Shear Roll Mill Pilot Plant

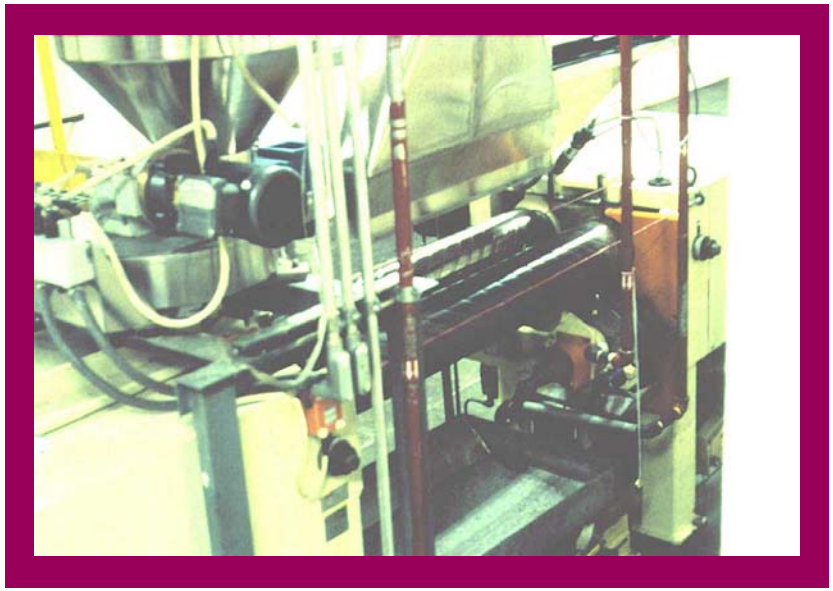
Dick Rentfrow

2 May, 2001

Alliant Techsystems Inc., Alliant Ammunition & Powder Co.
Radford Army Ammunition Plant, Radford, VA 24141
Voice mail: 540-639-7250; Telefax: 540-639-7214
E-mail: dick_rentfrow@atk.com

ATK's Strategic Vision

- SRM/TSE is the *ONLY* significant foreseeable cost and quality improvement technology for the next generation rocket motor.
- ATK's strategic business plan includes the development and installation of SRM/TSE facilities per the schedule enclosed.
- The recent acquisition of Thiokol supports that plan.



What is a Shear Roll Mill?

- Developers
  - BOWAS Induplan Chemie, of Salzberg, Austria
  - Existing 200mm SRM manufactured by ColorMetal
  - US patent in 1990 awarded to NWC-Nitrochemie.
- History with ATK
  - Purchased in 1991, ATK (then Hercules) @ their Kenvil, NJ facility.
  - Demonstrated 125 lbs/hr.dry weight of solventless JA-2 & produced 200,000 lbs DIGL-RP
  - Married up to a 96mm Berstorff TSE in Oct. 93.
  - Nov 1, 1993 an incident with the TSE ended the project. Kenvil was to be re-located to RFAAP.

How it works?

- Processing of Polymers and Rubber on continuous roll mills have existed for many years.
- The unit dewaters, mixes, colloids and pelletizes a water-wet paste of NC, plasticizers, ballistic modifiers and stabilizers.
- NC based propellant with a total plasticizer >30% by weight is a candidate for the SRM.
- Settable parameters include;
  - Roller temperatures (2 zones in each roller)
  - Roller RPM (counter-rotating with differential settings)
  - Roller Gap width (Settable at both ends, .5 to 5mm gap)
  - Feed rates (set through LIW feeder(s), multiple feeders possible)
- Product from a SRM;
  - Pellet feed stock for a TSE or,
  - Continuous “line” for post processing into “Carpet-roll”

Who are we teamed with?

NAVSEA
INDIAN HEAD

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA
ESTCP
ENVIRONMENTAL SECURITY TECHNOLOGY CERTIFICATION PROGRAM

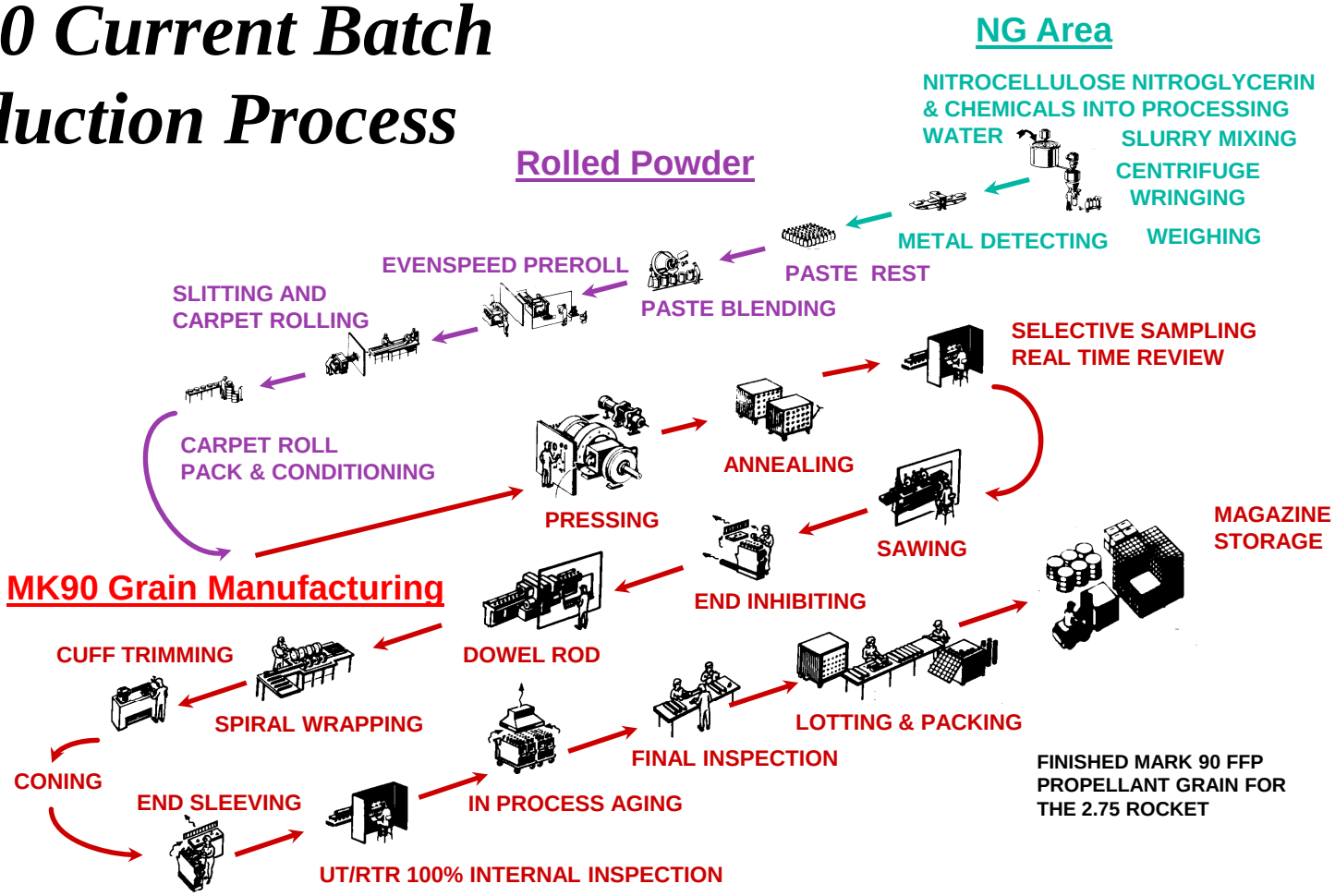
ARMAMENT RESEARCH, DEVELOPMENT & ENGINEERING CENTER
PICATINNY ARSENAL

Mk90 Project Description

- Demonstration objective
  - Demonstrate and validate an advanced manufacturing process for the MK 90 propellant grain
  - Develop a transition plan
- Expected results
  - UPC Reduction (Labor & Materials)
  - Environmental savings:
    - 10% reduction of propellant waste
    - 25% reduction of wastewater
    - 50% reduction of Nitroglycerin (NG) emissions
    - Less lead contaminated ash
  - Grain Quality improvements (Less defects)

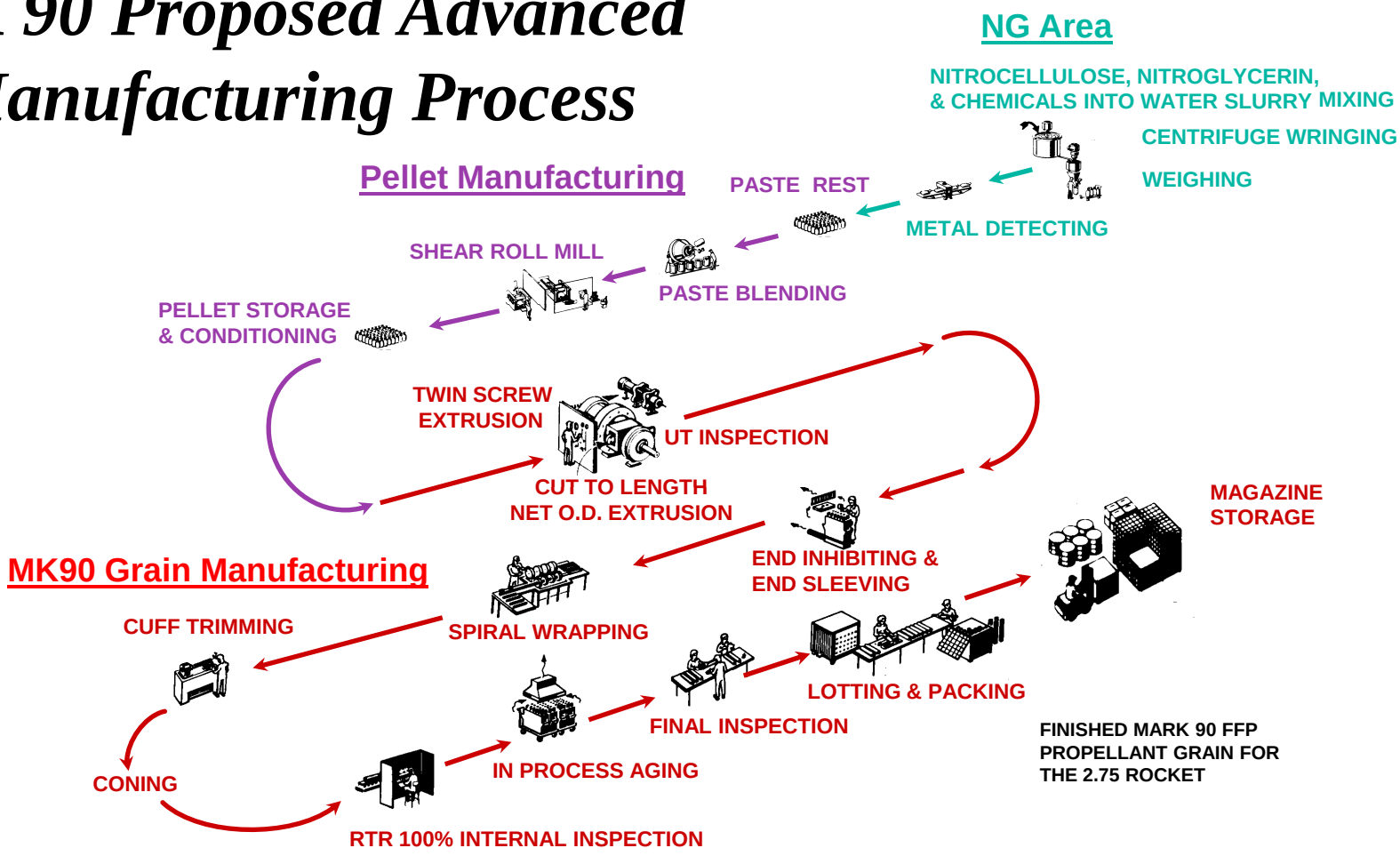
Project Description

MK 90 Current Batch Production Process



Project Description

MK 90 Proposed Advanced Manufacturing Process



Project Approach

Advanced Process vs. *Current Process*

- Technology assessment
  - Environmental impact
  - Product performance
  - Manufacturing cost
- Cost and performance data validation
  - Environmental and cost analysis via ECAM methodology
  - Standard ballistic qualification testing

Principal Project Performers

Alliant Techsystems, Inc. (ATK)

- Shear roll mill
  - Demonstrate feasibility and scale up (Nitrochemie)
  - Establish capability (RFAAP)
  - Process development and optimization
  - Production scale-up and Facilitization
- Environmental and cost analysis
  - Document current process
  - Shear Roll Mill process (via Pilot Plant)

Principal Project Performers

Indian Head Division, NSWC

- Twin screw process
  - Establish capability
  - Process development and optimization
  - Die modeling, design and fabrication
- Environmental and cost analysis
- Transition grain processing technology

Principal Project Performers

TACOM-ARDEC

- Independent environmental and cost audit
- Shear roll mill process modeling
- Totally Integrated Manufacturing Enterprise (TIME) implementation
- Development of model based control schemes
- Production facility
  - Conceptual designs
  - Projected costs

What have we done lately?

- Feasibility demonstration of the SRM is nearly complete.
  - Shipped 6400 lbs of AA-2 paste to Nitrochemie
  - Demonstrated the ability to manufacture well-colloided AA2 pellets> 1700 lbs returned to US.
  - Demonstrated the ability to scale the process from the 200-mm to the 300-mm shear roll mill
  - Developed and delivered 100 lbs. AA-2 inert simulant; shipped to IHDIV.
  - Completed cost and environmental models. ARDEC validated the Booz-Allen & Hamilton's cost estimate for implementing SRM and TSE at RFAAP.

Project Progress (cont.)

- Completed the preliminary hazard analysis of the twin screw extruder facility
- Initiated facility/equipment modification actions
  - New feeder
  - Remote screw removal system
  - Isolation system between extruder and feed system
  - Method of inspecting pellets
  - Reconfigure extruder
  - Die holder door redesign

Project Progress (Cont.)

- Completed the installation of the automatic cutting system
- Additional Inert simulant manufacture is in progress
- Began die modeling
  - Characterized AA2 propellant rheology
  - Modeled existing 2.75” extrusion die
- Initiated the preparation of the Process Review Board (PRB) package
  - Developing live processing plan
  - Experience at other facilities

Where are we going?

- Shear roll mill process
  - Complete the installation of SRM Pilot Plant.
  - Complete Demonstration and Validation phases with Indian Head & ARDEC.
  - Develop and demonstrate Conventional extrusion capability from SRM product (Carpet –Roll post processing)
  - Support the development of SRM Model (ARDEC, SIT)
- Twin screw extrusion process
  - Develop process – IHDIV, ATK
    - Determine safe operating windows; determine the affect of the process on grain consolidation, grain geometry and grain quality; determine the performance properties as a function of process conditions; determine the affect of the ATK pellets vs. Nitrochemie pellets on the process and grain quality
  - Develop Solvent Product processes with Thiokol. (Single –base and Multi-base)
- Project demonstration
  - Manufacture and test MK 90 rocket motors made using the SRM pellets from Germany and the Indian Head developed TSE
  - Manufacture and test MK 90 rocket motors made using the conventional process as well as the SRM combined with the conventional extrusion process - ATK
  - Compare results of the testing – IHDIV, ATK & ARDEC
  - Complete the validation of the environmental and cost analysis – IHDIV, ATK & ARDEC
  - Validate SRM Model.- ARDEC, ATK

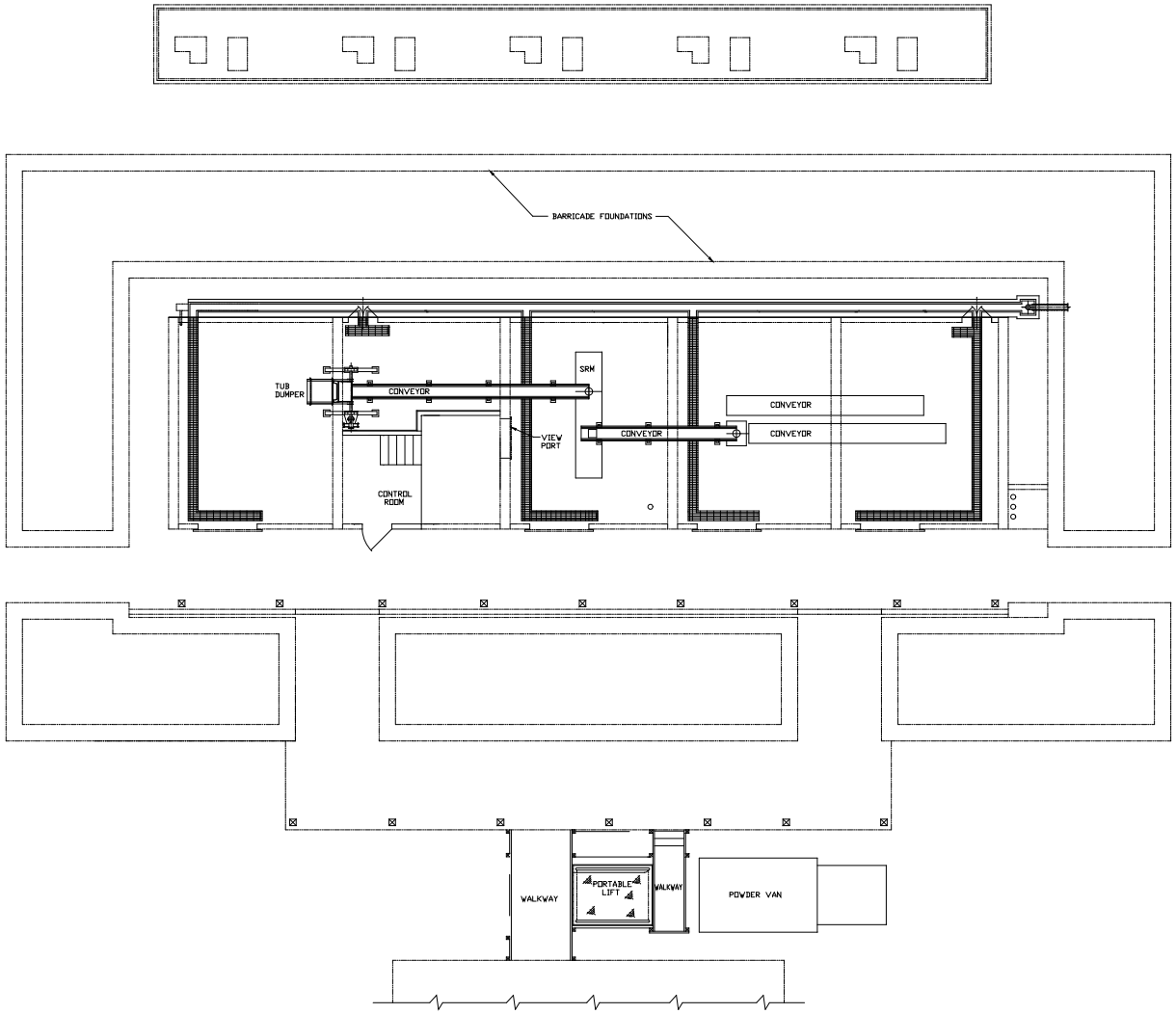
ATK 200mm SRM Status

- Pilot Plant effort divided into 6 phases;
  - Phase I Design - $180K ARMS funded
    - Facility layout and specifications complete. Detail components design underway.
  - Phase II Environmental Permitting - $32K Arms funded
    - Completed. Emissions report and permit submitted. No new permit required.
  - Phase III Current Facility Equipment Removal – Pending ARMS release ($507.7K)
    - Beginning equipment removal ahead of schedule due to underrun in Phase 1.
  - Phase IV Kenvil Equipment Refurbishment & New Equipment Purchase–$326K ATK Capital funded
    - Equipment refurbishment underway & on schedule
  - Phase V Kenvil & New Equipment Installation – Pending ARMS Release ($476.5K)
  - Phase VI Prove-out - $74K ATK Capital funded
- Remaining ARMS funds OSC approved. Awaiting general ARMS $ release.

ATK 200mm SRM Schedule Status

- Phases I,II, & IV (and head-start efforts on Phase III) completed by August 2001.
- Expect ARMS funding release ~May-June 2001.
- Facility ready for new equip.by September 2001.
- New equipment installed and ready for Prove-out by December 2001.
- Prove-out / pellet pilot lots by February 2002.

Shear Roll Mill Pilot Plant Layout



Project Plan

Solventless Rocket Motor Project	1999	2000	2001	2002	2003	2004	2005
Current Five Year Buy							
ADVANCED PROCESS							
Phase I - Concept							
Phase II - Demonstration							
Phase III - Process Optimization							
Phase IV - Facilitization							
Phase V - Qualification							
Implement in Production							

Current project covers both Phase I & Phase II

Expected Results

- ~50% direct Labor savings from Conventional Rolling to SRM.
- ~16% labor savings with TSE.
- Material and waste stream reductions = $846 K/yr
  (@ current production rates)
  - 50% Solid waste & 60% Waste water
- Payback period for Initial investment is < 3 years.
- NPV and IRR very high