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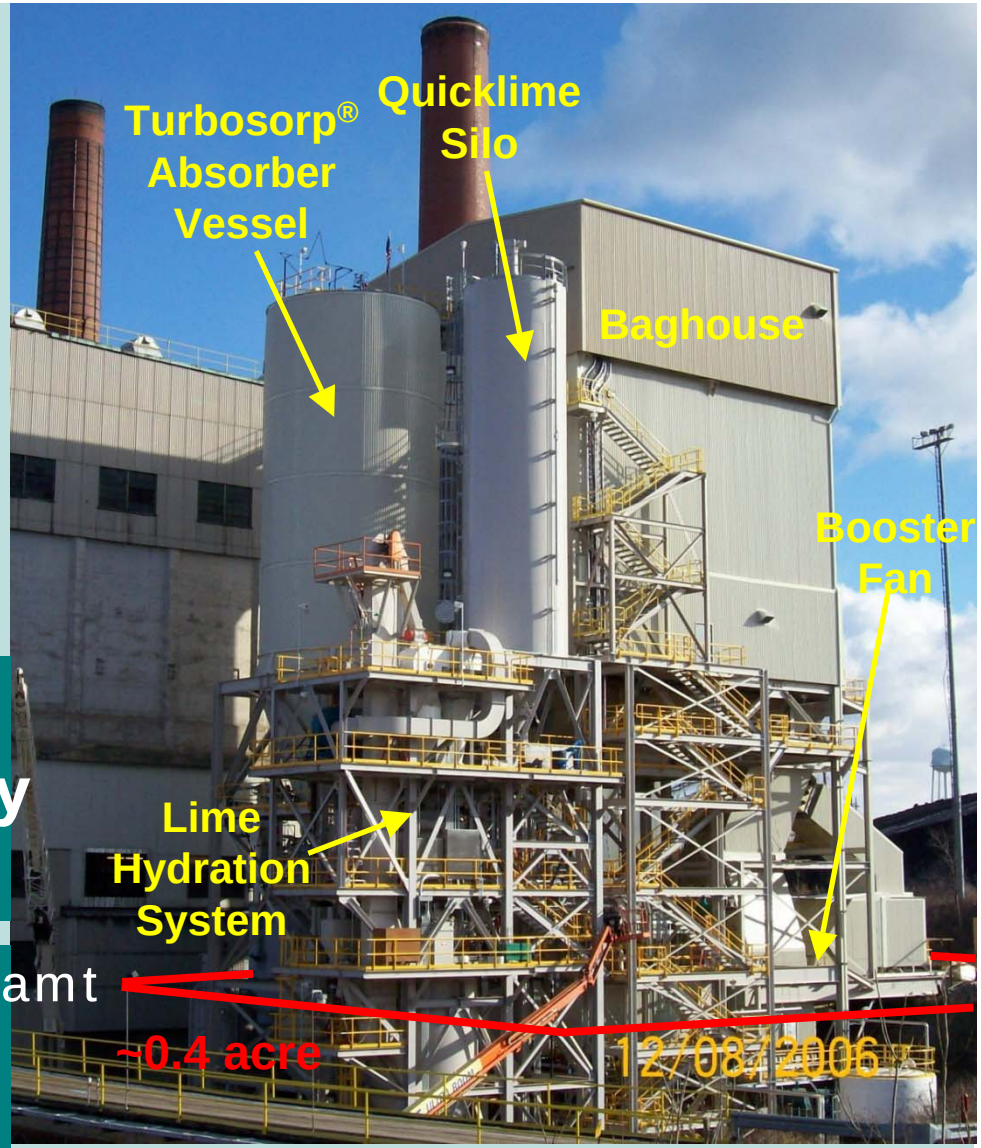

Verification of the Turbosorp© Technology Use of Existing Data

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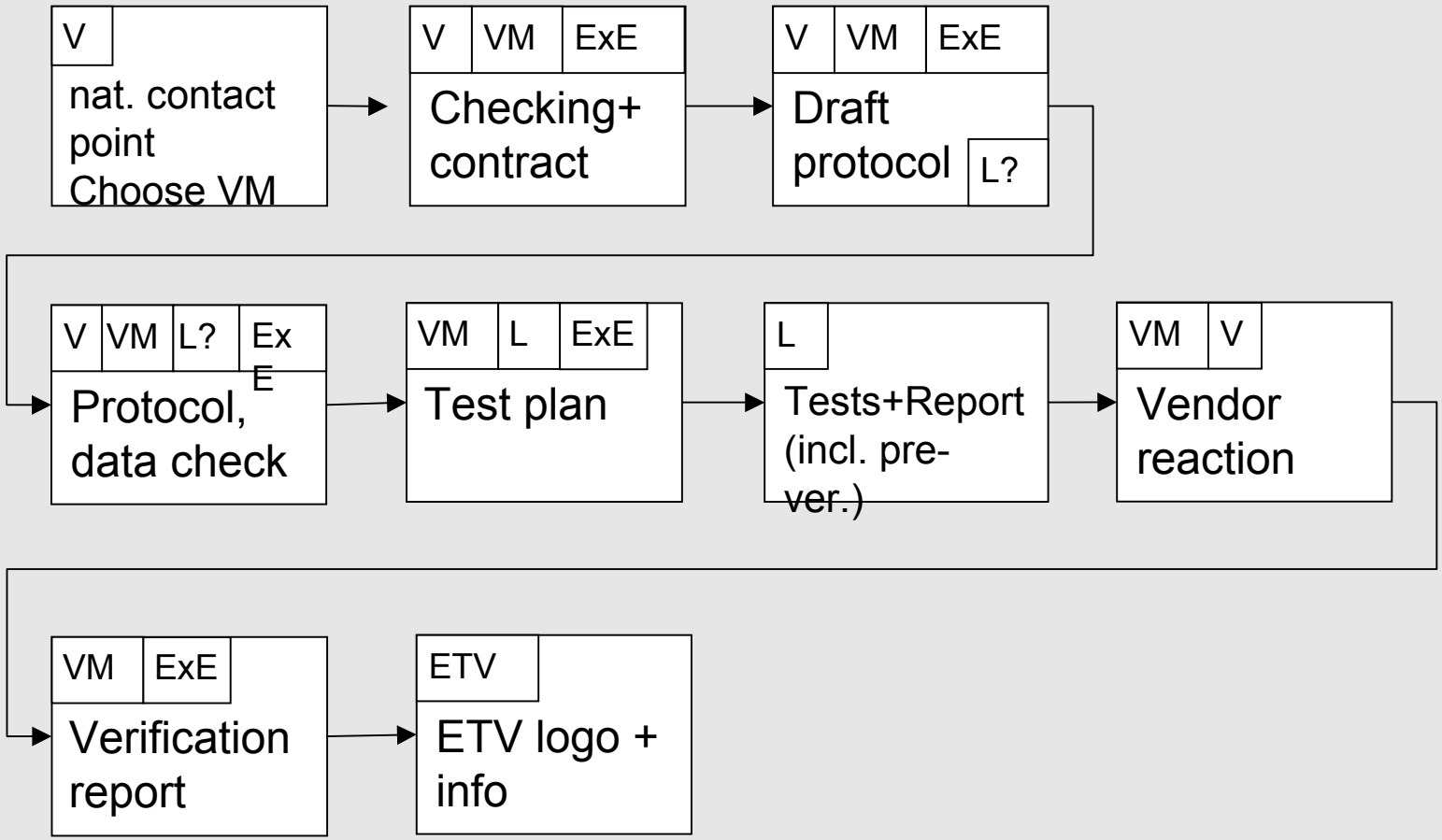
Contents

- Presentation of the Turbosorp© Technology
- Course of Events
- The Verfication System
- Outcome
- Experienced Problems
- Goals of the System

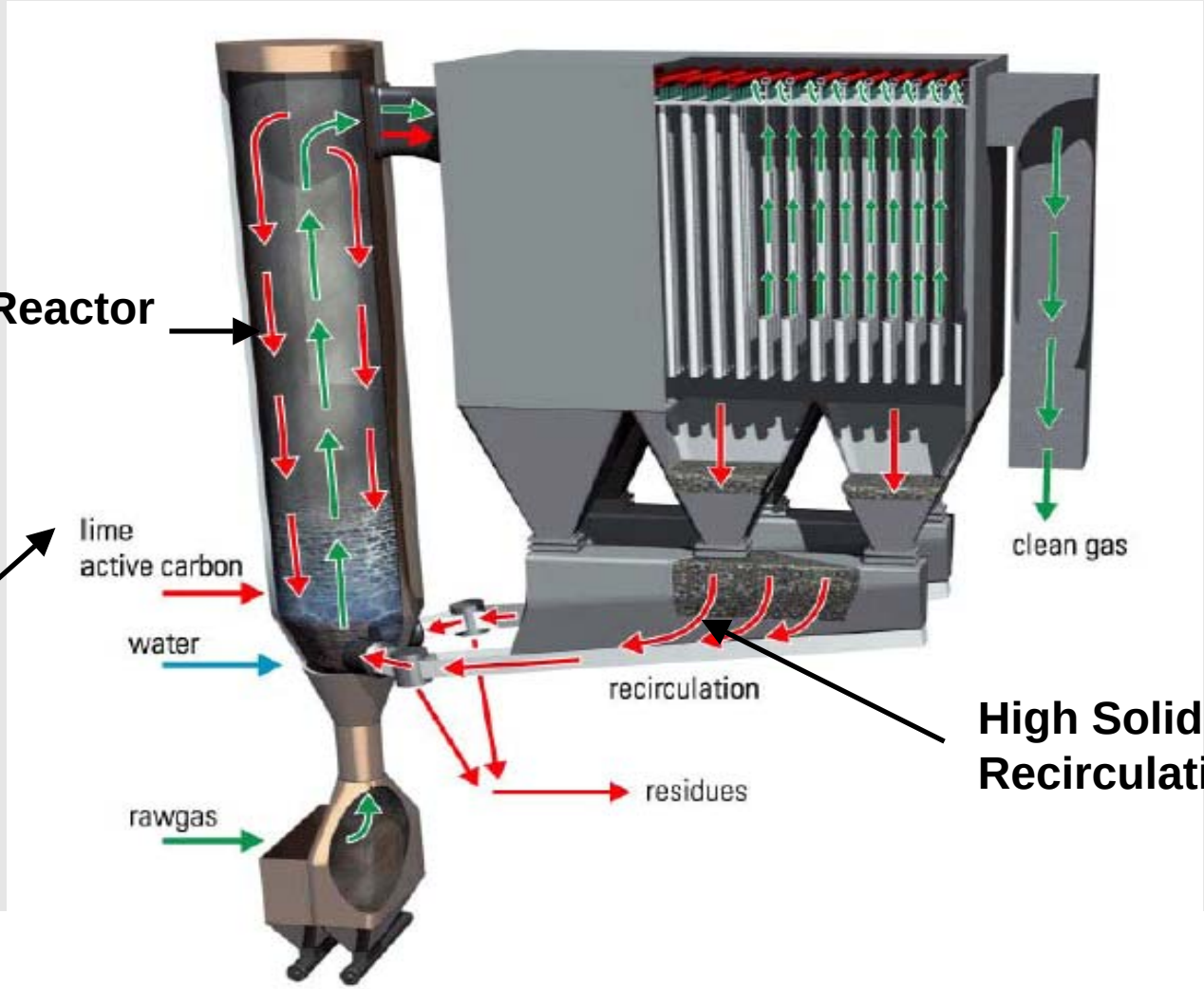
Who is who?

- Vendor
  - provides product to be verified and info about it
- Verification manager
  - administrates verification, knowledge about ETV system
- External Experts
  - defining list of parameters to be tested/verified
- Stakeholders: Customers, competitors, authorities etc.
  - help in defining list of parameters to be tested
- Test lab
  - performs tests, help in defining parameters
- ETV: European Technology verification organisation
  - overall quality control, awarding logo

Possible verification scheme



Turbosorp© Process
Flue Gas and Solids Path Diagram



Turbosorp® Design

- Turbulent Reactor Mixing
- Product recycle introduced above venturi - high flue gas solid contact
- Internal reactor solid recirculation – optimal lime consumption
- Multiple exposure and wetting of solids
- Reverse wall flow reducing sneakage
- High localized apparent reactor stoichiometry (5 – 10)
- Low overall system stoichiometries (1,1 – 1,8)
- No limit of recirculation due to approach to saturation
- All dry product handling, no slurries
- Materials: carbon, steel (unlined)

Turbosorp® Control and Performance

Five simple PID control loops:

- Outlet temperature (approach) – water
- SO_2 removal or outlet emission – lime
- Reactor bed density – product recycle
- Air slide product level – product rejection
- Minimum velocity (turndown) – flue gas

Performance

- High acid gas capture efficiency
- Low emission concentrations
- All dry products, low maintenance – high reliability

Typical Performance Guarantees Turbosorp® Emissions Summary

SO_2	95 – 98 %
SO_3	95 – 99 %
HCl	95 – 99 %
HF	95 – 99 %
Mercury	90 – 95 %

Coals up to 3,5% S

How do you derive a verifiable claim?

Claim

- **Claim:**
- The Turbosorp® technology claims a reduction of the concentration of acid gases (HCl, HF, SO_2), heavy metals (Hg, Cd, Tl) and PCDD/F by at least 90%, dust by at least 99%. The concentration of organic carbon in the clean gas is lower than 10 mg/Nm^3 (legal boundary limit in Austria).

Worldwide Turbosorp® Experience Summary

- Systems have been in operation since 1994
- Sixteen units with coal experience
  - 65 to 300 MW capacity
  - SO_2 removal efficiencies to 97%
  - Inlet SO_2 concentrations up to 10.000 mg/Nm^3
- Twenty-two units on waste-to-energy plants

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Test Location

Waste to Energy Plant

KRV Arnoldstein

Carinthia

Austria

www.krv.co.at

KRV Arnoldstein Testing Results

December 2004

Parameter	Claim	Measured Average Performance
Organic carbon (concentration)	≤ 10 mg/Nm^3	0.9 mg/Nm^3
PM removal	≥ 99%	100%
HCl removal	≥ 90%	99%
HF removal	≥ 90%	94%
SO_2 removal	≥ 90%	94%
PCDD/F	≥ 90%	96%
Hg	≥ 90%	94%
Cd	≥ 90%	100%
Tl	≥ 90%	100%

Outcome and Verification Report

- **Verification successful**

- **Additional data (vendor information)**
- Flue gas volume
- Power consumption (fan power, other consumers)
- Water consumption
- Active carbon consumption
- Lime consumption
- Man-power needed for operation
- Residues (total amount, fly ash, Cl-amount, S-amount)
- Lifetime of equipment
- Space needed

Experienced Problems

- Claim definition
  - specification of pollutants (acid gases, heavy metals)
  - range too broad,
  - very low concentration for one pollutant – resort to legal limit for this parameter
- Time – Delays due to low priority (over a year) but also due to ongoing development of the system
- Measurement uncertainties
- Cost assessment
- Test cases not vendor driven as will be in real cases

Questions to the vendor

- What was your experience with the project?
- What did you expect at the start?
- How did it turn out?
- How much effort did you have to put in the verification process? How much money?
- Would you participate again?

Questions to you

- **Do you trust the system?**
  Would you trust a system without stakeholder inquiry?
- **Publish all verification reports?**
- **Language barrier?**
- **Would you participate as experts?**
- **Any suggestions?**

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