

Decarbonising steel making by utilization of deeply cleaned coke oven gas.

Round Table Conference on Advancing India's Steel Industry Growth at Ranchi on 30th & 31st May, 2024

Introduction

- Steel industry worldwide is responsible for high CO₂ emissions contributing to climate change.
- New technologies like direct reduction iron (DRI) technologies are at the threshold of industrial implementation and may shape the steel making for the next decades.
- Until these technologies have reached their industrial maturity, changeover technologies shall also play a role in decarbonizing steel making.

- Coke oven gas contains a high percentage of hydrogen and is hence an excellent reduction agent in the blast furnace that can replace the injection of natural gas or coal fines.
- In order to serve as reduction agent in the blast furnace, coke oven gas has to be deeply cleaned from residual hydrogen sulfide and aromatic carbons such as BTX / naphthalene.
- A German steel plant is actually using deeply cleaned COG for blast furnace injection as a changeover technology and is saving a lot of costs due to savings in CO₂ trade certificates.

DMT's Core Technologies in a By-Product Plant

COG Cooling

- Primary Gas Coolers incl. chilled water stage
- Chilled Water Unit (absorption type or compression type)

Tar and Dust Removal

- Electrostatic Tar Precipitation (ETP)
- Tar Separation
- Gravel Filters

Gas Exhauster

COG scrubbing

- H₂S / NH₃ scrubbing
- naphthalene and/or BTX scrubbing

Scrubbing liquor regeneration

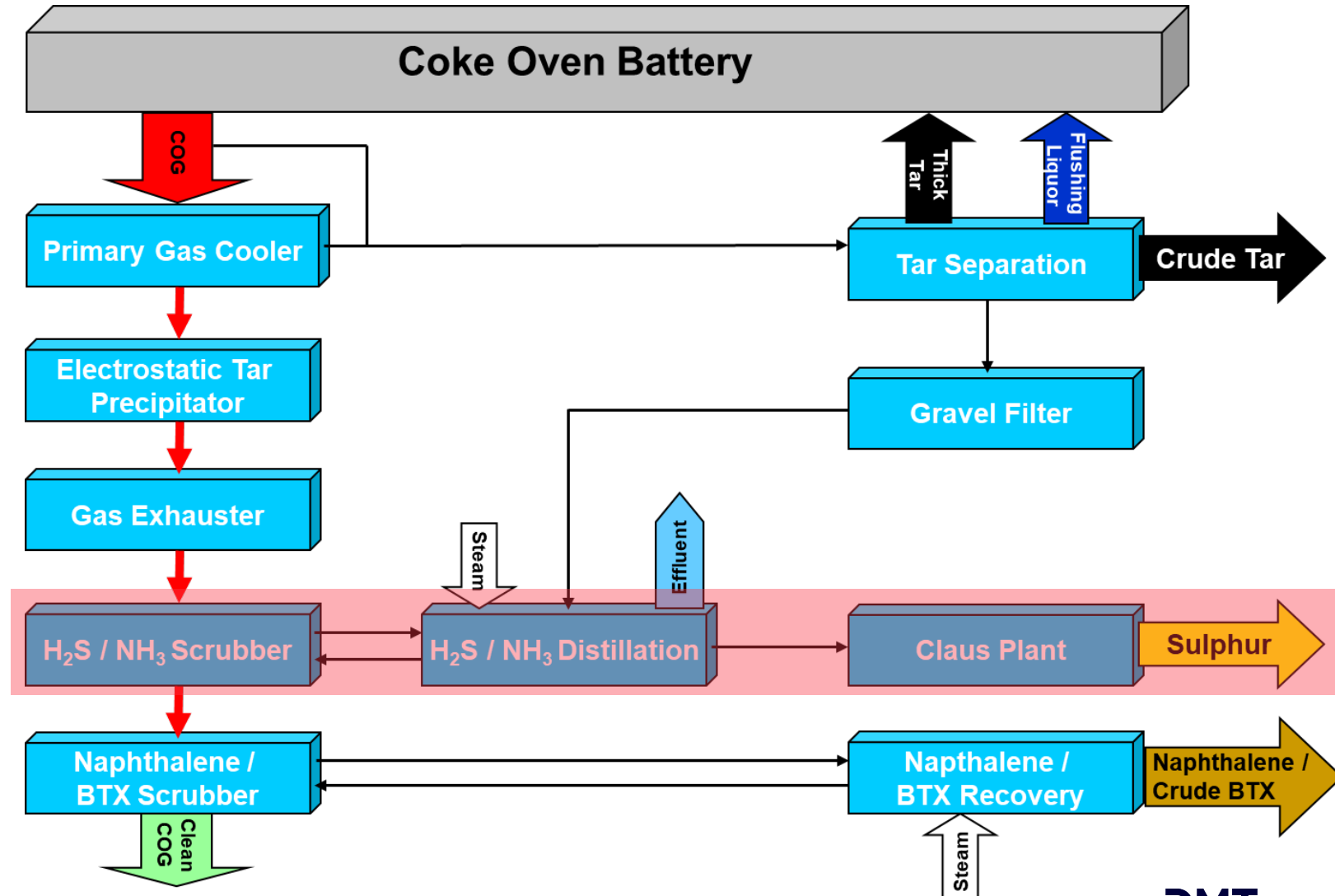
- H₂S / NH₃ stripping
- naphthalene / BTX stripping

Sulphur Generation

- Claus plant incl. NH₃ cracking

Waste Water Cleaning

- Waste water Treatment Plant



DMT Technological Highlight – Combi Gas Scrubber (H₂S, NH₃)



H₂S/NH₃-Combi-
Scrubber
83,000 Nm³/h

- **Several stages of packings**
used as gas –liquid mass transfer contact area; in combi-scrubbers with higher mass transfer efficiency through higher specific surface area and still limited risk of clogging and pressure drops
- **Special flow path inside packings**
to increase gas turbulence and maximize efficiency
- **Low pressure drop**
- **High efficiency liquid distribution trays**
to optimize scrubbing liquor distribution over the whole packing surface
- **Design flexibility:**
scrubbers with diameters higher than 5 m and heights of ca. 50 m
- **Typical clean gas parameters**
 - H₂S ≤ 500 mg/Nm³; NH₃ ≤ 30 mg/Nm³

DMT Technological Highlight – H₂S / NH₃ Combi-Stripper



NH₃ and H₂S
Combi-Stripper

- Titanium material for stripping columns and trays corrosion resistant and long life-time
- High stripping efficiency valve trays reduced ratio steam : liquid flows
- Self Cleaning Push Valves / Fix Valves
- Low steam consumption
- Wide Operation Range
- Low pressure drops
- Use of Vapor Condenser to adjust the content of NH₃/H₂S/H₂O Acid-Gas composition in order to improve efficiency of downstream sulphur recovery unit
- 100% Stand-by Solution with second combi-stripper
- Easy cleaning of column internals

DMT Technological Highlight – NH₃ Cracking/Sulphur Recovery



- **NH₃ / H₂S vapors incineration** without COG support during operation
- **NH₃ / HCN cracking** by Ni based catalyst
- **High conversion rate of H₂S** to elementary Sulphur
- **No emission to the environment,** tail gas feeding up-stream PGC
- **High Sulphur quality** > 99,5 % purity
- **Color bright yellow**
- **Sulphur product** in liquid or solid form

Claus Plant with integrated NH₃ cracking

DMT BPP Engineering - References India

Client	Location	Contract Year	Project	COG Flow
ArcelorMittal Nippon Steel	Hazira	2023	New complete BPP (greenfield)	74.000 Nm ³ (phase 1) 74.000 Nm ³ (phase 2)
Bhushan Power & Steel Ltd. (BPSL) (now JSW)	Rengali	2012	New complete BPP (greenfield)	70,000 Nm ³
Tata Steel	Jamshedpur	2012	Engineering, supply of key equipment & commissioning of a caustic soda scrubber (for a COG-to-hydrogen plant)	10,000 Nm ³
Bhilai Steel	Bhilai	2011	New complete BPP (greenfield) & additional coke oven gas treatment from other BPP	45,000 Nm ³ plus 105,000 Nm ³
Bhushan Steel Ltd. (BSL) (now Tata Steel)	Meremandali	2008	New complete BPP (greenfield)	77,000 Nm ³
SAIL Indian Iron and Steel Company (IISCO)	Burnpur	2007	New complete BPP (greenfield)	45,000 Nm ³

DMT's High Pressure COG Fine Cleaning

COG Booster

- Boosting COG up to 15 bar for HP cleaning

COG scrubbing

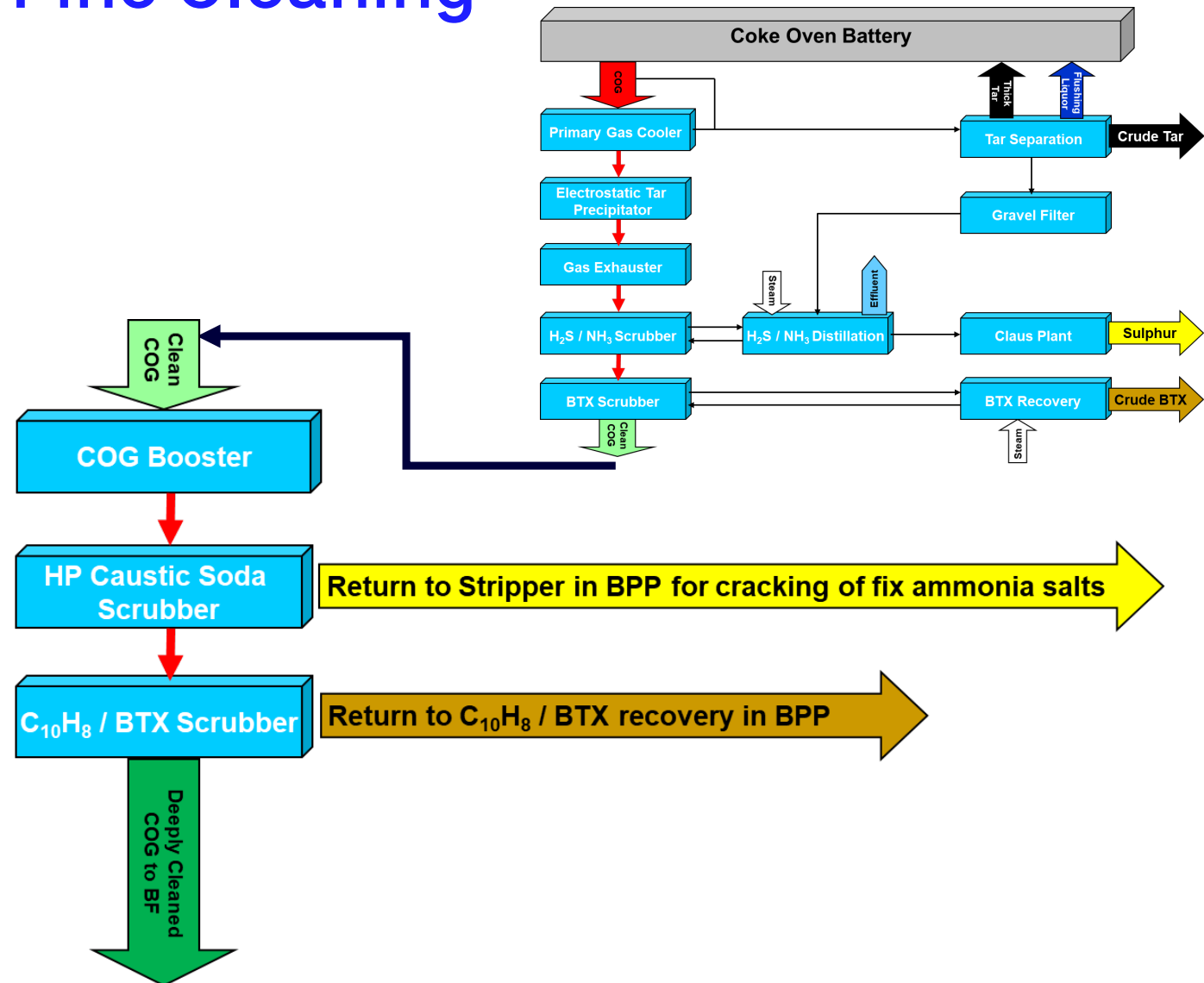
- HP Caustic Soda scrubber for H₂S removal
- HP Wash Oil scrubber for naphthalene and BTX removal

Scrubbing liquor regeneration

- Caustic soda liquor in BPP (H₂S / NH₃ stripping unit)
- Enriched wash oil in BPP (naphthalene / BTX stripping unit)

Chilled Water plant for COG cooling

- Deep cooling of COG down to <5°C (for North European winter conditions)



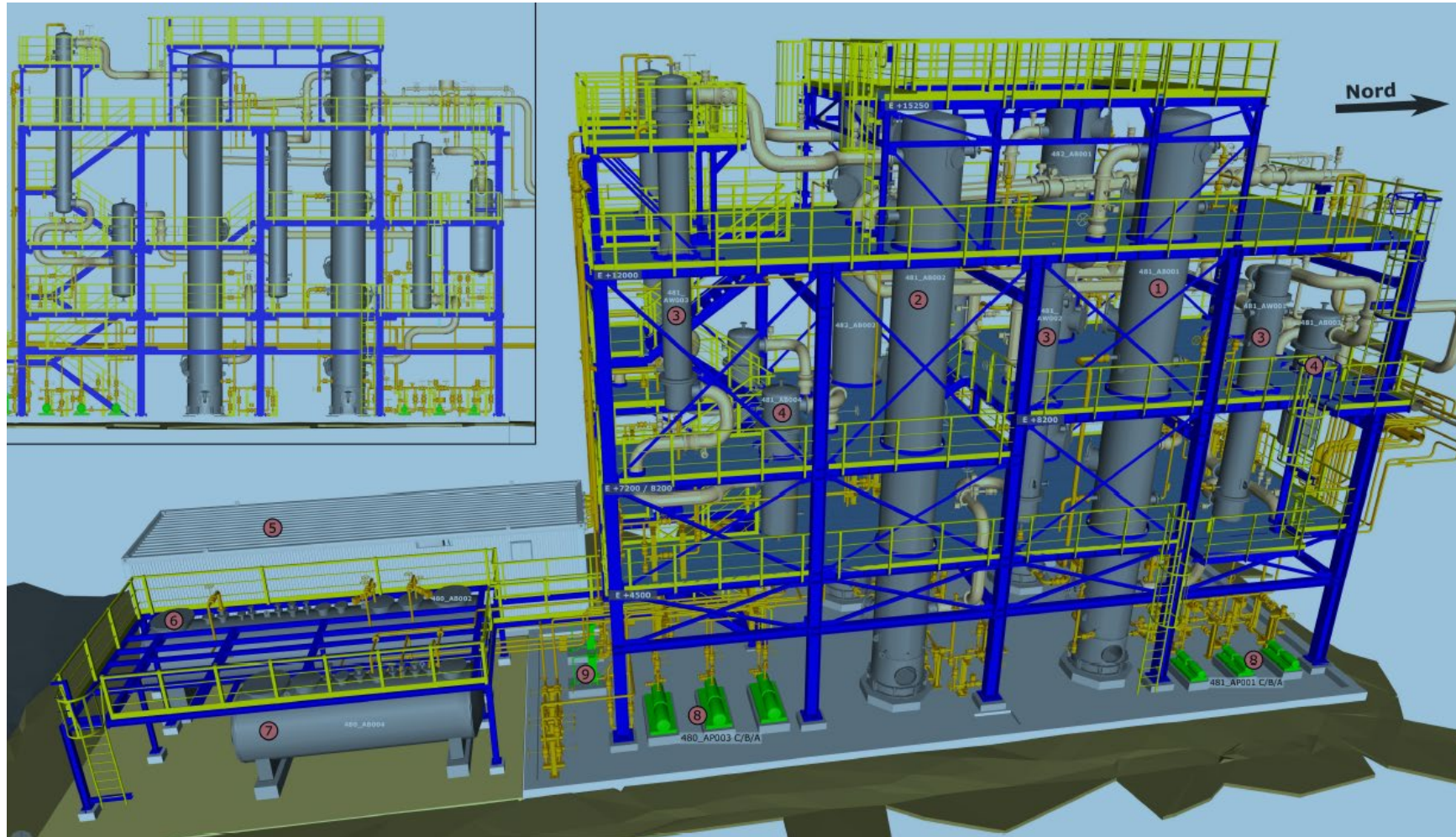
Technical Details High Pressure Scrubbing System

Basis of Design

	IN (from regular BPP)	OUT (from HP COG fine cleaning)
Coke Oven Gas Flow	40.000 m ³ /h (STP)	40.000 m ³ /h (STP)
Coke Oven Gas Temperature	22 – 27 °C	3 – 5 °C
Coke Oven Gas Pressure	< 0,5 bar g	6,5 – 13,7 bar g
Coke Oven Gas Composition		
H ₂	51 – 60 %	
CH ₄	20 – 25 %	
CO	5,5 – 7,5 %	
CO ₂	0,05 – 0,8 %	
N ₂	5 – 11 %	
O ₂	0,1 – 1,5	
NH ₃	< 0,03 g/Nm ³	
H₂S	< 0,5 g/Nm ³	< 20 mg/m ³
HCN	< 1 g/Nm ³	
BTX	approx. 30 g/Nm ³	< 500 mg/m ³
Tar	approx. 20 mg/Nm ³	

Technical Details High pressure scrubbing system

3D Model of the Plant



Main Dimensions

Length: 19,2 m

Width: 7,0 m

Height: 15,2 m

- 1 H₂S Scrubber (2x)
- 2 BTX Scrubber (2x)
- 3 heat exchanger (6x)
- 4 droplet separator
- 5 chiller plant
- 6 NaOH tank
- 7 scrubber oil tank
- 8 pumps (9x)
- 9 plate heat exchanger (2x)

Technical Details High pressure scrubbing system

Pictures from the reference plant in Germany





Thank you
for your attention !

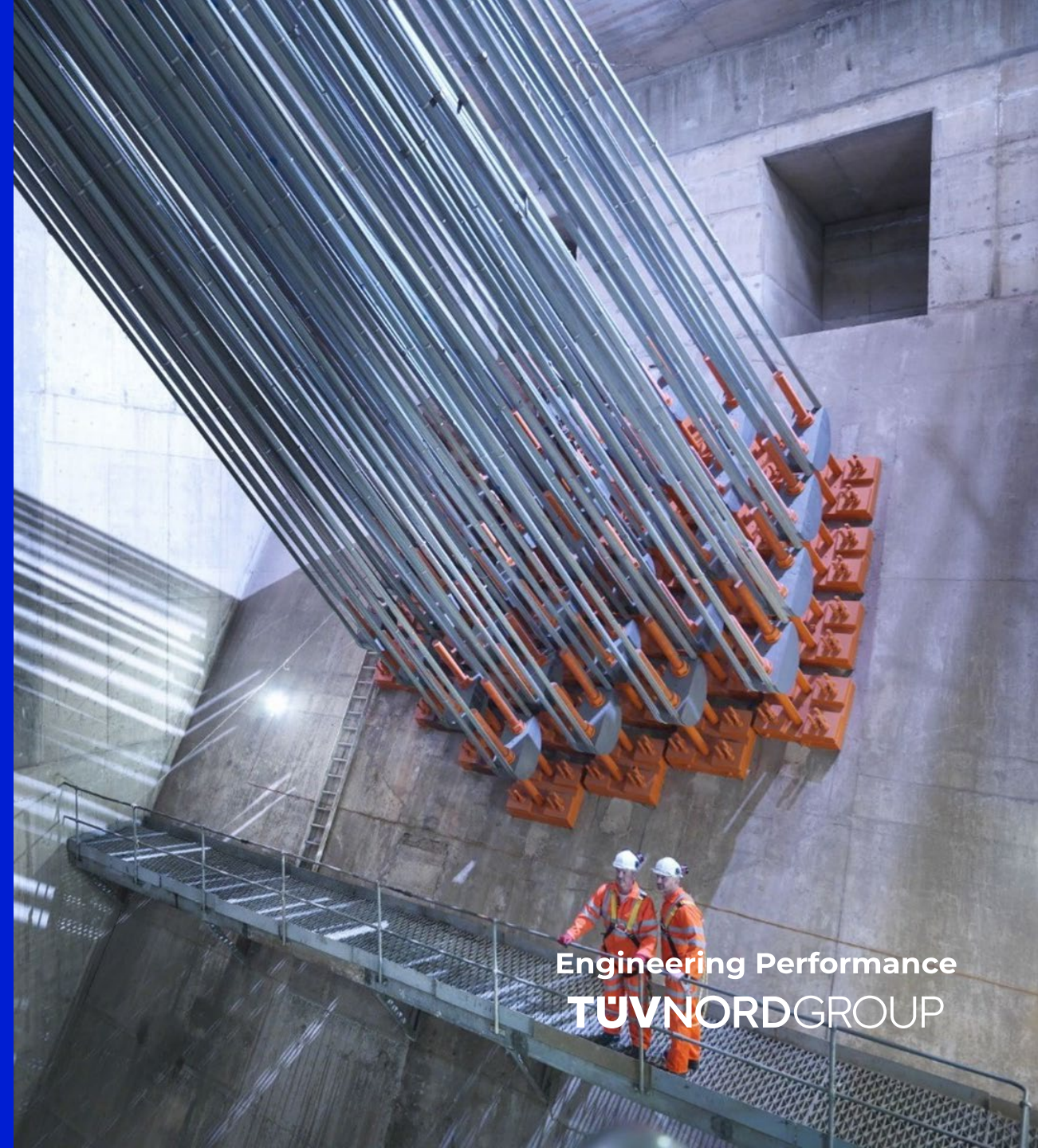
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Engineering Performance

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