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Nitrotriazolone: An Environmental Odyssey

Bob Winstead

NDIA Systems Engineering Conference
San Diego, California

Ordnance Systems – Holston Army Ammunition Plant

OSI Safety, Environmental & Quality Registrations

Safety – OSHAS 18001
Environmental – Fence-To-Fence ISO 14001
Quality – ISO 9001
1st GOCO to Receive All 3!

Modernization

Holston Army Ammunition Plant - Operating Contractor
25-year Facility Use Contract commencing in 1998

Premier JM&L LCMC GOCO Facility

Explosives Production

R & D

Current Manufacturing Mix

- CXM-7 – JDAAM Bomb
- Comp C-4 – M112, MICLIC
- HMX 80S – Trident
- PAX-21 – 60mm Mortar
- PBXN-9 & CXM-7 – Hellfire
- Comp B / B-4 – APKWS
- PBXN-10 – APOBS, Mongoose
- Comp A-3 – SMAW, 40mm
- LX-14 - Javelin
- CXM-3 – Cruise Missile
- CXM-9 – SLAM-ER
- IMX-101 – 155mm Artillery
- IMX-104 – Multiple applications
- PAX-28 – Precision Guided Mortar Munitions
- PAX-34 – Egyptian 120mm Mortar (ARDEC FMS)

Insensitive Munitions

- An insensitive munition is one that will not detonate under any conditions other than its intended mission to destroy a target.
- Beginning in 1987, the Army undertook a program to develop insensitive munitions to replace conventional energetics such as TNT and RDX.
- Insensitive Munitions (e.g., IMX-101, IMX-104, PAX-21 etc.) and their components (DNAN, NTO, NQ) have enhanced the safety of our warfighters
- To date, IMX-101 is the only formulation that has passed all six of the US Army's Insensitive Munitions Criteria

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Insensitive Munitions – Protecting Soldiers

Fragment Impact

Shaped Charge Jet Impact

Slow Cook-off

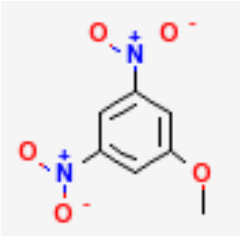
Fast Cook-off

Multiple Bullets into HE

Sympathetic Detonation

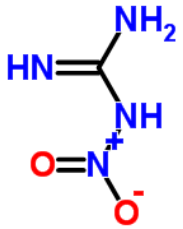
“New” energetic ingredients in insensitive formulations:

- Dinitroanisole: DNAN



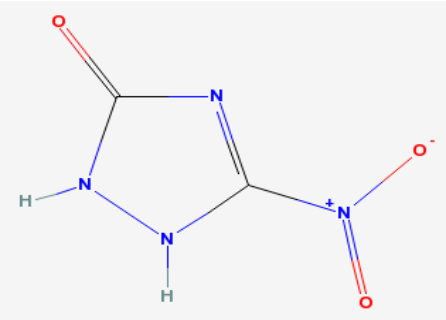
A waxy material: acts as a binders in the IM mixtures. Highly insensitive. Used in other countries and in PAX-21.

- Nitroguanidine: NQ



An older ingredient: a component of propellants: the US has a large stockpile from SFAAP.

- Nitrotriazolone : NTO



A “new” substance with excellent explosive and insensitive properties.

Nitrotriazolone

- First Identified in 1905.
- First explored for use as an insensitive munition component in 1985.
- Never manufactured in any quantity in the United States; therefore, not on the TSCA registry.

Toxic Substances Control Act

- Requirement for a Pre-Manufacturing Notification
  - The Pre-Manufacturing Notification requires information such as chemical properties, manufacturing locations, workers involved in manufacture, and distribution of product.
  - Knowing that questions had been raised about aquatic toxicity of analog chemicals such as hydrazine, BAE commissioned aquatic toxicity testing for NTO. Testes included *Ceriodaphnia*, *Pimephales* and green algae.
- The application was prepared and submitted in November 2007.

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The Pre-Manufacturing Notification Task I: Aquatic Toxicity

- 2008 – Some activity early on, but periodic checking does not get any additional information out of EPA
- 2009 – EPA requests additional aquatic toxicology data, stating that the first round of testing is insufficient. BAE contracts with a commercial laboratory for additional testing, which is undertaken between June and October of 2009.
- Concurrently, USAPHC is doing aquatic toxicity testing of NTO as well as human toxicity and exposure testing.
- BAE requests a meeting with EPA in February 2010 attempting to close the issue of aquatic toxicity.
- At this meeting, EPA accepts (finally) aquatic toxicity testing done by BAE and the Army's Public Health Command on behalf of PM-CAS.
  - I believe myself to be in the short rows.

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Insensitive Munitions – Nitrotriazolone (NTO)

- **NTO Springborn Aquatic Toxicity Study Finding of Nontoxicity — Jun 2009**
- **NTO USPHC Aquatic Toxicity Study Finding of Very Low Toxicity — Oct 2009**
- **NTO Springborn Finding of Non-toxicity to Trout, Algae, Daphnia Magna — Nov 2009**

Data courtesy of PM-JS, Picatinny Arsenal

Multiple Toxicity Tests with Findings of Non or Low Toxicity

Task II: Treatability

- In May 2010, EPA informs BAE that while the aquatic toxicity data is acceptable, that the treatment assessment division has determined that, in the absence of treatability data, EPA will assign a treatability score of zero to Holston's Industrial Wastewater Treatment Plant.
- BAE began a treatability study in our pilot-scale wastewater treatment plant model to determine treatability of NTO by our industrial wastewater treatment plant.
- This testing was undertaken from July-November 2010. The report was submitted in December 2010 and accepted by EPA. EPA assigned a 95% treatability factor to NTO using HSAAP's treatment processes and proceeded accordingly.

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Industrial Waste Water Treatment Facility

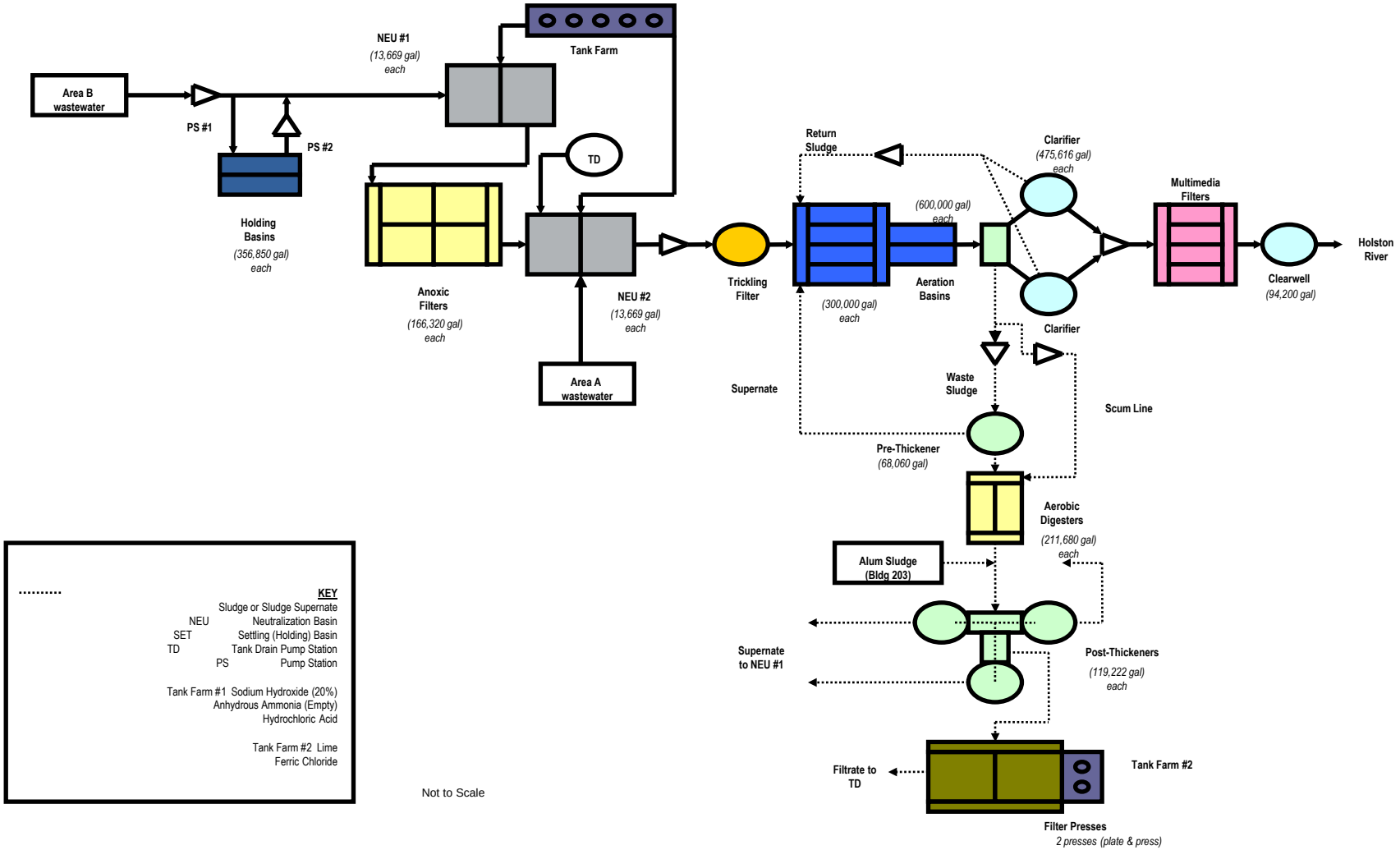

Figure 3 – IWWTF FLOW DIAGRAM

Task III: Human Toxicity and Exposure

- After a winter of frequent checking, BAE received the draft EPA Consent Order on 25 March 2011.
  - EPA has an aversion to email so they faxed all 66 pages at 5:00 on a Friday afternoon.
- Review of the consent order revealed a paragraph about water and 65 pages regarding industrial hygiene and worker exposure.
- EPA had used Amitrole as a surrogate for toxicity data on NTO and set requirements accordingly.
- BAE and PM-CAS immediately submitted all data collected from all sources, primarily USAPHC.
- A review meeting was scheduled for 27 April 2011……

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Toxicity Data – Nitrotriazolone

• NTO Springborn Ames Assay Test Finding of Not Mutagenic	Oct 2008
• NTO SITEK Cultured Chinese Hamster Ovary (CHO) Chromosome Aberration Negative Finding	Oct 2008
• NTO USAPHC (formerly USACHPPM) Acute Toxicity Test Finding >5000 mg/kg (NaCl = 3000)	May 2009
•90-Day USAPHC Environmental Technology sub-chronic Oral Toxicity Test	Mar 2010

Data courtesy of PM-JS, Picatinny Arsenal

Multiple Toxicity Tests with Findings of Non or Low Toxicity

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Selected Toxicity parameters of NTO and other energetics

Product	Lowest Observed Adverse Effect Level (LOAEL) (mg/kg/day)	LD_{50} (mg/kg, rat)	Occupational Exposure Limit (OEL) (mg/m^3)*
TNT	0.5	795-1,010	0.1 (ACGIH TLV)
NTO	30 (from 90-day sub-chronic oral toxicity study)	>5,000	0.9 (mg/Kg from EPA Draft consent order)
NQ	1000	10,200 (3850 for mice. For 99% NaCl: 3,000 [4,000 {mouse}])	10 (total dust) 5 (respirable dust) (ACGIH TLVs)

Results of 27 April 2011 Meeting with EPA

- Dr Mark Johnson of USAPHC attended to support toxicology data with EPA.
- Mr. Joe Dowden attended representing PM-CAS.
- The presentation went very well; EPA was very receptive to the data presented.
- Exposure monitoring will be done when production of NTO re-commences in the fall: Until then, workers must remain in conservative PPE.
- EPA is preparing final Consent Order for NTO.
- We are expecting a final version this month (May 2011).

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The voyage home between Scylla and Charybdis

The Final Push for Home

- The Consent Order was issued in June 2011.
- After negotiations on additional items including PPE requirements for NTO (!), the consent order was signed 13 August 2011 (V-NTO Day).
- BAE Submitted the required Notice of Commencement for manufacturing NTO.
- The Notice published in the Federal Register 21 September.
- Additional worker exposure and toxicity testing data is being collected and will be submitted to EPA upon completion.

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Lessons Learned from the Pre-Manufacturing Notification Submission Process

- Coordinate protocols with EPA in advance of ANY work. The initial testing BAE hired done in an attempt to be preemptive was of no use in the PMN process.
- Send EPA ALL the data you have, even if you think they don't need it.
  - We were taken to task by EPA for two things in this process: failure to submit all of the study work done by the Army in the aquatic toxicity arena in a timely manner, and
  - 2) not submitting all human health and toxicity data to EPA even though we had it from USAPHC via PM-CAS.
- This last was counter-intuitive to me, but contributed to additional delay when the draft consent order was issued by EPA in March 2011.
- The PMN process under TSCA includes assessment of worker exposure, toxicity issues and worker protection, traditionally believed (at least by me and most of the people I talked to) to be the purview of OSHA.
  - EPA had used Amitrole as a surrogate for NTO in the absence of data.

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Questions?