LIGHTWEIGHT 155mm (LW155)

SYSTEM PERFORMANCE SPECIFICATION

1.0 SCOPE

1.1 Identification (TBD)

1.2 System Overview The LW 155 will replace all US Marine Corps (USMC) cannon systems and be used as a direct support weapon. The US Army (Army) will use the system as a general support weapon in the light forces and as a direct support weapon for the Light Cavalry Regiment replacing all of the M198 155mm towed howitzers.

1.3 Document Overview This system specification describes the configuration of the Lightweight 155 (LW 155) formerly known as the Advanced Towed Cannon System (ATCAS). This specification is used to describe the performance requirements of the LW 155 and contains the operational and interface criteria for the system. Both services require the system to have the capability to accept the Pre-planned Product Improvements (P3I) listed in appendix A of this specification. The Army requires that a number of the P3I be on their production system; while, the USMC may procure them, as a separate action, to be added to their production system.

1.4 Security Classification (TBD)

2.0 APPLICABLE DOCUMENTS The following documents form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the content of this specification, the content of this specification shall be considered a superseding requirement.

2.1 Government

2.1.1 Specifications and Standards

2.1.1.1 Mandatory

QPL-46168-27	Coating, Aliphatic Polyurethane, Chemical Agent Resistant
MIL-STD-209(H)	Slinging and Tiedown Provisions for Lifting and Tying Down
MIL-STD-810E	Environmental Test Methods and Engineering Guidelines

2.1.1.2 Guidance

ATPD 2131	FMTV Performance Specification
APTD 2185	MTVR Performa nce Specification
MIL-STD-171(E)	Finishing of Metal and Wood Surfaces
MIL-STD-130(H)	US Military Property, Identification Marking
MIL-STD-1366(C)	Transportability Criteria
MIL-STD-1472(D)	Human Engineering Design Criteria for Military Systems
MIL-STD-1791(2)	Designing for Internal Aerial Delivery in Fixed Wing Aircraft
QPL-P-C-437	Cleaning Compounds. High Pressure Steam Cleaners

2.1.2 Drawings

Interface Drawings for 155mm Ammunition, Quadrilateral MOU #9357971

2.1.3 Other

MIL-HDBK-784	Guidelines/Designs to Minimize Contamination and to Facilitate Decontamination of Military Vehicles and Other Equipment
RAM Rationale Report (RRR), 2 June 95, Us Army TRADOC Advanced	Towed Cannon System (ATCAS) Reliability and Maintainability Requirements

ANSI C95.1-91

2.2 Non-Government

2.2.1 Specifications and Standards None.

2.2.2 Drawings

American Association of Railroads (AAR) Clearance Diagram
Gabarit Internationale de Chargement (GIC) Clearance Diagram

3.0 SYSTEM REQUIREMENTS

3.1 System Description The LW 155 will provide close and deep fire support and interdiction fires. It will be lightweight without sacrificing range, stability, accuracy or durability. The system is designed as a howitzer, prime mover and associated equipment. The system shall be deployable to any region and shall operate in most climatic conditions. The US Marine Corps will use the weapon as a direct support weapon, replacing all existing cannon systems. The US Army will use the LW 155 as a general support weapon in the light forces and as a direct support weapon for the Light Cavalry Regiment, replacing the M198 155mm towed howitzer.

3.2 Characteristics

3.2.1 Functional Characteristics

3.2.1.1 Mission The LW 155 shall shoot, move and communicate in accordance with the combat intensity levels and mission profiles specified in the LW 155 Design Reference Mission Profile (section 2 of the ATCAS RRR).

3.2.1.2 Threat Army light forces' artillery and USMC artillery can expect to face threat forces from light, guerrilla forces to massed mechanized formations in combat across the operational continuum from operations other than war (OOTW) to war. Threat cannon systems will range from antiquated to modern long range self-propelled and towed systems. Many cannon systems will rival or exceed western systems in range, rate of fire and precision. Threat artillery (cannon, rocket and missile) and aircraft will be able to deliver a full range of ordnance, including

conventional, Improved Conventional Munitions (ICM), Dual Purpose Improved Conventional Munitions (DPICM), smoke, fuel air explosives (FAE), electronic countermeasures (ECM), scatterable mines, guided, and homing submunitions. A small number of countries will be able to employ nuclear, chemical and biological weapons. Maneuver, reconnaissance and unconventional forces will pose the ground force threat. Threat maneuver and artillery forces will use equipment from a wide range of countries. Furthermore, armies will become more sophisticated as a result of technology proliferation and synchronization of maneuver and fire support systems. Electronic warfare capabilities will vary by adversary. However, threats to battalion and battery communications systems may be effective in disrupting fire control and artillery command and control. Reconnaissance and target acquisition capabilities will also vary among threat forces. These will range from single round locating radar, modernized sound ranging systems, and unmanned aerial vehicles (UAVs) to reliance on visual acquisition means. Threats to the LW 155 throughout its life cycle will increase as a result of technology improvements in target acquisition, munitions and delivery systems. Improvements in threat force mobility and armor will directly affect the survivability of light weapon systems. Current towed systems' limited mobility and greater reaction times make them more susceptible to enemy counterfire.

3.2.2 Performance Characteristics

3.2.2.1 Range

3.2.2.1.1 Maximum Range The LW 155 indirect fire maximum range shall be at least 30 (threshold) to 40 (objective) kilometers with rocket-assisted US munitions (i.e., M549A1) and 22.5 (threshold) to 30 (objective) kilometers with unassisted US munitions (i.e., M795, M825A1 or XM898) with the M203A1 propelling charge.

3.2.2.1.2 Minimum Range The LW 155 high angle indirect fire minimum range firing the M107 projectile and current propelling charges shall not be greater than 3,700 (threshold) to 2,700 (objective) meters.

3.2.2.1.3 Range Overlap The LW 155 shall be capable of engaging targets between minimum and maximum range without any gaps.

3.2.2.2 Bias & Precision

3.2.2.2.1 Bias Bias errors cause the offset between the fall-of-shot mean point of impact (MPI) and the target. The goal of artillery is to center the MPI on the target. The LW 155 shall have a bias circular error probable (CEP) not exceeding 200 meters (threshold) to 50 meters (objective) at 25 kilometers. This is based upon a two hour MET with 20 kilometer spatial separation from the MET station to the midpoint of the trajectory, firing the M864 projectile at low angle with the maximum charge, and a target location accuracy of 10 meters.

3.2.2.2.2 Precision Precision errors cause the fall-of-shot pattern. They are related to the interaction of component tolerances, such as cannon, fire control, projectile, and propellant. The LW 155 range precision probable error for low angle indirect fire shall not be greater than 0.0030 (.3 percent) of range for unassisted projectiles and 0.0035 (.35 percent) of range for assisted projectiles. Deflection probable error shall not exceed one mil at any range in low angle fire and two mils in high angle fire for both assisted and unassisted projectiles.

3.2.2.3 Rate of Fire

3.2.2.3.1 Maximum Rate of Fire The maximum rate of fire for the LW 155 shall be at least five (threshold) to eight (objective) rounds per minute firing all allowable shell/charge combinations (Copperhead excluded) for not less than two minutes in low angle fire (800 mils or less).

3.2.2.3.2 Sustained Rate of Fire The sustained rate of fire shall be at least two rounds per minute firing all allowable shell/charge combinations (Copperhead excluded) in low angle fire (800 mils or less) for as long as ammunition is available. As a minimum, this quantity should equal the gun section’s basic combat load.

3.2.2.4 Responsiveness

3.2.2.4.1 Emplacement The LW 155 (a single weapon) shall be emplaced and ready to fire (weapon is laid, at least one reference point has been established, one round of ammunition is

ready to be loaded, and communications with the Fire Direction Center (FDC) are established) by no more than five crewmen including the gunner and four other cannoneers in three (threshold) to two (objective) minutes or less, after the prime mover has stopped in position.

3.2.2.4.2 Displacement Once emplaced, the LW155 (howitzer, crew, prime mover, and associated equipment) shall be loaded and prepared to immediately depart the current location, by no more than five crewmen in two (threshold) to one (objective) minute.

3.2.2.4.3 Out-of-Traverse Mission During conduct of a fire mission, the LW155 shall be shiftable up to 3200 mils left or right of center of traverse and laid/ready to fire on a new target, by no more than five crewmen including the gunner and four other cannoneers, in three minutes (threshold) to two minutes (objective) from receipt of the new mission.

3.2.2.4.4 Low Angle Fire The LW155, when emplaced in a firing position and with a fuzed projectile ready to load, shall respond to an in-traverse (within 400 mils left or right of center traverse) low angle fire mission, with first round fired within 30 (threshold) to 20 (objective) seconds from receipt of fire commands (excluding Copperhead missions).

3.2.2.4.5 High Angle Fire The LW155, when emplaced in a firing position and with a fuzed projectile ready to load, shall respond to an in-traverse, high angle mission (1000-1275 mils) with first round fired within 45 (threshold) to 30 (objective) seconds from receipt of the fire commands (excluding Copperhead missions).

3.2.2.5 Direct Fire The LW155 shall be capable of direct fire at a quadrant elevation of zero mils on level ground, with at least charge seven white bag (M4A2), and shall have a sight that provides a direct fire capability.

3.2.2.6 Survivability

3.2.2.6.1 Nuclear, Biological and Chemical (NBC) Protection The LW155 shall be capable of withstanding the materiel damaging effects of NBC contamination, decontaminates, and the standard decontamination procedures. MIL-HDBK-784 is offered as a guide. Chemical agent resistant coating (CARC) paint shall be used per

QPL-46168-27. Critical LW155 components shall be decontaminable by the crew using standard organic decontamination equipment in 10 (threshold) to 5 (objective) minutes. (Critical components are those components required to be manually handled during conduct of emplacement and fire mission.) The LW155 shall be designed to facilitate decontamination of the howitzer, without dismantling or removing integral components of the end item. The LW155 design shall minimize areas where contaminating and decontaminating agents can collect.

3.2.2.6.2 Ballistic Vulnerability The LW155 System mission critical components (e.g., fire control instruments, hydraulic systems, and cables) shall be designed and configured to minimize their vulnerability to ballistic fragments.

3.2.2.6.3 Soldier Survivability The LW155 design shall maximize soldier survivability both as it affects the crew and the force as a whole. This includes minimizing the system's visual, auditory, and RF signature and exploiting the system's mobility and rapid emplacement and displacement capability.

3.2.2.7 Mobility

3.2.2.7.1 Towing The LW155 shall not exceed the towing capabilities of the prime mover. Guidance is provided in ATPD 2131 (Family of Medium Tactical Vehicles, FMTV) and ATPD 2185 (Medium Tactical Vehicle Replacement, MTVR). Prime mover maximum towing capacity is independent of the payload. As an objective, the track of the LW155 will not be wider than that of the FMTV and MTVR prime movers.

3.2.2.7.2 Fording The LW155 shall have a fording (water crossing) capability equal to that of the prime mover. During unprepared fording operations, at least 30 inches of water (fresh or salt), without addition of special equipment or adjustments. During prepared fording operations, up to 60 inches of water (fresh or salt, including waves), with special equipment or adjustments.

3.2.2.7.3 Emergency Repair The LW155 shall be capable of accepting a prime mover (M813, FMTV, or MTVR) wheel as a spare or another technical solution (i.e., *run-flat*) for emergency repair or replacement.

3.2.2.7.4 Speed The LW155 shall provide a suspension system to achieve towing speeds of not less than 88 kph (55 mph) on primary roads, 56 kph (35 mph) on secondary roads, and 24 kph (15 mph) cross-country
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3.2.2.7.5 Blackout Markers The LW155 shall be designed to incorporate blackout markers (with reduced infrared signature) and US Department of Transportation (DOT) rear lights while being towed.

3.2.2.7.6 Braking The LW155 on-board brake system, when attached to the prime mover, shall provide effective and controlled braking of the LW155 when stopping or slowing down from the maximum towing speeds on all road types, and when descending slopes of up to 60 percent. Additionally, the LW155 brakes shall be designed to preclude locking of the howitzer brakes except in an emergency (prime mover brake failure). The LW155 shall have manually operated parking brakes.

3.2.2.8 Transportability The general requirements of MIL-STD-1366, in concjunction with the requirements set forth below, may be used as a guide for determining dimensions, weight constraints, lifting and tiedown provisions for worldwide transportation of systems.

3.2.2.8.1 Fixed Wing The LW155 with its prime mover shall be air transportable on USAF C-141B and larger cargo aircraft. At least two LW155s shall be transportable in a single C-130 aircraft (without prime movers). MIL-STD-1791 is offered as a guide. The LW155 shall be configured for ease of loading and unloading from the above USAF aircraft without disassembly or assembly. The LW155 shall be air droppable using low-velocity aerial delivery (LVAD) from the C-130 and larger USAF heavy-drop cargo aircraft.

3.2.2.8.2 Rotary Wing The LW155 shall be externally transportable as a complete mission package (howitzer, crew, ammunition, and section equipment) by the CH-53E and CH-47D in high, hot conditions and by the MV-22 and CH-53D in low, cool conditions. The lift provisions for airmobile operations shall be designed to provide for a stable load at all speeds up to 200 knots.

3.2.2.8.3 Marine The LW155 shall be transportable by all type cargo ships and landing craft. The physical characteristics and dimensions of the LW155, while attached to the prime mover, shall allow loading and securing aboard naval shipping and landing craft larger than the Landing Craft Mechanized-8 (LCM-8).

3.2.2.8.4 Highway and Rail For rail and highway transportation, the LW155 shall meet both the AAR and GIC clearance diagrams. The LW155 shall be transportable by military and commercial transporters. The LW155 (at shipping weight) shall incur no damage when subjected to the MIL-STD-810 rail impact test. The howitzer, when towed by its prime mover, shall meet the highway legal limits of US and North Atlantic Treaty Organization (NATO) countries.

3.2.2.8.5 Lifting and Tiedown Provisions The LW155 shall be equipped with military standard lifting and tiedown provisions in accordance with MIL-STD-209.

3.2.3 External Interfaces

3.2.3.1 Ammunition The LW155 shall interface with all fielded and developmental US and NATO standard 155mm munitions and all current and developmental propelling charges (excluding liquid propellant) based on standard projectile/charge compatibility. Guidance is provided in the Interface Drawings for 155mm Ammunition Quadrilateral, MOU #9357971.

3.2.3.2 Prime Mover Interface The LW155 shall interface with the intended prime movers. The Army's intended prime mover is the FMTV. The USMC's intended prime mover is the MTVR. The current family of 5-ton trucks (ie, M813) may also serve as a temporary prime mover pending full fielding of the newer vehicles. In addition the system shall be moveable by Material Handling Equipment organic to USMC Artillery, the USMC Light Armored Vehicle (LAV), Advanced Amphibious Assault Vehicle (AAAV) and Landing Vehicle Track, Personnel (LVTP-7).

3.2.3.3 Command, Control and Communications Interface The LW155 shall interface with the Battery Computer System (BCS), Lightweight Computer Unit (LCU), communications equipment, and developmental systems. The LW155 shall be designed to

accommodate appropriate hardware to attach the M93/M94 Muzzle Velocity System (MVS), a Gun Display Unit (GDU) of the BCS, and developmental fire direction computers and displays.

3.2.3.4 Intrasystem Interfaces The LW155 shall accommodate/ provide intrasystem interfaces, including the vehicle, the crew, the weapon, Basic Issue Items (BII), Additional Authorized List (AAL) items, Material Handling Equipment (MHE), diagnostic equipment, and optical fire control.

3.2.3.5 Preplanned Product Improvements (P^{3}I) The LW155 shall allow for future flexibility and expansion. The Army LW155 requires a number of enhancements beyond the base howitzer (Appendix A). The USMC may procure these items as P ^{3}I.

3.2.4 Physical Characteristics

3.2.4.1 Weight The LW155 threshold weight is 9,000 pounds. The objective weight is as light as practical without sacrificing other performance characteristics included in this document, such as range, accuracy, survivability, and reliability/durability. The system weight includes the basic weapon, optical fire control and section equipment needed to fire the weapon. Non-critical section equipment, M93/94, and radios are not included.

3.2.4.2 Surface Finish The requirements of MIL-STD-171 may be used as a guide for the ontroll and preventionn of corrosion for the LW155. A final protective finish shall be chemical and decontamination resistant. The LW155 shall be capable of withstanding the materiel damaging effects of NBC contamination, decontaminates, and procedures used to decontaminate. The LW155 shall have corrosion resistant fearutes to minimize damage to exposed and non-exposed metal-bearing surfaces caused by prolonged exposure to salt water spray (96-hour salt spray) during amphibious operations..

3.2.5 Quality Factors

3.2.5.1 Reliability The LW155 Mean Rounds Between System Abort (MRBSA) shall be no less than 800 rounds (threshold) to 900 rounds (objective), to be demonstrated with an 80% confidence, when employed IAW with the LW155 Design Reference Mission Profile. An SA is defined, in accordance with the LW155 Failure

Definition and Scoring Criteria (section 3 of the ATCAS RRR), as any failure resulting in the loss or degradation of a Mission Essential Function (MEF) to a level below the minimum acceptable level defined as follows:

MEF	SA Criteria
To Shoot :	
Maximum Rate of Fire (2 minutes)	Less than 2 rounds per minute
Sustained Rate of Fire (indefinite)	Less than 1 round per minute
Maximum Range (with rocket assist)	Less than 15 km
Maximum Range (unassisted)	Less than 9 km
To Move :	
Primary Speed	Less than 30 km per hour
Secondary Speed	Less than 15 km per hour
Cross-Country Speed	Less than 5 km per hour

3.2.5.2 Maintainability

3.2.5.2.1 Operator/Crew Preventive Maintenance Checks and Services (PMCS) The system Operator/Crew PMCS shall not exceed 1.0 (threshold) to 0.5 (objective) maintenance clock-hours per day. Operator/Crew PMCS shall include all systematic care, inspection and servicing performed by the Operator/Crew as prescribed in the technical manual.

3.2.5.2.2 Corrosion Prevention Control PMCS PMCS required to keep the system corrosion free shall not exceed 2.0 (threshold) to 1.0 (objective) maintenance clock-hours per week.

3.2.5.2.3 Maintenance Ratio (MR) The system MR shall not exceed .04 (threshold) to .02 (objective) maintenance man-hours per operating hour. The MR shall include all maintenance demands, both scheduled and unscheduled (non-essential and essential), performed at the Unit, Direct Support and General Support levels. The MR shall exclude all maintenance, scheduled and unscheduled, performed at the Operator/Crew level. Specifically, it shall exclude all Operator/Crew PMCS and all Operator/Crew correctable maintenance procedures prescribed in the technical manual. An Essential Unscheduled Maintenance Demand is defined as any maintenance action resulting from an Essential Function Failure (EFF). An EFF is defined, in accordance the LW155 Failure Definition and Scoring Criteria, as the loss or degradation of an

MEF to a level below the minimum acceptable level defined as follows:

MEF	EFF Criteria
To Shoot :	
Maximum Rate of Fire (2 minutes)	Less than 5 rounds per minute
Sustained Rate of Fire (indefinite)	Less than 2 round per minute
Maximum Range (with rocket assist)	Less than 27 km
Maximum Range (unassisted)	Less than 18 km
Minimum Range (high angle)	Less than 3.7 km
Direct Fire	Loss of direct fire ability
To Move :	
Primary Speed	Less than 30 km per hour
Secondary Speed	Less than 15 km per hour
Cross-Country Speed	Less than 5 km per hour
Fording	Less than Prime Mover ability

3.2.5.2.4 Unit Mean Time To Repair (MTTR) The MTTR shall not exceed 30 minutes (threshold) to 15 minutes (objective) for all maintenance tasks, both scheduled and unscheduled, performed at the Unit level.

3.2.5.2.5 Direct Support MTTR The MTTR shall not exceed 2 hours (threshold) to 1 hour (objective) for all maintenance tasks, both scheduled and unscheduled, performed at the Direct Support level.

3.2.5.2.6 Maintenance Tasks No less that 70% of all maintenance tasks shall be performed at the Operator/Crew and/or Unit levels. No more than 25% of all maintenance tasks shall be performed at the Direct Support/General Support levels. No more than 5% of all maintenance tasks shall be performed at the Depot level.

3.2.5.2.7 Accessibility The system shall provide a means for routinely inspecting, testing and cleaning subsystems without removal of major assemblies. Accessibility shall also be provided at Line Replaceable Unit (LRU) and Shop Replaceable Unit (SRU) levels for ease of functional and diagnostic testing and repair by the Direct Support, General Support and Depot maintenance.

3.2.5.3 Durability

3.2.5.3.1 Cannon Tube Fatigue Life The cannon tube shall have a fatigue life of at least 2,650 equivalent full charge (EFC) rounds, based on firing M549A1 or M864 projectiles with M203A1 propelling charge. The cannon fatigue life shall exceed the wear life.

3.2.5.3.2 Breech Mechanism Fatigue Life The breech mechanism shall have a fatigue life of at lease 5,300 (threshold) to 10,000 (objective) EFC rounds based on the M203A1 charge.

3.2.5.3.3 Recoil Mechanism Service Life The recoil mechanism shall have a service life of 5,300 (threshold) to 10,000 (objective) EFC rounds based on the M203A1 charge.

3.2.5.3.4 Carriage and Cradle Service Life The carriage and cradle shall not require replacement for the life of the system.

3.2.6 Environments

3.2.6.1 Operating Environments The LW155 shall be operable in following conditions. There shall be no unique support requirements under these conditions.

3.2.6.1.1 Climatic

	Ambient Air Temperature (^{o} C)	Solar Radiation (W/m2)	Ambient Relative Humidity (%)
Hot			
Hot-Dry	32 to 49	0 to 1120	3 to 8
Hot-Humid	31 to 41	0 to 1080	59 to 88
Basic			
Constant High Humidity	const. to 24	negligible	95 to 100
Variable High Humidity	26 to 35	0 to 970	74 to 100
Basic Hot	30 to 43	0 to 1120	14 to 44
Basic Cold	-21 to -32	negligible	toward sat.
Cold			
Cold	-37 to -46	negligible	toward sat.

3.2.6.1.2 Natural Environments

Ice. Icing condition equivalent to 13 mm (0.5 in) of glaze with specific gravity of 0.9. The system shall withstand, without permanent damage, icing conditions as follows:

76 mm (3.0 in) glaze, specific gravity 0.9
152 mm (6.0 in) glaze/rime mix, specific gravity 0.5
152 mm (6.0 in) rime near the surface increasing linearly to 508 mm (20.0 in) at 122 m (400.2 ft) altitude, specific gravity of 0.2

Ice fog. Ice fog consisting of suspended ice crystals averaging 5 to 20 microns in diameter of sufficient density to limit visibility to 1.5m (4.9 ft).

Sand and dust. Particle concentrations of 1.06g/m3 (6.61 x 10-5 lbs/ft3) with wind speeds to 18 m/s 59 ft/s) at a height of 3m (10 ft). Particle sizes shall range from less than 74 micro meters (2.91 x 10-3 in) in diameter to 1000 micro meters (3.94 x 10-2 in) with the bulk of the particles ranging from 74 to 350 micro meters (2.91 x 10-3 in to 1.378 x 10-2 in).

Wind. Wind velocities up to 102 kph (63.3 mph).

Rain. Rain intensities as specified in the following table:

Duration	**Amount**		**Wind Speed, intermittent (knots)**
	(in)	**(mm)**	
1 minute	0.45	11.4	to 35 (63 kph)
5 minutes	1.00	25.4	to 35 (63 kph)
10 minutes	1.50	38.1	to 35 (63 kph)
1 hour	5.50	139.7	to 35 (63 kph)
12 hours	9.50	241.3	to 35 (63 kph)

Note: To include each of the shorter duration intensities. Raindrop sizes ranging from 0.6 mm to 4.0 mm (0.02 to 0.16 in.) with a median of 2.5 mm (0.10 in.). The larger drop sizes tend to be associated with the greater intensities.

Salt fog. Salt fog exposure for periods up to 96 hours. For test purposes, the salt fog solution shall be 5% by weight of sodium chloride in 95% by weight distilled water. The temperature in the exposure zone shall be maintained between 32 and 35°C (87.6° and 95.0°F). Fog density shall be approximately 31 (0.79 gal) of salt solution per 0.3 m3 (10.6 ft3) of chamber volume per 24 hours .

Hail. Hailstones up to 51 mm (2 in.) in diameter.

3.2.6.1.3 Induced Environments

Road shock. The LW155 shall not be damaged from road shock when towed IAW the system DRMP and within the prime mover mobility and towing specifications.

Vibration. The LW155 shall not be damaged from vibration when operated IAW the system DRMP and within the prime mover mobility and towing specifications.

Gun firing shock. The LW155 shall not be damaged from the firing shock of any authorized projectile/propelling charge combination.

Low-Velocity Aerial Delivery (LVAD). The LW155 will remain fully operational after LVAD.

3.2.6.2 Non-operating Environments The LW155 shall not incur permanent damage from exposure to the non-operating environments specified below. Following exposure, the LW155 shall be capable of performing as specified by 3.2.2 and its sub-paragraphs. During exposure, the LW155 shall be in a storage or transport configuration. For transport and storage not exceeding 90 days duration, the LW155 shall withstand the environments with no preservation preparation, special handling, or tranport equipment. The LW155 shall withstand long-term protected storage (inside warehouses or ships) for up to one (threshold) to two (objective) years and remain Fully Mission Capable.

3.2.6.2.1 Climatic

	Induced Air Temperature (° C)	Induced Relative Humidity (%)
Hot		

Hot-Dry	33 to 71	1 to 7
Hot-Humid	33 to 71	14 to 80
Basic		
Constant High Humidity	const. to 27	95 to 100
Variable High Humidity	30 to 63	19 to 75
Basic Hot	30 to 63	5 to 44
Basic Cold	-25 to -33	toward saturation
Cold		
Cold	-37 to -46	toward saturation

3.2.6.2.2 Natural Environments A minimum ambient pressure of 100 millibar, corresponding to failure of the air transportation system cabin pressurization equipment at 15,000 m (49,215 ft) altitude, while the system is in transportation configuration.

3.2.6.2.3 Induced Environments Exterior surfaces and components shall be capable of being cleaned by a steam and water jet cleaning process, using a cleaner conforming to QPL P-C-437, without incurring damage or degradation. Jet pressures shall be 724 kPa (105 psig) +/- 15.9 kPa (2.3 psig) for steam and 344.7 kPa (50 psig) +/- 34.6 kPa (5 psig) for water.

3.3 Design and Construction

3.3.1 Materials, Processes, and Parts

3.3.1.1 Materials The LW155 materials shall be selected on the basis of suitability for the intended use and availability in the US during a national emergency. Noncritical materials shall be used wherever practical, consistent with the requirements specified for the end item. Designs and materials that minimize absorption of NBC contaminants and facilitate rapid decontamination without adversely affecting the protective finishes shall be used.

3.3.1.2 Process Control The LW155 shall be constructed using a form of process control, such that the LW155 and its components are free from any defects which compromise system performance, reliability/durability, survivability, or safety. Welding shall not be employed as a repair measure for defective parts, unless specifically approved by the Contracting Officer.

3.3.1.3 Standard, Commercial, and Qualified Parts Parts which are in current production and available, as indicated by qualified parts lists, shall be used whenever possible. The number of unique parts shall be minimized.

3.3.1.4 Environmental Compliance Design and construction of the system shall be in compliance with applicable federal, state and local environmental laws and regulations. The use of hazardous and environmentally unacceptable materials shall be eliminated or reduced to an acceptable compliance level.

3.3.1.5 Metric System The LW155 shall be designed in accordance with the *hard metric* approach to the maximum extent practicable.

3.3.1.6 Radioactive Material Radioactive material shall not be used unless the performance requirements can not be achieved without such use. Any radioactive materials proposed will require prior Government authorization for use.

3.3.2 Name Plates and Product Markings The LW155 system and its associated parts, subassemblies, and assemblies shall be marked using MIL-STD-130H as a guide. Serial numbers shall be assigned by the Government.

3.3.3 Interchangeability Like units assemblies, sub-assemblies, and replacement parts shall be physically and functionally interchangeable without modification of the items or equipment, individual items shall not be hand-picked for fit or performance. Standard components, parts, tools, fasteners and test equipment shall be used to the maximum extent practicable.

3.3.4 Safety

3.3.4.1 Thermal Hazards All surfaces in the LW155 system that expose personnel to surface temperatures in excess of those defined below, during normal operation, shall be appropriately guarded and provide suitable labeling.

Exposure	Metal	Plastic
Momentary contact	60 degrees C	85 degrees C
Prolonged contact	49 degrees C	69 degrees C

3.3.4.2 Noxious Substances No material, which during any phase of the system life cycle shall expose personnel to noxious substances in excess of the Time Weighted Averages and Short Term Exposure Limits specified in the latest publication of the Threshold Limit Values by the American Conference of Governmental Industrial Hygienists.

3.3.4.3 Flammability The use of flammable materials shall be minimized. Components containing flammable materials, fluids shall minimize the possibility of leaks and spills. The combination of assembled components and materials or substances shall not be a source of unintended ignition and shall not support unintended combustion.

3.3.4.4 Mechanical Safety

3.3.4.4.1 Edge Rounding All exposed edges and corners that present a personnel safety hazard shall be suitably protected or rounded to a minimum radius of 13 mm.

3.3.4.4.2 Entrapment Safeguards shall be installed to prevent inadvertent contact with, or entrapment of, body parts or clothing in moving parts.

3.3.4.4.3 Mechanical Interconnection The system shall provide positive means to prevent the inadvertent mismatching of fittings, couplings, mechanical linkages and electrical connections, and the system shall minimize the likelihood of leaks and spills. Coding and markings should not be used as a substitute for this requirement.

3.3.4.5 Impulse Noise Firing impulse noise exposure for crew members shall not exceed the Peak Sound Pressure Levels (PPL) defined by Curve W. Curves X, Y and Z shall be selected only if it can be clearly documented that meeting the limit of curve W is beyond the current state of the art or that the cost is prohibitive. The PPL in decibels (dB) at time T (msec), for each curve is defined below:

Curve W: PPL = 140 at all times

Curve X: PPL = 160.5 + 6.64 log (200/T) for T <= 200

Curve Y: PPL = 6.5 dB above curve X at all times

Curve Z : PPL = 13 dB above curve X at all times

3.3.4.6 General

3.3.4.6.1 Hazard Severity The severity of all LW155 hazards shall be categorized using the criteria specified below:

Level	Category	Personnel Impact
1	Catastrophic	Death
2	Critical	Severe injury or severe occupational illness
3	Marginal	Minor injury or minor occupational illness
4	Negligible	Less than minor injury or occupational illness

3.3.4.6.2 Hazard Probability The probability of all LW155 hazards shall be categorized using the criteria specified below:

Level	Category	Definition
A	Frequent	Likely to occur
B	Probable	Will occur several times in the system’s life
C	Occasional	Likely to occur some time in the system’s life
D	Remote	Unlikely, but possible to occur in system’s life
E	Improbable	So unlikely, it can be assumed occurrence may not be experienced

3.3.4.6.3 Hazard Risk The above hazard probability and hazard severity criteria shall be used to generate a Hazard Risk Index for all hazards in the LW155 system. The LW155 system shall not contain any high or medium risk hazards as defined below:

Risk	Hazard Risk Index

MEDIUM	1E, 2D, 3B, 3C, 4A
LOW	2E, 3D, 3E, 4B-4E
HIGH	1A-1D, 2A-2C, 3A

3.3.5 Human Factors Engineering For additional information concerning HFE, MIL-STD-1472 is offered as a guide.

3.3.5.1 Crew Size The LW155 shall be operable and maintainable by a crew of ten men (nine cannon crewmen and one section chief) during around-the-clock operations.

3.3.5.2 Personnel Constraints The LW155 shall be operable and maintainable (at unit level) by the 5 th through the 95 th percentile male soldier/marine and repairable, maintainable, and supportable (above unit level) by the 5 th percentile female through the 95 th percentile male soldier/marine from the appropriate target personnel, consistent with other system performance requirements stated herein, by all MOS qualified personnel with respect to critical body measurements (for clearance, lifting, and force requirements) wearing clothing and equipment appropriate for the expected conditions of usage (to include NBC and cold weather gear).

3.3.6 Government Furnished Equipment (GFE) The following GFE cannon and optical fire control equipment are offered. The contractor is free to obtain or develop alternatives, provided they contribute to meeting the System Requirements included herein.

M284 (modified) Cannon Assembly
M138 Elbow Telescope
M172 (or modified M172) Telescope and Quadrant Mount
M18 Fire Control Quadrant
M137 Panoramic Telescope
M171 (or modified M171) Telescope and Quadrant Mount
M17 Fire Control Quadrant

3.4 Documentation Not applicable.

3.5 Logistics

3.5.1 Maintenance The LW155 shall be designed for ease of maintenance and servicing with minimum use of personnel, parts,

special tools, and equipment. The LW155 shall have similar or reduced support requirements as the predecessor system.

3.5.1.1 Maintenance Equipment

3.5.1.1.1 Tools and Support Equipment The system shall maximize use of existing tools and support equipment common to the current fielded artillery system.

3.5.1.1.2 Automatic Test Equipment (ATE) If Automatic Test Equipment (ATE) is needed, the Integrated Family of Test Equipment (IFTE) will be used by the Army and the Third Echelon Test Set (TETS) will be used by the Marine Corps.

3.5.1.2 Maintenance Concept The Government's preliminary LW155 maintenance concept calls for conformance to the principles of modular design. Repairs by removal and replacement are to be effected at the Organizational Level for modules most likely to or frequently wear out, break, or otherwise become unserviceable. Those modules and subassemblies most likely to become unserviceable prior to normal replacement time or major assembly overhaul must be capable of repair by intermediate maintenance personnel by replacement of spare/repair parts. Depot maintenance personnel will repair or overhaul those components, modules and assemblies beyond intermediate support capabilities and end items when returned to depot through normal supply channels. The LW155 shall not require any scheduled depot maintenance. Normal maintenance production shall be executed within the existing three-tier Marine Corps and Army ground equipment maintenance structure.

USMC/Army Ground Equipment Maintenance Structure

	USMC	ARMY
Organizational ("O")	1st Echelon 2d Echelon	Operator/Crew Using Unit
Intermediate ("I")	3d Echelon 4th Echelon	Direct Support General Support
Depot ("D")	5th Echelon	Depot

3.5.1.2.1 Organizational Maintenance

3.5.1.2.1.1 Operator/Crew Maintenance is performed by the user(s) of the equipment, it includes the proper care, use, operation, cleaning, preservation, lubrication and such adjustment, minor repair, testing, and parts replacement prescribed by pertinent technical publications, tools and parts allowances. **As a reference to the baseline M198 towed howitzer, the following MOS's perform maintenance at this level.** In the Marine Corps, maintenance is accomplished by MOS 0811 Field Artillery Cannoneer and 0802 Field Artillery Officer. In the Army, maintenance is accomplished by MOS 13B Cannon Crew Member.

3.5.1.2.1.2 Unit Maintenance is performed by specially trained personnel assigned to the unit. Appropriate publications authorize additional tools and necessary parts, supplies, test equipment, and skilled personnel to perform maintenance beyond the capabilities and facilities of Operator/Crew level maintenance. Efforts at this level encompass performance of scheduled/corrective maintenance; diagnosis and isolation of easily traced equipment malfunctions; replacement of major assemblies/modular components which can be removed/installed and do not require critical adjustment; and replacement of readily accessible piece parts not authorized at first echelon. **As a reference to the baseline M198 towed howitzer, the following MOS's perform maintenance at this level.** In the Marine Corps, maintenance is accomplished by MOS 2131 Towed Artillery Systems Technician and 2120 Weapon Repair Officer. In the Army, maintenance is accomplished by MOS 13BU6 Cannon Crew Member, and 63B Light-Wheeled Vehicle Mechanic.

3.5.1.2.2 Intermediate Maintenance This is maintenance performed by designated activities in direct and general support of using organizations. It includes calibration and repair and replacement of damaged or unserviceable parts, and provides technical assistance support through a secondary repairable float and/or contact team support to using organizations. For example, the Ordnance Maintenance Company of the Marine Force Service Support Group (FSSG) or Army Division Support Command provides intermediate maintenance services to its respective artillery organizations (Marine Artillery Regiment/DivArty), including that for fire control optics equipment. A similar activity does the same for Army artillery units. Intermediate maintenance normally entails third and fourth echelon services and, when supporting overflow organizational requirements, includes second echelon as

well. **As a reference to the baseline M198 towed howitzer, the following MOS's perform maintenance at this level.** In the Marine Corps, maintenance is accomplished by MOS 2131, Towed Artillery Systems Technician, 2120 Weapon Repair Officer, 2171 Electric-Optical Technician, 2125 Electric-Optical Repair Officer, 1316 Metal Worker, and 2161 Machinist. In the Army, maintenance is accomplished by MOS 45B10 Small Arms/Towed Artillery Repairer, 45G10 Fire Control Systems Repairer, 45K30 Armament Repair Supervisor, 913A Armament Repair Technician, 91B Ordnance Maintenance Management Officer, and 63B Organizational Light Wheeled Vehicle Mechanic.

3.5.1.2.2.1 Direct Support Maintenance is authorized by appropriate publications and performed by specially trained personnel, it includes diagnostic and isolation of equipment/modular malfunctions; adjustment and alignment of modules using test, measurement, and diagnostic equipment (TMDE); repair by replacement of modular components and piece parts which do not require extensive post-maintenance testing or adjustment; limited repair of modular components requiring cleaning, seal replacement, application of minor body work and evaluation of emissions of internal combustion engines.

3.5.1.2.2.2 General Support This level of maintenance is normally associated with the semi-fixed or permanent general support shops of Intermediate Maintenance Activities (IMAs) or frequently with organizational shops of units with a commodity peculiar mission. Work involves diagnosis, isolation, adjustment, calibration, alignment, and repair of malfunctions to the internal piece part level; replacement of defective modular components not authorized at lower levels; repair of major modular components by grinding or adjusting items; replacing internal and external piece parts; and performance of certain carriage and recoil mechanism repairs.

3.5.1.2.3 Depot Maintenance Depot level personnel perform major overhaul or complete rebuild of parts, subassemblies, assemblies, or end items, including the manufacture of parts and performance of required modifications, testing, and reclamation. Depot maintenance serves to support lower categories of maintenance by providing technical assistance and performing maintenance beyond their responsibility. Depot Maintenance Activities (DMAs) have more extensive repair facilities and employ production and

assembly line methods whenever practical as well as wholesale level direct exchange support.

3.5.2 Support The system shall be supportable by the standard Army Logistics System as well as the current maintenance policies in effect within the USMC at the time of fielding.

3.5.3 Facilities No new facilities shall be required. Basing and associated facility requirements shall not change from the predecessor system.

3.6 Personnel

3.6.1 MOS The system shall have no new Military Occupational Specialty (MOS). MOS 13B (Army) and MOS 0811 (USMC) personnel shall be the primary operators of the LW155.

3.6.2 Force Requirements There shall be no new force requirements. The total number of authorized maintainers and supporters shall not increase above what is required for the M198 baseline system.

3.6.3 Target Audience Description (TAD) The following abbreviated TAD is applicable for the LW155. When data becomes available for the quantity of personnel needed, these will be entered for the identified MOS or Warrant/ Commissioned Officer career management field. A copy of the complete TAD will be placed on hand with each approving agency.

USMC Abbreviated Target Audience Description (TAD) List

Item	MOS	Skill Levels	Title
1	0811	N/A	Field Artillery Cannoneer
2	2131	N/A	Towed Artillery Systems Technician
3	0802	N/A	Field Artillery Officer
4	2120	N/A	Weapon Repair Officer
5	1316	N/A	Metal Worker
6	2171	N/A	Electric-Optical Technician
7	2125	N/A	Electric-Optical Repair Officer
8	2181	N/A	Weapon Repair Chief
9	2161	N/A	Machinist

Note: USMC training is to Individual Training Standards (ITS), not skill level.

Army Abbreviated Target Audience Description (TAD) List

Item	MOS	Skill Levels	Title
1	13B *	10/20/30/40	Cannon Crew member
2	13C	10/20/30/40	TACFIRE Operations Specialist
3	13E	10/20/30/40	Fire Direction Specialist
4	13F	10/20/30/40	Fire Support Specialist
5	45B		Small Arms/Towed Arty Repairer
6	45G		Fire Control Systems Repairer
7	45K		Armament Repair Supervisor
8	55B**	10/30/40	Ammunition Specialist
9	55D**	10/20	EOD Specialist
10	63B	10/20/30/40	Light-wheeled vehicle mechanic
11	91A		Armament Repair Technician
12	91B		Ordnance Maintenance Mgmt Officer
13	91E**	10/20	EOD Specialist
14	131A	Warrant Off.	Field Artillery Targeting Tech
15	910A	Warrant Off.	Ammunition Tech. Warrant
16	13A	Comm. Officer	Field Artillery Officer
17	13E	Comm. Officer	Field Artillery Officer
18	91D	Comm. Officer	Ordnance Munitions Material Mgmt

Sources:
155MM STRAP (Draft Version 1, 6 Sep 95)
Update 12-4 dtd 19 Nov. 92, Military Occupational Classification and Structure

3.7 Characteristics of Subordinate Elements

3.7.1 Fire Control

3.7.1.1 Operability Fire control equipment will be fully operable by one crewman in all conditions to include night and NBC. It shall be able to withstand the firing shock of the LW155 at maximum charge and maximum rate of fire, as well as Low Velocity Aerial Delivery. It shall be compatible with accuracy requirements stated previously.

3.7.1.2 Sight System The LW155 shall be capable of direct and indirect fire using a one-man one-sight system on the gunner’s

(left) side. [On the M198 howitzer, direct fire with the one-man one-sight system (M137 sight) should be performed only when the gun and target are at the same elevation, with no mask obstacles between them.] The gunner shall set and/or read deflection and elevation by use of a display, readily visible from the left side elevation and traverse handwheels. The assistant gunner shall be able to set and/or read elevation by a separate display, readily visible from the right side elevation handwheel.

3.7.1.3 Boresighting It shall be possible for the LW155 crew to verify boresight as part of emplacement procedures. If boresight is out of tolerance (0.5 mil) the crew shall be able to boresight the weapon system tactically without the need for an external reference point.

3.7.1.4 Cant The fire control equipment shall be able to compensate for up to ten degrees of cant left or right of the weapon's level point.

3.7.2 Cannon Assembly

3.7.2.1 Chamber Temperature The LW155 shall have a visual sensor to determine chamber temperature to assist the crew in determining misfire procedures and rate of fire limitations.

3.7.2.2 Ignition System The LW155 shall have a reliable, improved ignition system that accommodates the firing rates specified in 3.2.2.3. It shall be designed so that the system will not ignite the propellant until the breech is closed and locked (witness marks aligned). Additionally, the propellant ignition system shall provide for a minimum of eight (threshold) to 30 (objective) ignitions without reloading by a crew member.

3.7.2.3 Breech Operation The LW155 breech shall open automatically after firing. The breech shall have inscribed alignment (witness) marks to provide a visual indication of breech closure.

3.7.3 Elevation Mechanism When fully emplaced and settled into position on level terrain, the LW155 shall be capable of setting a minimum elevation of zero mils or less and a maximum elevation of at least 1275 mils. The LW155 shall be able to fire all charges (except the M119 and M203 series charges) throughout its

full range of elevation. The minimum elevation for the M119 and M203 series charges shall be no greater than 300 mils. The LW155 shall be able to fire all allowable charge/elevation and deflection combinations on a surface with up to plus or minus ten degrees of cant. The howitzer shall not require a recoil pit for any allowable elevation and charge combination. An elevation handwheel is required on both the right and left side of the howitzer. The manual elevating mechanisms shall obtain at least ten (threshold) to fifteen (objective) mils of movement per handwheel turn. The equipment shall allow for simultaneous movement of the weapon for deflection and elevation during laying procedures.

3.7.4 Traversing Mechanism The LW155 shall be capable of firing with an on-carriage traverse capability of at least 400 mils left and right of center through the full elevation range. A manual traversing mechanism is required. It shall obtain at least ten (threshold) to fifteen (objective) mils of movement per handwheel turn. The equipment shall allow for simultaneous movement of the weapon for deflection and elevation during laying procedures.

3.7.5 Hydraulic Fluid The LW155 system shall be designed to employ a single, flame resistant, hydraulic fluid. Any additional hydraulic fluids proposed will require Government authorization prior to being implemented.

3.8 Precedence of Requirements

1. Maximum Weight
2. Responsiveness
3. Transportability/Mobility
4. Lethality
5. Vulnerability/Survivability
6. Maintainability/Sustainability

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Compliance The contractor shall be responsible for assuring compliance with all the requirements specified herein prior to delivery of the system to the Government. The Government reserves the right to perform any action deemed necessary to assure the system conforms to this specification prior to delivery to the Government.

4.2 Responsibility for Inspection The contractor shall be responsible for certifying that all components comply with all applicable configuration control documentation prior to evaluating conformance.

4.3 Requirements Cross Reference This section establishes the specific evaluation criteria for verifying the performance requirements specified in section 3 herein. The individual requirements cross reference verification methods are provided in matrix form at Appendix B. This matrix indicates the verification method, level, and responsible authority (contractor versus Government) required to certify compliance to each section 3 requirement. Each section 3 requirement is associated with a section 4 verification method.

4.3.1 Verification Methods A brief description of the verification methods as they apply to this specification is provided below:

4.3.1.1 Examination A visual inspection which may involve the review of the part and its respective installation, as well as its associated drawings, specifications, Quality Assurance Provisions and purchase orders to the extent necessary to establish compliance.

4.3.1.2 Analysis A review of data/information produced as a result of analytical computations, qualitative assessments, or tests conducted for another purpose.

4.3.1.3 Demonstration A non-instrumented test where success is determined on the basis of observation or the use of simple test equipment.

4.3.1.4 Test An instrumented formal quantitative measurement of specific system parameters using certified test equipment. This verification method may require analysis to interpret result.

4.3.2 Verification Levels A brief description of the verification levels as they apply to this specification is provided below:

4.3.2.1 System A complete LW155 howitzer.

4.3.2.2 Subsystem A complete hardware configuration item with uniquely identifiable performance requirements.

4.3.2.3 Component An assembly or piece-part of a subsystem with uniquely identifiable performance requirements.

4.3.3 Verification Responsibility A brief description of the verification responsibilities as they apply to this specification is provided below.

4.3.3.1 Government The Government shall be overall responsible for ensuring formal verification is completed, with technical assistance and on-site support by the contractor.

4.3.3.2 Contractor The contractor shall be responsible for performing the formal verification. The Government reserves the right to provide on-site representation to monitor and verify the results.

5.0 ACRONYMS AND DEFINITIONS

5.1 List of Acronyms

AAAV	Advanced Amphibious Assault Vehicle
AAL	Additional Authorized List
AAR	American Association of Railroads
ABCS	Army Battle Command and Control System
ABS	Anti-lock Brake System
AC	Active Component
AFATDS	Advanced Field Artillery Tactical Data System
AMSAA	Army Material Systems Analysis Activity
APS	Auxiliary Power System
ARDEC	Armaments Research, Development, and Engineering Center
ARL	Army Research Laboratory
ARTEP	Army Training and Evaluation Program
ATCAS	Advanced Towed Cannon System
ATE	Automatic Test Equipment
BCS	Battery Computer System
BDAR	Battle Damage Assessment and Repair
BII	Basic Issue Items
BIT	Built In Test

BITE	Built In Test Equipment
C^2	Command and Control
C^3	Command, Control and Communication
CATT	Combined Arms Tactical Trainer
CCTT	Close Combat Tactical Trainer
CEP	Circular Error Probable
CLS	Contract Logistical Support
COEA	Cost and Operational Effectiveness Analysis
COIC	Critical Operational Issues and Criteria
COMPUSEC	Computer Security
COMSEC	Communications Security
CTC	Combat Training Center
CTCITS	Combat Training Center Instrumentation and Training System
DC	Direct Current
DCD	Directorate of Combat Development
DIS	Distributed Interactive Simulation
DOD	Department of Defense
DOT	Department of Transportation
DOT&E	Developmental Operational Test and Evaluation
DPICM	Dual Purpose Improved Conventional Munitions
DRMP	Design Reference Mission Profile
DS	Direct Support
DTT	Doctrine and Tactics Training
EAP	Equipment Allowance Pool
ECM	Electronic Countermeasure
EFC	Equivalent Full Charge
EMD	Engineering and Manufacturing Development
ET	Embedded Training
EUMD	Essential Unscheduled Maintenance Demands
EUT	Early User Test
FAE	Fuel Air Explosives
FAMSIM	Family of Simulations
FDC	Fire Direction Center
FDTE	Force Development Test and Experimentation
FLOT	Forward Line of Troops
FMC	Fully Mission Capable
FMTV	Family of Medium Tactical Vehicles
FOC	Final Operational Capability
FOT	Follow On Test
FSAC	Fire Support Armaments Center
FSCATT	Fire Support Combined Arms Tactical Trainer
FUE	First Unit Equipped

GDU	Gun Display Unit
GIC	Gabarit Internationale deChargement
GITMO	Guantanimo Bay, Cuba
GPS	Global Positioning System
GS	General Support
HFEA	Human Factors Engineering Analysis
HHA	Health Hazard Assessment
HMMWV	High Mobility Multipurpose Wheeled Vehicle
I MEF	I Marine Expeditionary Force
I&KP	Instructor and Key Personnel
ICM	Improved Conventional Munitions
IET	Initial Early Training
IFSAS	Initial Fire Support Automation System
IFTE	Integrated Family of Test Equipment
II MEF	II Marine Expeditionary Force
III MEF	III Marine Expeditionary Force
ILS	Integrated Logistics Support
IOC	Initial Operational Capability
IOT	Initial Operational Test
IOT&E	Initial Operational Test and Evaluation
JORD	Joint Operational Requirements Document
kph	Kilometers Per Hour
LAV	Light Armored Vehicle
LCAC	Landing Craft Air Cushion
LCM-8	Landing Craft Mechanized-8
LCU	Lightweight Computer Unit
LORA	Level of Repair Analysis
LRU	Line Replaceable Unit
LSA	Logistical Support Analysis
LVAD	Low Velocity Aerial Delivery
LVTP-7	Landing Vehicle Track Personnel-7
LW155	Lightweight 155mm
MACOM	Major Command
MACS	Modular Artillery Charge System
MARCORSYSCOM	Marine Corps Systems Command
MCCDC	Marine Corps Combat Development Command
MCCRES	Marine Corps Combat Readiness Evaluation Systems
MCOTEA	Marine Corps Operational Test and Evaluation Agency
MEF	Mission Essential Function
MET	Meteorology
MHE	Materiel Handling Equipment
MLR	Medium Lift Replacement

MNS	Mission Needs Statement
MOFA	Multi Option Fuze Artillery
MOPP-4	Mission Oriented Protective Posture-4
MOS	Military Occupational Specialty
MOU	Memorandum of Understanding
MP	Mission Profile
MPF	Maritime Pre-positioning Force
MR	Maintenance Ratio
MRBSA	Medium Rounds Between System Abort
MTBF	Mean Time Between Failure
MTTR	Medium Time To Repair
MTVR	Medium Tactical Vehicle Replacement
MVS	Muzzle Velocity System
NAL MEB	North Atlantic Marine Expeditionary Brigade
NBC	Nuclear Biological Chemical
NET	New Equipment Training
NETT	New Equipment Training Team
NETTSP	New Equipment Training Test Support Package
OEC	Operational Evaluation Command
OMS	Operational Mode Summary
OMS/MP	Operational Mode Summary/Mission Profile
OOTW	Operations Other Than War
OPTEC	Operational Test and Evaluation Command
OPTEMPO	Operational Tempo
ORD	Operational Requirements Document
OS	Operating System
OSHA	Occupational Safety and Health Agency
OTE	Operational Threat Environment
P^3I	Preplanned Product Improvements
PE	Probable Error
PEO-FAS	Program Executive Office-Field Artillery Systems
PIAFS	Portable Inductive Artillery Fuze Setter
PM	Program/Project/Product Manager
PMCS	Preventative Maintenance Checks and Services
POC	Platoon Operations Center
POI	Program of Instruction
R&M	Reliability and Maintainability
RAM-D	Reliability, Availability, Maintainability, Durability
RC	Reserve Component
RDT&E	Research, Development Test and Evaluation
RF	Radio Frequency
RRR	RAM Rationale Report

RTD	Rounds Per Tube Per Day
RTS-M	Regional Training Sets-Maintenance
SA	System Abort
SAWE-RF-GPS	Simulation of Area Weapons Effects-Radio Frequency-Global Positioning System
SD	Standard Deviation
SESAME	Selected Essential - Item Stockage for Availability Method
SINCGARS	Single Channel Ground and Airborne Radio System
SMRC	Supply Maintenance Repair Code
SSA	System Safety Analysis
SSV	Soldier Survivability
STAR	System Threat Assessment Report
TAFIM	Technical Architecture Framework for Information Management
TAFSM	Target Acquisition/Fire Support Model
TAMCN	Table Authorized Materiel Control Number
TBD	To be determined
TBS	The Basic School
TECOM	Test and Evaluation Command
TES	Tactical Engagement Simulation
TM	Technical Manual
TTP	Tactics Techniques and Procedures
TTSP	Training Test Support Package
UAV	Unmanned Aerial Vehicles
UL	Unit Level
USAFAS	United States Army Field Artillery School
USAFATC	United States Army Field Artillery Training Center
USAOCS	United States Army Ordnance Center and School
WRMR	War Readiness Materiel Reserve

5.2 Definitions

5.2.1 Fire Direction - The tactical employment of firepower exercising the tactical command of one or more units in the selection of targets, the concentration and distribution of fire, and the allocation of ammunition for each mission. Also, the methods and techniques used to convert target information into appropriate fire commands. Fire direction includes tactical and technical fire direction.

5.2.1.1 Tactical Fire Direction - Tactical fire direction is the process of analyzing fire requests to determine an appropriate fire order outlining the method of attack. At the firing unit level, tactical fire direction functions include: recognize and execute by mission prioritization, determine ammunition type and volume using commander's criteria and ammunition inventory, check battlefield geometry and fire support coordination measures as directed, and accept or deny the mission. Tactical fire direction begins with receipt of a fire mission or request for fire and ends with the issue of a “Fire Order”.

5.2.1.2 Fire Order - The fire order concisely states the decision on how to engage the target. The fire order contains the following elements: target grid, length, width, and attitude; unit(s) to fire; adjusting element and method of fire; projectile, lot, fuze, and charge in adjustment; the basis for corrections; the distribution of rounds on target; special instructions (such as At My Command, Time on Target, and Do Not Load); the method, projectile, lot, fuze, and charge in the fire for effect (FFE) phase; and target number/priority target.

5.2.1.3 Technical Fire Direction - Technical fire direction is the process of converting weapon and ammunition characteristics, weapon and target locations, and meteorological information into fire commands to engage the target in accordance with the fire order. For each target, technical fire direction determines aimpoints, range, azimuth, firing interval, time of flight, angle T, Copperhead designate time, ballistic trajectories, and time of fire; checks immediate and intermediate crests; and performs final fire support coordination measures and safety checks.

5.2.1.4 Fire commands - The fire commands contain the following elements: warning order; pieces to follow, pieces to fire, method of fire; special instructions; projectile, lot, fuze, fuze setting, and charge; deflection (azimuth); quadrant elevation; method of FFE; and special commands such as Check Firing, Cancel Check Firing, and End of Mission.

5.2.2 Tactical Fire Control - Tactical fire control is the process of analyzing fire requests to determine the most suitable weapon, the method of fire, ammunition expenditure, unit(s) to fire, and time of attack. Tactical fire control is performed at the appropriate Fire Support Element level before a fire request

is sent to the cannon battalion. As such, tactical fire control precedes tactical fire direction. Tactical fire control is often incorrectly used synonymously with tactical fire direction.

5.2.3 Fire Control - Fire control is all operations connected with the conversion of aiming data (from fire commands and aiming devices) into pointing the weapon to deliver munitions on target.

5.2.4 Fire Control Equipment - Fire control equipment is the equipment necessary to perform fire control operations. This includes sighting and alignment devices, gun drives, processors, and peripheral equipment necessary to perform boresighting on a howitzer, as well as the devices required for gun laying of another howitzer.

REQUIREMENTS CROSS REFERENCE VERIFICATION MATRIX

PARAGRAPH	VERIFICATION METHOD				LEVEL			AGENCY	
	Exam	Anal	Demo	Test	Sys	Sub	Com	Cont	Govt
3.2.2 Performance Characteristics									
3.2.2.1 Range									
3.2.2.1.1 Maximum Range				X	X				X
3.2.2.1.2 Minimum Range				X	X				X
3.2.2.1.3 Range Overlap				X	X				X
3.2.2.2 Bias & Precision									
3.2.2.2.1 Bias				X	X				X
3.2.2.2.2 Precision				X	X				X
3.2.2.3 Rate of Fire									
3.2.2.3.1 Maximum Rate of Fire				X	X				X
3.2.2.3.2 Sustained Rate of Fire				X	X				X
3.2.2.4 Responsiveness									
3.2.2.4.1 Emplacement				X	X				X
3.2.2.4.2 Displacement				X	X				X
3.2.2.4.3 Out of Traverse				X	X				X
3.2.2.4.4 Low Angle Fire				X	X				X
3.2.2.4.5 High Angle Fire				X	X				X
3.2.2.5 Direct Fire				X	X				X
3.2.2.6 Survivability									
3.2.2.6.1 NBC Protection			X		X				X
3.2.2.6.2 Ballistic Vulnerability		X			X			X	

3.2.2.6.3 Soldier Survivability		X			X				X
3.2.2.7 Mobility									
3.2.2.71 Towing				X	X				X
3.2.2.7.2 Fording				X	X				X
3.2.2.7.3 Emergency Repair			X		X				X
3.2.2.7.4 Speed				X	X				X
3.2.2.7.5 Blackout Markers	X					X		X	
3.2.2.7.6 Braking				X	X				X

REQUIREMENTS CROSS REFERENCE VERIFICATION MATRIX

PARAGRAPH	VERIFICATION METHOD				LEVEL			AGENCY	
	Exam	Anal	Demo	Test	Sys	Sub	Com	Cont	Govt
3.2.2.8 Transportability									
3.2.2.8.1 Fixed Wing				X	X				X
3.2.2.8.2 Rotary Wing				X	X				X
3.2.2.8.3 Marine			X		X				X
3.2.2.8.4 Highway & Rail			X		X				X
3.2.2.8.5 Lifting and Tiedown Provisions				X	X				X
3.2.3 External Interfaces									
3.2.3.1 Ammunition				X	X				X
3.2.3.2 Prime Mover Interface				X	X				X
3.2.3.3 C3 Interface				X	X				X
3.2.3.4 Intra-system Interfaces			X		X				X
3.2.3.5 Preplanned Product Improvements	X				X				X
3.2.4 Physical Characteristics									
3.2.4.1 Weight	X				X				X
3.2.4.2 Surface Finish				X			X	X	
3.2.5 Quality Factors									
3.2.5.1 Reliability				X	X				X
3.2.5.2 Maintainability									
3.2.5.2.1 Operator/Crew PMCS		X			X				X
3.2.5.2.2 CPC		X			X				X

PMCS									
3.2.5.2.3 MR				X	X				X
3.2.5.2.4 Unit MTTR				X	X				X
3.2.5.2.5 DS MTTR				X	X				X
3.2.5.2.6 Maintenance Tasks		X					X		X
3.2.5.2.7 Accessibiity	X				X				X
3.2.5.3 Durability									
3.2.5.3.1 Cannon Tube Fatigue Life				X		X			X
3.2.5.3.2 Breech Mechanism Fatigue Life				X		X			X
3.2.5.3.3 Recoil Mechanism Service Life				X	X				X
3.2.5.3.4 Carriage and Cradle Service Life				X	X				X

REQUIREMENTS CROSS REFERENCE VERIFICATION MATRIX

PARAGRAPH	VERIFICATION METHOD				LEVEL			AGENCY	
	Exam	Anal	Demo	Test	Sys	Sub	Com	Cont	Govt
3.2.6 Environments									
3.2.6.1 Operating Environments									
3.2.6.1.1 Climatic				X	X				X
3.2.6.1.2 Natural Environments		X			X			X	
3.2.6.1.3 Induced Environments				X	X				X
3.2.6.2 Non-operating Environment									
3.2.6.2.1 Climatic		X			X			X	
3.2.6.2.2 Natural Environments		X			X			X	
3.2.6.2.3 Induced Environments			X		X				X
3.3 Design and Construction									
3.3.1 Materials, Processes and Parts									
3.3.1.1 Materials		X					X	X	
3.3.1.2 Process Control	X						X	X	
3.3.1.3 Standard, commercial and Qualified Parts	X						X	X	
3.3.1.4 Environmental Compliance	X						X	X	
3.3.1.5 Metric System	X						X	X	
3.3.1.6 Radioactive Matl	X						X	X	
3.3.2 Name Plates & Product Markings	X						X	X	
3.3.3 Interchangeability			X		X			X	

3.3.4 Safety									
3.3.4.1 Thermal Hazard		X				X		X	
3.3.4.2 Noxious Substances		X					X	X	
3.3.4.3 Flammability		X					X	X	
3.3.4.4 Mechanical Safety									

REQUIREMENTS CROSS REFERENCE VERIFICATION MATRIX

PARAGRAPH	VERIFICATION METHOD				LEVEL			AGENCY	
	Exam	Anal	Demo	Test	Sys	Sub	Com	Cont	Govt
3.3.4.4.1 Edge Rounding		X					X	X	
3.3.4.4.2 Entrapment		X				X		X	
3.3.4.4.3 Mechanical Interconnection		X				X		X	
3.3.4.5 Impulse Noise			X		X				X
3.3.4.6 General									
3.3.4.6.1 Hazard Severity		X			X			X	
3.3.4.6.2 Hazard Probability		X			X			X	
3.3.4.6.3 Hazard Risk		X			X			X	
3.3.5 Human Factors Engineering									
3.3.5.1 Crew Size			X		X				X
3.3.5.2 Personnel Constraints			X		X				X
3.3.6 GFE	N/A								
3.4 Documentation	N/A								
3.5 Logistics									
3.5.1 Maintenance				X	X				X
3.5.1.1 Maintenance Equipment									
3.5.1.1.1 Tools and Support Equipment	X						X	X	
3.5.1.1.2 ATE			X				X	X	
3.5.1.2 Maintenance Concept									
3.5.1.2.1 Organizational Maintenance									
3.5.1.2.1.1				X	X				X

Operator/Crew									
3.5.1.2.1.2 Unit				X	X				X
3.5.1.2.2 Intermediate Maintenance									
3.5.1.2.2.1 Direct Support				X	X				X
3.5.1.2.2.2 General Support				X	X				X
3.5.2.3 Depot Maintenance	N/A								
3.5.2 Support				X	X				X
3.5.3 Facilities		X			X				X

3.6 Personnel				X	X				X
3.6.1 MOS				X	X				X

REQUIREMENTS CROSS REFERENCE VERIFICATION MATRIX

PARAGRAPH	VERIFICATION METHOD				LEVEL			AGENCY	
	Exam	Anal	Demo	Test	Sys	Sub	Com	Cont	Govt
3.6.2 Force Requirements				X	X				X
3.6.3 Target Audience Description				X	X				X
3.7 Characteristics of Subordinate Elements									
3.7.1 Fire Control				X	X				X
3.7.1.1 Operating				X	X				X
3.7.1.2 Sight System				X	X				X
3.7.1.3 Boresighting				X	X				X
3.7.1.4 Cant				X	X				X
3.7.2 Cannon Assembly									X
3.7.2.1 Chamber Temperature				X	X				X
3.7.2.2 Ignition System				X	X				X
3.7.2.3 Breech Operation			X		X				X
3.7.3 Elevation Mechanism			X		X				X
3.7.4 Traversing Mechanism			X		X				X
3.8 Precedence	N/A								
4.0 Quality Assurance Provisions	N/A								

ATTACHMENT 1

ENHANCEMENTS/PRE-PLANNED PRODUCT IMPROVEMENTS

A.1 Rearm Device (Army only) The LW155 prime mover shall be equipped with a rearm device to permit the safe transfer of rounds and propelling charges from the cargo bed of the truck to the vicinity of the weapon. The ammunition shall be transferred in a safe and controlled manner and shall accommodate ease of loading and the maximum rate of fire. The same device shall also be used to transfer ammunition from a resupply vehicle to the LW155 prime mover when bulk ammunition transfer is not feasible.

A.2 Advanced Digital Fire Control To support the goals of Force XXI and the digitization of the battlefield, the Army requires that the LW155 have the capabilities listed below. The USMC may procure these items as P ^{3}I.

A.2.1 Capabilities

A.2.1.1 Fire Control capable of:

(a) Conducting technical fire direction.
(b) Self locating to not more than 10 meters horizontal circular error probable (CEP) and not more than 10 meters vertical probable error (PE) for all combat conditions and distances traveled.
(c) Determining and displaying direction and orientation of the howitzer to at least 1 mil Standard Deviation (SD) accuracy, and determining and displaying elevation to not less than 0.5 mil SD accuracy.
(d) Providing continuously updated location data while the LW155 is moving. The system will not require stopping to maintain the required accuracies if satellite signals are not temporarily lost for more than four minutes.
(e) Dismounting the system locating device to permit the LW155 to determine its position using reverse polar plot or triangulation techniques when satellite reception is inadequate from the howitzer position.
(f) Receiving data from, and automatically interfacing with, the on-board computer described below, the IFSAS, AFATDS, BCS, LCU, and their developmental replacements.
(g) Operating in air transport and marine modes.

ATTACHMENT 1

A.2.1.2 On-board computer including:

(a) Determining ballistic solutions (including for NATO standard munitions) and displaying firing data, selectable as either deflection or azimuth, for any fire mission.
(b) Receiving muzzle velocity data from the M93/M94 Muzzle Velocity System (MVS). Automatically managing muzzle velocity variants, to include digitally transmitting to designated subscribers.
(c) Receiving and storing up to 15 (threshold) to 30 (objective) preplanned fire missions or targets with all methods of control and attack.
(d) Receiving, formatting and transmitting messages compatible with the current version of IFSAS/BCS/AFATDS software, and be updatable at unit level. Shall be upgradable as IFSAS/BCS/AFATDS software is upgraded.
(e) Fully interfacing by wire and combat net radio with other LW155 computers and automated C^2 equipment at battery and higher levels, to include their developmental replacements. Additionally, the LW155 computer/radio interface shall be capable of automatically retransmitting messages over wire or radio.
(f) Interfacing with and providing fuze data to the Portable Inductive Artillery Fuze Setter (PIAFS).
(g) Accepting input of firing safety data and alerting the crew when violated.
(h) Managing, displaying and digitally transmitting to designated subscribers the ammunition inventory for both the resident and a second howitzer.
(i) Computing and applying boresight corrections for the entire arc of elevation.
(j) Receiving meteorological messages, computing and applying meteorological corrections.
(k) Interfacing with a hand-held display that allows the section chief to manually enter data and verify current gun settings.
(l) Automatically measuring and compensating for the effects of cant in the ballistic computations for fire missions.
(m) Include at least 200 percent excess capacity relative to present memory requirements.
(n) Intefacing with a PC-based “panel trainer” device, which may be required for digital fire control training.

A.2.1.3 Data displays integrated with the self-locating system and the on-board computer. The gunner's display shall display current elevation and deflection, and firing elevation and deflection. The assistant gunner's display shall display current elevation and firing elevation.

A.2.1.4 A direct fire sight that shall provide a first round hit probability of 0.30 (threshold) to 0.80 (objective) at 1500 meters against stationary NATO standard sized (2.3 by 2.3 meters) targets firing the M107 projectile and charge 7 white bags). It shall also facilitate tracking of moving targets to include an easy method to determine and set "leads", and provide night/poor visibility enhancement. This may be integrated with the ballistic computer.

A.2.1.5 A self-contained power supply capable of operations without servicing or recharging for at least six (threshold) to 10 (objective) hours at surge intensities as per the Operational Mode Summary/Mission Profile (OMS/MP). This power supply shall:

(a) If needed, be compatible with and rechargeable by the prime mover and alternate AC and DC power sources.
(b) Meet United States Air Force cargo specifications.
(c) If needed, be rech argeable on the move by the prime mover.

A.2.2 Embedded Training The LW155 automated fire control shall have an Embedded Training (ET) capability which shall be adequate to conduct pretest training for operational testing. This training capability along with training devices mentioned above shall be adequate for fielding and sustainment of the LW155. The ET system shall be transparent to the crew as a result of system hardware/software design. The ET system shall be interoperable with the Combat Training Center instrumentation and training systems (e.g. MILES, 2000, SAWE-RF) for gunnery training and for ensuring effective and responsive collective training for the LW155. An electronic interface between FSCATT and LW155 is required.

A.2.3 Computer Security (COMPUSEC) Protection of the computer resources shall be IAW prescribed regulations. Risk analysis and operating The Fire Support Combined Arms Tactical Trainer (FSCATT) shall be used approvals shall be predefined for both

operational systems and support facilities to ensure compliance in garrison and to facilitate future determination at any deployed location.

A.2.4 Weight The weight of the advanced digital fire control specified herein does not count against the 9,000 pound threshold basic weight, but shall have a combined weight of not more than 500 (threshold) to 200 (objective) pounds.

A.2.5 Bias The combination of the materiel requirements of the self-contained system and the on-board computer as noted above shall achieve a bias circular error probable (CEP) of 160 meters (threshold) to 50 meters (objective) at 25 kilometers. This is based upon a two hour MET with 20 kilometer spatial separation from the MET station to the midpoint of the trajectory, firing the M864 projectile at low angle with the maximum charge, and a target location accuracy of 10 meters.

A.2.6 Degraded Operations The LW155 shall have built in manual backups to allow continued operation of the howitzer should the primary systems (prime mover and on-board electronics) fail or not be available.

A.2.6.1 Power Loss. There shall be a manual back-up for all systems that require power, except the M93/M94 MVS and on-board computer. Other requirements remain unchanged.

A.2.6.2 Power Loss/Self-locating System Failure. The optical fire control equipment shall be maintained as a backup capability and shall be able to operate independently of the automated fire control system.

A.2.6.3 On-board Computer Failure. The LW155 will be capable of receiving and displaying digital fire commands which are received by wire and radio.

A.2.6.4 Secondary Functions. The LW155 will be capable of performing the following functions for a second degraded howitzer:

A.2.6.4.1 Radio Failure. Relaying via wire digital transmissions from designated subscribers to the second howitzer.

A.2.6.4.2 Computer/Radio Failure. Conducting technical fire direction and transmitting fire commands via wire.

A.2.6.4.3 Computer Failure. Maintaining howitzer status files such as howitzer location and azimuth of fire, ready status, muzzle velocities, and ammunition inventories.

A.2.6.4.4 Self-locating System Failure. Reciprocally laying and determining location within line of sight

A.2.6.5 Nuclear Effects All LW155 mission essential electronics shall be survivable to nuclear effects (High Altitude Electromagnetic Pulse at a minimum). The LW155 shall be survivable for battlefield electronic warfare threats such as Directed Energy, High Powered Microwave and non-nuclear Electromagnetic Pulse designed to destroy electronic systems such as communications, fire control, navigation, data processing and computers. All LW155 electronics shall be survivable consistent with developmental Field Artillery C^3 data systems.

A.2.6.6 Unique Requirements Any computer hardware/software developed or fielded for the LW155 shall be in accordance with the open system architecture and standards as specified in the DOD Technical Architecture.

A.3 On-Carriage Loading Device The LW155 design shall allow for the addition of an on-carriage loading device that shall achieve a consistently positive ram at all elevations with human interface of no more than one crewman. A backup manual ramming capability will be maintained. The loading device will not interfere manual ramming.

A.4 Powered Elevation and Traverse The LW155 design shall allow for the addition of powered elevation and deflection assists. A backup manual elevation and traverse capability will be maintained. The powered assists will not interfere with manual elevation and traverse.

ATTACHMENT 1

A.5 BIT/BITE Built-In Test (BIT) and Built-In Test Equipment (BITE) shall be used to successfully fault isolate to the single Line Replaceable Unit (LRU) 90 percent (threshold) to 95 percent (objective) of the time.

A.6 Electromagnetics

A.6.1 Hardening The LW155 shall be designed to control electromagnetic emissions and susceptibility characteristics of electronic, electrical, and electromechanical equipment and subsystems.

A.6.2 Interference/Compatibility Each component, assembly, and subsystem when installed as a complete system and operating as intended, shall cause no undesirable response, malfunction, or degraded performance of any other component, assembly or subsystem installed in, or associated with, the system. No component, assembly, and subsystem shall likewise be affected when other component, assembly, and subsystems are singularly or collectively operated.

A.6.3 Radiation Safety Personnel exposure to system generated RF fields shall not exceed whole-body specific absorption rates (SARs) of 0.4 W/kg or partial-body SARs of 8 W/kg for the frequency spectrum of 3 kHz to 300 gHz. The equivalent whole-body exposure levels (PELS) shall not exceed 1 mW/cm2 to 10 mW/cm2, as defined in ANSI C95.1-1991. The partial body exposure shall not exceed 20 mW/cm2, except for eyes, which shall not be exposed to more than 10 mW/cm2. Radiation safety shall be provided IAW ANSI C95.1-91.

A.7 Lightning The LW 155 shall not incur permanent damage from exposure to the indirect lightning fields specified in the following table for a lightning strike 10 m (32.8 ft) or more from the system.

Magnetic Field Rate of Change	3.2 x 10 ^9 A/m/S
Electric Field Rate of Change	1.3 x 10 ^12 V/m/S
Maximum Electric Field	3.0 x 10 ^6 V/m