PATRAM 2010

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TRANSPORT OF UF6 AND THE FUTURE OF THERMAL COMPLIANCE

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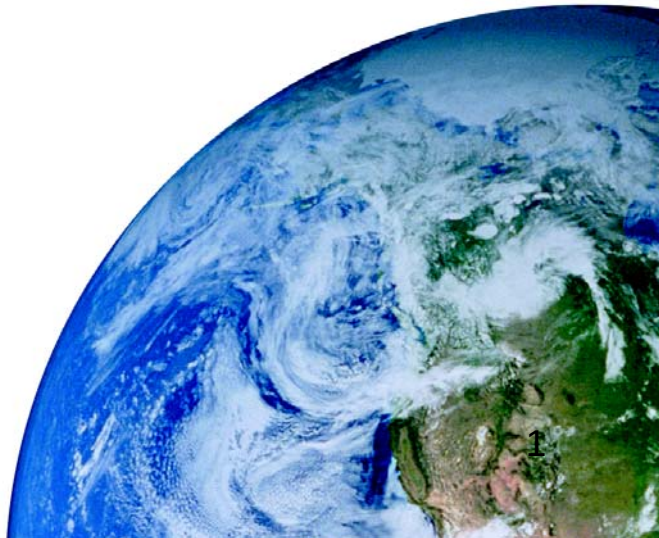

INTRODUCTION

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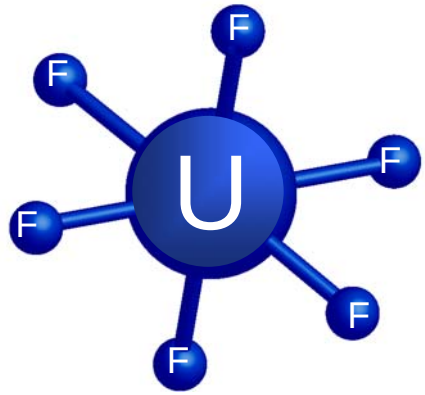
- **Uranium Hexafluoride (UF6)** **<non-fissile/fissile excepted>**
  - LSA-1 (LSA-2 reprocessed)
  - Specifically regulated, UN Model Regulations:
    - Radioactive
    - Subsidiary risk: corrosive
  - High transport volume
    - From converter to enrichment plants
    - From enrichment plants to deconverters
  - Excellent safety record
  - Natural and depleted mainly shipped in 48Y cylinders
  - Transport with Thermal Protectors since 2005



UF6 CYLINDER STANDARDS AND REGULATORY REQUIREMENTS

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- **Cylinder Standards:**
  - ANSI N14.1, US national standard
  - ISO7195, international alternative
  - Standards can be considered as equivalent for transport
- **Regulatory requirements:**
  - Approval for packages containing more than 0.1kg UF6
  - Test requirements:
    - Structural test, pressure test required by standards ✓
    - Free drop test, VPA and new design for plug ✓
    - Thermal test, no agreement on the demonstration of bare 48Y cylinders, CRP with no consensus ?

DEVELOPMENT OF THERMAL PROTECTORS BY INDUSTRY

WNTI

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- **TS-R-1 allows for two transport options:**
  - Under H(U) approval, demonstration of survival of fire test
  - Under H(M) approval, for large cylinders only
- **H(M) no longer an option in Europe since early 2005**
- **Industry needed to develop technical solutions**
  - Composite Thermal Protector (CTP)
  - Blanket Thermal Protector (BTP)
  - Effect: halve the heat input, double the survival time
- **Calculated survival time for bare cylinder in CRP was 25-35 min (30 min required)**
- **Resulting survival time with BTP/CTP: 50-70 min**

HANDLING & LOGISTICS (1)

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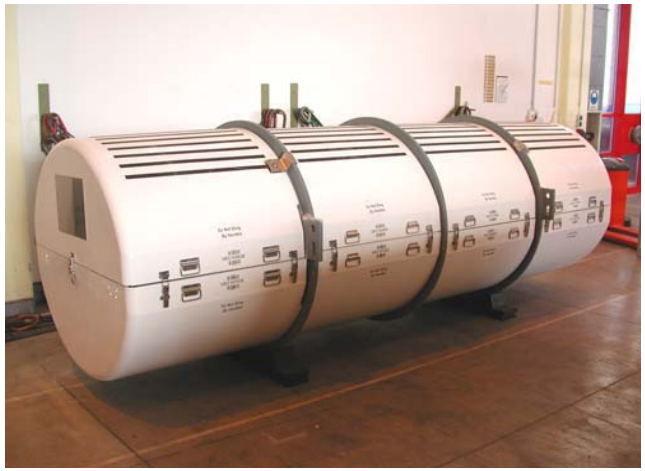
bare 48Y
UF6 cylinder



48Y cylinder with CTP

48Y cylinder with BTP

HANDLING & LOGISTICS (2)

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- **New handling procedures for safe and efficient assembly**
  - Manually
  - By mechanical means

- **Logistic system for registration and tracking**
- **Storage and transport concepts (on and off-site)**

HANDLING & LOGISTICS (3)

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- **Marking/Labelling**

- **Repair/Maintenance**
- **Different approaches by Competent Authorities has created challenges:**
  - Assembly /disassembly during transport
  - Transport of TP segments

BTP vs. CTP COMPARISON

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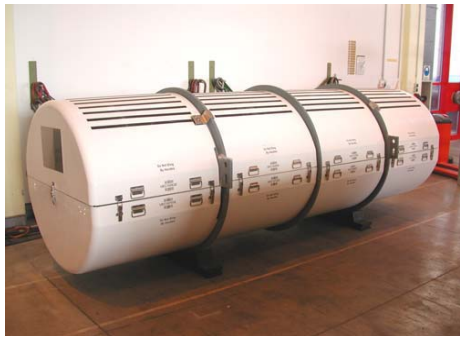
- **Both BTP and CTP are usable solutions**
- **Typical differences:**



» Withstand external forces better
» Weigh more
» Handling of segments need support

» Weigh less
» Can be folded to reduce volume
» Susceptible to damage
» Water absorption into insulation possible if damaged
» Freezing of wet insulation makes handling difficult

RISK CONSIDERATIONS

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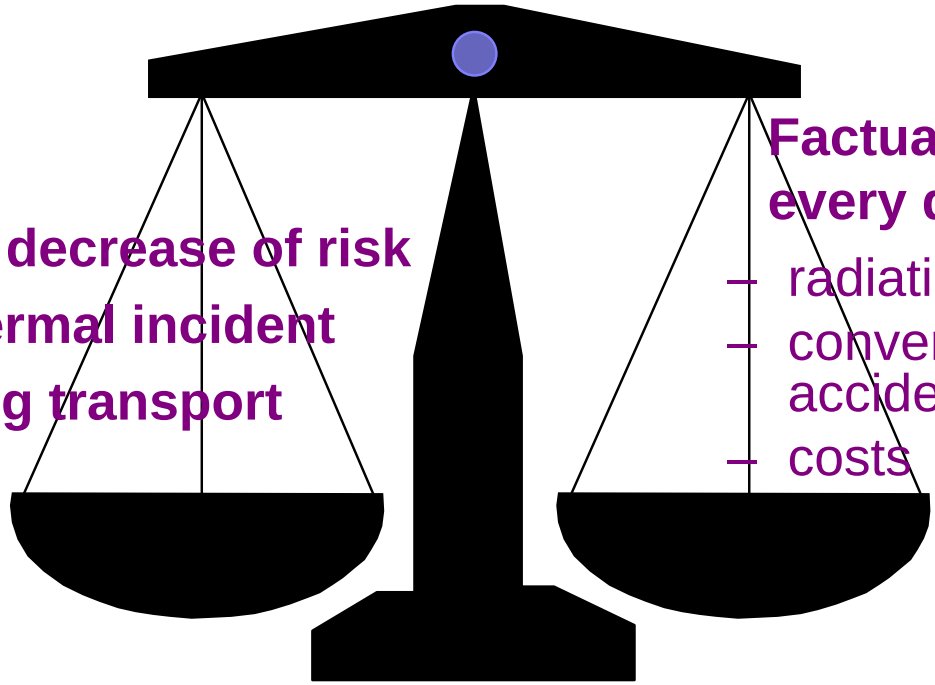
Use of TPs:



Statistical decrease of risk of a thermal incident during transport

Factual Increase in every day operations:

- radiation exposure
- conventional accident risk
- costs

Is the balance right?

FUTURE OF THERMAL COMPLIANCE FOR 48-INCH CYLINDERS (1)

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- **Does the bare cylinder survive the fire test?**
  - CRP, no consensus. Calculated range from 25-35 min.
  - Different expert analysis showed survival beyond 30 min.
- **Thermal requirement for UF6 was introduced in the 1996 Edition of TS-R-1**
  - Although CSM advised not to include the thermal requirement, but to continue the CRP work first.
- **Today, transport to and from Europe is only possible with a H(U) certificate**
  - Currently H(U) requires thermal protection
- Transport in North America is done with a H(M) certificate
  - No thermal protection required

FUTURE OF THERMAL COMPLIANCE FOR 48-INCH CYLINDERS (2)

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- **Industry sees a need for further study in this area**
- **Initiative has been started to resume the investigation of the thermal behaviour**
  - Goal:
    - learn more about thermal behaviour of UF6
    - optimization of the use TPs
  - Early and frequent contact with regulators to enable a common understanding of parameters
  - Enhanced computer modelling capabilities (Sandia) are expected to deliver new and more precise results

FUTURE OF THERMAL COMPLIANCE FOR 48-INCH CYLINDERS (3)

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- **New project requires large fundings and a new industry consortium is being formed**
- **Optimisation of current TPs by new computer model capabilities**
  - only outer sections of TPs?
  - only middle sections of TPs?
  - bare cylinder?

CONCLUSIONS

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- Thermal Protectors of type BTP and CTP are predominantly used for worldwide UF6 shipments since 2005
- Successful cooperation within industry ensured continued transport through TP development and use
- A new industry initiative is planning to revise the 15 years old scientific work and to reach a broadly accepted understanding of the UF6 behaviour under TS-R-1 fire conditions
- Frequent communication with regulators will be established to optimise the understanding and acceptance of the outcome
- The project is expected to deliver a realistic and warranted solution for the safe, efficient and reliable transport of UF6