-- 2000 Joint Services Small Arms Systems Section Annual Conference --

SMALL CALIBER AMMUNITION JOURNEY TO TECHNICAL EXCELLENCE

TACOM
Lethality, Survivability, Mobility and Sustainment for America's Army

ON THE LINE

ATK
ALLIANT TECHSYSTEMS

Mr. John Middleton
Mr. Ron Elbe
TACOM-ARDEC

Ms. Bobbie Russell
OSC (PROV)

Mr. Bruce Webb
ATK

JOURNEY PURPOSE

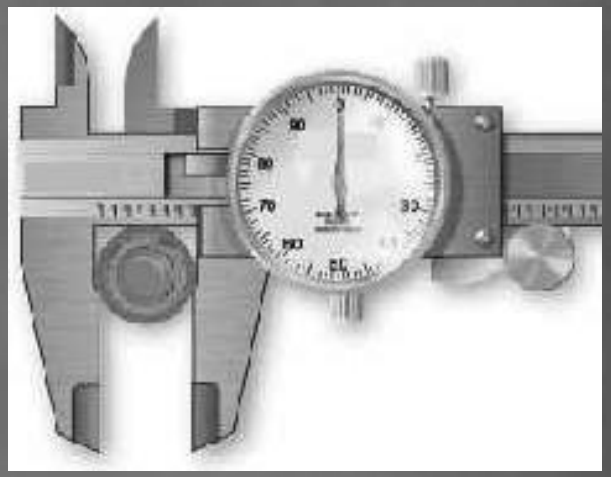
- **Understand the product's key performance characteristics**
  - **How does it work?**
  - **Why does it work?**
  - **How do we know?**
- **Move from "*react and fix*" to "*prevent and improve*"**
- **Risk reduction**
- **Provide products which perform more consistently (reduced variability)**

IDENTIFY KEY PERFORMANCE CHARACTERISTICS

- WHAT IS IMPORTANT TO MISSION EXECUTION?
  - FUNCTIONING
  - ACCURACY
  - PENETRATION

- WHAT IS KEY TO ASSURE ITEM CONSISTENCY?
  - VELOCITY
  - PRESSURE
  - DIMENSIONAL

DEFINE KEY DESIGN CHARACTERISTICS



- **DIMENSIONS**
- **TOLERANCES**
- **MATERIAL SELECTION**

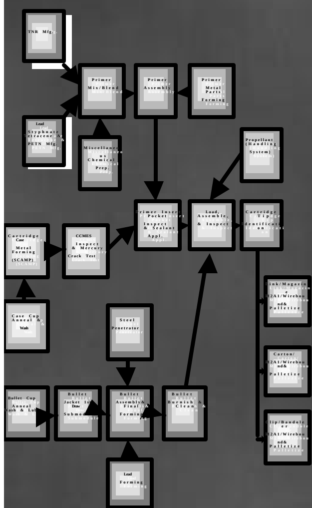
WHY IS IT IMPORTANT & HOW DO WE KNOW?

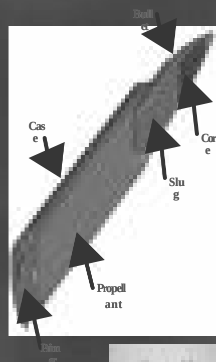
- TECHNICAL REPORTS & EXISTING DATA
- VERIFICATION TESTING WHEN DATA DOES NOT ALREADY EXIST (DESIGN OF EXPERIMENTS)
- PAST EXPERIENCE & ENGINEERING JUDGEMENT

THE JOURNEY PROCESS

- INITIAL TRAINING
- IDENTIFY INITIAL SET OF KEY PERFORMANCE AND DESIGN CHARACTERISTICS
- DEVELOPMENT OF INITIAL WALL CHART
- CONTINUE THRU PARTNERING W/ CONTRACTOR
- VERIFICATION THRU EXISTING DATA & TESTING

5.56mm, M855 Production Process Flow Chart





Accuracy

- Average vertical and horizontal standard deviation shall be no greater than 6.8 inches at 600 yards, or no greater than 1.8 inches at 200 yards using an indoor range.

Component	Drawing No#	Feature	Impact	How Do We Know?	Target	Current Status
M855 Cartridge	9342868	Crimp Axial Alignment Overall Length	Shot Start/ Bullet Deformation Bullet Deformation/ Stability Shot Start/ Bullet Engagement	BRL-MR-3??	2.260±.025[1]	
Case(SAW) Case(SCAMP)	9378276 11820451	Case Volume Uniformity Case Neck Concentricity & Uniformity Flash Hole Uniformity	Charge Weight Bullet Seat Burn Rate		2.230+0.007[1] 0.080+0.004[1]	
Bullet	9342869-1	Weight Uniformity Diameter Uniformity Profile >Cone Ht Concentricity Out Of Balance (Core/ Slug Off Center) Boattail >Base Of Bullet Lead Splash Meplat Eccentricity Of Bullet Point Fit Bullet Comp (Integrity) Jacket Wall Thickness Var Cannelure Diameter Surface Concentricity Jacket Hardness	Stability Stability Stability Stability Stability Stability Stability Stability Excessive Yaw Stability Stability Center Of Gravity Stability Stability Bullet Deformation	Report FC-3?5 ARSCD-TR-?? Report FC-3?5 Report FC-3?5 ARSCD-TR-?? Report FC-3?5 Report FC-3?5 Report FC-3?5 Report FC-3?5 TECP 700-700 Report FTB-R-5 TECP 700-700 BRL-MR-3? TECP 700-700 ARSCD-TR-?? TECP 700-700 TECP 700-700	63.5±.5gr[1] .225 Max[3] .040 Max[3] 0.2401[3] .2245[3]	
Green Bullet	9342869-2	Slug Diameter Slug Density Slug Weight Slug Length Slug Malleability Slug End Radius Avg Particle Size Bullet Jacket Cup Diameter	Stability Stability Stability Stability Stability Stability Stability Stability	30 ICAAP Test (all rows)	.175[4] 10.5-11.8[4] 32.0±.3gr[1] .49-.56[4] Flat End[4] 25µm Max[4]	Tungsten Tin In process
Propellant	1542?3	Burn Rate Foiling Charge Weight Chemical Composition >Calcium Carbonate Particle Size/Shape	Consistent Velocity Stability Stability Stability Stability	Report R-3?6 Report R-3?6	25%[3]	
Case mouth Sealant	12990882	Application (collet/too much) Bonding Strength	Shot Start Dispersion	ARDEC Test Data ARDEC Test Data		
Primer	1534279	Shot Start Action Time Energy Balance	Consistent Velocity Consistent Velocity Consistent Velocity	AMCP 706-?		

1 Drawing
2 Spec
3 Report
4 Test Data

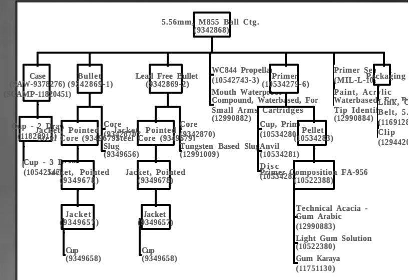
Weapon Function

- The cartridges shall function without casualty at 70ºF ± 2ºF and at the extreme temperature conditions of 125ºF ± 2 ºF and -65ºF ± 2ºF in the M249 Squad Automatic Weapon (SAW) M16A2 Rifle and the following NATO weapons; AR70, L85A1, FNC, & FAMAS F1 rifles.

Component	Drawing No#	Feature	Impact	How Do We Know?	Target	Current Status
M855 Cartridge	9342868	Crimp Axial Alignment Overall Length Mil Port Pressure (Avg+3SD)	Bullet in Bore Stubbing/ Failure To Feed Failure To Feed Failure To Feed	Report 109	35 lb Min[3] 2.260±.025[1] 15300psi[2]	
Case(SAW) Case(SCAMP)	9378276 11820451	Case Neck Uniformity Case Neck Concentricity Case Head Uniformity Sidewall Hardness Case Head Hardness Primer Pocket Surface Finish Extractor Groove Geometry	Failure To Feed Failure To Feed Failure To Feed Failure To Eject Failure To Extract Corrosion Failure To Extract Failure To Eject Failure To Extract Hangfire Misfire Failure To Feed Failure To Extract Failure To Extract	TECP 700-700 TECP 700-700 TECP 700-700 M16 RIFLE Review Report 605 TECP 700-700 TECP 700-700 TECP 700-700 TECP 700-700	2.230+0.007[1]	
Bullet	9342869	Length Of Bullet Diameter Concentricity Diameter Uniformity Profile	Failure To Feed Failure To Feed Failure To Feed Failure To Feed		.9230[1] .2245/.006[1]	
Propellant	1542?3	Calcium Carbonate Charge Weight Insufficient Amount Burn Rate	Foiling Misfire Bullet in Bore Hangfire	Report R-3?6 Report R-252 TECP 700-700 TECP 700-700 TECP 700-700	25%[3]	
Primer	1534279	Failure To Ignite Failure To Ignite Propellant Burn Rate Pellet Weight Assembly Low Sensitivity	Misfire Misfire Hangfire Misfire Cyclic Rate Misfire Misfire Misfire	TECP 700-700 TECP 700-700 TECP 700-700 TECP 700-700 Report R-2?5 TECP 700-700 TECP 700-700 M16 RIFLE Review		
Case mouth Sealant	12990882	Application (collet/too much)	Foiling	Report TN-134		
Link M27	1152?87	Dimensions Material Properties >Heat Treat	Failure To Feed Failure To Feed Failure To Feed			

1 Drawing
2 Spec
3 Report
4 Test Data

5.56mm, M855 Ball Cartridge Product Components



Safety

- The ability of the cartridge to safely fire in 5.56mm weapon systems without endangering the operator, damaging the weapon or rendering the weapon unsafe to fire.
- **Chamber Pressure Requirement** - The average chamber pressure of the sample cartridges, conditioned at 70ºF ± 2 ºF, shall not exceed 58,700 psi. Neither the chamber pressure of an individual sample test cartridge nor the average chamber pressure plus three standard deviations of chamber pressure shall not exceed 64,700 psi.

Component	Drawing No#	Feature	Impact	How Do We Know?	Target	Current Status
M855 Cartridge	9342868	Primer Crimp	Dropped Primer			
Case(SAW) Case(SCAMP)	9378276 11820451	Case Material Wall Thickness Hardness/Ductility	Split/Rupture Split/Rupture Split/Rupture	TECP 700-700 TECP 700-700 TECP 700-700		
Propellant	1542?3	Excessive Pressure Chemical Composition Unburned Propellant Charge Weight/Bullet in Bore	Split/Rupture Split/Rupture Breech Flash Weapon Stoppage			
Case mouth Sealant	12990882	Bonding Strength	Split/Rupture/ Blown Weapon	ARDEC Test Data ARDEC Test Data		
Primer	1534279	Pellet Weight Primer Sensitivity Pierced Primer	Hangfire Misfire Misfire	Report R-207 TECP 700-700		

1 Drawing
2 Spec
3 Report
4 Test Data

Penetration

- The bullet shall completely penetrate a 10 gage (.135") thickness AISI 1010 to 1020 steel plate target with hardness between RB 55 minimum and RB 70 maximum, (NATO plate) positioned at 0 + 5 º degrees obliquity and located 656 yards (600 meters) from the weapon. In addition, an aluminum witness plate (2024-T3 or equivalent nominally 0.20" thick) shall be located 6" behind the target to determine penetration. Testing shall be performed when the air is between 30 ºF and 95 ºF. This test is only performed for the First Article Test and for the first three production lots. If the requirement for penetration is successfully met for the First Article and three (3) consecutive production lots, this test may be discontinued.

Component	Drawing No#	Feature	Impact	How Do We Know?	Target	Current Status
M855 Cartridge	9342868	Crimp	Consistent Velocity			
Bullet	9342869-1	Weight Uniformity Diameter Uniformity Profile Concentricity Out Of Balance (Core/ Slug Off Center) Boattail Lead Splash Meplat Tightness of Bullet Comp Core Hardness Core Weight Core Dimensions	Tumbling/Key Hole Penetration Depth Tumbling/Key Hole Tumbling/Key Hole Tumbling/Key Hole Tumbling/Key Hole Tumbling/Key Hole Tumbling/Key Hole Jacketing/Breakup Jacketing/Breakup Jacketing/Breakup Jacketing/Breakup		R_{15N} 80[1] 10.0±.3gr[1]	
Green Bullet	9342869-2	Slug Diameter Slug Density Slug Weight Slug Malleability				
Propellant	1542?3	Burn Rate Charge Weight Chemical Composition Particle Size/Shape	Tumbling/Key Hole Tumbling/Key Hole Tumbling/Key Hole Tumbling/Key Hole			
Case mouth Sealant	12990882	Application (collet/too much) Bonding Strength	Consistent Velocity Consistent Velocity	ARDEC Test Data ARDEC Test Data		
Primer	1534279	Shot Start	Consistent Velocity			

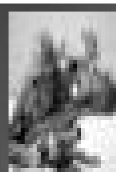
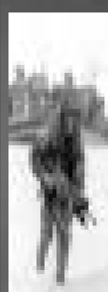
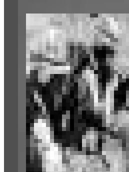
1 Drawing
2 Spec
3 Report
4 Test Data

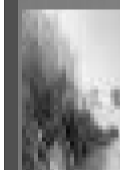
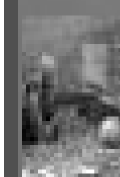
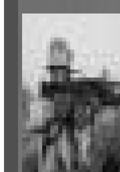
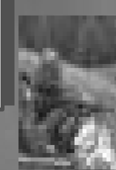
Environmental Durability

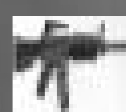
- The ability of the cartridge to remain functional in it's intended use after storage in a variety of extreme climatic conditions

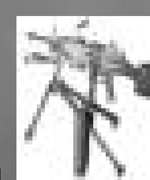
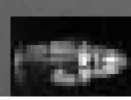
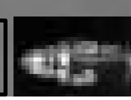
Component	Dwg No	Feature	Impact	How Do We Know?	Target	Current Status
M855 Cartridge	9342868	Crimp	Waterproofness			
Case(SAW) Case(SCAMP)	9378276 11820451	Corrosion	Failure To Extract Split/Rupture	Report 605		
Propellant	1542?3	Chemical Composition Particle Size/Shape	Shelf Life Burn Rate			
Case mouth Sealant	12990882	Application (collet/too much) Bonding Strength Chemical Composition Waterproofness	Moisture Buildup Moisture Buildup Moisture Buildup Moisture Buildup			
Primer	1534279	Chemical Composition	Primer Function			
Primer Sealant	MIL-L-10287	Waterproofness	Primer Function			
Packaging						

1 Drawing
2 Spec
3 Report
4 Test Data



5.56mm, M855 Ball Cartridge Key Performance Characteristics

OTHER BENEFITS OF THE JOURNEY

- **ESTABLISHES PERMANENT/INCREASING KNOWLEDGE BASE**
  - OPEN KNOWLEDGE BASE
    - SHARED BY CONTRACTOR AND GOVERNMENT

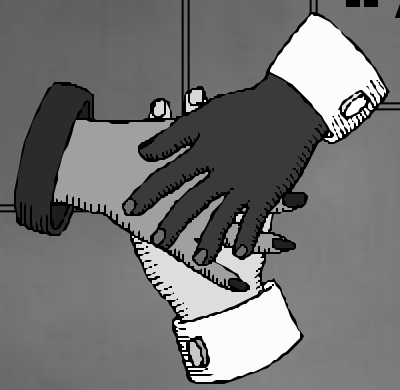
- **ENHANCES PROBLEM-SOLVING**
  - AVOID RE-INVENTING THE WHEEL

- **REDUCES KNOWLEDGE LOSS**
  - "GREY BEARD" RETIREMENTS

THE JOURNEY IS A TEAM EFFORT

GOVERNMENT

- OSC (PROV)
  -- Small Caliber/Lake City Team
- ARDEC
- PM SMALL ARMS



CONTRACTOR

- ALLIANT TECHSYSTEMS
  -- Alliant Lake City Small Caliber

OPERATIONS SUPPORT COMMAND'S ROLE

- PROVIDE OVERALL LEADERSHIP OF THE PROGRAM
  - PRIORITIZE JOURNEY CANDIDATES
  - PROVIDE FINANCIAL MANAGEMENT
- DEVELOP ACQUISITION STRATEGY
  - LONG TERM CONTRACTS
  - CONTRACTORS WHO WILL PARTNER
- INVOLVE MAJOR CONTRACTORS OVER ALL OSC PRODUCT LINES

ATK's ROLE

- ATK RESPONSIBLE FOR:

  THE PRODUCT AND PRODUCTION PROCESSES

  - DELIVERING
    - REDUCED VARIATION
    - HIGHER QUALITY
    - REDUCED SCHEDULE RISK

  - REDUCED COSTS FOR CUTOMERS AND ATK
    - REDUCED PRODUCTION COSTS
    - REDUCED TESTING AND SAMPLING
    - REDUCED SCRAP AND REWORK
    - REDUCED WAIVERS AND DEVIATIONS

THE JOURNEY COMBINES ENGINEERING AND PRODUCTION

- ENGINEERING KNOWLEDGE
  - PRODUCT UNDERSTANDING
  - PROCESS UNDERSTANDING
- PRODUCTION MANAGEMENT
  - SCHEDULE PERFORMANCE
  - PROCESS CONTROL
  - SCRAP REDUCTION
  - ‘LEAN THINKING ’ PRODUCTION METHODS

ARDEC'S ROLE

- **MATERIAL DEVELOPER**
  - RESPONSIBLE TO SOLDIER FOR PERFORMANCE
  - CONTROLS TOTAL SYSTEM DESIGN
  - INTERFACE BETWEEN WEAPONS AND AMMUNITION
- **ENGINEERING SUPPORT**
  - MAINTAIN CORE TECHNICAL CAPABILITY
  - PERMANENT, EVER-INCREASING KNOWLEDGE REPOSITORY

WHAT THE JOURNEY MEANS TO THE SOLDIER

- CONSISTENT PERFORMANCE
- IMPROVED MATERIAL AVAILABILITY

Same Result First Time, Every Time

Small Caliber Journey To Excellence
Points of Contact

NAME	ORGANIZATION	PHONE	EMAIL
Bobbie Russell	OSC Small Caliber Team	(309) 782-3006	russellr@osc.army.mil
Ron Elbe	TACOM-ARDEC	(309) 782-5475	elber@ria.army.mil
John Middleton	TACOM-ARDEC	(973) 724-7976	johnm@pica.army.mil
Bruce Webb	ATK Lake City	(816) 796-5285	bruce_webb@atk.com