



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

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Subject and Purpose



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

Fiscal Year	2005				2006				2007				2008			
Fiscal Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
System Requirements Review	●															
Preliminary Design Review					●											
Critical Design Review								●								
First Cutter Install ~24mo									●							
U.S.C.G.C Bertholf Bravo Trial (57MM At Sea-Fire Live Fire Event)														●		



Gun Computer System (GCS) Description



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

Forms

DDG and CG

SCG Deepwater WMSL

Used alone or Fully Integrated into AEGIS

Boat Systems

Integrated with Air Defense, Anti-Surface and NSFS
Functionality

Use of non-dedicated sensors, gyros and clocks

Process Engagement Orders

Filter 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



DDG/CG



WMSL



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
CONTROL/OPTIC
TOR MK 85
Mod 1



RADAR SET
AN/SPQ-9B (Northrop
Grumman, U.S.A)



The AN/SPQ-9B has been
re-engineered to Act Like a Dedicated GWS
for

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



SHIP SYSTEMS

DGPS, GPS, MK 39 INS,
MK 27 Gyro

MASTER
CLOCK

Engage

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



MVR



Gun
Camera



GCP



GLU



Blocking Panel



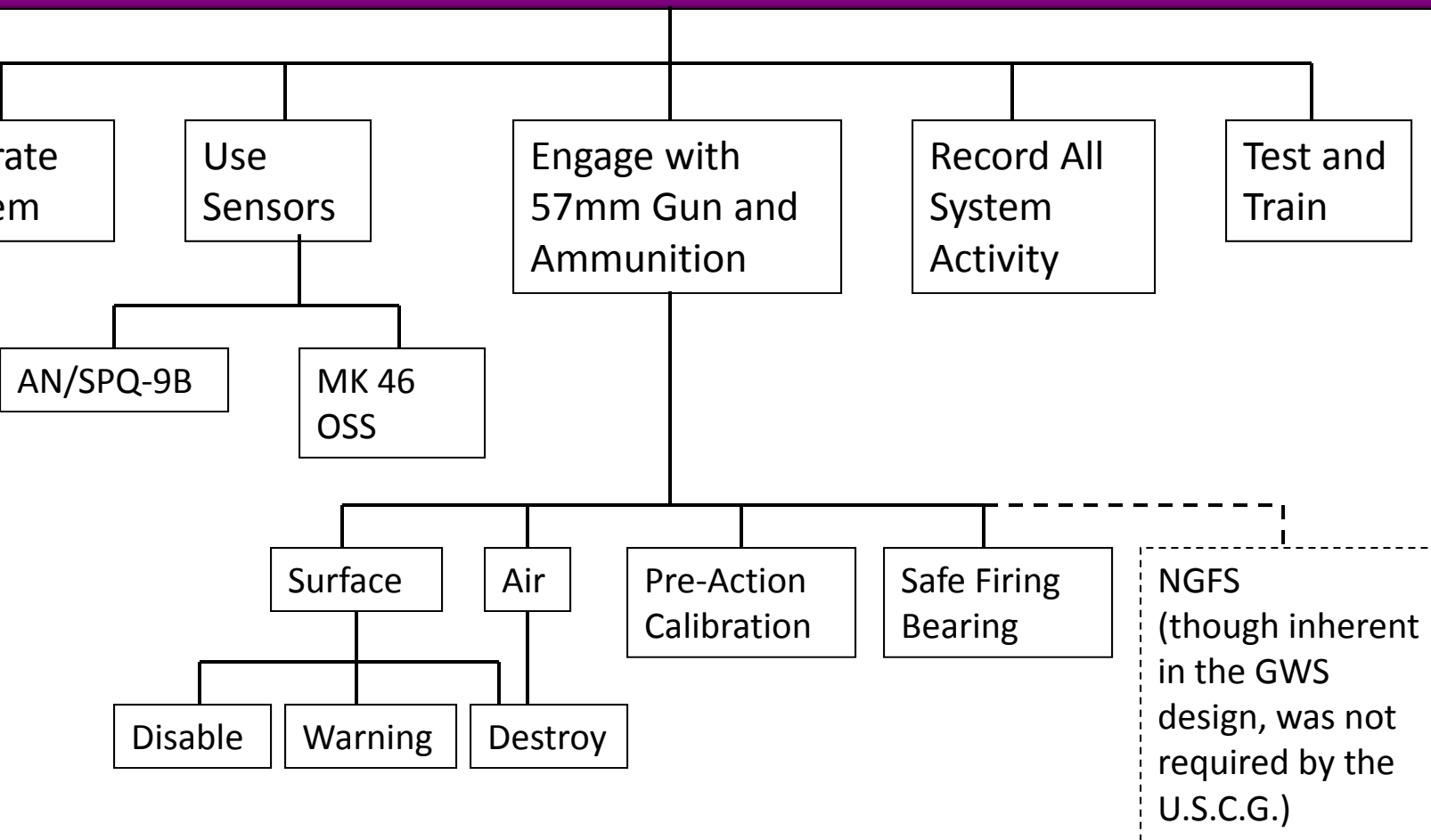
Ammunition

3P

TP

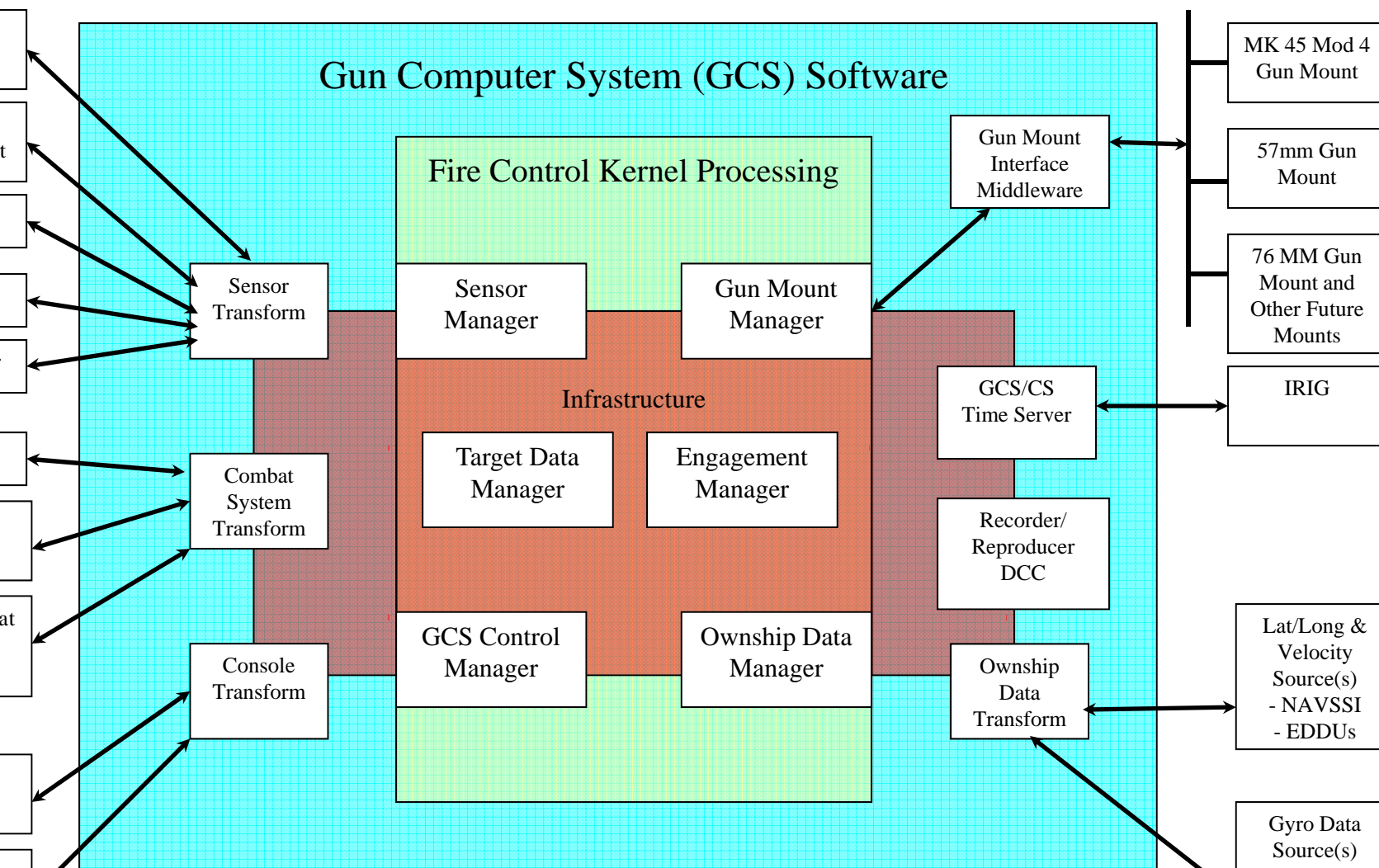


GWS MK 48 Top Level Requirements





Fire Control Enterprise Architecture





GWS MK 48 Basic Operation



Date: Feb 08 2007 Time: 14:20:41

Y
T
D
Y/S
Kts
D
Ft

Pattern Fire:
Surface: On

Det: Off

Piercing: Off

st: On (0-20) METERS

ght: Off (0-10000) YARDS

TP 3P Backup Fuze:

Target Centered... Prepare Refire

Ballistic Initial Velocity: 3475 FT/SEC

	Last Entered	Totals
(0-60)	<input type="text" value="0"/> RIGHT	0 RIGHT 0 MILS
(0-5000)	<input type="text" value="0"/> ADD	0 ADD 0 YARDS



Cursor Data

Lat: 38:15:31 N

Lon: 077:06:33 W

Bearing: 224 T

Range: 11,394 YDS

Radar

Video Controls

Brightness

Decay Time

View

Range Scale

Graphics

B-Scan Size

Map

PPT Center

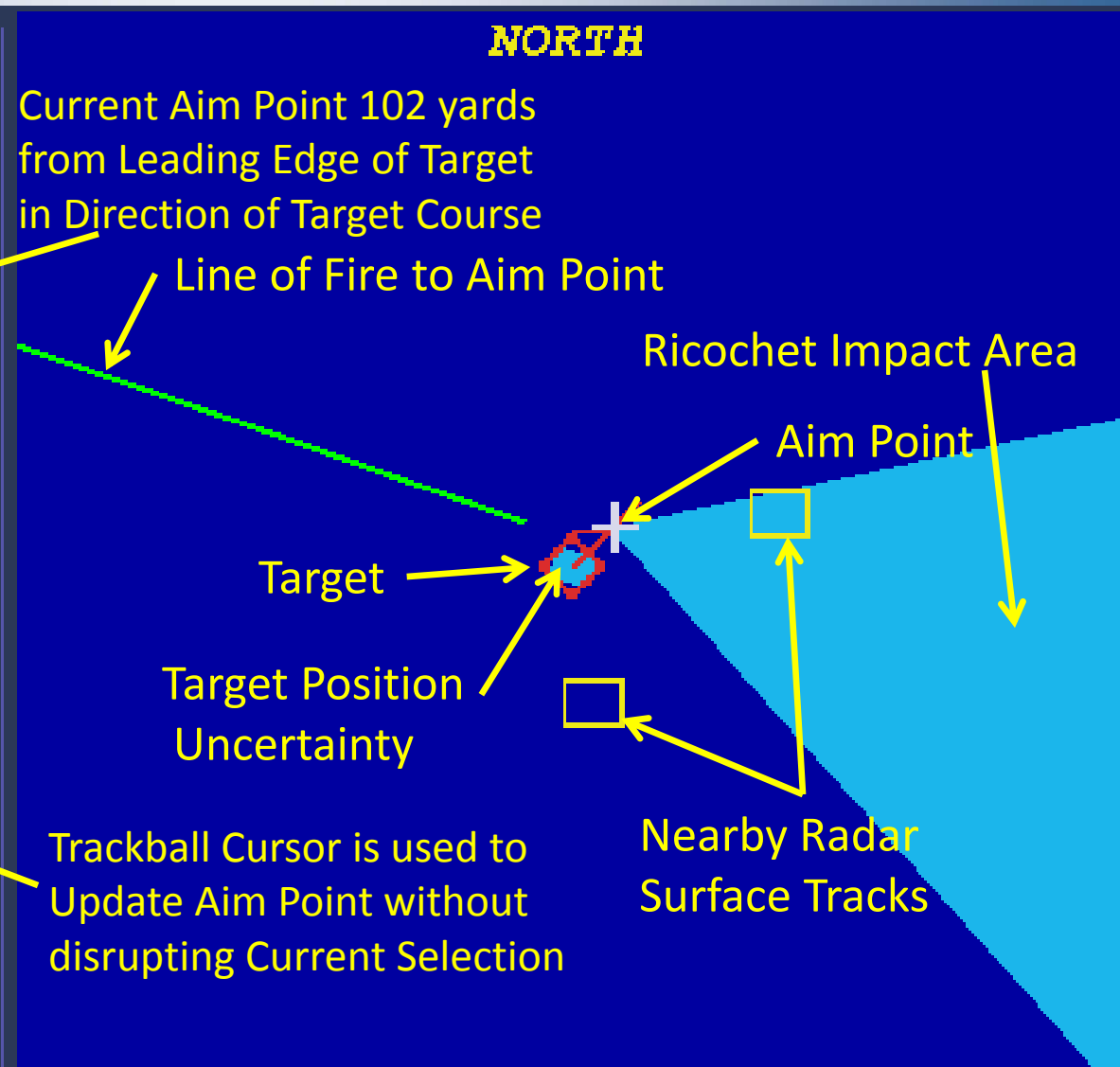
Step 7: Enter Adjustments and Fire Again



GWS Warning Fire Graphical Design



Engagement Data	
Selected Aimpoint	
ion	45 T
ce:	102 YDS
Cursor Data	
ion	44 T
ce:	455 YDS





GWS MK 48 Disabling Fire Operation

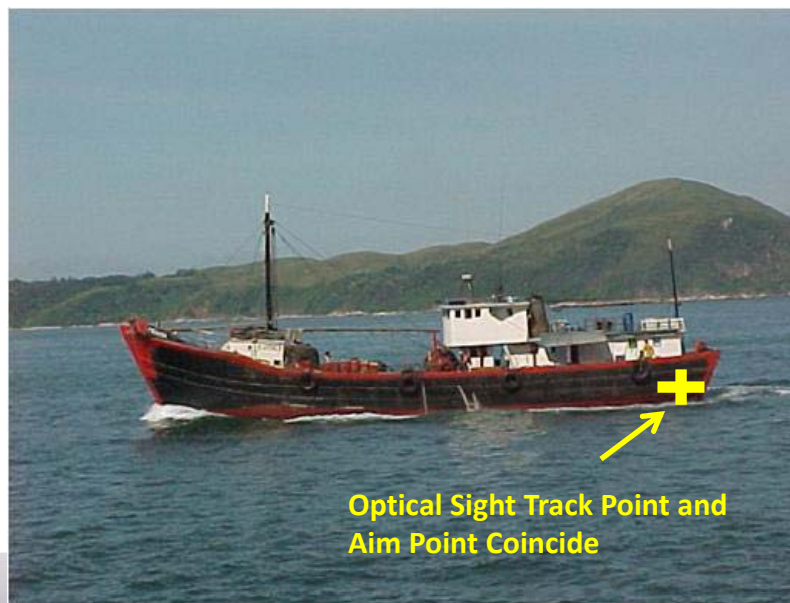


Optical Sight tracks some point on the target vessel. The GWS Console track ball and aim point move to the same position. The GWS Console Operator can move the aim point from the point of tracking by moving the trackball. There are three aiming strategies used:

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

2. For vessels trim by the stern or have an odd stern profile, making it difficult to maintain a stable optical sight track at the desired point of aim. Allow the optical sight operator to target a convenient "fat" (sizable exposed surface 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 the target after gun firing accuracy has been established.



Optical Sight Track Point and Aim Point Coincide



Operator Offset Aim Point

Optical Sight Track Point



Adaptation to 57mm Design: Loading Next Round to Fire and Point Detonation 3P Fuze Backup



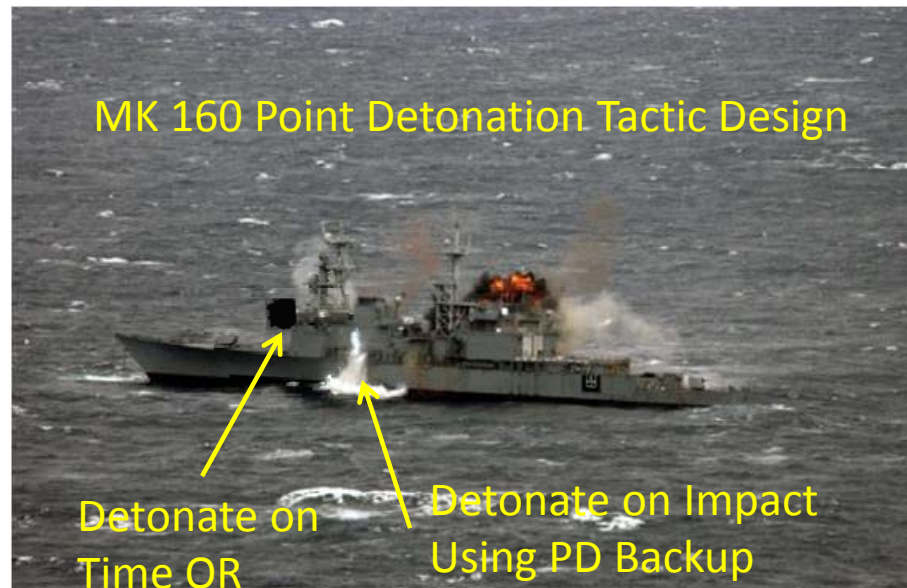
S.C.G. Maritime Law Enforcement states "inert ammunition must be used for Warning Shots and Disabling Fire"; the 57mm, TP projectile.

When firing, the 57mm design will always attempt to load a projectile at the ram position (next to be fired). If none of the desired type is available, it will load the next available ammunition type is available.

Because of this, a 3P, high explosive projectile may be at the ram position when the next mission requires inert, TP ammunition.

Adaptation: If a high-explosive projectile is at the ram position while the system is using restrained-response warning or disabling fire, a warning is displayed to the Console Operator which must be

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.





Assimilation of a Foreign Gun Mount into U.S. Service



Issues 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.

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.



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 with exceptions such
 as display of train from 0 to 360
 degrees. This supports common, precise
 terminology between the gunner's mate and
 the fire controlman.

GWS CONSOLE AN/UYQ-70(V)11



GUN CONTROL PANEL



GUN LAYING UNIT



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

U.S.: Degrees and Decimal Minutes

U.S.: Decimal Degrees

57mm: Decimal Radians

Gun Position		Order	Actual	Error
System Time:		14:39:20		
Link Status:		Up		
Train	102 D 20.1 M	102 D 20.1 M	0 D 0.0 M	
	102.335 D	102.335 D	0.000 D	
	1.7861 R	1.7861 R	0.0000 R	
Elevation	0 D 22.4 M	0 D 22.4 M	0 D 0.0 M	
	0.374 D	0.374 D	0.000 D	
	0.0065 R	0.0065 R	0.0000 R	

◆ Hold Display ◆ Start Display



Gun Weapon System MK 48 Mod 1 for WMSL 754-757



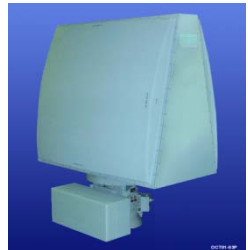
Detect

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

ELECTRO-OPTICAL
DIRECTOR MK 87 MOD 0



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GUN COMPUTER
SYSTEM CABINET
MK 119 Mod 2



GWS CONSOLE AN/UYQ-70(V)11
with MK 20 VIDEO



Sentric
Recorder

SHIP SYSTEMS

DGPS, GPS, MK 39 INS,
MK 27 Gyro

MASTER
CLOCK

Engage

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



MVR



Gun
Camera



GCP



GLU



Blocking Panel





GWS MK 48 Summary



GWS MK 48 – Being installed on (8)
U.S.C.G. Large Maritime Security
Cutters leverages off our U.S.N. MK34
GWS product family.

Proven MK 34 GWS tailored to
support rapid development.

GWS 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



Prior Ad Hoc Warning Fire Problems: Motivation for MK 160 Design

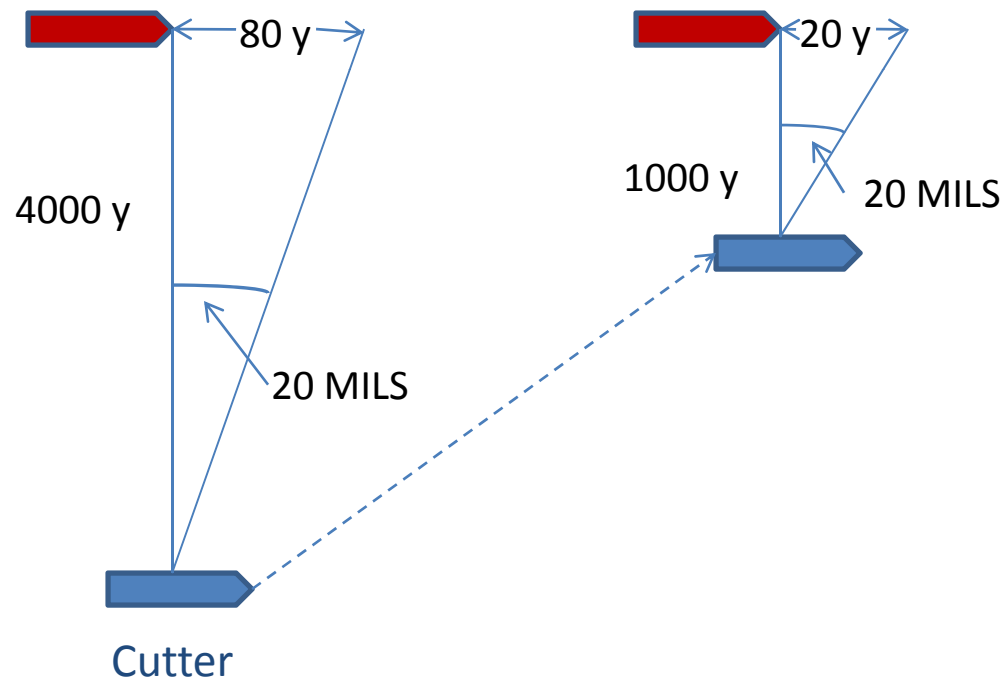


CO orders a warning shot 80 yards ahead of the target.

target is engaged and prior
ration systems aimed by
ult to hit the target after
of flight.

fire controlman has to
late a deflection spot in mils
(itary milliradian) to move
im point forward in the
tion of the target's course by
ards. Problem A: What part
e target is being tracked-
Amidships? This must be
d to the 80 yards.

using the target range, the
ontrolman enters a spot in
which results in 80 yards
d setting the stage for
em B: the distance enclosed





Evidence Collection and Event Playback within MK 48 GWS



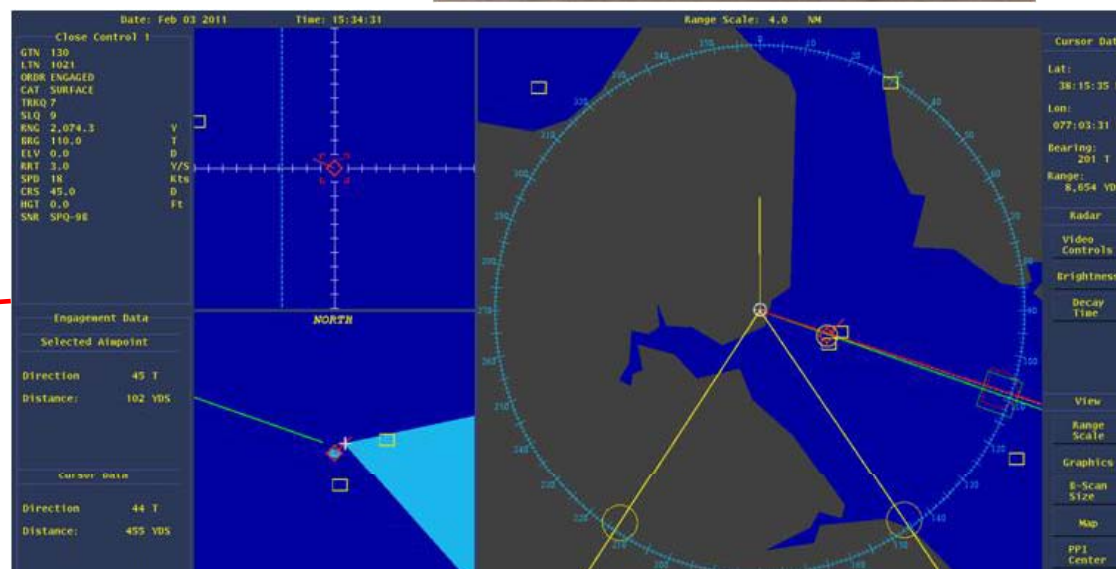
Incidents that may arise from gun use are serious. It is imperative to document what the GWS Operator saw and the use of the gun.

The MK 48 GWS Console includes a console-integrated accessory, the Sentric Media Recorder, to capture all GWS Console data and the Optical Sight Video, for evidence and event playback.

Typically, the MK160 records all digital interface data from every internal and external interface for data

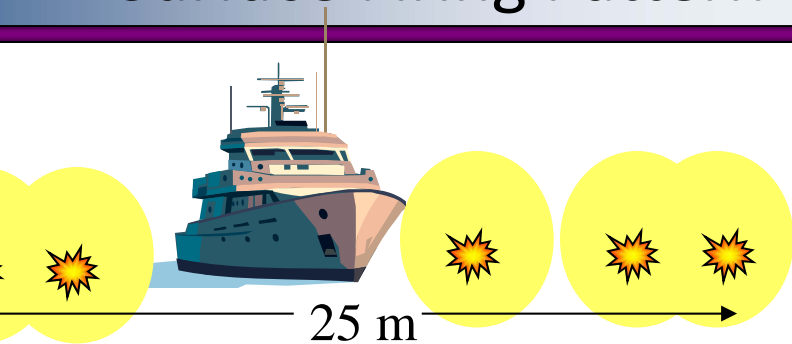


Sentric Recorder





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



Pattern is designed to lay a wall of projectiles across the target using 10 projectiles. Most GWS hold the height of a surface target, and the gun makes no target offset, if firing is normal then at least a pattern will be short. There are holes in the



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

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





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.