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UNITED STATES MARINE CORPS
Program Manager, Ground Weapons
Marine Corps Research, Development and Acquisition Command
Quantico, Virginia 22134-5080

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CBGF
19 MAY 1989

From: Program Manager, Ground Weapons
To: Distribution

Subj: INITIATION OF INTERNATIONAL MATERIEL EVALUATION (IME) OF FOREIGN
CANDIDATES FOR A LIGHTWEIGHT 155MM TOWED HOWITZER (LW155(T))

Encl: (1) Draft USMC Required Operational Capability (ROC) for
the Lightweight 155mm Towed Howitzer

1. The United States Marine Corps has identified a need for a lightweight 155mm towed howitzer (LW155(T)). A draft Required Operational Capability (ROC) has been generated by Marine Corps Combat Development Center (MCCDC), Quantico Virginia to document the need. The major characteristics of the weapon will be:

a. Ammunition. Compatible with the current and developing family of 155mm munitions (U.S. and NATO), full caliber matched extended range and non-extended range projectiles.

b. Ground Mobility. Compatible with its designated primary and auxiliary mover, the U.S. M-9000 series 5 ton 6X6 cargo truck and MC-4000 rough terrain forklift, respectively.

c. Maximum weight. Not to exceed 9,000 lbs (4,082 kg) with a desired weight of 8,000 lbs (3,629 kg).

d. Dimensions. The overall dimensions will not exceed the following:

Towed position
Length - 485 inches
Width - 110 inches
Height - 114 inches

Stowed Position
Length - 296 inches
Width - 110 inches
Height - 84 inches

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e. Amphibious Compatibility. Weapon must be compatible with all U.S. Naval amphibious shipping and landing craft.

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f. Air Transportability (Internal). The weapon must be transportable in the C-130, C-141, C-17, and C-5 aircraft, and must be fully operational on off-load.

g. Air Transportability (External). The weapon must be externally transportable by the CH-53E, CH-53D, and MV-22 aircraft on a high, hot day (4,000 feet altitude/95 degrees Fahrenheit).

h. Crew size. Must require no more than seven crewmen to emplace, displace, and operate the weapon.

i. Traverse and Elevation. Must be capable of smooth traverse and elevation. When the carriage is level, the howitzer will be capable of depressing to an elevation of at least -75 mils. When fired at maximum elevations the weapon should not require a recoil pit. Use of variable recoil system is acceptable. The howitzer should have a traversing capability of 800 mils (400 mils left and right of center) without shifting trails.

j. Safety Criteria. Environmental factors induced by dynamic blast and overpressure during firing shall not be greater than three pounds per square inch (PSI) within crew area, nor shall they create an unacceptable level of crew discomfort during sustained firing or degrade position and equipment and operation.

k. Ballistics. The weapon must be ballistically similar to the M199 cannon currently in U.S. inventory. Additionally, the range capability must be equal to or greater than that of the aforementioned ordnance utilizing US/NATO ammunition. Howitzer maximum range will be as follows:

- Conventional, unassisted munition..24 kilometers.
- Conventional, rocket assisted munition..30 kilometers.

1. Weapon must meet any other physical or performance specifications not contained within but addressed in the attached Draft ROC.

2. In response to the above stated need, Program Management Office, Ground Weapons, Marine Corps Research, Development, and Acquisition Command is initiating a Market Investigation to identify and assess the potential candidate equipments which will satisfy the requirement. Results will be provided to participants upon completion of the evaluation.

3. Request addressees provide to MCRDAC any available information on the potential candidates for use in conducting the evaluation. Responses should be received by this office by 1 Oct 89 for full consideration.

4. Point of contact at this command, is Major Steve C. Ward, CBGF, AUTOVON 278-

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DRAFT REQUIRED OPERATIONAL CAPABILITY (ROC)

FOR THE

LIGHTWEIGHT 155MM TOWED HOWITZER

1. Statement of the Requirement. The Marine Corps has a requirement for a lightweight 155mm towed howitzer. The howitzer will be less manpower intensive, more mobile, and more air-transportable than the M-198 155mm towed howitzer. The Lightweight 155mm Towed Howitzer will provide added mobility and decrease the load of helicopters and amphibious shipping during ship-to-shore movement and subsequent operations ashore. The weapon will be used by the Marine Corps artillery regiments in both direct support and general support artillery battalions.

a. The lethality, range, and variety of ammunition associated with 155mm systems are required for successful engagement of modern threat forces. In addition, there is a large existing stockpile of 155mm rounds, as well as developments for future 155mm round capabilities.

b. Mission area. This weapon falls under Mission Area 24, Fire Support (USDR&E mission area 212).

c. Supporting documents. The MMROP (Key Ground-Related Objectives), the Marine Corps Proposed ROC for a Lightweight Artillery Weapons System dated 31 January 1981, and the US Army Operational and Organizational Plan for an Advanced Lightweight 155mm Towed Cannon System dated 14 July 1988, describe the desirability of a Lightweight 155mm Towed Howitzer to provide the lethality and range necessary for fire support against threat forces.

d. Required IOC

(1) The M-101A1 105mm towed howitzer will continue to be used in the FMF in conjunction with the M-198, at the option of the GCE commander, to provide highly mobile direct support artillery to infantry units through the year 1995. Although the M-101A1 does not have the lethality and range required in the MMROP (Key Ground-Related Objectives), it does provide the mobility required by highly maneuverable ground forces.

(2) The M-198, which reached IOC in 1982, will be nearing the end of its life cycle in the year 2002. The Lightweight 155mm Towed Howitzer is the replacement for the M-198.

(3) The required Initial Operational Capability (IOC) for the Lightweight 155mm howitzer will be 1997. Fielding will be completed by 2002.

2. Threat and Operational Deficiency

a. Threat systems. The FMF's must be prepared to fight worldwide in low, mid, and high intensity conflicts. Potential enemy threats confronting USMC forces is contained, inter alia, in the Marine Corps Long Range Plan and Marine Corps Mid-range Objective Plan. Soviet/Warsaw Pact forces, Soviet client states, and liberation movements (especially fanatical ones) remain the most serious threat to U.S. forces in the foreseeable future. Threat tactics can range from terrorist acts, to small guerrilla operations, and to the massing of conventional medium to heavy armored forces to defeat an opponent, or even the use of area weapons of mass destruction--nuclear and chemical.

(1) Lucrative targets for indirect fire weapons will extend from small pockets of guerrilla resistance to dispersed or concentrated target arrays of light, motorized, and armored forces accompanied by mortars, artillery, air defense systems, engineer vehicles, command post vehicles, electronic warfare systems, and reconnaissance, surveillance, and target acquisition assets.

(2) Threat to the advanced Lightweight 155mm Towed Howitzer system will include rotary wing and high performance aircraft attacks, and counterbattery fire from light to heavy tube, rocket, and missile artillery, supported by sophisticated reconnaissance, surveillance, and target acquisition assets. Dual purpose improved conventional munitions and high explosive will be the primary Soviet artillery munitions for the near future; however, guided projectiles and terminal homing munitions are probably being developed for counterbattery fire. Personnel and supporting systems and equipment are much more vulnerable than the weapon, especially when chemical agents and nuclear weapon effects are considered. For example, all electrical systems will be susceptible to both nuclear and non-nuclear electro-magnetic pulses, and optical systems will be vulnerable to directed energy weapons. In addition, command and control will be subjected to electronic warfare activities such as signals intercept, direction finding, intensive jamming, and deception. Soviet style SPETSNAZ operations and terrorist acts will also be a threat factor to personnel and supporting units.

b. Operational deficiency. The primary 155mm towed howitzer presently used by the Marine Corps is the M-198, which has many positive features. Its weight and size are limiting factors which impacts on strategic and tactical mobility.

(1) The M-198 provides improved range than similar towed howitzers with similar weight. Originally, the CH-53E was intended to lift the howitzer. Procurement decisions and budget constraints have since decreased the scope of the CH-53E procurement, and other systems have been procured which require CH-53E lift capabilities. This results in a limited number of assets coming ashore by helicopter during the initial phases of an amphibious assault. The ground commander must choose between fire support and other equipment critical to the success of his mission. This problem can be eased by procuring a howitzer which provides fire support ranges comparable to the M-198 (but weighs less than 9,000 lbs), which could then be lifted by the CH-53D, and the MV-22, as well as the CH-53E.

(2) Once ashore, the M-198 has adequate mobility. However, it is sometimes difficult to move through sandy or muddy terrain.

3. Operational and Organizational Concepts

a. Operational Concepts

(1) The Lightweight 155mm Towed Howitzer will be used in direct support (DS) battalions and towed general support (GS) battalions. Organization of these units will not be changed. DS battalions will consist of 3 batteries with 8 guns each. GS battalions will consist of 3 batteries with 6 guns each.

(2) The Lightweight 155mm Towed Howitzer will provide indirect fire support for infantry units on the battlefield of the future during both offensive and defensive operations in low, medium, and high intensity conflicts. The system will provide a day/night, all weather fire support capability. (In the direct support role, normally one Lightweight 155mm Towed Howitzer battalion will support an infantry regiment.) General support 155mm batteries will provide reinforcing, general support reinforcing, and general support roles to the MAGTF. The weapon will operate in all climatic zones, day or night, in all types of weather.

b. Organizational Concepts

(1) Unit organization. For planning purposes this weapon will be organic to a field artillery battalion (155mm howitzer) whose organization will contain a headquarters battery which will provide administrative support, command and control, intelligence, fire direction functions, internal communications, survey, medical services, liaison for the command, logistical support, supplies, ammunition, and appropriate organizational maintenance; and three identical firing batteries of six howitzers each (general support battalion) and eight howitzers each (direct support battalion). Individual firing crews shall

consist of no more than seven men. The number of crew members needed is that number necessary to provide for sustained operations over an extended period of time without degrading the performance capability of the system. The number of crew members provided must be capable of accomplishing the duties associated with emplacement, firing, and displacement of the weapon within standard reaction times.

(a) Firing battery organization. Firing batteries will be organized with the capability for providing direct support or general support to each supported unit. Each direct support battery will consist of two firing platoons with four guns each, and a command and control section. General support batteries will consist of six guns and a command and control section.

(b) Battalion organization. Each Lightweight 155mm Towed Howitzer battalion will consist of three firing batteries and a headquarters battery.

(2) The following is an estimation of required numbers of weapons.

Active/Reserve Bn's	=	342
FLOAT	=	86
PWRS:	=	47
MPS:	=	72
RCR (ORF)	=	76
Guantanamo Bay	=	8
MCAGCC 29 Palms	=	16
Pre-Pos	=	24
<u>TOTAL:</u>	=	671

(3) Logistic support considerations. The batteries are capable of independent operations when augmented by personnel from the battalion headquarters. The weapon should be designed in as simple a configuration as possible to ease training and maintenance problems. The battalion will be supported logistically in the same manner as is the current field artillery battalion. Nuclear munitions and chemical munitions will be obtained from special ammunition supply points using procedures which are standard at the time. The system will require logistics support similar to that required by the present M-198 155mm towed howitzer. It will be supported by the standard

Marine Corps logistics system and will be compatible with maintenance requirements in effect at the time of fielding. It will be designed for reliability, availability, and maintainability (RAM) equal to or greater than the M-198 howitzer.

4. Essential Characteristics

a. **Mobility.** This paragraph describes the mobility of the Lightweight 155mm Towed Howitzer once it is placed on the ground in the theater of operations. The howitzer will support infantry units in all types of weather, day or night, and moving on primary (12%) and secondary (68%) roads and cross country (20%). The weapon must be capable of operations over unimproved roads, cross-country in sand, snow, mud, or ice. Fording operations will occur in 25% of all tactical land moves. The weapon must have cross-country mobility greater than that of the current towed medium field artillery weapon, i.e., the M198. The system should not require special licenses/escorts for highway transportation in the US/NATO/Japan.

(1) **Prime mover.** Due to its weight and range requirements, it is envisioned that the system will be a towed configuration and must be compatible with prime mover vehicles in production at the time. The M-198 uses an M-900 series 5-ton truck for a prime mover. The Lightweight 155mm Towed Howitzer can continue to use the M-900 series prime mover, with the eventual goal of having a prime mover which is MV-22 liftable.

(2) **Forklift.** The MC-4000 Auxiliary Mover (forklift) is presently used to provide mobility for the M-198 in battery positions and in locations where maneuvering with the prime mover is difficult. This forklift can continue to provide battery position mobility for the Lightweight 155mm Towed Howitzer, as well as moving ammunition to individual howitzer sections quickly and efficiently.

(3) **Tires.** Tires which are standard to the Marine Corps inventory during this time frame shall be used. It is desired that this system will incorporate non-flat tire technology, and that tires of the howitzer be interchangeable with the tires of the prime mover.

b. **Firepower, Accuracy.** The inherent range and lethality of the 155mm artillery weapon is required to maintain firepower which is comparable to that of threat forces, including Third World military units.

(1) **Direct Fire.** The weapon will have a direct fire capability to engage targets accurately out to a range of 1,500 meters. It is required that the Lightweight 155mm Towed Howitzer be able to shoot charge 7 in direct fire. Because there is the

potential for system weight to be significantly reduced by not using charge 8 in direct fire, it is not required that the howitzer shoot charge 8 in direct fire, though this capability is desired. Direct fire capability will include the use of a tracking sight.

(2) Minimum Range

(a) Direct Fire. Minimum range shall be practically zero km (depending upon cannoneer safety for each type of projectile) in the direct fire mode.

(b) Indirect Fire. Minimum range for new and developmental ammunition shall be not more than 1.5 km in low-angle indirect fire with a minimum quadrant of 200 mils, and not more than 2.5 km in high-angle indirect fire. For current standard projectiles, minimum range should be equal to that achieved by standard complete rounds when fired from the M198 howitzer.

(3) Maximum Range. Maximum range for development, full caliber, matched extended range projectiles shall be at least 28.5 km. Maximum range for developmental, full caliber, matched extended range and non-extended range projectiles shall be at least 22 km when firing from a new cannon (95% remaining life), the non-rocket assisted high capacity projectiles and rocket-assisted projectiles with rocket off. Maximum range for standard current projectiles should be equal to or greater than that achieved by the M198. Data listed in appropriate firing tables for the M198 shall be used as criteria for test of complete rounds of standard ammunition.

(4) Rate of Fire

(a) Maximum rate of fire, when firing the new ballistically similar family of projectiles shall be no less than four rounds per minute for a duration of six minutes at all elevations up to the elevations required to achieve maximum ranges of current and developmental ammunitions. A burst rate of fire for this weapon is not required.

(b) Sustained rate of fire shall be two rounds per minute for 30 minutes and one round per minute thereafter.

(c) The weapon should be capable of manual loading at all elevations up to the elevations required to achieve maximum ranges for current and developmental ammunitions.

(5) The weapon will be capable of at least 800 mils on-carriage traverse (at least 400 mils left and right of center).

Maximum traverse is desired without increasing the size, weight, or complexity of the weapon. The howitzer will be able to shift direction of fire 3200 mils in 2 minutes or less.

(6) Ammunition. All ammunition will be compatible with the current and developing family of 155mm munitions, full caliber matched extended range and non-extended range projectiles. Distribution of range probable error for full caliber projectiles in low angle fire shall be no more than 0.30 percent of range fired (required). (0.12% of range desired) Deflection probable error shall not exceed 1 mil at any range. Range and deflection probable errors listed in appropriate firing tables for the M198 towed howitzer shall be used as criteria for test of complete rounds of standard ammunition. Exterior ballistic performance of standard ammunition fired in the new weapon must equal or exceed these criteria to be deemed compatible for unrestricted use.

(7) Reaction Time. The weapon must be capable of firing the first round within the times and under the conditions indicated below from positions in relatively dry, level terrain. The times indicated apply under intermediate climatic categories and do not include the time necessary to compute firing data.

(a) During Daylight, Indirect Fire. Weapon emplaced and laid, ammunition available at the firing position, firing data available; no more than 60 seconds from receipt of initial fire command. Weapon not in position, initial firing command received by the time the weapon is laid: no more than 4 minutes from the time the weapon stops at the firing position.

(b) During Daylight, Direct Fire. Weapon emplaced and laid, ammunition prepared: no more than 20 seconds from receipt of initial fire command. Weapon not in position: no more than 2 minutes from time the weapon stops at the firing position.

(c) During Darkness. Under blackout conditions emplacement times must not be greater than 2.5 times those prescribed for daylight.

(d) Displacement. The weapon will be capable of displacing from its firing position within 4 minutes during daylight and 8 minutes under blackout conditions.

c. Communications. The weapon will be designed to be equipped with a Gun Display Unit (GDU) that will interface with the Battery Computer System (BCS). BCS will in turn interface with other fire direction systems.

d. Survivability

(1) Decontamination capability is required.

(2) Nuclear survivability is required. Electronic components will be hardened against the effects of electromagnetic pulse (EMP), particularly high altitude EMP.

(3) It is desired that the weapon will be designed so that critical components such as sights, hydraulics, fire control and cables are as vulnerable or less vulnerable to small arms fire than those on the current M-198 howitzer.

e. Vulnerability

(1) Susceptibility. The weapon is susceptible to ballistic damage from counterbattery artillery fires, threat aircraft, and other conventional weapons.

(2) Accessibility. The howitzer is not an electronic device, and is therefore not susceptible to communications countermeasures.

(3) Feasibility. Electronic warfare must be considered during all phases of development, with particular emphasis on providing system invulnerability to detection by radar, infrared sensors, optical devices, laser, and other known or developmental devices.

(4) Nuclear Hardening Standards. It is mandatory that the system survive the following environments:

(a) Air Blast. Peak overpressure (4.5 psi), positive phase duration (2.6 sec), overpressure impulse (4.8 psi/sec), and peak dynamic pressure (0.39 psi),

(b) Thermal radiation. Maximum irradiance is 23 $\text{cal/cm}^2\text{-sec}$, pulse width at half maximum irradiance of 0.255 sec; total energy 19 cal/cm^2 - 80 percent delivered in 7.1 sec.

(c) Initial Nuclear Radiation. Total dose is 3,000 rads (tissue) of which the maximum gamma contribution is 690 rads (tissue) and the maximum neutron contribution is 2500 rads (tissue), i.e., $(1.4\text{E}12 \text{ n/cm}^2)$ (fission spectrum). Peak gamma dose rate is $(1 \text{ E}8 \text{ rad tissue/sec.})$

(d) Electromagnetic Pulse (EMP). Maximum electrical field of (5E4 volts/meter), maximum magnetic field (920 amp-turns/meter), pulse rise time (10 nano-sec), (100 nano-sec) duration of plateau after max, (230 amp-turns per meter) magnetic field plateau, (1100 volts/meter) electric field at plateau, (7.1 micro-sec) overall pulse duration, and random polarity. These

values were determined from the entire spectrum of yields from 0.1 to 500 KT. They are not the product of any single weapon at any specific altitude or distance, but represent balanced levels beyond which no expense should be incurred to achieve further hardening. These levels assume that the crew has no shielding against nuclear radiation and that the essential elements of the system are weapon mounted; they apply to all parts of the weapon normally carried on the weapon from stockpile to target.

f. Transportability

(1) The howitzer will weigh not more than 9,000 lbs (4,082 kg), with a desired weight of 8,000 lb, and will be capable of being externally transported by CH-53E, CH-53D, and MV-22 aircraft on a high, hot day (4,000 feet altitude/95 degrees Fahrenheit).

(2) The weapon will be air transportable in C-130, C-141, C-17, and C-5 aircraft, and must be fully operational on off-load.

(3) The physical characteristics and dimensions of the weapon will be compatible with naval shipping and landing craft.

(4) It will be capable of unrestricted highway, marine, and rail transport with a system load and unload time not to exceed 30 minutes.

(5) It is assumed for the present that the howitzer will neither reduce nor increase the deployment transport requirements of the receiving units (prime mover assets, etc.).

g. Compatibility/Cooperative System. The Lightweight 155mm Towed Howitzer will be compatible with all US 155mm ammunition in the field or in development. The howitzer will be compatible with transportation assets in use now and planned for use at IOC date, 1997.

h. Reliability. Since a major portion of the annual DOD budget is apportioned for the maintenance burden, reliability and durability characteristics shall not be compromised and shall be the highest attainable within the state-of-the-art. For purpose of this document, mission reliability is defined as the probability that, in the combat environment, the weapon will perform its intended function for a specified period (see mission duration and mission profile under paragraph 4.0, Secondary Characteristics).

(1) The mission reliability of this weapon shall be at least 88 percent (required) and at least 91 percent (desired) for a firing of a 250-round mission. Mission reliability is further defined as the product of carriage, armament, and fire control

equipment reliabilities. For the purpose of computing mission reliability, a mission stopping failure is defined as any malfunction which the operator/crew cannot remedy by adjustment, repair, or replacement action using the controls, on equipment material (OEM) tools and OEM parts within specified reaction times, which may cause: inability to commence operation, cessation of operation, or degradation of performance capability of system/subsystem below designated levels; serious damage to subsystem by continued operations; serious personnel safety hazards. Simultaneous related malfunctions are considered as one failure and malfunctions which do not affect mission performance will not be considered a failure.

(2) Reliability should be such that the mean-number-of-rounds-between-failure will be at least 1,200 (required) and at least 1,600 rounds (desired). The tube life should be 17,500 rounds or greater, effective full charge (EFC).

(3) The weapon shall withstand the normal hazards in loading and unloading, handling during surface transport and storage, occupying and evacuating firing positions, and in executing fire missions.

(4) The breech-ring and firing mechanisms must have a 50 percent probability of enduring at least 10,000 (desired) and at least 15,000 (desired) EFC rounds, without need for replacement or overhaul, and must not be overly sensitive to sudden temperature changes.

(5) The carriage, including the top carriage, bottom carriage, and trails, shall have a 50 percent probability of enduring at least 15,000 EFC rounds without need for replacement or overhaul.

i. Storage Reliability. Storage reliability will be such that degradation in mission reliability will not exceed 1 percent from depot storage of 1 year, and 3 percent from field storage of 6 months. The weapon will be capable of withstanding storage under conditions defined in STANAG 2805D, without permanent impairment of its capabilities from the effects of extreme conditions.

j. Availability. The operational availability of this weapon shall be between 95.0 (required) and 97.0 (desired) percent assuming Administrative Logistics Down Time (ALDT) factor of 12 hours per hour of active maintenance. Design of the weapon shall be such that the active down time for any single organizational maintenance task will not exceed an average of 30 minutes; any direct support task will not exceed an average of 2 hours. Availability of the system should be the same as that of the M-198.

k. Maintainability

(1) The weapon design shall permit ease of accessibility to frequently checked items (e.g. lubrication points) and replacement items.

(2) Incorporated in the design will be features which will minimize malfunctions or damage to linkage due to mine explosions, freezing, and dirt accumulation.

(3) Maintenance of the howitzer will not require a protected environment beyond that normally available in the field (e.g. tentage), unless lighter, stronger materials can be used which significantly decrease howitzer weight.

(4) Howitzer section personnel will perform only such maintenance as can be accomplished with on-equipment material, tools and equipment kits. Section and unit maintenance personnel will perform scheduled maintenance.

(5) The weapon will be designed for ease of maintenance and servicing with minimum use of personnel, materiel, parts and special tools and equipment. The organizational maintenance shall require only individuals with the skills and knowledge currently prescribed for the appropriate MOS designations. The design shall capitalize on the advantages of unitization and modularization in maintenance and shall minimize and/or eliminate disassembly and piece part repair in the forward area.

(6) Maximum use should be made of government furnished equipment (GFE) and parts which are standard in the supply system and common to other weapons systems, unless a significant decrease in size will result from innovative use of materials.

1. Human Factors. The weapon will be operable and maintainable by the full range of USMC personnel (5th percentile through 95th percentile Marine) wearing the full range of field uniforms with special emphasis on restrictive NBC (MOPP IV) or arctic protective garments. Human requirements for lighting, vibration, shock, noise, and safety will be considered in all aspects involving the operator and maintainer, to assure the overall system performance is not degraded by human elements. Blast and noise induced by firing will be no greater than that for the M198.

m. Doctrine. The doctrine and tactics for employing the L/W 155mm howitzer will be the same as that for the M-198. Execution of tactics may be facilitated by the lighter weight of the howitzer.

n. Primary Characteristics

(1) The weight of the howitzer will be not more than 9,000 lb (4,082 kg). A weight of less than 9,000 lbs is highly desirable.

(2) Howitzer range will be as follows:

- required unassisted range of 24 km
- required assisted range of 30 km

(3) The dimensions of the howitzer shall be the minimum consistent with performance characteristics. The overall dimensions shall comply with the requirements of the Berne International Loading Diagram.

o. Secondary Characteristics. For the purpose of this document, mission reliability is defined as the probability that, in a combat environment, the weapon will function for a specified period and under stated conditions (as specified and stated below).

(1) Mission duration. The mission duration is defined, for the purposed of this document, as the total time encompassing all system functions which demand equipment operation during the mission profile outlined below.

(2) Mission profile. The expected use of the Lightweight 155mm Towed Howitzer in an intensive phase of operations is as follows:

(a) The mission duration will be 48 hours.

(b) During this period the weapon will either be firing, prepared to fire, or being moved from one firing position to another.

(c) The weapon can be expected to fire 250 rounds during these 48 hours.

(d) During these 48 hours, the weapon, towed by its prime mover, will be displaced five times and be towed a distance of 65 km. This will include 8 km of hard surface roads, 44 km of secondary roads, and 13 km cross-country. The weapon will be externally air-lifted a minimum of one time, towed under blackout conditions, and will perform one deep fording operation during this mission.

(3) Traverse and Elevation. The weapon must be capable of smooth traverse and elevation. Each handwheel must be capable of obtaining at least 10 mils of movement per handwheel turn. A traverse and elevation handwheel shall be provided the gunner and

an elevation handwheel shall be provided the assistant gunner. When the carriage is level, the howitzer will be capable of depressing to an elevation of at least -75 (required) and -100 (desired) mils. It is desired that the howitzer will fire at maximum elevation and not require a recoil pit. Use of variable recoil system is acceptable.

(4) Fire Control Equipment. Fire control equipment developed for this weapon must be simple, durable, and compatible with the weapon to achieve precision, rate of fire, and other essential characteristics stated in this document. The bearing system of lay will be used. The fire control characteristics will also conform to the characteristics listed below:

(a) It must be possible for the weapon crew to boresight the fire control equipment within 1 (desired) to 2 (required) minutes.

(b) Provide self-illumination scales, level vials, counters and reticles for all fire control equipment. If radioactive materials are used to provide self-illumination, their use shall comply with the provisions of AR 700-52 and AR 700-64 (US Army ground weapons system standards).

(c) It must be possible for the weapon commander to check the proper setting of the fire control instruments without hampering the gunner.

(d) The fire control equipment must be able to compensate for a 10 (required) to 12 (desired) degree cant of the weapon.

(5) Optics

(a) Indirect Fire. Both a 1-man 1-sight and 2-man 1-sight system shall be provided for indirect fire. The equipment must also allow the weapon to be laid for bearing and elevation simultaneously using either system. A 4-power, 10-degree field of view panoramic telescope shall be provided.

(b) Direct Fire. A ballistic reticle for an optimum propelling charge/projectile combination and a mil scale will be provided for direct fire. A moveable range line cursor will be incorporated. A 2-man, 2-sight system shall be provided for direct fire. A direct fire telescope with 8-power magnification and a field of view tailored to meet acceptable size, weight, and cost parameters (but not less than 6 degrees) shall be provided. A click-stop device for setting in leads of 5-mil increments will be provided.

(6) Priority of Characteristics. The first priority is light weight and mobility, which are entirely compatible. The

second priority is for a range comparable with that of the M198. Reliability, availability and maintainability are third, and precision is fourth.

p. Pre-Planned Product Improvements (P3I). N/A.

q. Operational Mission Failure. N/A.

r. Manpower Requirements. See paragraph (9.).

s. Onboard Storage. Storage space for essential equipment such as sighting equipment, etc. will be provided.

t. Standard automotive taillight and blackout light kits will be used.

u. Safety Criteria. Environmental factors induced by dynamic blast and overpressure during firing shall not be greater than three pounds per square inch (PSI) within crew area, nor shall they create an unacceptable level of crew discomfort during sustained firing or degrade position of equipment and operation.

v. Associated Considerations.

(1) Development and provisions for test equipment and special tools should be made concurrently with the end item for which they are to be used and should be accorded the same priority as the end item. The number of special items to test, strip, repair, and assemble should be kept to a minimum.

(2) Design of the weapon shall in no way degrade the performance or precision of the munitions beyond the needs established in the ROC.

w. Publications. Firing tables, field manuals, and technical manuals for the system will be required.

5. Inter/Intraoperability and Standardization Requirements

a. Compatibility/interface with other systems. The howitzer must be able to operate with standard US artillery equipment and ammunition, the prime mover, naval shipping, helicopter and air transport, and the Gun Display Unit (GDU). Compatibility in these areas is addressed in greater detail in other sections of this ROC. Provisions will be made for a quick hookup point on the weapon for telephone wire communications.

b. Interservice/NATO compatibility standardization. Meeting the requirements for standardization described in paragraph 5.a above will ensure that interservice/NATO compatibility is accomplished.

c. Facilities to provide for tiedown of the weapon on board ship, aircraft or surface transports shall be provided. All towing, lifting, and tiedown facilities shall be of a standard NATO size and agree with STANAG 4062 and 4101.

d. During the design and testing of this weapon, consideration should be given to compatibility of the weapon with standard and developmental chronographs.

e. Other mission areas affected and to what extent:

Mission Area 261 - Airlift
Mission Area 262 - Sealift

6. Related Efforts

a. Other USMC ROC's or requirements. The M198 ROC and the proposed ROC for a Lightweight Artillery Weapon System (1981) were reviewed, and appropriate specifications were included in this ROC.

b. Other Service Developments. The US Army began development of a lightweight 155mm howitzer. The Army development has had programmatical and technical difficulties, which in light of present and fiscal constraints, has caused funding to no longer be available for development. US companies which have prepared designs for the Lightweight 155mm Towed Howitzer have ceased major work on the system due to lack of funds.

c. NATO Developments. Vickers Shipbuilding and Engineering Limited (VSEL) of the United Kingdom is developing a prototype 155mm towed howitzer weighing 8,000 lbs, with the same range and ballistic characteristics as the M198 howitzer. The structural assemblies make maximum use of available high strength titanium alloy extrusions to optimize sections for strength, stiffness, and weight. The VSEL howitzer will use a modified XM284 cannon assembly (M109 Howitzer Improvement Program cannon) manufactured at Watervleit arsenal to VSEL's specifications.

7. Technical Feasibility and Energy/Environmental Impacts

a. Technical feasibility. The decreased mass of the weapon will make absorption of the shock attendant with increased firing ranges to be a critical part of the design.

(1) Innovative configurations may be required in order to provide reliable operation of the system in spite of long range requirements and smaller total mass for shock absorption. The technical feasibility of this requirement will be dependent upon design characteristics, and will be validated by field tests.

(2) The system is required to operate with the same degree of reliability and ruggedness as that of the M-198.

b. Energy/environmental impacts. Use of a lighter howitzer will have attendant decreases in energy usage on many fronts. A smaller prime mover can be used to transport the howitzer, and smaller helicopters and other aircraft will be able to move the weapon. The impact in decreased amphibious shipping will be relatively small but favorable. This will result in across-the-board energy savings during the entire life cycle of the Lightweight 155mm Towed Howitzer.

8. Life Cycle Cost Forecast. See attachment A.

9. Manpower Requirements. Fewer people will be required to operate the system than are presently required for the M-198 155mm towed howitzer. The new system will require a crew of 7 personnel, while the M-198 requires 10 personnel per section. The requirement for maintenance and support personnel will remain unchanged from the M-198 T/O, as shown below.

RANK/MOS	M-198	L/W 155MM
Operation (howitzer section)		
Sgt/0811	1	1
Cpl/0811	2	2
LCpl/0811	3	2
Pvt/0811	4	2
TOTAL	10	7

Maintenance:
No Change.

Support:
No Change.

10. Training Requirements

a. Howitzer section, fire direction, survey, communications, liaison, forward observer, fire direction, and amphibious operations techniques will be as prescribed for M198 battalions, both DS and GS. Training in these areas will be accomplished within the existing field artillery schools, and with normal unit training SOP.

b. Equipment and training devices will be necessary for efficient and effective operator and maintenance training at service schools and training centers. The basic issue of equipment at these locations must include spare parts and maintenance items. An inert training round may be used in training.

c. A means to identify traverse limits during service practice is desired in order to facilitate safety officer checks.

d. Training and maintenance literature for crewmen and maintenance personnel, and tabular and graphical firing data for FDC personnel will be made available concurrently with the development of the system so as to arrive prior to fielding of the system.

11. Amphibious/Strategic Lift Impact The decrease in lift required is calculated by subtracting the weight of the M-198 (15,600 lbs, or 7,076 kg) from the weight of the Lightweight 155mm Towed Howitzer (9,000 lbs, or 4,082 kg). The difference is 6,600 lbs (2,994 kg). The actual difference will likely be greater, because the actual Lightweight 155mm Towed Howitzer which is selected may weigh less than 9,000 lbs. This will result in greater decreases in required lift.

a. Amphibious Lift Impact. The decrease in weight of the howitzer alone (not including the possibility of a smaller prime mover and other associated equipment) will result in the following decrease in amphibious lift of a direct support battalion:

<u>UNIT SIZE</u>	<u>DECREASE IN LIFT REQUIRED *</u>
Howitzer Section	6,600 lbs (2,994 kg) (2.95 long tons)
8-gun Battery (Supporting a MEU)	52,800 lbs (23,950 kg) (23.57 long tons)
DS Battalion, 24 guns (supporting a MEB)	158,400 lbs (71,850 kg) (70.71 long tons)

b. Strategic Lift Impact. See figures listed in paragraph 11.a above.