METRIC

MIL-PRF-49323
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PERFORMANCE SPECIFICATION
FOR
THERMAL WEAPON SIGHT (TWS)

This specification is approved for use by Program Executive Office-Intelligence, Electronic Warfare & Sensors (PEO-IEW&S), Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE.

1.1 Scope. This specification establishes the performance, design, test, manufacture, and acceptance requirements for the Thermal Weapon Sights (TWS). The TWS is a lightweight, modular, self-contained, battery operated, medium to high resolution thermal imaging system intended for surveillance and fire control of individual and crew served weapons during daylight, darkness, adverse weather, and dirty battlefield conditions

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed in this section are needed to meet the requirements specified in sections 3 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet the requirements in all documents cited through out this specification, whether or not they are listed in this section.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be sent to: Project Manager, Night Vision/ Reconnaissance, Surveillance and Target Acquisition, ATTN: SFAE-IEW&S-NV-TB, Fort Belvoir, VA 22060.

DISTRIBUTION STATEMENT A. Approved for public release, distribution is unlimited.

2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in solicitation.

SPECIFICATIONS
MILITARY

MIL-B-49430	Battery, Non-rechargeable, Lithium Sulfur Dioxide, BA-5847
MIL-	Battery, Rechargeable, Lithium Ion, BB-2847
MIL-STD-1913	Dimensioning of Accessory Mounting Rail for Small Arms Weapons dated 3 FEB 95

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available for the Standardization Document Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA. 19111-5094)

2.2.2 Other Government documents, drawings and publications. The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DOCUMENT

Technical Bulletin #7	CECOM Safety Technical Bulletin #7 dated OCT 97

DRAWINGS

A3170556	TWS Mount Assembly, M16A3
A3170565	TWS Mount Assembly, M24

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.3 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents that are DOD-adopted are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI/EIA/TIA-232-E-1991	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, dated July 1991

(Copies available via World Wide Web at http://www.ansi.org)

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS (SMPTE)

SMPTE 170M	SMPTE Standard for Composite Analog Video Signal NTSC for Studio Applications: dated 1994

(Application for copies should be addressed to Society of Motion Picture and Television Engineers (SMPTE), 595 W. Hartsdale Avenue, White Plains, NY 10607)

2.4 Order of Precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS.

3.1 Item definition. The Thermal Weapon Sight (TWS) is a family of lightweight, infrared imaging devices of medium to high resolution used for surveillance and fire control of individual and crew served weapons during daylight, darkness, adverse weather (see 3.6.23), and dirty battlefield conditions (see 3.6.24). There are three configurations of TWS: Light Thermal Weapon Sight (LTWS), Medium Thermal Weapon Sight (MTWS), and Heavy Thermal Weapon Sight (HTWS). The three sights are not required to be interchangeable. Unless otherwise stated, the term TWS hereinafter shall refer to all three configurations of sights (LTWS, MTWS and HTWS). External cooling of the TWS is not allowed.

3.2 Major component list. Each TWS shall consist of all the following items:

a. Sensor
b. Objective telescope (specific configuration, installed)
c. Carrying case
d. Transit/storage case
e. Objective lens cover (installed)
f. Weapon mount (M16A3)
g. Operator manual, including laminated quick reference card
h. Lens cleaning kit
i. Commercial battery adapter.

3.3 Characteristics.

3.3.1 Performance characteristics. The TWS shall meet all requirements specified herein without damage (see 3.6.1) or degradation of performance (see 3.6.2) over all environmental conditions, including weapon firing.

3.3.1.1 Target Acquisition.

3.3.1.1.1 TWS Target Acquisition Requirements. The TWS shall provide the following minimum capabilities:

a. LTWS will have a 70 percent or greater probability of recognizing personnel (upright, moving, tactically deployed personnel) out to range of at least 550 meters in atmospheric conditions which provide seven kilometer visibility along an unobstructed line of sight.

b. LTWS will have a 90 percent or greater probability of recognizing personnel (upright, moving, tactically deployed personnel) out to range of at least 300 meters in dirty battlefield conditions (see 3.6.24).

c. MTWS will have a 70 percent or greater probability of recognizing personnel (upright, moving, tactically deployed personnel) out to range of at least 1650 meters in atmospheric conditions which provide seven kilometer visibility along an unobstructed line of sight.

d. MTWS will have a 90 percent or greater probability of recognizing personnel (upright, moving, tactically deployed personnel) out to range of at least 300 meters in dirty battlefield conditions (3.6.24).

e. HTWS will have a 70 percent or greater probability of recognizing personnel (upright, moving, tactically deployed personnel), and operating vehicle targets (BTR 60/70 when HTWS is 10

degrees off axis from frontal view of the vehicle) out to a range of at least 2200 meters in atmospheric conditions which provide seven kilometer visibility along an unobstructed line of sight.

f. HTWS will have a 90 percent or greater probability of recognizing personnel (upright, moving, tactically deployed personnel), and operating vehicle targets (BTR 60/70 when HTWS is 10 degrees off axis from frontal view of the vehicle) out to a range of at least 500 meters in dirty battlefield conditions (3.6.24).

3.3.1.1.2 Minimum Resolvable Temperature (MRT). The two dimensional MRT (see 3.6.13) shall not exceed the values listed below in Tables in Tables 3.3.1.1.2-1, 3.3.1.1.2-2, and 3.3.1.1.2-3. The below-listed MRT requirements are a composite of the vertical and horizontal MRT.

TABLE 3.3.1.1.2-1. LTWS MRT.

Spatial Frequencies (cycles/milliradian)	Temperature Difference (°C)
0.15	0.12
0.30	0.20
0.61	1.00

TABLE 3.3.1.1.2-2. MTWS NFOV MRT.

Spatial Frequencies (cycles/milliradian)	Temperature Difference (°C)
0.75	0.12
1.00	0.40
1.40	2.00

TABLE 3.3.1.1.2-3. HTWS NFOV MRT.

Spatial Frequencies (cycles/milliradian)	Temperature Difference (°C)
1.50	0.20
2.25	0.37
3.00	1.40

3.3.1.2 Signal Transfer Function (SiTF). For any brightness control setting and maximum gain control setting, the display luminance shall be equal to 90 or greater percent of the maximum luminance for a target ΔT of 2.5°C or less. For any brightness control setting and minimum gain control setting, the display luminance shall be equal to 90 or less percent of the maximum luminance for a target ΔT of 50°C or greater.

3.3.1.3 Image characteristics.

3.3.1.3.1 Image uniformity. Both large and small area uniformity requirements specified below shall be measured with the TWS viewing a uniform irradiance background. Uniformity shall be met within the minimum SiTF dynamic range for all fields of view.

3.3.1.3.1.1 Large area uniformity. The display luminance uniformity level, for all fields of view, across the entire display area shall not vary by more than 20 percent over the full display luminance output range.

3.3.1.3.1.2 Small area uniformity. The display luminance uniformity, in any local area (see 3.6.4), shall not vary by more than 10 percent over the full display luminance output range.

3.3.1.3.2 Image Quality. Spurious images and noise patterns shall not be perceptible on the TWS display. There shall be no discernible image persistence, or vibration. There shall be no perceptible rotation of the scene. Narcissus shall not be detectable in the TWS display. The TWS shall have no degradation of performance when used to observe, track, and/or fire at stationary or moving targets. The TWS shall provide imagery to the operator that does not exhibit any visible level of flicker, flashing (see 3.6.22) or intermittent operation.

3.3.1.3.3 Defective channels/no-information pixels. This requirement applies to the TWS sensor defective channels at the focal plane array output before uniformity correction/normalization. The TWS display shall not have or contribute to any dead or inactive lines of pixels.

3.3.1.3.3.1 Defective channels for scanning systems. This requirement applies to the system defective channels at the focal plane array output before non-uniformity correction. The system display shall not have or contribute to any dead or inactive lines of pixels. There shall be no dead channels in the critical display area. There shall be no more than five (5) defective channels outside of the critical display area. Defective channels shall be separated by at least one (1) good channel.

3.3.1.3.3.2 No-information pixels for LTWS. There shall be no more than 55 non-contiguous and zero contiguous no-information pixels in the central 128 (horizontal) $\times$ 86 (vertical) pixel area. There shall be no more than 100 no-information pixels and no sets of five or more contiguous no-information pixels in the critical display area (see figure 1). There shall be no sets of ten or more contiguous no-information pixels excluding the top three and bottom three pixel rows, and left three and right three pixel columns. The total number of no-information pixels shall not exceed 1.0 percent of the total number of pixels in the detector array.

3.3.1.3.4 Frame rate. The TWS shall have a frame rate of 30±1 frames/second.

3.3.1.3.5 Distortion. The TWS scene image distortion (see 3.6.8) shall not exceed 8 percent in the critical display area and 10 percent outside of the critical display area.

3.3.1.3.6 Noise Equivalent Temperature (NET). The TWS in all Fields-Of-View (FOV) shall have a NET of no greater than 0.12 °C for the mid-wavelength TWS systems and 0.175°C for long-wavelength TWS systems.

3.3.1.3.7 Spatial Noise. The fixed pattern image nonuniformity (spatial noise) shall not degrade system performance more than the requirements stated in Table 3.3.1.3.7.

Table 3.3.1.3.7 Spatial Noise

	Range from Calibration Point as a percentage of NEdT
+/- 15 degrees C	50%
+/- 30 degrees C	100%

3.3.1.4 Reflection. TWS must not, because of color or reflection, reveal the operator's position.

3.3.1.5 Field-of-View (FOV). LTWS shall have a minimum FOV of 14 degrees. MTWS shall have a minimum Narrow Field of View (NFOV) of 6 degrees, with an FOV in the Wide Field of View (WFOV) of 3 times the MTWS NFOV. HTWS shall have a minimum NFOV of 3 degrees, with an FOV in the WFOV of 3 times the HTWS NFOV. The WFOV for each configuration shall have an indicator that shall indicate the NFOV boundaries (see 3.3.2.10.1). NFOV and indicator line widths shall be in accordance with 3.3.2.10.1.

3.3.1.5.1 FOV change time. FOV change shall be accomplished in less than 2 seconds from initiation of the change, including video settling time.

3.3.1.5.2 FOV interalignment. For the MTWS and HTWS, any object which is displayed in the center of the WFOV shall be displayed in the center when switched to NFOV. The maximum displacement from center shall not exceed 15.0 mrad for the MTWS and 5.0 mrad for the HTWS.

3.3.1.5.3 FOV focus retention. Once the TWS has been initially focused in the NFOV at any range, no further focus adjustment shall be necessary when switching back and forth between the NFOV and WFOVs at that range. The point at which refocusing is necessary shall be in accordance with the requirements of 3.3.1.10.

3.3.1.6 Operational readiness. Over the full operating temperature range of 3.3.6.1, the TWS shall provide a recognizable image within 120 seconds after TWS power is applied and within 3 seconds after being switched from stand-by to full on. The image is recognizable if an observer, 120 seconds after the LTWS, MTWS and HTWS has been turned on, is able to resolve the middle spatial frequency 4 bar target called out in tables 3.3.1.1.2-1, 3.3.1.1.2-2, 3.3.1.1.2-3, set at twice the specified temperature. The delay time before automatically initiating stand-by mode shall be 30 (±15) seconds. A manual override of stand-by mode shall be provided (see 3.3.2.11.8). Manual override is not required for systems without a stand-by mode. If the offeror does not include a standby mode, it is a requirement for that system, over the full temperature range stated in paragraph 3.3.6.1, to provide a recognizable image within 3 seconds after power is applied.

3.3.1.7 Light security. The TWS, when used by a soldier (not wearing a protective mask or eyeglasses), shall not emit visible light detectable by the unaided human eye at a distance greater than or equal to 5 meters under all scene lighting conditions.

3.3.1.8 Audio security. The noise produced by each operating TWS, including full operation of all controls, shall be aurally non-detectable, under all operational conditions, at distances greater than 5, 15 and 15 meters, in all directions for the LTWS, MTWS and HTWS respectively. Background noise level shall be between 40 and 45 dB (A) for the measurement of audio security.

3.3.1.9 Eyepiece. Eye-relief from the vertex of the eye to vertex of the nearest eyepiece optical element surface along the optical axis shall not be less than 27 millimeters. The exit pupil diameter shall not be less than 10 millimeters at the eye-relief distance.

3.3.1.10 Depth of focus. TWS shall not require refocusing more than 5 times for the LTWS and MTWS and 8 times for the HTWS while tracking a target from minimum to maximum range.

3.3.1.11 Response outside FOV. The response of the TWS to sources of radiation (T<1000°C) outside the displayed FOV by more than 0.5° shall be less than 1 shade of gray over the total range of operator controls.

3.3.1.12 Shades of gray. The TWS shall provide at least 8 shades of gray (see 3.6.20) for the entire range of day/night operating conditions. For digital systems, the display shall provide at least 6 bits (non-dithered) of 64 discrete brightness levels.

3.3.1.13 Display Brightness. The TWS shall have variable display brightness (or level) to allow viewing in ambient illumination conditions from bright sunshine to total darkness without degrading system performance or inhibiting the operator's dark adapted vision. The display shall be capable of adjusting from 0.05 to at least 23 ftL.

3.3.1.14 Battery:

3.3.1.14.1 Battery Life. The TWS shall be able to be fully operational, over the full temperature range stated in paragraph 3.3.6.1, with one battery change allowed for a period of:

a. Systems with standby modes: 7 hours full on out of each 24 hour period and 3 additional hours in standby mode out of the same 24 hour period (combined total of 10 hours out of each 24 hours)

b. Systems without standby mode: 7 hours full on out of each 24 hour period

A battery warmer kit may be used to meet the battery life requirements at temperatures below –20°C.

3.3.1.14.2 Low battery indicator (LBI). The TWS system display shall include low battery indicator for the primary system battery which shall be displayed when 20 (±15) minutes of operational life remain. The indicator shall only be visible when activated and shall not be shown in the critical display area. The low battery indicator shall be optimized for the primary battery The LBI shall consist of the words “LOW BATTERY”, “LOW”, or “BATT”, or a pictorial representation of a battery.

3.3.1.14.3 Electrical interface.

3.3.1.14.3.1 Battery. The TWS shall operate on the standard rechargeable training battery (BB-2847/U). TWS shall also operate using a primary battery from the preferred power source list (see Appendix B) or a commercially available battery, packaged to fit in the same space constraints as the BB-2847/U). The use of commercially available batteries, not on the preferred battery list shall require a waiver from the Army Acquisition Executive prior to fielding.

3.3.1.14.3.2 Vehicle Power. The TWS shall be capable of being powered from vehicle power through the I/O connector with an external adapter. The TWS shall provide internal protection to prevent charging the primary battery when an external power adapter is connected to the TWS.

3.3.1.14.4 Battery Venting. The TWS battery compartment shall be designed to preclude major system damage or personnel injury in the event of a violent gas venting or rupture of battery cells causing high pressure within the compartment. The battery compartment must pass an internally applied pressure as prescribed in CECOM Safety Technical Bulletin #7 (see Attachment 15 of the contract), including the 50 percent safety factor. The current target battery for the TWS is a 2 D-cell, Lithium Manganese Dioxide ($LiMnO_2$) battery, having the same form, fit and function as the BA-5847. The contractor may utilize this battery, or propose the use of any commercially available primary battery (see requirements in 3.3.1.14.3.1) that meets the operating time and temperature requirements. If the offeror elects to use the $LiMnO_2$ battery, the system shall safely withstand a simulated venting test as prescribed in Attachment 15, utilizing a reduced pressure/testing factor of 5/9 or 0.555. Lithium 9-volt and AA batteries (or smaller) do not have a vent test requirement.

3.3.1.14.5 Battery Removal. The battery must be easily replaced without using tools, without removing the sight from the weapon, and without affecting boresight/zeroing/sight alignment.

3.3.1.15 Effects of sun in FOV. The TWS shall tolerate being aimed at the sun for extended periods of time $\geq$ 60 minutes with no permanent degradation after the sun has been removed from the TWS FOV. Upon the removal of the sun from the TWS FOV, the TWS image shall return to normal without any degradation in less than 5 seconds

3.3.1.16 Finishes. The TWS external color shall be any shade of lusterless black, dark green, or dark gray.

3.3.2 Physical characteristics. The TWS shall meet all requirements specified herein without damage (see 3.6.1) or degradation of performance (see 3.6.2) over all environmental conditions (including weapon firing).

3.3.2.1 Weight. The maximum allowable TWS weights, specified below in Table 3.3.2.1, include: the sensor body, objective lens, objective lens cover, eyepiece lens, eyepiece cover/cup, and M16A3 TWS mount assembly (A3170556). The maximum allowable weight of the TWS carrying case, which includes, case, one mounting bracket (excluding the MK-19 and MELIOS bracket), lens cleaning material, and operator's manual, shall not exceed 635 grams (1.4 lbs.).

TABLE 3.3.2.1 TWS Weight

TWS Type	Weight (Required)
LTWS	1.08 kilograms (2.38 pounds.)
MTWS	1.99 kilograms (4.38 pounds)
HTWS	2.44 kilograms (5.38 pounds.)

Note: Battery weight of 0.28 kg (0.62 pounds) is not included in Table 3.3.2.1 weights.

3.3.2.2 Weapon/TWS accuracy. The TWS, when installed or removed from the host weapon, shall not degrade the inherent accuracy of the host weapon system. The TWS shall not be significantly

affected by the operational characteristics of the host weapon. Momentary upsets due to firing or shading due to barrel heating are not considered significant.

3.3.2.3 Operating orientation. The TWS shall operate in any orientation without damage or degradation of performance.

3.3.2.4 Objective lens protection. An objective lens cover shall be provided to protect the primary objective lens from dirt, abrasion, or breakage. The objective lens cover shall be attached in a captive arrangement to allow the objective lens cover to be flipped out of the way during TWS usage, but remain securely attached to the system. The lens cover shall remain out of the way during weapon firing. The objective lens cover shall be a field replaceable item at the organizational (unit) maintenance level. The objective lens cover shall not come into contact with the optical surface of the objective lens when closed.

3.3.2.5 Lens Condensation. TWS objective and eyepiece internal optical surfaces shall not become obscured by condensation.

3.3.2.6 Carrying case. The TWS shall have a soft heat/water resistant carrying case that keeps the TWS secure and protected, and attaches to the individual load bearing equipment under all operational conditions. The case shall provide storage space for the TWS (with M16A3 or M24 mount attached), one mounting bracket (case shall allow for any of the host weapon brackets to fit, excluding MK-19 and MELIOS), one spare battery, operator's manual, and lens cleaning kit.

3.3.2.7 Transit/storage case. A transit/storage case shall be provided which holds one or multiple TWS systems, in carrying cases, including all accessories listed in 3.3.2.6 (excluding MK-19 & MELIOS). The TWS, in its transit/storage case, shall survive, without damage or performance degradation, normal commercial and military methods of transportation (i.e., infantry fighting vehicle, cargo aircraft, helicopters, field handling, and jumps with individual soldiers).

3.3.2.8 Mechanical zero. The infrared line of sight corresponding to the center of the TWS display shall be parallel to the sight's mounting surface to within 12% of the NFOV for the MTWS and HTWS and 10% of the LTWS FOV. With the reticle position indicator at zero/zero, the battlefield zero aimpoint of the reticle shall be aligned to the infrared line of sight corresponding to the center of the TWS display.

3.3.2.9 Boresight retention. The TWS, once boresighted to a weapon, shall retain boresight as defined in paragraphs 3.3.2.9.1 through 3.3.2.9.6 below.

3.3.2.9.1 Weapon boresight retention. The TWS, when mated to any supported weapon listed below, shall retain boresight over all environmental conditions within the limits specified below in Table 3.3.2.9.1-1, 3.3.2.9.1-2, and 3.3.2.9.1-3.

TABLE 3.3.2.9.1-1
Light TWS Environmental Boresight

TWS Type	BRACKET	RETENTION (mrad)
Light	M16 A1: 5.56 Rifle	0.8
	M16 A2: 5.56 Rifle	0.8
	M16A4: 5.56 Modular Weapon System (Rifle)	0.8
	M4: 5.56 Carbine	0.8
	M4 A1: 5.56 Carbine	0.8
	M4 A1: 5.56 Modular Weapon System (Carbine)	0.8
	M203: Grenade Launcher	5.0
	M136 AT-4: Light Anti-armor Weapon	0.8
	BDM: Bunker Defeat Munition	0.8
	MPIM: Muti-purpose Individual Munition	0.8

TABLE 3.3.2.9.1-2
Medium TWS Environmental Boresight

TWS Type	BRACKET	RETENTION (mrad)
Medium	M249 SAW: 5.56 Squad Automatic Weapon	0.5
	M240B: 7.62 Medium Machine Gun	0.5
	M60: 7.62 Machine Gun	0.5

TABLE 3.3.2.9.1-3
Heavy TWS Environmental Boresight

TWS Type	BRACKET	RETENTION (mrad)
Heavy	M2: 50 Caliber Machine Gun	0.5
	MK19: Grenade Machine Gun (40mm)	5.0
	M240G: 7.62 Machine Gun	0.5
	M16A2: Service Rifle	0.6
	M82A2: 50 Caliber Sniper Rifle	0.5

3.3.2.9.2 Mount/dismount boresight retention. The TWS, when affixed with the appropriate TWS mount for the weapon being used, and repeatedly mounted/dismounted from the weapon or weapon bracket (see 3.6.9) shall not have a boresight retention degradation in excess of 1 increment of reticle adjustment as defined in paragraph 3.3.2.11.3.

3.3.2.9.3 TWS Power On/off boresight retention. The TWS, when repeatedly cycled off and on, shall retain boresight to within 1 increment of reticle adjustment as defined in paragraph 3.3.2.11.3.

3.3.2.9.4 Input voltage drift boresight retention. The TWS shall retain boresight to within 1 increment of reticle adjustment as defined in paragraph 3.3.2.11.3 when the system input voltage is varied from minimum to maximum.

3.3.2.9.5 FOV boresight retention. The TWS, when repeatedly switched between the WFOV and NFOV, shall retain boresight to within 1 increment of reticle adjustment as defined in paragraph 3.3.2.11.3.

3.3.2.9.6 Tolerance stack-up. The above-listed boresight retention tolerances shall not stack up in excess of 2 increments of reticle adjustment as defined in paragraph 3.3.2.11.3.

3.3.2.10 Reticle. Reticle patterns shall be electronically generated in accordance with Appendix C. The horizontal reticle line shall be horizontal within 5 degrees referenced to the mounting surface of the system. The vertical reticle line shall be perpendicular to the horizontal reticle line within 0.1 degrees. The reticle shall be visible at all display brightness and gain control settings regardless of polarity. The reticle selection and boresight shall be retained during battery exchange. The M16 reticle pattern information in Appendix C shall also be used for M16A4, M4A1, M4A1 Carbine, M203, M136, BDM, and MPIM. The M24 reticle pattern information in Appendix C shall also be used for the M82A2. The zero offset for the M82A2, M16A4, M4A1, M4A1 Carbine, M203, M136, BDM, and MPIM will be agreed to by the IPPT after contract award.

3.3.2.10.1 Reticle size. Reticle line thickness shall be no greater than 0.82 mrad for the LTWS, 0.20 mrad for the MTWS, and 0.10 for the HTWS. The reticle line thickness tolerance shall be no greater than ±15%. Reticle size shall remain constant under all environmental conditions.

3.3.2.10.2 Reticle travel. The TWS shall have a minimum reticle travel of 33 percent of the FOV both vertically and horizontally from mechanical zero (see paragraph 3.3.2.8), totaling 66 percent of the display from stop to stop.

3.3.2.10.3 Reticle stability. The reticle adjustment increments shall remain uniform over the entire adjustment range. The reticle size, shape, and orientation shall remain stable over the entire adjustment range.

3.3.2.10.4 Reticle parallax. Parallax between a display image and the reticle shall not exceed 50 percent of 1 increment of reticle adjustment, in any FOV, at every eyepoint in the exit pupil.

3.3.2.10.5 Reticle brightness. The TWS reticle brightness and contrast shall be automatically optimized for visibility at all display brightness settings.

3.3.2.11 Controls. The operator control functions in section 3.3.2.11.1 through 3.3.2.11.8 shall be provided on each TWS. All controls to implement these control functions shall:

a. be mutually independent
b. have positive stops
c. be clearly marked to indicate function, direction and resulting action
d. not allow accidental movement of the controls in all environmental conditions including weapon shock
e. be adjustable using bare hands, MOPP-IV gloves and/or arctic mittens, and
f. be easily adjusted by the 5th to 95th percentile of U.S. Army and U.S. Marine personnel while in the firing position with the TWS mounted on all of the supported weapons.

The general locations of controls on the TWS are shown in Figure 5.

3.3.2.11.1 Off/on brightness. An off/on and brightness control function shall be provided to turn the TWS ON, OFF and to vary the peak brightness level (luminous intensity) of the display from the display minimum to maximum levels. TWS shall require a positive control actuation by the user to turn the system ON and OFF. The control shall be labeled “OFF” at the off position and shall be provided with a symbol depicting a continuously variable quantity from off to maximum brightness.

3.3.2.11.2 Contrast/gain. Contrast control function shall be continuously variable and shall simultaneously adjust the gain of all signal channels. An automatic gain setting control function shall be included. A manual gain control function shall be provided which, when activated, would override the automatic gain function and provide manual gain control. The control shall be labeled “CONTRAST” and shall be provided with a symbol depicting a continuously variable quantity. The automatic setting position shall be labeled “AUTO”.

3.3.2.11.3 Azimuth (AZ) and Elevation (EL) adjusters. The TWS system display shall provide a numerical indicator of the reticle position relative to the center of the display. Each incremental step of reticle adjustment shall move the reticle no more than 1 display pixels in azimuth and no more than 1 display pixels in elevation for each TWS configuration. WFOV and NFOV reticle positions shall be independently adjustable. The control shall be labeled “RETICLE ADJUST”. The reticle-adjust controls shall not exhibit backlash nor play.

3.3.2.11.4 Reticle selection. The TWS shall provide a control function capable of selecting any one of the reticles contained within the sight for all applicable weapons. Each reticle shall be labeled for the respective weapon for that switch position on either the external surface of the TWS or displayed electronically on the TWS display. The control shall be labeled “RETICLE SELECT”.

3.3.2.11.5 Polarity . The TWS shall provide an image contrast polarity control function such that targets of increasing temperature have increasing brightness in the white hot position and decreasing brightness in the black hot position. There shall be no noticeable delay in contrast reversal after activation of the control. The TWS display shall provide an indicator of the status of the polarity control, with the white-hot position labeled "WHT HOT" and the black-hot position labeled "BLK HOT."

3.3.2.11.6 FOV selector. For the MTWS and HTWS, a control function for selecting the NFOV and WFOV shall be provided. The appropriate reticle (wide or narrow FOV) shall be enabled automatically. Reticle activation shall be accomplished within 2 seconds, including settling time.

3.3.2.11.7 Standby switch. Enabling or disabling the TWS standby mode shall be accomplished using hands off switching technique. The TWS shall return from stand-by to full-on capability within 3 seconds.

3.3.2.11.8 EMERGENCY mode switch. The TWS shall provide a switch labeled "EMERGENCY" that overrides the STANDBY function (see paragraph 3.3.2.11.7). The TWS display shall provide an indicator labeled "EMER" when the EMERGENCY mode is activated. At system power-on, the EMERGENCY mode shall not be activated. The Emergency mode shall be disabled upon a second manipulation of the control.

3.3.2.12 Eyepiece lens focus. The eyepiece shall have a continuously adjustable mechanism to provide diopter focus range from plus two (+2) diopters to minus six (-6) diopters at the eye relief distance. A scale marked in 0.50 diopter increments accurate to within 0.50 diopters shall be provided.

3.3.2.13 Objective lens focus. A continuously adjustable mechanism shall be provided to focus the TWS infrared (IR) objective lens for the LTWS and MTWS from 10 meters to infinity, and the HTWS from 20 meters to infinity.

3.3.3 Interface requirements. Each TWS shall interface with the corresponding weapons specified in Tables 3.3.2.9.1-1, 3.3.2.9.1-2, and 3.3.2.9.1-3.

3.3.3.1 Mechanical interface. Each TWS shall interface mechanically via the M16A3 Mount Assembly (see drawing A3170556). The M16A3 Mount Assembly or equivalent shall be used to attach the TWS to each applicable weapon bracket via MIL-STD-1913 rail subassembly (see 3.6.9). The TWS utilized on the M24 should mechanically interface via the M24 Mount Assembly (see drawing A3170565)

3.3.3.2 Video interface. Each TWS configuration shall incorporate a video output port that will output video signals containing video information, reticles, and symbology. The LTWS shall display, on the internal display, monochrome input video from the I/O connector. The video signals shall be compatible with SMPTE RP 170M resolution (monochrome output is acceptable). The port shall be labeled "I/O." The video image provided at the I/O connector shall meet the image characteristics of 3.3.1.3 inclusive.

3.3.3.3 RS-232 Interface. The TWS shall provide an interface using the protocol for standard commercial RS-232 interfaces for sending and receiving data from an external source.

3.3.4 Reliability. The TWS shall have a 96.1 percent probability of completing a 20-hour mission without a failure with 80 percent confidence when operated under the reliability usage conditions provided in 3.3.4.1. A failure is defined as the inability to meet any of the requirements of this performance specification.

3.3.4.1 Reliability Usage conditions. The TWS shall operate in an environment consisting of the operational and storage temperature variations identified in 3.3.6.1, with 25 percent at high temperature extremes, 25 percent at low temperature extremes, and a minimum of 3 hours continuous non-operating exposure to extreme temperature storage conditions each 24 hour period. The MTWS and HTWS shall be subjected to vibration generated from vehicle mounting, at 100 percent of the vibration profile identified in 3.3.6.9.1 for an average of 0.68 minutes per hour of operation (62% full-on, 38% standby). The TWS shall experience 10 shocks per operating hour at a level simulating weapon firing shock identified in 3.3.6.9.2.

3.3.5 Maintainability. The TWS shall meet a minimum readiness maintenance ratio of 0.0048 maintenance man-hours per TWS system operational hour.

3.3.6 Environmental conditions. Each TWS shall meet all requirements specified herein without damage (see 3.6.1) or degradation of performance (see 3.6.2).

3.3.6.1 Operating/storage temperatures. The TWS shall not exhibit damage or degradation of performance when operated in a temperature environment of -37°C to +49°C, stored (non-operating) in a temperature environment of -46°C to +71°C for a minimum of six hours at each extreme.

3.3.6.2 Temperature shock. The TWS shall be fully operable and exhibit neither damage nor degradation of performance after exposure to rapid (within five (5) minutes) temperature changes from +49°C to -37°C and from -37°C to +49°C after stabilization at each extreme.

3.3.6.3 Humidity. The TWS shall be fully operable and exhibit neither damage nor degradation when exposed to atmospheric conditions of up to 88% humidity for not less than 10 days in a temperature environment of +31° C to +41°C inclusive.

3.3.6.4 Salt Fog. The TWS shall withstand exposure to salt fog atmosphere, consisting of 5 ±1 percent of salt solution, for a minimum of four (4) 24 hour periods and exhibit neither damage nor degradation of performance. Cosmetic changes are not considered damage or degradation of performance.

3.3.6.5 Explosive atmosphere. No authorized operator actions, including but not limited to TWS operation, assembly of modular or ancillary items, operator maintenance, or checks and services, shall cause ignition of an explosive atmosphere which is heavily laden with the fumes of ground vehicle and/or aircraft fuels.

3.3.6.6 Solar radiation. The TWS shall be fully operable and exhibit neither damage nor degradation of performance when exposed to sustained solar radiation of 1120 watts/m^2 of not less than two (2) hours in each 24-hour cycle. The TWS shall be subjected to a minimum of three (3) cycles.

3.3.6.7 Altitude. The TWS shall exhibit neither damage nor degradation in performance after exposure to sudden atmospheric pressure losses of up to an equivalent of 25,000 feet above sea level while in an uncased configuration.

3.3.6.8 Fungus. The TWS shall not support fungal growth.

3.3.6.9 Shock.

3.3.6.9.1 Functional shock/vibration. The TWS, while operating, shall not exhibit damage, degradation of performance, or loss of boresight when subjected to shocks typically encountered during operator field handling, dropping the TWS on the ground while mounted on the weapon, and vehicle transportation while the TWS is not in its carrying case (see Figure 2 for the functional shock profile; see Figure 6 and Table 6 for definition of vehicle vibration).

3.3.6.9.2 Weapon firing shock. Each type of TWS, while operating, shall not exhibit damage, degradation of performance, or loss of boresight when subjected to weapon firing, for that type of TWS, as identified in Table 3.3.6.9.2-1.

Table 3.3.6.9.2-1 Weapon firing shock

Weapon Configuration	Type of TWS	Rounds per Unit
M240G	Heavy TWS	5,000
M2	Heavy TWS	5,000
M240B	Medium TWS	5,000
M249	Medium TWS	10,000
M16A1/A2	Light TWS	5,000

3.3.6.10 Sand and dust. The TWS shall not exhibit damage (except for cosmetic deterioration of exposed surfaces) or degradation of performance when exposed to blowing sand and dust under the following conditions: relative humidity (RH) of 3% to 30%, air velocity of 1.5 m/sec to 8.9 m/sec. Dust shall be composed of silicon dioxide (SiO_2) at a concentration of 10.6$\pm$7 g/m3, applied for six (6) hours at +23°C and six (6) hours at +49°C. Sand shall be silicon dioxide at a 1.10 ± 0.25 g/m^3 concentration with a velocity of 3540 to 5700 ft/min for a duration of 6 hours (90 minutes on each vertical face).

3.3.6.11 Nuclear, biological, and chemical (NBC) contamination survivability.

3.3.6.11.1 NBC. The TWS is required to meet the NBC requirements specified in Appendix A of this specification. The TWS, while packaged in its carry case or transit case or in an operational configuration, shall be hardened against the effects of NBC agents and the decontamination process, and shall be decontaminable to negligible risk levels as specified in Appendix A, with the exception of rubber and canvas field replaceable accessories.

3.3.6.11.2 High Altitude Electromagnetic Pulse (HAEMP): The TWS, while packaged in its carry case or transit case and/or in an operational configuration, shall withstand the effects of HAEMP without damage or degradation of performance. The required high altitude electromagnetic pulse, HAEMP, has the following characteristics:

peak electric field amplitude of 30 kV/m,
10% to 90% rise time of 1 ns,
time to peak of 3 ns,
fall time to 50% amplitude of 50 ns, and

analytic expression of $E = \dfrac{E_0 \cdot t^3 \cdot e^{-at}}{(t^3 + \mathrm{t}^3) \cdot (1 + \mathrm{t} \cdot 0^{\mathrm{t}})}$;

where:

E_0=31871 V/m,
a=1.5x10^7 s^{-1},
τ=7.5x10^{-10} s, and
t is in seconds.

System upset during the event is allowed provided the system can meet requirements without damage or degradation of performance after being manually reset by the user in the field within the power-on time specified in paragraph 3.3.1.6.

3.3.6.12 Electromagnetic Interference Requirements (EMI):

3.3.6.12.1 Radiated emissions, electric field, 2 MHz to 18 GHz. The TWS shall not radiate E-field emissions in excess of those given in Figure 3 for the frequency range of 2 MHz to 18 GHz, or ten times the highest frequency generated within the TWS. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves.

3.3.6.12.2 Radiated susceptibility, magnetic field, 30 Hz to 100 kHz. The TWS shall not exhibit any malfunction, damage, or degradation of performance during or after being subjected to the magnetic fields shown in Figure 4.

3.3.6.12.3 Radiated susceptibility, electric field, 2 MHz to 18 GHz. The TWS shall not exhibit any malfunction, damage, or degradation of performance during of after being subjected to the following radiated field/field conditions:

a. Minimum radiated field levels of 50 Volts per meter (V/m) from 2 MHz to 18 GHz.

b. Radiated fields shall be performed in both vertical and horizontal polarization. Circularly polarized waves are not acceptable.

c. Radiated fields shall be characterized as a 1 kHz pulse modulation with a 50 percent duty cycle.

3.3.6.13 Leakage. The TWS shall not be penetrated by water, and upon complete system submersion for up to 10 minutes shall be fully operable and exhibit no damage or degradation of performance during subsequent operations. A003

3.4 Design and construction.

3.4.1 Materials, Parts and Processes. If the use of commercial (non-standard) items will not enable the system to meet its requirements, a standard part item may be used. The materials and parts used in the TWS system shall be moisture and corrosion resistant.

3.4.2 Marking and labeling. All TWS controls, including the purge port, shall be labeled. The TWS shall be marked externally with the NSN, part number, contractors name, contract number, production date, and serial number. Markings shall be designed to be legible and permanent for the entire life of the system.

3.4.3 Optics. If radioactive material is used in the TWS optical lenses, the amount of the radioactive material shall not exceed 550 ppm of the isotope Thorium 232 or any other radioactive material. All external optical lens surface shall use anti-reflective coatings. The TWS optical surfaces also need to meet the following additional requirements in 3.4.3.1 and 3.4.3.2.

3.4.3.1 Abrasion resistance for external optical surfaces. TWS optical surfaces that are normally exposed to external ambient environments shall survive exposure to a sand slurry. Lenses shall be mounted such that the top 0.005 inches of the exterior coating (surface) is exposed to a sand slurry composed of one part (by volume) number 60 graded (250m) sand and one part (by volume) water. A single bladed windshield wiper with a 40 grams (1.41 ounces) per 2.54 centimeters load shall be used to circulate the slurry over the sample(s) between 100 and 200 wipes per minute for a total of 5000 wipes. Coatings shall show no evidence of delamination, cracking, pitting, scratching, or staining as visually observed at the completion of this test.

3.4.3.2 Optical Coating Durability. All optical coatings shall show no visible evidence of delamination, cracking, pitting, scratching, or staining after exposure to the following conditions:

Adhesion: Tape pull with cellophane tape

Humidity: 49° C for 24 hours at 100% humidity
Moderate Abrasion: Cheesecloth rub (50 strokes) with moderate force
Temperature: -46° C and then +71° C for 2 hour each
Solubility: Cleaning solutions of acetone and isopropyl alcohol

3.4.4 Workmanship. The TWS shall be free of defects such as cracks, porosity, undercuts, voids, and gaps. Screws, nuts, and bolts shall show no evidence of cross-threading, mutilation, or hazardous and/or detrimental burrs. Wires and cables shall not be damaged and shall be positioned and/or protected to avoid contact with rough or irregular surfaces with sharp edges.

3.4.4.1 Soldering. All soldering methods and practices shall be sufficient to assure that all soldering of joints, wires, cables, PC boards, and other connections are of a quality necessary to meet or exceed all performance or stress requirements.

3.4.5 Radioactive material. There shall be no radioactive materials used in the TWS except for the optical coating as stated in 3.4.3.

3.4.6 Purge capability. If the TWS is required to be purged, the purge interface shall be compatible with standard Army purge equipment and purge gas without the use of special tools or adapters. The purge system shall also provide a purge venting capability to allow continuous flow of the purge gas through the system.

3.4.7 Interchangeability. All assemblies and replacement parts shall be physically and functionally interchangeable without modification of the items or the equipment down to the spare part level within each TWS configuration.

3.4.8 Human Performance/Human Engineering (HP/HE). The TWS shall comply with the following human performance/human engineering design criteria:

a. Arrangement, size, and shape of operator controls shall permit ready tactile or position identification and operation in darkness.

b. Access to operating controls shall be convenient for both right and left handed operators from all normal operating positions, primarily when mounted on the applicable weapon in a firing position.

c. The system shall facilitate safe, efficient, effective operation and maintenance by the 5th through 95th percentile of the U.S. Army and U.S. Marine Corps populations.

d. The configurations of the sights shall allow all operator functions, including normal care and cleaning and battery replacement, to be accomplished under all operational conditions, while wearing nuclear-chemical-biological (NBC) ensembles, arctic, cold and cold/wet protective clothing and equipment, and corrective lenses.

e. Labeling of controls shall provide for easy identification by the user of the control function.

3.4.9 Safety. The TWS shall comply with the design criteria to minimize health hazards and to ensure the safety of personnel (operator, maintainer, etc.) associated with the operation, maintenance, transportation, or repair of a complete system or component parts. The TWS shall be designed to be safe

under all conditions of normal use. The TWS shall provide maximum access and safety to personnel during installation, operation, and maintenance. All safety hazards not eliminated through design shall be addressed in the appropriate technical manuals.

3.4.10 BIT/BITE. The TWS BIT/BITE capability shall consist of visual indications on the internal display to support fault isolation.

3.5 Integrated Logistics Support/Manpower and Personnel Integration (ILS/MANPRINT).

3.5.1 Integrated Logistics Support (ILS). The following requirements are in addition to the Statement of Work requirements:

3.5.1.1 Maintenance concept. The TWS shall be designed to be maintained in accordance with the maintenance concept described in Table 3.5.1.1-1. Operator must be able to boresight/zero the TWS with its supported weapon.

TABLE 3.5.1.1-1. TWS Maintenance Concept

TWS	Organizational (Army/Marine Corps)	DS/Intermediate (Army/Marine Corps)	Depot (Contractor)
MTWS HTWS	Fault Isolation R/R LRU Verify Repair R/R Piece Parts: (Eyeguard, knobs, objective lens cover)	Fault Isolation R/R SRU Verify Repair	Repair or Replace SRU
LTWS	Fault Isolation R/R LRU Verify Repair R/R Piece Parts: (Eyeguard, knobs, objective lens cover)	Disposition to Depot	Repair LRU

3.5.1.2 Tools/Test, Measurement, and Diagnostic Equipment (TMDE). The TWS shall require no special tools and test equipment for focus, adjustment, and maintenance at or below the direct support level.

3.5.1.3 Manpower. There shall be no new MOS identified for the TWS operator or maintainer.

3.5.1.4 Training. The TWS, when mounted on any host weapon, shall be compatible with the use of current electronic (Multiple Integrated Laser Engagement System – MILES and MILES 2000) and sub-caliber training devices.

3.5.1.5 Logistics Delay Time. The TWS shall have a maximum administrative and logistics downtime of 47 hours.

3.5.1.6 Operational Availability. The TWS shall support an operational availability of no less than 99%.

3.6 Technical Interpretations. The following technical interpretations, when referenced in Section 3 or 5, are mandatory for this specification.

3.6.1 Damage. Damage is the deterioration of any physical characteristic including, but not limited to, surface material, corrosion, component durability, and safety, or the failure of coatings, adhesives, materials, hardware and fasteners. An item is also considered to be damaged if it exhibits flicker, flashing, intermittent operation, or degradation of performance.

3.6.2 Degradation of performance. Degradation of performance is a cumulative change of the measured level of performance to a value that is greater than 110% or less than 90% of the post-ESS measurement while remaining within the specified performance requirements. Cumulative change is that change which occurs or has occurred during one test or a series of tests.

3.6.3 This paragraph is left intentionally blank.

3.6.4 Local Area. A rectangular area of one-fourth of the vertical display FOV by one-fourth of the horizontal FOV.

3.6.5 Narcissus. Reflection of a cooled detector assembly, interior housing, or optics on the focal plane.

3.6.6 Defective channels for scanning systems. A channel which is dead (inactive), or exhibits noise created by responsivity greater than 200 percent or less than 50 percent of the mean responsivity of the entire array, or a channel which is connected to a good channel internal to the detector-dewar.

3.6.7 No-information pixel for staring systems. Detector elements that have a responsivity (volts/degrees Celsius) greater than 200 percent or less than 50 percent of the mean responsivity of the entire array.

3.6.8 Scene Image Distortion. The changing of the scene image due to variations in system magnification as a function of input field angle. This distortion includes total system distortion generated by electronics, mechanics, detector and optics.

3.6.9 Rail Mount. A bracket semi-permanently attached to the TWS that conforms to MIL-STD-1913. The rail mount is attached by screws to the TWS and provides quick attachment to the MIL-STD-1913 rail subassembly, which is a part of the weapon or interface bracket.

3.6.10 "g." An acceleration or deceleration of 9.8 meters/second^2.

3.6.11 Full-on mode. The cooler is operational (if applicable) and a thermal image is being presented.

3.6.12 Standby mode. The condition at which an item is energized yet not intended to provide full operating performance, but is at a state of readiness and enabled to provide full-on mode performance within a specified time upon the operator's command.

3.6.13 Minimum resolvable temperature (MRT). The minimum temperature difference required between light and dark bars in a standard bar target pattern (4-bar, 7:1 aspect ratio) at which a trained observer with normal vision (20/20, corrected if necessary) and unlimited viewing time can distinguish the bar pattern as four bars.

3.6.14 Boresight. The ability to align the TWS reticle to a specific optical axis, typically the weapon bore.

3.6.15 Boresight retention. The ability to retain an angular relationship between the reticle and the TWS mount interface.

3.6.16 Weapon boresight retention. The ability to retain an angular relationship between the reticle and a weapon's bore.

3.6.17 Cycle of operation. One cycle of operation is comprised of entering all three modes of operation for TWS and full manipulation of all controls on the test unit. The TWS will be turned on and allowed to stabilize and enter standby. The TWS will remain in standby for approximately one minute and then put in full operation. While in full operation, all controls will be fully manipulated. At this point, the TWS will be placed back in standby and then turned off.

3.6.18 Exit pupil. The diameter of a circle at the eye-relief distance within which the eye is presented full view of the image area.

3.6.19 Eye relief distance. The maximum distance from the eye pupil to the nearest flange surface on the eyepiece at which full field coverage can be observed. Measurements are made along the optical axis of the eyepiece.

3.6.20 Shade of gray. A displayed luminance ratio of the square root (SQRT) of 2. For example, if two luminance values are measured on a display such that one level is L1 and the other is L1*SQRT(2), then the change from one level to the other is one shade of gray. The minimum display luminance shall not be counted as a shade of gray.

3.6.21 Signal Transfer Function (SiTF). A curve or family of curves which describe the output display luminance in foot-lamberts (fL) of a device as a function of the input target temperature difference (ΔT) for various system gain and brightness control settings.

3.6.22 Flickering or Flashing. A non-operator-induced change in the device's output brightness, while viewing a uniformly illuminated background at any light level, that is either periodic, aperiodic or random in nature, and occurs more than one time while being viewed by an unaided eye for any duration of time.

3.6.23 Adverse Weather. Moderate rain, fog, salt fog, haze, mist, or snow.

3.6.24 Dirty Battlefield. Dirty battlefield contains elements from adverse weather, as well as dust and smoke (white phosphorous, hexachloro-ethane-zinc oxide (CL=2)).

3.6.25 Instantaneous Recovery. Full recovery of the TWS imagery in less than 100 milliseconds after completion of the interrupt event.

4. VERIFICATION.

4.1 Classifications of inspections. Inspections shall be classified as follows:

a. Initial production testing (IPT) (see 4.2).

b. Conformance inspections (CI) (see 4.3).

4.2 Initial production testing (IPT). Unless otherwise specified by the contract or purchase order, IPT shall be performed by the contractor. Units from the initial production lot shall be furnished and tested to verify compliance with the requirements of this specification in accordance with Table 4.2. Presence of one or more defects shall be cause for rejection of that unit and may be cause for rejection of IPT. Disposition of IPT samples shall be as specified in the Statement of Work.

TABLE 4.2
Initial production testing.

Inspections	Requirement Paragraph
Major Component List	3.2
Target Acquisition Requirements	3.3.1.1.1
Minimum Resolvable Temperature (MRT)	3.3.1.1.2
Signal Transfer Function (SiTF)	3.3.1.2
Large Area Uniformity	3.3.1.3.1.1
Small Area Uniformity	3.3.1.3.1.2
Image Quality	3.3.1.3.2
Defective Channels /No Information Pixels	3.3.1.3.3
Defective Channels for Scanning System	3.3.1.3.3.1
No-information Pixels for LTWS	3.3.1.3.3.2
Frame Rate	3.3.1.3.4
Distortion	3.3.1.3.5
Noise Equivalent Temperature (NET)	3.3.1.3.6
Spatial Noise	3.3.1.3.7
Reflection	3.3.1.4
Field-Of-View (FOV)	3.3.1.5
FOV Change Time	3.3.1.5.1
FOV Interalignment	3.3.1.5.2
FOV Focus Retention	3.3.1.5.3
Operational Readiness	3.3.1.6
Light Security	3.3.1.7
Audio Security	3.3.1.8
Eyepiece	3.3.1.9
Depth of Focus	3.3.1.10
Response Outside FOV	3.3.1.11
Shades of Gray	3.3.1.12

TABLE 4.2
Initial production testing (Continued)

Inspections	Requirement Paragraph
Display Brightness	3.3.1.13
Battery Life	3.3.1.14.1
Low Battery Indicator	3.3.1.14.2
Battery	3.3.1.14.3.1
Vehicle Power	3.3.1.14.3.2
Battery Venting	3.3.1.14.4
Battery Removal	3.3.1.14.5
Effects of sun in FOV	3.3.1.15
Finishes	3.3.1.16
Weight	3.3.2.1
Weapon Accuracy	3.3.2.2
Operating Orientation	3.3.2.3
Objective Lens Protection	3.3.2.4
Lens Condensation	3.3.2.5
Carrying Case	3.3.2.6
Transit/Storage Case	3.3.2.7
Mechanical Zero	3.3.2.8
Boresight Retention	3.3.2.9
Weapon Boresight Retention	3.3.2.9.1
Mount/Dismount Boresight Retention	3.3.2.9.2
On/Off Boresight Retention	3.3.2.9.3
Input Voltage Drift Boresight Retention	3.3.2.9.4
FOV Boresight Retention	3.3.2.9.5
Tolerance Stack-up	3.3.2.9.6
Reticle	3.3.2.10
Reticle Size	3.3.2.10.1
Reticle Travel	3.3.2.10.2
Reticle Stability	3.3.2.10.3
Reticle Parallax	3.3.2.10.4
Reticle Brightness	3.3.2.10.5
Controls	3.3.2.11
On/Off Brightness	3.3.2.11.1
Contrast/Gain	3.3.2.11.2
Azimuth (AZ) and Elevation (EL) Adjusters	3.3.2.11.3
Reticle Selection Switch	3.3.2.11.4
Polarity Switch	3.3.2.11.5
FOV Selector	3.3.2.11.6
Standby Switch	3.3.2.11.7
EMERGENCY Mode Switch	3.3.2.11.8
Eyepiece Lens Focus	3.3.2.12
Objective Lens Focus	3.3.2.13

Initial production testing (Continued)

Inspections	Requirement Paragraph
Mechanical Interface	3.3.3.1
Video Interface	3.3.3.2
RS 232 interface	3.3.3.3
Reliability	3.3.4
Reliability Usage Conditions	3.3.4.1
Maintainability	3.3.5
Operating/Storage Temperatures	3.3.6.1
Temperature Shock	3.3.6.2
Humidity Resistance	3.3.6.3
Salt Fog Atmosphere	3.3.6.4
Explosive Atmosphere	3.3.6.5
Solar Radiation	3.3.6.6
Altitude	3.3.6.7
Fungus	3.3.6.8
Functional Shock/Vibration	3.3.6.9.1
Weapon Firing Shock	3.3.6.9.2
Sand and Dust	3.3.6.10
NBC	3.3.6.11.1
HAEMP	3.3.6.11.2
EMI: Radiated Emission	3.3.6.12.1
EMI: Radiated Susceptibility (Magnetic)	3.3.6.12.2
EMI: Radiated Susceptibility (Electric)	3.3.6.12.3
Leakage	3.3.6.13
Materials, Parts and processes	3.4.1
Marking and Labels	3.4.2
Optics	3.4.3
Optics Abrasion Resistance	3.4.3.1
Optical Coating Durability	3.4.3.2
Workmanship	3.4.4
Soldering	3.4.4.1
Radioactive Material	3.4.5
Purge capability	3.4.6
Interchangeable	3.4.7
Human Performance/Human Engineering	3.4.8
Safety	3.4.9
ILS/MANPRINT	3.5

4.3 Conformance inspection. For conformance inspection requirements see the Statement of Work.

5. PACKAGING.

5.1 Packaging requirements. The packaging shall be in accordance with standard practices for commercial packaging of similar items.

*Figure not drawn to scale

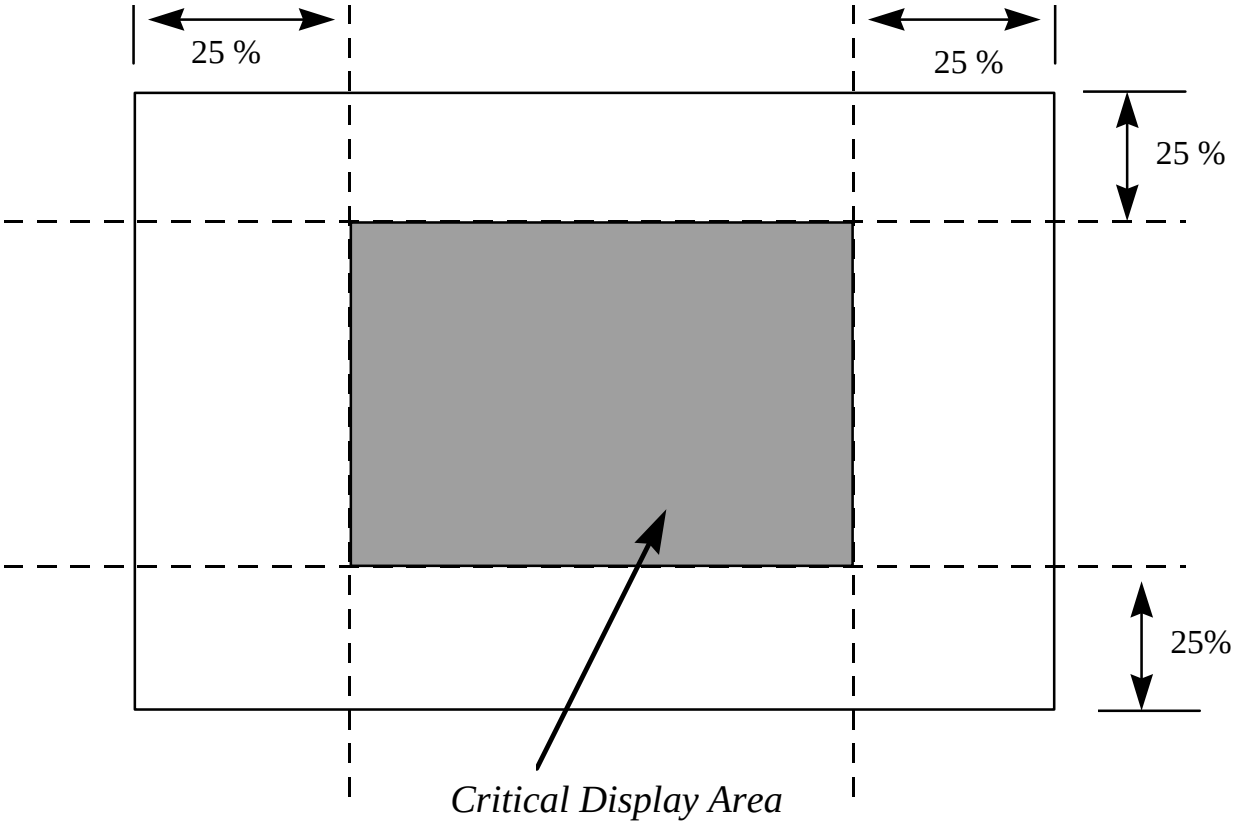
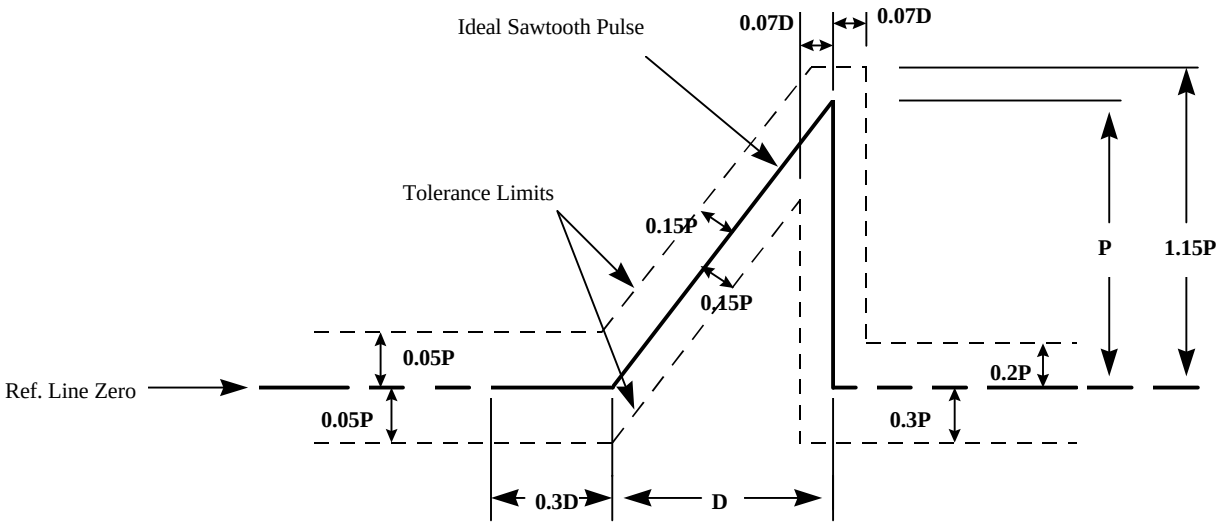


Figure 1: Critical Display Area

* Figure not drawn to scale



Functional Shock: D = 11 ms P = 40 G

FIGURE 2: FUNCTIONAL SHOCK PROFILE

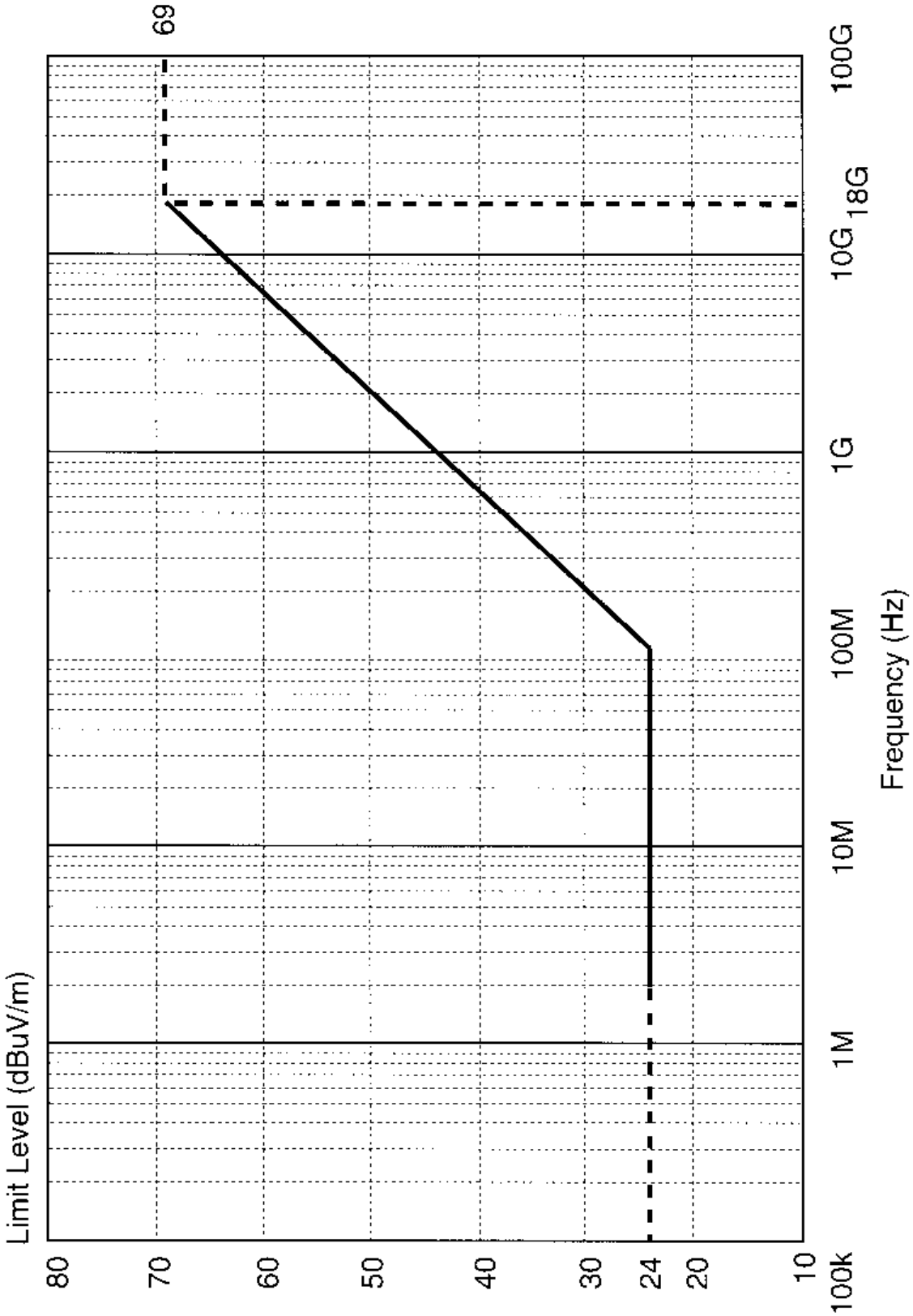


Figure 3. Radiated Emissions Electric Field, 2 MHz to 18 GHz

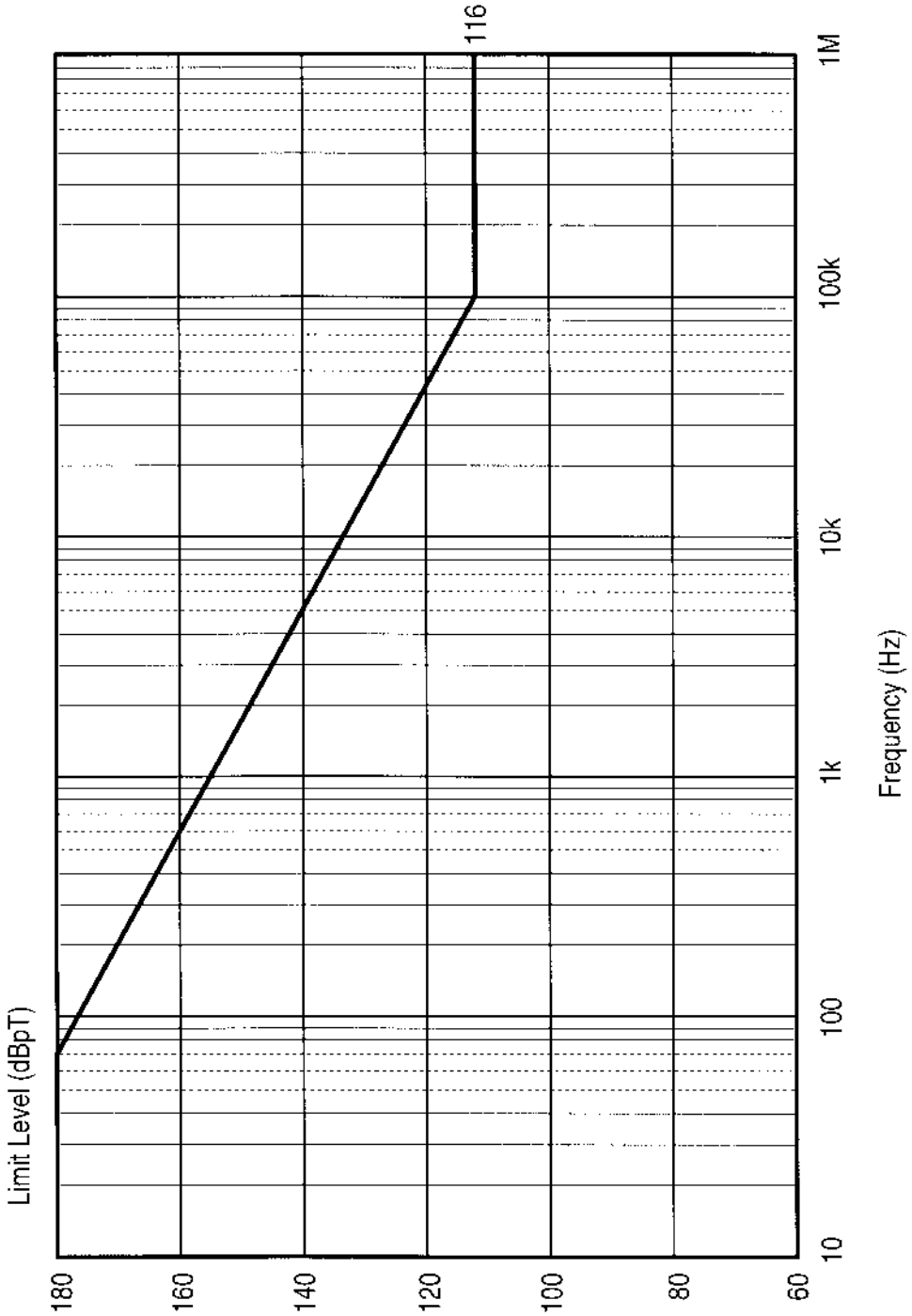


FIGURE 4. Radiated Susceptibility magnetic field, 30 Hz to 100kHz

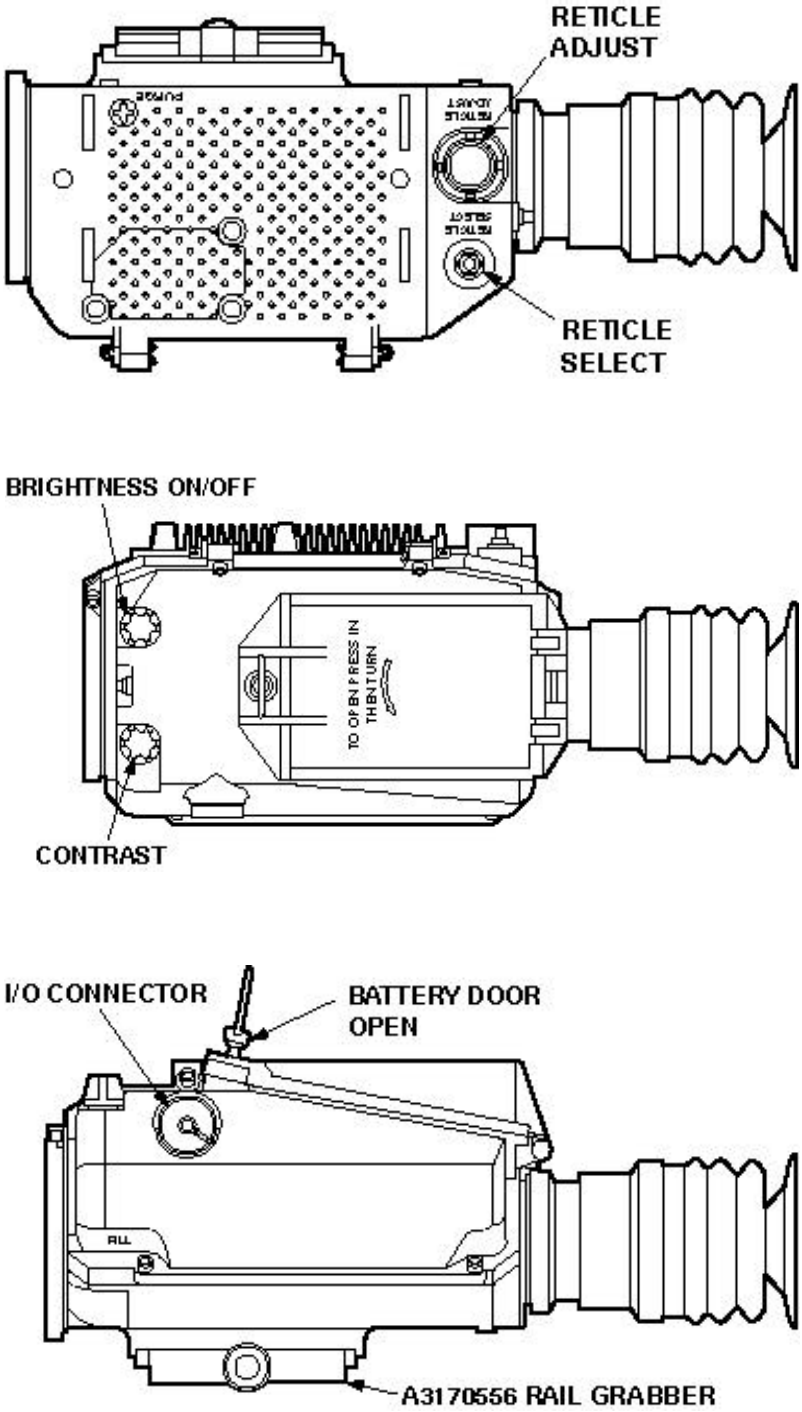


FIGURE 5 - General TWS Control Location

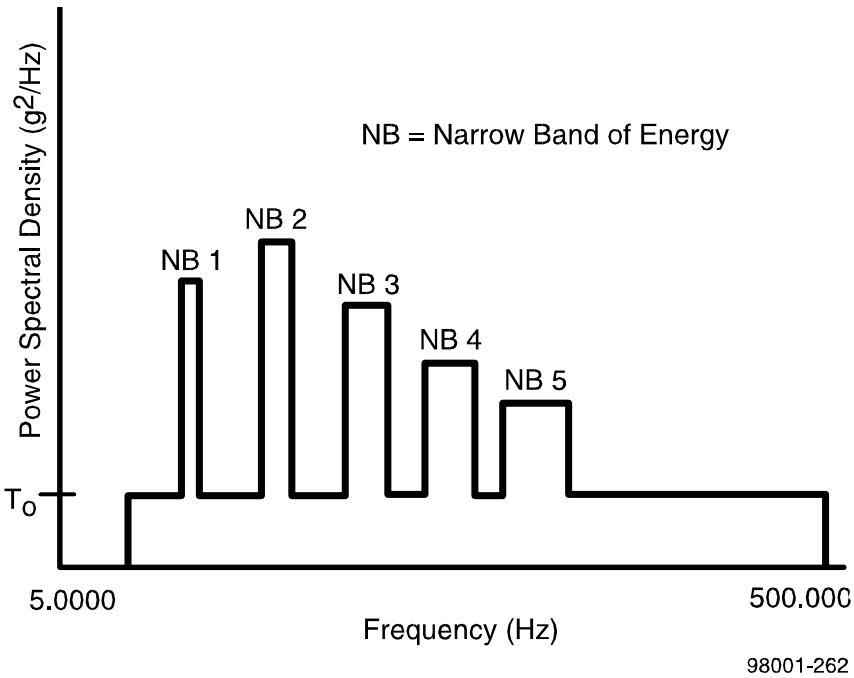


Figure 6 – Vehicle vibration characteristic curve

TABLE 6 NARROWBAND RANDOM-ON-RANDOM VIBRATION PROGRAM DATA
FOR INSTALLED EQUIPMENT IN THE TURRET OF THE M60A3 TANK

							Narrowband 1			Narrowband 2			Narrowband 3			Narrowband 4			Narrowband 5		
	5-500 Hz				Overall				Sweep			Sweep			Sweep			Sweep			Sweep
Test	Floor	No.	AV	AWF	RMS	Time	BW	Ampl	BW	BW	Ampl	BW	BW	Ampl	BW	BW	Ampl	BW	BW	Ampl	BW
Phase	g^2/Hz	Sweeps			g	min	Hz	g^2/Hz	Hz	Hz	g^2/Hz	Hz	Hz	g^2/Hz	Hz	Hz	g^2/Hz	Hz	Hz	g^2/Hz	Hz
Vertical Axis																					
V1	.0006	10	11	3	.61	54.0	20-25	.0139	2.5	40-50	.0088	5	60-75	.0012	7.5						
V2	.0007	10	20	2	.63	54.0	30-35	.0163	2.5	60-70	.0040	5									
V3	.0027	3	12	3	1.62	54.0	40-50	.0859	5.0	80-100	.0352	10	120-150	.0193	15.0	160-200	.0110	20	200-250	.0075	25
V4	.0016	3	12	3	1.25	54.0	55-65	.0933	5.0	110-130	.0265	10	165-195	.0035	15.0	220-260	.0034	20	275-325	.0019	25
V5	.0016	10	20	2	1.01	54.0	70-75	.0732	2.5	140-150	.0105	5									
Transverse Axis																					
T1	.0004	10	11	3	.46	54.0	20-25	.0038	2.5	40-50	.0009	5	60-75	.0005	7.5						
T2	.0005	10	20	2	.51	54.0	30-35	.0015	2.5	60-70	.0016	5									
T3	.0010	4	11	3	.83	54.0	40-50	.0204	5.0	80-100	.0085	10	120-150	.0017	15.0	160-200	.0012	20			
T4	.0012	8	11	3	.99	54.0	55-65	.0710	5.0	110-130	.0052	10									
T5	.0013	10	11	3	.90	54.0	70-75	.0583	2.5	140-150	.0045	5	210-225	.0014	7.5						
Longitudinal Axis																					
L1	.0004	10	20	2	.47	54.0	20-25	.0067	2.5	40-50	.0026	5									
L2	.0005	10	20	2	.51	54.0	30-35	.0067	2.5												
L3	.0009	8	11	3	.72	54.0	40-50	.0141	5.0	80-100	.0023	10									
L4	.0009	8	11	3	.72	54.0	55-65	.0133	5.0	110-130	.0026	10									
L5	.0014	10	20	2	.86	54.0	70-75	.0154	2.5	140-150	.0026	5									

AV = Number of Spectral Averages per Loop
AWF = Averaging Weight Factor

Exaggeration Factor = 2.00

APPENDIX A

NBC CONTAMINATION SURVIVABILITY CRITERIA FOR ARMY MATERIEL (REVISED)

A.1 SCOPE

A.1.1 Scope. This appendix establishes quantitative NBC contamination survivability criteria for Army material designed to perform mission-essential functions. This appendix is a mandatory part of the specification. The information contained herein is for compliance.

A.2 APPLICABLE DOCUMENTS

(This section is not applicable to this document.)

A.3 USE CRITERIA

A.3.1 Decontaminability criteria. (See explanatory notes).

A.3.1.1 Contaminants. The exterior and interior surfaces of material developed to perform mission-essential functions shall be designed such that NBC contamination remaining on, or desorbed or reaerosolized from, the surface following decontamination shall not result in more than a negligible risk (as defined in Table A-I) to unprotected personnel working inside, on, or one meter from the item. The following (worst case) conditions apply:

· A.3.1.1.1 Exterior surfaces. Exterior surfaces initially are uniformly and separately contaminated with:

a. 10 g/m^2 of thickened droplets of GD having a mass median diameter (MMD) of 2-5 mm

b. 10g/m^2 of thickened VX

c. 10g/m^2 of thickened HD

d. 10^5 $spores/m^2$ of biological agent 1-5 micrometers in size

e. 4g/m^2 of insoluble radioactive contaminants 37-200 micrometers in size and 185 Gbq/m^2 gamma activity.

· A.3.1.1.2 Interior surfaces. Initial contamination levels on interior surfaces subject to contamination are a factor of 10 lower than on exterior surfaces in the absence of evidence to the contrary.

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· A.3.1.1.3 Decontamination. Decontamination begins 2 hours after contamination using standard field decontamination or simulates, equipment and procedures; and the contamination process, excluding monitoring, lasts no longer than 75 minutes. Suitable simulants may be used.

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· A.3.1.1.4 Unprotected personnel. Exposure of unprotected personnel to the decontaminated material is not to exceed 12 hours based on the mission profile determined by the combat developer. Surface temperature is 30 °C average and exterior wind speed no greater than one m/s (3.6km/h).

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A.3.1.2 Induced activity. Material developed to perform mission-essential functions shall be designed such that, when exposed to neutron fluence from a nuclear detonation that results in a total dose of 2,600 cCy (rad) to the crew of the equipment, the neutron induced activity in the item will result in no more than a negligible risk as defined in Table A-I to unprotected personnel arriving at H+2 and remaining inside on, or one meter from the item for a period of time based on the mission profile not to exceed 12 hours.

A.3.1.2.1 Hardness criterion. (See explanatory notes). Material developed to perform mission-essential functions shall be hardened to ensure that degradation in selected quantifiable characteristics be no more than 20 percent over a 30-day period owing to 5 exposures to NBC contaminants, each followed by decontamination with procedures and decontaminants encountered in the field.

· A.3.1.2.2 Compatibility criterion. (See explanatory notes) The design of material developed to perform mission-essential functions shall take into consideration the combination of equipment and personnel in anticipated NBC protection. The combination of equipment and NBC protection shall permit performance of mission-essential operations, communications, maintenance, resupply, and decontamination tasks by trained and acclimatized troops over a typical mission profile in a contaminated environment not to exceed 12 hours. In meteorological conditions of areas of intended use. With no degradation, excluding heat stress, of crew performance of mission-essential tasks greater than 15 percent below levels specified for these tasks when accomplished in a non-NBC environment.

A.3 EXPLANATORY NOTES

A.3.1 Explanatory notes. Notes are as follows:

a. Selected negligible risk values are in Table A-I.

b. 1-hour delay prior to beginning decontamination allows time for agent sorption, yet is generally not long enough to allow elimination of surface hazard by weathering.

c. Initial contamination levels for interiors are a factor of 10 lower to account for the protection provided by the exposed areas that could reasonably be expected to result from a successful surprise attack on the material item postured in its normally susceptible to agent transfer from a contaminated crew.

d. Seventy-five minutes is a typical time for decontaminating items with present decontamination procedures.

e. A 30°C temperature represents a reasonable worst case temperature in the majority of likely areas of conflict.

f. Requiring low airspeeds (less than 3.6 km/h) results in greater chemical agent concentrations over time

g. A radioactive fallout contamination of 185 Gbq/m^2 would result in a H+1 dose rate of approximately 5 cGy (rad)/h at 1 meter from a typical large armored vehicle. Using 50 cGy (rad) as a negligible risk dose that would come from exposure over a mission profile period (maximum of 12-hours), one half from operational exposure (i.e., direct radiation from initial effects or from fallout on the ground) and the other half from equipment contamination, a decontaminability standard of 25 cGy (rad) dose per mission period is reasonable.

h. A neutron-induced activity of 25 cGy (rad) per mission (maximum of a 12-hour exposure) should be attainable for all items if reasonable attention is given to problem materials.

i. The "5 exposure" requirement in the hardness criterion refers to a cumulative total of contamination/ decontamination cycles using one or more contaminants and associated decontamination processes.

j. Mission Profile is a time-phased description of the operational events and environments an item experiences from beginning to end of a specific mission. It identifies the tasks, events, durations, operating conditions, and environment of the system for each phase of a mission. A mission profile should be based on a typical scenario for the item/system.

A.4 PHILOSOPHY

A.4.1 Philosophy. Criteria contained herein are based on the following philosophy: A soldier or crew surviving an NBC attack should be able to continue using mission-essential systems and equipment, in a full protective ensemble if necessary. When the mission permits, the systems and equipment should be capable of rapid restoration to a condition such that all operations can be continued in the lowest protective posture consistent with the mission and threat, and without long-term degradation of the material.

A.5 CHARACTERISTICS OF NBC CONTAMINATION SURVIVABILITY.

A.5.1 Characteristics. NBC contamination survivability is the capability of a system and its crew to withstand an NBC-contamination environment, including decontamination, without losing the ability to accomplish the assigned mission. Characteristics of NBC contamination survivability are Decontaminability, hardness, and compatibility. To survive NBC contamination , material must be criteria for all three.

A.5.1.1 Decontaminability. The ability of a system to be decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it is termed "Decontaminability". Key to this definition is the requirement to be able to reduce the hazard to personnel. Since the principal benefit of decontamination is to allow the crew to reduce its level of protection, decontaminability criteria must be related to the response of unprotected personnel. Even under a "fight dirty" concept of operation, decontaminability is required. NBC contaminants could eventually breach the shield of the unprotective ensemble. Therefore, when operations permit, they should be removed wherever they present a hazard. Further, decontamination reduces the soldier's vulnerability when the shield is dropped to satisfy basic physiological needs or to replace components of the NBC protective ensemble. Criteria for decontaminability were developed by analyzing toxicity data; determining agent concentration levels corresponding to negligible risk (5 percent mild incapacitation) to unprotected personnel; and relating agent concentration to time, temperature, wind speed and threat parameters. Decontaminability is enhanced by considering:

a. Materials. Maximize use of materials that do not absorb NBC contaminants and that facilitate their rapid removal with decontaminates readily available on the battlefield.

b. Design. Incorporate designs that reduce or prevent accumulation of NBC contamination and make those areas that are exposed readily accessible for decontamination .

c. Contamination control. Employ devices and means that reduce the amount of contamination to be removed, such as positive over-pressure systems for combat vehicles, packaging for supplies, and protective covers.

d. NBC equipment. Provide for integration of NBC detection, measurement, decontamination, and contamination control devices. Considerations for interrogations of such devices at the earliest stage of the material acquisition process promote maximum achievement of effective contamination avoidance, control, removal, and decomtanination verification.

A.5.1.2 Hardness. The ability of a system to withstand the damaging effects of NBC contamination and decontamination agents and procedures required to carry out the decontamination process is termed "hardness." Although strongly related to Decontaminability, hardness, is a distinct characteristic; Decontaminability is concerned with reducing the hazard to personnel as a result of decontamination efforts, while hardness is concerned with condition of the equipment after it has been subjected to an agent and decontamination. Criteria for hardness were developed by analyzing vulnerabilities of construction materials to agents and decontaminates; considering mission profiles of classes of material designed to perform mission-essential functions; and determining allowable percentage degradation's of quantifiable essential performance characteristics such as reliability, availability, and maintainability (RAM)standards.

A.5.1.3 Compatibility. The ability of a system to be operated, maintained, and resupplied by personnel wearing the full NBC protective ensemble is termed "compatibility." Even if a piece of equipment is completely hardened against NBC contamination and decontaminates and can also be easily decontaminated, it still must have the capability of being operated effectively while in an NBC contained environment. Thus, in the development of equipment designed to perform mission-essential functions one must consider the combination of the equipment and personnel in anticipated NBC protection.

A.5.2 Collective protection. Collective protection enhances compatibility because it provides crew members a clean environment until they must exit to perform some essential task outside the enclosure. Unless individual protective gear is decontaminated or discarded, reentering crewmen will enter dirty. In some cases, agents may enter collective protection enclosures before the equipment is "buttoned up". Thus, although collective protection may provide a "shirt sleeve" environment most of the time during a battle, it does not provide compatibility. However, for those systems for which collective protection does provide a continuous clean environment the combat developer mat elect to fulfill the compatibility requirement by utilizing collective protection. In doing so, he accepts the possibility of crew degradation should contamination enter and the crew be forced to don the individual protection ensemble.

A.5.3 Criteria for compatibility. Criteria for compatibility were developed by considering mission profiles of classes of equipment designed to perform mission essential functions, analyzing performance degradation of crew members operating the equipment while protective ensemble, determining allowable percentage degradation of mission-essential functions, and relating those degradations to time and temperature parameters.

TABLE A-I. Negligible risk values for NBC contaminants.

CONTAMINANT	VAPOR/AEROSOL	LIQUID[b]
	(mg/*min/m3)	(mg/70-kg man)
CHEMICAL		
VX	0.25 (0.02 for visual acuity)[a]	1.4
GD	2.50 (0.50 for visual acuity)[a]	30
HD	50.0	180 (0.01 mg/cm2)[d]
Biological[c]		
RADIOLOGICAL	(maximum 12 hour exposure)	
Contaminants	25cGy (rad)	
Induced Activity	25cGy (rad)	

NOTES

a. Applies to pilots and other whose visual activity is critical to mission accomplishment.
b. Applies to skin dose, not absorption through the eyes.
c. Negligible risk levels for biological agents are not determinable with the present data base. Since extremely minute quantities of some biological agents can cause incapacitation, equipment should be designed to allow a residue of no more than 500 spores/m^2 of the specified initial contamination levels.
d. Since the effect of HD is localized, it is not appropriate to consider a threshold dose of liquid HD as applying to the entire 70-kg man. Use of mass/body surface area (mg/cm^2) units to describe the dose for which negligible effects are observed is preferable with the provision that the location and surface area must be specified, since mild incapacitation depends on where the contamination exists and the intent of body surface involved.

APPENDIX B

PREFERRED POWER SOURCE LIST

1. PREFERRED COMMERCIAL POWER SOURCES

1.1 BATTERIES

BATTERY TYPE	NSN	MANAGED BY
“D” CELL ALKALINE	6135-00-835-7210	DLA
“C” CELL ALKALINE	6135-00-985-7846	DLA
“AA” CELL ALKALINE	6135-00-985-7845	DLA
“9 VOLT” ALKALINE	6135-00-900-2139	DLA
COMMERCIAL “6TL”	6140-01-210-1964	DLA
COMMERCIAL “2HN”	6140-00-057-2553	DLA
COMMERCIAL “4HN”	6140-00-059-3528	DLA

2. PREFERRED MILITARY POWER SOURCES

2.1 COMMUNICATIONS-ELECTRONICS APPLICATIONS

2.1.1 NON RECHARGEABLE BATTERIES

BATTERY	NSN	MANAGED BY
BA-5590A/U	6135-01-143-9450	CECOM
BA-5588A/U	6135-01-088-2708	CECOM
BA-5567A/U	6135-01-090-5365	CECOM
BA-5847C/U	6135-01-438-9447	CECOM
BA-5372/U	6135-01-214-6441	CECOM

2.1.2 RECHARGEABLE BATTERIES

BATTERY	NSN	MANAGED BY
BB-516A/U	6140-01-419-8191	CECOM
BB-390A/U	6140-01-419-8187	CECOM
BB-388A/U	6140-01-419-8190	CECOM
BB-503A/U	6140-01-419-8193	CECOM
BB-2847/U	6140-01-419-8194	CECOM

2.1.3 BATTERY CHARGERS

BATTERY CHARGER	NSN	MANAGED BY
PP-8444	6130-01-427-9604	CECOM
PP-8444A	6130-01-443-0970	CECOM

APPENDIX C

THERMAL WEAPON SIGHT RETICLE PATTERNS REQUIREMENTS

C.1. Reticle Indicators. The following paragraphs describe the use of the LTWS, MTWS and HTWS reticles. The indicators that are common for most reticles are described separately.

C.1.1 Common Reticle Indicators

C.1.1.1 Zeroing Aim Line and Aim Point. The two horizontal lines to the left and right of the zeroing aim point are referred to as the zeroing aim line. The zeroing aim line is used on the M16, M136, M60, M249, M2, MK19 and M16H reticles. The zeroing aim lines serve two purposes: 1) For reticles with multiple aim points, they indicate which aim point to use when zeroing the TWS; 2) Serve as a means of measuring angles for combat preparations, directing fire, or range estimation. For the angular measurements which can be determined from the zeroing aim line and aim point, refer to the applicable figure: for the LTWS and MTWS WFOV, refer to Figure C.1.1.1-1; for the MTWS NFOV and HTWS WFOV, refer to Figure C.1.1.1-2; for the HTWS NFOV, refer to Figure C.1.1.1-3.

C.1.1.2 NFOV Area Indicator. The NFOV Area indicator (see Figure C.1.1.2-1) is used on all MTWS and HTWS WFOV reticles. The four corners of the NFOV Area indicator outline the area of the thermal scene that will be magnified when FOV switch is set to NARROW.

C.1.2 LTWS Reticles. The LTWS provides reticles for use by the M16A1 rifle, M16A2 rifle, M16A3 rifle, M4 carbine, and M136 rocket launcher. For the LTWS reticles with respect to the weapon application, refer to Table C.1.2-1.

Not Drawn to Scale

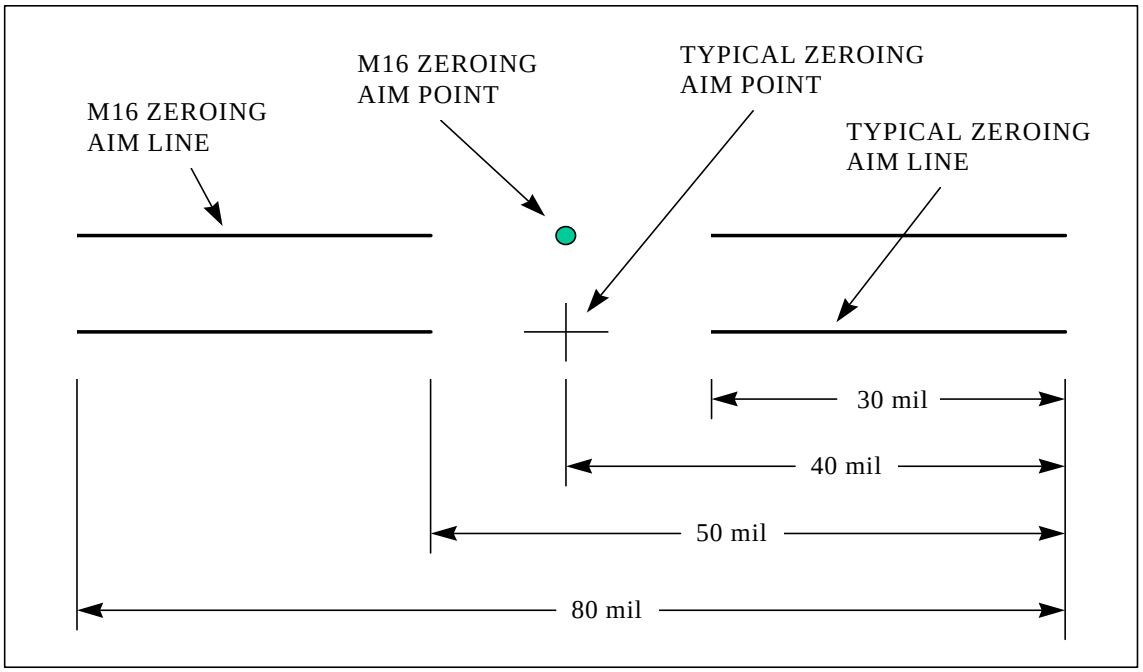


Figure C.1.1.1-1: Angular Measurements Using Zeroing Aim Line and Aim Point of LTWS and MTWS WFOV Reticles

Not Drawn to Scale

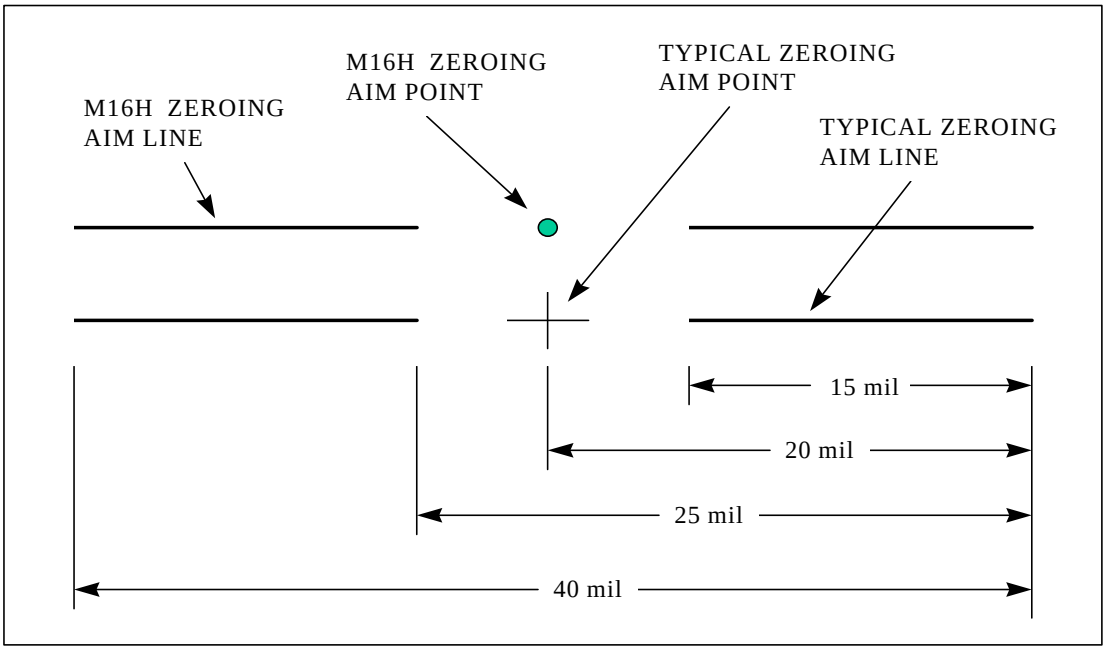


Figure C.1.1.1-2: Angular Measurements Using Zeroing Aim Line and Aim Point of MTWS NFOV and HTWS WFOV Reticles

Not Drawn to Scale

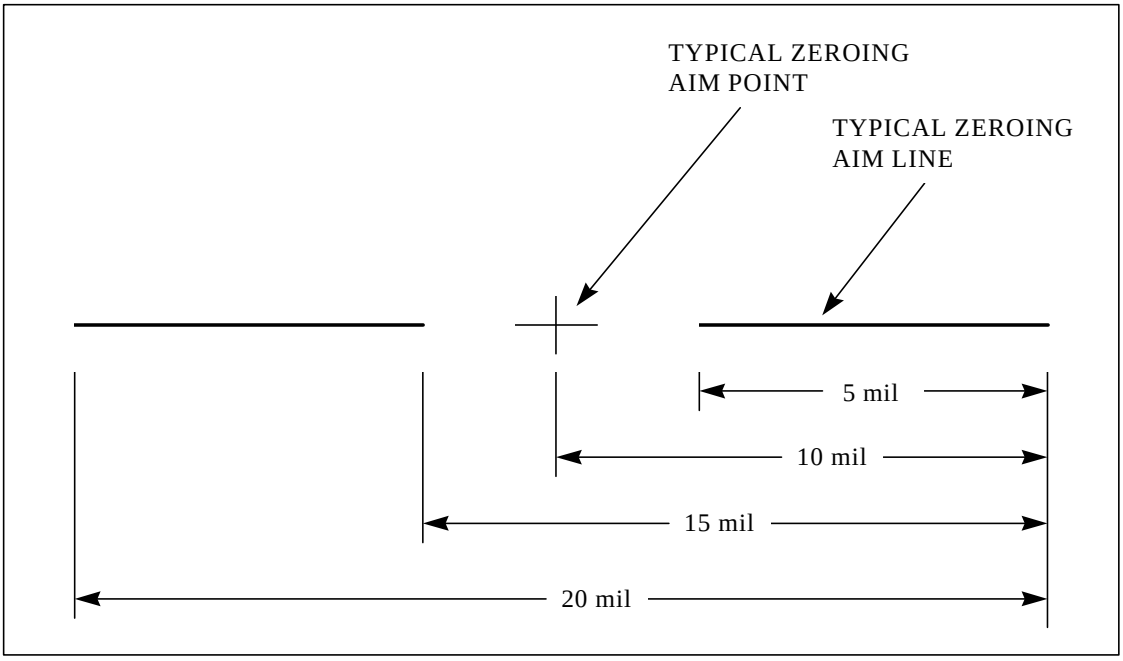


Figure C.1.1.1-3: Angular Measurements Using Zeroing Aim Line and Aim Point of HTWS NFOV Reticles

Not Drawn to Scale

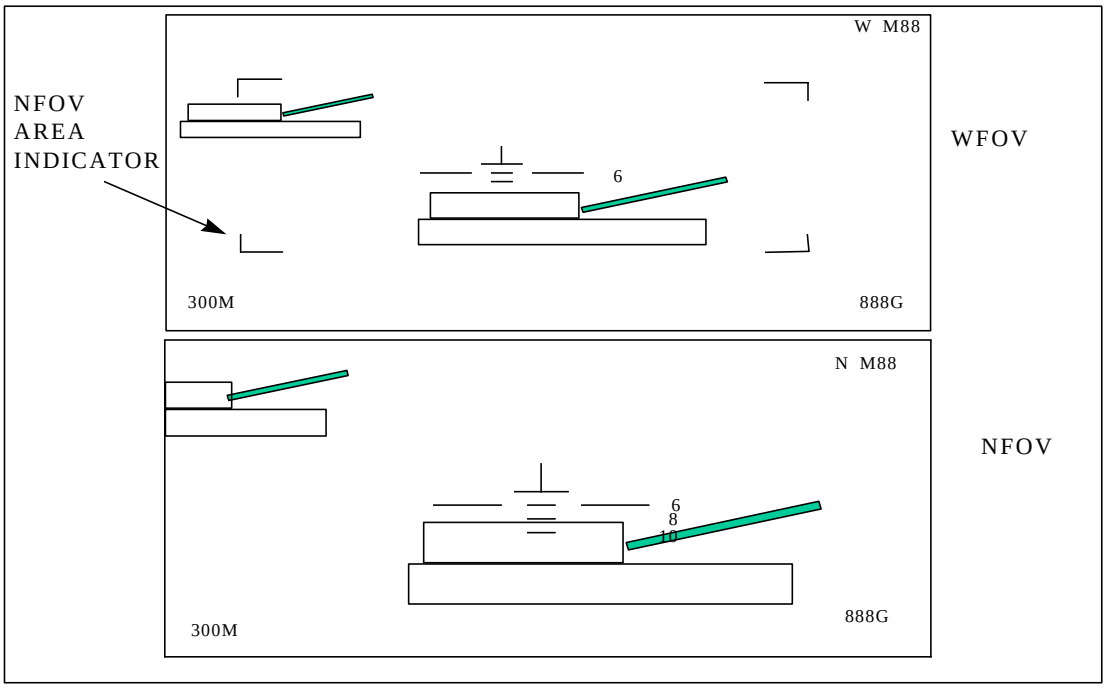


Figure C.1.1.2-1: NFOV Area Indicator

Not Drawn to Scale

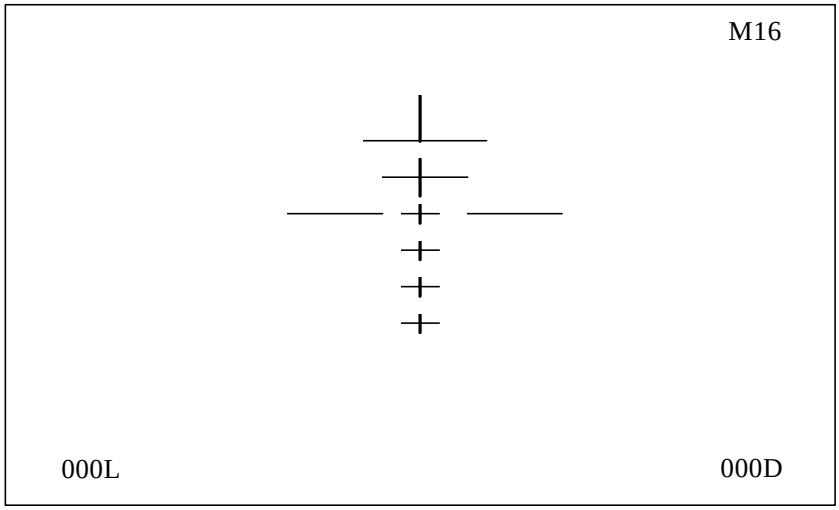
Weapon	Reticle
M136 Rocket Launcher	

Table C.1.2-1: LTWS Reticles with respect to weapon pplication (continued)

C.1.2.1 M16 Reticle. The M16 reticle is used for range estimation and target firing (see Figure C.1.2.1-1). The distance between the two horizontal lines reflects the width of a man at 25 meters. The distance between the two vertical lines reflects the height of a 5-foot man at 300 meters. The center dot is the aim point for firing at 300 meters.

Not Drawn to Scale

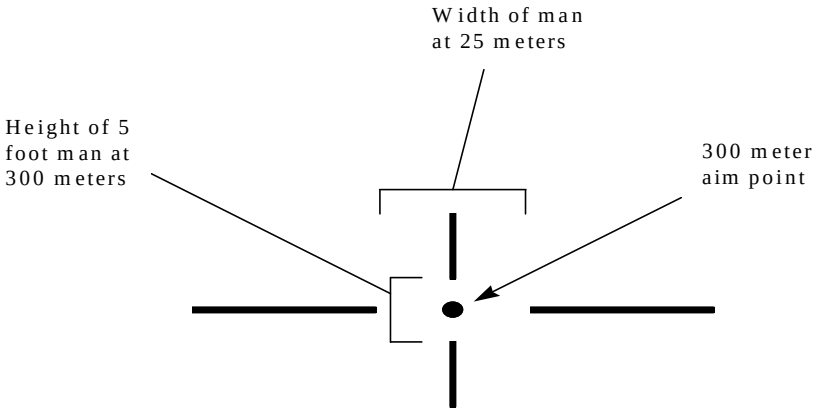


Figure C.1.2.1-1: M16 Reticle

C.1.2.2 M136 Reticle. The M136 reticle provides multiple cross-hairs used for range estimation and target firing (see Figure C.1.2.2-1). Each cross-hair is used at a different range. The range at which to use a specific cross-hair is indicated on side of the cross-hair, in the hundreds digit in meters (example: 3 = 300 meters). Each cross-hair is separated by a range of 100 meters. The vertical line of a cross-hair reflects the height of a 5-foot man at the specified range. The horizontal line of a cross-hair reflects the width of a 10-foot tank at the specified range. The firing aim point of each cross-hair is the point of intersection of the vertical and horizontal lines.

Not Drawn to Scale

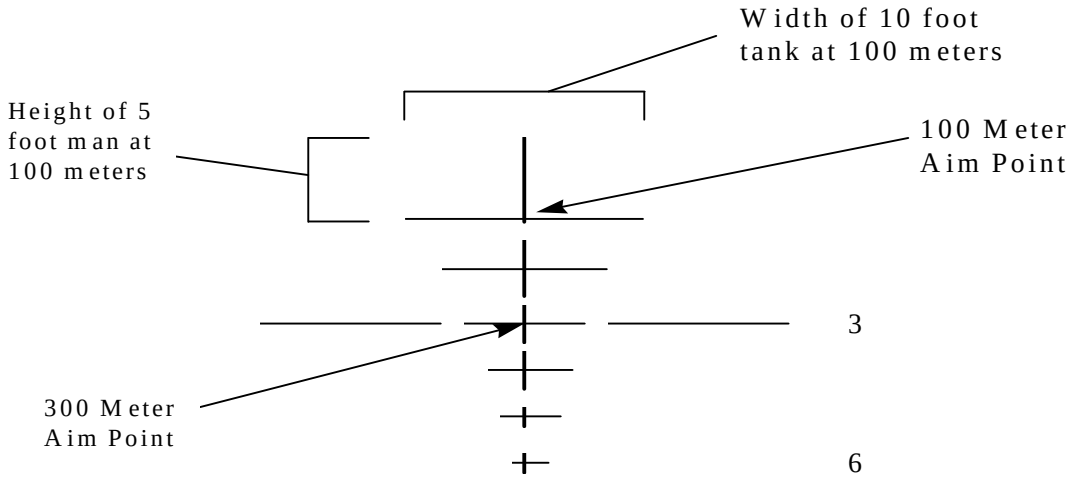


Figure C.1.2.2-1: M136 Cross-Hairs

C.1.3 MTWS Reticles. The MTWS provides reticles for use by the M60 machine gun and the M249 machine gun. For the MTWS reticles with respect to the weapon application and FOV, refer to Table C.1.3-1.

C.1.3.1 M60 and M249 Reticles. The M60 and M249 reticles provide multiple cross-hairs used for range estimation and target firing (see Figure C.1.3.1-1). Each cross-hair is used at a different range. The range at which to use a specific cross-hair is indicated on side of the cross-hair, in the hundreds digit in meters (example: 8 = 800 meters). For the M60 reticles, the unmarked cross-hair above the zeroing aim line is used at 200 meters (see Figure C.1.3.1-2). For the M249 reticles, the unmarked cross-hair above the zeroing aim line is used at 100 meters. For the M249 WFOV reticle, the unmarked cross-hair below the zeroing aim line is used at 600 meters (see Figure C.1.3.1-3). The vertical line of a cross-hair reflects the height of a 5-foot man at the specified range. The horizontal line of a cross-hair reflects the width of a 10-foot tank at the specified range. The firing aim point of each cross-hair is the point of intersection of the vertical and horizontal lines.

Not Drawn to Scale

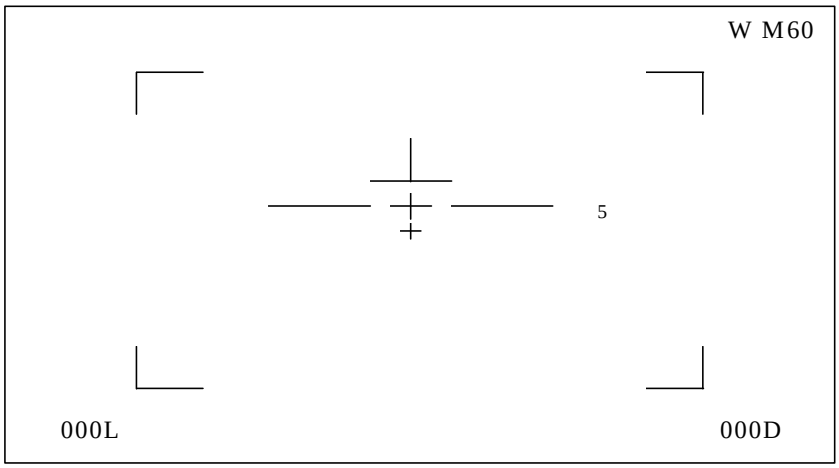
Weapon	FOV	Reticle
M60 Machine Gun	Wide	

Table C.1.3-1: MTWS Reticles with respect to weapon application and FOV

Not Drawn to Scale

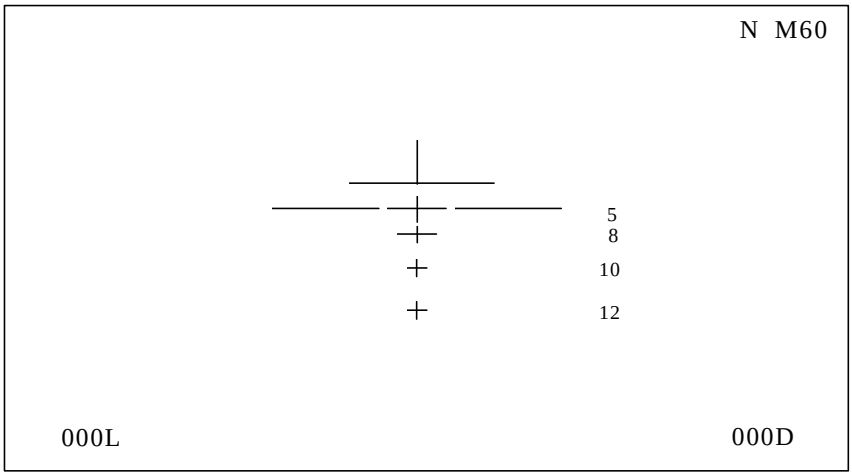
Weapon	FOV	Reticle
M60 Machine Gun	Narrow	

Table C.1.3-1: MTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

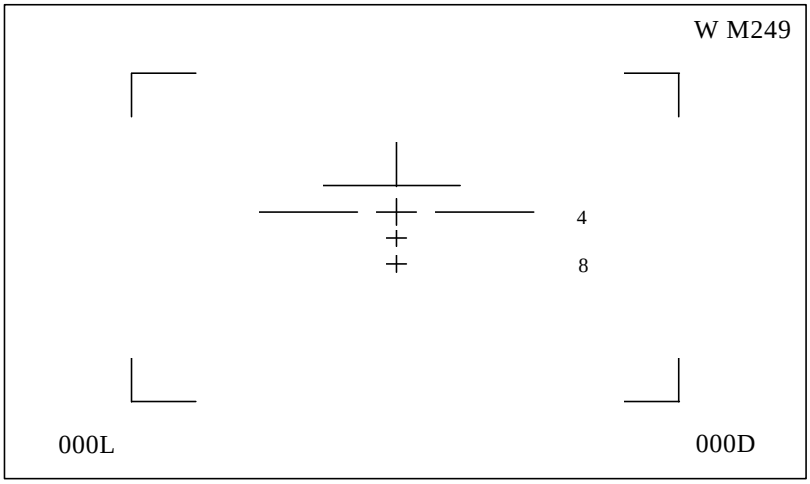
Weapon	FOV	Reticle
M249 Machine Gun	Wide	

Table C.1.3-1: MTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

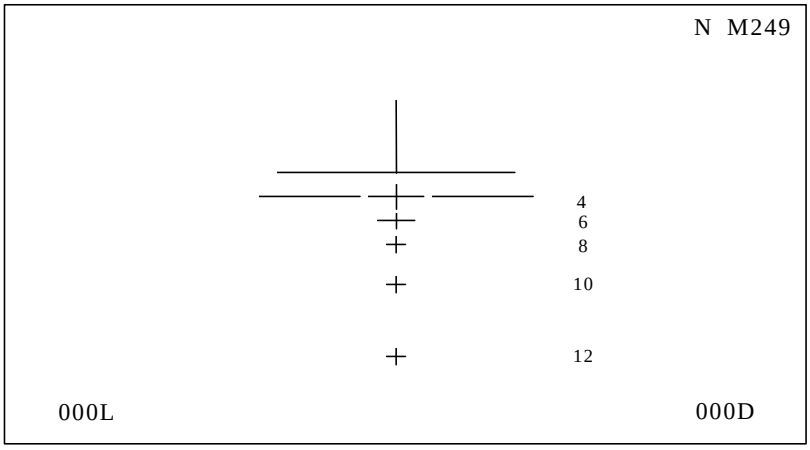
Weapon	FOV	Reticle
M249 Machine Gun	Narrow	

Table C.1.3-1: MTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

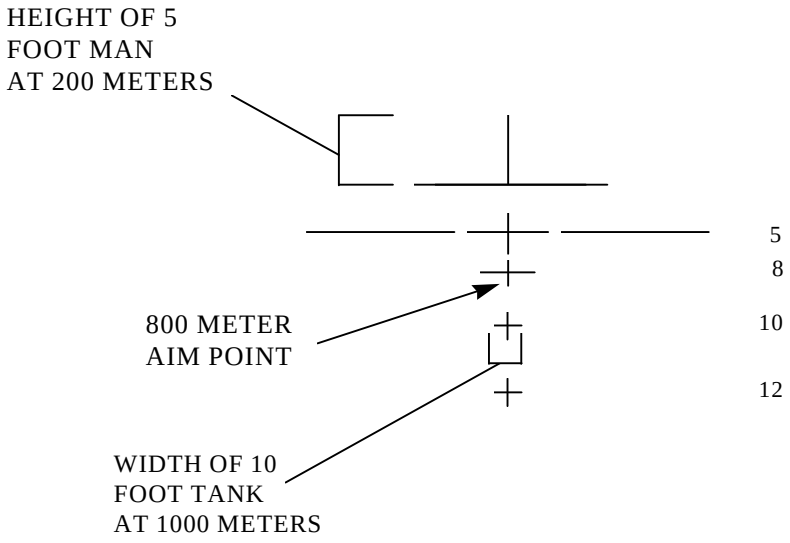


Table C.1.3.1-1: M60 and M249 NFOV Cross-Hairs

Not Drawn to Scale

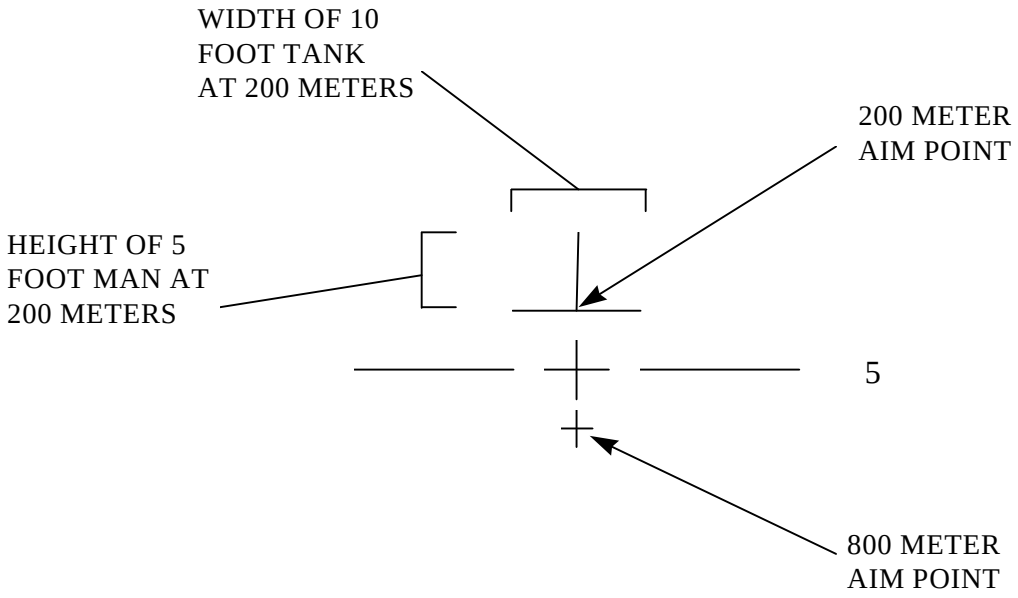


Table C.1.3.1-2: M60 WFOV Cross-Hairs

Not Drawn to Scale

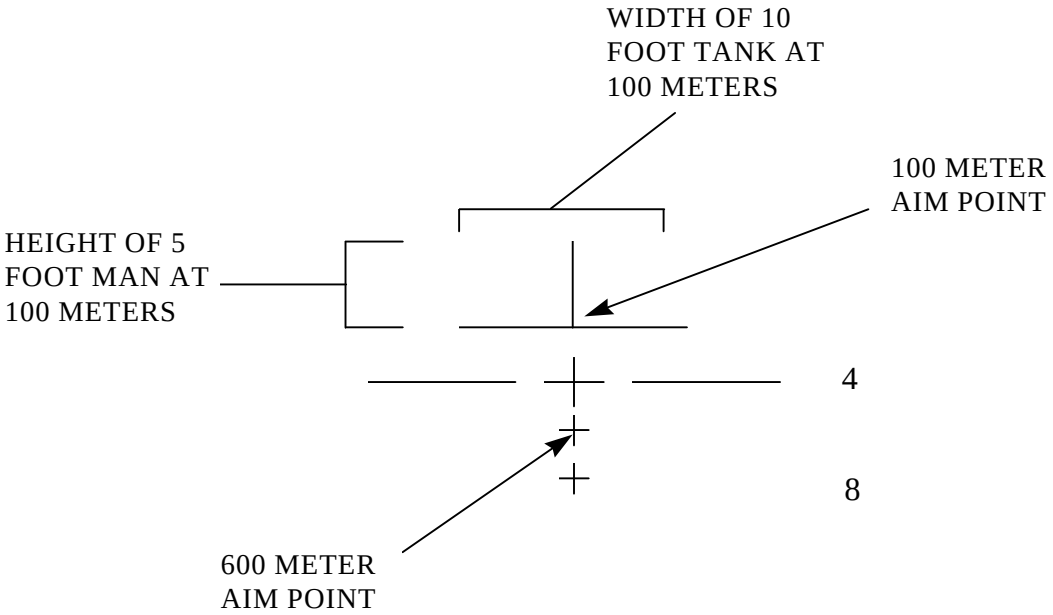


Table C.1.3.1-3: M249 WFOV Cross-Hairs

C.1.4 HTWS Reticles. The HTWS provides reticles for use by the M2 machine gun, MK19 machine gun, M24 sniper rifle, squad leaders M16 rifle and the MELIOS AN/PVS-6. For the HTWS reticles with respect to the system application and FOV, refer to Table C.1.4-1.

Not Drawn to Scale

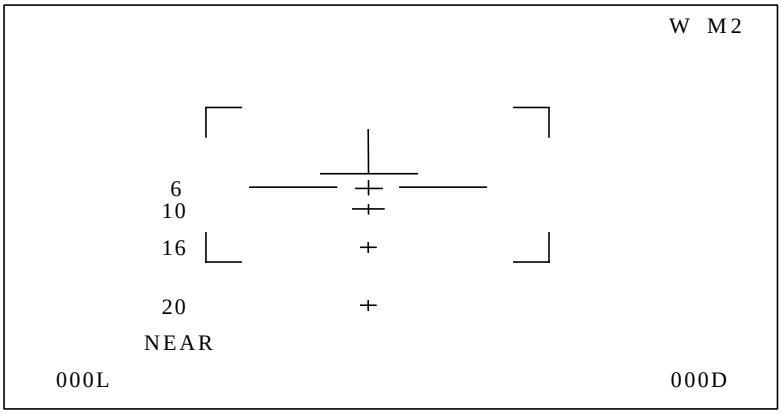
Weapon	FOV	Reticle
M2 Machine Gun	Wide	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV

Not Drawn to Scale

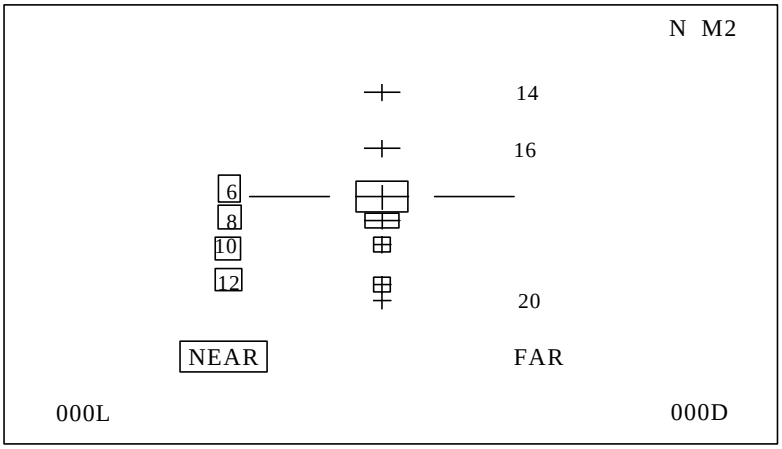
Weapon	FOV	Reticle
M2 Machine Gun	Narrow	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

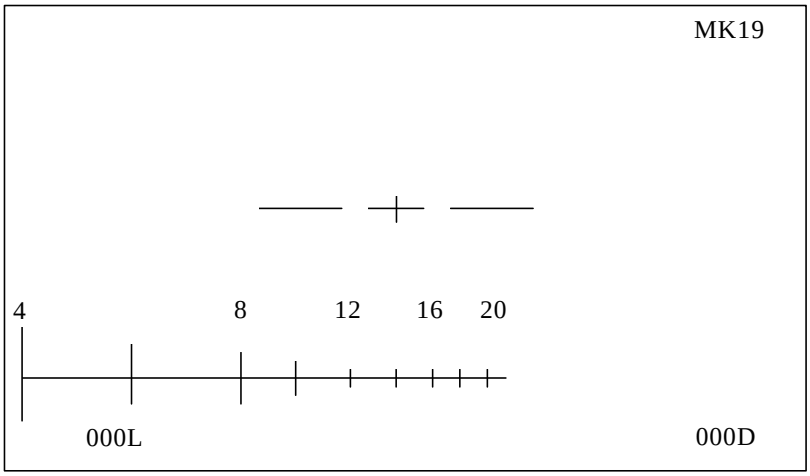
Weapon	FOV	Reticle
MK19 Machine Gun	Narrow	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

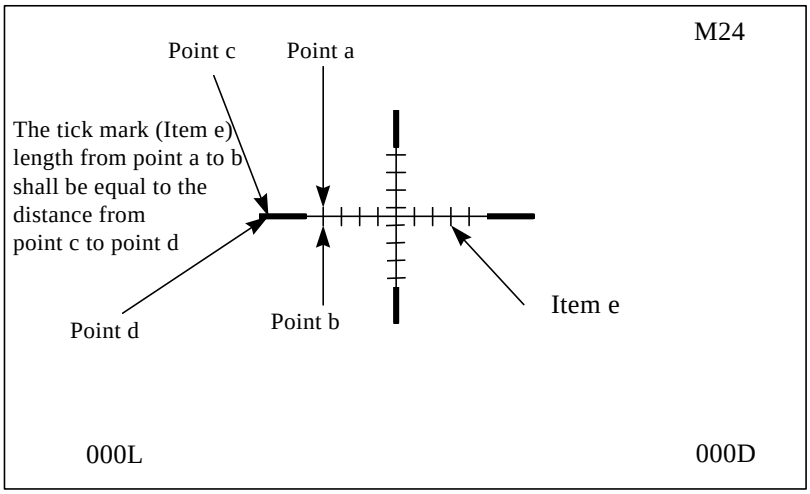
Weapon	FOV	Reticle
M24 Sniper Rifle	Narrow	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

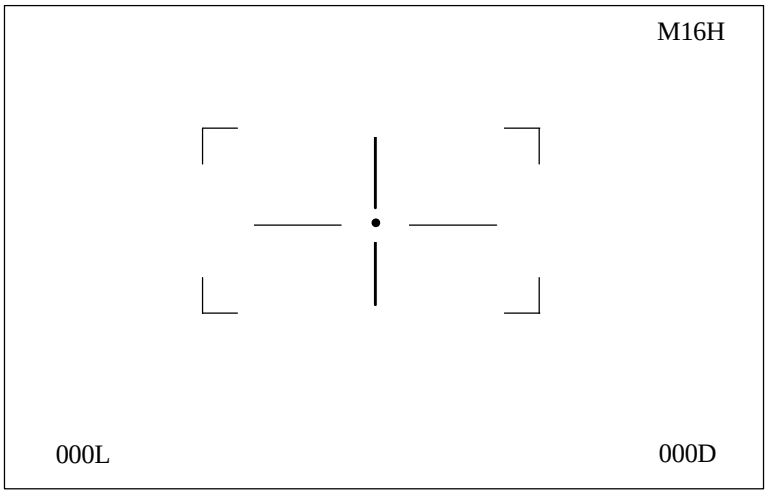
Weapon	FOV	Reticle
Squad Leaders M16 Rifle	Wide	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV (continued)

Not Drawn to Scale

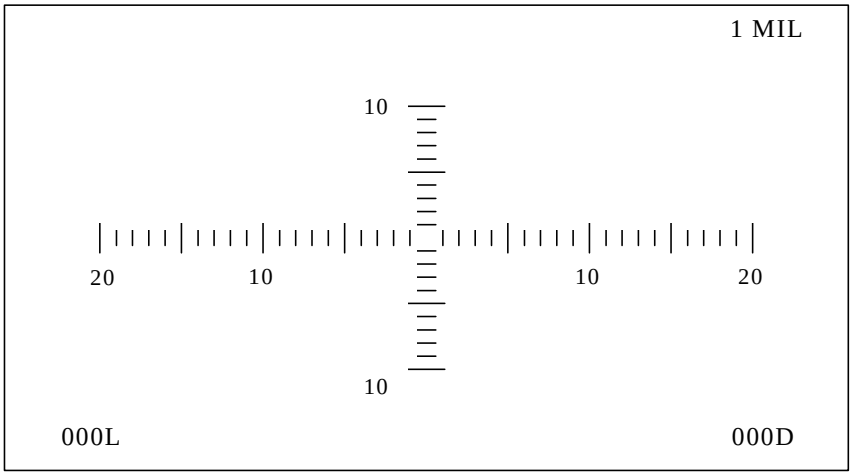
Weapon	FOV	Reticle
Squad Leaders M16 Rifle MELIOS	Narrow	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV (Continued)

Not Drawn to Scale

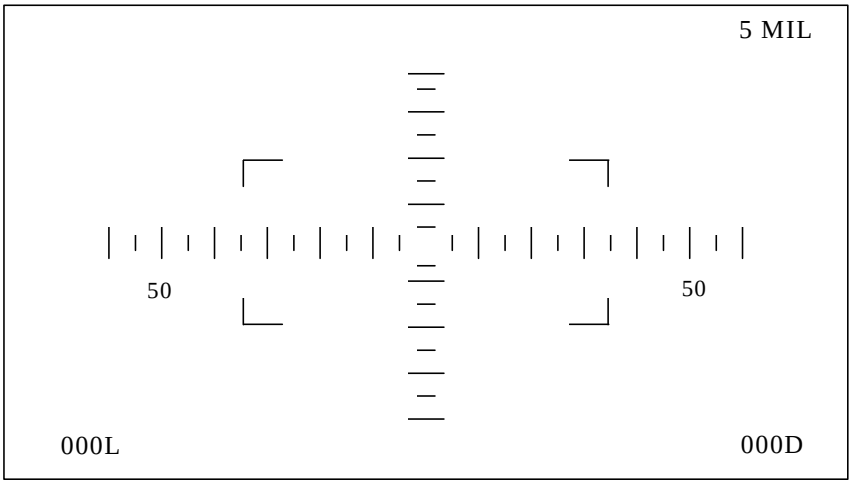
Weapon	FOV	Reticle
MK19 Machine Gun M24 Sniper Rifle MELIOS	Wide	

Table C.1.4-1: HTWS Reticles with respect to weapon application and FOV (Continued)

C.1.4.1 M2 Reticles. The M2 reticles provide multiple cross-hairs used for range estimation and target firing (see Figure C.1.4.1-1). Each cross-hair is used at a different range. The range at which to use a specific cross-hair is indicated on side of the cross-hair, in the hundreds digit in meters (example: 6 = 600 meters). For the WFOV reticle, the unmarked cross-hair above the zeroing aim line is used at 200 meters. The vertical line of a cross-hair reflects the height of a 5-foot man at the specified range. The horizontal line of a cross-hair reflects the width of a 10-foot tank at the specified range. The firing aim point of each cross-hair is the point of intersection of the vertical and horizontal lines. For the NFOV reticle, there are two sets of cross-hairs. The boxed cross-hairs and corresponding ranges on the left are used when the range lever on the M2 bracket is set to NEAR. The unboxed cross-hairs and corresponding ranges on the right are used when the range lever on the M2 bracket is set to FAR.

When using the WFOV reticle, the range lever on the M2 bracket must be set to NEAR.

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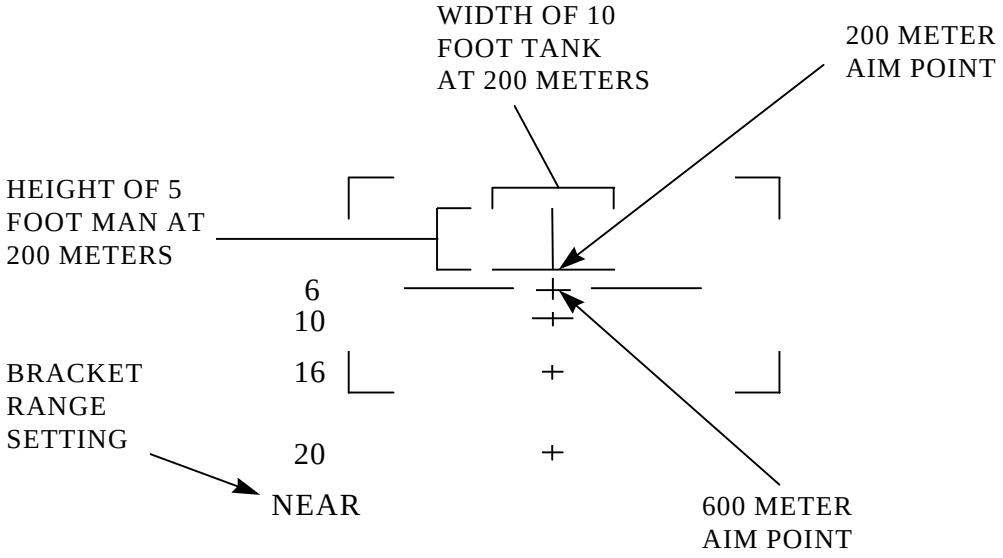

Figure C.1.4.1-1: M2 Cross-Hairs

C.1.4.2 MK19 Reticle. The MK19 reticle provides one cross-hair and a range scale (see Figure C.1.4.2-1). The numbers of the range scale are the hundreds digit in meters (example: 4 = 400 meters). The vertical lines of the range scale reflect the height of a 5-foot man at that specified range. The distance between two consecutive vertical lines reflects the width of a 10-foot tank at the range specified by the vertical line on the left. The vertical line of the cross-hair reflects the height of a 5-foot man at 800 meters. The horizontal line of the cross-hair reflects the width of a 10-foot tank at 800 meters. The firing aim point is the point of intersection of the vertical and horizontal lines of the cross-hair.

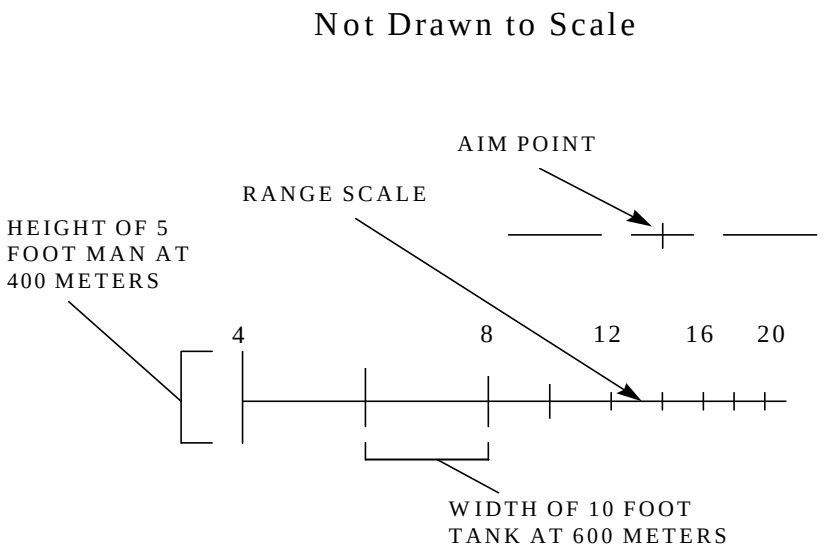

Figure C.1.4.2-1: MK19 Range Scale and Cross-Hair

C.1.4.3 M24 Reticle. The M24 reticle provides an aim point and an angular scale (see Figure C.1.4.3-1). The angular scale is used for combat preparations, directing fire, or range estimations. The angular measurement from center to center of two consecutive tick marks is equal to 1.0 mil. The angular measurement from inside edge to inside edge of two consecutive tick marks is equal to 0.8 mil. The angular measurement from outside edge to outside edge of two consecutive tick marks is equal to 1.2 mil.

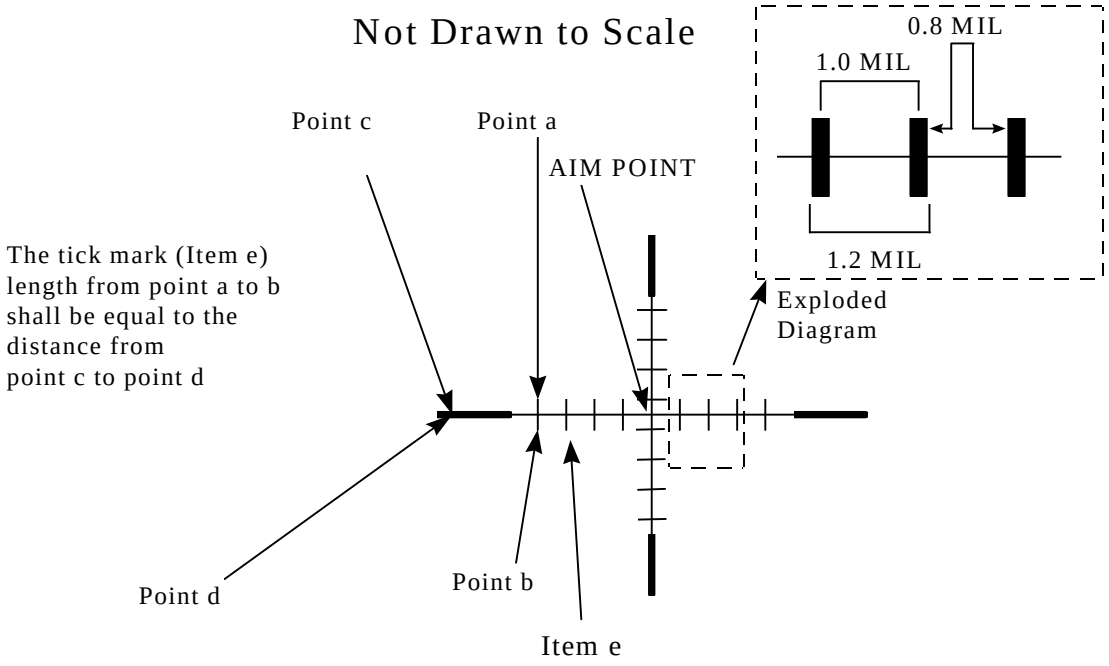

Figure C.1.4.3-1: M24 Aim Point and Angular Scale

C.1.4.4 Forward Observer Reticles. The forward observer reticles are used to measure angles for combat preparations, directing fire, or range estimations. Each increment of the scale is equal to the number of mils shown in the top right of the display (see Figure C.1.4.4-1).

Not Drawn to Scale

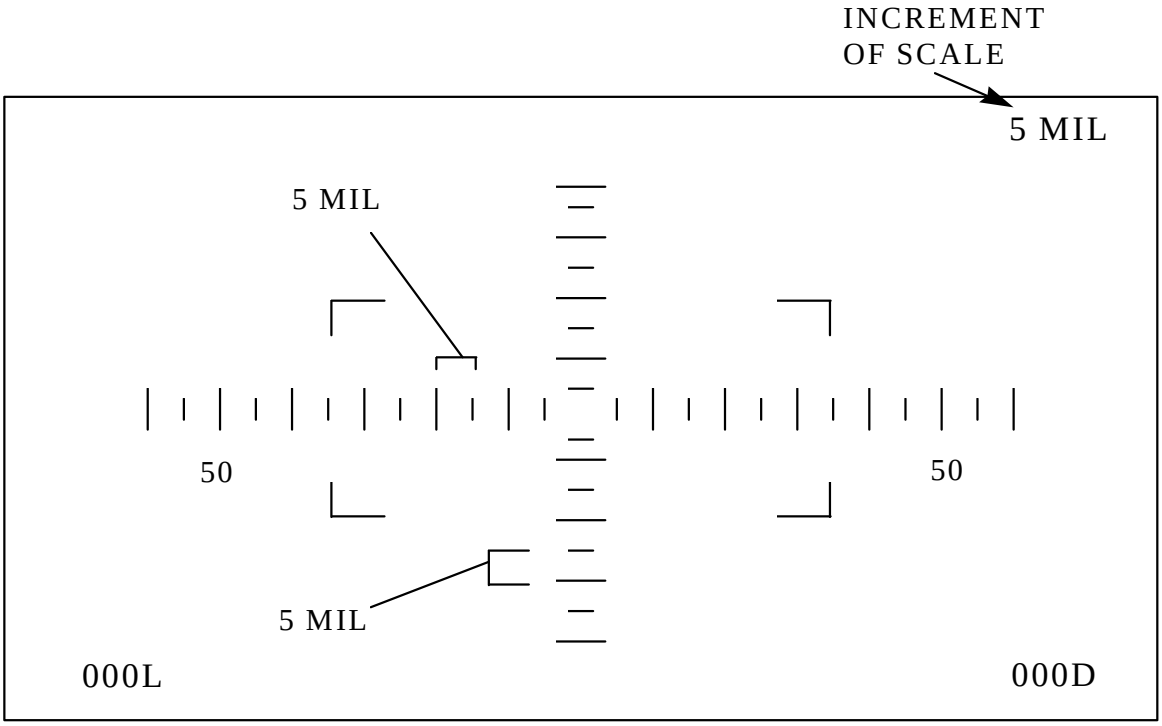

Figure C.1.4.4-1: Forward Observer Reticle