Section 15

Resources

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Involuntary Muscle Contractions and the Unintentional Discharge of a Firearm

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When the index finger activates the trigger mechanism of a firearm and it discharges, the action is usually intended. Under some conditions, however, this action can occur even though the person holding the firearm did not intend it. Because these conditions are very difficult to simulate in a laboratory, there are no scientific studies that specifically examine the unintended discharges of a firearm. Nonetheless, there is sufficient information in the scientific literature to help us understand the physiological reasons for the unintentional discharge of a firearm. The purpose of this commentary is to describe both the physiological basis for this phenomenon and the cues that could be used by firearms instructors to minimize its occurrence. How is it possible for a person holding a firearm to experience an unintentional discharge? The answer is that the muscles responsible for moving the index finger and depressing the trigger do so without the individual realizing that this happens. To a physiologist, this is not so unusual because individuals are not aware of most muscle actions that they perform during activities of daily living. When a muscle is activated by a direct command from the brain, the action is intended. This is known as a voluntary contraction (Prochazka, Clarac, Loeb, Rothwell & Wolpaw, 2000). However, muscles can also be activated by signals that arise from other locations within the nervous system besides the brain and such activation produces a muscle contraction that is not the result of a conscious decision. These actions are known as involuntary contractions. Unintentional discharges, which are not accidental discharges, are the result of involuntary muscle contractions that occur during the appropriate handling of a firearm. This article explains how involuntary muscle contractions can cause the unintentional discharge of a firearm.

ANATOMY OF THE HUMAN BODY

The foundation of the human body is the skeleton, which comprises a few hundred bones that are connected at joints by ligaments and other soft tissue. In biomechanical studies of human movement, the body is often described as consisting of about 17 segments based on the structure of the skeleton, where one segment represents the part of the body between two major joints Our limbs each comprise three segments: the hand, forearm, and upper arm for the arm and the foot, lower leg, and thigh for the leg. The forearm segment, for example, corresponds to the body structures located between the elbow and wrist and the thigh segment refers to the body structures that lie between the hip and knee joints. Movement involves the rotation of body segments about neighboring segments, even when the task is to move in a straight line from one position to another. In walking, the motion of one leg consists of the thigh segment rotating about the hip joint, the lower leg rotating about the knee joint, and the foot rotating about the ankle joint. The muscles that span the joints between adjacent body segments control these rotations. For example, muscles on the front (quadriceps femoris) and back (hamstrings) of the thigh control the motion of the lower leg about the knee joint, such as bending the knee. Muscles are activated to produce such actions by nerve cells that are located in the spinal cord, but only after the nerve cells themselves have been activated by signals either from the brain (voluntary contractions) or from other parts of the nervous system (involuntary contractions). Two points about this anatomy are important for a discussion of involuntary contractions in hand muscles: (1) the position of the hand while standing depends on the relative orientation of all the body segments located between the hand and the feet (Scholz, Schöner, & Latash, 1999). Due to this anatomical coupling, displacement of any intervening body segment will cause the hand to move; and (2) it is essentially impossible for one body segment to perform an action without causing other body segments to move. This second effect, which is most obvious during rapid and forceful actions, represents a biomechanical coupling between the body segments. To prevent the biomechanical coupling from causing unintended actions in other body segments, the nervous system must activate other muscles to counteract this effect (Darling & Cole, 1990: Galloway & Koshland 2002; Sainburg & Kalakanis, 2000; Zedka & Prochazka, 1997). This occurs automatically without the brain making a conscious decision to activate these muscles; thus, the muscle activity that stabilizes the body during the performance of a movement involves many involuntary muscle contractions.

NEUROLOGICAL CONNECTIONS BETWEEN LIMBS

In addition to the anatomical and biomechanical coupling that exists between body segments, there are connections within the nervous system (Alexander & Harrison, 2003; Barbeau, Marchand-Pauvert, Meunier, Nicolas, & Pierrot-Deseilligny, 2000) whereby an effect in one body segment can evoke an associated response in another body segment. Such neurological connections even exist between limbs (Koltzenburg, Wall, & McMahon, 1999; Serrien & Wiesendanger, 2001) and are important in producing the involuntary contractions that can cause the unintentional discharge of a firearm. To illustrate the nature of these neurological connections between limbs, two examples are presented: one example describes the speed of the involuntary contraction evoked in the other limb and the other example indicates the effect of practice on the associated response. The first example involves a reflex known as the withdrawal-crossed extension reflex (Andersen, Sonnenborg, & Arendt-Nielsen, 1999; Sherrington, 1910; Sonnenborg, Andersen, Arendt-Nielsen, & Treede, 2001). Imagine walking bare foot in your living room when you step on a thumb tack. Without thinking about it, you will lift the foot that stepped on the thumb tack off the floor and stiffen the other leg. Because the thumb tack provided a painful stimulus to the foot, the reflex response was to withdraw the foot from the stimulus (withdrawal reflex). At the same time, however, the other leg was stiffened (crossed extension reflex) so that you are able to keep your balance. In this example, the painful stimulus triggered two distinct actions: in one leg the knee joint was bent, whereas in the other leg it was stiffened. These involuntary contractions occur rapidly and you are usually not aware of them until the reflexes have been completed. This example shows how a sensory signal from one limb can elicit a rapid involuntary response in the other limb without involving the brain. This effect has also been shown with other types of reflexes (Delwaide, Sabatino, Pepin, & La Grutta, 1988; Koceja 1995; Pierrot-Deseilligny, Bussel, Sideri, Cathala, & Castaigne, 1973; Zehr, Collins, & Chua, 2001).

The second example examines the effects of strength training performed by one limb on the strength of the same muscles in the other limb. This effect is known as cross education (Zhou 2000). Numerous studies have found that when you perform several weeks of strength training with the muscles in one limb, not only do the exercised muscles get stronger but so do the same muscles, although not exercised, in the other limb. This effect has been observed in hand muscles, arm muscles, and leg muscles. For example, a 12-week strength training program that involves lifting loads >65% of maximum three times a week with the right leg will produce a 5-25% strength gain in the muscles of the left leg. On average, the strength gain in the unexercised limb is about 60% of that achieved in the exercised limb. Cross education has been observed after training programs that involve voluntary contractions, contractions evoked with electric shocks, and imagined contractions (Hortobágyi, Lambert, & Hill, 1997; Hortobágyi, Scott, Lambert, Hamilton, & Tracy, 1999; Shima et al., 2002; Yue & Cole, 1992; Zhou, 2000). The strength gain in the unexercised limb appears to be caused by changes that occur in the nervous system (Duchateau & Enoka, 2002), emphasizing the powerful neurological connections that exist between limbs.

FACTORS THAT INFLUENCE INTERLIMB EFFECTS

From the preceding discussion, it should be apparent that involuntary contractions could be evoked in hand muscles due either to biomechanical coupling between body segments or to neurological connections between limbs. A survey of the research literature indicates that there are at least three scenarios that could elicit involuntary contractions sufficient to cause the unintentional discharge of a firearm: sympathetic contractions, loss of balance, startle reaction. The term **sympathetic contraction**, which was coined by law-enforcement officers, refers to an involuntary contraction that occurs in the muscles of one limb when the same muscles in the other limb are performing an intended forceful action. In the physiology literature, this effect is known as a mirror movement or contralateral irradiation (Arányi & Rösler, 2002; Dimitrijevic et al., 1992; Mayston, Harrison, & Stephens, 1999; Zijdewind & Kernell, 2001). The intensity of the sympathetic contraction depends on the amount of force exerted during the intended action. When subjects pushed the index finger of the left hand sideways, for example, Shinohara, Keenan, and Enoka (2003) found that the sympathetic contraction in the muscles controlling the index finger in the right hand varied with the intensity of the left-hand contraction. When the index finger in the left hand pushed as hard as possible, the sympathetic contraction in the right hand produced a force that reached 25% of maximum. Sympathetic contractions in hand muscles appear to be caused by a failure to modulate connections between the left and right sides of the brain (Arányi & Rösler, 2002; Geffen, Jones, & Geffen, 1994; Liepert, Dettmers, Terborg, & Weiller, 2001). A common situation that could evoke a sympathetic contraction sufficient to produce an unintentional discharge would be a law enforcement officer attempting to restrain a struggling suspect with the left hand while holding a handgun in the right hand. Although sympathetic contractions have been observed in a number of research studies, the key issue concerns the intensity of the involuntary contraction. Is the force associated with a sympathetic contraction sufficient to depress the trigger and discharge a firearm? There is no direct answer to this question yet because studies of sympathetic contractions have not placed the hand in the same position as that used to hold a handgun. Nonetheless, it is possible to estimate the magnitude of this force, at least during laboratory measurements. For an average man (20-45 years, 170 lbs, 5ft 10 in), peak handgrip strength is about 125 lbs (Bemben, Massey, Bemben, Misner, & Boileau, 1996). The index finger contributes between 30 to 60% of the force to peak grip strength, depending on the position of the thumb and the width of the grip (Li, Latash, Newell, & Zatsiorsky, 1998; Radhakrishnan & Nagaravindra, 1993; Talsania & Kozin, 1998). Based on an average index finger contribution of 45%, the index finger in opposition with the thumb is capable of exerting 56 lbs of force during a maximal handgrip contraction. Because several studies indicate that a sympathetic contraction in hand muscles can reach 25% of maximum in laboratory settings (Shinohara et al 2003; Zijdewind & Kernell, 2001), a maximal sympathetic contraction would involve an index finger force of about 14 lbs, which is sufficient to overcome most trigger pulls on handguns. This value, however, probably underestimates the actual maximum force that can be achieved by the index finger during field operations due to the modulatory effects of stress on muscle contractions (Christou et al., 2002; Delwaide & Toulouse, 1983; Noteboom, Barnholt, & Enoka, 2001; Weinburg & Hunt, 1976; Williams & Barnes, 1989).

The second scenario involves the **loss of balance**. One of the most common uses of involuntary contractions are those elicited by the nervous system to maintain the variety of postures that we assume during activities of daily living. Postural contractions serve two functions (Horak & Macpherson, 1996): to place the body segments in an appropriate position for the performance of a movement and to maintain the balance of the individual. When balance is disturbed, rapid involuntary contractions are evoked that attempt to return the body to a position of equilibrium. Two features of the strategies used by the nervous system to maintain balance can evoke involuntary contractions in hand muscles. First, the involuntary contractions used to prevent a loss of balance depend on the options available to counteract the disturbance of balance (Cordo & Nashner, 1982; Elger, Wing, & Giles, 1999; McIlroy & Maki, 1995; Schieppati & Nardone, 1995). Consider the case of a law enforcement officer who has pulled over a pickup truck on a highway and walks alongside the passenger-side of the vehicle with his weapon drawn. The side of the road is covered with gravel and has a modest slope. The officer slips on the gravel. Without a conscious decision, the officer's nervous system will activate a sequence of involuntary contractions to prevent him from falling. If the officer is not close enough to grab either the pickup truck or his vehicle for support, the involuntary contractions will be focused in the leg muscles. If the officer can grasp either vehicle for support, however, most of the involuntary contractions will occur in the arm and hand muscles. Thus, the rapid involuntary contractions could involve the same muscles being used to hold the handgun. The second feature of the postural contractions involves the neurological connections between limbs. If only one limb experiences a loss of balance, the involuntary contractions will also be evoked in the other limb (Corna, Galante, Grasso, Nardone, & Schieppati, 1996; Dietz, Horstmann, & Berger, 1989; Marsden, Merton, & Morton, 1983). As a result of this interaction, an officer who loses her balance while grasping a subject with the left hand would automatically increase her grip with the left hand, but also experience involuntary contractions in the muscles of her right arm and hand. In this example, the postural contractions would be elicited in the muscles of both hands and arms even though it was the posture of only the left hand and arm that was disturbed.

The third scenario involves the **startle reaction**. This is a whole-body, reflex-like response to an unexpected loud auditory stimulus; sometimes it can be evoked with visual, vestibular, or somesthetic stimuli (Bisdorff, Bronstein, & Gresty, 1994; Bisdorff et al., 1999; Hawk & Cook, 1997). The startle reaction evokes rapid involuntary contractions that begin with an eye blink and progress to include bending of the neck, trunk and shoulders, elbows, fingers, and legs (Brown, 1995; Landis & Hunt, 1939). The reaction in the hands, which occurs less than 200 ms after the stimulus (loud sound), is for the person to make a fist. The startle reaction can have a marked effect on voluntary contractions (Nieuwenhuijzen, Schillings, Van Galen, & Duysens, 2000; Siegmund, Inglis, & Sanderson, 2001). For example, the reaction time was shortened by one half when a loud acoustic stimulus was superimposed on reaction-time movements (Valls-Solé, Rothwell, Goulart, Cossu, & Muñoz, 1999). The magnitude of the startle reaction is variable, including increases in amplitude with fear and arousal (Davis, 1984). Accordingly, an officer who is startled by a loud, unexpected noise while searching for a suspect with his weapon drawn would surely increase the grip force on the weapon, perhaps enough to cause an unintentional discharge.

CUES FOR FIREARMS TRAINING

Given that unintentional discharges are due to involuntary contractions, there are at least two strategies that firearms instructors can use to disrupt this association: (1) insist on a handling procedure that moves the index finger away from the trigger; and (2) train officers to reduce the number and intensity of involuntary contractions. The first strategy is currently used by many law-enforcement agencies and involves training officers to place the index finger outside the trigger guard and along the barrel of the gun until a decision has been made to discharge the weapon. This is a sound procedure because the force exerted by the index finger will vary as the officer performs various actions and the amplitude of these fluctuations in force will increase with stress (Christou et al., 2002; Flanagan & Wing, 1995; Noteboom et al., 2001). To prevent the fluctuations in index finger force from unintentionally depressing the trigger, it seems

wise to move the index finger away from the trigger mechanism until necessary. The increased time it takes to
move the index finger from alongside the barrel to the trigger when it is necessary does not impede the ability of an officer to discharge the weapon rapidly. Due to the organization of the muscles that control finger movements, however, this is not a fail-safe procedure. The fingers are controlled by a combination of small muscles in the hand and larger muscles in the forearm. To hold a handgun in a firing position, a person will use the hand muscles and the muscles on the front of the forearm (palm side) to grip the gun and a small muscle on the back of the forearm to keep the finger extended alongside the barrel. If events evoke involuntary contractions that cause the person to grip the gun more tightly, the force exerted by these muscles could overwhelm the action of the relatively small muscle that is used to keep the index finger straight alongside the barrel of the gun. Furthermore, it is difficult even with voluntary contractions to perform a movement with a single finger that does not influence the forces exerted by other fingers (Kilbreath & Gandevia, 1994; Kilbreath, Gorman, Raymond, & Gandevia, 2002; Li, Danion, Latash, Li, & Zatsiorsky, 2001). As a consequence of these effects, the index finger could be forced to join the gripping action and it could even slip inside the trigger guard and depress the trigger. The second strategy is to provide training programs that reduce the number and intensity of involuntary contractions. This raises two questions: Can involuntary contractions be trained? If so, what type of training is necessary? The answer to the first question is yes, it is possible to train involuntary contractions. One example involves the involuntary contractions associated with maintaining balance after a disturbance (Nashner, 1976). In this protocol, subjects stood on a platform that could be moved rapidly in either of two directions to stretch the calf muscles: (1) the platform is moved backward, which causes the standing person to sway forward at the ankle joint and thereby stretch the calf muscles; and (2) the platform is rotated toes upward and that the calf muscles are stretched. In the first case, the subject needs involuntary contractions in the calf muscles to arrest the forward sway and prevent a loss of balance. In the second case, however, the presence of involuntary contractions in the calf muscles will cause the subject to sway backward and hence to lose balance. Nashner & McCollum (1985) found that subjects could learn to suppress the unwanted voluntary contractions in the calf muscles with the second condition after several trials of practice. Similar findings have been reported for other reflexes (Chen, Chen, & Wolpaw, 2001; Kolb, Lachauer, Maschke, & Timmann, 2002; Nielsen, Crone, & Hultborn, 1993; Sveistrup & Woollacott, 1997; Wolf & Segal, 1996; Wolf, Segal, Heter, & Catlin, 1995). How could the involuntary contractions that tend to produce unintentional discharges be reduced with training? Although no amount of training has ever been shown to eliminate involuntary contractions, a strategy used in the fields of exercise prescription and rehabilitation medicine seems appropriate. This strategy is embodied in the Principle of Specificity, which states that the improvement in performance is specific to the activities used in the training program. For example, the increase in muscle strength that occurs after several weeks of training is greatest for the exercises used in training and is much less when the same muscles are used to perform other exercises (Semmler & Enoka, 2000). This specificity is even evident for exercises performed with one limb at a time compared with the same exercise done with both limbs together (Howard & Enoka, 1991; Rube &

Secher, 1990, Zhou, 2000). These research findings suggest that firearms training should include three elements: (1) officers must be placed in scenarios that are likely to evoke the types of involuntary contractions that can cause the unintentional discharge of a firearm; (2) presentation of these scenarios should manipulate the level of arousal of the trainees so that the training mimics the field experiences; and (3) training should be offered on a regular basis and more often than once a year. Thus, firearms training at a firing range will do little to reduce the involuntary contractions experienced by law-enforcement officers during field operations. In summary, scientific and clinical observations indicate that there are powerful influences between the limbs of the human body and that these effects are large enough to evoke an involuntary muscle contraction and cause the unintentional discharge of a firearm. The research literature identifies three scenarios that will predispose an individual to such involuntary muscle contractions. Firearms training should emphasize strategies that move the index finger away from the trigger until a decision has been made to fire the weapon and devise protocols that reduce the likelihood of an involuntary contraction by hand muscles during the performance of standard procedures.

References

Alexander, C. M., & Harrison, P. J. (2003). Reflex connections from forearm and hand afferents to shoulder girdle muscles in humans. *Experimental Brain Research, 148*, 277-282.

Andersen, O. K., Sonnenborg, F. A., & Arendt-Nielsen, L. (1999). Modular organization of human leg withdrawal reflexes elicited by electrical stimulation of the foot sole. *Muscle & Nerve, 22*, 1520-1530.

Arányi, Z., & Rösler, K. M. (2002). Effort-induced mirror movements. A study of transcallosal inhibition in humans. *Experimental Brain Research, 145*, 76-82.

Barbeau, H., Marchand-Pauvert, V., Meunier, S., Nicolas, G., & Pierrot-Deseilligny, E. (2000). Posture-related changes in heteronymous recurrent inhibition from quadriceps to ankle muscles in humans. *Experimental Brain Research, 130*, 345-361.

Bemben, M. G., Massey, B. H., Bemben, D. A., Misner, J. E., & Boileau, R.A. (1996). Isometric intermittent endurance of four muscle groups in men aged 20-74 yr. *Medicine and Science in Sports and Exercise, 28*, 145-154.

Bisdorff, A. R., Bronstein, A. M., & Gresty, M.A. (1994). Responses in neck and facial muscles to sudden free fall and a startling auditory stimulus. *Electromyography and Clinical Neurophysiology, 93*, 409-416.

Bisdorff, A. R., Bronstein, A. M., Wolsey, C., Gresty, M. A., Davies, A., & Young, A. (1999). EMG responses to free fall in elderly subjects and akinetic rigid patients. *Journal of Neurology, Neurosurgery, and Psychiatry, 66*, 447-455.

Brown, P. (1995). Physiology of startle phenomena. In S. Fahn, M. Hallett, H. O. Lüders, & C. D. Marsden (Eds.), *Negative Motor Phenomena* (pp. 273-287). Philadelphia: Lippincott-Raven.

Chen, X. Y., Chen, L., & Wolpaw, J. R. (2001). Time course of H-reflex conditioning in the rat. *Neuroscience Letters, 302*, 85-88.

Christou, E. A., Jakobi, J. M., Critchlow, A., Fleshner, M., Hutchison, K., & Enoka, R. M. (2002). Arousal-induced alterations in muscle activation and fluctuations in pinch-grip force are enhanced in older adults. *Society for Neuroscience Abstracts*.

Cordo, P. J., & Nashner, L. M. (1982). Properties of postural adjustments associated with rapid arm movements. *Journal of Neurophysiology*, *47*, 287-302.

Corna, S., Galante, M., Grasso, M., Nardone, A., & Schieppati, M. (1996). Unilateral displacement of lower limb evokes bilateral EMG responses in leg and foot muscles in standing humans. *Experimental Brain Research*, *109*, 83-91.

Darling, W. G., & Cole, K. J. (1990). Muscle activation patterns and kinetics of human index finger movements. *Journal of Neurophysiology, 63*, 1098-1108.

Davis, M. (1984). The mammalian startle response. In R. C. Eaton (Ed.), *Neural Mechanisms of Startle Behavior* (pp. 287-351). New York: Plenum.

Delwaide, P. J., Sabatino, M., Pepin, J. L., & La Grutta, V. (1988). Reinforcement of reciprocal inhibition by contralateral movements in man. *Experimental Neurology*, *99*, 10-17.

Delwaide, P. J., & Toulouse, P. (1983). The Jendrassik maneuver: quantitative analysis of reflex reinforcement by remote voluntary muscle contraction. In J. E Desmedt (Ed.), *Motor Control Mechanisms in Health and Disease* (pp. 661-669). New York: Raven.

Dietz, V., Horstmann, G. A., & Berger, W. (1989). Interlimb coordination of leg muscle activation during perturbations of stance in humans. *Journal of Neurophysiology, 62*, 680-693.

Dimitrijevic, M. R., McKay, W. B., Sarjanovic, I., Sherwood, A. M., Svirtlih, L., & Vrbová, G. (1992). Co-activation of ipsi- and contralateral muscle groups during contraction of ankle dorsiflexors. *Journal of the Neurological Sciences, 109*, 49-55.

Duchateau, J., & Enoka, R. M. (2002). Neural adaptations with chronic activity patterns in ablebodied humans. *American Journal of Physical Medicine and Rehabilitation, 81* (Suppl), S17- S27.

Elger, K., Wing, A., & Gilles, M. (1999). Integration of the hand in postural reactions to sustained sideways force at the pelvis. *Experimental Brain Research, 128*, 52-60.

Enoka, R. M. (2002). *Neuromechanics of Human Movement*, 3rd edition. Champaign, IL: Human Kinetics.

Flanagan, J. R., & Wing, A. M. (1995). The stability of precision grip forces during cyclic arm movements with a hand-held load. *Experimental Brain Research, 105*, 455-464.

Galloway, J. C., & Koshland, G. F. (2002). General coordination of shoulder, elbow and wrist dynamics during multijoint arm movements. *Experimental Brain Research, 142*, 163-180.

Geffen, G. M., Jones, D. L., & Geffen, L. B. (1994). Interhemispheric control of manual motor activity. *Behavioral Brain Research, 64*, 131-140.

Hawk, L. W., & Cook, E. W. (1997). Affective modulation of tactile startle. *Psychophysiology, 34*, 23-31.

Horak, F. B., & Macpherson, J. M. (1996). Postural orientation and equilibrium. In L. B. Rowell & J. T. Shepherd (Eds.), *Handbook of Physiology, Section 12. Exercise: Regulation and Integration of Multiple Systems* (pp. 255-292). New York: Oxford University Press.

Hortobágyi, T., Lambert, N. J., & Hill, J. P. (1997). Greater cross education following training with muscle lengthening than shortening. *Medicine and Science in Sports and Exercise, 29*, 107-112.

Hortobágyi, T., Scott, K., Lambert, J., Hamilton, G., & Tracy, J. (1999). Cross-education of muscle strength is greater with stimulated than voluntary contractions. *Motor Control, 3*, 205-219.

Howard, J. D., & Enoka, R. M. (1991). Maximum bilateral contractions are modified by neurally mediated interlimb effects. *Journal of Applied Physiology*, *70*, 306-316.

Kilbreath, S. L., & Gandevia, S. C. (1994). Limited independent flexion of the thumb and fingers in human subjects. *Journal of Physiology, 479*, 487-497.

Kilbreath, S. L., Gorman, R. B., Raymond, J., & Gandevia, S. C. (2002). Distribution of the forces produced by motor unit activity in the human flexor digitorum profundus. *Journal of Physiology, 543*, 289-296.

Koceja, D. M. (1995). Quadriceps mediated changes in soleus motoneuron excitability. *Electroencephalography and Clinical Neurophysiology*, *35*, 25-30.

Kolb, F. P., Lachauer, S., Maschke, M., & Timmann, D. (2002). Classical conditioning of postural reflexes. *Pflugers Archives, 445*, 224-237.

Koltzenburg, M., Wall, P. D., & McMahon, S. B. (1999). Does the right side know what the left is doing? *Trends in Neuroscience, 22*, 122-127.

Landis, C., & Hunt, W. A. (1939). *The Startle Pattern*. New York: Farrar & Rinehart.

Li, S., Danion, F., Latash, M. L., Li, Z-M., & Zatsiorsky, V. M. (2001). Bilateral deficit and symmetry in finger force production during two-hand multifinger tasks. *Experimental Brain Research, 141*, 530-540.

Li, Z-M., Latash, M. L., Newell, K. M., & Zatsiorsky, V. M. (1998). Motor redundancy during maximal voluntary contraction in four-finger tasks. *Experimental Brain Research*, *121*, 71-78.

Liepert, J., Dettmers, C., Terborg, C., & Weiller, C. (2001). Inhibition of ipsilateral motor cortex during phasic generation of low force. *Clinical Neurophysiology, 112*, 114-121.

Marsden, C. D., Merton, P. A., & Morton, H.B. (1983). Rapid postural reactions to mechanical displacement of the hand in man. In J. E. Desmedt (Ed.), *Motor Control Mechanisms in Health and Disease* (pp. 645-659). New York: Raven, 1983.

Mayston, M. J., Harrison, L. M., & Stephens, J. A. (1999). A neurophysiological study of mirror movements in adults and children. *Annals of Neurology, 45*, 583-594.

McIlroy, W. E., & Maki, B. E. (1995). Early activation of arm muscles follows external perturbation of upright stance. *Neuroscience Letters, 184*, 177-180.

Nashner, L. M. (1976). Adapting reflexes controlling the human posture. *Experimental Brain Research, 26*, 59-72.

Nashner, L. M., & McCollum, G. (1985). The organization of human postural movements: a formal basis and experimental synthesis. *Behavioral and Brain Sciences*, *8*, 135-167.

Nielsen, J., Crone, C., & Hultborn, H. (1993). *H*-reflexes are smaller in dancers from The Royal Danish Ballet than in well-trained athletes. *European Journal of Applied Physiology, 66*, 116-121.

Nieuwenhuijzen, P. H. J. A., Schillings, A. M., Van Galen, G. P., & Duysens, J. (2000).Modulation of the startle response during human gait. *Journal of Neurophysiology, 84*, 65-74.

Noteboom, J. T., Barnholt, K. R., & Enoka, R. M. (2001). Activation of the arousal response and impairment of performance increase with anxiety and stressor intensity. *Journal of Applied Physiology, 91*, 2093-2101.

Pierrot-Deseilligny, E., Bussel, B., Sideri, G., Cathala, H. P., & Castaigne, P. (1973). Effect of voluntary contraction on H reflex changes induced by cutaneous stimulation in normal man. *Electroencephalography and clinical Neurophysiology*, *34*, 185-192.

Prochazka, A., Clarac, F., Loeb, G. E., Rothwell, J. C., & Wolpaw, J. R. (2000). What do *reflex* and *voluntary* mean? Modern views on an ancient debate. *Experimental Brain Research, 130*, 417-432.

Radhakrishnan, S., & Nagaravindra, M. (1993). Analysis of hand forces in health and disease during maximum isometric grasping cylinders. *Medical & Biological Engineering & Computing*, *31*, 372-376.

Rube, N., & Secher, N. H. (1990). Effect of training on central factors in fatigue following two- and one-leg static exercise in man. *Acta Physiologica Scandinavica*, *141*, 87-95.

Sainburg, R. L., & Kalakanis, D. (2000). Differences in control of limb dynamics during dominant and nondominant arm reaching. *Journal of Neurophysiology, 83*, 2661-2675.

Schieppati, M., & Nardone, A. (1995). Time course of 'set'-related changes in muscle responses to stance perturbations in humans. *Journal of Physiology, 487*, 787-796.

Scholz, J. P., Schöner, G., & Latash, M. L. (2000). Identifying the control structure of multijoint coordination during pistol shooting. *Experimental Brain Research, 135*, 382-404
.
Semmler, J. G., & Enoka, R. M. (2000). Neural contributions to changes in muscle strength. In V. M. Zatsiorsky (Ed.), *Encyclopedia of Sports Medicine: Biomechanics in Sport* (pp. 3-20) Oxford, UK: Blackwell Science.

Serrien, D. J., & Wiesendanger, M. (2001). Dissociation of grip/load-force coupling during a bimanual manipulative assignment. *Experimental Brain Research, 136*, 417-420.

Sherrington, C. S. (1910). Flexion-reflex of the limb, crossed-extension reflex and reflex stepping and standing. *Journal of Physiology, 40*, 28-121.

Shima, N., Ishida, K., Katayama, K., Morotome, Y., Sato, Y., & Miyamura, M. (2002). Cross education of muscular strength during unilateral resistance training and detraining. *European Journal of Applied Physiology, 86*, 287-294.

Shinohara, M., Keenan, K. G., & Enoka, R. M. (2003). Contralateral activity in a homologous hand muscle during voluntary contractions is greater in old adults. *Journal of Applied Physiology, 94*, 966-974.

Siegmund, G. P., Inglis, J. T., & Sanderson, D. J. (2001). Startle response of human neck muscles sculpted by readiness to perform ballistic head movements. *Journal of Physiology, 535*, 289-300.

Sonnenborg, F. A., Andersen, O. K., Arendt-Nielsen, L., & Treede, R-D. (2001). Withdrawal reflex organization to electrical stimulation of the dorsal foot in humans. *Experimental Brain Research, 136*, 303-312.

Sveistrup, H., & Woollacott, M. H. (1997). Practice modifies the developing automatic postural response. *Experimental Brain Research, 114*, 33-43.

Talsania, J. S., & Kozin, S. H. (1998). Normal digital contribution to grip strength assessed by a computerized digital dynamometer. *Journal of Hand Surgery, 23B*, 162-166.

Valls-Solé, J., Rothwell, J. C., Goulart, F., Cossu, G., & Muñoz, E. (1999). Patterned ballistic movements triggered by a startle in healthy humans. *Journal of Physiology, 516*, 931-938.

Weinburg, R. S., & Hunt, V. V. (1976). The interrelationships between anxiety, motor performance, and electromyography. *Journal of Motor Behavior*, *8*, 219-224.

Williams, J. H., & Barnes, W. S. (1989). The positive inotropic effect of epinephrine on skeletal muscle: a brief review. *Muscle & Nerve*, *12*, 968-975.

Wolf, S. L., & Segal, R. L. (1996). Reducing human biceps brachii spinal stretch reflex magnitude. *Journal of Neurophysiology, 75*, 1637-1646.

Wolf, S. L., Segal, R. L., Heter, N. D., & Catlin, P. A. (1995). Contralateral and long latency effects of human biceps brachii stretch reflex conditioning. *Experimental Brain Research, 107*, 96-102.

Yue, G., & Cole, K. J. (1992). Strength increases from the motor program: a comparison of training with maximal voluntary and imagined muscle contractions. *Journal of Neurophysiology*, *67*, 1114-1123.

Zedka, M., & Prochazka, A. (1997). Phasic activity in the human erector spinae during repetitive hand movements. *Journal of Physiology, 504*, 727-734.

Zehr, E. P., Collins, D. F., & Chua, R. (2001). Human interlimb reflexes evoked by electrical stimulation of cutaneous nerves innervating the hand and foot. *Experimental Brain Research, 140*, 495-504.

INVOLUNTARY FIREARMS DISCHARGE – DOES THE FINGER OBEY THE BRAIN?

Christopher Heim, Eckhard Niebergall & Dietmar Schmidtbleicher

It was 2.30 a.m. In search of a fleeing suspect, Officer J. had parked his car and was standing in a dark backyard, his service weapon drawn. He was contemplating going back to his vehicle for his flashlight when suddenly he saw a shadow move about five yards in front of him. At that exact moment he was blinded by a flash of light that was immediately followed by a loud noise.

When questioned afterwards, Officer J. could only recall raising his arms to protect himself from the light. It was only when he counted the shells in his gun that he noticed that the loud noise he had heard after the flash had been his own gun going off. Thankfully no one had been injured – the projectile had hit a shed on the other side of the yard.

The shadow that had startled officer J. turned out to have been a 14-year old boy, who testified that he had always wanted to take a photograph of "a policeman in action" (first published in the German Polizeitrainer-Magazin 2/1998, page 10).

Over the past few years' incidents of involuntary discharges of police firearms – as described above – have been a cause of growing concern throughout Germany. In the early 1990s several police officers were prosecuted for injuring or even killing suspects by involuntarily discharging their weapons in the line of duty. Since 1999, at least four more suspects have been killed by involuntary discharges from police firearms. In 2001, a policeman accidentally killed his colleague when his weapon went off as they left a building *after* they had searched it for intruders. In the United States of America, similar incidents have been reported: in an article published in 1997, Edward Tully, currently Executive Director of NEIA, lists eleven cases of officers killing or injuring suspects, colleagues or even themselves by unintentionally discharging their firearm. Even earlier, Geller and Scott (1992) report 62 unintentional discharges by NYPD officers in 1990 alone. In a more recent article published in the Washington Post in 2002, O'Brien describes three unintentional discharges in Onondaga County (NY), one of these happening to one of the most experienced officers in the department: a firearms instructor unintentionally fired a hole through a classroom wall while teaching a class how to remove a weapon from the holster.

Not all incidents of involuntary firearms discharges are subject to court cases; often enough, the bullet will – luckily – go astray and for example "get stuck in the door frame", not harming anyone. However, in some incidents – at least in Germany – police officers have been sentenced as a result of such unfortunate events. For example, in 1995 three police officers were called to investigate a possible burglary at three a.m. in the morning. One officer stood alone with his weapon drawn in a dark backyard while two colleagues entered the house to search for the intruder. When the suspect saw the policemen entering the building, he climbed out of a window on the second floor and tried to slide down the drain pipe. Unfortunately for him, the drain pipe gave way and he fell from about five metres height. The officer, startled by the loud sound, looked up to see a shadow falling towards him and raised his hands in protection…the bullet passed through the suspect's neck while he was still in mid-air. The officer was sentenced to a fine of 8000 Deutschmarks because of negligent homicide.

This court sentence is an example of consequences officers had to face only a dozen years ago when charged with injuring or killing suspects (or innocent bystanders) by involuntarily discharging their firearms. Due to the dearth of information about the mechanisms that may underlie such incidents, prosecutors and defence lawyers alike were confronted with the same question: is it indeed possible to involuntarily overcome the trigger pull (which usually lies between four and six pounds) of a standard police weapon?

In an effort to find answers to this question Professor Dr. Roger Enoka, one of the most renowned sports physiologists and director of the Human Performance Research Laboratories in Arizona (USA), was invited to testify in a court case held in Frankfurt, Germany in 1995. Professor Enoka was one of the first researchers to examine the circumstances under which involuntary firearms discharges may occur. Based on a review of relevant literature he not only confirmed the possibility of involuntarily discharging a firearm, but also offered explanations of their possible causes: involuntary discharges, Enoka proposed, may result from involuntary muscle contractions in the hand holding a firearm. All human movements (and thus also the flexion of the index finger when pulling a trigger), so Enoka, are based on muscle contractions, which are generally caused by a direct command from the brain (known as a voluntary contraction). However, muscles can also be activated by signals that arise from other locations within the nervous system besides the brain, and such activation may produce a muscle contraction that is not the result of a conscious decision. This is especially likely to occur when the human body has to react quickly to an unexpected incident, for instance (as is illustrated at the outset) a light flashing directly in front of an individual. According to Enoka, there are three scenarios that can elicit involuntary muscle contractions that are sufficiently strong to bring about the involuntary discharge of a firearm: sympathetic contractions, loss of balance and startle reaction.

The term sympathetic contraction refers to the fact that an involuntary contraction may occur in the muscles of one limb when the same muscles in the other limb are performing an intended forceful action. In physiology literature this effect is known as a mirror movement, with the intensity of the sympathetic contraction depending on the amount of force exerted during the intended action. In policing, a common situation that may evoke such a sympathetic contraction would be, for example, a law enforcement officer attempting to restrain a struggling suspect with one hand while holding a handgun in the other.

The second scenario described by Enoka involves loss of balance. When balance is disturbed the human body evokes rapid involuntary contractions to return itself to a position of equilibrium. Thereby the involuntary contractions used to prevent a fall depend on the options available to counteract the disturbance of balance. Usually, compensatory movements following gait perturbations primarily involve correcting movements of the lower limbs to keep the body in balance, whereas movements of the arms are restricted to their extension forwards as a safeguard to counter an eventual fall. When an individual is holding a handle for support, there is, however, a tendency to use the arm muscles to maintain balance rather than the leg muscles. Under such circumstances the focal point of automatic postural activity is any contact point an individual has with his or her surroundings. In other words, if an individual's posture is disturbed while grasping an object, for instance a handgun, he or she is likely to grasp it more forcefully.

Startle reaction, the third scenario identified by Enoka, is a whole-body reflex-like response to an unexpected stimulus, possibly a loud noise. It evokes rapid involuntary contractions that begin with the blink of an eye and spread to all muscles throughout the body. The reaction of the hands occurs less than 200ms after the stimulus and leads to individuals clenching their fists. Enoka concludes: "Accordingly, an officer who is startled by a loud, unexpected noise while searching for a suspect with his weapon drawn would surely increase the grip force on the weapon, perhaps enough to cause an involuntary discharge."

However, no matter how feasible Enoka's explanations may have been and no matter to what extent they were corroborated by analyses of involuntary discharges (for instance by Tully, see above), they were not able to unequivocally answer the central question asked in German courtrooms: is it indeed possible to involuntarily overcome the trigger pull of a standard police weapon? The judges criticized that there was no empirical evidence that supported Enoka's theories, namely that involuntary muscle contractions brought about by neurological connections between limbs may indeed result in sufficient force being produced in the hand carrying a firearm to involuntarily overcome the trigger pull of a standard police service weapon. Moreover, there was a second question left unanswered: German police regulations unambiguously stipulate that when holding a gun, the index finger has always to be placed *outside* the trigger guard and may only be placed on the trigger when a *conscious* decision to fire has been taken. If these regulations were adhered to, incidents of involuntary discharge should be impossible.

During his stay in Germany, Professor Enoka met with Eckhard Niebergall, president of the German Police Trainers Association (Polizeitrainer in Deutschland e.V.) and Professor Dr. Dietmar Schmidtbleicher, also a sports physiologist like Enoka and Head of the Department of Human Movement Science at the University of Frankfurt. At this time, Professor Schmidtbleicher's department possessed one of the few laboratories in Germany that had the means of empirically validating the theories proposed

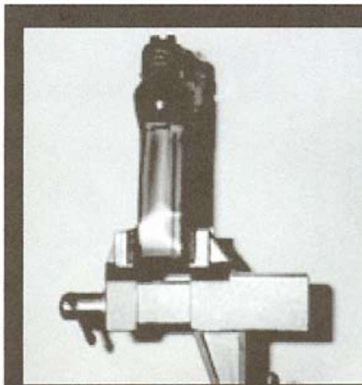


Figure 1: Attachment of the force sensing resistors on the back of the hand-stock.

Figure 2: Attachment of the force sensing resistors on the trigger and fastening of the sensors with tape.

by Enoka. Thus, with the aim of setting the jurisdiction regarding cases of involuntary firearms discharge on solid grounds, a research program was initiated.

For their research, Professor Schmidtbleicher's team fixed force sensing resistors to the handstock and trigger of a pistol *(see Figures 1 and 2 above)*, and asked 34 randomly chosen police officers to react to a set case. During the trial the force sensors implemented in the trial apparatus made it possible to register any changes in pressure exerted on the firearm by the participating officers. The results suggested that, despite the above mentioned regulations stipulating to keep the index finger away from the trigger *at all times* unless they are ready to fire, police officers may – in certain situations – not only make contact with the trigger, but that this contact may even go unnoticed: despite force readings registered by the sensors during the trial and video footage of the incidents clearly showing that seven of the 34 participating officers

Figure 3: Example of a force-time-curve registered for a participating officer in study one. From top to bottom: force exerted on the back of the handstock, force exerted on the trigger. The y-axis shows the electrical signal (in volts) registered by the force sensors, the x-axis shows the timeline of the trial.

(20.6%) had laid their index finger on the trigger at some point during the scenario, *all* participants, when questioned after the trial, maintained that they had not made contact with the trigger. Moreover, none of the participating officers could give any particulars about the force exerted on the hand stock, even though a noticeable increase in the amount of pressure exerted was registered *(see Figure 3 above)*.

With this knowledge that police officers may indeed no consciously make contact with the trigger during critical incident situations in mind, Professor Schmidtbleicher's team turned their attention to empirically validating the assumptions made by Enoka, namely that involuntary discharges may be the result of unintended muscle contractions. For this study, 25 participants (13 women and 12 men between 21 and 39 years of age) were asked to perform a series of trials that necessitated specific movements of only one limb while holding a pistol fixed with force sensing resistors *(see Figure 4 below)*. These sensors recorded changes in the pressure exerted on the firearm during the trial, making it possible to unequivocally determine if and to what extend activity in particular limbs may lead to an increase in the pressure exerted on the gun. The results clearly indicate that motor activity in other limbs may indeed lead to a significant increase in the force exerted on a firearm *(see Figures 5 and 6 at right)* and that the resulting pressure on the trigger can be sufficient to (involuntarily) overcome the trigger pull of most police weapons (see Table 1). These findings not only validated the theories proposed by Enoka, but, in doing so, also provided scientific evidence of the fact that it is indeed possible for police officers to *involuntarily* discharge a weapon in the line of duty.

Throughout Germany, at least, the findings had a significant impact on legal proceedings: in 1999, based on the statements made by Professor Schmidtbleicher and Eckhard Niebergall, a judge was prepared, for the first time, to consider the possibility of an involuntary discharge as mitigating circumstances for an officer impeached of killing a suspect when his gun went off during a struggle.

These important findings have resulted in a continued scientific interest, in both involuntary discharges and also in policing more generally. Thus, an exceptionally well resourced collaborative study between the police force of the German state Hesse and the University of Frankfurt is currently underway which intends to shed further light onto factors of gun handling during everyday police work. Aims of the study are thus not only to gain an even better understanding of the mechanisms that may lead to involuntary discharges, but also to get a better insight into tactical situations in general: are there – apart from the factors described by Enoka and empirically validated by Professor Schmidtbleicher's team – further factors that may increase the likelihood of involuntarily firing a gun? For example, what roles do cognition and perception play in cases of involuntary firearms discharge? More generally speaking: how do police officers perceive tactical situations, and to what extent are they limited in their ability to make use of sensory information appropriately? Moreover, do work experience, training experience and/or rank have any influence how officers cope with dangerous situations or how officers handle their firearms – and if so, in what way?

For this study, a unique measuring device was constructed by installing a number of sensors into a standard service weapon *(see Figure 7 at right)*. This weapon enables the scientists to register in real time the forces exerted on the handstock and the trigger, as well as record the current position of the trigger (i.e. the extent to which it has been pulled) and the horizontal and vertical position of the weapon (the direction, in which the weapon is aiming). Equipped with this

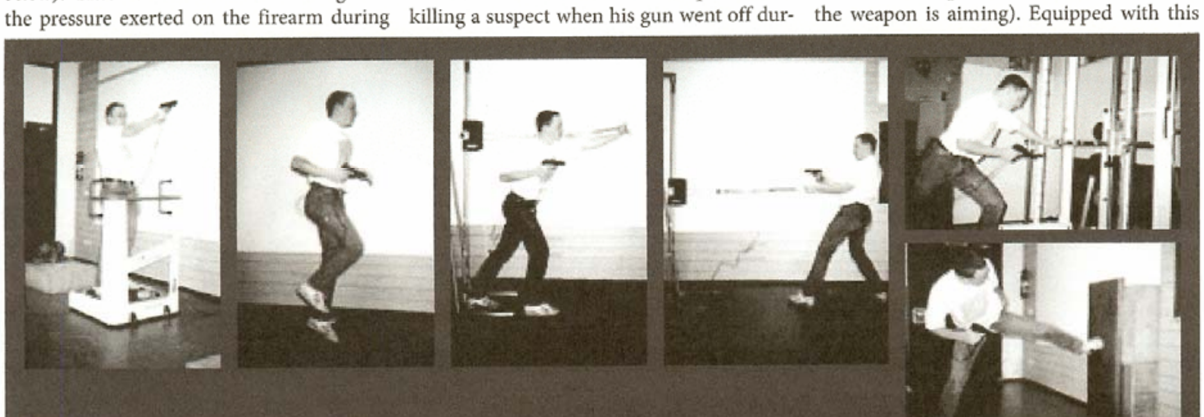


Figure 4: Trial settings in Study two.

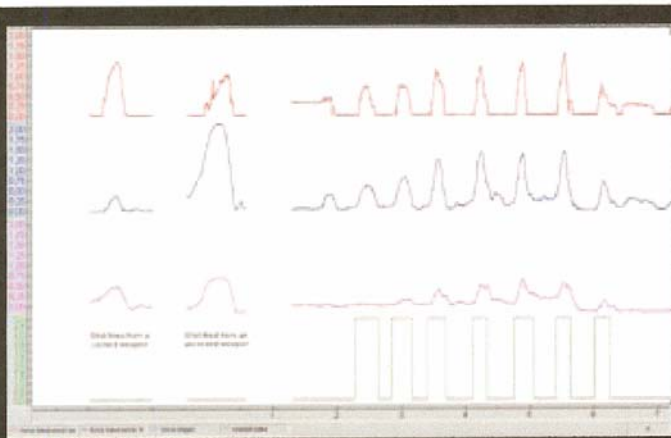


Figure 5: Exemplary force-time-curve registered in the trial "jump" in comparison to the forces reached when actually firing the weapon. From top to bottom: force exerted on the trigger, force exerted on the front of the handstock, force exerted on the back of the handstock. The bottom graph shows the trigger signal, marking the contact with the force plate.

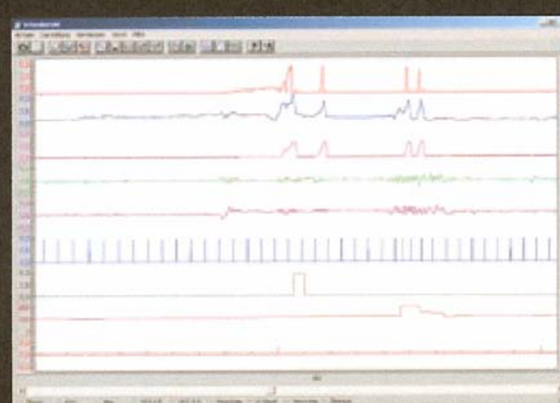
Figure 6: Mean force values for all participants registered at the back of the hand stock in the different trials in comparison to holding the gun when not performing a trial (reference value).

Figure 7: Force sensing resistors embedded in the handstock. The sensors were subsequently disguised.

Trial	n	uncocked	cocked
jump both legs submax	10	1	2
jump both legs max	10	3	3
jump ipsilateral submax	10	0	1
jump ipsilateral max	8	0	1
jump kontralateral submax	10	1	2
jump kontralateral max	10	1	1
bar pull	13	0	3
bar push	11	0	2
balance	12	1	4
pulley pull	13	0	2
pulley push	13	0	2
kick ipsilateral	11	1	3
kick contra lateral	13	1	3
Total	144	9	29

Table 1: Number of participants exceeding the pistol's release values for a cocked (trigger pull of 56.9 Newton) and uncocked (trigger pull of 22 Newton) weapon during the trials. At each trial the number of participants exceeding the release values at least once was counted as one, irrespective of the number of times a participant exceeded his personal release value. As mentioned in the text, a number of participants took their finger of the trigger during the trial. Thus, the table reads as follows: in the trial "jumping on both legs sub maximally", 10 (n) participants kept their finger on the trigger, of which one exerted enough pressure on the trigger to release a shot from an uncocked weapon, one further participant (adding up to two) exerted enough pressure to release a shot from a cocked weapon.

Figure 8: Example of the measurement values registered for a participating officer. From top to bottom: force exerted on the trigger, force exerted on the handstock, current position of the trigger, vertical and horizontal movement of the weapon, participant's heart rate, trigger signal, timeline in seconds.



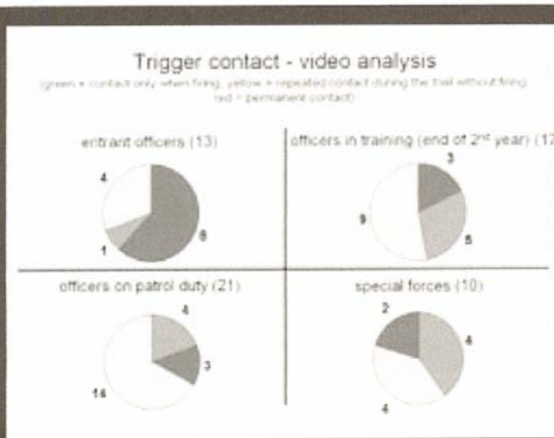


Figure 9: Trigger contacts by group during the trial.

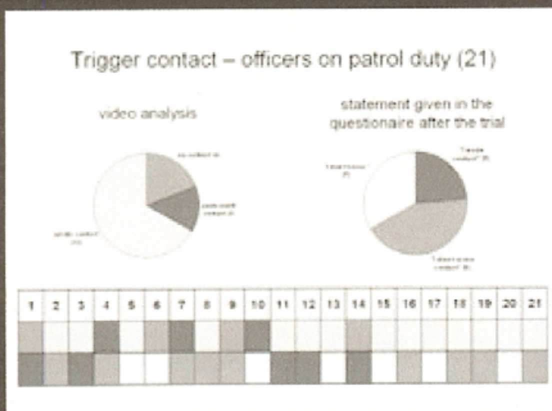


Figure 10: Comparison of the number of trigger contacts registered by the force sensing resistors with the statements given by participating officers when questioned after the trial. The bottom table shows the results of the measurements (second line) in comparison with the officer's statements in the questionnaire (third line). Identical colors symbolize concurrence between the officer's statements in the questionnaire and the analysis of video footage.

measuring device, 260 officers of different ages, gender, ranks and with different years of service and training experiences took part in a training scenario in the Hesse State Police Academy in Wiesbaden, Germany. In this training scenario (see the adjoining box), participating officers were individually confronted with a set case with an identical number of suspects, together with comparable auditory disturbances. During the training simulation the sensors installed in the weapon recorded the pressure participants exerted on the handstock, whether they made contact with the trigger with their index finger and, if so, to which degree the trigger was pulled and in which position the weapon was held. Additionally, participants' heart rates were monitored. All data were transferred to a computer by means of a telemetrical device (see Figure 8). Additionally, the situation was recorded with cameras from three different angles, allowing not only for retrospective comparison of the recorded data with the actual event, but also for an evaluation of the course of action each participant took during the setting. After going through the scenario participants were asked to fill in a questionnaire relating to their subjective experience of the operation.

First results of this study – based on the analysis of 66 participating officers – have been presented at the European Police Trainers Conference in Nuremberg, Germany (March 2006) and Jane's Annual Less Lethal Weapons Conference in Leeds, UK (October 2006). These are subsequently summarized.

The 66 officers analyzed to date can be divided into four different groups:

- 14 entrant officers who had started their training three weeks prior and thus had no weapons training whatsoever (mean age 21.7 ± 2.9 years)
- 19 officers in training at the end of their second year in the police school (mean age 21.3 ± 2.3 years)
- 22 regular officers on patrol duty (mean age 37.6 ± 8.9 years, mean duration on the force 17.6 ± 10.7)
- 11 officers belonging to Special Forces (SEK, MEK, PS) (mean age 30.2 ± 3.5 years, mean duration on the force 8.6 ± 4.8 years)

The first noticeable result is that in all groups a majority of officers placed their index finger inside the trigger guard at some point in the scenario *without actually firing the gun* (a few officers even had permanent contact with the trigger during the full length of the trial), thus violating police regulations to keep the finger off the trigger until a decision to fire has been taken, with the highest proportion – perhaps unsurprisingly – being reached in the group of the entrant officers who had not yet received any weapons training *(see Figure 9 at left)*. Analysis of the questionnaires filled out by the officers after the trial also confirmed that this violation of police rules appeared to occur nonconsciously: only very few participants were able to correctly give information about the position of their index finger during the trial *(Figure 10, left, exemplarily shows the answers given by the group of officers on patrol duty)*.

Even though only about a quarter of the data from participating officers have been analyzed to date, the results already offer new insights into the occurrence of incidents of involuntary discharge. During the scenario, four of the 66 participating officers (one out of each "trainee" group and two out of the group of officers on patrol duty) fired their weapon at a point in which there was no obvious threat either for themselves or for the lives of others: in all four cases the officers shot just after the second suspect had stepped out of the bank but *before* he had pulled his weapon. In all four cases the officer stood at least five meters away from either suspect at the time of the shooting, and in all four cases the officer shot in an immediate response (less than 300ms after) to the startle stimulus (the gun being fired by a trainer behind his or her back). Furthermore, in all four cases the officer had his or her index finger lying on the trigger immediately prior to the startle stimulus occurring.

It is unclear, however, what exactly caused the officers to fire since none of the three scenarios described by Enoka (sympathetic contractions, loss of balance or the physiological human startle reaction) appear to be applicable to the situation: none of the participants lost their balance at any time in the scenario, at no time did the officers forcefully use any other limb when holding the gun in their hand and in only one of the four cases (and even then only after repeatedly viewing the videotape of the scene in slow motion) could the whole-body reflex-like response in reaction to the unexpected stimulus (the shot fired behind the back of the officer) described by Enoka be found.

These results lend support to the notion described above that there are further factors that could "contribute" to involuntary discharges of police firearms. First clues concerning what these may be are to be found in the questionnaires filled in by the participants after the trial: in the questionnaire, one of the four officers wrote that he had fired at "the man with the gun", another justified his action by stating that "the third man came out of the bank and shot". Both statements are verifiably inaccurate: in both cases, the second suspect had not even drawn his weapon at the time the officer fired. This suggests that the officer's inaccurate perception may have been the cause for his (wrongful) actions. At the same time, the question must be asked how well officers are in fact able to accurately report on what has happened: there is sufficient data in scientific literature that shows that humans are not very good at reporting on their mental states. In other words: when people attempt to report on their cognitive processes leading to their response to certain stimulus, they often do not do this on the basis of any true introspection. Instead, their reports may be based on a priori judgments about the extent to which a particular stimulus *may* have been the cause for their action: the statements made in the questionnaire may be the result of the officers trying to make sense of and/or justify their actions for themselves *after* the event. This will be a key issue to look at in the further analysis. **TFI**

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Endnotes

Enoka R. (2003). Involuntary muscle contractions and the unintentional discharge of a firearm. Law Enforcement Executive Forum, 3 (2), 27-39

Geller WA & Scott MS (1992). Deadly Force: What we know. A Practitioner's Desk Reference on Police-Involved Shootings. Washington, DC: Police Executive Research Forum.

Heim C, Schmidtbleicher D & Niebergall E (2006). The risk of involuntary firearms discharge. Human Factors 48 (3), 413-421

Heim C, Schmidtbleicher D & Niebergall E (2006). Towards an understanding of involuntary firearms discharges: Possible risks and implications for training. Policing: An International Journal of Police Strategies & Management 29 (3), 434-450

O'Brien J (2002). Experts find Glocks prone to accidents. www.cominolli.com/postnews2.pdf

Tully E (1996). Unintentional Discharge of Police Weapons (Part 1). Blue Line Magazine, Vol. 8 No.10, S. 18-21

Tully E (1997). Unintentional Discharge of Police Weapons (Part 2). Blue Line Magazine, Vol. 9 No.1, S. 9-11

CASE DESCRIPTION:

The trial was conducted in the interactive training centre at the Hesse State Police Academy in Wiesbaden, Germany. This features a realistic reconstruction of a street in the city of Wiesbaden with a hotel, a restaurant and two banks.

Before the trial, participating officers were given a general description of the situation they were about to encounter: "You are on your beat in the streets of Wiesbaden together with your partner, an officer in training. Your call sign is NERO 13/01" (the role of the officer in training was played by an instructor). Immediately prior to entering the scenario, this description was specified as follows: "NERO 13/01. We have just received a distress call from a man named Rücker. Mr. Rücker lives in the Aunelstreet beside the Bank of Nassau. He has in-formed us that a man was shot in front of his house. We have no further information on the culprit other than he is about 1,90m tall and is dressed in a dark jacket. He is armed with either a pistol or a revolver. A backup and an ambulance are underway. Be cautious."

Upon entering the scenario, the officers first see a woman lying on the floor about ten meters (twelve yards) in front of them crying for help (Figure 11, Picture 1). When addressed by the officer, the woman will tell him that she has been shot at and wounded by a man dressed in dark clothes and that this man has fled "around the corner". If questioned further, the woman will only repeat what she has said, thus rendering no further information to the officer. At the same time, a second person lying around the corner (and thus not visible for the officer) will begin to cry for help, drawing the officer away from the injured woman and around the corner. When turning the corner, the officer sees a man kneeling with his back towards him (first suspect) over an obviously injured second person, who is lying on the ground about seven meters (8-9 yards) away from the officer. When addressed by the officer, the man turns round and stands up (Figure 11, Picture 2), exposing a knife in his right hand but otherwise offering no threat to the officer and obviously willing to talk. During the ensuing "conversation", a man dressed in dark clothes and wearing a mask (second suspect) steps out of the neighboring bank, clearly showing his *empty* hands (Figure 11, Picture 3). At the same moment, in order to startle the officer, a gun is fired *behind the officer's back* by an instructor. The second suspect starts to shout at the first suspect with menacing gestures. To underline this, he pulls a gun out of his pocket and holds it, clearly visible for the officer, in *low-ready position* pointing in the direction of the first suspect. When addressed, the second suspect immediately turns towards the officer (gun still in the *low-ready position*) and threatens to kill him (eventually pointing his gun directly at the officer) so that the officer is forced to shoot to save him- or herself. Thereafter, the scenario is continued until the officer has secured the first suspect (Figure 11, Picture 4) and gained control of the situation.

Figure 11: Description of the training scenario. Top left (1): The officer entering the scenario. Top right (2): The officer turns the corner and addresses the first suspect. Bottom left (3): The second suspects steps out of the bank with his hands raised and empty. Bottom right (4): Scene after the exchange of fire. The persons wearing the yellow jerseys do not play a part in the scenario.

The Trigger Finger Dilemma: A Perspective Revisited

from Issue #20, January, 1992

by Thomas J. Aveni

Much has been written as of late concerning appropriate trigger management relevant to the semiautomatic pistol. Given the enormous evolution of pistol design in the last decade it's not surprising that some traditional concepts that had been commonly applied to double-action pistols (and revolvers) are now being questioned. Much of the controversy here can be attributed to one's definition of what constitutes efficient pistol design. My own personal thoughts in this area are that the ideal service pistol should afford an ergonomic blend of speed, precision, reliability and safety. While a "foolproof" firearm design is probably something unattainable (and many would argue undesirable), there should be more consideration given to safety than many firearms designers would have us think. The ubiquitous factory disclaimers advising consumers to leave pistol chambers empty were obviously not formulated with law enforcement personnel in mind, and police firearms trainers are thereby bequeathed the challenge of balancing safety with the obvious tactical mandate for a fully charged weapon.

One of the most serious challenges that we as firearms trainers must meet is that of preparing our people for the ravages of severe stress that they may have to endure in a life threatening confrontation. We can never fully replicate it in a safe training environment, but we must strive to do so as best we can without compromising safety. The challenge here is nothing short of enormous if taken seriously. All available data bases concerning armed police confrontations reflect dramatic degradation of even the most rudimentary weapons skills. While I'm convinced that frequent training of even the most thorough and realistic quality will never completely neutralize the effects of life-threatening stress, I also firmly believe it may well serve to diminish functional skill erosion through the programming of desired subconscious psychomotor responses. Safe and efficient trigger management is but one of the subconscious responses we'll be attempting to program, and a very critical one at that.

The phenomenon associated with life-threatening stress has been referred to as "tachy-psyche" when associated with perceptual distortions (of time, distance, etc.), But the term "body alarm reaction" is perhaps most appropriate as it encompasses impaired motor function along with perceptual impairment. Two of the most critical physical manifestations of body alarm reaction are; (1) general muscle tightening, and (2) loss of digital dexterity. Both have a direct and dramatic impact on trigger management. You need not be in a gunfight to experience these impairments. Anyone whose career experience includes an exhilarating high-speed pursuit through rush-hour traffic (an administrative no-no now in many jurisdictions) may recall the sensation of having the muscles of the arms, shoulders and legs rigid, with a virtual "white-knuckling" of the hands to the steering wheel. Relate this experience to the level of psychomotor impairment experienced in armed encounters and we begin to understand why police only achieve low shot/hit ratio in firefights that are generally at distances of 0-6 feet.

Complicating matters further still is a physical phenomenon encountered most routinely on a day-to-day basis. It is being referred to in some circles as "involuntary muscle contraction", and its consequences can be every bit as tragic as anything experienced in a gunfight. In a (3/91) superior court decision in Burlington County, New Jersey, this very issue become one of the focal points in a case involving a police officer indicted and tried for "negligent homicide". The accused officer had been assisting other officers in the capture and restraint of a suspect who had reportedly twice escaped from custody that same evening. The accused officer (off-duty at the time of the occurrence) had his pistol unholstered while assisting in the ordeal when the pistol discharged, killing the suspect. Expert witnesses (including a sports physiologist) argued successfully that the type of physical exertion the officer had engaged in with his pistol unholstered contributed to the weapons unintentional discharge. Three elements were identified as potential causal factors in involuntary muscle contraction; (1) loss of balance ("postural disturbance"), (2) startle effect, and (3) interlimb interaction (in exertion of maximal force). My own case files are brimming with examples of unintentional discharges that can be attributed to involuntary muscle contraction.

We at Smith & Wesson academy have been teaching that contact with the trigger could be made at the "ready" position with double action revolvers and pistols. It is believed that the length of trigger travel and weight of pull necessary to activate most double-action handguns is sufficient to minimize unintentional discharges of the weapon. This concept has not presented any significant concern in utilization of double action handguns fired in the double-action mode (where all initial judgmental shots are fired with this genre of handgun). The problem more recently has been with single-action handguns, and some so-called "double-action only" pistols that in actuality closely approximate single-action trigger dynamics. Many of these pistols have trigger-pull lengths and weights that are roughly half of what we'd normally expect from a traditional double-action pistol or revolver. Combine short, light trigger strokes with the stress-charged environment that many lawmen find themselves immersed in, and we've found an explanation for the proliferation of what might accurately be referred to as "involuntary discharges". Knowing that the seemingly endless array of pistols currently being marketed present nightmarish problems for trainers whose agencies either issue or authorize several pistol makes and/or variants, strategy must evolve to cope with the problem. Programming officers to treat all firearms with similar regard in this area has additional fringe benefits. If we train and program our personnel not to engage the handgun trigger until the target is to be engaged we'll have programmed psychomotor skills consistent with those taught with shoulder-fired weapons as well (carbine, shotgun, submachine gun and rifle), which are in essence single-action type firearms. Since most of our repetitive programming with firearms is with handguns, good or bad, it will undoubtedly have a strong residual effect in deployment of shoulder weapons. Again, a very strong argument for consistent policy and training in trigger-finger placement.

In embracing this philosophy, there will naturally be some tradeoffs. If using a double-action revolver or pistol, it could well be argued that we suffer some inefficiency and aren't fully utilizing the margin of safety built into the trigger. I would counter by suggesting that this margin of safety is still utilized, even when unintended. Manufacturers of pistol designs utilizing relatively short, light trigger strokes have been vigorously pushing the "off-target, off-trigger" concept for some time. The very nature of these designs has still contributed greatly to the disproportionate number of unintentional discharges experienced with their particular products. My assertion is that if the trigger is inadvertently engaged under stress, or perhaps when experiencing some sort of "involuntary muscle contraction", the margin of safety built-in to a double-action handgun may still prove vital. Let me make it abundantly clear however that even a double-action design will not preclude unintentional discharges resulting from sloppy or careless gun- handling procedures, let alone prevent them when the physical and neurological havoc of a stressful encounter become part of the equation. The issue concerning efficiency is a bit more challenging. My observations of students performing "shot-break" exercises from the "ready position", five (5) yards from target indicate times that are consistently .2 of a second slower (electronically timed) when using double-action pistols or revolvers in conjunction with this off-target, off-trigger philosophy. How might .2 of a second impact on tactical decisiveness? That would be extremely difficult if not impossible to accurately assess. It is often suggested that hasty engagement and manipulation of the trigger when presenting a double-action handgun from the ready to the target induces a tendency to "slap" the trigger (rather than apply the steady rearward pressure desired for an undisturbed sight picture). This tendency is in fact quite common. Its likelihood is diminished somewhat when we allow contact with the trigger at an earlier stage of weapon presentation (i.e. "the ready position"). When employing the "off- target, off-trigger" philosophy, a smooth, controlled engagement of the trigger as the weapon is presented from the ready to the target is only afforded through deliberate and repetitive application of proper technique. We must first clarify some standards before proceeding on to technique.

If applying the "on-target" criteria for engagement of the trigger, how specific should we be in defining "on-target"? Given the typical proximity of an armed police confrontation, need we hesitate in engaging the trigger until our sights have acquired "center mass" of the thoracic cavity? It is believed that this is not only undesirable, but unnecessary as well. From a legal and moral perspective, if faced with an immediate lethal threat, target area could justifiably be argued to be from head-to-toe of a would-be assailant. Apply this standard to our stereo-typical 0-6' confrontation, and we discover that even from a "ready" position we are likely to have the weapon covering our adversary's toes, and therefore already "on-target"! Naturally I'm not advocating engaging an opponent's extremities with gunfire (unless it's the only part of him exposed), nor am I advocating covering-down on any portion of an opponent's body with finger-on-trigger when no immediate threat is posed. I'm merely using this scenario to illustrate a vital point. "off-target, off- trigger" need not be construed as severe a limitation as some make it out to be.

There are trainers whom I highly respect teaching what is being referred to as a "cover-ready" technique, whereby the officer would point his handgun at the would-be assailant's sternum area, finger off-trigger. Some are teaching a similar technique, but advocate pointing the handgun between the suspect's knees and crotch area to avoid obstructing view of any threatening hand movement that might otherwise go undetected with a sternum technique. From a purely tactical perspective this makes a great deal of sense, especially if dealing with a subject armed with an edged or impact weapon at a minimal stand-off distance. What would concern me is that in teaching this technique we've initiated a "gray area" in our trigger-finger philosophy (i.e. The trigger finger is off the trigger when the weapon is in fact on target). My concern would be that it would complicate our efforts in programming of reflexive psychomotor skills, perhaps instilling in our officers confusion over exactly what our standard of safety is, and perhaps some degree of tactical hesitancy as well. Let's take the tactical consideration a logical step further. Suppose we've perceived a lethal threat while our handgun is still holstered. No problem here. The trigger is engaged as it ordinarily would be, when the strong hand has been seated into the supporting hand and is being presented to the target. This is consistent with what we've been teaching with all weapon systems.

The next issue in need of further specificity is where precisely is "off-trigger" when we are in fact off-target. This may be determined in part by several varying factors; size of shooters hand in relation to pistol, length and configuration of trigger guard, etc.. Proponents of resting the tip of the trigger finger against the front of the trigger guard may find that disparity of hand size may well detract from this technique. Resting the trigger finger along the frame, above the trigger seems to be the most preferred method. There are some advocates of curling the index finger so that only the tip touches the frame, thus minimizing the length of finger contraction necessary to contact the trigger. Regardless of personal preference, an intensive regimen involving repetitive programming of muscle memory for reflexive engagement and disengagement of the trigger is a must. Financial constraints aren't as prohibitive as one might expect, as dry-drills will lay a solid foundation in this pursuit.

Observe, study and coach your people. Are their trigger fingers returning to the frame as the weapon is lowered to the ready? Your feedback will be critical during this reprogramming phase. Scrutinize your officers even more closely during interactive, scenario-based training. The inducement of stress in this training environment will generally uncover a latent yet strong subconscious tendency of "trigger affirmation", as officers fall back on finger contact with the trigger as a source of comfort. Keep correcting this problem. I have purposely engineered scenarios whereby those officers "cheating" with their trigger fingers compel themselves to unintentionally shoot someone unarmed (well hidden until the last possible moment) when experiencing a "startle reflex." This approach seems even more dramatic when scenario-based training is conducted in reduced light. When an officer shoots someone unintentionally in scenario-based training, the lesson learned may be strong enough to correct whatever residual skepticism he/she may have had towards trigger-finger discipline.

It's unlikely that this trigger-finger controversy will be laid to rest with any one journalistic endeavor, but given the volatility of our chosen profession and given the broad array of firearms we need qualify and familiarize ourselves with, reassessment of trigger-finger philosophy would indeed seem to be an irresistible force.

Director's note: Portions of this text were revised to include recent training experiences.

U.S. Department of Labor
Occupational Safety & Health Administration
Eye and Face Protection – 1910.133

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Occupational Safety & Health Administration

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Regulations (Standards - 29 CFR)

Eye and face protection. - 1910.133

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- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** I
- **Subpart Title:** Personal Protective Equipment
- **Standard Number:** 1910.133
- **Title:** Eye and face protection.

1910.133(a)

General requirements.

1910.133(a)(1)

The employer shall ensure that each affected employee uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation.

1910.133(a)(2)

The employer shall ensure that each affected employee uses eye protection that provides side protection when there is a hazard from flying objects. Detachable side protectors (e.g. clip-on or slide-on side shields) meeting the pertinent requirements of this section are acceptable.

1910.133(a)(3)

The employer shall ensure that each affected employee who wears prescription lenses while engaged in operations that involve eye hazards wears eye protection that incorporates the prescription in its design, or wears eye protection that can be worn over the prescription lenses without disturbing the proper position of the prescription lenses or the protective lenses.

1910.133(a)(4)

Eye and face PPE shall be distinctly marked to facilitate identification of the manufacturer.

..1910.133(a)(5)

1910.133(a)(5)

The employer shall ensure that each affected employee uses equipment with filter lenses that have a shade number appropriate for the work being performed for protection from injurious light radiation. The following is a listing of appropriate shade numbers for various operations.

Filter Lenses for Protection Against Radiant Energy

Operations	Electrode Size 1/32 in.	Arc Current	Minimum(*) Protective Shade
Shielded metal arc welding	Less than 3	Less than 60 ...	7
	3-5	60-160	8
	5-8	160-250	10
	More than 8	250-550	11
Gas metal arc welding and flux cored arc welding		less than 60 ...	7
		60-160	10
		160-250	10
		250-500	10
Gas Tungsten arc welding		less than 50 ...	8
		50-150	8
		150-500	10
Air carbon	(Light)	less than 500 ..	10
Arc cutting	(Heavy)	500-1000	11
Plasma arc welding		less than 20 ...	6

		20-100	8
		100-400	10
		400-800	11
Plasma arc cutting	(light)(**)	less than 300 ..	8
	(medium)(**)	300-400	9
	(heavy)(**)	400-800	10
Torch brazing		....	3
Torch soldering		....	2
Carbon arc welding		....	14

Filter Lenses for Protection Against Radiant Energy

Operations	Plate thickness-inches	Plate thickness-mm	Minimum(*) Protective Shade
Gas Welding:			
Light	Under 1/8	Under 3.2	4
Medium	1/8 to 1/2	3.2 to 12.7	5
Heavy	Over 1/2	Over 12.7	6
Oxygen cutting:			
Light	Under 1	Under 25	3
Medium	1 to 6	25 to 150	4
Heavy	Over 6	Over 150	5

Footnote(*) As a rule of thumb, start with a shade that is too dark to see the weld zone. Then go to a lighter shade which gives sufficient view of the weld zone without going below the minimum. In oxyfuel gas welding or cutting where the torch produces a high yellow light, it is desirable to use a filter lens that absorbs the yellow or sodium line in the visible light of the (spectrum) operation.

Footnote(**) These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the workpiece.

1910.133(b)

Criteria for protective eye and face devices.

1910.133(b)(1)

Protective eye and face devices purchased after July 5, 1994 shall comply with ANSI Z87.1-1989, "American National Standard Practice for Occupational and Educational Eye and Face Protection," which is incorporated by reference as specified in Sec. 1910.6.

1910.133(b)(2)

Eye and face protective devices purchased before July 5, 1994 shall comply with the ANSI "USA standard for Occupational and Educational Eye and Face Protection," Z87.1-1968, which is incorporated by reference as specified in Sec. 1910.6, or shall be demonstrated by the employer to be equally effective.

[59 FR 16360, April 6, 1994; 59 FR 33910, July 1, 1994; 61 FR 9227, March 7, 1996; 61 FR 19547, May 2, 1996]

Safety Glasses Standards
ANSI Z87.1-2003

Z87.1-2003
The new standard is a voluntary standard and there is no requirement that manufacturer or end user comply with it unless it is mandated by the United States Department of Labor – OSHA. However, in the past, most manufacturers have chosen to comply with revisions to the Z87.1 Standard.
Currently, OSHA requires (29 CFR 1910.133) that eye protectors comply with the 1989 version of the Z87.1 Standard, and eye protection devices now in use may continue to be used.

*****All of the protective eyewear we sell already complies with the performance requirements of the new standard. The new marking requirements will be phased in over time by each manufacturer.*****

1. Two Levels of Protection:
Basic and High
LENSES: The new standard designates that lenses will be divided into two protection levels, Basic Impact and High Impact as dictated by test criteria. Basic Impact lenses must pass the “drop ball” test, a 1" diameter steel ball is dropped on the lens from 50 inches. High Impact lenses must pass “high velocity” testing where 1/4" steel balls are “shot” at different velocities.

Spectacles: 150 ft./sec.
Goggles: 250 ft./sec.
Faceshields: 300 ft./sec.

FRAMES: Now, all eyewear/goggle frames, faceshields or crowns must comply with the High Impact requirement. (This revision helps eliminate the use of “test lenses”, and assures all protectors are tested as complete - lenses in frame - devices). After making an eye hazard assessment, employers (safety personnel) should decide on appropriate eyewear to be worn, although High Impact would always be recommended. All of our spectacles are High Impact protectors.

2. Now, Products Must Indicate
Impact Protection Level.
To identify a device’s level of impact protection, the following marking requirements apply to all new production spectacles, goggles and faceshields. Basic Impact spectacle lenses will have the manufacturer’s mark, i.e. an AOSafety product will have “AOS” and a Pyramex product will have a "P" etc. Goggles and faceshields will have AOS and Z87 (AOS Z87). High Impact spectacle lenses will also have a plus + sign, (AOS+) or "P+" etc. All goggle lenses and faceshield windows are to be marked with the manufacturer's mark, Z87, and a + sign (AOSZ87+).

*Note: Lenses/windows **may have** additional markings. Shaded lens may have markings* *denoting a shade number such as 3.0, 5.0 etc. Special purpose lenses may be marked with “S”. A variable tint lens may have a “V” marking.*

3. Sideshield Coverage Area Increased

Sideshield coverage, as part of the lens, part of the spectacle, or as an individual component, has been increased rearward by 10-millimeters via a revised impact test procedure. While side protection in the form of wraparound lens, integral or attached component sideshield devices is not mandated in this standard, it is highly recommended. Further, OSHA does require lateral protection on eye protection devices wherever a flying particle hazard may exist, and flying particle hazards are virtually always present in any occupational environment. All of our non-prescription safety spectacles meet the requirements of OSHA and the new Z87.1 for side protection.

4. No Minimum Lens Thickness Requirement For High Impact Lenses.

The new standard does not have a “minimum lens thickness” requirement for High Impact spectacle lenses. The previous standard required a 2-millimeter “minimum”. However, the protective advantages of wrap-around lenses and the many other advancements in eyewear design have eliminated this need.

Note: Glass lenses still fall into the Basic Impact lens category. The “minimum lens thickness” of 3 millimeters remains in effect for this category.

info@safetyglassesusa.com

Baltimore County Police Department Range
Lead Poisoning

Range Information

Lead Poisoning

The purpose of this article is not to suggest curtailing shooting or reloading activities in any way. Rather, it is to make Officers, Firearms Instructors, and Administrators aware of the possibility of lead poisoning and how to protect yourself from toxic lead contamination.

A Firearms Safety Hazard

The U.S. Environmental Protection Agency (EPA) classifies lead as a heavy metal with no beneficial biological use in the body. When a person inhales or ingests lead, it is absorbed into the bloodstream. Once in the body it becomes very difficult to remove. Continual exposure results in the accumulation of lead in the body, and measurable amounts of lead indicate cumulative exposure over a lifetime.

The EPA has determined that lead poses a serious health hazard to everyone. Unfortunately, individuals working with and around firearms often overlook the harmful effects of lead. Therefore, firearms range personnel must take precautions to control all unnecessary exposure to this toxic element. For firearms range personnel, knowing the hazards of lead is a primary responsibility. Taking the necessary precautions to minimize exposure is a duty of all firearms instructors.

Effects of Lead on the Body

Approximately 6 percent of all lead ingested or inhaled is deposited in the blood or soft body tissues, such as the kidneys, brain, or other vital organs. The remaining 94 percent is deposited in the bone. Because the body mistakes lead for calcium, it presumes that, once deposited, the lead needs to be stored. However, the body does break down lead so that it can be removed. The time required for this process is measured by the term "half-life", which means the amount of time the body needs to excrete one-half of that lead. The half-life of lead is approximately 20 years. This means one-half of the lead dosage absorbed by the body through only one exposure and deposited in the bone would still be present after 20 years.

Health Concern

For decades, the presence of lead in the environment has been widespread, beginning with smelting factories and continuing with the manufacture of glazed pottery, batteries, and lead gasoline. It has only recently been acknowledged as a serious threat to public health that warrants government control.

In 1971, the EPA began enforcing the Lead Based Paint Poisoning Prevention Act, which restricts the amount of lead used in paints. Seven years later, the agency set the National Ambient Air Quality Standards, which serves as the primary mechanism to reduce lead in gasoline. However, even with these standards and controls, the residue of lead in food, water, and dirt can elevate the lead level in a person's blood.

Firearms and exposure to lead, typically the exposure to lead on the firing line occurs as soon as the shooter pulls the trigger and the hammer falls. This action causes the primer of the cartridge to explode, in the chamber, which then ignites the main powder charge. At this point, a breathable cloud of lead particles is expelled into the air, with lead dust spraying the shooter's hands.

Lead particles also shear off as the bullet travels through the barrel. When the bullet leaves the barrel, a second cloud of contaminants, in the form of the muzzle blast, blasts into the air. Then, as the bullet strikes the impact area, another contaminated cloud rises.

When shooters inhale these clouds of contaminates, lead particles go directly into their lungs and are quickly absorbed into the bloodstream. The blood then transfers the lead to soft body tissue and bone. Heat from smoking, sweating, or physical activity accelerates this process.

Lead can also settle on the skin and hair, and in turn, can be absorbed through the pores of the skin. If lead particles reach the mouth, they can be ingested into the digestive system.

Exposure increases at clean-up time. Handling empty casings can result in lead being transferred to the skin. The weapon cleaning process also removes much of the remaining lead in the barrel and transfers it to the cleaner's hands. Oils and solvents used to clean and lubricate weapons cause the natural oils in the skin to evaporate, leaving dry skin and open pores through which the lead can pass.

Symptoms of Lead Poisoning

The numerous symptoms of lead poisoning mimic various diseases, often making diagnosis difficult. Most commonly, individuals experience abdominal pain, fatigue, nausea, subtle mood changes, headaches, constipation, irritability, and depression. Muscle pain, muscle weakness, weight loss, impotence, convulsions, anemia, and renal failure may occur with increased lead levels in the body.

Testing for Lead

Testing for lead can be performed in several ways. The blood lead level (BLL) test detects recent exposure to lead but does not provide information regarding long term or past exposure. The BLL measures the quantity of lead in micrograms per deciliter of blood, written as us/100 dl, that is micrograms of lead per 100 deciliters of blood.

The Occupational Safety and Health Administration (OSHA) Standards states that the median blood levels for adults should be about 15 ug/100 dL. For reproductive health, the blood level should stay below 30-ug/100 dL. OSHA recommends removal from the work place of any employee whose BLL measures 40 ug/100 dL or higher.

The zinc protoporphyrin (ZPP) test can be performed in conjunction with the BLL to determine longer exposure. Lead interferes with the absorption of iron into the blood, which is needed to transport oxygen, thereby allowing zinc to replace iron. The ZPP measures the amount of zinc in the blood, which remains elevated longer than the BLL. The normal range for the ZPP is 0-100 dl. An elevated ZPP indicates concentration in the bone marrow.

The only effective test used for bone lead levels is the disodium edentate (EDTA) chelating agent test. EDTA, a solution that is administered intravenously, bonds with the lead in bone, and clears it from body compartments so that it is excreted through the urine. EDTA both tests and treats an individual; however, medical personnel use it only in extreme cases of lead poisoning because of the potentially harmful side effects.

Special Risks

In males, high levels of lead can decrease the sex drive and cause sterility. Lead can also alter the structure of sperm cells, thereby potentially causing birth defects.

Pregnant women are vulnerable to rapid absorption of lead, along with calcium, from the blood into the bone. This mobilization occurs due to hormonal changes caused by pregnancy. In pregnant women, lead passes unimpeded through the placenta to the fetus, potentially causing miscarriages of the fetus and birth defects.

Children are more vulnerable to lead toxicity than adults are. Children exposed to lead may manifest into slow learning, mental drifts, slight retardation in development, hypertension, and behavioral problems. Excessive blood levels in children can seriously and irreversibly damage a child's brain and nervous system. Because the symptoms mirror those of various childhood diseases, many doctors do not test for lead.

Precautions on the Range

Precautions can be taken both on and off the range to protect shooters, instructors, and their families from lead poisoning. Administrative controls and good hygiene are two necessary tools. In addition, all shooters and instructors should practice the following dos and don'ts of range safety.

Do Not Smoke on the Range

Smoking any type of tobacco products on the range should be prohibited to prevent acceleration of inhaled lead into the blood stream and ingestion of lead transferred from hands to the cigarette, cigar, etc.

Do Not Eat on the Range

Lead dust on hands and face can be ingested through contact with food. Airborne lead expelled from the weapon can also contaminate food.

Don't Collect Fired Brass in Baseball Caps

Many shooters use their baseball caps to collect spent brass, this contaminates the cap with lead particles, When the cap is placed back on the head, the lead is deposited into the hair and absorbed into the skin. Providing boxes for the brass prevents this practice.

Do Be Aware Face, Arms, and Hands Are Covered With Lead

Shooters and instructors should wash thoroughly with cold water and plenty of soap. Cold water is preferred because warm water enhances the absorption of lead by opening the pores of the skin. If no water is available, shooters should consider carrying a box of wet hand wipes or a bottle of cool water and a washcloth for this purpose.

Do Be Aware That Hair and Clothes Are Still Contaminated

Shooters and Firearms Instructors should wear an outer garment, such as a jumpsuit or coveralls, or change clothes before going home. Contaminated clothes should not be cleaned by blowing, shaking, or other means that dispense lead into the air. To prevent cross-contamination, range clothes should be washed separately from the family's regular laundry. Families with infants should be particularly careful, since infants are most vulnerable to lead contamination. Families with infants should be particularly careful since infants are most vulnerable to lead contamination. Changing to clean clothing before leaving the range prevents recontamination of the hands and any contamination of the family vehicle.

Do Change Shoes Before Entering The Residence

Shoes can also transport lead into the home. Shoes should be left at the door to prevent tracking lead onto floors and carpets. Ordinary vacuuming does not remove lead from the home, but redistributes it by blowing it in to the air to be inhaled and/or resettled onto the carpet.

Do Avoid Physical Contact With Family Members Until After Shower, Shampoo, and Change of Clothes

Lead can be transferred by casual contact. Family and friends should not be hugged or kissed until after a shower and a change of clothes. Any physical contacts should be avoided while the shooter is still in range clothing.

Indoor Ranges

Most indoor ranges have a greater lead dust problem than outdoor ranges. However, range personnel can institute several controls to lower the amount of lead dust in these facilities.

The choice of ammunition is one such control. Nonjacketed ammunition produces the most lead dust and fumes, jacketed ammunition, the least. Shotgun shells produce more airborne lead dust than any handgun round. Currently, many ammunition manufacturers are developing lead-free ammunition.

Indoor ranges should not be carpeted, since lead dust settles and contaminates the rugs. A High Efficiency Particulate (HEPA) vacuum, which has a 3-stage particulate air filter is the best vacuum to use for lead.

Because water cannot be treated for lead contamination, personnel should use water sparingly to remove lead when cleaning ranges. If water is used for lead removal, minimizing the amount of water used will result in less pollution. Range maintenance employees should wear disposable coveralls and air purifying masks while cleaning and/or repairing indoor ranges.

What Does All This Mean To You?

Baltimore County Police Department conforms to OSHA lead standards, which became law in 1978. The police department monitors firearms training instructors for lead, and employees are informed of their results. Medical monitoring, such as BLL testing of employees, is conducted and funded by the department. In addition, air-purifying masks are provided to employees.

Washroom and showers are provided to ensure proper clean-up and eating areas are separate from lead contaminated areas. A Lead Abatement Training program has been instituted for all firearms training instructors who may be exposed to lead.

The department has placed warning signs on the range and weapon cleaning area that read: "WARNING, No Smoking or Eating in the gun cleaning area." Additional signs have been placed stating: "Wash Hands With Cold Soapy Water."

The blood level of the typical Baltimore County Police Officer is about four. The typical blood level of those continuously assigned to the Firearms Training Unit is slightly higher. As long as the above precautions are observed, employees of Baltimore County continue to remain safe from excessive exposure.

During the early years of firearms training, neither eye protection or ear protection was provided or encouraged on the range. Today, most departments now require both types of protection on the line.

Currently we have learned that another health hazard, - Lead Poisoning, threatens the physical well being of shooters and instructors in firearms ranges. However, through administrative controls and education, departments can reduce the on-the-job exposure of employees and their families to lead.

If you have any questions, please contact the Range Staff, 410-887-2330.

Revised October 17, 2007

Agency for Toxic Substances and Disease Registry –ATSDR Public Health Statement for Lead

This Public Health Statement is the summary chapter from the Toxicological Profile for Lead. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-800-232-4636.

This public health statement tells you about lead and the effects of exposure to it

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Lead has been found in at least 1,272 of the 1,684 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which lead is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to this substance may harm you.

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to lead, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 What is lead?

Lead is a heavy, low melting, bluish-gray metal that occurs naturally in the Earth's crust. However, it is rarely found naturally as a metal. It is usually found combined with two or more other elements to form lead compounds.

Metallic lead is resistant to corrosion (i.e., not easily attacked by air or water). When exposed to air or water, thin films of lead compounds are formed that protect the metal from further attack. Lead is easily molded and shaped. Lead can be combined with other metals to form alloys. Lead and lead alloys are commonly found in pipes, storage batteries, weights, shot and ammunition, cable covers, and sheets used to shield us from radiation. The largest use for lead is in storage batteries in cars and other vehicles.

Lead compounds are used as a pigment in paints, dyes, and ceramic glazes and in caulk. The amount of lead used in these products has been reduced in recent years to minimize lead's harmful effect on people and animals. Tetraethyl lead and tetramethyl lead were once used in the United States as gasoline additives to increase octane rating. However, their use was phased out in the United States in the 1980s, and lead was banned for use in gasoline for motor vehicles beginning January 1, 1996. Tetraethyl lead may still be used in gasoline for off-road vehicles and airplanes. It is also still used in a number of developing countries. Lead used in ammunition, which is the largest non-battery end-use, has remained fairly constant in recent years. However, even the use of lead in bullets and shot as well as in fishing sinkers is being reduced because of its harm to the environment.

Most lead used by industry comes from mined ores ("primary") or from recycled scrap metal or batteries ("secondary"). Lead is mined in the United States, primarily in Alaska and Missouri. However, most lead today is "secondary" lead obtained from lead-acid batteries. It is reported that 97% of these batteries are recycled.

1.2 What happens to lead when it enters the environment?

Lead occurs naturally in the environment. However, most of the high levels found throughout the environment come from human activities. Environmental levels of lead have increased more than 1,000-fold over the past three centuries as a result of human activity. The greatest increase occurred between the years 1950 and 2000, and reflected increasing worldwide use of leaded gasoline. Lead can enter the environment through releases from mining lead and other metals, and from factories that make or use lead, lead alloys, or lead compounds. Lead is released into the air during burning coal, oil, or waste. Before the use of leaded gasoline was banned, most of the lead released into the U.S. environment came from vehicle exhaust. In 1979, cars released 94.6 million kilograms (208.1 million pounds) of lead into the air in the United States. In 1989, when the use of lead was limited but not banned, cars released only 2.2 million kg (4.8 million pounds) to the air. Since EPA banned the use of leaded gasoline for highway transportation in 1996, the amount of lead released into the air has decreased further. Before the 1950s, lead was used in pesticides applied to fruit orchards. Once lead gets into the atmosphere, it may travel long distances if the lead particles are very small. Lead is removed from the air by rain and by particles falling to land or into surface water.

Sources of lead in dust and soil include lead that falls to the ground from the air, and weathering and chipping of lead-based paint from buildings, bridges, and other structures. Landfills may contain waste from lead ore mining, ammunition manufacturing, or other industrial activities such as battery production. Disposal of lead-containing products contribute to lead in municipal landfills. Past uses of lead such as its use in gasoline are a major contributor to lead in soil, and higher levels of lead in soil are found near roadways. Most of the lead in inner city soils comes from old houses with paint containing lead and previous automotive exhaust emitted when gasoline contained lead.

Once lead falls onto soil, it sticks strongly to soil particles and remains in the upper layer of soil. That is why past uses of lead such as lead in gasoline, house paint, and pesticides are so important in the amount of lead found in soil.

Small amounts of lead may enter rivers, lakes, and streams when soil particles are moved by rainwater.

Small amounts of lead from lead pipe or solder may be released into water when the water is acidic or “soft”. Lead may remain stuck to soil particles or sediment in water for many years. Movement of lead from soil particles into groundwater is unlikely unless the rain falling on the soil is acidic or "soft". Movement of lead from soil will also depend on the type of lead compound and on the physical and chemical characteristics of the soil.

Sources of lead in surface water or sediment include deposits of lead-containing dust from the atmosphere, waste water from industries that handle lead (primarily iron and steel industries and lead producers), urban runoff, and mining piles.

Some lead compounds are changed into other forms of lead by sunlight, air, and water. However, elemental lead cannot be broken down.

The levels of lead may build up in plants and animals from areas where air, water, or soil are contaminated with lead. If animals eat contaminated plants or animals, most of the lead that they eat will pass through their bodies.

1.3 How might I be exposed to lead?

Lead is commonly found in soil especially near roadways, older houses, old orchards, mining areas, industrial sites, near power plants, incinerators, landfills, and hazardous waste sites. People living near hazardous waste sites may be exposed to lead and chemicals that contain lead by breathing air, drinking water, eating foods, or swallowing dust or dirt that contain lead. People may be exposed to lead by eating food or drinking water that contains lead. Drinking water in houses containing lead pipes may contain lead, especially if the water is acidic or “soft”. If one is not certain whether an older building contains lead pipes, it is best to let the water run a while before drinking it so that any lead formed in the pipes can be flushed out. People living in areas where there are old houses that have been painted with lead paint may be exposed to higher levels of lead in dust and soil. Similarly, people who live near busy highways or on old orchard land where lead arsenate pesticides were used in the past may be exposed to higher levels of lead. People may also be exposed to lead when they work in jobs where lead is used or have hobbies in which lead is used, such as making stained glass.

Foods may contain small amounts of lead. However, since lead solder is no longer used in cans, very little lead is found in food. Leafy fresh vegetables grown in lead-containing soils may have lead-containing dust on them. Lead may also enter foods if they are put into improperly glazed pottery or ceramic dishes and from leaded-crystal glassware. Illegal whiskey made using stills that contain lead-soldered parts (such as truck radiators) may also contain lead. Cigarette smoke may also contain small amounts of lead. The amount of lead found in canned foods decreased 87% from 1980 to 1988 in the United States, which indicates that the chance of exposure to lead in canned food from lead-soldered containers has been greatly reduced. Lead-soldered cans are still used in some other nations. In the most recent studies, lead was not detectable in most foods and the average dietary intake of lead was about 1 microgram (a microgram is a millionth of a gram) per kilogram of body weight per day. Children may be exposed to lead by hand-to-mouth contact after exposure to lead-containing soil or dust.

In general, very little lead is found in lakes, rivers, or groundwater used to supply the public with drinking water. More than 99% of all publicly supplied drinking water contains less than 0.005 parts of lead per million parts of water (ppm). However, the amount of lead taken into your body through drinking water can be higher in communities with acidic water supplies. Acidic water makes it easier for the lead found in pipes, leaded solder, and brass faucets to be dissolved and to enter the water we drink. Public water treatment systems are now required to use control measures to make water less acidic. Plumbing that contains lead may be found in public drinking water systems, and in houses, apartment buildings, and public buildings that are more than 20 years old. However, as buildings age, mineral deposits form a coating on the inside of the water pipes that insulates the water from lead in the pipe or solder, thus reducing the amount of lead that can leach into the water. Since 1988, regulations require that drinking water coolers must not contain lead in parts that come into contact with drinking water.

Breathing in, or swallowing airborne dust and dirt, is another way you can be exposed to lead. In 1984, burning leaded gasoline was the single largest source of lead emissions. Very little lead in the air comes from gasoline now because EPA has banned its use in gasoline for motor vehicles. Other sources of lead in the air include releases to the air from industries involved in iron and steel production, lead-acid-battery manufacturing, and nonferrous (brass and bronze) foundries. Lead released into air may also come from burning of solid waste that contains lead, windblown dust, volcanoes, exhaust from workroom air, burning or weathering of lead-painted surfaces, fumes and exhaust from leaded gasoline, and cigarette smoke.

Skin contact with dust and dirt containing lead occurs every day. Recent data have shown that inexpensive cosmetic jewelry pieces sold to the general public may contain high levels of lead which may be transferred to the skin through routine handling. However, not much lead can get into your body through your skin.

In the home, you or your children may be exposed to lead if you take some types of home remedy medicines that contain lead compounds. Lead compounds are in some non-Western cosmetics, such as surma and kohl. Some types of hair colorants, cosmetics, and dyes contain lead acetate. Read the labels on hair coloring products, use them with caution, and keep them away from children.

People who are exposed at work are usually exposed by breathing in air that contains lead particles. Exposure to lead occurs in many jobs. People who work in lead smelting and refining industries, brass/bronze foundries, rubber products and plastics industries, soldering, steel welding and cutting operations, battery manufacturing plants, and lead compound manufacturing industries may be exposed to lead. Construction and demolition workers and people who work at municipal waste incinerators, pottery and ceramics industries, radiator repair shops, and other industries that use lead solder may also be exposed. Painters who sand or scrape old paint may be exposed to lead in dust. Between 0.5 and 1.5 million workers are exposed to lead in the workplace. In California alone, more than 200,000 workers are exposed to lead. Families of workers may be exposed to higher levels of lead when workers bring home lead dust on their work clothes.

You may also be exposed to lead in the home if you work with stained glass as a hobby, make lead fishing weights or ammunition, or if you are involved in home renovation that involves the removal of old lead-based paint.

1.4 How can lead enter and leave my body?

Some of the lead that enters your body comes from breathing in dust or chemicals that contain lead. Once this lead gets into your lungs, it goes quickly to other parts of the body in your blood.

Larger particles that are too large to get into your lungs can be coughed up and swallowed. You may also swallow lead by eating food and drinking liquids that contain it. Most of the lead that enters your body comes through swallowing, even though very little of the amount you swallow actually enters your blood and other parts of your body. The amount that gets into your body from your stomach partially depends on when you ate your last meal. It also depends on how old you are and how well the lead particles you ate dissolved in your stomach juices. Experiments using adult volunteers showed that, for adults who had just eaten, the amount of lead that got into the blood from the stomach was only about 6% of the total amount taken in. In adults who had not eaten for a day, about 60–80% of the lead from the stomach got into their blood. In general, if adults and children swallow the same amount of lead, a bigger proportion of the amount swallowed will enter the blood in children than in adults. Children absorb about 50% of ingested lead.

Dust and soil that contain lead may get on your skin, but only a small portion of the lead will pass through your skin and enter your blood if it is not washed off. You can, however, accidentally swallow lead that is on your hands when you eat, drink, smoke, or apply cosmetics (for example, lip balm). More lead can pass through skin that has been damaged (for example, by scrapes, scratches, and wounds). The only kinds of lead compounds that easily penetrate the skin are the additives in leaded gasoline, which is no longer sold to the general public. Therefore, the general public is not likely to encounter lead that can enter through the skin.

Shortly after lead gets into your body, it travels in the blood to the "soft tissues" and organs (such as the liver, kidneys, lungs, brain, spleen, muscles, and heart). After several weeks, most of the lead moves into your bones and teeth. In adults, about 94% of the total amount of lead in the body is contained in the bones and teeth. About 73% of the lead in children’s bodies is stored in their bones. Some of the lead can stay in your bones for decades; however, some lead can leave your bones and reenter your blood and organs under certain circumstances (e.g., during pregnancy and periods of breast feeding, after a bone is broken, and during advancing age).

Your body does not change lead into any other form. Once it is taken in and distributed to your organs, the lead that is not stored in your bones leaves your body in your urine or your feces. About 99% of the amount of lead taken into the body of an adult will leave in the waste within a couple of weeks, but only about 32% of the lead taken into the body of a child will leave in the waste. Under conditions of continued exposure, not all of the lead that enters the body will be eliminated, and this may result in accumulation of lead in body tissues, especially bone.

1.5 How can lead affect my health?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict animal care guidelines because laws today protect the welfare of research animals.

The effects of lead are the same whether it enters the body through breathing or swallowing. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults to lead at work has resulted in decreased performance in some tests that measure functions of the nervous system. Lead exposure may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people. Lead exposure may also cause anemia. At high levels of exposure, lead can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production.

We have no conclusive proof that lead causes cancer (is carcinogenic) in humans. Kidney tumors have developed in rats and mice that had been given large doses of some kind of lead compounds. The Department of Health and Human Services (DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens based on limited evidence from studies in humans and sufficient evidence from animal studies, and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans. IARC determined that organic lead compounds are not classifiable as to their carcinogenicity in humans based on inadequate evidence from studies in humans and in animals.

1.6 How can lead affect children?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age.

Studies carried out by the Centers for Disease Control and Prevention (CDC) show that the levels of lead in the blood of U.S. children have been getting lower and lower. This result is because lead is banned from gasoline, residential paint, and solder used for food cans and water pipes. However, about 310,000 U.S. children between the ages of 1 and 5 years are believed to have blood lead levels equal or greater than 10 µg/dL, the level targeted for elimination among young children in the Unites States by 2010.

Children are more vulnerable to lead poisoning than adults. Children are exposed to lead all through their lives. They can be exposed to lead in the womb if their mothers have lead in their bodies. Babies can swallow lead when they breast feed, or eat other foods, and drink water that contains lead. Babies and children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. These activities make it easier for children to be exposed to lead than adults. The dirt or dust on their hands, toys, and other items may have lead particles in it. In some cases, children swallow nonfood items such as paint chips; these may contain very large amounts of lead, particularly in and around older houses that were painted with lead-based paint. The paint in these houses often chips off and mixes with dust and dirt. Some old paint contains as much as 50% lead. Also, compared with adults, a bigger proportion of the amount of lead swallowed will enter the blood in children.

Children are more sensitive to the health effects of lead than adults. No safe blood lead level in children has been determined. Lead affects children in different ways depending on how much lead a child swallows. A child who swallows large amounts of lead may develop anemia, kidney damage, colic (severe “stomach ache”), muscle weakness, and brain damage, which ultimately can kill the child. In some cases, the amount of lead in the child’s body can be lowered by giving the child certain drugs that help eliminate lead from the body. If a child swallows smaller amounts of lead, such as dust containing lead from paint, much less severe but still important effects on blood, development, and behavior may occur. In this case, recovery is likely once the child is removed from the source of lead exposure, but there is no guarantee that the child will completely avoid all long-term consequences of lead exposure. At still lower levels of exposure, lead can affect a child’s mental and physical growth. Fetuses exposed to lead in the womb, because their mothers had a lot of lead in their bodies, may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood also may slow mental development and cause lower intelligence later in childhood. There is evidence that these effects may persist beyond childhood.

Children with high blood lead levels do not have specific symptoms. However, health workers can find out whether a child may have been exposed to harmful levels of lead by taking a blood sample. They can also find out how much lead is in a child’s bones by taking a special type of x ray of the finger, knee, or elbow. This type of test, however, is not routine.

1.7 How can families reduce the risk of exposure to lead?

If your doctor finds that you have been exposed to substantial amounts of lead, ask whether your children might also have been exposed. Your doctor might need to ask your state health department to investigate.

The most important way families can lower exposures to lead is to know about the sources of lead in their homes and avoid exposure to these sources. Some homes or day-care facilities may have more lead in them than others. Families who live in or visit these places may be exposed to higher amounts of lead. These include homes built before 1978 that may have been painted with paint that contains lead (lead-based paint). If you are buying a home that was built before 1978, you may want to know if it contains lead based paint. Federal government regulations require a person selling a home to tell the real estate agent or person buying the home of any known lead-based hazards on the property. Adding lead to paint is no longer allowed. If your house was built before 1978, it may have been painted with lead-based paint. This lead may still be on walls, floors, ceilings, and window sills, or on the outside walls of the house. The paint may have been scraped off by a previous owner, but paint chips and lead-containing dust may still be in the yard soil. Decaying, peeling, or flaking paint can introduce lead into household dust and the area where this is occurring should be repainted. If your paint is decaying or your child has symptoms of lead poisoning, you may want to have your house tested for lead. In some states, homeowners can have the paint in their homes tested for lead by their local health departments. The National Lead Information Center (1-800-532-3394) has a listing of approved risk assessors (people who have met certain criteria and are qualified to assess the potential risks of a site) and of approved testing laboratories (for soil, paint, and dust).

Sanding surfaces painted with lead-based paint or using heat to peel the paint may cause exposure to high levels of lead. Many cases of lead poisoning have resulted from do-it-yourself home renovations. Therefore, any renovations should be performed by a licensed contractor who will minimize exposure to household members. It is important for the area being renovated to be isolated from the rest of the house because of lead-containing dust. The federal government requires that contractors who test for or remove lead must be certified by the EPA or an EPA-approved state program. Ask to see certifications of potential contractors. Your state health department or environmental protection division should be able to identify certified contractors for you. The National Lead Abatement Council (P.O. Box 535; Olney, MD 20932; telephone 301-924-5490) can also send you a list of certified contractors.

Families can lower the possibility of children swallowing paint chips by discouraging their children from chewing or putting these painted surfaces in their mouths and making sure that they wash their hands often, especially before eating. Lead can be found in dirt and dust. Areas where levels of lead in dirt might be especially high are near old houses, highways, or old orchards. Some children have the habit of eating dirt (the term for this activity is pica). Discourage your children from eating dirt and other hand-to-mouth activity.

Non-Western folk remedies used to treat diarrhea or other ailments may contain substantial amounts of lead. Examples of these include: Alarcon, Ghasard, Alkohl, Greta, Azarcon, Liga, Bali Goli, Pay-loo-ah, Coral, and Rueda. If you give your children these substances or if you are pregnant or nursing, you may expose your children to lead. It is wise to know the ingredients of any medicines that you or your children use.

Older homes that have plumbing containing lead may have higher amounts of lead in drinking water. Inside plumbing installed before 1930 is most likely to contain high levels of lead. Copper pipes have replaced lead pipes in most residential plumbing. You cannot see, taste, or smell lead in water, and boiling your water will not get rid of lead. If you have a water-lead problem, EPA recommends that anytime water in a particular faucet has not been used for 6 hours or longer, you should flush your cold water pipes by running water until it is cold (5 seconds–2 minutes). Because lead dissolves more easily in warm water than in cold water, you should only use cold water for drinking, cooking, and preparing baby formula. You can contact your local health department or water supplier to find out about testing your water for lead. If your water tests indicate a significant presence of lead, consult your water supplier or local health department about possible remedies.

You can bring lead home in the dust on your hands or clothes if lead is used in the place where you work. Lead dust is likely to be found in places where lead is mined or smelted, where car batteries are made or recycled, where electric cable sheathing is made, where fine crystal glass is made, or where certain types of ceramic pottery are made. Pets can also bring lead into the home in dust or dirt on their fur or feet if they spend time in places that have high levels of lead in the soil.

Swallowing of lead in house dust or soil is a very important exposure pathway for children. This problem can be reduced in many ways. Regular hand and face washing to remove lead dusts and soil, especially before meals, can lower the possibility that lead on the skin is accidentally swallowed while eating. Families can lower exposures to lead by regularly cleaning the home of dust and tracked in soil. Door mats can help lower the amount of soil that is tracked into the home; removing your shoes before entering the home will also help. Planting grass and shrubs over bare soil areas in the yard can lower contact that children and pets may have with soil and the tracking of soil into the home.

Families whose members are exposed to lead dusts at work can keep these dusts out of reach of children by showering and changing clothes before leaving work, and bagging their work clothes before they are brought into the home for cleaning. Proper ventilation and cleaning—during and after hobby activities, home or auto repair activities, and hair coloring with products that contain lead—will decrease the possibility of exposure.

Lead-containing dust may be deposited on plant surfaces and lead may be taken up in certain edible plants from the soil by the roots; therefore, home gardening may also contribute to exposure if the produce is grown in soils that have high lead concentrations. Vegetables should be well washed before eating to remove surface deposits. Certain hobbies and home or car repair activities like radiator repair can add lead to the home as well. These include soldering glass or metal, making bullets or slugs, or glazing pottery. Some types of paints and pigments that are used as facial make-up or hair coloring contain lead. Cosmetics that contain lead include surma and kohl, which are popular in certain Asian countries. Read the labels on hair coloring products, and keep hair dyes that contain lead acetate away from children. Do not allow children to touch hair that has been colored with lead-containing dyes or any surfaces that have come into contact with these dyes because lead compounds can rub off onto their hands and be transferred to their mouths.

It is important that children have proper nutrition and eat a balanced diet of foods that supply adequate amounts of vitamins and minerals, especially calcium and iron. Good nutrition lowers the amount of swallowed lead that passes to the bloodstream and also may lower some of the toxic effects of lead.

1.8 Is there a medical test to determine whether I have been exposed to lead?

The amount of total lead in the blood can be measured to determine if exposure to lead has occurred. This test shows if you have been recently exposed to lead. Lead can be measured in teeth or bones by x ray techniques, but these methods are not widely available. These tests show long-term exposures to lead. The primary screening method is measurement of blood lead. Exposure to lead also can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. EP is a part of red blood cells known to increase when the amount of lead in the blood is high. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below about 25 micrograms per deciliter (µg/dL). These tests usually require special analytical equipment that is not available in a doctor's office. However, your doctor can draw blood samples and send them to appropriate laboratories for analysis.

1.9 What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as "not-to-exceed" levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for lead include the following:

CDC recommends that states develop a plan to find children who may be exposed to lead and have their blood tested for lead. CDC recommends that the states test children:

- at ages 1 and 2 years;
- at ages 3–6 years if they have never been tested for lead;
- if they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and Children;
- if they live in a building or frequently visit a house built before 1950;
- iif they visit a home (house or apartment) built before 1978 that has been recently remodeled; and/or
- if they have a brother, sister, or playmate who has had lead poisoning.

CDC considers children to have an elevated level of lead if the amount of lead in the blood is at least 10 µg/dL. Many states or local programs provide intervention to individual children with blood lead levels equal to or greater than 10 µg/dL. Medical evaluation and environmental investigation and remediation should be done for all children with blood lead levels equal to or greater than 20 µg/dL. Medical treatment (i.e., chelation therapy) may be necessary in children if the lead concentration in blood is higher than 45 µg/dL.

EPA requires that the concentration of lead in air that the public breathes be no higher than 1.5 micrograms per cubic meter ($\mu g/m^3$) averaged over 3 months. EPA regulations no longer allow lead in gasoline. The Clean Air Act Amendments (CAAA) of 1990 banned the sale of leaded gasoline as of December 31, 1995.

Under the Lead Copper Rule (LCR), EPA requires testing of public water systems, and if more than 10% of the samples at residences contain lead levels over 0.015 milligrams per liter (mg/L), actions must be taken to lower these levels. Testing for lead in drinking water in schools is not required unless a school is regulated under a public water system. The 1988 Lead Contamination Control Act (LCCA) was created to help reduce lead in drinking water at schools and daycare centers. The LCCA created lead monitoring and reporting requirements for schools, as well as the replacement of fixtures that contain high levels of lead. However, the provisions in the LCCA are not enforceable by the federal government and individual states have the option to voluntarily comply with these provisions or create their own.

To help protect small children, the Consumer Product Safety Commission (CPSC) requires that the concentration of lead in most paints available through normal consumer channels be not more than 0.06%. The Federal Hazardous Substance Act (FHSA) bans children's products containing hazardous amounts of lead.

The Department of Housing and Urban Development (HUD) develops recommendations and regulations to prevent exposure to lead. HUD requires that federally funded housing and renovations, Public and Indian housing be tested for lead-based paint hazards and that such hazards be fixed by covering the paint or removing it. When determining whether lead-based paint applied to interior or exterior painted surfaces of dwellings should be removed, the standard used by EPA and HUD is that paint with a lead concentration equal to or greater than 1.0 milligram per square centimeter (mg/cm^2) of surface area should be removed or otherwise treated. HUD is carrying out demonstration projects to determine the best ways of covering or removing lead-based paint in housing.

EPA has developed standards for lead-paint hazards, lead in dust, and lead in soil. To educate parents, homeowners, and tenants about lead hazards, lead poisoning prevention in the home, and the lead abatement process, EPA has published several general information pamphlets. Copies of these pamphlets can be obtained from the National Lead Information Center or from various Internet sites, including http://www.epa.gov/opptintr/lead.

OSHA regulations limit the concentration of lead in workroom air to 50 $\mu g/m^3$ for an 8 hour workday. If a worker has a blood lead level of 50 µg/dL or higher, then OSHA requires that the worker be removed from the workroom where lead exposure is occurring.

FDA includes lead on its list of poisonous and deleterious substances. FDA considers foods packaged in cans containing lead solders to be unsafe. Tin-coated lead foil has been used as a covering applied over the cork and neck areas of wine bottles for decorative purposes and to prevent insect infestations. Because it can be reasonably expected that lead could become a component of the wine, the use of such foil is also a violation of the Federal Food, Drug, and Cosmetic Act. FDA has reviewed several direct human food ingredients (i.e., food dyes) and has determined them to be “generally recognized as safe” when used in accordance with current good manufacturing practices. Some of these ingredients contain allowable lead concentrations that range from 0.1 to 10 ppm.

1.10 Where can I get more information?

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological profile for Lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Mt. Sinai School of Medicine

Why Measure Lead in Bone?

Contents

The Health Effects of Lead

The harmful health effects of lead have been known for thousands of years, but observations of injurious effects at low levels of lead have been the subject of increasing concern in the past few years. Recent research has pointed to possible dangers faced by specific populations who risk lead exposure from mobilization of their body lead stores, e.g., children, pregnant women and osteoporotics. Lead toxicity is reported to be a major public health problem in the United States today. The general population is exposed to lead in their environment. This lead can come from several sources, e.g., house paint, water and soil. Although lead has been banned from house paint, older housing stock still contains lead paint which can contaminate household dust. Lead was removed from American gasoline in the early 1980s, and lead levels in children has fallen considerably. Yet this previous use has resulted in soil contamination which still exists. Lead continues in use in many plumbing fittings. Many areas still receive their water supply through lead pipes. All of these factors can lead to an elevated total lead consumption.

Environmental exposure to lead is not the only source of lead-related health effects. Many industrial workers in the United States have potential occupational exposure to lead, and lead poisoning is still seen at occupational health clinics.

Clinical lead poisoning in itself does not define the extent of lead-related health problems. Recent research has shown that increased lead exposure, even at legally permissible levels, can lead to harmful, though sub-clinical, effects. Some of the earliest symptoms of the ailment are non-specific, such as fatigue and muscle pain and are frequently ascribed to factors other than lead poisoning. Other effects include changes in kidney function, inhibited central nervous system function and reduced nerve conduction velocity, the latter having been demonstrated in lead workers who showed no symptoms. This means that more adults may be affected by both environmental and occupational lead exposure than can be estimated from the numbers who present at clinics.

Lead in Blood

At the present time, exposure to lead is most commonly monitored by measuring blood-lead levels. The criteria for lead poisoning and lead toxicity are based on blood-lead as a standard. However, the biological half-life of lead in blood is approximately 36 days. It is therefore an indicator only of recent lead exposure. Blood-lead reflects chronic exposure only if exposure is constant and the measurements were constant and well documented. Deleterious health effects of lead resulting from long-term lead exposure will only be correlated with current blood-lead levels if lead exposure has been relatively constant over a long period of time, up to the time of sampling.

Measuring lead in blood has methodological drawbacks and limits on physiological interpretation. Methodologically, measuring lead in blood frequently requires a venous sample and sending blood to a laboratory for analysis. In most states, the delay between sampling and analytic results can be 6-8 weeks. This delay obviously impedes efficient public health prevention, since in the absence of immediate feedback no decision can be made on risk reduction at the time of initial screening or clinic visit. Often, it is difficult to locate the persons who were sampled after this delay, and, of course, exposures may continue in the interval. Physiologically, the measurement of lead in blood is not a direct assessment of target organ dose, since the red cell is not a critical target for lead toxicity. Kinetically, blood is not a good analog for critical targets, such as soft tissue, because of the relatively short half-life of lead in blood as compared to target organs or bone.

Blood-lead is not known for the general population

Long-term lead exposure is of primary health concern but can rarely be ascertained from blood-lead records. No one in the general population has an adequate blood-lead measurement history. However, ^{109}Cd K X-Ray Fluorescence (XRF) bone-lead measurements allow the direct measurement of long-term lead exposure.

At the present time, little is known about the range of chronic environmental exposures in the general population. Further research is required for the full implications of chronic lead exposure to be thoroughly understood. However, ^{109}Cd K XRF bone-lead measurements have the potential to enhance our understanding of the effects of low-level lead exposure and consequently to determine whether the current intervention criteria, which are based on blood-lead levels, afford adequate protection against the effects of lead. Bone-lead measurements may also provide an additional screening technique in the identification of high-risk populations.

Lead in Bone

Lead is predominantly stored in the human body in calcified tissues; 90-95% of the total lead burden is contained within bone in non-occupationally exposed adults. The total lead content of bone is reported to be up to 200 mg in 60-70 year old men, less in women. The turnover rate of lead in cortical and trabecular bone is slow; quantitative estimates of the half-life vary, but there is a consensus that it is of the order of years or even decades. Therefore, through childhood and most of adult life, lead exposure from both environmental and occupational sources results in an increased lead concentration within the bone matrix. A measure of bone-lead content thus reflects integrated or cumulative, and thus long-term or chronic, lead exposure and provides a useful surrogate indicator of the cumulative dose of lead presented over time to the target organs of lead.

In vivo bone-lead measurements may therefore clarify the risks associated with lead exposure in two ways. Health effects which are associated with chronic lead exposure may be identified by their correlation with bone-lead level, and bone-lead measurements may ultimately allow the identification of subjects at risk from mobilization of their body lead stores and allow appropriate intervention strategies to be devised.

Possible mobilization of lead from bone

Under conditions where bone physiology is undergoing a period of change, such as during pregnancy, aging and osteoporosis, it would appear that lead can be released from the bone mineral matrix, increasing blood-lead levels and constituting a further source of lead exposure. It would seem likely that the level of this endogenous exposure would be dependent on bone-lead burden.

K X-Ray Fluorescence measures long-term lead exposure

Several large in vivo studies have confirmed that the integrated ^{109}Cd K XRF bone-lead measurement is a measure of long-term lead exposure. Bone-lead measurements have been performed on more than 800 occupationally exposed workers in England, Sweden and Finland in several studies. The occupationally exposed groups were studied as extensive blood-lead records were available on these subjects; in some cases records extended as far back as 1950. It was found in all the individual studies that bone-lead level of all bone sites including the tibia, calcaneus and sternum, correlated with the "Cumulative Blood-lead Index" (CBLI). The CBLI is an integrated time-weighted average blood-lead level and thus corresponds to total lead exposure. The studies reported that ^{109}Cd K XRF bone-lead measurements could therefore be considered to be a measure of cumulative lead exposure.

Evidence therefore exists that the ^{109}Cd K XRF method can provide an accurate measurement of bone-lead level, to well within the currently available levels of precision, and further that this measurement of lead in bone can be considered to be a measure of long-term lead exposure.

The radiation dose and consequent risk arising from a K XRF bone-lead measurement are very small for all age groups, including children.

MARKSMANSHIP

The following information was taken from a small book written by Gary Anderson, Olympic Gold Medalist Rifle Shooter. When someone of this caliber gives out advice in an area that you are attempting to learn, it is wise to listen. He knows of what he speaks! He went to the Olympics and out-shot the best the world had to offer. Naturally, these techniques are intended for precision marksmanship and will not work for some of the close range fast shooting required with a patrol rifle in some situations. His teachings will assist you with the slower pace long range shooting you may be required to do.

TRIGGER CONTROL

The easiest way to fire a bad shot is to pull the trigger incorrectly. In importance to the expert rifleman, proper trigger control is second only to holding the rifle still.

The grasp of the right hand on the pistol grip is the first detail to work out in learning trigger control. This hand does all the work of pulling the trigger. Its grasp on the pistol grip should be firm but not strained. The thumb is extended forward but not curled over the stock. Your whole hand should feel comfortable. The index finger should not touch the stock at any point. In this way, the pressure of the finger on the trigger will be straight back and not to the side. The index finger should contact the trigger at the first joint or just ahead of the first joint.

The action of the index finger on the trigger should be independent of all other parts of the body except the brain, which is receiving the images of the sight picture. The best method of trigger control for the beginner is the simplest one. This method calls for a gradual and continuous increase of pressure on the trigger. This pressure should start as soon as a good sight picture is seen and should ‘ continue until the shot is fired. Only four to six seconds should be needed for this. With a two-stage trigger, the initial stage can be taken up before the front sight is aligned with the bull. With both the two-stage and the single-stage trigger, the final pressure on the trigger must start as soon as the front sight and bull are properly aligned.

Only after many months of experience should other methods of pulling the trigger be tried. The method most commonly used by advanced shooters is the graduated pull, in which pressure is applied to the trigger in short segments. That is, applications of pressure are made only when the sight picture looks good. This pressure that has already been applied is held constant whenever the front sight moves from the bull. Before attempting this method of trigger pull, it is important for the beginner to master the smooth pull and its gradual increase of pressure.

When pulling the trigger, the trained rifleman concentrates so much on holding the rifle still that the action of the index finger becomes nearly automatic in firing the rifle when the best sight picture is achieved. Especially for the beginner, the shot should not be fired at an exact moment of the shooter’s choice. The squeeze on the trigger should be so gradual that when the shot is fired, it is a surprise. This eliminates the danger of flinching or jerking in anticipation of the shot.

There is always a strong temptation to snap the trigger quickly when the front sight approaches the bull, in the thought that a good shot can be made. This action of trying to “grab a ten” is called jerking. Usually the result is a shot that is far from where you thought it would be. Another common error in trigger control is flinching. This comes from the shooter’s fear of the noise or recoil of the rifle and is usually characterized by his tightening up the shoulder, pulling the shoulder away from the rifle, or closing his eyes before the shot is fired. The best way to cure either of these errors is to make up your mind that you will not flinch or jerk and that you are not afraid of the rifle. If you are able to convince yourself that jerking the trigger will always produce poor shots, then there will be no reason to do it. If you are able to realize that the recoil or noise of the rifle will not hurt you, then there will be no reason to flinch. These examples help to explain why shooting is called a sport of the will.

A training exercise used by many expert riflemen to correct defects in trigger control is “dry firing.” You can do this in your own home by placing a small black bull at one end of a room and then firing at this target without using cartridges and noting exactly how the sight picture appeared at the instant the firing pin fell. By dry firing, it is possible to develop a smooth trigger pull and to note the mistakes that you made in pulling the trigger. Whether by dry shooting or by live firing, it does take a considerable amount of training to perfect your trigger control.

BREATH CONTROL

If you continue to breathe while pulling the trigger, the rifle will remain in constant motion and you will never be able to hold the rifle still enough to hit the bull’s-eye. It is thus necessary to hold your breath while the shot is being fired, in order to make the body as motionless as possible. Breath control is required also to ensure the continued proper functioning of the body during the shooting competition.

During the normal respiratory cycle, there is a natural pause between exhalation and inhalation. During this pause, or right after exhaling, you should begin to hold your breath to fire the shot. Al this point the breathing muscles are most relaxed and the lungs are under the least strain. Even though exhalation has been made, there is still plenty of oxygen left in the lungs so that there is no danger of oxygen starvation of the body.

The breath should be held for no longer than ten to twelve seconds, because after this the eyes will begin to blur slightly and the lungs will be straining to resume breathing. If the shot is not fired in this length of time, then stop, take a few new breaths, and start the shot over. Breath control, then, simply refers to holding the breath by extending the normal respiratory pause while the shot is being fired.

USING THE SLING

The importance of the sling is emphasized by the fact that expert riflemen make every attempt to relax the left arm -the arm that supports the rifle -as much as possible. They attempt to see that the muscles of this arm exert no effort at all in holding the rifle. The sling thus serves as a kind of anchor cable that holds up the left forearm and rifle.

The first thing to be considered in using the sling is the placement of the loop on the arm. Some shooters place the loop low, near the elbow, and some place it as high as possible. It is best for the beginning shooter to keep the sling high enough to go around the arm above the biceps muscle. This generally provides the best position for support. The shooter must next adjust the length of the sling and the location of the fore-end stop or sling swivel to which the sling is attached. Some fore-end stops do not move to the rear. In this case, you must not be afraid to move your hand to the rear, leaving the fore-end stop where it is. With most rifles, the fore-end stops are placed too far forward to encourage good positions, and the right hand must be moved to the rear to raise the rifle high enough to keep the head in a good erect position. If the fore-end stop will move to the rear, then it is placed against the right hand between the thumb and index finger after it has been properly located to give the hand something to relax against. Following this, the length of the sling is adjusted so that it is tight enough to take the entire load of the rifle's weight off the left arm.

One of the vital keys to good shooting in the prone, sitting, and kneeling positions is the use of the sling. The easiest way to check if the sling is used right is to note the feeling of the left arm. If your arm is straining to hold up the rifle, then the sling is not tight enough. It is certainly obvious that anyone who desires to become a good shooter must learn how to use the sling to best advantage.

BONE SUPPORT

As has been stated, the best way to shoot a high score is to hold the rifle still; and the best way to hold the rifle still is to develop a position that is based on bone support. It is possible in all four positions, and with the aid of a sling in prone, sitting, and kneeling, to support the rifle entirely upon the bone structure of the body. One of the cardinal rules of shooting is to use bones and ligaments to support the rifle whenever this is possible- since muscles will tire and develop tremors, while bones are capable of constant and unchanging support.

There are numerous examples of how this principle can be applied in the perfection of the four shooting positions. An obvious one deals with the left arm in standing. In this position, it is possible to hold the left arm and elbow free of the body. In the preferred standing position, however, it is necessary to keep the arm resting on the body, for then the rib cage provides bone support for the left arm while the left forearm, in turn, furnishes bone support for the rifle. It is this position, in which the left arm rests on the side that is used by all of the current world champions.

There is another good illustration of this principle in the standing position. The recommended way to shoot standing is to bend the torso to the right and to the rear in supporting the rifle. The need for doing this can readily be seen if you will hold your rifle in position while standing erect and note the strain that the weight of the rifle places on your back. By simply leaning back and bending to the right, you transfer the weight of the rifle onto the spinal column and a system of bone support is developed, where before the rifle was held up by the efforts of the muscles in the back and shoulders.

Other examples of this principle include: in the standing position, the use of both legs to support the body; in the kneeling position, the vertical placement of the left leg or shin, so

that the weight of the rifle falls onto the left knee and consequently directly onto the foot; and in prone position, the placement of the left elbow slightly to the left of the rifle so that it can give maximum support to the rifle and upper torso.

Whenever any doubt arises about the placement of any element of the body in any position, it is best to use the principle of bone support. Each phase of the position should be carefully checked to determine if the legs, the arms, and the torso are positioned to give maximum bone support to the body and rifle. Each position must be carefully adjusted so that this fundamental rule for developing the four positions is closely followed.

RELAXATION

To name the seventh principle "relaxation" is somewhat misleading. Actually, it is impossible to completely relax the body, and for a shooter to do so would mean that his position would collapse! Even in the ideal state of near perfect balance, the bones of the body must be held in position by some degree of muscle tension. Relaxation, then, refers to reducing this muscle tension to the necessary minimum.

If a shooter builds his position on the principles of bone support and balance, he must still learn how tight he should hold his muscles. Because a good position is based on balance, only a small degree of muscle tension should be needed to keep this position stable. If we assumed that a muscle exerting maximum force was at 100% tension, and a totally relaxed muscle was at 0%, then we could describe a muscle used in shooting as needing to be at only 5% to 10% tension. Muscles used in shooting that are contracted beyond this point will eventually develop tremors and encourage poor holds as they tire, which they will do faster when they are more tense. Every shooter must make a conscious effort to relax the muscles of his body so that the tension is reduced to the minimum degree necessary to maintain the position.

There is a second way in which the principle of relaxation is applied in shooting. An experienced shooter will tell you that muscles must never be used to make the rifle point at the target. The best way to check this is to get into position and then let the rifle move to its natural aiming point by letting the whole body relax. This can be done with the eyes closed if this will help the rifle settle to its natural position. If the rifle points high or low, then it is necessary to shift the left arm forward or to the rear and adjust the sling in prone, sitting, or kneeling position. In standing position, the butt of the rifle must be shifted up or down on the shoulder to compensate for the difference at the target. If the rifle points to either side, then it is necessary to turn the entire position so that the rifle points naturally at the target. The rifle should never be forced into position by the use of muscle tension. Each time you shoot, you should check to see that the body is relaxed and that the rifle does have its natural point of aim on the target. You can see now that the principle of relaxation complements the principles of bone support and balance and leads to improved results.

MECHANICAL ZERO (MZ) and ZEROING THE LAW ENFORCEMENT RIFLE

Before starting to zero it is necessary to determine and mark mechanical zero on the rifle sights. This may be done expediently with nail polish and the procedure will be explained on following pages. Mechanical zero may be marked more permanently with a metal scribe, or fine file, using a straight edge and backing up with paint marks. It is also necessary to be familiar with the following terms and definitions.

"MECHANICAL ZERO" can be defined as a marked sight setting that can be easily returned to without the possibility of error.

Unless MECHANICAL ZERO has been established and marked, ZERO sight settings cannot be easily and accurately set on the rifle.

MECHANICAL ZERO is recorded as "MZ".

ZERO

"ZERO" can be defined as the sight settings required on the rifle to shoot point of aim = point of impact under a given set of conditions.
(NOTE: Changing any one of these conditions will result in changing the point of impact.)
ZERO sight settings are always recorded as clicks from MECHANICAL ZERO.

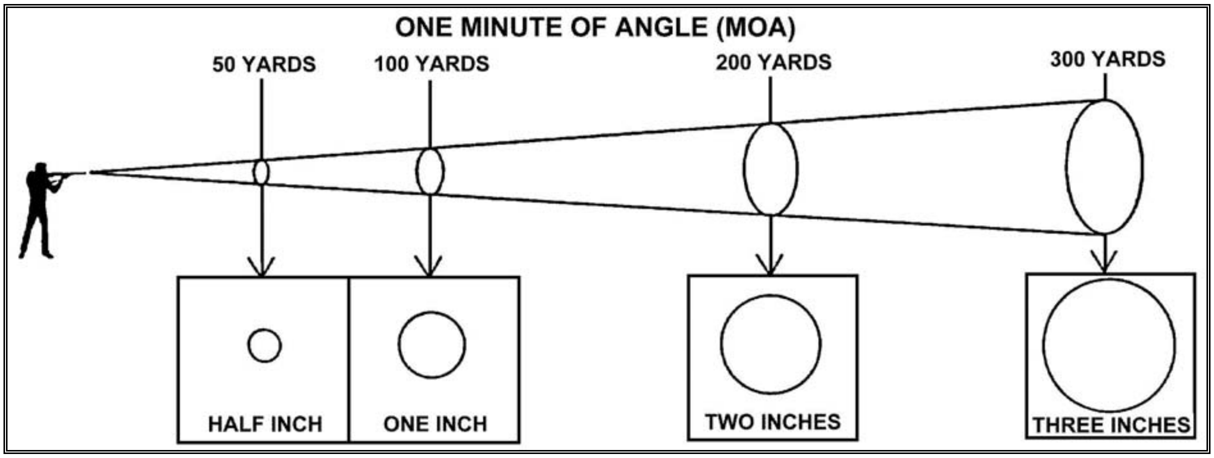
INITIAL SIGHT SETTINGS

The "INITIAL SIGHT SETTINGS" can be defined as the recommended sight settings from which to start the zeroing procedure. If the rifle, and particularly the sighting system, is in good mechanical condition the RECOMMENDED INITIAL SIGHT SETTINGS will result in the shots being "on paper" (law enforcement silhouette type target) at 100 yards.

GENERIC SIGHT ADJUSTMENT

Any movement of the rear sight moves the group in the same direction.
Any movement of the front sight moves the group in the opposite direction.

MINUTE OF ANGLE (MOA)



There are 360 degrees in a circle, and one minute of angle is 1/60 of one degree. One minute of angle is equal to 1.0472" at 100 yards, but for all practical purposes it is generally accepted that one minute of angle is equal to one inch at 100 yards. This equates to ½ inch at 50 yards, 2 inches at 200 yards, 3 inches at 300 yards, etc.

Minute of angle is easily translated to rifle sight "clicks."

Minutes of Angle (MOA) for Each "Click" on the Rifle Sights				
TYPE OF RIFLE	**Front Windage**	**Front Elevation**	**Rear Windage**	**Rear Elevation**
Colt AR-15A1	N/A	1 MOA	1 MOA	N/A
Colt AR-15A2	N/A	1.25 MOA	0.5 MOA	1 MOA
Colt short sight radius	N/A	1.875 MOA	0.75 MOA	1.5 MOA
MI & M14 Service	DRIFT	N/A	1 MOA	1 MOA
M1 & M14 Match	DRIFT	N/A	0.5 MOA	1 MOA *
Ruger Mini-14	N/A	N/A	1 MOA	1 MOA
H&K 91	N/A	N/A	1.25 MOA **	1.25 MOA **
H&K 93	N/A	N/A	1.6 MOA **	1.6 MOA **
Steyr A.U.G.	N/A	N/A	1.5 MOA	1.5 MOA

* Plus or Minus ½ MOA Is Achieved by Rotating the Hood
** Refers to ¼ Turn of the Sight Drum (Note: May or May Not "Click")

INDIVIDUAL ZEROING PROCEDURE

The INITIAL SIGHT SETTINGS that will be used to fire the first group of shots are set on the sights and are recorded (as MZ or as clicks from MZ).

The shooter fires a group of at least five rounds, attempting to fire each shot from exactly the same position and at exactly the same point of aim.

After firing the first group of shots the target is inspected. The location of the center of the group in relationship to the point of aim is determined. If the center of the group does not coincide with the point of aim, the required group movement (IN MINUTES OF ANGLE) is recorded. If the target is to be re-used all shot holes must be patched or clearly marked.

Sight adjustments are made to the rifle and the new sight settings are recorded (AS CLICKS FROM MZ).

Another group is fired to check where the group impacts on the target with the new sight settings.

This procedure is repeated until the center of the group is the same as the point of aim.

When the center of the group coincides with the point of aim, the rifle now has a ZERO for all the conditions under which the group was shot.

It is then recommended that at least three or four more groups are fired for confirmation. The ZERO sight settings are now recorded as clicks from mechanical zero.

AGENCY ZEROING PROCEDURE

In law enforcement agencies where rifles are not issued on an individual basis, but rather may have to be shared by more than one officer, it is recommended that the agency firearms instructor zero all of the guns.

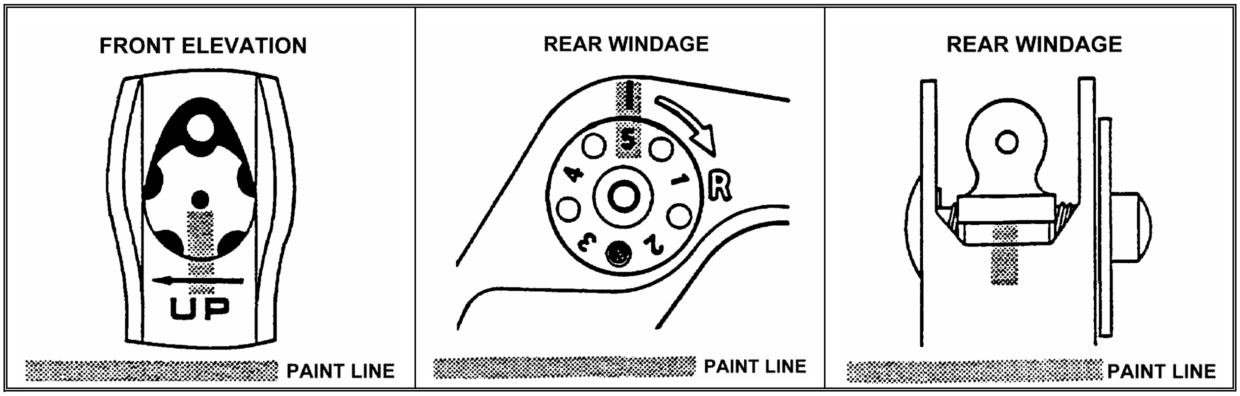
The instructor starts by setting the sights and marking mechanical zero on the guns as described in “MARKING SIGHTS FOR MECHANICAL ZERO”. Starting with the “RECOMMENDED INITIAL SIGHT SETTINGS”, the instructor now zeros the guns as described in “INDIVIDUAL ZEROING PROCEDURES”. Once each gun is zeroed (for the instructor) the sights are marked for ZERO (in a different color - there are now two sets of marks) and a waterproof label is attached to the gun recording the ZERO sight settings (as clicks from mechanical zero).

With this procedure, any officer is able to employ any agency gun - because all the guns shoot to the same point of impact (providing the ZERO sight marks are lined up).

In theory, an officer may have to “hold off’ to hit the intended target. If this is the case, the individual officer’s hold off will be the same for every agency gun. In practice, the officer’s hold off is unlikely to be significant at patrol rifle distances and with patrol rifle shooting proficiency standards.

MARKING MECHANICAL ZERO

COLT AR15A1

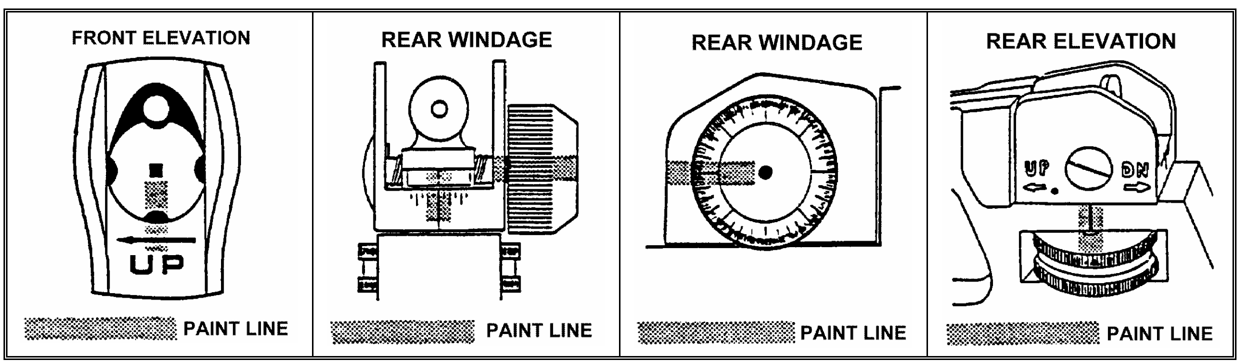


FRONT ELEVATION: Turn the front sight up or down until post shoulders are flush, or level, with the sight base. Mark MECHANICAL ZERO as shown.

REAR WINDAGE: Center rear aperture by counting the number of clicks from far left to far right and turning back halfway. Mark MECHANICAL ZERO as shown. Always use the same aperture.

INITIAL SIGHT SETTINGS: Front elevation = MZ, Rear windage = MZ.

COLT AR15A2



FRONT ELEVATION: Turn the front sight up or down until post shoulders are flush, or level, with sight base. Mark MECHANICAL ZERO as shown.

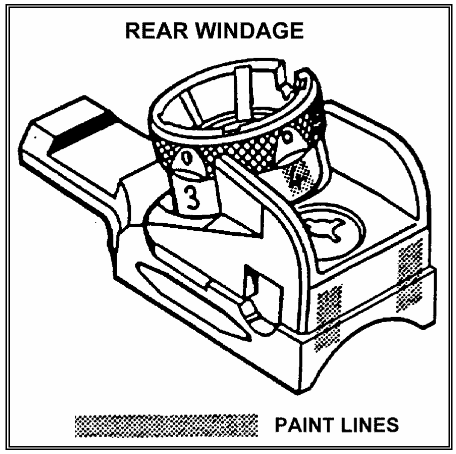
REAR WINDAGE: Lay short-range aperture down. (Marking “0-2” not visible) Center (sideways) by eye using center index line on sight base and single index line on top of short-range aperture. Mark MECHANICAL ZERO as shown. Always use the same (long-range) aperture.

REAR ELEVATION: Turn sight all the way down as far as possible (until bottomed out). Be sure the sight is in a notch. Mark MECHANICAL ZERO as shown.

INITIAL SIGHT SETTINGS: Front elevation = MZ, Rear windage = MZ, Rear elevation = MZ.
NOTE: Use front elevation adjustment for initial zero. Thereafter use rear elevation adjustment.

MARKING MECHANICAL ZERO

H&K 91 & 93

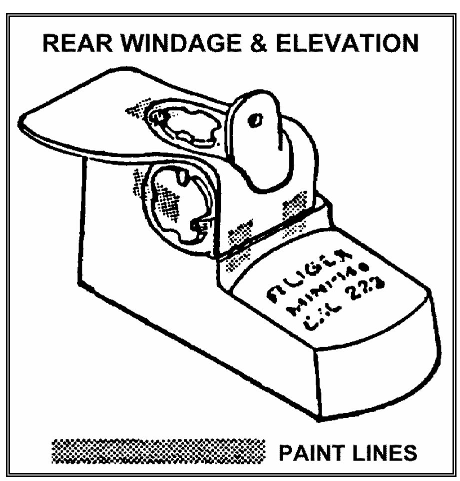


REAR WINDAGE: Center sight block (sideways) by eye. Mark MECHANICAL ZERO as shown.

REAR ELEVATION: Turn all the way down (counter-clockwise) until the sight drum is bottomed Consider this MECHANICAL ZERO. Marking is impractical. Pick one of the three numbered apertures, mark as shown, **always use the same aperture** (apertures change point of impact).

INITIAL SIGHT SETTINGS: Rear windage = MZ, Rear elevation = 12U (12 x ¼ turns or 3 full turns).

RUGER MINI-14



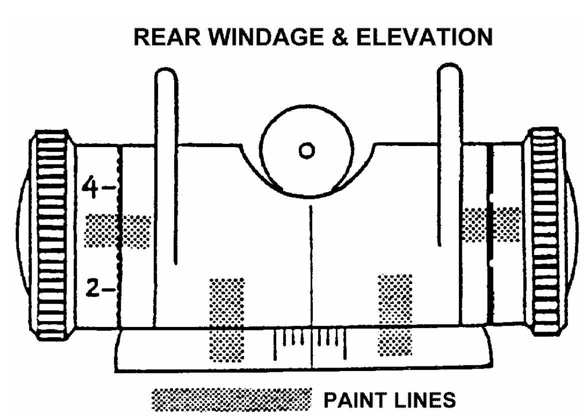
REAR WINDAGE: Using rear sight windage screw, center (sideways) rear peep sight by eye. Mark MECHANICAL ZERO as shown.

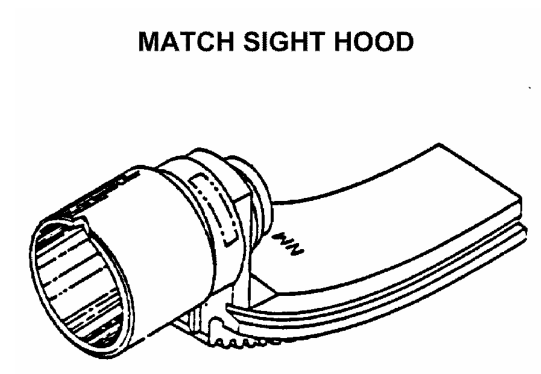
REAR ELEVATION: Turn rear sight elevation screw until rear peep sight is as far down as possible (bottomed out). Mark MECHANICAL ZERO as shown.

INITIAL SIGHT SETTINGS: Rear windage = MZ, Rear elevation = 12U.

MARKING MECHANICAL ZERO

M1 & M14 SERVICE & MATCH





M1 & M14 SERVICE

REAR WINDAGE: Center (sideways) by eye using single index line on sight body and center index line on sight base. Mark MECHANICAL ZERO as shown.

REAR ELEVATION: Turn elevation drum until rear sight aperture is as far down as possible (bottomed out). Mark MECHANICAL ZERO as shown.

INITIAL SIGHT SETTINGS: Rear windage = MZ, Rear elevation = MZ.

M1 & M14 MATCH

Marked as for M1 & M14 service. While the thread pitch of the windage screw is different, giving, ½ M.O.A. increments, the hood is the only visible difference in the sights. The hood may be rotated with the notch facing up (+ ½ M.O.A.) or down (- ½ M.O.A.).

INITIAL SIGHT SETTINGS: Rear windage = MZ, Rear elevation = MZ, notch in hood must be turned down.

NOTE: Under ideal circumstances, when zeroing M1 & M14 service & match rifles, center the rear aperture for windage (MZ) and move the front sight as required until true zero is achieved with rear windage at MZ. This makes available the greatest number of rear windage adjustment clicks on either side of MECHANICAL ZERO.

ZEROING CHART		
Name:	*Location:*	*Date:*
Rifle:	*Serial #.*	*Ammunition:*
Distance:	*Position:*	*Support.*

On this Rifle, the Minute of Angle Change for Each "Click" on the Sights Is:			
Front Windage	*Front Elevation*	*Rear Windage*	*Rear Elevation*
On this Rifle the Recommended Initial Sight Settings to Fire the First Group Are:			
Front Windage	*Front Elevation*	*Rear Windage*	*Rear Elevation*

1. FIRE THE FIRST GROUP

1A. The group needs to move (in MOA):	*up*	*down*	*left*	*right*
1B. The required sight adjustment in clicks is:	*F/R*	*U/D*	*F/R*	*L/R*
1C. Adjust the Sights and Then Record the Sight Settings on the Rifle as Clicks from MZ				
Front Windage	*Front Elevation*	*Rear Windage*	*Rear Elevation*	

2. FIRE THE SECOND GROUP

1A. The group needs to move (in MOA):	*up*	*down*	*left*	*right*
1B. The required sight adjustment in clicks is:	*F/R*	*U/D*	*F/R*	*L/R*
1C. Adjust the Sights and Then Record the Sight Settings on the Rifle as Clicks from MZ				
Front Windage	*Front Elevation*	*Rear Windage*	*Rear Elevation*	

3. FIRE THE THIRD GROUP

1A. The group needs to move (in MOA):	*up*	*down*	*left*	*right*
1B. The required sight adjustment in clicks is:	*F/R*	*U/D*	*F/R*	*L/R*
1C. Adjust the Sights and Then Record the Sight Settings on the Rifle as Clicks from MZ				
Front Windage	*Front Elevation*	*Rear Windage*	*Rear Elevation*	

ZERO SIGHT SETTINGS AS CLICKS FROM MECHANICAL ZERO			
Front Windage	*Front Elevation*	*Rear Windage*	*Rear Elevation*

Minutes of Angle (MOA) for Each "Click" on the Rifle Sights				
TYPE OF RIFLE	**Front Windage**	**Front Elevation**	**Rear Windage**	**Rear Elevation**
Colt AR-15A1	N/A	1 MOA	1 MOA	N/A
Al - short sight radius	N/A	1.5 MOA	1.5 MOA	N/A
Colt AR-15A2	N/A	1.25 MOA	0.5 MOA	1 MOA
A2 - short sight radius	N/A	1.875 MOA	0.75 MOA	1.5 MOA
M1 & M14 Service	DRIFT	N/A	1 MOA	1 MOA
M1 &M14 Match	DRIFT	N/A	0.5 MOA	1 MOA *
Ruger Mini-14	N/A	N/A	1 MOA	1 MOA
H&K 91	N/A	N/A	1.25 MOA **	1.25 MOA **
H&K 93	N/A	N/A	1.6 MOA **	1.6 MOA **
Steyr A.U.G.	N/A	N/A	1.5 MOA	1.5 MOA

* Plus or Minus ½ MOA Is Achieved by Rotating the Hood

** Refers to ¼ Turn of the Sight Drum (Note: May or May Not "Click")

Recommended Initial Sight Settings	
Colt AR15A1	**Front Elevation = MZ** **Rear Windage = MZ** Always use the same (long-range) aperture.
Colt AR15A2	**Front Elevation = MZ** **Rear Windage = MZ** **Rear Elevation = MZ** Always use the small aperture. Use front elevation adjustment for initial zeroing.
M1 / M14	**Rear Elevation = MZ** **Rear Windage = MZ**
Ruger Mini-14	**Rear Windage = MZ** **Rear Elevation = 12U**
H&K 91 & 93	**Rear Windage = MZ** **Rear Elevation = 12U (12 "clicks" or 3 full turns**) Pick ONE aperture; always use the same aperture.
Steyr A.U.G.	**Elevation = MZ** **Windage = MZ** Do **NOT** adjust the sights before marking MZ. Consider whatever setting is on the gun as MZ.

RANGE DRILLS

CONTROLLED PAIRS FROM PRIMARY FIRING POSITIONS
10 YARDS

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fires a controlled pair to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should load from the lowest position and scan on the way up.

DRILL 1:

Distance - 10 yards
Time - 3.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from LOW guard, assume a **speed kneeling** position and fire 2 to the body.

DRILL 2:
Distance - 10 yards
Time - 3.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from LOW guard, assume a **double kneeling** position and fire 2 to the body.

DRILL 3:

Distance - 10 yards
Time - 4.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from LOW guard, assume a **braced kneeling** position and fire 2 to the body.

DRILL 4:

Distance - 10 yards
Time – 4.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from LOW guard, assume a **speed sitting** position and fire 2 to the body.

DRILL 5:
Distance - 10 yards
Time - 3.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from LOW guard, assume a **squat position** and fire 2 to the body

Note: Shooters unable to assume these positions may shoot from any kneeling position.

CONTROLLED PAIRS FROM PRIMARY FIRING POSITIONS
15 YARDS

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fires a controlled pair to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should **load from the lowest position and scan on the way up.**

DRILL 1:

Distance - 15 yards
Time - 3.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a speed kneeling position and fire 2 to the body.

DRILL 2:

Distance - 15 yards
Time - 4.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **double kneeling** position and fire 2 to the body.

DRILL 3:

Distance - 15 yards
Time -4.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **braced kneeling** position and fire 2 to the body.

DRILL 4:

Distance - 15 yards
Time - 4.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** and fire 2 to the body.

DRILL 5:
Distance - 15 yards
Time - 3.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **squat position** and fire 2 to the body.

Note: Shooters unable to assume these positions may shoot from any kneeling position.

CONTROLLED PAIRS FROM PRIMARY FIRING POSITIONS
25 YARDS

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fires a controlled pair to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should load from the lowest position and scan on the way up.

DRILL 1:

Distance - 25 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, assume an **offhand** position and fire 2 to the body.

DRILL 2:
Distance - 25 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, assume a **speed kneeling** position and fire 2 to the body.

DRILL 3:

Distance - 25 yards
Time -5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, assume a **double kneeling** and fire 2 to the body.

DRILL 4:
Distance - 25 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, assume a **braced kneeling** and fire 2 to the body.

DRILL 5:
Distance - 25 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, assume a **squat position** and fire 2 to the body.

DRILL 6:

Distance - 25 yards
Time - 4.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard assume a **sitting position** and fire 2 to the body.

DRILL 7:

Distance - 25 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard assume a **sitting position** and fire 2 to the body.

DRILL 8:

Distance - 25 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard assume a **prone position** and fire 2 to the body.

DRILL 9:

Distance - 25 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start Guard, assume a **roll over prone** position and fire 2 to the body.

Note: Shooters unable to assume these positions may shoot from any kneeling position.

CONTROLLED PAIRS FROM PRIMARY FIRING POSITIONS
50 YARDS

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fires a controlled pair to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should load from the lowest position and scan on the way up.

DRILL 1:

Distance - 50 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume an **offhand** position and fire 2 to the body.

DRILL 2:

Distance - 50 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** position and fire 2 to the body.

DRILL 3:

Distance - 50 yards
Time -6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **double kneeling** and fire 2 to the body.

DRILL 4:

Distance - 50 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **braced kneeling** and fire 2 to the body.

DRILL 5:

Distance - 50 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **squat position** and fire 2 to the body.

DRILL 6:

Distance - 50 yards
Time - 5.0 seconds
Load - 1 in chamber, full magazine
Weapon: C-1, Selector on SAFE
Drill - Start from guard, assume a **speed kneeling** and fire 2 to the body.

DRILL 7:

Distance - 50 yards
Time - 8.0 seconds
Load - 1 in chamber, full magazine
Weapon: C-1, Selector on SAFE
Drill - Start from guard, assume a **sitting position** and fire 2 to the body.

DRILL 8:

Distance - 50 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Weapon: C-1, Selector on SAFE
Drill - Start from guard, assume a **prone position** and fire 2 to the body.

Note: Shooters unable to assume these positions may shoot from any kneeling position.

CONTROLLED PAIRS FROM PRIMARY FIRING POSITIONS
75 YARDS

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fires a controlled pair to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should load from the lowest position and scan on the way up.

DRILL 1:

Distance - 75 yards
Time - 5.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume an **offhand** position and fire 2 to the body.

DRILL 2:

Distance - 75 yards
Time - 6.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** position and fire 2 to the body.

DRILL 3:

Distance - 75 yards
Time -6.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **double kneeling** and fire 2 to the body.

DRILL 4:

Distance - 75 yards
Time - 6.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **braced kneeling** and fire 2 to the body.

DRILL 5:
Distance - 75 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **squat position** and fire 2 to the body.

DRILL 6:

Distance - 75 yards
Time - 5.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** and fire 2 to the body.

DRILL 7:

Distance - 75 yards
Time - 10 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **sitting position** and fire 2 to the body.

DRILL 8:

Distance - 75 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **prone position** and fire 2 to the body.

Note: Shooters unable to assume these positions may shoot from any kneeling position.

CONTROLLED PAIRS FROM PRIMARY FIRING POSITIONS
100 YARDS

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fires a controlled pair to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should load from the lowest position and scan on the way up.

DRILL 1:

Distance - 100 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume an **offhand** position and fire 2 to the body.

DRILL 2:

Distance - 100 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** position and fire 2 to the body.

DRILL 3:

Distance - 100 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **double kneeling** and fire 2 to the body.

DRILL 4:

Distance - 100 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **braced kneeling** and fire 2 to the body.

DRILL 5:
Distance - 100 yards
Time - 7.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **squat position** and fire 2 to the body.

DRILL 6:

Distance - 100 yards
Time - 7.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** and fire 2 to the body.

DRILL 7:

Distance - 100 yards
Time - 10 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard assume a **sitting position** and fire 2 to the body.

DRILL 8:

Distance - 100 yards
Time - 8.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **prone position** and fire 2 to the body.

Note: Shooters unable to assume these positions may shoot from any kneeling position.

GROUPING AND SKILL BUILDER FROM PRIMARY FIRING POSITIONS 100 YARDS

Controlled Pairs

The shooter faces the target with the weapon in condition one, safety on. On command, the shooter will assume a firing position and fire 5 rounds to the body. The position can be utilized to change the trajectory of the bullet or to acquire a more stable firing platform. The firing position will provide a lower profile for the shooter making, him a smaller target. The shooter should be acquiring front sight picture before and after each shot. Ammunition management is the shooters responsibility. The shooter should **reload from the lowest position and scan on the way up.**

Note: Emphasis is placed on **precision and basics**. Shooter is encouraged to concentrate on sight alignment, breath control, and trigger press.

DRILL 1:

Distance - 100 yards
Time – No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume an **offhand** position and fire 5 rounds to the body.

DRILL 2:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** position and fire 5 rounds to the body.

DRILL 3:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **double kneeling** and fire 5 rounds to the body.

DRILL 4:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **braced kneeling** and fire 5 rounds to the body.

DRILL 5:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard assume a **squat position** and fire 5 rounds to the body.

DRILL 6:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **speed kneeling** and fire 5 rounds to the body.

DRILL 7:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **sitting position** and fire 5 rounds to the body.

DRILL 8:

Distance - 100 yards
Time - No Limit
Load - 1 in chamber, full magazine
Drill - Start from guard, assume a **prone position** and fire 5 rounds to the body.

Note: Shooters unable to assume these positions may shoot from any kneeling position.

HAMMERS

The shooter faces the target with the weapon in condition one, safety on. This drill is similar to controlled pairs, but the time is compressed. On command, the shooter will fire a hammer (2 rounds) to the body. The shooter should be acquiring front sight picture before the first round and after the last round. Ammunition management is the shooters responsibility. The shooter should **load and continue to scan**.

DRILL 1:

Distance - 3 yards
Time - 1.0 second
Load - 1 in chamber, full magazine
Drill - Start from LOW guard and fire a hammer (2 rounds) to the body.

DRILL 2:

Distance - 5 yards
Time - 1.50 seconds
Load - 1 in chamber, full magazine
Drill - Start from LOW guard and fire a hammer (2 rounds) to the body.

FAIL TO STOP

The shooter faces the target with the weapon in condition one, safety on. This drill is designed to stop a subject who fails to stop his assaultive behavior. On command, the shooter will fire (2 rounds) to the body, and one marksmanship shot to the "A" zone of the head. The shooter should be acquiring front sight picture before and after each round. Ammunition management is the shooters responsibility. The shooter should **scan** after completing the drill.

DRILL 1:

Distance - 5 yards
Time - 2.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from guard and fire a fail to stop (2 rounds) to the body, one to the "A" zone of the head.

DRILL 2:

Distance - 7 yards
Time - 3.0 seconds
Load - 1 in chamber, full magazine
Drill - - Start from guard and fire a fail to stop (2 rounds) to the body, one to the "A" zone of the head.

DRILL 3:

Distance - 10 yards
Time - 3.5 seconds
Load - 1 in chamber, full magazine
Drill - - Start from guard and fire a fail to stop (2 rounds) to the body, one to the "A" zone of the head.

A, B, C DRILL

The shooter faces the target with the weapon in condition one, safety on. This drill is designed to stop a subject who is wearing armor and moving. On command, the shooter will fire (2 rounds) to the center of the body “A” zone, one marksmanship shot to the “A” zone of the head, then (2 rounds) to the pelvic girdle. The head is a small, mobile target, and is difficult to hit. If the center mass shots fail, and the head shot misses, the pelvic shot may stop the opponent. The rounds could break the pelvic or hip-bones, dropping the opponent to the ground. The shooter should be acquiring front sight picture before and after each round. Ammunition management is the shooters responsibility. The shooter should assess the situation after completing the drill**. Just because he is down does NOT mean the fight is over; it just means you’ve had your turn!** Scan and assess carefully.

DRILL 1:

Distance - 5 yards
Time – 3.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard and fire an A, B, C, drill; 2 rounds to the body one to the “A” zone of the head, 2 rounds to the pelvic girdle.

DRILL 2:

Distance - 7 yards
Time - 3.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard and fire an A, B, C, drill; 2 rounds to the body, one round to the “A” zone of the head, 2 rounds to the pelvic girdle.

DRILL 3:

Distance - 10 yards
Time - 4.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard and fire an A, B, C drill; 2 rounds to the body, one round to the “A” zone of the head, 2 rounds to the pelvic girdle.

SUPPORT SIDE 90 DEGREE PIVOTS

The shooter stands on the firing line with the support side facing down range, safety "on", the weapon side shoulder facing up range. (Right hand shooters face right / left hand shooters face left). Shooters begin with feet shoulder width apart. The muzzle is down in an exaggerated position. The back is straight and the knees slightly bent. On a firing command, the shooter looks over his shoulder and visually acquires the target. The shooter then takes one step forward with the weapon side leg. He plants his feet and simultaneously pivots 90 degrees on both feet, turning the reaction side to the target. Once the pivot is complete, the shooter mounts the rifle, acquires the sights, releases the safety, and fires 2 shots to the body.

DRILL 1:

Distance - 10 yards
Time - 3.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's support side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 2:

Distance - 25 yards
Time - 4.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's support side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 3:

Distance - 50 yards
Time -5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's support side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 4:

Distance - 75 yards
Time - 5.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's support side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 5: **Distance - 100 yards**

Time - 6.0 seconds
Load - 1 in chamber, full magazine

Drill - Start from Guard, with the shooter's support side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

WEAPON SIDE 90 DEGREE PIVOTS

The shooter stands on the firing line with the support side facing up range, safety "on and thumb on the safety. Shooters begin with feet shoulder width apart. The muzzle is down in an exaggerated position. The back is straight and the knees slightly bent. On a firing command, the shooter looks over his shoulder acquiring the target visually. The shooter then steps across the body at a 45-degree angle with the reaction side foot. The shooter pivots towards the target. Once the pivot is complete, the shooter mounts the rifle, acquires the sights, releases the safety, and fires 2 shots to the body

INSTRUCTOR NOTE: Right handed shooters should be located on the left side of the firing range and right handed shooters on the left. This will aid in not having muzzles track someone on your firing line.

DRILL 1:

Distance - 10 yards
Time - 3.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's weapon side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 2:

Distance - 25 yards
Time - 4.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's weapon side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 3:

Distance - 50 yards
Time -5.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's weapon side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 4:

Distance - 75 yards
Time - 5.5 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's weapon side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

DRILL 5:

Distance - 100 yards
Time - 6.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooter's weapon side shoulder facing down range. The shooter pivots 90 degrees and fires 2 to the body.

180 DEGREE PIVOTS

Beg1n with the shooter's back facing down range. The muzzle is down, feet shoulder width apart and knees slightly bent. The back should be straight. On the firing command, the shooter steps across the body in a 45 degree angle with the weapon side leg. The shooter turns his head and looks down range to acquire a visual target. The shooter pivots on both feet toward the support side, making a 180 degree turn in that direction. Once the pivot is complete, the shooter mounts the rifle, acquires the sights, releases the safety, and fires 2 shots to the body.

DRILL 1:

Distance - 10 yards
Time - 3.0 seconds
Load - 1 in chamber, full magazine
Drill - Start from Guard, with the shooters facing up range. The shooter pivots 180 degrees and fires 2 to the body.

DRILL 2:

Distance - 25 yards
Time - 4.0 seconds
Load - 1 in chamber, full magazine
Drill - - Start from Guard, with the shooters facing up range. The shooter pivots 180 degrees and fires 2 to the body.

DRILL 3:

Distance - 50 yards
Time -5.0 seconds
Load - 1 in chamber, full magazine
Drill—Start from Guard, with the shooters facing up range. The shooter pivots 180 degrees and fire 2 to the body.

DRILL 4:

Distance - 75 yards
Time – 6.0 seconds
Load - 1 in chamber, full magazine
Drill - - Start from Guard, with the shooters facing up range. The shooter pivots 180 degrees and fires 2 to the body.

DRILL 5:

Distance - 100 yards
Time - 8.0 seconds
Load - 1 in chamber, full magazine
Drill - - Start from Guard, with the shooters facing up range. The shooter pivots 180 degrees and fire 2 to the body.

TRANSITION DRILLS

In the event the rifle malfunctions or is out of ammunition (and no more magazines), transition from the rifle to the handgun might be necessary. It is important to for the student to develop a habit of transition in the event of such an occurrence. Studies have indicated that the transition takes less time than clearing a malfunction.

The transition is only necessary for close quarter combat. If the shooter is behind cover and/or a long distance away, consider clearing the malfunction or acquiring more ammunition.

I. Standard Sling

A. With your support hand on the fore-end, lower the muzzle down, touching the back of the support hand to the support side thigh. This should leave the muzzle pointing down and slightly outside of the support side foot. Another option is to clutch the fore-end up to the upper support side chest, back of the fingertips touching the chest. This should leave the muzzle straight up, off of the support side of the head.

B. Shift your strong side leg forward as your draw your handgun.

C. Assume a proper one-handed shooting stance.

D. Evaluate, and fire your handgun if necessary.

II. Tactical Carry Sling

A. Let go of the rifle with your strong hand, pulling the muzzle down with your off hand.

B. Draw your handgun with your strong hand.

C. Evaluate and fire if necessary.

Application

Separately, instruct the shooter coaches to load one magazine for the shooter with five rounds. The <u>last round</u> to be fired will be a "dummy" round. This should be done without the shooter knowing. From the 15-yard line, have the shooters fire five rounds at the target.

Show the class how many of the shooters attempted to clear their weapons instead of transitioning, and complete the following course of fire:

From the 15-yard line, students will load magazines with five rounds. On command, the student will fire five rounds and transition safely to the handgun and fire two shots at the target.

The instructor will conduct the drill until students demonstrate they are comfortable with the drill.

15 yards	**Fire five rounds (one inert)**	**Transition to sidearm**

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AUBURN POLICE DEPARTMENT
RIFLE (.223) QUALIFICATION
COURSE OF FIRE

Officers start at the 50 yd. with the rifle loaded and wearing their appropriate team gear.
First stage of fire: Officers will start at the low ready position and fire two rounds to the body in 6 seconds from the prone position. They fire this drill three times for a total of six rounds. Time limit for the two shot stages is 6 seconds.

Sequence: 1. Low ready to prone.
2.Fire two rounds to body.
3. Repeat
4. Repeat.

Second stage of fire: Officers will start at the low ready position and fire two rounds to the body in 6 seconds from the squat or sitting position. They fire this drill three times for a total of six rounds. Time limit for the two shot stages is 6 seconds.

Sequence: 1. Low ready to squat or sitting position.
2. Fire two rounds to body.
3. Repeat.
4. Repeat.

Third stage of fire: Officers will start at the low ready position and fire two rounds to the body in 5 seconds from the kneeling position. They fire this drill three times for a total of six rounds. Time limit for the two shot stages is 5 seconds.

Sequence: 1. Low ready to squat or sitting position.
2. Fire two rounds to body.
3. Repeat.
4. Repeat.

Fourth stage of fire: Officers move forward to the 25 yard line. Officers will start at the low ready position and fire two rounds to the body from standing off hand, speed kneel, reload, fire two rounds to the body in 8 seconds. They fire this drill two times for a total of four rounds. Time limit for the four rounds is 8 seconds.

Sequence: 1. Low ready to standing oft hand-semi.
2. Fire two rounds to body.
3. Repeat.

AUBURN POLICE DEPARTMENT
RIFLE (.223) QUALIFICATION
COURSE OF FIRE

Fifth stage of fire: Officers move forward to the 15 yard line. Officers will start at the low ready position and fire two rounds to the body in 3.5 seconds from standing off hand position. They fire this drill three times for a total of six rounds. Time limit for the two shot stages is 3.5 seconds.

Sequence: 1. Low ready to standing off hand.
2. Fire two rounds to body.
3. Repeat.
4. Repeat.

Score and mark target holes: There should be 32 holes max points **(160).**

Sixth stage of fire: Officers move forward to the 10 yard line. Officers will start at the low ready position and fire two rounds to the body from standing off hand and fire one round to the head in 3 seconds. Repeat this drill one time. The time limit for each sequence is 3 seconds.

Sequence: 1. Low ready to standing off.
2. Fire two rounds to body.
3.Fire one round to head.
4. Repeat.

Seventh stage of fire: Officers move forward to the 7 yard line. Officers will start at the low ready position and fire two rounds to the body from the speed kneeling position in 3 seconds. They will repeat this drill one time. Time limit for the two rounds is 3 seconds.

Sequence: 1. Low ready to speed kneeling.
2. Fire two rounds to body.
3. Repeat.

Eighth stage of fire: Officers stay at the 7 yard line. Officers will start at the low ready position and fire two rounds to the body from the speed kneeling position and one round to the head in 3 seconds. They will repeat this drill one time. Time limit for the two rounds is 3 seconds.

Sequence: 1. Low ready to speed kneeling.
2.Fire two rounds to body.
3.One round to the head.
4. Repeat.

AUBURN POLICE DEPARTMENT
RIFLE (.223) QUALIFICATION
COURSE OF FIRE

Ninth stage of fire: Officers move forward to the 5 yard line. Officers will start at the low ready position and fire three rounds to the body in 2 seconds from the standing off hand. Repeat the course of fire for a total of six rounds. Time limit for the three rounds is 2 seconds.

Sequence: 1. Low ready to standing off hand.
2.Fire three rounds to body.
3. Repeat.

Tenth stage of fire: Officers stay at the 5 yard line. Officers will start at the low ready position and fire two rounds to the body from the standing off hand position and one round to the head in 2 seconds. They will repeat this drill one time. Time limit for the three rounds is 2 seconds.

Sequence: 1. Low ready to standing off hand.
2. Fire two rounds to body.
3.One round to the head.
4. Repeat.

Score and mark target holes: There should be 60 holes max points (300).

SCORING SYSTEM:
Sixty shots with a maximum score of 5 points per round = 300
Point values:

5 Points Body hits inside the eight ring[1] or any hit in head scoring zone.

4 Points Body hits in the seven ring.

1 Points Any other hit on the silhouette including hits on the head outside of head scoring zone.

All shots must hit silhouette any misses are a DNQ.
Minimum Qualifying score is 255 points or 85%.

30 RD. QUALIFICATION COURSE FOR SEMI-AUTO RIFLE
MILL CREEK P.D.

This course is designed to utilize the B-21 style target. The course is scored as follows:
All hits designated to the body will be scored only if they are in the maximum scoring area (the 5 zone). All hits designated as head shots will be scored only if they are in the designated scoring area of the head. Any shots fired after the designated maximum time will not be scored. The shooter needs 100% to qualify. This course is meant to emphasize accuracy, changing shooting platforms, failure of body shots and tactical reload of the semi-automatic carbine rifle. Each shooter will be allowed only two attempts at qualification. Shooters failing to qualify will be scheduled for remedial training and requalification.

Stage 1

Prior to starting the stage, the rifle will be in the car carry condition, stock collapsed. Chamber empty, magazine inserted, safety on. Upon command the shooter will load and make ready the weapon then commence firing to the body of target. Stage 1 has 90 seconds maximum time allowed.
From the 25 yard line.

1) 6 rounds standing right barricade; tactical reload
2) 6 rounds kneeling; tactical reload
3) 6 rounds prone.

Stage 2

Starting from the low ready (round is chambered, safety on, muzzle slightly depressed and eyes on target). Four separate strings to be fired on separate command, 5 seconds maximum time allowed per string.
From the 15 yard line.

1) Two rounds to the body and one to the head.
2) Two rounds to the body and one to the head.
3) Two rounds to the body and one to the head.
4) Two rounds to the body and one to the head.

Scoring and evaluation.

TACOMA P.D. RIFLE QUALS COURSE

(RIFQUAL2)

(Computer program line number)

Using the 6-step barricade. All stages begin with the shooter in the standing position.
50 yard line

(2) **Barricade Level #1**

Standing – rifle slung muzzle up, 2 rounds.

(3) **Barricade Level #2**

Standing – rifle slung muzzle down, 3 rounds.

(4) **Barricade Level #3**

Standing – rifle slung muzzle up, 2 rounds.

(5) **Barricade Level #4**

Standing – rifle slung muzzle down, 3 rounds.

(6) **Barricade Level #5**
Standing – rifle slung muzzle up, 3 rounds.

(7) **Barricade Level #6**
Standing – rifle slung muzzle down, 3 rounds.

(8) **Stand in front of the barricade, guard position. On command, move out toward your target. When the target turns, stop, fire 2 rounds. (Target should be faced when shooter nears the 40-yard line) After firing, dress line to the right.**

(9) **On command, move out at guard position. When the target turns, stop, fire 2 rounds. (Targets should be faced when shooter nears the 30-yard line) Immediate reload, safety on.**

Move barricade to the 25-yard line.

TACOMA P.D. RIFLE QUALS COURSE

(RIFQUAL2)

Using the 6-step barricade. All stages begin with the shooter in the standing position.

25 yard line

(10) **Barricade Level #1**

Standing - rifle shouldered your choice, 2 rounds.

(11) **Barricade Level #2**

Standing rifle shouldered your choice, 3 rounds.

(12) **Barricade Level #3**

Standing rifle shouldered your choice, 2 rounds.

(13) **Barricade Level #4**

Standing rifle shouldered your choice, 3 rounds.

(14) **Barricade Level #5**

Standing rifle shouldered your choice, 3 rounds.

(15) **Barricade Level #6**

Standing rifle shouldered your choice, 3 rounds.

(16) **Stand in front of the barricade, guard position. On command, move out toward your target. When the target turns, stop, fire 2 rounds. (Face target when shooter nears the 20-yard line) Dress line to the right.**

(17) **On command, move out at guard position. When the target turns, stop, fire 2 rounds. (Face target when shooter nears the 10-yard line)**

(18) **On command, move out at guard position. When the target turns, stop, Transition to your pistol, but do not fire your pistol. Challenge!**

(Face target when shooter nears the 10-yard line)

Return target(s) to the range house for scoring.

Aberdeen Police Department
Firearms Training Unit

Course title or number: Rifle Qualification Course for Patrol Rifle.
Course designed by: FTU
Primary Objectives: Demonstration of appropriate marksmanship.
Secondary Objectives: Demonstration of safe weapon handling and operation skills. Proper use of cover, combat reloading and moving with the weapon.
Explanation of Objectives: The primary and secondary objectives are designed to insure the safe and proficient handling of the patrol rifle. They allow the demonstration of the basic skills needed by the officer to operate the rifle in an effective manner while at the same time promoting confidence by the officer in his/her operating and marksmanship skills. These objectives also assist the FTU to identify areas of needed training on a personal level for each officer.
Course Overview: The annual patrol rifle qualification is a 30 round course shot from the 100-yard line, 50-yard line and the 25-yard line.
The **100-yard** line course of fire is a ten (10) round course in 60 seconds. The officer will load and make ready and on the command, “threat,” will choose a shooting position and fire ten (10) rounds in 60 seconds with a mandatory tactical reload prior to the last shot being fired.
The **50-yard** line course of fire is a ten (10) round course in 60 seconds. The officer will load and make ready and on the command, “threat,” will fire three (3) rounds standing on the right side of the barricade, three (3) rounds while standing on the left side of the barricade and four (4) rounds while prone on either side of the barricade. A mandatory tactical reload is required prior to the last shot being fired.
The **25-yard** line course of fire is a ten (10) round course in 40 seconds. The officer will load and make ready and on the command of “threat,” fire three (3) rounds standing on the right side of the barricade, three (3) rounds standing on the left side of the barricade and four (4) rounds kneeling on either side of the barricade. A mandatory tactical reload is required before the last shot is fired.
Verification of Objectives: Visual observation of the shooters weapon handling and operation skills, use of cover, and movement with the weapon by FTU instructors.
100 percent of the rounds fired from the 100-yard line must be on the body of the Caudle II target.

100 percent of the rounds fired from the 50-yard line must be within the scoring circle of the Caudle II target.
100 percent of the rounds fired from the 25-yard line must be within the “9” ring or better on the Caudle II target.
A FTU member will score the target and the score will be recorded on the officers training sheet for that day.

Hackathorn Carbine Classifier

Designer: Ken Hackathorn

Scoring: Limited Vickers (each point down equals one second)

Targets: Three IDPA silhouettes, spaced two yards apart, with the target heights as follows: T1 @ 6', T2 @ 4' and T3 at 5'.

Range equipment needed: Electronic shot timer; carbine with two magazines, pouch and sling; barricade and 55 gallon drum

Rounds: 90

Phase I – 20 yards

1. The shooter starts with two magazines, one loaded with 25 rounds and the other with five rounds. The carbine is loaded first with the 25 round magazine, round chambered, safety on and at low ready.
2. On the signal, the shooter fires two rounds on each target while moving forward. All six rounds must be fired before the shooter reaches the 15-yard line.
3. At the 15-yard line, the shooter lines up on T1. On the start signal, the shooter movers laterally to the right firing one shot at each target, then moves to the left, again firing one shot at each target for a total of six rounds. All rounds must be fired on the move. **Cumulative round count: 12**
4. Shooter aligns on T2 and on start signal begins backing up, firing two rounds on each target. **Cumulative round count: 18**
5. Shooter then loads with the five round magazine and places the magazine from the gun in his carry pouch.
6. At 20 yards, begin with back to the targets and on signal, pivot and engage each target with two rounds, reload and again engage each target with two rounds for a carbine "El Presidente". The weapon and both magazines should be empty at this point. **Cumulative round count: 30**
7. **Score and paste targets. Each target should have 10 hits. Misses incur five-second penalties.**

Phase II – 30 yards

1. The shooter starts with two magazines: one with 28 rounds and one with two rounds. This phase begins with the 28 round magazine in the carbine, round chambered and safety on.
2. On signal, engage T1 with a failure drill (two rounds to the body and one to the head).
3. Repeat as before on T2.
4. Repeat as before on T3. **Cumulative round count: 39**

5. On signal, fire two rounds to the head of each target. **Cumulative round count: 45**
6. Shooter begins with carbine in low ready from the weak side shoulder and upon signal, fires one round on each body. Remove the magazine in the carbine and place in the pouch. Replace with the two round magazine. **Cumulative round count: 48**
7. Shooter begins with his back to the targets and on signal to fire, pivots and fires one shot on each target, reloads and again fires one shot on each target. **Cumulative round count: 54**
8. On signal, fire one shot at each target, drop to kneeling and again fire one shot at each target. The carbine should be empty on completion of this drill. **Cumulative round count: 60**
9. Score and paste targets. There should be three hits on each head and seven hits on each body.

Phase III – 40 yards

1. Begin with a magazine of 18 and a magazine of 12. Load and chamber from the 18-round magazine. Assume position behind a PPC or Bianchi type barricade.
2. On signal and using the barricade for cover, engage each target with two rounds in tactical order; switch sides AND shoulders and again engage each target with two rounds in tactical order for a total of 12 rounds. Remember: right side barricade – right shoulder and left side of barricade – left shoulder. **Cumulative round count: 72**
3. Beginning behind the barricade and using it for cover, upon signal, engage each target in tactical order with two rounds each. Execute a reload behind cover and upon the reload being complete in all respects, advance to the 35-yard line, taking cover behind the 55-gallon drum at that point. From the kneeling position at that point, and using the barrel as cover, engage each target with two rounds each. **Cumulative round count: 84**
4. Begin standing behind the barrel at 35 yards. Upon the start signal, drop to kneeling, using the barrel for cover and engage each target with two rounds from the OPPOSITE side that you used for cover in the preceding step (no weak side shoulder transition necessary). The carbine and magazines should be empty at this point. **Cumulative round count: 90**
5. Score and paste the targets. Each target should have 10 hits.

Scoring: Limited Vickers (no extra shots allowed). The actual time for each stage is added together with penalties (one point down equals one extra second of time). The score is expressed in total seconds.

Pass/Fail: 215 seconds
Good: <175 seconds
Excellent: <150 seconds

WASHINGTON STATE LAW

RCW 9A.16.040 Justifiable homicide or use of deadly force by public officer, peace officer, person aiding.

(1) Homicide or the use of deadly force is justifiable in the following cases:

(a) When a public officer is acting in obedience to the judgment of a competent court; or

(b) When necessarily used by a peace officer to overcome actual resistance to the execution of the legal process, mandate, or order of a court or officer, or in the discharge of a legal duty.

© When necessarily used by a peace officer or person acting under the officer's command and in the officer's aid:

(i) To arrest or apprehend a person who the officer reasonably believes has committed, has attempted to commit, is committing, or is attempting to commit a felony;

(ii) To prevent the escape of a person from a federal or state correctional facility or in retaking a person who escapes from such a facility; or

(iii) To prevent the escape of a person from a county or city jail or holding facility if the person has been arrested for, charged with, or convicted of a felony; or

(iv) To lawfully suppress a riot if the actor or another participant is armed with a deadly weapon.

(2) In considering whether to use deadly force under subsection (1)© of this section, to arrest or apprehend any person for the commission of any crime, the peace officer must have probable cause to believe that the suspect, if not apprehended, poses a threat of serious physical harm to the officer or a threat of serious physical harm to others. Among the circumstances which may be considered by peace officers as a "threat of serious physical harm" are the following:

(a) The suspect threatens a peace officer with a weapon or displays a weapon in a manner that could reasonably be construed as threatening; or

(b) There is probable cause to believe that the suspect has committed any crime involving the infliction or threatened infliction of serious physical harm.

Under these circumstances deadly force may also be used if necessary to prevent escape from the officer, where, if feasible, some warning is given.

(3) A public officer or peace officer shall not be held criminally liable for using deadly force without malice and with a good faith belief that such act is justifiable pursuant to this section.

(4) This section shall not be construed as:

(a) Affecting the permissible use of force by a person acting under the authority of RCW 9A.16.020 or 9A.16.050; or

(b) Preventing a law enforcement agency from adopting standards pertaining to its use of deadly force that are more restrictive than this section. [1986 c 209 ß 2; 1975 1st ex.s. c 260 ß 9A.16.04