DETAPIPE™ - CHANGING REACTIVE METAL PIPE SYSTEMS FOR HPAL AND POX OPERATIONS

Edgar E. Vidal

evidal@nobelclad.com

NobelClad – VP of Marketing & Business Development

Colorado School of Mines – Affiliate Faculty in Extractive Metallurgy

Abstract

Availability and supply chain concerns around titanium are always in the minds of designers and end users of High-Pressure Acid Leaching (HPAL) and Pressure Oxidation (POX) circuits. Because of the extreme conditions of temperature, pressure and acidity, titanium alloys are often selected for components of these circuits such as the autoclave itself, valves, pipe straights and elbows. Because of the relatively thick walls needed for these pipes and elbows, the cost of these components can become an economic concern for the project. Additionally, handling, fixturing, repairing a solid titanium pipe adds technical challenges particularly in remote operations. NobelClad has developed a proprietary cylindrical cladding process to produce a titanium, zirconium or tantalum cladded surface on the inside of carbon or stainless-steel pipes – called DetaPipe™. In combination with explosion cladded flanges (DetaClad™), these pipe spools and elbows utilize significantly less amount of titanium alloys, where these alloys become just a corrosion barrier and not part of the pressure boundary. Because of the unique characteristics of the cladding process, many different titanium alloys can be used, including those that have increased corrosion, erosion and ignition resistance, which tend to be significantly more expensive when compared to pure titanium. Examples of combinations produced, along with mechanical, thermal and fatigue characterizations performed are presented.

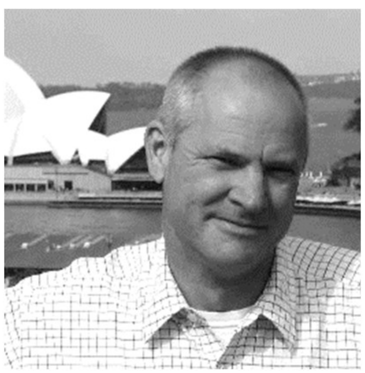
- Keywords: Clad pipes, explosive cladding, titanium, zirconium, tantalum, HPAL, POX, nickel extraction, refractory gold, acid leaching, autoclaves

Present at ALTA2024

Dr. Edgar E. Vidal

Vice President of Marketing and Business Development
Affiliate Faculty of The Kroll Institute for Extractive Metallurgy – Colorado School of Mines

Specializes in developing technologies and business opportunities related to selection and development of materials and processes. Professor of Extractive Metallurgy



Alex Van Leeuwarden

Managing Director at International Engineering Solutions Pty Ltd
Agent for NobelClad – Australia

More than 40 years' experience in industry from an engineering and maintenance perspective for: mechanical equipment, thermal applications (pyrometallurgical), corrosion resistant applications (hydrometallurgical), abrasion resistant applications, for existing operations or on newly constructed plants.

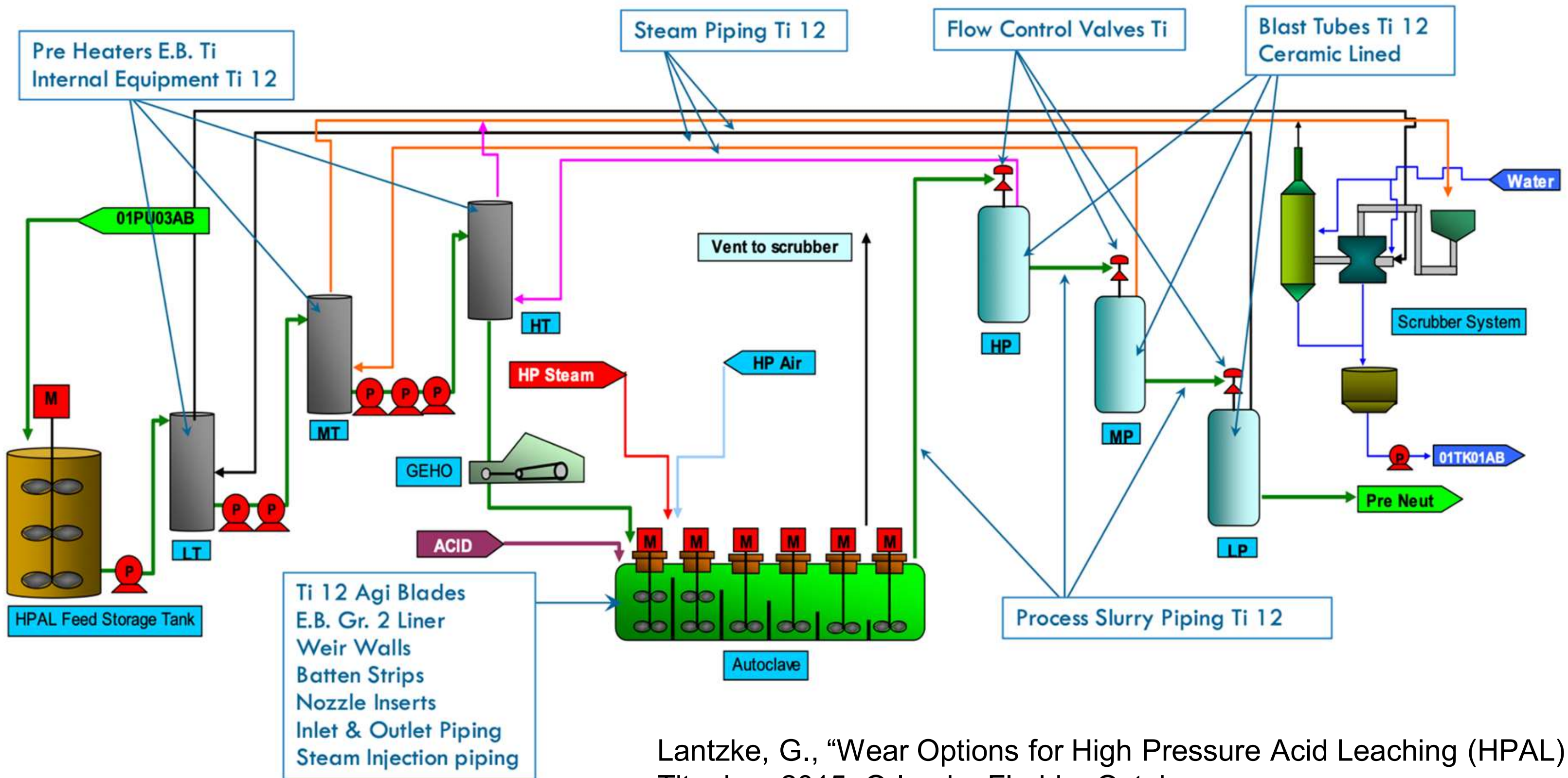
NobelClad is Global

- 200 employees
- 13 languages

Pennsylvania, United States

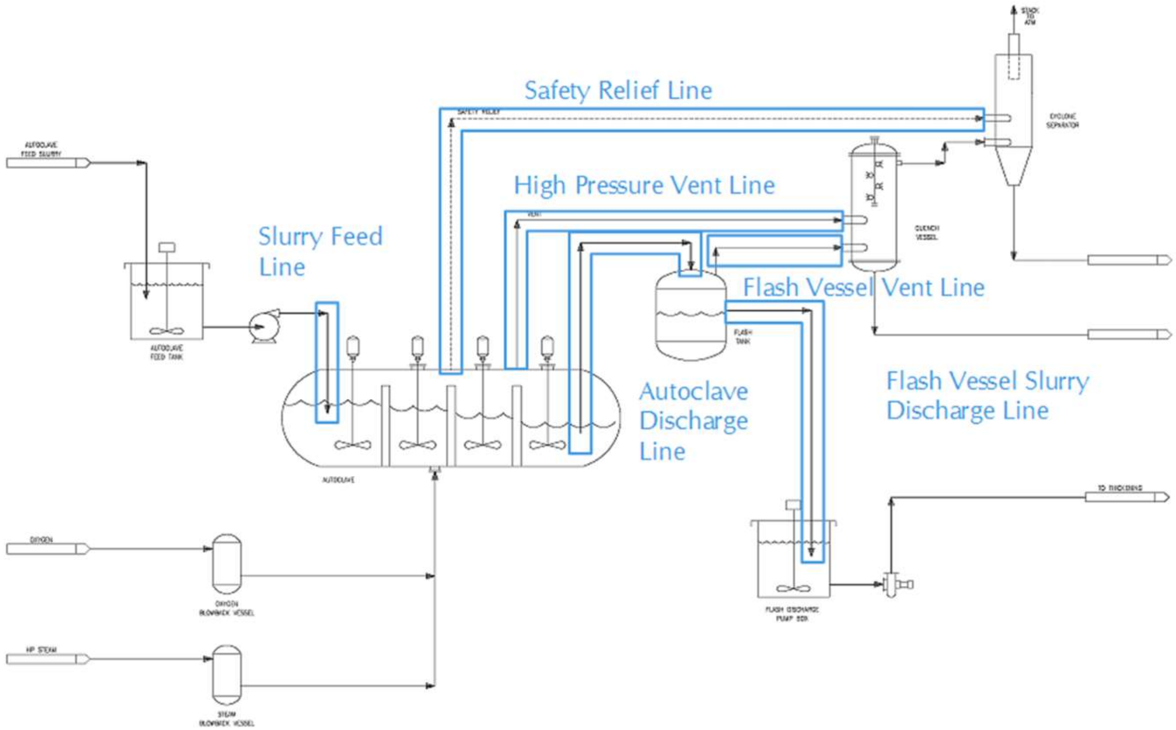
Rhineland-Palatinate, Germany

Use of Titanium Piping and Components



Lantzke, G., “Wear Options for High Pressure Acid Leaching (HPAL) Applications,” Titanium 2015, Orlando, Florida, October.

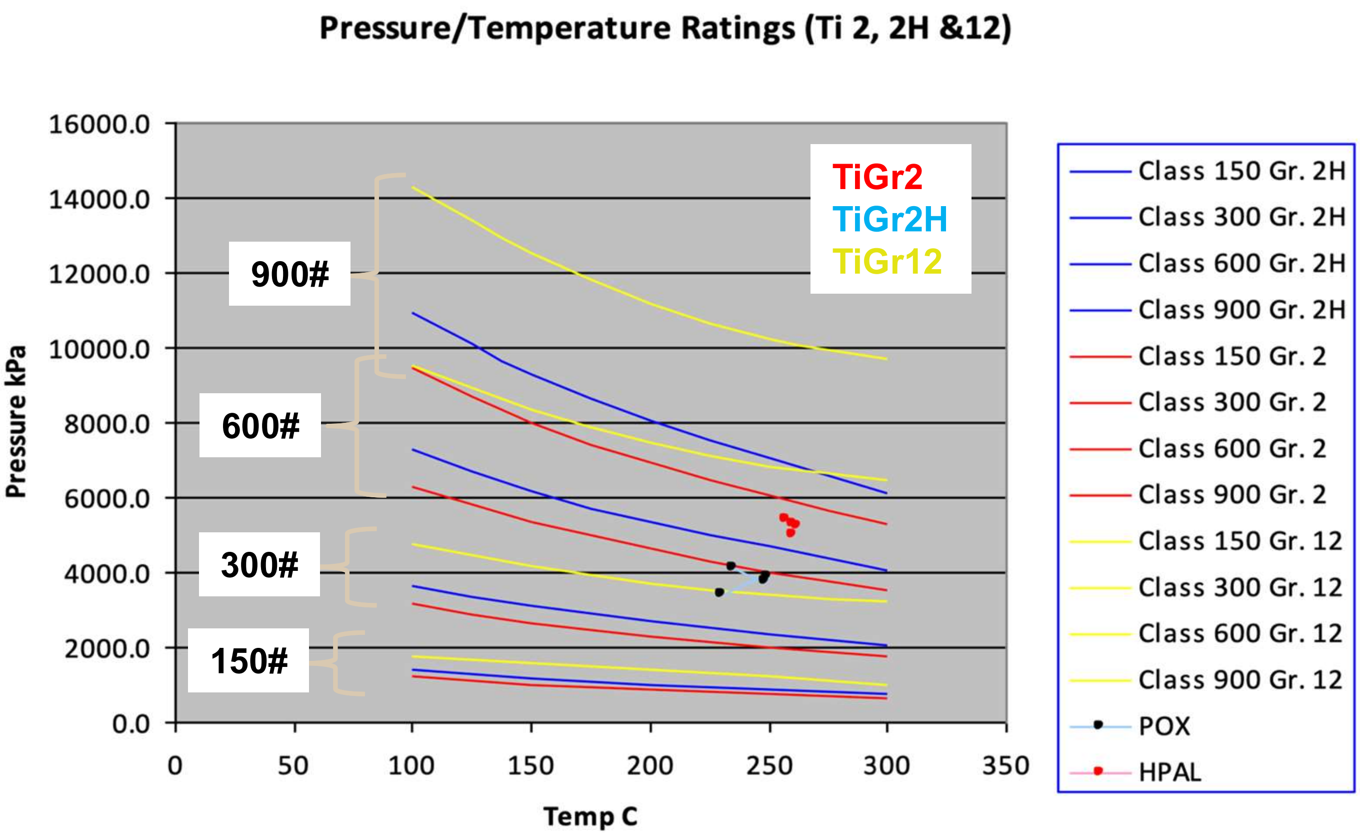
Use of Titanium Piping



Mercer, L.N., Clappison, J., "Design and Fabrication of Titanium Piping for Pressure Hydrometallurgy Service," Titanium 2010, Orlando, Florida, October.

- Pressure Class 300#
  - Slurry feed lines
  - High pressure vent line
  - Autoclave discharge line
  - Safety relief line
- Pressure Class 150#
  - Flash vessel vent and slurry discharge lines
  - Slurry sampling lines
- Suitable for HPAL and POX

Pressure and Temperature Ratings for Titanium Grades 2, 2H and 12



Mercer, L.N., Clappison, J., "Design and Fabrication of Titanium Piping for Pressure Hydrometallurgy Service," Titanium 2010, Orlando, Florida, October.

- Based on ASME B16.5 Appendix A equations
- Pressure/Temperature conditions of HPAL/POX are shown (red and black dots)
- Three case studies based on using:
  - TiGr2: #600, #900
  - TiGr12 #300, #600
  - Selection is to comply with ASME B16.34 for valves

Limitations of Working with Solid Titanium Pipes

Table 2 – Case Study Design Conditions

	Case Study 1 POX		Case Study 2 POX		Case Study 3 HPAL	
Material	Ti Grade 2H	Ti Grade 12	Ti Grade 2H	Ti Grade 12	Ti Grade 2H	Ti Grade 12
Flange Rating	600#	300#	600#	600#	900#	600#
Corrosion Allowance mm (inch)	3 (0.1)		3 (0.1)		3 (0.1)	
Design Temperature °C (°F)	230 (446)		249 (480)		260 (500)	
Design Pressure kPa(g) (psig)	3392 (491)		3875 (562)		5000 (725)	

Table 4A – Maximum Wall Thickness for Welded 3D Bends

Max Thickness for 3D bend – Welded Pipe		
Pipe Diameter mm (inch)	Ti Grade 2/2H	Ti Grade 12
50 (2)	sch 80	sch 40
100 (4) -300 (12)	sch 120	sch 80

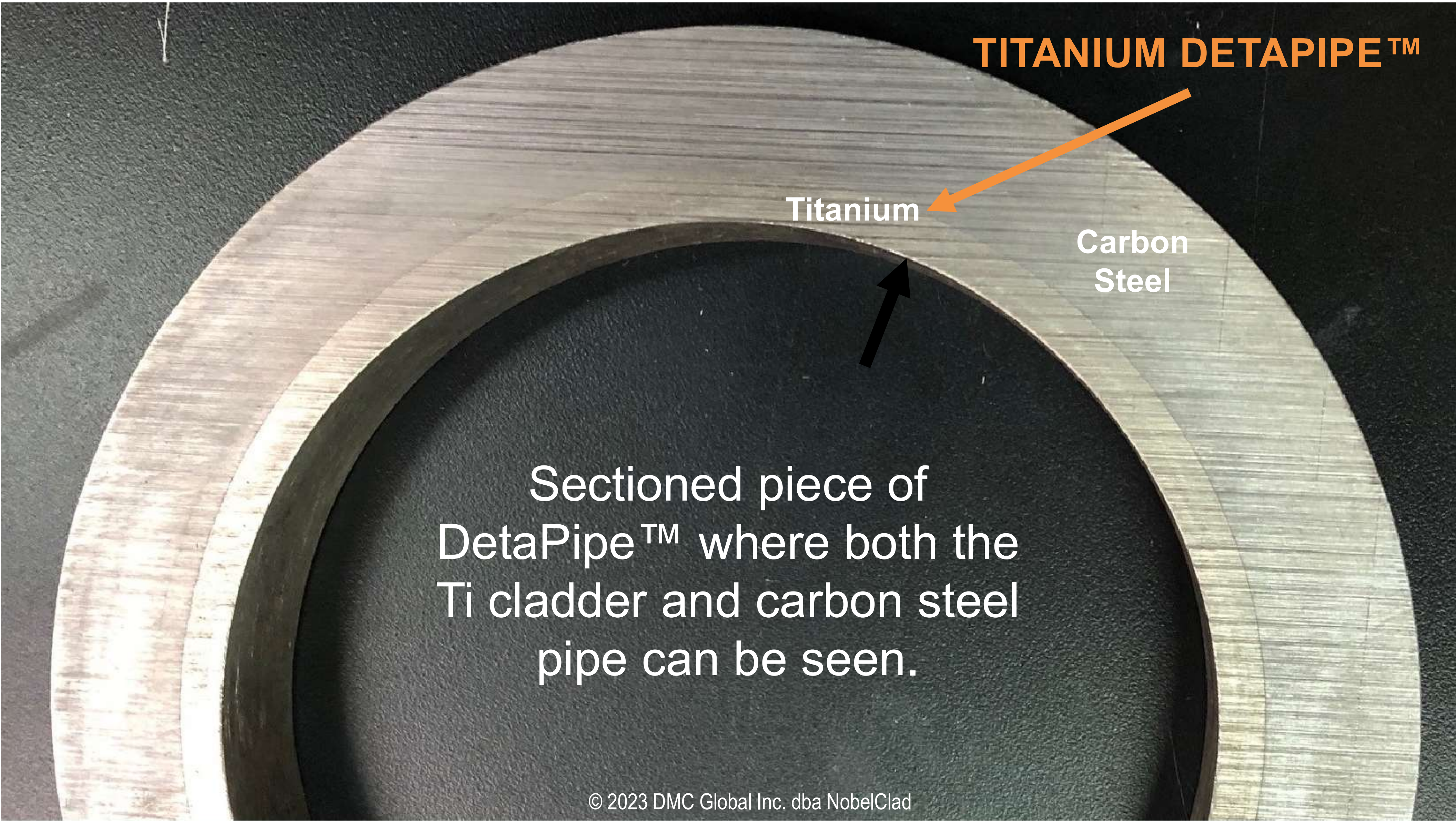
Table 4B – Maximum Wall Thickness for Seamless 3D Bends

Max Thickness for 3D bend - Seamless Pipe		
Pipe Diameter mm (inch)	Ti Grade 2/2H	Ti Grade 12
50 (2) -300 (12)	sch 160	sch 160

Mercer, L.N., Clappison, J., "Design and Fabrication of Titanium Piping for Pressure Hydrometallurgy Service," Titanium 2010, Orlando, Florida, October.

- The valve ratings override the design criteria for the pipe flanges
- Ti stubs with ASTM A150 carbon steel lap joint flanges are utilized to reduce cost
  - However, the pressure/temperature rating of titanium still rules since it is lower than carbon steel
- The actual titanium wall thickness is not based on the flanges, but the actual pressure/temperature of the process
- Ti pipe thickness is limited by its fabricability into 3D bends

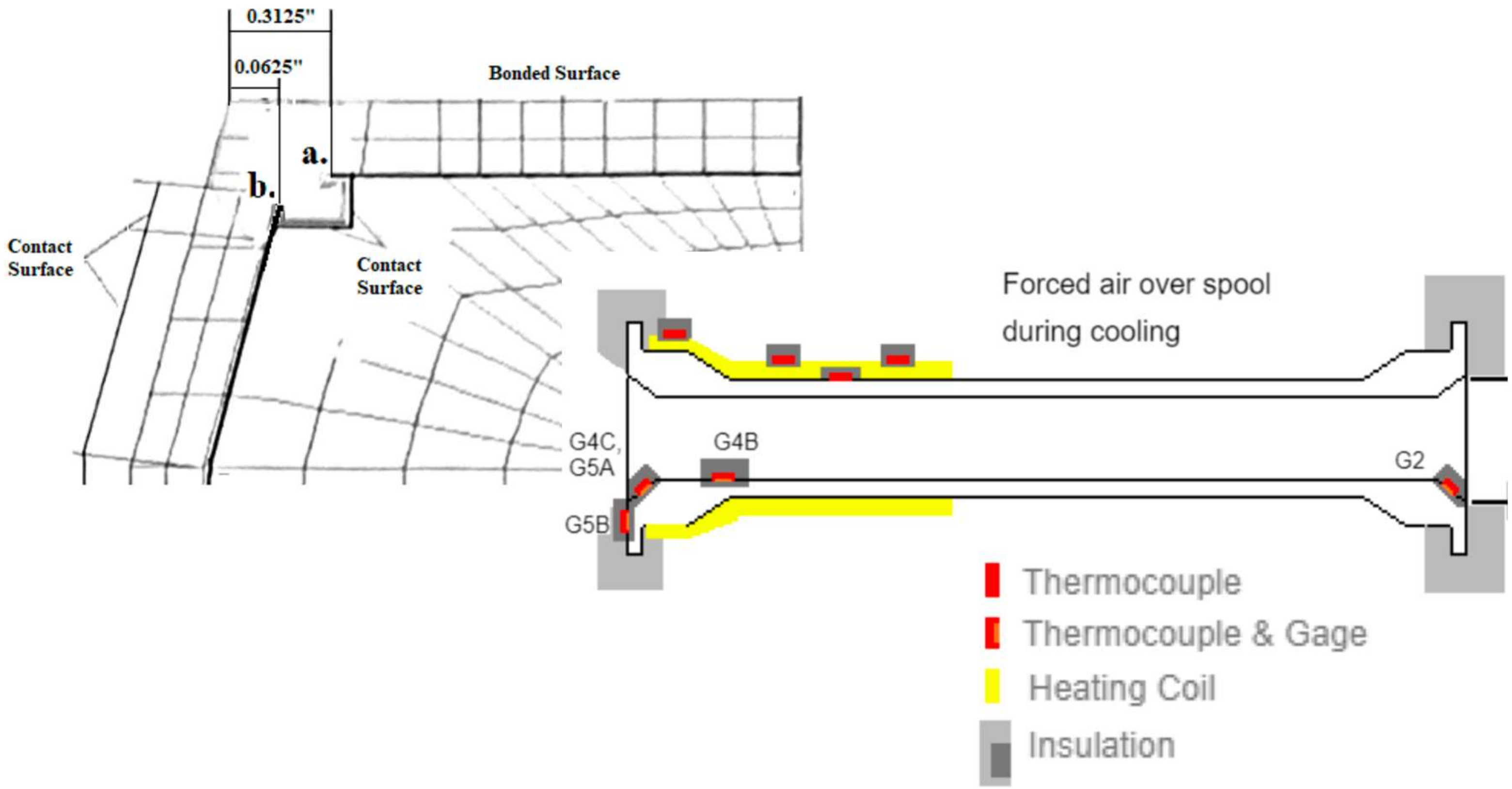
There is a solution: DetaPipe™ Titanium or Zirconium or Tantalum


TITANIUM DETAPIPE™
Titanium
Carbon Steel
Sectioned piece of DetaPipe™ where both the Ti cladder and carbon steel pipe can be seen.
© 2023 DMC Global Inc. dba NobelClad

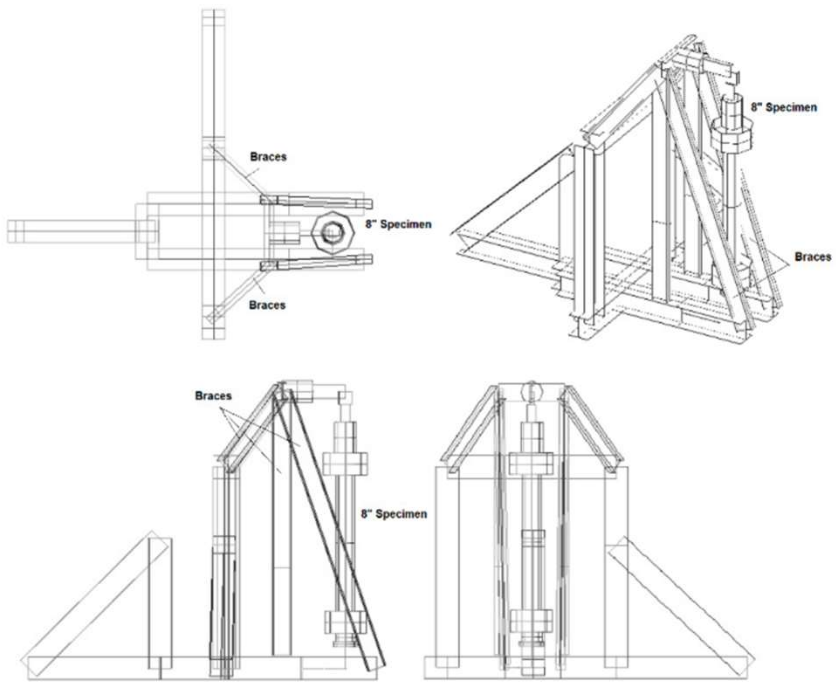
What is Being overcome with DetaPipe™

- Rather than a pipe completely made of titanium, we only use the minimum corrosion allowance thickness of titanium since it is a cladder (e.g. 3-mm)
- The pipe thickness is still designed for the the pressure/temperature of the process, but now, there is no issue with the pressure/temperature rating of titanium being lower than carbon steel
- The maximum thickness of walls for making a 3D bend is not an issue anymore since the pipe it self is carbon steel
- ASME B16.5 and B31.3 still apply, but much easier to implement since it is carbon steel.
- External pipe maintenance and fixturing is simple using carbon steel compared to titanium
- DetaPipe™ can be made using indifferently with seam-welded or seamless titanium

NobelClad has performed extensive thermomechanical Tests to ensure the reliability of the product



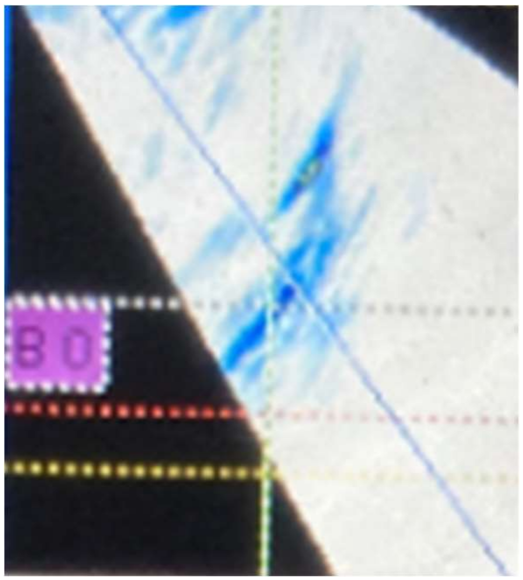
Markl / Hinnant Load Frame for Bending Fatigue Tests



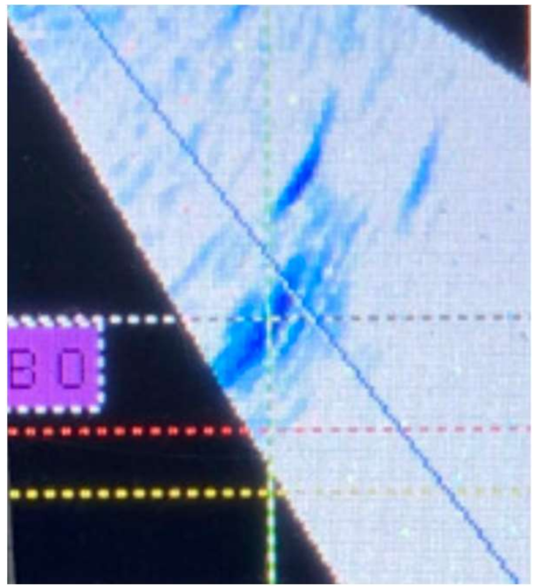
8" Sched 160 Specimen and Bracing

Phased Array UT Analysis of the Flange Weld – 8” 1500# Pipe

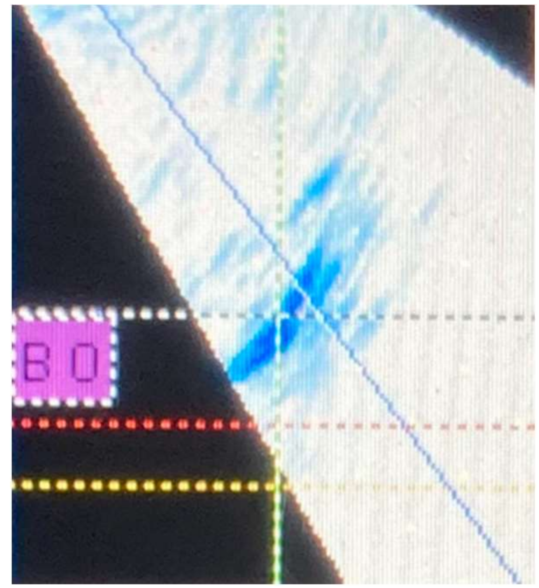
DetaPipe Under Thermal Cycling to 200C and 250 bar – Checked Every ~100 cycles



Reference flaw location at 0° and 0 cycles



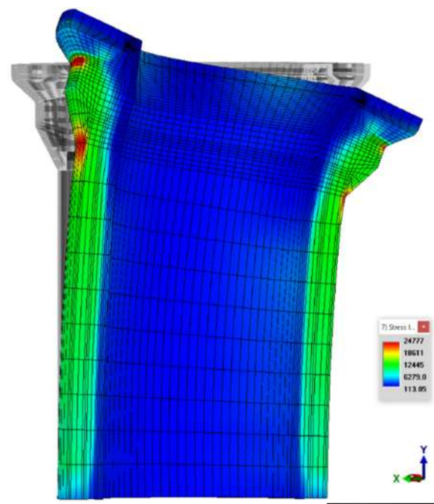
Reference flaw location at 0° and 183 cycles



Reference flaw location at 0° and 1602 cycles

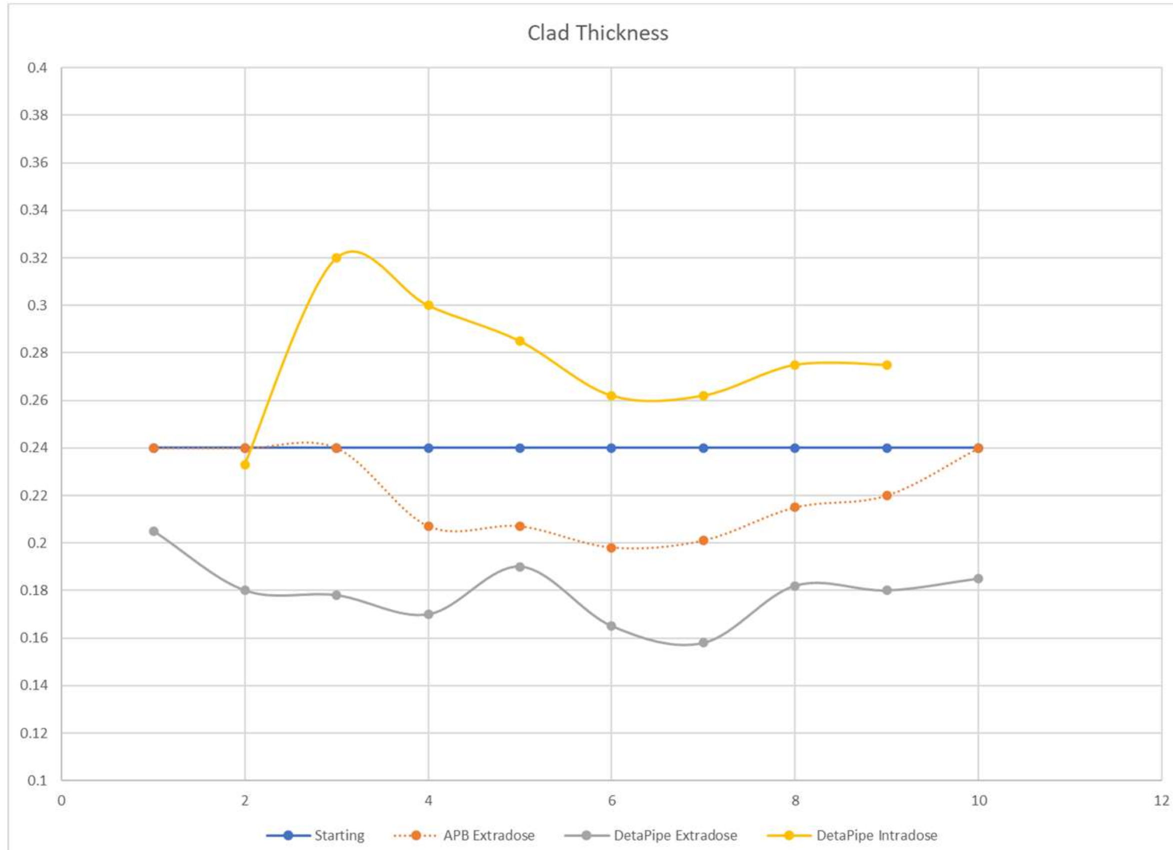
DetaPipe™ Pipe Spool Evaluation

- FEA & Cycle Fatigue Failure Analysis
  - Thermal cycling > 200°C and > 250 Bar
  - 1600+ cycles no cracks
- Exceeds performance of B31.3 for solid titanium
- Can it withstand thermal and pressure cycling?
  - 1600+ cycles
- PT of ID & Surface of Flange face welds
- Thermal cycling at pressure, temperature and bending moment



DetaPipe™ Elbow – R&D product advancement

1st trial elbow assembly 1.5D radius



DetaPipe™ Elbow – R&D product advancement

2nd trial elbow

- 16” NPS, Sch 40 LR Elbow
- 14” NPS Ti-Gr.2, Sch 40 LR Elbow with Ti-Gr.2 pipe

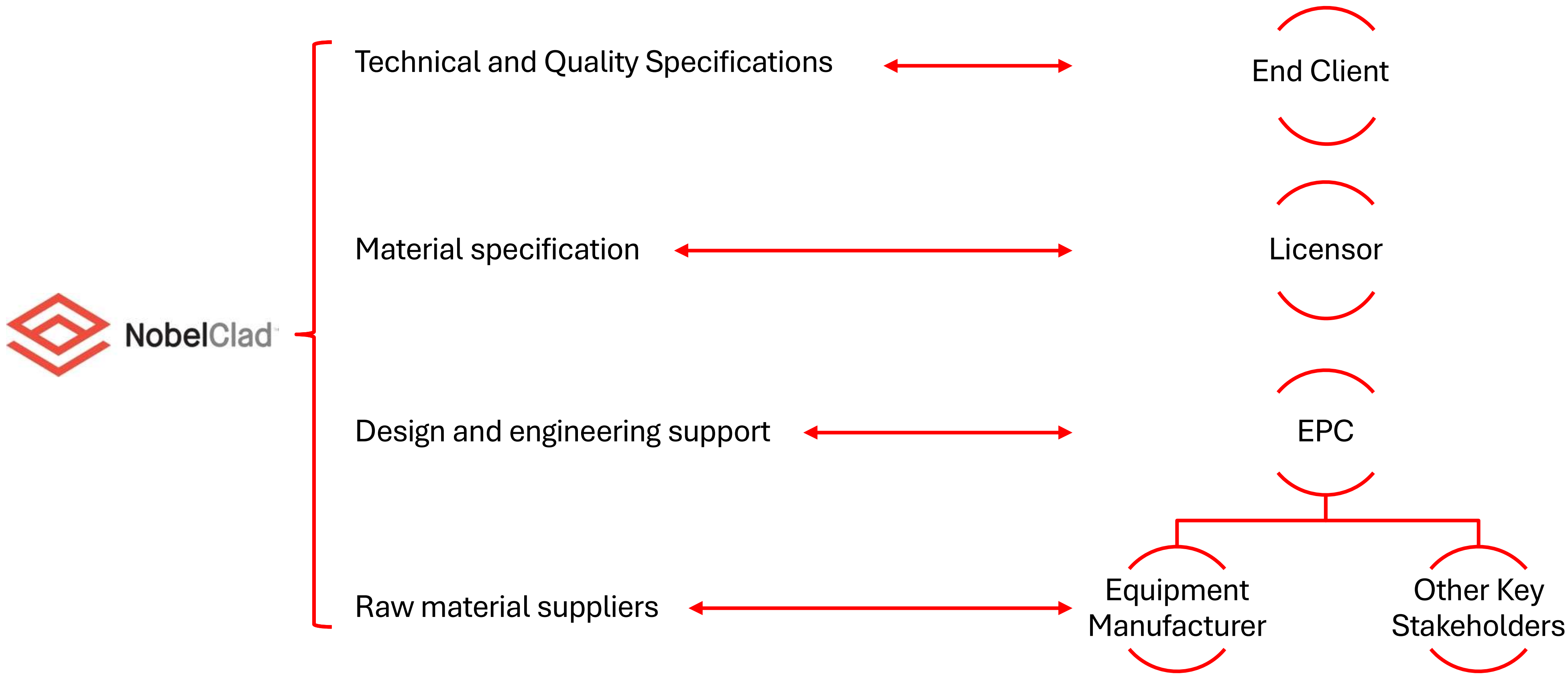
Example of 10D DetaPipe™ elbow pipe spool with Grayloc® hubs

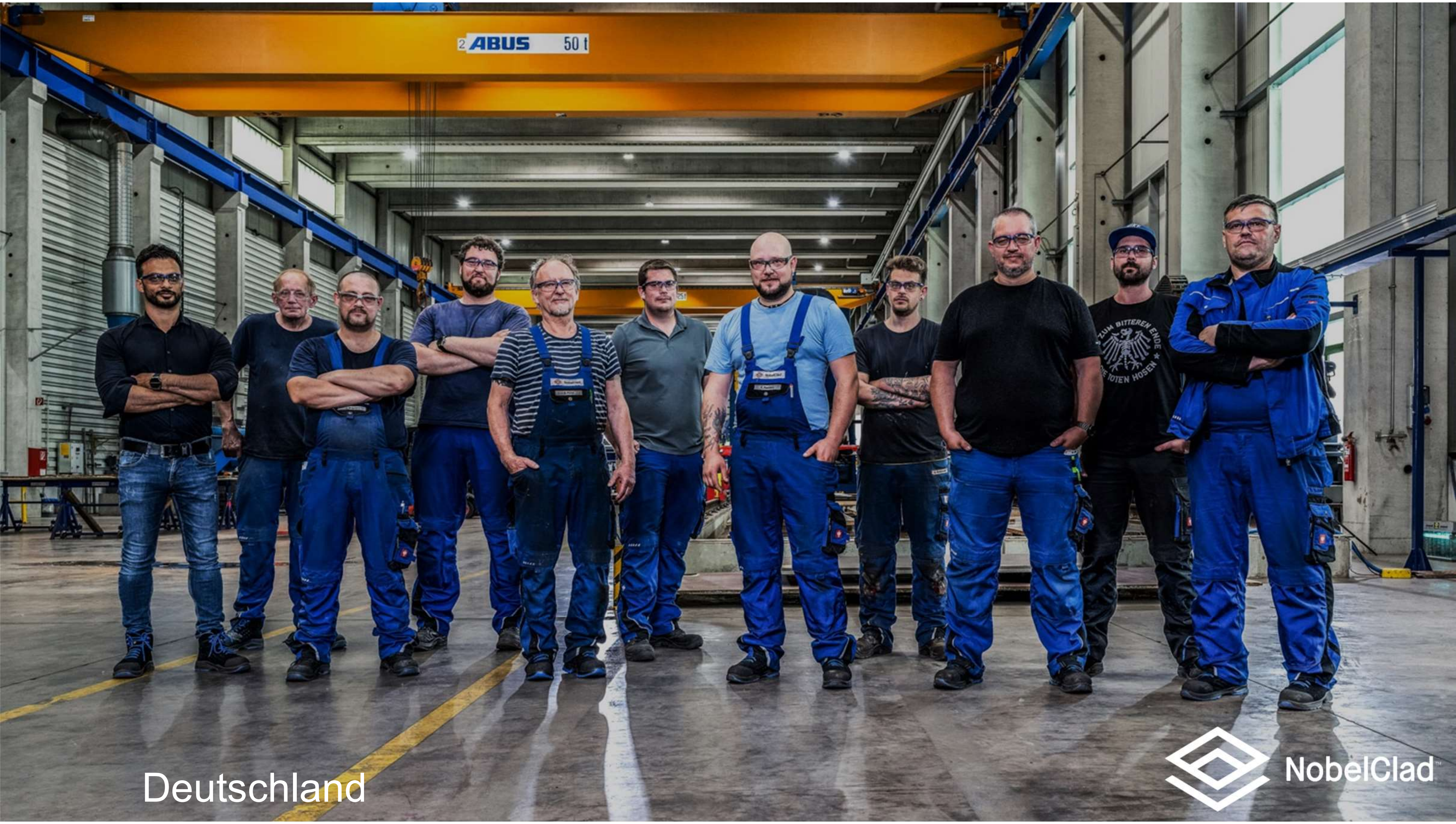
DetaPipe™ Tee development

DetaPipe™ Product Testing

- Liquid penetrant testing (PT) of welds
- Hydrostatic test
- Dimensional inspection
- Radiographic inspection (RT)
- Certification package includes:
  - Raw material certifications, PT, RT and partial data (where applicable) of the pressure welds and hydro test of the spool prior to cladding
- DetaPipe™ is made to NobelClad's DETA-221 internal specification for cladding

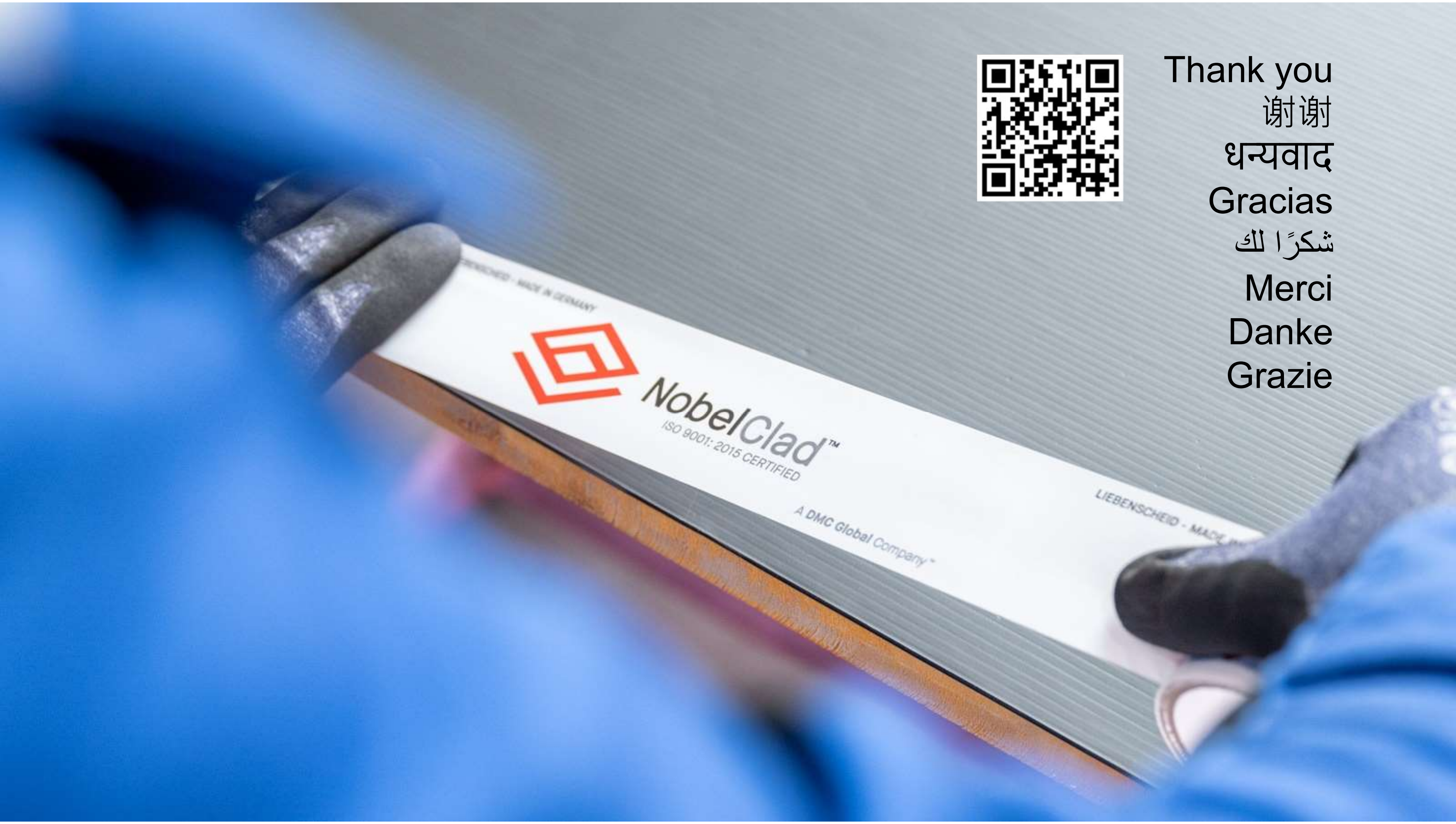
NobelClad Brings Value Added to your Solution




ABUS 50 t
Deutschland
NobelClad

United States of America

NobelClad



Thank you
谢谢
धन्यवाद
Gracias
شكرًا لك
Merci
Danke
Grazie