



BOXING CANADA

PHYSICAL PREPARATION MANUAL

(revised, June 15, 2016)



BOXING CANADA

Physical Preparation Manual

National Coaching Certification Program

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Physical conditioning is a key factor that affects the boxer's performance, and several athletic abilities must be trained and developed to (1) meet the competitive demands of boxing, and (2) reduce the potential risks of injuries inherent to the sport. Without an adequate level of fitness, boxers cannot take full advantage of their technical or tactical abilities during a fight.

However, and despite the key role physical conditioning plays in Boxing, this remains an area that is often not dealt with in a systematic manner at Club level. Even top Canadian amateur boxers sometimes show significant shortcomings in the area of fitness and, arguably, a more thorough approach to physical preparation could be a key factor for improving performance.

This stand alone manual on physical preparation provides comprehensive information about training principles, and about specific methods and guidelines that can be used to develop selected physical athletic abilities, both in young boxers and in those who compete at Club and provincial levels. Training methods dealing with the following will be discussed:

- Stamina (aerobic conditioning)
- Speed
- Speed-endurance
- Flexibility
- Strength endurance
- Strength

This information is intended to help coaches prescribe conditioning programs and activities that are adapted to the individual needs of their boxers, consistent with the developmental guidelines and training priorities that were emphasized in Boxing Canada's LTAD model. Throughout the manual, guidelines for setting and controlling intensity, establishing sound progressions, and ensuring safe training conditions are included, and coaches should pay particular attention to these important factors.

Principles and methods that can be used to improve motor athletic abilities such as *Balance*, *Coordination*, and *Agility* were outlined in Chapter 7 of the Apprentice Coach Reference Material, and for this reason will not be repeated in the present document. This manual is completed by a series of annexes, including a wide range of flexibility and resistance training exercises. This should provide coaches with all the material they need to design their fitness training programs.

This document contains a lot of information, which cannot all be dealt with during a coach training workshop. It should therefore be consulted regularly and on an "as-needed basis" as a reference. I trust that this manual will be a useful tool to all Boxing Coaches working with competitive athletes. I welcome comments and suggestions for improving it and making it even more effective.

Daniel Trépanier, High Performance Director



CHAPTER 1 – ATHLETIC ABILITIES AND PHYSICAL DEMANDS OF BOXING

1.1- Physical Athletic Abilities: Review and Key Points

The term *athletic ability* refers to the aptitude a person has to carry out certain types of efforts, movements, or tasks that support performance in sport.

Athletic abilities can be grouped into four general categories: Physical, Motor, Tactical, and Mental.

The concepts were presented and discussed in both Boxing Canada's Apprentice Coach and the NCCP Multisport workshops.

Table 1.1 on the following page is therefore presented only as a reminder. It focuses on the physical athletic abilities, i.e. those that are determined primarily by:

- (1) the rate at which energy and force can be produced by the muscles, and
- (2) the range at which the movements can be executed.

Table 1.1- Definitions of the Physical Athletic Abilities

Physical Athletic Abilities	Definitions and Key Points
Maximum speed	<p>There are two types of speed:</p> <ol style="list-style-type: none"> 1. speed of locomotion, i.e. the ability to cover a given distance in the shortest possible time during an all-out effort of very short duration (<i>8 seconds or less</i>); e.g.: 50-m sprint 2. speed of movement, i.e. performing a particular movement or a short series of movements as quickly as possible; e.g., throwing a jab; blocking a punch; executing a combination of punches. <p>Both types of speed are based on the athlete's ability to accelerate specific body parts quickly (see speed strength below), and to perform movements at very high frequencies.</p>
Speed-endurance	The ability to sustain efforts at near maximum speed for as long as possible (<i>normally, very intense efforts lasting between 8 and 60 seconds</i>).
Aerobic stamina: endurance	The ability to sustain a dynamic effort over an extended period of time without interruption (normally, efforts lasting several minutes, or even hours).
Aerobic stamina: maximal aerobic power	The highest power output an individual can generate while producing energy aerobically. A workload corresponding to 100% of MAP can usually be sustained for approximately 5 to 8 minutes. <i>Note: The actual workload a person can sustain during strenuous efforts lasting between 2 and 10 minutes is largely determined by his or her MAP: a higher MAP means a higher work intensity.</i>
Flexibility	The ability to perform movements of large amplitude about a joint without sustaining injury.
Maximum strength	The highest level of tension generated by a muscle or muscle group during a maximum contraction, regardless of the duration of the contraction.
Speed-strength	The ability to perform a muscle contraction or overcome a resistance as fast as possible (<i>normally, very brief efforts of 1 or 2 seconds</i>).
Strength-endurance	The ability to perform repeated muscle contractions at intensities below maximum strength (<i>normally, 15 to 30 repetitions, or more</i>).

1.2- Overview of the Importance of Specific Athletic Abilities in Boxing

Table 1.2 on the following page provides an overview of the physical and motor athletic abilities required to perform in Boxing, and of their importance.

Table 1.2 - Overview of the physical and motor athletic abilities required to perform in Boxing, and of their importance

Importance in Boxing ↳	Physical Abilities							Motor Abilities	
	Speed	Speed- Endurance	Aerobic Stamina	Maximum Strength	Speed- Strength	Strength- Endurance	Flexibility	Coordination	Balance
	High	Moderate	High	Moderate (relative to body weight)	Very high	Very High	Moderate to High	Very high	Very High
Examples of Boxing situations requiring this athletic ability...	Boxers do not sprint or move their body very quickly between two points, like in many other sports. However, they must execute a variety of fast movements, and speed supports performance in moves such as: footwork, blocks, parries, punches, combinations, etc.	Speed-endurance allows the boxer to (1) sustain the production of efforts at very high intensity lasting 10 seconds or more during certain phases of a fight; (2) execute many repetitions of certain movements throughout a fight, without a marked decrease in their speed (i.e. punches; jabs; etc.).	Aerobic power and endurance help the boxer accomplish high volumes of training, sustain a high level of intensity throughout a fight, and recover more quickly from training and competition.	Strength is required in the hands, arms, shoulders, torso, core, and legs. Along with speed, strength is necessary to generate powerful punches. An adequate level of muscular strength also contributes to protecting the boxer's body and articulations against injuries that could result from the opponent's blows.	Speed strength allows the gloved hand to be accelerated very quickly when performing a punch, a jab, a block, etc.	Strength - endurance allows the boxer to execute many repetitions of certain movements throughout a fight, without a marked decrease in the amount of muscular tension that can be generated each time (i.e. punches; jabs; etc.).	Flexibility allows the boxer to perform each offensive or defensive movement with the required amplitude. It also helps to protect specific body parts against injuries such as muscle tears that can occur while performing very quick movements, or during misses.	Coordination is a critical motor ability in boxing, and it supports nearly every boxing skill, because an appropriate position and sequence are almost always required. It comes into play in actions such as the pivot, the punch, footwork, combination moves, parries, etc.	The success of nearly all boxing skills depends upon the stability of the boxer's stance. If a boxer loses balance even momentarily, he/she is in no position to attack or defend, and becomes extremely vulnerable.



CHAPTER 2 – TRAINING PRINCIPLES

2.1- Introduction

Whether the coach is designing a training program or reflecting about the use of a training method for improving a particular athletic ability, certain principles should always be taken into account to guide his or her choices:

1. Adaptation
2. Overload
3. Recovery
4. Progression
5. Specificity
6. Individualization
7. Variation
8. Non-uniformity of gains
9. Reversibility
10. Maintenance

Each principle is briefly described in the table on the following page.

Table 2.1- Training Principles and Their Implications for the Athletic Preparation Process

This Principle...	Has these implications for training activities...
Adaptation	Training represents a stress for the body. In response to this stress, the body adapts: it recovers and becomes better at dealing with this form of stress.
Overload	For adaptation to occur, an appropriate stimulus, or training load, must be applied at regular intervals. The training load must represent a challenge for the athlete, and it must create some fatigue and a temporary decrease in the athlete's performance
Recovery	Adaptations that follow the application of a training load take place only if the body can recover from the training load and the resulting fatigue
Progression	Overloading must be progressive; e.g., athletes must move from easy to more difficult activities, from simple to complex activities, and from lower to higher intensities
Specificity	Adaptations are specific to the training load applied, the muscle groups involved, the exercise conditions in place, and the energy systems used
Individualization	The training objectives, loads used, or choice of method must be a function of the individual athlete's current work capacity The response to training, in terms of both the rate and magnitude of the adaptation, may vary greatly from athlete to athlete
Variation	To have maximum effect, the training stimulus must be varied from time to time, even though the target athletic ability or energy system may remain the same.
Non-uniformity	Adaptations do not always occur in a linear and predictable fashion; in fact, they are usually rapid and more noticeable at the beginning of a program, but they usually <i>plateau</i> after several weeks or months of training When athletes are less fit, it is possible to achieve significant fitness gains with a variety of training stimuli; but as fitness increases, the training stimulus must become more specific to produce the desired training effect
Reversibility	Adaptations may regress if there isn't an appropriate training stimulus
Maintenance	Once an adaptation has occurred, its regression can be prevented, even if the amount and frequency of training are reduced, as long as the <i>intensity</i> and the <i>specificity</i> of workloads remain adequate, i.e. at the level of development the athlete seeks to maintain

2.2- Key Training Variables Coaches Must Take into Account

Regardless of the athletic ability involved, coaches manipulate a number of variables when they design training programs for their athletes.

Four training variables, *intensity*, *volume*, *frequency*, and *progressions*, merit special attention and are briefly discussed in this section.

Intensity

Intensity refers to the degree of difficulty or the magnitude of effort felt by the athlete when performing a particular task. A higher speed of movement or a greater resistance to overcome are two ways intensity can be increased.

Working at the right intensity is critical to obtain the desired training adaptations. Regardless of the type of training done, the optimal development of athletic abilities and their subsets requires that athletes work at critical thresholds, or intensities. Coaches and athletes therefore need to know how to estimate exercise intensity as precisely as possible, and how to correctly apply this knowledge during training.

Working at the right intensity is critical to ensure the desired training adaptations will occur.

Exercise intensity must be based on each athlete's capabilities. Training loads must be prescribed in a manner that is consistent with the *Individualization* principle. In other words, they must take into account *what each athlete is actually capable of doing* at a given point in time. For instance, a particular intensity (e.g., running at 12 km/h for a certain period of time to improve aerobic endurance) may represent an adequate training stimulus for some athletes, but it may be too low or too high for others.

While it may not always be possible for athletes to exercise at *precisely* the required intensity, training activities should take place within a certain range (e.g., 3% to 5%) of the required intensity, and deviations from those ranges should be kept to a minimum.

When setting intensity for a given mode of exercise (running, swimming, cycling, etc.) the values used must be drawn from data obtained in the same mode of exercise. For example, maximum heart-rate values obtained in swimming should not be used as a point of reference when setting intensities in running.

Volume

Volume refers to the amount of work done by the athlete when performing a particular task. A longer duration of effort and a higher number of repetitions of a particular exercise are two ways volume can be increased.

Frequency

Frequency refers to the number of times a particular athletic ability is trained during a given period of time, usually one week.

The frequency chosen depends on the ability trained, the athlete's training status, the athlete's ability to recover, and the training load. As a general rule, training frequency must be *higher* when the goal is to *develop or improve* the level of an athletic ability than when the goal is to *maintain* an athletic ability at a given level.

Progressions

To promote optimal adaptation, avoid excessive fatigue, and reduce the risk of injury, the nature of the ***training activities should progress from general to specific*** and from ***simple to complex***. ***Workloads must also be increased gradually***.

It is relatively easy to prescribe an effective workload if data are available about the athlete's fitness level and his or her ability to handle certain types of workouts. When such information is not available, however, the coach must exercise good judgment and proceed carefully by trial and error.

General guidelines on progressions that could be used when training each athletic ability are presented in the following Chapters.

These guidelines are intended to reduce the possible negative repercussions of workload increases.

Training activities should progress from general to specific, and from simple to complex.

Workloads must also be increased gradually.



CHAPTER 3 – OVERVIEW OF TRAINING METHODS

3.1- Introduction

Four (4) training methods are commonly used to develop the physical athletic abilities:

1. Continuous Training
2. Interval Training (also known as *Intermittent Training*)
3. Fartlek
4. Circuit Training

Each method has its own general characteristics and, depending on variables such as exercise mode, load/intensity, duration of effort, and recovery, the athletic abilities trained will vary.

3.2- Definitions and general descriptions of training methods

Some key points about each method are presented in Table 3.1 on the following page.

Applications of these methods for developing specific athletic abilities will be outlined in the following Chapters.

Table 3.1 – Key Points about Various Training Methods

Method	Key Points
Continuous Training (Cont Tr)	<ul style="list-style-type: none"> • Cont Tr consists of sustained efforts with no pauses. • Intensity generally is generally low to moderate, and stays fairly constant throughout the activity. • Cont Tr is effective mainly for training aerobic stamina, more specifically the “aerobic endurance” component.
Interval or Intermittent Training (IT)	<ul style="list-style-type: none"> • IT involves alternating periods of effort and recovery in a planned manner. • The efforts are called <i>repetitions</i>, and they’re usually grouped in sets; e.g., running for 5 minutes, then taking a 2-minute active recovery, and repeating 5 times represents one set of five repetitions • IT programs or prescriptions usually specify the following: <ol style="list-style-type: none"> 1. Number of sets to be performed 2. Number of repetitions or work periods in each set 3. Intensity: the workload at which each repetition or work period is to be performed 4. Type of recovery between repetitions/work periods and between sets 5. Duration of the recovery interval between repetitions/work periods and between sets • In general, there should be 3 or 4 sets when the total number of reps is 15 or more; 2 sets when there are 8 to 15 reps, and one set if there are 6 or fewer reps. • IT offers many possibilities for the development or maintenance of many physical athletic abilities, including aerobic stamina, speed and speed-endurance. Many training methods used in the development of strength, strength-endurance, and speed-strength are also a form of IT. • Some IT programs explicitly specify a work: rest ratio, or W:R. This refers to the ratio of the duration of the periods of effort to the duration of the recovery that follows. For example, a W:R of 2:1 means that the work interval is twice as long as the recovery period; so if the effort lasted 60 seconds, the recovery interval should be 30 seconds. Conversely, a W:R of 1:5 means that the recovery should be 5 times longer than the work interval.

Table 3.1 – Key Points about Various Training Methods (continued)

Method	Key Points
Fartlek	<p>Fartlek is a form of continuous exercise in which intensity fluctuates, but somewhat randomly.</p> <p>Contrary to IT, there is no set pattern to the periods of effort and recovery, and the athletes (or the coach) determine the specifics of the workout as they go.</p> <p>As a result, depending on the intensity and duration of efforts, a Fartlek session can contribute to the development of a variety of physical athletic abilities, e.g. Aerobic Endurance, MAP, or Speed Endurance.</p>
Circuit Training (CT)	<p>CT is a conditioning approach in which the athlete completes several stations, each featuring a particular exercise.</p> <p>Exercises may involve the athlete’s own body weight (e.g. push-ups, sit-ups, chin-ups, dips, etc.), or resistance-training equipment such as free weights or machines. Other forms of exercise can also be included, such as stretching, rope skipping, etc.</p> <p>Stations are arranged close to one another, and the athlete either spends a set amount of time at each (e.g. he or she works for 30 or 60 seconds), or performs a certain number of repetitions. Athletes usually exercise different muscle groups at each station, which allows some recovery to occur.</p> <p>Depending on the characteristics of the exercises used, CT may be effective for developing Strength-Endurance and/or Aerobic Stamina. It is a good way of introducing beginners to resistance training.</p>



CHAPTER 4 – TRAINING AEROBIC STAMINA

4.1- Why is Aerobic Stamina Important in Boxing?

During any exercise that is performed continuously over a minute or so, the body's aerobic system plays a key role in producing the energy that is necessary for the muscles to contract.

Effective aerobic training results in the following:

- the athlete's cardio respiratory system (lungs, heart, and blood vessels) becomes more effective at delivering high amounts of oxygen to the working muscles;
- within the muscles themselves, specific adaptations occur which allow greater amounts of oxygen to be used by the metabolic processes that produce energy; and
- the metabolic by-products and the heat that are generated inside the muscles are removed more efficiently

Given the nature of Boxing, the duration of each round, and the number of rounds in a fight, the boxer's aerobic fitness will be a key factor determining his or her performance.

Indeed, aerobic stamina will allow the boxer to sustain a high level of intensity and to remain "mobile" throughout a round, as well as round after round. It will also help to delay the onset of general fatigue that the boxer may feel as the fight progresses, and play an important role in the recovery process between rounds - and between fights in the case of a tournament.

4.2- What Type of Aerobic Stamina Does the Boxer Need?

For the activities in which the aerobic system plays an important role in producing energy, there are “two components” of Stamina that must be considered:

- 1- the ability to work very hard for a few minutes only
- 2- the ability to sustain moderate to high intensities over extended periods

During intense efforts ranging between 3 and 10 minutes or so, performance is mainly determined by a subset of Aerobic Stamina referred-to as “maximum aerobic power”, or MAP. As the effort gets longer, particularly when it exceeds 30 to 45 minutes, another form of stamina referred-to as “aerobic endurance” becomes increasingly important.

Some sports such as distance running or road cycling require that the athlete develop both his or her “maximum aerobic power” and “aerobic endurance” to a very high level. The reasons are that they must be able to sustain moderate intensities continuously over periods of 2 hours or more, and also keep up with several phases during the competition when intensity may fluctuate and become very high.

Clearly, because of the relatively short duration of a fight, boxers do not need the same type of “aerobic endurance” as distance athletes. Rather, due to the high intensity of the efforts they must produce, they work in a range of intensities that is generally fairly close to their “MAP”.

However, as part of their training process, athletes cannot focus exclusively on developing the “MAP” component of their aerobic stamina. As we will see later in this chapter, MAP training is very demanding, and could leave to excessive fatigue if not planned carefully. For this reason, boxers must develop both their aerobic endurance and their MAP.

4.3- The 5 Steps for Prescribing Aerobic Training Workouts

Coaches should follow five simple steps when prescribing aerobic training workouts:

- 1- Determine the component of aerobic stamina to be trained (aerobic endurance or MAP) and the training objective (development or maintenance)
- 2- Select the mode of exercise to be used by the athlete
- 3- Select an appropriate method
- 4- Set the intensity the athlete should work at
- 5- Determine the amount of work to be done by the athlete

4.4- Exercise Modes for Aerobic Training

Exercise modes refer to the *type of activity the athlete does* when he or she trains (e.g. running vs cycling vs swimming, etc.).

All activities that (1) involve large muscle masses (e.g. the legs; or arm and back muscles; or arm, back and leg muscles), (2) are performed at a suitable intensity, and (3) are sustained over a sufficiently long period, can contribute to improving the athlete's aerobic stamina.

The table on the following page lists a variety of non-boxing specific exercise modes that are effective for improving aerobic stamina. All can be used by young participants, beginners, and recreational boxers, who do not need a high level of specificity in their training. Most can also be used by competitive boxers during the off-season, or at the beginning of their preparation program.

However, for the serious or competitive boxer preparing for a fight, the choice of an exercise mode for aerobic training is not a trivial aspect. The reason for this is that *training adaptations are specific to the muscle groups involved and the conditions in which efforts are produced.*

During the weeks leading to a fight, the exercise mode used for aerobic conditioning should therefore become increasingly specific to the demands of Boxing, and focus on activities such as running or rope skipping.

Boxing drills or activities can also be used for developing aerobic stamina in a highly specific manner leading to a competition; in this case, however, it might be necessary to modify some of the "normal" competitive conditions in order to (1) ensure appropriate Work-Rest ratios are in place for effective aerobic training, and (2) achieve the desired training effects (see the tables outlining IT sessions later in this document for specific details and examples).



Table 4.1 - General exercise modes that are effective for improving aerobic stamina.

Modes	Comments
Running *	<ul style="list-style-type: none"> • Involves mostly leg muscles. • Impact exercise; boxers with back, hip, knee, and/or ankle problems, as well as older athletes or those who must lose some weight, should consider other modes of exercise. • Minimum equipment necessary; can be performed year-round. • Quality shoes and adequate fitting are important to reduce the risk of injury. • Boxers should consider running on the grass rather than on concrete or asphalt to reduce impact level; however, uneven terrain may be associated with increased stress on the articulations of the lower body.
Treadmill running *	<ul style="list-style-type: none"> • Involves mostly leg muscles; somewhat lower impact level compared to running on the road. • Requires access to specialized equipment. • Can be performed year-round, at home or in a fitness centre.
Rope jumping *	<ul style="list-style-type: none"> • Involves mostly leg muscles; somewhat lower impact level compared to running on the road. • Effective activity to improve coordination in addition to aerobic fitness. • This activity has long been used in the conditioning process of boxers, and ropes are available in most gyms. • Can be performed year-round, at home or in a gym.
Cycling (road)	<ul style="list-style-type: none"> • Involves mostly leg muscles; low impact exercise. • Requires access to a bicycle; however, this piece of equipment is fairly common and there is no need to use a highly specialized machine to get the training benefits. • Although somewhat weather dependent, this activity can be done for many months of the year. • Adequate adjustment of the athlete's position on the bicycle is necessary for maximum benefits and reduced risk of injury.
Stationary bicycle/ cycle ergometer	<ul style="list-style-type: none"> • Involves mostly leg muscles; low impact exercise. • Access to a stationary bicycle or an ergocycle is necessary. • Specialized equipment can be purchased to convert a road bicycle into a stationary bicycle. • Workloads can be set precisely on some models • Can be performed year-round, at home or in a fitness centre. • Adequate adjustment of the athlete's position on the bicycle is necessary for maximum benefits and reduced risk of injury.
Elliptical trainer *; rowing machine	<ul style="list-style-type: none"> • Involves muscles of the lower and upper body; low impact exercise. • Requires access to specialized equipment. • Can be performed year-round, at home or in a fitness centre.
Swimming	<ul style="list-style-type: none"> • Involves mostly muscles of the upper body; low impact exercise. • Breast stroke could be more suitable than other styles for boxers, as more leg action involved • Can be performed year-round. • Requires access to an aquatic facility.
Cross country Skiing; Ice skating	<ul style="list-style-type: none"> • Involves muscles of the lower and upper body; low impact exercise. • Seasonal activities, although ice skating can be performed year round if an artificial ice surface is accessible.
Roller/in-line skating	<ul style="list-style-type: none"> • Involves mostly leg muscles; low impact exercise. • Adequate protective equipment should be worn to reduce the risk of injury in case of a fall. • Seasonal activity.

* These exercise modes are particularly effective for competitive boxers due to their higher degree of specificity. Stairs climbing could also be an excellent exercise for boxers.

4.5- Training Aerobic Stamina: General Guidelines

Table 4.2 below presents a summary of the key points to keep in mind for effective aerobic training.

Variables	Key points ...
Exercise modes/movements	Dynamic activities involving large muscle groups should be used. Whenever possible, the legs should be involved in the aerobic training activities done by the boxer.
Methods	Continuous Training, Interval Training, Fartlek, Circuit Training, and Boxing-specific exercises can all be used to train aerobic stamina. Circuit Training will tend to become less effective for aerobic training as the athlete gets fitter.
Exercise characteristics	Continuous efforts lasting several minutes, or intermittent efforts in which the W:R is 3:1, 2:1, or 1:1 can all be used to improve aerobic stamina. The W:R ratio depends of exercise intensity and the length of work intervals. When the intensity is high, work intervals are shorter, and the recovery period can even be the same or even a bit longer than the work interval.
Setting intensity	Whether the goal is to develop aerobic endurance or maximal aerobic power (MAP), the best way to prescribe training intensities is to use percentages of the athlete's own MAP. This applies for all exercise modes. Methods to estimate aerobic training intensities based on heart rate are presented in the next section.
Time to exhaustion at various intensities	<p>On average, an intensity corresponding to 100 % of MAP can be sustained for approximately 5 to 8 minutes during a single maximum effort. Lower intensities can be sustained progressively longer, but the basic principle that follows always applies: the higher the intensity, the shorter the effort. The actual time a particular sub-maximal intensity can be sustained (e.g. 60, 70, or 80 % of MAP) may vary greatly between athletes, depending on their respective level of <i>endurance</i>.</p> <p>Because of the recovery periods between efforts, interval training makes it possible for an athlete to do a fairly high volume (or amount) of training at high intensity. The resulting fatigue is also usually <i>less</i> than if the same amount of work were done continuously, which allows quality sessions to be planned more often in the athlete's program.</p>
Position in a session or a day	In a training session, or if more than one training session is scheduled during the day, aerobic training should take place <i>after</i> activities aimed at training motor abilities, sport-specific skills, as well as most forms of resistance training. Aerobic training can also take place <i>before</i> a flexibility-specific training session.
Programming considerations	<p>Training for aerobic stamina should begin early in the athlete's general preparation program. Aerobic endurance should be trained before MAP. CT should be used at the beginning of the program, then Fartlek and IT sessions should be introduced progressively.</p> <p>Progression should be through an increase in exercise duration first, <i>then</i> intensity.</p> <p>Development: 3 sessions per week</p> <p>Significant improvements in 6 – 8 weeks</p> <p>Maintenance: 1 session per week</p>
Safety considerations	Ensure proper hydration throughout CT, Fartlek, or IT sessions, particularly when exercising in hot and humid conditions. Carbohydrate should be ingested every 20 minutes or so during continuous efforts lasting 75 minutes or more.

4.6- Setting and Controlling Workout Intensities for Aerobic Training

The most accurate way of prescribing aerobic training intensities is to use *percentages of the individual's maximum aerobic power (MAP)*. MAP is the highest power output an individual can generate while producing energy aerobically. A workload corresponding to 100% of MAP can usually be sustained for approximately 5 to 8 minutes. Lower intensities can be sustained for much longer, depending on the athlete's endurance and training status.

For most boxers and coaches, the simplest and most practical method to estimate the percentage of MAP at which an aerobic activity is performed to refer to the heart rate (HR) during exercise.

Heart rate (HR) is one of the key physiological parameters used by athletes and coaches to estimate the relative intensity of aerobic exercise. The relationship between HR and intensity is generally linear throughout a large portion of the aerobic work range: the higher the intensity of an effort, the higher the heart rate (up to a point), as the heart must pump more blood to deliver oxygen to the active muscles. However, the relationship between HR and work intensity is not perfect or always very accurate. Despite some limitations, HR remains a simple and useful guide for estimating exercise intensity during aerobic workouts.

Several formulas using HR have been published, but the most accurate is known as the *Heart Rate Reserve*, or the Karvonen formula. It can be used to estimate exercise intensity during both continuous and intermittent aerobic training sessions, although it tends to be more accurate for continuous training. In the case of IT, it can be used when medium or long intervals are performed (2 minutes or more), and HR should be recorded after 60 seconds or so of exercise. For shorter intervals, speed or the "feeling of perceived exertion" should be used by the athlete to gauge intensity.

Three HR measurements are needed to use the Karvonen formula:

1. Maximum HR (max HR)
2. Resting HR (HR rest)
3. HR during exercise (HR exercise)

Annex 1 presents methods for measuring max HR, resting HR, and HR during exercise.

HR fluctuations can provide direct feedback about changes in the relative intensity of the exercise. HR response also provides information that makes it possible to individualize some types of aerobic training. In addition, HR can be used as a point of reference to assess aerobic fitness improvements: training causes cardiovascular adaptations that allow the heart to pump more blood at each contraction, and HR at a given sub-maximal workload is generally lower than before.

Widely available and affordable lightweight, portable HR monitors have made it easy to accurately measure athletes' HR in a variety of sport-specific exercise conditions. This technology has become popular with coaches because of its potential for quantifying training loads and monitoring athletes. The small size, ease of use, and light weight of such monitors makes it possible to record HR accurately over extended periods during training or competition without interfering with performance.

The compatibility of HR monitors with computers and the availability of specialized software also make it possible to rapidly and easily perform sophisticated analyses of HR data. This allows coaches to obtain valuable information on the demands of their sport and on the overall level of stress athletes experience as they perform certain tasks.

The Karvonen formula is:

$$\% \text{ of MAP} = (\text{HR exercise} - \text{HR rest}) \div (\text{max HR} - \text{HR rest})$$

Example

Athlete A has a maximum HR of 200 bpm and a resting HR of 50. To exercise at an intensity of approximately 70% of his or her MAP, the target HRs should be approximately 155 bpm.

$$0.7 = (x - 50) / (200 - 50), \text{ where } x \text{ represents the target HR (unknown at this point)}$$

$$0.7 = (x - 50) / 150$$

$$150 * 0.7 = x - 50$$

$$105 = x - 50$$

$$155 = x$$

When using this formula, athletes should be advised to target a *HR range* rather than a *specific value*. For instance, in the example above Athlete A could exercise at 155 ± 3 bpm.

Note: *If the intent is to perform at a relatively constant workload throughout the session, the target range should be increased by 5 to 8 bpm after 30 minutes or so to reflect the rise in HR that typically occurs during exercise, even if the intensity remains unchanged. This is known as the “cardiac drift” (see Annex 2 for more details).*

Tables indicating target HR

To save time and avoid having to perform this type of calculation over and over, tables indicating target HR for various aerobic workout intensities are included on the following pages.

These tables are based on a wide range of values for max HR and HR at rest, and they can be used to determine quickly target HR for individual athletes.

Tables for determining target heart rates (HR) during aerobic training

The following tables are based on the Karvonen formula, which uses HR to estimate the intensity of an aerobic exercise. Intensities are expressed as percentages of the individual's MAP. To use these tables, the athlete's resting HR and max HR values must be known. First, select the table that corresponds to the athlete's max HR. Then, select the row that corresponds to his or her HR at rest. Lastly, determine the target HR given the desired workout intensity.

Example: The athlete's max HR is 205 bpm, and his or her resting HR is 55 bpm. To work at an intensity of 75% of MAP, the target HR should be 168 bpm (range: 165-170 bpm).

Table 4.3- Use this table to estimate target heart rates during exercise if the athlete's max HR is 210 bpm.

If HR at rest is...	...and max HR is 210 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	138	146	154	162	170	178	186	194	202	210
55 bpm	140	148	156	164	171	179	187	195	202	210
60 bpm	143	150	158	165	173	180	188	195	203	210
65 bpm	145	152	159	167	174	181	188	196	203	210
70 bpm	147	154	161	168	175	182	189	196	203	210
75 bpm	149	156	163	170	176	183	190	197	203	210

Table 4.4- Use this table to estimate target heart rates during exercise if the athlete's max HR is 205 bpm.

If HR at rest is...	...and max HR is 205 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	135	143	151	159	166	174	182	190	197	205
55 bpm	138	145	153	160	168	175	183	190	198	205
60 bpm	140	147	154	162	169	176	183	191	198	205
65 bpm	142	149	156	163	170	177	184	191	198	205
70 bpm	144	151	158	165	171	178	185	192	198	205
75 bpm	147	153	160	166	173	179	186	192	199	205

Table 4.5- Use this table to estimate target heart rates during exercise if the athlete's max HR is 200 bpm.

If HR at rest is...	...and max HR is 200 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	133	140	148	155	163	170	178	185	193	200
55 bpm	135	142	149	157	164	171	178	186	193	200
60 bpm	137	144	151	158	165	172	179	186	193	200
65 bpm	139	146	153	160	166	173	180	187	193	200
70 bpm	142	148	155	161	168	174	181	187	194	200
75 bpm	144	150	156	163	169	175	181	188	194	200

Table 4.6- Use this table to estimate target heart rates during exercise if the athlete's max HR is 195 bpm.

If HR at rest is...	...and max HR is 195 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	130	137	144	152	159	166	173	181	188	195
55 bpm	132	139	146	153	160	167	174	181	188	195
60 bpm	134	141	148	155	161	168	175	182	188	195
65 bpm	137	143	150	156	163	169	176	182	189	195
70 bpm	139	145	151	158	164	170	176	183	189	195
75 bpm	141	147	153	159	165	171	177	183	189	195

Table 4.7- Use this table to estimate target heart rates during exercise if the athlete's max HR is 190 bpm.

If HR at rest is...	...and max HR is 190 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	127	134	141	148	155	162	169	176	183	190
55 bpm	129	136	143	150	156	163	170	177	183	190
60 bpm	132	138	145	151	158	164	171	177	184	190
65 bpm	134	140	146	153	159	165	171	178	184	190
70 bpm	136	142	148	154	160	166	172	178	184	190
75 bpm	138	144	150	156	161	167	173	179	184	190

Table 4.8- Use this table to estimate target heart rates during exercise if the athlete's max HR is 185 bpm.

If HR at rest is...	...and max HR is 185 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	124	131	138	145	151	158	165	172	178	185
55 bpm	127	133	140	146	153	159	166	172	179	185
60 bpm	129	135	141	148	154	160	166	173	179	185
65 bpm	131	137	143	149	155	161	167	173	179	185
70 bpm	133	139	145	151	156	162	168	174	179	185
75 bpm	136	141	147	152	158	163	169	174	180	185

Table 4.9- Use this table to estimate target heart rates during exercise if the athlete's max HR is 180 bpm.

If HR at rest is...	...and max HR is 185 bpm: target HR during exercise to work at an estimated intensity of ...									
	55 % MAP	60 % MAP	65 % MAP	70 % MAP	75 % MAP	80% MAP	85 % MAP	90 % MAP	95 % MAP	100 % MAP
50 bpm	122	128	135	141	148	154	161	167	174	180
55 bpm	124	130	136	143	149	155	161	168	174	180
60 bpm	126	132	138	144	150	156	162	168	174	180
65 bpm	128	134	140	146	151	157	163	169	174	180
70 bpm	131	136	142	147	153	158	164	169	175	180
75 bpm	133	138	143	149	154	159	164	170	175	180

4.7 - Training Aerobic Stamina: Endurance

Method 1: Continuous Training

For many coaches and athletes, continuous training (Cont Tr) is *THE* form of training that comes to mind when the objective is to train aerobic stamina. However, coaches must be aware that, depending on the intensity and the duration of the workout, the training effects of Cont Tr may be quite variable. Here are a few key points about Cont Tr:

- The mode of exercise selected for aerobic training should involve the same muscle groups as those primary involved for movement in the sport. For a boxer, general activities such as running, rope skipping cycling, or skating would all be effective to develop aerobic endurance because leg muscles are involved extensively.
- When using Cont Tr, the best training effects on aerobic endurance come from workouts performed at intensities of 70-75% of MAP, or even higher.
- Trained athletes can sustain low-intensity Cont Tr (60-65% or less of MAP) for very long periods (up to several hours in the case of well-trained endurance athletes), especially if they consume adequate amounts of carbohydrate and water.
- Low-intensity Cont Tr (60-65% or less of MAP) of short to moderate duration can serve as light training sessions, particularly during the Competition Period or the Specific Preparation Phase. At very low intensities (40 – 50% of MAP, or even less), Cont Tr sessions or activities can also be used for active recovery.
- The following table outlines the likely effects of Cont Tr sessions of various durations on (1) subjective feelings of fatigue likely to be experienced by the athlete at the end of the exercise (an indicator of the training load) and (2) the development of aerobic endurance and maximal aerobic power. This table applies to moderately fit individuals with an “average level of endurance” who are involved in a sport that does not have high physical demands. Since aerobic endurance may vary greatly among individuals, this information is only as a general guide.
- When establishing an initial training progression for the use of Cont Tr follow these general guidelines:
 - Given your assessment of the athlete’s fitness level, start with the *lowest* combination of volume and intensity proposed for a session that is either *moderate* or *somewhat demanding*
 - Based on how the athlete responds to this training load, adjust as necessary. For instance:
 - Decrease the volume if the athlete has difficulty completing the entire workout at the prescribed minimal intensity
 - Use a higher prescribed volume if it’s very easy for the athlete to complete the entire workout at the prescribed minimal intensity
 - Once you have a general feel for the athlete’s capabilities, select a combination of volume and intensity that represents an appropriate challenge for the athlete, given the training objectives.

Table 4.10 shows the expected training effects of continuous training on the development of Aerobic Stamina (Aerobic Endurance and MAP), given the intensity and the duration of exercise. This information is presented as a general guideline only, and applies to moderately fit boxers.

Table 4.10- Effect of Continuous Training at Various Intensities on Aerobic Endurance and MAP

Intensity (% of MAP)	Duration (minutes)	Expected Feeling of Fatigue at the End of the Session	Effect on the Development of...	
			Aerobic endurance	MAP
≤ 30 - 50 *	15 – 30 +	Easy	Very low	None
60	≤ 20	Easy	Low	Low
	30 - 45	Easy to Moderate	Some	Low
	45 – 60	Somewhat demanding	Moderate	Low
	75 – 90 +	Demanding	Good to very good	Low
70	≤ 20	Easy	Low	Some **
	30 - 45	Moderate to somewhat demanding	Some to moderate	Some **
	45 - 60	Somewhat demanding to demanding	Good	Some **
	75 +	Demanding to very demanding	Very good	Some **
75 - 80	≤ 20	Moderate to somewhat demanding	Moderate	Moderate **
	30 - 45	Somewhat demanding to demanding	Good to very good	Moderate **
	45 - 60	Demanding to very demanding	Very good to excellent	Moderate **
	75 +	Very demanding	Excellent	Moderate **
85 - 90	15 - 20	Demanding	Good to very good	Good **
	20 +	Very demanding	Very good to excellent	Good **

* This range of intensities is appropriate for active recovery sessions or activities.

** The fitter the athlete, the lower the resulting training effects on MAP at these intensities.

Method 2: Interval Training for Aerobic Endurance

- IT at intensities comprised between 80 to 90 % of MAP can be very effective for the development of the boxer's aerobic endurance. Sessions performed at such high intensities will likely be perceived as somewhat demanding or even very demanding.
- Intensities below 80% of MAP should not be used for IT; they are best used in Cont T sessions.
- Table 4.11 on the next page outlines a variety of IT sessions that can be effective for developing aerobic endurance. Recovery intervals between each effort and between sets should be active, and consist in light jogging or walking. The athlete should not be completely inactive.

Method 3: Fartlek for Aerobic Conditioning

Fartlek is a Swedish word meaning “speed play”. It is a form of continuous exercise in which intensity can fluctuate somewhat randomly. However, contrary to IT, there is no set pattern to the periods of effort and recovery, and the athletes (or the coach) determine the specifics of the workout as they go, often based on the characteristics of the course or terrain used. Depending on the intensity and duration of efforts, and how they are arranged, a fartlek session can contribute to the development of aerobic endurance, MAP, or speed endurance.

Fartlek can be used as a hard session at any stage of the season, especially during the Specific Preparation Phase and the Pre-competition Phase. It can also add some variety to the athletes' training program. Here's an example of a group fartlek session in cycling on a circuit that is 5 to 8 km long and includes a good hill.

- Athletes perform a 15-to-20-minute warm-up at 60 - 65% of MAP while inspecting the circuit.
- During lap 1 of the circuit, athletes ride at a constant pace and at moderate intensity (70 - 75% of MAP) for a few km, then speed up and cycle as hard as possible over 2 or 3 km; then recover actively at 60% or so of MAP for a few minutes before reaching the hill.
- Athletes start the climb at a good pace, then accelerate suddenly to near-maximal intensity in the middle of the hill, and continue the intense effort for the 2 or 3 km after the hill. They complete the rest of the circuit at a constant speed that corresponds to 70 - 75% of MAP.
- In lap 2 of the circuit, athletes ride at moderate speed, sprinting on the hill and maintaining the effort on the flat for 300 or 400 m; then recover at low speed for several minutes for the rest of the lap.
- In lap 3 of the circuit, athletes cycle as hard as possible, with riders taking turns setting the pace for 30 to 45 seconds; the athlete who leads rides at his or her own pace, and all riders sprint to an imaginary finish at the end of the lap.
- Athletes finish with a cool-down period of several minutes.

Table 4.11- Examples of IT Sessions for Aerobic Endurance

Protocol	Intensity (% MAP)	Sets	Repetitions/ Set	Repetitions (min:s)	Recovery (min:s) between		Duration of the Session*
					Repetitions	Sets	
END 1	85	4	6	1:30	1:00	3:00	1 h 08 min
END 2	90 †	3	6	1:30	2:00	5:00	1 h 12 min
END 3	85	3	5	2:30	2:00	5:00	1 h 17 min
END 4	90 †	2	6	2:00	3:00	10:00	1 h 16 min
END 5	90 †	2	5	2:30	3:00	10:00	1 h 09 min
END 6	90 †	2	4	3:00	3:00	10:00	1 h 02 min
END 7	85	2	5	3:00	3:00	8:00	1 h 10 min
END 8	85	2	5	3:30	3:00	10:00	1 h 19 min
END 9	85	2	4	5:00	3:00	10:00	1 h 18 min
END 10	80	2	4	5:00	2:00	8:00	1 h 08 min
END 11	90 †	1	6	3:30	4:00	-----	45 min
END 12	90 †	1	5	4:00	4:00	-----	40 min
END 13	90 †	1	3	5:00	4:00	-----	27 min
END 14	85	1	7	4:30	4:00	-----	1 h 00 min
END 15	85	1	5	6:00	4:00	-----	50 min
END 16	85	1	4	7:00	4:00	-----	55 min

* Excluding the warm-up and cool-down † Will also contribute to the development of MAP

Important note: The name of the sessions (e.g., END1; END2; etc.) does not mean that they are a progression from each other. The number of sets and repetitions are presented as guidelines only, and may have to be modified depending on the athlete's level of fitness. See Progression guidelines later in this section.

4.8 - Training Aerobic Stamina: Maximum Aerobic Power (MAP)

- MAP is usually best developed by working at intensities of 95 % to 100 % of MAP for relatively short intervals. As mentioned previously, lower intensities are more suitable for improving endurance, although intensities of 85 to 90% of MAP will also be effective in improving the MAP of lesser trained individuals.
- As Table 4.12 on the following page shows, interval or intermittent training (IT) with work intervals ranging from 30 seconds to several minutes can be used to improve MAP.
- In fact, shorter efforts of 15 or 20 seconds could even be used effectively for improving MAP. If such short duration efforts are used, work intervals should be longer than or equal to the recovery that follows (e.g., W:R of 2:1; 1:1). For instance: effort of 20 seconds followed by 20 seconds of recovery, repeated 8 to 10 times; effort of 15 seconds followed by 10 seconds of recovery, repeated 8 to 12 times. 2 or 3 sets of such efforts could be done, with 5 minutes or so of recovery between sets.
- Recovery intervals between each effort and between sets should be active, and consist in light jogging or walking. The athlete should not be completely inactive.

Table 4.12- Examples of IT Sessions for Maximum Aerobic Power

Example #	Intensity (% MAP)	Sets	Repetitions/ Set	Repetitions (min:s)	Recovery (min:s) between		Duration of the Session*
					Repetitions	Sets	
MAP 1	100	3	6	1:00	2:30	5:00	1 h 02 min
MAP 2**	100	3	8	0:30	1:30	5:00	35 min
MAP 3	95	4	6	1:00	1:00	3:00	55 min
MAP 4	100	2	6	1:15	2:00	10:00	55 min
MAP 5	95	3	6	1:15	2:00	5:00	1 h 08 min
MAP 6	100	2	5	1:30	3:00	10:00	59 min
MAP 7	95	2	8	1:30	3:00	10:00	1 h 26 min
MAP 8	100	2	4	1:45	3:00	10:00	52 min
MAP 9**	100	1	5	1:45	4:00	-----	29 min
MAP 10	95	2	6	1:45	3:00	10:00	1 h 11 min
MAP 11	100	1	6	2:00	4:00	-----	36 min
MAP 12	95	2	5	2:00	3:00	10:00	1 h 04 min
MAP 13	100	1	4	2:30	4:00	-----	26 min
MAP 14	95	1	6	2:30	4:00	-----	39 min
MAP 15	95	1	4	3:00	4:00	-----	28 min

* Excluding the warm-up and cool-down

** Also benefits the training of speed endurance

Important note: The name of the sessions (e.g., MAP1; MAP2; etc.) does not mean that they are a progression from each other. The number of sets and repetitions are presented as guidelines only, and may have to be modified depending on the athlete's level of fitness. See Progression guidelines later in this section.

4.9- Progression in the Use of IT for Training Aerobic Stamina

Once you have determined that the athlete is capable of completing IT workouts without undue stress, you may want to consider the types of progression that can be used in an IT program for developing aerobic stamina. Some guidelines are presented in the table below.

Table 4.13- Some Interval Training Progression Guidelines within a Program.

Type of Progression	Possible Progressions	Rationale
Progression in intensity	<ul style="list-style-type: none"> - Progress from endurance training to MAP training - When working on aerobic endurance, start with sessions of lower intensity, e.g., 80 % of MAP, and increase intensity to 85 %, then 90 % - When working on MAP, start with sessions of lower intensity, e.g., 90 % of MAP, and increase intensity to 95 %, then 100 % 	<ul style="list-style-type: none"> - Allows metabolic, technical/motor, articularoskeletal, and psychological adaptations to occur at lower intensities first, before moving on to the stress of higher intensities
Progression in duration	<ul style="list-style-type: none"> - For a given intensity, progress from shorter to longer sessions. 	<ul style="list-style-type: none"> - Prepares the athlete to complete progressively longer training sessions
Progression from quantity to quality	<ul style="list-style-type: none"> - Given the selected intensity, use sessions that feature a high number of repetitions but shorter work intervals at the start of the training program, and then progress to longer work intervals but fewer repetitions. 	<ul style="list-style-type: none"> - Emphasizes total work time at targeted intensities earlier in the program - Progressively increases the ability to sustain longer and longer repetitions before recovering

4.10- Boxing-Specific Interval Training for Aerobic Stamina

Interval work can also be done in the gymnasium using boxing-specific drills, for instance footwork, work on the heavy bag, or pad work. This is a highly specific form of aerobic training that the boxer should use during the weeks leading to a competition. It must be emphasized that this type of training should be preceded by adequate aerobic conditioning in the form of continuous training or interval training using more general exercise modes (e.g. running).

Aspects to consider when implementing a Boxing-specific IT work program:

- The athlete could begin with footwork; then, he or she could progress to punching work on the heavy bag, and lastly to offensive and defensive work on pads.
- Proper footwork and movements must be executed throughout each work interval on the bag or on pads.
- The quality of technical execution of all boxing-specific attacking or defensive moves must also be maintained throughout the effort periods.
- As outlined previously, the most important aspect to keep in mind when doing IT for aerobic conditioning is the W:R ratio. To keep things simple, when doing boxing-specific aerobic training, the length of the recovery should be shorter or equal to the work interval.
- In preparation for a fight, one way to mimic the competitive demands is to do as many sets as there are rounds scheduled, and to break each set (or round) into work-rest intervals.
- Initially, work intervals should be short (e.g. 15 seconds), and their length should be increased progressively to 30, 60, and 90 seconds. As the contest nears, work interval can be stepped up to two minutes to increase specificity.

Examples of progressions that can be used for Boxing-specific IT aerobic conditioning work are shown in the series of tables on the following page. Each work interval should be performed at very high intensity throughout, such that the boxer's maximum heart rate is achieved during each round.

Where an asterisk (*) is shown, the following progression could be applied over time: (1) start the IT conditioning program with what is indicated in the table, and (2) increase gradually the number of repetitions within each set or "round" *such that the cumulative time of **all the work intervals** gets closer to the actual duration of a round*. For instance, in the first example below (work and recovery intervals of 15 seconds), this would mean increasing progressively the number of repetitions within a set from 4 to 8 in order to complete a "round" of 2 minutes, and from 6 to 12 in order to complete a "round" of 3 minutes. In this case, longer recovery may be necessary between sets or rounds (e.g. 2 or 3 minutes instead of 1 minute).

Table 4.14- Examples of Boxing-specific IT aerobic conditioning workouts.

* Work interval	15 seconds	Repeat 4 times to complete 1 round of 2 minutes, and 6 times to complete 1 round of 3 minutes.	Follow each round or set by a 1-minute active rest. †	Repeat 3 or 4 times to complete the number of rounds scheduled in the fight
Recovery	15 seconds			
* Work interval	30 seconds	Repeat twice to complete 1 round of 2 minutes, and 3 times to complete 1 round of 3 minutes	Follow each round or set by a 1-minute active rest. †	Repeat 3 or 4 times to complete the number of rounds scheduled in the fight
Recovery	30 seconds			
Work interval	30 seconds	Repeat 2 or 3 times to complete 1 round of 1 min 30 sec or 2min 15 sec, and 4 times to complete 1 round of 3 minutes	Follow each round or set by a 1-minute active rest. †	Repeat 3 or 4 times to complete the number of rounds scheduled in the fight
Recovery	15 seconds			
Work interval	40 seconds	Repeat twice to complete 1 round of 2 min, and 3 times to complete 1 round of 3 minutes	Follow each round or set by a 1-minute active rest. †	Repeat 3 or 4 times to complete the number of rounds scheduled in the fight
Recovery	20 seconds			
Work interval	45 seconds	Repeat twice to complete 1 round of 2 min	Follow each round or set by a 1-minute active rest. †	Repeat 3 or 4 times to complete the number of rounds scheduled in the fight
Recovery	15 seconds			
Work interval	60 seconds	Repeat 2 or 3 times to complete a round (set)	Follow each round or set by a 1-minute active rest. †	Repeat 3 or 4 times to complete the number of rounds scheduled in the fight
Recovery	30 seconds			
Work interval 1	30 seconds	Follow each round or set by a 1-minute active rest. †	Repeat 2 or 3 times	
Recovery 1	10 seconds			
Work interval 2	30 seconds			
Recovery 2	20 seconds			
Work interval 3	30 seconds			
Recovery 3	30 seconds			
Work interval 4	30 seconds			

† The duration of the active rest may be increased if necessary, up to 2 minutes.

Picture 8.1- Coach measuring a boxer's heart rate (HR) after an interval workout on the heavy bag. Refer to Annex 1 for the procedure to record HR.



Record HR
over 10 seconds
(see Appendix 1
for details).



CHAPTER 5 – SPEED TRAINING

5.1- Importance of Speed in Boxing, and Factors that Influence Speed

Speed is one of the most important factors in the physical preparation of boxers. Without adequate speed, the athlete cannot deliver blows that will score, or perform the movements that are necessary to defend effectively against a skilled opponent.

While an athlete's aerobic stamina is predominantly determined by metabolic and cardiovascular factors, speed is largely affected by the *neuromuscular system*. Neural factors make it possible for the muscles primarily responsible for performing a particular movement to contract very quickly, and then to relax. As the muscles responsible for the movement contract, opposing muscles must also “learn” to relax at the same time; this way, they do not “interfere” during the action, thus ensuring that maximum speed of movement can be achieved.

For this reason, speed and speed training cannot be disassociated from motor abilities such as agility and coordination, as they play a key role in the proper technical execution of fast movements. Strength is also an important factor in the expression of speed; indeed, the ability to generate high levels of force will be beneficial to the contracting muscles in most instances.

Another important factor supporting speed, which is often ignored or neglected, is *flexibility*. Adequate flexibility is necessary to (1) ensure that limbs or specific body parts can move with optimal amplitude in order to generate the force required for fast actions, and (2) reduce the risks of injuries that could be sustained when muscles get stretched as a result of the momentum gained by specific body parts during fast, dynamic movements.

Lastly, in a sport such as boxing, a critical element to take into account in the area of speed and speed training is *reaction time*, i.e. the delay between the moment the athlete's brain perceives a particular cue or signals, and the moment a motor response is initiated. For the boxer to be successful, his or her movements must not only be fast, they must also be initiated at the right time.

5.2- What Type of Speed Does the Boxer Need?

There are two types of speed that concern boxers:

3. speed of locomotion, i.e. the ability to move the body from point A to point B as fast as possible;
4. speed of movement, i.e. performing a particular action as quickly as possible, such as when throwing a jab or blocking.

Both are based on the athlete's ability to accelerate specific body parts in the shortest possible time, and to perform movements at very high frequencies.

Of the two, speed of movement is the most important in Boxing. Indeed, boxers do not really need to sprint or to chase their opponent, and they usually need to take only a few steps at a time to get to where they want to be in the ring. However, they must execute various types of punches very quickly and explosively, and perform a variety of sudden movements with their arms, trunk, or legs to defend effectively.



This being said, speed of locomotion remains an important performance factor to develop in the overall athletic development process of young athletes, and for this reason it should not be excluded from the program of boxers.

5.3- General Guidelines for Speed Training

The following are key points to keep in mind for any form of speed training:

- Interval training is the most efficient method that should be used. A thorough warm-up must precede any form of speed training.
- Because of the neuromuscular factors involved and the need to obtain optimal coordination, the movements performed should be as sport-specific as possible. Speed training should be planned for all the movements or actions that boxers must perform at high velocity during a fight.
- Boxing exercises selected for speed training must be such that the athlete will focus on the speed of execution, not on “how to perform the technique”. Consequently, speed training must involve techniques or movements that the athlete masters thoroughly.
- To improve speed, movements must be performed at maximum or near-maximum velocity, and exercise time must be fairly short.
- To ensure maximal velocity of movement, the resistance to overcome should be very low. For instance, during the initial stages of speed training for specific offensive or defensive movements involving the arms, no gloves should be used and the boxer should perform the movements alone. Then, light gloves should be used, and a progression should be followed until the weight of gloves used in competition is reached. The athlete should then progress to high-speed punching on a target, performing both single punches at maximal speed, and punches executed at maximal frequency over a period of 6 to 8 seconds. (Depending on their weight category, the best Russian and Cuban boxers are able to punch 65 to 74 times in 6 seconds).
- When repeated high-speed punching on a target is done, exercises should be performed on gym equipment that has a small frequency of oscillation (e.g. heavy bags or wall pads). Such equipment enables boxers to punch with full amplitude of movement and at maximum frequency. Gloves must be worn when working on bags or pads.
- The *recovery between each repetition and between sets must be long*; this will allow the athlete to perform subsequent repetitions at high speed with no major decrease in velocity and power output. W:R should be about 1:12 – 15, or even longer. For instance, a 5-second sprint should be followed by a 60 second recovery period.
- Between reps and sets, recovery should be active, and consist in *very light activity* involving the muscles used during the work interval (e.g., a slow walk after sprinting, light movements of the arms after punching).

The key principles of speed training are:

- using techniques the boxer masters
- thorough warm-up
- high velocity of movements
- low resistance to movement
- short efforts followed by a long recovery
- quality of execution
- no fatigue
- relatively small volume of work overall

- The overall number of repetitions in a speed training session must remain fairly low (12 to 16 or so); a few more reps can be performed if efforts are really short (i.e. less than 5 seconds). Therefore the overall amount of work performed during a speed training session will be relatively low. The key word here is *quality*, not quantity.
- Maintaining good technique is critical to the development of muscular coordination. When signs of fatigue appear (e.g., the frequency of movements or the quality of the technical execution decline), speed training should be stopped.
- Speed training should be scheduled early during the main part of the training session, when the athlete is not yet tired. Due to the very high intensity required, a thorough warm-up must also precede any form of speed training to avoid injury.
- Speed work should be scheduled when the athlete is not too tired from previous training sessions.
- In the athlete's program, speed training should be preceded by several weeks of other forms of preparatory training (strength-endurance, strength, aerobic stamina).

5.4- Training Methods for Speed

Table 5.1 presents the recommended methodology for training speed of locomotion.

Table 5.2 presents the recommended methodology for training speed of movement.

Table 5.1- Example of Training Methods for Speed of Locomotion

This Variable...	Should be ...	
Type of training	Interval training	
Activities/movements	<ul style="list-style-type: none"> • For boxers, short sprints or elevating the knees alternatively as fast as possible while running on place are suitable forms of exercise. • Progressive acceleration before initiating the effort 	
Intensity of each repetition	95% or more of maximum speed for the type of movement involved	
Duration of each repetition*	3 - 5 s	6 – 10 s
Number of repetitions per set	4 - 6 +	3 - 5 +
Number of sets	2 - 4	2 - 3
Total number of repetitions	8 - 24	6 - 15
Duration of recovery between repetitions	45 - 75 s	75 - 120 s
Type of recovery between repetitions	Active, very low-intensity recovery, followed by passive recovery for 20 - 30 s before the next effort	
Recovery between sets	Active, very low-intensity recovery for 5 to 8 minutes (light jogging or walking), followed by passive recovery for about 1 minute before initiating the next set.	
Stop if...	Speed of movement or quality of execution decreases	
Total time of a speed session (repetitions and recovery)**	15 to 58 minutes	16 to 50 minutes
Frequency		
• For development	2 - 3 X per week, for 4 to 8 weeks	
• For maintenance	1 X per week	
For significant improvements in...	4 - 6 weeks	
Other training effects	Coordination, agility	

* Excluding the progressive acceleration phase

** Excluding warm-up and cool-down

Table 5.2- Example of Training Methods for Speed of Movement

This Variable...	Should be...
Type of training	Interval training with long pauses
Activities/movements	Ultra-specific sport movements performed against low or no resistance. For offensive or defensive movements involving the arms, no gloves should be used initially, so movements can be executed without any resistance. Then, progress to executing the movements with light gloves, and lastly with the gloves used in competition.
Intensity	As fast as possible
Duration of each repetition	<ul style="list-style-type: none"> • Less than 1 s for a single-action (e.g. jab, power punch, etc. with or without gloves). • About 6 to 8 s for movements performed at a high frequency (e.g. repeated punches on a bag using gloves).
Number of repetitions per set	4 - 5
Number of sets	2 - 4
Total number of repetitions	8 - 20
Duration of recovery between repetitions	15 to 20 times longer than the effort
Type of recovery between repetitions	Active, very low-intensity recovery, followed by passive recovery for 20 s or so
Recovery between sets	Active, low-intensity recovery for 2 - 3 minutes
Stop if...	Quality of execution or speed of movement decreases
Total time (repetitions and recovery)*	5 to 16 minutes (excluding warm-up and cool-down)
Frequency**	
• Development	2 - 3 X per week
• Maintenance	1 X per week
Significant improvement in...	4 - 6 weeks
Other training effects, including degree	Coordination, agility

* Excluding warm-up and cool-down

5.5- Other Considerations for Speed Training

- Speed training must not be viewed as a general conditioning session where more is better and work is harder when recovery is short. Rather, speed training must always be seen as quality work, and recovery between efforts must be long enough to ensure proper technique can be preserved during the work interval.
- The last few seconds of recovery that precede each effort should be passive; during this time, the athlete should concentrate and prepare psychologically to perform at maximum speed while maintaining good technique (mental imagery).
- Progression can be applied by increasing total volume: by adding a few repetitions within sets, by adding a set, or by increasing intensity (if possible). Recovery periods must not be reduced when the primary training effect desired is greater speed. Whether and how to increase volume depends on the goals of the training program and the athlete's response to speed training. If the athlete can perform the minimal number of reps and sets prescribed in the following tables without a decrease in speed and quality of execution and without feeling undue fatigue, volume can be increased. Volume can be increased every 2 or 3 weeks thereafter.

5.6- Training Reaction Time

Reaction time is the interval between (1) the presentation or detection of an unanticipated stimulus and (2) the beginning of the response. Ex.: The time elapsed between the moment the boxer sees an opening in the opponent's defence, and the moment he or she *initiates* a jab.

A short reaction time allows the boxer to exploit his or her speed of movement, to capitalize on openings that can be created during a fight, and to apply successfully a variety of tactics that are based on detecting a flaw in the opponent's defence or a particular movement he or she does.

To assess reaction time, a simple method called the "ruler drop test" can be used. To perform this test, the only piece of equipment required is a one 1 metre ruler and an assistant. The test is conducted as follows:

1. The ruler is held by the assistant between the outstretched index finger and thumb of the athlete's dominant hand; the top of the athlete's thumb must be level with the zero centimetre line on the ruler.
2. The athlete is instructed to catch the ruler as soon as possible after it has been released. No count down is used by the assistant. The assistant checks that the athlete is ready, and releases the ruler shortly thereafter.
3. The distance between the bottom of the ruler and the top of the athlete's thumb where the ruler has been caught is then recorded. This is the athlete's result to the test.
4. The shorter the distance, the better the performance. The test can be repeated 2 or 3 times, and the best result is used to determine the athlete's reaction time.

From this measurement, and knowing the acceleration due to gravity (9.81m/s^2), a physics formula can be used to determine the athlete's reaction time. The table below shows reaction times estimated from various results obtained during the "ruler drop test".

Table 5.3- Reaction times estimated from the "ruler drop test" results.

Distance on the rules (cm)	Estimated reaction time (seconds)	Distance on the rules (cm)	Estimated reaction time (seconds)
5	0.10	15	0.18
7	0.12	17	0.19
9	0.14	19	0.20
11	0.15	23	0.22
13	0.16	27	0.24
14	0.17	30	0.25

Results can be analyzed by comparing with the results to previous tests, or to normative data. The following table shows norms available for the 16 to 19 age group. No distinctions are made between males and females.

Table 5.4- Normative Data for Reaction Times

Excellent	Above Average	Average	Below Average	Poor
$\leq 7,5$ cm	7,6 – 15,9 cm	16,0 – 20,4 cm	20,5 - 28 cm	≥ 28 cm

Table Reference: Davis B. et al; Physical Education and the Study of Sport; 2000

It is expected that, with appropriate training, the analysis would indicate an improvement from test to test, until an adequate score is achieved. Methods that can be used to improve the athlete's reaction time include:

- Repeating the ruler drop test regularly, using each hand.
- Playing video games that require quick decisions, as well as eye-hand coordination.
- Pad work games requiring the boxer to throw a particular type of punch to the target as quickly as possible when the coach moves one hand or provides another cue that is likely to occur during a fight. This will work the boxer's observation skills and reaction time to a particular stimulus.
- Sparring sessions in which the two boxers are kept at a distance such that they cannot hit each other. When one attacks, the other one must use the appropriate defence, and vice versa. The focus must be on quick actions and movements throughout.
- Real sparring sessions in which speed is the focus.



CHAPTER 6 – SPEED ENDURANCE TRAINING

6.1- Importance of Speed Endurance in Boxing

Speed endurance is the ability to perform efforts at very high speed for an extended period. A sport situation commonly used to illustrate this athletic ability is a 400-m race in track and field. Depending on the competition level, the event may last between 40 and 50 seconds; the intensity is extremely high, but not quite as much as in a 200 m or a 100 m race.

In Boxing, the concept of speed-endurance must be viewed a bit differently than in the above example. Indeed, boxers almost never perform non-stop maximum efforts that last 30 to 60 seconds during a fight. Perhaps the only situation when this could take place would be if the boxer decided to attack “all-out” and throw punches at high frequency for that long. This is possible, but rather uncommon, and few boxers would base their preparation on such a strategy.

However, boxers may have to perform tens of short bursts at near maximum intensity throughout a fight. And while each single effort may last only a few seconds, and be followed by some less intense phase, recovery between bursts is rarely complete. Inevitably, some fatigue will set in. Because the goal of the boxer is to attack the opponent as many times as possible, speed endurance is needed to avoid a progressive decrease in the power or speed of his or her blows as the fight progresses.

The nuance between stamina and speed endurance may not be obvious, but it exists: stamina will allow the boxer to “keep fighting” round after round even when he or she is tired, but speed endurance will make him or her “fight hard, fast, and accurately” longer.

6.2- Developing Speed Endurance

Table 6.1 on the following page provides some general guidelines regarding IT for speed endurance. Some resistance training exercise and training protocols may also contribute to improving speed endurance.

To develop the speed-endurance of their leg muscles, boxers can do the following types of exercises:

- Repeated sprints lasting between 10 to 20 seconds
- Repeated runs at a very high pace, or alternative elevations of the knees while running quickly on place, with repetitions lasting between 20 to 75 seconds or so
- Repeated stop-and-go type efforts of various durations (agility runs; see example later in this section).

To develop the speed-endurance of their arm, back, and torso muscles, boxers can do sets of high-frequency/all-out punching on a heavy or wall bag, with repetitions lasting between 15 to 30 seconds or so.

6.3- Other Considerations Regarding the Development of Speed Endurance

- The systematic development of speed-endurance before puberty is NOT recommended.
- Given the importance of the aerobic system in Boxing, some form of aerobic conditioning and also some resistance training should precede the use of specific methods designed to improve speed-endurance.



e 6.1- Examples of Training Methods for Speed-Endurance

This Variable...	For Short Efforts, Should Be ...	For Intermediate Efforts, Should Be ...	For Long Efforts, Should Be ...
Type of training	Interval	Interval	Interval
Target intensity	All-out or near all-out ≈ 95 to 100 % of the maximum speed for the exercise done	A little below the maximum speed for the exercise done (92 %-95 %)	Still very high, but speed of movement can be paced and controlled, given the longer effort duration
Duration of each repetition	10 s: W:R = 1:12 15 s: W:R = 1:8	20 s: W:R = 1:6 30 - 45 s: W:R = 1:6 to 1:8	60 - 75 s W:R = 1:6 to 1:8
Number of repetitions per set *	4 - 6	3 - 5	4 - 5
Number of sets	3 - 4	2 - 3	1
Total number of repetitions	12 - 24	6 - 15	4 - 6
Duration of recovery between repetitions **	1 min 30 s - 2 min	1 min 30 s - 4 min	6 min
Type of recovery between repetition	Active, very low intensity	Active, very low intensity	Active, very low intensity
Recovery between sets	Active, low-intensity recovery for ≈ 6 minutes	Active, low-intensity recovery for ≈ 10 minutes	Active, low-intensity recovery for ≈ 10 minutes
Stop if...	Athlete can no longer maintain the required intensity or pace		
Total time (repetitions and recovery)	34 - 70 minutes	28 - 90 minutes	38 - 80 minutes
Frequency			
For development	2-3 X per week	2 X per week	2 X per week
For maintenance	1 - 2 sets, 1 X per week	1 - 2 sets, 1 X per week	1 set, 1 X per week
Significant improvements in...	4 - 6 weeks	4 - 6 weeks	4 - 6 weeks

* The higher number of repetitions per set should be for shorter efforts

** Longer recovery may be needed for efforts closer to all-out intensity for the duration considered



CHAPTER 7 – FLEXIBILITY TRAINING

7.1- Why Is Flexibility Training Important in Boxing?

For the boxer to perform offensive or defensive movement with the required amplitude, a good flexibility is required. Developing this athletic ability may also contribute to reducing the risks of injuries such as muscle tears that can occur while executing very quick movements, or during misses.

7.2- Types of Stretching

To improve flexibility, muscle fibres and connective tissue must be stretched.

Table 7.1 on the following pages describes three common stretching methods that can be used to improve flexibility:

- static stretching
- active stretching
- assisted stretching

Regardless of the type of stretching used, flexibility increases when:

1. the tension in the muscle or muscle group being stretched is reduced
2. force is applied to increase range of movement

To reduce the risks of injuries during stretching, the key points to keep in mind are:

- muscles should be stretched only when they are warm;
- movements must remain under control during stretching; and
- no pain should be felt at any time.

Muscle provides considerable resistance to the range of motion at a joint. Neuromuscular reflexes protect muscles from overstretching, especially when they are lengthening quickly (for example, in a dynamic movement).

*One neuromuscular reflex, called the **myotatic stretch reflex**, provokes a muscle contraction, and therefore reduces the rate of lengthening of a muscle that is being stretched rapidly. The muscle resists the establishment of an extreme range of motion, and in some cases this may lead to a tendon injury. Some stretching methods evoke this reflex, while others do not, and are therefore safer - in particular for lesser-trained athletes.*

Table 7.1 - Stretching Methods that Can Be Used in Flexibility Training.

Stretching Method	Description: when performing this type of stretch the athlete must...	Examples	Notes
Static Stretching	<ul style="list-style-type: none"> - Get into the starting position for the stretching exercise - Assume the stretched position slowly and in a controlled manner; at this point, the muscles are stretched only slightly - Increase the intensity of the stretch progressively and in a controlled manner until the limit of the range of motion is reached; at this point, some tension is felt, but no pain - Hold the position for 20 to 30 seconds, more if possible - At the end of the stretch, release the tension slowly, and get into the starting position again - Stay relaxed, and breathe normally throughout - Repeat 2 to 4 times - If applicable, repeat the stretch for the other side of the body 	<ul style="list-style-type: none"> - Sitting toe touch performed slowly - Hold one leg in front of the body, rest it on a chair, and stretch the hamstrings 	<ul style="list-style-type: none"> - Apply light force throughout the stretch - When the limit of the range of motion is reached, the muscles opposing those being elongated do not contract to allow the stretch to increase further - Don't use bouncing movements at the end of the stretch - If pain occurs during the stretch, slowly decrease the intensity of the stretch - Static stretching: <ul style="list-style-type: none"> - Is easy to learn - Produces little soreness - Has a generally low risk of injury - Doesn't trigger the myotatic stretch reflex
Active Stretching	<ul style="list-style-type: none"> - The steps involved in active stretching are very much like those for static stretching, except that the <i>athlete's own force</i> is used to move the body part to be stretched and brings it into the appropriate stretching position - Stretch in a controlled manner - Hold the stretch position for 10 to 20 seconds - Repeat 2 to 4 times - If applicable, repeat the stretch for the other side of the body 	<ul style="list-style-type: none"> - Stand on one leg, lift the other leg out in front of the body as high as possible, and twist from side to side 	<ul style="list-style-type: none"> - Active stretching doesn't trigger the myotatic stretch reflex - Static stretching is preferable when the elasticity of the muscles being stretched (agonists) restricts flexibility - Active stretching is preferable when the weakness of the muscles being stretched (agonists) restricts flexibility

Stretching Method	Description: when performing this type of stretch the athlete must...	Examples	Notes
Assisted Stretching	<p>Assistance may come from self-applied force, from a partner, or from a device (e.g., a towel or rubber tubing)</p> <p><i>Assisted Stretching with Self-Applied Force</i> To perform this type of stretch, the participant performs either a static or an active stretch, but also applies force towards the end of the movement to increase range of motion.</p> <p><i>Assisted Stretching with Force from a Partner</i> This is a more advanced method for flexibility training, which should NOT be used by children or by people who do not have the necessary experience or level of maturity required to ensure safe manipulations and force application. This method will not be presented and discussed in this manual, but will be dealt with in other NCCP workshops.</p>	<ul style="list-style-type: none"> - The athlete himself or herself applies pressure on a limb to stretch further and increase the range of motion. - When stretching the neck, lean the head to the side, and use the hand to gently apply some force to increase the range of the stretch 	<ul style="list-style-type: none"> - Assisted stretching: <ul style="list-style-type: none"> - Involves a greater range of motion than in other types of stretching - Is very effective at increasing the range of motion - Can lead to some muscle soreness and stiffness - Stretch to as full a range as possible before getting extra stretch from either self-applied force or force from a partner

7.3- General Guidelines for Training Flexibility

As mentioned before, key words to always keep in mind for flexibility training are: *warm muscles, controlled movements during stretching, and no pain*. The following table outlines additional important aspects coaches and athletes must keep in mind when training flexibility.

Table 7.2 – Guidelines for Flexibility Training

Variables	Key points...
Type of training	- Individually (or with the assistance of a partner in the case of some advanced methods).
Activities/ movements	- Reaching the limit of the range of motion under control and with no pain - Stretching the muscles and connective tissues - See Annex 4 for sample exercises
Intensity	Performed so that some tension is felt in the muscle being stretched, but no pain
Duration of each repetition	- Varies with the training status of the individual and type of stretching performed: - Up to 30 seconds or more for static stretching - Up to 20 seconds for active stretching
Number of repetitions	- At least one exercise for each of the major muscle groups - Where applicable, do the exercise on both the right and the left sides of the body - 3 to 4 repetitions of each exercise, using the same kind of stretching (passive, active, etc.) for all reps
Recovery time between repetitions	- A few seconds
Recovery time between sets	- Optional; relatively short
Type of recovery	- Passive, or gentle, relaxed movements
Position in training session	- Stretching should <i>follow</i> an adequate general warm-up, and athletes should: <ul style="list-style-type: none"> ○ Do moderately intense aerobic activity lasting at least 10 to 15 minutes; this can vary, depending on the time it takes to elevate the temperature of the muscles and connective tissue, especially in a hot or cold environment ○ During the warm up, use the muscle groups that will be stretched ○ Be sweating by the time flexibility training starts - If different types of stretches are performed the sequence should be: static stretching exercises first, then active stretching exercises, and then assisted stretching exercises. - Within a flexibility training session, move from the general (major joints) to the specific (sport-specific joints and ranges of motion) - Specific flexibility training should take place late in the session, when the muscles are warm

Variables	Key points...
Safety considerations	<ul style="list-style-type: none"> - Stretch muscles only when they're warm - Avoid jerky movements when doing stretching exercises - Keep muscle stretching under control at all times - If any pain occurs while stretching, slowly decrease the intensity of the stretch and return to the resting position - Breathe slowly and stay relaxed when stretching - Stretching must be viewed as an individual activity; athletes must not compete against one another when doing flexibility training
Position in the training program	<ul style="list-style-type: none"> - At the beginning of a training program, focus on static stretching - After a few sessions of static stretching, start extending the stretch slightly beyond the limit of the range of motion; for example, if trying to touch the toes, grasp the ankles to pull the body a bit closer to the toes - Then progressively introduce active stretching, and assisted stretching, over time — in that order - Boxers should perform a minimum of 3 flexibility-specific training sessions per week; these sessions can be performed at the end of a gym session, or when the athlete is training on his or her own.

7.4- Additional Considerations Pertaining to Flexibility Training

- 1- The amount and nature of flexibility training required by each athlete will vary according to his or her individual range of movement. When done properly, stretching exercises generally do not result in any significant muscle fatigue or damage. Therefore, most athletes can easily do four (4) or more stretching sessions per week.
- 2- To improve the range of movement for a particular joint action, the athlete must perform exercises that involve that joint action. It is quite possible for an athlete to have good hip but poor shoulder flexibility. Flexibility is therefore joint-specific.
- 3- A joint should be mobilized in all directions so that the full range of mobility is achieved. Therefore, if a particular stretching exercise involves flexion of a joint, the next exercise should involve extension of the same joint.
- 4- Many stretching exercises can help athletes improve their flexibility, and there are often several variations of the same exercise. Most exercises can also be executed using more than one stretching method (passive, active, etc.).
- 5- To maximize gains, plan for specific flexibility training sessions *outside* the warm-up and cool-down parts of regular training sessions. If time restrictions apply, schedule activities designed to improve flexibility *for the end of a session*, not during the warm-up.
- 6- Athletes can do several flexibility training sessions a day. For instance, one flexibility session can take place at the end of a morning workout, a second one later in the day.

- 7- To build strength at vulnerable, stretched-out positions, perform static (isometric) contractions, and hold them for three to five seconds.
- 8- Varying flexibility training can help athletes adhere to the program. Vary the types of stretches, exercises, and equipment used (towels, resistance balls, etc.) to add variety and effectiveness to the program.
- 9- Athletes can significantly *increase* flexibility in about 6 to 8 weeks.
- 10- Given the importance of flexibility in Boxing, once athletes have achieved adequate flexibility as a result of their stretching program, they should do at least two flexibility-specific training sessions per week for maintenance.

7.5- Sample Stretching Exercises

Annex 3 presents a series of flexibility training exercises that are appropriate for the key muscle groups involved in Boxing.

Of course, there are many more exercises that could be included in a boxer's stretching program, so coaches should feel free to include additional exercises or modify those that are described in Annex 3 depending on the specific needs of their athletes.



CHAPTER 8 –RESISTANCE TRAINING FOR STRENGTH STRENGTH ENDURANCE, AND SPEED STRENGTH

8.1- Introduction

In the process of developing strength, speed-strength, or strength-endurance, athletes may perform a variety of exercises and use many different devices. For instance, exercises can be performed using their own body weight, free weights, machines, pneumatic devices, Swiss balls, medicine balls, etc. This type of athletic preparation is often referred-to as *Resistance Training*.

Table 8.1 lists some of the advantages and disadvantages of equipment commonly used in resistance training.

Table 8.1- Pros and Cons of Common Resistance Training Equipment

Resistance can come from...	This has the following advantages...	... and the following disadvantages...
Athlete's own body-weight	<ul style="list-style-type: none"> - Very low cost - Excellent for young athletes - May simulate some sport movements - Effective for developing strength-endurance - Exercises with balls may contribute to improving balance, and train stabilizing muscles (including core muscles) 	<ul style="list-style-type: none"> - Limited effect on the development of maximum strength for many exercises - More difficult to isolate specific muscles
Free Weights	<ul style="list-style-type: none"> - Wide range of overload possibilities - Relatively low cost - Greatest variety of movements - Trains the stabilizing muscles - Requires little space 	<ul style="list-style-type: none"> - Initially requires more supervision - Requires more technical instruction - Training alone on some exercises can be dangerous when heavy loads are lifted - Can be hard to isolate some muscles

Resistance can come from...	This has the following advantages...	... and the following disadvantages...
Machines	<ul style="list-style-type: none"> - Safe for beginners - Requires minimal instruction - Isolates specific muscles - Requires minimal supervision or spotting - Can create overload throughout a greater part of the range of movement compared to free weights 	<ul style="list-style-type: none"> - Overloads stabilizer muscles minimally - Some machines cannot accommodate very tall or very short individuals - Available mainly in gyms - High cost of equipment
Other equipments (Medicine Balls, Tubing, etc.)	<ul style="list-style-type: none"> - Can be effective for developing speed-strength or strength-endurance, depending on the type of exercise and the protocol used - May help simulate some sport movements 	<ul style="list-style-type: none"> - May produce unnatural resistance patterns in some cases (tubing)

8.2- Types of Muscle Contractions

The table below describes three different types of muscle contractions that can occur when performing resistance training exercises.

Table 8.2- Types of Muscle Contractions

Term	Definition	Key Points and Examples
Concentric Contraction	Contractions in which 1) muscles <i>shorten</i> under tension and 2) movement occurs at a joint	<p>Examples:</p> <ul style="list-style-type: none"> - The biceps shorten in chin-ups as the athlete <i>raises</i> himself or herself and the angle at the elbow decreases (say from 180° to 15°). - The triceps work concentrically in the bench press as the angle at the elbow <i>increases</i> (as the weight is raised).
Isometric Contraction	Contractions in which muscles develop tension but <i>joint angles</i> remain the same. In other words, muscles contract but <i>no movement occurs</i> .	<ul style="list-style-type: none"> • Isometric contractions are often called <i>static</i> contractions. • In isometric contractions, muscles try to shorten, but this contraction is balanced by an equally strong contraction of the opposing muscle partner (antagonists) OR by an effort against an immovable external resistance. <p>Examples:</p> <ul style="list-style-type: none"> - Contracting the biceps in one arm in the absence of movement (the triceps will also contract). - Placing one hand in the palm of the other and pushing hard without any movement occurring.

Term	Definition	Key Points and Examples
Eccentric Contraction	Contractions in which 1) muscles <i>lengthen</i> under tension and 2) movement occurs at a joint	<ul style="list-style-type: none"> • Compared to isometric or concentric contractions, eccentric contractions: <ul style="list-style-type: none"> - Can generate 45-50% more tension. - Involve fewer muscle fibres, which causes each muscle fibre to be subjected to higher levels of tension. - Cause more damage to muscle fibres, which can result in some pain in the muscles in the hours that follow; this is called delayed onset muscle soreness (DOMS¹). <p>Examples:</p> <ul style="list-style-type: none"> - The biceps contract eccentrically in chin-ups when the athlete <i>lowers</i> his or her body and the angle at the elbow increases (say from 15° to 180°). - The triceps work eccentrically in the bench press as the angle at the elbow <i>decreases</i> (as the weight is lowered).

¹ *Delayed Onset Muscle Soreness (DOMS) is usually felt 8 to 12 hours after exercise, reaches a peak within 24 to 48 hours, and can persist for 3 to 5 days. DOMS may be associated with a significant decrease in force generation and range of motion; such performance decreases are observed mostly at the beginning of a program or in untrained individuals.*

8.3- Key Resistance Training Variables

When developing resistance training programs, coaches must take several key variables into consideration, i.e.:

- Intensity or load of each repetition
- Number of consecutive repetitions
- Number of sets
- Speed/ tempo of execution
- Recovery or rest interval between sets
- Number of different exercises performed during the session

Each of the above is briefly dealt with in the following table.

Table 8.3 - Key Resistance-Training Variables

Variables	Key Points
Repetition (rep)	<ul style="list-style-type: none"> A repetition is one complete execution of an exercise. Athletes should always aim to do each repetition properly, that is, with the proper grip, throughout the desired range of motion, and under control.
Intensity or load	<ul style="list-style-type: none"> Intensity or load is generally expressed: <ol style="list-style-type: none"> As a percentage of maximum strength. For example, if an athlete can lift 50 kg during a maximum contraction, working at 80% of maximum strength involves lifting 40 kg. OR In RMs, that is, in terms of the number of times a given weight can be lifted. For instance, 1 RM means the weight can be lifted only once, and 5 RMs means the weight can be lifted 5 times but not 6. The greater the load, the greater the amount of weight lifted.
# of Exercises	<ul style="list-style-type: none"> The # of exercises in a session depends mainly on the athlete's training objectives and training status. Sessions usually involve 6 to 12 different exercises, and several sets of each exercise are usually performed.
# of reps	<ul style="list-style-type: none"> In general, the more repetitions an athlete does in a row, the lower the intensity.
# of sets	<ul style="list-style-type: none"> A set is a group of repetitions performed consecutively. A set is usually followed by a recovery period, whose length varies according to the type of training being performed. In general, the lower the number of reps per set, the higher the number of sets should be, and vice versa. One or two sets of a particular exercise may be enough for beginners. But after 3 to 4 weeks of training, athletes should do 3 or more sets, as it promotes strength gains more efficiently. At a given relative intensity, e.g., 70% of 1 RM, smaller muscle groups (e.g., biceps) generally recover <i>faster</i> than larger ones (e.g., quadriceps). It is therefore usually possible to do more sets of exercises involving smaller muscles. Muscle groups not used much in daily activities (e.g., neck muscles) usually make significant gains even if only a few sets are performed. Athletes should do <u>at most</u> 30 to 36 sets per session. Some experts even recommend a maximum of 20 to 25 sets. For instance, if 8 different exercises are selected and the athlete performs 3 sets of each, the total number of sets for the session is 24. Depending on the training objectives, effective resistance training sessions can take \approx 60 – 75 minutes or less.
Speed/Tempo	<ul style="list-style-type: none"> Speed/tempo is the pace at which an exercise is performed, and it is usually expressed as a 3-digit number. For example, 2-1-2 means: <ul style="list-style-type: none"> 2 seconds for the concentric phase 1-second pause after the concentric phase 2 seconds for the eccentric phase When the resistance to overcome is high, speed of movement is generally slower. And when the resistance to overcome is low, speed of movement can be faster. Speed/tempo can have a significant effect on the adaptations that occur at the cellular and neuromuscular levels: <ul style="list-style-type: none"> Training done at slower tempos but with greater resistance leads to increases in strength but has little effect on the rate of force development. Training done with faster tempos but with less resistance significantly increases the rate of force development but does not yield large strength gains.
Recovery or Rest Interval	<ul style="list-style-type: none"> In general: <ul style="list-style-type: none"> The fewer the number of RMs in one set, the longer the rest period should be before the next set. Short rest intervals tend to promote greater metabolic adaptations, while longer rest intervals promote neural adaptations.

8.4- Resistance Training Exercises

Annex 4 presents sample resistance training exercises that are appropriate for the key muscle groups involved in Boxing.

Sample exercises are provided using a variety of equipment and approaches, including the athlete's own body weight, barbells, dumbbells, machines, medicine balls, and Swiss balls.

For many exercises, variations and progressions are also outlined.

These exercises and their variations are particularly relevant for the development of strength-endurance and maximum strength, but some can also be used to improve speed-strength (see next section).

Of course, there are many more exercises that could be included in a boxer's resistance training program, so coaches should feel free to include additional exercises or modify those that are described in Annex 4 depending on the specific needs of their athletes.



8.5- Order of Resistance Training Exercises during a Session

Four approaches are commonly used to determine exercise sequence in a resistance-training session. When planning the optimal order of exercises during a session, coaches can apply more than one approach, e.g. new multi joints movements could be done first, then new single-joint exercises, and then body parts could be alternated for the rest of the session.

Table 8.4- Approaches for setting exercise sequence in a resistance-training session

Approaches	Key Points
New Movements First	<ul style="list-style-type: none"> • New lifts, especially those with complex movements, should precede well-practised lifts. If an athlete is learning how to do a new exercise that is technically challenging, it is often better to practise these lifts when the body is less tired; it promotes the acquisition of the appropriate motor patterns. • Athletes should do total-body exercises and those requiring balance and coordination at the start of their training sessions.
Multi-joint Exercises Before Single-joint Exercises	<ul style="list-style-type: none"> • Multi-joint exercises such as the squat have higher skill, coordination, and balance requirements than single-joint exercises (e.g., leg extension). • Doing multi-joint exercises first ensures that the synergist muscles and stabilizers that contribute to proper technique are less tired. • This approach is useful for all athletes, and it is highly recommended for athletes with less resistance-training experience.
Alternation of Body Parts	<ul style="list-style-type: none"> • This approach alternates exercises for the lower body, the upper body, and core muscles; that way, the same region doesn't work twice in a row, which promotes recovery. However, the athlete may find it quite demanding to alternate exercises involving large muscles (for example, thighs and upper back), given the generalized fatigue that may result, so the choice of exercise also becomes important when using this approach. • This approach is particularly suited for strength-endurance work, and for athletes who are relatively new to resistance training.
Large Muscles First	<ul style="list-style-type: none"> • Exercising the large muscles first ensures that the prime movers are overloaded effectively. For example, working the forearms before doing chin-ups may weaken the grip and prevent the latissimus dorsi from receiving enough stimulation. • The order generally recommended for exercising body parts is: <i>legs → back → chest → shoulders → upper arms → abdominals.</i> • When this approach is used, athletes do all sets at a single station with appropriate rest between sets. • This approach is more suited for athletes with a good resistance training background.

8.6- General Safety Guidelines when Doing Resistance Training

- Include a thorough warm-up and cool-down in every resistance training session.
- Emphasize proper technique at all times, and stop an exercise when the quality of technical execution starts to break down. Pay particular attention to proper alignment of body segments while performing exercises.
- Using methods that are too advanced or loading patterns that are too intense can result in potentially serious injuries.
- When the resistance training method used makes it necessary to know the athlete's maximum strength, great care is necessary to set the loads correctly and safely. Methods for determining the athlete's maximum strength in a safe and progressive manner are outlined in Section 7.5. In the case of children, beginners, or during puberty, maximum strength should be estimated from the results to 10 RM tests.
- In exercises with free weights, the barbells or dumbbells must always be equally loaded on each side.
- Except for strength-endurance and speed-strength exercises done with low to moderate weights (50% or less of maximum strength), free-weight exercises require one or more spotters. This includes exercises in which a bar:
 - Moves over the head
 - Is positioned on the back
 - Is racked at the front of the shoulders
 - Passes over the face
- Spotters should:
 - Ensure the lifting area is clear of objects and that the athlete can do the movements without being distracted or affected by the presence of others
 - Be at least as strong as the lifter
 - Use an alternated hand grip when holding a bar
 - Assume a straight back and stable position; it optimizes leverage
 - Spot at the wrists or dumbbells when this equipment is used
- Athletes training without spotters should use machines or reduce exercise intensity.

8.7- Methods for Determining Maximal Strength

The purpose of maximal strength tests is to measure or to estimate the highest load that an athlete can lift while performing a particular resistance training exercise. In some strength-training methods, workloads are prescribed in percentages of maximal strength, or 1 RM. This corresponds to the weight that can be lifted with proper form and control only once. Because strength gains can take place fairly quickly in a well-designed program, loads may have to be adjusted on a regular basis to ensure continued progress. For these reasons, knowing the 1-RM value for an exercise (or estimating it as precisely as possible) is an important information to have when designing certain types of resistance training programs.

General safety Aspects

- Prepubescent athletes should not attempt maximal lifts.
- Athletes should not attempt maximal lifts until they have:
 - Developed good general conditioning
 - Acquired sound lifting technique for the movements where max strength is measured
 - Been involved in a progressive training program with low to moderate loads for 15 to 20 sessions
- Performing overhead exercises with heavy weights is potentially dangerous. Inexperienced individuals should not attempt such lifts.
- With athletes new to strength training, it is advisable to assess the 1-RM value for a given exercise by extrapolating from the results to a 10-RM test (see next page).
- It might initially be advisable to use a machine as opposed to free weights when attempting to determine maximal strength in some exercises. A high degree of coordination and involvement from the stabilizing muscles is needed to lift heavy loads with free weights, and this may be challenging for inexperienced athletes. If a machine is used, the results will tend to be *10 to 15% higher* than with free weights for the same movement.
- The area where the test takes place must be clear of equipment or other athletes, with the exception of spotters.
- In movements such as the bench press or squat, where a heavily loaded bar can inflict very serious injuries, maximal lifts should never be attempted alone. Experienced spotters should be present during the attempt, and they should be ready to intervene quickly if necessary. Some movements should also be performed in racks that protect the athlete from being injured if failure occurs.

Equipment needed

- This type of test may be relevant for training exercises such as the squat, dead lift, leg extensions, leg press, hamstring curls, bench press, biceps curls, etc. These exercises are described in detail in Annex 8. Depending upon the exercise, the equipment needed may vary, and include: a bench, a bar with collars and free weights, a lift rack, dumbbells, or a weight lifting machine such as Universal or Cybex.

Procedure - 10-RM Test

A 10-RM load corresponds to the weight that can be lifted correctly 10, but not 11, consecutive times at a regular cadence with proper form throughout.

It is possible to infer the 1-RM weight from the 10-RM weight by dividing the latter by a general factor of 0.75, or by a factor associated to a specific exercise. For instance, 0.60 seems to be a more accurate coefficient to use for the hamstrings curl, and 0.70 has been recommended for the squat. However, in all cases, individual differences are likely to come into play.

Example for the squat: if the 10-RM value is 80 kg, the estimated 1-RM value would be: $80 \text{ kg}/0.70 \approx 115 \text{ kg}$. Although this approach provides only an estimate of the 1-RM value, the stress on the lifter and the associated risk of injury are considerably less than in an actual maximal strength test. For this reason, the 10-RM test is recommended for athletes who are new to strength training or for the beginning of a program for more experienced athletes. The table below explains step-by-step how to determine the 10-RM load for a given exercise.

Table 8.5- Procedure for the 10-RM test

Steps	Procedure	Comments
1	<ul style="list-style-type: none"> Select a weight that corresponds to approximately 50% of the estimated 1-RM value. 	<ul style="list-style-type: none"> This initial value can be based on weights the athlete being tested has lifted in training or on what other athletes of the same age, experience, and build can do for the same exercise.
2	<ul style="list-style-type: none"> The athlete warms up with 10 repetitions of the load corresponding to 50% of the estimated 1-RM value. 	<ul style="list-style-type: none"> The athlete should be capable of lifting this weight more than 20 consecutive times, so performing 10 reps should represent a fairly easy effort.
3	<ul style="list-style-type: none"> After 90 seconds of recovery and some light stretching, the weight is increased by 10%, and the athlete again performs 10 repetitions. 	<ul style="list-style-type: none"> Proper form must be maintained for each rep. of the movement. The athlete must provide feedback about his or her perceived effort after each set. Increments in weight should be smaller if the effort is perceived as demanding. If free weights are used, a spotter must be prepared to intervene as the test progresses.
4	<ul style="list-style-type: none"> After 2 or 3 min of recovery and some light stretching, the weight is again increased by 10%, and the athlete again performs 10 reps. 	
5	<ul style="list-style-type: none"> Depending on the athlete's feedback, repeat the above procedure by increasing the resistance by 2.5 to 5% until the athlete can no longer perform the 10 reps without help. 	
6	<ul style="list-style-type: none"> Retest after 24 hours. After a general warm-up, have the athlete perform 2 sets of 10 to 15 reps with a resistance of 50% of the 10-RM value previously determined. After 3 min of recovery, have the athlete do as many reps as possible with the 10-RM load. 	<ul style="list-style-type: none"> If free weights are used, an experienced spotter must be prepared to intervene. If the athlete can do more than 10 reps, increase the weight by 1-2 kg, give a 3-min recovery, and perform as many reps again with the new load. Repeat as necessary to obtain the 10-RM load.

Procedure - 1-RM Test

The table below explains step-by-step how to determine the 1-RM value for a given exercise. If free weights are used, an experienced spotter must be prepared to intervene from step 3 onwards.

Table 8.6- Procedure for the 1-RM test

Steps	Procedure	Comments
1	Estimate the 1-RM load for the specific movement from the load that corresponds to 10 RM, according to the procedure outlined in the previous table.	<ul style="list-style-type: none"> • The 10-RM and 1-RM tests should occur on separate days. • For example, for the squat, if the 10-RM value is 80 kg, the estimated 1-RM value would be: $80 \text{ kg} / 0.70 \approx 115 \text{ kg}$
2	Ask the athlete to perform one set of 10 reps with 50% of the estimated 1-RM value.	<ul style="list-style-type: none"> • Using the above example, the weight would be 57.5 kg. • Allow a 3-minute break.
3	Ask the athlete to perform one set of 5 reps with 75% of the estimated 1-RM value.	<ul style="list-style-type: none"> • Using the above example, the weight would be approximately 86 kg. • Allow a 3-minute break.
4	Ask the athlete to perform one set of 2 reps with 85 to 90% of the estimated 1-RM value.	<ul style="list-style-type: none"> • Using the above example, the weight would be between 97 and 104 kg. • Allow a 3-minute break.
5	Ask the athlete to perform one rep with 95% of the estimated 1-RM value.	<ul style="list-style-type: none"> • Using the above example, the weight would be approximately 109 kg. • Allow a 5-minute break.
6	Assuming the athlete is capable of lifting the previous weight, add 2.5 to 5.0 kg, and have the athlete perform another attempt after the pause; repeat the procedure until the athlete can no longer perform the rep without help.	<ul style="list-style-type: none"> • Allow a 5-minute break between each subsequent attempt.

8.8- Training Strength-Endurance

General Training Guidelines

General training guidelines for improving strength-endurance are outlined in the table below.

Table 8.7- General Training Guidelines for Strength-Endurance

This Variable...	Has this value for developing and maintaining strength-endurance
Number of Repetitions per Set When Using the RM Method for Intensity	15-30
Intensity Expressed relative to Maximum Strength*	30-50% + of maximum strength
Tempo **	Regular and controlled, e.g., 2-1-2 or 2-1-3
Number of Sets per exercise	2 or more
Recovery between Sets (min:s)	0:30-2:00
Training Sessions per Week	2-3
Significant improvements in... *	4 to 6 weeks
Can be maintained by training...	Once a week

* May vary with muscle group and training status.

** See the table entitled Key Resistance Training Variables for specific information about tempo.

Circuit Training to Improve Strength-Endurance and Base Strength

Circuit training or circuit weight training is a conditioning approach in which the athlete completes stations of exercises with his or her own body weight (push-ups, sit-ups, jumping jacks, squat thrusts, chin-ups, dips, etc.) or resistance-training equipment such as free weights or machines. Other forms of exercise can also be included, such as stretching, running, bicycling, and rope skipping. Successive stations are arranged close to one another. Athletes usually exercise different muscle groups at each station, which allows some recovery to occur.

Circuit training can be used by all athletes. However, this method is particularly effective with beginners to improve strength-endurance or to introduce them to resistance training. In the latter case, the main benefits are:

- Learning to execute specific resistance-training movements and exercises with proper form using relatively low weights.
- Developing a level of base strength and inducing some adaptations in the musculoskeletal system that prepare the athlete to sustain the stress of higher loads.

Circuit training is therefore a good way of introducing children or lesser trained individuals to resistance training. It can also be used by experienced athletes at the beginning of a resistance training program. However, if athletes have a good resistance-training background, the effectiveness of circuit weight training may be limited. The table below outlines the key features of circuit training.

Table 8.8 General Guidelines for Circuit Training

Circuit-Training Variable	Key Points
Number of Stations	May vary, but is usually between 6 and 10 - 12.
Exercises	Stations should be planned so that the athlete will have worked each body part upon completion of a circuit. As a rule, stations should alternate exercises that work the whole body, the upper body, the lower body, and the core/trunk, in this order. The following table presents a list of basic exercises for each body part that can be included in a circuit-training.
Exercise Intensity	In exercises using resistance-training equipment, intensity is normally set at 30-40% of maximum strength for beginners, at 40-60% of maximum strength for more experienced athletes.
Activities at a Station	In stations where resistance-training exercises are performed, athletes perform either a fixed set of repetitions (12-15) at a regular cadence <i>OR</i> work non-stop and try to perform as many reps of the exercise as possible in a designated time period (e.g., 20 or 45 seconds). In this case, the movements are not executed explosively as they would be in speed-strength training, but at a fast, regular cadence.
Recovery between Stations	Rest intervals between stations can be in the order of 45 to 60 seconds <i>OR</i> kept to a minimum (15-20 seconds or so). In the latter case, the athlete normally walks or jogs from one station to the next; this promotes near-continuous effort throughout the circuit, which increases the demands on the aerobic system.
Completion of a Circuit and Circuit Duration	A circuit is completed once the athlete has performed the exercises at all the stations. The time to complete a circuit depends on the type and the number of exercises, and may range between 5 and 15 minutes.
Recovery between Circuits	The rest period between each circuit can be short (1 or 2 minutes) or long (3-5 minutes). Shorter recovery is associated with greater aerobic demands.
Number of Circuits	The number of circuits depends on the time available, the training objectives, and the athlete's fitness level. Athletes usually complete 2 or 3 circuits, but they may do as many as 5 if there are fewer stations in a circuit.
Progression	See table 8.10 for an example of progression over 8 weeks.

Table 8.9 provides an example of Circuit Training exercises for various body parts. Additional resistance training exercises are listed and described in Annex 4, and can also be used in designing a circuit.

Table 8.9- Sample Circuit Training Exercises

Muscle groups	Exercises
Whole body	Squat thrusts; Jumping jacks; Rope Skipping; Jogging; Stationary Bicycling; Elliptical Machine; Treadmill Walking or Running
Upper-body	Push-ups; Chin-Ups; Bench Press; Lat Pull Down; Biceps Curls; Parallel Bar Dips; Seated or Upright Row; Shoulders Shrugs;
Lower-body	Leg Press; Leg Extension; Squats; Squats with Swiss Ball; Leg Curls; Step Ups
Core and trunk	Sit Ups; Back Extension; Side Flexions; Russian Twists; Trunk Rotations; Side Raises; Leg Raises

The table below provides an example of Circuit Training progression over 8 weeks.

- There should be 2 sessions in week 1, and 2 to 3 sessions per week from weeks 2 to 8, depending on the athlete's schedule.
- There should be at least 48 hours of recovery between each Circuit Training session.
- Week 4 is an example of “easy week” in the progression, to allow for recovery.
- If the athlete is doing boxing-specific training on the same day as a circuit session, Circuit Training should be performed last, and there should be a suitable recovery period between the two sessions.

Table 8.10- Sample Circuit Training Progression Over 8 Weeks.

Weeks	Number of stations	Workload at each station		Number of circuits and recovery between circuits	
		Work	Rest	Number	Rest (minutes)
1	8	20 sec	20 sec	2	2
2	8	30 sec	30 sec	2	2
3	8	45 sec	45 sec	2	3
4	10	20 sec	20 sec	3	2
5	10	30 sec	30 sec	3	2
6	10	30 sec	30 sec	4	2
7	10	45 sec	30 sec	3	3
8	10 - 12	30 sec	30 sec	3	2

8.9- Training Maximal Strength

- An athlete's maximal strength is determined by: (1) the size of the working muscles; and (2) neural factors.
- Maximal strength can be improved by working at intensities greater than 60% of the athlete's maximum strength (or 1 RM) and by doing 1 to 15 repetitions in a set. Safe and progressive methods to determine the athlete's maximum strength were described in Section 7.5.
- As a general rule, methods that feature very high intensities and fewer repetitions per set promote strength gains that come predominantly from neural adaptation, while methods that use lower intensities and more repetitions per set can bring about important gains in muscle size and mass.
- When many repetitions are performed (10 or more), the term *extensive* is sometimes used to refer to the higher volume of work done against lower resistances. This approach promotes strength gains through growth in muscle size (hypertrophy) and gains in muscle mass. The extensive strength training method is safer than methods using higher loads, and for this reason it should be used until the athlete has developed a solid strength foundation.
- On the other hand, when fewer repetitions are performed in each set (e.g. 6 to 10 or so) and intensity ranges between 75 and 85% of the athlete's maximum strength, the term *intensive hypertrophy strength training* is sometimes used.
- Strength training methods that use maximum or near maximum weights (1 to 5 repetitions, 85 to 100 % of maximal strength) induce strength gains that come principally from neural adaptations. While some hypertrophy may occur, gains in muscle mass and size are generally much less than with the extensive and intensive methods. This approach can therefore be effective with experienced boxers who have an extensive resistance training background, and who wish to improve their strength without increasing their muscle mass significantly. However, due to the heavy loads used it is riskier than the other methods, and for this reason it *should not* be used by children, beginners, or during puberty.

Table 8.11 on the following page presents general training guidelines for improving Maximal Strength using the *Extensive Hypertrophy*, *Intensive Hypertrophy*, and *Maximum Weights* methods.

Table 8.11- General Training Guidelines for Improving Maximal Strength

This Variable...	Has this value for developing strength mainly through hypertrophy and increases in muscle mass...		Has this value for developing strength mainly through increased neural drive...
	<i>Extensive Approach</i>	<i>Intensive Approach</i>	<i>Maximum Weights</i>
Number of Repetitions per Set (when using the RM method for intensity)	10-15	6-10	1-5
Intensity (when expressed relative to maximum strength)*	≈ 60-75% of maximum strength	≈ 75-85% of maximum strength	≈ 85-100% of maximum strength
Tempo (seconds) Concentric phase Eccentric phase	2-3 ** 3-4		2-5 4-5
Number of Sets per exercise	2-4	2-4	3-5
Recovery between Sets (min:s)	2:00	2:00-3:00	2:00-5:00
Sessions per Week	2 initially; 3 when the athlete has a good training foundation		
Number of Weeks before Method is Varied	4 or 5 weeks	3 or 4 weeks	2 or 3 weeks

* May vary with muscle group and training status.

** Some advanced methods emphasize longer concentric contractions.

8.10- Training Speed-Strength (Power)

General considerations

Speed-Strength is a demanding form of resistance training that should be used only when the athlete has gained an appropriate strength foundation resulting from several months of training (see Section 8.11). Such training should progress from a Strength-Endurance program, to a maximal strength program using first the extensive a hypertrophy method, and then the intensive a hypertrophy method.

Training guidelines

The table below presents general guidelines for improving Speed- Strength. This form of training must always be viewed as « high quality training », and therefore ample recovery must be available between sets. Athletes should work against light resistances initially.

Table 8.12- General Training Guidelines for Improving Speed- Strength

This Variable...	Has this value for developing and maintaining speed-strength...	
	Against Light Resistance	Against Heavier Resistances
Number of Repetitions per Set	5-10	3-5
Intensity	Use a resistance corresponding to 25-40 % of maximum strength for the chosen exercise	Use a resistance corresponding to the 8-10 RM load for the chosen exercise
Tempo	Explosive right from the start of the movement; the athlete must try to accelerate the load as fast as possible	Explosive right from the start of the movement; the athlete must try to accelerate the load as fast as possible even if the actual movement doesn't occur at a fast speed.
Number of sets of a particular exercise	3-5	
Recovery between Sets (min:s)	Complete; 3:00 or more, as more recovery may be needed in later sets	Complete; 3:00-5:00 or more, as more recovery may be needed in later sets
Training Sessions per Week	2; up to 3 in very well-trained athletes	

Plyometric Training to Improve Speed-Strength/Power

- Muscles that are *stretched* before a concentric contraction contract *faster* and generate more force: 15-20% more force at the beginning of a concentric contraction than muscles that aren't pre-stretched. This is called the *stretch-shortening cycle*, or SSC.
- Plyometrics are essentially SSC exercises. They involve three steps:
 1. The muscle is stretched, often as a result of eccentric muscle action.
 2. There is a transition phase between the end of the muscle lengthening (or pre-stretch) and the beginning of the concentric contraction. *The shorter this transition phase, the more powerful the concentric muscle contraction will be.*
 3. The muscles contract concentrically; this produces the desired movement, such as a jump or a throw.
- Given their fundamental characteristics, plyometric exercises are particularly effective in the development of speed-strength. Examples of plyometric exercises are described in Annex 5.
- Plyometric exercises can make very high demands of the musculoskeletal system, so certain precautions are needed when using them. Table 8.13 presents general training guidelines pertaining to plyometrics, and lists certain safety measures coaches should take into consideration.
- Also, while all plyometric exercises rely on SSC, their specific characteristics have a direct effect on intensity and on the stress imposed to the musculoskeletal system. To increase training effectiveness and reduce the risk of injury, a plyometric program should progress gradually from lower intensity drills to more advanced plyometric exercises — especially if athletes have a limited resistance-training background — and from lower to higher volume of contact times with the ground or throws for upper-body exercises with medicine balls. Table 8.14 presents general guidelines applicable to the loading parameters and to the progressions that should be followed when using plyometric training.

Table 8.13- General Training Guidelines for Plyometric Training

Area Requiring Caution	Key Points
Prerequisites	<ul style="list-style-type: none"> • Athletes shouldn't start systematic plyometric training until they've been involved in a general conditioning and resistance-training program for at least one full year • Athletes shouldn't do demanding lower-body plyometric exercises until they can squat 1.5 times their own body weight. See <i>Exercise intensity</i> below for some general guidelines about factors that make plyometric exercises more demanding, and the last few pages of section 6.5.10 for descriptions of plyometric exercises featuring different intensity levels. • Athletes shouldn't do demanding upper-body plyometric exercises until they can bench-press 1 to 1.5 times their own body weight • A minimum level of balance is necessary: <ul style="list-style-type: none"> - Athletes shouldn't do low-intensity plyometric exercises until they can balance on one foot for at least 30 seconds - Athletes shouldn't do more intense plyometric exercises until they can balance on one foot in a semi-squat position for at least 30 seconds • Athletes with little or no resistance-training background should be introduced to plyometric exercises gradually and carefully; see the following table for key guidelines.
Type of Equipment and Landing Surface	<ul style="list-style-type: none"> • Athletes should use proper footwear, i.e., footwear with good ankle and arch support and a wide, anti-slip sole • The landing surface must have adequate shock-absorbing characteristics: <ul style="list-style-type: none"> - Suitable surfaces include grass fields, padded artificial turf, suspended floors, and wrestling mats. - Harder surfaces such as asphalt, concrete, tile, and hardwood are not recommended, and neither are thick shock-absorbing mats or trampolines • Any boxes used must be solid and have a non-slip landing surface at the top
Exercise Intensity	<ul style="list-style-type: none"> • Exercise intensity is greater if: <ul style="list-style-type: none"> - One leg or one arm is used, as opposed to both - The start of the exercise involves impact; for instance, when athletes perform in-depth jumps (jumping off a box to the ground and quickly jumping up as high as possible), the intensity is very high, and the higher the box, the higher the intensity - The athlete carries additional weight (e.g., a weighted vest or a barbell) when doing movements that involve impact as an exercise starts - The athlete has some horizontal speed, as opposed to no speed, at the start of the exercise - Two or more of the above are combined
Progression of Volume and Intensity	<ul style="list-style-type: none"> • The progression should be from: <ul style="list-style-type: none"> - Low to higher volume at a given intensity - Low-intensity exercises to moderate-intensity exercises to higher intensity exercises
Athlete's Weight	<ul style="list-style-type: none"> • Athletes weighing 90 kg or more should avoid high volumes of lower-body plyometric exercises (see Table 8.14 for volume recommendations in plyometric training programs).
Jumping Height	<ul style="list-style-type: none"> • Assuming good landing technique and the use of an appropriate landing surface, the most likely cause of injuries in lower-body plyometric exercises is <i>excessive jumping height</i>. • In-depth-jumping heights between 50 and 110 cm seem to have the same effect on performance improvement; therefore, to reduce the risk of injury, athletes shouldn't jump higher than 50 cm.

Table 8.14- Loading Parameters and Progressions Guidelines for Plyometric Training

Plyometric-training Variable	Athletes with Little or No Plyometric-training Background	Athletes with Some Resistance- and Plyometric-training Background	Athletes with Extensive Resistance- and Plyometric-training Background
Exercise intensity	Mostly low	Low and moderate	Low, moderate, and high
Example of exercises	Rope skipping; jumps with both legs; movements with both arms; movements initiated <i>from</i> the floor, not above it; movements with no prior horizontal momentum.	Some movements involving one limb, horizontal component, and limited vertical component (0.3-0.5 m).	All types of plyometric exercises, including in-depth jumping from heights of about 0.5 m*
Number of different lower-body exercises performed in a session (additional upper-body exercises can be included if relevant to the sport)	2-3	3-4, all low intensity early in the program; then 2 low intensity, 2 moderate intensity	4-6, low and moderate intensity early in the program; then 1-2 low intensity; 2-4 high intensity
Number of reps of a given exercise per set	4-8	6-10	8-12
Number of sets of a given exercise	2	2-3	2-3
Recovery time between sets	10 to 15 times the time it takes to complete the set Plyometric training sessions must not be viewed as conditioning sessions, and recovery must be long enough for the athlete to do high-intensity and high-velocity contractions in the exercises		
Total volume of training per session (e.g., number of contacts with the ground or throws)**	Early in the program: 40-60	Early in the program: 60-80	Early in the program: 80-100
	Mid-part of the program: 60-80	Mid-part of the program: 80-100	Mid-part of the program: 100-120
	Latter part of the program: 80-100	Latter part of the program: 100-120+	Latter part of the program: 120-140+
Training sessions per week	1-2	2	2-3
Recovery between sessions	A minimum of 48, and up to 72 hours, between sessions. Athletes should be fresh at the beginning of each plyometric training session. Plyometric training should not take place the same day as or the day following a heavy resistance-training session, as muscles may still be sore; as a solution to the potential planning issues this may create in the program of some athletes, heavy resistance-training sessions for the upper body and low-intensity plyometrics sessions for the lower body can be scheduled for the same day, and vice versa, to achieve the desired number of sessions during a week.		
Program duration	8-12 weeks of development, then one session a week for maintenance		

* Some studies have measured vertical jump performance following training at different in-depth jump heights (50, 75, 80, and 110 cm). Similar results were observed for jumps of 75 cm and 110 cm and for jumps of 50 cm and 100 cm. The training benefits of jumping from heights above 50 cm seem limited, given the higher risk of injury as height increases.

** General guidelines only.

8.11- Programming Guidelines for adolescent or adult athletes who have no or limited background in resistance training

When designing programs for adolescents and adults who have no or limited backgrounds in resistance training, or who have not been involved in this type of training for a long period of time, coaches should consider the following:

- In an athlete's long-term development, strength-training methods usually follow this progression:

Strength-endurance methods → hypertrophy methods → the method of maximum weights → speed-strength methods, including serious plyometrics

- The time spent emphasizing each type of training depends upon a variety of factors, including the age of the athlete, and his or her training background.
- The development of both maximal strength and speed-strength should be viewed in the mid- to long-term perspective of athletic development (i.e. several years), as opposed to the short term (one season).
- Athletes new to resistance training should start with body weight exercises and progress to free weights. During their first year of resistance training, these athletes should focus on general muscular development, be exposed to a variety of exercises and training modes, and avoid training programs that are too specific. Advanced methods such as maximum weights for relative strength, speed-strength, and demanding plyometrics *should not be used*.
- At the start of a resistance training program using free weights or machines, many experts recommend to focus on strength-endurance for several weeks initially, particularly with adolescents. For these athletes, circuit weight training can also be used as an effective introduction to resistance training. This allows low to moderate resistances to be used, and to emphasize proper technique and execution throughout each repetition of individual exercises.
- Following a basic introductory phase and several weeks of strength-endurance training, these athletes may progress to a more intense phase and work on the development of maximal strength. When this is done, it is important to ensure that an appropriate transition occurs in the intensity from the end of the strength-endurance phase and the start of maximal strength training. Similar strength gains can be obtained using a variety of approaches with beginners. For instance, in participants with no prior resistance training background comparable improvements in maximal strength have been reported when using intensities ranging from 5 to 10 RMs. To ensure safety and proper progression, loading patterns that range between 8 and 12 RMs should therefore be used, 8 RMs representing the highest intensities.

- Competition amongst athletes should be discouraged, particularly amongst teenage boys who are likely to want to show “how strong they are” to others. Resistance training should be viewed as an individual activity.
- Due to the rapid strength gains that can be observed at the beginning of a resistance training program, coaches should ensure the loads are adjusted as necessary to perform the required number of RMs.
- Initially, a training frequency of twice a week (every 3 days or so) should be adequate.
- Frequency of training can be increased to 3 sessions a week after several weeks of training. Given a constant volume of work to accomplish during the week, 3 sessions per week will generally be more effective than 2 in the case of beginners. Daily training sessions can be considered, but in this case the one session should focus on the upper body, and the other on the lower body.
- With beginners, the order of exercises should be such that the body parts alternate (e.g., lower body, core, upper body). This will likely result in a lower perception of fatigue, promote proper execution of the exercises, and allow athletes to complete the entire workout that was planned.
- With beginners, when adjusting the loading parameters or seeking to introduce variety in the program, coaches should increase only one variable at a time (e.g. number of reps, number of sets, etc.), consistent with the goals of the resistance - training program.

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Annex 1 - Heart Rate Measurements

Overview

The following pages provide information about the procedures for determining maximum heart rate (HR), HR during exercise, and HR at rest.

These measurements are needed when using the Karvonen formula, a method that can be used to estimate the intensity of aerobic workouts. Comparisons of HR responses at specific workloads before and after a training program can also be used to assess the evolution of aerobic fitness. Training causes cardiovascular adaptations that allow the heart to pump more blood at each contraction, and HR at a given submaximal workload is *generally lower* than before when performing the same task.

Procedures for determining maximum Heart Rate

The first step in using HR to set training intensities or to monitor the effects of training is to determine the athlete's maximum HR (max HR). Two methods commonly used for doing this include:

- (1) 220 minus age and similar formulas
- (2) Progressive maximal tests

220 Minus Age and Similar Formulas

Max HR is genetically determined. In able-bodied 20-year-olds, max HR is usually around 195-200 bpm regardless of sex. It then declines gradually by about 10 bpm per decade. This has led to the development of the simple and well-known 220 minus age formula to estimate max HR. However, these values represent averages, and important variations (e.g., ± 10 bpm or more) can be observed in any age group. For instance, the max HR of a 25-year-old female could be similar to that of a 50-year-old man, and differences of 20 bpm or more can be observed within the same age group.

To account for some of these limitations, some authors have suggested to add 5 to the value obtained when using the 220- age formula. For instance, for a person 20 years of age, max HR would be estimated to 205 bpm, as opposed to 200 bpm.

Another formula to estimate max HR based on age is: $Max\ HR = 209 - 0.587 \times (age\ in\ years)$

The intent of this formula is also to correct some of the errors associated with the "220 minus age" formula. However, the margin of error remains high compared to direct measurements.

Because of their limited precision, these formulas should not be used to determine max HR in young, healthy athletes. Rather, max HR should be determined during a maximal tests, using one of the methods described below.

Progressive Maximal Tests to determine max HR

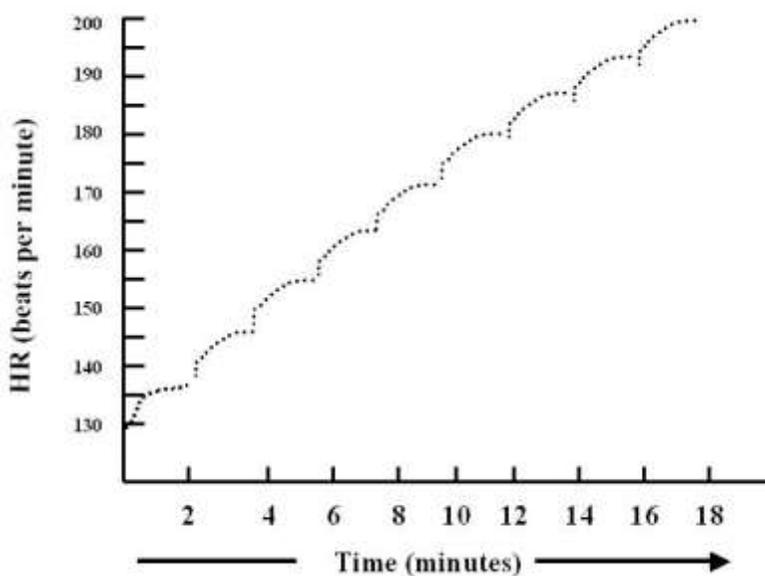
Notes:

1. For the method described below, it is assumed that the athlete has access to an HR monitor. If this is not the case, the athlete's pulse should be recorded at either radial (thumb side of the wrist) or carotid (junction of the head and neck) sites over a 10-second period **immediately** after the work bout. Recording over longer periods is not recommended because recovery will have begun by then, and max HR may be underestimated. If the count is between two heart beats at the end of the 10-second period, add 0.5 to the count. For instance, if the count is between 33 and 34 at the end of 10 seconds, use 33.5 beats as the count, and estimate max HR as $33.5 \times 6 = 201$ bpm.
2. The mode of exercise and the position of the body during the effort may affect max HR. Max HR tends to be **higher** when more or larger muscle groups are involved (e.g., running versus cycling versus swimming; exercising with the legs versus the arms), **lower** when body position is horizontal or inclined as opposed to vertical.

Continuous Progressive Maximal Tests

HR values measured at the end of progressive maximal are simple, valid, reliable ways of determining max HR. In this type of test, exercise intensity is increased progressively in a step-wise fashion over several minutes until the athlete reaches exhaustion.

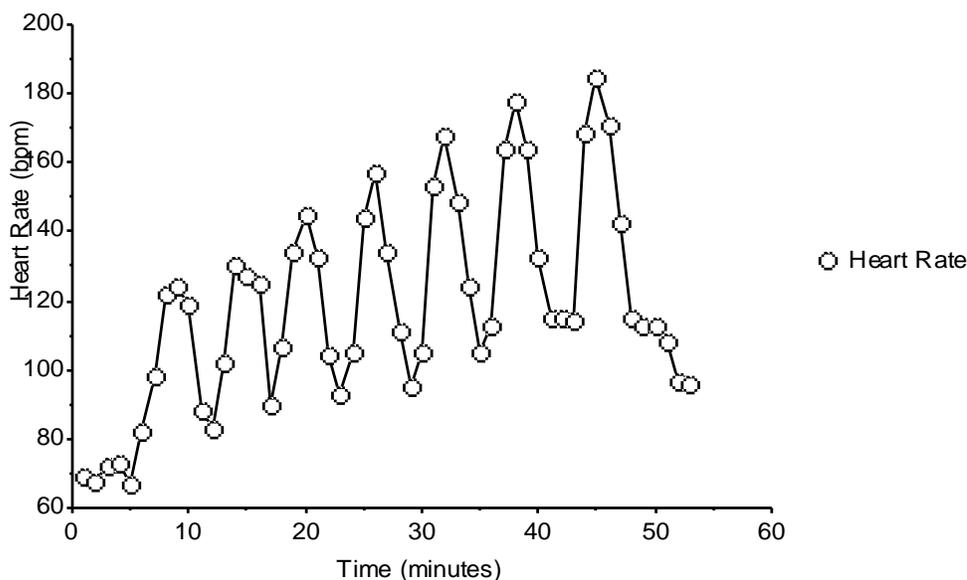
Alternatively, the athlete exercises for a few minutes in sport-specific conditions at an HR of 120 to 140 beats per minute (bpm). HR is then increased by 8 to 10 bpm, and the new intensity is maintained for about 2 minutes. Similar step-wise increments are repeated until the athlete is exhausted or HR plateaus despite an increase in intensity; this should occur in 12 to 16 minutes. During this type of effort, HR increases gradually after intensity is increased, rather than abruptly, as the figure below shows.



In addition to HR, mode of exercise, exercise conditions, environmental conditions during the test, and speed or power output at each stage (if applicable) should be recorded for future comparison. The test should be repeated at least twice within a short time period to ensure that the values obtained represent the athlete's actual max HR.

Discontinuous Progressive Maximal Tests

In these tests, the athlete recovers partially between high-intensity exercise bouts. The figure below shows the HR response of an elite cyclist during a discontinuous progressive maximal field test. Although these tests are valid ways of determining max HR, they are time-consuming tests.



Repeated Maximum Efforts

Another method of determining max HR consists of performing a thorough warm-up and then doing 6 to 8 30-second repeats at near-maximum effort with 20- to 30-second pauses between each repetition.

Because it takes some time for the cardiovascular and metabolic systems to adjust once exercise has begun, a single maximum effort initiated from rest and lasting 1 or 2 minutes should not be used to assess max HR. Although it is possible for athletes to reach maximum or near-maximum HR in all-out efforts of short duration, a high level of motivation and arousal is required. As a result, the reproducibility of the data may be affected.

Determining HR during Exercise

If an HR monitor is used, HR values are provided in real time during exercise and associated with a specific time. It is therefore easy to see HR information for a particular moment, throughout a session, or for a specified period of time. However, if no HR monitor is available, the athlete must learn how to determine HR during exercise.

For continuous exercise, HR can be taken either any time throughout the workout or at predetermined times. Where necessary, values can be recorded for later analysis.

For intermittent or interval work, HR should be taken immediately after each repetition.

Pulse rate recorded manually during exercise should be taken over a 10-second period, using the procedure outlined in the note above.

Determining HR at Rest

Resting HR can be obtained by recording HR during sleep with an HR monitor or by recording HR manually after waking up.

In the latter case, HR *should not* be taken immediately after the alarm has rung or after getting out of bed, as HR is likely to be higher than during sleep. Instead, the athlete should:

- Stay in bed and relax for a few minutes while taking deep, slow, controlled breaths.
- Avoid any brisk movement.
- Take his or her HR over a 15-second period at a radial (thumb-side of the wrist) or carotid (junction of the head and neck) site. If the count is between two heart beats at the end of the 15-second period, add 0.5 to the count.
- Multiply the count by 4 to get resting HR in bpm. For instance, if there are 12.5 beats in a 15-second period, resting HR is estimated at 50 bpm ($12.5 \times 4 = 50$).

Annex 2: Some Limitations to the Use of Heart Rate to Quantify Aerobic Training Loads

Using target heart rate (HR) to quantify aerobic training loads may allow coaches to individualize the training stimulus and to adjust training as fitness improves. However, the relationship between HR and work intensity is not perfect. Some of the limitations of using HR to set aerobic training intensities are outlined below.

Factors that may influence HR values during exercise	It has these implications when HR is used to estimate exercise intensity...
HR tends to increase with exercise duration even if intensity doesn't change; this is normal, and it is called <i>cardiac drift</i>	<p>Because cardiac drift is caused largely by the loss of fluid through sweating and by other cardiovascular adjustments that occur during exercise to help regulate body temperature, HR values tend to become less precise measures of aerobic intensity when:</p> <ul style="list-style-type: none"> • exercise is prolonged • it's hot or humid (higher sweating rate) • clothing or other equipment insulates the body • the athlete is dehydrated <p>Under these conditions, HR may <i>overestimate</i> the intensity the athlete is working at relative to his or her maximal aerobic power (MAP).</p>
HR usually increases with psychological stress; however, in some cases, it may decrease	<p>HR may <i>overestimate</i> or <i>underestimate</i> actual intensity relative to MAP, and it can be difficult to determine which response is being observed.</p> <p>However, the chances are greater that psychological stress increases HR at a given submaximal workload, and so overestimation is more likely.</p>
It takes a few seconds for HR to adjust to a given workload; whether athletes reach the HR approximating the desired percentage of MAP therefore depends on the length of the work interval	<p>HR is not a valid measure of intensity:</p> <ul style="list-style-type: none"> • In IT sessions with short, high-intensity work intervals • In intervals performed at intensities greater than 100% of MAP <p>In these cases, target speeds or split times should be used to estimate intensity, not HR.</p>

Annex 3

Sample Stretching Exercises

This Annex present a series of flexibility training exercises that are appropriate for the key muscle groups involved in Boxing.

For certain exercises, some *Variations* and *Progressions* are also proposed.

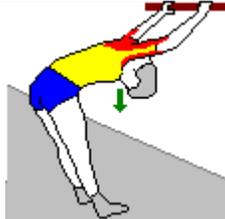
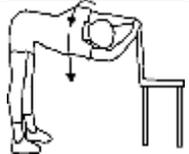
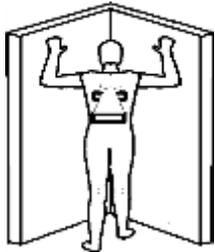
- A **variation** is another, slightly different way of performing a particular exercise.
- A **progression** is a more challenging or difficult way of performing an exercise; progressions should be introduced after a few weeks of training.

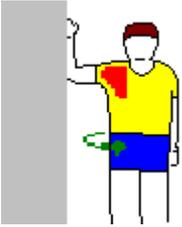
There are many more exercises that could be included in a boxer's stretching program, so coaches should feel free to include additional exercises or modify those that are described in the following pages depending on the specific needs of their athletes.

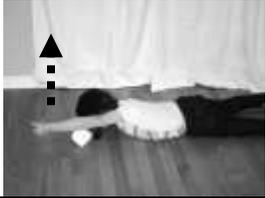
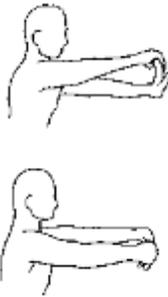
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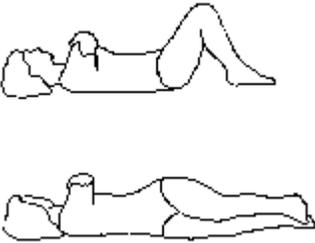
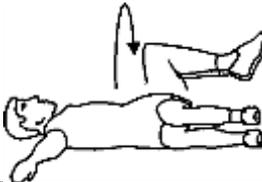
1. The guidelines presented in Chapter 7 should always be followed when performing flexibility exercises.
2. Stretching movements that are performed on one side should always be repeated on the other side.
3. Stretches should be stopped immediately if the athlete feels any pain.

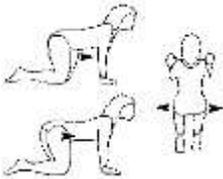
Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Neck and upper back	Flex 1	<p>“No” movement (look right and left)</p> 	Neck muscles are relaxed. Head is <i>slowly</i> turned to the side.	*Static; Active; Assisted;	<ul style="list-style-type: none"> • These exercises should be preceded by a series of slow rotations of the head. • Flexibility exercises for the neck must be executed in a smooth, controlled manner. Jerky/bouncing movements must be avoided. • Stretching movements for the neck must <u>never</u> be performed with the assistance of another person. • The athlete should breathe normally when performing each stretch. • If pain is felt when performing any of these basic movements, a neck problem may be present, and it may be advisable to consult a specialist. • These three exercises should be performed throughout the rider’s program. <p>Variation: All 3 exercises can be performed while standing up, or seated.</p> <p>Progression: Hands can be used to apply force in a controlled manner, to increase stretch range.</p> 
	Flex 2	<p>“Yes” movement (flexion-extension)</p> 	Neck muscles are relaxed. Chin is slowly moved towards chest. Head is then lifted and slowly extended towards back. Avoid hyper flexion and hyper extension	Static; *Active; Assisted;	
	Flex 3	<p>Lateral flexion of neck</p> 	Neck muscles are relaxed. Head is slowly leaned to the side, trying to “place the ear on the shoulder”.	Static; *Active; Assisted	

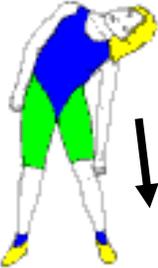
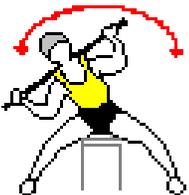
Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Shoulders and chest	Flex 4	Straight arms behind back 	Arms fully straightened, in the back. Head kept upright, neck relaxed. Arms raised slowly behind the back.	*Active; Assisted	Variation and progression: Movement performed with the feet horse-width apart, and hip flexion 
	Flex 5	Seated lean back 	Sitting, legs straight, arms extended to rear. Palms on the floor, 30 cm behind hips; fingers pointing away from the body. Hands slide to the rear, torso leans backwards.	Static; *Active	
	Flex 6		After reaching forward, a bar is grasped. Arms and back are kept straight, and the upper body is lowered slowly until a stretch is felt in the chest muscles.	Static; *Active	 Variation: Controlled twists; movement repeated on each side.
	Flex 7	Corner stretch 	Standing in a corner, hands and forearms are placed against the wall. Elbows are at shoulder level and arms pointed directly at the ceiling. Chest is leaned toward the corner until a stretch is felt in the chest muscles.	Static; *Active	

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Shoulders and chest (cont.)	Flex 8	<p>Hand on the wall stretch</p> 	Standing in a doorway, one arm is flexed at 90 degrees with the palm of the hand place against doorjamb. Upper body is leant forward and shoulder blades are brought together.	Static; Active; *Assisted	<p>Variation: The stretch can be performed using a Swiss ball. The arm is kept straight and the palm of the hand is placed on top of the ball</p> 
	Flex 9	<p>Behind the neck stretch</p> 	One arm is flexed, and elbow is raised above head. Hand of flexed hand reaches down towards scapula of opposite side. Elbow of flexed arm grabbed with other hand. Elbow pulled down gently.	Static; Active; *Assisted	<p>Variation: Both hands are joined together behind the back; the lower hand then pulls the other gently.</p> <p>Progression: Hand of arm being stretched can hold a towel, which is gently pulled by the other hand.</p>
	Flex 10	<p>Arm across chest</p> 	One arm slightly flexed, positioned across chest. Opposite hand grasps upper arm above elbow. Arm is pulled across the chest.	Static; Active; *Assisted	Also serves as a stretching exercise for the shoulder articulation.
Shoulders, arms, and upper back	Flex 11	<p>Straight arms above head</p> 	Arms in front of torso, fingers interlocked, palms facing each other. Arms straightened slowly above head, palms facing up. Hands and arms reach upwards slowly, then slightly to the back.	*Active; Assisted	Also serves as a stretching exercise for the shoulders and forearms.

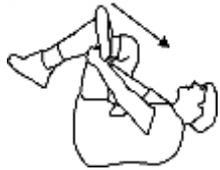
Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Shoulders, arms and upper back	Flex 12	<p>Straight arm raise, lying</p> 	Lying on the stomach, head resting on a towel, one arm is placed on the side of the body, the other extended with the thumb up. The extended arm is lifted slowly, as high as possible.	Static; *Active	
	Flex 13		Arms are extended in front or on each side of the body, and kept straight. Palms of the hands face down. Wrists are extended as fingers are kept straight and point up.	Active	 <p>Variation: Wrist rotations where large circles are drawn with the hands.</p>
		Flex 14		Arms are extended in front or on each side of the body, and kept straight. Palms of the hands face up. Wrists are extended as fingers are kept straight and point down.	
Wrists and forearms	Flex 15	<p>Finger stretch</p> 	<p>(1) Sitting or standing up, one arm is raised in front of the body. Wrist is flexed, and fingers point up. Using the other hand, the palm and the fingers are <i>gently</i> pulled toward the body.</p> <p>(2) Wrist is extended, and fingers point down. Using the other hand, the stretched hand is <i>gently</i> pulled toward the body.</p>	Assisted	<p>Progression: Kneeling, arms straight and in front of the body, palms in contact with the floor and fingers pointing toward the knees. Body moved back slowly while palms are kept on the floor.</p> 

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Trunk and lower back	Flex 16	<p>Trunk rotations, standing</p> 	<p>Standing position, feet shoulder width apart and hands on the hips. Body is rotated as far as possible to one side.</p>	Active	<p>Variation: Trunk rotations are performed with both arms raised at shoulder level</p> <p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Look behind to add to the stretch. 2. Perform the rotations with a stick behind the neck, standing or seated. 
	Flex 17	<p>Trunk rotation, lying</p> 	<p>Lying on the back with arms crossed over the chest; knees bent, feet flat on the floor. Head/trunk are turned to one side while both knees slowly turn to the other side and are brought down.</p>	Active	<p>Progression: Lying down with both arms extended to the side; knees are flexed at 90 degrees and brought up. Legs are kept parallel to the floor while trunk rotates to bring leg in contact with the floor.</p> 
	Flex 18	<p>Spinal twist</p> 	<p>Sitting position, one leg extended (ex. left), the other bent with foot across, placed against left knee; back of left elbow on the side of right leg; right palm on the floor, about 30 – 40 cm behind hips. Right knee pushed to the left with left elbow while shoulders and head are turned to the right as far as possible. Participant tries to look behind his/her back.</p>	*Static; Active; Assisted;	

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Trunk and lower back	Flex 19	<p>Taill wagging</p> 	Kneeling on the floor in the "all-four's" position, looking to the floor or a few meters ahead. With the shoulders still, one hip is moved toward the shoulder as far as possible.	Active	<p>Progression: The athlete can perform the movement while sitting on a Swiss ball. *</p> 
	Flex 20	<p>Semi-leg straddle</p> 	Sitting position, knees flexed about 40 degrees, legs relaxed. Knees are pointed outward. Trunk is leaned forward, with arms extended and reaching ahead.	*Static; Active; Assisted	
	Flex 21	<p>Forward bend</p> 	Standing tall, knees are bent slightly. Upper body is curled and hands grab ankles. While holding on to the ankles, legs are gradually straightened until a stretch is felt in the back of the legs and lower back.	Active	<p>Variation: The body curl can be performed in the sitting position.</p> 
	Flex 22	<p>Cat stretch</p> <p><i>Expiration</i></p>  <p><i>Inspiration</i></p> 	Kneeling on the floor in the "all-four" position, looking to the floor or a few meters ahead. With the shoulders still, trunk is slowly sagged as far as possible, so the back is arched, yet kept relaxed; neck is extended and performer looks up towards the ceiling. The back is then rounded up as much as possible by contracting the lower abdominal muscles, and the head lowered. All motion is initiated from the lower back.	Active	

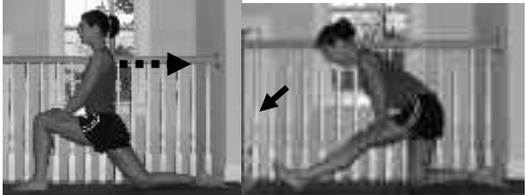
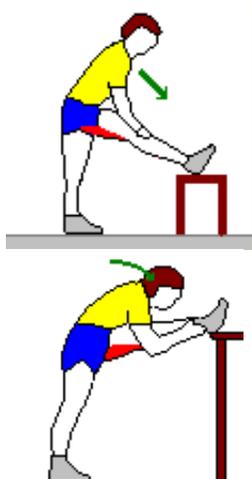
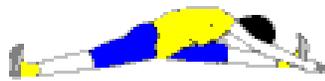
Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Trunk and side of the body	Flex 23	<p style="text-align: center;">Side bend</p> 	<p>Feet separated by about 40 cm. Keeping arms straight and to the side, lean on the side from waist as far as possible.</p>	<p>* Static; Active</p>	<p>Variations: (1) At the beginning of the movement, one arm is extended and fingers point up; arm is flexed and above the head as body is bent. (2) Hands are joined, palms facing each other. Straight arms are raised above head. Keeping arms straight, lean from waist as far as possible.</p> <p>Progressions: (1) Standing or kneeling, side bends are performed with the arms straight above the head, holding a stick in the hands. (2) In the sitting position, side bends are performed with a stick or a light bar placed behind the head; arms are flexed at 90 degrees.</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center;">Progression 1 Progression 2</p>
	Flex 24	<p style="text-align: center;">Side bend with flexed arm</p> 	<p>Feet separated by about 40 cm. One arm is flexed, and the elbow raised above the head; the hand reaches down towards the shoulder of the other arm. Elbow of flexed arm grabbed by other hand. Elbow pulled behind head. Keeping arm bent, lean from waist as far as possible. Knees must not be bent.</p>	<p>Static; *Active</p>	<p>Progression: Lying on the side on top of a Swiss ball, leg extended and placed one in front of the other for support. Side of the body is placed on top of the ball while top arm reaches over and across.</p> 

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Core	Flex 25	<p>Back extension, lying</p> 	Lying face-down, hands are placed directly beneath the shoulders, palms on the floor. While keeping the hips on the floor, upper body is pushed up <i>slowly</i> as high as possible.	*Assisted	
	Flex 26	<p>Shoulder stretch</p> 	Kneeling down on the floor, both arms extended and hands are placed on top of a Swiss Ball, shoulder width apart. The ball is slowly rolled in front of the body as far as possible.	Static; *Active	
	Flex 27	<p>Back extension, kneeling with arm straight</p> 	Kneeling down on the floor, one arm is extended above the head. While keeping the legs on the floor, upper body is brought back <i>slowly</i> as far as possible.	Static; *Active	<p>Progression: Back extension on Swiss ball: sitting on a Swiss ball with feet firmly placed on the ground, body is slowly lowered over the ball; finger tips are touching, and arms raised over the head. Abdominal and back muscles are kept relaxed throughout the stretch.</p> 

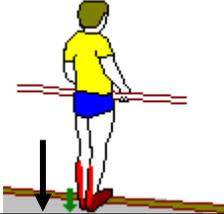
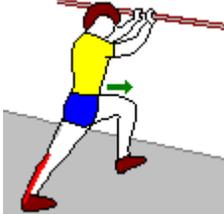
Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Hips	Flex 28	<p>Hip extension</p> 	Lying on the stomach, arms flexed with hands under the chin, legs straight. One leg is lifted slowly, as far high as possible.	*Active	Variation: The leg being raised is flexed at 90 degrees.
	Flex 29	<p>Forward lunge</p> 	Front foot flat to the ground; rear leg straight; back foot pointed in same direction as front foot, rear heel may be left. Torso kept upright. Hands above head, or resting on front leg or hips. Hip slowly lowered forwards and downwards.	*Static; Active	
	Flex 30	<p>Hip stretch while kneeling</p> 	Kneeling down, one leg in front of the body. Rear foot pointing back, leg flat on the floor. Both hands are placed on the knee of the leading leg, or on the hips. Hips are slowly moved forward while keeping upper body straight.	*Active	<p>Variation: Perform the exercise at the bottom of a stairways.</p> <p>Progression: Tilting the pelvis forward will increase the stretch.</p>
	Flex 31	<p>Supine knee flex</p> 	Lying on back, back flattened to the floor by pulling abdominal muscles up and in. One leg is flexed and the knee brought towards the chest. Both hands are placed on leg below the knee. Flexed leg is pulled towards the chest while lower back is kept flat on the floor.	Static; Active; *Assisted	<p>Variations: (1) A towel can be placed behind the knee, and pulled with the hands slowly to increase the range of motion. (2) Both legs can be pulled at the same time.</p> <p>Progression: One leg can be crossed over the leg that is pulled. In this case, hands are placed behind the knee for the pull.</p> 

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Thigh and hip flexors	Flex 32	<p style="text-align: center;">Quadriceps stretch</p> 	<p>Standing, a wall or stationary object is touched for balance. Ankle or forefoot grasped, and heel placed against buttock.</p>	<p>Static; Active; *Assisted</p>	<p>Variations: the athlete may...</p> <ol style="list-style-type: none"> 1. Straighten the hip and move the knee backward to do the stretch. 2. Perform the movement lying down.  <p>Progression: the athlete may...</p> <ol style="list-style-type: none"> 1. Place the forefoot of one leg on a chair or on top of a Swiss ball, and flex the support leg slowly while hip is straightened. 
	Flex 33	<p style="text-align: center;">Kneeling quadriceps stretch</p> 	<p>On the floor, one leg bent and pointing to rear, other leg bent in front of body; heel of front leg touching other knee. Arms straight, hands behind body. Torso leaned backwards slowly. No pain or discomfort must be felt in the knee.</p>	<p>*Static</p>	

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Hamstrings and buttock	Flex 34	<p style="text-align: center;">Sitting toe touch</p> 	<p>Sitting, torso vertical, legs straight. Torso leaned forward, toes grasped with each hand. Toes pulled slightly as torso brought forwards. Position held. Toes released, and movement repeated with ankles. Position held. Still grasping ankles, toes pointed away from body; torso is brought forward as far as possible.</p>	<p>Static; *Active</p>	<p>Variation: Standing hamstrings stretch.</p> <p>Progressions: the athlete may touch the floor with the finger tips, the knuckles, and the palms of the hands</p> 
	Flex 35	<p style="text-align: center;">Semi straddle</p> 	<p>Sitting, torso vertical, legs straight. One leg bent, with sole of foot touching inside of straight leg, and kept as close as possible to floor. Toes grasped, and pulled slightly as torso brought forwards. Position held. Toes released, and movement repeated with ankles. Still grasping ankles, toes pointed away from body; torso brought forward as far as possible.</p>	<p>Static; *Active</p>	
	Flex 36	<p style="text-align: center;">Leg raise</p> 	<p>Lying on back; back flattened to the floor by pulling abdominal muscles up and in. One leg is raised slowly as high as possible while remaining straight, and then slowly returned to the floor.</p>	<p>*Active</p>	

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Hamstrings and buttock	Flex 37	<p style="text-align: center;">Hamstrings stretch, kneeling</p> 	<p>Starting in the lunge position with one knee on the floor, the trunk is slowly brought back until the front leg is slightly bent. Hands are placed on thigh. Back is kept straight and the trunk is flexed slowly forward at the hip.</p>	<p>*Static; active</p>	<p>Progressions: (1) Hands slowly move down towards the foot of the stretched leg as the trunk leans forward as far as possible. (2) Stretch performed in the standing position. Foot of the stretched leg is raised (progress up to hip level). Both legs are kept straight.</p> 
	Flex 38	<p style="text-align: center;">Straddle (spread eagle)</p> 	<p>Sitting, torso vertical, legs straight and spread as far as possible. Toes of one foot grasped by both hands, and pulled slightly. Chest brought towards leg. Position held. Toes released.</p>	<p>*Static; Active</p>	<p>Progression: Begin with toes, then perform the same exercise when grasping the ankles.</p> <p>Variation: Same general procedure but exercise is done while grasping right toes with right hand and left toes with left hand.</p>

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Groin	Flex 39	Standing inner thigh stretch 	Standing, feet well apart, feet pointing forward, hands placed on the hips. One knee is flexed while the other leg is kept straight.	*Active	Variation: The foot of the leg that is flexed points outwards. Progressions: The distance between the feet is increased. Hands may be used to keep balance. 
	Flex 40	Butterfly or lotus 	Sitting, torso vertical, legs straight. Knees flexed and heels brought together. Feet pulled towards body. Hands put on feet, elbows on legs. Torso bent as elbows push legs down gently.	Static; Active; *Assisted	Variations: <ol style="list-style-type: none"> 1. Torso is kept straight, legs move down. 2. Torso is bent, but legs not pushed down by elbows.
	Flex 41	Wide squat 	Standing, feet horse-width apart, toes pointing slightly outwards; hands placed in front of the body with fingers touching. Torso and neck are kept straight. Squat movement is performed, bringing torso slightly forward. Thighs open and seat is lowered as much as possible.	*Active	Progressions: <ol style="list-style-type: none"> 1. Slowly shift weight from one leg to the other, and maintain the position. 2. As seat is lowered, elbows apply pressure at knee level to increase the stretch

Body part	Code	Exercise	Key points during execution	Types of stretch (* type described)	Comments / Variations and Progressions
Calf	Flex 42	<p>Heel drop</p> 	Standing on step or board (8-10 cm). Balls of feet on step or board. Legs kept straight, heeled lowered slowly.	Active; *assisted	<p>Variations:</p> <ol style="list-style-type: none"> 1. Heels lowered with knees slightly bent. 2. Stretched performed one leg at a time.
	Flex 43	<p>Calf wall stretch</p> 	Standing, a wall or stationary object is touched for balance. Feet flat on the floor. Toes of rear foot 20 to 30 cm behind heel of front foot, feet pointing forward. Hips brought slowly ahead.	*Static; active	<p>Variation: Rear leg is bent, and knee moved forward to perform the stretch.</p> 
Ankle and foot	Flex 44	<p>Extension of the foot</p> 	Sitting, one leg crossed over the other and kept parallel to the floor. Fingers grasp toes, and thumb is placed under the foot. Foot and toes are extended slowly by applying force with the hand and the fingers.	*Assisted	
	Flex 45	<p>Ankle rotations</p> 	In the standing position, one heel is raised, and toes are placed on the floor; body weight is supported by other leg. Wide circles are done with the raised heel.	*Active	

Annex 4 – Sample Resistance Training Exercises

Organization and format of the information provided

The following tables present a series of resistance training exercises that are appropriate for the key muscle groups supporting performance in Boxing. These exercises deal with the following body parts: neck, upper back, lower back, shoulders, arms, forearms, fingers, chest, abdomen, trunk, thighs, legs, and calves.

Within each group, exercises can be performed with either:

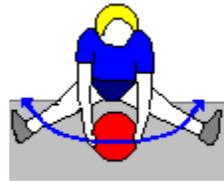
1. the athlete's own body weight (in this case, some equipment such as a Swiss ball may be used); or
2. weights (dumbbells; barbells; machines; etc.) or other forms of devices or equipment designed to increase the resistance when executing a movement (e.g. pulleys, medicine balls, elastic bands, etc.).



Exercise performed using the athlete's body weight



Exercise performed using the athlete's body weight and a Swiss ball



Exercise performed using a Medicine ball



Exercise performed using a machine.



Barbell



Dumbbells

In the tables, some *variations* and *progressions* are also proposed for most exercises.

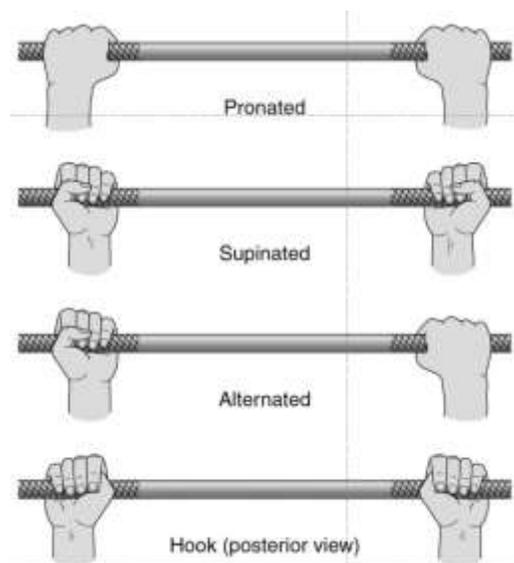
- A **variation** is another, different way of performing an exercise. It may involve the same muscle groups, or additional muscles may be recruited during the movements.
- A **progression** is a more challenging or difficult way of performing an exercise.

Progressions should be introduced after a few weeks of training. Some of the progressions that are described include the use of equipment such as balance boards or other devices that create a balance challenge (e.g. half-round foam rollers; BOSU balls). The use of this type of equipment is highly recommended in boxing to provide increased overloading to muscle groups that are responsible for posture and balance, in particular core and stabilizing muscles. In the tables, an asterisk (*) denotes a higher degree of specificity for the variation or the progression described.

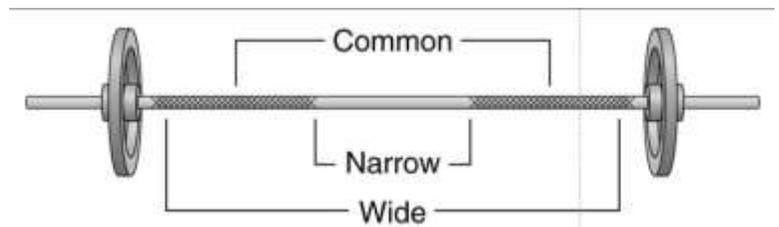
Types of grips

In some exercises, the grip used to hold the bar or the implement, as well as the distance that separates the hands, can impact the way muscles work, and which muscles will work the most.

The figure below shows four types of grips:



The figure below shows where the hands should be placed on the bar for the common (standard) grip, the narrow grip, and the wide grip.



Where necessary, the type of grip to use when executing specific exercises is indicated, in the tables that describe the exercises.

Important

- The guidelines presented in section 8.10 should be followed when performing the exercises. Particular attention must be paid to the recommendations pertaining to the following:
 - type of load,
 - number of repetitions,
 - speed of the movements,
 - number of sets,
 - recovery between sets

These variables have a direct impact on the resulting training effects.

- Resistance training exercises that are performed on one side must always be repeated on the other side, and the same number of repetitions and sets must be done.
- In the case of exercises that are performed with the athlete's own body weight or using equipment such as Swiss balls, the number of repetitions or the time muscles should contract isometrically may be quite variable initially, depending on the fitness level of the athlete. At the beginning of a program, it may be sufficient to perform only one set of 8 or 10 repetitions of an exercise; however, as fitness improves, the number of repetitions may be increased up to 20 or 30 - depending upon the exercise and the objective that is sought - and the number of sets can progress from one to 3. Various methods that can be used to further increase the loading are also outlined with some exercises.
- All the exercises that are described are suitable for developing strength-endurance. Significant strength gains may also result in the muscle groups involved, particularly at the beginning of a program, or in lesser trained individuals.
- Exercises that are appropriate for the development of maximum strength have this symbol **■** besides their name. For safety reasons, spotters should be present when heavy loads are used with free weights.
- Exercises that are appropriate for the development of speed-strength have this symbol **▲** besides their name. Example of plyometric exercises that can be used to develop speed-strength are presented in separate tables at the end of this section.
- There are many more exercises that could be included in a boxer's resistance training program. Coaches should feel free to include additional exercises, or modify those that are described in the following pages depending on the specific needs of their athletes.

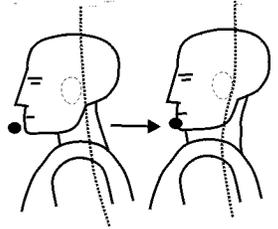
Posture exercises (excerpt from “Golf Training Manual 2009” by G. Wells PhD). Used with permission

Postural exercises should be performed regularly to address potential misalignments.

Chin Tuck

Purpose: To strengthen the erector muscles of the neck and to stretch the muscles at the base of the skull to set the head in proper position.

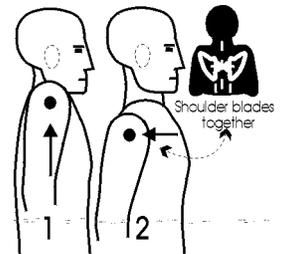
Instructions: Standing tall, simply tuck the chin in by moving the head back over the shoulders. Hold for 5-10 seconds.



Shoulder Mobilization

Purpose: To stretch and strengthen the shoulders to help alleviate rounded shoulders.

Instructions: Standing tall, first lift your shoulders toward your ears and hold that position for 5-10 seconds. Then relax the shoulders back to resting position. The next step is to then contract the muscles between the shoulder blades and pull the shoulders back together as far as possible. Hold this position for 5 seconds and then relax.



Shoulder Strengthening

Purpose: To stretch and strengthen the shoulders to help alleviate rounded shoulders.

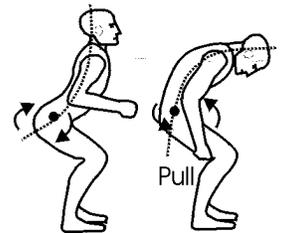
Instructions: Lying in a prone position on a mat, place the arms as indicated in the diagram and squeeze your shoulders together lifting the entire arm off the ground. Keep your forehead on the ground for this exercise.



Spinal Curvature

Purpose: To increase the mobility and range of motion of the spine, and to strengthen the postural muscles.

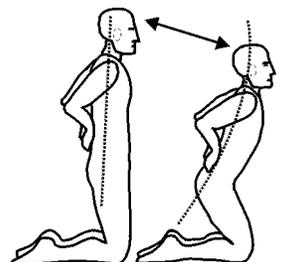
Instructions: Standing in address and bent slightly forward at the waist, begin by extending your back and looking up. Hold this position for 5-10 seconds. Then flex your back forward and to look at your toes. Hold for 5-10 seconds.



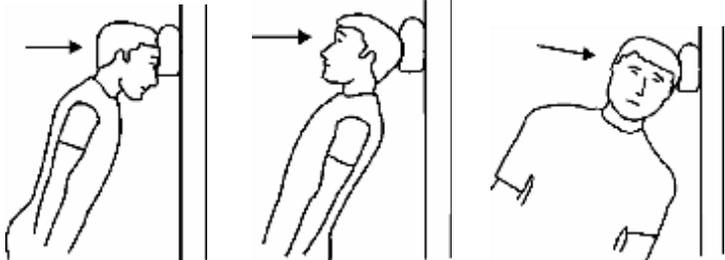
Spine Erector Strength

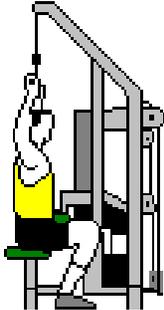
Purpose: To strengthen the muscles that support the spine and to learn balance points for the hip and core muscles while at address.

Instructions: Kneeling as shown in the diagram, place your hands on your lower back and lean forwards gradually as far as possible while maintaining balance. Hold the position for 15-30 seconds.

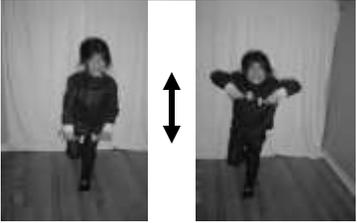
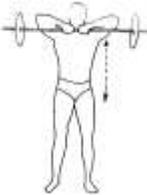


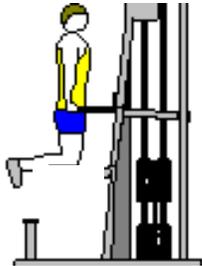
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Neck	RT1	Resisted flexion ■ 	The Set-up: the athlete... <ul style="list-style-type: none"> - Stands erect with the neck and back straight. - Places the palms of the hands against the forehead. The movement: the athlete... <ul style="list-style-type: none"> - Applies pressure with the hands while neck muscles contract isometrically to resist. - Adjusts the pressure according to his/her strength. 	<ul style="list-style-type: none"> - These exercises can be performed while standing or sitting. - These exercises should be preceded by a series of slow rotations of the head. - Exercises aimed at strengthening neck muscles must always be executed in a smooth, controlled manner, and must <u>never</u> be performed with the assistance of another person. - Jerky/bouncing movements must be avoided. - The athlete should breathe normally when performing each exercise. - If pain is felt when performing any of these basic movements, a neck problem may be present, and it may be advisable to consult a specialist.
	RT 2	Resisted flexion (side) ■ 	Same as above, except pressure is applied to the side of the head.	Variations: The athlete may ... <ol style="list-style-type: none"> 1. Place a towel around the back of the head, hold the extremities in each hand, and place the hands in front of the body, slightly narrower than shoulder width apart, to perform exercise RT3. 2. Perform these exercises on a neck machine. 3. Begin the exercises with the head positioned at different angles. Progressions: The athlete may ... <ol style="list-style-type: none"> 1. Maintain isometric contractions for 10 seconds initially, and progress to 30 seconds. Perform 2 or 3 sets of each exercise on each side. 2. Allow the head to move as the resistance is being applied, while keeping the resistance as high as possible. 3. Place a small pillow or folded towel against a wall at head

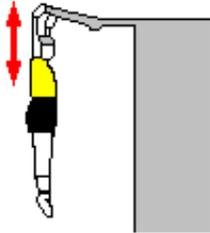
	<p>RT 3</p>	<p>Resisted extension ▣</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Stands straight with the neck and back aligned. - Places the hands behind the head (they can be joined). <p>The movement: the athlete...</p> <ul style="list-style-type: none"> - Tries to extend the neck and move the head back, while muscles contract isometrically to resist. - Adjusts the pressure according to his/her strength. 	<p>height. Then, the head is placed against the support, and the athlete <i>slowly</i> leans against the wall taking the weight onto the neck. The position is held for 10 seconds, and up to 30.</p> 
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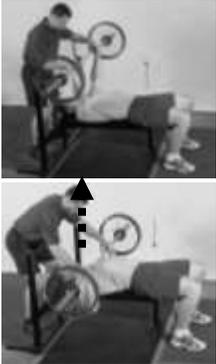
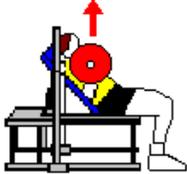
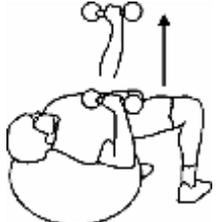
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Neck, shoulders and upper back	RT 4	<p style="text-align: center;">Shoulder shrugs</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - In the standing position, holds a dumbbell in each hand, arms dangling at the sides. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Tenses the shoulders and the neck, then raises the shoulders as high as possible toward the ears while keeping the arms straight at the sides. - Holds the position for 2 seconds. Slowly lowers the shoulders back to the initial position. 	<p>The athlete must hold the same weight in each hand.</p>
	RT 5	<p style="text-align: center;">Lat pull down ▣</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - In the sitting position, anchors the upper thighs under the restraint bar of a lat pull-down exercise machine - Grasps the bar with a pronated grip (palms facing the front) about 10 to 15 cm wider than the shoulders. The arms are fully extended, and the torso is kept erect. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Uses the muscles of the upper back, to pull down the bar in front of the head until it touches the upper chest. As the bar is being pulled down, the upper body is angled about 20 degrees toward the back. - Returns the bar to its starting position slowly and under control, with the trunk returning to an upright position. 	<ul style="list-style-type: none"> - The athlete exhales as the bar is lowered against resistance, and inhales as the bar rises to the starting position. - The movement is initiated with the arms; leaning back and jerking the weight must be avoided. - The athlete may consider using wrist straps if the forearms are weak or the elbow flexors tire before the upper back. <p>Variations: The athlete may...</p> <ul style="list-style-type: none"> - Use a narrow grip; it forces greater elbow flexion and increases the load on the shoulder extensors. - Use a narrow supinated grip (palms towards the body); it helps develop the biceps brachii - Angle the torso back <i>before</i> initiating the movement; this increases the load on the scapula retractors and recruits the lower back muscles isometrically.

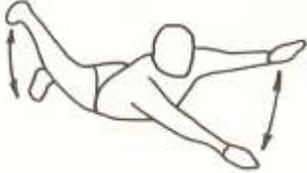
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Shoulders and upper back	RT 6	<p style="text-align: center;">Cable row</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Sits down at the cable-row machine or on the bench in front of a pulley, places the feet on the footrest, bends the legs at the hips and knees, and grasps the handle. - Slides the buttocks back on the seat until the back is straight and the knees are slightly bent; this relieves pressure on the lower back. - Has the arms straight, and there is a slight stretch in the shoulders before starting the movement. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Flexes the arms and retracts the shoulder blades to pull the handle toward the lower rib cage. - Keeps the back straight and the elbows close to the side of the body during the pull. - Focuses on keeping both shoulder blades retracted as the pull finishes. - Maintains the torso upright or leaning back slightly when the handle touches the abdomen; elbows should be behind the body at this point. - Returns the handle to its starting position slowly and under control; the arms should be straight at the end of this phase. 	<ul style="list-style-type: none"> - The movement is initiated with the arms; leaning back and jerking the weight must be avoided. - The athlete exhales when pulling the handle, and inhales during the return phase. - The athlete should look ahead during the movement. <p>Variations: The athlete may perform the exercise...</p> <ol style="list-style-type: none"> 1. In the standing position. 2. With a handle in each hand. * 3. With a handle in each hand, the feet shoulder-width apart, and the knees flexed, as in the boxing stance. * 4. With a handle in each hand or in one hand only, sitting on a Swiss ball <p>Progressions: The athlete may perform the exercise...</p> <ol style="list-style-type: none"> 1. With a handle in each hand, the feet shoulder -width apart, the knees flexed in the half-seat position, and with the feet placed on a half rounded foam roller. The athlete must focus on maintaining balance while standing on the rollers and executing the movement. * 2. Same as above, but with the feet placed on a tilt board. Alternatively, each foot can be placed on a tilt board. The body will be pulled forward when the handle is pulled toward the body; the hips should be pushed backwards to cancel out this effect.* <div style="display: flex; justify-content: space-around; align-items: center;"> <div data-bbox="1213 1101 1430 1365" style="text-align: center;">  </div> <div data-bbox="1583 1112 1799 1365" style="text-align: center;">  </div> </div>
		Half rounded foam rollers	Tilt boards	

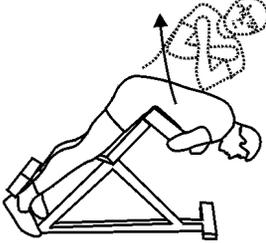
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Shoulders and upper back	RT 7	<p>Upright row on one leg</p>   <p>Variation 2</p>	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Holds a dumbbell in each hand and places them in front of the body, with the inside of the hands against the upper thighs. - Flexes one leg, and stands on one foot. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Pulls the dumbbells straight up toward the chin (not sideways) while maintaining the trunk upright; the elbows are higher than the shoulders at the end of the lift. - Holds the position for 2 seconds. - Lowers the dumbbells slowly to the initial position. 	<ul style="list-style-type: none"> - The movement must be repeated standing on the other leg. - The athlete exhales when lifting, and inhales during the return phase. - The athlete should look ahead during the movement. <p>Variations: The athlete may perform the exercise...</p> <ol style="list-style-type: none"> 1. With both feet on the floor. 2. With both feet on the floor using a barbell instead of dumbbells. 3. With dumbbells, both feet on the floor and shoulder-width apart. * <p>Progressions: The athlete may perform the exercise...</p> <ol style="list-style-type: none"> 1. With the heel of the supporting leg raised. * 2. With the foot of the supporting leg on a tilt board. *
	RT 8	<p>Bent over row with one arm</p>   <p>Variation 2</p>  <p>Variation 3</p>	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Holds a dumbbell in one hand, and hangs the arm straight down with the palm facing the thigh. - Flexes the opposite leg and puts it on an exercise bench. - Bends forward at the waist until the torso is almost parallel to the floor, and places the hand on the bench for support, keeping the arm straight. - Looks straight down at the floor, or a few meters in front. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Pulls back the shoulder, then continues pulling the dumbbell up until it reaches the side of the body. - Holds the position for 2 seconds. - Lowers the dumbbell slowly to the initial position. - Keeps the back straight throughout. 	<ul style="list-style-type: none"> - The movement must be repeated with the other arm, standing on the other leg. - The athlete exhales when lifting, and inhales during the return phase. <p>Variations: The athlete may perform the exercise...</p> <ol style="list-style-type: none"> 1. Using a Swiss ball or a BOSU ball instead of a bench for support. 2. With both arms, using an inclined bench. 3. With one knee flexed and placed on top of a BOSU ball, the other leg extended and pointing to the rear. The rowing arm is on the same side as the supporting knee and the other arm is extended, palm of the hand on the floor, for support. 4. With both feet on the floor, shoulder-width apart, the trunk flexed the knees slightly bent and one hand on top of a Swiss ball for support. The arm holding the dumbbell hangs straight down, and the back of the hand holding the weight faces the front. The shoulder is pulled back, and the dumbbell is pulled up, with the elbow pointing away from the body. <p>Progression: Heavier dumbbells may be used.</p>

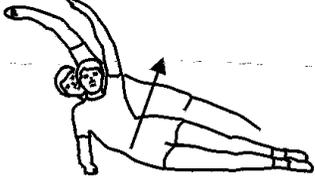
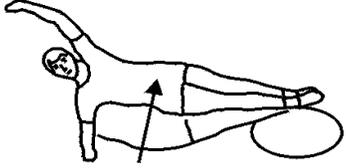
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Arms, shoulders, and chest	RT 9	<p>Push up ▲</p>  <p>From the knees if initial upper-body strength is low</p>	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Positions the hands on the floor and slightly more than shoulder-width apart. - Spreads the fingers out and points them forward; it increases the base of support. - Keeps the arms straight, with a slight bend at the elbows. - Keeps the neck, torso and the lower limbs in a straight line. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Lowers the whole body under control until the arms are flexed to 90 degrees. - Does not bounce at all in the bottom position. - Pushes the whole body upward smoothly by pressing evenly with both arms. - Stops short of elbow lockout during the ascent; it keeps tension on the triceps. - Inhales on the descent, and exhales on the ascent. 	<ul style="list-style-type: none"> - The body forms a straight line throughout. The hips and shoulders must ascend at the same time. The head is kept in a neutral position throughout the movement. - Tightening the abdominal muscles helps keep the body aligned. - The chest comes close to the ground at the bottom of the descent. <p>Variations: the athlete may perform the exercise with the...</p> <ol style="list-style-type: none"> 1. Hands wider apart (up to 80 cm); it increases the load on the pectoralis major. 2. Hands positioned so that they almost touch; it increases the recruitment of the triceps. 3. Feet on a raised surface: it shifts the load to the upper portion of the pectoralis major. <p>Progressions: the athlete may perform the exercise ...</p> <ol style="list-style-type: none"> 1. From the knees, if he or she does not have enough upper-body strength for regular push ups initially. 2. With the hands grasping a small medicine ball. 3. With the feet on a Swiss ball (normal, wide, narrow set ups). 4. See also plyometric push ups at the end of this section.
	RT 10	<p>Parallel Bar Dips ▣</p> 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Grasps the bar so that the hands are shoulder-width apart. - Using the legs, pushes the body into the starting position with the arms fully extended. - If the parallel bars are not very high off the floor, bends the knees to ensure that the feet do not touch the floor on the descent. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Lowers the body under control and steadily by flexing the arms. - Raises the body by straightening the arms. - Keeps the torso upright throughout. 	<ul style="list-style-type: none"> - The athlete inhales on the descent, and exhales during the ascent. - The athlete must not bounce at the bottom of the descent; it can lead to shoulder injuries. - To ensure a full range of motion, the forearms must contact the upper arms in the bottom position. - The ascent stops short of full elbow lockout. <p>Variation: The athlete may keep the elbows out at the sides; it increases the load on the pectoralis major.</p> <p>Progression: A dumbbell may be placed between the knees to increase the resistance.</p>

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Arms and shoulders	RT 11	<p>Chin-ups ■</p> 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Grasps a bar in a supinated grip (palms towards the body). - Positions the hands shoulder-width apart. - Fully extends the arms, with the torso in line with the upper arms. - If necessary, bends the knees so the feet don't touch the ground. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Simultaneously leans back and pulls with the arms to pull the body toward the bar. The elbows are down and back. - Continues the ascent until the chin clears the bar. - Descends until the trunk is in an upright position, the arms are fully extended, and the shoulder blades are elevated. - Inhales during the ascent, and exhale on the descent. 	<ul style="list-style-type: none"> - The athlete must move slowly and under control, and must not bounce at the bottom of the descent. - Athletes who have weak forearms and risk losing their grip should wear wrist straps. - The upper arms and scapula adductors must be stretched at the bottom of every repetition; it completes the range of motion. - The legs should stay in line with the torso as much as possible. - There should be no flexion of the hips. <p>Variations: the athlete may...</p> <ol style="list-style-type: none"> 1. Use a narrow grip; it increases the load on the shoulder extensors. 2. Lean at the torso; leaning back through the entire movement increases the load on the scapula retractors. In this variation the lower portion of the chest touches the high bar. 3. Use a narrow pronated grip (palms facing the front); it increases the load on the brachialis and brachioradialis muscles. <p>Progressions:</p> <p>The chin-up requires a certain amount of strength. Athletes who don't have the required strength level may use the following progressions:</p> <ol style="list-style-type: none"> 1. Hang from the chin-up bar with the knees bent so that a spotter can provide support by grasping both feet. 2. Then, the spotter provides support by grasping only one ankle. 3. Then, the spotter provides support by grasping the athlete at the waist and providing only enough assistance for the athlete to clear the bar. 4. Athletes who are well-trained and need additional resistance may hold a dumbbell between the ankles.

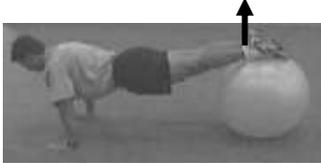
Body part	Code	Exercise	Comments / Variations and Progressions	Body part
Arms, shoulders, and chest	RT 12	<p>Bench press ■ ▲</p>   <p>Variation 2</p>  <p>Variation 4</p>	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Lies on the bench so that the eyes are directly under the bar. - Positions the hands shoulder-width apart on the bar. The hands must be evenly spaced on the bar relative to the centre of the bar. - Places the feet so that the heels are directly under the knees. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Lowers the bar in a semi-arc to mid-chest, keeping full control at all times, making contact with the chest about 4 cm above the nipples; the bar is not bounced on the chest. - Keeps the wrists in a neutral position throughout the movement. - Keep the upper back and buttocks on the bench at all times. - Initiates raising the bar by pressing up smoothly, applying pressure evenly with both arms. - Raises the bar until the elbows are extended, but not locked. - Uses the feet to maintain balance during the movement. - Repeats the movement at a controlled and even speed to perform the desired number of repetitions. - Inhales while lowering the bar, and exhales while raising the bar. 	<ul style="list-style-type: none"> - The elbows should move under the bar toward the top of the lift. - The last repetition should have the same form as the first, and the bar must contact the same spot on the chest. - Use a spotter to help maintain form when completing repetitions; the spotter should help move the weight into the starting position and make sure the weight returns to its rack after the set is over. <p>Variations: the athlete may...</p> <ol style="list-style-type: none"> 1. Use different grips. A wide grip increases the load on the pectoralis major. A narrow grip increases the load on the triceps. 2. Use an incline bench. It shifts the overload on the upper portion of the pectoralis major. 3. Use dumbbells; it develops strength through a greater range of motion and ensures equal loading on both arms. Rotate the dumbbells inward during the press using the shoulders, not the elbows and wrists. 4. Use dumbbells, and perform the exercise with the back supported by a Swiss ball. <p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Perform the exercise on a machine initially, as it is safer and easier. 2. Boxers do not have to lift extremely heavy weights to benefit from this exercise. Initially, a load that corresponds to 40% or so of the athlete's body weight should be used, and 10 to 12 repetitions should be performed. This should not be very demanding. 3. After a few weeks, the resistance should be such that the last 2 or 3 repetitions should now begin to feel fairly demanding, though extra reps should still be possible. 4. Once the athlete has become familiar with the exercise and is capable of performing the bench press with good form throughout using moderate weights, loads corresponding to 12, 10 and 8 RMs could then be used.

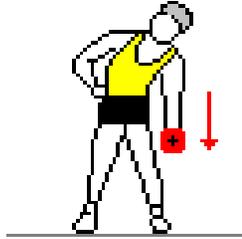
Body part	Code	Exercise	Comments / Variations and Progressions
Lower back	RT 13	<p>Back arches, lying</p> 	<p>The exercise can be repeated 10 to 15 times.</p> <p>Variation 1: Exercise is performed on a BOSU ball. Arms can be placed along the body, or crossed over the chest.</p>  <p>Variation 2: Ball balance, both hands on the floor. Position the ball under your abs and hips, hands on the floor and legs straight and off the floor. Hold that position for 20 to 30 seconds, keeping your body in a straight line, abs pulled in.</p>  <p>Variation 3: As above, but one arm is slowly raised to the side, Care must be taken not to roll or allow any part of the body to collapse. The position is held and the movement is repeated with the other arm.</p>
	RT 14	<p>Back hyperextension with arm and leg movements</p> 	<p>The movement must be repeated with the other leg and arm.</p> <p>Variation: The athlete may perform the exercise on a Swiss ball, stabilizing the body by placing the abdomen on top of the ball, and keeping opposing hand and foot in contact with the floor.</p>  <p>Progressions: the athlete may ...</p> <ol style="list-style-type: none"> 1. Begin with 8 to 10 repetitions or so on each side, and move up to 15 or more. 2. Progress from 1 to 3 sets.

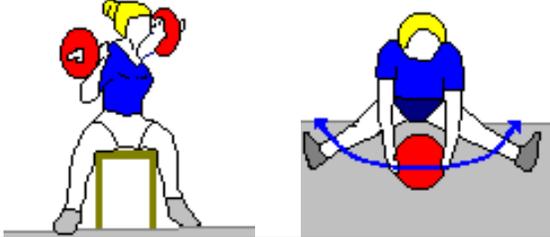
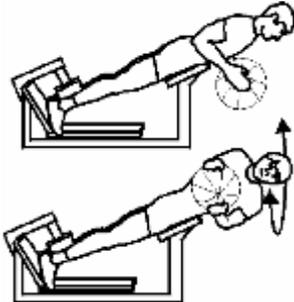
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Lower back	RT 15	<p style="text-align: center;">Back extension</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Takes position on a back extension rack, with the feet firmly anchored. - Crosses the arms over the chest, and bends forward slowly. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Slowly unrolls the back and raises the torso until the body is in a straight line. The movement begins by tightening the hamstrings (upper back of the legs), then the gluteus muscles (bum), then the lower back, and finally the upper back. - Returns to the original position and repeats. 	<p>Variations: The athlete may...</p> <ol style="list-style-type: none"> 1. Once the back is straight, perform a rotation of the torso to one side, then the other. 2. Perform the exercise with the hands placed on each side of the head, as opposed to cross over the chest.  <ol style="list-style-type: none"> 3. Perform the exercise using a Swiss ball; in this case, the feet must be tucked against a wall for stability. <div style="display: flex; justify-content: space-around;">   </div> <p>Progression: the athlete may...</p> <ol style="list-style-type: none"> 1. Progress from 10 to 15 repetitions, and from 1 to 3 sets. 2. Use a medicine ball or a dumbbell to increase the resistance.

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core	RT 16	<p style="text-align: center;">Pelvic raise</p> 	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Lies on the back, knees flexed at 90 degrees or so, arms extended along the body. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - Raises the pelvis by pressing through the heels (not the toes) until the trunk and the thighs form a straight line. - Holds for 3 to 5 seconds, and slowly returns to the initial position. 	<p>Variations: The athlete may perform the exercise on a Swiss ball.</p> <p>(1) With the back resting on the ball and the trunk inclined at 45 degrees, the hips are raised so that the head, neck, torso and thighs form a straight line.</p>  <p>(2) Lying down, back, hips, and arms on the floor, heels resting on the ball. Keeping the abdominal muscles tight, the hips are slowly lifted off the floor until body is in a straight line. The position is held for 3 to 5 seconds, before slowly returning to the initial position.</p>  <p>Progressions:</p> <ul style="list-style-type: none"> - Weights can be held on the hips for added resistance. - For variation 2 above, one leg can be taken off the ball once the hips are lifted. - Progress from 10 to 15 to 20 repetitions, and from 1 to 3 sets.
	RT 17	<p style="text-align: center;">Side raises</p> 	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Lies on the side, with the lower arm flexed and placed on the floor for support, the other on the side of the body. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - Lifts the hips as high as possible off the floor, and extends the non-supporting arm above the head. 	<p>Variation:</p> <p>Progression: The athlete may perform the exercise on a Swiss ball.</p> <p>Progress from 10 to 15 repetitions, and from 1 to 3 sets.</p> 

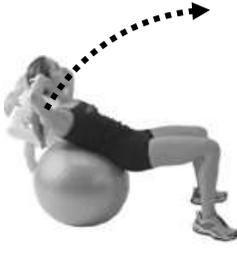
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core	RT 18	<p style="text-align: center;">Plank</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Lies on his or her stomach with the body in a straight line and the tip of the toes touching the floor. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Places the hands and elbows on the ground in “prayer” position. - Raises the body off the ground using the arms and toes as pivot points. - Keeps the body in a straight line and perfectly still. 	<p>The athlete must breathe throughout the exercise.</p> <p>Progressions: the athlete may perform the Plank with some weight placed on the back or buttock.</p>
	RT 19	<p style="text-align: center;">Side plank</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Lies on his or her stomach and assumes a push-up position. - Extends both arms to be in the “up” position. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Shifts the weight to one arm and leg, and performs a quarter rotation of the body to one side. - Keeps the supporting arm extended and locked; the other arm may be raised or kept to the side. - Keeps the body in a straight line and perfectly still. 	<p>The athlete must breathe throughout the exercise.</p> <p>Variation: The athlete may perform a “star plank” by raising an arm and a leg.</p> 

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core	RT 20	<p>Plank on Swiss ball</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Lies with the stomach on a Swiss ball, with the feet touching the floor behind the ball. - Leans forward to touch the floor with the hands. - Places the hands shoulder width apart, and looks straight down. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - Walks the hands away from the ball until the ball reaches the upper thighs. The feet will be suspended, and the athlete will be balancing on the hands and the ball. - Keeps the shoulders directly above the hands and tighten the abdominal muscles. - Returns to the start position and repeats. 	<p>Once the position is assumed, the athlete should hold it for 3 to 5 deep breaths.</p> <p>Progressions: the athlete may...</p> <ul style="list-style-type: none"> - Hold the position longer. - Work the ball down to the shins, forefoot (shown), or place the tip of the toes on top of the ball.  <ul style="list-style-type: none"> - Raise one leg while assuming any of the above positions. 
	RT 21	<p>Plank with Hip Twists</p>  	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Gets into a push-up position with the feet on top of a Swiss ball. - Moves the feet apart towards the side of the ball, turning the ankles so that he or she has some grip on the ball with the feet. - Holds the body in a straight line with the legs straight and hands placed directly under shoulders. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Slowly twists the ball to one side, then the other, while keeping the shoulders as level as possible. 	<ul style="list-style-type: none"> - The athlete must not sag in the middle. <p>Progressions: the athlete may increase the...</p> <ul style="list-style-type: none"> - Amplitude of the twists. - Speed of the movements.

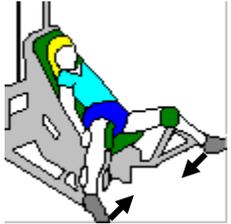
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core – side of the body	RT 22	<p>Side flexions with dumbbell</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Stands erect with the feet slightly less than shoulder width apart. - Holds a dumbbell in one hand, and places the other hand to the hip or to the side. - Focuses on a point on the wall slightly above eye level. <p>The movement: the athlete...</p> <ul style="list-style-type: none"> - Slowly bends to the side of the hand holding the dumbbell. - Lowers the weight as much as possible without losing balance. - Slowly returns to the initial position. 	<ul style="list-style-type: none"> - The athlete must not twist or bounce during the movement. - The spine must remain as straight as possible. <p>Variation: The exercise can be performed with the feet closer.</p> <p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Increase the weight of the dumbbell. 2. Perform the exercise on a half-round foam roller for a less stable stance. 3. Stand on the flat side of a foam roller.
	RT 23	<p>Side flexions with medicine ball</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Sits on a bench or a Swiss ball with the back straight, a medicine ball on his or her lap. - Places the feet shoulder width apart and flat on the floor for balance. <p>The movement: The athlete...</p> <ul style="list-style-type: none"> - Slowly lifts the ball and places it above the head. - Slowly moves the ball from side to side as far as possible. - Remains balanced throughout. 	<p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Sits on a chair or a bench initially, and then progress to a Swiss ball. 2. Use a heavier medicine ball. 3. Hold the ball above the head, and perform progressively larger circles with the hands.

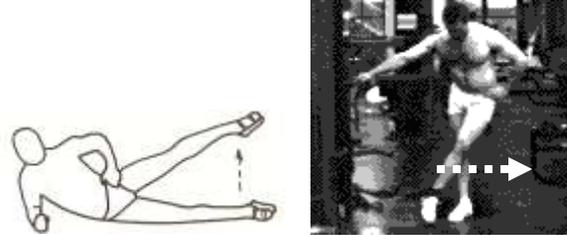
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core	RT 24	<p style="text-align: center;">Trunk rotations</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Stands erect with the feet shoulder width apart and flat on the floor for balance. - Places a barbell behind the neck and across the shoulders. - Positions the hands on the bar so that the arms are flexed approximately 90 degrees. <p>The movement: The athlete...</p> <ul style="list-style-type: none"> - Slowly rotates the shoulders and the trunk as far as possible in one direction. - Holds the position for 2 seconds. - Repeats the movement in the opposite direction. 	<p>The movement must be smooth throughout.</p> <p>Variations: the athlete may perform the exercise...</p> <ol style="list-style-type: none"> 1. Sitting on a bench. 2. Sitting on the floor with the legs open, and move a medicine ball from side to side. <p>Progressions: The athlete may use only a bar initially, and increase the resistance progressively by adding weight.</p> 
	RT 25	<p style="text-align: center;">Rotations to the side</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Takes position on a back extension rack with the feet solidly anchored. - Raises the upper body so the head, trunk and legs are in line. - Holds a medicine ball in front of the body with the arms flexed at 90 degrees. <p>The movement: The athlete...</p> <ul style="list-style-type: none"> - Slowly rotates the upper body from one side to the other. 	<ul style="list-style-type: none"> - The athlete must keep the back straight throughout the exercise, and must perform smooth rotations. <p>Progressions: The athlete may increase the resistance progressively by using a heavier medicine ball.</p>

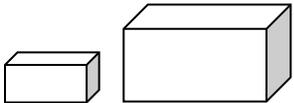
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core	RT 26	<p>Counter rotations</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Stands with the feet shoulder width apart, with the knees slightly flexed. - Holds a medicine ball in front of the body, with the elbows flexed at 90 degrees. - Focuses on a point on the wall slightly above eye level, to maintain proper neck alignment. <p>The movement: the athlete...</p> <ul style="list-style-type: none"> - Slowly rotates the head, the trunk and the ball to one side while turning the hips on the other side. - Stops, and hold the position for 2 seconds. - Returns to the starting position, and performs the movement on the other side in a smooth, continuous motion. 	<ul style="list-style-type: none"> - The legs and the feet should remain still throughout the movement. <p>Progressions: The athlete may ...</p> <ol style="list-style-type: none"> 1. Perform the exercise on a tilt board. 2. Increase the resistance progressively by using a heavier medicine ball.
	RT 27	<p>Russian twists with Swiss ball</p>  <p style="text-align: center;">Variation 2</p>	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Lies with the shoulders on a Swiss Ball, legs bent at 90 degrees. - Extends the arms over the chest, with the tips of the fingers touching. <p>The movement: the athlete...</p> <ul style="list-style-type: none"> - Slowly rotates the shoulders to one side while keeping the arms straight, until they are parallel to the floor. - Returns to the starting position, and performs the movement on the other side. 	<p>Variations: The athlete may...</p> <ol style="list-style-type: none"> 1. Perform the exercise with the torso in the upright position, the back lying flat against a wall, the knees flexed at 90 degrees, the feet shoulder width apart, and a small medicine ball between the thighs. The quadriceps muscles contract isometrically to maintain the position. * 2. Do as above, but place a Swiss ball between the wall and the back.* <p>Progressions: The athlete may...</p> <ol style="list-style-type: none"> 1. Increase the resistance by holding a light dumbbell or a small medicine ball with the hands 2. Increase the resistance further by using a heavier dumbbell or medicine ball.

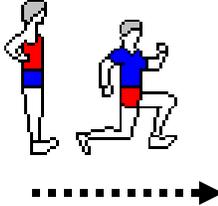
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core (abdominal muscles)	RT 28	<p>Crunches</p> 	<p>The Set-up</p> <ul style="list-style-type: none"> - Lie on the floor. - Bend the knees slightly more than 90 degrees, and place the feet flat on the floor. - Turn the feet in, with the big toes touching each other (optional). - Keep the chin on the chest. <p><i>Note: The hand position varies with the progression.</i></p> <p>The Movement</p> <ul style="list-style-type: none"> - Contract the hamstrings isometrically by pressing down on the floor with the heels. - Use the upper abdominal muscles to crunch the torso. This forces the shoulders toward the legs and shortens the torso. - Continue the ascent until a 40-45-degree angle is achieved. Do NOT go beyond 45 degrees. - Return to the starting position, keeping the back rounded and the chin on the chest. 	<ul style="list-style-type: none"> - Exhale during the ascent, and inhale during the descent. - Keep the pelvis tilted and the lower back flat on the ground. - Smooth, steady movements are the key to this exercise. There must be no bouncing on the ground at the bottom of the descent. <p>Progressions (from easier to more difficult): the athlete may ...</p> <ul style="list-style-type: none"> - Keep the hands at the sides. - Cross the hands on the chest. - Place the fingertips on the temples or on the forehead (as shown). - Position the hands behind the head. - Extend the arms back, and keep them behind the body. <p>Variations: the athlete can ...</p> <ol style="list-style-type: none"> 1. Add twisting motions. 2. Pause during the movement; it negates momentum and increases the difficulty. 3. Begin the exercise with the legs elevated and parallel to the floor, then slowly raise the head and the upper back, and touch opposite knee with the elbow 4. Perform the exercise on a Swiss ball. 5. Perform twists while doing the exercise on a Swiss ball. 6. Place a ball between the knees and squeeze the legs together to hold it. Keeping the lower back on the floor, the heels are lifted as high as possible, with the knees still bent. The position is held for 3 to 5 seconds, and the ball is lowered (see below).
			<div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>Variation 3</p> </div> <div style="text-align: center;">  <p>Variation 4</p> </div> <div style="text-align: center;">  <p>Variation 5</p> </div> <div style="text-align: center;">  <p>Variation 6</p> </div> </div>	

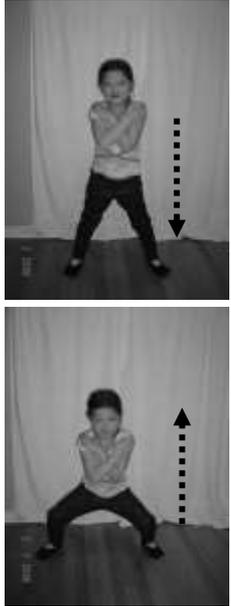
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Core (abdominal muscles)	RT 29	<p>Leg raises</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Lies in the back on an incline board or on the floor. - If an inclined board is used, grasps the handle above the head and lock the arms; if lying on the floor, extends the arms, and places the palms of the hand on the floor. - Makes sure the big toes are touching; it fully recruits the abdominals. - Flexes the hips so that the thighs are at a 45 degree angle (floor) or vertical (board). - Keeps the chin on the chest throughout the movement. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Moves the thighs upward in a semi-circular arc until the feet are directly above the hips. - Slowly returns the legs to the starting position. 	<p>Keep the elbows locked at all times; it prevents the arms and shoulders from assisting in the movement.</p> <p>Breathing: Inhale as the legs are pulled upward, and exhale as the legs are lowered</p> <p>Variation: The athlete can twist during the movement to involve the obliques.</p> <p>Progressions: The athlete may...</p> <ul style="list-style-type: none"> - Use an inclined board, or increase the slope of the board. - Increase the resistance by holding a light dumbbell between the feet, or by wearing ankle weights. - Perform the exercise from a chin-up bar.
	RT 30	<p>Leg pushes</p> 	<p>The Set-up: the athlete...</p> <ul style="list-style-type: none"> - Lies on the floor with the back flat and the arms placed along side the body. - Raises the legs so they form an angle of 90 degrees with the body. A partner whose feet are positioned near the athlete's shoulders and on each side of his/her head gently grabs the toes. - Bends the knees slightly. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - The partner pushes on the athlete's feet; the push must be straight ahead. - The athlete allows his or her legs to go down, but resists the gravity, decelerating the legs gradually until they are brought gently in contact with the floor. - The athlete slowly raises the legs back to the starting position. 	<ul style="list-style-type: none"> - The athlete must keep the legs extended with a slight bend throughout. - The partner may count down before the push. <p>Variation: The athlete may perform the exercise with the legs shoulder width apart.</p>

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Inner thighs - adductors	RT 31	Ball squeezes 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Sits on a bench, the feet on the floor, the legs parallel, and the back straight. - Places a ball whose diameter is approximately 25-30 cm between legs, so the inner thighs are against the ball. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Squeezes the ball with the inner thighs and holds for 5 seconds - Relaxes for 5 seconds, and repeats 10 to 15 times 	<p>The athlete must breathe throughout the exercise.</p> <p>Variation: The athlete may use different size balls.</p> <p>Progression: The athlete may use a small ball initially, and progress until the legs are shoulder width apart.</p>
	RT 32	Adduction of the leg using a pulley	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Attaches a cable cuff around the ankle of the working leg. - Raises the working leg to the side at an angle of approximately 30 degrees, keeping it straight, and shifts the weight on the other; while in this position, the cable of the pulley should be tight, but the weight should not be lifted yet. - Stands erect with the hands on the hips, or holding on to an object for balance. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Brings the working leg towards the supporting leg in a controlled, sweeping motion, and stops when the foot crosses the body. - Holds the position for 2 seconds, and returns slowly to the initial position. 	<p>The athlete must keep the hips stable and square throughout the movement, and avoid upper body movements.</p> <p>Variation: The exercise can be performed using an elastic band.</p>
	RT 33	Adduction of the legs on a inner thigh machine 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Positions him/herself on the machine, with the legs well apart; depending on the machine, a pad should be in contact with the inside each leg a few centimetres above the knee, and/or along the inside of the leg. - Sits with the back against the back rest; the lower back should be arched. - Grasps the handles of the machine for stability during the movement. <p>The Movement</p> <ul style="list-style-type: none"> - Squeezes the legs together in a slow, controlled movement. - Slowly allows the legs to move apart and return to the initial position while keeping control of the movement. 	

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Hip extensors	RT 34	Abduction of the leg 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Stands up with the back straight. - Puts the feet close to each other, or positions the working leg so that it slightly crosses the other over. - Put the hands on the hips, or holds on to an object for balance. - Focuses on a point slightly above eye level; this maintains proper body alignment. <p>The Movement</p> <ul style="list-style-type: none"> - Keeps the working leg straight, and slowly elevates it to the side as high as possible. - Holds the position for 2 seconds. - Returns the leg slowly back to the initial position. - The athlete must keep the body still throughout, and avoid side movements with the hips. 	<p>Variation: The athlete may perform this exercise laying on the side, with one arm flexed and used for support, the other to the hip.</p>  <p>Progressions: To increase the resistance the athlete may:</p> <ol style="list-style-type: none"> 1. Use ankle weights or an elastic band. 2. Use a pulley system, cross the working leg in front of the supporting leg, and raise it to the side in a sweeping motion. At the beginning of the movement, the cable of the pulley should be tight, but the weight should not be lifted yet.
	RT 35	Abduction of the leg on a outer thigh machine 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Positions him/herself on the machine, with the legs together; depending on the machine, a pad should be in contact with the outside each leg a few centimetres above the knee, and/or along the outside of the leg. - Sits with the back against the back rest, ensuring the lower back is arched. - Grasps the handles of the machine for stability during the movement. <p>The Movement</p> <ul style="list-style-type: none"> - Pushes outward to separate the legs to the sides as far as possible. - Slowly allows the legs to return to the initial position. 	<p>The movement must be performed slowly and under control.</p> <p>Variation: The athlete may perform the exercise leaned back on the floor, with a rubber band strapped to the ankles, the band providing the resistance.</p>

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
	RT 36	<p>Single-leg step-ups ▣</p> 	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Faces a box, bench, or step; points the toes slightly outward, and places a foot on the step. - Maintains an upright, relaxed posture, with the chin slightly up. - Focuses on a point on the wall slightly above eye level, to maintain proper neck alignment. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - Climbs up on the bench as smoothly as possible, keeping the trunk as erect as possible throughout the movement. - Does not let the back leg contact the step, and keeps the back leg slightly flexed at the hip. - Stops the step-up leg just short of knee lockout. - Bends the step-up leg to initiate the descent. - Descends slowly and steadily, and slightly flex the knee of the back leg; this absorbs the descent on landing. - Bends the knee slightly as the foot of the back leg contacts the ground. 	<ul style="list-style-type: none"> - The athlete must inhale on the descent, and exhale on the ascent. - The same number of repetitions and sets must be performed for each leg. - When introducing the exercise, do NOT use a barbell or weights; focus exclusively on correct technique. - The lower back and abdominals must not be fatigued at the start of the exercise. - The athlete should keep the hips under the shoulders as much as possible during the movement. - During the ascent, the knee should NOT move in toward the midline of the body. <p>Variations: The athlete may...</p> <ol style="list-style-type: none"> 1. Step onto a BOSU ball instead of a box bench, or step. 2. Vary the height of the step; it recruits different muscle groups. A higher step involves the hamstrings and calf muscles more, and a lower step involves the inner quadriceps more. 3. Stand approximately 60 cm to the side of the step (shoulders parallel to the step), with one foot on the middle of the step, and perform a lateral step up. <p>Progressions: The athlete may...</p> <ol style="list-style-type: none"> 1. Start with a low step, and increase the height as strength improves. 2. Perform the exercise with a weighted barbell across the shoulders and behind the neck. 3. Increase the resistance on the barbell progressively.
			 <p>Progression 1</p>	 <p>Progression 2</p> <p>Variation to progression 2: The athlete may hold the barbell in front of the torso; it increases the involvement of the quadriceps.</p>

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
	RT 37	<p>Lunge</p> 	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Stands upright, feet shoulder width apart. - If used, holds the weighted bar behind the neck, in such a way that it contacts the thickest area of the trapezius. - Focuses on a point on the wall slightly above eye level; this helps maintain proper neck and chin alignment. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - Keeps the torso upright, takes a step forward. - Contacts the ground with the heel of the leading foot, and transfers quickly the weight to the entire foot; as a result, most of the weight will now be on the front leg. - Slowly lowers the hips as the front leg is flexed. - Maintains the front foot flat to the ground and the rear leg straight with the toes in contact with the ground. - Pushes down forcefully with the leading leg to return to the initial position. 	<p>The back knee must not come in contact with the ground during the movement.</p> <p>Variations: the athlete may...</p> <ol style="list-style-type: none"> 1. Place the leading foot on a BOSU ball when performing the lunge. 2. Descend to a lunge position, and take several “lunge steps”; the leading foot and the leading arm must be opposite. <div style="display: flex; align-items: center;">   </div> <p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Use only his or her body weight initially. 2. Use dumbbells, or a barbell with weights. The initial resistance should be set at 20 or 25 % of the athlete’s own body weight, and increased progressively. 3. Assume the lunge position and, as he or she presses up with the front leg, jump up and switch legs in the air, landing in a lunge position, but with different leading and back legs. This is a form of plyometric exercise that can be used to develop speed strength if the muscles of the front leg contract quickly after the landing. No additional resistance should be used when performing this exercise.

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
	RT 38	<p>Squat with no bar</p> 	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Stands straight with the feet shoulder-width apart, toes pointing slightly outside. - Distributes his or her weight evenly on each leg. - Crosses the arms over the chest in such a way that the tips of fingers touch the opposing shoulders. - Focuses on a point on the wall slightly above eye level; this helps maintain proper neck and chin alignment. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - In a smooth motion, slowly flexes the knees and lowers the seat as low as possible, but without reaching a point of discomfort. - Extends the legs, and returns to the initial position in a smooth, controlled manner, keeping the back as straight as possible throughout the ascent. - Inhales on the descent, and exhales on the ascent. 	<p>Variations: The athlete may...</p> <ol style="list-style-type: none"> 1. Extend the arms in front of the body. 2. Shift the weight to one leg while in the squat position, extend and return to the initial position in a smooth, controlled manner. 3. Shift the weight from one foot to the other a few times while in the squat position. <p>Progressions: the athlete may ...</p> <ol style="list-style-type: none"> 1. Use dumbbells to increase the resistance; in this case, the arms should hang in front of the body. 2. Perform the exercise on a balance board or BOSU balls. <div style="display: flex; justify-content: space-around; align-items: center;">   </div> 3. Begin with one foot on the floor and the other on top of a BOSU ball or a box; make a side step onto the ball or box without rotating the trunk or the hips, squat with both feet on the ball or box, and return to the initial position on the opposite side. <div style="display: flex; justify-content: center; align-items: center; margin-top: 20px;">  </div> 4. Perform progression 3 above with a wider initial side step, in a lower position, or using a higher box. 5. Perform the above holding a medicine ball, and increase the weight of the ball over time.

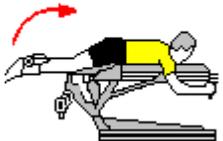
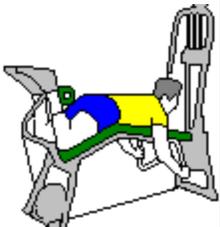
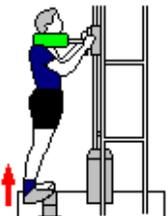
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
	RT 39	<p>Isometric wall squat with ball</p>  	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Stands straight with the lower back pressing lightly against a Swiss ball. - Places the feet shoulder-width apart or slightly wider, the toes pointing slightly outside. - Keeps the arms straight to the side of the body. - Focuses on a point on the wall slightly above eye level; this helps maintain proper neck and chin alignment. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - In a smooth motion, slowly lowers the seat and flexes the knees to an angle of approximately 45 degrees. - Contracts the thigh muscles isometrically, pushes slightly back against the ball, and maintains the position as long as possible (up to 1 minute or so), until a “burning sensation” is felt in the thighs. - Extends the legs, and returns to the initial position in a smooth, controlled manner, keeping the back as straight as possible during the ascent. - Breathes normally throughout. 	<p>Variations: the athlete may ...</p> <ol style="list-style-type: none"> 1. Do the exercise without a ball, with the back placed directly against a wall. 2. Raise the heels when maintaining the static position. 3. Bend the knees to 60 or 90 degrees. 4. Perform up and down “pulsing” movements, rolling the ball between the back and the wall.*  <p>Progression: the athlete may ...</p> <ol style="list-style-type: none"> 1. Increase the duration of the exercise, from 30 seconds or so initially to 45, 60, 75 and 90 seconds. * 2. Lift one foot and perform the wall squat with only one supporting leg. 3. Hold a dumbbell in each hand to increase the resistance. 4. Perform the up and down “pulsing movements” at a higher pace. *

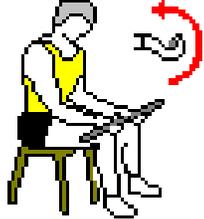
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
	RT 40	<p>Single leg squat</p> 	<p>The Set-up: the athlete</p> <ul style="list-style-type: none"> - Holds a dumbbell in each hand. - Stands on one foot, the opposite leg flexed. - Keeps the back straight and the arms extended. - Focuses on a point on the wall slightly above eye level; this helps maintain proper neck and chin alignment. <p>The Movement: the athlete</p> <ul style="list-style-type: none"> - In a smooth motion, slowly flexes the knee of the support leg, as low as possible without losing balance. - Holds the position for 1 or 2 seconds. - Extends the legs, and returns to the initial position in a smooth, controlled manner, keeping the back as straight as possible throughout the ascent. - Inhales on the descent, and exhales on the ascent. 	<p>Balance must be maintained throughout the execution of this exercise.</p> <p>The foot must remain flat at all times, and the weight must not be shifted to the toes.</p> <p>The trunk may be allowed to bend forward naturally during the down phase, to enable a greater flexion of the leg.</p> <p>Progressions: The athlete may perform the exercise on a balance board or on a BOSU ball.</p> 

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Legs , back, core	RT 41	<p data-bbox="449 302 596 363">Squat with a bar ◻ ▲</p> 	<p data-bbox="684 302 968 326">The Set-up: the athlete...</p> <ul data-bbox="684 337 1178 740" style="list-style-type: none"> - Stands facing a barbell on a squat rack. - Ducks under the bar so that the bar contacts the thickest area of the trapezius. - Places the hands on the bar as close as possible to the outside of the shoulders. - Pushes the elbows forward so that they are directly under the bar. - Focuses on a point on the wall slightly above eye level; this helps maintain proper neck and chin alignment. - Positions the feet shoulder width apart, with the toes pointing slightly outward. <p data-bbox="684 773 1016 797">The Movement: the athlete...</p> <ul data-bbox="684 808 1188 1357" style="list-style-type: none"> - Straightens the legs to lift the weight off the rack. - Takes one or two steps back to get clear of the rack - Lowers the hips, keeping the back as straight as possible. - Lowers the body under control until the angle at the knee is approximately 90 degrees. - Focuses on keeping the elbows under the bar throughout the movement. This ensures that as much of the load as possible stays over the centre of gravity. - Extends the legs, and returns to the initial position in a smooth, controlled manner, keeping the back as straight as possible throughout the ascent. 	<ul data-bbox="1220 302 1955 732" style="list-style-type: none"> - For safety reasons, this exercise must be performed from the floor, not on a bench or box. - Using a towel or padded foam to cushion the load is not recommended, as it may increase the stress on the vertebrae. - The athlete must inhale on the descent, and exhale on the ascent. - If ankle flexibility is poor, consider placing a board under the heels to allow proper hip alignment at set-up. - The athlete must not lean forward during the movement as it may increase the loading on the lower back, or bounce in the bottom position. - Exercises that may tire the lower back and the abdominal muscles should be avoided before doing back squats, especially if heavy loads are used. <p data-bbox="1220 760 1373 784">Progressions:</p> <ul data-bbox="1220 792 1955 1149" style="list-style-type: none"> - Boxers do not have to lift extremely heavy weights to benefit from this exercise. Initially, a load that corresponds to 50% or so of the athlete's body weight should be used, and 8 to 10 repetitions should be performed. This should not be very demanding. - After a few weeks, the resistance should be such that the last 2 or 3 repetitions should now begin to feel fairly demanding, though extra reps should still be possible. - Once the athlete has become familiar with the exercise and is capable of performing the squat with good form throughout using moderate weights, loads corresponding to 12, 10 and 8 RMs could then be used. <p data-bbox="1220 1182 1524 1206">Variations: The athlete may</p> <ul data-bbox="1220 1214 1913 1357" style="list-style-type: none"> - Position the heels on a board, and position the heels closer together while squatting. This increase the load on the knee extensors. - Place the hands farther apart, and outside the shoulders. This increases the load on the hip extensors. *

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions	
Legs and back	RT 42	Dead lift ■	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Stands facing a barbell with the feet flat on floor, and the bar touching the shins. - Flexes the knees and grabs the bar with the hands placed outside the legs, using a reverse grip (palms facing in opposite directions). - Keeps the back and the arms straight, elbows slightly touching legs with the shoulders back. - Focuses on a point on the wall slightly above eye level. <p>The Movement: the athlete...</p> <ul style="list-style-type: none"> - Pulls the bar up slowly and evenly, keeping it close to the body; pulling is accomplished by pressing the feet into the floor and extending the legs and the hips. - Pauses at the top, when the legs are fully extended. - Lowers the bar slowly to the initial position by pushing the hips back and flexing the legs. - Keeps the arms and the back straight throughout 	<ul style="list-style-type: none"> - The athlete must inhale at the beginning of the movement, hold his or her breath during the lift, exhale in the end position, and hold his or her breath while lowering the bar to the initial position. <p>Progressions:</p> <ol style="list-style-type: none"> 1. Boxers do not have to lift extremely heavy weights to benefit from this exercise. Initially, a load that corresponds to 50% or so of the athlete's body weight should be used, and 8 to 10 repetitions should be performed. This should not be very demanding. 2. After a few weeks, the resistance should be such that the last 2 or 3 repetitions should now begin to feel fairly demanding, though extra reps should still be possible. 3. Once the athlete has become familiar with the exercise and is capable of performing the dead lift with good form throughout using moderate weights, loads corresponding to 12, 10 and 8 RMs could then be used. 	
					Beginning
					Middle
	End position				

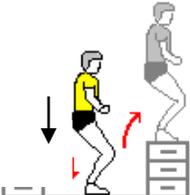
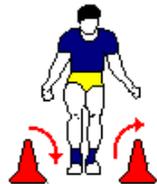
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Legs	RT 43	Leg extension ■ 	The Set-up: the athlete... <ul style="list-style-type: none"> - Sits on the leg extension machine with the back straight and grasps the seat's handle. - Places the ankles in contact with the pad, keeping the feet and the legs parallel. - Focuses on a point on the wall slightly above eye level. The Movement: the athlete... <ul style="list-style-type: none"> - Extends the legs fully at the knee while keeping the legs parallel and maintaining the buttock in contact with the seat throughout. - Stops momentarily at the end of the movement, and locks the knees partially. - Lowers the pad slowly and under control to the initial position. 	<ul style="list-style-type: none"> - The athlete must not arch or twist the body during the leg extension. - The roller pad must not be bounced at any time during the movement. - The athlete inhales at the start or while the weight is being lowered, and exhales as the legs are extended. <p>Variations: the athlete may perform this exercise...</p> <ol style="list-style-type: none"> 1. With one leg only, but reduce the load. <p>Progressions: the athlete may ...</p> <ol style="list-style-type: none"> 1. Increase the load gradually. 2. Perform the leg extension with both legs, but lower the resistance slowly and under control with one leg only.
	RT 44	Leg press ■ ▲  	The Set-up: the athlete... <ul style="list-style-type: none"> - Sits on the leg press machine with the back straight and grasps the seat's handle. - Puts the feet flat on the machine's pedals, toes pointing slightly outward, keeping the legs parallel. - Focuses on a point on the wall slightly above eye level. The Movement: the athlete... <ul style="list-style-type: none"> - Extends the legs fully, with the pressure on the balls of the feet and the heels. - Keeps legs parallel, and maintains buttock in contact with the seat. - Stops momentarily at the end of the movement, just short of locking the knees - Allows the foot pedals to move backward slowly, and returns to the initial position. 	<ul style="list-style-type: none"> - The knee angle must be between 60 and 90 degrees in the starting position. - The athlete must not arch or twist the body during the leg press. - The weight must not be bounced at any time during the movement. - The athlete inhales at the start or while the weight is being lowered, and exhales as the legs are extended. <p>Variations: the athlete may perform this exercise...</p> <ol style="list-style-type: none"> 1. With one leg only, but reduce the load. 2. On an incline leg press machine, feet shoulder-width apart. <p>Progressions: the athlete may perform this exercise...</p> <ol style="list-style-type: none"> 1. Increase the load gradually. 2. Perform the leg press with both legs, but lower the resistance slowly and under control with one leg only.

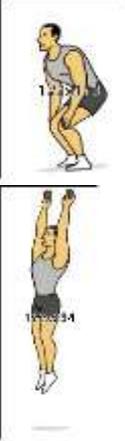
Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Legs – knee flexors (hamstrings)	RT 45	Leg curls 	The Set-up: the athlete ... <ul style="list-style-type: none"> - Lies face down with the legs extended and the lower calves hooked against the roller pads of the machine. - Positions the body so that the kneecaps extend a few centimetres over the edge of the machine; this allows free movement of the knee joint - Ensures that the roller pads are pressing against the lower portion of the calf and Achilles tendon; if necessary, adjust the position of the roller pads. - Grips the edge of the machine or its hand grips to stabilize the upper body. - Points the feet forward; this minimizes the involvement of the gastrocnemius. 	<ul style="list-style-type: none"> - The athlete must exhale while raising the resistance arm, and inhale while lowering it. - The body should be kept in contact with the table of the leg curl machine throughout the exercise. - The focus should be on keeping the movement continuous and smooth while raising and lowering the resistance. Variations: the athlete may ... <ol style="list-style-type: none"> 1. Use one leg, but reduce the load. 2. Perform the exercise in the seated position. * 
			The Movement <ul style="list-style-type: none"> - Pulls the lower leg against roller pad, using the hamstrings to lift the resistance arm in a semi-circle. - Flexes the leg, and lifts the resistance arm until the top of the roller pad contacts the buttocks. - Lower the legs slowly until the hamstrings are fully stretched; this maximizes eccentric contractions. 	
Calves	RT 46	Heel raises 	The Set-up: the athlete ... <ul style="list-style-type: none"> - Stands on a stair or high block with the toes close to the edge and the heels well off the stair or block; the stair or block must be high enough that when the heel is lowered it does not contact the ground. - Points the chin slightly up, and focus on a point slightly above eye level; this maintains proper neck alignment. The Movement: the athlete... <ul style="list-style-type: none"> - Slowly lowers the heels as far as possible toward the ground, and keep the position for 2 seconds. - Then, rises as high as possible on the toes, and returns to the starting position to complete one repetition. - Keeps the trunk straight throughout the movement. - Inhales on the descent, and exhales on the ascent. 	<ul style="list-style-type: none"> - This exercise complements step-ups. - The descent must be slow and under control, without any bouncing. Variations: the athlete may perform the exercise... <ol style="list-style-type: none"> 1. With the feet shoulder width apart.* 2. Using a heel-raise machine or device. Progressions: the athlete may perform the exercise ... <ol style="list-style-type: none"> 1. On one leg, and bend the non-working leg at about 90 degrees to isolate it from the movement. 2. As above, and hold a single dumbbell on the same side as the working leg, and use the free hand to maintain balance. 3. With a heel raise machine against a heavier resistance.

Body part	Code	Exercise	Key points during execution	Comments / Variations and Progressions
Hands and forearms	RT 47	<p>Wrist curls</p>   <p>Variation 1</p>	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Sits at the end of a flat exercise bench. - Positions the feet on the ground, shoulder-width apart. - Rests the forearm extensors on the thighs, with the wrists and hands hanging over the knees. - Leans slightly forward to keep the forearms on the knees. - Holds the bar tightly with a supinated (palms up) grip and the hands close together. - Lets the weight of the bar pre-stretch the forearm. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Uses the wrist flexors to curl the barbell upward in a semi-circle arc as high as possible. - Lowers the bar until the forearm muscles are fully stretched. - Inhales while raising the bar, and exhales while lowering it. 	<ul style="list-style-type: none"> - The forearms are kept stationary on the knee throughout the movement. - The forearms should not come off the knee during the movement. - Movement should occur only at the wrists. - Lower the bar in a controlled manner and at an even speed. - The hands and forearms should always be trained last in a workout; it prevents fatigue in the muscles required for grip strength in other exercises. <p>Variations: The athlete may...</p> <ol style="list-style-type: none"> 1. Perform the exercise with the palms down; it recruits the wrist extensors. 2. Use dumbbells; it reduces strain on the wrist joints and allows for a greater range of motion.
	RT 48	<p>Wrist rolls</p> 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Holds a stick to which a weight is suspended by a rope. - Extends the arms in front of the body, shoulder height, palms facing down. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Raises the weight by rolling the stick between the palms and the fingers, using one hand after the other. - Rolls the weight down to the initial position. 	<ul style="list-style-type: none"> - The arms are kept straight in front of the body throughout the exercise. <p>Variation: The athlete may use a supinated grip (palms up).</p> <p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Increase the resistance by using a heavier weight. 2. Roll the hands faster.
	RT 49	<p>Hand grips</p> 	<p>The Set-up: the athlete ...</p> <ul style="list-style-type: none"> - Grabs a tennis or a rubber ball in one hand. <p>The Movement: the athlete ...</p> <ul style="list-style-type: none"> - Presses with the fingers and squeezes the ball as hard as possible. - Holds the position for 2 or 3 seconds, then releases the tension. 	<p>The athlete may perform this exercise in the standing or sitting positions. Perform with each hand.</p> <p>Variation: The athlete may use a hand grip device.</p> <p>Progressions: the athlete may...</p> <ol style="list-style-type: none"> 1. Increase the number of repetitions to 30 or so. 2. Use a firmer ball or hand grip.

Annex 5 – Sample Plyometric Training Exercises

The following tables present low-intensity and moderate-intensity plyometric exercises for the lower and the upper body. Higher intensity plyometric exercises such as depth jumping are not discussed in this text, as they are considered too advanced.

Low-intensity Exercises	
Rope Skipping	<ul style="list-style-type: none"> • Skip rope, and alternate the landing leg.
Squat Jump, Hands behind Neck	<ul style="list-style-type: none"> • Stand with the feet shoulder-width apart, the back straight, and the trunk flexed slightly forward. • Place the hands behind the neck, with the fingers interlocked. • Lower the body until the thighs are parallel to the ground, and jump up quickly, keeping the hands behind the neck. • Don't hold the squat position before jumping; instead, extend the ankles to their maximum range, and minimize the time between dipping down and jumping up. • Land on both feet. • Rest for 1-2 seconds before repeating.
	Jump to Box <ul style="list-style-type: none"> • Stand facing a box, with the feet slightly more than shoulder-width apart. • Lower the body into a semi-squat position, and jump quickly onto the box, landing softly on both feet. • Don't hold the semi-squat position before jumping; instead, extend the ankles to their maximum range, and minimize the time between dipping down and jumping up. • Step back down from the bench, and repeat. Do NOT jump down.
Lateral Jump to Box	<ul style="list-style-type: none"> • Do exactly as for the Jump to Box exercise, but start from beside the box.
Medium-intensity Exercises	
	Side Jumps with Both Feet <ul style="list-style-type: none"> • Do exactly as for the Lateral Jump to Box exercise, but jump over <i>small</i> cones from front to back and from side to side. • Alternatively, jump into a series of rings positioned a few feet apart and forming a square or a rectangle. • Minimize contact time with the ground between jumps. • Take a short rest after 4 to 6 consecutive jumps, and repeat.
Double-leg Tuck Jumps	<ul style="list-style-type: none"> • Stand with the feet shoulder-width apart, the knees slightly bent, and the arms at the side. • Jump quickly, and bring both knees to chest. • Land softly on the balls of both feet, and repeat the movement immediately, trying to minimize contact time with the ground.

Medium-intensity Exercises	
<p>Squat Jumps, Arms Extended</p> 	<ul style="list-style-type: none"> • Stand with the feet shoulder-width apart, the back straight, and the trunk flexed slightly forward. • Position the arms at the side of the body, and flex the elbows slightly. • Lower the body until the thighs are parallel to the ground, and the jump up quickly, driving the arms up at the same time. • Don't hold the squat position before jumping; instead, extend the ankles to their maximum range, and minimize the time between dipping down and jumping up. • Land on both feet. • Rest for 1-2 seconds before repeating.
<p>Split Squat Jumps</p>	<ul style="list-style-type: none"> • Stand with the feet shoulder-width apart, and move one leg back 50 to 60 cm, using the ball of the back foot to maintain balance (lunge position). • Keep the head and back straight. • Lower the body by bending the front knee until the thigh is parallel to the floor, and then jump up quickly, extending the ankles to their maximum range. • In the air, switch the position of the legs: move the back leg forward and the forward leg back.
<p>Bounding</p> 	<ul style="list-style-type: none"> • Begin a light run. • After a few metres, push off forcefully with the left foot, bringing the right leg and the left arm forward. • Repeat the movement with the other leg and arm, and try to maximize the time in the air.
<p>Bounding into Rings</p>	<ul style="list-style-type: none"> • Do exactly as for the Bounding exercise, but land in a series of rings positioned 1 to 1.3 m in front of the body and on the same side as the front leg.

Upper Body

Low-intensity Exercises	
<p>Overhead Throws</p>	<ul style="list-style-type: none"> • Face a wall from a distance of 3 or 4 metres. • Stand with one foot slightly in front of the other and the knees slightly bent, and holding a medicine ball above the head. • Bring the medicine ball back behind the head, and quickly throw it forward and into the wall as forcefully as possible. • Pick the ball up after it bounces off the wall, and repeat for the required number of repetitions. • Minimize the time between pulling the ball back and initiating the throw. • This exercise can also be performed with a partner instead of a wall.

Side Throws	<ul style="list-style-type: none"> • Stand with the feet shoulder-width apart, one foot about 30 cm in front of the other, and the back straight. • Hold the medicine ball with both hands, with the arms bent slightly. • Bring the ball to the hip on the side of the rear foot, and quickly and forcefully toss it forward to a wall or to a partner. • Repeat for the required number of repetitions. • Minimize the time between bringing the ball into position and initiating the throw.
Throw and Go	<ul style="list-style-type: none"> • Stand with the feet slightly more than shoulder-width apart and the knees slightly bent. • Bring the medicine ball to chest level. • Using both hands, quickly and forcefully push the ball straight out as far and as fast as possible. • As the ball is pressed forward, explode with either leg, and sprint forward a couple of steps.
Medium-intensity Exercises	
Over-the-Back Toss 	<ul style="list-style-type: none"> • Stand with the feet slightly more than shoulder-width apart. • Grasp the ball, and lower the body into a semi-squat position. • Extend the body and the arms explosively, and throw the ball to a partner, up and over the body as far as possible, generating most of the power from the legs. • Catch the ball returned by partner and repeat for the required number of repetitions.
Medicine Ball Push-ups	<ul style="list-style-type: none"> • Assume a push-up position with the arms straight and the palms on the medicine ball. • Quickly remove the hands from the ball, move the hands wider apart than the shoulders, and drop down. • Catch the fall with both hands, flexing the arms slightly and letting gravity flex the elbows further until the chest almost contacts the ball. • Quickly and forcefully push on the ground and extend the arms so that the hands leave the ground. • Reposition the palms on the medicine ball; if the push is not powerful enough, flex the arms and recontact the ball. • Repeat for the required number of repetitions.

Medium-intensity Exercises	
Plyometric Push-ups	<ul style="list-style-type: none"> • Assume a push-up position. • Lower the body to the floor, and push up quickly and forcefully so that the hands leave the ground. • Catch the fall with both hands, and immediately lower the body into a push-up position again. • Repeat for the required number of repetitions.

Annex 6 - Resistance Training and Women

There are several myths regarding the use of resistance training by women, and many are unsubstantiated. The table below lists three common misconceptions, and presents a summary of research data.

Misconceptions	What Research Shows...
Resistance training causes large increases in women's body size and weight	<ul style="list-style-type: none"> • When men and women follow the same resistance training program, women experience significant increases in muscle strength but smaller increases in muscle size than men. • The potential for hypertrophy is lower in women than in men, and neural factors seem to be chiefly responsible for the gains observed. Only women with a genetic predisposition to hypertrophy who do high-volume, high-intensity training experience significant increases in muscle size. • Resistance training may help to reduce body fat and increase lean-body mass. This may lead to a <i>slight</i> increase in overall weight, since muscle weighs more than fat.
Women should use only low intensities when doing resistance training	<ul style="list-style-type: none"> • The light training loads often recommended for women are frequently substantially below the threshold necessary for appropriate strength, speed-strength or strength-endurance adaptations to occur.
Women should use different resistance training methods and equipment than men	<ul style="list-style-type: none"> • Males and females should both follow a progressive loading approach, and the training programs of female athletes can be based on the same principles and loading parameters as those for men. • Males and females both need to be taught how to perform exercises correctly to avoid injuries and obtain optimal results. There is no evidence that resistance training leads to more injuries among women if they use proper technique and increase loads progressively.

Annex 7- INJURY PROTOCOL

Any injury sustained by a boxer must be reported and documented.

Injuries include any physical injury, as well as symptoms such as ‘bell rung’, ringing in the ears, dizziness, vision disturbances, persisting headaches, etc.

In the event of an injury sustained during training (including sparring), or when a boxer becomes aware of an injury, the following procedure must be followed by the athlete:

- 1) Communicate the nature or the symptoms of the injury to the Head Coach or to his or her Assistants as soon as possible.
- 2) Document the injury in a training logbook. If the athlete is unable to do so, the Head Coach or his or her Assistants should be responsible to record the information.

If the Head Coach suspects that an injury to the head has occurred during training, the boxer must immediately be referred to a physician.

Training and sparring must also be stopped, and the return to training should be done gradually, as per the recommendations of the physician and the general guidelines described in Annex 3 of the *Apprentice Coach* manual.

Annex 8- Sample program - Teenage Competitive Boxer involved in 4 competitions per year, including a Provincial Championship.



Note: The bands associated with Shadow Boxing, Bag Work, etc. at the bottom of the figure serve to outline how much a particular form of training is used at specific stages of the boxer’s program.

