Waste to Energy Plant ZEVO Malešice/Prague

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PRAŽSKÉ SLUŽBY

NEPŘEKONATELNÝ SERVIS

CERTIFIKOVÁNO ZÚS ČSN EN ISO 9001:2001

TÜV CERT

EN ISO 9001:2000 / EN ISO 14001:2004
Certifikát č. 0410010813/000-E01,
0410420059027/000-E1

Waste - Burden or Energy Source?

Benefits and Risks - Operational Experience - Alternatives

(Energy Recovery from the Collected MSW and its Operational Impacts)

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Watenvi - Odpady a jak dále 2014, Brno

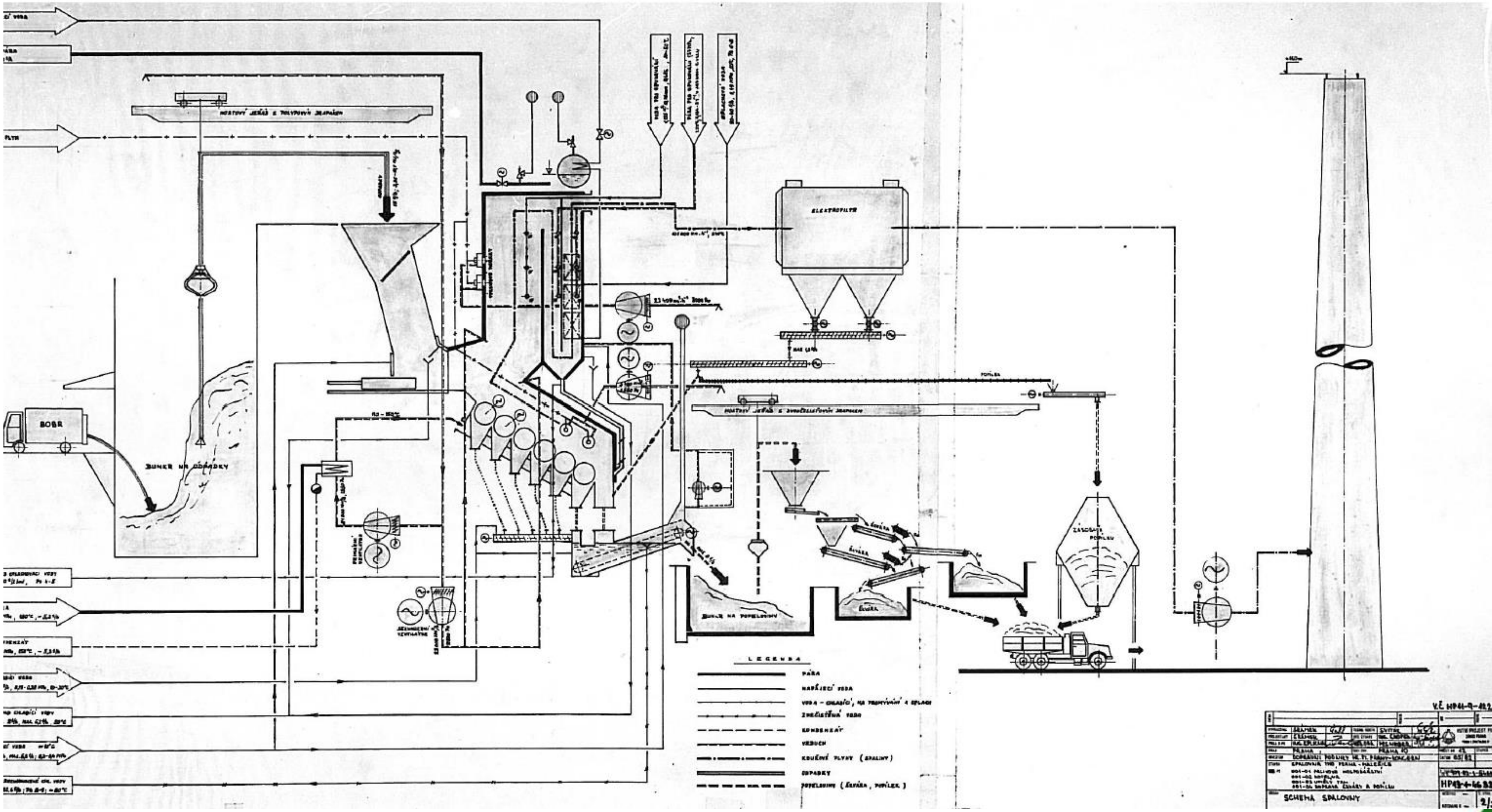
April, 23th – 24th, 2014

Contents

„Curriculum vitae“ of ZEVO Malešice

- In - 1986 ⇨ Decision to build WtE Malešice/Prague as replacement to the incinerator Vysočany (1930 – 1997)
- In - 1988 ⇨ Initiation of the construction of WtE Malešice
- in - 1989 ⇨ Inclusion of wet washing stage into the planing procedure (1988 first design included only ESP)
- in - 6/1998 ⇨ Initiation of test runs
- in - 7/1998 ⇨ Initiation of trial operation
- in - 9/1998 ⇨ Transition to permanent operation
- in - 2000 ⇨ Addition of SNCR DeNOx technology to the process
- (for reduction of NOx in the flue gas)
- in - 2000 ⇨ Application of active carbon into lime suspension (PCDD/F and Hg adsorption in the wet washing stage)
- in - 2006 ⇨ Initiation of the new PCS Delta V
- in - 2007 ⇨ Addition of SCR DeDiox technology
- in - 4/2009 ⇨ Initiation of the construction of cogeneration and SCR DeNOx
- in - 9/2010 ⇨ Initiation of stable supply of electricity into public grid
- in - 1/2011 ⇨ Initiation of the operation of cogeneration and SCR DeNOx

Technological Scheme of ZEVO middle 80´th



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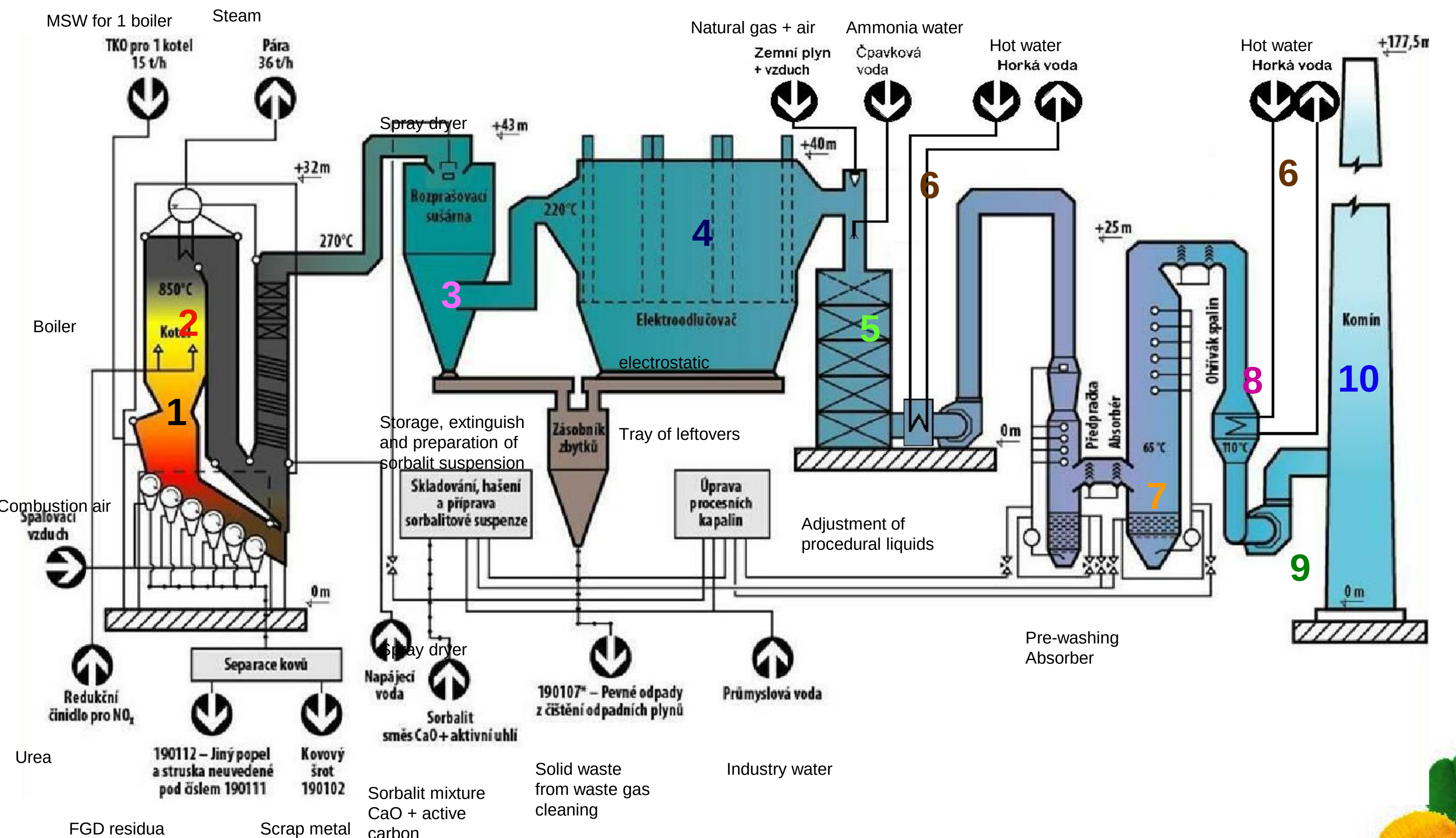
Technological Scheme of ZEVO today

1.Incineration 2.SNCR DeNOx 3.Semidry absorption 4.ESP 5.SCR DeDiox/DeNOx 6.Heat recuperation 7.Wet flue gas washing 8.FG reheating 9.Flue gas fan 10.Chimney



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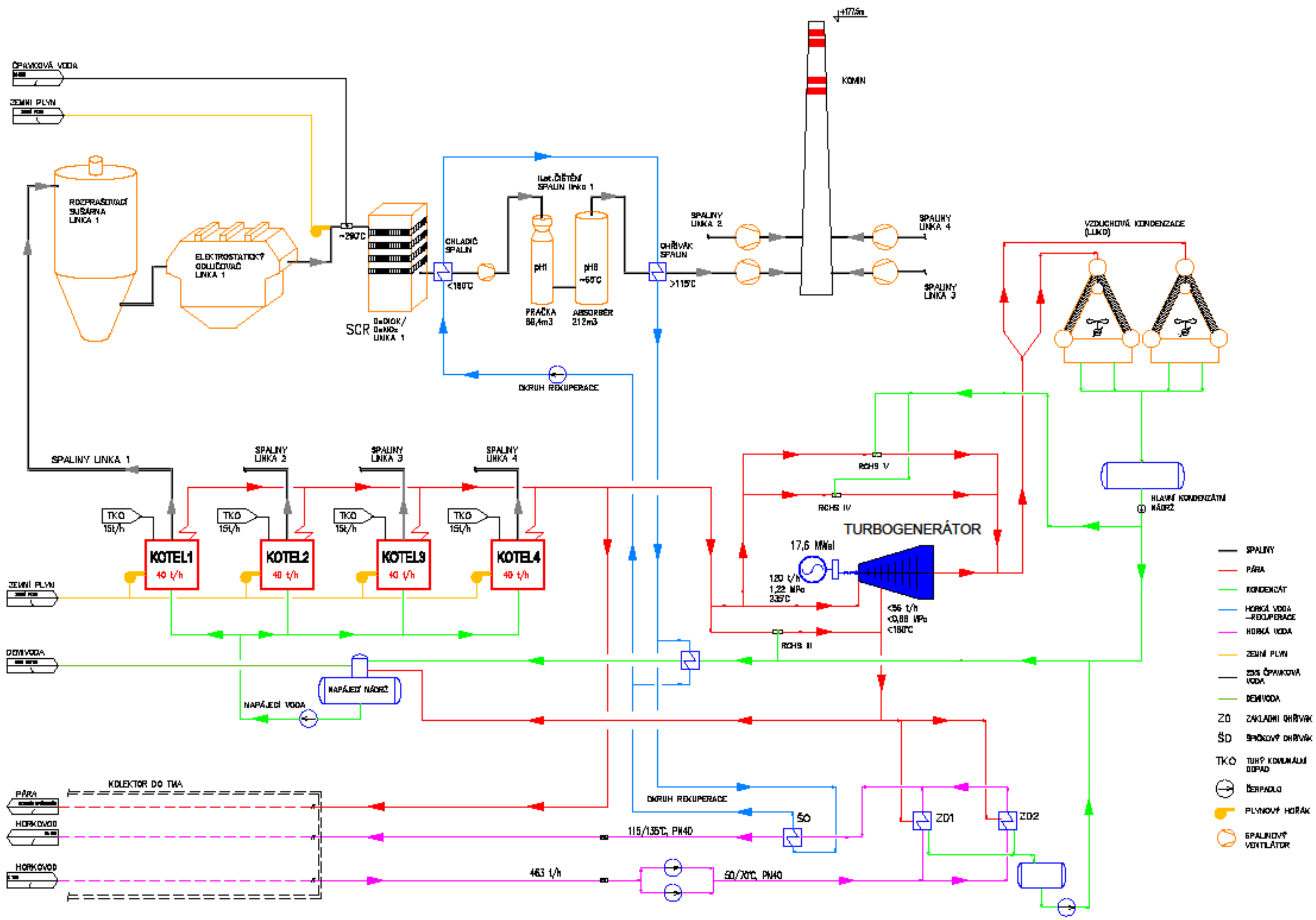
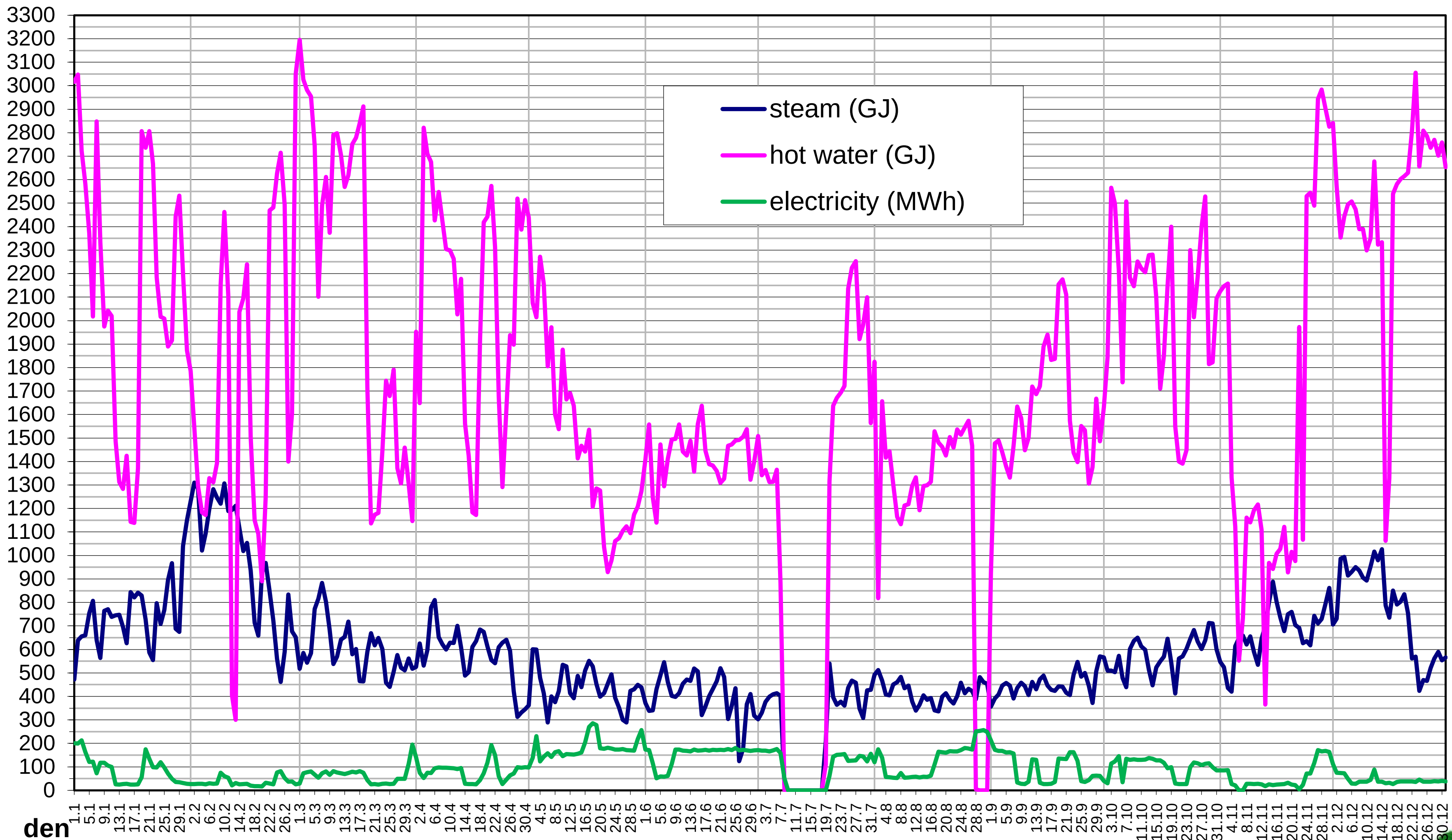
Energy Recovery Scheme of ZEVO



ZEVO Technology - Energetical Part

Material and Energy Balances

Electricity and Heating Supply 2012



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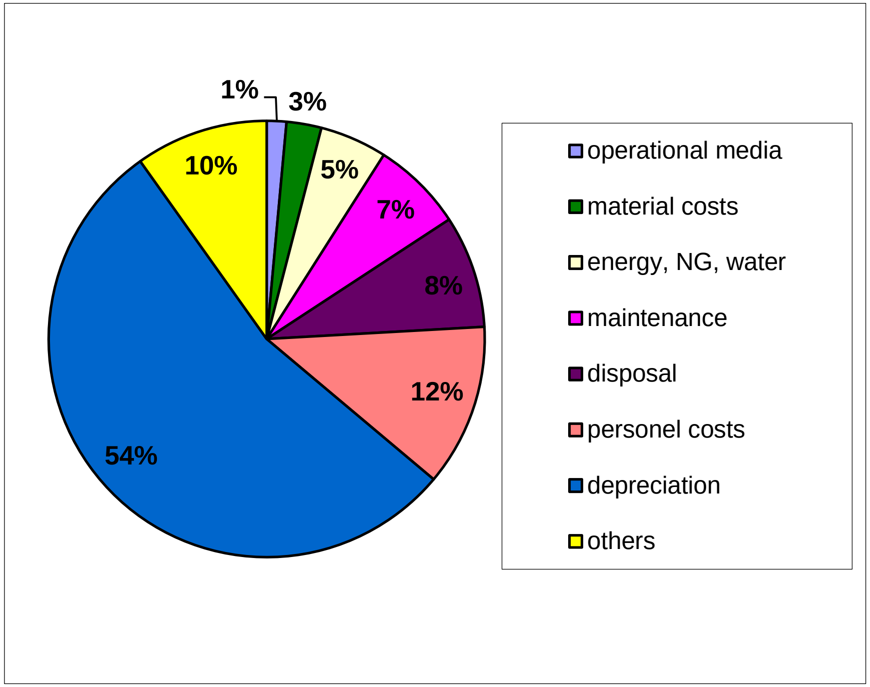
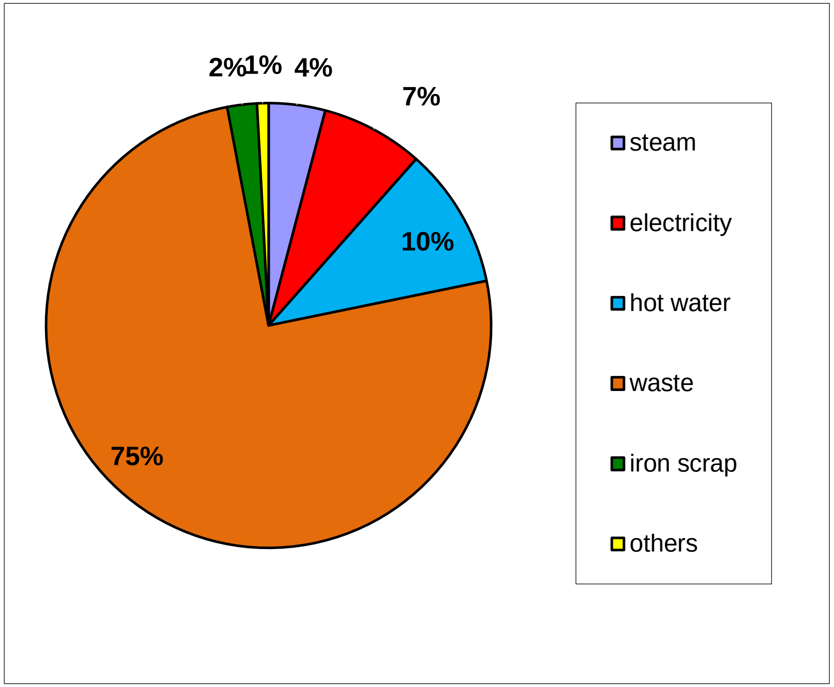
Operational Costs and Revenues

- Operational costs are about 465.000 thousands CZK/a
- Revenues are about 490.000 thousands CZK/a
- Profit for upholding of technology improvement





1 USD = 20 CZK

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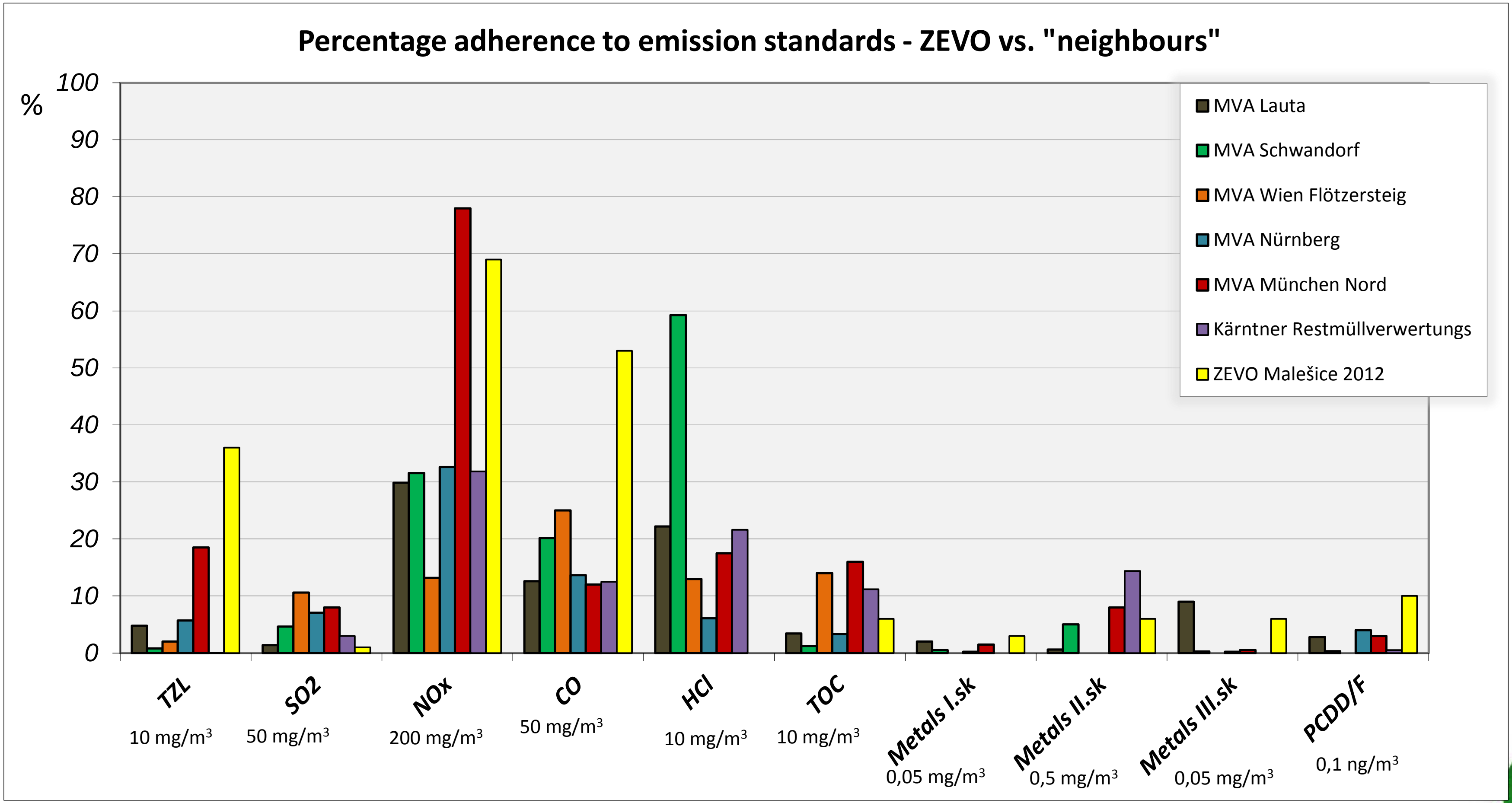
ZEVO emissions vs. neighbours 2012

Emission limits compare with other incineration plants



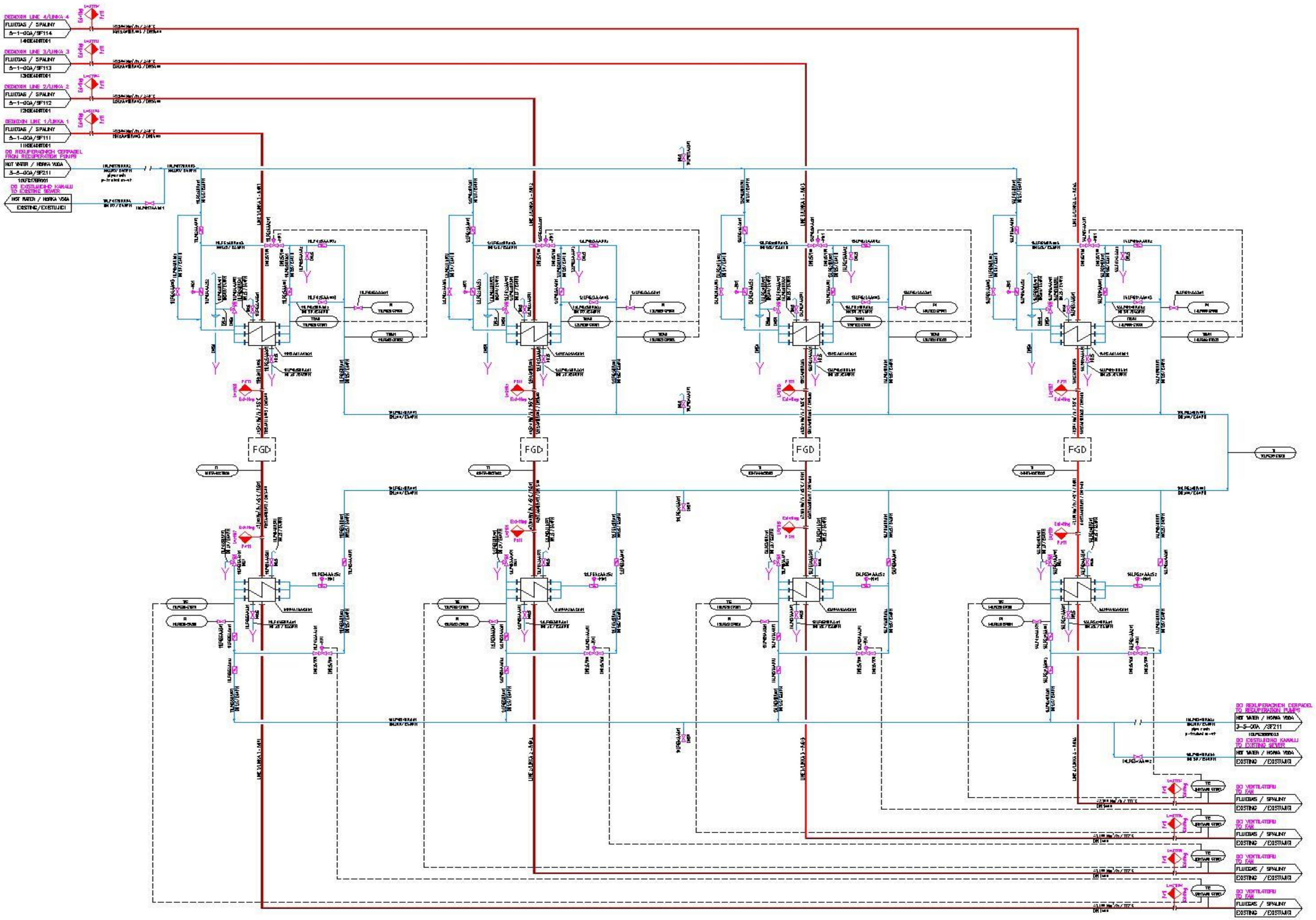
Operational Conditions and Experience

- Efficiency R1
  - Decides about recovery or disposal – Wte criteria „to be or not to be“
  - At least 0,60 for old plants
  - About 0,7 for ZEVO (75% in Heat, 25% in Electricity generated)
- CHP and PES (KVET a UPE)
  - Decides about bonuses
  - Efforted values higher then 15%
- Waste and Fluegas = corrosive and abrasive – Weak points
  - Refractory (high heat transfer vs. low CO emissions)
  - Wessel (overheaters vs. steam conditions, usualy 400°C and 40 bar)
  - Heatexchangers in flue gas stream (efficiacy vs. reliability)
- Technology choice is a question of the whole operating time
  - Quality as question of price vs. reliability as question of maintenance
  - Sum of investment costs, operational costs and maintenance costs = C
- References
  - Proved technologies = probably higher price but less worry!

Weak point – Heat recuperation leakage

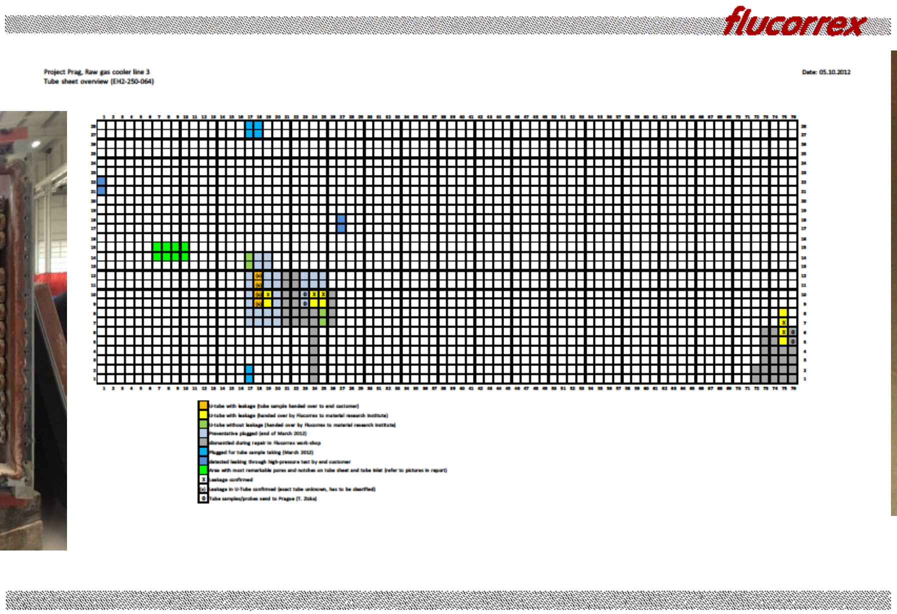
- Heat recuperation parameters
  - Each line contains cooler (C-Steel) and reheater (C-Steel, NiCr and PTFE)
  - Heat transfer by hot water, temperature 140/180 °C, pressure 2,8 MPa
  - Flue gas coolling after SCR DeDiox/DeNOx reactor (from 290°C to 180°C)
  - Reheating of flue gas after FGC (from 65°C to 115 °C)
  - City heating water supply temperature increase by 6°C (spot exchanger)
- Advantages
  - Saving 3x3MW heat = 10% (previously defeated by passing wet FGD)
  - Steamsubstitution in reheater by recuperation heat – selling more electricity
- Problems after operation start 08/2010 on recuperation circle occured
  - Leakage on cooler line 1 app. after ½ year in operation – tube plugged
  - Leakage on reheater line 1 app. after 1 year in operation – repaired by Ni alloy clamp mounting
  - Leakage 1 year after start of operation on cooler line 3 – tube plugged
  - Repeated (4 times!) leakage on coller line 3 in 1 ½ years – tubes plugged,
  - After last leakage dated 07/2012 cooler dismounted and repaired by partially tubes replacement by manufacturer flucorrex (CH)
  - Cooler L1 mounted back in 09/2012, leakage after 12 hours of operation!
  - L3 has been operated without cooler from 11/2012 to 05/2013 – heat substitution by DeNOx burners = natural gas costs!
  - 08/2013 100% tube replacement at L1 and L3 by CZ company, still running

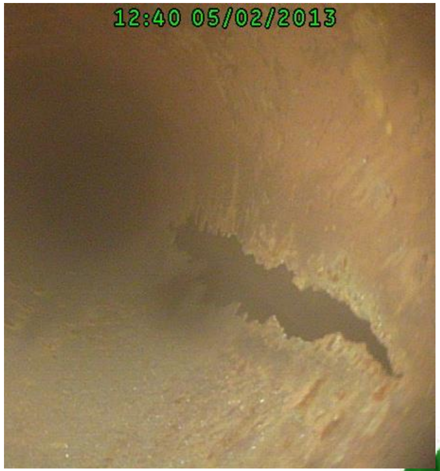
Recuperation of Heat from Flue Gas



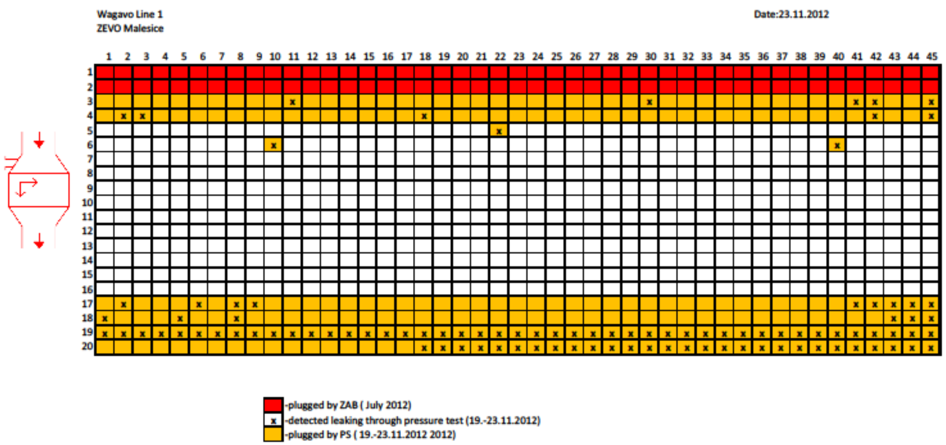
Heat Recuperation – Cooler possition

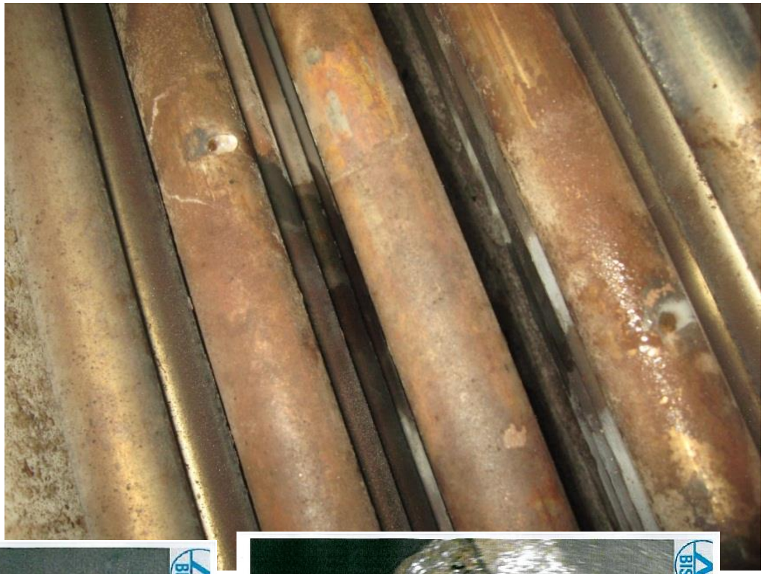
Heat Recuperation – Damages to cooler



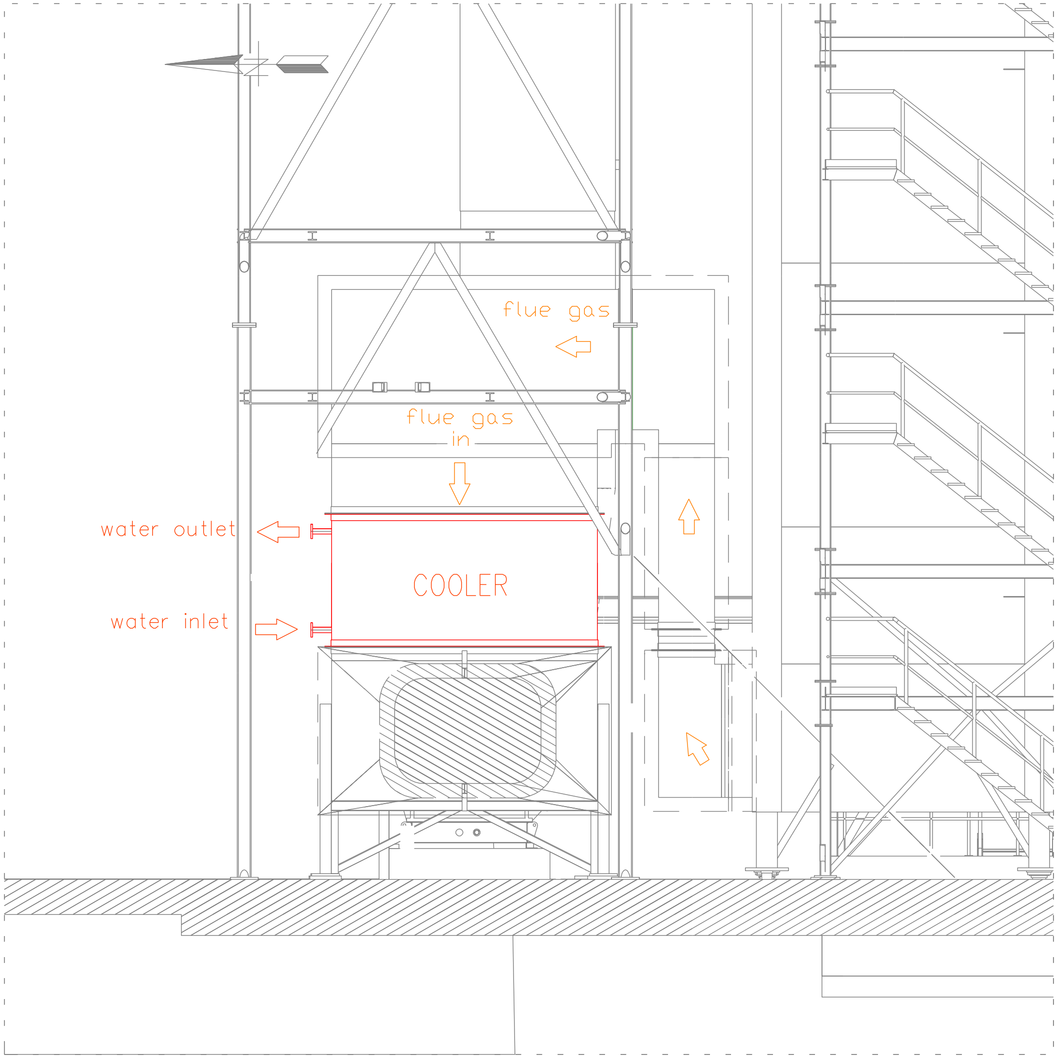


Heat Recuperation – Damages to reheater

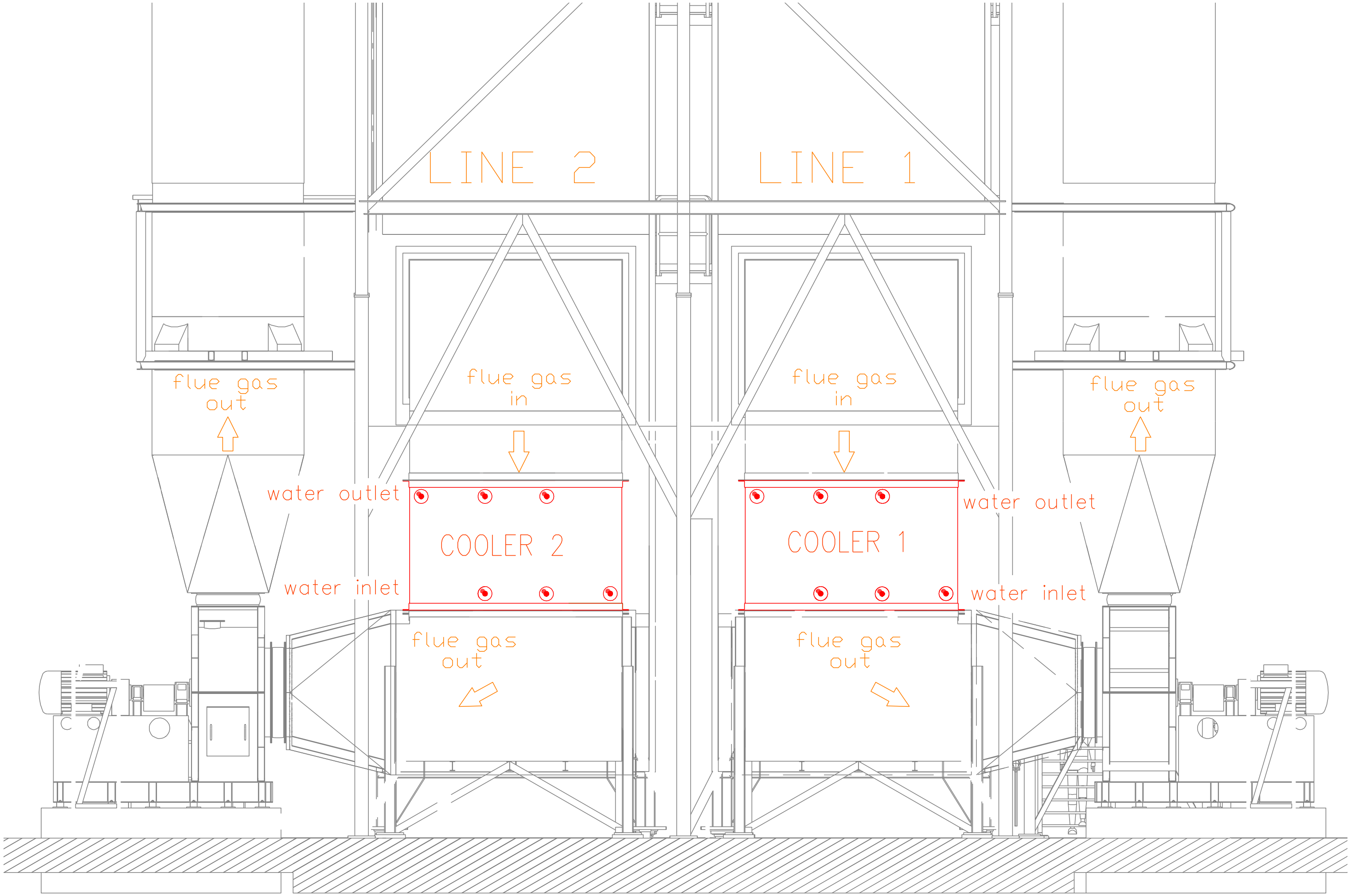




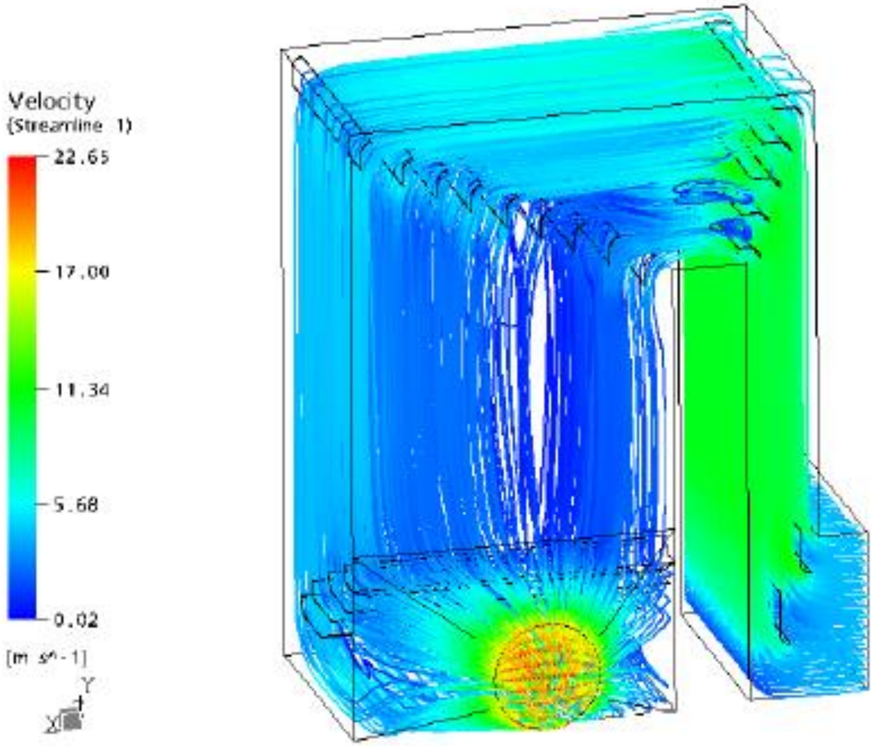
Heat Recuperation – Cooler construction



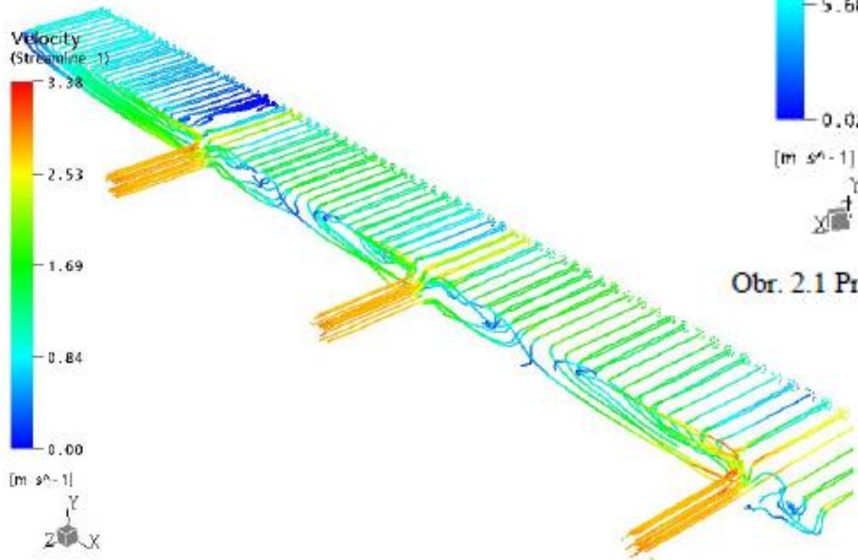
Heat Recuperation – Cooler construction



Heat Recuperation – Cooler flows

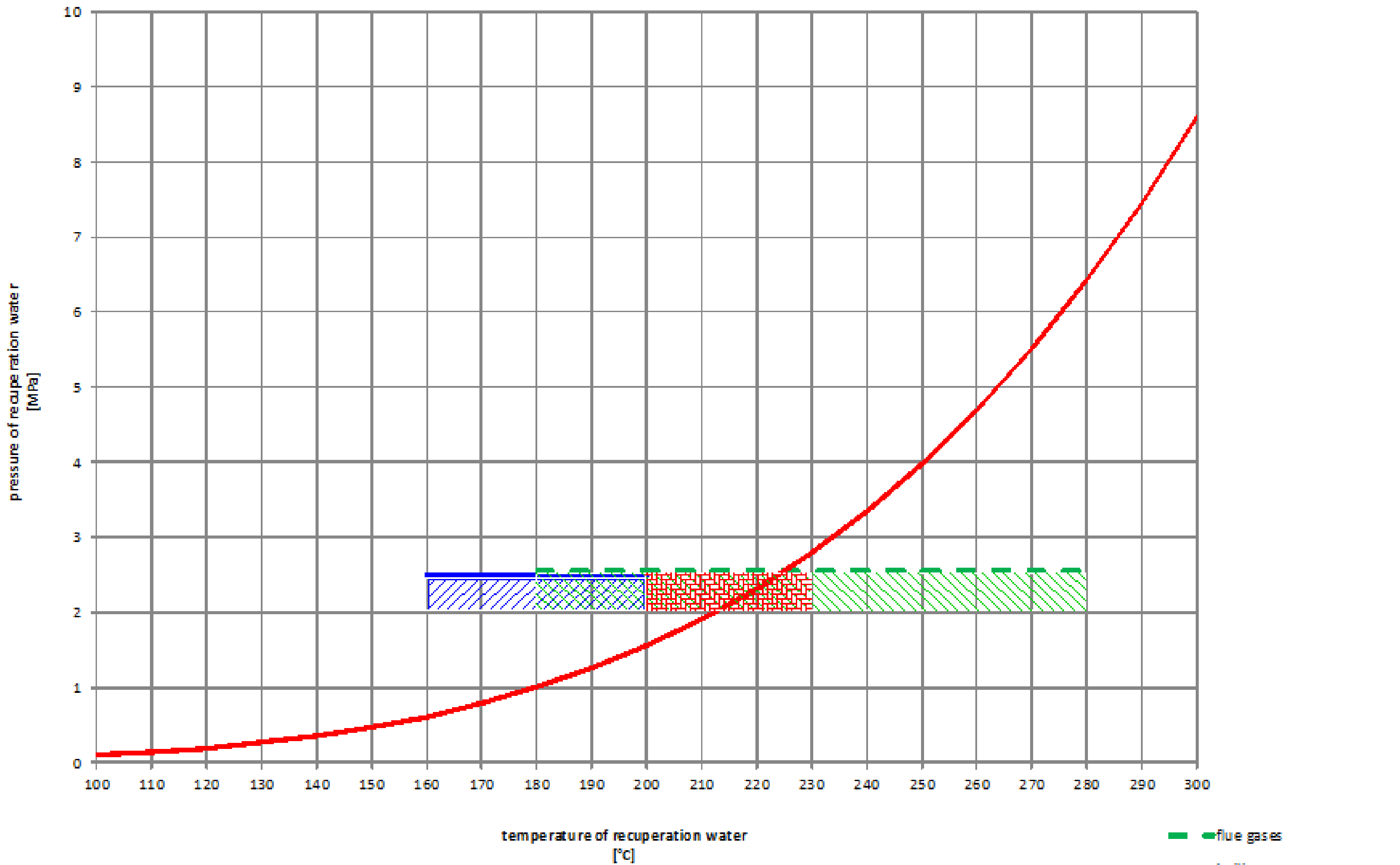


Obr. 2.1 Průtok spalin přes výměník a spalinovou cestu (max. provozní podmínky)



Obr. 2.4 Distribuce média do trubkového svazku

Heat Recuperation – p-T Diagram Water and Steam



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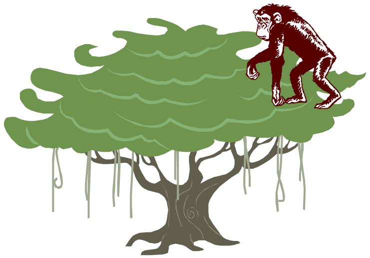
Weak point – Heat recuperation leakage

- Damage illustration and operating conditions
  - Leakage from cooler always in 10 to 20 cm distance from tube plate
  - Leakages in the middle part of cooler (either first or last rows!)
  - Initiating leakage on one tube (material) caused extensive derogation of surrounding area – repeated local damages
  - No operational failures because defects only on two coolers (L1+L3)
  - Recuperation water quality refers to turbine condensate – pH ower 8.5, no Cl contents
  - Coolers asymetric flow flue gas-cooling water lines 1 and 3 to 2 and 4
  - Leakage from reheater initiated under teflon layer during stand-by period
  - Reheaters symmetric flow line 1-4
- Possible reasons for damages
  - Local overheating caused by boiling inside tubes
  - Local cooling down under dew point of SO_3
  - Damages on the PTFE layer by dropped parts + chlorine migration from wet flue gas through PTFE layer to NiCr tube (in incrustations)

Weak point – Heat recuperation leakage

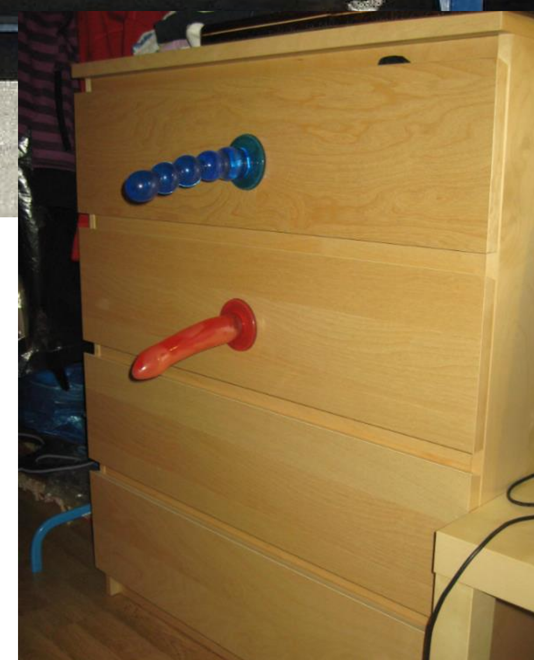
- Solutions – steps allready done
  - New reheater for line 1 and 2 ordered by investor, material changed to Ni based alloy for tubes
  - Revamping of old reheater by thicker C-steel tubes (2,5 mm instead of 1,5 mm)
  - Further droplets elimination in flue gas before entering reheaters
  - New cooler with double tube thickness + revamping of old cooler by thicker tubes (2,5 mm instead of 1,5 mm)
  - Modification of inlet flanges on water side, dazzle plates for flow equalization
- Solutions – steps in planning - possibilities?
  - Measuring flue gas velocities and pressures across cooler
  - Measuring of dew point SO_3
  - Modification of flue gas flow by guidance plates in future
  - Elimination of SO_3 dew point reaching by water temperature increase
- Solutions – problem analysis
  - Research and Development Institutes
  - Operators Experience
  - Half Kingdom and Princess as Reward ☺

Alternatives to WtE?



- Avoiding waste production
  - where are the social limits?
- Reducing waste production
  - wasteless technologies, package reduction…technological limits!
- Reusing of „waste“
  - returnable bottles, castings…environmental impacts?
- Material recycling
  - paper, plastics…how high can be the practicable rate?
- Mechanical biological treatment
  - quality of outputs…their usability?
- Coincineration of pretreated waste in power plants
  - waste remains waste…emissions or costs?

Recycling – possibilities ☺




Don´t waste waste!
Use it as energy source!

What´s to be kept in mind about WtE…???

- Legislative conditions for WtE
  - 17. BImSchV was a driving force for WtE conditions on the european level
  - Regulations 75/442/EEC, 1999/31/EC and 2000/76/EC for EU
  - Reg. 185/2001 (new wording in preparation), 415/2012 and 201/2012 for CZ
- MSW is a renewable energy source with permanent availability
  - Every EU citizen produces 350 kg MSW/a, i.e. 3,5 GJ energy in waste
  - Recovered MSW could substitute 7% of heat and electricity demand
- Support of heat and electricity recovery from MSW
  - Excessive bonuses for „green energy“ from sun and wind
  - In some member states also bonuses for WtE – MSW containig 50% „green C“
- There is no technology without environmental impact!
  - Question of „sustainable development“
  - Principle of „the smaller evil“ (landfilling vs. energy recovery)
- MSW is contributor to the energetic state selfsufficiency
  - Less dependance on foreign import of energy (gas, oil)
  - Politically and economically safe source (smart grids, smart cities)
- Energy recovery from MSW by WtE´s in Europe
  - About 400 WtE plants in Europe (F 130, DE 70, SE 31, CH 28, A 14, CZ 3 (+5))
  - Lack of financial resources by government – occasion for private investors!
- WtE technology is expensive but perspective due to fuel sustainability
  - Operating life over 30 years
  - Specific investment costs about 500 to 700 Euro per ton yearly capacity

WtE ZEVO Malešice/Prague

Ecological sound recovery of clean energy from 300 thousand tons of Prague’s waste …generation of heat and power for 18 thousand households!

Waste – Burden or Energy Source?

Thank you for your attention

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It depends on what we do with…
…WtE…for a better future!