A Strategy for Identifying and Evaluating Munitions Constituents on Ranges

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Introduction

- **Strategy**
  - Identify Munitions constituents (MCs) on Test and Training Ranges
  - Evaluate MCs as Constituents of Concern (COCs) and Emerging Constituents (ECs)
  - Document Critical Information and Technical Gaps Preventing Evaluation of MCs as COCs and ECs
- **Website**
  - Display Information Generated Through Implementation of the Strategy
  - Facilitate Gathering and Evaluating New Information and Identifying Information gaps

Premise

Informed, Cost-Effective Range Management Depends on Knowledge of:

- **Chemicals Potentially Released from Munitions**
  - Tested
  - Used
  - Disposed
- **Regulatory Requirements**
- **Fate and Transport**
- **Toxicology and Risk Assessment**
- **Analytical Chemistry**

Definitions

- **Munitions Constituents (MCs)**
  - Chemicals Originating from Munitions
  - Ingredients: Explosive and Non-Explosive
  - Products: Emissions and Breakdown
- **Constituents of Concern (COCs)**
  - MCs in Air, Soil, or Water on Range
  - Potentially Exceeding Standards or Posing Threat
- **Emerging Constituents (ECs)**
  - MCs that may Soon be Recognized as Widespread COCs
  - New Occurrence, Toxicology, Risk Assessment, Fate and Transport Information
  - New Standards or Analytical Methods

Purpose

- **Develop Comprehensive, Systematic Approach to Answer Two Major Questions:**
  - What Should We Sample for on Ranges?
  - What are the Likely Emerging Constituents?

Basic Elements

- Identify and Quantify Munitions Tested, Used, Treated on Range
- Identify Explosive, Delay, Fuel and Other Chemical Mixtures in Munitions
- Identify Ingredients of the Mixtures (Including Major Impurities)
- Pursue Information Sources for Munitions not Addressed in MIDAS (e.g. Commercial Manufacturers)

Basic Elements (Continued)

- **Identify Major Breakdown Products of Each Constituent**
  - Explosion
  - Combustion
  - Degradation
- **Estimate Amounts of Constituents Potentially Released**
  - Types and Numbers of Munitions
  - Amounts of Constituents in Mixtures in the Munitions
  - Estimated Dud Rates
  - Estimated Low-Order Detonation Rates

Basic Elements (Continued)

- **Determine Regulatory Status of Each Chemical**
  - Standards
  - Guidance
- **Characterize the Knowledge Base for Each Chemical**
  - Toxicology & Risk Assessment
  - Chemical & Physical Properties
  - Fate & Transport
  - Analytical Methods

Special Steps for Emerging Constituents

- **Address Reasons Why a Constituent may Emerge**
  - New Constituent Used in New or Modified Munitions
  - Old Constituent Used in Much Greater Quantities
  - New Regulatory Standards
  - New Toxicological or Risk Assessment Information
  - New Analytical Method with Much Lower Detection Limits

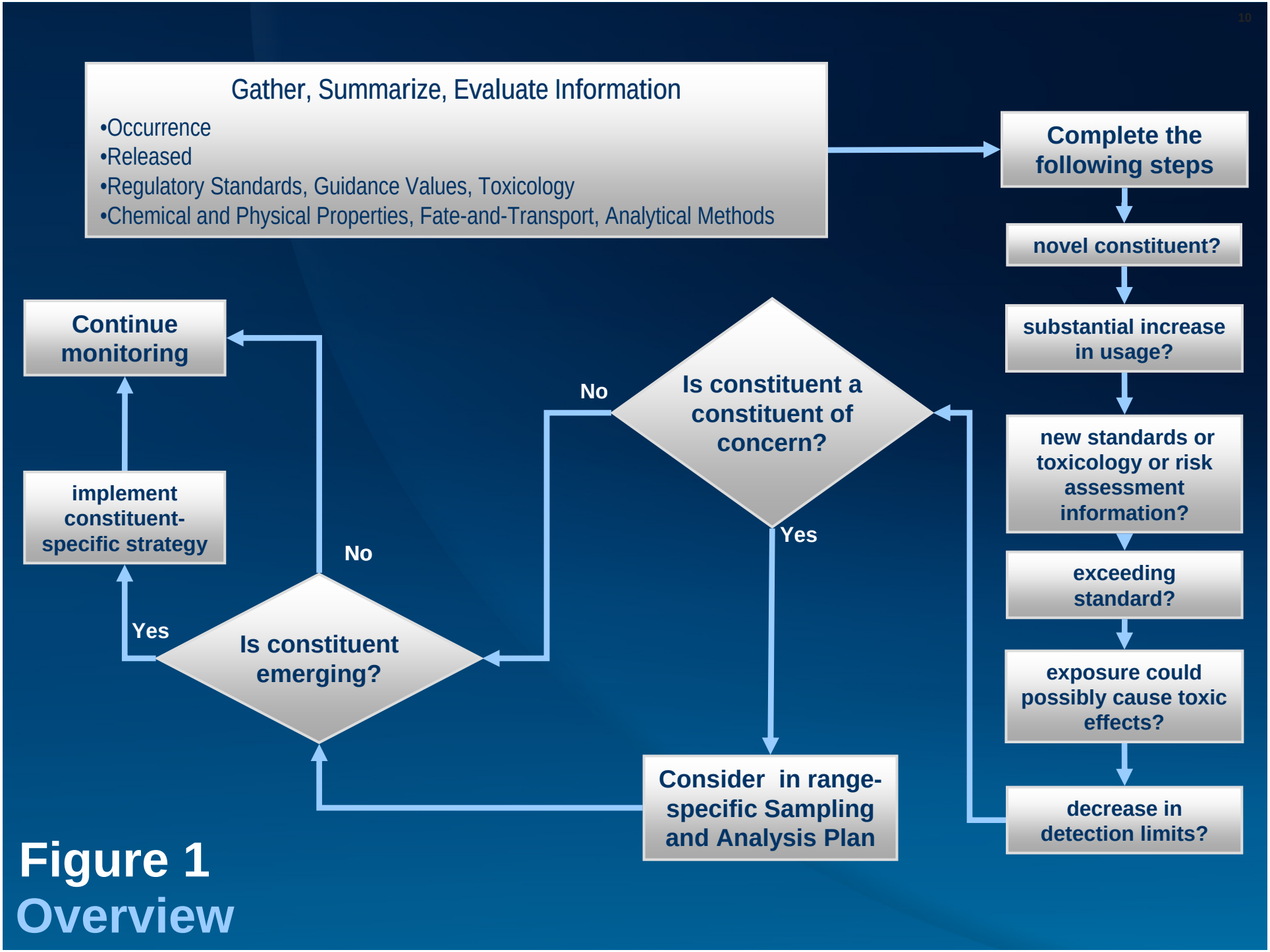


Figure 1
Overview

Determining Occurrence of Munitions on Range

1	2	3	4
Munitions: Use on Aircraft Identify Munitions Associated with Aircraft Used for Training Purposes on Range Consider, for Example: Aircraft Equipment (e.g., Ejection Seats; Missile Release Systems) • Aircraft Guns • Chaff • Cluster Bombs • Flares • Fuzes • Guided Bombs • Incendiary Bombs • Mines • Missiles • Penetrator Bombs • Practice Bombs • Rocket System Components • Sub-Munitions	Munitions: Past and Present Identify, Quantify and Characterize Testing and Use of Munitions on Range Consider, for Example: • Testing Method • Quantity Tested • Initial Operational Capability • Past Use • Current Use • Current Inventory • Production Status • Production Rate • Quantity Planned • Dud Rate • Low-Order Detonation Rate	Munitions: New and Developing Identify Munitions Being Modified or Developed and Currently Tested or May Be Tested or Used on Range Consider, for Example: • Research and Development Status • Testing Method • Quantity Tested • Initial Operational Capability • Quantity Planned	Summarize Information • List Munitions and Estimates of Numbers of Munitions Tested or Used on Range • List New and Developing Munitions Currently Tested or May Be Tested or Used on Range in the Future

Figure 2

Examples

- **Illustrate Execution of the Strategy**
- **Highlight Critical Information and Technical Gaps**
- **Support Recommendations**
- **Munition: BLU-110B/B (1,000-lb Penetrator)**
  - Explosive: PBXN-109 (400 lbs)
  - Constituent: Isophorone Diisocyanate (4 lbs)

Examples (Continued)

- Table 1. Munitions Used in Air Force Aircraft
- Table 2. Key Information on Munitions Used by the Air Force
- Table 3. Ingredients of PBXN-109 in BLU-110B/B
- Table 4. Regulatory Standards and Guidance
- Table 5. Toxicology and Risk Assessment Information
- Table 6. Properties of PBXN-109 Ingredients
- Table 7. Preliminary Evaluation of Isophorone Diisocyanate (IPDI)

Table 1-B Penetrator Bombs

Bomb	Name or Description	Aircraft																		
		A-1	A-7	A-10	A-37	A-100	B-1	B-2	B-29	B-36	B-52	C-130	F-4	F-5	F-15	F-16	F-22	F-35	F-105	F-111	F-117
BLU-107	Durandal		X											X		X				X	
BLU-109	HAVE VOID						X	X			X			X	X	X					X
BLU-110							X	X			X			X	X	X					
BLU-111							X	X			X			X	X	X		X			
BLU-113	"Desert Storm Special"							X			X				X						
BLU-116	AUP			X										X	X	X					X
BLU-117			X	X			X	X			X		X		X	X		X		X	X

Table 2-A Bombs (Continued)

Bomb/ Bomblet	Type	Weight	Status/ Quantity Current *Planned*	IOC	Substances of Interest (Weight)	Notes
BLU-107	Penetrator Bomb	450 lb		1988	HE (330 lb)	Fires "runway buster" rocket booster that penetrates runway surface, and delayed explosion buckles runway
BLU-108/B	AT Bomblet		Production	1992	Octol, Cyclotol, PBXN-107, or PBXW-11?	•Contains four "hockey puck" shaped skeet infrared sensing smart warheads, each with 1 lb Copper explosively formed penetrator (EFP) •6 BLU-108/B in AGM145/B (2001) and 10 in CBU-97/B •Bomblet of choice for the AGM-154B (JSOW) •Capable of integration into AGM-158 (JSSAM)
BLU-109	Penetrator Bomb	2,000 lb	Production		•BLU-109/B: Tritonal 80/20 Mix (535 lb) •BLU-109A/B: PBXN-109 (524 lb)	•Detailed Information in MIDAS •Used in AGM-130, GBU-24 and GBU-31(V)4/B
BLU-109(D-1)/B	Practice	1,955 lb			Inert Filler E Composition (555 lb)	Detailed Information in MIDAS
BLU-110	Penetrator Bomb	992 lb			PBXN-109 (385 or 395 lb)	•Detailed Information in MIDAS for BLU-110A/B and BLU-110B/B •BLU-110A/B has somewhat less PBXN-109 than BLU-110B/B
BLU-111	Penetrator Bomb	517 lb			PBXN-109 (189 lb)	Detailed Information in MIDAS for BLU-111A/B
BLU-113	Penetrator Bomb	4,700 lb	Inventory (300)	1991	Tritonal (645 lb)	•Warhead on GBU-28 •Candidate Eglin Steel Alloy (ES-1) casing
BLU-114	"Blackout"/"Soft" Bomblet				Chemically Treated/Coated Carbon Graphite filaments or strands	Used in CBU-97 ("Blackout Bomb")
BLU-116/B	Penetrator Bomb	1,700 lb			PBXN-109 (240 lb)	•AUP case made of Nickel-Cobalt Steel Alloy (9430M or Air Force 1410) •Used in GBU-24 C/B •Compatible with AGM-130, GBU-15, GBU-24, GBU-27 •"Twin" of BLU-109/B •Can contain Tritonal?
BLU-117	Penetrator Bomb	1,970 lb			PBXN-109 (930 lb)	•Detailed Information in MIDAS for BLU-117A/B •Used in the GBU-10 Paveway II
BLU-118	Incendiary Bomb	500 lb	Obsolete	Viet Nam	Napalm	
BLU-118/B	Guided HTI Bomb	~1975 lb		2002	PBXIH-135 (Navy only?) (~560 lb)	•Air Force is pursuing Solid Fuel Air Thermobarics/Explosive using Hydrocarbon such as Gasoline or Methane and Aluminum Particles •Candidate thermobaric explosives included PBXIH-135, HAS-13, and SFAE (solid fuel air explosive) •Compatible with AGM-130, GBU-15, GBU-24

Table 3 Ingredients of PBXN-109 in BLU-110B/B

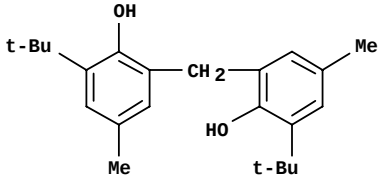
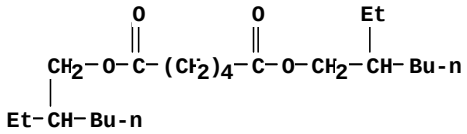
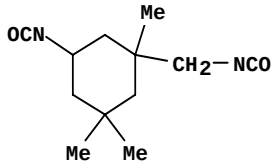
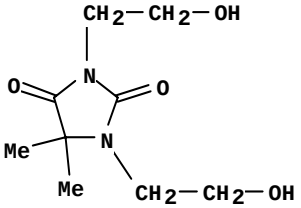
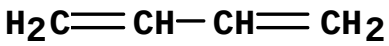
Ingredient (Abbreviation) [*CA Name*]	CASRN	Formula	Structure	Percentage of Total PBXN-109 by Weight	Amount in BLU-110B/B
2,2' Methylenebis(4-methyl-6-t-butylphenol) (AO) [*Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl- (9CI)*]	119-47-1	$C_{23}H_{32}O_2$		0.1%	0.4 lb
Aluminum [*Aluminum (8CI,9CI)*]	7429-90-5	Al	Not Applicable	20%	79 lb
Dioctyl adipate (DA) [*Hexanedioic acid, bis(2-ethylhexyl) ester (9CI)*]	103-23-1	$C_{22}H_{42}O_4$		7.35%	29 lb
Isophorone diisocyanate (IPDI) [*Cyclohexane, 5-isocyanato-1-(isocyanatomethyl)-1,3,3-trimethyl- (9CI)*]	4098-71-9	$C_{12}H_{18}N_2O_2$		0.95%	3.8 lb
N,N'-Bis(2-hydroxyethyl)dimethylhydantoin (HEDMH) [*2,4-Imidazolidinedione, 1,3-Bis(2-hydroxyethyl)-5,5-dimethyl-(9CI)*]	26850-24-8	$C_9H_{16}N_2O_4$		0.26%	1 lb
Polybutadiene (PBD) [*1,3-Butadiene, homopolymer (9CI)*]	9003-17-2 Component: 106-99-0	$(C_4H_6)_x$	Component : 	7.35%	29 lb

Table 4-A Regulatory Standards and Guidance for PBXN-109 Ingredients

Ingredient	CASRN	ACGIH TLV	ATSDR MRL	ATSDR PLHS	CAA HAP	CAA NAAQS	CAA Section 602	Cal ECIR	Cal Prop 65	CHPPM ITF-40
Al	7429-90-5	X		X						
AO	119-47-1									
DA	103-23-1			X						
HEDMH	26850-24-8									
IPDI	4098-71-9	X								
PBD	9003-17-2									
RDX	121-82-4	X	X	X						
TPB	603-33-8									

Table 4-A Regulatory Standards and Guidance for PBXN-109 Ingredients (continued)

Ingredient	CASRN	CLC FSL	CWA PPL	EPA DWSHA	NIOSH REL	OSHA PEL	RAIS FS RSG	SC POP	SDWA CCL	SDWA CCL2
Al	7429-90-5	X			X	X	X		X	X
AO	119-47-1									
DA	103-23-1			X						
HEDMH	26850-24-8									
IPDI	4098-71-9				X					
PBD	9003-17-2									
RDX	121-82-4	X		X	X		X		X	X
TPB	603-33-8									

Table 5-A Toxicology and Risk Assessment Information for PBXN-109 Ingredients

Ingredient	CASRN	ATSDR TP	Cal TCD	CHPPM Draft TE	CHPPM WTA	EPA ECOTOX	EPA IRIS	EPA IRIS 04	EPA IRIS SLR
Al	7429-90-5	X				X			
AO	119-47-1								
DA	103-23-1					X	X	X	
HEDMH	26850-24-8								
IPDI	4098-71-9								
PBD	9003-17-2								
RDX	121-82-4	X		X	X	X	X	X	
TPB	603-33-8								

Table 5-A Toxicology and Risk Assessment Information for PBXN-109 Ingredients (continued)

Ingredient	CASRN	EPA Region 3	EPA Region 9	IARC	NTP ICCEC	NPT ROC	ORNL TS	RAIS EB	RAIS TV
Al	7429-90-5	X	X	X			X	X	
AO	119-47-1			X					
DA	103-23-1	X	X						
HEDMH	26850-24-8								
IPDI	4098-71-9								
PBD	9003-17-2								
RDX	121-82-4	X	X				X	X	X
TPB	603-33-8								

Table 6 Example: Properties of PBXN-109 Ingredients (Continued)

Ingredient	CASRN	Properties			Notes
		Property	**Value/Condition**	**Note**	
		•**BCF**	2080 @ pH 1-10	(1)	
		•**BP**	162-163°C @ 14 Torr	(2)	
		•**BP**	158-159°C @ 15 Torr	(3)	
		•**BP**	286.9±13.0°C @ 760 Torr	(1)	
		•**EoV**	52.60±3.0 kJ/mol	(1)	(1) Calculated using Advanced Chemistry Development (ACD/Labs) Software Solaris V4.67 (2004 ACD/Labs) (2) Schmitt, Karl; US 3352913 1967 (3) Schmitt, Karl; DE 1202785 1965
		•**FP**	116.0±45.3°C	(1)	
IPDI	4098-71-9	•**H acceptors**	4	(1)	
		•**H donors**	0	(1)	
		•**K_{oc}**	8250 @ pH 1-10	(1)	
		•**logD**	4.67 @ pH 1-10	(1)	
		•**logP**	4.668±0.710	(1)	
		•**MS**	Sparingly Soluble @ pH 1-10	(1)	
		•**MW**	222.28	(1)	
		•**VP**	2.57 x 10^{-3} Torr @ 25°C	(1)	

The Way Forward

- **Develop and Verify Comprehensive Database (Tables 1-3)**
  - Specific Munitions of Specific Weapons Systems
  - Chemical Mixtures in Munitions
  - Ingredients and Impurities of Mixtures
  - Detonation, Combustion and Degradation Products
- **Develop Comprehensive Information Summaries (Tables 4-6)**
  - Regulatory Information
  - Toxicology and Risk Assessment Information
  - Chemical and Physical Properties
  - Fate and Transport Information
  - Analytical Methods

The Way Forward (Continued)

- **Develop Detailed, Specific Criteria and Guidance**
  - "Adequate," "Potential," "Substantial," "Widespread," "Persistent"
  - Rules of Thumb: Army Risk Assessment Modeling System; CHEMFATE
  - Professional Judgment
- **Develop Evaluation Reports and Fact Sheets**
  - Address Each Constituent that may be Released from Munitions Tested, Used or Treated on Ranges
  - Evaluation Reports Modeled after Table 7

Table 7 Example: Preliminary Evaluation of Isophorone Diisocyanate (IPDI)

Factor	Results
Occurrence	BLU-110B/B is a 992-pound penetrator that has been used on the B-1, B-2, B-52, F-5, F-15, and F-16 aircraft (Table 1-B). BLU-110B/B contains 395 pounds PBXN-109, an "insensitive" explosive mixture developed by the Navy. PBXN-109 is used, or has been used, in several other Air Force munitions, including AGM-86/D (prior to 1991), AGM-114/M, BLU-116/B, GBU-12, and MK-83: •Tables 2-A and 2-B •Air Force 2004-2005 Updated Weapons File: https://peonet.eglin.af.mil/weapons There are about 3.8 pounds of IPDI in the PBXN-109 in each BLU-110B/B (Table 3). Information on the testing, usage (for practice), low-order detonation and dud rates of BLU-110B/B is not sufficient to estimate the amount IPDI that may have been, or could be, released on Air Force ranges. However, most, if not all, of the IPDI is expected to be destroyed in high-order detonations, some IPDI may be released to the environment in low-order detonations, and all of the IPDI may eventually be released from duds if left in place. Usage of this large modern bomb for practice on ranges is expected to be limited, low-order detonations and duds are expected to be rare, leaving duds in place for long periods is unlikely, and testing is expected to be restricted to a small number of ranges.
Regulatory Standards/ Guidance	The ACGIH TLV and NIOSH REL for IPDI is 0.005 ppm in air (8-hour time-weighted average); NIOSH also recommends 0.02 ppm as the 15-minute short-term inhalation exposure limit, and provides a "skin notation:" •Table 4 •ACGIH Threshold Limit Values and Biological Exposure Limits (1999) •http://www.cdc.gov/niosh/npg/npgd0356.html •http://www.cdc.gov/niosh/pel88/4098-71.html No other guidance levels and no regulatory standards were found in sources examined. However, IPDI is on the list of Extremely Hazardous Substances mandated by Section 302 of the Emergency Planning Right-to-Know Act of 1986 (EPCRA): The EPCRA Reportable Quantity (RQ) for release incidents is 100 lbs and the Threshold Planning Quantity (TPQ) is 500 lbs: •http://www.safehometowns.org/appendix_a.pdf •http://www.epa.gov/fedrgstr/EPA-TRI/2003/September/Day-08/tri22770.htm

Table 7 Example: Preliminary Evaluation of Isophorone Diisocyanate (IPDI) (Continued)

Factor	Results
Toxicology and Risk Assessment	No regulatory toxicology or toxicology guidance information was found for IPDI in the sources examined (Table 5). However, twenty three (23) "adverse effect, including toxicity" references were found using SciFinder. These studies address primarily the occupation-related allergic contact dermatitis and respiratory irritation and allergy (asthma) caused by IPDI. A report found in a broader Internet search suggests that aromatic isocyanates (including IPDI) may be carcinogens (http://www.epa.gov/dfe/pubs/auto/profile/diisopro.pdf), based on analogy to toluene diisocyanate and 3,3'-dimethoxybenzidine-4,4'-diisocyanate. The latter were found to be carcinogenic in rodents in two-year repeated-dose studies by the oral exposure route.
Properties	IPDI is sparingly soluble in water, and is expected to have a significant potential for bioconcentration in the environment (Table 6).
Fate and Transport	No relevant references for "the fate and transport of IPDI in soil, water or air" were found using SciFinder. A broader Internet search revealed that IPDI decomposes on burning to produce "toxic fumes including nitrogen oxides, hydrogen cyanide, carbon monoxide, carbon dioxide." Also, IPDI "reacts slowly with water at room temperature, vigorously at high temperature, to produce toxic and corrosive substances:" •http://www.inchem.org/documents/icsc/icsc/eics0499.htm •http://www.state.nj.us/health/eoh/rtkweb/1068.pdf Hydrolysis and sorption are apparently the primary fate mechanisms of IDPI in the environment (http://www.epa.gov/dfe/pubs/auto/profile/diisopro.pdf). Hydrolysis of the N=C=O can occur within hours, although the low water solubility of IPDI will reduce rate of hydrolysis in the environment. In the absence of hydrolysis, sorption to soils and sediments will be substantial. The hydrolysis or sorption of IPDI will substantially limit or prevent the migration of IPDI in soil to groundwater and surface water. The biodegradation of IPDI is minimal, and degradation of the hydrolysis products of IPDI will vary depending on the moieties formed. IPDI is not expected to degrade in the atmosphere – The removal of IPDI from air occurs by washout or dry deposition. Volatilization of IPDI is negligible. The volatilization of IPDI from surface waters would be expected to take years. The information available was not sufficient to identify comprehensively the likely products of detonation, combustion, or hydrolysis of IPDI.
Analytical Methods	Methods for measuring concentrations in air to determine occupational exposures were found in a broad Internet search: •http://www.osha.gov/dts/chemicalsampling/data/CH_248100.html •http://www.irsst.qc.ca/en/_RSST4098-71-9.html However, no methods were found for measuring IPDI concentrations in soil or water in a SciFinder search or a broader Internet search.

Table 7 Example: Preliminary Evaluation of Isophorone Diisocyanate (IPDI) (Continued)

Topic	Results
Conclusions	Preliminary evaluation indicates little or no release of IPDI from BLU-110B/B on Air Force ranges. Any releases from the testing or usage of BLU-110B/B are unlikely to exceed the EPCRA RQ (100 lbs.). IPDI may be carcinogenic. However, the small quantities of IPDI that may be released from BLU-110B/Bs would be highly sorbed to soils and sediments or hydrolyzed in water. Thus, IPDI has little potential to contaminate groundwater or surface water, which therefore represent incomplete or negligible exposure pathways for potential human receptors. Inhalation and dermal exposures to IPDI sorbed to airborne surface soil particles are possible, but are unlikely to be significant. IPDI has the potential to bioconcentrate in the environment. However, the small quantities of IPDI that may be released from BLU-110B/Bs on ranges and the limited potential for IPDI transport from ranges suggests that the bioconcentration of IPDI represents an unlike threat to potential human or ecological receptors. The information available is not sufficient to identify all of the likely detonation, combustion, hydrolysis or other degradation products of IPDI in the environment. However, the small quantities of IPDI that may be released from BLU-110B/Bs on ranges suggests that the breakdown products of IPDI are unlikely threats to human or ecological receptors. The available information does not indicate that IPDI is a likely emerging constituent. This is because substantial and widespread release of IPDI is not expected from the testing and usage of BLU-110B/B on Air Force ranges, and no new analytical methods were found for IPDI in the preliminary search conducted for this exercise.
Recommendations	•Conduct a comprehensive search for information on the testing, usage, low-order-detonation and dud rates of BLU-110B/B on Air Force ranges to characterize the likely occurrence of IPDI with greater certainty. •Conduct a comprehensive literature search and continue to monitor the scientific literature on the toxicity of IPDI to enable early detection of emerging issues (e.g., a demonstration of the carcinogenic potential of IPDI) and a pro-active approach to addressing these issues. •Conduct a comprehensive literature search and continue to monitor the scientific literature on analytical methods under development for measuring IPDI in ambient air, soil and water to enable the early detection of emerging issues (e.g., a demonstration that there are measurable concentrations of IPDI in groundwater at ranges), and a pro-active approach to addressing these issues. •Conduct a comprehensive search of the scientific literature to identify the likely products of the detonation, combustion, hydrolysis, and biodegradation of IPDI in the environment to enable complete assessment of the potential for IPDI on ranges to threaten human health or the environment.

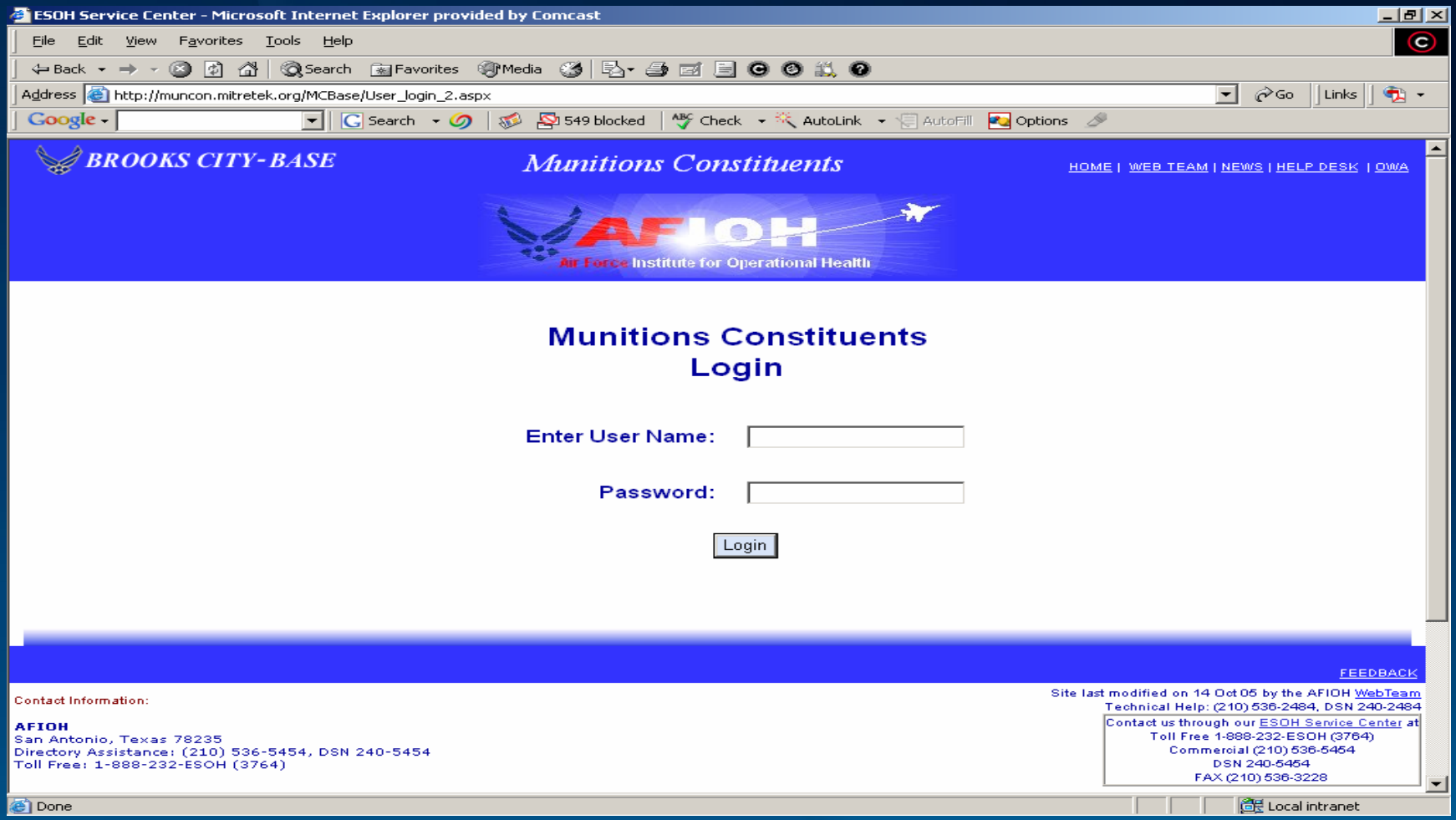
Summary of Strategy

- **Strategy for Identifying and Evaluating Munitions Constituents on Air Force Ranges**
- **Process is:**
  - Comprehensive
  - Systematic
  - Fully Documented
- **Solid Foundation for:**
  - Developing Technically Defensible, Credible Range Assessment Studies
  - Meeting Requirements of DOD Directive 4715.11
  - Addressing Emerging Constituents Proactively

Website

- **Purpose**
  - Display Information Generated Through Implementation of the Strategy
  - Facilitate Gathering and Evaluating New Information and Identifying Information gaps
- **User Roles**
  - Reviewer
  - Range Administrator
  - Content Administrator
  - Analyst
  - User Administrator
  - Security Administrator
  - Super Administrator

Web Site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Air Force Institute for Operational Health
Munitions Constituents Login
Enter User Name:
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Login
FEEDBACK
Contact Information:
AFIOH
San Antonio, Texas 78235
Directory Assistance: (210) 536-5454, DSN 240-5454
Toll Free: 1-888-232-ESOH (3764)
Site last modified on 14 Oct 05 by the AFIOH WebTeam
Technical Help: (210) 536-2484, DSN 240-2484
Contact us through our ESOH Service Center at
Toll Free 1-888-232-ESOH (3764)
Commercial (210) 536-5454
DSN 240-5454
FAX (210) 536-3228
Done
Local intranet

User Functions

- **Range Administrator (e.g., Range Operator, Base Historian)**
  - Enter/Edit Information and Run Reports on a Specified set of Ranges
  - Some may have Access to Information for all Ranges
  - Source of Range-Based Information
- **Content Administrator (e.g., Weapons Expert, Chemist)**
  - Enter/Edit Information Across all Ranges and Services
  - Weapons Systems, Munitions, MCs
- **Analyst (e.g., Chemist, Hydrogeologist, Risk Assessor)**
  - Run Reports for MCs Across all Ranges and Services
  - Evaluate each MC as a COC or EC using Decision-Tree

User Roles

Range-Specific User can Download:

- **Likely COCs Based on Weapons Systems and Munitions Tested or Used on Range**
  - Point-of-Departure for Selection of COCs to Assess or Monitor
  - Subset of Likely COCs from Website
- **Pertinent Regulatory Standards and Toxicity Values**
- **Validated Analytical Methods for Likely COCs**
- **Fact Sheets Explaining why each MC on Range is or is not a Likely COC**

User Roles (continued)

Analyst can Develop:

- **High-Level Evaluations of MCs Based on Information on the Website**
- **Recommendations to Guide Development of Research Projects and Programs for COCs and ECs**
- **Fact Sheets for Use by Range Managers, Acquisitions Personnel, Policy Makers, *etc*…**

Summary of Website

- **Founded on the Strategy**
- **Tool for:**
  - Facilitating Implementation of the Strategy
  - Gathering and Organizing Pertinent Information
  - Making Information Accessible to Defined Users
  - Identifying Critical Information and Technical Gaps
  - Guide Development of Research Projects and Programs
- **Secure Access to Information and Functions**

Comments and Questions

- **Focus-Group Meeting**
  - Input on Future Development of the Website
  - Maximize Usability and Usefulness to Range Managers and Operators
- **Contact**

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- Mr. Drew Rak (Mitretek Systems)

Backup Material

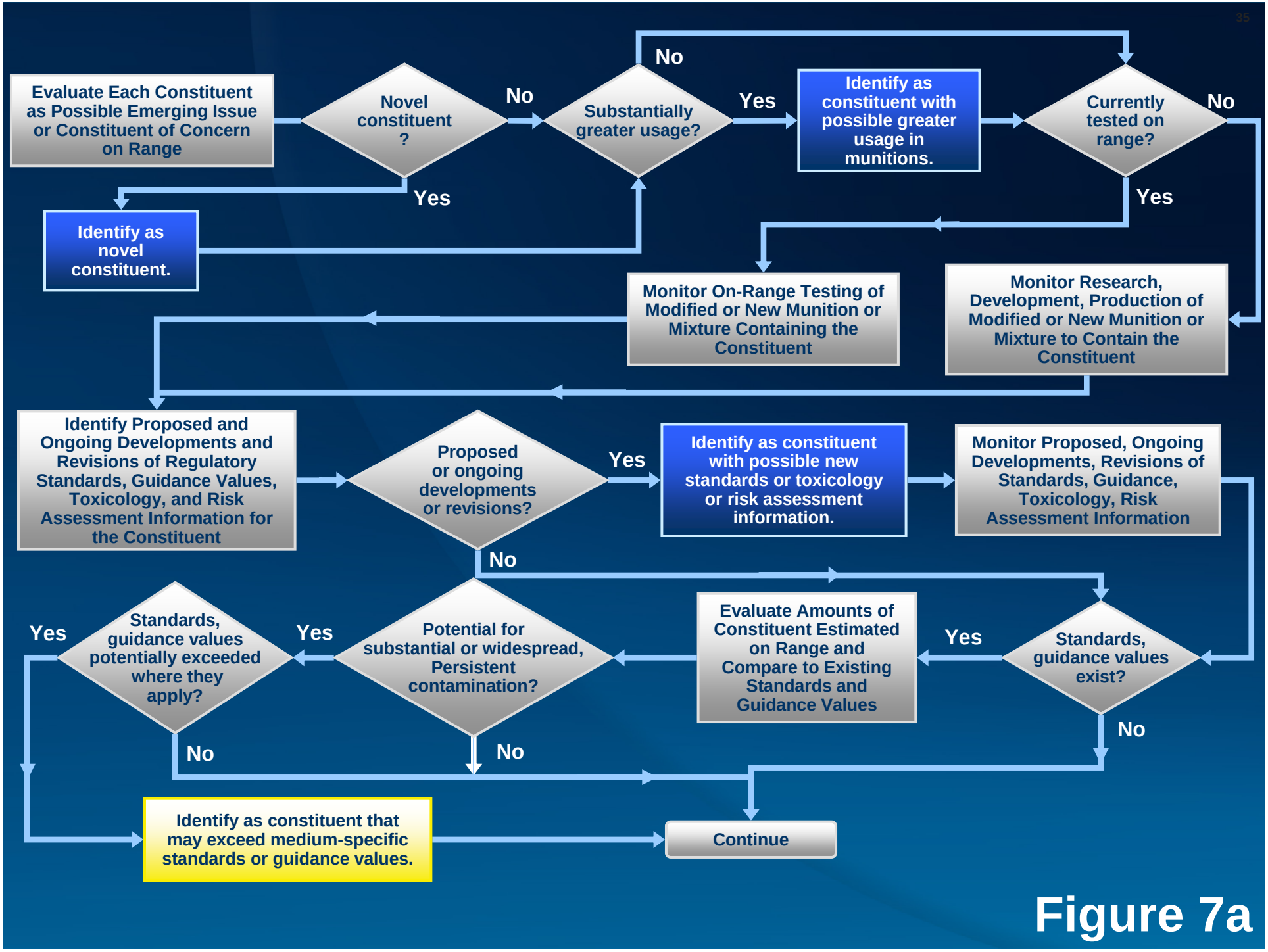
Evaluate Each Constituent as Possible Emerging Issue or Constituent of Concern on Range
Novel constituent ?
No
Yes
Identify as novel constituent.
Substantially greater usage?
No
Yes
Identify as constituent with possible greater usage in munitions.
Currently tested on range?
No
Yes
Monitor On-Range Testing of Modified or New Munition or Mixture Containing the Constituent
Monitor Research, Development, Production of Modified or New Munition or Mixture to Contain the Constituent
Identify Proposed and Ongoing Developments and Revisions of Regulatory Standards, Guidance Values, Toxicology, and Risk Assessment Information for the Constituent
Proposed or ongoing developments or revisions?
Yes
Identify as constituent with possible new standards or toxicology or risk assessment information.
Monitor Proposed, Ongoing Developments, Revisions of Standards, Guidance, Toxicology, Risk Assessment Information
No
Standards, guidance values exist?
Yes
Evaluate Amounts of Constituent Estimated on Range and Compare to Existing Standards and Guidance Values
Potential for substantial or widespread, Persistent contamination?
Yes
Standards, guidance values potentially exceeded where they apply?
Yes
No
No
No
Identify as constituent that may exceed medium-specific standards or guidance values.
Continue

Figure 7a

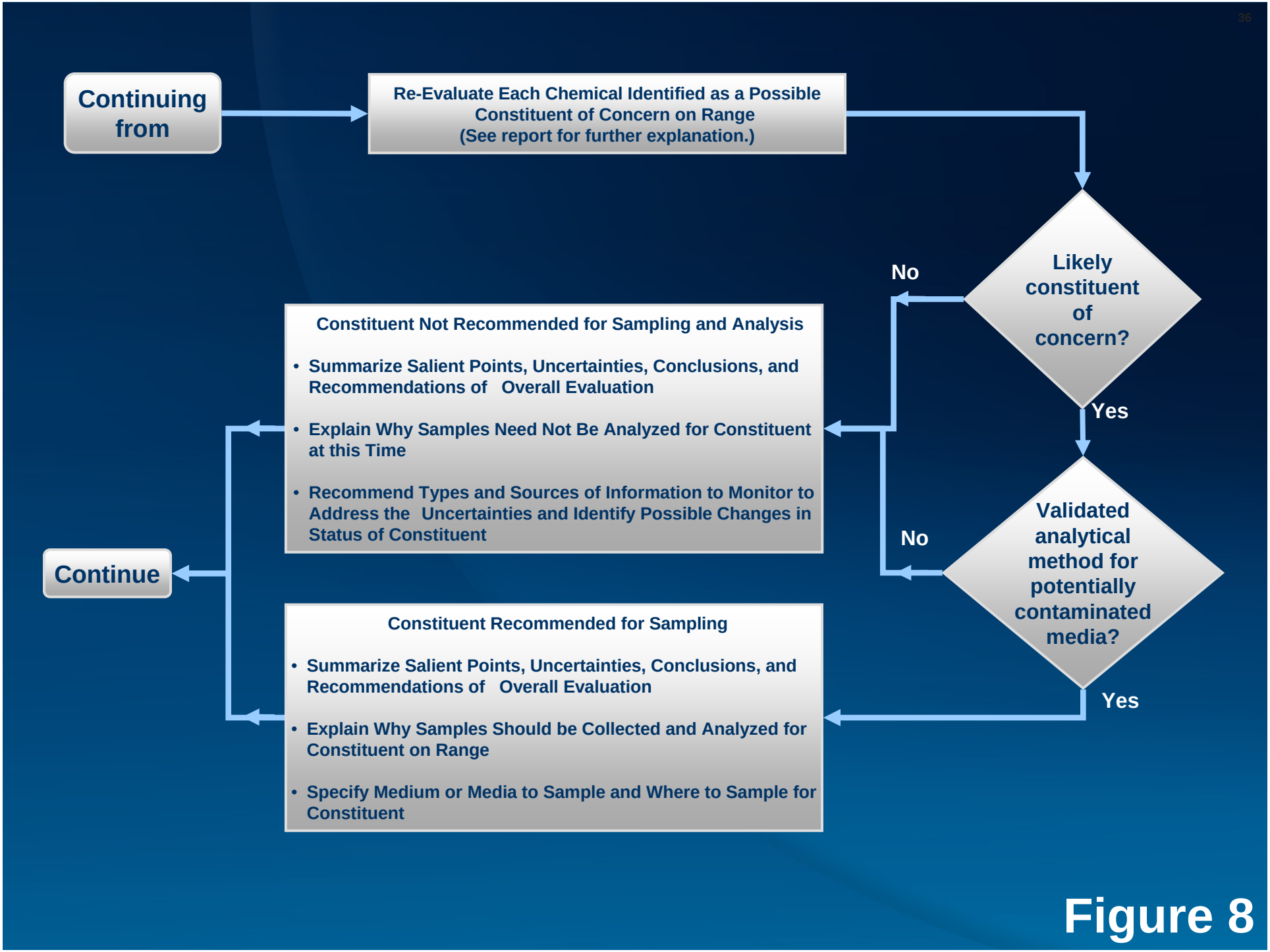
Continuing from
Re-Evaluate Each Chemical Identified as a Possible Constituent of Concern on Range
(See report for further explanation.)
Likely constituent of concern?
No
Yes
Constituent Not Recommended for Sampling and Analysis
• Summarize Salient Points, Uncertainties, Conclusions, and Recommendations of Overall Evaluation
• Explain Why Samples Need Not Be Analyzed for Constituent at this Time
• Recommend Types and Sources of Information to Monitor to Address the Uncertainties and Identify Possible Changes in Status of Constituent
Validated analytical method for potentially contaminated media?
No
Yes
Continue
Constituent Recommended for Sampling
• Summarize Salient Points, Uncertainties, Conclusions, and Recommendations of Overall Evaluation
• Explain Why Samples Should be Collected and Analyzed for Constituent on Range
• Specify Medium or Media to Sample and Where to Sample for Constituent

Figure 8

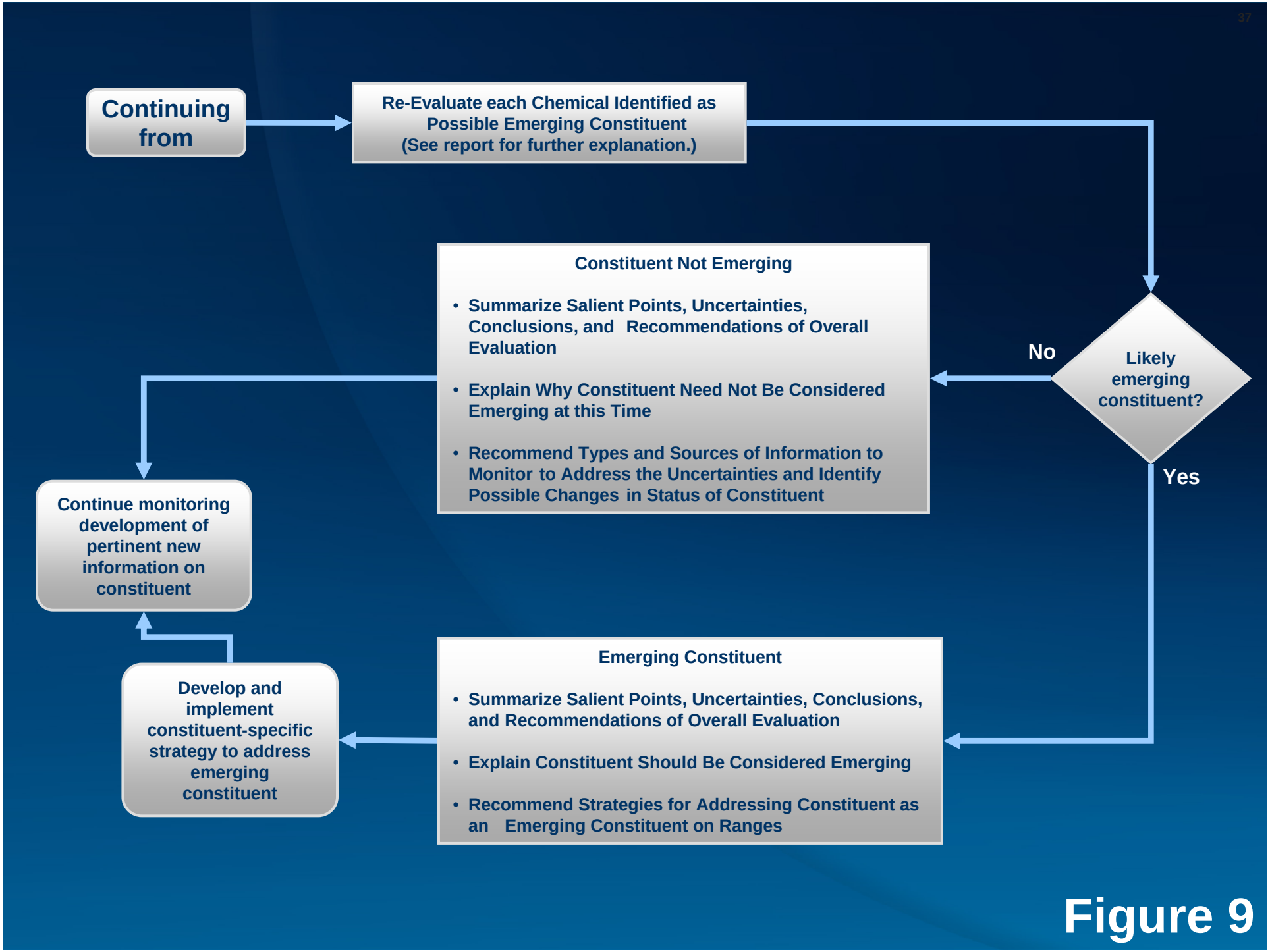
Continuing from
Re-Evaluate each Chemical Identified as Possible Emerging Constituent (See report for further explanation.)
Likely emerging constituent?
No
Yes
Constituent Not Emerging
• Summarize Salient Points, Uncertainties, Conclusions, and Recommendations of Overall Evaluation
• Explain Why Constituent Need Not Be Considered Emerging at this Time
• Recommend Types and Sources of Information to Monitor to Address the Uncertainties and Identify Possible Changes in Status of Constituent
Continue monitoring development of pertinent new information on constituent
Develop and implement constituent-specific strategy to address emerging constituent
Emerging Constituent
• Summarize Salient Points, Uncertainties, Conclusions, and Recommendations of Overall Evaluation
• Explain Constituent Should Be Considered Emerging
• Recommend Strategies for Addressing Constituent as an Emerging Constituent on Ranges

Figure 9

Purpose

Perspective 1

Develop Comprehensive, Systematic Process to:

- **Identify MCs on Ranges**
  - May Have Been Released (Past)
  - May Be Released (Current and Future)
- **Evaluate MCs as Potential COCs and ECs**
  - Identify Likely COCs for Range Assessments
  - Identify Likely ECs to Address Proactively
- **Identify Critical Information and Technical Gaps:**
  - Occurrence
  - Standards & Guidance
  - Toxicology & Risk Assessment
  - Chemical & Physical Properties
  - Fate & Transport
  - Analytical Methods

Acronyms and Abbreviations for Table 2

Acronyms

ADW:	Agent Defeat Warhead	**EGBU:**	Enhanced Guided Bomb Unit	**LOCAAS:**	Low Cost Autonomous Attack System
AFX:	Air Force Explosive	**EMD:**	Engineering Manufacture and Development	**LRIP:**	Low Rate Initial Production
AGM:	Air-to-Ground Missile	**FAE:**	Fuel-Air Explosive	**MIDAS:**	Munitions Items Disposition Action System
AM:	Anti-Materiel	**GBU:**	Guided Bomb Unit	**MMC:**	Miniature Munition Capability
APAM:	Anti-Personnel Anti-Materiel	**GP:**	General Purpose	**oz:**	Ounces
AT:	Anti-Tank	**GPS:**	Global Positioning System	**PBX:**	Plastic/Polymer-Bonded Explosive
AUP:	Advanced Unitary Penetrator	**GSX:**	Gelled-Slurry Explosive	**PBXIH:**	Plastic/Polymer-Bonded Explosive, Indian Head
BDU:	Bomb, Dummy Unit	**HAS:**		**PBXN:**	Plastic/Polymer-Bonded Explosive, Navy
BLU:	Bomb Live Unit	**HE:**	High Explosive	**PBXW:**	
C&B:	Chemical and Biological	**HMX:**	High Melting Explosive	**PDU:**	Printed Data for Dispensers
CBU:	Cluster Bomb Unit	**HNS:**	Hexanitrostilbine	**PETN:**	Pentaerythrite Tetranitrate
CBW:	Chemical and Biological Weapon	**HTI:**	High-Temperature Incendiary	**RDX:**	Royal Demolition/Dutch Explosive
CEB:	Combined Effects Bomb	**HTPB:**	Hydroxyl-Terminated Polybutadiene	**SBS:**	Small Bomb System
COPC:	Constituent of Potential Concern	**IOC:**	Initial Operational Capability	**SDB:**	Small-Diameter Bomb
CS:	o-Chlorobenzylmalononitrile (tear gas)	**IR:**	Infrared	**SDD:**	System Development and Demonstration
CXU:	Charge Spotting Bomb Unit	**JASSM:**	Joint Air to Surface Stand-Off Missile	**SFAE:**	Solid Fuel-Air Explosive
DSHTW:	Direct Strike Hard Target Weapon	**JDAM:**	Joint Direct Attack Munition	**SFW:**	Sensor Fused Weapon
DST:	Destructor	**JSOW:**	Joint Stand-Off Weapon	**SSB:**	Small smart bomb
DTRA:	Defense Threat Reduction Agency	**JSSAM:**	Joint Air to Surface Standoff Missile	**SUU:**	Suspended Utility Unit
E/B:	Enhanced Bomb	**LBU:**	Leaflet Bomb Unit	**TNT:**	2,4,6-Trinitrotoluene
EFP:	Explosively Formed Penetrator	**LGB:**	Laser Guided Bomb	**TV/IR:**	Video/Infrared Camera
		LGTR:	Laser Guided Training Round	**WWII:**	World War II
		MOAB:	Massive Ordnance Air Blast Bomb	**PBX:**	Plastic/Polymer-Bonded Explosive

Abbreviations

~:	Approximately
CL:	Class
CL-20:	Hexanitrohexaazaisowurtzitane
CS:	o-Chlorobenzylmalononitrile (tear gas)
gl:	Gallons
gm:	Grams
gr:	Grains
lb:	Pounds
MK:	Mark
	= No Information Found or Information Incomplete or Questionable

References for Table 2

GlobalSecurity.org: http://www.globalsecurity.org/military/systems/index.html
Air Force Link: http://www.af.mil/factsheets/
Air Force 2004-2005 Updated Weapons File: https://peonet.eglin.af.mil/weapons
Federation of American Scientists (FAS): http://www.fas.org/man/dod-101/sys/ac/equip/index.html
Aerospaceweb Aircraft Museum: http://www.aerospaceweb.org/aircraft/
MIDAS: Munitions Items Disposition Action System, Defense Ammunition Center, US Army
PACAF Instruction 21-202: http://www.e-publishing.af.mil/pubfiles/pacaf/21/pacafi21-202/pacafi21-202.pdf
Various Internet search results using Google Browser
Venik's Aviation, Aviation Bombs: USA: http://216.239.39.104/search?q=cache:N4_3NFTHsxIJ:www.aeronautics.ru/archive/reference/Aviation_Bombs/USA.htm+BLU-17+weight&hl=en

Table 4A and 4B - Abbreviations / Acronyms for PBXN-109 Ingredients

Al:	Aluminum
AO:	Anti-Oxidant
DA:	Dioctyl adipate
HEDMH:	N,N'-Bis(2-hydroxyethyl)dimethylhydantoin
IPDI:	Isophorone diisocyanate
PBD:	Polybutadiene
RDX:	Royal Demolition/Dutch Explosive
TPB	Triphenylbismuth

= No Standards or Guidance for Ingredient

Table 4A and 4B - Abbreviations / Acronyms for Regulatory and Guidance Lists

ACGIH TLV:	American Conference of Governmental Industrial Hygienists - Threshold Limit Values
ATSDR MRL:	Agency for Toxic Substance and Disease Registry – Minimal Risk Levels
ATSDR PLHS:	Agency for Toxic Substance and Disease Registry - Priority List of Hazardous Substances
CAA HAP:	Clean Air Act - Hazardous Air Pollutants
CAA NAAQS:	Clean Air Act – National Ambient Air Quality Standards
CAA Section 602:	Clean Air Act - Section 602
Cal ECIR:	California Environmental Protection Agency - Emergent Chemical Information Request
Cal Prop 65:	California Environmental Protection Agency - Proposition 65
CHPPM ITF-40:	Center for Health Promotion and Preventive Medicine – International Task Force-40
CLC FSL:	CleanupLevels.com – Federal Screening Levels
CWA PPL:	Clean Water Act - Priority Pollutants List
EPA DWSHA:	US Environmental Protection Agency - Drinking Water Standards and Health Advisories
NIOSH REL:	National Institute for Occupational Health and Safety – Recommended Exposure Limits
OSHA PEL:	Occupational Safety and Health Administration -Permissible Exposure Limits
RAIS FS RSG:	Risk Assessment Information System – Federal and State Regulatory Requirements and Guidance
SC POP:	Stockholm Convention - Persistent Organic Pollutants
SDWA CCL:	Safe Drinking Water Act - Candidate Contaminant List
SDWA CCL2:	Safe Drinking Water Act - Candidate Contaminant List 2
SDWA NDWR:	Safe Drinking Water Act - National Drinking Water Regulations
SNR HEEC:	Second National Report - Human Exposure to Environmental Chemicals
USGS:	US Geological Survey

Table 5A and 5B - Abbreviations / Acronyms for PBXN-109 Ingredients

Al:	Aluminum
AO:	Anti-Oxidant
DA:	Dioctyl adipate
HEDMH:	N,N'-Bis(2-hydroxyethyl)dimethylhydantoin
IPDI:	Isophorone diisocyanate
PBD:	Polybutadiene
RDX:	Royal Demolition/Dutch Explosive
TPB	Triphenylbismuth

= No Information for Ingredient

Table 5A and 5B - Abbreviations / Acronyms for Regulatory and Guidance Lists

ATSDR TP:	Agency for Toxic Substance and Disease Registry –Toxicity Profiles
Cal TCD:	California Environmental Protection Agency - Toxicity Criteria Database
CHPPM Draft TE:	Center for Health Promotion and Preventive Medicine – Draft Toxicity Evaluations
CHPPM WTA:	Center for Health Promotion and Preventive Medicine – Wildlife Toxicity Assessments
EPA ECOTOX:	US Environmental Protection Agency – Ecological Toxicity Database
EPA IRIS:	US Environmental Protection Agency – Integrated Risk Information System
EPA IRIS 04:	US Environmental Protection Agency – Integrated Risk Information System 2004 Update
EPA IRIS SLR:	US Environmental Protection Agency – Integrated Risk Information System Screening-Level Review
EPA Region 3:	US Environmental Protection Agency – Region 3
EPA Region 9:	US Environmental Protection Agency - Region 9
IARC:	International Agency for Research on Cancer
NTP ICCEC:	National Toxicology Program - Interagency Committee for Chemical Evaluation and Coordination
NPT ROC:	National Toxicology Program - Report on Carcinogens
ORNL TS:	Oak Ridge National Laboratory – Toxicity Summaries
RAIS EB:	Risk Assessment Information System – Ecological Benchmarks
RAIS TV:	Risk Assessment Information System – Toxicity Values

The Way Forward (Continued)

- **Consult Reliable, Accurate Information Sources, such as:**
  - Range Operators and Managers
  - Air Force Weapons Experts
  - MIDAS
  - Technical Manuals/Orders
  - Army Armament Research and Development Command (ARDC)
  - Air Force Research Laboratory (AFRL)
  - Army Defense Ammunition Center (DAC)
  - Strategic and Environmental Research and Development Program (SERDP)
  - State and Federal Regulatory Agencies
  - Non-Government Organizations
  - Army CHPPM
  - Chemical Abstracts Service

Strategy Document

- **Title:** *Strategy for Identifying and Evaluating Munitions Constituents and Emerging Constituents on Air Force Ranges*
- **Date: 31 January 2005**
- **Mitretek Systems**
- **Air Force Institute for Operational Health (AFIOH)**