



NATIONAL PROTOCOLS FOR THE ASSESSMENT OF STRENGTH AND POWER

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Developed by:

National and State Institute and Academy of Sport and
NIN strength and conditioning coaches.



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1. INTRODUCTION

After the Tokyo 2020 Olympic and Paralympic Games, and with the announcement of the 2032 Brisbane Olympic and Paralympic Games, Australia is expected to see an influx of talented athletes into national sporting pathways. Establishing up to date strength and power assessment protocols as we venture into this period will allow for valuable insight and reflection to further advance our understanding of athletic development, and in turn, sporting successes on the international stage.

This national approach is important as it allows for comparable data to be obtained across the country, between athletes, and across different sports. It will also allow for the longitudinal tracking of developing athletes through to Brisbane 2032. Often this data is used to investigate the effectiveness of training programs and to answer the many practical and research questions that arise in attempts to optimise sports performance. As such, there needs to be a high standard of quality control during testing situations.

The purpose of this document is to outline updated testing protocols for strength and power assessment that have a sound theoretical basis but are also practical in the training environment. Version 2 (v2.0) of the National Protocols for the Assessment of Strength and Power were adapted by strength and conditioning coaches from across the National Institute Network (National/ State Institutes and Academies of Sport, the NIN) and National Sporting Organisations (NSO) who interact closely with elite and developing athletes and coaches to optimise sporting success. This document captures their collective insight and experience.

Before proceeding to the protocols, it is important to understand that this is a working document that outlines the desired protocols for the assessment of strength and power based on current theory and best practice within the Australian high performance sporting environment. It is expected that these protocols will be updated with the discovery of new and pertinent information and the development and acquisition of new innovative testing equipment.

This set of protocols is not designed to limit the ability of the S&C coach to assess athletic qualities by other tests that the S&C coach may feel to be sports or athlete specific. It must be noted though, that this document outlines the protocols for the most commonly used and accepted assessments within the NIN environment, and provides a way in which test results can be gathered with a degree of validity, accuracy and reliability.

1.1 OBJECTIVES OF TESTING

The assessment of strength and power is of critical importance in elite sport to:

- Profile an athlete's physical capacities; strengths, weaknesses, and potential musculoskeletal imbalances.
- Profile a sport and determine the potential relevance of strength and power to its context.
- Assess the response to a training intervention.
- Monitor the effects of training, detraining and rehabilitation.
- Allow an athlete's response to training to be reflected upon and reported to the sport coach and performance support team.
- Provide information for the prescription and planning of training.
- Provide motivation and encouragement to the athlete using feedback and goal setting.
- Monitor an athlete's skill/technique acquisition under maximal load.

1.2 APPLIED DEFINITIONS FOR STRENGTH AND POWER ASSESSMENT

The following definitions and classification system have been employed for strength and power assessment tests detailed in this manual.

1.2.1 Strength

Maximum strength is the peak force an athlete generates to overcome a given external mass without reference to time. It is the basic quality that influences power [Schmidtbleicher et al., 1992]. It is measured in kilograms [kg].

1.2.2 Power

Power is generated and is a function of work and time [power = force x velocity]. Power can be measured in any dynamic movement associated with an applied force, regardless of speed. It is measured in watts [W].

Strength and power results can be assessed as a given number of repetitions [1RM, 3RM, 6RM], where 1RM is the maximum mass an athlete can lift for one repetition while maintaining technical proficiency. Three RM and six RM are the heaviest mass an athlete can lift with good technique and no external assistance three or six times with technical proficiency.

The majority of the strength and power assessment protocols included in this manual can be used for maximal 1, 3 or 6RM testing. Before choosing your RM, it is important to consider:

- Most athletes are not accustomed to using 1RM in training, multiple repetitions provide greater familiarity to training sets.
- Multiple repetitions allow for assessment of technique during performance of test and allow for the early detection of technique deterioration.
- Some lifts [i.e. Olympic lifts] do not lend themselves to multiple RM testing due to the nature of the lift.

When recording the results for strength testing data, the actual mass lifted, and repetitions completed are to be recorded along with any exercise specific attributes that may be important for certain exercises [i.e. hand width, knee angle, etc]. Predictive equations should not be used to calculate 1RM as they have been shown to be influenced by the muscle group tested, exercises performed [Morales et al., 1996], training level [Braith et al., 1992; Baker et al., 1995] and there can be large variability ($\pm 10\%$) using sub-maximal repetitions to predict maximal strength [Braith et al., 1992].

2. ATHLETE PREPARATION

The primary objective of testing is to assess changes in performance following a training intervention. It is well documented that many physiological capacities can be influenced by variables such as diet, fatigue, arousal, medications, illness, injury and environmental conditions. Due to this, athletes who present themselves for testing should be in a similar state between testing sessions (Fricker and Fallon, 2000) and a standardised pre-test protocol is strongly recommended to aid reliable testing.

It is recognised that it is impractical to standardise every single facet of athlete preparation when performing tests over an extended training period (i.e. months and years), however, the following aspects should be monitored and standardised as much as possible.

It should be noted that the safety of the athlete when performing the lifts within this document (or indeed any testing activity), is paramount and it is not acceptable to take any unnecessary risks when performing maximal lifts for the assessment of strength and power. If in doubt as to the readiness or suitability of the athlete another testing session should be scheduled so as not to risk injury to an athlete.

2.1 TRAINING

Best practice suggests that, in the 72 hours prior to testing, athletes should have no training induced severe physiological or neural fatigue (Abernethy et al., 1995), however in elite populations this may not be an achievable outcome. Rather, what is suggested is that an athlete should not perform an unaccustomed exercise or sporting/training stimulus in this time that may result in sarcomere damage and/or decreased activation of motor units.

Unaccustomed exercises include:

- a change in resistance exercise selection;
- increases in training volume (number of sets, exercises, or resistance sessions);
- or the performance of high-volume eccentric contractions (Nosaka et al., 2001; Byrne et al., 2001).

Unaccustomed sporting/training stimuli include:

- learning new skills;
- increased training stimulus/intensity;
- or increased duration.

To ensure task familiarisation, the exercise to be assessed (e.g. bench press) should be incorporated into the usual training routine prior to testing. A minimum of 6 sessions is recommended for familiarisation to allow the athlete to get a “true” maximum on the testing day, reduce tissue damage and increase confidence.

2.2 SUPPLEMENTS

At the present time, only a few performance supplements are considered to have enough scientific evidence to support marginal gains in strength and power (Maughan et al., 2018). These supplements include caffeine (McLellan et al., 2016; Pickering et al., 2019) and creatine (in the form of creatine monohydrate) (Rawson et al., 2003; Lanhers et al., 2016).

From a practical perspective, habitual coffee drinkers are unlikely to report a marked

improvement in test results and normal daily intakes can be maintained. The use of caffeinated sports or commercial beverages in amounts greater than 6 mg.kg⁻¹ two hours prior to testing should be discouraged.

Whenever possible, supplements should be standardised across multiple testing sessions. For more information, please refer to [The AIS Sports Supplement Framework](#).

2.3 FREQUENCY AND SCHEDULING OF TESTING

A planned testing schedule should be outlined as a part of an annual plan and should be reflective of the specific targets established for each phase of training. Annual planning of testing will enable the strength and conditioning coach to address the areas highlighted in section 2.1 [Training]. While feedback can be attained from each training session based on intensity, it is recommended that the minimum period needed to evaluate true performance change is 6 weeks.

In larger groups of athletes [e.g. team sports], multiple assessors and multiple stations may be used to improve efficiency and reduce the amount of time needed to test. In this case, assessors should remain consistent with the exercises they are assessing (i.e. remain at that exercise station for the duration of that testing session, at subsequent sessions in the future), and athletes should proceed through the same test order.

2.4 TIME OF TESTING

While strength has been reported to peak in the early evening [1400-1900 hours] [Atkinson and Reilly, 1996] athletes should be tested at the same time of day in subsequent tests to avoid fluctuations in performance due to circadian rhythm [Winget et al., 1985].

2.5 TEST ORDER

It is imperative that strength and power testing be coordinated with any other physiological assessments during the annual training cycle and within a given testing week. Testing power should be performed at a different time to endurance and field testing due to the possible effects of potentiation and/or fatigue. The time span needs to be greater than 1 hour to avoid this phenomenon.

Tests should be completed in an order that allows for fast and explosive tests to precede slower strength and strength endurance tests (i.e. countermovement jump prior to back squat). Furthermore, multi-segment or total body exercises should be completed prior to more isolated or single segment exercises (i.e. squat prior to single leg incline leg press). Exercises should then be varied by upper body and lower body where possible to allow more recovery between. The testing battery may also be split across two days if required. However, once established, the test order should be replicated between test sessions.

Examples

Single Day Testing Session

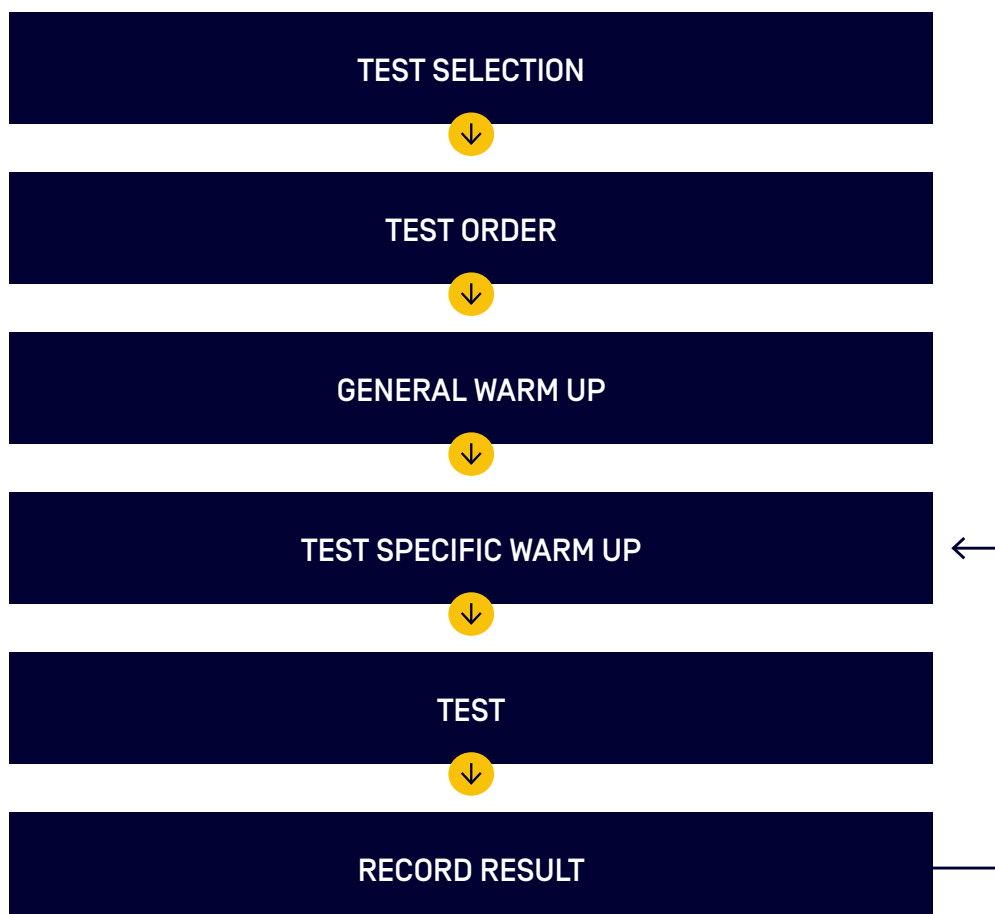
Explosive	<ul style="list-style-type: none"> Counter Movement Jump Drop Jump Power Clean
Strength	<ul style="list-style-type: none"> Back Squat Bench Pull Incline Leg Press (Single Leg) Bench Press

Split Testing Session

DAY 1		DAY 2	
Explosive	<ul style="list-style-type: none"> Countermovement Jump Squat Jump Drop Jump 	Explosive	<ul style="list-style-type: none"> Isometric Mid-Thigh Pull (Fast Ramp) Power Clean
Strength	<ul style="list-style-type: none"> Back Squat Bench Press 	Strength	<ul style="list-style-type: none"> Deadlift (Barbell) Bench Pull

3. USING THE PROTOCOLS

The protocols outlined in this document were designed to be printed individually to allow for easy reference in the testing environment. The general warm up should be completed once at the beginning of the testing session. An additional test specific warm up may be warranted due to the specific demands of the test.



3.1 GENERAL WARM UP

The general warm up allows for coach discretion and understanding of your athlete to include an appropriate upper body, lower body, or full body dynamic warm up to facilitate range of motion and increase in body temperature. It is the athlete's or coach's discretion whether they utilise stretching of any form as part of a general warm up and in recovery periods of the specific warm up.

3.2 TEST SPECIFIC WARM UP

The general warm up is then followed by a test specific warm up in which the action of the selected test is performed with a gradual increase of mass and decrease of repetitions. The intensity should be adjusted to the individual's level of strength/fitness and or training age. The coach should use recent training data or previous RM results to calculate the test warm up set loads.

Note: The full specific warm up may not be necessary for all exercises in your testing battery. i.e. It may not be necessary to complete a full specific warm up for a bench pull if you have already completed testing for chin ups and bench press.

3.3 TEST SETS

Following the specific warm up and recovery the test sets can begin. If the first lift was successful, continue to add mass (i.e. 95%, 97.5%, 100%, >100% of predicted RM load) until a repetition maximum is achieved (i.e. 1RM).

- Minimum mass increments should be guided by ease of each trial. However, it is important not to over-estimate increments and to note that increments less than the typical error (TE)¹ for that test may not necessarily reflect a true biological change.
- Ideally, specified RM test should be completed within 4 trials (not including the warm-up).
- If an athlete is unable to complete tests as per protocol, variations should be noted on testing results information.
- Athlete body mass for each test session should be recorded prior to commencing the tests themselves. Body mass should be assessed on calibrated scales and include the clothes and shoes the athlete will be tested in.

3.4 LIMITATIONS

This document serves to outline standardized protocols to allow for valid and reliable comparison of results between tests, between athletes and testing completed in different environments. However, it does not delve into assessing change or data interpretation. Practitioners and researchers must consider the reliability and validity of all variables obtained from strength and power assessment before interpretation and the following must be considered during data interpretation:

- Training adaptations are specific and may not be detected if the training and testing exercises are dissimilar or the test is not sensitive to small training gains.
- The tests measure a specific strength quality during a specific task. Care must be taken when reporting what influence and importance these changes have on sport specific performance unless this relationship has been published previously.
- Multiple factors influence the degree of association between underlying strength and power qualities and sporting movement, as well as the degree to which training induced improvements in these qualities transfer to performance (Young et al., 2005; Campo et al., 2009; Cormie et al., 2010a; Harris et al., 2008b).
- Interpreting results from a single testing day may not be representative of training adaptation. There are many factors that contribute to maximal exertion (i.e. motivation, over-estimation of RM loading, arousal, etc.).

¹ Typical Error (TE): is an indicator of the normal day to day variability of the test. If the change from test to test is greater than the TE, it can be considered a "real change". Changes less than the TE are not likely to represent true biological change. For more information regarding reliability statistics, please visit Will Hopkin's website <http://sportsci.org/resource/stats/>

4. POWER ASSESSMENT PROTOCOLS

4.1 POWER CLEAN

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency. It is suggested a qualified strength and conditioning coach (ASCA Level 2 or 3) should supervise this test.

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is the athlete's total weight lifted.

Equipment Checklist

- ☐ Bar (Olympic 20kg/15kg)
- ☐ Barbell collars
- ☐ Weight plates (0.5kg-25kg increments)

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM
Set 1: 40-60%	Less than or equal to 10 reps	Less than or equal to 12 reps
	Recovery: ≥ 2 minutes	
Set 2: 60-70%	≤ 5 reps	Less than or equal to 6 reps
	Recovery: ≥ 2 minutes	
Set 3: 70-80%	≤ 5 reps	Less than or equal to 6 reps
	Recovery: ≥ 2 minutes	
Set 4: 90%	1-3 reps	3-5 reps
	Recovery: 2-5 minutes	

Preparation

- The use of a weight belt, lifting straps, knee wraps and lifting shoes are optional but should be consistent between tests and recorded.
- Repetitions should be completed as soon as possible after each other, however a single rest of no more than 10 seconds is allowed to re-position hands/feet etc if greater than 1RM is being used.
- Recommended assessor position: 45 degrees to front of athlete to facilitate observation of posture and catch position.

Test/Technique

- Start position: Feet should be placed under the loaded barbell so that the bar is directly above the balls of the feet. Feet should be hip width. Grip should be slightly wider than shoulders. Shoulders should be forward over the bar and back should be held (braced) in a straight or concave set position. Elbows fully extended.
- Initial movement of the bar should be generated from the legs by extending the knees with no change to the back angle at the pelvis.
- During the lift, the barbell should remain close to the body, and hips, knees and ankles should be fully extended (triple extension) before catching the bar.
- After triple extension and before the catch, the feet move laterally to the athletes preferred front squat/catch position.
- The bar should be caught on the upper chest and shoulder/anterior deltoids, with the elbows in a front rack position (elbows inside hands and lifted so the humerus is almost parallel to floor).
- Finish position: Upon catching the bar the athlete must not collapse into a squat position where crease of hips drops below top of knees (vs. clean where there is no limit to depth of squat at catch position) and athlete must return to full standing position.
- The weight must be caught and seen to be under control if the repetition is to be valid.
- Record RM result in kilograms.

Technical Violations:

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Failing to have the correct set-up, lift and catching techniques.
- Failing to catch the bar in a controlled movement.
- Collapsing into a full front squat position where crease of hips drops below top of knees, after the catch.
- Uneven splitting of the feet forward or sideways during the catch.
- Not returning to standing position with good control of the bar.
- Greater than 10 seconds rest between repetitions.

Recording Checklist

- ☐ Weight lifted (kilograms)
- ☐ Repetitions
- ☐ Use of a weight belt, lifting straps, knee wraps and lifting shoes

Examples



Start position



Catch position



Finish position

4.2 POWER SNATCH

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency. It is suggested a qualified strength and conditioning coach (ASCA Level 2 or 3) should supervise this test.

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is added to the athlete's total weight lifted.

Equipment Checklist

- ☐ Bar (Olympic 20kg/15kg)
- ☐ Barbell collars
- ☐ Weight plates (0.5kg-25kg increments)

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM
Set 1: 40-60%	Less than or equal to 10 reps	Less than or equal to 12 reps
	Recovery: ≥ 2 minutes	
Set 2: 60-70%	≤ 5 reps	Less than or equal to 6 reps
	Recovery: ≥ 2 minutes	
Set 3: 70-80%	≤ 5 reps	Less than or equal to 6 reps
	Recovery: ≥ 2 minutes	
Set 4: 90%	1-3 reps	3-5 reps
	Recovery: 2-5 minutes	

Preparation

- Grip the bar at a width that places it in the crease of the hip with elbows locked out. This will mean the bar makes contact with the soft tissue between the anterior superior iliac spines and the pubic crest. Hold the same grip overhead to ensure this hand position clears the head.
- The use of a weight belt, lifting straps, knee wraps and lifting shoes are optional but should be consistent between tests and recorded.
- Repetitions should be completed as soon as possible after each other, however a single rest of no more than 10 seconds is allowed to re-position hands/feet etc if greater than 1RM is being used.
- Recommended assessor position: 45 degrees to front of athlete to facilitate observation of posture and elbow lockout.

Test/Technique

Start position: Feet should be placed under the loaded barbell so that the bar is directly above the balls of the feet. Feet should be hip width. Shoulders should be in front of the bar and back should be held (braced) in a straight or concave set position.

Note: The hips are slightly higher in the set position for the snatch than for the power clean.

For taller athletes (> 190 cm) it is recommended that blocks of ≥ 2.5 cm be used.

- Initial movement of the bar should be generated from the legs by extending the knees with no change to the back angle at the pelvis.
- During the lift, the barbell should remain close to the body, and hips, knees and ankles should be fully extended (triple extension) before catching the bar.
- After triple extension and before the catch, the feet move laterally to the athletes preferred overhead squat/catch position.
- Finish position: The bar is caught on straight arms (lockout) and held above the head. Upon catching the bar, the athlete must not collapse into a squat position where crease of hips drops below top of knees (vs. snatch where there is no limit to depth of squat at catch position) and athlete must return to full standing position.
- The weight must be caught and seen to be under control if the repetition is to be valid.
- Record RM result in kilograms.

Technical Violations

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Failing to have the correct set-up, lift and catching techniques.
- Failing to catch the bar in a controlled manner with elbows extended.
- Collapsing into a full overhead squat position where crease of hips drops below top of knees, after the catch.
- Not returning to standing position with good control of the bar.
- Uneven splitting of the feet forward or sideways during the catch.
- Greater than 10 seconds rest between repetitions.

Recording Checklist

- ☐ Weight lifted (kilograms)
- ☐ Repetitions
- ☐ Block height (if used)
- ☐ Use of a weight belt, lifting straps, knee wraps and lifting shoes

Examples



Start position



Catch position



Finish position

5. STRENGTH ASSESSMENT PROTOCOLS

5.1 BENCH PRESS

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is added to the athlete's total weight lifted. It is also recommended to have two experienced spotters, especially during maximal efforts, while performing this test. Preferred spotting position: One person at each end of the barbell.

Equipment Checklist

- | | |
|--|--|
| <input type="checkbox"/> Flat bench and rack | <input type="checkbox"/> Weight plates (0.5kg-25kg increments) |
| <input type="checkbox"/> Barbell (Olympic 20kg/15kg) | <input type="checkbox"/> Blocks/steps for feet where needed |
| <input type="checkbox"/> Barbell collars | <input type="checkbox"/> Chest boards if testing reduced range |

Test Procedure and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- Athletes self-select the width of grip that they prefer, with coach's approval, to ensure desired bottom position is achievable. This should remain consistent over consecutive attempts and between tests. In the bottom position, forearms should be perpendicular to the floor.
- Feet are to be placed flat on the ground. For an athlete who cannot reach the floor without excessive heel lift or lower back arch, blocks/steps may be securely positioned under the feet.

Recommended assessor position: 45° angle from the base of the bench, eyeline lowered to facilitate observation of feet, shoulders and buttocks and bar contacting chest.

Test/Technique

- Once the bar is unracked and the athletes' elbows are in full extension, the bar is lowered in a controlled manner, making controlled contact with the highest point of the chest.
- The bar is then pressed upwards, completing the lift with full elbow extension.
- If the lift was successful, continue to add weight until a repetition maximum (RM) is achieved (i.e. 95%, 97.5%, 100%, 105% etc).
- Ensure athletes receive adequate rest between RM attempts (2-5mins).
- Once a technical violation is observed, test is concluded.
- Record RM result in kilograms to the nearest 0.5 kg.

For athletes who need to be tested with reduced range, the use of chest boards is permitted. Total height of boards in centimetres (cm) must be recorded with RM result.

Technical Violations

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Failing to make contact with, or excessively bouncing the bar off the chest.
- Lifting the shoulders, back or buttocks off the bench.
- Raising either foot off the ground so that it breaks contact with the floor.
- Excessive deviation of bar from 'normal' position (observed in warm-up).
- An uneven bar during the lift (shoulder elevation or asymmetrical extension of arms during lift).
- If the bar is assisted or touched by one or both spotters.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- | | |
|--|--|
| <input type="checkbox"/> Weight lifted (kilograms) | <input type="checkbox"/> Height of boxes under feet (in cm — if applicable) |
| <input type="checkbox"/> Repetitions | <input type="checkbox"/> Height of chest boards used (in cm — if applicable) |

Examples



Start/finish position



Middle position

5.2 BENCH PULL

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is added to the athlete's total weight lifted.

Equipment Checklist

- ☐ Hip flexed bench pull bench
- ☐ Barbell (Olympic 20kg/15kg)
- ☐ Weight plates (0.5kg-25kg increments)
- ☐ Barbell collars

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- Athletes may choose the width of grip that they prefer initially but this should remain consistent over consecutive attempts and between tests.
- Set bench height so that the athlete can comfortably take their desired grip whilst the weight plates are off the ground in a dead hang position (i.e. not touching the ground between reps).
- Measure depth of bench from the top of the padding to the point of bar and bench contact (on underside of bench). Record in cm.
- Recommended assessor position: 45° from the base of the bench, eyeline lowered to facilitate observation of knees, shoulders, and head (athlete to select one of either forehead, chin or cheek) maintaining contact with the bench, and the bar making contact with the underside of bench.

Test/Technique

Once the bar is unracked and the athlete's arms are in a dead hang position (weight off the floor), the bar is pulled upwards to touch the underside of the bench.

- The bar is then lowered in a controlled manner to the start position (weight off the floor).
- Use of abducted or adducted bench pull technique should be noted on testing results information:
 - Abducted Bench Pull: Elbow/humerus abducted >45 degrees to the side of the body at the top of the pull (i.e. bar is lifted towards chest).
 - Adducted Bench Pull: Elbow/humerus adducted <45 degrees to the side of the body at the top of the pull (i.e. bar is lifted towards navel).
- Chin, chest, and knees should remain in contact with the bench throughout the lift. Knees must not be gripping the outside of the bench. Feet should remain off the ground throughout the lift and in the same position throughout.
- If the lift was successful, continue to add weight until a repetition maximum (RM) is achieved (i.e. 95%, 97.5%, 100%, 105% etc).
- Ensure athletes receive adequate rest between RM attempts (2-5mins).
- Once technical violation is observed, test is concluded.
- Record RM result in kilograms to the nearest 0.5 kg.

Technical Violations

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Movement of the head, chest, or deviation of legs from start position.
- Movement of the hip into flexion or extension.
- The bar failing to make contact with the bench.
- Excessive deviation of bar from 'normal' position observed in warm-up (ie. maintain abducted or adducted position).
- An uneven bar during the lift (shoulder depression, uneven flexion of elbows during lift), including if the bar touches the rack.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- | | |
|---|---|
| <input type="checkbox"/> Weight lifted (kg) | <input type="checkbox"/> Technique: Abducted or adducted |
| <input type="checkbox"/> Repetitions | <input type="checkbox"/> Depth of Bench (from top of padding to the point of bar and bench contact on underside of bench) |

Examples



Start/finish position



ABducted



ADducted

5.3 CHIN UP [Pronated Grip]

All weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). The chin up/dip belt system should also be weighed and added to the results if used.

Equipment Checklist

- | | |
|---|--|
| <input type="checkbox"/> Straight chin up bar | <input type="checkbox"/> Weight plates (0.5kg-25kg increments) |
| <input type="checkbox"/> Chin up/dip belt | |

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

1. Body weight chin ups: ≤ 5 reps

Recovery: ≥ 2 minutes

If using additional external weight:

2. 40-50 % of predicted 1RM: ≤ 5 reps

Recovery: ≥ 5 minutes

Note: For those expected to perform bodyweight chin ups only, utilise appropriate derivatives for warm up (i.e. assisted chin up).

Preparation

- Chin ups should be performed with a medium width pronated grip. The grip should be no wider than 1 hand width outside the shoulders while in the hang position.
- A straight chin up bar should be used for testing chin ups.

Recommended assessor position: Side on to athlete ideally at eye level with bar.

Test/Technique

- Starting from a hang position (fully extended elbow position, with scapula engaged and spine in a neutral position) the athlete is required to pull body up in one smooth action so that at the top of the lift, the angle of the mandible (the corner of the jaw under the ear) is over the bar.
- The body is then lowered in a controlled manner to full elbow extension.
- Record repetitions and RM result in kilograms on recording sheet.

Total weight lifted [kg] = body mass + plates + belt

- Legs may be held in semi-flexed position or extended throughout the lift; however, they must not be moved in a way that increases momentum in the pulling phase of the lift.
- Athletes should be encouraged to complete the lift with minimal head movement.

Technical Violations:

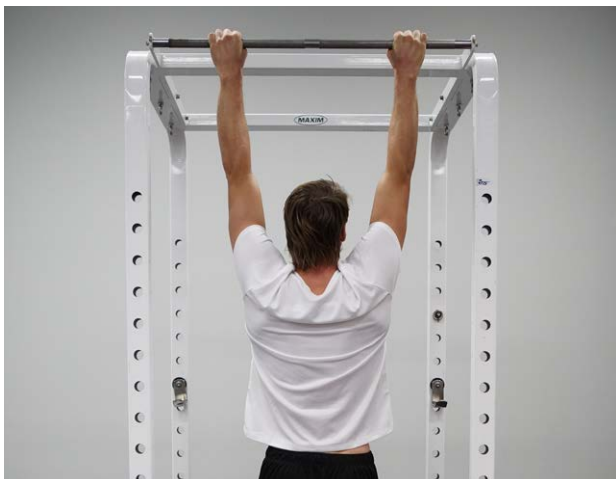
The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Not achieving correct height (rear angle of mandible equal to or below bar height).
- Breaking of the hips and/or knees from start position during the lift.
- Body swing during lift.
- Not returning to full elbow extension or starting shoulder position between repetitions.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- ☐ Weight lifted (body mass including clothes and shoes + weight plates + weight of belt in kg)
- ☐ Repetitions

Examples



Start/finish position



Middle position



Angle of the Mandible above the height of the bar

5.4 CHIN UP [Supinated Grip]

All weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). The chin up/dip belt system should also be weighed and added to the results if used.

Equipment Checklist

- ☐ Straight chin up bar
- ☐ Weight plates (0.5kg-25kg increments)
- ☐ Chin up/dip belt

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

1. Body weight chin ups: ≤ 5 reps

Recovery: ≥ 2 minutes

If using additional external weight:

2. 40-50 % of predicted 1RM: ≤ 5 reps

Recovery: ≥ 5 minutes

Note: For those expected to perform bodyweight chin ups only, utilise appropriate derivatives for warm up (i.e. assisted chin up).

Preparation

- Chin ups should be performed with a medium width supinated grip. The grip should be no wider than 1 hand width outside the shoulders while in the hang position.
- A straight chin up bar should be used for testing chin ups.
- Recommended assessor position: Side on to athlete ideally at eye level with bar.

Test/Technique

- Starting from a hang position (fully extended elbow position, with scapula engaged and spine in a neutral position) the athlete is required to pull body up in one smooth action so that at the top of the lift, the angle of the mandible (the corner of the jaw under the ear) is over the bar.
- The body is then lowered in a controlled manner to full elbow extension.
- Record repetitions and RM result in kilograms on recording sheet.

Total weight lifted [kg] = body mass + plates + belt

- Legs may be held in semi-flexed position or extended throughout the lift; however, they must not be moved in a way that increases momentum in the pulling phase of the lift.
- Athletes should be encouraged to complete the lift with minimal head movement.

Technical Violations:

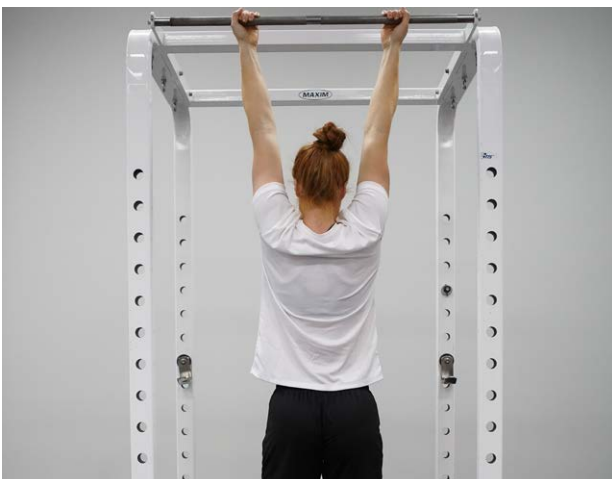
The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Not achieving correct height (rear angle of mandible equal to or below bar height).
- Breaking of the hips and/or knees from start position during the lift.
- Body swing during lift.
- Not returning to full elbow extension or starting shoulder position between repetitions.
- Greater than 3 seconds rest between repetitions.

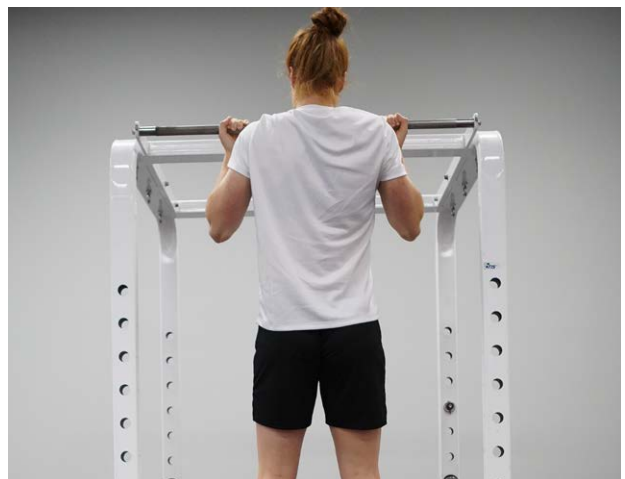
Recording Checklist

- ☐ Weight lifted (body mass including clothes and shoes + weight plates + weight of belt in kg)
- ☐ Repetitions

Examples



Start/finish position



Middle position



Angle of the Mandible above the height of the bar

5.5 INCLINE LEG PRESS [Double Leg]

Weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Prior to starting the test, the weight of the leg press sled needs to be measured (refer to individual manufacturer specifications or assess with a strain gauge).

Please note that due to the differences between leg press manufacturers, comparison of strength data on different machines is not recommended, but rather to be used for longitudinal tracking for that piece of equipment only.

Equipment Checklist

- ☐ Leg press machine
- ☐ Goniometer/90 degree angle template
- ☐ Weight plates [0.5kg-25kg increments]

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- Set the seat back position at 90 degrees to the angle of slide. If adjustable, set the footplate angle to 110 degrees from angle of slide.
- In the start position, feet should be placed so that when knees are extended, hips are flexed to 90 degrees. Athletes may choose their own feet width.
- Hands are kept on handles next to the hips or held on torso (not on the thighs or knees).
- If using a leg press with dual footplates, ensure they are securely attached so the footplates do not move independently.
- Recommended assessor position: Side on to athlete and at level of knees to assess depth.

Test/Technique

- Once the athlete has unracked the sled and legs are fully extended (not locked out), the weight is lowered to a depth corresponding to 90 degrees of knee flexion (assessed via an indicative line representing the femur bone as shown by the line drawn between the centre of rotation of the knee and hip joints in picture XX).
- The sled is then pressed back up to full leg extension (not complete lockout) to complete the repetition.
- Record RM result in kilograms on recording sheet.

Total weight lifted [kg] = weight plates + mass of sled

Technical Violations:

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Not achieving required depth during lowering of weight.
- Allowing hips/buttocks to lose contact with the seat.
- Excessive valgus/varus (lateral/medial) knee movement deemed unsafe by the assessor.
- Repositioning of feet from start position.
- Placing hands on thighs and/or knees to assist lift.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- ☐ Weight lifted (sled + weight plates in kg)
- ☐ Repetitions
- ☐ Foot plate angle

Examples



Start/finish position



Middle position

5.6 INCLINE LEG PRESS [Single Leg]

Weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Prior to starting the test, the weight of the leg press sled needs to be measured (refer to individual manufacturer specifications or assess with a strain gauge).

Technically, the single leg press test is completed as per incline leg press test (detailed in 4.4.1) but each set should be completed with both the left and right leg before moving to the next weight.

Please note that due to the differences between leg press manufacturers, comparison of strength data on different machines is not recommended, but rather to be used for longitudinal centre tracking only.

Equipment Checklist

- ☐ Leg press machine
- ☐ Goniometer/90 degree angle template
- ☐ Weight plates (0.5kg-25kg increments)

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

The warm up should ensure that a safe and effective foot position is established before undertaking testing.

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation/Test:

- Set the seat back position at 90 degrees to the angle of slide. If adjustable, set the footplate angle to 110 degrees from angle of slide.
- In the start position, foot should be placed so that when knee is extended, the hips is flexed to 90 degrees.
- Athletes may choose their own foot position but it should be symmetrical left to right.
- Hands are kept on handles next to the hips or held on torso.

Technique:

- Once the athlete has unracked the sled and leg is fully extended (not locked out), the weight is lowered to a depth corresponding to 90 degrees of knee flexion (anterior surface of the thigh is 90 degrees with anterior surface of the shin).
- The sled is then pressed back up to full leg extension (not complete lockout) to complete the repetition.
- The support foot can move slightly during the lift as long as it is not moving in a way that is assisting the other leg.
- Record RM result in kilograms on recording sheet.

Total weight lifted [kg] = weight plates + mass of sled.

Technical Violations:

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Not achieving required depth during lowering of weight.
- Allowing hips/buttocks to lose contact with the seat.
- Excessive knee movement deemed unsafe by the assessor.
- Significant repositioning of foot being tested from start position so as to change the nature of the lift.
- Moving the support foot during the lift excessively or in a way that is assisting the other leg.
- Placing hands on thighs to assist lift.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- ☐ Weight lifted (sled + weight plates in kg)
- ☐ Repetitions
- ☐ Foot plate angle

Examples

Start/finish position



Middle position

5.7 BACK SQUAT [Thigh parallel to floor]

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency. It is suggested a qualified strength and conditioning coach (ASCA Level 2 or 3) should supervise this test.

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is the athlete's total weight lifted. It is also recommended to have two experienced spotters, especially during maximal efforts, while performing this test. Preferred spotting position: 1 person at each end of the barbell.

This test refers to the parallel squat. For protocols relating to the 90° knee angle squat, please refer to protocol 5.8

Equipment Checklist

- ☐ Squat rack with safety bars
- ☐ Weight plates (1kg-25kg increments)
- ☐ Bar (Olympic 20kg/15kg)

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- Safety bars should be set at the highest possible point without affecting the athlete's squat range of motion.
- Heel blocks should not be used unless anatomical structures limit the athlete's range of motion or prevent the exercise from being performed with correct technique. Use of heel blocks should be consistent between tests and noted in the recorded data.
- Use of a weight belt is optional but should be consistent between tests.
- The athlete should assume a natural stance with feet approximately shoulder width apart.
- Bar should be held in a 'high' bar position resting on the upper trapezius during the test.
- Hands should be held in a comfortable position as close to shoulders as possible.
- Recommended assessor position: Side on to athlete to facilitate observation of hip/knee angle, trunk posture and depth.

Test/Technique

- Once the bar has been unracked, the athlete lowers the weight with knees travelling forward over toes. Heels must remain in contact with the floor at all times.
- Athletes are required to lower to a designated depth where thigh is parallel to floor thus axes of rotation of hips becomes level with knees.
- Knees and hips are then extended to standing with trunk as upright as possible.
- Record RM result in kilograms.

Technical Violations:

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Excessive forward or sideways movement from the athlete's usual technique.
- Excessive valgus/varus (medial/lateral) knee movement deemed unsafe by the assessor.
- Loss of controlled spinal position.
- Heels lifting off the floor.
- Not lowering to required depth (thigh parallel to floor).
- Raising of hips prior to shoulder elevation on initial concentric drive.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- | | |
|--|---|
| <input type="checkbox"/> Weight lifted (kilograms) | <input type="checkbox"/> Use of heel blocks |
| <input type="checkbox"/> Repetitions | <input type="checkbox"/> Use of weight belt |

Examples



Start/finish position



Middle position — Thigh parallel squat depth

5.8 BACK SQUAT [90° Knee angle]

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency. It is suggested a qualified strength and conditioning coach (ASCA Level 2 or 3) should supervise this test.

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is the athlete's total weight lifted. It is also recommended to have two experienced spotters, especially during maximal efforts, while performing this test. Preferred spotting position: 1 person at each end of the barbell.

This test refers to the 90° knee angle squat. For protocols relating to the parallel squat, please refer to protocol 5.7.

Equipment Checklist

- | | |
|--|--|
| <input type="checkbox"/> Squat rack with safety bars | <input type="checkbox"/> Goniometer/90 degree angle template |
| <input type="checkbox"/> Bar (Olympic 20kg/15kg) | <input type="checkbox"/> Weight plates (1kg-25kg increments) |

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm-up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- Safety bars should be set at the highest possible point without affecting the athlete's squat range of motion.
- Heel blocks should not be used unless anatomical structures limit the athlete's range of motion or prevent the exercise from being performed with correct technique. Use of heel blocks should be consistent between tests and noted in the recorded data.
- Use of a weight belt is optional but should be consistent between tests.
- The athlete should assume a natural stance with feet approximately shoulder width apart.
- Bar should be held in a 'high' bar position resting on the upper trapezius during the test.
- Hands should be held in a comfortable position as close to shoulders as possible.
- Recommended assessor position: Side on to athlete to facilitate observation of hip/knee angle, trunk posture and depth.

Test/Technique

- Once the bar has been unracked, the athlete lowers the weight with knees travelling forward over toes. Heels must remain in contact with the floor at all times.
- Athletes are required to lower to a designated depth where the knee angle is 90° with heel on the floor and bar over midfoot.
- Knees and hips are then extended to standing with trunk as upright as possible.
- Record RM result in kilograms.

Technical Violations:

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Excessive forward or sideways movement from the athlete's usual technique.
- Excessive valgus/varus (medial/lateral) knee movement deemed unsafe by the assessor.
- Loss of controlled spinal position.
- Heels lifting off the floor.
- Not lowering to required depth (90° knee flexion).
- Raising of hips prior to shoulder elevation on up phase.
- Greater than 3 seconds rest between repetitions.

Recording Checklist

- | | |
|--|---|
| <input type="checkbox"/> Weight lifted (kilograms) | <input type="checkbox"/> Use of heel blocks |
| <input type="checkbox"/> Repetitions | <input type="checkbox"/> Use of weight belt |

Examples



Start/finish position



Middle position — 90 degree knee angle squat depth

5.9 DEADLIFT [Barbell]

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency. It is suggested a qualified strength and conditioning coach [ASCA Level 2 or 3] should supervise this test.

All bars and weight plates used for this test must be calibrated if they are not Category A accredited by the International Weightlifting Federation (IWF). Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is the athlete's total weight lifted.

Equipment Checklist

- ☐ Bar (Olympic 20kg)
- ☐ Weight plates (0.5kg-25kg increments)
- ☐ Barbell collars

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- The athlete should assume a natural stance with feet hip/shoulder width apart.
- The use of a weight belt, lifting straps and knee wraps are optional but should be consistent between tests and recorded.
- Recommended assessor position: Side on to athlete to facilitate observation of posture.

Test/Technique

- Start position: Feet should be placed under the bar, so that the bar is directly above the balls of the feet. Grip should be slightly wider than shoulders. The grip can be overhand or an alternate grip, meaning one hand pronated and the other supinated. Shoulders should be forward over the bar and spine should be braced and held in a neutral position.
- Initial movement of the bar should be generated from the legs by extending the knees with no change to the angle of the back at the pelvis.
- During the lift: The bar is lifted in one continuous motion to the point where the body reaches a fully upright/standing position, with the knee and hip joints extended to a 'neutral' position [i.e. the back in line with the rest of the fully upright body]. The back must not bend or show excessive flexion during the lift.

- Repetitions should be completed as soon as possible after each other, but there must be a pause to eliminate any bouncing or stretch-shorten cycle utilisation). A single rest of no more than 5 seconds is allowed to re-position hands/feet etc if greater than 1RM is being used.
- The bar may be dropped to floor between repetitions.
- Record RM result in kilograms.

Technical Violations

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Failing to have the correct set-up and lifting techniques.
- Failing to lift the bar in one continuous motion.
- Excessive flexion of the spine during the lift.
- Greater than 5 seconds rest between repetitions.
- Failing to pause between repetitions (i.e. tap and go error).

Recording Checklist

- | | |
|--|---|
| <input type="checkbox"/> Weight lifted (kilograms) | <input type="checkbox"/> Type of grip used |
| <input type="checkbox"/> Repetitions | <input type="checkbox"/> Use of a weight belt, lifting straps, knee wraps and lifting shoes |

Examples



Start position



Finish position

5.10 DEADLIFT [Trap Bar / Hex Bar]

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency. It is suggested a qualified strength and conditioning coach [ASCA Level 2 or 3] should supervise this test.

The trap bar to be used must be weighed prior to testing due to varied design and manufacturing processes. Trap bars should be consistent between testing occasions. Barbell collars must be weighed prior to test if used. Their combined weight (bar, weight plates and collars) is the athlete's total weight lifted.

Equipment Checklist

- | | |
|---|--|
| <input type="checkbox"/> Trap bar / Hex bar | <input type="checkbox"/> Weight plates (0.5kg-25kg increments) |
| <input type="checkbox"/> Barbell collars | <input type="checkbox"/> Blocks (if required) |

Test Procedures and Protocols

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

% PREDICTED RM	1RM	3RM	6RM
Set 1: 40-60%	≤ 10 reps	≤ 12 reps	≤ 15 reps
	Recovery: ≥ 2 minutes		
Set 2: 60-70%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 3: 70-80%	≤ 5 reps	≤ 6 reps	≤ 10
	Recovery: ≥ 2 minutes		
Set 4: 90%	1-3 reps	3-5 reps	6-8 reps
	Recovery: 2-5 minutes		

Preparation

- The S&C coach may choose either low or high handle but must remain consistent over consecutive attempts and between tests. If using high handles, the handle height must be recorded (measure from level of barbell sleeve to bottom/lowest point of high handle).
- The use of a weight belt, lifting straps and knee wraps are optional but should be consistent between tests and recorded.
- Recommended assessor position: Side on to athlete to facilitate observation of posture.

Test/Technique

- Start position: The athlete should stand in the middle of the bar, with feet hip/shoulder width apart. Hand in the middle of the handle. Shoulders should be forward over the hands. Hips should be higher than knees and the spine should be braced and held in a neutral position.
- Initial movement of the bar should be generated from the legs by extending the knees with no change to the angle of the back at the pelvis.

- During the lift: The bar is lifted in one continuous motion to the point where the body reaches a fully upright/standing position, with the knee and hip joints extended to a 'neutral' position (i.e. the back in line with the rest of the fully upright body). The back must not bend or show excessive flexion during the lift.
- Repetitions should be completed as soon as possible after each other, but there must be a pause to eliminate any bouncing or stretch-shorten cycle utilisation). A single rest of no more than 5 seconds is allowed to re-position hands/feet etc if greater than 1RM is being used.
- The bar may be dropped to floor between repetitions.
- Record RM result in kilograms.

Technical Violations:

The following technical violations will result in the trial being invalid and a second trial at the same weight provided:

- Failing to have the correct set-up and lifting techniques.
- Failing to lift the bar in one continuous motion.
- Not reaching full extension at the top of the lift.
- Greater than 5 seconds rest between repetitions.
- Failing to pause between repetitions (i.e. tap and go error).

Recording Checklist

- | | |
|--|--|
| <input type="checkbox"/> Weight lifted (kilograms) | <input type="checkbox"/> Handle height (in cm — if applicable) |
| <input type="checkbox"/> Repetitions | <input type="checkbox"/> Use of weight belt |

Examples



Start position — High handle version



Finish position — High handle version

6. FORCE PLATE PROTOCOLS

6.1 SQUAT JUMP [Non Counter-Movement Jump]

Please note that each force plate system used to record force data will likely have its own software that will require their own specific instructions. These system specific instructions are not meant to be overridden by the information provided here.

Equipment Checklist

- ☐ Force plate
- ☐ Goniometer / 90 degree angle template
- ☐ Operating system/software

Test Procedures and Protocols

Force Plate Set Up

Ensure the force plate/s are placed on a flat surface and are assessed as level.

Note: Different surfaces will affect data output; test on the same surface where possible. However, if you test on multiple surfaces, assess the difference between surfaces and compare data accordingly.

- Verify the force plates if they have been moved between the last test.
- Zero the force plate prior to beginning the test as per your system instructions.
- If using dual force platforms, ensure left and right plates are correctly placed and identified in software.
- Conduct a pre-test trial to ensure the force output is accurate (analyse system weight).

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

- Countermovement jumps x 5
- Squat jumps x 3

Preparation

- Ask athlete to step onto plate/s.
- Weigh athlete while they are standing as still as possible.
- Start position: Athlete should assume a standing position with feet approximately shoulder width apart with hands on hips. Hands must not break contact with the hips for the duration of the test.
- It is recommended that the assessor watch the athlete perform their jump rather than the force trace to ensure correct technique is maintained. Data captured in the software can be reviewed upon test completion before moving on to next athlete or test.

Test/Technique

- From the standing start position the athlete slowly squats down to a depth where their knees are flexed to 90 degrees, feet are flat on the floor and chest is as upright as their anatomy allows.
- The athlete must hold this position for at least 3 seconds with a high degree of stillness.
- Once the pause duration has been completed the athlete immediately drives up with a maximal effort vertical jump, making sure that there is no countermovement (head, shoulders or hips dipping) at the start of the jump phase.
- Hands must not break contact with the hips during the jump or landing.
- During the jump, it is essential that the athlete maintains extension of the hip, knee, and ankle joints. This prevents them achieving any additional flight time by bending their legs (i.e. tuck jump). Hands must not break contact with the hips for the duration of the test.
 - The athlete should land on the balls of the feet with full extension at the hip, knees, and ankles. Once ground contact has been made the athlete is allowed to flex to absorb the impact of landing.
 - The athlete must reset to the starting position after each jump allowing at least 3 seconds between reps of stable standing and repeat for the total number of jumps required.

Note: Different force time variables may require more jumps to be reliable. Please consider metrics for analysis before selecting total number of jumps (Cormack et al. 2008, Merrigan et al. 2021, Petrigna et al. 2019, Warr et al. 2020).

- Review that reps and test type have been completed and detected correctly in your software (if not, you may need to complete additional reps or test again at another time).
- Save data as per individual system protocols.

Technical Violations

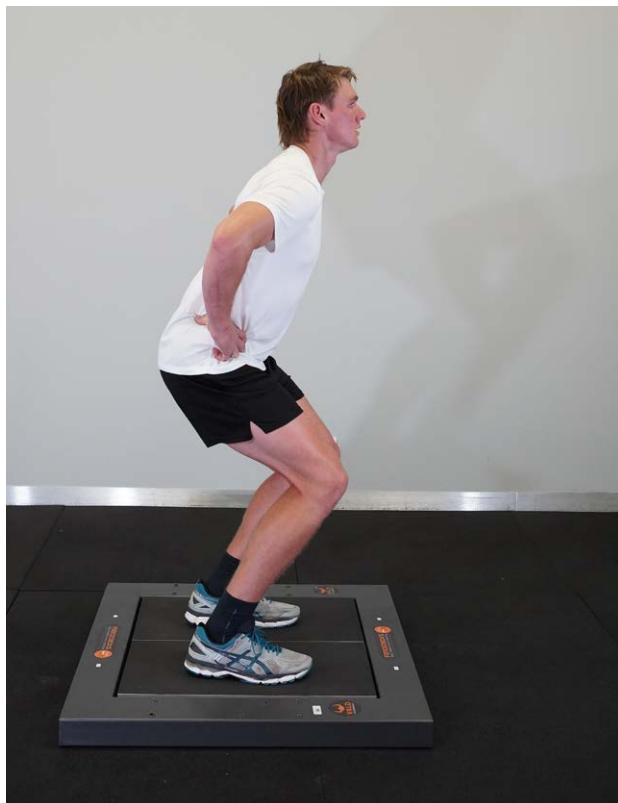
The following technical violations will result in the trial being invalid:

- Failing to achieve and/or hold starting squat position.
- Any countermovement: shoulders or hips dipping prior to take off. See force traces below.
- Allowing hands to move from hips.
- Bending of the knees or hips mid-flight.
- Landing with bent knees or hips at initial contact.

Recording Checklist

- ☐ Force data

Examples



Start position



Mid-air position

Valid Force Traces and Examples of Violations

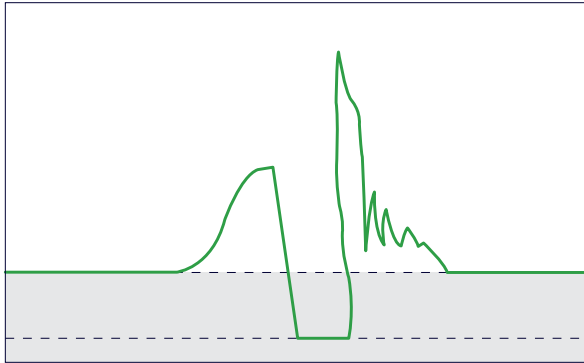


Figure 1: Successful squat jump rep.

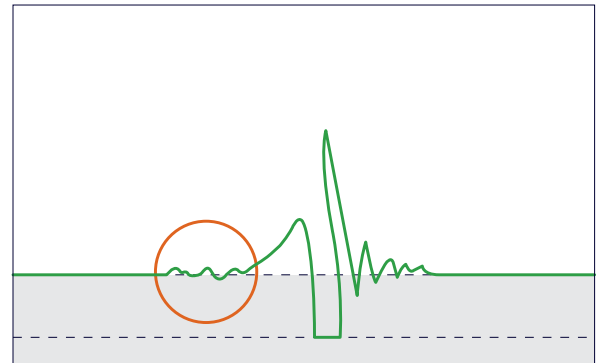


Figure 2: Failing to achieve and/or hold starting squat position.

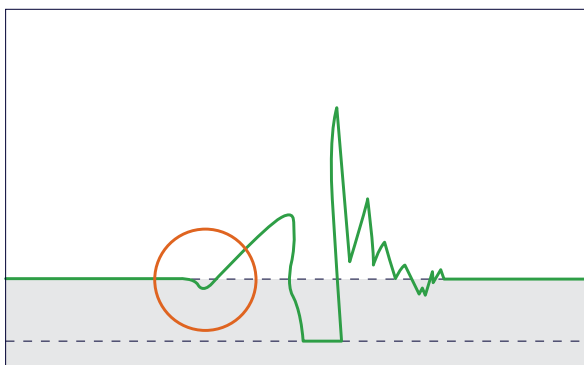


Figure 3: Any countermovement: shoulders or hips dipping prior to take off.

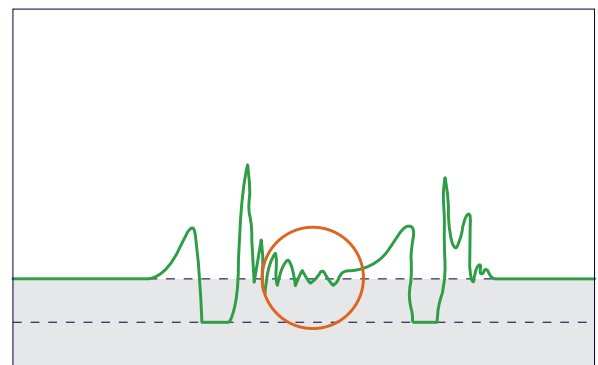


Figure 4: Failure to achieve 2 seconds of 'quiet' stillness between repetitions.

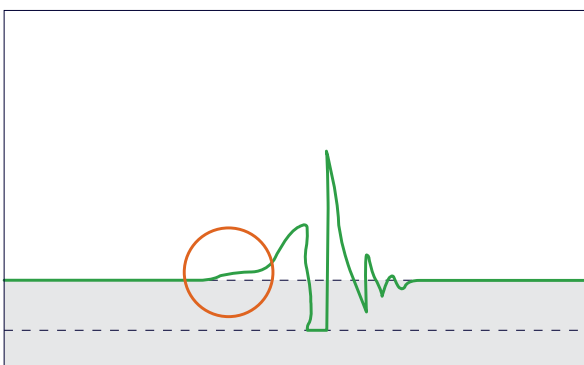


Figure 5: Pre-loading of the platform by the athlete.

6.2 COUNTER-MOVEMENT JUMP

Please note that each force plate system used to record force data will likely have its own software that will require their own specific instructions. These system specific instructions are not meant to be overridden by the information provided here.

Equipment Checklist

- ☐ Force plate
- ☐ Operating system/software

Test Procedures and Protocols

Force Plate Set Up:

Ensure the force plate/s are placed on a flat surface and are assessed as level.

Note: Different surfaces will affect data output; test on the same surface where possible. However, if you test on multiple surfaces, assess the difference between surfaces and compare data accordingly.

- Verify the force plates if they have been moved between the last test.
- Zero the force plate prior to beginning the test as per your system instructions.
- If using dual force platforms, ensure left and right plates are correctly placed and identified in software.
- Conduct a pre-test trial to ensure the force output is accurate (analyse system weight).

Suggested Warm Up

Exercise Specific Warm Up

- Countermovement jumps x 3-5

Preparation

- Ask athlete to step onto plate/s.
- Weigh athlete while they are standing as still as possible.
- Start position: Athlete should assume a standing position with feet approximately shoulder width apart with hands on hips. Hands must not break contact with the hips for the duration of the test.
- It is recommended that the assessor watch the athlete perform their jump rather than the force trace. Data captured in the software can be reviewed upon completion.

Test/Technique

- From a still start position the athlete moves into a self-selected countermovement depth, then immediately drives up with a maximal effort vertical jump.
- Hands must not break contact with the hips during the jump or landing.
- During the jump, it is essential that the athlete maintains extension of the hip, knee, and ankle joints. This prevents them achieving any additional flight time by bending their legs (i.e tuck jump).
- The athlete should land on the balls of the feet with full extension at the hip, knees, and ankles. Once ground contact has been made the athlete is allowed to flex to absorb the impact of landing.
- The athlete must reset to the starting position after each jump allowing at least 3 seconds between reps of stable standing and repeat for the total number of jumps required.

Note: Different force time variables may require more jumps to be reliable. Please consider metrics for analysis before selecting total number of jumps (Cormack et al. 2008, Merrigan et al. 2021, Petrigna et al. 2019, Warr et al. 2020).

- Review that reps and test type have been completed and detected correctly in your software (if not, you may need to complete additional reps or test again at another time).
- Save data as per individual system protocols.

Technical Violations

The following technical violations will result in the trial being invalid:

- Allowing hands to move from hips.
- Heels lifting on down phase of jump.
- Bending of the knees or hips mid-flight.
- Landing with bent knees or hips at initial contact.

Recording Checklist

☐ Force data

Examples



Start position



Mid-air position

Valid Force Traces and Examples of Violations

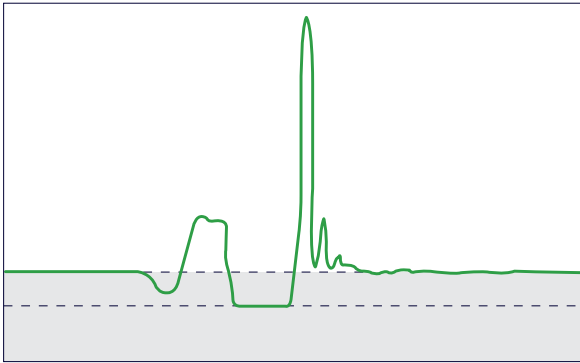


Figure 6: Successful countermovement jump rep

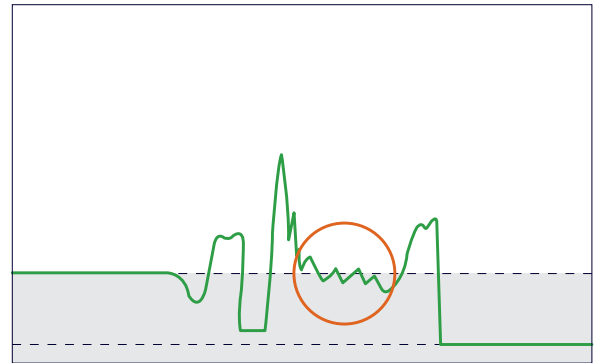


Figure 7: Heels lifting on down phase of jump.

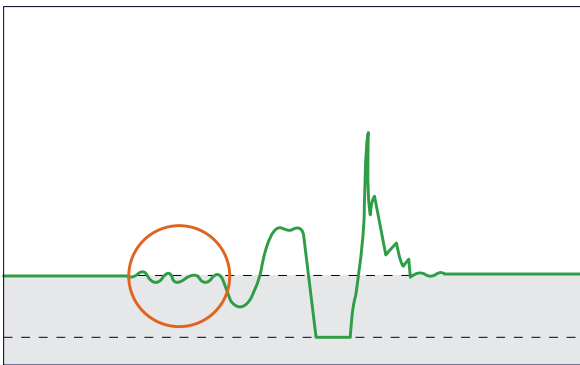


Figure 8: Failure to achieve 2 seconds of 'quiet' stillness before starting repetitions.

6.3 DROP JUMP [Double Leg]

This test involves high impact forces and should not be administered with athletes at risk of injury or who have current lower limb injuries. Athletes should practice this test in the weeks leading up to the testing day as a familiarisation.

Please note that each force plate system used to record force data will likely have its own software that will require their own specific instructions. These system specific instructions are not meant to be overridden by the information provided here.

There are two different types of drop jump test:

- Standard drop jump: The drop jump height is fixed (typically 30cm).
- Incremental drop jump: The drop jump height should start at 15 cm and progressively increased by 15 cm until there is a decrement in performance as indicated by the reactive strength index.

Note: Box height is measured from the top of the force plate to the top of the box.

Equipment Checklist

- | | |
|---|--|
| <input type="checkbox"/> Force plate | <input type="checkbox"/> Operating system/software |
| <input type="checkbox"/> Box / Step of known height | <input type="checkbox"/> Ruler / Tape measure |

Test Procedures and Protocols

Force Plate Set Up

- Ensure the force plate/s are placed on a flat surface and are assessed as level.

Note: Different surfaces will affect data output; test on the same surface where possible. However, if you test on multiple surfaces, assess the difference between surfaces and compare data accordingly.

- Verify the force plates if they have been moved between the last test.
- Zero the force plate prior to beginning the test as per your system instructions.
- If using dual force platforms, ensure left and right plates are correctly placed and identified in software
- Conduct a pre-test trial to ensure the force output is accurate (analyse system weight).

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

- Countermovement jumps x 5
- Pogo's x 10
- Drop jumps x 3 (long to shorter ground contact time)

Preparation/Test

- Place a box of the desired height, as close to the force plates as possible without touching them.
- Weigh athlete while they are standing as still as possible.
- Start position: The athlete should stand on edge of box and place hands on hips.
- Athlete is required to keep upper body in an upright position and hands on hips throughout all phases of test.

Technique

- From the start position the athlete is required to step off the box and upon landing perform a vertical jump for maximal height.
- Emphasis should be placed on jumping for maximal height whilst minimising ground contact time.
 - During the jump, it is essential that the athlete maintains extension of the hip, knee, and ankle joints. This prevents them achieving any additional flight time by bending their legs (i.e. tuck jump).
 - The athlete should complete the final landing on the balls of the feet with full extension at the hip, knees, and ankles. Once the final ground contact has been made the athlete is allowed to flex to absorb the impact of landing.

Technical Violations

The following technical violations will result in the trial being invalid:

- Incorrect technique when dropping from box (i.e. jumping or lowering instead of stepping off the box).
- Both feet not hitting the platform at the same time.
- Allowing hands to move from hips.
- A ground contact time of greater than 0.2 seconds.
- Box comes in contact with force plates.

Recording Checklist

☐ Force Data

☐ Box height

Examples



Start position



Finish position

6.4 DROP JUMP [Single Leg]

This test involves high impact forces and should not be administered with athletes at risk of injury or who have current lower limb injuries. Athletes should practice this test in the weeks leading up to the testing day as a familiarisation.

Please note that each force plate system used to record force data will likely have its own software that will require their own specific instructions. These system specific instructions are not meant to be overridden by the information provided here.

There are two different types of drop jump test:

- Standard drop jump: The drop jump height is fixed (typically 15cm).
- Incremental drop jump: The drop jump height should start at 10 cm and progressively increased by 5 cm until there is a decrement in performance as indicated by the reactive strength index.

Note: Box height is measured from the top of the force plate to the top of the box.

Equipment Checklist

- | | |
|---|--|
| <input type="checkbox"/> Force plate | <input type="checkbox"/> Operating system/software |
| <input type="checkbox"/> Box / Step of known height | <input type="checkbox"/> Ruler / Tape measure |

Test Procedures and Protocols

Force Plate Set Up

- Ensure the force plate/s are placed on a flat surface and are assessed as level.

Note: Different surfaces will affect data output; test on the same surface where possible. However, if you test on multiple surfaces, assess the difference between surfaces and compare data accordingly.

- Verify the force plates if they have been moved between the last test.
- Zero the force plate prior to beginning the test as per your system instructions.
- If using dual force platforms, ensure left and right plates are correctly placed and identified in software.
- Conduct a pre-test trial to ensure the force output is accurate (analyse system weight).

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

- Countermovement jumps x 5
- Pogo's x 10
- Single leg pogo's x 10 ES
- Drop jumps x 3 (long to short ground contact time)
- Single leg drop jumps x 3 each side (long to short ground contact time)

Preparation/Test

- Place a box of the desired height, as close to the force plates as possible without touching them.
- Weigh athlete while they are standing as still as possible.
- Start position: The athlete should stand on edge of box and place hands on hips.
- Athlete is required to keep upper body in an upright position and hands on hips throughout all phases of test.

Technique

- From the start position the athlete is required to step off the box and land on one leg. Upon landing perform a vertical jump for maximal height off one leg.
- Emphasis should be placed on jumping for maximal height whilst minimising ground contact time.
 - During the jump, it is essential that the athlete maintains extension of the hip, knee, and ankle joints. This prevents them achieving any additional flight time by bending their leg (i.e. tuck jump).
 - The athlete should complete the final landing on the ball of the foot with full extension at the hip, knee, and ankle. Once the final ground contact has been made the athlete is allowed to flex to absorb the impact of landing.

Technical Violations

The following technical violations will result in the trial being invalid:

- Incorrect technique when dropping from box (i.e. jumping or lowering instead of stepping off the box).
- Allowing hands to move from hips.
- A ground contact time of greater than 0.2 seconds.
- Box comes in contact with force plates.

Recording Checklist

☐ Force Data

☐ Box height

Examples



Start position



Finish position

6.5 ISOMETRIC MID-THIGH PULL — Fast Ramp

The isometric mid-thigh pull (IMTP) fast ramp protocol should be used where practitioners are looking to analyse time specific force data such as rate of force development or force at certain time points.

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency and familiarity. Athletes should practice this test in the weeks leading up to the testing day as a familiarisation and to pre-determine their appropriate bar height. It is suggested a qualified strength and conditioning coach (ASCA Level 2 or 3) should supervise this test.

Please note that each force plate system used to record force data will likely have its own software that will require their own specific instructions. These system specific instructions are not meant to be overridden by the information provided here.

Equipment Checklist

- | | |
|--|--|
| <input type="checkbox"/> Force plate | <input type="checkbox"/> Tape measure |
| <input type="checkbox"/> IMTP rack and bar | <input type="checkbox"/> Wrist straps |
| <input type="checkbox"/> Goniometer | <input type="checkbox"/> Operating system/software |

Note: If you do not have access to an IMTP rack, another system may be used if it is secure and does not move during the test. For example: Upside down j-hooks (secured to the rack) and a bar to pull up against.

Test Procedures and Protocols

Force Plate Set Up

- Position the force plate/s under/on the IMTP rack.
- Ensure the force plate/s are assessed as level.

Note: Different surfaces will affect data output; test on the same surface where possible. However, if you test on multiple surfaces, assess the difference between surfaces and compare data accordingly.

- Verify the force plates if they have been moved between the last test.
- Zero the force plate prior to beginning the test as per your system instructions.
- If using dual force platforms, ensure left and right plates are correctly placed and identified in software.
- Conduct a pre-test trial to ensure the force output is accurate (analyse system weight).

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

Submaximal IMTP's: These can be complete on or off the force plates.

1. 3 sec hold at 50% perceived maximal effort

Recovery: ≥ 1 minute

2. 3 sec hold at 75% perceived maximal effort

Recovery: ≥ 1 minute

3. 3 sec hold at 90% perceived maximal effort

Recovery: ≥ 1 minute

Preparation

Body position for the isometric mid-thigh pull should be comparable to the second pull position of the clean: upright torso, slight flexion in the knee resulting in some ankle dorsiflexion, shoulder girdle retracted and depressed, shoulders above the bar, arms straight, midfoot directly under the bar approximately hip width apart, knees underneath and in front of the bar, and thighs in contact with the bar (close to the inguinal crease dependent on limb length).

A self-selected knee and hip angle between the recommended ranges below (Comfort et al., 2019) is best practice in the applied setting and demonstrated high reliability and low measurement error. This practice allows for the individual athlete's anthropometrics to be considered and allows them to assume an optimal pulling position.

Initial Athlete Set Up

- Ask the athlete to step onto the force plates and grip the bar with a clean grip. Lifting straps will be used during data capture to ensure maximal force production is achieved and grip strength is not a limiting factor.
- Adjust the bar height accordingly to account for the athlete's limb lengths.
 - Knee angles should be between 120-135 degrees
 - Hip angles should be between 140-150 degrees

Note: When setting joint angles, the athlete should ensure that no tension is applied to the bar, but that all "slack" (e.g. elbow flexion and shoulder girdle elevation/protraction) is removed from the body.

- Once the athlete's optimal pulling position is established, record the marking/number to identify bar height.

Measuring Bar Height:

- To ensure IMTP testing can be replicated between practitioner and testing sites, bar height in centimetres (cm) must be recorded and kept with each athlete's results. Bar height must remain consistent over consecutive attempts and between tests (with an exception for athlete growth).
- Bar height is measured from the top of the force platform to the bottom of the bar when no tension is applied.

Test/Technique

- Begin force capture and ask the athlete to step onto the force plates and stand still to record body weight.
- Assume the athletes preferred IMTP position with wrist straps firmly secured.
- Cue the athlete to take the tension/remove slack on the bar, without pre-tensing the involved muscles (<50N change in force output is acceptable).
- Cue the athlete to "push their feet into the ground as fast and as hard as possible when the test begins". Inform the athlete that they have 3-seconds before they need to maximally push. Count down "3-2-1-Push!".
- Allow the athlete to push for a period of 3-5 seconds before stopping. Verbal encouragement should be used during the attempt.
- Cue the athlete to remain still on the force plate until the trial is saved
- Rest for >2 mins between attempts.
- A minimum of 2 trials should be performed to determine the athlete's peak isometric force output. If after the second trial the athlete's force output is significantly higher than the first, the practitioner should perform additional test/s until the peak force output drops.
- An acceptable pair of trials should have <250 N difference in peak force.

Technical Violations

The following technical violations will result in the trial being invalid and a second trial provided:

- Thighs moving away from the bar.
- Excessive rounding of the back.
- Heels lifting off the floor.
- Swaying backwards allowing shoulders to excessively move behind bar.
- A force signature (depicted below) that shows:
 - Excessive pretension: >50 N change while taking the tension on the bar.
 - Multiple pulls or efforts.
 - A pre-effort countermovement.
 - Unstable weighing period.
 - If peak force occurs at the end of the trial.

Recording Checklist

☐ IMTP bar height (cm from force plate)

☐ Force data

Examples



Valid Force Traces and Examples of Violations

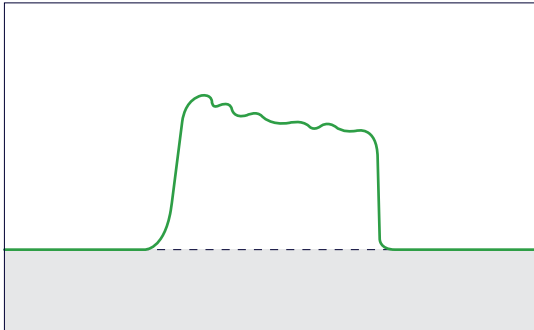


Figure 9: Successful IMTP - FR rep

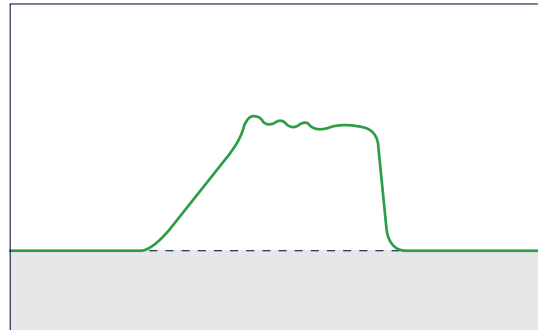


Figure 10: Violation - Slow ramp

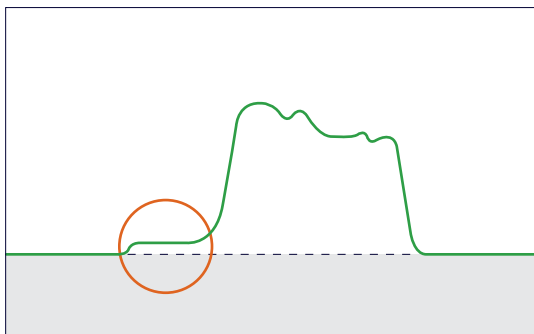


Figure 11: Violation - Excessive pretension:
>50 N change while taking the tension on the bar

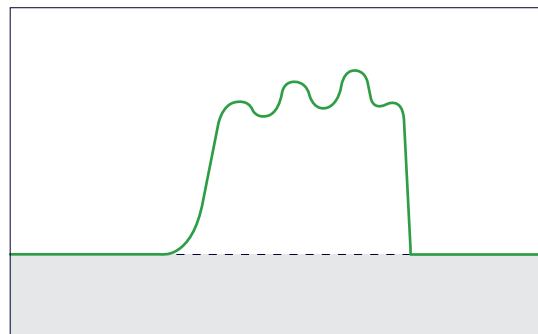


Figure 12: Violation - Multiple pulls or efforts

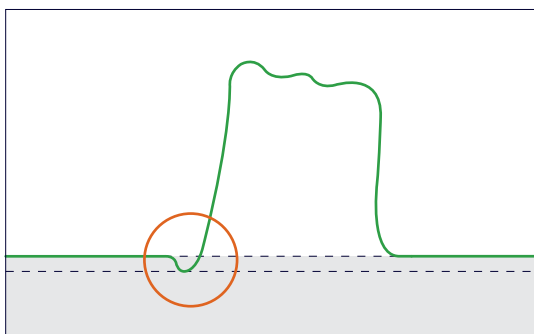


Figure 13: Violation - A pre-effort countermovement

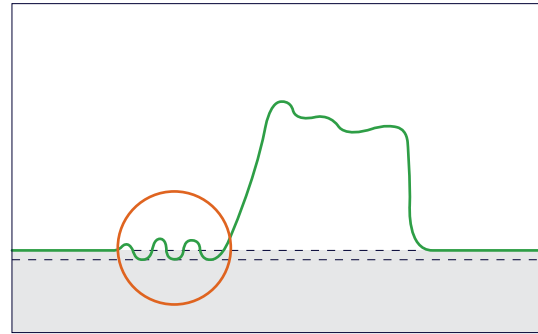


Figure 14: Violation - Unstable weighing period

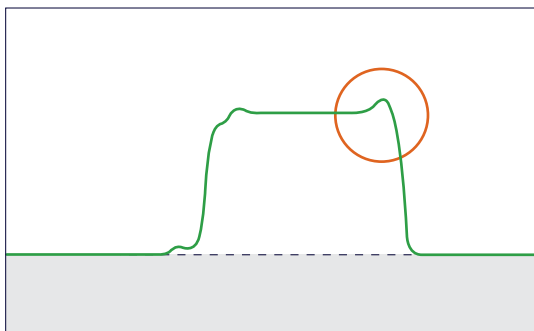


Figure 15: Violation - Peak occurring at end of trial

6.6 ISOMETRIC MID-THIGH PULL — Slow Ramp

The isometric mid-thigh pull (IMTP) slow ramp protocol should be used where practitioners are looking to analyse non-time-specific data such as peak force. For protocol to assess rate of force development, please see section 5.4.1.

This test requires a high level of technical proficiency and is recommended for athletes with a suitable level of competency and familiarisation. Athletes should practice this test in the weeks leading up to the IMTP testing day as a familiarisation and to pre-determine their appropriate bar height. It is suggested a qualified strength and conditioning coach (ASCA Level 2 or 3) should supervise this test.

Please note that each force plate system used to record force data will likely have its own software that will require their own specific instructions. These system specific instructions are not meant to be overridden by the information provided here.

Equipment Checklist

- | | |
|--|--|
| <input type="checkbox"/> Force plate | <input type="checkbox"/> Wrist straps |
| <input type="checkbox"/> IMTP rack and bar | <input type="checkbox"/> Tape measure |
| <input type="checkbox"/> Goniometer | <input type="checkbox"/> Operating system/software |

Note: If you do not have access to an IMTP rack, another system may be used if it is secure and does not move during the test. For example: Upside down j-hooks (secured to the rack) and a bar to pull up against.

Test Procedures and Protocols

Force Plate Set Up

- Position the force plate/s under/on the IMTP rack.
- Ensure the force plate/s are level.

Note: Different surfaces will affect data output; test on the same surface where possible. However, if you test on multiple surfaces, assess the difference between surfaces and compare data accordingly.

- Verify the force plates if they have been moved between the last test.
- Zero the force plate prior to beginning the test as per your system instructions.
- If using dual force platforms, ensure left and right plates are correctly placed and identified in software.
- Conduct a pre-test trial to ensure the force output is accurate (analyse system weight).

Suggested Warm Up

This additional specific warm up may be warranted for some athletes due to the specific demands of the protocols/test.

Exercise Specific Warm Up

Submaximal IMTP's: These can be complete on or off the force plates.

1. 3 sec hold at 50% perceived maximal effort

Recovery: ≥ 1 minute

2. 3 sec hold at 75% perceived maximal effort

Recovery: ≥ 1 minute

3. 3 sec hold at 90% perceived maximal effort

Recovery: ≥ 1 minute

Preparation

Body position for the isometric mid-thigh pull should be comparable to the second pull position of the clean: upright torso, slight flexion in the knee resulting in some ankle dorsiflexion, shoulder girdle retracted and depressed, shoulders above the bar, arms straight, midfoot directly under the bar approximately hip width apart, knees underneath and in front of the bar, and thighs in contact with the bar (close to the inguinal crease dependent on limb length).

A self-selected knee and hip angle between the recommended ranges below (Beckham et al. 2018) is best practice in the applied setting and demonstrated high reliability and low measurement error. This practice allows for the individual athlete's anthropometrics to be considered and allows them to assume an optimal pulling position.

Initial Athlete Set Up

- Ask the athlete to step onto the force plates and grip the bar with a clean grip. Lifting straps will be used during data capture to ensure maximal force production is achieved and grip strength is not a limiting factor.
- Adjust the bar height accordingly to account for the athlete's limb lengths.
 - Knee angles should be between 120-135 degrees
 - Hip angles should be between 140-150 degrees

Note: When setting assessing joint angles, the athlete should ensure that no tension is applied to the bar, but that all "slack" (e.g. elbow flexion and shoulder girdle elevation/protraction) is removed from the body.

- Once the athlete's optimal pulling position is established, record the marking/number to identify bar height.

Measuring Bar Height:

- To ensure IMTP testing can be replicated between practitioner and testing sites, bar height in centimetres (cm) must be recorded and kept with each athlete's results. Bar height must remain consistent over consecutive attempts and between tests (with an exception for athlete growth).
- Bar height is measured from the top of the force platform to the bottom of the bar when no tension is applied.

Test/Technique

- Begin force capture and ask the athlete to step onto the force plates and stand still to record body weight.
- Assume the athletes' preferred IMTP position with wrist straps firmly secured.
- Cue the athlete to take the tension/remove slack from the bar/upright system, without pre-tensing the involved muscles (<50N change in force output is acceptable). If you are using a rack for testing, ensure that the bar is snug against the hooks or pins.
- Cue the athlete to progressively push their feet into the ground for a 2-3 second ramp, increasing to maximal force production. The maximal effort should then be maintained for another 3-5 seconds before stopping.
- Inform the athlete that they have 3-seconds before they need to maximally pull. Count down "3-2-1-Push!".
- Allow the athlete to push for a period of 3-5 seconds of maximal force production before stopping, ensuring the athlete has reached their peak force and the curve is trending down before cessation. Verbal encouragement should be used during the attempt.
- Cue the athlete to remain still on the force plate until the trial is saved
- Rest for >2 mins between attempts.
- A minimum of 2 trials should be performed to determine the athlete's peak isometric force output. If after the second trial the athlete's force output is significantly higher than the first, the practitioner should perform additional tests until the peak force output drops.
- An acceptable pair of trials should have <250 N difference in peak force.

Technical Violations

The following technical violations will result in the trial being invalid and a second trial provided:

- Thighs moving away from the bar.
- Excessive rounding of the back.
- Heels lifting off the floor.
- Swaying backwards allowing shoulders to excessively move behind bar.
- A force signature (depicted below) that shows:
 - Excessive pretension: >50 N change while taking the tension on the bar.
 - Multiple pulls or efforts.
 - A pre-effort countermovement.
 - Unstable weighing period.

Recording Checklist

☐ Force data

☐ IMTP bar height (cm from force plate)

Examples



Valid Force Traces and Examples of Violations

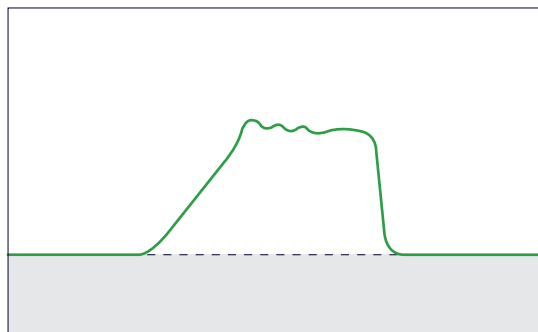


Figure 16: Successful IMTP - SR rep

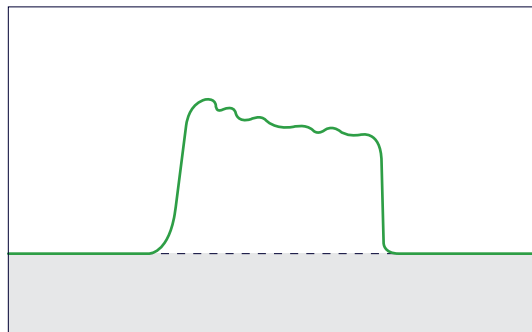


Figure 17: Violation - Fast ramp

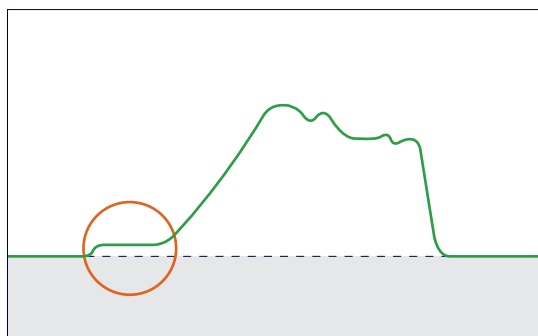


Figure 18: Violation - Excessive pretension:
>50 N change while taking the tension on the bar

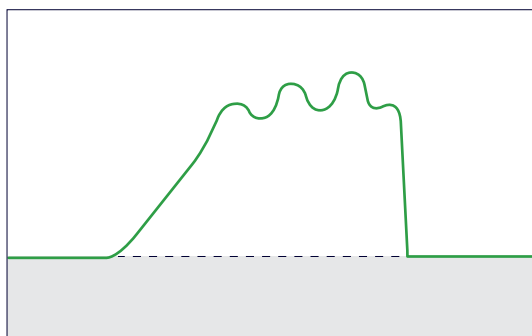


Figure 19: Violation - Multiple pulls or efforts

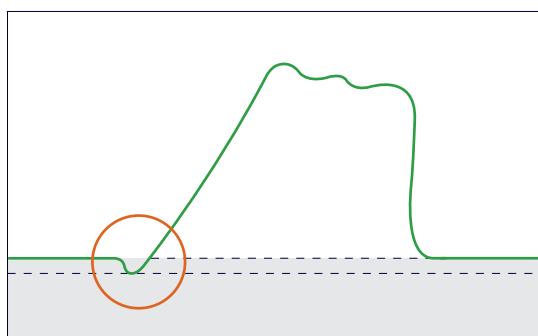


Figure 20: Violation - A pre-effort countermovement

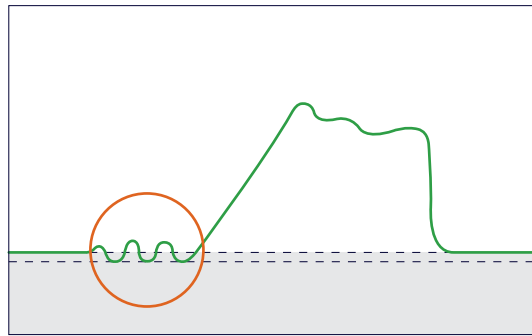


Figure 21: Violation - Unstable weighing period

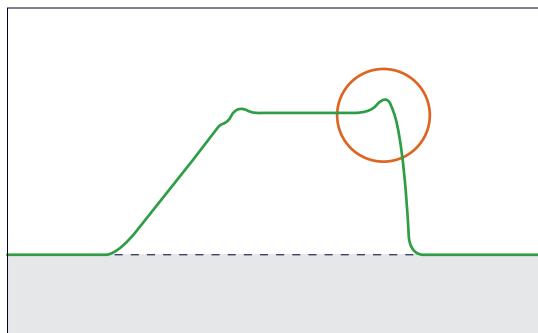


Figure 22: Violation - Peak occurring at end of trial

7. TEMPLATE FOR ADDITIONAL PROTOCOLS

A system for the addition of new protocols not included in this document will be implemented to facilitate any new inclusions. Once the system is established, and the relevant quality assurance processes are determined, the process will be outlined here.

8. TRACEABILITY INFORMATION

Date	Protocol	Details
July 2007	NSAPP_v1.7_2007	Protocols established
Sept 2021	NSAPP_v2.0_2021	<p>Entire document edited to include updated research and practical elements. Practitioners from the NIN and NSO's were included in the review.</p> <p>Addition of:</p> <ul style="list-style-type: none">• Chin Up (Pronated & Supinated)• Squat (Parallel & 90 degree knee)• Deadlift (barbell and trap/hex bar)• Force plate protocols<ul style="list-style-type: none">— Squat Jump— Countermovement Jump— Drop Jump (Double and single leg)— Isometric mid-thigh pull (fast and slow ramp) <p>Removal of:</p> <ul style="list-style-type: none">• Strength endurance• Other strength and power tests• Diet

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