REMEDIATION AND SECURING ACTIVITIES
AT A FORMER HCH AND 2,4,5-T PRODUCTION SITE IN GERMANY

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Lindane production had/has a waste management problem since approximately 85% waste isomers are formed and need to be managed. It was common practice to separate the active gamma-isomer and then to dump the remaining approx 90% waste isomers, consisting mainly of alpha-HCH and some beta/delta/epsilon-HCH.
Management of HCH Waste Isomers
HCH/2,4,5-T Production Hamburg

HCH production Hamburg (1950th)

The factory commenced Lindane production in 1951 and stored the waste isomers on site for the first three years.
The factory invented the recycling of HCH waste isomers (1954).
Production Scheme of the HCH/2,4,5-T Factory

Benzene + Chlorine

Raw HCH

Waste HCH (85%)

TriCBz, TetraCBz

Lindane (approx. 15%)

Decomposer residue
PCDD/PCDF in %!

2,4,5-TCP
2378-TCDD

2,4,5-T

2,5-DCI-4-Br-Phenol

Bromophos

Residues
PCDD; PXDD/F
The PCDD/PCDF level in residues of the HCH decomposer finally resulted in the closure of the pesticide factory.

Weber et al 2006: 274 ppm TEQ; 2.8% PCDD/F
Jürgens et al 1989: 86 ppm TEQ; 1.4% total

0.1% of TEQ
Remediation/Securing of the Factory

- Exploration, remediation and containment activities at the production site started in 1984 and were conducted until 1998.

- Additionally, landfill sites where waste from the production are stored were investigated and were (partly) secured.

- The main contamination load was found as deposits in the landfills where production wastes (including at least 380 kg TEQ PCDD/PCDF) were stored from more than three decades operation.

- The deposition sites are not addressed in this presentation but were/are the major contamination.
Contamination of soil below the former HCH and 2,4,5-T production site in Hamburg

Groundwater contamination!

Below production: HCHs 262 t; PCBz 551 t; PxCP 18 t; PCDD/F TEQ (6 kg)
The contamination on the production area was not the result of specific deposition activities but mainly stem from the spillage of daily routine operation (spills from the production processes, leaks from transportation pipes, storage, loading and de-loading of the chemicals and interim storage of HCH waste isomers).

This could be concluded from the correlation of contaminants in the soil and the respective locations of the productions.

⇒ Relevant for all pesticide productions!
At the start of the remediation planning (1984) and within the first phase (until 1994) the aim was a thorough clean-up of 25,000 m³ highly contaminated soil by excavation and onsite incineration covering also estimated 10,000 m³ of highly contaminated building materials.

Further an in-situ bioremediation was planned to degrade and remove target contaminants in the contaminated ground water and deeper soil layers. For this approach groundwater was pumped, cleaned over activated carbon and pumped back to the ground water enhanced with oxygen and nutrients to increase the biodegradation of contaminants by microorganisms (already present in the groundwater).

However onsite incineration failed (corrosion & technical); bioremediation did not show expected effect & was stopped
1) Dichtwand  
2) Spundwand  
3) Auffüllung  
4) Oberflächenabdeckung  
5) Phase-Brunnen  
6) Brunnen zur Absenkung des Grundwassers  
7) Brunnen zur Reinigung des Umfeldes  
8) Wasseraufbereitungsanlage  
9) verbleibende Gebäude
Sixty-four buildings and chemical facilities on the production site needed to be removed for redevelopment of the area. (total building volume of 130,000 m³ with a weight of 27,000 t).

The contaminants in buildings included PCDD/PCDF (from 2,4,5-T synthesis and HCH recycling), HCH, PCBz, chlorophenol etc.

Several buildings were contaminated by PCBs used in paints, sealants and epoxide flooring.

Additionally many buildings were contaminated with high load of asbestos.
A graded remediation strategy was developed for individual buildings depending on the degree of contamination largely depending on the PCDD/PCDF, HCH, EOX, PCB & asbestos content.

The buildings were thoroughly screened for contaminated areas and pre-treated with a range of decontamination techniques before demolition.

The majority could then be demolished by conventional break down techniques.
Highly contaminated production building (old 2,4,5-T production) was demolished under a full protection housing.
Remediation of Buildings - Highly Contaminated Productions

- Bromophos production
- 2,4,5-TriCP production
- HCH Decomposer
Alternatively were only enclosed at the sides with an open top and break down operation were performed under a fine water spray film (e.g. HCH production, HCH decomposition, Lindane production). This approach was found to be a very efficient method for the demolition of contaminated building. Construction residues went to incineration.
Monitoring during demolishing of buildings:

Air monitoring was used for screening of possible emissions to assure the appropriateness of this approach.

In two cases levels of ambient air were around 5 pg TEQ/Nm3 limit. Source was cutting operations of PCB painted steel bars!
Buildings with high contamination levels in only some specific areas were screened and selectively decontaminated with graded protection levels for personnel.

„New“ 2,4,5-T production
Remediation of Buildings - Partly High Contaminated Productions

Conventional demolishing after decontamination

„New“ 2,4,5-T production
Plaster were removed by high pressure water (2000 bar)

The disposal pathway depended largely on the PCDD/PCDF, PCB, EOX and asbestos content.

Parameter for removal:
EOX > 100 mg/kg
PCDD/F >1000 ngTEQ/kg

High PCDD/PCDF load on plaster of e.g.
• 2,4,5-T production (156,000 ngTEQ/kg)
• HCH decomposition (382,000 ngTEQ/kg)
Buildings with only surface contamination were demolished after removal of contaminated materials (e.g. plaster, PCB in epoxide flooring & paints), mainly using removal with high pressure water and waste water catchment and cleaning.
The cost for demolition of the 64 buildings was approximately 9.5 Million Euro. Additionally, the deposition and incineration/destruction expenses of contaminated parts were 4.8 Million Euro.

The cost for the analytical screenings during demolition were 1.2 Million Euro including 1548 EOX screenings, 224 PCDD/F analysis, 83 PCB, PCBz, HCH, PxCPh analysis and some other measurements. Key: detailed screening for selective removal and minimization of areas requiring specific treatments.

The total cost of remediation and securing activities of only the production site were approximately 110 million Euro.
In 2008, the 10 years guarantee for the securing wall ended. In a public hearing in May 2009, it was communicated that the wall is still fully operational.

The “pump and treat” activities are ongoing and to our knowledge no specific time limit is set. From the estimated 830 t of chlorinated organics in the underground 10 to 30 tons have been pumped and destroyed over the last ~15 years. Therefore the largest share of contamination is still in the subsoil.
Contamination levels of the plume in ground water outside the contained area has decreased over the years, demonstrating effective containment up to now.

Some of landfills are monitored.

For how long these pump and treat and monitoring activities need to be continued??.

When will the securing wall need to be renewed?
A key experience from the pesticide factory in Hamburg is that production residues deposited in the landfills and on-site spillages on the production area posed the highest contamination and required the greatest efforts/cost for evaluation, remediation and securing.

The demolition of the contaminated buildings were necessary for the redevelopment of the area but posed a relatively minor threat to humans & environment (but a risk for demolition staff) and could be managed with specific techniques developed for this scheme at reasonable cost.
The case revealed that during the routine operations at a pesticide factory (e.g. production, storage, transport) a considerable amount of chlorinated organics was spilled into the soil of the production area and that these contaminants including the normally low mobile PCDD/PCDF can migrate through the soil down to a depth of nearly 50 meter.

Since these contaminations resulted largely from routine operation relevant contamination can be expected at other production sites of chlorinated pesticides/organics and investigations are necessary.

The experiences gained in Hamburg can be valuable for other pesticide/organohalogen production sites.
Thank you for your attention!

(dirty dozen)

- PCDD
- PCDF
- PCBs
- Aldrin
- Chlordane
- DDT
- Dieldrin
- Endrin
- HCBs
- Heptachlor
- Toxaphene
- Mirex
- Endrin
- PFOS, PFOA, PFHxS
- PBDE, PBB, HBCD, PBDD/F
- HBBz PBP
- TBBPA, TBPME
- SCCP, MCCP, LCCP
- PeCB, PCN, HCHs, Chlordecone
- Endosulfan
- PAHs, Nitro-PAH
- Halogenated PAHs Sn-Organics
- Hg, Cd, Pb et al.
- Biocides
- Pesticides Pharmaceuticals

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