Flame Retardants - Fire Safety & Regulatory Status

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Why are Flame Retardants Needed?

- Flame retardants are used to help:
  - Prevent ignition
  - Delay the spread of fires
  - Delay the time of flashover to enable people time to escape

Extract from a Dutch TV documentary, RTL 5, 2000

It is estimated that escape times can be up to 15 times longer when flame retardants are present, providing increased chances of survival

"Fire-Hazard comparison of fire retarded and non fire retarded products," NIST 1988, http://fire.nist.gov/bfrlpubs/fire88/art003.html

Toronto, Canada, August 2, 2005: Flame retardants were credited with increasing escape times for all 309 passengers from this jet, which was ultimately completely consumed by fire.

Washington Post, Aug. 5, 2005

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Why are Flame Retardants Needed?

- Fire prevention is essential from a number of perspectives:
  - Protection of life
  - Protection of property and the environment
  - Prevention of immediate local pollution to air and water
  - Prevention of lesser-known long-term environmental effects

Results of a 2005 study of UK and International fire statistics, performed by Surrey University, has shown that since 1988 furniture fire safety regulations were introduced for commercial and residential furniture

- At least **230** lives have been saved per year
- Over **2,000** injuries have been prevented per year

(Surrey University 2005 study: full study plus Surrey University summary press release: available at www.cefic-efra.org)

The introduction of voluntary flammability standards made possible by the use of flame retardant plastics in the TV enclosures and accessories led to a significant reduction in the number of TV-initiated fires, even with a sharp increase in the total number of TV sets per household. It is estimated that **190 lives are saved annually** through the use of brominated flame retardants in TV enclosures.

F. Clarke, "The life safety benefits of brominated flame retardants in the United States," Final Report to the Chemical Manufacturers Association Brominated Flame Retardant Industry Panel, Benjamin/Clarke Associates, 1997

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Why are Flame Retardants Needed?

- The National Institute of Standards and Technology (NIST) published the results of a recent historical survey of multi-story building collapses due to fire
  - The report concluded that fires represent a hazard to all building types, materials, and occupancies
  - It was noted that the fire-fighting difficulty in all taller buildings must be recognized
  - Longer times are needed to escape or access the higher floors of tall buildings
  - Strengthen model safety fire codes and strict adherence to prevent tragedies similar to The Station nightclub fire in Rhode Island

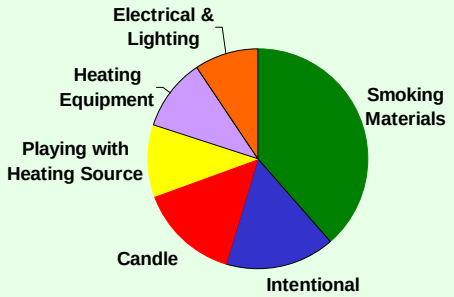
Beitel, J and N Iwankiw, 2005."Historical Survey of Multistory Building Collapses," Fire Protection Engineering, Summer 2005, Issue No. 27

Fires in which upholstered furniture was the first item ignited in 2002-2005

- 7,630 average home fires per year
- 600 average civilian fire deaths per year
- 920 average civilian fire injuries per year

- On average, **one of every 13 upholstered furniture fires resulted in death**
- On average, **294 civilian fire deaths per year not caused by smoking material**

Major Causes of Upholstered Furniture Fires



Home Fires That Began With Upholstered Furniture, Marty Ahrens, NFPA, May 2008

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US Fire Loss in 2008

- 1,451,500 fires reported in the US during 2008 (🡻 6.8%)
  - $15.5 Billion in property loss

Every **22 seconds** a fire department responded to a fire.

One structure fire was reported every **61 seconds**.

- 515,000 fires occurred in structures
- 414,000 of these fires (78%) occurred in residential properties

One home structure fire was reported every **82 seconds**.

- **3,320 civilian fire deaths** – 83% occurred in the home
- **103 firefighter deaths**
- 16,705 civilian fire injuries

One civilian fire death occurred every **2 hours and 38 minutes.**

- 236,000 vehicle fires occurred – 365 civilian deaths

Source: *Fire Loss in the United States During 2008* by Michael J. Karter, Jr., NFPA, Quincy, MA
Firefighter Fatalities in the United States – 2008, by Rita F. Fahy, Paul R. LeBlanc and Joseph L. Molis, NFPA, Quincy, MA

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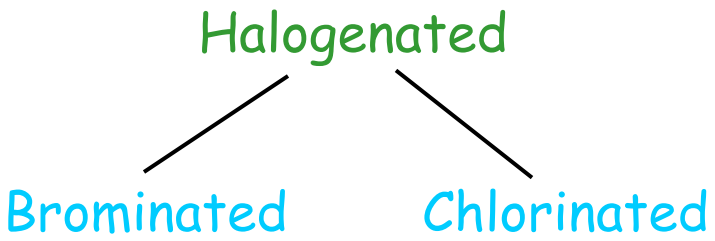
Common Flame Retardant Classes



Mineral

Others…

Phosphorus

- There are many different flame retardants in each of these classes
- Each individual flame retardant has it's own unique set of environmental, human health, physical, and chemical properties
- The distinct nature of individual flame retardants requires that each be treated on it's own merits

European Union (EU) Risk Assessment

- The EU Regulation 793/93 - EU Risk Assessment was one such assessment process adopted in 1993
  - The most comprehensive assessment of a materials environmental and human health characteristics
  - Products were assessed individually, not as a class
  - Determined the need for further testing to fill in data gaps
  - Determined if there was a need to limit risks
  - This process:
    - Examined mammalian toxicology
      - Acute, chronic
      - Established acceptable human exposure limits: Predicted No-Effect Conc. (PNEC)
    - Examined environmental fate and toxicology
      - Established acceptable environmental exposure limits: PNEC
    - Examined all releases to water, soil, air, from all operations throughout lifecycle
      - Volumes, processing, uses, waste streams
      - Established human and environmental exposures: Predicted Environmental Concentrations (PEC)
    - Evaluated risk: Exposures versus limits
      - Determined if exposure is above or below established limits

The Risk Assessment paradigm

http://ecb.jrc.ec.europa.eu/risk-assessment/

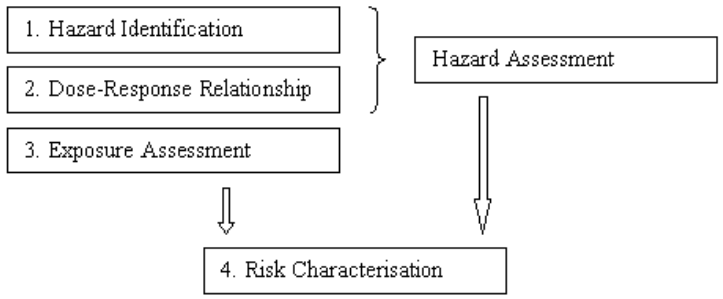
3. The Risk Assessment paradigm

The purpose of a risk assessment is to determine the risk posed by a chemical or a chemical product. The assessment of the risks of a chemical as such or in a product, consists of four steps:

1. hazard identification
2. dose-response assessment
3. exposure assessment
4. risk characterisation

The interrelationship of the four steps are shown in Figure 1.

Figure 1



Hazard Identification
Indication of the adverse effect which a chemical has an inherent capacity to cause.

Dose-response Assessment
Estimation of the relationship between dose, or level of exposure to the substance, and the incidence and severity of an effect, where appropriate.

Exposure Assessment
Estimation of the concentration/dose to which human populations (e.g., workers, consumers and man exposed indirectly through the environment) or environmental compartments (e.g., aquatic env ironment, terrestrial environment, atmosphere) are or may be exposed. This estimation entails the determination of the sources, emission routes and degradation pathways of the chemical.

Risk Characterisation
The estimation of the incidence and severity of the effects likely to occur in a human population or environmental compartment due to actual or predicted exposure to a chemical, and may incl ude "risk estimation", i.e., the quantification of that likelihood.

Restriction of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)

- Directive 2002/95/EC - came into force July 1, 2006
  - Restricts the placing on the EU market new electrical and electronic equipment containing certain levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB), and polybrominated diphenyl ether (PBDE) flame retardants
  - On Dec 3, 2008, the European Commission issued a proposal to revise the RoHS Directive
    - The Commission's proposal (expected to enter into force the end of 2011) does not add any new substances to the RoHS restrictions list
    - It does link the future assessment of substances under RoHS to the principles behind REACH, the EU's chemicals policy
    - European Parliament and the Council will address this during their consideration of the Commission proposal in 2009-2010
    - Not sure what, if anything, will be added

Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH)

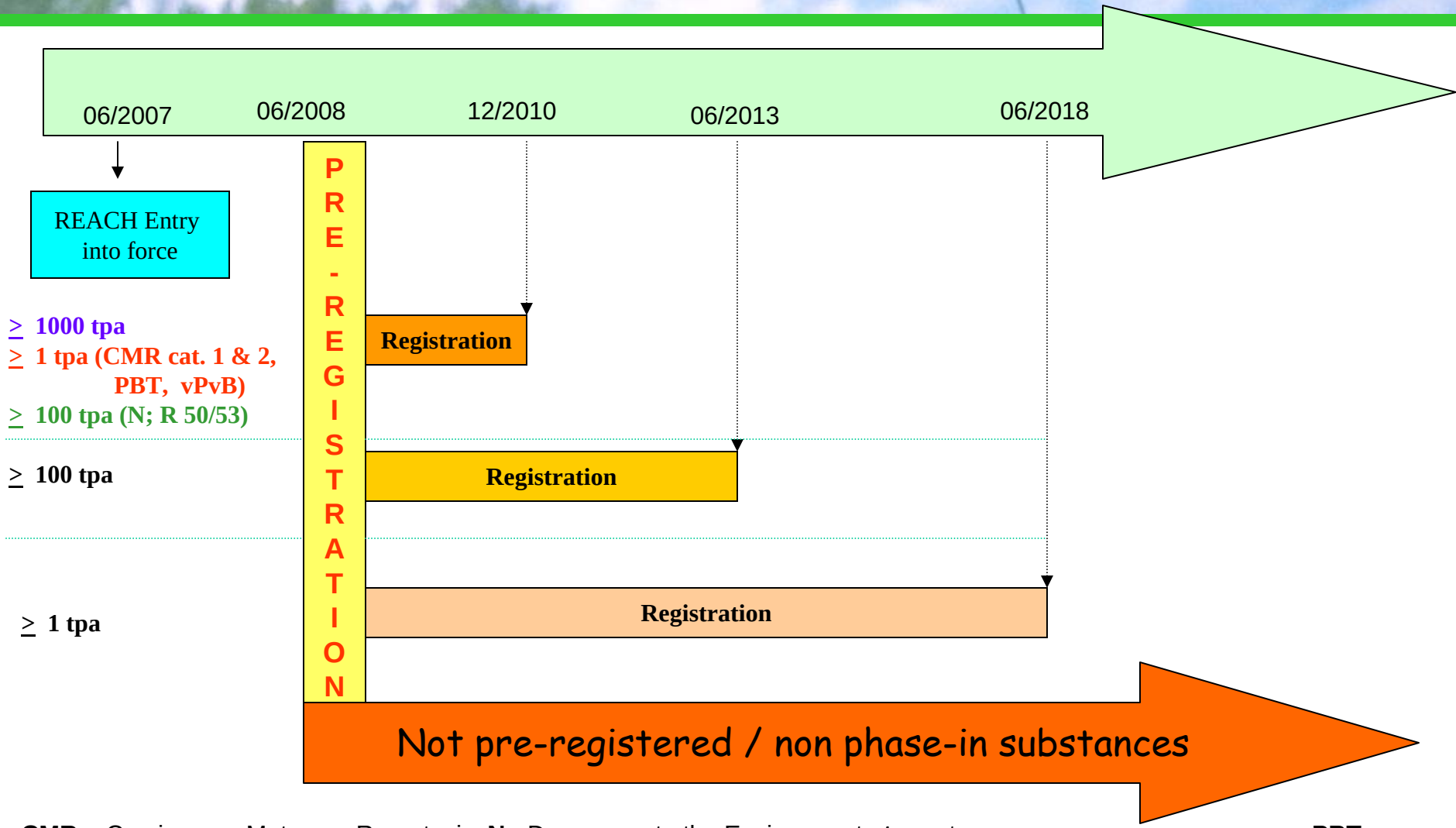
- REACH is a new European Community Regulation on chemicals and their safe use (EC 1907/2006) - entered into force on 1 June 2007
  - Registration, Evaluation, Authorization and Restriction of Chemical substances
- All manufacturers and importers of chemicals in the EU must identify and manage risks linked to the substances they manufacture and market
- REACH replaces about 40 pieces of legislation (including the EU Risk Assessment process) with a streamlined and improved Regulation
- Industry must bear most responsibilities to manage the risks posed by chemicals and provide appropriate safety information to their users
- REACH calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified

Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH)

- **Registration** - Requires
  - Data generation on substances
  - Assessment of risks
  - Recommendation for risk management measures
  - A technical dossier and a chemical safety report when volume > 10 tonnes per year
- **Evaluation** – Provides
  - Opportunity for checks on registrations
  - Mechanism for Member States to ensure that a substance is evaluated if there are grounds for considering a substance constitutes a risk
- **Authorization** – Allows
  - Good functioning of the internal market
  - While assuring that the risks from substances of very high concern are properly controlled
- **Restriction** - Allows
  - Substances presenting risk to be placed on market subject to restrictions

Pre-registration completed

REACH – Registration timelines



CMR = Carcinogen, Mutagen, Reprotoxic, **N** - Dangerous to the Environment , **tpa** = tonnes per annum per company, **PBT** = Persistent, Bioaccumulative, and Toxic, **R 50/53** = Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment, **vPvB** = very Persistent and very Bioaccumulative

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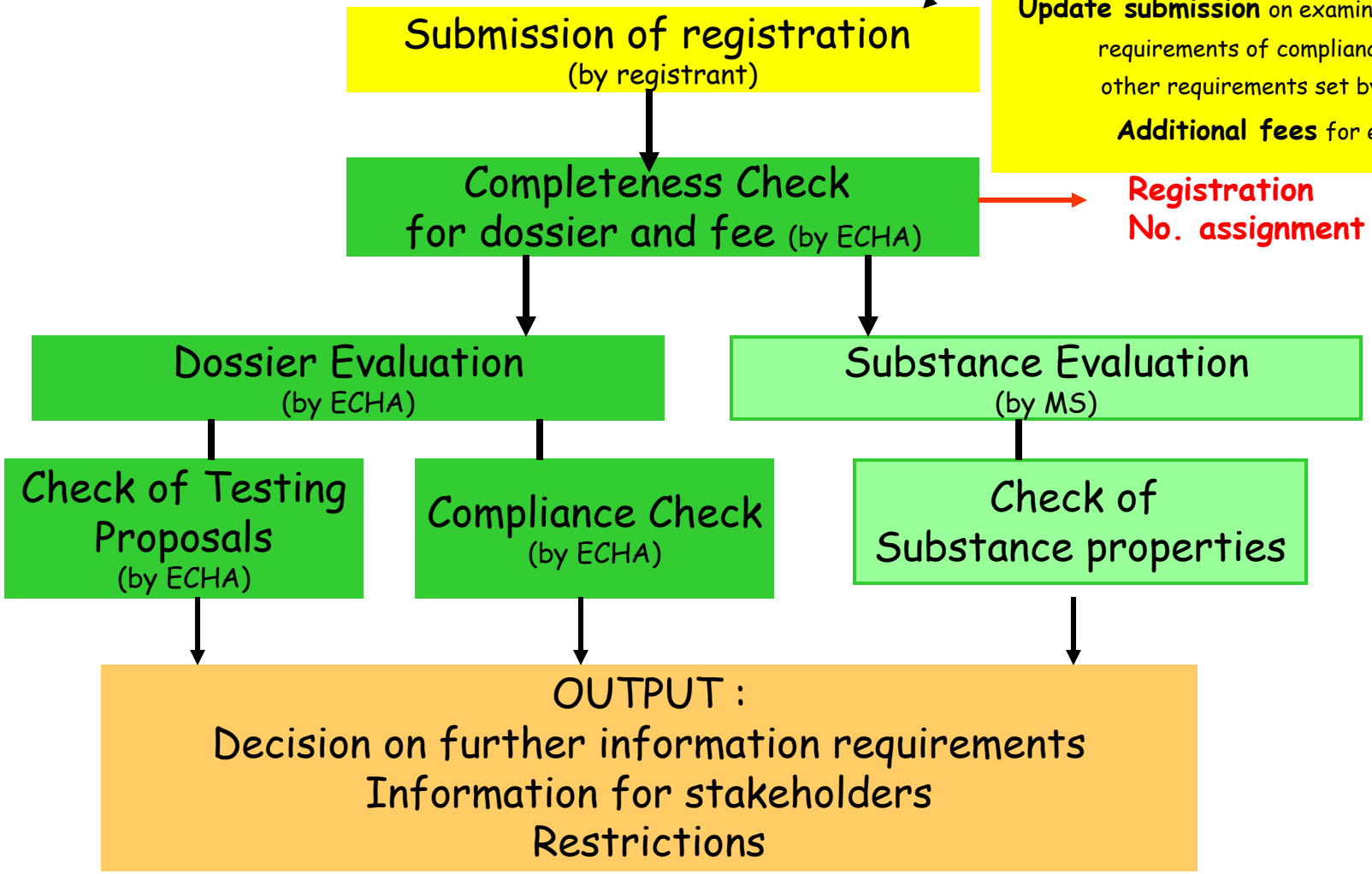
REACH – Evaluation

Duties of registrants :

Update with undue delay and with relevant new information (uses, hazard information, tonnage band)

Update submission on examined testing proposals, requirements of compliance checks and other requirements set by Authorities

Additional fees for each update



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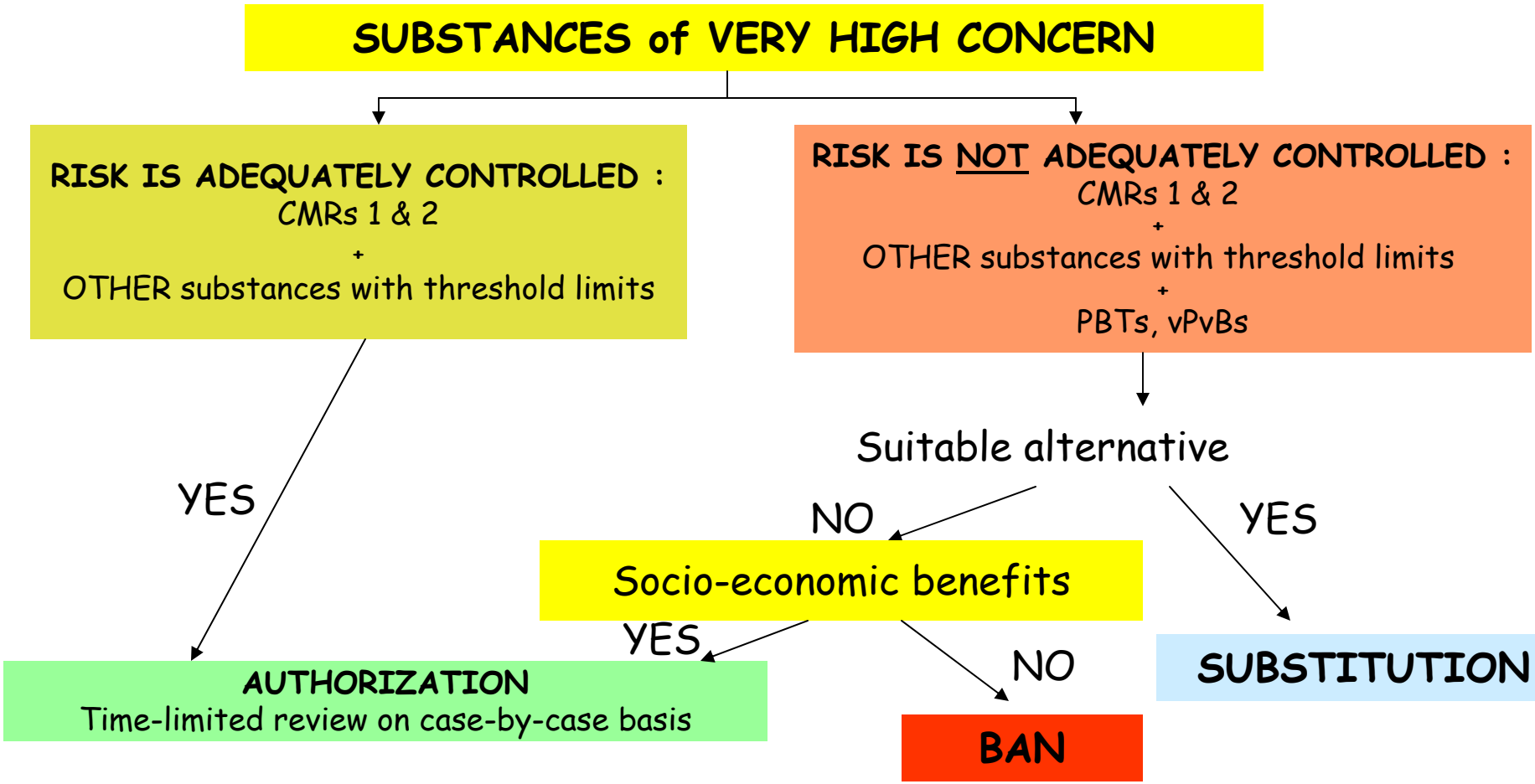
REACH – Authorization

- Substances targeted by authorization are Substances of Very High Concern (SVHCs):
  - CMR (Carcinogen, Mutagen, Reprotoxic) cat. 1 and 2
  - PBT (Persistent, Bioaccumulative, and Toxic)
  - vPvB (very Persistent and very Bioaccumulative)
  - Substances with equivalent concern (e.g. endocrine disruptors)
  - There are reporting, notification, and information obligations for suppliers of SVHC substances, and preparations and articles containing them
- The Authorization process comprises three stages:
  - **Identification** of SVHC (Candidate list) - This triggers notification and communication obligations for candidate list in articles, with possible *black list* effects
  - **Inclusion** of candidate substances in the list of substances subject to authorization (Annnex XIV)
  - **Decisions** on applications for authorization

REACH – Authorization

Potential Options for Authorization



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US Activity – Current Regulations

- The Toxic Substances Control Act (TSCA)
  - TSCA came into effect in the late 1970's - a major objective is to characterize and evaluate the risks posed by a chemical to humans and the environment before the chemical is introduced into commerce
  - EPA secures information, has authority to control (ban or place other restrictions) any of the substances that were determined to cause unreasonable risk to public health or the environment
    - Test Rules for existing chemicals
    - Premanufacturing Notices for new chemicals
- State-by-state regulations
  - Specific regulations on a limited number of flame retardants in individual states
- National Research Council
  - Performed quantitative risk assessment on 16 flame retardants (2000)

US Activity – Current Regulations

- US Consumer Product Safety Commission (CPSC)
  - Performed quantitative risk assessments on various flame retardants for both upholstered residential furniture fabrics and foam (2006)
  - Performed a preliminary assessment of the potential health risks associated with the use of selected FR chemicals in upholstered furniture foam (2006)
- EPA
  - "Polybrominated Diphenyl Ethers (PBDEs) Project Plan"
    - Reports issued in 2006 and 2008
  - High Production Volume (HPV) Challenge
    - Industry volunteered to provide health and environmental effects data publicly available on chemicals produced or imported in the United States in the greatest quantities (~2200 HPV chemicals)
  - Design for Environment (DfE) program
    - Partnership with a broad range of stakeholders to better understand the environmental, health, and safety aspects of materials
    - Furniture Flame Retardancy Partnership (low-density polyurethane foam)
    - Wire and Cable Partnership
    - Flame Retardants in Printed Circuit Boards Partnership – in progress

US Activity – Evolving Regulations

- California Green Chemistry Initiative
  - Signed into law Oct 2008 (AB 1879 and SB 509)
  - Final report of recommendations released http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/index.cfm
  - Encourage the development of “green chemistry” solutions to environmental and human health issues arising from currently used chemicals - involvement of wide group of stakeholders
- Potential TSCA Reform
  - Criticisms include
    - Lack of publicly available data on existing chemicals
    - Slow, cumbersome process for review


Wednesday, September 23, 2009

ECOS Annual Meeting

EPA Eyes Chemical Bans In Bid To Strengthen TSCA Program

WHITEFISH, MT -- EPA toxics chief Steve Owens says the agency is considering banning chemicals and other toxic substances as part of a broad agenda to ramp up enforcement of its existing authority under the Toxic Substances Control Act (TSCA), even as the administration works with Congress to strengthen the underlying law.

Canada

- Implementation of Chemical Substances Plan
  - 23,000 chemicals categorized in 2006 and evaluated in a screening risk assessment
  - Polybrominated diphenyl ethers (PBDEs) have undergone screening risk assessment
    - They are classified as CEPA toxic
      - Penta-BDE and Octa-BDE slated for “virtual elimination”
      - Deca-BDE will be managed under an “Environmental Performance Agreement (EPA)” - out for public review, and is currently based on an emissions control program, (VECAP™)
      - “State of the Science Report on the Bioaccumulation and Transformation of Decabromodiphenyl Ether” issued by Environment Canada in March 2009
        - » *“…available data do not show that this substance meets Bioaccumulation criteria as defined under the Persistence and Bioaccumulation Regulations under CEPA (1999).”*
      - Canadian government is proposing a partial prohibition of Deca-BDE in electronics goods
    - Screening risk assessments for TBBPA and HBCD should be complete in 2009

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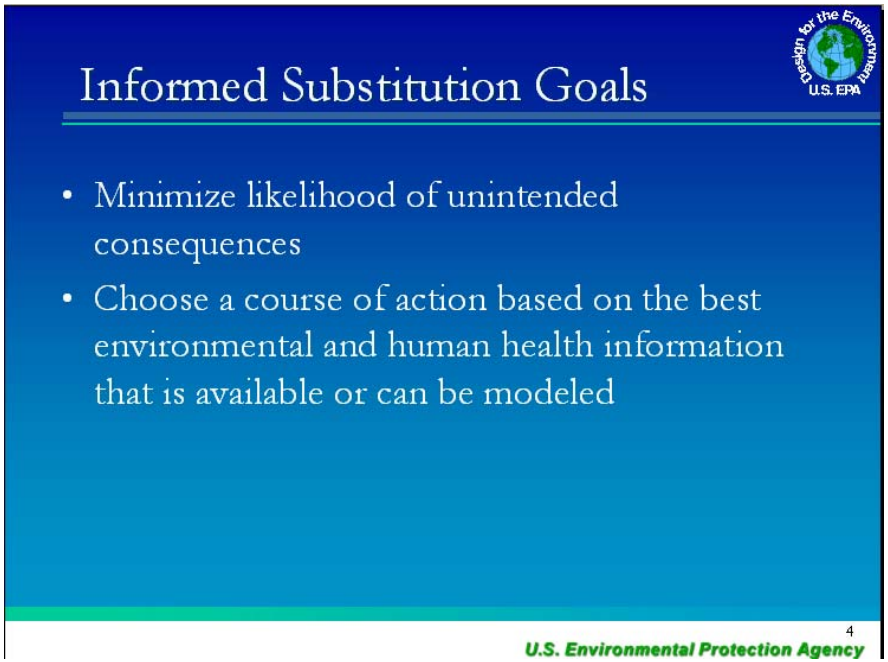
Informed Substitution



- Programs in Progress - Flame Retardant Assessment for Electronic Equipment
  - US EPA Design for Environment (DfE) Electronics Partnership, “Flame Retardants in Printed Circuit Board”
  - International Electronics Manufacturing Initiative (iNEMI)
  - High Density Packaging Users Group (HDPUG)

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Fire Fighter Exposure

Firefighters have extremely dangerous jobs

- Typically items involved in fires are a complex mixture of materials
- Regardless of whether or not flame retardants are involved
  - Some of the combustion gases generated during fires that contribute to acute toxicity are CO, HCN, HCl, and acrolein [1]
  - Polycyclic Aromatic Hydrocarbons (PAHs) and polyhalogenated dibenzodioxins and furans (PHDDs/PHDFs) are pollutants generated in fires [1]

Fire Fighter Exposure continued…

- Combustion Gases
  - "Clearly, fire gases are dangerous to fire fighters and other citizens who could be exposed, independent of the presence or absence of flame retardants [2] "
  - "Combustion gases contain very high concentrations of acutely toxic substances [3] "
  - The acute toxicity of fire gases is controlled by carbon monoxide (CO) – responsible for over 90% of fire deaths [1]
  - Polycyclic Aromatic Hydrocarbons (PAHs) and polyhalogenated dibenzodioxins and furans (PHDDs/PHDFs) are the most important pollutants generated in fires [1]
    - Using the "Unit-Risk model, compared to PAHs, the impact of PHDDs/PHDFs on our health is negligible [1]
    - In the Lengerich fire (Germany in 1992), measurements and their respective cancer risk and relationship showed that the PAHs have an up to 500 times higher cancer risk than the PHDDs/PHDFs [1]

Fire Fighter Exposure continued…

- PAHs are generated in all fires [1]
  - There are several hundred different substances in the PAH family [1]
  - Many PAHs generated in fires are carcinogenic compounds, including benzo[a]pyrene (BaP) [1]
  - PAHs are found in high amounts in the soot after fires [1]
- It is clear that fire fighters should employ full protective gear on the scene of a fire independent of the presence or absence of flame retardants in the products involved in the fire

- Clean up After Fires
  - Faithful use of full protective gear will provide adequate protection to fire fighters due to inhalation of fire gases and dermal exposure to soot containing numerous fire products adsorbed onto the surface of soot [2]

1) Troitzsch, J, “Fire Gas Toxicity and Pollutants in Fires – The Role of Flame Retardants,” FR2000 Conference, London, 8th-9th February 2000
2) “Review of Fire Emissions from Products with and without BFRs and the Hazard of Exposure for Fire Fighters and Clean-up Crews”, SP Report 2007:74
3) Rechenbach, P, Troitzsch, J, “Smoke Toxicity and Pollutants from Fires”, Kunststoffe 89 (1999) 9, pp. 132-134

Conclusions

- Flame Retardants provide a valuable role in our society
  - Prevent ignition
  - Delay the spread of fires
  - Delay the time of flashover to enable people time to escape
- It is important that Flame Retardants are safe in use
- Regulations that are being developed worldwide provide the platform to achieve this goal with a level of confidence

For More Information…

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