US Army Armament Research
Development Engineering
Center
Picatinny Arsenal New Jersey

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Environmentally Compliant Coating Technology for Ammunition Items

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Powder Coating for Small-Arms Bullet Tip Identification

Overview

Small Arms Ammunition Tip ID

Current Process

Integrating Powder Coating

Performance

Cost

Environmental Benefits

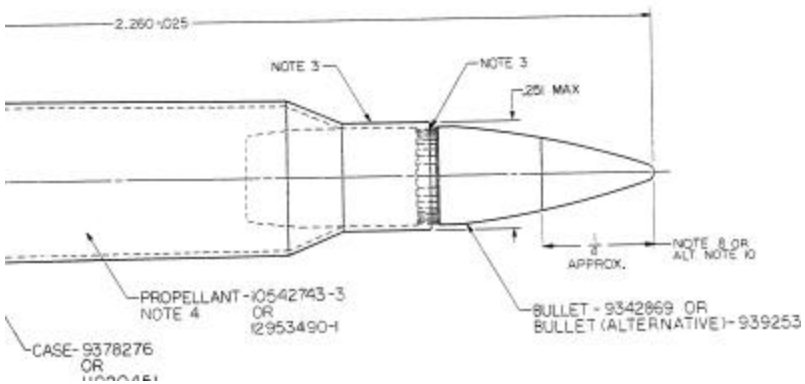
Program Progress

Powder Coating for Small Caliber Ammunition Bullet Tip ID

Team

- Partnership with Department of Energy Kansas City Plant (Allied Signal), Concurrent Technologies Center (National Defense Center for Environmental Excellence).
  - DOE - Identify specific powder coating technologies to be applied at LCAAP. Assess technology in high speed production environment
  - CTC - Identify safety constraints and design new equipment to be installed at LCAAP
  - LCAAP - Evaluate proposed processes and equipment. Conduct Preliminary Hazard Analysis

Powder Coating for Small Caliber Ammunition Bullet Tip ID



8 - Green No. 34138 of FED-STD-595, Lacquer, Spec MIL-L-10287.

10 - Alternate identification paint, Green No. 34138 of FED-STD-595, Waterbased Acrylic Coating, Approved Contractor (Olin/LCAAP) Purchase Description--Pending Staffing and Issuance of Military/Federal ANSI Specification

Tip ID is used to:

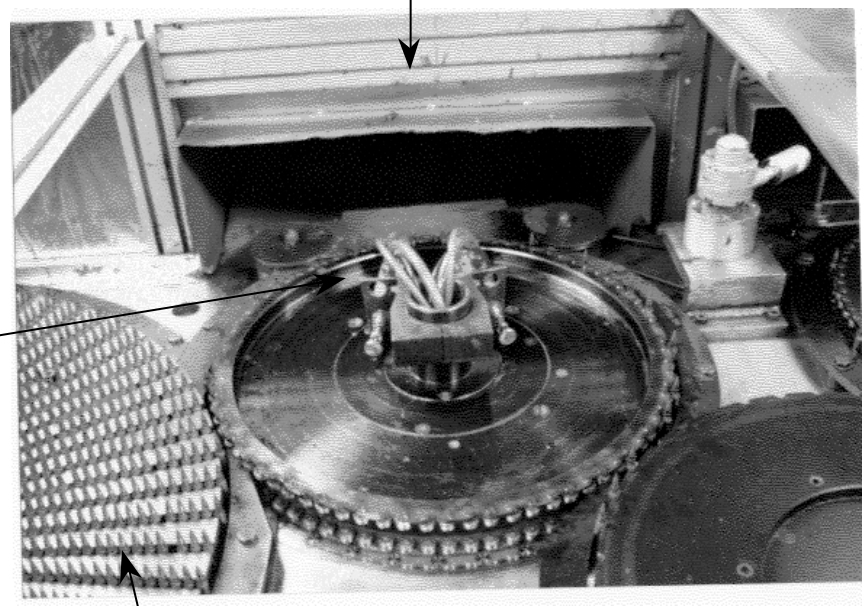
- Distinguish between Ammunition types on the field
- Insure separation of ammo types in the Ammunition Load Plant
- Color and type of paint is specified in TDP

Powder Coating vs. Traditional Coatings

Powder Coating for Small Caliber Ammunition Bullet Tip ID

Current System

5.56 mm M855 and M193 paint is sprayed on in high speed painting operation



Powder Coating for Small Caliber Ammunition Bullet Tip ID

Current System

Caliber .50 and 7.62 mm uses a dipping process.

M8 Painting Line

Powder Coating for Small Caliber Ammunition Bullet Tip ID

Problems with Current System

Wasteful - M855 uses only 5 - 10% of Paint sprayed

Current Paint contains 3.5 lb.. /gal of VOC's

Prior to 1993 VOC content was up to 6.5 lbs/gal in a lacquer based paint. LCCAP switched to Water Based paint which resulted in eliminating 20,000 lbs + of VOC air emissions and 500 gallons of waste sludge.
1995 estimates of waste includes 28.000 lbs of sludge

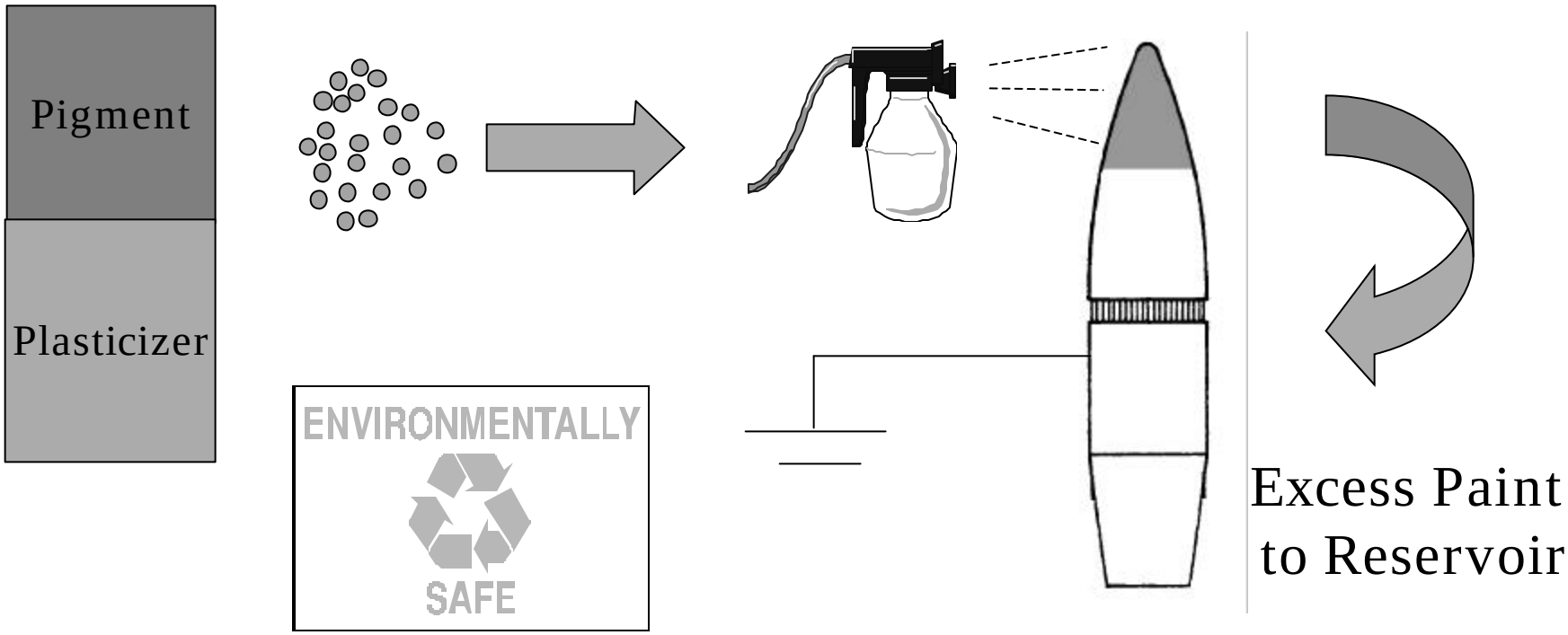
Powder Coating for Small Caliber Ammunition Bullet Tip ID

Problems with Current System

High Maintenance Costs

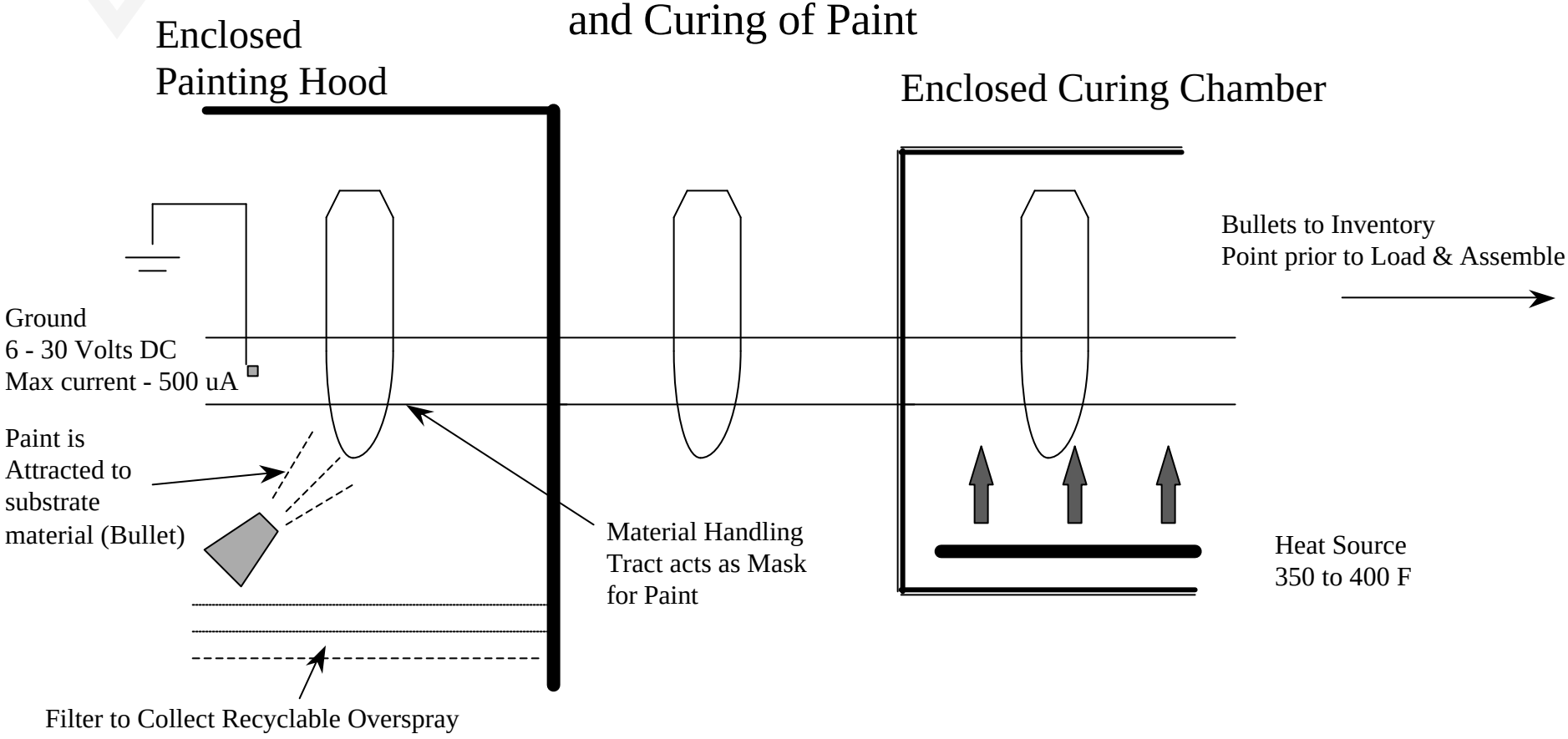
Poor Quality Finish

Powder Coating vs. Traditional Coatings



Powder Coating for Small Caliber Ammunition
Bullet Tip ID

Proposed Concept for Application and Curing of Paint



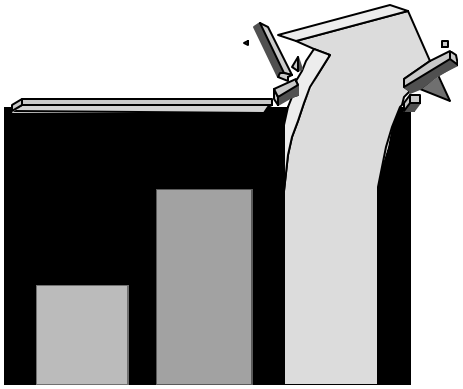
Production Track Direction →
Speed depends upon duration of cure

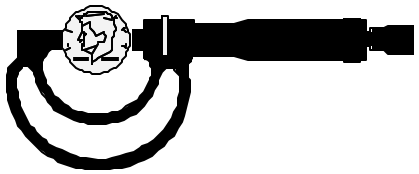
Powder Coating for Small-Arms Bullet Tip Identification

Objective

- To verify the potential efficacy and environmental benefits of implementing Powder Coating technology at the Lake City Army Ammunition Plant (LCAAP) for use in painting ammunition tips for identification purposes.
- Operating Parameters
- Powder Coating on projectiles must:
- Demonstrate Superior Durability
- Provide No Safety Hazards
- Applicable to current LCAAP Production

Challenges with Implementing Environmental Technologies





Performance vs. Cost vs. Environmental Impact

Powder Coating for Small Caliber Ammunition Bullet Tip ID

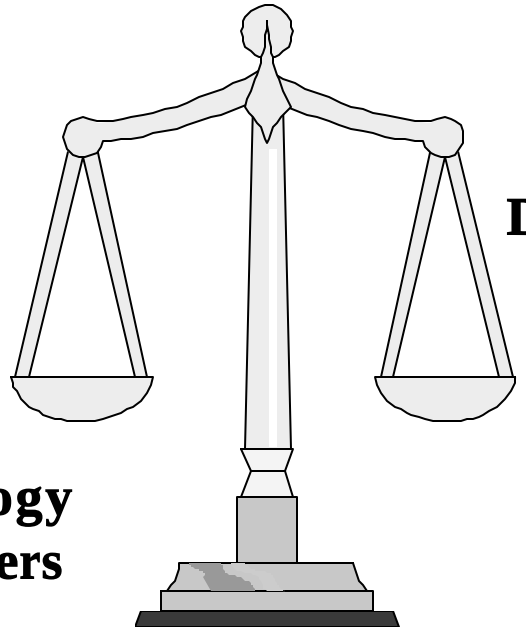
Benefits of Implementing Powder Coating

- High Tolerance to Contaminants
- No Hazardous Wastes - No VOC's
- All over spray is recyclable
- Substantially reduced Re-work
- More Consistent Finish, Durable Coatings can withstand rough handling
- Flow time equivalent to current operations
- Potential Cost Savings

Powder Coating for Small Caliber Ammunition
Bullet Tip ID

Project Specific Challenges

1. Integration



Desired Product Performance & Facility Capability

Technology Parameters

Powder Coating for Small-Arms Bullet Tip Identification

Resolution of Project Specific Challenges

- Resolution of Safety Issues (effect of Electrostatic Charge and Exposure to High Heat requires investigation to identify application to LCAAP adaptation
- Process Insertion point dictates proposed application and curing methods
- Proposed Design must meet Contractor and Government Safety Requirements
- Proposed Cure methodologies must be proven to exhibit no adverse performance effect on completed product

Powder Coating for Small Caliber Ammunition Bullet Tip ID

Program Approach

- Assess Current Powder Coating Technology emphasizing:
  - LCAAP's safety concerns
  - Identification of contaminant removal
  - LCAAP's high production rate
- Evaluate effects of Curing and Electrostatic Charge on projectiles and pyro-technical mixtures
- Design application methods, curing equipment and related handling processes to implement proposed system at LCAAP
- Perform validation test in production environment

Safety Testing

Heat and Electrostatic Charge Exposure

- Projectiles were exposed to 300 F for up to twenty minutes with no safety incident
- Energetics were downloaded and inspected - no visible degradation
- Projectiles were exposed to electrostatic charge of 25,000 V (20 A) IAW MIL-STD-331, test F1
- No safety incidents or visible signs of projectile contact
- Energetics were downloaded and inspected - no visible degradation
- Energetics from both tests were sent to CTC for X-Ray Diffraction Tests

Energetics Tested:
Igniters - I-136, I-136A, I-280, I-194, I-560
Tracer Mixtures - R-440, R-256, R-528
Incendiary Mixtures - IM-11, IM-28

Safety Testing

X-ray Diffraction Tests

- Energetics from Heat Exposure tests were used
- Used to detect any changes in the chemical composition at the atomic level
- X-ray signature of the compounds change whenever:
- new compounds are added or deleted signifying a chemical property change due to added heat
- Crystallinity signifies a change but not into a new compound.
- Results: No detectable changes between the control sample and the processed samples

Safety Testing

Differential Scanning Calorimeter Analysis

- Performed by LCAAP Chemical Laboratory Group
- Heat energy is added to Energetics to determine compositional changes in the material, i.e. presence of increased oxidation, release of free radicals etc.
- Temperatures from 0 to 400 degrees Celsius (750 F)
- Results: No energetic material experienced any deviation from the control in terms of compositional change until temperatures were in excess of 300 Celsius (570 F)

Energetic Sensitivity Tests

- Performed by Safety Management Systems
- Used to determine material properties of energetics subjected to a Varity of sensitivity stimuli
- Impact Probit, Friction Probit, ESD Probit and Fischer-Johns Auto-ignition Temp

Safety Testing

Sensitivity continued

- Results:
- Impact Probit - Overall low probability of initiation ~ 10^2 - 10^5
- Friction Probit - Very low probability of initiation ~ 10^7 - 10^8
- ESD Probit - Low probability of initiation ~10^4 - 10^5
- Fischer-Johns Auto-ignition Temperature - No energetic would initiate at temperatures less than 300 Celsius

Curing Analysis

- Completed by Department of Energy / Allied Signal Kansas City Plant
- The purpose of this study was to:
    1. Determine the curing methodology
    2. The operations parameters of employing the proposed cure
    3. Address the temperature as a safety issue

Curing Method

- Convection Vs. Infrared
- Retained Heat and Time to Cure

Curing Analysis

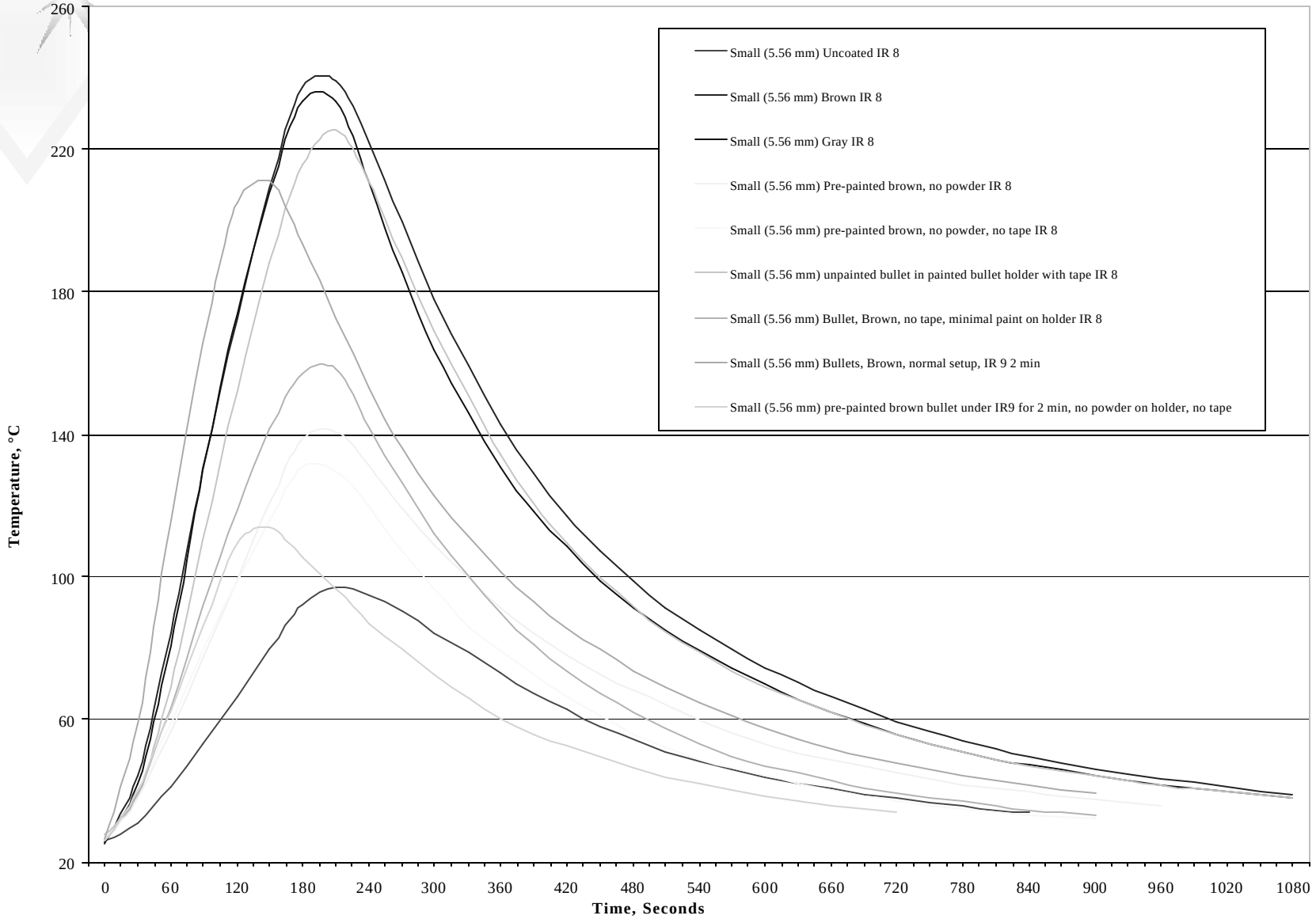
Operational Parameters

- Time to Cure
  - 2 minutes - 5.56 mm
  - 2.5 minutes - 7.62 mm
  - 8 minutes - Cal .50
- Dark paints cause the substrate to get hotter
- Safety Issues
- Curing heat affecting the rest of the bullet and cartridge

Recommendations

- Minimize cure time
- Each paint color will require tailored process in production
- Mask the remainder of the cartridge to allow cooling

IR Heating of 5.56 mm Bullets, Settings and Setup as Labeled

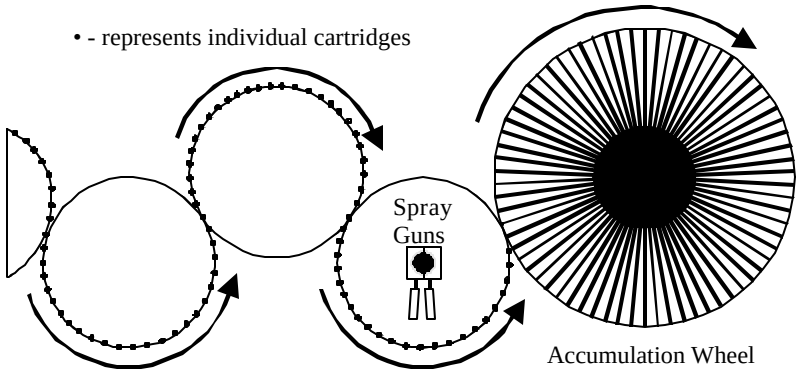


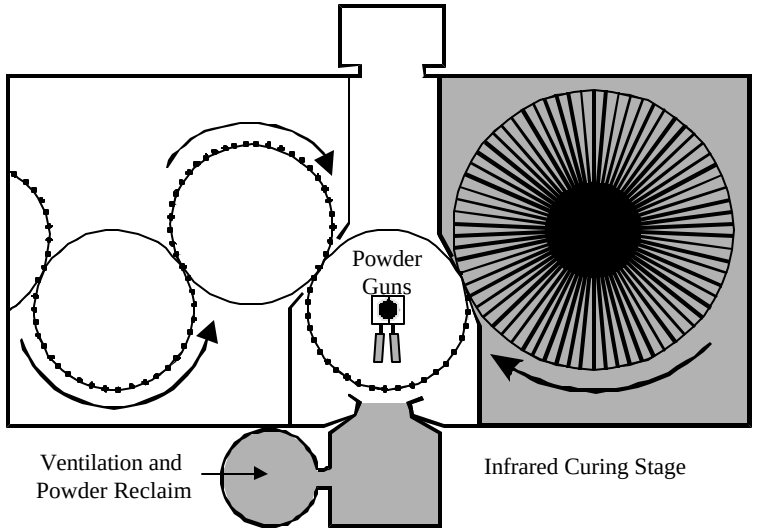
Conceptual Design

- CTC has completed conceptual designs for PHA using Safety Test inputs
- Approved by ARDEC, Olin and LCAAP Safety Departments

5.56 mm

- Uses current set-up with modifications

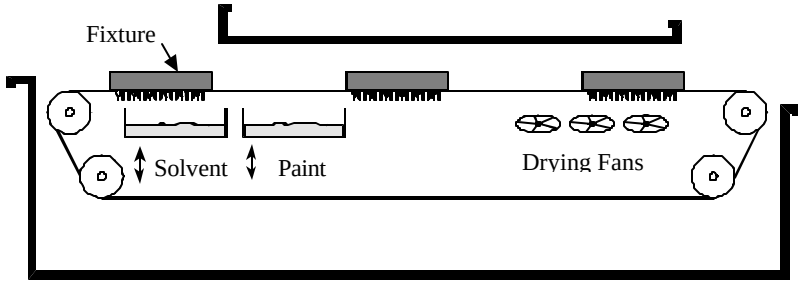




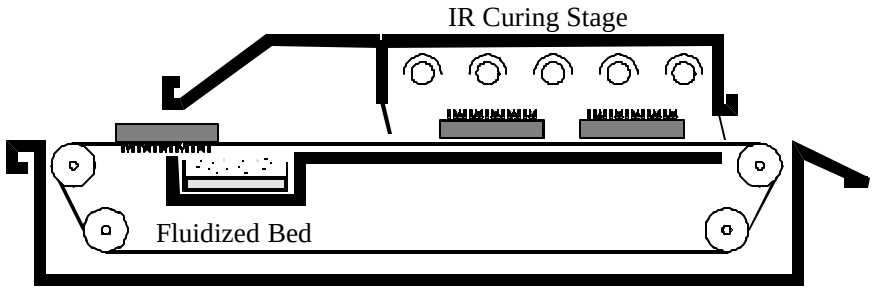
Conceptual Design

7.62 mm

- Proposed New machine and process



Current 7.62mm Paint Line

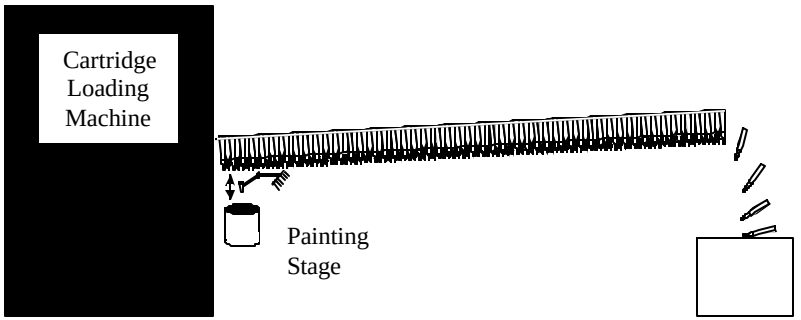


Proposed Powder Coating Line

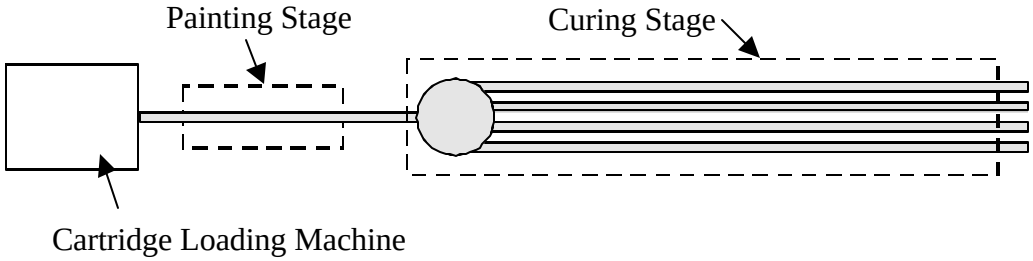
Conceptual Design

Caliber .50

- Uses much of the current equipment and a similar painting process



Current Painting Line and Drying Track



Proposed addition to existing machine

Powder Coating for Small Caliber Ammunition Bullet Tip ID

Liquid Paint vs.. Powder Coating at LCAAP

	Current Process		Powder Coating	
Process	Waste Generated	Note	Waste Generated	Note
Preparation	0.25 lb.	Includes Mixing of paint for consistency	0.0 lb.	No preparation needed. Paint is ready to apply from container
Transportation	0.05 lb.	Loss due to "flash off"	0.0 lb.	Any Loss would be due to spillage only
Spraying / Dipping	2.5 lb.	Overspray Disposal	0.25 lb.	In the event paint collected in filters is not recycled
Equipment Clean-up	0.50 lb.	Paint that remains on equipment	0.0 lb.	Design of application aids in preventing loss
Curing	0.0 lb.	Ambient Temperature	0.0 lb.	No loss in curing
Total	4.3 lb.		0.25 lb.	

Substantially reduced waste

Assumption Process wastes per 2000 5.56 mm M855 cartridges. Equipment running at normal rate

Approximately 0.9 grains of paint applied to each bullet.

Powder Coating for Small Caliber Ammunition Bullet Tip ID

	Current Process		Powder Coating	
Process	Cost	Note	Cost	Note
Acquisition	$4.50	5.0 lbs of paint required for 2000 rounds	$3.50	0.90 lbs of paint required for 2000 rounds
Preparation	$8.00	0.3 hours for mixing	$0.0	
Transportation	$6.25	From Storage to site	$6.25	From Storage to site
Spraying / Dipping	$18.00	Includes set-up time, filters, inspection	$6.00	Includes set-up time, filters, inspection
Equipment Clean-up / Re-work	$10.00	Removal of excess paint from equipment and mis-applications	$2.00	
Curing	$0.0	Current Drying track requires no resources	$3.00	Assumes convection heating for .5 hours @350F
Waste Disposal	$1.75	Sludge and contractor disposal	$0.50	Landfill for disposed filters
Total	$48.50		$21.25	

Savings of over 40 % compared to current processes

Powder Coating for Small-Arms Bullet Tip Identification

Summary of Project Progress to Date

- Safety Testing complete
- System Safety
  - Heat and Electrostatic Exposure - X -ray Diffraction Test
  - Differential Scanning Calorimeter and Energetic Sensitivity Tests
- Performance Impact
  - Heat Exposure Tests - X ray Diffraction
  - Function Tests - in progress
- Curing Process Analysis Complete
- Preliminary Hazard Analysis
- Identified Proposed Equipment and Process Modifications
- CTC and IFS have begun work on the build specifications
- Expected Completion – Winter 2000/2001