Gun Weapon System MK 48 for the United States Coast Guard
Large Maritime Security Cutters (WMSL 750-757)

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The GWS MK 48 was developed in response to the urgent gun fire control needs of the US Coast Guard for its newest Homeland Security Maritime Platform.

Adaptation of existing Naval lethal tactics into US Coast Guard Law Enforcements non-lethal tactics

Integration of a foreign gun mount terminology and operation into a US Gun Weapon System

### Rapid Development Timeline

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<td>System Requirements Review</td>
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<td>First Cutter Install ~24mo</td>
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<td>U.S.C.G.C Bertholf Bravo Trial (57MM At Sea-Fire Live Fire Event)</td>
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Gun Computer System (GCS)

Description

Approved for development in 1982 for DDG-51 Class Destroyers.

- DDG and CG
- SCG Deepwater WMSL
- DDG/CG and alone or Fully Integrated into AEGIS
- Integrated with Air Defense, Anti-Surface and NSFS functionality
- Use of non-dedicated sensors, gyros and clocks

Process Engagement Orders
- Filters Track Data for Gun Engagements
- GCS track initiation based on OSS data
  - Allows C&D engagement
  - Develops Ballistic Solution for 5” and 57mm projectiles
  - Develops Stabilized Gun Pointing Orders
  - Supports Destructive, Warning and Disabling Fire

5”/54 & 5”/62 Conventional / ERM

57mm
Gun Weapon System MK 48 Mod 0 for WMSL 750-753

**Detect**

- OPTICAL SIGHT SYSTEM MK 46 Mod 1 (Kollmorgen, U.S.A)
- CONTROL/DISPLAY CONSOLE MK 132 Mod 0
- RADAR SET AN/SPQ-9B (Northrop Grumman, U.S.A)

**Control**

- GUN COMPUTER SYSTEM MK 160 Mod 12 (NSWC, U.S.A)
- GUN COMPUTER SYSTEM CABINET MK 119 Mod 2
- GWS CONSOLE AN/UYQ-70(V)11
- Sentric Recorder

**Engage**

- 57mm GUN MOUNT MK 110 Mod 0 (Bofors, Sweden)
- MVR
- Gun Camera
- GCP
- GLU
- Blocking Panel
- Ammunition
- 3P TP

**SHIP SYSTEMS**

- DGPS, GPS, MK 39 INS, MK 27 Gyro
- MASTER CLOCK
GWS MK 48 Top Level Requirements

- Generate System
  - Use Sensors
    - AN/SPQ-9B
    - MK 46 OSS
  - Engage with 57mm Gun and Ammunition
    - Surface
      - Disable
      - Warning
      - Destroy
    - Air
  - Pre-Action Calibration
  - Safe Firing Bearing
  - Record All System Activity
  - Test and Train
    - NGFS (though inherent in the GWS design was not required by the U.S.C.G.)
Fire Control Enterprise Architecture

Gun Computer System (GCS) Software

- Fire Control Kernel Processing
  - Sensor Manager
  - Gun Mount Manager
  - Target Data Manager
  - Engagement Manager
  - GCS Control Manager
  - Ownship Data Manager

- Infrastructure
  - Sensor Transform
  - Gun Mount Interface Middleware
  - Combat System Transform
  - GCS/CS Time Server
  - Recorder/Reproducer DCC
  - Ownship Data Transform
  - Ownship Data Manager

- Source(s)
  - Lat/Long & Velocity Source(s)
    - NAVSSI
    - EDDUs
  - Gyro Data Source(s)

- Mounts
  - MK 45 Mod 4 Gun Mount
  - 57mm Gun Mount
  - 76 MM Gun Mount and Other Future Mounts
  - IRIG
GWS MK 48 Basic Operation

Step 1: Hook Radar Video or Track Symbol

Step 2: Optical Sight Line of Sight Slews to Hooked Position for Visual Evaluation to Surface

Step 3: Set Target Category Scan Display (B-SCAN) and Optical Sight Video

Step 4: Engage Target

Step 5: Select Method of Engagement, Tactics and Salvo Size

Step 6: Fire and Observe Splashes in Bearing Scan Display (B-SCAN) and Optical Sight Video

Step 7: Enter Adjustments and Fire Again
GWS Warning Fire Graphical Design

Engagement Data

Target

Position

45

T

Distance:

102

YDS

Cursor Data

Target

Position

Uncertainty

Trackball Cursor is used to Update Aim Point without disrupting Current Selection

NORTH

Current Aim Point 102 yards from Leading Edge of Target in Direction of Target Course

Line of Fire to Aim Point

Ricochet Impact Area

Aim Point

Target

Target Position Uncertainty

Nearby Radar Surface Tracks
GWS MK 48 Disabling Fire Operation

Optical Sight tracks some point on the target and the GWS Console track ball and aim point are in the same position. The GWS Console Operator can input the aim point from the point of tracking by the trackball. There are three aiming strategies:

1. Where the optical sight line of sight is pointed at the safe laser range finder-provided range.

2. The vessels trim by the stern or have an odd stern balance, making it difficult to maintain a stable optical sight at the desired point of aim. Allow the optical sight to target a convenient “fat” (sizable exposed face area) portion of the target and allow the aim point to be adjusted from the optical sight-tracked point to the desired location.

3. Finally, because it may have been a while since the gun last fired, allow the Disabling Fire aim point to be set from the optical sight track to a position completely aft of the target and then walked back onto target after gun firing accuracy has been established.
Adaptation to 57mm Design: Loading Next Round to Fire and Point Detonation 3P Fuze Backup

S.C.G. Maritime Law Enforcement states “inert ammunition must be for Warning Shots and Disabling Fire”; the 57mm, TP projectile.

Unless the target is physically hit, shallow projectile angles of fall on short range targets will likely result in fuze non-function if the fuze is set to Impact mode. The MK160 avoids this by setting the fuze to function on Time and detonating the projectile at the computed time of intercept. The result is a Point Detonation using the 3P backup fuze function if the target is struck, or close aboard fragmentation on the target if not directly struck.

If none of the projectile type is available, it will load inert ammunition type is available. In case of this, a 3P, high explosive tile may be at the ram position when next mission requires inert, TP ammunition.

Adaptation: If a high-explosive tile is at the ram position while the system is using restrained-response warning or firing fire, a warning is displayed to the Console Operator which must be Detonate on Time OR Detonate on Impact Using PD Backup.

MK 160 Point Detonation Tactic Design
Assimilation of a Foreign Gun Mount into U.S. Service

57mm Units and Terminology Examples

- **Units:**
  - (57mm) Meters/Second vs. (U.S.) Feet/Second
  - (57mm) Radians and Radians/Second used for Gun Resolver Display vs. (U.S.) No use of Radians for Gun Position-related displays
  - (57mm) 0 to +/-180 Degrees Convention vs. (U.S.) 0-to-360 Degrees Convention

- **57mm Terminology:** “Unsafe” is an action (verb) taken on the 57mm Gun prior to firing. The operator is “unsafing” the gun.

- **57mm Terminology:** “Disturbing” Errors are errors that do not prevent the accomplishment of a critical function.

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Assumptions of Foreign Influences/Priorities 57mm Design

By design, the first High-Explosive projectile of any 57mm salvo is non-settable and uses the default proximity fuze function. In the U.S., however, this design results in the misemployment of that first projectile in various tactical circumstances. For example, when the operator orders an Air Burst at a particular height and range, or when armor piercing is ordered.

The 57mm design assumed no need for a built-in simulation capability. The U.S. places high value on training. The lack of a 57MM built-in simulation capability makes GWS training less effective.

The 57mm, 3P high-explosive ammunition is designed with a Point Detonation Back Up function. This is a positive feature and is used to advantage in the U.S. design.
MK 160 Approach to Terminology Differences

C.G. decision to man a gunner’s station using the Gun Control Panel MK 160 to adopt 57mm terminology.

GWS Console AN/UYQ-70(V)11

GWS Console with exceptions such as display of train from 0 to 360 degrees.

This supports common, precise communication between the gunner’s mate and controlman.

MK 160 assists the fire controlman by generating a display of 57mm units and U.S.

<table>
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<th>System Time:</th>
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<table>
<thead>
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<tr>
<td>0.0065 R</td>
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U.S.: Degrees and Decimal Minutes
U.S.: Decimal Degrees
57mm: Decimal Radians
Gun Weapon System MK 48 Mod 1 for WMSL 754-757

Detect

- ELECTRO-OPTICAL SENSOR SYSTEM MK 20 MOD 0 (Kollmorgen, U.S.A)

Control

- GUN COMPUTER SYSTEM MK 160 Mod 12 (NSWC, U.S.A)
  - GUN COMPUTER SYSTEM CABINET Mk 119 Mod 2
  - GWS CONSOLE AN/UYQ-70(V)11 with MK 20 VIDEO
  - Sentric Recorder

Engage

- 57mm GUN MOUNT MK 110 Mod 0 (Bofors, Sweden)

- MVR
- Gun Camera
- GCP
- GLU, Blocking Panel

SHIP SYSTEMS

- DGPS, GPS, MK 39 INS, MK 27 Gyro
- MASTER CLOCK

Ammunition

The AN/SPQ-9B has been engineered to Act Like a Dedicated GWS or
GWS MK 48 Summary

GWS MK 48 – Being installed on (8) S.C.G. Large Maritime Security Officers leverages off our U.S.N. MK34 VS product family. Proven MK 34 GWS tailored to support rapid development.

GW MK 48 Integration of Warning and Disabling Fire uses graphical methods and engagement processing supporting warning, disabling, and destruction methods of engagement within a single engagement for flexible response.

The use of a Foreign Gun Mount above MK 160 design decisions related to terminology differences and influences of the country of
BACKUPS
CO orders a warning shot 80 yards ahead of the target. Target is engaged and prior to hit the target after flight. Fire controlman has to estimate a deflection spot in mils (military milliradian) to move point forward in the direction of the target’s course by 80 yards. Problem A: What part of the target is being tracked—Amidships? This must be added to the 80 yards. Using the target range, the controlman enters a spot in which results in 80 yards and setting the stage for Problem B: the distance enclosed...
Evidence Collection and Event Playback within MK 48 GWS

...
Adaptation to 57mm Design: Surface Firing Pattern and Aiming Cutouts

The MK160 implements aiming and firing limits in addition to the 57mm software-designed limits. This provides an “Or’d” safety check and a way of tailoring limits. For example, MK160 does not allow pointing in the direction of the superstructure while the gun mount allows pointing over and across the superstructure.

Adaptation: When the surface firing pattern target height is used to enable the entire pattern to detonate in the air as a supportive

25 m
Other Key MK 160 Adaptations to 57mm Design

Provided the gun magazine is loaded, the MK160 can complete all the steps of target engagement and readiness to fire without moving the gun mount, including transitions from local gun mount control to MK 160 control, thus concealing the Captain’s intentions.

The MK 160 system provides a built-in 57mm simulator that allows simulated pointing and firing.

The MK 160 has developed a method of testing the analog firing order and the analog unsafe signals without requiring a sailor to go top side to physically load a primer or test case for that purpose.

Anytime communications with the gun are restored, the MK 160 will warn the GWS Console operator if the gun has gone from a loaded condition to being unloaded.

The 57mm does not take local control of pointing when communications with fire control have failed. This can result in mount motion when communications with the fire control system are re-established. Such events, while technically correct, can catch the officer of the watch off-guard. To prevent this, when communications with the gun mount are restored after being down for a significant period of time, the GWS Console operator must approve the coupling of the MK160 gun mount orders to the gun.

The compartmentalization of 57mm ammunition can hurry the operator’s reload order to the point that premature orders to reload while firing is in progress are likely- interrupting the salvo in progress. The MK160 precludes this by holding off orders to reload or load until any currently fired salvo is ended.