



# ***MK 46 Mod 1 At-Sea Evaluation***

## ***A Overview of Live-Fire Test Events Conducted Onboard the LPD 17 August 2006***

***Prepared for:***

***NDIA 42<sup>nd</sup> Annual Gun  
and Missiles Systems  
Conference***

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# Outline



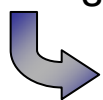
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- Collaborative Effort
- The Test Platform
- Test Setup
- Ammunition
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# Background

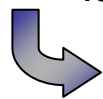


- Combat System Ship Qualification Trial (CSSQT) required of all new ships as part of Post-Delivery Test and Trials (PDT&T) phase
  - Emphasis on gun system as this will be a new system on the lead ship of a new ship class



## **LPD 17 CSSQT Air & Surface Events**

- Objective: Conduct live-fire exercises to collect data to verify if ship's force can safely and effectively operate GWS in its assigned mission and to verify safe operation of GWS itself
- Questions raised regarding accuracy of various ammunition types (armor-piercing (AP) and high-explosive (HE))
  - Is AP ammo more accurate and is it worth the additional cost?



## **LPD 17 AP vs. HE Ammunition Comparison Test**

- Objective: Conduct live-fire exercise to collect % hit versus range data
- Questions regarding the effectiveness of the MK 46 Mod 1 GWS
  - Is its performance as indicated by M&S Tools during trade-off studies?



## **MK 46 Mod 1 GWS At-Sea Risk Reduction Test for LHA 6**

- Objective: Conduct live-fire exercise to collect engagement data



# Collaborative Effort



## NAVSEA – Warfare Centers



- PM4 (under PEO IWS3C) – Conventional Ammunition Manager
- Code 40 - ISEA for MK 46 (PMS 317)



- Code W22 – WSEM for LHA(R) Program
- Code G32 – Lead Gun Systems Engineer, LHA 6
- Code G61 – Provided Photo Documentation and Instrumentation
- Gun Tech Warrant Holder (plus A&A Ships CS TWH in SEA06)



- LPD 17 CSSQT Project Office



## NAVSEA – PEOs



- PMS 317 – Provided Platform (LPD 17) and Range Time (VACAPES OPAREA) during CSSQT at-sea period
- PMS 377 – Provided funding and ammunition for LHA(R) events



- PMS 495 – Provided APFSDS-T ammunition assets to all parties under MoA



- IWS1 – Provided input to LHA(R) test events
- IWS3C – Provided input to LHA(R) test events and oversaw ammunition allocation (3C/PM4)

## Outside of NAVSEA



- ONI/SABER & SWDG (OPNAV N72) – Provided input & concurrence for LHA(R) test event scenarios
- NAVAIR NAWC Aircraft & Weapons Divisions – provided targets & targets support
- DRPM AAA & GDAMS – Provided support for MK 46 GWS

# Collaborative Effort (Cont.)



- 2 separate Memorandums of Agreement – Involving 3 separate Program Executive Offices, 4 Program Management Offices, and two Surface Warfare Center Divisions (Dahlgren and Crane Divisions)
  - 2-Party MoA between PMS 317 (LPD 17) & PMS 377 (LHA(R))
    - Use of LPD 17 as test platform for LHA 6 RRT



- 4-Party MoA between PEO Ships/PMS 317 & PMS 377, PEO IWS3C/PM4 (NSWC Crane by extension), and PEO LMW/PMS495 (NSWC DD by extension)
  - Provision of 1440 MK 258 Mod 1 APFSDS-T hydro-ballistic rounds for all planned at-sea test events





## ***Collaborative Effort (Cont.)***



- Three overarching test plan documents
  - PMS 317 Sponsored Test Events
    - LPD 17 CSSQT Plan, Vols. 1 & 2
    - 30-Millimeter x 173 Armor-Piercing and High-Explosive Ammunition Comparison Test Plan (NSWCDD/MP-06/76)
  - PMS 377 Sponsored Test Events
    - MK 46 Mod 1 Gun Weapon System (GWS) At-Sea Risk Reduction Test For The Amphibious Assault Ship (LHA) 6 (NSWCDD/MP-06/35)

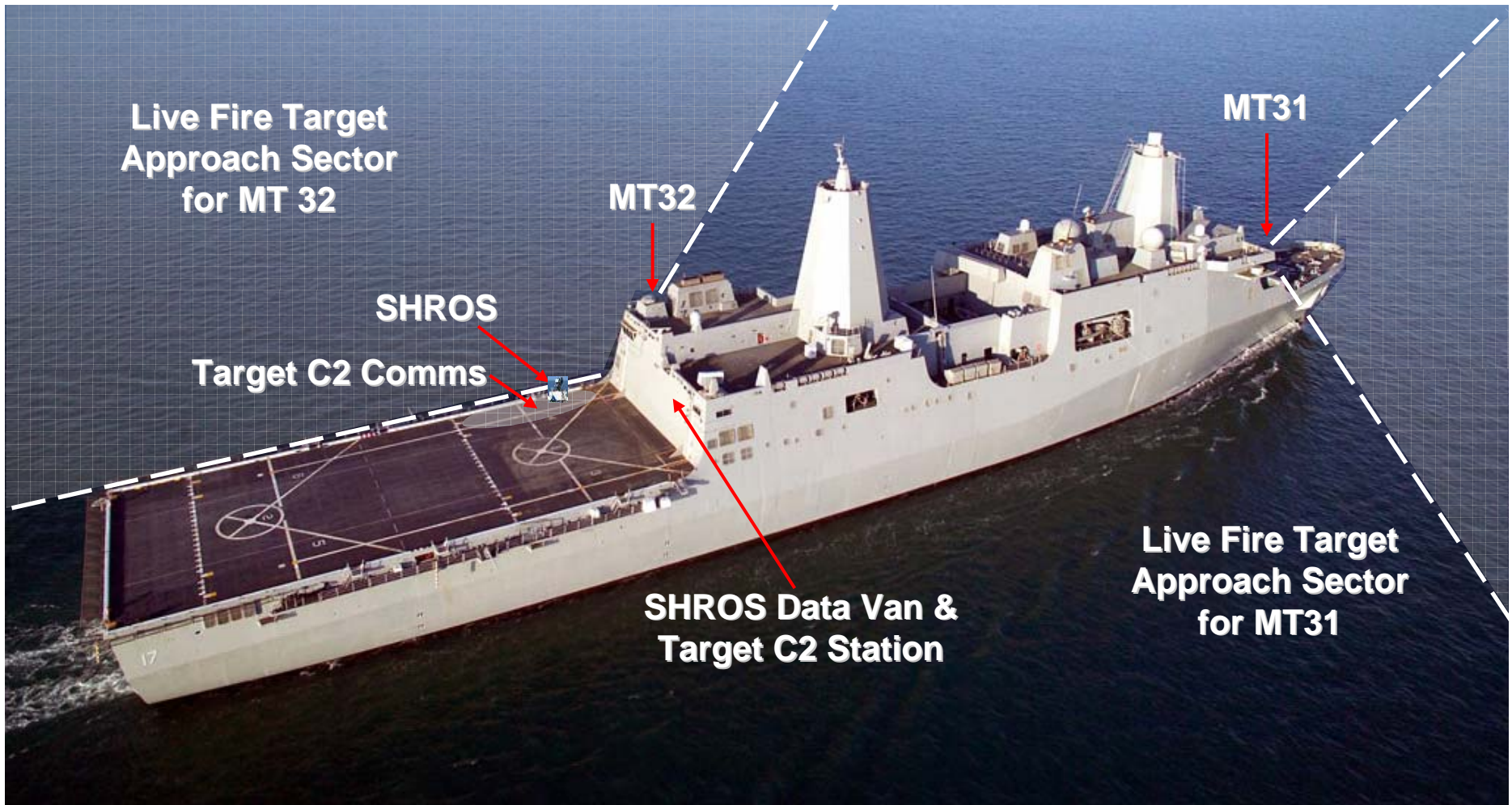
# The Test Platform

## USS San Antonio (LPD 17)



- Built by Northrop Grumman Ship Systems, Commissioned 14 January 2006
- 684 feet OAL, 105 ft beam, 23 ft draft, 24,900 ton displacement (full load)
- 363 Crew, 699 Troops, Surge capacity of +101 (800 total)
- Intended to replace older LPD 4 and LSD 36 classes
- Designed to carry and launch the EFV (14 vehicles) and the LCAC (2 in well deck)
- Can operate 2 MV-22 *Osprey* tilt-rotors or 4 CH-46 *Sea Knight* helicopters simultaneously
- MK31 Mod 1 RAM Guided Missile System (2 launchers), 30mm MK 46 Mod 1 Gun Weapon System (2 systems), .50 cal M2HBs (single and twin mounts)

# Test Setup – LPD 17

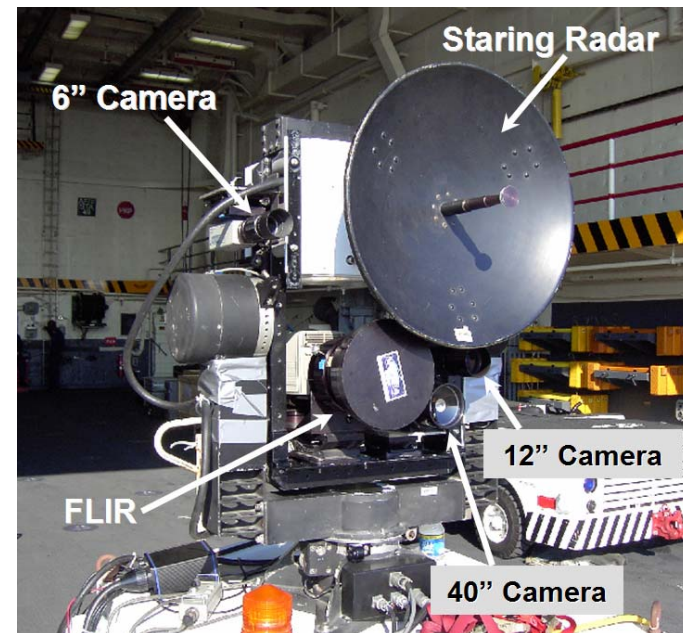




- Shipboard High Resolution Optical System (SHROS)
  - Operated by NSWCDD personnel
  - Provides day video, infrared video, and radar data
  - Independent sensor system not coupled to the weapon system
  - Mounted on edge of flight deck
  - Controlled from command and control (C2) Data Van located in hangar bay
- Documentary video recording
  - MK 46 battle-sight display video, interior and exterior views, roving documentary video and still photography
  - Command and Control and other activities for investigation into Human Systems Integration (HSI) issues



SHROS Mount

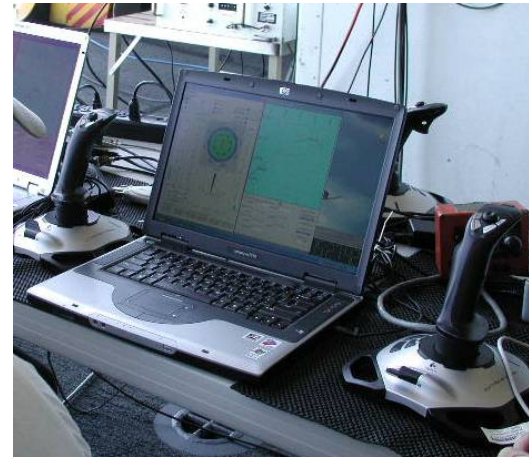


SHROS Sensor Package

# Test Setup – Target C2



**RCO  
Station**



**PCCU system**

**C2 antennae**



- Remote targets command and control operations
  - Remote Control Operators (RCO) C2 station located in the hangar bay
  - C2 antennae located on flight deck for clear line of sight (LOS) to targets
- Targets operated using either the Portable Command and Control Unit (PCCU) or radio control
- Operated by NAVAIR NAWC Aircraft and Weapon Divisions

# Ammunition



MK 239 Mod 0 TP-T, PGU-15/B TP	MK 258 Mod 1 APFSDS-T	MK 266 Mod 2 HEI-T, MK 264 Mod 0 MPLD-T
NALC AA65	NALC AA71 Substitute	NALC AA89
1850 Rounds	1440 Rounds	1600 Rounds

<b>APFSDS-T</b>	Armor-Piercing, Fin-Stabilized, Discarding Sabot, Traced	<b>NALC</b>	Naval Ammunition Logistics Code
<b>HEI-T</b>	High-Explosive (HE) Incendiary, Traced	<b>TP</b>	Target Practice
<b>MPLD-T</b>	Multi-Purpose, Low Drag, Traced	<b>TP-T</b>	Target Practice, Traced

# Target Set



HSMST



QST-33 SEPTAR

Steel Mesh Billboard    Plywood Billboard



**Over 22 total targets made available for the various test events**



Vindicator UAV

Towed Sled Billboard



SDST (Jet-ski)



# Test Objectives



- CSSQT Events
  - Can ship's force operate the MK 46 Mod 1 safely and effectively in its assigned mission on the LPD 17?
- AP vs. HE Ammunition Comparison Test (AP/HE Comparison)
  - Collect % hit vs. range for APFSDS-T and HEI-T/MPLD-T ammunition types on stationary billboard targets for various ranges
- LHA 6 Risk Reduction Test (RRT)
  - Collect kill assessment, engagement timeline, and % hit vs. range, target position data



# Constraints/Issues



- Minimize Combat System/Crew impact on successful conduct of the test
  - Established ROE (Detect & ID established prior to engagement with MK46)
  - Simplified engagements without sacrificing potential realism
- MT31 vs. MT32
  - MT32 provided more deck space near mount for SHROS and target C2 packages
  - Arc of fire over port-quarter allowed for minimal ship structure influence on test events
- Potential Unexploded Ordnance
  - Several firing events called for the use of AA89 ammunition (MK 266 Mod 1 HEI-T/MK 264 Mod 0 MPLD-T linked 1:1) against Fleet standard High Speed Maneuvering Surface Targets, or HSMSTs. These craft were based on RHIB hulls which were very rugged and fairly unsinkable
  - Nature of 30mm point-detonating HE ammunition may lead to potential unexploded ordnance situation (plan for worst case)
  - Test plans changed to accommodate this reality
    - Only inert ammunition would be fired at HSMST targets and wood/foam billboards
    - Any target engaged with HE had to be disposed of at-sea
  - Other targets reconfigured or designed for use with AA89 ammunition
    - De-foamed QST-33 SEPTAR
    - Steel mesh billboards built as targets for AA89 ammunition during AP-HE Comparison Test
  - **Bottom line: any target engaged with HE ammunition would have to be sunk post-event**

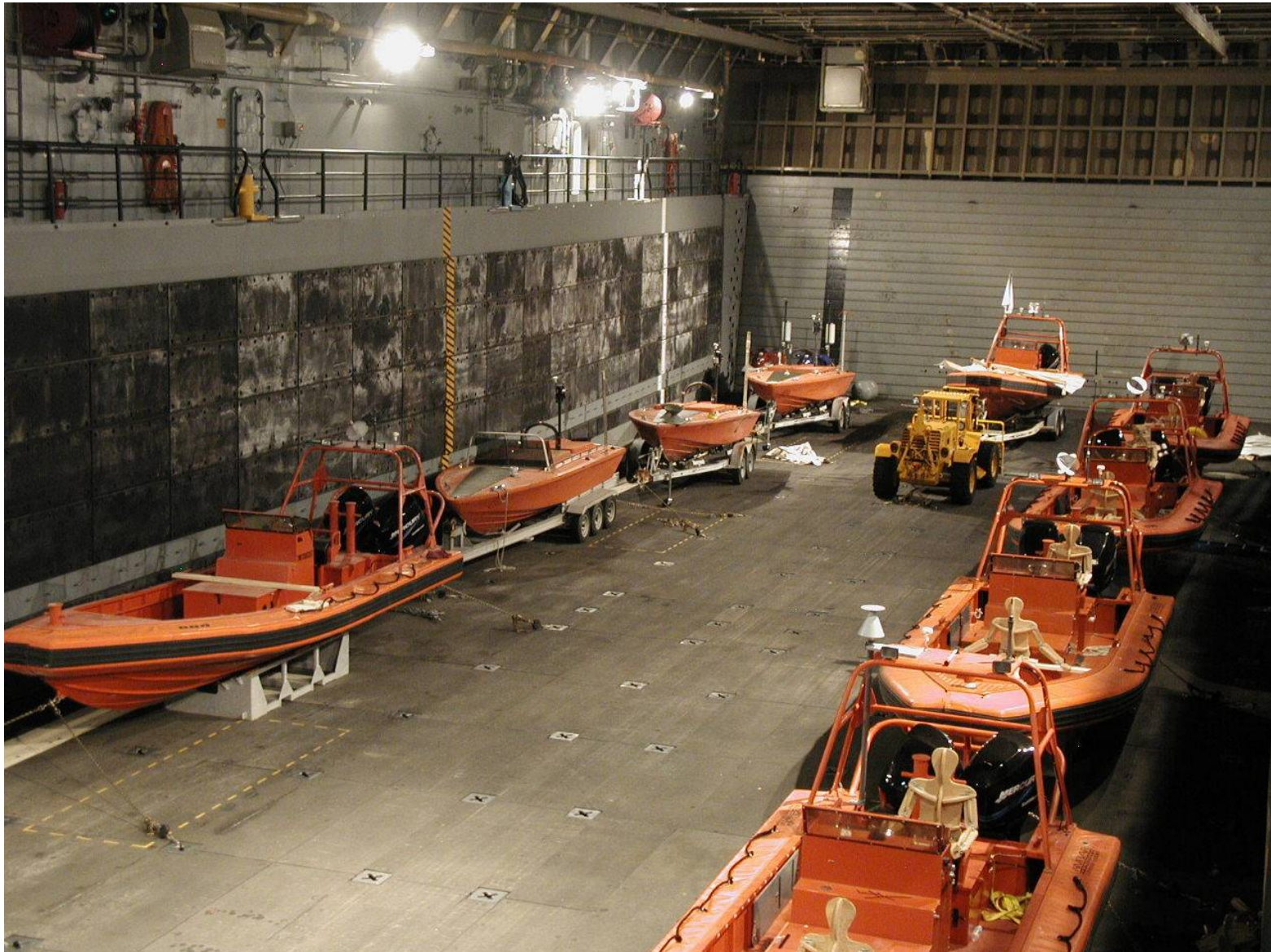


# LPD 17 Test Evolution & Events



- LPD 17 CSSQT
  - Surface Events vs. MT32 and MT31
  - Air Event vs. MT32
  - Sled Event vs. MT32 (*not executed*)
- Ammunition Comparison Test
  - Firing Runs vs. MT32 covering 3 Range Bands
- LHA 6 Risk Reduction Test
  - 4 Firing Runs vs. MT32
- 9 total gun firing events planned
  - All gun firing events had to be completed in a 5 day window
  - All gun test events competed with ship drills, inspections, and other test events with respect to time and ship's force availability

# Awaiting Their Fate...





# ...Kick 'em Out!



Launching a QST-33 SEPTAR off LPD 17's Stern Ramp

# Test Environment

- Test environment ranged from calm seas and little wind to 15+ knot winds and large swells and whitecaps
- Environment varied over test evolution from rough seas to clam and back again
- Boat targets airborne at times in rough seas
- Screen captures from SHROS covering live-fire events



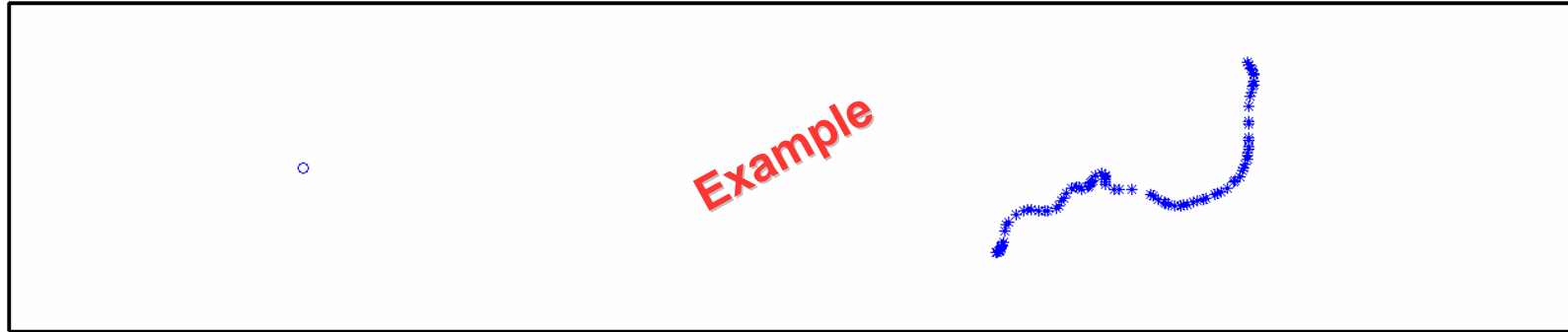


# *Types of Data Collected*

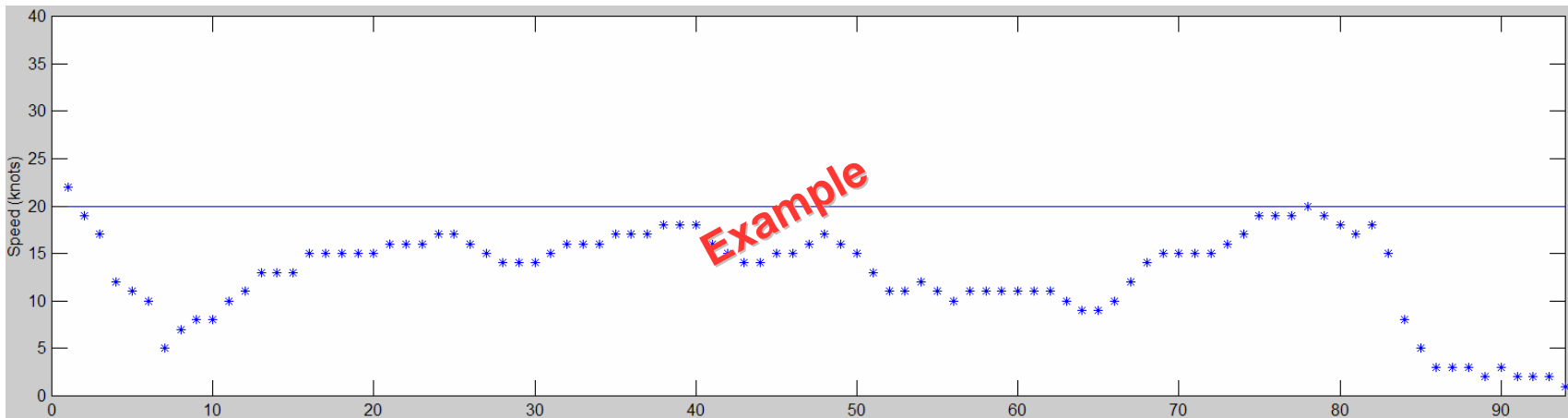


- Video
  - Battle-sight (MK 46), SHROS (Color, FLIR), Roving/Documentary (including video/audio covering activity involving HSI issues)
- Timeline
  - IRIG-B
- Target Behavior Information
  - Speed, Heading, Location
- Photographic
  - Target Damage Assessments
  - Test Setup & Execution

# Types of Data Collected (cont.)



GPS Plots and Timeline Information of Target Path for Event Reconstruction



Target Speed Plots



# Summary



- Given a new ship, new gun system, and inexperienced crew...
- LPD 17 CSSQT
  - Ship's force operated MK 46 Mod 1 safely and effectively
  - Ship qualified for SuW mission
  - Results documented in "*USS San Antonio (LPD 17) CSSQT Summary Report, 22 January 2007*"
- AP vs. HE Ammunition Comparison Test
  - All requisite data collected
  - Results documented in NSWCDD/MP-07/21, "30-Millimeter Armor-Piercing Versus High Explosive Ammunition Comparison Test Report"
- LHA 6 Risk Reduction Test
  - All requisite data collected
  - Results documented in NSWCDD/MP-07/15, "*MK 46 MOD 1 Gun Weapon System At-Sea Risk Reduction Test For The Amphibious Assault Ship (LHA) 6 Test Report*"
- 1 firing event out of 9 not executed (CSSQT Sled Event)
- Several valuable lessons learned from planning through execution to be applied to follow-on at-sea tests
- Entire test evolution was a success



# ***QUESTIONS?***

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