparation of current and prospective Brigadesmen. It includes;

- detail of the physical demands required of a Mines Rescue Brigadesman
- background information on exercise and training
- recommendations on how to prepare for success in the Mines Rescue Functional Capacity Evaluation.

All information in this document is intended to be a general guide and consultation with an Exercise Physiologist is recommended for more specific individual information.

## Section 1: The physical demands of a Mines Rescue Brigadesman

The University of Wollongong was engaged by Coal Services to assist with quantifying the physical demands of a Mines Rescue Brigadesman and to develop a bona fide physical assessment and performance standard based on these findings.

From the initial rounds of research, the University of Wollongong, in collaboration with NSW Mines Rescue, identified the following tasks to be essential to the role and of the greatest physical demand for a Mines Rescue Brigadesman:

- Walking and transporting equipment underground
- Support work (Propping)
- Fire fighting
- Casualty evacuation

During the second part of the research project, tasks were broken into components and aligned to exercise categories. The final part of the project involved the creation of a circuit, designed to resemble the physical demands of a Mines Rescue Brigadesman. Table 1.1 details exercise types and the specific tasks required.

Table 1.1:

Exercise Type	Task	Specification
1. Cardiorespiratory Endurance	<ul style="list-style-type: none"> <li>● Walking up a grade</li> <li>● Casualty evacuation (stretcher carry)</li> </ul>	<ul style="list-style-type: none"> <li>● One arm carry 7.5kg</li> <li>● One arm carry 28.7kg for 200m</li> </ul>
2. Local Muscle Endurance	<ul style="list-style-type: none"> <li>● Digging</li> <li>● Construct link and lock</li> </ul>	<ul style="list-style-type: none"> <li>● Shovel 105kg gravel mass</li> <li>● 8.7kg per link and lock</li> </ul>
3. Muscular strength lift and place	<ul style="list-style-type: none"> <li>● Lift prop to shoulder height</li> </ul>	<ul style="list-style-type: none"> <li>● Approx. 20kg</li> </ul>
4. Muscular strength hold and carry	<ul style="list-style-type: none"> <li>● Stretcher carry through hatch</li> <li>● Casualty evacuation (stretcher carry)</li> </ul>	<ul style="list-style-type: none"> <li>● 28.7kg/hand for 2-3m</li> <li>● One handed carry 28.7kg for 200m</li> </ul>
5. Muscular strength drag	<ul style="list-style-type: none"> <li>● Casualty drag</li> <li>● Fire-hose drag</li> </ul>	<ul style="list-style-type: none"> <li>● 93kg over 8m</li> <li>● ~294N force over 20m</li> </ul>
6. Postural constraints/ flexibility	<ul style="list-style-type: none"> <li>● Construct link and lock</li> <li>● Digging</li> <li>● Stretcher carry through hatch</li> <li>● Cutting a prop</li> </ul>	<ul style="list-style-type: none"> <li>● Squat, lift from ground to overhead</li> <li>● Bend over, twist/turn</li> <li>● Duck to move through hatch</li> <li>● One handed pull from bent over position</li> </ul>

(Groeller et.al, 2017 - paper 2)

## Section 2: MR FCE Circuit Tasks

*CS Health will provide the following PPE:*

- BG4
- Miners belt
- Miners lamp and battery
- Self-rescuer
- Hearing protection (ear plugs)

*PPE to be provided by the Brigadesman:*

- Hard hat
- Underground boots (free of loose coal)
- Safety glasses (at Brigadesman discretion)
- Gloves (at Brigadesmen discretion)
- Pit clothing

### Walking on a Treadmill

- Wearing all PPE (full PPE details in Module 3), the Functional Capacity Evaluation Participant (FCEP) steps onto the treadmill, holding the 7.5kg MARS bag.
- The assessor gradually increases the treadmill incline and speed.
- Initially, the FCEP is permitted to touch the handles of the treadmill to ensure they are steady and comfortable with walking on the treadmill.
- The assessment time starts when the grade and speed reach 6% and 4.2 km/h. From this point the FCEP should not hold the handles of the treadmill, however if they feel unsteady they may be permitted to briefly grasp the treadmill. FCEP should be closely monitored.
- The FCEP is allowed to carry the bag using their preferred method, for example in either hand, on or over their shoulder, and are permitted to change as they wish.
- The assessment is passed if the FCEP is able to complete 10 minutes of walking while carrying the bag.



### Walking Transition

- After completing the treadmill walking task the FCEP needs to walk to the MRFCE area to complete the remainder of the circuit tasks.
- This transition walk is included to accommodate the difference in the distance between the gym (treadmill location) and the functional assessment area across the different CS Health offices.
- For consistency, a fixed 3mins duration transition walk over a distance of 170m is required to allow for the walking transition between treadmill and the casualty drag task location in the MRFCE area.
- Where the physical distance between these locations is less than 170m the FCEP wearing all PPE and holding the 7.5kg MARS bag, will complete the required number of 10m laps to ensure the set distance is met.
- If transition is completed prior to the cumulative time of 13mins (treadmill walk and walking transition), the FCEP should rest (standing) until the time elapses. At this time they should commence the Casualty Drag.





## Casualty Drag

- Wearing all PPE, the FCEP drags the casualty 8m with urgency in a controlled and safe manner.
- There is no specified technique, however FCEP should drag from the head end, moving backwards. Commonly used techniques include: under-grip under the casualty arms, over-grip under the arms, grasping clothing at the shoulders.
- FCEP is allowed to prepare prior to the 13min mark and when that time elapses they are to start the drag.
- When practicing the drag, FCEP should be instructed or reminded of safe lifting technique including lifting with the legs. To reduce lower back strain FCEP should be encouraged to stand straight or lean slightly backwards during the drag, rather than leaning forwards. This practice should occur prior to the commencement of the timed circuit.
- FCEP drags the casualty to the 4m mark, turns and drags it back to the starting position.
- Total drag distance 8m.
- No time limit on this task, anticipated progressive circuit timing is 13min 20s (0min 20s). Please note the time in brackets relates to the offices where the wall timer in the FCE area is started after the Treadmill and Walking transition tasks.



## Unilateral Carry

- Wearing all PPE, the FCEP is to pick up the jerry can (28kg) with one hand and complete five 10m laps (total 50m).
- They then put the jerry can down, pick it up with the other hand and complete five 10m laps.
- The total distance walked is 100m.
- FCEP is allowed to walk at their chosen speed, however they must not run.
- Rest is permitted with the change of hands, however not within either 50m distance.
- The assessment is passed if the FCEP is able to complete 100m carrying the jerry can, 50m with each hand.
- FCEP would fail if they cannot maintain the grip strength to complete each 50m lap.
- No time limit for this task, anticipated progressive circuit timing is 15min 02s (2min 02s).



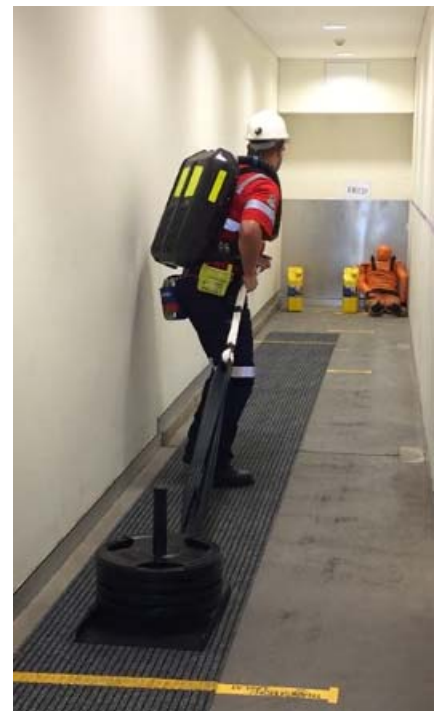
### Bilateral Carry

- Wearing all PPE, the FCEP is to pick up one jerry can (28kg each) in each hand and walk 1.5m, turn around and walk back 1.5m to the start mark.
- This test should be performed in a controlled manner and FCEP is not permitted to use momentum or swing the jerry cans.
- The test is passed if the FCEP can carry the two jerry cans a total distance of 3m without needing to put them down.
- No time limit for this task, anticipated progressive circuit timing is 15min 07s (2min 07s).



### Hose Drag

- Wearing all PPE, FCEP picks up the hose (rope) and holds it at hip height. Facing forwards, they are to take a step, leaning forwards using their weight to advance, and then bring the rear foot together to meet the lead foot.
- Using this step-to technique, they are to advance 7.5m, dragging the hose.
- The FCEP turns the sled around and completes another 7.5m drag and this is repeated so that four 7.5m drags are performed.
- The test is passed if the FCEP can complete four 7.5m drags using the specified technique over a total distance of 30m.
- No time limit for this task, anticipated progressive circuit timing is 16min 48s (3min 48s).

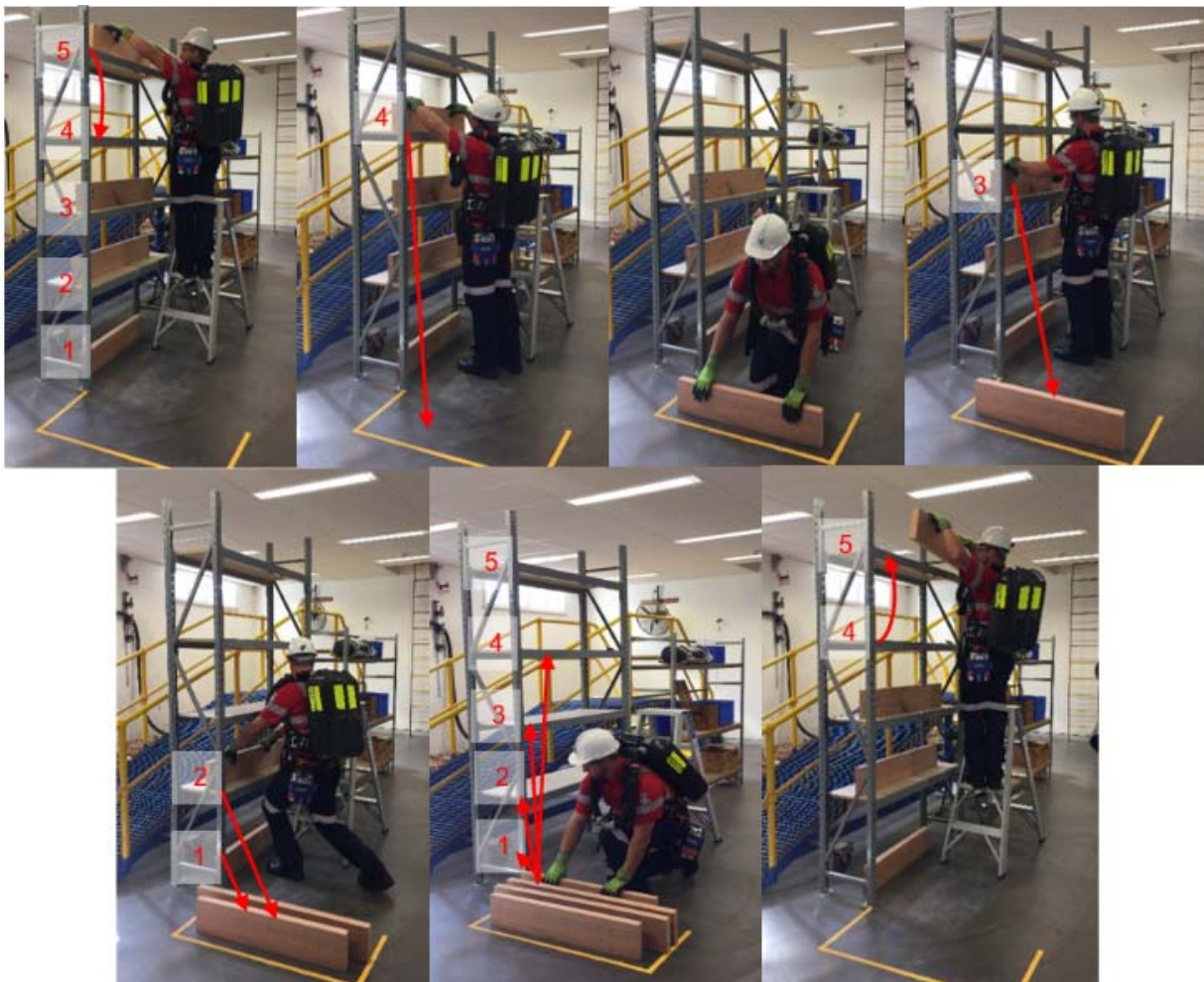
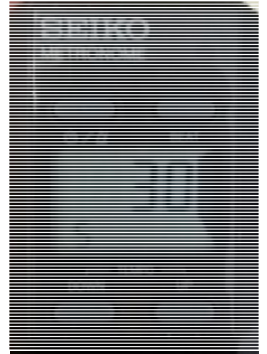


### Rest

- Wearing all PPE, FCEP is to stand and rest until the progressive circuit time has reached 20mins. They are permitted to move if they wish, however should not sit or lean against anything.
- If all tasks are completed within the anticipated times the rest will be 3mins 12sec, however if completed faster/slower a greater/lesser rest is allowed.
- The progressive circuit timing upon completion of this task is 20min 00 (7min 0s).

## Shelf Stacking

- One piece of timber should be moved every 10 seconds for a total period of 5 minutes. To facilitate timing, the metronome should be set to 30bpm and 5/4 time (see pic below - 4 low pitch and 1 high pitch beep every 10 seconds).
- Wearing all PPE, the FCEP dons gloves (optional) and at a progressive circuit time of 20mins the FCEP using the ladder should place the timber (~7.5kg) from position 5 (top shelf) and move it to position 4 (3<sup>rd</sup> shelf). The FCEP can choose to use one, two or three steps and should be supervised at all times for safety.
- At the next high pitch beep (10s) they are to move this same timber piece from position 4 down to the marked area on ground level.
- At the next high pitch beep, they are to move the timber from position 3 (2<sup>nd</sup> shelf) down to the marked area and so forth for position 2 (1<sup>st</sup> shelf) and 1 (ground level) until all timber pieces are located in the marked area.
- Once unpacked into the marked area, the FCEP will commence the process in reverse by placing a timber piece in position 1, 2, 3, 4 and then moving the timber from position 4 to 5 at each consecutive 10 second interval.
- This task continues until all pieces have been unpacked and repacked a total of three times each. At completion of the task, the timber pieces should be in the original shelf positions (timber in position 1, 2, 3 and 5).
- Timber should be placed upright rather than on the wide/flat side in the centre of the shelf.
- The assessment is passed if a FCEP can place pieces every 10s for the 5mins fixed duration.
- The progressive circuit time at completion of this task is 25mins 0s (12min 0s).





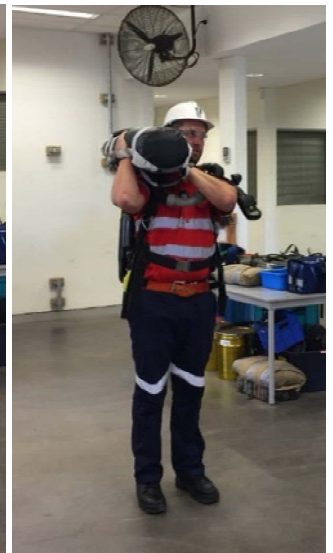
### Digging

- Wearing all PPE, FCEP shovels gravel (aggregate) from one pit to an adjacent pit using the polypropylene shovel.
- Total aggregate load is 105kg.
- The assessment is passed if the FCEP can continuously shovel until the full load has been transferred.
- No time limit for this task, anticipated progressive circuit timing is 27 min 00s (14min 0s).



### Lift and Hold

- Wearing all PPE, the FCEP lifts the 20kg power bag from ground level and from there transfer it onto their shoulder.
- They should support it on their shoulder for 1min without changing sides. The bag is then replaced back to the starting position at ground level.
- The FCEP should be reminded of safe lifting technique when performing this test, specifically lifting with the legs rather than their back. They are not to use the bag handles to complete the lift.
- The progressive circuit time at completion of this task is 29mins 42s (16min 42s).
- FCE timing ceases at the completion of this task and the wall timer and stopwatch are stopped with the finish time being documented on the data collection form.



### Moving through Hatch

- Wearing all PPE, FCEP is to step through the frame. They are permitted to use whatever movement pattern or technique they wish. This test is designed to ensure FCEP have the necessary range of movement and postural ability to move through an obstacle of this type.
- To help reduce risk of falling, FCEP are permitted to grasp the insides of the hatch as is typical in an underground environment
- The assessment is passed if FCEP is able to move through the space. Coaching, for example you need to duck more, is permitted and it does not matter if FCEP or the breathing apparatus touches the frame.
- If a FCEP is unable to move through the hatch this constitutes an automatic fail, in order to provide feedback on their ability, they may be permitted to attempt the remainder of the assessment.
- There is no time restriction for this task.





### Push/Pull Sawing

- Wearing all PPE, FCEP use a push/pull device at ground level to perform a continuous push-pull motion.
- FCEP assumes their preferred low posture to complete this task.
- Continuous unilateral sawing at a conformable pace for 2 minutes.
- It is an automatic fail if the FCEP is unable to perform a simulated sawing movement for a duration of two minutes.
- Timed 2 minute test.



At the completion of the assessment, the Brigadesmen will achieve a result based on the criteria below;

#### **Pass – Brigadesmen:**

Successfully complete moving through the hatch and push/pull (sawing) task  
AND  
Successfully complete the treadmill walk  
AND  
Successfully completed total circuit (excluding postural tasks) within 29min 42 sec

#### **Provisional Fail – Brigadesmen:**

Successfully complete moving through the hatch and push/pull tasks  
AND  
Successfully complete the treadmill walk  
AND  
Successfully completed total circuit (excluding postural tasks) within time buffer zone (29min 42 sec to 30min 47 sec)

*The retest should be conducted within 1-4 weeks (ideally) post this MR FCE attempt but can be completed up to 12 weeks from this time. The re-test MR FCE will have no further time buffer zone allowed.*

#### **Fail – Brigadesmen:**

Unable to complete moving through the hatch and/or push/pull task  
AND/OR  
Unable to complete the treadmill walk  
AND/OR  
Unable to complete total circuit within 30min 47 sec

*Re-testing can occur after a minimum of 12 weeks has elapsed to allow time for improvement of physical ability. This re-test will have a further time buffer zone allowed.*

This table summarises the above information and provides the guidance times for successful completion of the timed circuit. Please note the individual task times in the second column are for guidance only. A “pass” result is achieved by completion of the entire timed circuit in 29 minutes 42 seconds.

Sub-test	Timing	Cumulative timing	Minimum performance
Moving through hatch	-	-	Complete activity
Push/pull	-	-	Complete activity
Walking on Treadmill	10 min	10 min	Maintain for 10 min
Walking transition	3 min	13 min	
Dummy drag	20 sec	13 min 20 s	
Unilateral Carry	1 min 42 s	15 min 2 s	
Bilateral Carry	5 sec	15 min 07 s	
Hose drag	1 min 41 s	16 min 48 s	
Rest	3 min 12 s	20 min	
Shelf stacking	5 min	25 min	
Digging	2 min	27 min	
Unilateral Carry	1 min 42 s	28 min 42 s	
Lift and Hold	1 min	29 min 42 s	Complete within 29 min 42 s NB: buffer zone 30 min 47 s

### Sample scenario and exercise program to improve performance under guidance of an Accredited Exercise Physiologist

A person attended CS Health for their Mines Rescue Brigadesman medical. During completion of the Functional Capacity Evaluation, it was noted that the participant had difficulty completing the link and lock task within the allocated time. They were advised to seek the assistance of an Exercise Physiologist to improve their performance of this task. The participant had no injuries or considerations that may have affected safe performance of exercise.

As per table 1.1 at the beginning of this document, the link and lock task was categorised as a local muscular endurance task. The task of constructing a link and lock is predominantly an upper body task with repetitive use of both upper limbs. It does however require pieces of link and lock timber to be lifted from ground level before being lifted to varying heights, including overhead height. From the task specifications, it involves the use of 8.7kg pieces of link and lock timber. A range of exercises were prescribed to the person by an exercise physiologist, including:

- dumbbell squat
- bicep curl
- bilateral shoulder press

In line with muscular endurance guidelines, the person was advised to perform 3 sets of 10 repetitions, with progress to 20 as tolerance allowed, completing the program twice weekly. Rest between sets was set between 30 sec and 2 minutes. To ensure the exercises were specific to the task, the load would progress to a minimum of 9kg.

After a period of time following the program, the participant returned to CS Health for re-testing of his Mines Rescue Functional Capacity Evaluation. During the second attempt, the individual demonstrated his ability to perform the link and lock task as part of the evaluation circuit, successfully completing the test within the set time limit.

### Seeking further Advice

If you require more specific advice on how to prepare for the updated Mines Rescue Functional Capacity Evaluation a consultation with an Exercise Physiologist is available through all CS Health offices or with other service providers in your local area. If you plan to train yourself, you should seek advice prior to the commencement of training. Below are the contact details for our regional offices:

#### **Lithgow**

T: +61 (2) 6350 1050  
F: +61 (2) 6351 2407  
3 Proto Ave, Lithgow, NSW, 2790  
P.O Box 72, Lithgow, NSW, 2790

#### **Mudgee**

T: +61 (2) 6370 6100  
F: +61 (2) 6372 2470  
Unit 4, 64 Sydney Road, Mudgee, NSW, 2850  
P.O Box 1156, Mudgee, NSW, 2850

#### **Singleton**

T: +61 (2) 6571 9900  
F: +61 (2) 6572 2667  
1 Civic Avenue, Singleton, NSW, 2330  
P.O Box 317, Singleton, NSW, 2330

#### **Speers Point**

T: +61 (2) 4948 3100  
F: +61 (2) 4953 0541  
143 Main Road, Speers Point, NSW, 2284  
P.O Box 101, Boolaroo, NSW, 2284

#### **Woonona**

T: +61 (2) 4286 5400  
F: +61 (2) 4285 4144  
558-580 Princes Highway, Woonona, NSW, 2517  
P.O Box 42, Corrimal, NSW, 2518



## Section 3: How to prepare for your Mines Rescue Functional Capacity Evaluation

It is essential that Mines Rescue Brigadesmen have sufficient muscle strength, endurance, flexibility and aerobic power (cardiorespiratory fitness) to perform rescue tasks. In order to reach and maintain such a level of physical conditioning, regular exercise is required. Below is a set of general guidelines that will help a current or prospective Brigadesman to meet the required physical standard.

The physical standard includes cardiorespiratory and muscular endurance, muscular strength and flexibility. To this end, training in preparation for the demands of a Brigadesman should include all of these elements. The amount and type of training required to reach this standard will depend on the level of conditioning when training is commenced, in addition to the resources available for training (e.g. equipment, time etc.). It is important to understand the basic principles of training detailed in Section 2 of this document when planning a training regimen, so that it can be tailored safely and effectively to suit each person.

As a general summary:

- Attempt to exercise on most days of the week with at least two days of resistance based exercise and the remainder performing cardiorespiratory based exercise.
- Stretching should be performed regularly and is best placed after a workout rather than before.
- Exercises should be as specific as possible to the role of a Mines Rescue Brigadesman in order to maximise potential benefits in performance.
- Training should be varied regularly to avoid risk of overuse, minimise boredom and ensure improvements in performance do not plateau.
- For cardiorespiratory based exercise, perceived exertion should be a minimum of 11 on the 15 point BORG scale to ensure that sufficient improvement is achieved.

### How to avoid overtraining?

- Plan training sessions ahead of time to account for any anticipated additions in physical or mental stress
- Structure rest periods into training on a weekly basis
- Ensure nutrition is optimal for recovery, particularly around heavy training sessions
- Gradually increase training load and duration
- Vary training structure to avoid repetitious training sessions

## Section 4: The importance of exercise

The amount of exercise you should undertake is dependent on a number of factors, including exercise type, duration, intensity and frequency. Your health status is also an important consideration to minimise risk of injury or adverse event.

### Duration and intensity

The Australian guidelines (Commonwealth Dept of Health, 2014) for healthy physical activity recommend a combination of endurance/aerobic and resistance training. They recommended endurance exercise be performed on most, preferably all, days/week, accumulating a total of 150-300 minutes of moderate or 75-150 minutes of vigorous intensity exercise. Additionally, resistance training is recommended on at least two days/week.

Exercise should be performed for at least 30 minutes/day, which can be accumulated in minimum 10 minute blocks. Further benefit may be gained from exercising for more than 30 minutes each day.

The following daily exercise durations are recommended, depending on fitness levels:

- Sedentary: less than 30 minutes
- Somewhat active: minimum of 30 minutes
- Regular exerciser: 40-50 minutes
- Moderately active: 60-70 minutes
- Athlete: 80-90 minutes

Exercise intensity should be maintained at a minimum moderate level to maximise health benefits:

- Sedentary: light – moderate (Rating of Perceived Exertion (RPE) 9-13)
- Somewhat active: moderate (RPE 11-14)
- Regular exerciser: moderate – heavy (RPE 12-17)
- Moderately active: moderate – very heavy and occasionally exhaustive (RPE 12-19)
- Athlete: variable within ranges of moderate – maximal (RPE 12-20)

(Groeller and Taylor, 2008; Borg, 1998)

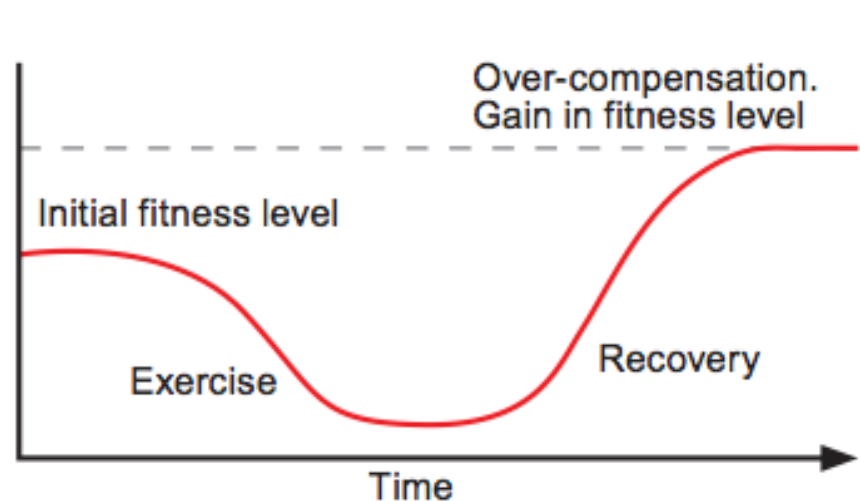
### Frequency

Caution should be used when commencing a vigorous exercise program for the first time. It is recommended to follow the intensity categories listed above, and to gradually increase intensity as suitable.

## Principles of exercise

### Overload

Our bodies are designed to adapt to physical stress when the load applied is slightly greater than what the body is accustomed to tolerate. As demonstrated in the below graph, physical stress (exercise) causes fatigue and a temporary reduction in performance. Following appropriate recovery/rest, adaptation in fitness occurs, ultimately leading to an improvement in performance. If this slight increase in loading of the body is not regularly and appropriately adjusted to allow for this increase in performance, improvements may plateau.



<https://trailmag.co.za/adrenal-overload-super-compensation-graph-t17/>

### Specificity

Improvement in performance occurs mainly in the activities or exercises in which you are training. For example; endurance training for cycling will allow for significant improvement in cycling performance but the same improvement may not be observed for swimming performance. This is not to say that overall improvement in general fitness will not result in some enhancement in performance of tasks that differ from the training mode, however maximal adaptation will occur for the mode of exercises the training was specifically targeted for.

Although specificity is important, training does not always need to be specific to the role of a Mines Rescue Brigadesman. Training in a purely specific manner may lead to difficulty targeting the separate components of overall physical fitness required to perform the intended role. It can also lead to an increased risk of injury due to the highly repetitive and intense nature of the required training.

### Overtraining

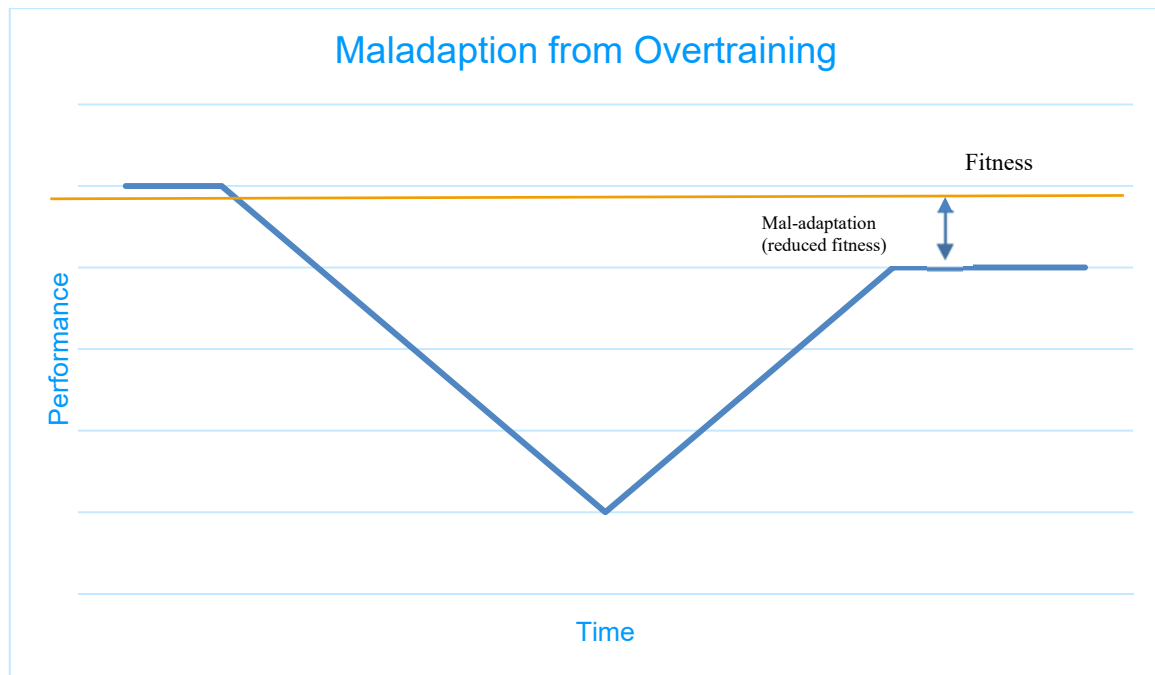
Whilst it is important to provide sufficient stimulus to the body for adaptation to occur, it is important to be aware of and consider the potential effects of overtraining.

Overtraining can be short or long term and may occur without any physical or psychological symptoms other than a reduction in performance. Stresses outside of physical training (e.g. new born child, major renovations etc.) may make recovery more difficult and therefore contribute to the potential for overtraining. This should be considered when establishing a training schedule.



Some signs of possible overtraining are:

- A decline in mood conducive to optimal training and increased sense of physical effort (Forster, 1998; O'Connor et.al, 1991; Morgan 1994; Halson et al., 2003).
- Changes in exercise skill or technique (O'Connor et al., 1991)
- Changes in immune response (Mackinnon and Hooper, 1996)
- Reduction of muscle energy reserves which may reduce performance (Costill et al., 1988)
- Decline in submaximal and maximal heart rate (Hedelin et.al, 200; Halson et al., 2003)



## Types of exercise

### Endurance

Endurance exercise is undertaken over a prolonged duration and relies heavily on the consumption of oxygen to produce the energy required to sustain activity. Endurance performance is affected by;

- aerobic power or the maximum amount of oxygen that can be consumed per minute
- the efficiency of energy use
- the intensity of exercise being performed
- the ability of the body to sustain a high percentage of maximal oxygen uptake

Each attribute can be improved through training, with improved heart performance, development of new blood vessels to supply the working muscles, increased energy producing cells, increased blood volume, and stored fuel within the muscles.

In order to attain significant improvements in endurance fitness, a minimum heart rate of 65% of the age predicted heart rate maximum (220 minus age), or a rating of 11 on the 20 point Borg RPE scale (see Fig 1.1 on page 10). (ACSM, 1998; Borg, 1988)

There are 4 different types of endurance training. These include continuous, fartlek, interval and pace tempo training. All methods of endurance training have their own benefits. The most common and relevant types of training are detailed on the next page.

### ***Continuous training***

This is a common form of training usually used to increase baseline fitness. For this style of training, higher exercise intensity may not result in greater benefit.

Benefits:

- Improved aerobic power/endurance
- Improved muscle energy production
- Increased utilisation of fat as fuel
- Improved ability to maintain posture and technique due to slower onset of fatigue

Watch out for:

- Training intensity that is too high or too low
- Bone, muscle or joint soreness, particularly if performing high impact activities such as running
- Increasing training duration too soon creates risk of overtraining

Exercise example:

- 40 minutes of jogging at a moderate pace.

### ***Interval training***

Research findings suggest that short-duration interval training may provide greater aerobic stimulus to the body than continuous training at the same intensity due to a reduced effect on the build-up of fatigue. Interval training involves fixed work and rest periods. During rest periods, an active recovery activity is recommended.

Benefits:

- Improved aerobic power/endurance
- Improved performance economy
- Time efficient
- Easy to individualise

Watch out for:

- Varying pace over the interval
- Training at an inappropriate pace for your current level of fitness
- Allowing for insufficient rest periods

Examples:

- 3 minutes hard effort, 3 minutes moderate recovery, repeated 5 times
- 15 seconds hard effort, 15 seconds rest, repeated for 10 minutes total duration
- 1 minute hard effort, 2 minutes rest, repeated for 5 intervals

## Strength

Resistance training may involve the use of machines and free weights in a gym based environment but is not limited to this. Resistance training is any exercise performed against load that is designed to increase the effort required to perform movement. Cycling in a hard gear, walking up stairs and yoga are all considered to be resistance exercises that will increase body strength. As long as the load is greater than what the body is normally used to, strength will result.

When performing resistance training, the most strength gains occur in the first 6-8 weeks of commencing a program after which the gains tend to slow. To avoid this slowing effect, it is important to vary your programme. It is also important to note that strength gains are specific to the type of muscle activation and movement trained. Heavily controlled strength training may not be as beneficial for a rapid or powerful response. The principle of specificity applies to resistance training. Improvements to performance will be optimal where strength training can replicate the actual tasks required.

## General information

- Perform large muscle group exercises (e.g. squats, lunges, push-ups, ab crunches) before smaller muscle group exercises (e.g. calf raise, upright row).
- Perform exercises that move several joints (seated row) rather than exercises that are focused on a single joint (bicep curl).
- Exercises that isolate a single muscle are not necessarily bad but if overused may lead to muscle imbalances.
- Complex exercises that require significant co-ordination should be performed prior to simple exercises.
- Load should **not** be increased by more than 10% in a week. An increase in load should only be considered if the desired number of repetitions has been exceeded on two separate training sessions.
- Focus on movement control rather than load lifted.
- Pin-loaded machines recommended for less experienced trainers progressing towards free weights.

## Protocols

### Muscular Strength

- 4-8 large muscle group, multi-joint exercises per session
- Increased rest 3-5 minutes (1-2 minutes for smaller muscle groups)
- 3-5 sets, 2-6 repetitions, 2-8 rep maximum (RM)
- 2 sessions per week focusing on whole body workout

### Muscular Endurance

- Rest 30 sec-2 minutes
- 1-3 sets, 10-20 repetitions, load dependent on repetitions (lighter than RM)
- 1-2 sessions/week

### Muscular Power

- 3-6 large muscle group, multi-joint exercises in each training session
- Functional exercises relevant to task are best
- Maintenance of good form important
- Increased rest 3-5 minutes
- 3-5 sets, 2-8 repetitions, 6-20RM
- 2 sessions per week
- Exercises are not performed to fatigue but focus on speed of exercise



### **Muscle Hypertrophy (growth)**

- 4-8 large muscle group, multi-joint exercises per exercise session
- Reduced rest – 30-60 seconds between sets
- 4-8 sets, 6-15 repetitions, 6-15RM
- 2 sessions per week focusing on whole body workout

### **Strength training**

The upper and lower body are linked by the pelvis and trunk, and associated core muscles. This means movements of the upper and lower limbs are transferred through the core, making it an important area to train, particularly for lifting and load carrying. In training the core, it's important to focus on the inner or deep muscles, and the outer superficial muscles.

As the inner muscles are more difficult to control and are often weakened by inactivity, it is important to specifically target this area. Strengthening exercises should reflect our normal daily activities and Mines Rescue duties. Exercises where the spine is maintained in a neutral or 'straight' position or in a controlled manner may provide the best functional training.

In training the core, it is important to learn how to activate, and keep activated, specific muscles, particularly while moving the rest of the body. Core exercises are mild and held over a sustained period, rather than being strong over a short length of time.

For assessment and further guidance on the best way to approach core strength, it is recommended to consult an Exercise Physiologist.

### **Stretching/Flexibility**

During stretching exercises, it is not only the muscle that is stretched but also the tendon, ligament, bones, joint and nerves. The muscle and tendon are the most affected during stretching, and stretching is known to increase the range of motion in the joint being stretched.

However this effect is not permanent and is dependent on the type of stretch performed. Given the effect of stretching is not permanent, it should be performed regularly and should be balanced with strengthening.

Current evidence suggests stretching should be done after other exercises to help reduce muscle soreness and improvement of range of motion (Herbert and Gabriel, 2002; Reisman et al., 2004).

### **Stretching types**

#### **Static, passive or isometric stretching**

This is where the muscle or limb being stretched is stationary, while another body part moves slowly to produce the stretch. This is effective for relaxation and increased joint range of motion (Taylor et al., 1990).

#### **Dynamic or ballistic stretching**

This is where the stretch is caused by rapid or bouncing movements of the limb. Some caution should be applied when using this form of stretch as it is associated with increased muscle soreness and injury (Mackinnon et al., 2003; Taylor et al., 1990). This form of stretch should only be performed after a warm up.

#### **Proprioceptive neuromuscular facilitation (PNF) stretching**

This is a combination of static and dynamic stretching. In PNF stretching, the muscle opposite that being stretched is activated momentarily causing a relaxation effect on the muscle being stretched, and allowing an increased range of motion.

An example would be the quadriceps muscle group being tensed prior to stretching the hamstring. This form of stretch normally requires another person to assist, with the progressive lengthening of the muscle being stretched during the relaxation phase.

#### ***General information***

- Concentrate on the joints of the body relevant to the desired performance
- Hold each stretch for 15-30 seconds and repeat approximately 4 times
- Stretching should not cause pain, but should cause a noticeable relaxation effect
- Static stretching is the recommended form of stretching due to its simplicity, effectiveness and minimal risk of injury
- Stretching should be performed when the body is warm

## Section 5: Other considerations

### Monitoring Exercise

In the absence of a heart rate monitor, exercise intensity can be indirectly gauged through use of the rate of perceived exertion (RPE) method. Perceived exertion means detecting and understanding the feelings arising from the body during physical activity (Noble and Robertson, 1996), and is intended to measure whole body effort and not limb specific effort or discomfort.

A 15 point scale was developed by Borg (1965) to allow for exertion to be reported in a way that was directly related to heart rate and power output. See Fig 1.1 for a copy of this scale. Based on this relationship, it is likely that a rating of less than 11 would not provide an adequate level of training. For endurance exercises, RPE of 11-14 would be enough effort for a deconditioned person to see benefit. An RPE of 13-17 may be required for better trained people, while any exercise of an intensity greater than 17 should be carefully structured into a training program and reserved for only those who are well-trained. This intensity is not recommended for untrained older people.

Fig 1.1 – Borg 15 point Perceived Exertion Scale.

rating	description
6	NO EXERTION AT ALL
7	EXTREMELY LIGHT
8	
9	VERY LIGHT
10	
11	LIGHT
12	
13	SOMEWHAT HARD
14	
15	HARD (HEAVY)
16	
17	VERY HARD
18	
19	EXTREMELY HARD
20	MAXIMAL EXERTION

<http://www.topendsports.com/testing/rpe-scale.htm>

### Diet and performance

Food has long and short term effects on well-being and performance. Optimising diet has many advantages including:

- Increasing fatigue resistance and faster recovery
- Enhanced endurance
- Improved immune function
- Reduced body fat
- Decreased risk of lifestyle related diseases such as diabetes, heart disease etc.

International dietary guidelines recommend the consumption of a variety of nutritious foods including:

- Plenty of fresh fruits (2 serves daily) and vegetables (5 serves daily)
- Plenty of cereals (including breads, rice, pasta and noodles), preferably wholegrain
- Lean meat, fish, poultry
- Milk, yoghurt and cheese, using reduced fat options where possible
- Plenty of water (or fluids)

In addition to the limiting of:

- Total fat consumed (particularly saturated fat)
- Alcohol (no more than 2 standard drinks/day with 2 alcohol free days/week)
- Salt
- Foods high in sugar

#### **Tips for developing healthy eating habits:**

- Start the day with a good breakfast such as low-fat cereal, yoghurt, and wholegrain toast with low-fat spread or omelette. Breakfast helps to kick start your metabolism for the day.
- Eat small, healthy snacks (e.g. handful of nuts, piece of fruit, low fat yoghurt) every 2-3 hours to ensure your metabolism is sustained throughout the day.
- Drink more water.
- Limit fat and oil in cooking to an absolute minimum.
- Use cooking methods such as grill, braise and steam over frying, boiling etc. This helps to drain excess fat and maximise the nutrients available in your foods.
- Reduce salt intake by not adding salt to your food and choosing low salt pre-prepared foods. For packaged foods, aim for <350mg/100g serving.
- Alcohol, soft drinks and energy drinks have a significant energy content so try to minimise consumption of these drinks.
- Allow yourself treats but have them in small controlled portions as infrequently as you can.
- Using the professional help of a dietician can assist when endeavouring to change lifestyle.
- If eating out, try to choose healthy options.

#### **Aging**

With advancing age comes unavoidable reductions in physiological function. It is known that metabolism, neuromuscular function/co-ordination, pulmonary (lung) function, cardiovascular (heart) function, peak aerobic power and the ability to regulate body temperature reduces with increasing age. The good news is that most of these declines are observed alongside the adoption of a more sedentary lifestyle. As a result, the degree of reduction can be slowed or even halted and improvements made by maintaining a healthy lifestyle, which includes keeping active and maintaining good nutrition.

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