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Technical Note

The Heart Rates and Movement Speed of Specialist Tactical Police During a Multistorey Active Shooter Training Scenario

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ABSTRACT

International Journal of Exercise Science 16(4): 281-292, 2023. Specialist police tactical groups (PTGs) are involved in situations that extend beyond the capability of general duties police and can include responding to active shooter incidents. Due to the nature of their tasks, these officers typically carry and wear additional equipment which can impart an increased physical cost, for which the officers must be prepared. The aim of this study was to examine the heart rate responses and movement speeds of specialist PTG officers during a multistorey active shooter scenario. Eight PTG officers completed an active shooter scenario within a multistorey office building district whereby they were required to carry and wear their usual occupational personal protection equipment (average load = 16.25 ± 1.39 kg) while clearing high-risk environments and locating an active threat. Heart rates (HR) and movement speeds were all recorded via HR and global positioning system monitors. Average PTG officer HR over the duration (19.14 ± 0.70 minutes) was 165 ± 6.93 bpm (89 ± 4% age predicted heart rate maximum (APHRmax)) with 50% of the scenario performed at intensities between 90-100% APHRmax. Around 75% of the scenario had the officers moving at speeds of between 3-6.99 kilometers per hour (km/h), although speeds of 7-10.99 km/h were not uncommon. Understanding the responses of specialist officers during a multistory active shooter scenario may help in designing specific strength and conditioning programs to meet this potential scenario demand.

KEY WORDS: Fitness, police, SWAT, specialist response group, active threat

INTRODUCTION

Police officers, both those performing general duties and those performing in specialist roles, are at the forefront of state and national security (44). These individuals have a sworn duty to protect life and property as part of their occupation. The occupational duties of these police officers can vary significantly, ranging from sedentary tasks to those which can be physically demanding and performed in high-risk environments (5, 11, 19, 29, 34). Sedentary activities in general duties police can be typified by periods of prolonged sitting (e.g., desk-based tasks) followed by high intensity and physiologically demanding tasks (e.g., suddenly exiting a vehicle to chase an offender, whilst navigating obstacles and uneven terrain).

Specialist police tactical groups (PTGs), including Special Weapons and Tactics or SWAT teams, are involved in situations that extend beyond the capability of general duties police (19, 29). These might include search warrant executions, search and rescue missions, crisis, hostage and negotiation operations, and bomb threat response (5, 19, 20, 29, 40, 41). Furthermore, specialist police are required to respond to an active shooter incident. An 'active shooter', by definition, is an individual armed with a firearm(s) that is actively engaged in killing or attempting to cause serious harm to multiple people in a populated location (18). In 2021 alone, the Federal Bureau of Investigations in the United States of America classified 61 incidents as active shooter incidents (13). Further, the role of specialist police in national affairs has steadily increased as global terrorism threats continue to evolve (4), and, as such, these specialist police could find themselves involved in active shooter incidence associated with terrorism; the tragedy at the Bataclan Concert Hall serving as an example (27).

With the increased responsibility and risks associated with these tasks, specialist police are often required to carry additional personal protective equipment (PPE) above that of general duties police. Specialist PTG personnel, in addition to the 10kg load carried by general duties police (duty belt, sidearm, baton, radio, body armour, etc.) (3) are often required to carry loads up to 20kg and at times 40kg (e.g., additional weaponry, respirators, breaching equipment, ballistic shields and battering rams) (5, 8, 19). Whilst these loads form an integral component of PPE, they can also impart an additional physiological cost (e.g., increases in heart rate, oxygen consumption, heat production neuromuscular fatigue, etc.) to the wearer, increase their risk of injury, and negatively impact on their performance (5, 7, 8, 35, 43).

The requirement to carry load can be mitigated by higher levels of fitness (39, 42). For example, load carriage performance in specialist police has been found to be strongly ($r = -.712$) and significantly associated with both aerobic fitness (as measured via a 20m Progressive Shuttle Run Test: PSRT) (42) and relative strength (as measured via 1 Repetitions Maximum (RM) squat ($r=-0.395$ to -0.401), deadlift ($r=-0.288$ to -0.285), bench press ($r=-0.330$ to -0.360) and loaded chin ups ($r=-0.468$ to -0.607) (39, 42). As such, elevated fitness levels are often associated with selection into these specialist police units (36) and explain why specialist police are, in general, fitter than the general population and other police (31) and may be akin to that of elite athletes (47).

Given the global increase in threat levels, such as those imposed by an active shooter, and the requirement of specialist police to carry additional occupational loads, the physiological profile imparted by load carriage during an active shooter event requires further investigation to develop strength and conditioning frameworks that would prepare officers for these types of tasks. The purpose of this study was to profile the physiological responses of specialist police whilst undergoing a multistorey building active shooter scenario whilst wearing occupational loads. The intent of this study was to provide a greater insight into this job specific task, which may assist in creating strength and conditioning programs, to enhance occupational performance.

METHODS

Participants

Retrospective data were provided for eight male specialist police officers (Table 1) undergoing an active shooter training scenario in a multistorey building. Data were collected from all personnel who completed the scheduled training activity. More detailed personnel data was not available, noting that these limitations in access to detailed personnel data is not uncommon in research within law enforcement populations (33). Ethical approval to conduct this study was provided by the Bond University Human Research Ethics Committee (RO1585). Officers were informed of the benefits and risks of the study and provided informed consent prior to participation. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (32).

Table 1. Participant characteristics and load carriage

Parameters	Mean ± Standard Deviation
Age (years) (n=7*)	39.71 ± 3.09
Years of specialist service (years) (n=7*)	10.29 ± 2.56
Height (cm) (n=7*)	181.57± 2.99
Bodyweight (kg) (n=8)	88.13 ± 5.06
VO_{2max}† (ml/kg/min) (n=7*)	50.22 ± 2.24
Load Carriage Weight/PPE (kg) (n=8)	16.25 ± 1.39
Relative Load Carriage Weight/PPE (%) (n=8)	18 ± 1.5%

* Data were unavailable for one officer due to work requirements. † VO_{2max} values had been previously derived from the officer's 20m Progressive Shuttle Run results two weeks earlier and calculated using the equation proposed by Leger et al. (26).

Protocol

Prior to the scenario, the ages (in years) and height (in cm) were self-reported by the officers whilst bodyweight (in kilograms: kg) was recorded using Tanita BC82 Fitplus scales (wearing shorts and shirts, without footwear). All officers were prepared for a 'black' (urban) role, and as such, their operational loadout consisted of full PPE (including ballistics vest and plates, helmet, and boots), primary and secondary weapons, and all accessories (e.g., personal radio, etc.) resulting in a mean load of 16.25 (± 1.39) kg or 18 ± (1.5) % of bodyweight.

Active Threat in a Multistorey Building: This training scenario consisted of multiple active threats contained within a multistorey building. The building layout included multiple internal offices, workstations, closed doors, internal staircases, and open areas across 500m. The officers were briefed prior to commencement, that they were responding to an active shooter with potential hostages. At each level they would face high risk situations (e.g., uncooperative, or confused civilians, an armed offender/s, etc.) where the use of PTG tactics was required to resolve each situation presented. The officers moved in a team of two on the command of the assessor clearing each level before proceeding into the staircase and ascending to the next. A leap-frog approach was employed where one officer would proceed up the stairs onto the first landing and provide cover while the second officer sprinted up the stairs to the next landing and proceeded to provide cover. The full scenario was declared finished when all areas were cleared of high-risk situations. Throughout the active shooter scenario, heart rate and movement speed values detailed below were recorded to represent the individual task demands the officer's encountered throughout the scenario.

Objective Measures: Measures of heart rate (HR) were recorded using a Polar Heart Rate Monitor (Polar Team Pro, Polar Electro, Finland). HR values included average HR (HRave), maximum Heart Rate (HRmax) and officer's age predicted heart rate maximum (APHRmax), derived using the formula of 220-age (2), presented as a percentage value (%APHRmax). Using %APHRmax, officer results were separated into five different HR intensity zones and categorized by the amount of time spent in each HR zone. The HR zones were calculated as per Polar Heart Rate software and categorized as: HR Zone 1 (50-59%), HR Zone 2 (60-69%), HR Zone 3 (70-79%), HR Zone 4 (80-89%) and HR Zone 5 (90-100%) (12). These HR zones are part of the Polar system output.

Movement speed values (distance covered per hour: km/h) were recorded via GPS units (Polar Team Pro, Polar Electro, Finland). Speed-distance specifically, where time spent maneuvering at different speeds, were collected, and collated into six different speed zones. The zones were split as follows: Speed Zone 0 (<3km/hr), Speed Zone 1 (3-6.99 km/h), Speed Zone 2 (7-10.99 km/h), Speed Zone 3 (11-14.99 km/h), Speed Zone 4 (15-18.99 km/h), and Speed Zone 5 (19+ km/h). Any variation in total duration that was not recorded into any of the designated speed zones were assumed to be <3 km/hr. The high-risk simulation was required to be completed as quickly and thoroughly as possible and was timed by the unit's strength and conditioning coach and researcher (JR) via the GPS units.

Throughout the scenario the specialist PTG officers were assessed on ten individual performance criteria competencies. The competency assessments were based on how they planned, approached, communicated, and responded to specific tasks and high-risk incidents encountered throughout the specialist course. This data, which was not part of this study, is noted as it informs that the officers were observed and assessed to ensure that scenarios were completed as instructed and, as such, correct skills and drills associated with an active shooter scenario were enforced.

Statistical Analysis
The data were provided in a Microsoft Excel spreadsheet and subsequently imported into the Statistical Package for the Social Sciences (IBM SPSS, Armonk, USA, version 24) for analysis. All individual data (body weight, age, VO_{2max} and load carriage weights) were analyzed descriptively with means and standard deviations calculated.

RESULTS

All eight PTG officers completed the scenario and provided data. The mean task duration was 19.14 (± 0.70) mins and the mean distance covered was 489 (± 58) meters.

Heart Rate: HRave of officers was 165 (± 6.93) bpm with an average HRmax of 177 (± 8.24) bpm (Figure 1). In respect to relative values, officers recorded average %APHRmax values (ave%APHRmax) of 89 (± 4)% and average maximum %APHRmax values of 96 (± 4)% for the duration of the scenario with one individual exceeding 100% of their %APHRmax (Figure 2). No individual presented with a HRave of below 156 bpm, nor a %APHRmax below 83%. When considered in relation to intensity HRmax zones, the officers, on average, spent 50% of their duration in HR Zone 5 (90-100%) and 44% in HR Zone 4 (80-89%) as displayed in Figure 3. No officer spent more than 11s in HR Zone 1 once the scenario began.

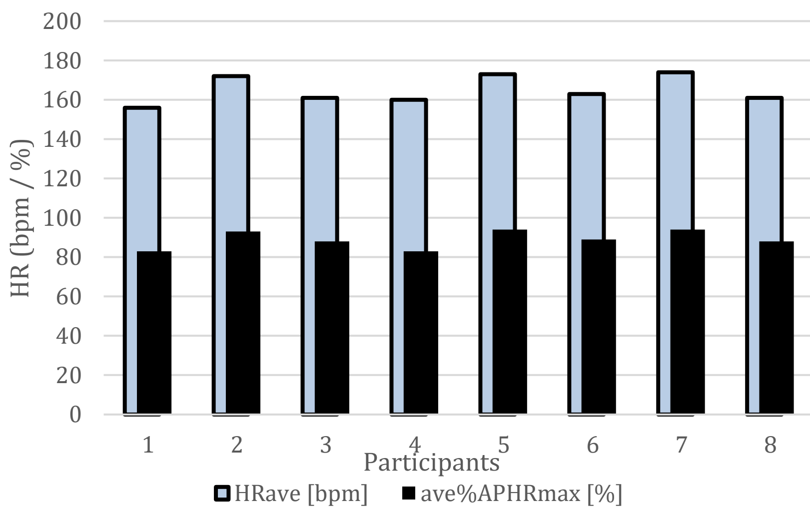

Figure 1. Mean HRave and average %APHRmax by participant. Legend: HRave = Heart rate average: bpm = beats per minute: ave%APHRmax = Average percentage of age predicted heart rate maximum.

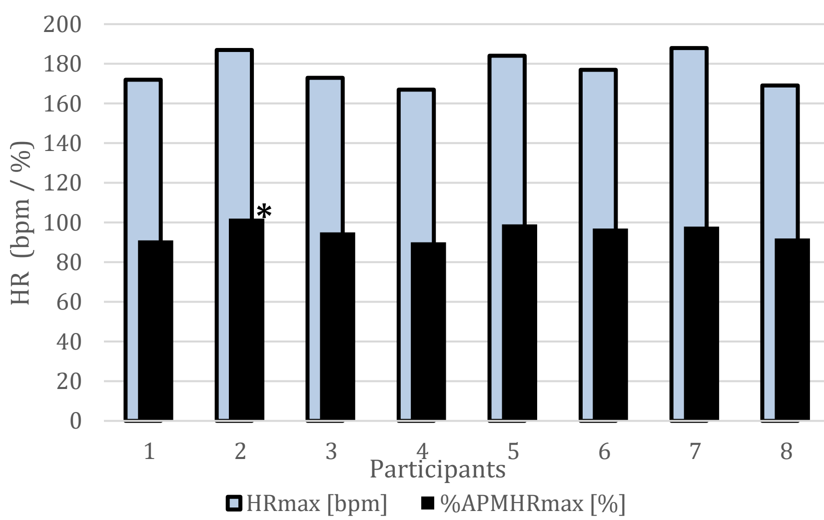

Figure 2. Mean HRmax and %APHRmax values by participant. Legend: HRmax = Heart rate maximum: bpm = beats per minute: %APHRmax = percentage of age predicted maximum heart rate maximum. * = denotes participant whose average %APMHRmax breached 100%.

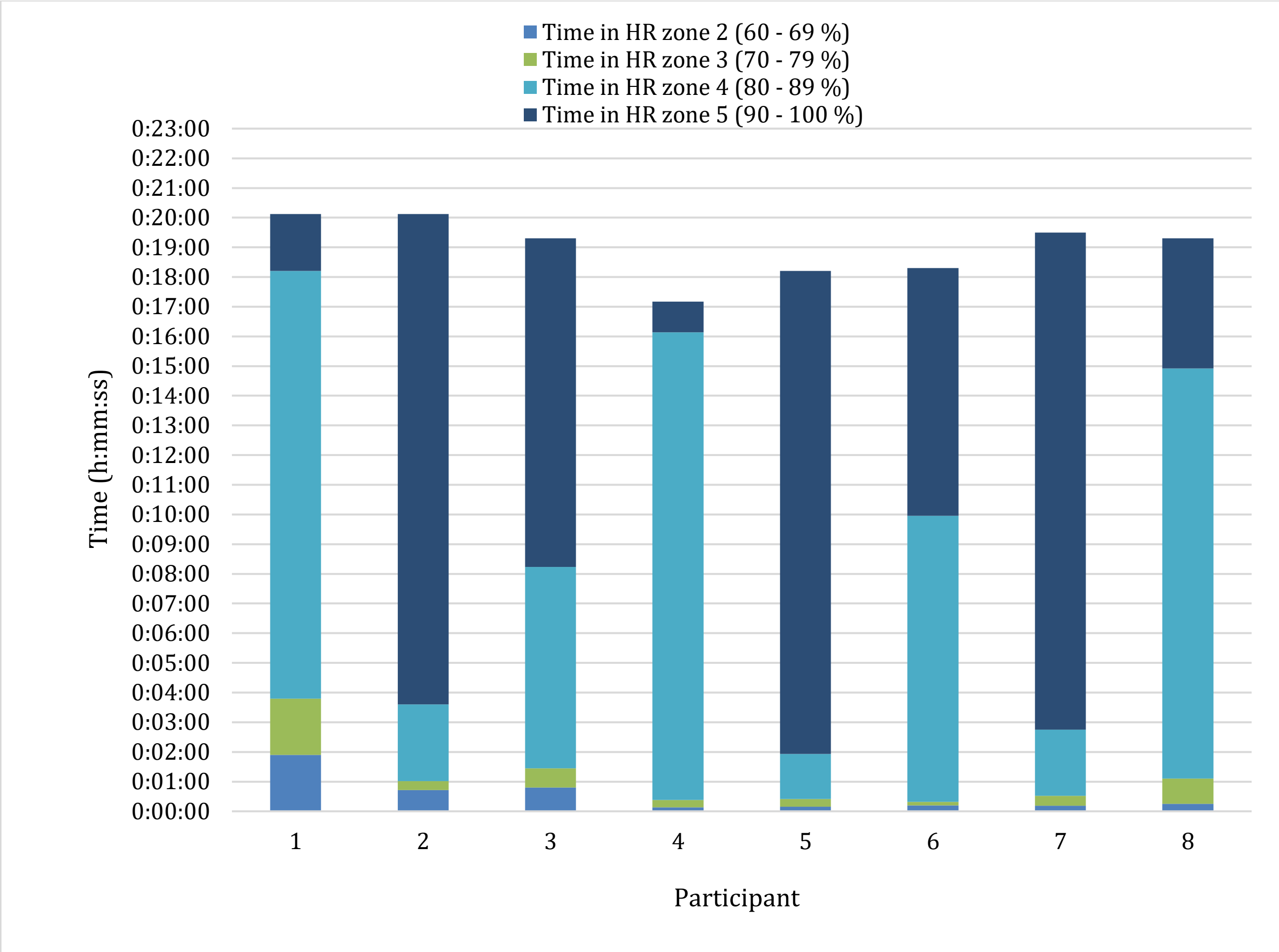

Figure 3. Time Spent in HR Zones.

On average, most of the distance covered (75%) was moving within Speed Zone 1 being 3-6.99km/hr while 4% of scenario duration was spent in Speed Zone 2 being 7-10.99km/hr. Time spent in the different speed zones reduced as the speed increased (Table 2).

Table 2. Breakdown of the relative time spent in each zone for the scenario.

Speed Zones	Time spent in Speed Zone Mean ± SD
Zone 0 (<3km/hr)	20.5 ± 5.8%
Zone 1 (3-6.99km/hr)	75.1 ± 4.8%
Zone 2 (7-10.99km/hr)	4.13 ± 2.5%
Zone 3 (11-14.99km/hr)	0.4 ± 0.7%
Zone 4 (15-18.99km/hr)	0%
Zone 5 (19+km/hr)	0%

DISCUSSION

The purpose of this study was to profile the physiological responses of specialist police whilst undergoing a multistorey building active shooter scenario and wearing occupational loads. The results of this study demonstrated the officers were required to sustain intense physical exertion, near or at maximal effort for a period of nearly 20 minutes. During the scenario, which lasted for an average of 19 minutes, the mean officer HRave was 165 bpm or 89% of APMHR. During this time officers were constantly varying speeds but mostly moving at between 3-6.99 km per hour while wearing an average load of 16 kg or 18% of their body weight.

Officers in this study were similar in age (9), body weight (8, 9, 30, 39, 43), and aerobic fitness (30) to specialist police populations presented in previous research, although slightly older when compared to other populations with mean ages circa 33 years of age (8, 43, 46). While, the loads carried by the officers in this study were heavier than those carried by general police (circa 10kg (3)), they were lighter (16.25 ± 1.39 kg) than those of other specialist tactical response group teams of 22.8kg (7, 8) and 21-25kg (19). Further, and of note, the officers in this study were all full time PTG officers as opposed to part time PTG officers (10).

When the %APHRmax of the officers is compared to the grading by Garber et al. (14), the 89 (± 4) %APHRmax workload equates to a 'vigorous' intensity (77-95%APHRmax) while the average maximum %APHRmax of 96 (± 4)% equates to a 'near maximal to maximal' (≥96%) intensity. Thus, the findings of this study support that a multistorey active shooter scenario could see specialist police working at vigorous to maximal efforts for the duration of the task; in this instance circa 20 minutes. While it could be argued that these high HRs may be due to psychophysiological stress, research by Woodford et al. (46) found that SWAT members who completed three active shooter scenarios presented with limited anxiety and cortisol responses due to their experience levels (SWAT experience = 28 ± 13 months) which was markedly lower than the experience of officers presented in this study (123.43 ± 30.77 months). This further suggests that increases in speed, more specifically the number of explosive movements performed, can be more physically demanding and costly (metabolically) than increases in load weight alone (35).

Officers spent 94% of the scenario duration in or above HR Zone 4 (80-89%HRmax). To clearly illustrate the cardiovascular demands placed upon the officers in a more familiar sporting context, this intensity can be likened to that of a professional soccer match that similarly relies on the ability to produce repeated intermittent explosive bouts (1). The mean exercise intensity of a soccer match has been shown to require players to work between 80-90% of HRmax whereas 65% of a match duration (58.5minutes) is spent between 70-90%HRmax (1). Although very different in occupations, the cardiovascular stressors are similar.

Pending the task and environment, it is imperative that PTG officers are well conditioned to meet the physical demands of a potential active shooter event; notably through metabolic conditioning that focuses on replicating the high-intensity intermittent nature (>80%MHR) of such a task. The importance of aerobic fitness is further supported by Robinson et al. (42) who investigated whether strength, power, or aerobic endurance had the greatest association with load carriage performance (42). Robinson and colleagues concluded that, while strength and power performance were significantly correlated with load carriage performance (up to r=-

0.607), aerobic fitness performance was the strongest correlator (r = -.712) (42). These results support the approach that optimal load carriage performance may be achieved by performing load carriage tasks in conjunction with aerobic fitness and full body strength and lower limb power training (6, 15-17, 21-24, 35, 38, 45).

The role of strength and power training has recently been researched by Orr and co-workers (37, 39). In 2019, their systematic review suggested that measures of lower-body strength and power are related to load carriage performance and are important physical factors for load carriage ability (37). Furthermore, as load carriage tasks can negatively impact the performance of leg strength and power, the authors concluded that leg strength and power development should be important considerations in regards to tactical personnel training and assessment (37). A separate study by Orr and colleagues in 2022 (39), further highlighted that a moderate to strong correlation existed between absolute and relative strength measures with loaded task performance. The absolute deadlift score had the strongest correlation to the victim drag test (85kg victim wearing 15kg of operational load, r=-0.747) whilst the relative pull-up score showed the strongest correlation with pack march performance (5km pack march wearing 40kg of operational load, r=0.468). Orr and colleagues concluded that the requirement to lift a portion of the dummy off the ground during the victim drag may explain the importance of absolute strength whilst the requirement to transport load affixed to the body may explain the importance of relative strength; a supposition later supported by the work of Lockie et al., (28). Therefore, by improving absolute and relative upper and lower body strength task performance which requires the moving of load should improve in this population (39). Furthermore, given that different approaches can be used to develop absolute versus relative strength, understanding the nature of the tasks required and officer strengths and weaknesses must be considered when programming. In this scenario no victim / body drags were required with the officers mainly required to move themselves at high speed. Thus, in this instance relative strength (in addition to aerobic fitness) may be more important than absolute strength; acknowledging that at any given point in an active shooter situation, injured persons may need to be dragged to safety or behind cover.

The distance and speed recorded during the scenario was significantly lower when compared to elite soccer players, who on average cover 120 meters per minute across a 90 minute match (25). During said match, 63% of the total distance was covered by players at a speed of between 0-11 km/hr, whereas 7% of the total distance was covered at higher speeds >19.1 km/hr (25). Considering this, running speeds during the soccer matches was significantly higher when considered against the relative distance covered across the scenario informing this study, where the average work rate was 25.5 meters per minute. Although at a lower work rate in relation to speed/distance, the physical demand of being required to carry an additional 18% body weight of external load, which imparts a notable energy cost (33), is postulated to be the cause of the similar HR intensities despite the lower speed/distance values between PTGs and elite soccer players.

Several limitations to this research are of note. HR measures recorded had a potential ceiling effect due to the formula of 220-age being utilized to calculate APHRmax. The sample size was what would typically be considered small consisting of only eight officers. However, this sample size is common in research focused on this type of population (7, 43) due to the specialist nature, experience, and specific pool of applicants, and, as such, while the sample size may appear limited it does represent a relatively large proportion of the sample population.

In conclusion, active shooter scenarios can be physically demanding for PTG police officers eliciting near and maximal heart rate responses (>80% MHR) coupled with various intermittent explosive speeds of movement within multistorey buildings; all whilst wearing operational load and PPE. Strength and conditioning coaches working with these populations need to consider the physiological (aerobic, relative and absolute strength, and power requirements) and environment demands (e.g., stairs, long open expanses) imparted by these tasks and ensure that their conditioning is designed to elicit heart rate responses and speeds of movements required for responding to active shooter scenarios, for the anticipated task duration, whilst wearing their required PPE.

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