Maasvlakte Power Plant 3; Theory versus Practice

Sevilla, 15th April 2015

Ing. Aris Blankenspoor
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- Why a new power plant? Permit process!
- MPP3 key data & Technology choice
- Theory of good project management; Safety and Front End Loading at MPP3
- The construction project
- Lessons learned
Short introduction to E.ON
Some facts & figures  (Annual Report 2014)

- Sales: 111 billion euro
- Net income: -/- 3.1 billion euro
- Investments: 4.6 billion euro
- Sales electricity: 735 TWh
- Sales gas: 1.161 TWh
- Households: 35 million
- Employees: 58,500

**Europe**: Focused and synergistic positioning

**Outside Europe**: Targeted expansion
Leading E.ON developments

- **Nuclear**: State of the art plants like Irsching (60%).
- **Gas**: Plant reduction by 80%.
- **Renewables**: Largest investor in Europe (3rd worldwide).
- **Savings**
- **Smart grid**
- **Connecting energy**
E.ON to split into two publicly listed companies

Two highly competitive companies with distinct identities

Empowering customers

Shaping markets

New Company
Two leading companies for two energy worlds

Distinct opportunities, mindsets and capabilities
Why a new power plant?
Permit Process!
Age Dutch power plants: replacement is necessary

(Dutch government in energy report 2006)

Combined heat & power (gas fired) was heavily subsidized in 90’s
Fuel mix in Europe (2006)

NL too much dependent on gas
Emissions: the installations for flue gas cleaning

- Coal mill
- Flue gas desulpharisation
- DeNOx installation
- E-Filter
- Chalk suspension
- Flue gas
- Boiler
- Ash / slag
- Fly ash
- Gypsum
- Chimney
- Cleaned waste water
- Water treatment
## Comparison of emission values (mg/m³)

<table>
<thead>
<tr>
<th>Component</th>
<th>IPPC /BREF</th>
<th>DCMR</th>
<th>Technique</th>
<th>MPP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>20-150</td>
<td>20-40</td>
<td>98% reduction MPP3: ok</td>
<td>max. 40</td>
</tr>
<tr>
<td>NOx</td>
<td>90-150</td>
<td>30-75</td>
<td>80-90 % reduction MPP3: ok</td>
<td>max. 65</td>
</tr>
<tr>
<td>Dust</td>
<td>5-20</td>
<td>1-3</td>
<td>5 or 6 fields filter MPP3: 6</td>
<td>max. 3</td>
</tr>
</tbody>
</table>
Energy-efficient = CO\textsubscript{2}-efficient

- MPP3 has high efficiency (~ 47%). This leads to approx. 20% less CO\textsubscript{2}-emissions per KWh
- MPP3 is CO\textsubscript{2} capture ready
- MPP3 is ready for heat supply to industries and residential areas in the region
- Possibility for co-firing biomass is being researched and is part of the environmental permit
ROAD Project – Full Chain CCS Demonstration

**Capture:** 250 MWe, 1.1 Mton/yr
**Transport:** 25 km pipeline, 16” max. capacity 5 Mton/yr
**Storage:** depleted offshore gas field (P18-A)
**Start of operation:** 2016 …
**Capital investment:** approx. M€ 400 (M€ 330 funded)
**Project Developer:** Maasvlakte CCS Project C.V.
Reduction CO₂ emission power plant

- Old coal
- Biomass
- CCS demo
- Heat supply
- Full scale CCS
## Planning

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Environmental Impact Assessment:</td>
<td>December 2006</td>
</tr>
<tr>
<td>Submit environmental permits:</td>
<td>June 2007</td>
</tr>
<tr>
<td>Environmental and building permits granted:</td>
<td>April 2008</td>
</tr>
<tr>
<td>Start building activities:</td>
<td>April 2008</td>
</tr>
<tr>
<td>Pouring concrete foundation:</td>
<td>April 2009</td>
</tr>
<tr>
<td>First boiler column:</td>
<td>January 2010</td>
</tr>
<tr>
<td>Boiler pressure test:</td>
<td>October 2012</td>
</tr>
<tr>
<td>Commissioning:</td>
<td></td>
</tr>
<tr>
<td>In operation:</td>
<td></td>
</tr>
<tr>
<td>Last permit irrevocable (NPA)</td>
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</tr>
</tbody>
</table>
MPP3 key data
MPP3 key data

Gross capacity 1,100 MW
Efficiency ~ 47%
Steam conditions 620°C 285 bar
Start construction April 2008
In operation 2014 / 2015

E.ON is Owner, Engineer & Integrator

Workers on site > 2,500
LTIFR 0
TRIF 1,4
Record safe days 1,337
Safe hours > 9,500,000
Worked hours ~ 14,700,000
Maasvlakte: a history of land and water

- Very large scale industrial area
- Deep waterway: easy transport of coal and biomass
- Sufficient cooling water
- Infrastructure present
- Building space available
- Maasvlakte 2 = new co-siting opportunities

Maasvlakte is one of the best options in Europe for a coal fired power plant.
Technology choice
Technology Choice

- Pulverized coal = proven technology, safe, reliable, economic, clean & innovative
- MPP3 has high efficiency (47% versus 38%)
  - This leads to approx. 20-30% less CO₂-emissions
  - Complex technology, T-24 boiler material, steam 600°C, 285 bar, sea water cooling
- Once through boiler => turn down ratio 83%
- Hot start to full load in 105 minutes
- Ramp up speed 50 MW/minute
- Electrical power (net): 1,069 MW<sub>el</sub>
  - ID size fan limits flue gas duct to 800 MW<sub>el</sub>
  - Generator limits capacity to about 1,155 MW<sub>el</sub>
- MPP3 is CO₂ capture ready
- MPP3 is ready for heat supply to industries and residential areas in the region
- Possibility for co-firing biomass (up to 30%)
- Flue Gas Cleaning to comply with emission levels far below BAT
T24 Recap and executed measures

**Influencing the medium**
- Optimised chemical cleaning (pickling)
- Optimised water chemistry of boiler water

**Influencing stresses**
- Heat treatment at 450°C-520°C of the complete boiler with external burners

**Influencing material condition**
- Local heat treatment at temperatures in the range of 600°C in highly stressed areas

![Diagram](source: VGB)

![Graph](source: RWE)
Root cause investigation revealed a systematic defect in the heat affected zone of the weldings of the tube material HR3C.

Intercristalline corrosion of HR3C material was the reason for cracks in heat affected zones.

HR3C material was sensitized by T24 related Stress Release Heat Treatment (SRHT) and triggered by chemicals in water phase.

Triggering Chemicals entering during previous processes SRHT, flushing and chemical cleaning of the boiler.
High efficient turbine; Actual operating clearances significantly smaller than intended

Assembly clearance (Montagespiel)  
Design clearance (calculated 2D by supplier as intended)  
Actual Operating Clearance (Ist Betriebsspiel) (calculated 3D EON)
The theory of good project management; Safety and Front End Loading at MPP3
“Efficiency and safety focus need not, and should not, compromise each other. This is a cultural and management issue. We owe a safe working environment to our employees and subcontractors - and not the least to their families, to our customers and to the communities we work for and among.”

Dr. Johannes Teyssen
(CEO E.ON AG)
HSE Performance over time

Technology and standards
- Engineering improvements
- Hardware improvements
- Safety emphasis
- E&H Compliance

HSE Management Systems
- Integrated HSE-MS
- Reporting
- Assurance
- Competence
- Risk Management

Improved culture
- Behaviour
- Visible leadership / personal accountability
- Shared purpose & belief
- Aligned performance commitment & external view
- HSE delivers business value
PATHOLOGICAL | who cares as long as we’re not caught

REACTIVE | Safety is important, we do a lot every time we have an accident

CALCULATIVE | we have systems in place to manage all hazards

PROACTIVE | we work on the problems that we still find

GENERATIVE | HSE is how we do business round here

Increasingly informed

Increasing Trust/Accountability
Culture Ladder

PATHOLOGICAL
- The lawyers/regulator said it was OK
- Of course we have accidents, it’s a dangerous business
- Sack the idiot who had the accident

REACTIVE
- We are serious, but why don’t they do what they’re told?
- Endless discussions to re-classify accidents
- You have to consider the condition under which we are working
- The lawyers/regulator said it was OK
- Of course we have accidents, it’s a dangerous business
- Sack the idiot who had the accident

CALCULATIVE
- We cracked it!
- Lots and lots of audits
- HSE advisers chasing statistics

PROACTIVE
- Resources are available to fix things before an accident
- Management is open but still obsessed with statistics
- Procedures are “owned” by the workforce

GENERATIVE
- Chronic unease
- Safety seen as a profit centre
- New ideas are welcomed
Prof. Jop Groeneweg (Leiden University):

“An excellent primary process makes a safety department unnecessary.”
Aris Blankenspoor (E.ON):

“An excellent primary process starts with Front End Loading.”
Front End Loading (FEL)

1. Cost of change is low value (% of overall commitment)
2. Cost of change is high value (% of overall commitment)
Optimize project result

- Feasibility: +/-50%
- Concept: +40/-25%
- Basic: +15/-10%
- Detailed: +40%
- Realisation: +15%
- Handover: +10%

Total Investment costs:
- Estimated Total Final Costs: +10%
- Investment request: +15%
- -50% 
- -25%
- -15%
- -10%
Focus on Safety

• Why:
  • Investment size and statistics
  • Other projects 2 fatalities & >10 heavy injuries
  • Target GPM MPP3 “zero” fatality & HI

• How:
  • Assume systems are available
  • Shared purpose and believe
  • Culture change / communication
  • Example behavior and leadership
  • 90% of incidents due to human error
  • Control of primary process
  • Control of quality and logistics
  • No changes philosophy
  • No rush jobs
  • FEL / preparation is 90% of success
  • Risk transition through project phases

Challenges from the practice

• Many construction employees on site (10,000)
• Over 2500 workers
• Safety culture and behavior contractors
• Size and weight of equipment
• Complicated logistic process (JIT)
• Failure of contractors to deliver standards in terms of time, cost and quality
• Non-proven technology e.g. T-24 material, turbine
• Subcontractor management & pre selection
• VIP’s e.g. constructability reviews in design
• Delay in design documents

• Result: Changes
Conclusion Safety and Front End Loading

• Culture is leading safety since 90% of the incidents are due to human error

• FEL and good preparation of the construction process leads to zero change

• Well developed process safety and risk transfer prevents operational and environmental incidents

• Zero change leads to the highest safety performance AND to cost efficiency

• Well prepared Front End Loading and Safety go hand in hand

• However; challenges still lead to unexpected change.

Front End Loading must be a “leading indicator” for high safety performance and project cost efficiency.
The construction project
10,000 m²
7,500 tons of steel
650 piles (30 m, 1.5 m Ø)
27,000 m³ of concrete

2.50 – 4 meters thick
First coal in storage
First coal fire: September 2013
## Main Lessons Learned

<table>
<thead>
<tr>
<th>Subject</th>
<th>Explanation</th>
<th>Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permit irrevocable</td>
<td>With a valid permit the project stays at risk. Irrevocable permit is required.</td>
<td>External stakeholder management and intensive alignment with authorities required.</td>
</tr>
<tr>
<td>Proven technology</td>
<td>Time delay project mainly based on exotic materials T24 &amp; HR3C and IP turbine</td>
<td>Use proven technology / do not perform as early adapter with highest technical parameters</td>
</tr>
<tr>
<td>E.ON specialists</td>
<td>E.ON experts were in the lead to manage external OEM</td>
<td>Maintain a critical mass of own company specialists</td>
</tr>
<tr>
<td>Supplier reliability</td>
<td>Critical suppliers do not perform as expected (quality)</td>
<td>Closer cooperation with strategic - key suppliers</td>
</tr>
<tr>
<td>Front End Loading</td>
<td>Sub-optimal development of project in early phases leads to changes during execution</td>
<td>Projects to be developed more extensively before FID Use front end loading approach</td>
</tr>
<tr>
<td>Safety</td>
<td>Safety results are lagging indicators of the primary process</td>
<td>90% of success depends on preparation and no change. Incidents happen for 90% due to human behavior</td>
</tr>
</tbody>
</table>
Thank you very much for your attention