Indo-US

Workshops on

Security of Dual use Agrochemicals

Improving Security at Vulnerable Locations in the Agrochemical Supply Chain

2017

August 1, 2017 New Delhi
Dr. Jitendra Kumar, Coordinator

August 4, 2017 GFSU, Gandhinagar, Gujarat
Prof. V. K. Jain & Prof. Y.K. Agrawal, Coordinators

August 8, 2017 CSIR-IICT, Hyderabad
Dr. G. V. M. Sharma & Dr. K. V. Raghavan Coordinators

Institute of Pesticide Formulation Technology

Gujarat University Ahmedabad

GFSU Gujarat Forensic Sciences University

CSIR-IICT, Hyderabad, India

Pacific Northwest National Laboratory

CSP Chemical Security Program

Oregon State University

Abstracts

CSIR-Indian Institute of Chemical Technology

Hyderabad - 500 007

About CSIR-IICT

CSIR-Indian Institute of Chemical Technology, a constituent of CSIR is a leading research Institute in the area of chemical sciences. The core strength of IICT lies in Organic Chemistry and it continues to excel in this field for over seven decades. The research efforts during these years have resulted in the development of several innovative processes and products necessary for human welfare such as drugs, agrochemicals, food, organic intermediates, adhesives etc. More than 150 technologies developed by IICT are now in commercial production. The R&D work is fully geared to meet the requirements of technology development, transfer and commercialization. IICT has active collaborations with several countries including France, Germany, UK, Switzerland, Italy, USA, Australia, Japan, Korea etc. One of the main strengths of IICT is its rich pool of scientists and PhD students numbering over 700. The scientific training imparted by the institute led to the high quality researchers of global standard.

About Hyderabad

Hyderabad, the capital city of Telangana state is historically known as City of Pearls. It has several industries, research and financial institutions. Special economic zones dedicated to information technology have encouraged companies from across India and around the world to set up operations and the emergence of pharmaceutical and biotechnology industries in the 1990s led to the area's naming as India's "Genome Valley". There are several tourist attractions such as Charminar, Golkonda Fort, Birla Temple, Makkah Masjid, Hussain Sagar lake, Film City, Silicon Valley, Shilparamam, Salarjung Museum and several other historical places to have memorable time at Hyderabad.




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Pacific Northwest National Laboratory

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Oregon State University

Abstracts

सत्यमेव जयते

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सचिव, भारत सरकार
वैज्ञानिक और औद्योगिक अनुसंधान विभाग, तथा
महानिदेशक

Girish Sahni
Secretary, Govt. of India
Department of Scientific & Industrial Research, and
Director General

वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
Anusandhan Bhawan, 2, Rafi Marg, New Delhi-110001

Message

The contribution of chemical sector in food, nutraceuticals, Drugs & Pharmaceuticals, materials and other fields is immense. The chemical secor is playing a key role in our day-to-day life of human being. The safety and security of chemicals, thus acquires immense importance, since some of the chemicals can be used both for constructive and destructive purposes. Though lot has been discussed about 'Chemical Safety' and practised, the concept on 'Chemicals Security' is an emerging topic.

It is a great pleasure for me to announce, that three workshops are being proposed in 2017 on the 'Security of Dual Use Agrochemicals (improving security at vulnerable locations in the agrochemicals supply chain), at different venues, i.e. New Delhi, Ahmedabad and Hyderabad, by CSIR-Indian Institute of Chemical Technology, Hyderabad, India; Pacific Northwest National Laboratory (PNNL), US Chemical Safety Program (CSP), Oregon State University (OSU), USA Institute of Pharmaceutical Formulations Technology, Gujarat University and Gujarat Forensic Science University to expand the knowledge in wider parts of the country.

I am pleased to learn that the organizers have planned series of such joint workshops every year, not only in India, but also in other countries of the region, to bring awakening in the community, for appropriate contributions to the safer well-being of global population.

I wish the program a grand success.

[Girish Sahni]

New Delhi

August 2, 2017

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CSIR - Indian Institute of Chemical Technology
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
(Council of Scientific & Industrial Research)
(विज्ञान और प्रौद्योगिकी मंत्रालय, भारत सरकार / Ministry of Science & Technology, Govt. of India)
तारनाका Tarnaka, हैदराबाद Hyderabad - 500 007, T.S, भारत India

डॉ. एस. चंद्रशेखर एफएनएएससी, एफएएससी, एफएनए
निदेशक

Dr. S. Chandrasekhar, FNASc, FASc, FNA
Director

July 21, 2017

Message

It's a great pleasure for me to be associated with the proposed Indo-US Workshops-2017 on the 'Security of Dual Use Agrochemicals (improving security at vulnerable locations in the agrochemicals supply chain)', in continuation of the similar Indo-US Workshop on 'Chemical Security' of 'dual use' chemicals in 2016, jointly by PNNL & USCSP, USA and CSIR-IICT, India. As part of the program of 2017, three workshops are being proposed at different venues - New Delhi, Ahmedabad and Hyderabad, by PNNL, USCSP, Oregon State University, USA; Institute of Pharmaceutical Formulations Technology, Gujarat University and Gujarat Forensic Science University and CSIR-Indian Institute of Chemical Technology, India. It is heartening to note that several such joint workshops are being planned all over the country and in other countries of the region in the coming years, to bring awareness amongst the populations. The safety and security of chemicals is of utmost importance, since the dual use chemicals can even be used for destructive purposes. Thus, the proposed workshops on 'Chemical Security' are of high importance.

I welcome all the eminent participants, speakers and observers from Industry, Academia and Government and other agencies. I am sure, the outcomes of the workshop are going to be very useful for the Governments, both in India and USA, to come out with improved regulations towards the 'Chemical Security' of Dual Use chemicals.

(S. Chandrasekhar)

MESSAGE

For more than 50 years, the Pacific Northwest National Laboratory (PNNL) has advanced the frontiers of science and engineering in the service of humanity. We make fundamental scientific discoveries that illuminate the mysteries of our planet and the universe. We apply our scientific expertise to tackle some of the most challenging problems in energy, the environment, and security. We are honored to combine forces with our colleagues from the Council of Scientific and Industrial Research, Indian Institute of Chemical Technology, Gujarat Forensics Science University, Institute of Pesticide Formulation Technology, National Academy of Agricultural Sciences, Oregon State University, and the U.S. Department of State's Chemical Security Program to develop and provide training to enhance agrochemical security. We look forward to continuing this engagement with our U.S. and Indian colleagues -- to work together to improve chemical security around the world.

On behalf of Dr. Steven Ashby (Director of PNNL) and Jack Dishner (U.S. Department of State's Chemical Security Program), I warmly welcome you to this workshop.

Clifford S. Glantz
Chemical Security Project Director and Senior Staff Scientist
Pacific Northwest National Laboratory

Institute of Pesticide Formulation Technology
Sector -20, Udyog Vihar, Gurgaon-122 016.

Message

It's a great pleasure for me to be associated with the proposed Indo-US Workshops-2017 on the 'Security of Dual Use Agrochemicals (improving security at vulnerable locations in the agrochemicals supply chain). As part of the program of 2017, three workshops are being proposed at different venues - New Delhi, Ahmedabad and Hyderabad, by PNNL, USCSP, Oregon State University, USA; Institute of Pesticide Formulations Technology, Gurugram Gujarat University and Gujarat Forensic Science University and CSIR-Indian Institute of Chemical Technology, India. It is heartening to note that several such joint workshops are being planned all over the country and in other countries of the region in the coming years, to bring awareness amongst the populations.

Agrochemicals like fertilizers and pesticides, have given farmers a powerful means to enhance growth and control pests infestation problems. However, apart from the concerns of potential impacts on human and environmental health, producers now have new concerns about agricultural chemicals. The safety and security of chemicals is of utmost importance, since the dual use chemicals can even be used for destructive purposes. Thus, the proposed workshops on 'Chemical Security' are of high importance.

I extend my hearty welcome to all the International guests, eminent speakers and participants from Industry, Academia and Government Department. I am sure, the outcomes of the workshop will be very useful for the Governments, to come out with improved regulations towards the 'Chemical Security' of Dual Use agrochemicals.

(Jitendra Kumar)

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Prof. H. A. Pandya
Vice Chancellor

Message

The use and availability of hazardous agrochemicals, such as pesticides, is widespread and these chemicals are of great importance. Security in the manufacture, transport, distribution, and storage of these chemicals is of utmost concern. I am happy that INDO-US workshops on security of dual use agrochemicals (Improving Security at Vulnerable Locations in the Agrochemical Supply Chain) is being organised at Delhi, Ahmedabad and Hyderabad. Eminent Indian and US speakers will dwell on the dual use agrochemicals and the security concerns. I am sure that these one day INDO -US workshops will combine expertise, tools, techniques and promote international chemical security best practices, used in US and India that could be deployed more broadly across the region. I extend my best wishes for the great success of these one day INDO-US workshops.

With Best Wishes

Prof. (Dr.) H. A. Pandya

Message

Around the world there is a need to ensure that agrochemicals are safely and securely stored for their intended purposes. Throughout the agrochemical supply chain, security precautions can reduce the likelihood that terrorists may acquire, through theft or purchase, hazardous agrochemicals or their precursors for use in developing terror weapons.

I am happy that US Department of Energy's Pacific Northwest National Laboratory (PNNL), and Oregon State University, USA; Institute of Pesticide formulation Technology, Gurugram; Gujrat Forensic Science University, Gandhinagar, Gujarat University, Ahmedabad and CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, are jointly organizing one day Workshops at three different locations on security of dual use agrochemicals (Improving Security at Vulnerable Locations in the Agrochemical Supply Chain). I am sure that deliberations and interactions during these workshops will bring out fruitful results and will help recommend a right approach for the security of agrochemicals. I wish grand success to these workshops.

Dr. J.M. Vyas

Theme of Workshop

The agrochemicals in India are highly regulated. The insecticide Act (1968) and Insecticide rules (1971) regulate their import, registration process, manufactures, sale, transport and distribution. They have to necessarily undergo the registration process with the central Insecticide Board of India and can be made available for use or sale. For setting up agrochemical manufacturing plants or their expansion in India, the clearance has to be obtained by the State Pollution Control Boards after submitting the reports on hazard and risk analysis and environment impact assessment as per the Environment Protection Act (1986).

The dual use agrochemicals in the world [signatories of Chemical Weapons Convention (CWC) including India] are governed by the regulations of the Organization for the Prohibition of Chemical Weapons (OPCW) at The Hague, The Netherlands. They are listed under schedules 2 and 3 of the CWC Act. The National Authority on Chemical Weapons Convention (NACWC) is established at the Cabinet Secretariat, Government of India for working on safety and security of dual purpose chemicals. The latter required more attention in India in the light of chemical terrorism incidents happening throughout the world.

The participants are for the three workshops will be drawn by invitation from agrochemicals industries, the regulating and security agencies, academic and research institutions and the government agencies and industry organizations concerned with the chemical security. The US Department of State's Chemical Security Program, Washington-DC, Pacific Northwest National Laboratory (PNNL), The Oregon State University, all from USA, along with CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Gujarat Forensic Science University (GFSU), Gandhinagar, Gujarat University, Ahmedabad and Institute of Pesticide Formulation Technology, Gurugram, have taken a joint initiative to organize three workshops. They will network with the eminent national and local organizations to execute the technical programme formulated by the International Advisory Committee of the workshop.

The Indo-US presentations on the technical and regulatory aspects will be covered in six technical sessions at each workshop venue. The Indian and US speakers will dwell on the dual use agrochemicals - the security concerns, history of attacks, their safety and security at production, storage, transport and supply chain, cyber security, evaluating and improving their security, regulatory aspects, working with law enforcing agencies and the finally 'the way forward'.

Patrons, Advisory and Organizing Committees

Patrons

- Dr. Girish Sahni, Director General, CSIR & Secretary DSIR, Government of India, New Delhi
- Dr. S. Chandrasekhar, Director, CSIR-Indian Institute of Chemical Technology, Hyderabad
- Prof. H. A. Pandya, Vice-Chancellor, Gujarat University, Ahmedabad
- Dr. J. M. Vyas, Director General, Gujarat Forensic Science University, Ahmedabad

International Advisory Committee

- Dr. K. V. Raghavan, INAE Distinguished Professor, CSIR-IICT, Hyderabad
- Dr. Clifford S. Glantz, Pacific Northwest National Laboratory, Richland, WA, USA
- Dr. Radha Kishan Motkuri, Pacific Northwest National Laboratory, Richland, WA,USA
- Dr. Laura Schmidt Denlinger, Pacific Northwest National Laboratory,, Richland, WA, USA
- Mr. Jack Dishner, U.S. Department of State, Washington-DC, USA
- Mr. Rob Siefken, Pacific Northwest National Laboratory,, Richland, WA, USA
- Dr. V Sathuvalli, Oregon State University, Hermitson, Oregon, USA
- Prof. Y. K. Agrawal, Director, Institute of Research & Development
- Dr. Vipin Kumar, Director, National Innovation Foundation, Gandhinagar, Gujarat
- Dr. Shital Patwa, Director, Admin. & Ind. Liason (DDU, Nadiad), Gujarat
- Prof. V. K. Jain, Gujarat University, Ahmedabad
- Dr. Jitendra Kumar, Director, Institute of Pesticide Formulation Technology, Gurugram
- Dr. G. V. M. Sharma, Chief Scientist, CSIR-Indian Institute of Chemical Technology, Hyderabad
- Dr. K. Ravindranath, Chief Scientist, CSIR-Indian Institute of Chemical Technology, Hyderabad

Central Organizing Committee

- Dr. V. K. Jain, (Co-ordinator, Gandhinagar), Gujarat University, Ahmedabad
- Dr. Jitendra Kumar (Co-ordinator, New Delhi), IPFT, Gurugram
- Dr. G. V. M. Sharma (Co-ordinator, Hyderabad), Chief Scientist, CSIR-IICT, Hyderabad
- Dr. S. Prabhakar, Principal Scientist (Convenor, Hyderabad), CSIR-IICT, Hyderabad

Local Organizing Committee: New Delhi

- Dr. P.K. Patanjali, Chief (Formulation)
- Dr. Pinki Bhandari, Dy. Chief (BS)
- Dr. L.K. Thakur, Incharge(Analytical)
- Dr. Amrish Agrawal, Specialist(Formulation)
- Dr. Samsul Alam, Specialist (Analytical)
- Shri Rajib Bhaumik
- Sh. Sanjay Gandhi

- Sh. Mukesh Kumar Singh
- Sh. Mahesh Kumar Saini
- Sh. Pawan Kumar Jain

Local Organizing Committee: Ahmedabad

- Dr. P. Maiti, GFSU, Gandhinagar
- Dr. B. Prajapati, GFSU, Gandhinagar
- Dr. Divya Mishra, Gujarat University, Ahmedabad
- Mr. Manthan Panchal, Gujarat University, Ahmedabad
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Local Organizing Committee: CSIR-IICT, Hyderabad

- Dr. G. V. M. Sharma (Co-ordinator), Chief Scientist
- Dr. K. Ravindranath, Chief Scientist
- Dr. B. V. Subba Reddy, Chief Scientist
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INDO-US Workshop on "Security on Dual Use Agrochemicals" ***(Improving Security at Vulnerable Locations in the Agrochemical Supply Chain)***
August 8, 2017

CSIR-Indian Institute of Chemical Technology, Hyderabad 500 007

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TECHNICAL PROGRAM

Workshop Registration

09:00 – 10:00 Registration (Welcome Drink)

Opening Session (10:00-10.45)

Welcome, Greetings and Introduction of Speakers and Participants	**Dr. G.V.M. Sharma** Chief Scientist, CSIR-IICT, India
Purpose and Goals of the workshop	**Dr. Clifford S. Glantz** Chief Scientist, PNNL, USA **Dr. Radha Kishan Motkuri** Principal Scientist, PNNL, USA
Address by the Guest of Honour	**Mr. Geoffrey Chin** Chief, Political Economic Affairs US Consulate, Hyderabad **Mr. C. Parthasarathi** Principle Secretary (Agriculture) Telangana, Hyderabad
Inaugural Address by the Chief guest and release of Abstract book	**Dr. S. Chandrasekhar** Director, CSIR-IICT, India
Vote of Thanks	**Dr. S. Prabhakar** Principal Scientist, CSIR-IICT, India

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10:45-11.15 Tea Break (Social Interaction)

Technical Session 1: What are the Dual Use Agrochemicals & Their Security Concerns

(11:15-12:30) CHAIRS: Dr. Rob Siefken and Dr. Jitendra Kumar

11:15 – 11:30 L1: **The Security Concerns of Dual Use Agrochemicals**

- Who are the potential adversaries who might want to steal and weaponize the agrochemicals?
- What are the potential consequences of such an attack?

Dr. Clifford S. Glantz
Chief Scientist, PNNL, USA

Questions and Answers

11:30 – 11:50 L2: **The Identification of Dual use Agrochemicals**

- What commonly used agrochemicals are potentially weaponizable?
- What technologies are used to weaponize agrochemicals?

Dr. S. Prabhakar and Dr. K. Srinivas
Principal Scientist, CSIR-IICT, India

Questions and Answers

11:50 – 12:10 **L3: Security throughout the Agrochemical Supply Chain**

- How are the agrochemicals stored and transported?
- What are typical security vulnerabilities in the supply chain?

Dr. Radha Kishan Motkuri
Principal Scientist, PNNL, USA
Questions and Answers

12:10 – 12:30 **L4: Supply chain and Vulnerabilities**

Dr. V. V. Sasi Kumar
Deputy CIF, Telangana State, India
Questions and Answers

Technical Session 2: Cyber Security and Integrated Security Vulnerability Assessment.

(12:30-13:30) **CHAIRS: Dr. Radha Kishan Motkuri and Dr. B. V. Subba Reddy**

12:30 – 12:50 **L5: Cyber security in Agrochemical Industry**

Dr. Clifford S. Glantz and Mr. K. Ravindranath
Chief Scientist, PNNL, USA and Chief Scientist, CSIR-IICT, India
Questions and Answers

12:50 – 13:30 **L6: Evaluating the Security of Dual Use Agrochemicals**

- Physical security and system effectiveness evaluation process
- Vulnerability to intrusion system analysis (VISA) methodology

Mr. Rob Siefken, Chief Security Expert, PNNL, USA
and Mr. Ganesh, Security Officer, CSIR-IICT, Hyderabad
Questions and Answers

13:30 - 14.30 **Lunch (Social Interaction)**

Technical Session 3: Approaches for Evaluating and Improving Agrochemical Security

(14:30-16:20) **CHAIRS: Dr. Clifford Glantz and Dr. R. Srinivas**

14:30 – 15:00 **L7: Regulations**

Mr. P. Chandra Mohan
Director of Factories, Govt. of Telangana, India
Questions and Answers

15:00 – 15:20 **L8: Agrochemical Security Regulations - US and India Scenario**

Dr. Vidyasagar Sathuvalli
Assistant Professor, Oregon State University, USA

Questions and Answers

15:20 – 16:00 **L9: How to Work with Law Enforcement to Establish and Strengthen the Dual use Agrochemical Security**

- Working with law enforcement personnel to prevent an incident
- Security Incident detection, reporting, and response.

Mr. Rob Siefken, Chief Security Expert, PNNL, USA
and Mr. Ganesh, Security Officer, CSIR-IICT, Hyderabad
Questions and Answers

16:00-16:20 Tea Break (Social Interaction)

Technical Session 4: Agrochemical Hazards and Security Regulatory Guidance

(16:20-17:20) CHAIRS: Prof. V. K. Jain and Dr. Vidyasagar Sathuvalli

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16:20 – 16:40 **L10: The Hazards and Risk Potential of Dual Use Agrochemicals**

Dr. M. Surianarayanan
CSIR-CLRI, India
Questions and Answers

16:40 – 16:50 **L11: Security Practices in US**

- Introduction to CFATS

Dr. Clifford S. Glantz
Chief Scientist, PNNL, USA
Questions and Answers

16:50 – 17:20 **L12: Global Chemistry Code of Ethics**
Dr. B. Saha
Director, Nagarjuna Agrichem Ltd., India
Questions and Answers

Valedictory Session: Workshop Wrap Up

17:20 – 17:50 **Concluding Remarks and Next Steps**

- Who to turn to for help?
- How to use workshop materials
- Final Questions and Answers

Dr. Clifford S. Glantz, Dr. G. V. M. Sharma, Dr. Radha Kishan Motkuri, Dr. Rob Siefken, Mr. K. Ravindranath and others

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INDO-US Workshop on "Security on Dual Use Agrochemicals" ***(Improving Security at Vulnerable Locations in the Agrochemical Supply Chain)***
August 4, 2017

Gujarat Forensic Science University, Ahmedabad

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Bio-Sketch of Dr. M. Surianarayanan

Dr. Surianarayanan, a fellow of the Madras Science Foundation, is currently the Principal Scientist at the Cell for Industrial Safety and Risk Analysis, CSIR-Central Leather Research Institute. His research areas of interests are chemical process safety, thermo kinetic analysis of chemical process reactions, occupational safety and health, accident database, charge transfer polymerizations, drug delivery systems and Biocalorimetry. Dr Surianarayanan has over 120 publications in peer-reviewed journals besides three book chapters. He has presented his research work in more than 60 conferences. He did his postdoctoral research at the Kanagawa Industrial Technology Research Institute, Japan under Science and Technology Agency fellowship of Govt. of Japan. He was also a visiting fellow at the Science and Technology Research Center of Mitsubishi chemical corporation of Japan during 2000-2002 and carried out advance research on modeling and simulation of runaway phenomenon for exothermic chemical reaction systems. He is currently the reviewer for 45 SCI journals.

Dr Surianarayanan has been a member of several consultancy projects executed by CISRA in the area of Quantitative Risk Analysis and Thermochemical Analysis. He was also a member of the investigation team and special committees for accident analysis appointed by the Govt. of Tamilnadu. Recently he was nominated as the convener-member of the Central CSIR-Team for modernization and mechanization of fireworks industries for accident prevention. He is the member of the Regional committee of ICC and Chairs the SHE committee of Indian Chemical Council, Southern Region and has organized several workshops and seminars in Chemical Process Safety. Currently he is a member of the Executive Committee and Joint Secretary of National Safety Council, Tamil Nadu Chapter. Dr Surianarayanan is serving as a member of the State Crisis Group of the Government of Pondicherry. He is the member of CHD 7 & CHD 8 National Committees of Bureau of Indian Standards and also member and convener for many panels for National Standard Development.

Dr Surianarayanan has delivered several invited lectures in various platforms in Chemical Process Safety. Dr. Surianarayanan is a recognized research guide of Anna University, Madras University & Satyabhama University and is teaching safety engineering to ME/ M.Tech and B.Tech students.

HAZARD AND RISK POTENTIAL OF DUAL USE AGROCHEMICALS

DR M SURIANARAYANAN
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AGROCHEMICALS

- **Agrichemical refers to pesticides including insecticides, herbicides, fungicides and nematicides, termiticide, molluscicide, piscicide, avicide, rodenticide, predacide, bactericide, insect repellent, animal repellent, antimicrobial, fungicide, disinfectant (antimicrobial), and sanitizer.**
- **It may also include synthetic fertilizers, hormones and other chemical growth agents**

USE OF AGROCHEMICALS IN INDIA

- Government-issued permits for purchase and use of approved agrichemicals may be required.
- Significant penalties can result from misuse, including improper storage resulting in spillage.
- On farms, proper storage facilities and labelling, emergency clean-up equipment and procedures, and safety equipment and procedures for handling, application and disposal are often subject to mandatory standards and regulations.
- Usually, the regulations are carried out through the registration process
- Agrochemicals use in India is highly regulated

DUAL USE AGROCHEMICALS

- **Ammonium Nitrate**
- **Potassium Nitrate**
- **Urea**
- **Cyanides - Most Of The Synthetic Pyrethroids - Fenvalerate, Cypermethrin, Aphamethrin, Deltamethrin, Cyhalothrin, Cyfluthrin**
- **Phosgene - Many Of The Carbamate Family - Aldicarb, Carbaryl, Propoxur, Oxamyl And Terbucarb**
- **Phosgene - Urea Derivatives - Diuron,**
- **Thiophosgene – Fipronil**
- **Schedule 2 & 3 of OPCW**

HAZARDS OF DUAL USE AGROCHEMICALS

HAZARDS IN MANUFACTURING, STORAGE AND TRANSPORTATION

✓ Two types of Hazards and Risk

- ❖ Toxicity
- ❖ Explosion potential

These two basic properties make them a dual use chemicals of concern

➢ in bulk storage may pose significant environmental & health risks, particularly in the event of accidental spills.

Hazards Associated with these agrochemicals make them vulnerable – Potential for security risks exist

WHAT ARE THE HAZARDS

- **Hazardous chemical molecules – S, P, & N in their structure**
- **Instability in the process, storage & transportation conditions**
- **Batch manufacturing**
- **Runaway reaction possibilities**
- **Too lengthy manufacturing steps**
- **Huge inventory of molecular (toxic) solvents**
- **Poor process control systems**
- **Fire & Explosion potential and release of toxic substances**
- **Transportation hazards**
- **Huge volume of Hazardous solid and liquid effluents**
- **Unsecured sites, plants and storage areas**
- **Understanding on delineation between "safety Vs security"**

METHODS FOR HAZARD AND RISK ASSESSMENT OF DUAL USE AGROCHEMICALS

MATERIAL DATA SHEETS

Hazard Identification Methods :

- Safety Audits
- Check Lists
- Micro Calorimetric Techniques For Instability & Runaway Potential
- Hazard And Operability Studies (HAZOP)
- Near Miss & Accident Investigations
- Chemical Process Quantitative Risk Analysis (CPQRA)

VULNERABILITY ANALYSIS (SECURTY) FOR THE PERSPECTIVE OF PROCESS RISK AND HAZARDS

STEPS IN RISK ANALYSIS OF AGROCHEMICAL MANUFACTURING

✓ **TECHNICAL DESCRIPTION OF THE PLANT AND ACTIVITIES :**
Topgraphy, chemical substances, description of buildings, the process equipment

✓ **IDENTIFICATION OF POTENTIAL HAZARDS**
Events that could lead to LOC, fires and explosions

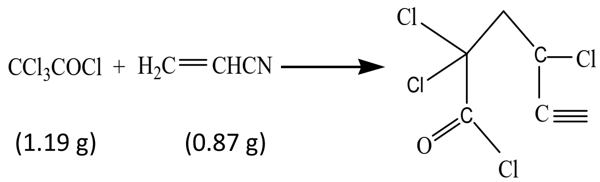
✓ **CONSEQUENCES OF THE IDENTIFIED EVENTS**
Death or injuries to people living in the plant, neighborhood & environmental effects due to fire fighting water containing pesticides

✓ **LIST OF PROPOSALS FOR PREVENTIVE MEASURES**

✓ **SUGGESTIONS FOR EMERGENCY PLANNING**

DISPERSION OF TOXIC FIRE PRODUCTS & FIRE WATER CONTAINING HAZARDOUS CHEMICAL SUBSTANCES

CASE STUDY : Process Chemistry of Telomerization

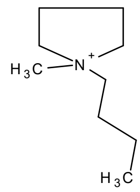


Telomer

Experiments for ARC

1) No ionic liquid - 0.87 g AN
2) Ionic liquid – 0.87 g AN ; IL= 0.35 g
3) No IL - excess of AN (1.3 g)

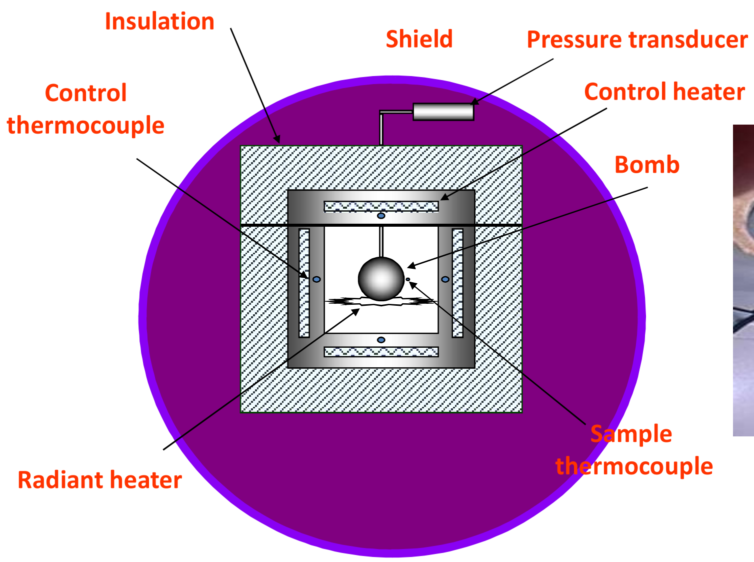
IL used =>

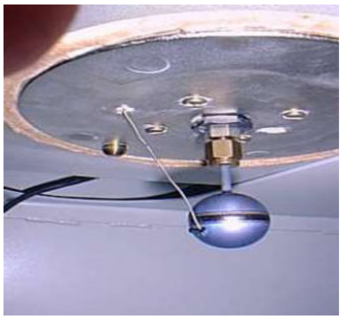


$(CF_3SO_2)_2 N^-$

[p1,4][tf2N]

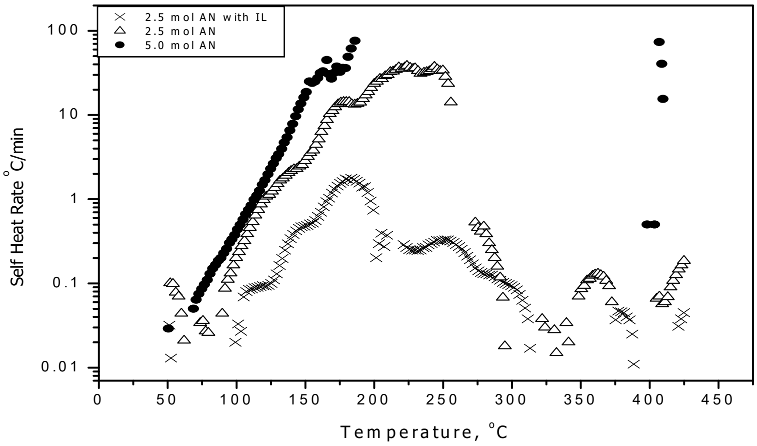
M. Surianarayanan, R Vijayaragjhavan and D.R. MacFarlane, Ind. Eng. Res. 46, 1025 ***(2007)***





Accelerating rate calorimeter (ARC)

Telomerization reaction – Comparison of self-heat rates

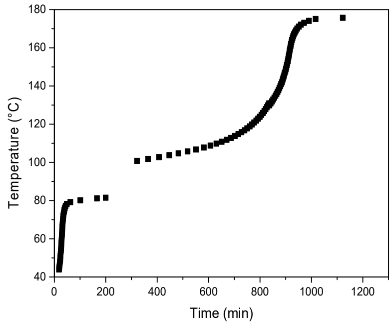


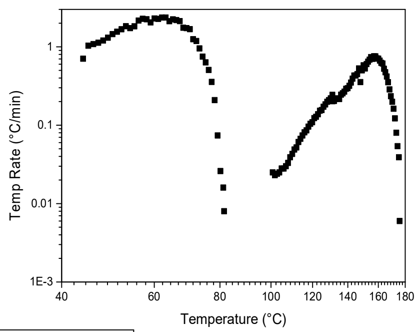
⇒ Onsets at 50 °C in all cases – lowest for IL (0.02°C/min)

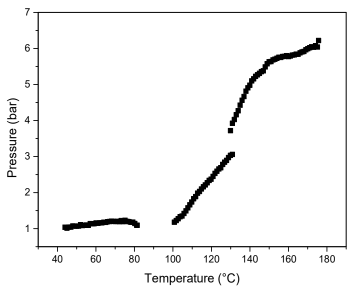
⇒ Peak self heat rate – in the presence of IL (1.8°C/min at 175 °C)

– in the absence of IL for 2.5 m AN (30°C/min at 225 °C)

ANOTHER EXAMPLE OF AN EXPLOSION INCIDENT IN AGROCHEMICAL INDUSTRY







Accelerating Rate Calorimetry Studies

Thermal Stability of Chemicals

S.No	Chemical	ΔHr (KCal / mol)	Thermal Stability Classification - CHETAH ERE Criterion #1	#2	#3	#4	Overall Energy Release Potential
	GASES						
1	Isobutylene	-3.6	M	L	L	L	L
	LIQUIDS						
2	Acetic Acid	-103.3	L	L	H	L	L
3	Acctonitrile	19.1	H	L	M	M	H
4	Chloro acetyl chloride	58.7	L	L	H	L	L
5	Chloro acetyl isopropyl parachloroaniline	-36.9	M	L	M	L	L
6	2 Chlorocyclobutanone	-75.3	M	M	H	L	L
7	4 Chlorocyclobutanone	-93.6	L	L	H	L	L
8	Diethyl amine (DEA)	-18.0	M	L	L	L	L
9	Diethyl thio phosphoril chloride (DETPC)	-198.6	L	L	M	L	L
10	Dimethyl formamide (DMF)	-43.7	M	L	M	L	L
11	Dimethoxy thio phosphoric acid (DMTA)	-165.2	L	L	M	L	L
12	Ethylene dichloride	-33.0	L	L	H	L	L

H- High M-Medium L-Low

Thermal Stability of Chemicals

S.No	Chemical	ΔHr (KCal / mol)	Thermal Stability Classification - CHETAH ERE Criterion #1	#2	#3	#4	Overall Energy Release Potential
13	Hexane	-39.9	L	L	L	L	L
14	Isophthallic Adid	-168.8	M	M	M	L	L
15	Isopropyl alcohol	-72.7	L	L	M	L	L
16	Isopropyl promide	-23.6	L	L	M	L	L
17	Methanol	-48.0	M	M	M	L	L
18	Monochloro acetic acid	-104.9	L	L	H	L	L
19	Ortho dichloro benzene (ODCB)	6.8	M	M	M	L	L
20	Ortho/para nitor chloro	9.0	H	M	H	M	H
21	Pyridine	33.4	H	L	L	M	H
22	Tertiary Botonol	-74.7	L	L	L	L	L
23	Tetra chloro butyric acid (TBA)	-100	L	L	H	L	L
24	Tetra chloro butyric acid chloride (TBAC)	-100.3	L	L	H	L	L
25	Trichloro acetyl chloride	-58.3	L	L	L	L	L
26	Tricthyl amine (TEA)	-25.6	M	L	L	L	L
27	O-Xylene	4.1	M	L	L	L	L

H- High M-Medium L-Low

List of Chemicals

S.No	Chemical	Process			NFPA Hazard Classification		
		CMAC	AF	CPF	Health Hazard Nr	Flammability Nr	Reactivity Nr
15	Diethyl thio phosphoril chloride (DETPC)			✓			
16	Dimethyl formamide (DMF)	✓			1	2	0
17	Dimethoxy thio phosphoric acid (DMTA)		✓				
18	Ethylene dichloride			✓	2	3	1
19	Hexane	✓			1	3	0
20	Hydrochloric acid (HCl)	✓		✓	3	0	0
21	Isopropyl alcohol		✓		1	3	0
22	Isopropyl bromide		✓				
23	Methanol		✓		1	3	0
24	Methylene dichloride (MDC)			✓	2	0	1
25	Monochloro acetic acid		✓	✓	3	1	0
26	Ortho dichloro benzene (ODCB)			✓	2	2	0
27	Ortho / para nitro chloro benzene (ONCB / PNCB)		✓				
28	Sulphuric Acid	✓			3	0	2
29	Tertiary butanol	✓					

TBN Reactor Section

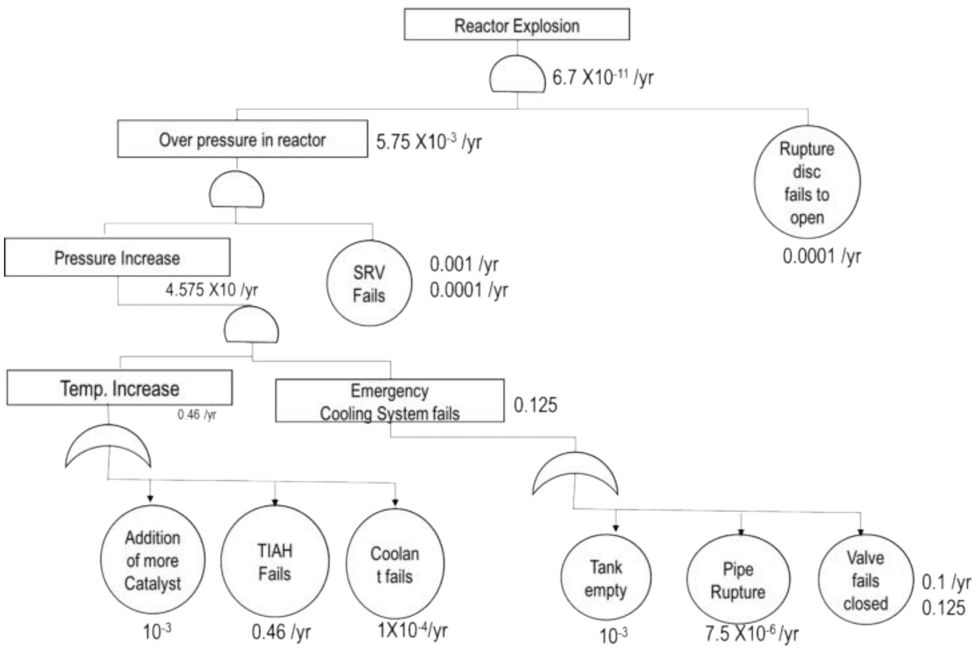
Event	Equipment	Type of failure	Chemical involved	Hazardous events	Justification
1	AN transfer line from feed tank	Leak/ rupture of transfer line $\emptyset = 25\ mm$	AN	Toxic dispersion and pool fire	Highly toxic, highly flammable Nh=4, Nf=3
2	TBN Reactor	Leak/rupture of drain line $\emptyset = 37\ mm$	AN,TBN,CTC ,ACN	Toxic dispersion/pool fire	AN is highly toxic and flammable, Nh=3, Nf=3 ACN is flammable CTC is toxic
3	CTC transfer line from feed tank	Leak/rupture of transfer line $\emptyset = 37\ mm$	CTC	Toxic dispersion	Highly toxic, Nh=3

Affected distance due to toxic dispersion of acrylonitrile

S. No	Scenario	Chemical	Opening dia (mm)	Temp (˚C)	Pr. (bar)	Out flow kg	Out flow kg/sec	Source Strength for dispersion kg/sec	Wind velocity (m/s)Stability	Affected distance (m) LC_{50}	LC_1	IDLE
1.	Rupture of tank (R=11m)	AN	N.A	35	1	1600	-	0.42	1.4F	225	335	5900
								0.7	2.7D	75	115	1525
2.	Rupture of bottom transfer line (20 min release) (R=8.7 m)	AN	0.03	35	1	-	1.1	0.27	1.4F	135	225	4300
								0.45	2.7D	-	75	1150
3.	Leak in bottom transfer line (R=5.1 m)	AN	0.01	35	1	-	0.2	0.09	1.4F	-	-	2100
								0.15	2.7D			375
4.	Rupture of bottom transfer line with bund, bund dia = 1.87 m. Area = 2.7m^2, (Height for 10 min release = 0.277 m, 20 min release = 0.45m)	AN						0.003	1.4F			
								0.006	2.7D	Quantity too small to cause damage		

Where
R-Radius of pool, LC_{50} - 50 % lethality, LC_1-1 % lethality, IDLH-Immediately Dangerous to Life and Health, N.A-Not Applicable

Fault tree for Explosion in Telomerisation or Cyclization Reactor



Damage distance due to physical explosion

S.no	Scenario	Volume (m^3)	Temp (˚C)	Rupture pressure (bar)	Damage distance (m)		
					D1	D2	D3
1.	Leak of TBAC reactor wall	7.5	100	27	18	40	111

Where

D1 Distance over which overpressure ≥ 0.3 bar

D2 Distance over which overpressure ≥ 0.1 bar

D3 Distance over which overpressure ≥ 0.03 bar

Damage distance due to jet fire

S. No	Scenario	Dia of opening (m)	Temp (˚C)	Pr (bar)	Source Strength for Dispersion (kg/sec)	Jet Length (m)	Jet Width (m)	Affected distance			
								C/W or D/W	D1	D2	D3
	IB Storage tank										
1.	Rupture of vapor line	0.05	25	3	1.4	22.5	1.9	D/W	41.3	43.3	48.0
								C/W	5.9	8.9	15.9
2.	Leak in vapor line	0.02	25	3	0.2	9.0	0.7	D/W	17	17.8	19.7
								C/W	2.6	3.6	5.7

Where,

C/W Cross wind

DW Down wind

D1 Distance over which radiation intensity ≥37.5 kW/m^2

D2 Distance over which radiation intensity ≥ 12.0 kW/m^2

D3 Distance over which radiation intensity ≥4.0 kW/m^2

Damage Distance due to UVCE

S. No	Scenario	Source Strength for dispersion (Kg)	Temp (◦C)	Pressure (bar)	Wind velocity (m/sec) Stability (m/sec)	UFL distance (m)	LFL distance (m)	Damage Distances (m)		
								D1	D2	D3
1	Rupture of liquid transfer line of the bullet capacity 65 m^3 (App. 2 min release)	2653	35	4	1.4 F 2.7 D	15 3.0	298 234	43 40	128 121	458 404
2	Rupture of vapor transfer line	1.2 kg/sec	35	4	1.4 F 2.7 D	- -	33 21	- -	- -	- -
3	Rupture of liquid transfer line of the bullet capacity 10 m^3	11.7 kg/sec	35	4	1.4 F 2.7 D	40 25	171 71	31 -	93 -	309 -

Where
D1 Distance over which heat radiation intensity 0.3 bar
D2 Distance over which heat radiation intensity 0.1 bar
D3 Distance over which heat radiation intensity 0.03 bar

Damage distance due to Confined Explosion

Chemical : Isobutylene

S. No	Scenario	Temp (◦C)	Confinement Volume (m3)	Peak Over Pressure		Damage Distances (m)		
				Bar	Distance	D1	D2	D3
H	**2CB Reactor**	67	3000	0.5	50	74	223	743

Where

D1 Distance over which overpressure ≥ 0.3 bar

D2 Distance over which overpressure ≥ 0.1 bar

D3 Distance over which overpressure ≥ 0.03 bar

Affected Distances due to Toxic Dispersion

S. No	Scenario	Chemical	Opening dia (m)	Temp (◦C)	Pressure (bar)	Outflow Kg/sec	Source Strength for Dispersion Kg/sec	Wind Velocity (m/s)/ stability	Affected distances (m)		
									LC50 (50% lethality)	LC1 (1% lethality)	IDLH
$SOCl_2$ Feed tank(TBAC reactor)											
1.	Rupture of line for 10 min release (R=7.1m) Where R is radius of pol	$SOCL_2$	0.03	3.5	1	2.4	0.33	1.4F			
								SO_2	-	100	135
								HCL	-	-	225
							0.56	2.7D			
								SO_2	-	-	-
								HCL	-	-	75
2.	For 20 min release (R=9.5m)	$SOCL_2$	0.03	3.5	1	2.4	0.58	1.4F			
								SO_2	-	150	200
								HCL	-	-	350
							0.97	2.7D			
								SO_2	-	-	75
								HCL	-	-	100
3.	Leak in line for 20 min release (R=4.4m)	$SOCL_2$	0.01	3.5	1	0.4	0.13	1.4F			
								SO_2	-	-	75
								HCL	-	-	125
							0.2	2.7D			
								SO_2	-	-	-
								HCL	-	-	-

IDLH - Immediate danger to life and health

CONCLUSIONS

- ✓ HAZARD AND RISK POTENTIAL DO EXIST IN AGROCHEMICAL MANUFACTURING
- ✓ OUTSIDERS OR INSIDERS CAN TAKE ADVANTAGE TO MALICIOUSLY TRIGGER THE PROCESS OR THE PROCESS CONTROL SYSTEMS
- ✓ SECURITY ASSESSMENT SHOULD BE DONE ON PRIORITY TO THESE INSTALLATIONS

THANK YOU !

HISTORY OF DUAL USE CHEMICAL ATTACKS AND LESSONS LEARNT

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Chemical Attacks

The intentional use of chemicals as weapons for the purpose of causing significant social and economic disruption as well as damage to human health and to the environment.

*MDCH Chemical Terrorism Website 2005

CHEMICAL WEAPON ATTRIBUTES

- CW agents are extremely toxic synthetic chemicals that can be dispersed as a gas, liquid or aerosol or agents adsorbed to particles to become a powder

- Can be delivered through bombs, rockets, artillery shells, spray tanks, and missile warheads; can be dispersed as vapors, aerosols or liquids

- Many kinds have been developed since WWI, including
  - Nerve Agents
  - Choking Agents
  - Blister Agents
  - Blood Agents,
  - Riot-control Agents
  - Psychomimetic Agents
  - Toxins.

DUAL-PURPOSE CHEMICAL AWARENESS

Chemicals used in industry or everyday life that can also be used in bad ways.

EXAMPLES OF DUAL PURPOSE CHEMICALS

Sr No	CHEMICALS	INDUSTRIAL APPLICATIONS	CW precursor
1	Triethanolamine	Cement additives, lubricants	N-Mustard
2	Hydrofluoric acid	Integrated circuit fabrication	Nerve agent
3	Sodium cyanide	Mining, electroplating	Blood agent
4	Thiodiglycol	Paints, inks	S-Mustard
5	Ammonium bifluoride	Metal cleaning	Nerve agent
6	Sodium fluoride	Toothpaste, insecticide, wood preservative	Sarin-Nerve agent
7	Dimethylamine	Agricultural chemicals	Tabun
8	Sodium sulfide	dehairing agent in leather	Blistering agent

SUMMARY OF HISTORICAL ATTACKS USING CHEMICAL OR BIOLOGICAL WEAPONS

The listing is limited to events after 1900 (while there were some earlier instances of chemical/biological warfare, these instances were generally of very limited effectiveness).

Events included:

- **use in warfare:** multiple attacks within a war are grouped together.
- **use by terrorists:** includes attacks with larger numbers of casualties.
- **other:** several criminal incidents and accidental chemical releases are included because of their significance.

Source:
Adopted from compiled report by **Wm. Robert Johnston**
http://www.johnstonsarchive.net/terrorism/chembioattacks.html

Note that some incidents are disputed, and casualty figures in some cases are very uncertain.

Historical attacks using chemical or biological weapons

Date	Location	Attacker	Agent	Affected pop	Casualties	Description
21 - 27 Oct 2016	near Mosul, Iraq	Islamic State militants	sulfur	civilians, soldiers	2 killed, 1,500 injured	sulfur mine set on fire, producing widespread sulfur dioxide plumes
8 Mar 2016	Taza, Kirkuk, Iraq	Islamic State	blistering agent	civilians	1 killed, 600 injured	attack on town; fatality was 3-year-old child
23 Jan 2015	between Mosul, Iraq, and Syrian border	Islamic State militants	chlorine	Kurdish soldiers	~30 injured	truck bomb with chlorine-filled tanks used against troops
Sep - Oct 2014	Duluiya and Balad, Iraq	Islamic State militants	chlorine, possibly mustard gas	Iraqi and Shiite soldiers	40 injured	bombs with chlorine-filled cylinders used against defending troops
27 Mar - 22 Apr 2014	Syria--Damascus, Kafr Zita in Hama, and Talmenes in Idlib	Syrian military suspected	chlorine, others	civilians	104 killed, 200 injured	chlorine bombs used on civilians in two towns
21 Aug 2013	Damascus suburbs, Syria	Syrian military	sarin nerve gas?	civilian urban areas	1,429 killed (including 426 children), 2,200 injured	rockets with chemical agents fired at about 12 areas in suburbs south and east of Damascus, targeting rebel-held areas
19 Mar - 13 Apr 2013	Syria--Damascus, Al-Otaybeh, Khan al-Assal, Adra, Aleppo, Sheikh Maqsoud, and Saraqeb	Syrian military?	multiple chemical agents?	rebel soldiers and civilians	at least 44 killed, 76 injured	multiple attacks, mostly blamed on Syrian government; Syrian government accuses rebels of the attacks
Apr 2012 - Jun 2013	Afghanistan--Takhar province (9), Sar-e-Pul province (4), others	Islamist terrorists	pesticides?	schoolchildren	1,952 injured (including 1,924 children)	23 poison attacks on girls' schools, some cases of water poisoning
Mar 2012 - Apr 2013	Afghanistan	Islamist terrorists	rat poison?	police, other civilians	53 killed, 40 injured	9 attacks involving poisoning of food at police stations/academies
Apr - Aug 2010	Afghanistan--Kabul (6), Kunduz (4), others	Islamist terrorists	pesticides?	schoolchildren	672 injured (including 636 children)	20 gas attacks on girls' schools
11 Mar 2007	Iraq	Islamist terrorists	mustard gas	U.S. soldiers	2 injured	failed improved explosive device using chemical weapon artillery shells
Oct 2006 - Jun 2007	Iraq cities--Ramadi (6), Baghdad (3), Falluja (3), others	Islamist terrorists	chlorine	civilian targets	115 killed*, 854 injured (including 85 children)	15 car/truck bombings with chlorine tanks used; most fatalities were from the explosions, most injuries from the chemical releases

Historical attacks using chemical or biological weapons(Contd)

Date	Location	Attacker	Agent	Affected pop	Casualties	Description
8 Oct 2006	Numaniyah, Iraq	Islamist terrorists	poison	policemen	**7 killed**, 700 injured	poisoning of food at meal on police base; unconfirmed
25 Sep 2006	Baghdad, Iraq	Isalmist terrorists	mustard gas	U.S. soldiers	2 injured	improved explosive device using chemical weapon artillery shells
15 May 2004	Baghdad, Iraq	Islamist terrorists	sarin nerve gas	U.S. soldiers	2 injured	failed improvised explosive device using chemical weapon artillery shell near Baghdad airport
24 Jun - Jul 2003	near Mosul, Iraq	Islamist terrorists	sulfur	civilians, soldiers	? injured	sulfur stockpiles at mine set on fire, producing widespread sulfur dioxide plumes; at least 41 U.S. soldiers injured
11 Nov 2002	Changde, PR China	criminal	poison	schoolchildren	193 injured (mostly children)	poisoning of food at high school
26 Oct 2002	Moscow, Russia	Russian soldiers	fentanyl incapacitating agent	terrorists and civilian hostages	**124 killed**, 501 injured	Chechen terrorists took 800 hostages at Moscow theater, 23 Oct; Russian forces used fentanyl when storming the theater and killing all the terrorists on 26 Oct, but many hostages were killed or injured by the gas
18 Sep - 9 Oct 2001	United States--Washington, DC, New York City, NY, others	Bruce Ivins?	anthrax	government and civilian media individuals; postal employees and customer	**5 killed**, 17 injured	anthrax-laced letters mailed to federal officials in Washington DC and new media offices in multiple locations; many casualties among postal workers
20 Mar 1995	Tokyo	Aum Shinrikyo cult	sarin nerve gas	Tokyo subway	**12 killed**, 5,511 injured	nerve gas releases in subway; many permanent injuries
28 Jun 1994	Matsumoto, Japan	Aum Shinrikyo cult	sarin nerve gas	civilians	**7 killed**, 270 injured	overnight release of nerve gas in city
21 Jan 1994	Ormancik, Turkey	terrorists	chemical agent	civilians	**16 killed**	attack on village using chemical grenades
16 Mar 1988	Halabja, Iraq	Iraqi military	cyanide, mustard gas, nerve agents	Iraqi Kurdish civilians	**5,000 killed**, 8,000 injured	use of chemical agents against civilians in village; additional use of agents by Iranian military possible

Historical attacks using chemical or biological weapons(Contd)

Date	Location	Attacker	Agent	Affected pop	Casualties	Description
6 Sep 1987	Zamboanga City, Philippines	terrorists	poison	policemen	**19 killed**, 140 injured	water poisoning with pesticide at constabulary
1987 - Aug 1988	Iraq-Iran	Iranian military	mustard gas, cyanide	Iraqi soldiers	?	some use
2 - 3 Dec 1984	Bhopal, India	accidental	methyl isocynate gas	civilians	**3,787 killed**, 558,125 injured (including 200,000 children)	accidental release from pesticide plant, with gas plume blown across city of Bhopal
9 - 19 Sep 1984	The Dalles, Oregon, United States	Bhadwan Shree Rajneesh cult	salmonella	civilian restaurants	751 injured	food poisoning in several restaurants; was experiment in preparation to interfere with upcoming election
Aug 1983 - Jul 1988	Iraq-Iran	Iraqi military	chemical agents	Iranian soldiers and civilians	**21,000 killed**, 92,000 injured	extensive use against soldiers and civilians
Jun 1979 - mid 1981	Afghanistan	Soviet and Afghan militaries	multiple chemical agents	civilians and rebel soldiers	**3,042 killed**	used in at least 47 instances in the invasion of Afghanistan
Apr 1979	suburbs southeast of Sverdlovsk, USSR	accidental	anthrax	civilians	**68 killed**, 300 injured	accidental release from bioweapons production facility caused anthrax outbreak in Sverdlovsk; cause of outbreak was denied by Soviet government
18 Nov 1978	Guyana--Jonestown, Georgetown	People's Temple cult	poison	cult members and children	**913 killed** (including 276 children)	mass suicide by cult members
1978 - 1983	western Kampuchea	Vietnamese military	chemical agents	civilians, soldiers	**1,014 killed**	used in at least 124 instances by government forces against rebel areas
mid 1975 - 1983	Laos--Vientiane, Xiangkhoang, and Louangphrabang provinces	Laotian and Vietnamese militaries	chemical agents	civilians, soldiers	**6,504 killed**	used in at least 261 instances by government forces against rebel areas

CHEMICAL ATTACKS – TERRORISM

- 126 chemical terrorism events 1975-2000
- 2002: increase in chemical events (20)
  - Uses – Attempted acquisitions
  - Plots
  - Possessions
  - No chemical hoaxes
- Agents:
  cyanide (8), unknown (4), arsenic (2), sodium hydroxide, pesticide, mercury, sodium azide, tetranium, ammonium nitrate

Monterey Institute, CNS 2003

SCOPE OF ACCESSIBLE CHEMICAL TERRORISM THREATS

- 627,000 toxic chemicals in PoisIndex™
- 600 new chemicals each year
- 1.5 billion tons hazardous shipments annually (500,000 shipments/day)

Dual-use chemical example: Cyanide

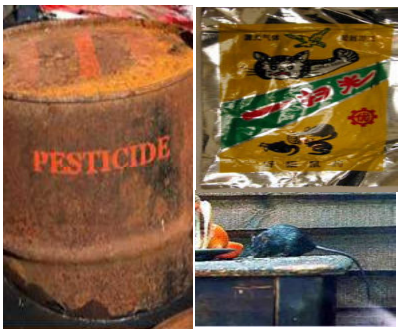
- Widely used in mining and metal plating industries, but is also a well known poison.
- Tylenol capsules -Product tampering*
- Tylenol capsules laced with KCN
- 7 deaths, fall 1982, Chicago, Illinois, USA
- Led to tamper-proof product packaging
- Popular with criminals and terrorists because it is relatively easy to obtain
- HCN is CW agent

* "Tylenol Crisis of 1982." *Wikipedia, The Free Encyclopedia.* 22 Nov 2007, 06:04 UTC. Wikimedia Foundation, Inc. 28 Nov 2007 <http://en.wikipedia.org/w/index.php?title=Tylenol_Crisis_of_1982&oldid=173056508>.

Dual-use chemical example: Pesticides

Tetramethylenedisulfotetramine (TETS)
$C_4H_8N_4O_4S_2$

Widely used in homes and agriculture, but also used to poison people.

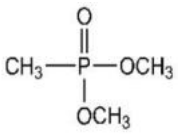


- Dushuqiang (Strong Rat Poison)
- Outlawed in China in the mid-1980s, but was still available
- Nanjing, China, Sept. 2002
- 38 people killed by poison in snack-shop food, >300 sick
- Jealously by rival shop owner
- Hunan, China, Sept. 2003
- 241 people poisoned by cakes served by school cafeteria
- Motive and perpetrator unknown
- Tongchuan City, Shaanxi, China, April 2004
- 74 people poisoned by scallion pancakes
- Motive and perpetrator unknown
- 5 other incidents reported between 1991 and 2004

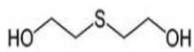
Ann. Emerg. Med., Vol. 45, pg. 609, June 2005

Many lab/industrial chemicals have dual uses

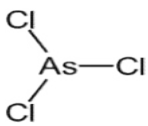
- Dimethyl methyl phosphonate (DMMP)
  - Flame retardant for:
    - building materials, furnishings, transportation equipment, electrical industry, upholstery
    - *Nerve agent precursor*



- Thiodiglycol
    - Dye carrier, ink solvent, lubricant, cosmetics, antiarthritic drugs, plastics, stabilizers, antioxidants, photographic, copying, antistatic agent, epoxides, coatings, metal plating
    - Mustard gas precursor



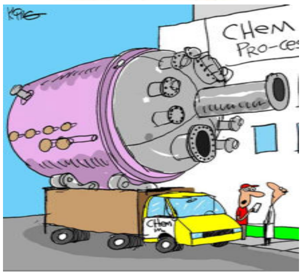
- Arsenic Trichloride
    - Catalyst in CFC manufacture, semiconductor precursor, intermediate for pharmaceuticals, insecticides
    - *Lewisite precursor*



From: Chemical Weapons Convention: Implementation Assistance Programme Manual (on CD)

Dual-use Chemicals: Explosives

- Theft of conventional explosives
  - Chemical suppliers
- Users such as mines or construction sites
- Diversion of industrial or laboratory chemicals
  - Chemical suppliers
  - Chemical factories
  - Academic teaching or research laboratories
- Disposal sites



Theft / manufacture of explosives: Fertilizer Bomb

- Ammonium nitrate fertilizer and fuel oil (diesel, kerosene)
- Used to bomb Alfred P. Murrah building in Oklahoma City, OK, USA in April 1995
  - with nitromethane and commercial explosives
  - 168 dead, including children
- Favored by IRA, FARC, ETA*, etc.

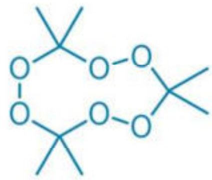
*Irish republican army,
The Revolutionary Armed Forces of Colombia
European Tropospheric-Scatter **Army**

Theft / manufacture of explosives: TATP

Triacetone triperoxide (TATP)

- Invisible to detectors looking for Nbased explosives
- Made using acetone, hydrogen peroxide, strong acid (HCl, sulfuric)
- Favored by terrorists *"Mother of Satan"*
  - Brussels Bombings 2016
  - Parris Attack Nov. 2015

Wikipedia downloaded July 2016
http://en.wikipedia.org/wiki/Acetone_peroxide



TATP

Diversion of industrial / laboratory chemicals: Bali bombing

- Amrozi purchased chemicals used to make bombs
- One ton of potassium chlorate* purchased in three transactions from the Toko Tidar Kimia fertilizer and industrial chemicals store in Jalan Tidar, Surabaya, owned by Sylvester Tendean.
  - Claimed he was a chemical salesman.
  - Obtained a false receipt saying he purchased sodium benzoate.
  - Tendean lacked proper permit to sell this chemical, didn't know the chemical would be used to make a bomb.
- Details of Aluminum powder purchases not known

* Some press reports state potassium chloride, but this is clearly an error
http://www.smh.com.au/articles/2003/06/09/1055010930128.html
http://www.thejakartapost.com/news/2002/12/18/amrozi-owns-possessing-chemicals.html

Diversion of industrial / laboratory chemicals: Sodium Azide

- **Widely available from older automobile airbags**
- **1980s to 1990s**
- **Poisonous**
- **Reacts explosively with metals**
- **Biological laboratory drains have exploded from discarded waste solutions containing NaN3 as a preservative.**
- **Has been found in possession of terrorists**

Environmental Release of Chemical Weapons

- Approximately 19 million gallons of Agent Orange were used by the US military in southern Vietnam between 1962 and 1971. An aggressive herbicide which defoliates trees, it was used on a large scale in Vietnam's jungles to enable US troops to spot Communist troops more easily.
- It eradicated around 15% of South Vietnam's vegetation, and gave rise to serious health problems for the soldiers, civilians and local wildlife that were exposed to it.
- Agent Orange contains dioxin, a highly toxic substance that is still detected in the bodies of Vietnamese people today. It contaminated the soil and rivers and, through the food chain, passed into fish - a staple of the Vietnamese diet.
- Apart from the serious human health effects of Agent Orange - which include cancer and birth defects - the rapid loss of vegetation that it causes leads to severe soil erosion. This contributes to a major drop in species population due to habitat degradation. High concentrations of dioxin persist in the land, and ecosystems have suffered irreversible damage.
- The impact of chemical weapons dumping by the Japanese Army in China is thought to be just as severe.

BAD PROCESS PRACTICE AND GROSS NEGLIGENCE

- Seveso, Italy 09 July 1976, Givaudan, subsidiary of Hoffmann La Roche
- Trichlorophenol (TCP) production from 1,2,4,5 – Tetrachlorobenzene and caustic soda
- Dioxin (Super poison) invariably a contaminant in TCP,
  2,4,5 – Trichlorophenoxy acetic acid
  (Agent Orange), defoliant

Seveso Incident….

- Operators charged reactor on Friday, initiated the reaction but stopped it for the weekend
- 24 hr later reactor exploded spilling vapors containing an estimated 2 kg of killer dioxin
- Skin reaction on people, 1,00,000 animal deaths, spontaneous abortions in pregnant women
- Huge environmental damage, fears of genetic damages
- Reclamation took 5 years

Chemical Weapons in Iran-Iraq War (1980-88)

- **Iraq used chemical weapons in Iran during the war in the 1980s.**
- **Around 100,000 Iranian soldiers and civilians were affected by Iraqi chemical weapons during the 1980-88 war with Iraq.**

Victims of Iraqi chemical weapons

DUTCH BUSINESSMAN DIVERTED CHEMICALS TO IRAQ

- ✓ **During 1984 to 1988, Mr van Anraat, by means of one or more companies either owned by him or in which he had actual control, supplied several shipments of thiodyglycol7 (TDG), a key component of mustard gas, and trimethyl phosphite8 (TMP), a component to produce nerve agent, to the State Organisation for Oil Refineries and Gas Industry (SORGI) in Iraq.**

- ✓ **Initially the chemicals were obtained from producers in Japan via an intermediary. Later, when the exchange rate for the yen was not as advantageous, he obtained them from producers in the United States via the same intermediary.**

- ✓ **During this period, Iraq was engaged in armed conflict with the Islamic Republic of Iran, a conflict which lasted from 1980 to 1988. Beginning in 1984, allegations of the use of chemical weapons during that conflict were reported by the media as well as investigated and verified by the United Nations (UN)9.**

- ✓ **Additionally, in 1987-88, settlements in Iraq primarily inhabited by persons of Kurdish descent were attacked with chemical weapons by Iraqi warplanes. The attack on the village of Halabja, in particular, received widespread media coverage, including explicit photographs of the victims.**

Effects of Chemical Weapons: Halabja, Iraq: 1988

- **Iraq used mustard gas and nerve agents against Kurdish residents of Halabja, in Northern Iraq, in 1988 resulting in ~5000 deaths**

Believed to be Agent Orange victims

Chemical Terrorism in Japan

- Two recent examples of the use of chemical weapons in a terrorist attack, were in Japan in the mid 1990s
- Nerve agent sarin (GB) used by the Aum Shinrikyu doomsday cult
- Matsumoto : 27 June 1994 &
- Tokyo : 20 March 1995

List of terrorist incidents in India

Date	Incident & Description	Location	Fatalities	Injured	Status of case
August 2, 1984	Meenambakkam bomb blast	Tamil Nadu	30	25	Verdict given
March 12, 1993	1993 Bombay bombings	Mumbai	257	713	verdict given
December 30, 1996	Brahmaputra Mail train bombing		33	150	N/A
February 14, 1998	1998 Coimbatore bombings	Tamil Nadu	58	200+	Verdict given
May–July 2000	2000 Church bombings	Karnataka, Goa and Andhra Pradesh			Verdict given
October 1, 2001	2001 Jammu and Kashmir legislative assembly car bombing	Jammu and Kashmir	38		
December 6, 2002	2002 Mumbai bus bombing	Mumbai	2	14	
January 27, 2003	2003 Mumbai bombing	Mumbai	1		
March 13, 2003	2003 Mumbai train bombing	Mumbai	11		
July 28, 2003	2003 Mumbai bus bombing	Mumbai	4	32	
August 25, 2003	25 August 2003 Mumbai bombings	Mumbai	52		
August 15, 2004	2004 Dhemaji school bombing	Assam	18	40	
July 28, 2005	2005 Jaunpur train bombing	N/A	13	50	
October 29, 2005	2005 Delhi bombings: Three powerful serial blasts in New Delhi at different places	Delhi	70	250	
March 7, 2006	2006 Varanasi bombings: Three synchronized terrorist attacks in Varanasi in Shri Sankatmochan Mandir and Varanasi Cantonment Railway Station	Varanasi	21	62	
July 11, 2006	2006 Mumbai train bombings: Series of 7 train bombing during the evening rush hour in Mumbai	Mumbai	209	500	

Source : https://en.wikipedia.org/wiki/List_of_terrorist_incidents_in_India

List of terrorist incidents in India(contd)

Date	Incident & Description	Location	Fatalities	Injured	Status of case
September 8, 2006	2006 Malegaon bombings: Series of bomb blasts in the vicinity of a mosque in Malegaon, Maharashtra	Maharashtra	37	125	
February 18, 2007	2007 Samjhauta Express bombings	Haryana	68	50	
May 18, 2007	Mecca Masjid bombing	Hyderabad	13		
August 25, 2007	August 2007 Hyderabad bombings - Two blasts in Hyderabad's Lumbini park and Gokul Chat.	Hyderabad	42	54	
October 11, 2007	Ajmer Dargah bombing	Rajasthan	3	17	
October 14, 2007	One blast in a movie theatre in the town of Ludhiana on the Muslim holy day of Eid ul-Fitr	Ludhiana	6		
November 24, 2007	A series of near-simultaneous explosions at courthouse complexes in the cities of Lucknow, Varanasi, and Faizabad	Uttar Pradesh	16	70	
May 13, 2008	Jaipur bombings: 9 bomb blasts along 6 areas in Jaipur	Jaipur	63	200	
July 25, 2008	2008 Bangalore serial blasts: 8 low intensity bomb blasts in Bangalore	Bangalore	2	20	arrests made
July 26, 2008	2008 Ahmedabad bombings: 17 serial bomb blasts in Ahmedabad	Gujarat	29	110	arrests made
September 13, 2008	13 September 2008 Delhi bombings: 5 bomb blasts in Delhi markets	Delhi	33	130	
September 27, 2008	27 September 2008 Delhi bombing: Bombings at Mehrauli area, 2 bomb blasts in Delhi flower market	Delhi	3	21	
September 29, 2008	29 September 2008 western India bombings: 10 killed and 80 injured in bombings in Maharashtra (including Malegaon) and Gujarat bomb blasts	Maharashtra	10	80	
October 1, 2008	2008 Agartala bombings	Agartala	4	100	
October 21, 2008	2008 Imphal bombing	Imphal	17	40	
September 8, 2006	2006 Malegaon bombings: Series of bomb blasts in the vicinity of a mosque in Malegaon, Maharashtra	Maharashtra	37	125	

List of terrorist incidents in India(contd)

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October 1, 2008	2008 Agartala bombings	Agartala	4	100	
October 21, 2008	2008 Imphal bombing	Imphal	17	40	
October 30, 2008	2008 Assam bombings	Assam	77	300	
November 26, 2008	2008 Mumbai attacks	Mumbai	171	239	Verdict given

List of terrorist incidents in India(contd)

Date	Incident & Description	Location	Fatalities	Injured	Status of case
January 1, 2009	2009 Guwahati bombings	Assam	6	67	
April 6, 2009	2009 Assam bombings	Assam	7	62	
February 13, 2010	2010 Pune bombing	Pune	17	60	
December 7, 2010	2010 Varanasi bombing	Varanasi	1	20	
July 13, 2011	2011 Mumbai bombings	Mumbai	26	130	
September 7, 2011	2011 Delhi bombing	Delhi	19	76	
August 1, 2012	2012 Pune bombings	Pune	0	1	
February 21, 2013	2013 Hyderabad blasts	Hyderabad	16	119	
17 April 2013	2013 Bangalore blast	Bengaluru	0	16	
7 July 2013	Bodh Gaya bombings	Bihar	0	5	
27 October 2013	2013 Patna bombings	Bihar	5	66	
25 April 2014	Blast in Jharkhand	Jharkhand	8	4-5	
28 April 2014	Blast in Budgam District	Jammu and Kashmir	0	18	
1 May 2014	2014 Chennai train bombing	Tamil Nadu	1	14	
12 May 2014	Maoist blast in Gadchiroli District	Jharkhand	7	2	
28 December 2014	Bomb blast at Church Street, Bangalore	Bengaluru	1	5	
March 7, 2017	2017 Bhopal–Ujjain Passenger train bombing	Bhopal, Madhya Pradesh		10	

Source : https://en.wikipedia.org/wiki/List_of_terrorist_incidents_in_India

Lessons Learnt

- Increasing Chemical & Biological Attacks – New Risks & New Roles
- India is more vulnerable
- Preparedness for Chemical Attacks
- Emergency response
- Availability of Personal Protective Equipments
- Other equipments
- Risk Communication
- Site Management
- Antidotes
- HAZMAT Experts
- Appropriate protection
- Medical aid/ Expertise
- Police to respond
- Training

HOW ARE WE GOING TO ADDRESS THE THREAT?

- ✓ Changes to regulation,
- ✓ Intelligence
- ✓ Bolstering existing systems
- ✓ Public health
- ✓ Poison centres
- ✓ Establishing new research priorities
- ✓ Adopting new educational approaches

Thank you for the kind attention!

Bio-Sketch of Dr. Vidyasagar Sathuvalli

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Phone: +1 541-223-1699

Vidyasagar Sathuvalli is a native of India, and received the BS in Horticulture in 2002 from Tamil Nadu Agricultural University, India. His career at Oregon State University began in 2004, and in 2007 he received the MS in Plant Breeding and Genetics. In 2011, he received the PhD in Plant Breeding and Genetics from Oregon State University. His dissertation work was in the identification of sources of genetic resistance and map based cloning of eastern filbert blight resistance in hazelnut. Hazelnut is an important specialty crop for Oregon.

Upon completion of the PhD, Dr. Sathuvalli was named post-doctoral research associate, and in 2012 he joined the faculty of Oregon State University, and holds the Oregon Potato Research/Extension Endowed Professorship. He networks broadly across the United States and internationally for potato improvement, and is especially interested in developing new russet potato varieties with improved resistance to biotic and abiotic stress responses and developing genetic and genomic resources for potato.

Dr. Sathuvalli is author or co-author of more than 30 peer-reviewed publications, has 11 published abstracts, and has released six potato cultivars through Oregon State University. He is named on another four potato releases through the Tri-State potato breeding partnership. He has secured or been a sharer in more than USD $1.95 M in competitive grants, gifts, and cooperative agreements. He is a popular speaker and presenter to industry, growers, and the plant breeding community internationally.

Indo-US Workshop on Security of Dual use Agrochemicals

AGROCHEMICAL REGULATIONS IN THE UNITED STATES

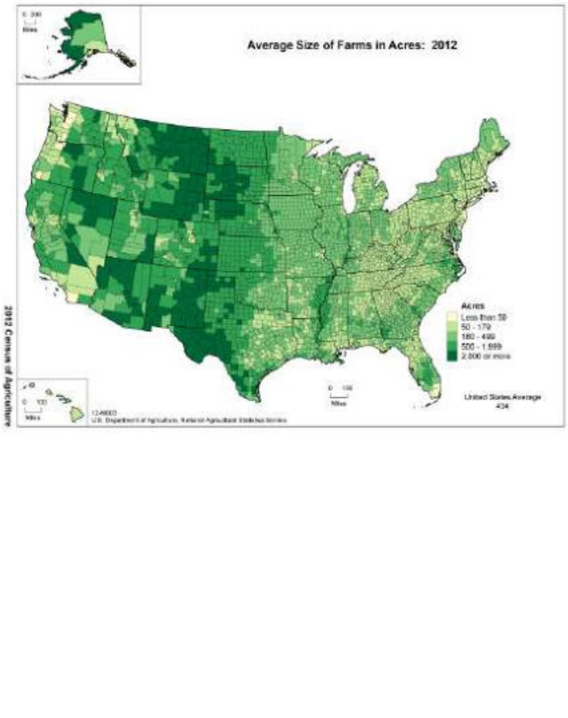
Prof. Vidyasagar Sathuvalli, Mr. Cory C. Cooley
Oregon State University, Hermiston, OR, USA

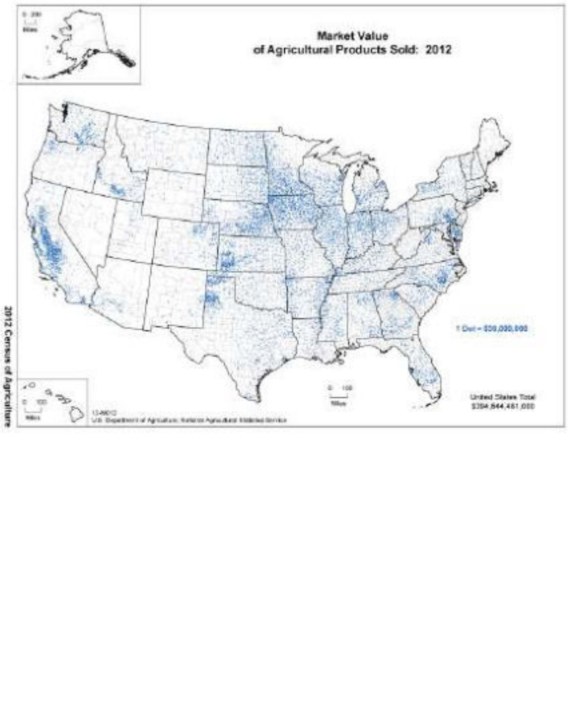
Dr. Radha Kishan Motkuri, Dr. Rob R Siefken and Dr. Clifford S. Glantz
Pacific Northwest National Laboratory (PNNL), Richland, WA, USA

Pacific Northwest NATIONAL LABORATORY

Oregon State University

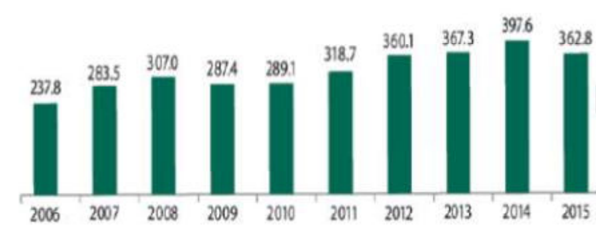
US Agricultural Scenario





U.S. Farm Expenditures

Fig. 1. U.S. Total Farm Expenditures, 2006 – 2015 ($ billion)



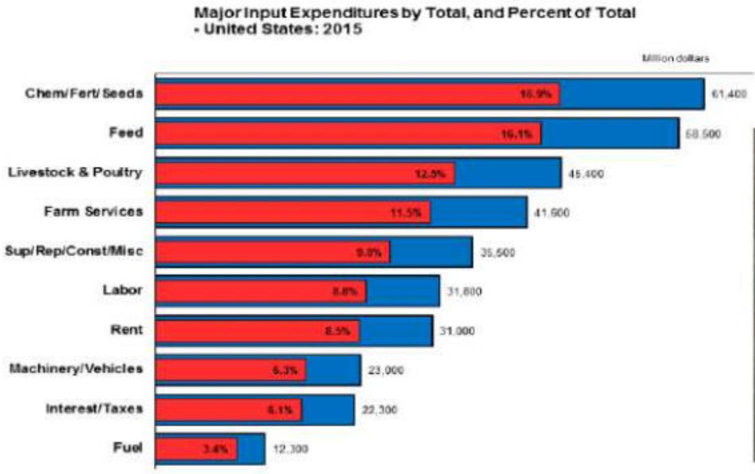
Source: USDA NASS.

Table 1. Farm Expenditures, by Category, 2015 ($ billion and percent)

	$ billion	%
Feed	58.5	16.1
Livestock, poultry, and related expenses	45.4	12.5
Farm services	41.6	11.5
Labor	31.8	8.8
Rent	31.0	8.5
Fertilizer, lime, and soil conditioners	25.5	7.0
Seeds and plants	21.3	5.9
Farm supplies and repairs	18.7	5.2
Farm improvements and construction	16.1	4.4
Agricultural chemicals	14.6	4.0
Taxes	12.8	3.5
Fuel	12.3	3.4
Other expenses	33.2	9.2
Total	**362.8**	**100.0**

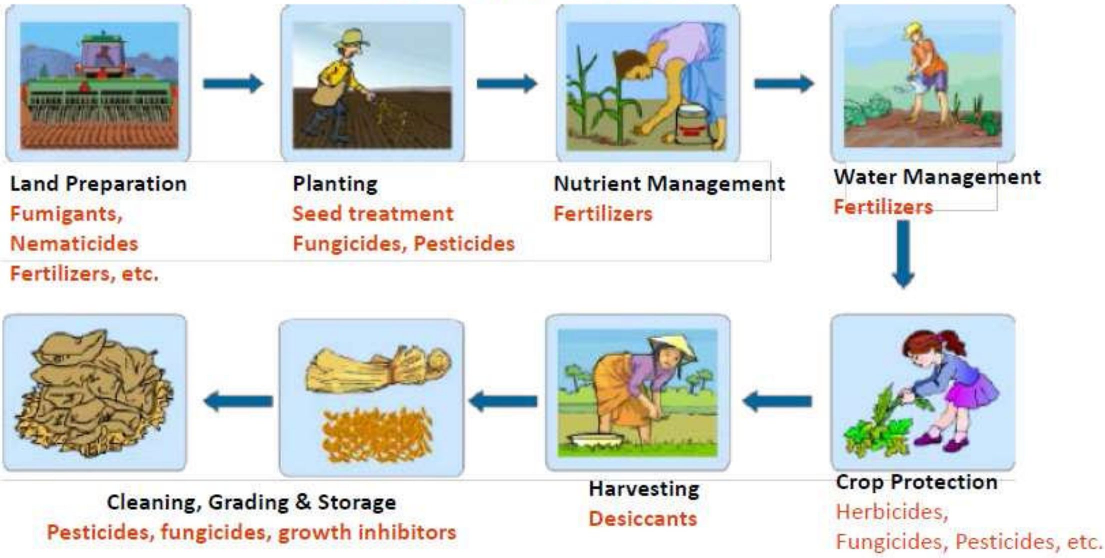
Source: USDA NASS.

U.S. Farm Expenditures



USDA NASS – August 2016

Agrochemical Usage in Crop Production



Laws and Regulations by Farm Activity

Topic	Type of Farm or Ranch Activity:	Link to Program Area Information	Requirements of Farm
Pesticide use by workers or handlers:	Mixing, loading and application of pesticides and any other farm labor that involves exposure to pesticides.	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Pesticide Label Worker Protection Standard	Label restrictions typically require protective clothing and engineering controls (e.g., tractors with enclosed cabs and air recirculation systems).

Restricted Pesticide Use:	Pest control with the use of 'restricted use' pesticides.	Certification and training regulations	Required training for farmers and/or their pesticide applicators that use 'restricted use' pesticides.
Pesticide Use:	Storage and disposal of pesticides and pesticide containers.	Pesticide Containers Pesticide Storage Pesticide Disposal	Follow label instructions for storing and disposing of pesticides and containers.
Pesticide Use and Water:	Applications of (1) biological pesticides and (2) chemical pesticides that leave a residue, in which applications are made directly to waters of the United States, or where a portion of the pesticide will unavoidably be deposited to waters of the United States.	National Pollutant Discharge Elimination System (NPDES) Water Related Pesticides Rule	Applications required to be covered under a National Pollutant Discharge Elimination System (NPDES) permit.
Pesticide use and endangered species:	Pest control on farmland or forests that have endangered species habitat.	EPA Office of Pesticide Programs Endangered Species Protection Program Bulletins Live	Farmer must follow label requirements and county bulletin requirements (if available) to ensure protection of endangered species.
Pesticide Use:	Crop and livestock production practices that involve pest control.	Pesticide Label	Follow label instructions to apply pesticide legally. 6

Laws and Regulations

Laws are meant for protecting the public and the environment.

- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
- Federal Food Drug and Cosmetic Act (FFDCA)
- Food Quality Protection Act (FQPA)
- Pesticide Registration Improvement Act (PRIA)
- Endangered Species Act (ESA)

FIFRA Gives EPA Authority

- Federal Insecticide Fungicide and Rodenticide Act
- Administered by EPA (Environmental Protection Agency)
- EPA administers manufacturing, distribution sale, use, storage, and disposal of pesticides
- EPA regulates the production, distribution, sale, use, and disposal of pesticides
- Develop regulations, oversee enforcement

FIFRA

- Impose civil and criminal penalties
- Stop the sale or use of any pesticide
- Issue removal orders and seize products if a product is a risk
- Reevaluate older pesticides
- Implement programs to certify applicators of RUP's
- Protect agricultural workers and handlers from occupational pesticide exposure

Restricted Use Pesticides (RUP)

- Have higher toxicity than general use products - more likely to harm humans or the environment.
- A pesticide is labelled as RUP if it exceeds certain criteria related to human health, or hazards to non-target organisms or ecosystems.
- Some active ingredients may be listed in both use categories depending on the formulation, application method, or intended use.

- RUP's may be sold to only certified applicators, private, public, consultant or commercial.

Pesticide Registration

- Every pesticide must be registered, except minimum Risk pesticides.
- Every use of the pesticide must be registered – General or Restricted
- Approve the Label and regulate devices
- EPA takes into account economic & environmental costs & benefits

Pesticide Reregistration

- Is reviewing older pesticides, products registered before 1984, while considering data on human health, environmental, and ecological effects on pesticides. Conclusions are called Reregistration Eligibility decisions (REDs).
- In 1996 congress passed the Food Quality Protection Act (FQPA) amendments to FIFRA.
- FQPA mandated a new program known as, registration review. EPA periodically reevaluates pesticides to ensure that products in the marketplace can still be used safely as policies and practices change. In turn, labels may be updated.

FFDCA

- Federal Food, Drug and Cosmetic Act
- Food and Drug Administration (FDA) administers FFDCA
- Primary responsibility is to regulate foods, cosmetics, drugs and medical devices.
- EPA sets the tolerances and FDA enforces tolerances

Food Quality Protection Act

- Established health risk standard when assessing the risks if pesticides in food or feed.
- When reassessing existing tolerances, the FQPA requires EPA to focus on risks to infants and children.
- Also mandates EPA to: only establish a tolerance when there is "reasonable certainty" that no harm will result from combined sources of exposure. Review all old pesticides to meet safety standards, and test pesticides for endocrine disruption.

Violations and Federal Penalties

Unlawful acts includes:

- Distributing or selling an unregistered product
- Making false advertisement claims
- Selling a misbranded or adulterated product
- Defacing labels or labeling
- Refusing to keep records or permit authorized inspections
- Making a guarantee not on the label
- Selling an RUP to a noncertified applicator
- Using a pesticide in any manner inconsistent with the labeling

Worker Protection Standard

- The WPS requires employers to provide agricultural workers and pesticide handlers with certain protections. These include pesticide safety training, personal protective equipment, and decontamination supplies designed to prevent or reduce harm from occupational pesticide exposures.

- Applies to all employers in FARM, FORESTRY, NURSERY, and Enclosed space production.
- If you own a farm, have a business who hires a person to spray farm plants, or you are a crop consultant, or a custom applicator, then WPS apply.

Worker Protection Standar

WPS Standard Rules

- Protect workers during applications
- REI's- label states.
- Personal Protection Equipment (PPE)
- Emergency help available
- Cleanup supplies available
- Annual pesticide training given
- Contact by voice every 2 hours w/ pesticide that has skull and crossbones symbol.
- Constant contact if using fumigant in enclosed space
- Warning to workers of treated areas
- Worker information placement (central posting)

Pesticide Licensing and Education

- EPA has established standards for the certification of pesticide applicators and requirements for state, tribal, and federal agencies to establish pesticide applicator certification programs. Any such agency that wants to certify applicators to use RUP's must have an EPA approved certification plan that describes how the certifying authority will carry out its credentialing program.

Pesticide Consultant
TRAINING REPORT

RAJAKALYAN VIDYASAGAR SATHUVALLI

License #: AG-L1026433PC		Initiated:	04/10/2013
Certification Begin:	01/01/2017	Renewed:	11/28/2016
Certification End:	12/31/2021	Expiration:	12/31/2017

APPROVED RECERTIFICATION COURSES ATTENDED - 01/01/2017 THRU DATE OF THIS PRINTING

Session #	Type	Date	Description	City	St	Cr*
173990101		06/21/2017	Oregon State University Extension - Potato Field Day	Hermiston	OR	2

Recordkeeping

- United States Department of Agriculture administers the program that establishes federal recordkeeping requirements for private applicators.

- Keeping records protects you from lawsuits, helps determine which treatments work, helps plan future purchases, provides information needed by medical staff, and documents steps taken to protect farmworkers etc.

Other Federal Laws

- Endangered Species Act
- Pesticide Container-Containment Rule
- Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- Clear Water Act

Dr. RADHA KISHAN MOTKURI
Sr. Scientist

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RESRACH EXPEREINCE

Dr. Motkuri is a senior research scientist with the PNNL Energy processes and Materials Division. He has over 16 years of experience in material chemistry with an emphasis on porous materials such as zeolites, metal-organic frameworks (MOFs), covalent organic frameworks (COFs), mesoporous silica and porous carbon for potential applications. He serves/d as principal investigator (PI), Co-PI, project manager and task manager in diverse range of projects in material chemistry funded by the US-DOE-Advanced Research Projects Agency (ARPA-e), DOE Office of Energy Efficiency and Renewable Energy (EERE), US State Department - CSP, and PNNL's internal Laboratory Directed Research. Highlights of his recent research include the development of the materials for advanced adsorption chillers for buildings, navy, vehicles (US patent); new capability development for novel and continuous production of MOFs/composites (US patent). Dr. Motkuri has published more than 58 peer-reviewed publications (including two reviews, two book chapters, and eight cover articles) and 12 international patents (six USA patents). Dr. Motkuri organized or co-organized several sessions at American Chemical Society (ACS) meeting, including *Porous Materials for Energy Conversion* (ACS 246th meeting), *Carbon Dioxide Management* (ACS 248th meeting) and Functional porous materials for sustainable energy (ACS 254th meeting). He is on the editorial board of "**Inorganica Chimica Acta** (Elsevier)" and "***Synthesis and Catalysis***".

SELECTED PUBLICATIONS

- Jian Zheng, Rama S. Vemuri, Luis Estevez, Philip K. Koech, Donald M. Camaioni, B. Peter McGrail, Radha K Motkuri,* Pore-engineering of metal-organic frameworks for adsorption cooling applications, JACS (ASAP) 2017, DOI: 10.1021/jacs.7b04872
- Das, R. S. Vemuri, I. Kutnyakov, P. B. McGrail, Radha K. Motkuri,* "An Efficient Synthesis Strategy for Metal-Organic Frameworks: Dry-Gel Synthesis of MOF-74 Framework with High Yield and Improved Performance", ***Scientific Reports, 2016, 6, 28050***
- D. Banerjee, A. M. Plonka, C.M. Simon, R. K. Motkuri, J. Liu, X. Chen, M. Haranczyk, J.B. Parise, B. Smith, P. K. Thallapally, Metal organic framework with exceptional adsorption, separation and selectivity towards Xenon, ***Nature Communications, 2016, 7, 11831***
- M. D. Oleksiak, A. Ghorbanpour, M. T. Conato, L. C. Grabow, B. P. McGrail, Radha K. Motkuri,* J. D. Rimer, Synthesis Strategies for Ultrastable Zeolite GIS Polymorphs as Sorbents for Selective Separations, *Chemistry –A European Journal*, 2016, 22, 16078 – 16088; DOI: 10.1002/chem.201602653; (Journal cover– October 2016)
- R. K. Motkuri,* P.K. Thallapally, H.V.R. Annapureddy, S.K Nune, C.A. Fernandez, L.X. Dang, R. Krishna, B.P. McGrail, A flexible metal-organic framework for selective separation of polar solvent vapors and isomers, ***Chemical Communications 2015, 51, 8421***
- R.K.Motkuri,* H.V.R.Annapureddy, V.Murugesan, B.P.McGrail, L.X.Dang, R.Krishna, P.K. Thallapally, Fluorocarbon Adsorption in Hierarchical Porous Frameworks, ***Nature Communications 2014, 5, 4368***

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The Agrochemical Supply Chain

Dr. Radha Kishan Motkuri, Dr. Cliff Glantz, Dr. Xiao-Ying Yu, and Juan Yao
Pacific Northwest National Laboratory, Richland, WA, USA

Dr. Vidyasagar Sathuvalli
Oregon State University, Hermiston, OR, USA

Indo-US Workshop on Agrochemical Security Training
August 2017

Agrochemical Supply Chain Safety & Security
Why It Matters?

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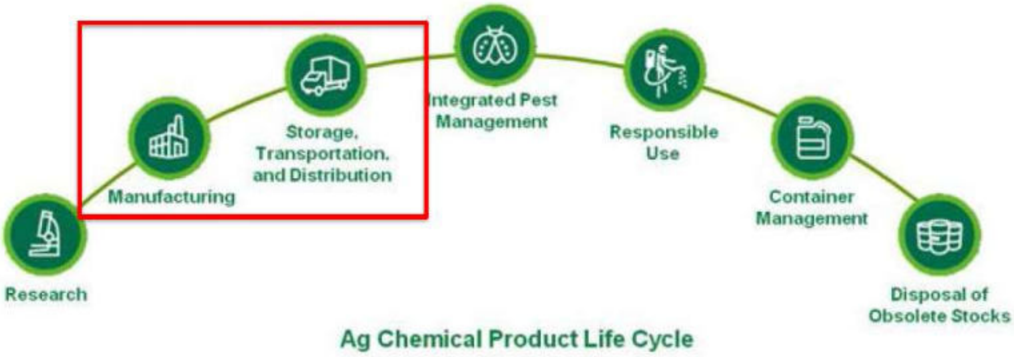
- Agrochemicals can be intentionally misused to cause deadly effect.
  - For example, fertilizers are critical to modern agriculture, but they can be misused as explosives.
- Appropriate security and awareness measures ~~that~~ can prevent/reduce the possibility of misuses.
- Supply chain play an important role in preventing these misuses through secure storage and handling of agricultural chemicals.

Agrochemical Supply Chain Safety & Security
Why It Matters?

- Good security begins with an effective security plan.
- A good security plan has many parts and depends on the size and activities of the operation.
- The life cycle of an agrochemical involves

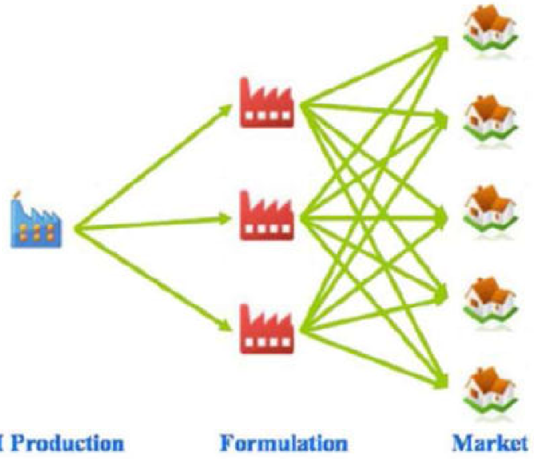


http://www.dowagro.com/en-us/sustainability/crop-protection-stewardship/what-is-crop-protection-stewardship

- Research Storage Transportation Personnel Disposal Response

Agrochemical Supply Chain Security

- The supply chain comprises all operations from design, production, formulation, packaging, transport, storage, use and waste management.
- Typical security vulnerabilities exist in Transport and Storage



Supply chain network of an agrochemical company

Transport

Storage

Urech, Plant Pathology, 1999

Agrochemicals Transport and Storage

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- Are important in preventing vandalism, theft, or the possible misuse of products by terrorists and saboteurs.
- Must meet federal, state and local regulations, depending on agrochemical application and the amount of chemicals being stored and transported.

Supply Chain Responsibilities

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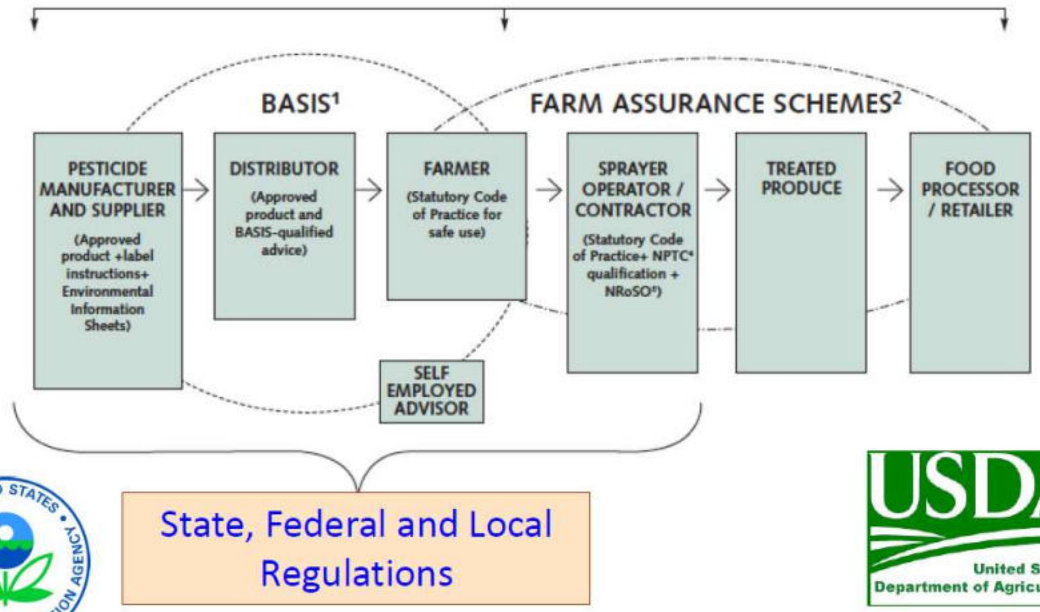
- Agrochemical manufacturer and supplier, distributor and end user are four key players in preventing the misuses through secure storage and handling of agrochemicals.
- Be aware of the rights and responsibilities when working with agrochemicals.
- It needs team work to prevent the agrochemicals from falling into wrong hands.

Supply Chain Responsibilities



Modified from Crop Protection Association

Agrochemicals on Your Farm: Safety

Usage Safety → **Storage Safety** → **Disposal Safety**

Usage Safety
- Read package labels
- Obtain health hazard information
- Prevent injury and exposure
- Prepare and apply safety measures

Storage Safety
- Discourage storing unnecessary chemicals
- Store chemicals in secure area
- Store chemicals in their original containers

Disposal Safety
- Do not pour chemicals down any drain, sink.
- Do not save or reuse empty chemical containers

(The Center for Food Security & Public Health, 2017)
http://www.prep4agthreats.org/Technological-Man-Made/agrochemicals-safety

Suggested Security Approaches to Transporting Agrochemicals

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- Create a paper trail for any agrochemical you transport.
- Transport agrochemicals in a locked vehicle.
- Avoid unnecessary stop and high population areas during the transportation.
- Be alert to any suspicious activities, e.g. vehicles following your truck, strangers asking questions, or anyone snooping around your cargo.
- Do not pick up hitchhikers and do not discuss your cargo with those not involved.
- Do not leave products unattended during the transportation.
- Check your load at delivery to ensure no product is missing.
- Carefully check background of all new drivers.
- Every driver should be properly licensed and trained in good practices for handling fertilizer and pesticides that may be hazardous in the hands of suspicious and/or dangerous people.

Florida Cooperative Extension Service, 2005

Suggested Security Approaches to Storing Agrochemicals

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- Maintain inventories list of stored agrochemicals quantities
- Keep track of who removes agrochemicals from your facility.
- Store agrochemicals in a facility with
  - locked gate
  - fence
  - good lighting
  - security system, etc.
- Check the entry and structural integrity of the facility daily to prevent unauthorized access .

Florida Cooperative Extension Service, 2005

Indicators of Suspicious Activities in the Agrochemical Supply Chain—I

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- Facilities Manufacturing Agrochemicals
  - Abnormal valves, connections, or piping that could be used to steal agrochemicals.
  - Individuals or personnel with small containers not normally used at the facility such as barbecue tanks, cylinders, closed pails, or cans.
  - Suspicious vehicles or persons monitoring hazardous materials shipments into and out of the facility.

(DHS, Chemical Sector Security Awareness Guide, 2012)

Indicators of Suspicious Activities in the Agrochemical Supply Chain—II

Pacific Northwest NATIONAL LABORATORY Proudly Operated by Battelle Since 1965

- Facilities Transporting or Distributing Agrochemicals
  - Abandoned trucks, cars, tank trucks, or unnecessary and unexplained delays in delivery or receipt.
  - Truck, rail, or towboat personnel who do not have proper identification or who are acting suspiciously.
  - Delivery or receipt of materials outside of normal operating hours and procedures.
  - Inventory control problems including:
    - Irreconcilable discrepancies in quantity and quality of materials.
    - Missing or damaged container, truck, or tank car seals.
    - Discrepancies between seal numbers and shipping documents
  - Unauthorized repackaging of chemical inventory from large containers, such as drums, to smaller containers. This may indicate illegal activity between company employees and truck driver/distributor.
  - Contact with unknown individuals en route to shipment destination.
  - Unauthorized or suspicious attempt to divert, delay, or reroute shipments.

(DHS, Chemical Sector Security Awareness Guide, 2012)

Indicators of Suspicious Activities in the Agrochemical Supply Chain—III

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- Sales or Ordering of Agrochemicals
  - The party ordering the material cannot answer basic questions on material use, explanation for current use, normal end-use application, or safety and handling.
  - The party ordering offers unusually favorable payment terms, such as a higher price, a higher lump-sum cash payment, or better interest rate than the prevailing market.
  - An order of unusual material or quantities inconsistent with the customer's business or established ordering pattern.
  - Requests for samples, particularly large samples (pails), of hazardous listed materials by new or unknown parties.
  - Unexplained, unapproved, or new delivery location for sensitive materials to an existing customer or a reluctance to provide information on the location of end use.
  - A transaction involving a third-party consignee that is unusual when compared to standard business practices.

(DHS, Chemical Sector Security Awareness Guide, 2012)

References and Resources

Pacific Northwest NATIONAL LABORATORY
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- Suggest we add the references used in the slides or add more details of the references cited in each slide. Currently, it is not possible to locate the cited reference.
- Also suggest we add some available websites or books etc. here for further information.

Pacific Northwest
NATIONAL LABORATORY
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THANK YOU

BIO-DATA

Mr. V V SASI KUMAR

a).Graduated in B.Tech –Mechanical Engineering from JNTU, ANATAPUR.

b).M.Tech in Production Science & Technology from IIT, KHARAGHPUR, WB.

c).LLB from Kakateeya University, Wrangal.

d).PRESENTED PROJECT WORK RELATED TO ENVIRONMENTAL PERFORMANCE INDICATORS IN THE CEMENT PLANTS, AS A PART OF THE PGDIPEL (ENVIRONMENTAL LAWS), AT NLSUI, BANGALORE.

e) Presently serving to the Factories Department of the Telangana State Government, as a Deputy Chief Inspector of Factories, Nalgonda, having 24 years of experience.

Associate Member of Sigma Xi, Sr Member of AIChE, Member of ASME, ACM.

INDO-US WORKSHOPS ON SECURITY OF DUAL USE AGROCHEMICALS. August 8, 2017, CSIR-IICT, Hyderabad.

The Agrochemical Supply Chain - How are the agrochemicals stored and transported? What are typical security vulnerabilities in the supply chain?

V V S KUMAR,DEPUTY CIF
FACTORIES DEPT .
GOVT OF TELANGANA

Most consumed pesticides in INDIA
(during 2005-06 to 2009-10)

Sl. No.	Pesticide (Technical Grade)	Quantity consumed (metric tonnes)
1	Sulphur (fungicide)	16424
2	Endosulfan (insecticide)	15537
3	Mancozeb (fungicide)	11067
4	Phorate (insecticide)	10763
5	Methyl Parathion (insecticide)	08408
6	Monocrotophos (insecticide)	08209
7	Cypermethrin (insecticide)	07309
8	Isoproturon (herbicide)	07163
9	Chlorpyrifos (insecticide)	07163
10	Malathion (insecticide)	07103
11	Carbendazim (fungicide)	06767
12	Butachlor (herbicide)	06750
13	Quinalphos (insecticide)	06329
14	Copper oxychloride	06055
15	Dichlorvos (insecticide)	05833

EXPORT OF MAJOR PESTICIDE & INSECTICIDE FROM INDIA

PEST/INSECT	2015-2016 Q	2015-2016V	2016-2017Q	2016-2017V
D.D.T.	0	0	0	0
MALATHION	1010	1943	311	591
DIMETHOATE	20	52	7	17
D.D.V.P.	550	1461	199	736
QUINALPHOS	235	1036	64	276
ENDOSULPHAN	0	0	0	0
CYPERMETHRIN	8837	45949	4544	21480
FENTHION	0	0	10	18
OTHER PESTICIDES	41058	214054	23114	99860
OTHER INSECTICIDES	31146	276427	17204	133076
COPPER-OXYCHLORIDE	810	1818	388	830

1. Alkali Chemicals	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Imports	409	499	511	868	630	658	995	874
Exports	179	111	148	342	347	345	145	159
2. Inorganic Chemicals								
Imports	129	174	189	195	196	264	278	287
Exports	101	123	98	377	383	289	121	135
3. Organic Chemicals								
Imports	869	1211	1639	1548	1639	2182	2487	2496
Exports	62	116	83	143	187	315	407	333
4. Pesticides (Tech.)								
Imports	11	6	14	13	19	22	19	22
Exports	66	75	72	87	93	103	110	131
5. Dyes & Pigments								
Imports	27	32	25	28	30	36	40	42
Exports	173	200	198	236	258	265	305	328
Total 5 Major Chemicals								
Imports	1446	1922	2378	2651	2514	3162	3820	3721
Exports	581	626	599	1187	1268	1317	1087	1087
Production	7713	7945	7564	7895	8509	8730	8690	8839
Capacity Utilisation (%)	76	75	71	70	73	73	73	73

Performance of selected Major Chemicals (Group-Wise) during 2006-07 to 2013-14 at a Glance (Figures in 000'MT) (Source Ministry of Chemicals & Fertilizers Government of India)

IV).Re-labeled products : are variations of counterfeiting and fraud that deliberately misrepresent product contents to avoid regulatory and consumer scrutiny by exploiting branded products and consumer cost-sensitivity. These products are frequently presented as more expensive pesticides in order to capitalize on price differentials with less costly products, and generally do not include content appropriate instructions regarding safe use and storage.

V).Refilling: legitimate pesticide containers and dispensing pesticides into non-approved containers are potentially deadly and criminal practices of illicit pesticide suppliers and distributors, as well as uninformed traders seeking to capitalize on bulk purchases. In developing countries, food or beverage containers are often re-used as their size and availability make them attractive for small farmers and household use.

ILLICIT PESTICIDES EFFECTS ON HUMAN HEALTH, ENVIRONMENTAL AND ECONOMIC RISKS

1).**EFFECTS ON HUMAN HEALTH : Effects on human health can range from** mild skin irritation to blood and nerve disorders, endocrine disruption, genetic changes, respiratory and tissue failure, coma and death.

b).Improperly used, stored or disposed illicit chemicals and pesticides can amplify already negative effects of these substances by complicating treatment protocols due to unknown or untested compounds.

c).Direct or primary exposures may occur through inappropriate or unprotected application of pesticides, oversprays, or leakage of improperly stored or contained chemicals as well as accidental ingestion. Indirect or secondary exposures may occur through the consumption of contaminated foods or water.

d).the reduction and elimination of persistent organic pollutants (POPs) and highly hazardous pesticides (HHPs) with particular attention to health effects from consumer consumption of pesticides as reflected through MRLs. MRL is often set at detection level if use of a particular pesticide is not permitted in a specific country.

Environmental risks: a)Improperly managed, pesticides contribute to air pollution, contamination of ground water and riparian systems, and soil contamination in addition to negative impacts on non-targeted plants, birds, animals and marine life, particularly sensitive species.

b).Even properly used, pesticides can negatively impact fisheries resources, migratory birds, and habitats. Millions of birds and fish are estimated to die annually from pesticide exposure (Pimental, 2005). Certain pesticides have been implicated as a potential cause of endocrine function disruption, amphibian decline and deformities, as well as decline in pollinator species.

c).Restrictions and bans on pesticides, including highly hazardous pesticides, are not universal. Regulatory gaps generate potential for hazardous exposures, especially from the introduction and use of illicit pesticides.

SCHEDULE 1

[Part - I]

(a) Toxic Chemicals: Chemicals having the following values of acute toxicity and which owing to their physical and chemical properties, are capable of producing major accident hazards:

Sr.No	Toxicity	Oral toxicity LD50(mg/kg)	Dermal toxicity LD50(mg/kg)	Inhalation toxicity LC50(mg/l)
1.	Extremely toxic	> 5	<40	< 0.5
2.	Highly toxic	>5-50	>40-200	< 0.5 - 2.0
3.	Toxic	>50-200	> 200-1000	>2-10

Commonly used Pesticides Having Adverse Effects on Human Health as Reported in INDIAN Economic and Political Weekly .

WHO Classification	***Name of Pesticide***
1 Extremely toxic, class Ia	Phorate OP
LD,$_{50}$ (oral acute) 1-50 mg/kg of body	Phosphamidon OP
weight (red triangle)	Monocrotophos OP
2 Highly toxic, Class Ib	Dichlorovos (DVDP) OP
LD$_{50}$ (oral acute) 51-500 mg/kg of body	Oxydemeton methyl OP
weight (yellow triangle)	Edifenphos F Chlorpyriphos
,	Quinalphos OP
,	Imidacloprid OP
,	Triazophos OP
,	Cypermethrin SP
,	Fenvalerate SP
,	Alphamethrin SP
,	Dimethoate OP
,	Endosulfan OC
3 Moderately toxic, Class II	Acephate OP , Malathion OP
Acephate OP LD$_{50}$ (oral acute) 50-500mg/kg	
of body weighr(blue triangle)	
4 Slightly toxic, Class III LD$_{50}$ (oral acute) xxxx	Note: OP - organophosphorus, OC- organochlorine
500 mg/kg of body weight (green triangle) xxxx	SP- synthetic pyrethroids, F - fungicides

III)ECONOMICAL RISKS :a). There are a number of economic implications from the growth in illicit pesticides. For governments, a particularly important concern stems from lost revenues from uncollected taxes. Lost revenue reduces regulatory capacity and enforcement resources.

b). Illicit and counterfeit products in the market may also restrict commercial development and innovation. Developers and producers unable to recoup research investments or to protect IPRs in specific markets may withdraw from market participation.

c). MRLs out of tolerance for banned and registered pesticides may cause a food crop or product to be rejected at import or distribution levels. This generates economic losses to the farmer and the exporting company as well as requiring the costs of safe destruction of contaminated crops.

d). Precautionary risk management, or the precautionary principle, is designed to achieve the highest levels of health and environmental protections through prevention, and highlights the delicate and challenging balance between science, public policy, and consumer demands.

IV).SPECIAL SECURITY CONSIDERATIONS :

a). Additional security concerns specific to illicit pesticides transport and distribution involve crew and cargo safety, public safety and national security.

b). Particular components of agro-chemicals (fertilizers and pesticides) can be used to manufacture explosive devices. "Transportation of wrongly labeled chemical products may pose a significant risk to logistics companies, and also to emergency services in case of an accident" .

c). Agricultural and food supply chains are critical infrastructure elements for every country. Infrastructure protection activities must be informed by recognition of the interdependencies of industrial sectors and global markets as well as threats of catastrophic disruption due to natural disasters and deliberate acts of sabotage and terrorism.

d). Over three quarters of seizures of high risk chemicals in 2013, including ammonium nitrate and potassium chlorate, were reported to be used in the illicit manufacturing of improvised explosive devices (IEDs) by the Rogue Nations.

ILLICIT PESTICIDE GLOBAL SUPPLY CHAIN :

a). Control efforts and prosecutions as well as enhanced inspection controls by the NATIONS at Ports have resulted in organized crime tactical changes in the distribution of illicit pesticide products, including components being shipped separately through multiple ports to obscure content, origins, and identity before landing in the ultimate market for the product.

b). A significant number of all illicit products move through supply chains and consumer networks without detection or seizure due to misrepresentation of goods on packaging or fraudulent shipping documents.

c). Regulators and border inspectors are challenged by small package volumes and unfinished goods that reduce the effectiveness of traditional detection and seizure strategies.

d). Lack of timely action by rights holders for small package detentions combined with separate distribution through post and courier of ancillary items, such as certification marks, labels, and empty packaging, may circumvent or diminish the identification of counterfeit and illicit goods (EuropolOHIM, 2015).

e). One of the most daunting aspects of interdiction and control of any illicit trade is identifying illicit cargo within the vast volumes of worldwide air, maritime, rail and road cargo shipments in the context of expanding world markets, logistics networks, free trade zones and variable national regulatory programmes.

a).The Internet and e-commerce have become major enablers for the distribution and sale of counterfeit goods (Europol-OHIM, 2012), including potentially illicit pesticides, which represents another particular and growing concerns to regulatory and enforcement authorities.

b). In India, a manufacturer of pesticides for internal agricultural consumption and export, non-genuine and illegal pesticides are increasingly recognized as a major economic, environmental and human health concern.

c).More than 60 technical grade pesticides are manufactured in the country by 125 producers and more than 500 pesticide formulators operating throughout the country (PTI, 2014).

d).Recent enforcement activities, media coverage and farmer protests have highlighted efforts to address the growing problem of illicit pesticides which is reported to affect up to one-third of the volume and one quarter of the value of the domestic pesticides industry - up to USD 525 million in 2013 (FICCI, 2015).

e).The Parliament is currently considering pending regulation (Pesticide Management Bill 2008) to update its pesticide regulatory regime, penalties for violators and harmonization with international intellectual property standards.

The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000.

- The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008.

- 684 HAZARADOUS CHEMICALS ARE LISTED UNDER PART-II OF THE MSIHC RULES.

STORAGE OF PESTICIDES UNDER THE INDIAN FACTORIES (AMENDED)ACT 1987 AND TELANGANA STATE FACTORIES RULES.

a).LIMIT THE QUANTITIES AND TYPES OF PESTICIDES STORED.
b).STORED IN A DRY ,WELL-VENTILATED,SEPARATE AREA WHERE FIRE PROTECTION IS PROVIDED.
c).SHALL BE STORED IN ORIGINAL CONTAINERS WITH LABELS IN PLAIN VIEW.
d).IF THE ORIGINAL CONTAINER IS IN A DAMAGED CONDITION ,CONTENTS SHOULD BR TRANSFERRED TO A SUITABLE SOUND CONTAINER AND LABEL IT CLEARLY.
e).PPE SHOULD BE PROVIDED TO THE WORKERS.
f).THER STORAGE SITE SHOULDBE LOCATED WHERE FLODDING IS UNLIKELY AND THE SOIL SHOUD BE TO PREVENT CONTAMINATION BY STORM WATER OR SOIL PERCOLATION.
g).SCBA SHALL BE USED WHILR FIGHTING WITH THE FIERS OF PESTICIDE TO AVOID BREATHING OF TOXICANT SMOKE.
h).CONTAIN THE WATER USED FOR FIRE FIGHTING AT THE STORAGE SITE.
i).PERSONS NEAR PESTICIE FIRES SHOULD BE EVACUATED.
j).ABSORBENT MATERIAL SUCH AS RE-USABLE GELLING AGENTS, VERMICULITE, CLAY, PET LITTER OR ACTIVATED CHARCOAL SHOULD BE ON HAND ALONG WITH A GARBAGE CAN AND SHOVEL TO QUICKLY CONTAIN AND CLEAN UP ANY SPILLS.

Materials Safety Data Sheets(MSDS) for each pesticide should be posted in a prominent location.

An emergency response plan (OSEP) should be made available. Such a plan lists actions to take and personnel to contact in the event of a spill or accident.

An automatic smoke detection system or smoke and heat detection system should be installed. Suitable methods for extinguishing fires should be installed

Personal protection equipment such as respirators, chemical resistant (CR) gloves, CR footwear, coveralls with long sleeves, protective eyewear, CR headgear, CR aprons and a first-aid kit/anti-dotes should be available immediately outside the storage area.

Rinse liquid pesticide containers three times when emptied. The rinse material should be poured into a spray tank and Transported to a Hazd. Waste Disposal Site.

RULE 18 OF MSIHC RULES,1989 IMPORT OF HAZARDOUS CHEMICALS

a).Rule 2-Any person responsible for importing hazardous chemicals in India shall provide before thirty days or as reasonably possible but not later than the date of import to the concerned authorities as identified in

b).Column 2 of Schedule 5 the information pertaining to-

1. the name and address of the person receiving the consignment in India;
2. the port of entry in India;
3. mode of transport from the exporting country to India;
4. the quantity of chemical (s) being imported; and
5. Complete product safety information.

c).Rule 3. If the concerned authority of the State is satisfied that the chemical being imported is likely to cause major accident, it may direct the importer to take such safety measures as the concerned authority of the state may deem appropriate.

d).Rule(3 A) In the case the concerned Authority of the State is of the opinion that the chemical should not be imported on safety or on environmental considerations, such Authority may direct stoppage of such import.

UNDER RULE 18 OF MSIHC RULES,1989 IMPORT OF HAZARDOUS CHEMICALS

e). Sub Rule-4. The concerned authority at the State shall simultaneously inform the concerned Port Authority to take appropriate steps regarding safe handling and storage of hazardous safe handling and storage of hazardous chemicals while off-loading the consignment within the port premises.

f). Sub Rule-5. Any person importing hazardous chemicals shall maintain the records of the hazardous chemicals imported as specified in Schedule 10 and the records so maintained shall be open for inspection by the concerned authority at the State or the Ministry of Environment and Forests or any officer appointed by them in this behalf.

g).ub Rule-6. The improper of the hazardous chemical or person working on his behalf shall ensure that transport of hazardous chemicals from port of entry to the ultimate destination is in accordance with the Central Motor Vehicles Rules, 1989 framed under the provision of the Motor Vehicles Act, 1988.

UNDER RULE 18(5)OF MSIHC RULES ,1989 SCHEDULE -10

FORMAT FOR MAINTAINING RECORDS OF HAZARDOUS CHEMICALS IMPORTED

1. **Name and address of the Importer:**

2. **Date and reference number of issuance of permission to import hazardous chemicals:**

3. **Description of hazardous chemicals:**
   - **a).Physical form:**
   - **b).Chemical form:**
   - **c).Total volume and weight (in kilogram's/Tones)**

4 **Description of purpose of Import:**

5. **Description of storage of hazardous chemicals:**
   - **a).Date:**
   - **b).Method of storage**

RULE 129. TRANSPORTATION OF GOODS OF DANGEROUS OR HAZARDOUS NATURE TO HUMAN LIFE

Every owner of a goods carriage transporting any dangerous or hazardous goods shall,

(a). Shall display a distinct mark of the class label appropriate to the type of dangerous or hazardous goods as specified ;

(b). Shall be equipped with safety equipment for preventing fire, explosion or escape of hazardous or dangerous goods;

(c) .Shall be fitted with Tachograph (an instrument to record the lapse of running time of the motor vehicle; time speed maintained, acceleration, deceleration, etc.) conforming to the specifications of the Bureau of Indian Standards;

(d). Shall be fitted with a spark arrester.

Rule 131. Responsibility of the consignor for safe transport of dangerous or hazardous Goods.

1) It shall be the responsibility of the consignor intending to transport any dangerous or hazardous goods listed in Table III, to ensure the following, namely:—

(a)the goods carriage has a valid registration to carry the said goods;

(b) the vehicle is equipped with necessary first-aid, safety equipment and antidotes as may be necessary to contain any accident;

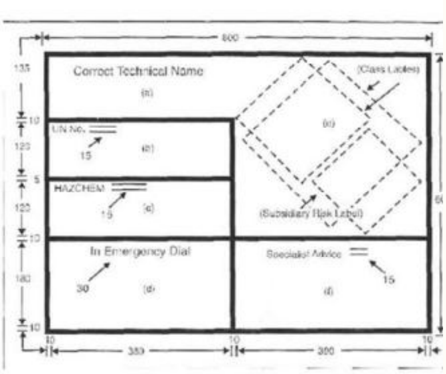
(c) that the transporter or the owner of the goods carriage has full and adequate information about the dangerous or hazardous goods being transported; and

(d) that the driver of the goods carriage is trained in handling the dangers posed during transport of such goods.

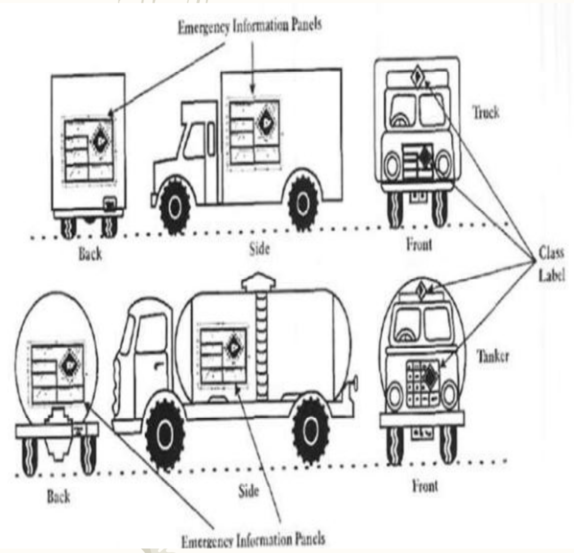
RULE 133. RESPONSIBILITY OF THE DRIVER

(1)The driver of a goods carriage transporting dangerous or hazardous goods shall ensure that the information given to him in writing is kept in the driver's cabin and is available at all time while the dangerous or hazardous goods to which it relates, are being transported.

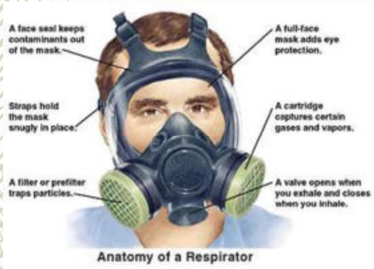
(2) Every driver of a goods carriage transporting any dangerous or hazardous goods shall observe at all times all the directions necessary for preventing fire, explosion or escape of dangerous or hazardous goods carried by him while the goods carriage is in motion, and when it is not being driven he shall ensure that the goods carriage is parked in a place which is safe from fire, explosion and any other risk, and at all times the vehicle remains under the control and supervision of the driver or some other competent person above the age of 18 years.]



Rule 134. Emergency information panel.

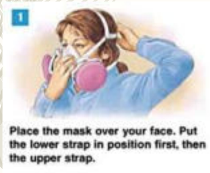


Different Type Of Masks



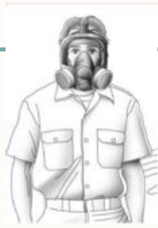
Full Face Mask Respirator

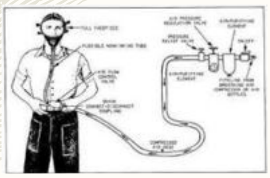
Half Face Mask Respirator



Cleaning Mask

Different Type Of Cartridges





Supplied Air

- Higher Protection Factors
- Increased Comfort
- Reduced User Errors
- Applicable to most contaminants
- Reduced Maintenance efforts
- No fit testing required
- Options of cooling incoming air
- Growing popularity in the Indian Work Place

e-commerce

a). It is required to address the proliferation of websites selling Pesticides, Agrochemicals with dubious Shell Life & Concentration.

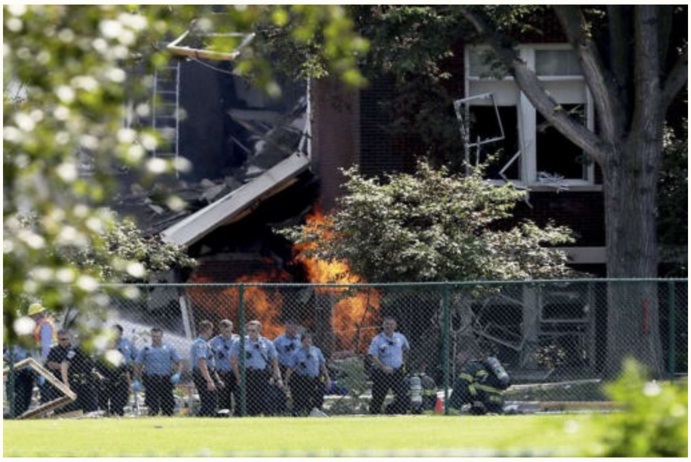
b).There are alarming number of websites that were selling misbranded pesticides ,illicit pesticides, and restricted Chemicals were being sold to the Unregistered Vendors .

c).Regulations are to be Amended for stepping up efforts against the online traffickers of illegal pesticides.

d).The sale of unregistered products, the making of unaccepted claims about the registered pesticides being sold, and the sale of restricted-use pesticides to people who are not certified to use them.

Crisis Groups

- Formed under Chemical Accidents (Emergency Preparedness and Response) Rules 1996
- Manufacture, Storage and Import of Hazardous Chemicals Rules 1989
- Factories Act 1948 and Rules made there under
- To deal with the emergencies arising out of chemical accidents



Levels of Crisis Group

- Central Crisis Group
- State Crisis Group
- District Crisis Group
- Local Crisis Group

Chemical Accident

- Accident involving a fortuitous or sudden or unintended occurrence while handling any hazardous chemicals resulting in continuous, intermittent or repeated exposure to death or injury to any person or damage to any property.
- At least 12 persons were injured, four seriously, in an explosion caused by leakage of carbon disulfide (CS_2) at Hindustan

OFFSITE EMERGENCY

- If the consequences of emergency exceeds the four walls of the industrial activity
- Involvement of District Administration in saving the life and property
- Coordination of various department and organisations
- Preparation of Offsite Emergency Plan.
- China jails 49 for catastrophic Tianjin Warehouse blasts, in which killed at least 165 people in August 2015.

Composition of DCG

I	District Collector	Chairperson
II	Dy. Chief Inspector of Factories	Member Secretary
III	District Emergency Officer	Member
IV	Chief Fire Officer	Member
V	District Information Officer	Member
VI	Controller of Explosives	Member
VII	Chief-Civil Defence	Member

Functions of DCG

- Apex body in the district to deal with major chemical accidents
- To provide expert guidance for handling chemical accidents.
- Assist in the preparation of the off-site emergency plan
- Review all the on-site emergency plans
- Assist the district administration in the management of chemical accidents
- Continuously monitor every chemical accident
- Ensure continuous information flow from the district to the Central and State Crisis Groups

ACTION PLAN FOR TRANSPORT ACCIDENT:

- Action plan is similar to an industrial installation.
- The person to inform the emergency is Driver of the vehicle/cleaner of the vehicle if they are safe. Otherwise any passerby will inform the emergency to the Emergency Control Center. The information flow thereafter is similar to the above.
- Possibility of affected region is lesser than in case of industrial installation but the nature of accident scenario being dynamic and sometimes occurs in the area where there is more population; control of the situation may become critical.
- Here the important role players are the first responders ie police, fire and medical authorities.
- Control of traffic, neutralizing the chemical or combating the fire, evacuation of public in the downwind direction are the important activities.

CERTAIN HON'BLE INDIAN COURTS DECESSION.

DR.ASHOK VS UNION OF INDIA AND OTHERS, SUPREME COURT OF INDIA, HON'BLE JUSTICE S.C AGARWAL AND
HON'BLE JUSTICE G.B PATTANAIK, SCC,MAY-02-1997.

UNION OF INDIA Vs MALIAKKAL INDUSTRIAL ENTERPRISES ,
KERALA HON'BLE HIGH COURT BY
THE HON'BLE JUSTICE Mr.K.M JOSEPH &
HON'BLE JUSTICE Mr.A.HARIPRASAD, JUN-03-2014.

Controlling illicit pesticide markets and actors in the Trade.

Recommendations :-

a). All the Pesticides/Agrochemicals that are to be imported shall produce an end usage certificate , certifying that the Agrochemicals that are to be imported are for the designated Legal usage.

b).The Agrochemicals that are in more demand by Quantities & Value ,the Nations shall be under vigilance to prevent entry of spurious, illicit Pesticides to fill the Demand Supply Gap at a lesser Prices.

c).Providing a High Security Tag , Hologram to the Agrochemicals Consignment Shipped to the Nations.

d).Ordering of the Pesticides by the Retailers/Bulk Users /End Users shall be online through a High Security Network under the surveillance of the Government agencies both at Nation/International Levels

e).All the manufacturers ,Formulation Units, Retailers/Bulk Users ,Wear Houses shall be Registered with the Authorities.

Recommendations :-

f). The manufactures, Suppliers, Importers, Wear houses, Exporters ,Retailers Handling the HHP, Highly Toxic and its Precursors shall be under strict Surveillance.

g).Periodically Assessing the Security aspects and Vulnerabilities in the supply chain of Agrochemicals and sharing the missing Links across the Nations.

h).Importing of Pesticides /Agrochemicals for Non-Agricultural Purposes can be under Strict Surveillance.

i).Disposing of the Agrochemicals Containers and expired Shell Life Pesticides shall be under strict Surveillance.

j).Periodic Campaigning to bring awareness among the Concerned Stakeholders related to the Illicit Agrochemicals and Pesticides.

k).Technologies, manufacturing equipment suppliers for making of Illicit Agrochemicals shall be Regulated.

THANK YOU

Biosketch

Rob Siefken

Rob Siefken is a Senior Security Operations Specialist at PNNL. He supports multiple large-scale security programs. He works with both domestic and international security forces to support vulnerability assessment, counter terrorism, incident response training, design basis threat, and crisis management support programs.

A key focus of his work is the security of critical infrastructure, including the electricity, oil and natural gas, water, nuclear, and key manufacturing. Recent work includes:

- Supporting the DOE Office of International Affairs, in the development of design basis threat assessments, security force training, and security effectiveness assessments for critical energy infrastructure in Iraq.
- Providing Radiological Threat Reduction law enforcement response training in 19 different countries over a two-year period.
- Planning and executing a no-notice security exercise on the border of Ukraine and Moldova. He served as the exercise director, coordinating the work of a variety of governmental agencies and local participants.
- Supporting the US Federal Bureau of Investigation, Department of State, and Department of Homeland Security on a wide array of security programs.

EVALUATING THE SECURITY OF AGROCHEMICALS

Rob Siefken, PNNL

- Understand the process of a self assessment
- Describe the adversary and response timelines
- Discuss the Vulnerability of Integrated Security Assessment (VISA) tool for self assessments

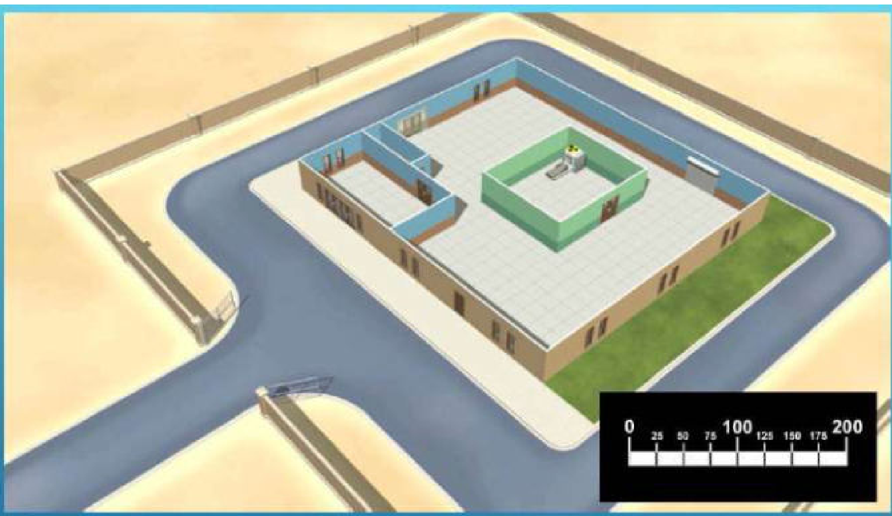
OBJECTIVES

THE PROCESS

- What are you protecting against? (Design Basis Threat)
- What are you protecting?
  - Characterize the "target" and the protection system
  - List unacceptable consequences
- What is your protection strategy?
  - Denial, containment, or reporting
- What resources do you have now?

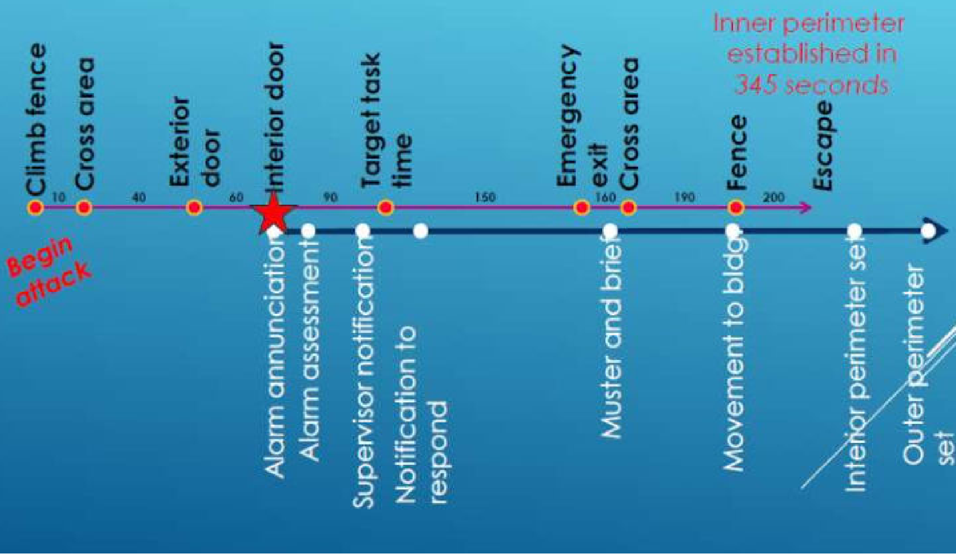
THE PROCESS CONT.

- Analyze the protection system against a given threat
  - Realistic and credible threats based on accurate information and intelligence
  - Only existing physical security / cyber systems used
- Determine the security upgrades you need
- Analyze the system using the potential upgrades
- Make a risk-informed decision
  - Management and $$$

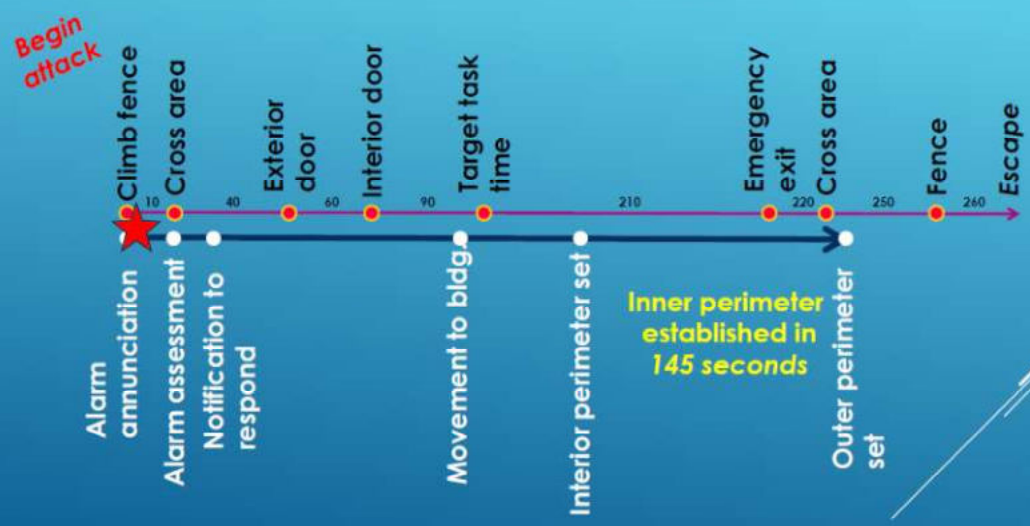


EXAMPLE ADVERSARY TASK TIME – IN SECONDS

ADVERSARY AND RESPONSE TIMELINE 1



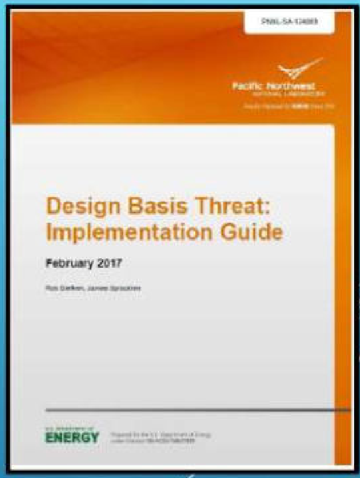
ADVERSARY AND RESPONSE TIMELINE 2



- It's Free!
- The Vulnerability to Integrated Security Analysis (VISA) tool and methodology
- Simple and effective user guide
- Proven Effective and still used today through out the U.S Department of Energy Complex
  - Fixed sites
  - Transportation assets
  - Other Safeguards and security assets

A PROVEN TOOL TO HELP

- VISA tool and methodology
  - Used in DOE complex since 1977
  - Still used today
- Self assessments
- Justify security related expenditures
- Risk-based approach to safeguards and security


Pacific Northwest

Design Basis Threat: Implementation Guide

February 2017

ENERGY

USER GUIDE AVAILABLE

QUESTIONS OR COMMENTS

WORKING WITH LAW ENFORCEMENT AGENCIES

Rob Siefken, PNNL

- Understand that prevention is critical
- Discuss the importance of early detection and assessment
- Discuss critical aspects of an inter agency response
- Identify a path foreword to improve safeguards and security

OBJECTIVES

- Invite Law Enforcement and HazMat teams to where the materials are
  - Awareness is critical
  - Onsite tours and briefings
  - Hazard identification
    - Threats to Responders
    - Threats to the Public
  - Crisis communications identified
  - Incident command issues identified

THE GOAL IS PREVENTION

- Oh No! It's gone! What do I do?
- With out detection there cannot be accurate assessment
- Adversary timeline vs. the responder timeline
- Physical security systems to help with early detection
  - Cameras
  - Other sensors

SECURITY INCIDENT DETECTION

WHO'S IN CHARGE?

- Jurisdiction issues for each agency
- Each agency has different capabilities
- Evidence management system understood by all
- Consequence management procedures and policies for:
  - Resource management
  - Population management
  - Investigations
  - Traditional media and the public
  - Social media plans
- The unified approach for an inter-agency response is critical

MOVING FORWARD

- Develop a strong partnership with Law enforcement and Hazmat response agencies
- Develop awareness strategies for outside organizations
- Maintain existing partnerships
- Tabletop exercises to educate personnel and validate existing plans, procedures, and protection systems


QUESTIONS OR COMMENTS

Brief Profile of Dr. S. Prabhakar

Dr. S. Prabhakar
Principal Scientist & Associate Professor of AcSIR
Analytical Chemistry & Mass Spectrometry
CSIR-Indian Institute of Chemical Technology,
Hyderabad-500 007
E-mail: prabhakar@iict.res.in

Dr. Sripadi Prabhakar obtained his B.Sc. degree in chemistry and biology (1989) and M.Sc. degree in organic chemistry (1992) from Osmania University, Hyderabad, India. He performed his doctoral work on the development of mass spectral techniques for stereochemical problems and received a Ph.D. degree in chemistry (1997). After completing his Ph.D., he joined as a Scientist at the National Centre for Mass Spectrometry, CSIR-Indian Institute of Chemical Technology, Hyderabad. He is continuing his research on the application of mass spectrometry in organic and biological chemistry including the special topic on analysis of chemical warfare agents and their degradation products in environmental samples. He achieved postdoctoral fellowship (2007–2009) at the Department of Chemistry, George Washington University, USA, and a postdoctoral fellowship (2001–2003) at Oxford Glycobiology Institute, University of Oxford, Oxford, UK. His research interests include detection and identification of chemical warfare agents and their degradation products in environmental samples, metabolite profiling of body fluids, shotgun metabolomics for clinical use, targeted metabolomics, study of isomeric compounds and gas-phase rearrangements, isolation and quantification of small molecules in biological fluids (pharmacokinetics). Right from inception, he has immense contributions to the Centre for Analysis of Chemical Toxins (CACT), CSIR-IICT, which is an ISO/IEC 17025 (NABL) accredited laboratory for the off-site analysis of chemicals related chemical weapons convention. The centre obtained OPCW designation status in 2008 and the team is regularly participating in official OPCW PTs to retain the designation status. He was awarded 'Eminent Mass Spectrometrist' award by ISMAS in 2013. He serves as a Life Member for the Indian society for mass spectrometry and the Indian Society for Analytical Scientists, and as a Fellow of the Telangana Academy of Sciences, Hyderabad. He is a member of editorial board for the Rapid Communications in Mass Spectrometry, Journal of Chemistry and Science Journal of Medicine. He has published 130 research papers in peer-reviewed international journals and supervised nine Ph.D. students. He is a certified GLP inspector and technical assessor for NABL.

Full name	**Dr. Srinivas Kantevari**
Present Position	Principal Scientist & Associate Professor AcSIR Crop Protection Chemicals Division, CSIR-Indian Institute of Chemical Technology, Hyderabad, INDIA Ph: (+)91-40-27191440; Mobile: (+)91-9177597871 e-mail: ksrinivas@iict.res.in; Kantevari@yahoo.com **sites.google.com/site/skantevariresearchgroup/dr-srinivas-kantevari**

Academics:

Ph.D. (1995), Indian Institute of Technology (IIT)-Delhi, Hauz Khas, New Delhi, INDIA.
NIH Sr. Research Fellow (Dec 2006- Oct 2008) & **Sr. Research Associate** (July 2001- June 2003) at Department of Pharmacology and Physiology, Drexel University College of medicine, Philadelphia, USA.

Research Activities:

Organic Synthesis; Medicinal Chemistry; Chemistry for Crop protection; Heterocyclic Chemistry
Process Development of APIs, Agrochemicals and Intermediates.

1 Design, synthesis and evaluation of new chemical entities for drug discovery programs (i) As antitubercular agents, (ii) Dual inhibitors for cardiovascular diseases; (iii) Inhibitors targeting NLRP3 inflammasome; (iv) Photolabile compounds to control cellular chemistry and physiology.
2 Development of novel crop protection agents (i) Ryanodine receptor activators, safer neonicotinoids as Insecticides (ii) Fungicides and (iii) Herbicides.
3 Logic-based novel Organic Transformations, Heterocyclic chemistry and Dendrimer chemistry

Major ongoing projects:

1) Novel immunomodulatory agents for type II diabetes, DBT-Indo-Australia Biotechnology Fund, **PI & Project Coordinator-India side**, 2014-17.
2) Synthesis of New chemical entities- Industry sponsored project- Insecticides India Ltd. 2016-18.
3) Process development of Cyazofamid- Sponsored by Insecticides India Ltd. 2016-17.

Processes developed and delivered to Industry.

1) Process for the preparation of LOSARTAN-K, (Cadila Pharmaceuticals, Gujarat)
2) Synthesis of isoquinoline alkaloid R-S NOSCAPINE (INGA Pharmaceuticals, Mumbai)
3) Value added products from n-butylbenzene (Vinati Organics Ltd., Mumbai)
4) Preparation of Inkjet dyes & other specialty chemicals (Vasant Chemicals)
5) Process for the conversion of 3-cyanopyridine to 2-chloro nicotinic acid (Jubilant Organics Ltd., Delhi)

Research publications: 86; Patents: 5;

Ph.D. supervised: 8; Ph.D. working: 6; M.Sc/ M.Pharm thesis: 28.

Other Information: ACS Reviewer appreciation award 2011; Member, American Chemical Society (ACS), USA; Editorial Board Member-Merck Index Online-Royal Society of Chemistry, London 2016; Reviewer for ACS, RSC, Wiely and Elsvier journals. Delivered >50 invited lectures in various conferences, research and educational institutes in India and abroad.

Identifying Dual Use Agrochemicals

Dr. Prabhakar Sripadi and Dr. Srinivas Kantevari

CSIR-Indian Institute of Chemical Technology
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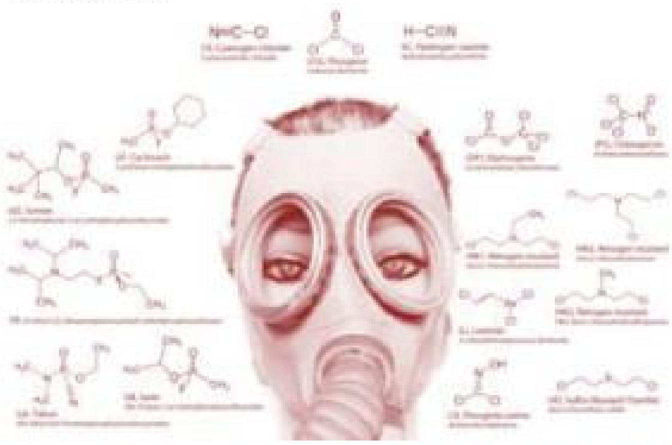
Dual use chemicals?

Chemicals used in industry or everyday life that can also be used in bad ways (legal and illegal use)

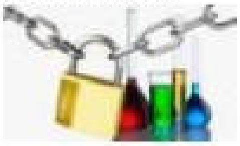
- -Chemical weapon precursor
- -Explosive precursor
- -Drug precursor



What chemicals are of most concern for diversion?
Common laboratory/industrial chemicals that would be targeted by someone for illegal reasons (chemical weapon/explosive/drug)

Chemical Safety
To Prevent/protect against chemical laboratory accidents

Chemical Security
To prevent/protect against the misuse of chemicals for non-peaceful purposes



Both ensure protection of:
Workers, Plant facility, Community, Environment, Economy

Chemical Security Questions

Is your facility secure?

How easy would it be for someone to steal chemicals?

Are the chemistry workrooms, stockrooms, classrooms and labs always locked and secure?

Is someone always there when these rooms are open?

Do you check your orders when chemicals arrive to be sure some chemicals are not missing?

Dual Use Chemicals

I. Toxic chemicals

E.g.: chlorine, phosgene, sodium cyanide, and sodium azide

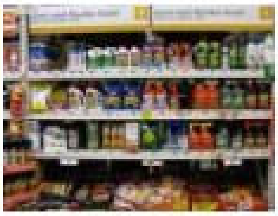
Or

II. Precursors for toxic chemicals

E.g.: PCl_3, Nitrophenols, Isocyantes etc.

Dual-use chemical example Pesticides

- Widely used in homes and agriculture



- But also used to poison people.
  Dushuqiang (Strong Rat Poison)
  - Outlawed in China in the mid-1980s, but was still available
  - Nanjing, China, Sept. 2002
    - 38 people killed by poison in snack-shop food, >300 sick
  - Hunan, China, Sept. 2003
    - 241 people poisoned by cakes served by school cafeteria
  - Tongchuan City, Shaanxi, China, April 2004
    - 74 people poisoned by scallion pancakes

Ref:
Ann. Emerg. Med., Vol. 45, pg. 609, June 2005

Dual-use chemical example
"Chlorine"

Legal Use

Manufacturing of chlorinated compounds
- Organic chlorine compounds (PVC, ethylene chlorides)
- Inorganic chlorine compounds (HCl, PCl_3)
- Disinfecting and bleaching products

Illegal Use

Chlorine gas cylinders blown up (using explosives)
World War I as a chemical weapon

Dual-use chemical example
Cyanide
Ammonium nitrate

Cyanide (Sodium cyanide)

Legal Use

Used in production of agrochemicals (herbicides and pesticides)

Illegal Use

Poison
Precursor to HCN (a CW agent)

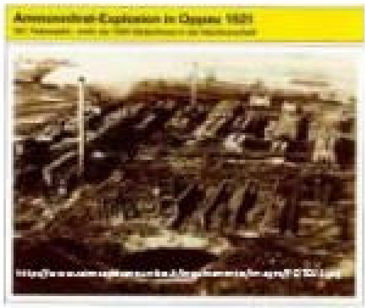
Ammonium Nitrate

Legal Use

Used in Agriculture
Industrial explosive

Illegal Use

ANFO (Ammonium nitrate/fuel oil) is a widely used bulk industrial explosive.
Used Nastly



Dual-use chemical example
Industrial chemical

Sodium Azide (NaN_3)

- Used in agriculture (farming) for pest control
- Used in automobile airbags
- (Electrical charge convert to nitrogen gas inside the airbag)
- Chemical preservative in hospitals and labs. laboratories.
- Reacts explosively with metals
  - Biological laboratory drains have exploded from discarded waste solutions containing NaN_3 as a preservative.
- When poured into a drain, release toxic gas (harm)
- The most commonly reported health effect from azide exposure is hypotension
- Fatal doses occur with exposures of 700 mg (10 mg/kg).

Dual-use chemical example
Diversion of Industrial chemical

Potassium Chlorate ($KClO_3$)

Herbicide

Kill grasses and weeds non-agricultural sites

'56' active products containing sodium chlorate as an active ingredient

Other agro chemicals:

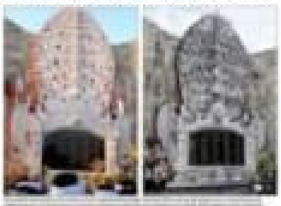
Sodium chlorate

Calcium chlorate

Magnesium chlorate

Bali bombing

- One ton of potassium chlorate



Van Bomb:

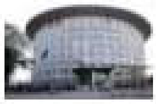
Potassium chlorate

Aluminum powder

Many industrial chemicals have dual uses

- **Dimethyl methyl phosphonate (DMMP)**
  - Flame retardant for:
    - building materials, furnishings, transportation equipment, electrical industry, upholstery
  - Nerve agent precursor
- **Thiodiglycol**
  - Dye carrier, ink solvent, lubricant, cosmetics, anti-arthritic drugs, plastics, stabilizers, antioxidants, photographic, copying, antistatic agent, epoxides, coatings, metal plating
  - Mustard gas precursor
- **Arsenic Trichloride**
  - Catalyst in CFC manufacture, semiconductor precursor, intermediate for pharmaceuticals, insecticides
  - Lewisite precursor

International Chemical Control Groups



Chemical Weapons Convention
Organization for the Prohibition of Chemical Weapons

The Australia Group

Export Controls

EU Regulations
REACH

UN Security Council Resolution 1540

India Hazardous Substances
Factories Laws in AP

CWC: Chemicals on schedules subject to verification measures

- **Schedule 1**:
  - Known CW agents
  - Highly toxic, closely related chemicals, or CWA precursors
  - Has little or no peaceful application
- **Schedule 2**:
  - Toxic enough to be used as a CWA
  - Precursor to or important for making a Schedule 1 chemical
  - Not made in large commercial quantities for peaceful purposes
- **Schedule 3**:
  - Has been used as a CWA
  - Precursor to, or important for making a Schedule 1 or 2 chemical
  - Is made in large commercial quantities for peaceful purposes
- Unscheduled Discrete Organic Chemicals (UDOC)
- Lists of scheduled chemicals follow: also in documents on CD

CWC – List of Scheduled chemicals

Schedule 1

A. Toxic chemicals

(1) [illegible]

(2) [illegible]

(3) [illegible]

(4) Sulfur mustards: [illegible]

(5) Lewisites: [illegible]

(6) Nitrogen mustards: [illegible]

(7) Saxitoxin

(8) Ricin

B. Precursors

(9) [illegible]

(10) [illegible]

(11) [illegible]

(12) [illegible]

Schedule 2

A. Toxic chemicals

(1) Amiton: [illegible]

(2) PFIB: [illegible]

(3) BZ: 3-Quinuclidinyl benzilate

B. Precursors

(4) Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl or propyl (normal or iso) group but not further carbon atoms.

(5) [illegible]

(6) [illegible]

(7) Arsenic trichloride

(8) 2,2-Diphenyl-2-hydroxyacetic acid

(9) Quinuclidin-3-ol

(10) [illegible]

(11) [illegible]

(12) [illegible]

(13) Thiodiglycol: Bis(2-hydroxyethyl)sulfide

(14) Pinacolyl alcohol: 3,3-Dimethylbutan-2-ol

Schedule 3

A. Toxic chemicals

(1) Phosgene: Carbonyl dichloride

(2) Cyanogen chloride

(3) Hydrogen cyanide

(4) Chloropicrin: Trichloronitromethane

B. Precursors

(5) Phosphorus oxychloride

(6) Phosphorus trichloride

(7) Phosphorus pentachloride

(8) Trimethyl phosphite

(9) Triethyl phosphite

(10) Dimethyl phosphite

(11) Diethyl phosphite

(12) Sulfur monochloride

(13) Sulfur dichloride

(14) Thionyl chloride

(15) Ethyldiethanolamine

(16) Methyldiethanolamine

(17) Triethanolamine

CWC:
Reporting requirements

- Use/transfer of these chemicals is allowed for research, medical, or pharmaceutical purposes.
- Reporting requirements depend on facility type, chemical types and amounts.
  - "Other Facility" type, as defined in CWC documents, most relevant here
  - Amounts of chemicals that would require that your National Authority approve the work and report your institution annually to the OPCW
    - Schedule 1: 100g aggregate
    - Schedule 2: 1 kg for 2A*, 100 kg for other 2A, 1 Tonne of 2B
    - Schedule 3: 30 Tonnes
    - UDOC: 30 or 200 Tonnes (lower number if contains P, S, or F)

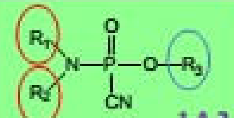
Estimated No. of
Scheduled chemicals as per CWC

Schedule Number	No. of chemicals
1.A.1	~ 24,000
1.A.2	~ 60,000
1.A.3/ 1.B.10	~ 240,000
1.A.4	9
1.A.5/ 1.A.6	3
2.B.4	Millions
2.B.5	20
2.B.6	100
2.B.10	10
2.B.11	8
2.B.12	10

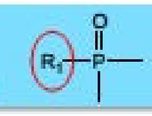
Me,
Et,
Pr,
i-Pr


1.A.1

C1-C10 alkyl (Including cycloalkyl)


1.A.2


1.A.3


2.B.4

Toxic Industrial Chemicals

- Less deadly than CWAs
- Some of them listed in Schedule-2 (CWC)
- Not Fatal
- Cause serious health problems

High	Medium	Low
[illegible]	[illegible]	[illegible]

Classification of Agrochemicals

Agrochemicals

Fertilizers

-Organic
-Inorganic (Most)

Pesticides

-Organic
- Insecticides
- Fungicides
- Herbicides
- Weedicides
- Nematocides
- Biopesticides

-Inorganic (Most)

Thiodiglycol and thionyl chloride

chloroethanol

Na_2S
(or)
K_2S

Thiodiglycol

Chlorination

Thionyl chloride ($SOCl_2$)
Hydrochloric acid (HCl)
Phosgene ($COCl_2$)
Phosphours trichloride (PCl_3)

SCl_2
Ethylene

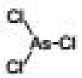
Sulfur Mustard
(World War I)

n = 1-5

n = 1-5

Sulfur Mustards

Arsenic Trichloride



H_2O

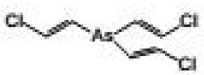
As_2O_3

H—C≡C—H
Acetylene

Lewisites (CWC, 1.A.5)

Lewisite 1

Lewisite 2

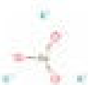


Lewisite 3

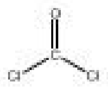
Arsenic Insecticides

Calcium arsenate

Potassium arsenite

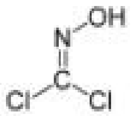


Phosgene

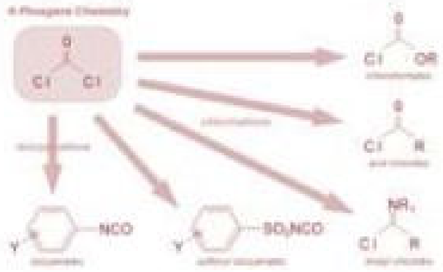


Phosgene

Warfare agent
World war 1



Phosgene Oxime (Blistering agent)



Dimethylcarbamate insecticides
- E.g. Dimetan
- Pyramat

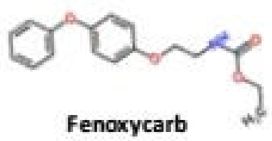
Oxime carbamate insecticides
- E.g. Alanycarb
- Butocarboxim

Phenyl methylcarbamate insecticides
- E.g. Butacarb
- Dimethacarb

Aminoethanols

2-Amino ethanol

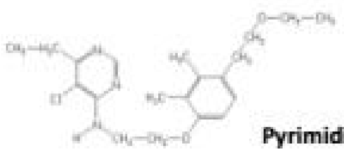
2-[(Hydroxymethyl)- amino]ethanol



Fenoxycarb

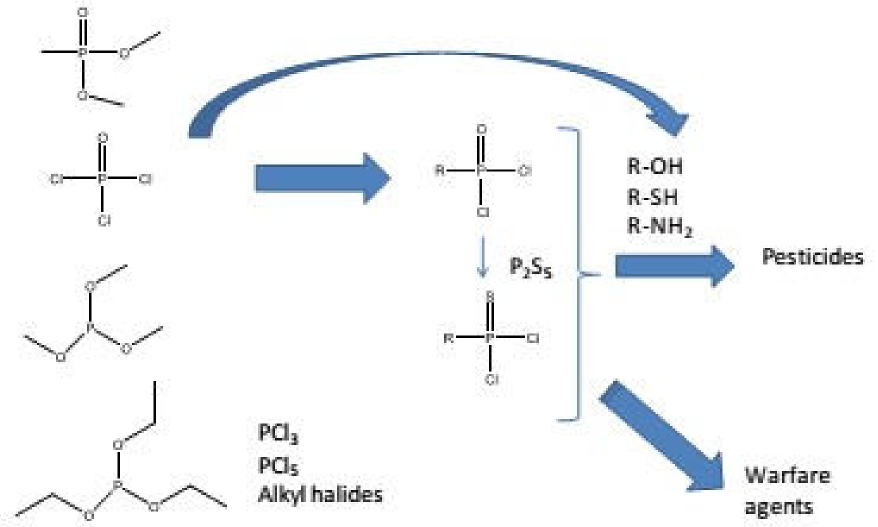
Triethanolamine
Methyl diethanolamine
Ethyl diethanolamine

Nitrogen Mustard
(CW agents)



Pyrimidifen

Organo Phosphorus Pesticides



International Chemical Controls: The Australia Group

- Started in 1985
- 40 nations plus European Commission
- Supports CWC compliance
- Arrangement to prevent exports from being used for chem/bio weapons
  - Harmonize export control

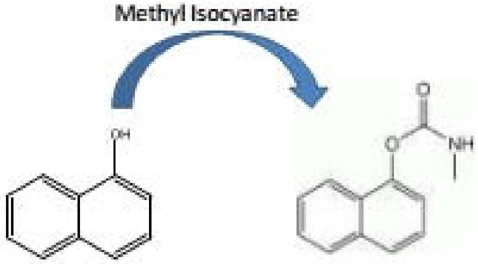
- Applies to exports of
  - Chemical weapon agents and precursor chemicals
  - Biological agents, pathogens
  - Dual-use chem/bio manufacturing facilities, equipment, related technology, and software
- Includes a no-undercut policy
  - Countries will not approve an export that another member country denied

http://www.australiagroup.net/en/index.html

Cyanates

$H_3C\text{-}NH_2 + COCl_2 \rightarrow H_3C\text{-}N{=}C{=}O$ → Bhopal tragedy

Methyl Isocyanate



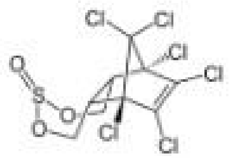
Carbaryl

Thionyl Chloride

Thiodiglycol
Amino ethanols

$SOCl_2$

Sulfur Mustards
Nitrogen Mustards



Off-Site Detection of Chemical Agents

Steps

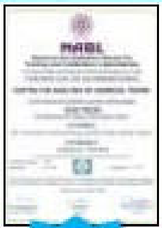
1. Sample Preparation
- Liquid-liquid extraction
- Solid phase extraction

2. Separation (Chromatography)
- Gas chromatography
- Liquid Chromatography

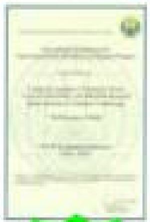
3. Detection
- Mass Spectrometry
  - GC-MS, LC-MS, HRMS, MS/MS etc.
- NMR Spectroscopy
  - ^{1}H, ^{13}C, ^{31}P-NMR
- Element specific detectors
  - GC-NPD, GC-FPD, GC-ECD

Note:
Original chemical should not change (no degradations)/ escape

CSIR-IICT established a dedicated centre "CACT" for off-site analysis of CWAs in 2004 with ISO/IEC 17025 accreditation



ISO/IEC 17025 Accreditation for CACT (2016)



OPCW designation certificate for CACT 2015

Mass Spectrometry based techniques (for Off-site analysis)

GC-MS

- Schedule 1
- Non-polar
- Semi-polar

- Schedule 2 or 3
  Prior derivatization
  e.g.
  Silylation, Methylation

EI mass spectra
(CI for M.Wt.)

Easy to identify
if available in library

NIST > 2 lakh
Wiley > 6 Lakh

CWAs: (<6000)
OCAD & VGWD

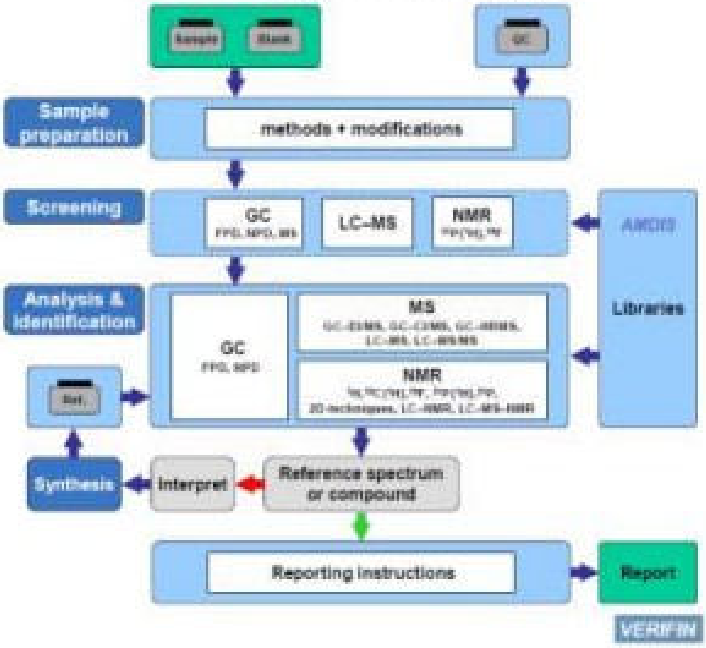
AMDIS software

LC-MS

Polar compounds (ESI)
Non-polar Semipolar (APCI)

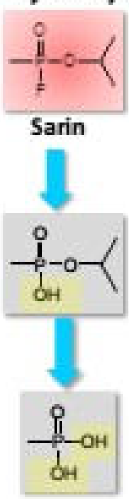
Characterization:
MS/MS libraries & Reference compounds

Analysis Strategy



Degradations of Sarin

Hydrolysis

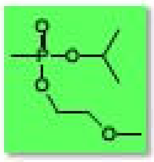


1.A.1

2.B.4

2.B.4

Decontamination with DS2

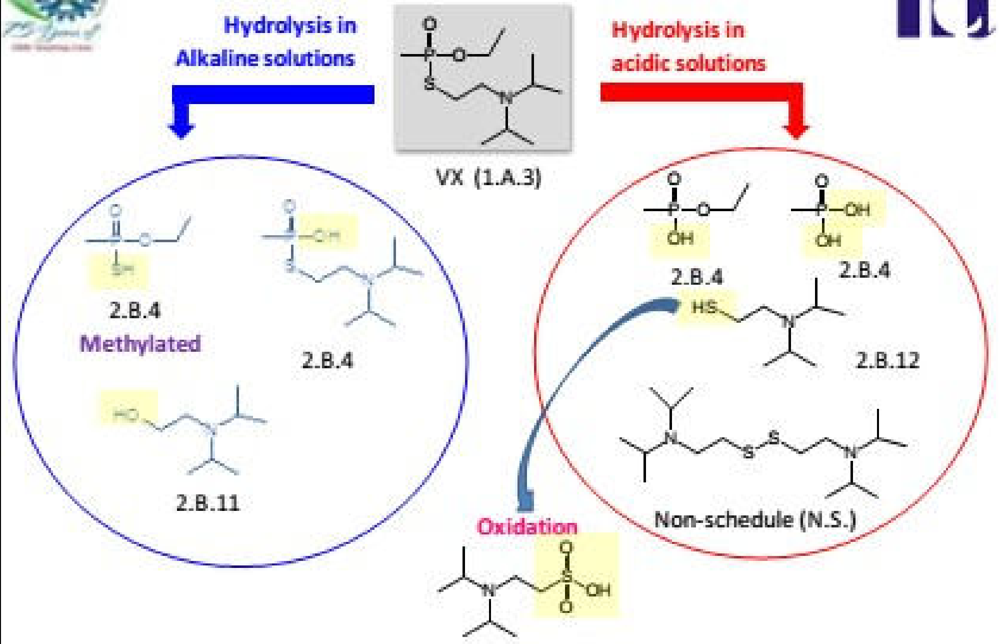


DS2 contains:
- 70% diethylenetriamine
- 28% 2-methoxyethanol
- 2% sodium hydroxide

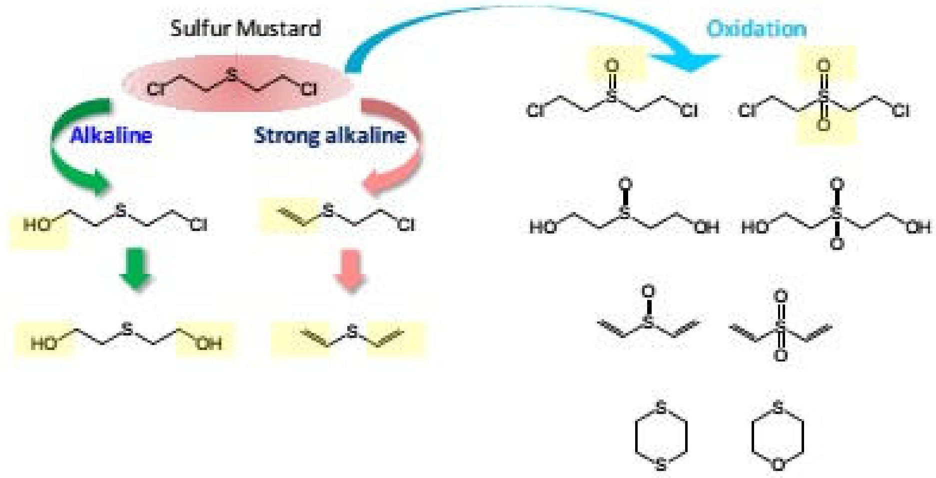
Note:

Degradation products could be precursors to synthesize parent compound

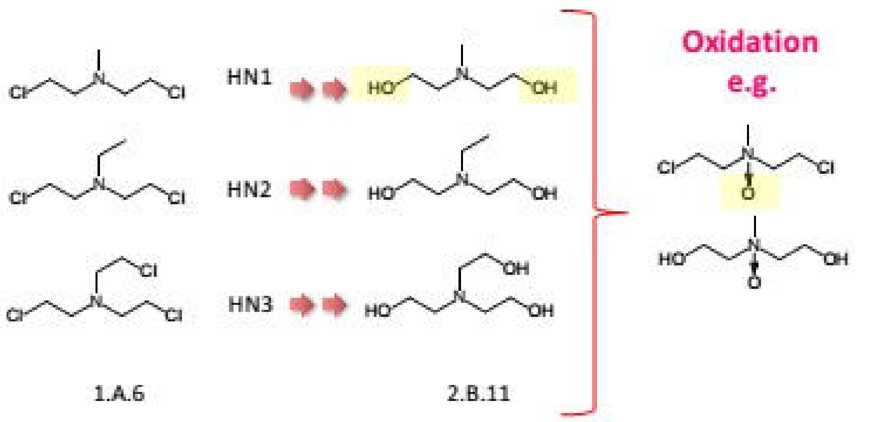
Degradations of 'VX'



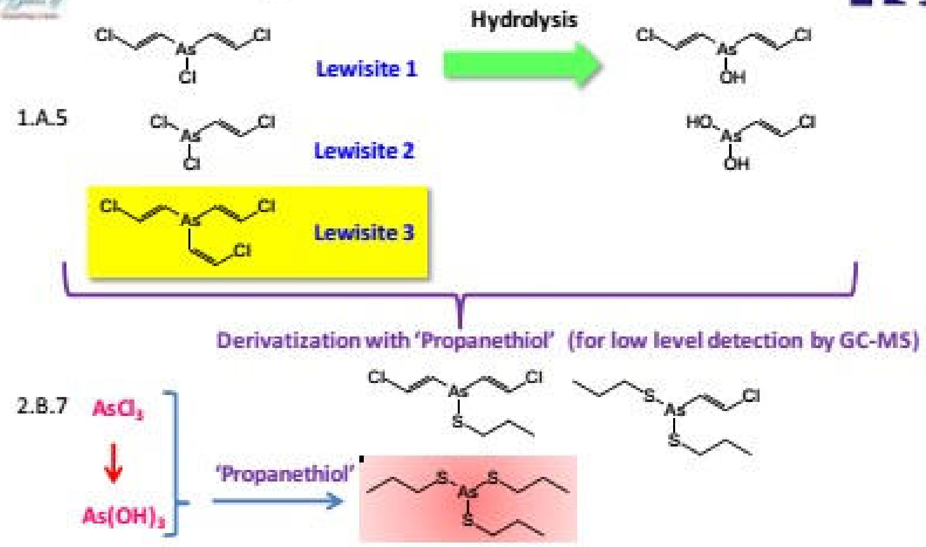
Degradations of 'Sulfur Mustard'



Degradations of 'Nitrogen Mustards'



Degradations of 'Lewisites'



Any Questions?

BIOSKETCH

Dr B. SAHA

At present Dr. B. Saha is Director – R&D, L.R. Research Laboratories, Nagarjuna Agrichem Limited. Prior to this, he was Director in Gharda Chemicals, General Manager in Monsanto and has worked in senior positions in Pfizer and Bhabha Atomic Research Centre. He is in the editorial advisory board of Agri Business Global (USA) and was editor of "Indian Society for Environmental Science & Technology Newsletter". Dr. Saha was in the editorial advisory board of "Farm Chemicals International, USA" and "Carbohydrate Newsletter". He was also a Principal Investigator and member of the steering committee of Government of India sponsored "New Millennium Indian Technology Leadership Initiative Project".

Dr. Saha is closely associated with "International Union of Pure and Applied Chemistry (IUPAC)". He is member of "IUPAC Committee on Chemistry and Industry", "IUPAC Inter-Divisional Committee on Green Chemistry for Sustainable Development" and "IUPAC Division of Chemistry and Environment".

Dr. Saha has been Visiting Professor in reputed Universities and Institutes including IIT. He carried out post-doctoral research with Nobel Laureate Professor Derek Barton. He was awarded Homi Bhabha Gold Medal.

Dr. Saha has been Chairman and Invited speaker in various International and National seminars such as:

(a) Chairman "Crop World India" 2011 and 2012
(b) Invited Speaker, "IUPAC World Congress of Chemistry", Sao Paulo, 2017.
(c) Invited Speaker, "2nd Bio-Control Asia Conference", Bangkok, 2017.
(d) Invited Speaker, "Regional Workshop on Chemical Industry and Sustainable Development", Beijing, 2016.
(e) Invited participant in American Chemical Society Sponsored workshop to develop "Global Code of Ethics for Chemists", Kuala Lumpur, 2016
(f) Invited speaker in "IUPAC World Congress of Chemistry", Busan, South Korea, 2015.
(g) Invited speaker, "Agrochemex, 2015", Ho Chi Minh City, Vietnam, 2015.
(h) Discussion Leader in "IUPAC International Congress of Pesticide Chemistry" of the seminar "Developing Global Leaders for Research, Regulation and Responsible Care in Crop Protection Chemistry in 21st Century", San Francisco, 2014.
(i) Invited speaker, American Chemical Society Annual Conference, San Francisco, 2014
(j) Invited Speaker, "China Crop Protection Society International Seminar", Shanghai, 2012
(k) Invited Speaker, "Crop World Global", London, 2011
(l) Invited Speaker, "Agrochemex", Shanghai, 2011

Global Chemists' Code of Ethics

Dr. B. Saha
Director- R&D, L.R. Research Laboratories, Nagarjuna Agrichem Limited, Hyderabad
E-mail: drbsaha@rediffmaill.com

For more than a century, chemistry has contributed significantly to improve the quality of life in this planet. At the same time, knowledge of chemistry has also been used for malicious purposes such as making of chemical weapons, illegal drugs etc. Against this background, "Global Chemists Code of Ethics Workshop" was held in Kuala Lumpur from April 4 to 6, 2016.

The aim of the workshop was to collaboratively draft an actionable code of ethics for chemists. The program was organized by the International Division of American Chemical Society with support from the Pacific Northwest National Laboratories (USA) and was hosted by Malaysian Institute of Chemistry. The workshop was attended by 30 participants from 17 countries. After 3 days of deliberations, "Global Code of Ethics" was prepared covering Safety, Security, Scientific Writing and Publishing, Research, Environment and Making Positive Change Happen. The code is now being implemented globally. Details will be discussed including chemical security.

GLOBAL CHEMISTS' CODE OF ETHICS

DR. B. SAHA

Director – R&D, L R Research Lab

Nagarjuna Agrichem, Hyderabad, India

E-mail: drbsaha@rediffmail.com

- **INTRODUCTION: CONTRIBUTION OF CHEMISTRY**
- Chemistry is the science that has made the modern world
- Contribution of Chemistry can be seen in all walks of life

MISUSE OF CHEMISTRY KNOWLEDGE

- Although Chemistry has contributed in all walks of life, knowledge of Chemistry has also been misused.
- For example
- - Manufacture of illegal drugs like LSD
- - Weapons of mass destruction like mustard gas.

ACCIDENTS CAUSED BY CHEMICALS

- Major accidents have been caused by chemicals
- Bhopal Tragedy.

- ENVIRONMENTAL DAMAGE BY CHEMICALS
- Chemicals can cause severe damage to the environment.

WORKSHOP TO DRAFT

“GLOBAL CHEMISTS’

CODE OF ETHICS”

WORKSHOP TO DRAFT "GLOBAL CHEMISTS' CODE OF ETHICS":

- "Global Chemists' Code of Ethics Workshop" was held in Kuala Lumpur from April 4 to 6, 2016
- Hosted by Malaysian Institute of Chemistry and sponsored by American Chemical Society.
- Attended by 30 participants from 17 countries
- Goal of the workshop was to collaboratively draft an actionable "Global Code of Ethics for Chemists" to make the world better.

BEFORE THE WORKSHOP:

- Before the workshop, the facilitators sent a set of questions to participants.
- For example:
- "What should we tell our students if they ask about synthesis of illegal drugs, explosives and chemical weapons?"

Chemical practitioners: Scientists, engineers, technicians, trades people, business people or anyone else who has contact with chemicals at work or at home.

Chemistry professionals: As a subset of chemical practitioners, chemistry professionals refers to scientists and engineers, who, by virtue of their specialized education, certifications or licensures, are authorized to offer chemistry services to the public.

- WORKSHOP TO DRAFT "GLOBAL CHEMISTS' CODE OF ETHICS":
- Dr. A. A. Campbell, President, American Chemical Society made the opening remarks.
- Dr. H. B. M. Som of the Organization for the Prohibition of Chemical Weapons (OPCW) made a presentation on existing codes of ethics.
- This was followed by discussion on questionnaire mentioned earlier.

- **WORKSHOP TO DRAFT "GLOBAL CHEMISTS' CODE OF ETHICS":**
- The participants were then divided in 3 groups.
- Each group was given responsibility to deliberate and prepare a preliminary draft on 2 topics.
- Afterwards each of the 6 topics were discussed in detail by all the 3 groups.
- Subsequently, large group discussion was held to reach consensus on entire code.

- **WORKSHOP TO DRAFT "GLOBAL CHEMISTS' CODE OF ETHICS":**
- 1. Environment
- 2. Safety
- 3. Chemical Security
- 4. Conducting Research
- 5. Scientific writing and publishing
- 6. Making positive change happen

ENVIRONMENT

GLOBAL CHEMISTS'

"CODE OF ETHICS" APPROVED

BY CONSENSUS

ENVIRONMENT:

- Environmental sustainability should be an integral part of research and education.
- Chemical practitioners should work within their organizations to help develop sound environmental plans and policies.
- Chemistry professionals must ensure safety and health of coworkers and the community, and protect the environment for future generations.

ENVIRONMENT:

- Chemistry professionals should encourage inclusion of environmental sustainability as a key element in chemistry instruction and engagement with the community.
- Chemistry professionals are responsible to ensure the proper use and disposal of chemicals.
- They should endeavor to increase their knowledge of the short and long term effects of chemicals on the environment and to apply informed quality control principles.

SAFETY

- **SAFETY:**
- A culture of safety is very important and should be sustained by management, including academic, industrial and government leadership.
- Management should work with chemical practitioners in all aspects of safety including training, regular audits and the development of safety culture. There should always be awareness of safety regulations protecting health and the environment.

- **SAFETY:**
- **All chemical practitioners should exercise safety procedures. Engineering and administrative controls for**
- **safety should be in place. Proper personal protective equipment and garments should be used when working with chemicals or in an area with hazards.**

CHEMICAL SECURITY

SECURITY:

- A culture of security is important to protect dual use chemicals and facilities.
- All stakeholders in the chemical supply chain should ensure and practice chemical security.
- Chemical practitioners should ensure that laboratories and industrial facilities have the capacity to secure chemicals.
- Security measures need to be reviewed regularly.
- Management should have oversight of security and should follow all local and international laws and regulations.

RESEARCH

- **RESEARCH:**
- Research in chemical sciences should benefit mankind and improve quality of life, while protecting the environment and preserving it for future generations.
- Researchers should conduct their work with the highest integrity and transparency and avoid conflicts of interest.
- Research should promote the exchange of new scientific and technological information and knowledge relating to the application of chemistry for the benefit of humankind and the environment.

SCIENTIFIC WRITING AND PUBLISHING

- **SCIENTIFIC WRITING AND PUBLISHING:**
- Chemistry professionals should promote and disseminate scientific knowledge in research and innovation through outreach, scientific writing and publication for sustainable development.
- Chemistry professionals should maintain honesty and integrity in all stages of the publication process, which must meet the highest possible standards of data reproducibility and correctness without plagiarism.

- **SCIENTIFIC WRITING AND PUBLISHING:**
- Chemistry professionals who supervise others have a responsibility to ensure that their scientific writings are free of defects and errors.
- Chemistry professionals should promote peaceful, beneficial applications and uses of science and technology through a variety of media.
- Chemistry professionals have a responsibility to assess information intended for release prior to dissemination.

MAKING POSITIVE THINGS HAPPEN

- **MAKING POSITIVE THINGS HAPPEN:**
- Chemical practitioners should promote a positive perception and public understanding and appreciation of chemistry.
- This is done through research, innovation, teamwork, collaboration, community outreach, and high ethical standards.
- Chemistry professionals should act as role models, mentors, and advocates of the safe and secure application of chemistry to benefit humankind and preserve the environment for future generations.

- MAKING POSITIVE THINGS HAPPEN:
- **They should instill and encourage curiosity and innovation early and often, and recognize and award achievements where appropriate.**
- **Finally, chemistry professionals should provide professional inputs and opinions to government and other decision makers regarding industrial, environmental, and other issues.**

- **SUMMARY:**
- **GLOBAL CHEMISTS' OF ETHICS HAVE BEEN PREPARED COVERING THE FOLLOWING :**
- **1. Environment**
- **2. Safety**
- **3. Chemical Security**
- **4. Conducting Research**
- **5. Scientific writing and publishing**
- **6. Making positive change happen**

THE CODE OF ETHICS IS NOW BEING IMPLEMENTED GLOBALLY.

THANK YOU!

BIOSKETCH

Clifford Glantz (Project Manager)

Cliff Glantz is a senior staff scientist and project manager with PNNL's Earth and Biological Sciences Directorate. His research focuses on consequence assessment modeling, emergency response and preparedness, critical infrastructure protection, risk management, and cyber-physical security. He is the Chair of the Department of Energy (DOE) Subcommittee on Consequence Assessment and Protective Actions (SCAPA) and coordinates its national five working groups. He is also a member of the DOE Meteorological Coordinating Council, several American National Standards Institute Working Groups, and the U.S. National Atmospheric Release Advisory Center (NARAC) User's Advisory Group.

In the U.S., Cliff Glantz's work is supported by the DOE, Department of Homeland Security, Department of Defense, and other agencies. Internationally, his work is supported by the European Union Chemical, Biological, Nuclear, and Radiological (CBRN) Risk Mitigation Center of Excellence Initiative, International Atomic Energy Agency, and United National Interregional Crime and Justice Institute. He has authored over 70 technical publications and papers, 100 conference presentations, and won a number of awards for his research during his 30+ year tenure at PNNL. He is on the editorial board of the new journal, *Global Security: Health, Science, and Policy.*
His recent work includes:

- Leading the DOE SCAPA in coordinating emergency management and planning across all of DOE's national laboratories, related research facilities, and operational field offices.
- Enhancing and reviewing atmospheric dispersion and consequence assessment modeling systems.
- Enhancing the Chemical Mixture Methodology suite of tools for evaluating the health consequences of exposure to atmospheric releases of mixtures of hazardous chemicals.
- Developing emergency preparedness and response exercises and training programs.
- Consequence assessment team member and software developer for the Hanford Site Emergency Operation Center
- Developing security guidance, assessment methods, and educational products for CBRN facilities.
- Managing a wide array of cybersecurity programs for critical infrastructure protection.
- Conducting work to integrate physical and cybersecurity assessments.

Why Should You Be Concerned with The Security of Agrochemicals?

CLIFF GLANTZ, JUAN YAO, RADHA KISHAN MOTKURI

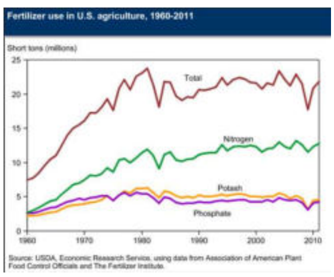
Pacific Northwest National Laboratory

Indo-US Workshop on Agrochemical Security Training
August 2017

Common Agrochemicals Applied in US

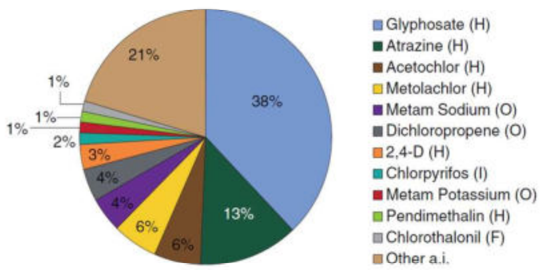
Commonly Used Fertilizers

- Nitrogen
- Phosphate
- Potash



(United States Department of Agriculture (USDA), Fertilizer Use & Markets, 2016)

Top Pesticides by Active Ingredient



herbicide = H, insecticide = I, fungicide = F, and other = O

(USDA, Pesticide Use & Markets, 2016)

Common Agrochemicals Applied in India

Type of Fertilizers Produced in India

Type of fertilizers	Grade
Straight Nitrogenous	
Ammonium Sulphate (AS)	20.6% N
Calcium Ammonium Nitrate (CAN)	25% N
Ammonium Chloride	25% N
Urea	46% N
Straight Phosphatic	
Single Super Phosphate (SSP)	16% P_2O_5
Triple Super Phosphate (TSP)	46% P O
NP/NPK Complex Fertilizers	
Urea Ammonium Phosphate	24-24-0
	28-28-0
	14-35-14
Ammonium Phosphate Sulphate	16-20-0
	20-20-0
Diammonium Phosphate (DAP)	18-46-0
Mono Ammonium Phosphate (MAP)	11-52-0
Nitro Phosphate	20-20-0
	23-23-0
Nitro Phosphate with Potash	15-15-15
NP/NPKs	17-17-17
	14-28-14
	19-19-19
	10-26-26
	12-32-16

(Department of Fertilizers, Indian Fertilizer Scenario, 2013)

Commonly Used Pesticides

Name of Pesticide	Consumption (MT, 2009-10)
Phorate	3284
Mancozeb	3118
Methyl Parathion	2739.32
Cypermethrin	2473
Carbendazim	1992
Monocrotophos	1815
Malathion	1739.39
Quinalphos	1595
Acephate	1513
Triazophos	1164.48
Dichlorvos	960
Fenvalerate	776
2,4 – D	662
Dimethoate	636
Captan	471
Zineb	462
Paraquat dichloride	NA
Chlorpyrifos	NA
Phosalone	NA
Carbofuran	NA

(State of Pesticide Regulations in India, 2013)

Agrochemicals Are Helpful !

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- Enhancing crops growth
- Defeating pests
- Allowing the cultivation of crops in new regions

But Also Harmful !!!

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- Chemical burns (e.g., anhydrous ammonia)
- Flames (from the ignition of flammable materials)
- Poisoning (through oral exposure, inhalation, skin contact)
- Chronic illness (cancer)

Pesticides stored in corroded containers create a health hazard.

Children died in Texas pesticide gas poisoning, 2017

Misuse of Agrochemicals

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- Inadvertent misuse
  - lack of adequate knowledge of application
  - inefficient training and supervision
- Malicious misuse
  - includes theft, diversion, sabotage and intentional contamination using existing agrochemicals
  - weaponization of agrochemicals

Potential Threat Agents/ Adversaries

- External threat agents
  - Antisocial elements
  - Terrorists
  - Militant Activiists
  - Criminals
  - Nation states
- Internal threat agents
  - dissatisfied or mentally ill employees
  - former employees
  - External threat agents working within the organization

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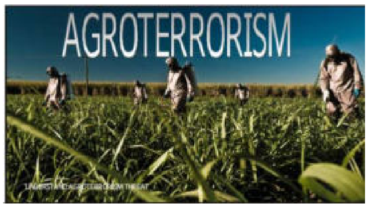
The Objectives of The Intentional Misuse

- Kill and injure people
- Damage the environment
- Cause massive disruption or destruction of property
- Embarrass officials
- Cause unrest
- Profit
- Affect the decisions of political leadership of a certain population



Weaponizable Fertilizer

- Oklahoma City bombing was a domestic terrorist truck bombing
- Ammonium nitrate based bomb
- Killed 168 people and wounded more than 500.

The Alfred P. Murrah Federal Building after the bombing, 1995

Properties That Make Fertilizers Weaponizable Chemicals

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YJ1 YJ2

- Capable of significant destruction when used as fertilizer bomb
- Relatively cheap and easily accessible
- Less expertise required for making the fertilizer bomb

Pesticides as Weapons!

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- Before murdering thousands at the World Trade Center, the 9/11 terrorists tried to gain access to crop dusters
- Goal was ot use the dusters to spray pesticides or other toxins over populated areas
- There is growing concern about the use of pesticides as chemical weapons or in making chemical weapons.

Properties That Make Pesticides Potential Chemical Weapons

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- Poisonous and even deadly at small quantities or low dose
- Are formulated for “mass delivery” in the form of fine sprays
- Easy to acquire large amount
- Comparatively easy to weaponize.
- Organic chemistry knowledge is widespread.
- Can massively poison people directly and indirectly by contaminating food crops, animals, and water supply

Exposure Routes and Hazards of Pesticides

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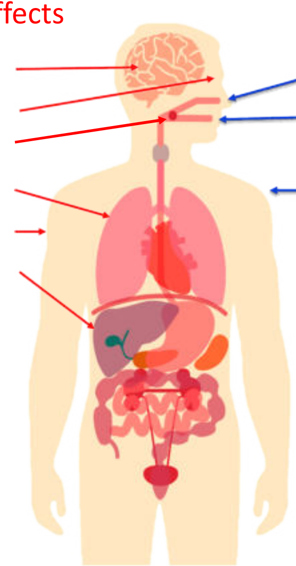
Acute adverse health effects

- Neurotoxicity
- Eye irritation
- Respiratory irritation
- Lung damage
- Skin irritation
- Liver damage, etc.



How pesticides get in

- Inhalation
- Oral exposure (food or water)
- Skin Absorption

(Weisenburger, Human Pathology, 1993)

Examples of Poisonous Pesticides—Paraquat

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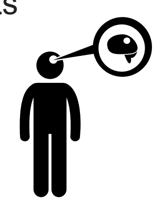
- Herbicide
  - kills a wide range of grasses (non-selective)
  - very fast-acting
  - classified as "restricted commercial use"
- Symptoms after exposure to high concentration
  - dyspnea (shortness of breath)
  - eye irritation
  - nausea or vomiting
  - coma and somnolence
  - death

(Registry of Toxic Effects of Chemical Substances (RTECS), 2017)

Examples of Poisonous Pesticides—Organophosphate

- Insecticides
- Have the same mechanism of action as nerve agents
  - Potent inhibitors of acetylcholinesterase
- Symptoms and signs
  - central nervous system (headache, convulsions, coma)
  - respiratory system (shortness of breath, respiratory arrest)
  - cardiovascular system (increased heart rate, low blood pressure)
  - gastrointestinal system (nausea, diarrhea)
  - musculoskeletal system (weakness, paralysis)



(Centers for Disease Control and Prevention https://emergency.cdc.gov/agent/nerve/tsd.asp)

How to Enhance Agrochemical Security

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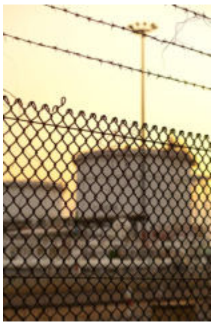
Prevention!

Reporting!

Response!

Prevention—Address Security Vulnerabilities in the Agrochemical Supply Chain

- Storage
  - E.g. maintain inventories; install security system
- Transportation
  - E.g. Ship pesticides in a locked vehicle
- Personnel
  - E.g. develop effective hiring and labor relations with policies, background check
- Disposal
  - E.g. arrange for prompt and safe disposal



(Florida Cooperative Extension Service, 2005) 17

Report Suspicious Behavior

- Suspicious purchaser
  - seems unfamiliar with details of how to use fertilizers
  - acts nervous, seems uneasy or vague, and avoids eye contact
  - demands immediate possession of purchased product instead of future delivery
  - refuses to provide addresses, phone number or any other contact information

Florida Cooperative Extension Service, 2005

Report to Law Enforcement

- Report to the local law enforcement if there are
  - any suspicious activities, vehicles, persons
  - threats to personnel or facilities
  - sabotage to facilities or equipment
  - missing products

Response Plan and Risk Assessment

- Develop the response plan
- Ensure that people who work on dual-use weaponizable agrichemicals know the plan
- Drills and exercises
- Assess the potential consequences for mitigation plan development

Cybersecurity and Agrochemicals

CLIFF GLANTZ, JUAN YAO, ROB SIEFKEN, RADHA KISHAN MOTKURI
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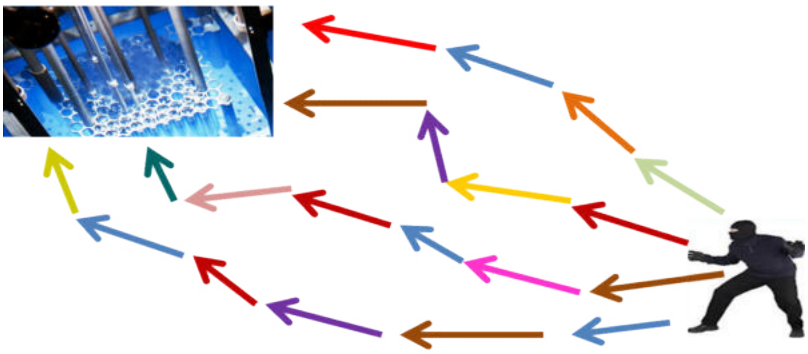
What Is an Attack Vector?

- An attack vector is a path (or means) by which an attack can be carried out on a target



Think Like an Attacker

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- One way to improve security is to start thinking like an adversary when planning for or reviewing facility security.
- "If I were an adversary, what could I do to penetrate security and achieve my goals?"

Types of Attacks

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- May be a physical attack
- May be a cyberattack
- May be an insider action
- May be a blended attack

Blended attacks

- Chemical security can be jeopardized by blended attacks.

Integrating Security

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- A **physical intrusion** and **cyberattacks** can both compromise chemical security.
- **Integrating security programs** and processes can help facilities better understand the array of security threats they face from blended attacks. For example:
  - Insider actions support a cyberattack. That cyber attack supports a physical break-in to steal chemicals.
  - A cyberattack compromises chemical inventory data, support the theft and diversion of weaponizable agrochemicals.

Lack of Recognition

- Security evaluations and exercises at chemical facilities often only **focus on traditional** types of physical attacks.
- Because of the added complexity and lack of experience with cyber attacks, **cyber threats are often excluded** from security training and exercises.

- By not training staff, including security personnel, to recognize and withstand blended attacks, facility staff forces may be inadequately prepared to deal with blended attacks.

Access to Chemical Storage

Secure the Data Center (SDC)

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- Computer security may gain you little if an adversary can obtain **physical access** to locations where chemicals are stored.
- An organization should consider who, when, where, and how staff members, suppliers, and customers can access chemical storage sites..
- Establish role-based requirements for who can access chemical storage facilities.

Security Questions

Sample questions that should be considered:

- How will access to sites containing agrochemicals be granted?
- Who controls the keys?
- How are staff members prevented from diverting or stealing agrochemicals?
- Are storage sites secured, alarmed, or under surveillance?

Physical or Cyber—It's All Security

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Chemical Security Practices in US

CLIFF GLANTZ, ROB SIEFKEN, JUAN YAO, RADHA KISHAN MOTKURI
Pacific Northwest National Laboratory

Indo-US Workshop on Agrochemical Security Training
August 2017

General Guidance in Security Practices

YJ1

- Regulatory authorities
  - develop the security performance standards for high-risk chemical facilities
- Chemical facilities
  - Complete security vulnerability assessment
  - Develop site security plans
  - Implement protective measures to comply with the performance standards

Identify the High-risk Chemical Facilities

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- Identify the high-risk chemical facilities based on the security risk they present. Risk is based on:
  - The intent and capability of an adversary in respect to attacking a facility – the **threat**.
  - The **consequence** of a successful attack on a facility.
  - The **likelihood** that an attack on a facility will be successful.

US Practices for Securing the High-risk Chemical Facilities

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- The Chemical Facility Anti-Terrorism Standards (**CFATS**) program:
  - Establishes Risk-Based Performance Standards (RBPSs)
  - Identifies and regulates high-risk chemical facilities to ensure they have security controls in place to reduce the risks associated with their chemicals.
  - Uses a dynamic multi-tiered risk assessment process
  - Requires the chemical facilities meet security standards

Risk-Based Performance Standards (RBPSs)

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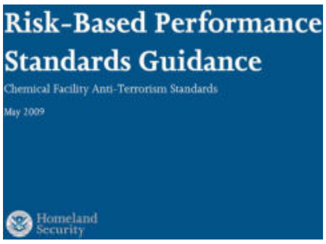
- The 18 standards cover areas including:
  - Secure site assets
  - Screen and control access
  - Shipping, receipt, and storage
  - Theft and diversion
  - Cybersecurity
  - Incident Response
  - Security Monitoring.



- Based on a “tiered” approach
  - Higher-tier facilities are expected to meet higher levels of performance than lower-tier facilities.
- Allows individual facilities choose the most cost-effective protective measures to meet the standards

CFATS “Risk-based Performance Standard Guidance”, 2009

RBPSs—Secure Site Assets

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- Secure and monitor restricted areas or potentially critical targets within the facility
- Physically limit the accessibility of the asset to reduce the likelihood of unauthorized release, theft, or sabotage. For example:
  - barriers
  - lighting.
- Maintain regular surveillance or close observation over restricted areas and critical assets to detect, evaluate, and communicate the presence of unauthorized persons or activities

RBPSs—Theft and Diversion

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- Deter theft or diversion of potentially dangerous chemicals
- Prevention methods for facilities with theft/division chemical of interest (COI)
  - inventory control systems that can monitor and/or track the theft/diversion of COI
  - procedures that make it more difficult to steal or divert the chemicals,
  - physical measures that make the actual movement of such chemicals more difficult.

Questions?

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PROFESSIONAL EXPERIENCE:

Ravindranath is a Chief Scientist, Head Chemical Engg. & Instrumentation at CSIR-IICT. He has more than 30 years of experience in Instrumentation & Automation design for process plants both Basic engineering and Detail Engineering requirements. Worked for many pilot scale and commercial process plants right from project engineering components, design of control philosophy, design of Plant level control systems, designing process interlocks & safety interlocks etc., Experienced in Design, configuration of process plant DCS systems, PLC systems and system integration. Heading a TEAM of around 30 members which includes Scientist, Engineers & Technicians. Ravindranath is M.Sc Tech in Process Instrumentation from Andhra University & BSc degree from Osmania University.

- **Teamed with various Process groups, project management groups and systems engineering teams for developing optimal Instrumentation plan targeted for various chemical plants.**
- **Worked for Government & Public Sector sponsored projects, Worked with external clients to develop and execute jointly as collaborative projects.**
- **Presently Working with large Industrial Clients in translating and transfer of Industrial technologies on commercial scale capacities of around 4, 000 to 10,000 Tonnes per annum process plants.**

INDUSTRIAL INSTRUMENTATION SYSTEMS
&
PROTECTION AGAINST THREATS

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INDUSTRIAL INSTRUMENTATION

Comprises of Measurements & Control Systems which include:

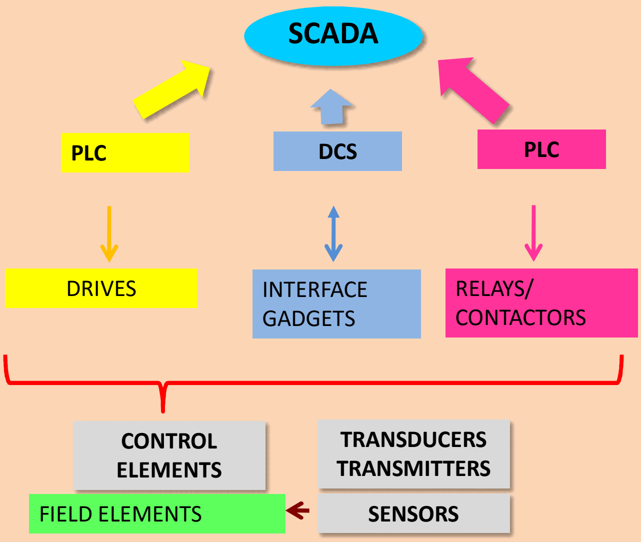
- PLC's (Programmable logic controllers)
- DCS (Distributed Control Systems)
- SCADA(Supervisory control & data acquisition
- HMI(Human Machine Interface)
- SIS(Safety Instrumented system)
- Any other Plant Automation Systems

CONTROL SYSTEMS

Which are computer based systems that are being used in all commercial plants.

- Monitor & Control Process Parameters
- Used as independent safety control systems
- Manage all sequential controls, Receipies
- Record Alarms and alerts operator
- Handles Process & Safety Interlocks etc.,
- Any other process related assignments

General Flow Chart of Industrial Instrumentation



INDUSTRIAL AUTOMATION SYSTEMS advantages

Are Configured with ladder logics, which has

- SCADA used as a front end with HMI's which gives the feel of the plant
- Quite successful systems to handle real time monitoring and control
- Capable of Multi Tasking
- High speed responses
- Redundant Systems

INDUSTRIAL AUTOMATION SYSTEMS Challenges

- Lack of knowledge about security
- Difference in Understanding with respect control systems environment and information environment
- System integrator needs to understand safety and security of the system
- Confidentiality
- Conceptually different applications and different requirements

INDUSTRIAL AUTOMATION SYSTEMS Challenges

Are dependent on Information technology as it

- Communication systems
- Connections with IT networks with Control System networks
- Wireless systems, modems
- PASSWORD PROTECTIONS
- THIRD PARTY GADGETS WITH OPEN PROTOCOLS
- WORK UNDER DIFFERENT BALL GAMES WITH RESPECT TO IT & CONTROL SYSTEMS

INDUSTRIAL AUTOMATION SYSTEMS Propable Solutions

- Should be on independent dedicated Communication systems
- Develop the Logic programmes in small small applications and then integrate
- No connection with IT application networks
- MULTI LEVELPASSWORD PROTECTIONS
- INCORPORATE INTRINSIC SAFETY PARAMETERS
- INCREASED SECURITY ACCESS LEVELS

- BUT STILL IT'S JUST A BEGINNING AND IT NEEDS A CONTINUOUS EFFORTS, IMPROVEMENTS AND ITS AN OPEN ENDED THINKING…………………

HOPE TO MEET THE CHALLENGES OF PRODUCTION WITH SECURITY

THANK YOU

P.M. Chandra Mohan B.E., (Elec)
Director of Factories
Government of Telangana

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5th Floor, 'B' Block, B.R.K.R. Bhavan,
Near Tank Bund Road, Hyderabad - 500 063.

INDO-US WORKSHOPS ON SECURITY OF DUAL USE AGROCHEMICALS.

August 8, 2017, CSIR-IICT, Hyderabad.

The Agrochemical Supply Chain - How are the agrochemicals stored and transported? What are typical security vulnerabilities in the supply chain?

******** By Mr V.V SASI KUMAR, DYCIF, NLG. Govt of Telangana.

Brief Extract: --- Agricultural development continues to remain the most important objective of Indian planning and policy. In the process of development of agriculture, pesticides have become a valuable tool as a plant protection agent for boosting food production. Further, pesticides play a significant role by keeping away of many dreadful diseases of the Plants. However, exposure to pesticides/Agro Chemicals as a part of dual usage by Sabotage, Occupationally, Transportation Accidents in the supply Chain and environmentally causes are jeopardizing the existence of mankind.

One of the important UN convention ratified by the Nations in April,1997 is Chemical Weapon Convention (CWC), the International Treaty Banning the Development, Production, Transportation and use of Chemicals arms. Today 188 States, accounting for 98% of world Population as well as 98% of Global Chemical Industry have signed and Ratified the CWC. Presently the Indian Economy is shifting from Agricultural Economy to Industrial Economy. There is a Proliferation of Chemical, Cosmetic and Pharma (API) Industries, using the no of Argo Chemicals & Toxicants as listed in the Annexure to CWC Treaty for peaceful purposes and Development of Mankind.

Now the Prime focus of the CWC as pointed out by a British CW analyst Julian Perry Robinson is that **"Protecting the Nations from the malign exploitation of dual use Chemistry"**, Production equipment and Technologies that have both peaceful and Military Applications. The History of Warfare reveals that even the Nations used crudely to contain the enemies and Terrorize the Civilians the deadly Industrial Hazardous Chemicals like Chlorine, Phosgene, Hydrogen Cyanide (HCN) gas, Ammonia etc.

Some of these listed Hazardous Agrochemicals of the manufacturing facilities under the Schedules of Factories Act,1948 and the Amended Act,1987 & Telangana State Factories Rules, Environment Protection(EP) Act,1986 and the Rules made there under, The Manufacture, Storage and Import of Hazardous Chemicals Rules(MSIHC) 1989- under the EP Act, The Chemical Accidents Emergency Planning and Preparedness Rules,1996 under the EP Act are regulating with a concerned for Public and Employee Safety and also preventing its Dual usage.

The Central Motor Vehicles Rules,1989 for the safety in Transportation of Agrochemicals under the Motor Vehicles Act, 1988, The Hazardous Substances (classification, Packaging and Labelling Rules),2011 under EP Act,1986, THE Insecticide Act ,1968 and Insecticide Rules, 1971, Amended Rules 1991 are certain Indian Statutory enactments governing the Regulation aspects of Safe usage of Agrochemicals. The Security aspects are governed by the Code of IPC-1860, Crpc-1973, CPC-1908.

But there is no Comprehensive Legislation under the Indian Statutes, preventing the dual misuse of Agrochemicals. There are about 229 Pesticides have been Registered under the Insecticide Act,1968.

The Hon'ble Supreme Court of India had felt in the following PIL by **Dr. Ashok Versus Union of India**,1997 that the BHC Pesticide which are detrimental to Human Health shall be listed out by Amending the Insecticide Act,1968. There by the Indian Courts are also expressed concerned for the use of Agrochemicals, which are detrimental to Human Health.

Potential misuse of Agro Chemicals for terror activities and Preventive Security Measures; by KR Ganesh, Security Officer, CSIR-Indian Institute of Chemical Technology, Hyderabad, email: ganesh@iict.res.in

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In recent past the world has witnessed spurt in terror acts using un-foreseen and un-imaginable means and methods causing loss of life and property. The cruel methods used were mowing down the people by using heavy cargo vehicles and stabbing and shooting randomly. This indicates the level of desperate mind set of these terrorists to achieve their sinful aims using local resources. In most of the incidents the security agencies failed to sniff /prevent these activities and this menace is expected to grow further and pose new challenges.

Some of the case studies indicate that the terror modules are continuously planning and evolving all possible kind of sinister methods to prove their entity. Mostly, these acts are executed by using local members and local resources there by evading premonition and detection by the security agencies. Further, these terror groups consist highly motivated members possessing technical skill and knowledge.

Thus, in pursuit of their goals a highly probable method they may indulge is misuse of Agrochemicals for terror activities. Agro chemicals such as fertilizers are critical to modern agriculture and easily available, but they are chemicals that have other uses. One of these uses is as explosives. Appropriate security measures can reduce the possibility of misuse.

The aim is to make participants aware of the potential misuses of fertilizers and explain security awareness/ measures that can prevent fertilizers from falling into the wrong hands.

Why do terrorists want fertilizers?

Fertilizer bombs are appealing tools for terrorists because the logistics of making a fertilizer bomb are simple. The materials are relatively cheap and accessible; they can be prepared in a short amount of time; and only simple tools are needed to create and detonate them In these factors, a fertilizer bomb far outweighs the production of sophisticated electronic bombs, where more complexity means more opportunities for failure.

Terrorist groups were noted for specifically seeking out sources of nitrate fertilizers, and internationally, there have been thefts of significant amounts of ammonium nitrate. There are three principal high-nitrogen chemicals used in the production of
Fertilizers: ammonium nitrate, potassium nitrate and urea.

Another potential misuse of agrochemicals are using crop dusters designed to spray harmful pesticides or other toxins on a human or animal population.

Also, a growing problem observed worldwide is the misuse of the fertilizing agent anhydrous ammonia in boosting the production of the recreational drug called methamphetamine which increases the drug dealer’s profits and the nexus between the terror outfits and drug dealers may facilitate funding terror acts.

Thus, there is a noted and significant concern about the misuse of the Agrochemicals for terror acts which are inherently made of raw materials consisting Acids, Bases, Flammable Oxidizers / Pyrophoric Substances. Light-Sensitive Chemicals and Carcinogens.

Most people would think of fertilizers as harmless bulk chemicals, but now that you understand how fertilizers can be misused, you can understand the need for an attitude of security in dealing with them. Virtually everyone who uses fertilizers – especially bulk suppliers and bulk users – needs to increase security so that these materials do not fall into the wrong hands.

Preventive security:

An effective preventive security measures should take into account each of the following areas namely **• Storage • Transportation • Personnel • Disposal • and Response ;**

Storage: Evaluate as to how easy would it be for fertilizer to "disappear" from your Facility and design the security measures as below.

- Maintain inventories so that you always know the exact quantities of fertilizer you have.
- Use logbooks to keep track of who removes fertilizers from your facility.
- Store fertilizers in a building which can be locked or in a fenced enclosure with a locked gate.
- Consider providing a second security perimeter, such as a fence with a locked gate surrounding your storage facility.
- Arrange for a walk-through and walk-around security cover to check for attempted entry, vandalism, and structural integrity.
- Provide good lighting on all sides of your storage facility.
- For sensitive and bulk strorage facilities, install security systems, such as intrusion alarms and camera systems, and make sure they are properly maintained.

Transportation: Transportation is the weak link in your security? Once materials leave your facility, you may feel that your job is done, but it is important that fertilizers you sell make it all the way to the end user. The following tips will help you in developing a simple, effective security approach to transporting fertilizers.

- Create a paper-trail and ship fertilizer in a locked vehicle in variably.
- Ensure direct delivery to the point taking the best route available to avoid high population areas, tunnels and bridges etc. (GPS Tracking etc).
- Exercise extreme caution if it becomes essential to stop avoid unguarded and unlighted areas where theft is a substantial risk and be on your way as soon as possible.
- Be alert to vehicles following your truck, strangers asking questions, or anyone snooping around your cargo.
- Do not pick up hitchhikers; do not talk about your cargo on CB radio etc And do not discuss your cargo with those not involved.
- Always telephone your customer if you find you will be late for a delivery.

- Do not leave product at field site unless it is well attended or secured within buildings.
- Check your load at delivery to ensure no product is missing and always obtain a signed delivery ticket.

Personnel: Do you know your employees? Do you know who has access?

- Carefully check background of all new drivers. Every driver should be properly licensed and trained in good practices for handling fertilizer and pesticide chemicals that may be hazardous in the hands of suspicious and/or dangerous people. Include criminal history background checks
- Consider fingerprinting and photographing employees who handle hazardous materials.
- Be aware of personal identity theft, Impersonation and false references, etc.
- Request employees to watch for suspicious activities and ask persons they don't recognize to identify themselves and state their reasons for being at the facility.
- Adopt a company security whistleblower protection policy.
- Know who has keys and access to hazardous material storage areas and retrieve keys and employment identification cards from an employee and change computer access passwords when their employment ends.
- Assess a worker's violence potential and take appropriate security precautions when terminating or disciplining an employee.

Disposal: Do you have a plan for safe and secure disposal?

- Maintain security over material which is being disposed of until it is claimed by appropriate authorities.
- Ensure prompt and safe disposal of materials as per standard methods and policies.
- Maintain appropriate records to that effect.

Security: Response: Do you have a formal response plan? Do your employees know it?

- Develop an emergency plan for your facility. Train your workers in the plan and rehearse it with them.
- Post emergency response numbers, including fire, law enforcement, medical contacts, and toxic control in several locations in your facility. Make all employees aware of these response numbers. Include your facility address and locations for easy reference during an emergency phone call in all languages needed by your workforce.
- Report to appropriate authorities any suspicious activities, vehicles, persons, threats to personnel or facilities, sabotage/vandalism to facilities or equipment, and thefts, inventory shortages, or missing products that could pose a risk to public health or safety.

Identifying Suspicious Behaviour: People who are buying chemicals for illegal purposes usually look just like everyone else. However, for many criminals, it takes some practice to disguise their motives. Try to use objective criteria in evaluating customers. Watch for unusual or suspicious behavior by a purchaser who:

- Seems unfamiliar with details of using fertilizers.
- Acts nervous, seems uneasy or vague, and avoids eye contact.

- Demands immediate possession of purchased material instead of future delivery.
- Asks for material in smaller individual containers rather than in bulk.
- Insists on paying in cash instead of using a check or a credit card.

Reporting: Who should you contact if you suspect theft? SOP to

- Notify your manager.
- Report any thefts of fertilizer and/or equipment and any suspicious behaviour to your local law enforcement agency. The appropriate agency and phone number to be provided.

Summary:

There are three major solid forms of nitrogen fertilizer: ammonium nitrate, potassium nitrate and urea. These three fertilizer products can be used to create simple and powerful explosives.

Examine storage and handling procedures and develop a security plan for these five areas**: • Storage • Transportation • Personnel • Disposal • Response**

Remember and understand that specific security measures can prevent unlawful access to fertilizers and Good security begins with an effective security plan. A good security plan has several parts. The parts you use depend on the size and activities of your operation.

SAFETY AND SECURITY IS EVERY BODYS CONCERN

The Security of Dual use Chemicals
Hazards, Vulnerability and Risk Assessment

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In the chemical industry, highly toxic chemicals or their precursors are used as basic raw materials, intermediates, or as final products. Chemicals that are useful, and can be used as precursors to chemical weapons are called as dual use chemicals. Industries handling such dual chemicals have to be careful and should have an effective safety protocol to face the threat by terrorism.

In this article, the authors discuss the threat posed by chemical terrorism, physical and cyber approaches available for attacking chemical facilities, and the consequences of an attack involving the theft or environmental release of dual-use chemicals.

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Introduction

In the chemical industry, highly toxic chemicals or their precursors are used as basic raw materials, intermediates, or as final products. Such chemicals are defined as dual use chemicals if they are also considered as precursors to chemical weapons. This article addresses the potential threat posed by them including several unresolved issues on their safety and security. An Indo-US Workshop on vulnerability assessment for dual use weaponisable chemicals was held at Hyderabad on 28-29 July 2016. It was jointly organised by the CSIR-Indian Institute of Chemical Technology, Hyderabad, the Pacific Northwest National Laboratory (PNNL), Richland, USA and the US State Department on Chemical Security, Washington, DC. More than 50 experts from USA and India attended the workshop. The focus of the workshop was to identify latest techniques and tools to evaluate the security vulnerability of chemical installations or facilities containing dual use chemicals. A three-member team from PNNL consisting of Dr. Clifford Glantz, Rob Siefken and Dr. Radha Kishan Motkuri provided the faculty along with the experts from CSIR-IICT, Hyderabad led by Dr. S Chandrasekhar, Director; Dr. K V Raghavan, the Former Director and Dr. GVM Sharma, the Chief Scientist.

Chemical Terrorism can be defined as the unlawful use of chemical or biological agents and or assets of an installation to intimidate or coerce them in furtherance of political or social objectives of threat agents. The recent technological advances in dual use chemicals are likely to reduce the technological barriers for engaging in chemical terrorism. In this paper we discuss the threat posed by chemical terrorism, physical and cyber approaches available for attacking chemical facilities, and the consequences of an attack involving the theft or environmental release of dual-use chemicals. We outline an eight-step process that provides a framework for building a chemical security risk management program. The paper continues with information on traditional chemical safety and consequence assessment processes and the potential for incorporating these processes into a chemical security program.

> **There are multiple ways potential adversaries could sabotage a chemical facility or engineer the theft of dual-purpose, weaponisable chemicals. Adversaries, armed with traditional weapons, could attack a facility and sabotage chemical manufacturing, processing, storage, or transportation that may lead to the release of hazardous chemicals into the environment.**

Potential threat agents / events

Chemical terrorism introduces a new risk paradigm for the chemical industry worldwide handling dual use chemicals. Its assets can become vectors for destruction. Security threats can come from internal or external threat agents. The former includes dissatisfied employees, contract agencies and other adversaries within the system. The latter includes antisocial elements, extremists with criminal record and terror outfits including certain nation states. Their prime objective is to cause massive disruption or destruction of public property and lives by expending their men and material resources over a specific period of time. The target is normally so selected that it has a high probability of achieving the prime objective. Globally, no clear consensus exists with respect to which threat agent poses the greatest risk. The typical threat events are theft, diversion, sabotage and intentional contamination.

Methods to compromise Chemical Security

There are multiple ways potential adversaries could sabotage a chemical facility or engineer the theft of dual-purpose, weaponisable chemicals. Adversaries, armed with traditional weapons, could attack a facility and sabotage chemical manufacturing, processing, storage, or transportation that may lead to the release of hazardous chemicals into the environment. Alternatively, adversaries could engineer the theft of dual use weaponisable chemicals from chemical manufacture, storage, or transportation facilities.

Traditionally, critical infrastructure facilities have been mindful of the threats posed by physical attacks. In recent years, the threat posed by a cyberattack on a chemical facility has skyrocketed. Modern chemical facilities make extensive use of digital control and information systems to control various processes conducted throughout the lifecycle of hazardous chemicals. Many such systems are directly connected to the internet or are connected to the internal plant networks that are externally accessible e.g., through connections that allow vendors to remotely monitor or update their control system products. Many control systems have known cybersecurity vulnerabilities for which security patches exist.[1] Some security vulnerabilities do not have patches and this includes vulnerabilities known only to attackers. Other security vulnerabilities remain undetected for now, but may be discovered at some point in the future. The issue of cyber vulnerabilities extends beyond process control systems. They allow adversaries to jeopardize the confidentiality of sensitive process data, impact the availability of systems and violate the integrity of control system operations. The worst of these can result in the damage or destruction of process equipment and heighten the risk of fires and explosions that could release hazardous chemicals to the environment and endanger the health and safety of workers and the public. Adversaries can mount cyberattacks from thousands of miles away from the comparable safety provided by being in another country. Attackers can range from solo recreational hackers to teams of sophisticated professionals working in support of organized crime organizations or nation states.[2 to 4]

Physical and cyberattacks can be integrated to increase the probability of success and consequences of an attack. Cyber-enabled physical attacks involve cyberattacks on physical security systems (e.g., monitoring equipment, alarms, communication) to reduce the effectiveness of security defences to protect against a physical attack. Physically enabled cyberattacks involve the use of physical break-ins to gain hands-on access to digital equipment. Intruders or other unauthorized personnel can physically damage, disable, or steal digital equipment. They can also use their physical access to and manipulate the settings of process control systems. This is of growing concern as physical security programs have replaced non-computerized surveillance, alarms, communications, and access control systems with faster and more efficient digital systems. The downside to these enhancements is that these digital systems are also susceptible to cyberattack. A concern for both physical attacks and cyberattacks are the actions of "insiders". These insiders are chemical facility staff members, employees of the parent company, contractors, vendors, or government officials whose jobs allow them enhanced physical or cyber access to chemical facility information, systems, or materials. A cooperative or coerced insider can subvert many defencive systems and drastically increase the likelihood and consequences of anattack.

The Chemical Facility Anti-Terrorism Standards (CFATS) program in the USA identifies and regulates high-risk chemical facilities to ensure they have security measures in place to reduce the risks associated with these chemicals.[5] Initially authorized by the USA Congress in 2007, CFATS requires facilities identified as high-risk to meet and maintain performance-based security standards appropriate to the facilities and the risks they face. The USA operates a chemical security inspection program to help ensure facilities have security measures in place to meet CFATS requirements.

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Potential consequences of an attack on a Dual Use Chemical Facility

The consequences of chemical terrorism attack on a dual use chemical facility could be quite severe. There could be significant consequences from the sabotage of such a facility, or the theft or diversion of hazardous dual use chemicals. If there is an intentional release into the atmosphere at a chemical facility, or if hazardous or weaponisable materials are stolen and later released in populated areas, the human health and safety impacts might be enormous.[6] Even without a catastrophic release to the environment, the sabotage of a chemical facility could have a devastating socioeconomic impact. Loss of production, the cost of replacement or repair of damaged equipment, loss of reputation with customers and the public, and liability issues could put a chemical facility out of business. Increased expenses for protective measures and liability insurance, as well as an unfavorable change in governmental and public perceptions of chemical facilities, could extend negative impacts throughout the chemical industry. At a minimum, other facilities will have to take prompt action, often in a less than cost-effective manner to prevent comparable incidents of sabotage or theft at their own facilities.

Steps Industry Can take to improve Security

The assessment and effective management of security risks at chemical facilities can be accomplished by following a standard risk management framework.

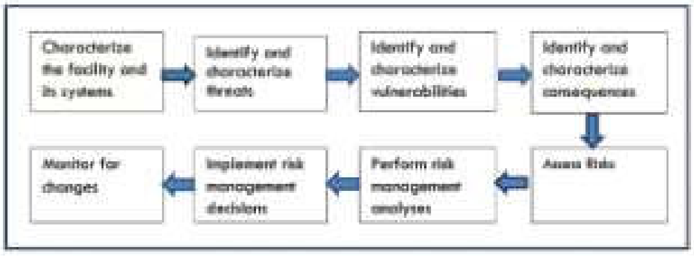

Figure 1. Steps in the Risk Assessmentand Management Process for Dual Use Chemical Facilities and their Critical Infrastructure

A number of standards and guidance products provide information to support performing security risk assessment and risk management activities. Some of this guidance focuses on the chemical sector, but a lot of excellent guidance has been developed for other sectors and can be applied to the chemical sector. A sample of helpful products include the International Organization for Standardization (ISO)27000-series standards,[7&8] USA CFATS[2], USA National Institute of Standards and Technology (NIST) guidance documents for protecting information security,[9-11] United Nations Interregional Crime and Justice Research Institute (UNICRI) guidance documents[3-4] and the International Atomic Energy Agency (IAEA) Nuclear Security Series.[12&13]

Regardless of the organization providing security risk assessment and management guidance, the major steps proposed by each methodology are strikingly similar (**Figure 1**). The first step involves the organization acquiring a thorough understanding of how its chemical facility works. There must be an adequate identification and characterization of the facility's systems, their functions, information technology and communication infrastructure, and system interdependencies. The current security systems, both for physical and cyber security must be characterized. In addition, the management and human operational components must also be understood, including personnel roles, responsibilities, training, and security awareness. For some facilities, this information is already available; for others documentation is lacking.

> Protective Action Criteria (PACs) are essential components for assessing the human health consequences from airborne release of hazardous chemicals. These concentration limits, combined with estimates of exposure, provide the information necessary to predict human health impacts and to select appropriate protective actions. PAC values are available for more than 3,100 chemicals. The development of the PACs is based on the Acute Exposure Guideline Levels (AEGLs), Emergency Response Planning Guidelines (ERPGs), and Temporary Emergency Exposure Limits (TEELs).

The following step is an assessment of the threat environment. Risk assessors need to know who are the potential attackers, what are their realistic capabilities, why might they be interested in attacking the facility and how might they go about staging an attack. Nation state security organizations, international organizations, law enforcement departments, and industry associations may collect, analyse and do most of the work to make threat information readily available to security personnel at chemical facilities.The threat characterization may involve the development of a design basis threat (DBT) which defines the maximum credible attack that the physical and digital systems at the facility must successfully withstand.[12&13]

The next step is to understand the security vulnerabilities that may exist at a facility. There are various physical and cyber security vulnerability assessment approaches that can be used to characterize security vulnerabilities. These start with a review of engineering drawings, blueprints, photographs, operating procedures, emergency response plans and security tests. Next, targets are characterized, including their locations and critical components. An understanding of vulnerabilities requires a reliable knowledge of the defence and resilience measures in place at the facility. This involves a review of critical security system components, physical and cyber protection plans and procedures, incident response capabilities, staff training and awareness, and other factors.[9] Using the facility, threat and vulnerability information collected so far, attack scenarios can be developed by identifying sequential activities performed by the attackers and the timeline needed to achieve their goals. An excellent description of attack scenarios and attack trees are provided by.[14]A number of tools exist for doing vulnerability analyses for physical and cyber security like CARVER[15] and VISA.[16]

In the next step, an analysis is made of the consequences of a successful compromise of security. At the system level, consequences involve the loss of confidentiality, integrity, and availability. For evaluating overall consequences, their effect on one or more systems are combined and the net result from the loss of confidentiality, integrity, and availability is determined. For an attack that results in the release of hazardous chemicals into the environment, there are a number tools that can be used to estimate human health impacts. The modelling of impacts begins with a characterization of the type, amount, and release parameters for the hazardous chemicals emitted to the environment. In most cases, the atmospheric transport pathway is the environment path of greatest concern. A number of easy-to-use models exist that can characterize the atmospheric dispersion and downwind exposure to hazardous chemicals. This includes chemical dispersion models such as Phast Risk,[17] ALOHA,[18] and EPIcode.[19] Once a dispersion model predicts chemical concentration at a receptor, that information can be used to estimate human exposure and the resulting health and safety impacts.

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- Mild, transient health effects (PAC-1).
- Irreversible or other serious health effects that could impair the ability to take protective action (PAC-2).
- Life-threatening health effects (PAC-3).

The Chemical Mixture Methodology (CMM) is the default method recommended by the US Department of Energy (DOE) to assess potential health impacts on individuals and their ability to take protective actions after the exposure to an airborne mixture of hazardous chemicals.[23&24] The CMM is used around the world to support emergency preparedness and response at a wide range of chemical facilities. The CMM computes the Hazard Index (HI) for each chemical in a mixture at a receptor point. The HI is the ratio of the concentration of the released chemical at the receptor location to itsdesignated exposure limit (typically a PAC value).

The Risk management couples the results of risk assessment with risk treatment options. Risk treatment involves the identification of potential security enhancements that can be put into place to achieve risk reduction. These options may involve the implementation or modification of one or more management, operational, or technical security controls.

The sum of HIs of all the chemicals in the mixture is considered during the initial screening assessments. If the sum of HIs for all chemicals >1.0, it indicates that an individual could experience the adverse health effects associated with the concentration limit and that a more refined additional consequence assessment is warranted to provide more definitive information.In that case, the next step is to evaluate the potential adverse health effects using a biological systems approach.

The CMM uses health code numbers (HCNs) to distinguish and categorize different health effects according to the toxicity end-points or target organ systems. The HCNs are similar to medical diagnostic codes. They are used to evaluate group relevant adverse health effects that target the same organs or biological systems (e.g., acute cardiovascular, eye, respiratory toxic effects). The resources used to assign the HCNs are similar to the toxicological literature used in PAC development.[23] If the sum of HIs of a target organ is >1.0, protective actions are needed to guard against potential exposure. If the sum of HIs of any specific target organ effect is ≤1.0 for a given mixture, additional protective actions may not be required. CMM analyses are conducted using the Microsoft Excel-based CMM Workbook along with user guide available for download.[25] The CMM development team has also designed and is testing a new tool, called the "CMM Wizard"[26], for on-line or off-line use.

In the next step, chemical security risk estimates are obtained after assessing threats, vulnerabilities, and consequences. Depending on the quality and quantity of the supporting data, the risk characterization can range from a simple qualitative assessment to full-blown quantitative assessment.

The Risk management couples the results of risk assessment with risk treatment options. Risk treatment involves the identification of potential security

Traditionally, the Maximum credible undesirable Event Analysis (MCUEA) identifies and quantifies the damage potential of worst case scenarios and estimates the effectiveness of existing safeguards including process controls, administrative procedures and the attributes of facility design. In the context of chemical terrorism involving dual use chemicals, MCUEA can be used for assessing the vulnerability of facility, adequacy of operating procedures, workers background information, adequacy of emergency drills, chemical safety of the facility and any oversights in chemical security.

enhancements that can be put into place to achieve risk reduction. These options may involve the implementation or modification of one or more management, operational, or technical security controls. Lists of potential security controls are available from many sources.[8&10] After identifying risk treatment options, the cost of implementing new options or enhancing the existing options has to be examined. Design, acquisition, installation, implementation, operation, and maintenance are the major components of costs. In the next step, after assessing risk treatment options and their cost, the risk management process evaluates the cost effectiveness of each set of risk treatment options. A selection can then be made based on an evaluation of legal or organizational requirements, risk reduction benefit, cost, and the acceptability of the residual risk that would remain after the selection of each viable option. The risk assessment and management process should be clearly documented to support security auditing and reassessment activities. Frameworks for risk-based approach to chemical security are described in publications like ISO 27001[7] and NIST 800-39.[9] In the subsequent step, risk management decisions are implemented to enhance the security. The final step involves the monitoring the effectiveness of the security program as the threat, vulnerability, consequence, and available security controls evolve with time.

Incorporating Chemical Safety and consequence Assessment Processes

In the present and subsequent parts of this paper we identify some of the established processes for chemical safety and consequence analysis that can be adopted to undertake a chemical security assessment. The safety and consequence assessment process involves two key tasks viz., developing a screening process for identifying the assets to be protected and to prioritize the implementable actions. As outlined earlier in this paper, this includes an analysis of threats, vulnerabilities, and consequences. The screening of the facilities and operations for safety and security vulnerability potential require a good understanding of the risk levels of various undesirable events. The focus will then shift to developing the implementable risk reduction measures. It is generally considered prudent to identify worst case event scenarios for vulnerability analysis since they provide a bounding assessment.

Asset identification and characterization

The asset characterization involves identification of one or more assets of a chemical installation associated with particular chemicals of interest. An asset, in some cases, may be associated with more than one chemical of interest to the assessor. Also, a single chemical of interest may have more than one security chemical release issue associated with it. The typical types of releases from process equipment are pool, jet or flash fires, unconfined or confined gas / vapour explosions and dense or passive gas / vapour dispersions. The asset identification as a single item or inter connected

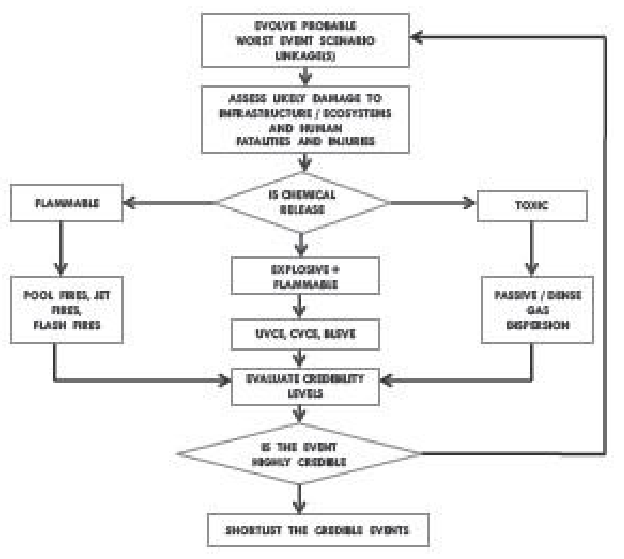

Figure.2: Road Map for Evolving Credible Worst Event Scenarios

multiple items, for a given chemical release scenario will normally be based on largest chemical inventory and / or most severe process conditions.

Maximum Credible Undesirable Event Analysis

Traditionally, the Maximum credible undesirable Event Analysis (MCUEA) identifies and quantifies the damage potential of worst case scenarios and estimates the effectiveness of existing safeguards including process controls, administrative procedures and the attributes of facility design. In the context of chemical terrorism involving dual use chemicals, MCUEA can be used for assessing the vulnerability of facility, adequacy of operating procedures, workers background information, adequacy of emergency drills, chemical safety of the facility and any oversights in chemical security. The outcome of MCUEA provides the quasi quantitative estimate of the adverse impact on the immediate and distant environments. The methodology for evolving the worst case chemical accident scenarios has received attention while developing quantitative tools to assess the emergency preparedness of chemical installations.[27] Central to this theme is the need to establish the credibility of the envisaged worst accident scenarios in quantitative terms.[28] The MCUEA is being employed successfully in chemical and petrochemical plants and chemical industry parks.

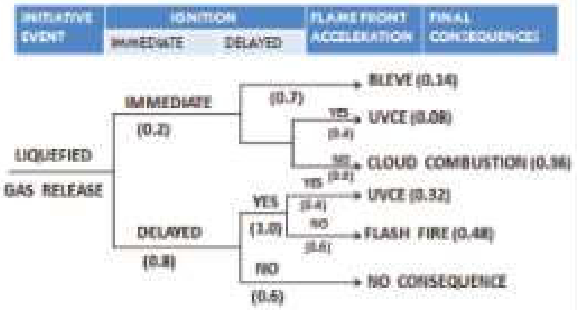

Figure.3: A Typical Event Tree for Probability Assessment

Concepts and Methodologies of MCUEA

Credible worst accident events occur within the realm of possibilities and they are severe enough to cause significant damage to environment, people and infrastructural facilities. To formulate them, a combination of events have to be put together through a heuristic process relying on wisdom and scientific knowledge on chemical events of high damage potential. The supporting information includes physicochemical and transport properties of concerned chemicals, chemical reaction and storage conditions, shape, strength and process utility of plant equipments and piping and built-in safety and security features. External factors like site topography, neighbourhood details and meteorological conditions have also to be considered.

> Severity of chemical events can be deduced from statistics from past accidents. However, three factors viz., probability of occurrence, potential for fatalities and potential for economic / property loss have to be considered to be broadly assess the extent of severity of a worst chemical event. The fatalities and financial losses involved in adverse chemical events can be evaluated through semi-empirical correlations based on asset density in the vicinity of the event, probability of occurrence of the event.

Normally safety and security experts consider instantaneous release of entire chemical load in a container and total failure of mitigation / safety measures for evolving the worst case scenarios.

Significant advances have been made in developing appropriate methodologies for MCUEA in chemical process safety.[29,30] The events with the highest or significant damage potential within the realm of possibility have to be selected and a systematic procedure has to be evolved with a thoroughness of hazard identification and consequence analysis. The worst case event scenario identification forms the reference point of a chemical security vulnerability assessment. They indicate the worst affected geographic areas in which people will be at high security risk. They will also form the appropriate scenarios for emergency planning.

Figure 2 provides the roadmap for selection, damage potential and credibility assessment of worst event scenarios. They may be single events or combination of them. In the case of latter, the event scenario provides the typical situation that covers a set of probable events with high damage potential. The source models for chemical release from process vessels are reported. They are based on fundamental or empirical or semi-empirical equations representing the physicochemical processes occurring during the chemical release. Its leakage through a vessel can be represented by the mechanical energy balance with incompressible or compressible fluid assumption[31] Vapors and liquids are ejected from process units in single or two phases. The flow of fluids through pipes is represented by the loss of mechanical energy resulting from friction including the losses from flow through pipelength, valves and other fittings. Liquids stored under pressure above their boiling points, on vessel developing a leak, partially flashes into vapour sometimes explosively. Two phase flashing discharge is described by empirical models. Models have also been reported for evaporation of boiling and non-boiling liquid pools. Instantaneous gas / vapour release from pressurized vessels containing pressurized liquid at its boiling point can be calculated. An excellent review of these tools has been reported.[32]

The consequences due to flash, pool and jet fires, explosions, boiling liquid expanding vapor explosion (BLEVE) and toxic gas dispersions can be evaluated by several models.[33-35] The damage distances to specified end points with high consequences are predicted. Discharge calculations are carried out first to set release characteristics, then dispersion calculations to determine the concentration of the hazardous chemicals and finally flammability explosion and toxicity consequences are evaluated.

Probability Assessment through Event Tree Analysis (ETA)

ETA is a useful tool to evaluate probabilities of various events in terms of failure probabilities. It is a bottom up graphical mathematical procedure based on logical modelling. It starts with a single initiating event and evolves into cascading branches and nodes. It can be integrated into quantitative hazard analysis.[36] It is essential that an analysis of unwanted or wanted events have to be anticipated to produce meaningful probability results. The typical probabilities for immediate and delayed ignitions, flame front acceleration, jet and flash fires, BLEVE and others of a hazardous event is presented in **Figure 3**. With few historical precedents in probability evaluation in chemical terrorism, assessing its risk potential is rather difficult. New data needs to be generated from the past analysis.

Extent of Severity of Worst Chemical Release Events

Severity of chemical events can be deduced from statistics from past accidents. However, three factors viz., probability of occurrence, potential for fatalities and potential for economic / property loss have to be considered to be broadly assess the extent of severity of a worst chemical event. The fatalities and financial losses involved in adverse chemical events can be evaluated through semi-empirical correlations based on asset density in the vicinity of the event, probability of occurrence of the event, the area inside the damage radius and unacceptable financial loss and fatality rate.[30]

Summary

There are several unresolved issues in evaluating the potential threat posed by the dual use chemicals in case of chemical terrorism. This paper introduces a risk paradigm for the chemical industry to address chemical security issues. This approach is valid not only in India, but worldwide. The existing processes for assessing chemical safety can be used as the basic framework to address chemical security issues or to examine security and safety issues in an integrated manner.

References

1. DHS.2006. Recommended Practice for Patch Management of Control Systems. https://ics-cert.us-cert.gov/sites/default/files/ recommended_practices/ RP_Patch_Management_S508C .pdf
2. U.S DHS. 2009. Risk-Based Performance Standards Guidance – Chemical Facility Anti-Terrorism Standards https://www.dhs.gov/sites/default/files/publications/CFATS-Risk-Based-Performance-Standards-508.pdf
3. UNICRI. 2015a. Information Security Best Practices for CBRN Facilities. United Nations Interregional Criminal Justice Research Institute. Turin, Italy. http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-25112.pdf.
4. UNICRI. 2015b. How To Implement Security Controls for an Information Security Program at CBRN Facilities" United Nations Interregional Criminal Justice Research Institute. Turin, Italy. http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-ACT-10019.pdf.
5. UNICRI. 2015c. Information Security Management System Planning for CBRN Facilities.United Nations Interregional Criminal Justice Research Institute. Turin, Italy. http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24874.pdf.
6. Lu, Quan Hai T. 2015. Cyber Attacks – The New WMD Challenge to the Interagency InterAgency . Journal Vol. 6, Issue 2, Special Edition, Spring 2015. http://thesimonscenter.org/wp-content/uploads/2015/05/IAJ-6-2-Spring-2015-48-57.pdf
7. ISO.2014a."ISO/IEC 27000:2014 Information technology – Security techniques – Information security management systems – Overview and vocabulary." International Organization for Standardization. http://standards.iso.org/ittf/licence.html.
8. ISO, 2014b."ISO 27001 Controls and Objectives Annex A."International Organization for Standardization. http://gender.gov.mu/English/Documents/activities/gender%20

infsys/AnnexD(1302.pdf.

9. NIST. 2012. Guide for ConductingRisk Assessments: Information Security. NIST-800-30, National Institute of Standards and Technology. US Department of Commerce. Gaithersburg, Maryland. http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-30r1.pdf

10. NIST. 2013. Security and Privacy Controls for Federal Information Systemsand Organizations. NIST 800-53 Rev 4. National Institute of Standards and Technology. US Department of Commerce. Gaithersburg, Maryland. http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-53r4.pdf

11. NIST. 2015. Guide to Industrial Control Systems (ICS). NIST 800-82 Rev 2. National Institute of Standards and Technology. US Department of Commerce. Gaithersburg, Maryland. http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-82r2.pdf

12. IAEA. 2011a. Nuclear Security Recommendationson Physical Protectionof Nuclear Materialand Nuclear Facilities (INFCIRC/225/Revision 5). International Atomic Energy Agency(IAEA). IAEA Nuclear Security Series No. 13. Vienna, Austria. https://www.iaea.org/sites/default/files/publications/documents/infcircs/Pub1481_web_0.pdf

13. IAEA. 2011b. Computer Securityat Nuclear Facilities. International Atomic Energy Agency(IAEA). IAEA Nuclear Security Series No. 17. Vienna, Austria. http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1527_web.pdf

14. Scheier, Bruce. 1999. Shcneir on Security: Attack Trees. https://www.schneier.com/academic/archives/1999/12/attack_trees.html

15. Government Training Inc., CARVER+Shock Vulner-ability Assessment Tool., Hand Book (ISBN: 978-U9832361-7-7)

16. PIC Security Standards Council., Payment Card Industry Security Standards., Overview Document (2008)

17. PHAST., QRA and Risk Analysis Software by DNV-GL., environmentclearance.nic.in

18. R.Jones etal., ALOMA 5.4.4: Technical Document-ation., US Dept of Commerce, NOAA Technical Memorandum NOS OR&R 43, Seattle, WA, USA (2013)

19. C.Lagdon., EPI Code Computer Code Application Guidance for Documented Safety Analysis., US Department of Energy, Washington DC. USA (2004)

20. Craig DK, Baskett RL, Davis JS, Dukes L, Hansen DJ, Petrocchi AJ, Powell TJ, Sutherland PJ, Tuccinardi J, TE. 1999. Recommended default methodology for analysis of airborne exposures to mixtures of chemicals in emergencies. Applied Occupational and Environmental Hygiene14(9):609-617.

21. Craig DK, Davis JS, DeVore R, Hansen DJ, Petrocchi AJ, Powell TJ. 1995. Alternative guideline limits for chemicals without environmental response planning guidelines. Am. Ind. Hyg. Assoc. J.56:919-925.

22. Craig DK, Davis JS, Hansen DJ, Petrocchi AJ, Powell TJ, Tuccinardi J, T. E. 2000. Derivation of temporary emergency exposure limits (TEELs). Journal of Applied Toxicology20:11-20.

23. Yu X-Y, Petrocchi AJ, Craig DK, Glantz CS, Trott DM, Ciolek J, Lu P-Y, Bond J-A, Tuccinardi J, TE. 2010. Development and applications of the chemical mixture methodology. J. Applied Toxicology30: 513-524.

24. Yu, X.-Y., Glantz, C.S., Yao, J., He. H., Petrocchi, A.J., Craig, D.K., Ciolek, J.T., Booth, A. E. 2013. Enhancing the chemical mixture methodology in emergency preparedness and consequence assessment analysis. Toxicology 313(2-3):174-184. doi: 10.1016/j.tox. 2012.10.011

25. CMM Workbook., https://sp.eota.energy.gov/EM/Sitepages/SCAPA-Home.aspx

26. CMM Wizard., https://digitalcommons.calpoly.edu/cgi/view content.cgi? Article=1139 & Context=star

27. I.F.Khan., "Techniques and Methodologies for Risk Analysis in Chemical Process Industries"., Shodganga.inflibnet.ac.in (2010)

28. F.I.Khan and S.A.Abbasi., "A Criterian for Developing Credible Accident Scenarios for Risk Assessment".,J.Loss. Prev. in Proc.Ind 15(6), 467-475 (2002)

29. I.L.Hirst and D.A.Carter., "A Worst Case Methodology for Risk Assessment of Major Chemical Installations"., Proc. Safety Progress 19(2), 78 (2000)

30. F.I.Khan., "Use Maximum Credible Accident Scenarios for Realistic and Reliable Risk Assessment"., Chem.Eng. Progr 97(11), 56-64(2001)

31. A.Daniel, J.F.Crowl and F.Louvar., Chemical Process Safety: Fundamentals with Applications, 2nd Edition, Prentice Hall Inc., New Jersey, USA (2002)

32. OGP, "Risk Assessment of Data Directory – Conse-quence Modeling"., Report No.434-7 of International Association of Oil and Gas Procedures (OGP)., March (2010)

33. M.Dadashzadeh., F.Khan, K.Hawboldt and P. Amyotte., an Integrated Approach for Fire and Explosion consequence Modeling., Fire Safety Journal 61, 342 to 6

34. H.Witlox, M.Harper and D.Webber., "Modeling and Validation of Dispersion following an Instantaneous vapour or two phase release from a pressurized vessel., 50th Annual Loss Prevention Symposium, 12th Global Congress on Process Safety, Houston, Texas, USA, 11-13 April (2015)

35. R.Pula, F.I.Khan, B.Veitch and P.R.Amyotte., "AGrid Based Approach for Fire and Explosion Consequence Analysis"., The Institution of Chemical Engineers, Elsevier Inc., (2006)

36. J.A.Vilchez., V.Espejo and J.Casal "A proposal of Generic Event Trees and Probabilities for the Release of Different Types of Hazardous Materials"., upcommons.upc.edu (2010).

Prof. V.K. Jain, received his bachelors in Chemistry Honors (1980) and Masters of Science in Inorganic Chemistry (1982) and PhD (1989) from University of Delhi. He qualified N.E.T. in 1988. Joined as Lecturer in the Chemistry Department in the School of Sciences at Gujarat University in 1991 and became Professor in March 2007.

With 26 years of Post Graduate teaching experience at Gujarat University, he has successfully guided 16 students through their Ph. D and has four students working under his supervision at present. He has 2 Indian patents (filed in 2013-2014), 70 research articles and four review articles in International Journals to his credit. He has more than 1250 citations with an h-index and i-10 index of 16 and 28, respectively. In addition, he has completed many Major research projects from UGC; GUJCOST (DST) Gujarat and CSIR, New Delhi. Currently, he is handling major research project from DRDO, DST-SERB and also acting as the Co-ordinator of UGC DSA-DRS phase III program on "Supramolecules and Nano Materials". He is also the co-author of the book entitled Group Theory and Symmetry in Chemistry. He has organized, participated and presented his research work in various national and international conferences in India and has also had the opportunity to present his work abroad (Missourie 2005, Chicago 2008 and Washington DC 2016). He is also a referee for various reputed International Journals. He is also a member of various academic and professional bodies.

PROFESSIONAL MEMBERSHIPS / AFFILIATIONS

- Member of State Level Expert Appraisal Committee (SEAC) (2014-2017-20) Gujarat State, Ministry of Environment and Forests, Government of India, New Delhi.
- Expert, R & D Advisory committee, GPCB, Gandhinagar
- Council member (2011-2014-17) and Member of Chemical Research Society of India, Bangalore.
- Co-convener, Ahmedabad-Local Chapter of Chemical Research Society of India.
- Fellow of Indian Chemical Society. Associate Fellow Gujarat Science Academy.Member of Indian Science Congress. Member of Association of Indian Analytical Scientists. Member of Institution of Chemist. Member of National academy of Sciences.
- Member of Board of Studies, Research Progress Committees and examiners in various reputed Universities.

- **Area of interest and specialization:** To design, synthesize and characterize new functionalized supramolecular chemosensors derived from Calixpyrroles, Calix[4]resorcinarenes, Oxacalixarene, Azacalixarene and Thiacalixarenes. To study their binding behaviour towards various analytes (toxic and trace cations, anions, biomolecules, explosives and pesticides etc.) in environmental and biological samples. To use hydrazide derivatives of few Calix-systems as reducing as well stabilising agent to yield highly stable and water dispersible nanoparticles. To synthesise and characterise calix protected metallic and bimetallic nanoparticles e.g. Copper, Silver, Gold, Platinum and Palladium nanoparticles. To explore them as chemosensors, nano catalyst in various organic reactions, antioxidant, molecular logic gate, and resistive random access memory device. To support and rationalise the findings of experimental observation with the help of computational methods (Molecular docking and dynamics).

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Date of Birth: February 5, 1958
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Research Interests:

- Synthesis of Natural Products, Carbohydrates, Foldamers
- New Drug Discovery
- Bioprocess and Biotransformation

Professional Carrier:

1987-2005	Scientist / Asst. Director, Indian Institute of Chemical Technology, Hyderabad
2005-2010	Deputy Director, Indian Institute of Chemical Technology, Hyderabad
2009-present	Chief Scientist & Head, OBC and MCB Departments, CSIR-IICT, Hyderabad

Scientific Activities: Collaborations – National and International

1997-1998	National Inst. Health (USA) - anti-HIV IICT-187919	Project Leader
1998-1999	Leukosite Inc. (USA) - New Routes to 5-LO inhibitors	Project Leader
1998-2001	SmithKlineBeecham, (UK) – SPOC/Process/Scaffolds	Project Leader
2000-2002	ArQule, Boston (USA) - Solution Phase Org. Chem.	Project Leader
2002-2002	NYBC, New York (USA) - entry inhibitors for HIV	Project Leader
2004-2005	DuPont, Delware (USA) - NCES – agro chemicals	Proj. Co-ordinator
2004-2006	Givaudan, Zurich(**Switzerland**) - Routes - Fragrance Chem.	Project Leader
2008-2011	**Indo-French** (CEFIPRA) - Peptide based Organo Catalysis	Project Leader
2009-2011	**Indo-Russian** (DST-RFBR) – Wood waste to Drugs	Project Leader
2014-2017	**Indo-French** (CEFIPRA) – Sp^3CH bond activation	Project Leader
1998-2003	**CSIR** (India) - Young Scientist Award – New Saccharides	Project Leader
1999-2002	**DST**, New Delhi (India) - Nodulation Factors	Project Leader
1999-2002	**DST/Ranbaxy** (India), Anti-inflammatory (COX-2) NCEs	Project Leader
2000-2001	**NMITLI-CSIR** (India)- Defunctionalization of Carbohy.	Project Leader
2002-2012	**CSIR**, New Delhi - Asthma and allergic disorders	Nodal Scientist
2012-2017	**CSIR**, New Delhi – 1. COPD, 2. ORIGIN, 3. IntelCoat	Project Leader
2014-2017	**INAE** (India) - Scientometric Analysis	Proj. Co-ordinator
2016-2017	**Indo-US** Project on Bioethanol	Project Leader
1989(Jan/Aug.)/2011	ND Zelinsky Inst. of Org. Chem, Moscow (**USSR**)	Visiting Scient.
1998 (Jul./Aug.)	SmithKline Beecham, Harlow (**UK**)	Visiting Scient.
2001 (Aug.)	ArQule, Boston (**USA**)	Visiting Scient.
2007	Ludwig-Maxmillan Univ, Munich (**Germany**)	Sr. DAAD Fellow
2008/2010	Kyushu University, Fukuoka (**Japan**)	Visiting Professor
2009/2010/2013/2015	University of Rennes, Rennes (**France**)	Visiting Scient.
2013	CSIR-Delegation, VNU and VAST (**Vietnam**)	Member

Achievements – Honors – Awards:

2010	OPPI Scientist Award (Org. Pharma. Producers of India, India)
2009	AP Scientist Award (APCOST, AP, India)
2008	Ranbaxy Research Award (Ranbaxy Science Foundation, India)
2007	NASI-Reliance Platinum Jubilee Award (National Academy of Sciences, India, India)
1992	CSIR Young Scientist Award (CSIR, India),
2013	Fellow, Royal Society of Chemistry, UK
2009	Fellow, National Academy of Sciences India, Allahabad (NASI)
1996-2017	Ph. D.s: 50 (4-working); Pubs.: 220; Patents: 15; Books/Chapters – 1 / 4

Dr. Jitendra Kumar (b. 24 June, 1963) is the Director, Institute of Pesticide Formulation Technology, Gurugram, Haryana. Before present assignment, he served as Director, ICAR-Directorate of Medicinal and Aromatic Plant Research, Boriavi, Anand, Gujarat, India and Professor & Principal Scientist, Division of Agricultural Chemicals, India Agricultural Research Institute (IARI), New Delhi. He did his postdoctoral on process development for extraction of artemisinin from Artemisia annua at Biological Chemistry Division, Rothamsted Research, UK.

Dr Jitendra Kumar has made significant contribution in the area of agrochemical formulations, botanicals and Nanotechnology. His work has led to the development of several patented technologies. A process for preparation of Azadirachtin concentrates developed by him is in commercialization and has earned, besides the premium, royalty for the full term of ten years. Three more companies have been licensed with this technology along with another process for making its liquid pesticidal concentrates and are in the process of their further commercialization. In 2012, three nano formulations of azadirachtin, imidacloprid, and carbofuran and preparation of self assembled polymeric nano-materials developed by him have also been released to industry. Controlled release formulations of natural and synthetic pesticides, particularly the botanical based seed coats have been released by the Institute to National Research Development Corporation (NRDC) for their possible commercialization. Besides, Technologies for safe storage of seeds, crops and animals health have also been developed by him.

He has over 400 scientific publications including 19 patents / patent applications, 135 research papers and 11 books. He has guided 5 Ph.D. and 3 M.Sc. students at the Post Graduate School, IARI, New Delhi. He has also guided 1 M.Sc. student at Anand Agricultural University, Anand.

Dr. Jitendra Kumar is the recipient of several awards and recognitions. ICFRE Neem Award, 1996; NATP-World Bank Fellowship, Michigan State University, USA, 2000; SPPS Meritorious Scientist Award, 2003; INSA-Royal Society Bilateral Exchange Fellowship, Rothamsted Research, UK, 2004; Dr Ram Nath Singh Award 2006; Affiliated member of International Union of Pure and Applied Chemistry, North Carolina, USA, 2008 ; Convener of IUPAC sponsored First, Second & Third International Conference on Agrochemical Protecting Crop, Health and Natural Environment, 2008, 2012 and 2016 New Delhi; Joint Secretary, 1999-2002; Treasurer, 2002-2005 and General Secretary, 2005-2009, Society of Pesticide Science, India; NRDC Meritorious Innovation Award, 2010; Member, Academic council, Post Graduate School, IARI, 2010-14; SPPS Outstanding Scientist Award, 2013; Served as Member, Board of Management, Junagadh Agricultural University, Junagadh, Gujarat, Anand agricultural University, Anand Gujarat, Kota Agricultural University, Kota, Rajasthan, Financial Management Committee, Anand, Gujarat; President, Medicinal and Aromatic Plants Association of India, Anand, Gujarat; Member, Research Advisory Committee of National Research Centre on Seed Spices, Ajmer and NRC on Litchi, Muzaffarpur. Chairman, FAD-26 (Bureau of Indian Standards); Fellow of Society of Plant Protection Sciences (SPPS) India; National Academy of Biological Sciences (NABS) & National Academy of Agricultural Sciences (NAAS).

Institute of Pesticide Formulation Technology

(An ISO : 17025-2005 Certified Laboratory for Chemical Testing)

Department of Chemicals & Petrochemicals
Ministry of Chemicals & Fertilizers, Govt. of India

Institute of Pesticide Formulation Technology (IPFT), an Autonomous Institution under the Department of Chemicals & Petrochemicals, Ministry of Chemicals & Fertilizers, Govt. of India, Gurugram (Haryana) is working towards the development of safer, efficient and environment friendly pesticide formulations and Data Generation on Bio-efficacy, Phytotoxicity and Residue Analysis of pesticides and their formulations for registration with CIB/RC. The laboratory is Accredited by NABL as per ISO/IEC – 17025 (2005) for the testing of Pesticides (Technical & Formulations), Pesticide Residues in various food matrices and CWC related chemicals.

IPFT has successfully developed 60 technologies of user and environment friendly new generation formulations. About 15 Patents have been filed for new formulations developed by IPFT. Various technologies have been transferred to pesticide industries for commercialization. Different bio-botanical formulations have been developed as safe alternative to synthetic pesticides. IPFT has developed nano-technology based formulations for getting good bio-efficacy at minimum pesticide doses.

SERVICES WE OFFER:

- ✓ **Development of user and environmental friendly pesticide formulations**
- ✓ **Optimization of formulations/quality improvement**
- ✓ **Prescription formulations suiting the needs of the customer**
- ✓ **Generation of data on liquid effluent treatment**
- ✓ **Analysis of Pesticide Formulations and their Residues**
- ✓ **Impurity profiling of pesticide technical material**
- ✓ **Shelf-life data generation of the pesticides and their formulations**
- ✓ **Exploratory work as per industry's requests**
- ✓ **Bioassay and persistence studies**
- ✓ **Bio-efficacy data generation as per CIB protocols**
- ✓ **Phytotoxicity and phytotonicity studies**

Gujarat University at a Glance

Established in 1949 under the Gujarat University Act, the Gujarat University is largest and oldest university of the Gujarat state. The idea of setting up the university conceived in 1940s and seed of inceptions was laid down by Shri Sardar Vallabhbhai Patel. The glore of university is reflected in some of the eminent alumni like Dr. Vikram Sarabhai, Shri Narendra Modi (Prime Minister, India), Dr. K. Kasturirangan (Former Chairman, ISRO), Gujarat University is the largest university in the state catering to the needs of higher education of more than two lakh students scattered over 235 colleges, 15 recognised institutions and 24 approved institutions. There are 34 Post-Graduate University departments and 221 P.G. Centres with diversified courses in faculties of 1. Arts, 2. Commerce 3. Science, 4. Education, 5. Law, 6. Medical and 7. Dental. There are about 40 ongoing major and minor research projects funded by UGC, DBT, SERF, DST, CSIR, SAC/ISRO, MoES, MHRD, GUJCOST, GSBTM, Central and State government etc. The Gujarat University start-up and Entrepreneurship Council (GUSEC) supports start-ups, entrepreneurs and innovators in Gujarat. The academic capability and potential of the university is recognized by the globally reputed research organizations like PRL, ISRO, Plasma Research Institute, Entrepreneur Development Institute engaged in extended research activities of the university. The university has a state of art Convention Centre with three exhibition halls to cater the needs of social/academic/industrial organizations to organize academic and industrial summits and conventions.

Gujarat Forensic Sciences University at a Glance

The Government of Gujarat has established a super specialized University which is unique and first of its kind in the world for conducting regular / Post Graduate courses in the field of Forensic Science, Behaviorual Science, Research & Development, Criminology and other allied areas. It is situated at Gandhinagar, the capital of Gujarat which is a vibrant, industrious, safe and business friendly state.

Ahmedabad a major city of Gujarat, is also an industrial and educational hub having esteemed institutes such as IIM, IIT, NID,NIFT, CEDI and others. Ahmedabad and Gandhinagar are very well connected with other parts of the country and the world. The International Airport is hardly 20 kilometers away from the University.

The Government of Gujarat has established this University by passing an Act in the Legislative Assembly on 28th September, 2008. Consequent to this, Dr. J.M. Vyas has taken over as the first Director General (Vice Chancellor) of the University.

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Founded in 1868, Oregon State is the state's Land Grant university. It is one of only two universities in the U.S. to have Sea Grant, Space Grant and Sun Grant designations as well. The University is comprised of 11 colleges including Agricultural Sciences; Business; Earth, Ocean, and Atmospheric Sciences; Education; Engineering; Forestry; Liberal Arts; Pharmacy; Public Health and Human Sciences; Science; and Veterinary Medicine. Research is conducted at 15 Agricultural Experiment Stations, 35 county Extension offices provide outreach education; the OSU-Cascades campus in Bend, Oregon offers higher education opportunities to citizens in the high desert country. Thus, Oregon State University has a presence in every one of Oregon's 36 counties, a statewide economic footprint of $2.371 billion (USD) and an impact that reaches across the state and beyond. With students in Corvallis, Bend, Newport and Portland, plus online students across Oregon, the nation and the world, Oregon State University has some 31,500 students.

Dr. Sathuvalli is stationed at the Hermiston Agricultural Research and Extension Center, part of the statewide network of agricultural experiment stations. The station at Hermiston Oregon, 121 hectares in size, serves nearly 202,340 hectares of high valued irrigated agriculture in Oregon and Washington's Columbia Basin. The center concentrates on discovery and implementation of agricultural, horticultural and ecological opportunities, and provides solutions to production restraints. Laboratories, greenhouses, screen houses and equipment provide a modern research facility. Fifteen center-pivot irrigation systems, including one variable rate system, provides field research under controlled conditions.

Research at the station addresses cereal breeding, potato varietal development, horticultural production and quality, integrated pest management, enhancement of potato nutrition, and riparian and stream ecology; and two extension units: plant pathology/diagnostics and commodity-crops production and groundwater quality. Cooperative research is conducted with faculty from other state experiment stations, the Oregon Department of Agriculture, University of Idaho, Washington State University, USDA, Oregon Department of Fish and Wildlife, the Confederated Tribes of the Umatilla Indian Reservation, and Ag Canada.

The Hermiston center has worked to identify adapted crops and develop modern, environmentally sound production practices for the region. Research and Extension strive to alleviate restraints to existing crop production and marketing. In recent years, the center provided leadership, research, and knowledge essential to allow growers to diversify production and convert 30,000 acres of commodity crops to high-value crops.

Pacific Northwest National Laboratory

Pacific Northwest National Laboratory (PNNL) is a leading United States (U.S.) Department of Energy (DOE) research laboratory. For over 50 years PNNL has pushed the boundaries of science. Our discoveries and innovations have strengthened the world's scientific foundations and have provided solutions to complex problems in energy, the environment, and security.

PNNL employs over 4,500 scientist, engineers, and non-technical staff. Our annual research and development expenditures are approximately $1 billion per year. Our main campus and two branch campuses are located in Washington State. We have satellite offices in Portland, Oregon and Washington DC. Last year PNNL staff published over 1,000 peer-reviewed publications, were granted 78 patents, and received numerous awards research and technology transfer activities.

Pacific Northwest
NATIONAL LABORATORY

Richland, WA, USA

U.S. Department of State Chemical Security Program

The U.S. Department of State Chemical Security Program (CSP) is tasked with strengthening global security by preventing terrorist attacks and access to weaponizable chemicals, weapons-applicable expertise, equipment, technologies, and related infrastructure. The CSP partners with government, security, academic, and industrial communities in Africa, the Middle East, and Asia, to strengthen their ability to thwart chemical attacks. CSP accomplishes this aim by sponsoring projects designed to identify and address chemical security vulnerabilities and identify and investigate early warning signs of chemical attacks in preparation. CSP focuses its efforts on maintaining partnerships in countries where nefarious actors may have the interest and ability to acquire expertise, chemicals, and related materials to undertake a chemical attack.

CSP
CHEMICAL SECURITY PROGRAM

U.S. Department of State's Chemical Security Program
Washington, D.C., USA

National Mol Bank (NMB) Facility

CSIR-Indian Institute of Chemical Technology, Hyderabad

सीएसआईआर-भारतीय रासायनिक प्रौद्योगिकी संस्थान, हैदराबाद

- DST (Department of Science & Technology)-CSIR (Council for Scientific & Industrial Research) jointly funded facility
- A unique facility to store samples at -20 °C
- A gold mine for "Drug Discovery" process
- Capacity to store ~1.6 million (~16 Lakh samples)
- Samples are stored under nitrogen atmosphere controlling the oxygen and moisture content
- Samples are expected to have a shelf-life of at least 20 years
- Samples contributed by
  - CSIR-IICT
  - CSIR Laboratories
  - IITs and IISc
  - Universities
  - Private Colleges
- Synthetic samples with +90% purity and isolated natural products with +85% purity
- A unique 2D bar-coded system ensures minimal error in sample storage and retrieval
- All the compounds are screened against assays
  - Anticancer
    - Breast cancer (MCF-7)
    - Prostate cancer (DU145)
    - Non-small cell lung cancer (A549)
    - Cervical cancer (HeLa)
  - Antiinfective
    - *Mycobacterium smegmatis*/*M. bovis*
- Diverse scaffolds with unique synthetic/ natural product-like structural features
- More than 500 natural products available for screening

Autoplant-100

- Integrated automated system for handling reaction preparation through liquid handling, solid weighing, dispensing and work-up
- Upto 12 experiments can be run at a time with independent control of all process parameters in each reactor
- Four reactors can be pressurized upto 100 Bar
- Feeding and sampling can be done under reaction conditions
- Dispensed amounts, stirrer speed, temperature pressure time and other data are stored in read only log file for further references

SLT

- Integrated automated workstation for combinatorial/parallel synthesis under inert gas atmosphere
- Reagent preparation, liquids and solid dispensing, multistep synthesis, work-up, purification, output for analysis and product transfer achieved through simple clicks in the PC
- Ventilated, conditioned hood for sensitive reactions
- Can work from -70 °C to +200 °C and at ambient pressure to 100 bar pressure

CSIR - Indian Institute of Chemical Technology

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