



effee®

WE BRING THE HEAT

Effee 26th Oct 2023

Motivation for on-site repair



- Move work out of turn arounds
 - Reduce turnaround time / increase turnaround capacity
 - Improved and predictable quality
 - **Improved HSE**
 - Reduce POB
-
- Effe: Can handle projects from initial studies, qualification activities, project management, engineering and coordination to final execution

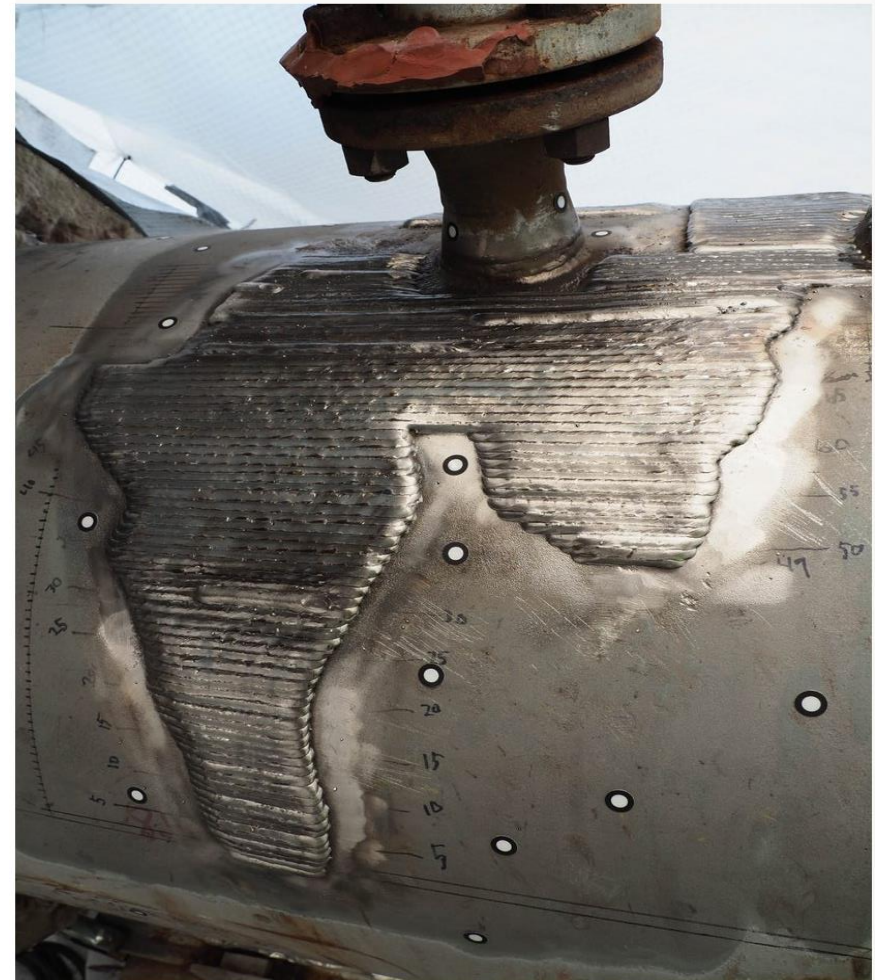
Effee On Site Repair, On-Stream



Robotic welding / AM repair of
on-stream equipment



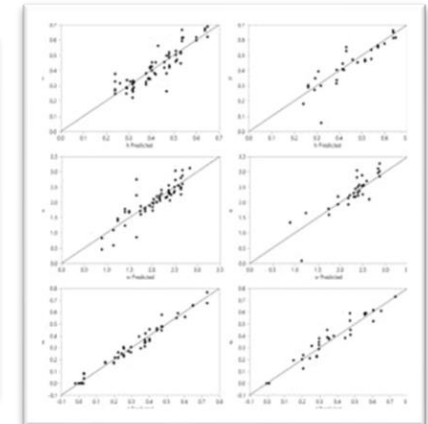
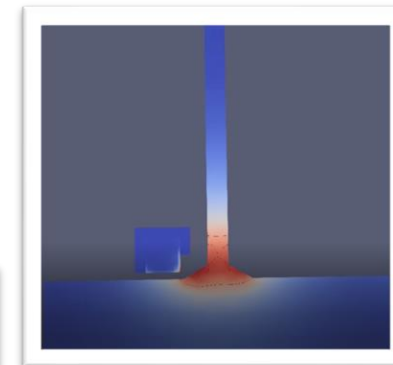
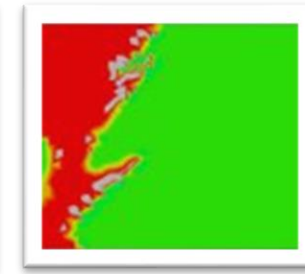
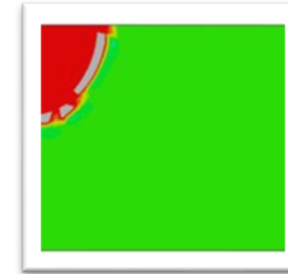
MAG (GMAW) welding of 1 mm plate




Tailored organization



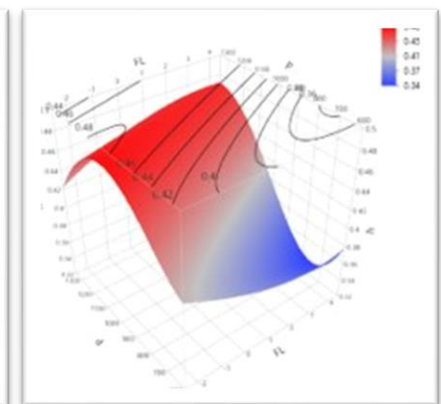
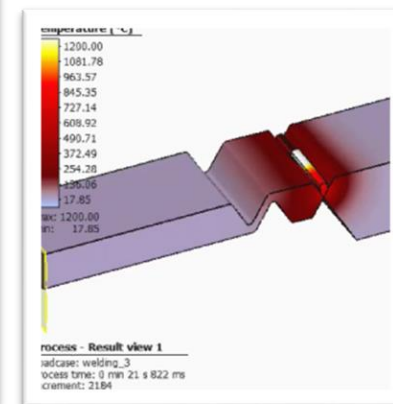
- Additive manufacturing
- Welding and induction simulation
- Induction heating
- Mathematical modelling, software and AI
- Materials science and engineering
- Robotic and manual welding expertise
- Laser welding
- Machining
- Mechanical engineering
- Standards, codes, rules and regulations





Utbedringer av korrosjonsskader på anlegg i drift.

Erik Belland
EFFEE INDUCTION AS
2021.02.04





effee

ETRONIC
VALUE

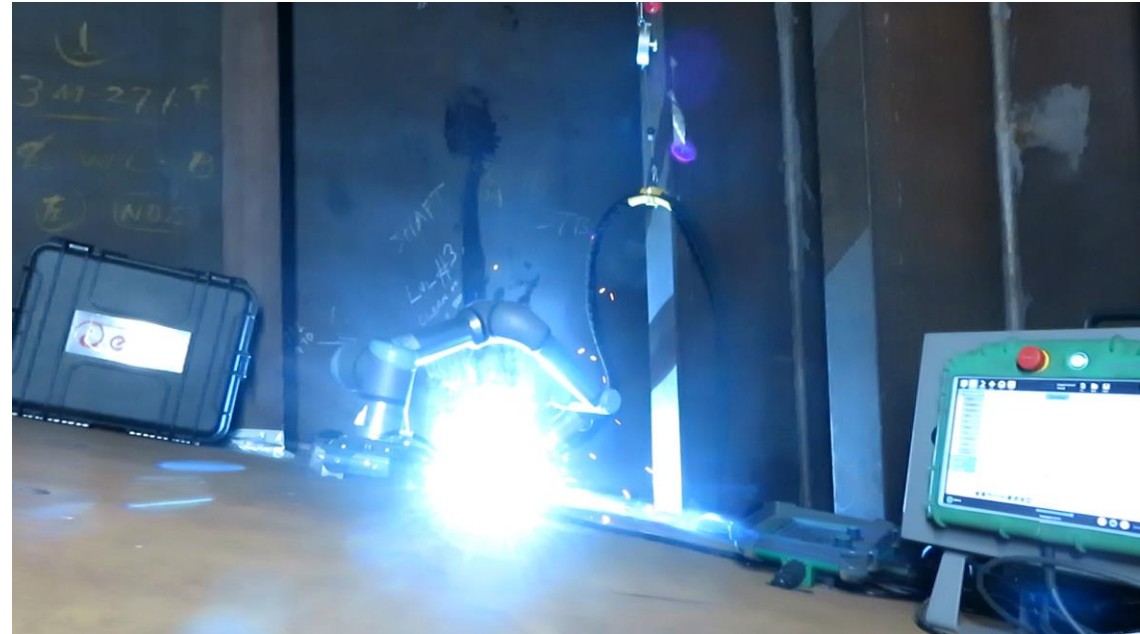


ZARGES

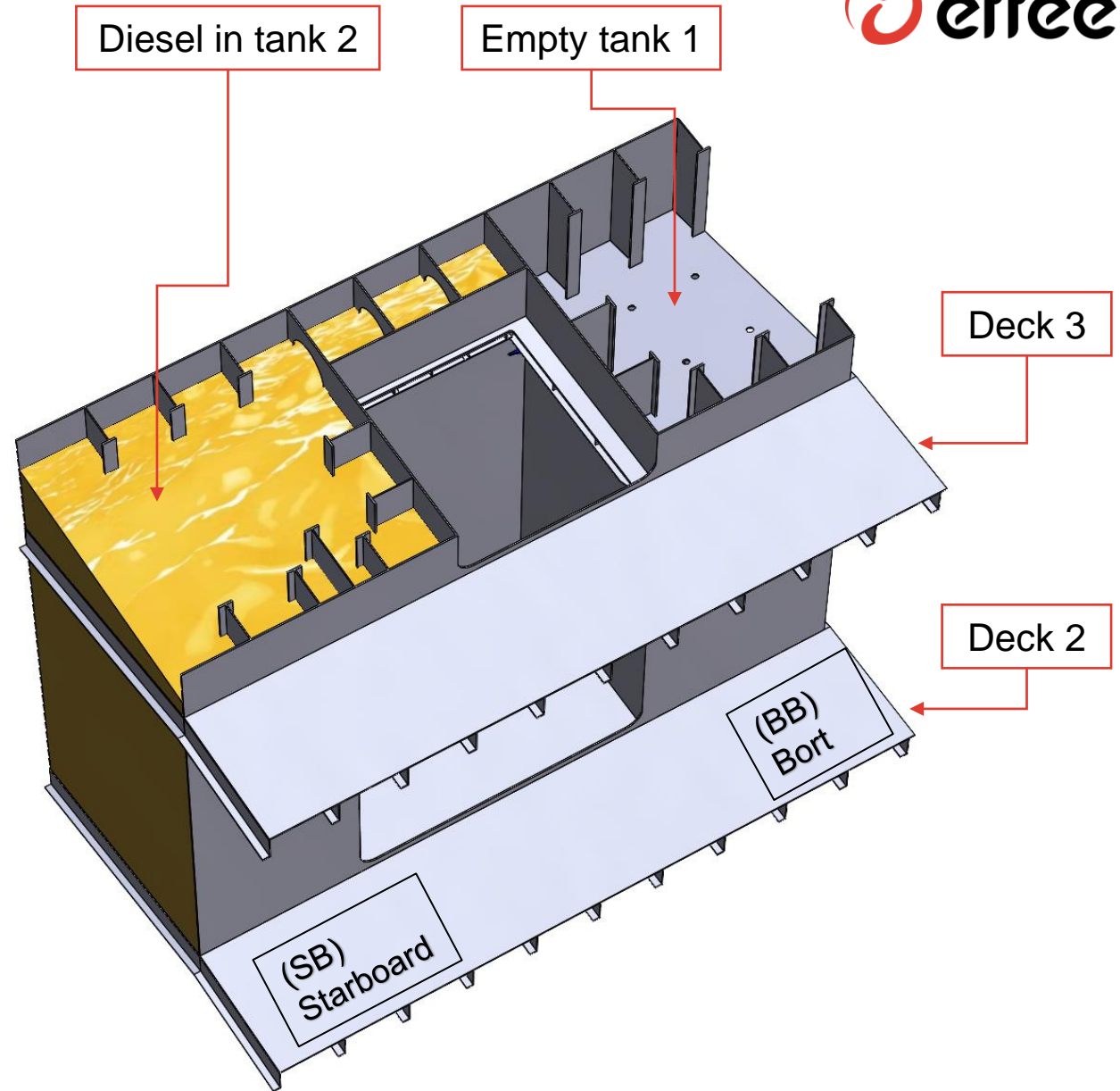
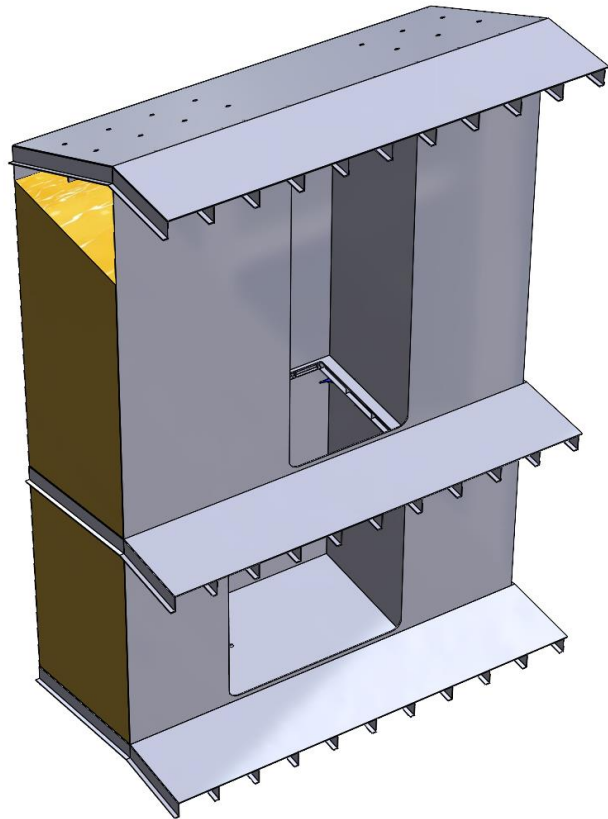
FPSO On-stream repair



- Fatigue crack discovered during inspection in diesel tanks containing fuel for emergency generators.
- Stiffening brackets installed to mitigate further fatigue damage.
- Robotized welding of stiffening brackets conducted to avoid shut-down.



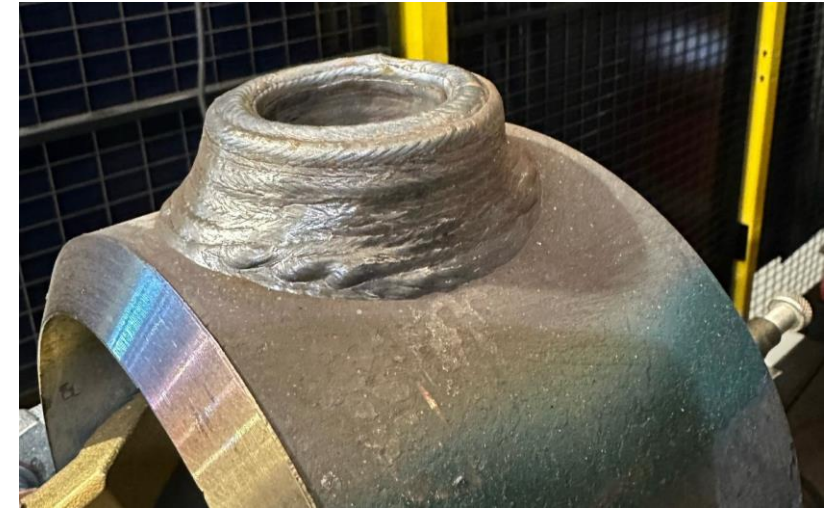
On-Stream Repair



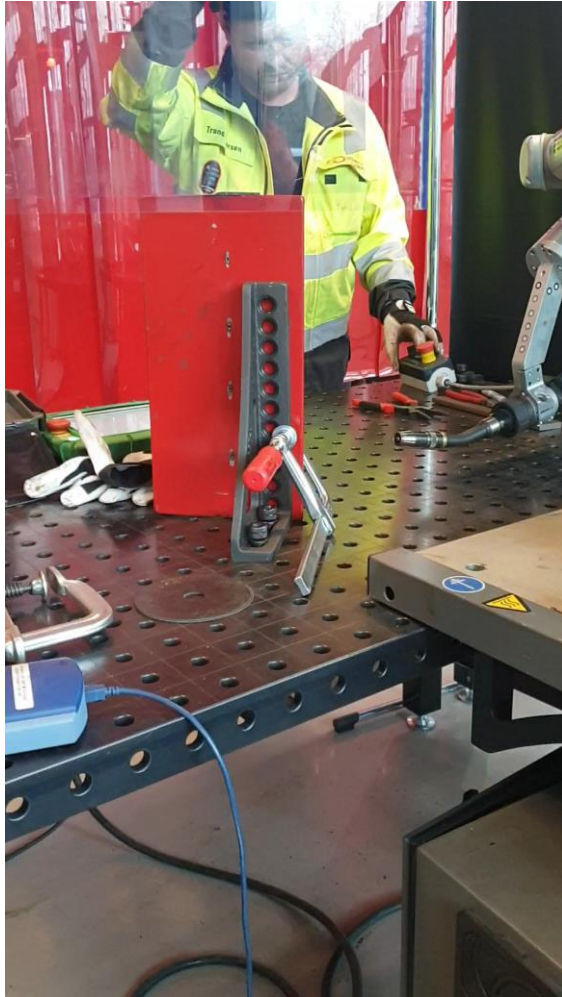
On-stream hot tap welding



Safer hot tap operations



Helicopter garage study



On-stream philosophy can be utilized to weld on plates and structures to avoid damage to Coatings or harmful fumes



Compact habitat for robotic welding

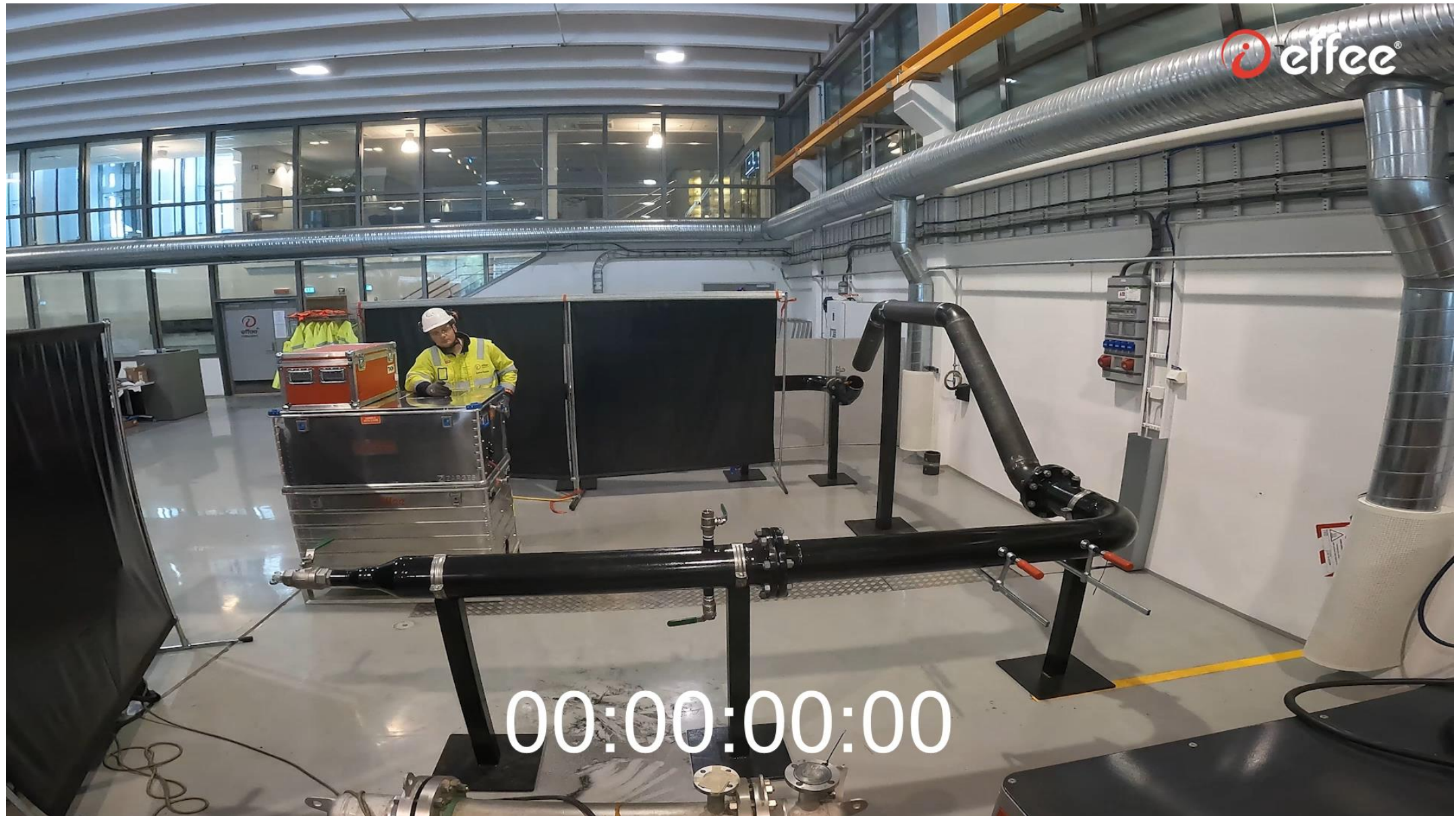


- Less hassle
- Less POB
- Added safety with Inert-gas

Only possible with robotic welding.



But, doesn't it take a long time to set up?





Weld build-up and cladding

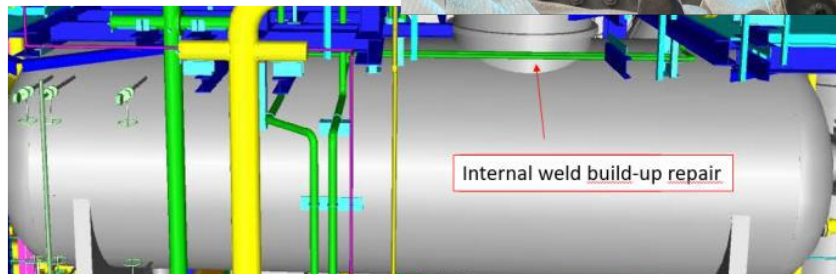
Deaerator vessel weld build-up



- 22.5 km filler metal giving 1.2 km weld, executed in 4,5 days (day & nightshifts), reducing time by around 70%

Local Post-Weld Heat Treatment (PWHT)

- No defects found during NDT
- Saved appr. 14 turnaround days.



Flare KO drum

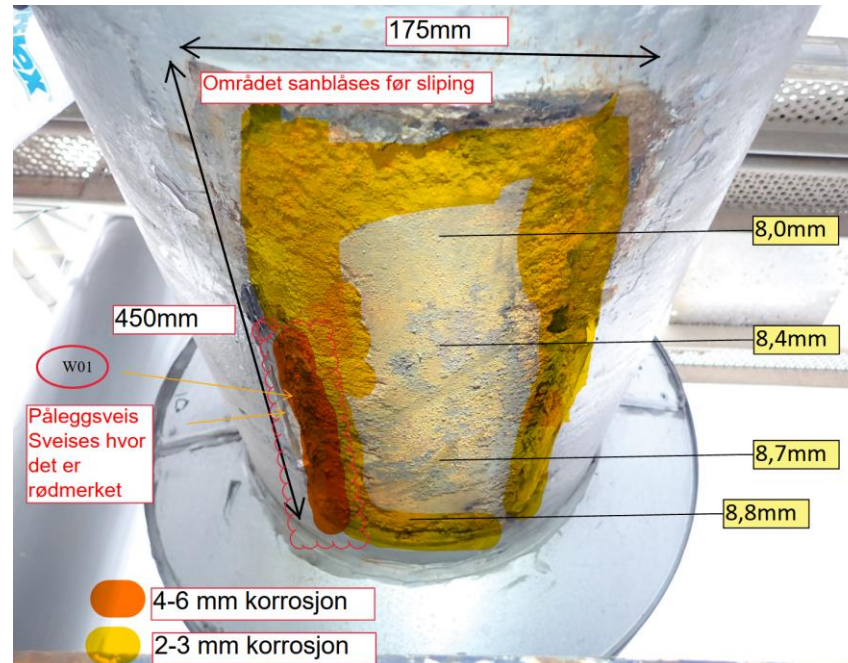
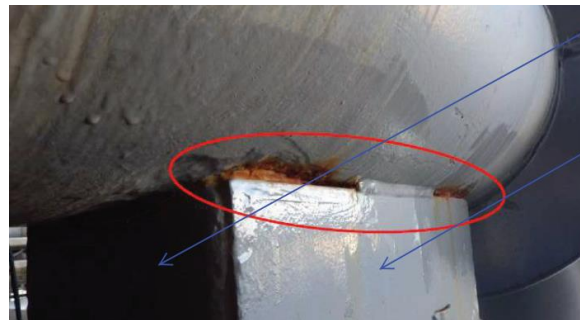


- 9 corroded areas internally in Flare KO Drum repaired with weld build-up, reducing execution time by 50% and allowing welding with operators positioned outside the vessel during welding



16'' Pipe external weld build-up

- Carbon steel pipe corrosion under pipe support (and insulation)
- 16'' Purge Gas, A106 Grade B steel, 7,92 mm nom. thickness incl. 1,5 mm corrosion allowance



After Magnetic Particle Test – The entire welded area ground flat to ensure that Ultrasonic Examination could be performed

Internal Cladding

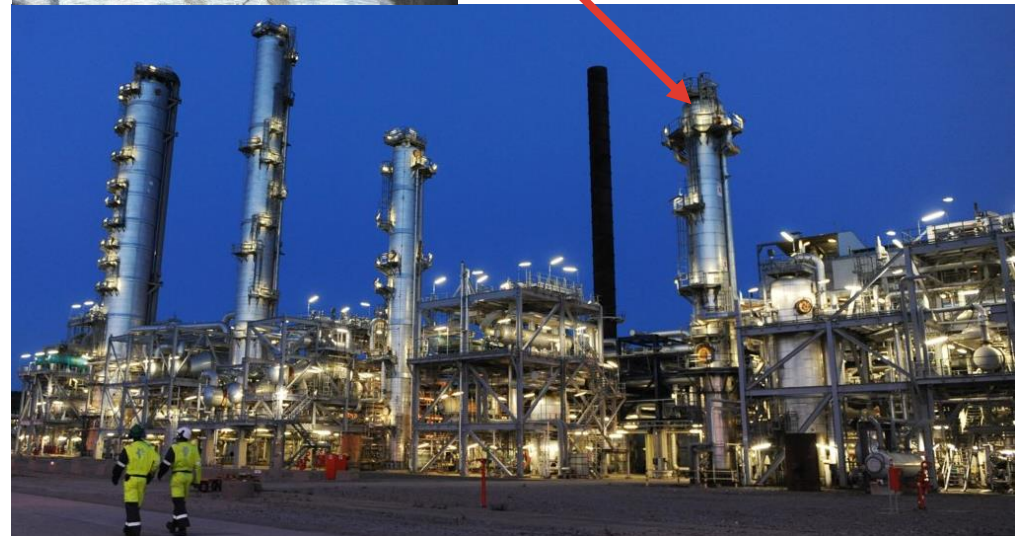


Equipment: Pressure Vessel (Saturator)
Material: CS - A516 gr. 70 + SS 309 and SS347 cladding

Hydrogen bake-out (by induction heating) and robot weld repair inside the Saturator column.

Inconel 625 cladding onto a combination of carbon steel, SS309 and SS347.

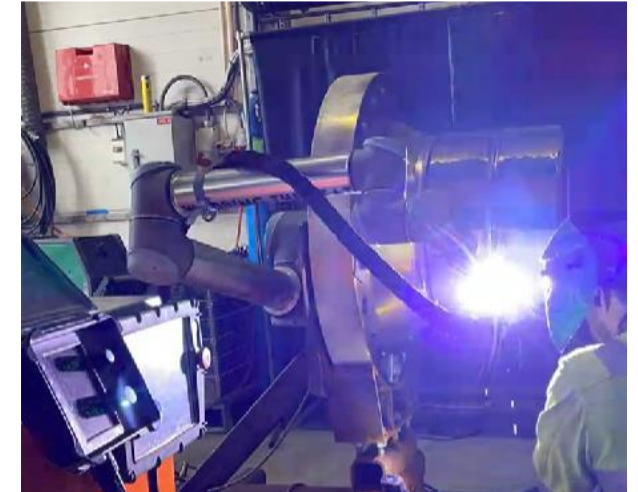
A highly specialized job that enabled large time and cost savings



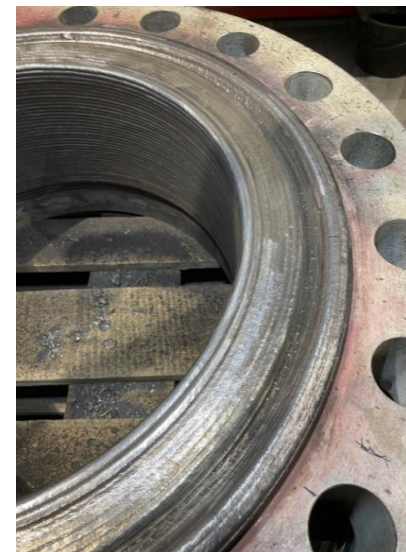
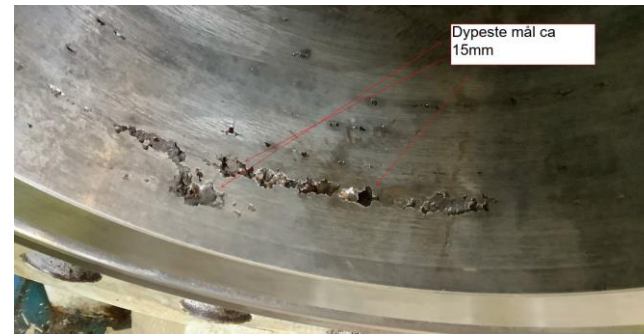
Inlet Heater, full pen robotic weld



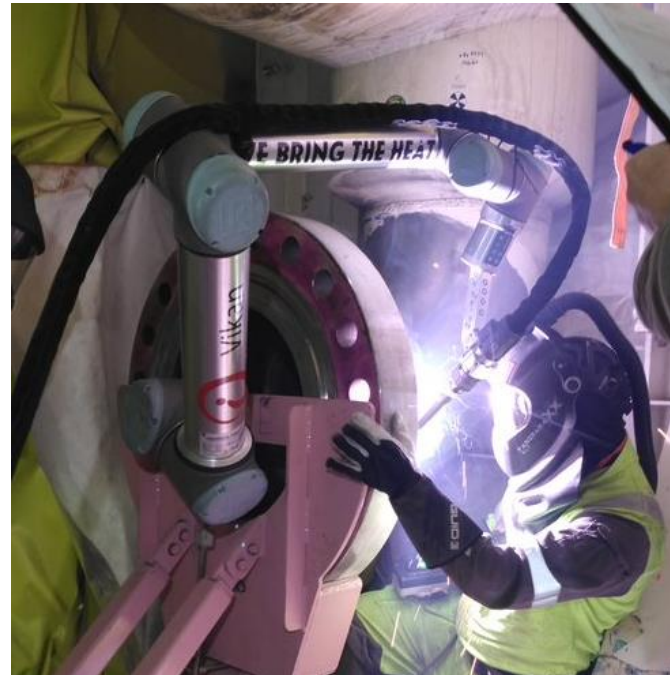
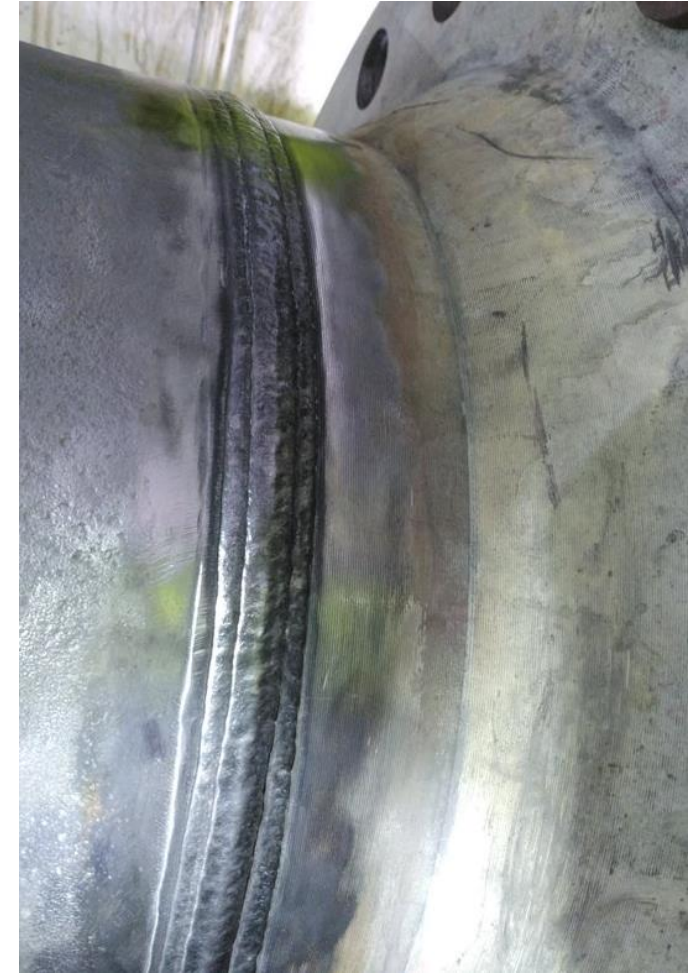
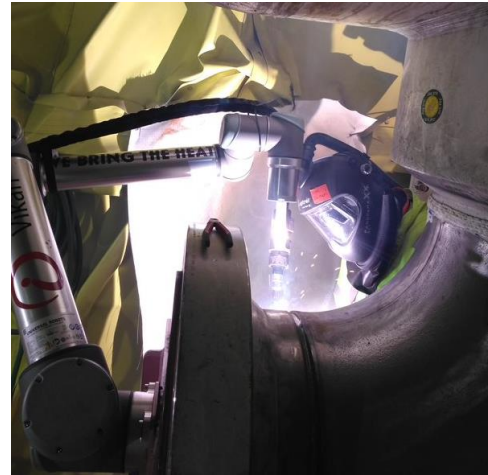
- Existing nozzle flange to be cut off and replaced with new flange because of internal corrosion
- «Golden weld» (i.e. no pressure testing after welding), requiring extensive NDT and inspector follow-up during qualification and execution
- PWHT performed after welding, and corrosion-resistant weld overlay (i.e. cladding) on the internal surfaces
- Executed offshore in November 2022



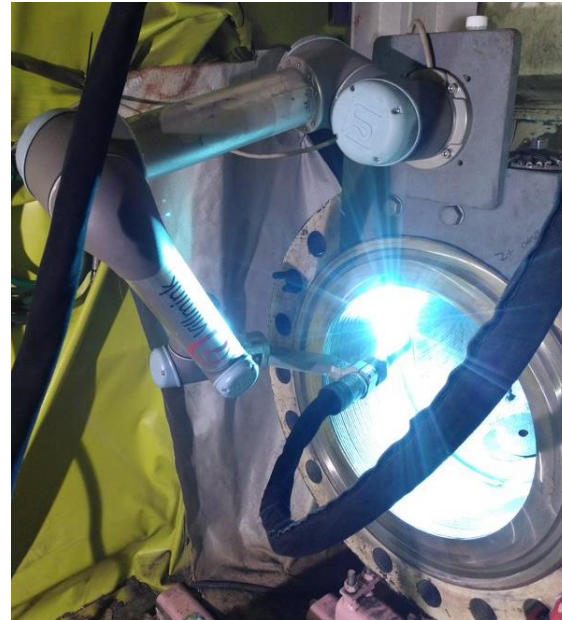
(New flange after cladding,
before machining)



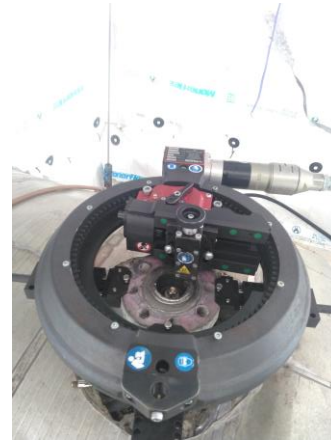
Inlet Heater, full pen robotic weld



Inlet Heater, full pen robotic weld



2'' nozzle, heat exchanger (internal corrosion)





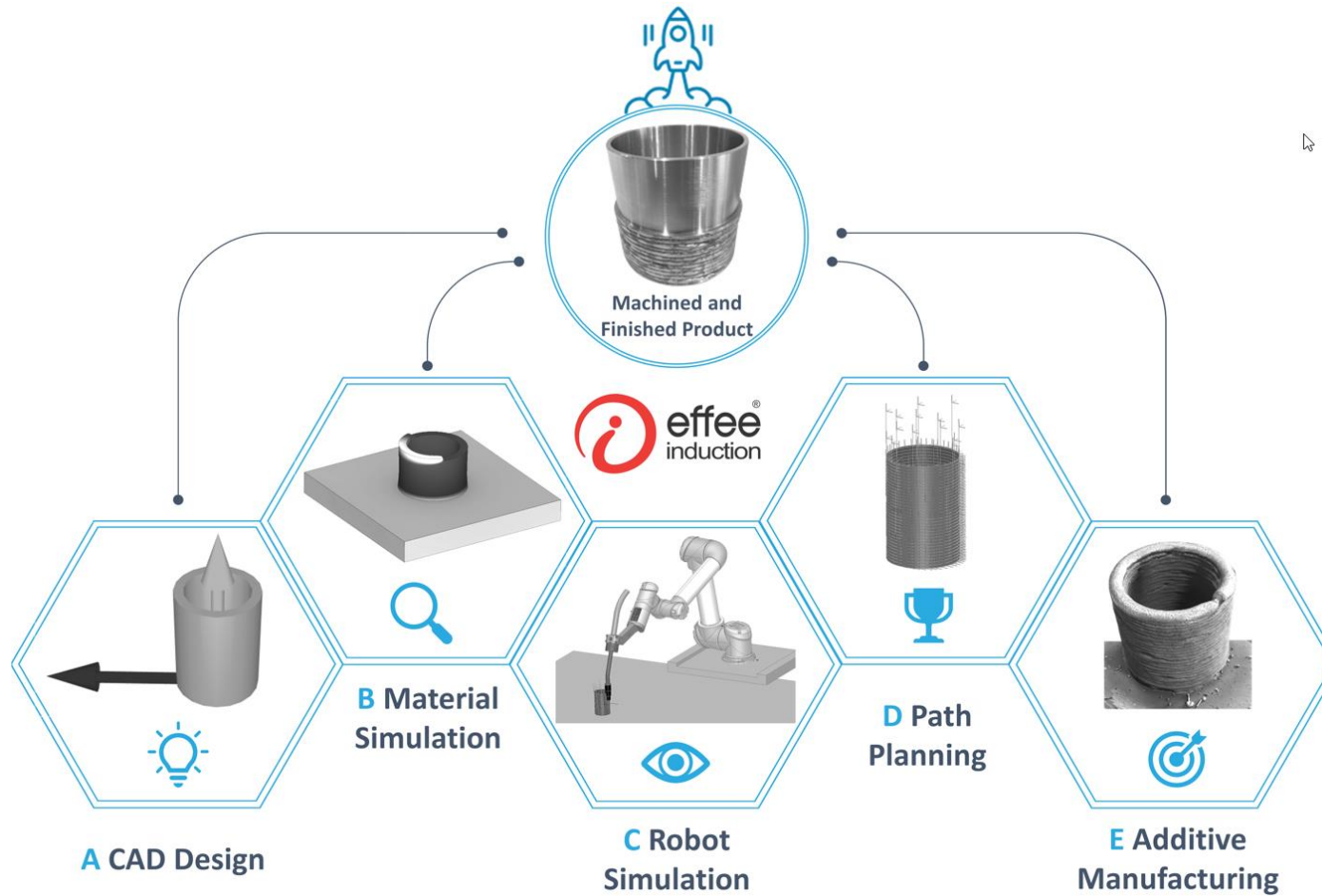
Special projects

320MW generator component





3D-printing: when you can't get it machined



Robotized Plasma cutting



Know what you get!



Sigma Select Sequence Repeat PF samples
(RD-SS-8) First Bead in clad layer

Offset →
Heat input
↓

+0 %
(0,368 kJ/mm)

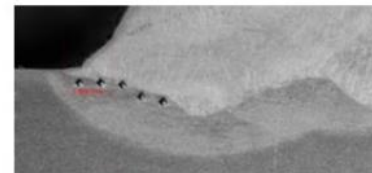
+10 %
(0,405 kJ/mm)

+20 %
(0,443 kJ/mm)

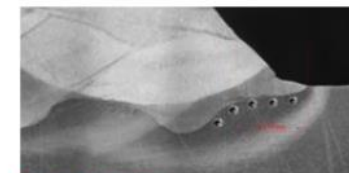
+1 mm

+1,5 mm

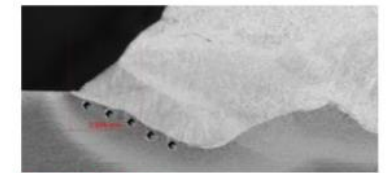
+2 mm



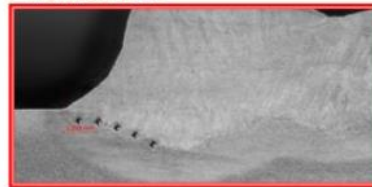
Avg HAZ start: 342



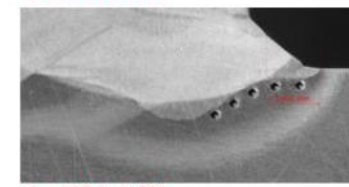
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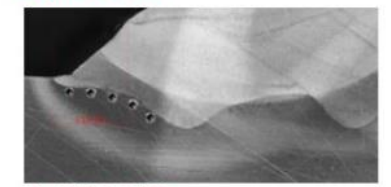
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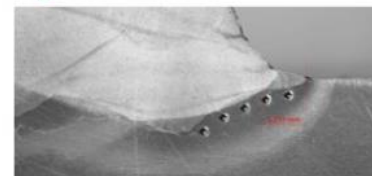
Avg HAZ start: 292



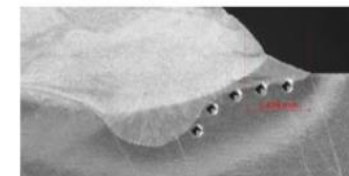
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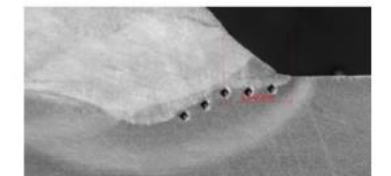
Avg HAZ start: 327



Avg HAZ start: 300



Avg HAZ start: 299



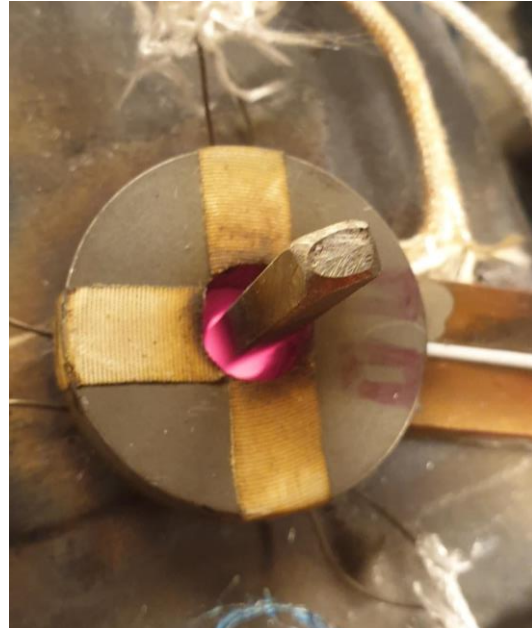
Avg HAZ start: 292

A person wearing a dark uniform is holding a handheld device with two circular emitters. The device is emitting a bright blue light. The background is dark and out of focus, showing some industrial or laboratory equipment.

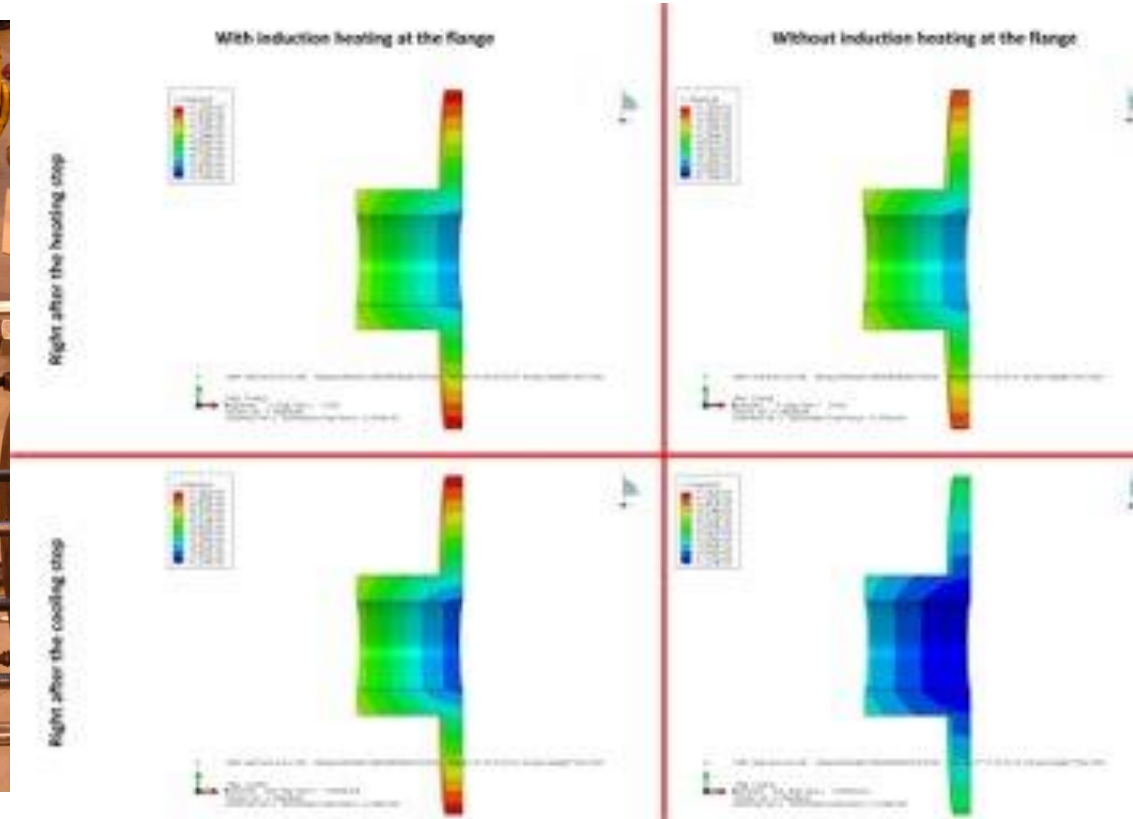
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Heat treatment

Local heat treatment



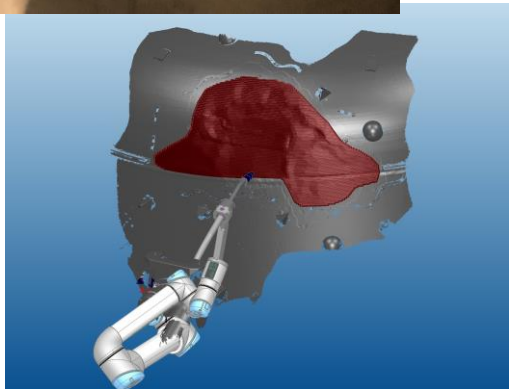
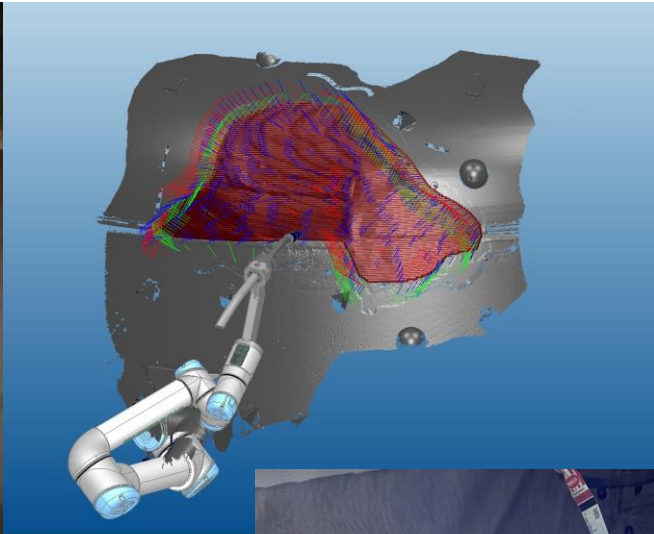
Simulations





Remote repairs

Blow off tank 3D print



3D-print on compressor casing



3D-scan

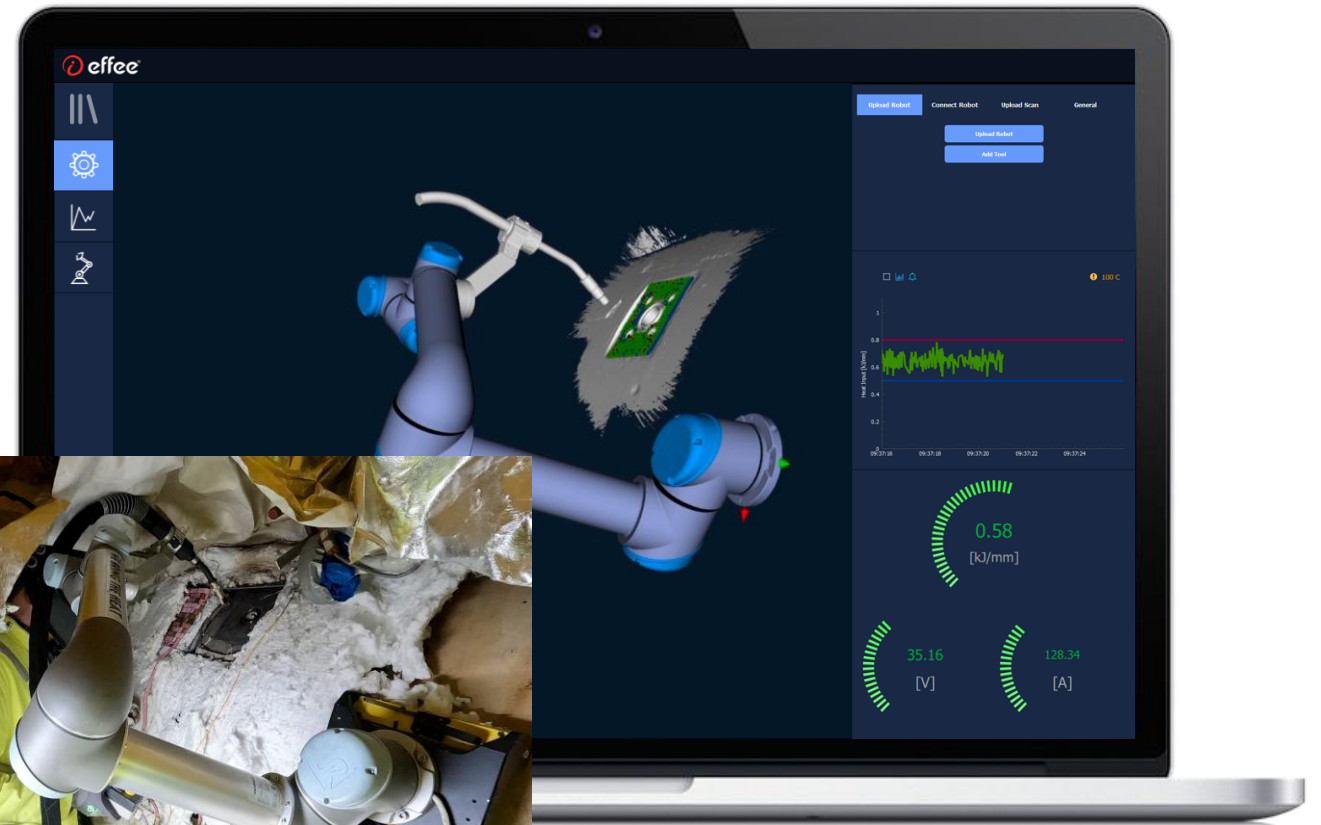
Planning & simulation - onshore

Rigging and preparations offshore

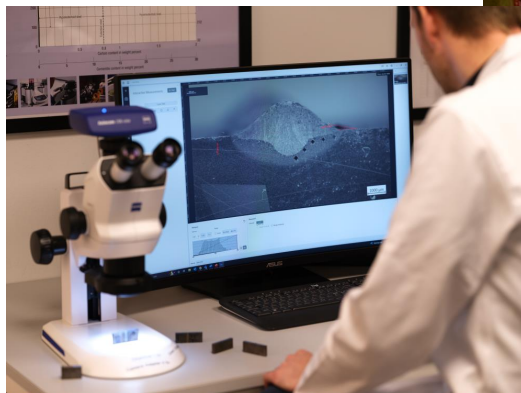
Send file offshore and load

Small adjustments

Play weld!

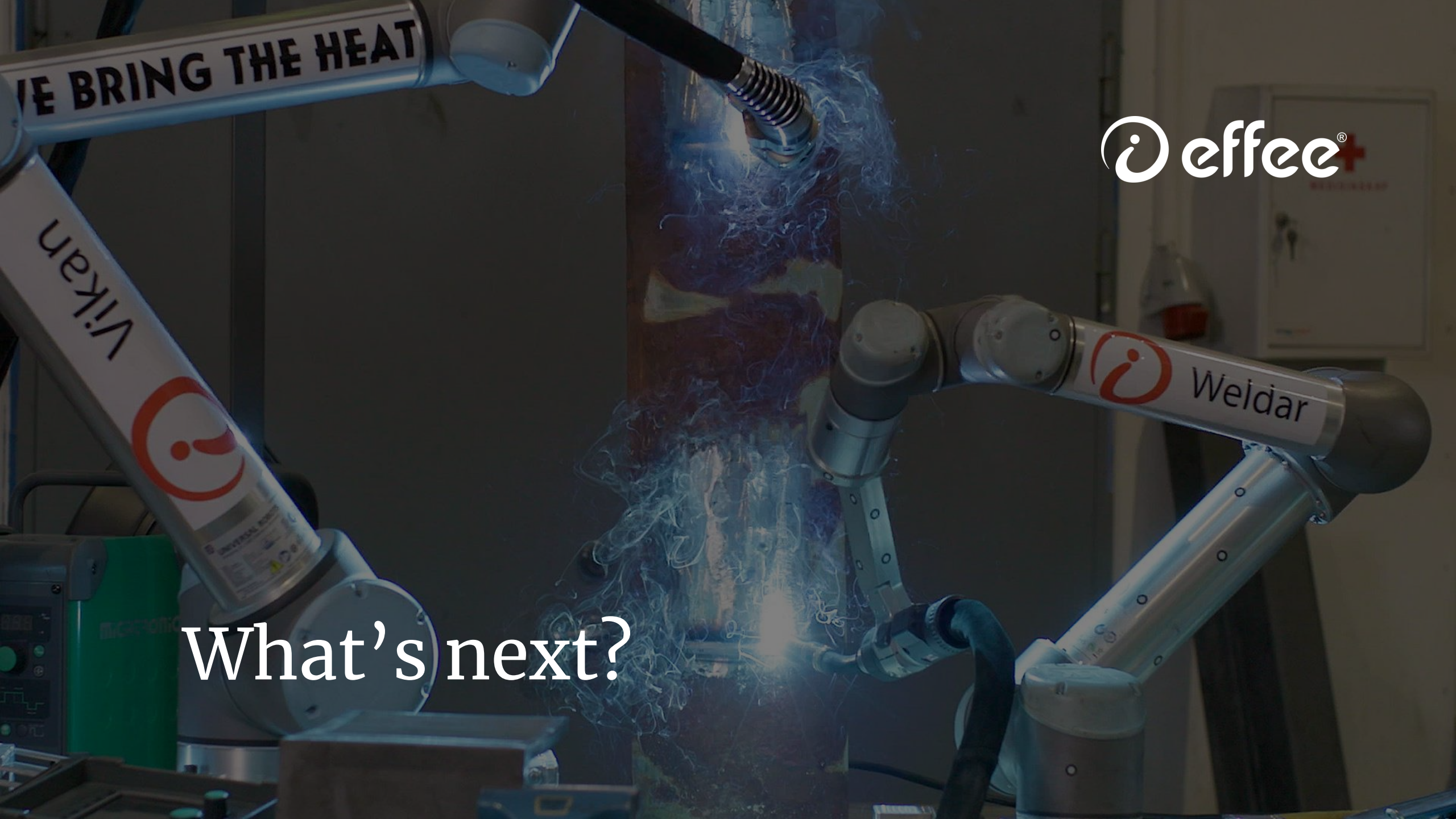


Simultaneous



Compressor repair Execution offshore





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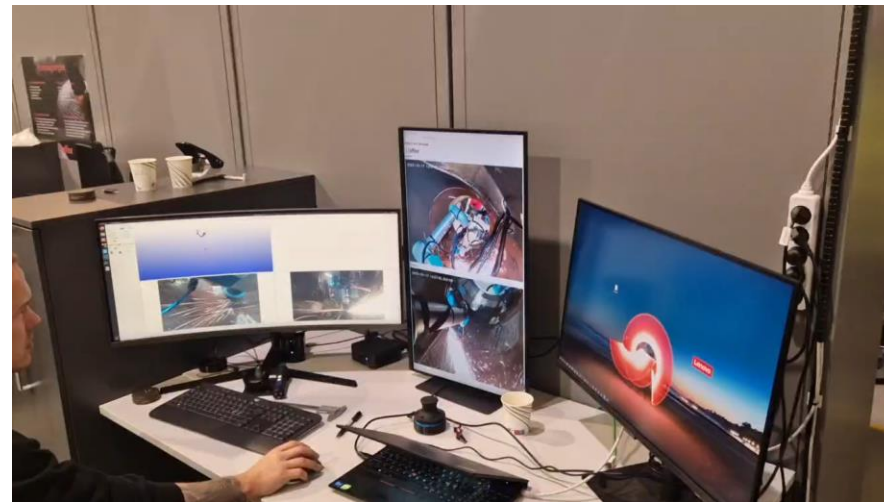
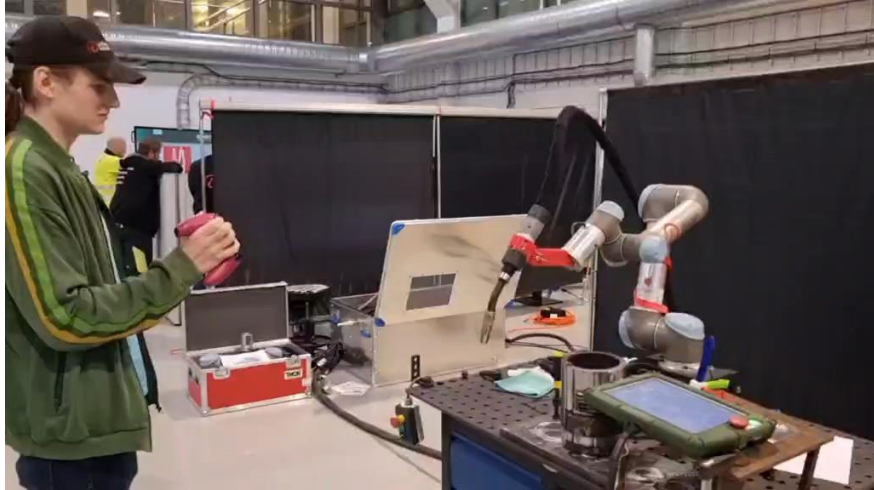
What's next?

(Fully) remote repairs

Next generation repair technologies



A new toolbox for remote repairs



Platform is developed – next steps



- Proof of concept for remote
 - Welding / additive manufacturing
 - Grinding
 - Laser cleaning
- Focus on;
 - Ability to adjust to different jobs, material qualities and filler metals
 - Ability to perform collision testing and tool path simulations to avoid robot failure modes
 - Digital documentation system for monitoring and recording
 - A demonstration ready solution
- Suggested next steps;
 - Evaluate: field readiness and experience exchange
 - Develop field ready solution and train operators
 - Tool carrier solution for bringing robot in place
 - Pilot project

Ripple effect

- Radical (but controlled) innovations happening!
- We are scratching the surface
- New technologies can transform the way we approach repairs



S

SAMHOLD

V

VERDISKAPENDE

E

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I

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