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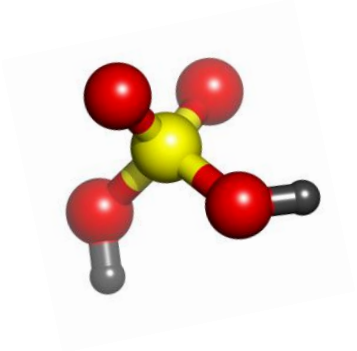
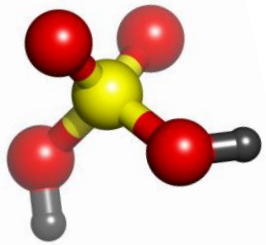


Chemical Transportation Safety & Security

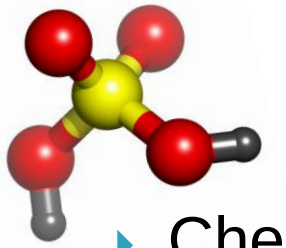
. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories



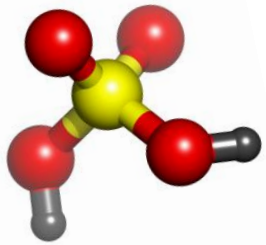
Introduction

- Chemical Transportation
- Case Study Involving the Shipment of Lithium Batteries
- Chemical Transportation Risk Management - Safety
  - Resources to help manage risks
  - Identify, analyze and reduce risks
  - Safety risks
- Chemical Transportation Risk Management - Security
  - Resources and Regulations
  - Identify, analyze and reduce security risks
- Summary



Types of Chemical Transportation

- Chemical transportation:
  - Inside the plant
    - trucks, forklifts, pipelines, etc.
  - Local
    - Vehicles - company owned, contract services
    - pipelines
  - In-country
    - Similar to local
    - Trains
    - Ships
    - Air transport
  - International transport
    - Trucks (company owned or contract services), pipelines
    - Trains
    - Ships
    - Air transport



Chemical Transportation

- It is an essential element in the chemical supply chain and
- Globalization has resulted in:
  - Increased volume
  - Increased speed
  - Strain on transportation infrastructure

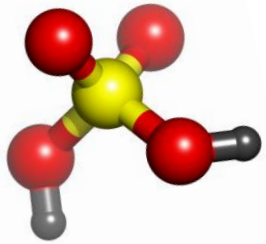
Chemical Transportation Safety Risks

- Transporting hazardous chemicals and hazardous waste

  Risks to *people*, *facilities*, *communities* and the *environment*

- Transport vehicle may carry both people and product

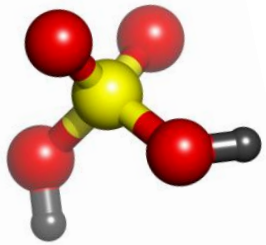
- Transport companies may outsource and consolidate hazardous materials
  - Package incompatible materials
  - Insecure packaging & improper labeling



Current Complexity in Chemical Transportation Increases Risk

- Thousands of regulated hazardous materials
- Differences in regulations by country
- Use of different hazard classes
- Different modes of transportation

  Road, rail, air, marine, pipeline
- Multiple packaging types

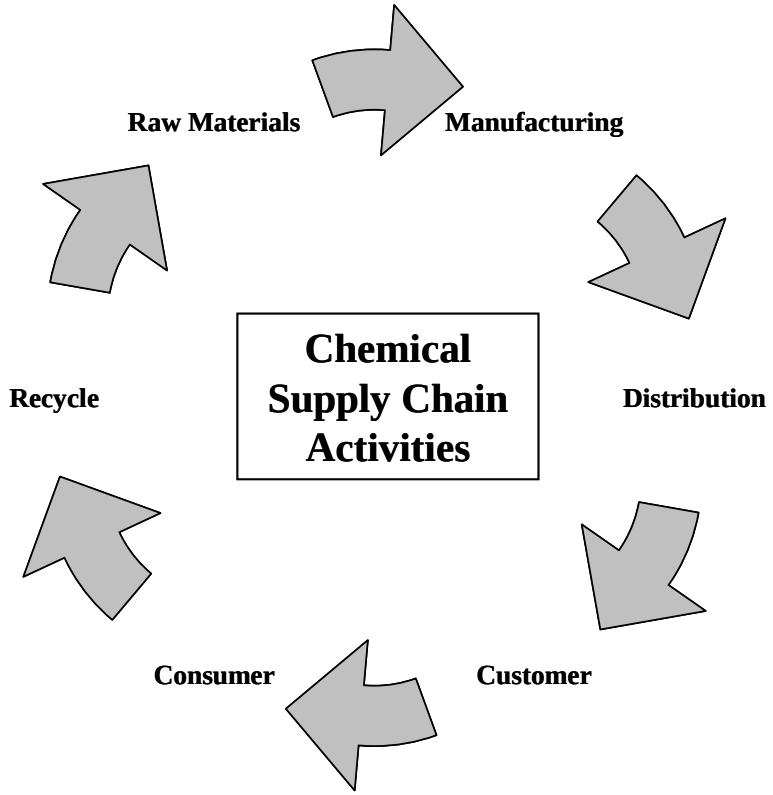


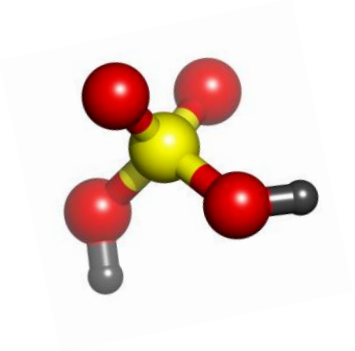
Transportation Risk Management

Due to the complexity of many supply chains, transportation risk management is a shared responsibility.

Roles and responsibilities may differ for each stakeholder.

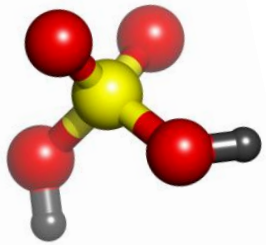
Individual activities and actions can impact the risk to the overall *chemical supply chain.*





A Case Study Involving Lithium Batteries and Improper Packaging

Accident No. DCA04MZ001U.S. National Transportation Safety Board. http://www.ntsb.gov/



A Case Study Involving Lithium Batteries and Improper Packaging

Transportation mode: Air

Date: 7 Aug. 2004

Hazardous Material: Lithium-ion batteries

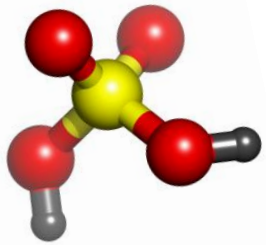
Type of accident: Cargo fire at the terminal

Carrier: Air freight line (non-passenger carrier)

Result: Damage to cargo unit load device ~$20,000 USD.

No injuries.

Accident No. DCA04MZ001U.S. National Transportation Safety Board. http://www.ntsb.gov/

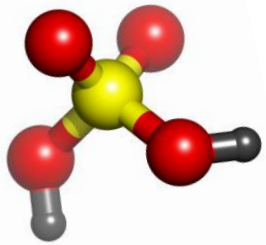


A Case Study Involving Lithium Batteries and Improper Packaging…

Background Information:

- Lithium batteries are described as Class 9 goods [miscellaneous dangerous goods – international term is hazardous materials].
- This was a prototype battery pack manufactured by a US firm.
- Battery pack was to be shipped to France for electric car research.
- Because it was a prototype battery pack special approval was required for this shipment.

U.S. National Transportation Safety Board. http://www.ntsb.gov/



A Case Study Involving Lithium Batteries and Improper Packaging

Shipping Requirements as specified by the US Department of Transportation –

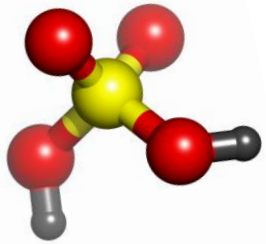
- Battery pack
  - Size - 157 x 43 x 23 cm
  - Weight = 159 Kg
- Package specifications –
  - Insulating fiber glass case
  - Inside a wooden box
  - Fiberglass case bolted to the wooden box
  - Total weight = 240 Kg

U.S. National Transportation Safety Board. http://www.ntsb.gov/

A Case Study Involving Lithium Batteries and Improper Packaging…

This is what the packaging was supposed to look like.

U.S. National Transportation Safety Board. http://www.ntsb.gov/



A Case Study Involving Lithium Batteries and Improper Packaging…

How did the company prepare the lithium battery pack for packaging?

- Type of Package –
  - Cardboard box

- The package contained –
  - Battery pack with exposed terminals
  - Metal wrenches with a plastic bag of nuts and bolts.

U.S. National Transportation Safety Board. http://www.ntsb.gov/

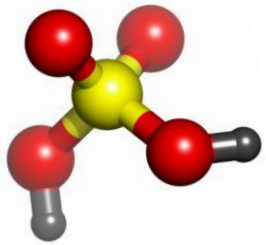
A Case Study Involving Lithium Batteries and Improper Packaging…

This is how the battery packs were packaged.

Cardboard box with battery packs

Metal tools inside the same box.

U.S. National Transportation Safety Board. http://www.ntsb.gov/

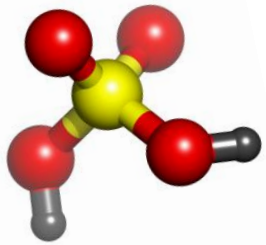


A Case Study Involving Lithium Batteries and Improper Packaging…

What Happened?

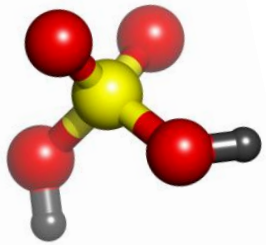
- It was determined that the metal tools shifted during transportation and short circuited the positive and negative terminals of the battery pack causing localized heating.
- This heating caused the packaging to burn and ruptured of some of the other lithium ion battery cells.

U.S. National Transportation Safety Board. http://www.ntsb.gov/



A Case Study Involving Lithium Batteries and Improper Packaging…

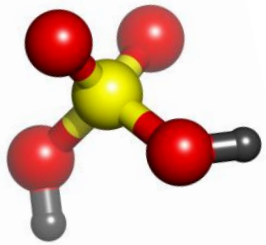
Why did this accident happen?



A Case Study Involving Lithium Batteries and Improper Packaging…

There were guidelines detailing the proper packaging of the lithium-ion batteries.

These guidelines were not followed.

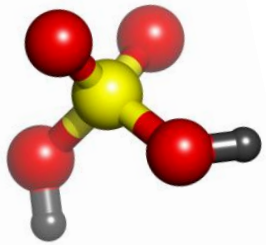


A Case Study Involving Lithium Batteries and Improper Packaging…

What could have been the outcome?

This fire could have occurred during the flight, resulting in the loss of the airplane and possibly the loss of life.

The freight box containing the battery pack was being loaded into the airplane when the worker smelled smoke.



Transportation Risk Management

CSP
CHEMICAL SECURITY
ENGAGEMENT PROGRAM

Chemical
SAFETY AND SECURITY TRAINING

Center for Chemical Process Safety (CCPS) Risk Management Publication

CCPS (2008). Guidelines for Chemical Transportation Safety, Security, and Risk Management

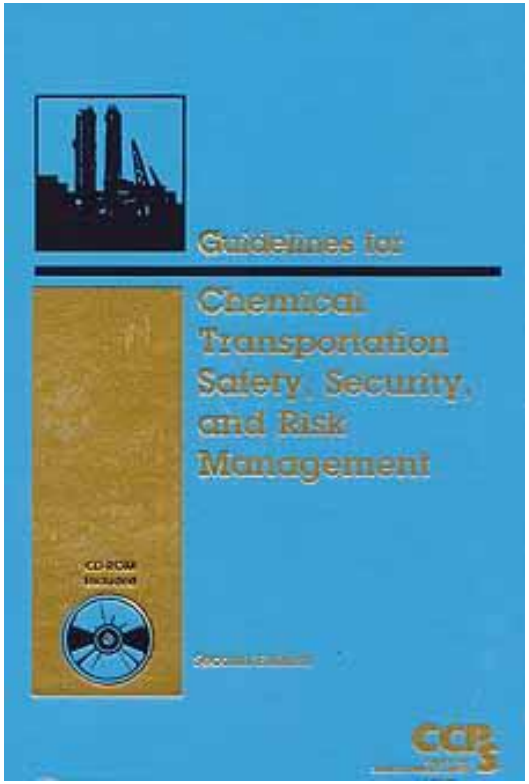
Covers transportation safety, security and risk management

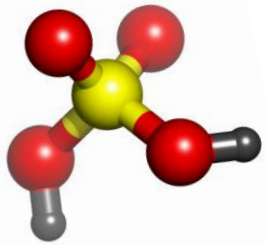
Provides tools and methods to assist transportation professionals and other stakeholders

Presents a comprehensive framework for managing transportation risks

Introduces practical techniques for screening, identifying, and managing higher-level risks

Emphasizes the need to balance safety with security

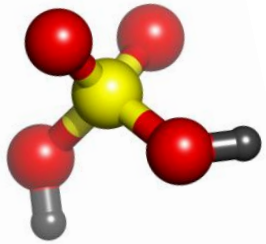




Transportation Risk Management

To help calculate risks -

- *CCPS Guidelines* gives estimates for the likelihood of incidents involving:
  - Pipelines
  - Rail
  - Trucks
  - Barges
  - Ocean-going vessels
  - Intermodal transport



CCPS Transportation Risk Management (TRM)

The CCPS TRM process includes the following elements:

- Primary Management System
- Identification and prioritization of hazards
- Risk Analysis
- Risk Reduction
- Program Sustainability

Transportation Risk Management Primary Management System

Primary Management Systems

Management systems should adhere to regulations and accepted international transportation standards.

- UN Model Regulations

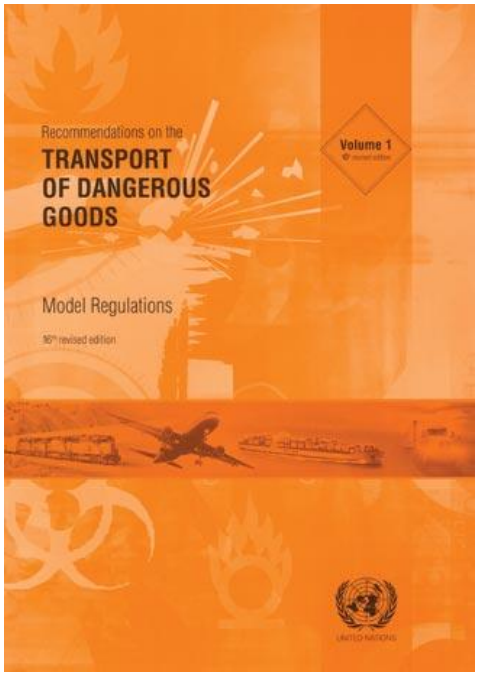
  http://www.unece.org/trans/danger/publi/unrec/12_e.html

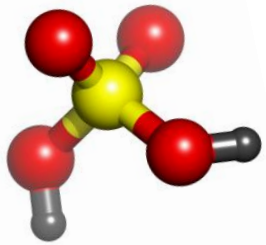
- International Maritime Organization (IMDG Code)

  http://www.imdgsupport.com/

- International Air Transport Association (IATA)

  Dangerous Goods Regulation, 52nd Ed.



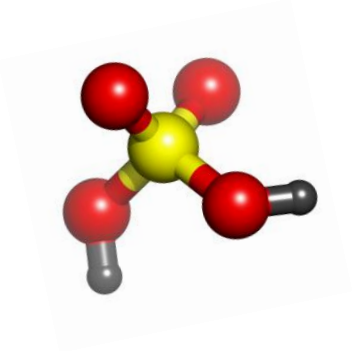


Transportation Risk Management Primary Management System

A Primary Management System Should Also Include:

- Management Commitment

  "Risk Reduction Culture"
- Policies, procedures & practices
- Emergency preparedness & response procedures
- Incident reporting system
- Management of change
- Periodic auditing of the system



Transportation Risk Management Model

Risk = f(scenario, consequence, likelihood)

Transportation risk management follows a general risk management model -

1. **Identification and Prioritization:** screen to identify and escalate issues/scenarios for more detailed risk analysis.
2. **Analysis:** the process of evaluating and estimating the overall level of risk associated with the selected scenarios.
3. **Evaluation:** compare the results against evaluation criteria used for making decisions to set the level of risk mitigation.
4. **Reduce:** develop, compare and select ways to reduce the risks to a target level if needed or as needed.

CCPS Guidelines for Chemical Transportation Safety, Security, and Risk Management

Transportation Risk Management

Identify Risks

What are the hazardous materials that will be transported?

- What are the physical and chemical properties of the materials?
  - Flammable, toxic, corrosive, reactive?
  - Gas or liquid?
- (How are they packaged?)

Photos: U.S. Department of Transportation

Transportation Risk Management

Analyze Risks

External (Accidents)

- Collisions-road, rail
- Cargo shift-road, air
- Derailment-rail
- Crash-air
- External impact-pipeline

Internal Events

- Release or spill that is not due to an external impact
- Example: equipment or containment failure

Photos: US National Transportation Safety Board

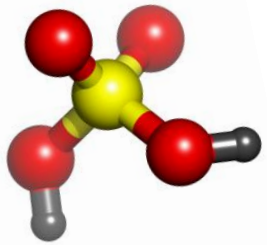
Transportation Risk Management

Analyze Risks

Potential Causes of Incidents

- Human factors
- Equipment defects
  - Corrosion
  - Overpressure
- Overfilling
- Improper packaging
- Vehicle impact
- Transportation infrastructure

Photo: US National Transportation Safety Board



Transportation Risk Management

Analyze Risks

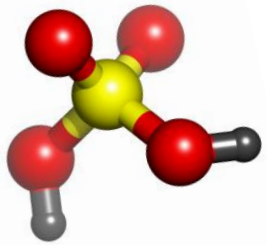
Risk = f(scenario, consequence, likelihood)

Consequence

- Fatalities/injuries
- Property damage
- Environmental damage
- Business impact/fines
- Negative media
- Distribution system disrupted

Likelihood

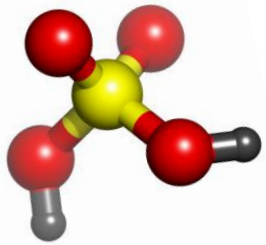
- Expected probability and frequency



Transportation Risk Management
Evaluate Risks

- After analyzing the risks with respect to possible
  - Scenarios,
  - Consequences and
  - Likelihood.
- Compare the results against evaluation criteria that was used and
- Make decisions to set the level of risk mitigation.

Photo: US National Transportation Safety Board

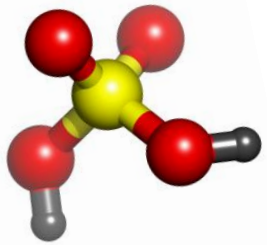


Transportation Risk Management

Risk Reduction

Address highest priority safety hazards first by:

- Written procedures
- Personnel training
- Hazard communication
- Packaging
- Spill containment
- Equipment inspection
- Personnel protection (PPE)
- Emergency response and reporting

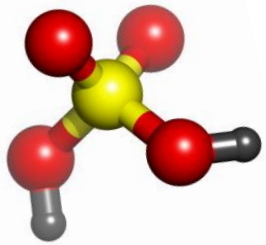


Transportation Risk Management

Risk Reduction

Written procedures –

Written procedures outlining different steps and procedures associated with shipping and receiving chemicals for your company.



Transportation Risk Management

Risk Reduction

Personnel Training –

- Train personnel on the handling, packaging, shipping and receiving of chemicals.
- They need to know local transportation as well as international regulations for the shipment of hazardous chemicals.
- Make sure that more than one person has the training.
- Make sure training is up-to-date.

Transportation Risk Management

Risk Reduction

Hazard Communication

- Safety data sheets
- Shipping papers
- Labeling
- Placards (information signs)

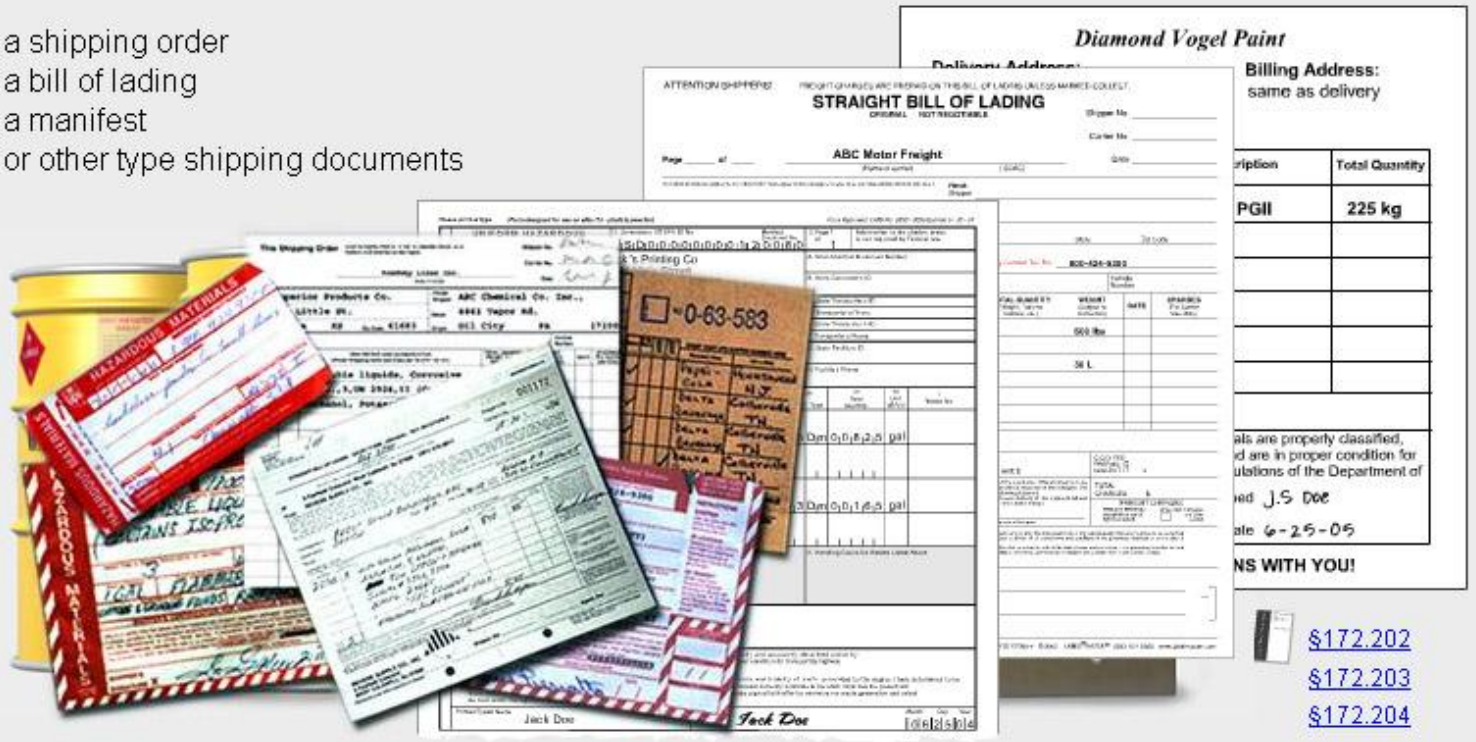
Transportation Risk Management

Risk Reduction

Definition of Shipping Papers

As used in the HMR, a shipping paper for hazardous materials transportation is any document that contains the information required to describe the hazardous material being transported. It may include:

- a shipping order
- a bill of lading
- a manifest
- or other type shipping documents



US Department of Transportation. http://www.dot.gov/

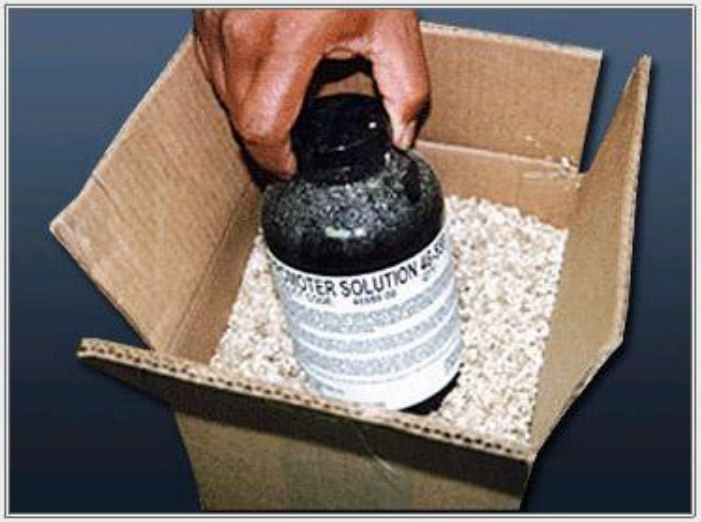
Transportation Risk Management

Risk Reduction

Closure Requirements

Closure requirements for containers of liquid hazardous materials include:

- Close tightly and securely
- Inner packaging must remain upright
- Provide cushioning when needed
- Closed in a consistent and repeatable manner
- Closed as required by the manufacturer's closure instructions, if applicable



US Department of Transportation. http://www.dot.gov/

§173.24(a)
§173.24(e)(5)
§173.24(f)

Transportation Risk Management

Risk Reduction

UN Standard Packagings

Packagings tested to meet the Part 178 performance requirements are called "UN Standard Packagings."

- Standards
- Package Marking Requirements

§171.8

US Department of Transportation. http://www.dot.gov/

Transportation Risk Management

Risk Reduction

Lab Packs Outer Packaging

For lab packs, the outside packaging must be a:

- UN1A2 or UN1B2 metal drum;
- UN1D plywood drum;
- UN1G fiber drum; or
- UN1H2 plastic drum tested and marked at least for Packing Group III materials.

Metal

Fiber

Polyethylene

§173.12(b)(1-2)

US Department of Transportation. http://www.dot.gov/

Transportation Risk Management

Risk Reduction

Leaking or Damaged HM Packages

Repackage leaking or damaged HM packages in metal or plastic salvage drums. The drums must have a removable head. The drums must be compatible with the material.

- Standards
- Markings
- Shipping Papers
- Overpack Requirements

§173.3(c)

US Department of Transportation. http://www.dot.gov/

Transportation Risk Management
Risk Reduction

Emergency Response Guidebook (ERG)

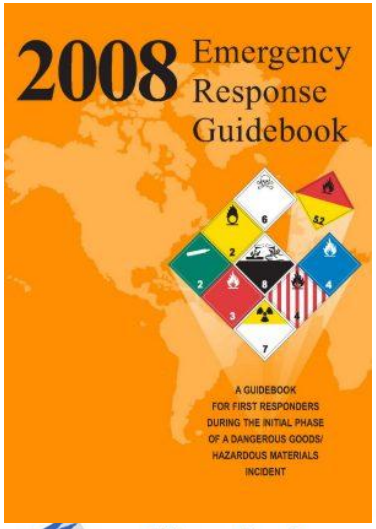
- Interactive internet version:

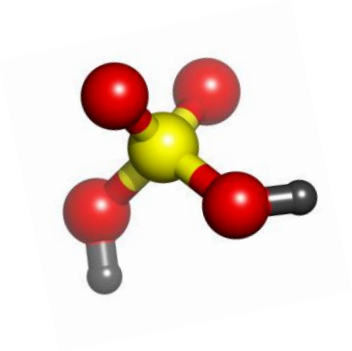
http://wwwapps.tc.gc.ca/saf-sec-sur/3/erg-gmu/erg/ergmenu.aspx

- Developed jointly by:

  US DOT, Transport Canada, Secretariat of Communications and Transportation Mexico

- For first responders to transportation incident
- Guide to quickly identify material classification
- Protect initial responders and public

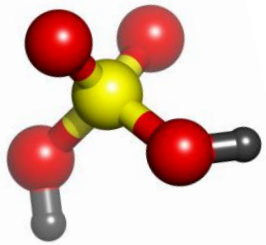




Chemical Transportation Security Risks

CSP
CHEMICAL SECURITY
ENGAGEMENT PROGRAM

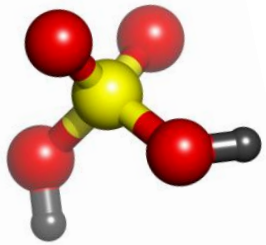
Chemical
SAFETY AND SECURITY TRAINING



Chemical Transportation Security Risks

- In-plant threat
  - Sabotage shipments
  - Intentional release
  - Theft
- In-transit threats
  - Hijacking
  - Theft of materials
  - Sabotage
- Attacks on pipelines

http://www.phmsa.dot.gov/hazmat/security



Transportation Risk Management *Security* Risks

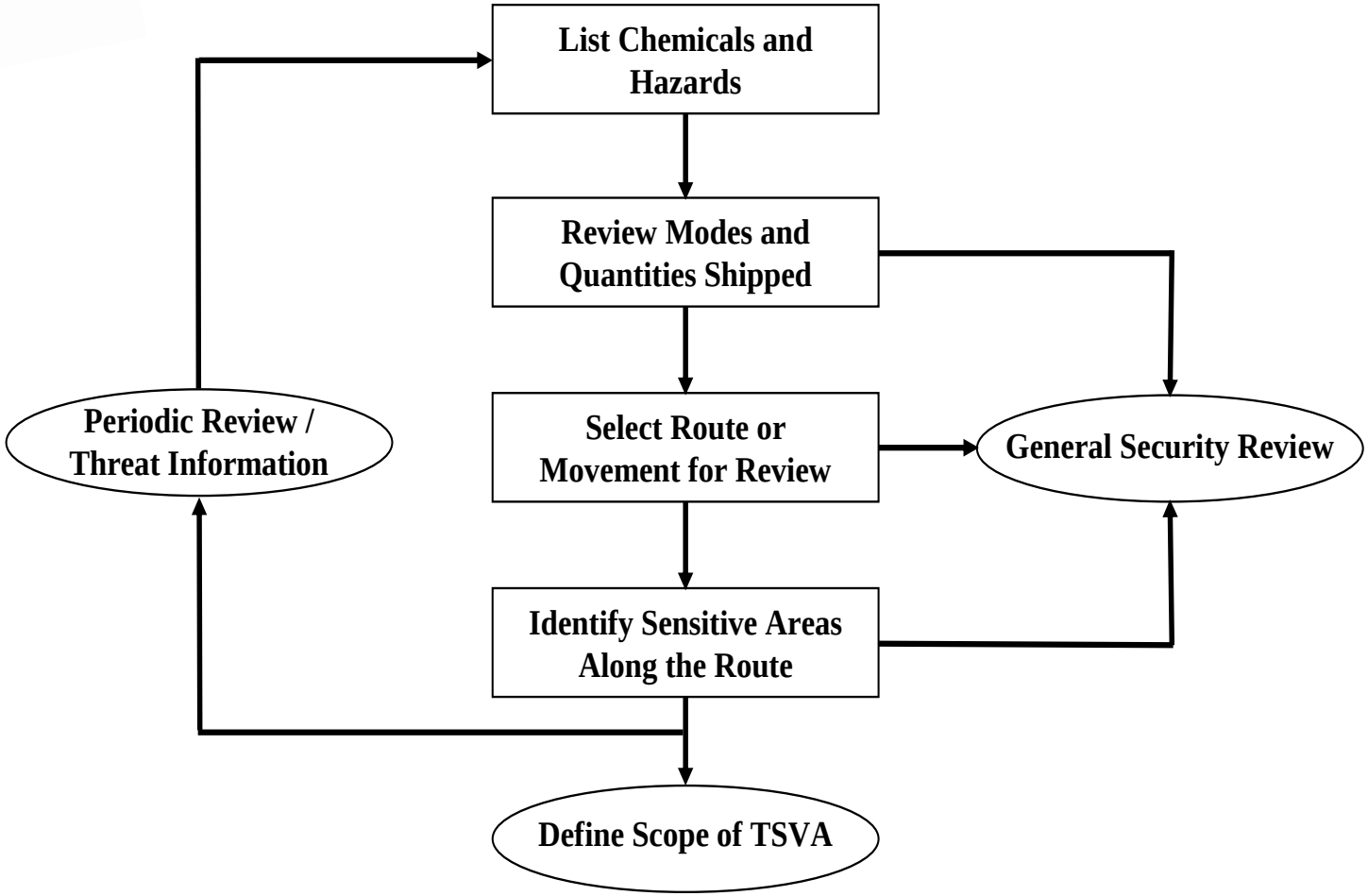
Security Risk = *f*(consequence, vulnerability, threat)

Is similar to safety risks

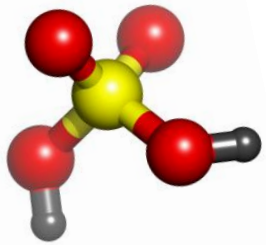
Safety Risk = f(scenario, consequence, likelihood)

- For security risks the initiating event is a direct attack.
- The magnitude of the incident could be greater.
  - Larger releases of hazardous material are possible,
  - Populations would be most likely the target.

Transportation Security Vulnerability Analysis



CCPS (2008). Guidelines for Chemical Transportation Safety, Security, and Risk Management



Transportation Security Risk Management
Risk Reduction

Plant Security

- Include internal transfers in plant security plan
- Limit access to facilities and shipping information
- Secure transportation equipment
- Keep an inventory of hazardous materials
  - Use tamper resistant seals
- Personnel Security
  - Background checks
  - Identification cards or badges

Transportation Security Risk Management
Risk Reduction

In transit security threats

- Vehicle travels on unprotected public roads, rail or sea
- Surroundings are constantly changing
- Sabotage or theft is not detected until in progress
- One person responsible for transport
- Typically there are no security personnel accompanying shipment

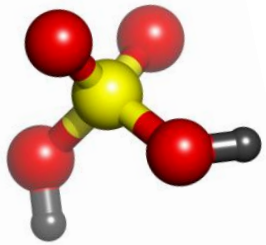
Photo: U. S. Transportation Security Administration

Transportation Security Risk Management
Risk Reduction

Potentially sensitive materials that are shipped by highway

- Depends on quantity and packaging
- ~ ≥ 3000 liters in single container
  - Explosives
  - Flammable Gases
  - Anhydrous Ammonia
  - Toxic Gases
  - Flammable Liquids & Solids
  - Oxidizers
  - Water reactive
  - Corrosives
  - Radioactive, infectious substances

Credit: US TSA Highway Security Sensitive Materials



Transportation Security Risk Management
Risk Reduction

High risk shipments require *high-level* controls:

Increase possibility of detecting an attack

- Provide for additional security personnel
- Alarm the shipment
- Use communication systems

Transportation Security Risk Management
Risk Reduction

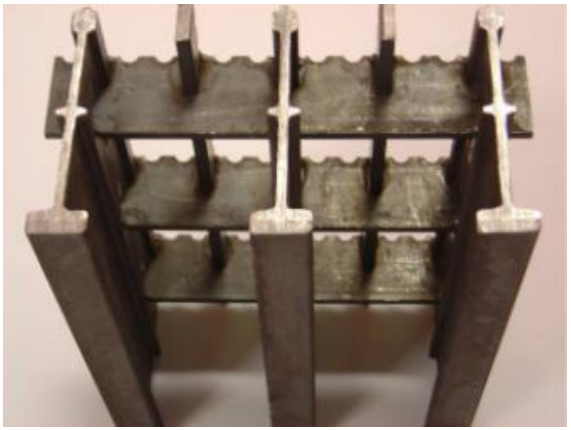
Increase the possibility of <u>delaying</u> an attack

- Cargo secured to vehicle
- Immobilize vehicle
- Hazardous material in vault
- Locks, barriers, entanglements

Drum Cage

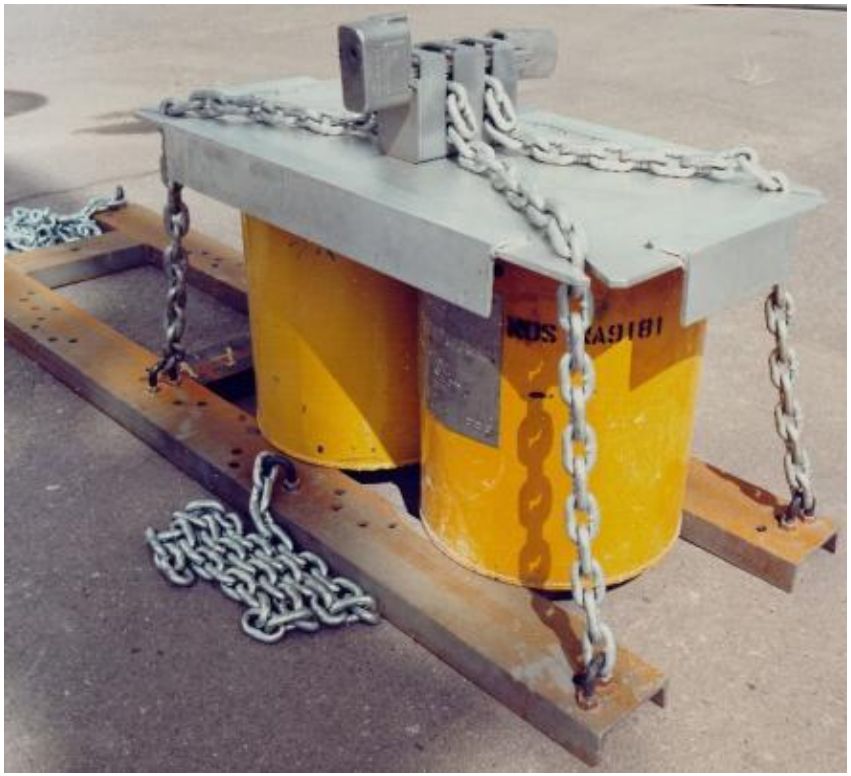
Photo credit: DOE NNSA Presentation, October 17-November 5, 2010

Transportation Security Risk Management
Risk Reduction



Metal Grating

Smoke Obscurant

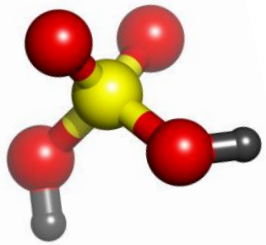


Container Tie Down

Photo credit: DOE NNSA Presentation, October 17-November 5, 2010

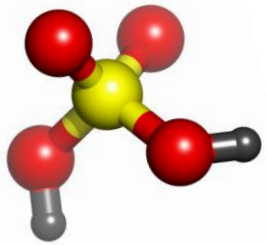
Transportation Security Risk Management
Risk Reduction

Photos: TSA User's Guide on Security Seals for Domestic Cargo



Transportation Risk Management
Selection of Transportation Contractor

- Evaluation of accident history and transportation safety plans
- Safety training of personnel
- Certifications/licensing
- Condition of equipment
- Confirm the following:
  - Secure packaging
  - Shipping documentation/bill of lading
  - Labelling
  - Safety data sheets
  - Appropriate PPE for spill response
  - Spill containment kits on board
  - Emergency Contact Information on board



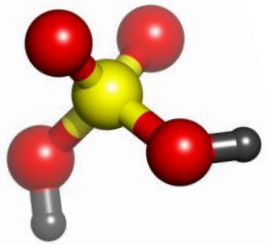
US Federal Motor Carrier Safety Regulations

The US FMCSA regulates:

- Driver qualifications
- Years of service
- Equipment standards
- Driving and parking rules
- Alcohol and controlled substances
- Financial responsibility
- Operational requirements

HAZMAT training required for:

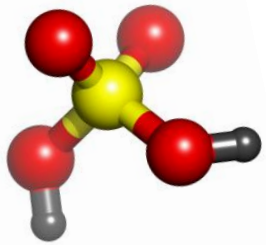
- Personnel who prepare, load/unload, or transport hazardous materials.



Balancing Transportation Security with Safety

Issue	Safety	Security
Placards	Commodity information needed by emergency responders to react appropriately to an accident and minimize any impact.	Commodity information could be used by terrorists to target specific chemicals.
Rerouting	May result in more accidents if there are longer transits or the infrastructure along an alternate route may be less well maintained or contain undesirable features (uncontrolled intersections, no shoulders, etc.).	Eliminating a shipment near a specific location (most likely a highly populated or critical area) may inadvertently transfer the risk from one community to another.

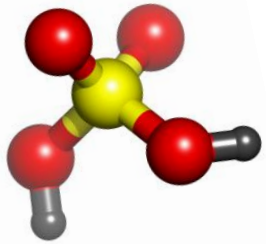
CCPS (2008). *Guidelines for Chemical Transportation Safety, Security, and Risk Management*



Balancing Transportation Security with Safety

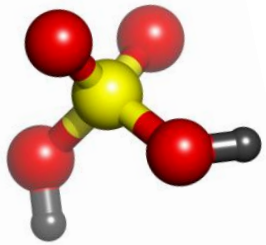
Issue	Safety	Security
Working with supply chain partners (implementing security countermeasures)	Technology can be used for both safety and security (e.g., GPS to indicate location en route, emergency response to accident, and monitoring time-sensitive chemicals/materials).	Technologies focused on security should not distract the main function of the carriers (e.g., the safe transport of chemicals from point A to B).
Risk Analysis Methods	• Rational and structured results lead to recommendations • Participation and engagement by individuals with different perspectives, roles, and backgrounds/skill sets for safety, security, and transportation • Similar methodology • Same decision metrics (guidelines)	

CCPS (2008). *Guidelines for Chemical Transportation Safety, Security, and Risk Management*



Summary

- Chemical Transportation
- Case Study Involving the Shipment of Lithium Batteries
- Chemical Transportation Risk Management - Safety
  - Resources to help manage risks
  - Identify, analyze and reduce risks
- Chemical Transportation Risk Management - Security
  - Resources and Regulations
  - Identify, analyze and reduce security risks

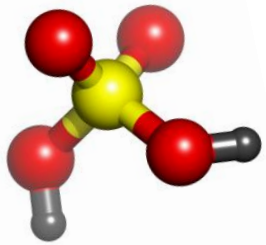


Transportation Risk Management

Evaluate

Example -

- A company ships a hazardous chemical from Factory A to Factory B.
- There are two different roads that connect Factory A and B.
- One road (Route 1) is in very poor condition and goes through a heavily populated part of City, but the distance to Factory B is shorter.
- The other road (Route 2) is in better condition, does not go through any populated areas, but the distance to Factory B is longer and takes more time.

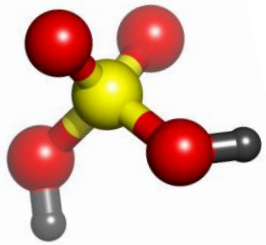


Transportation Risk Management

Evaluate

Example….

- A review of the transport logs shows that trucks traveling along Route 1 experience a breakdown or minor accident one time in about every 20 trips. However, no major chemical spill has resulted yet.
- The company has done a analysis and has concluded that 1 in every 50 accidents a truck will overturn and its hazardous cargo could spill.
- The company has decided that this is an unacceptable risk based on their evaluation criteria.



Transportation Risk Management

Reduction

Example….

The company has decided that Route 1 is an unacceptable risk to the local population and will begin using Route 2 even though the distance is longer and takes more time.