



## THE **STRUCTURAL SAFETY IMPROVEMENT** FOR FPSO HULLS

**ColdShield Installation Process**

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# ColdPad General Principle

## *Presentation Agenda*

- **COLD PAD Generic Principle Introduction**
- **ColdShield Project Presentation**
- **Installation Process**
  - Laboratory stage
  - Pre-industrial stage
  - Industrial stage
- **Example of product performances**

# FPSO – Floating Production Storage Offloading

## *Main information*

Floating Factory: Similar to Super-tankers

Production on station

Typical production capacity: 100kB/D

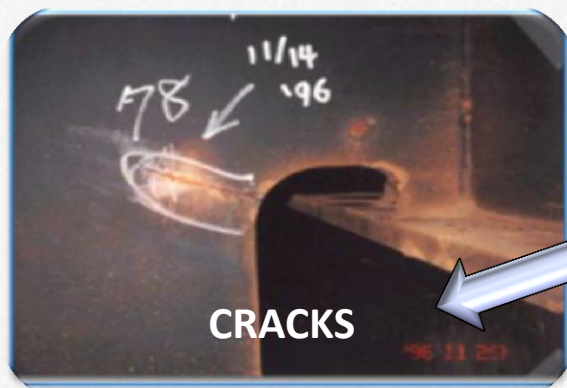
Typical production trade value: 35M€/W

Storage Capacity: Up to 2 Million barrels

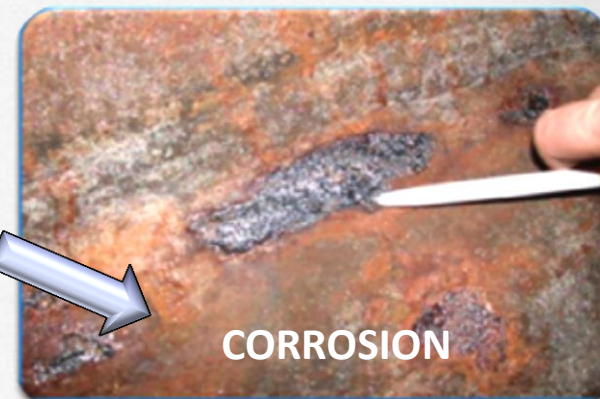
About 300 Operating Units today



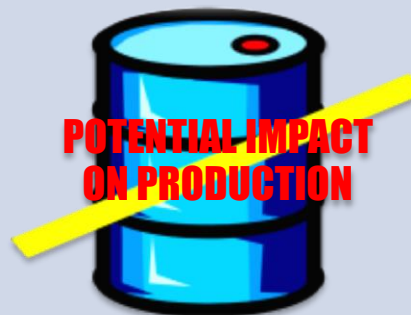
## Hull Ageing



All offshore steel structures are subject to:



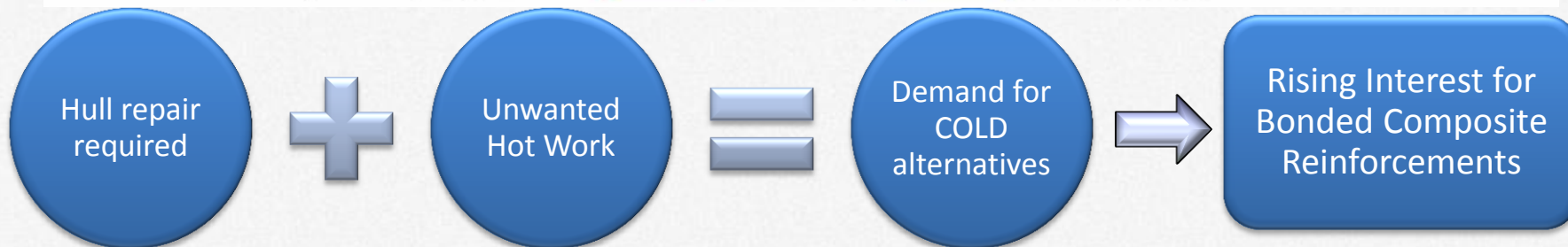
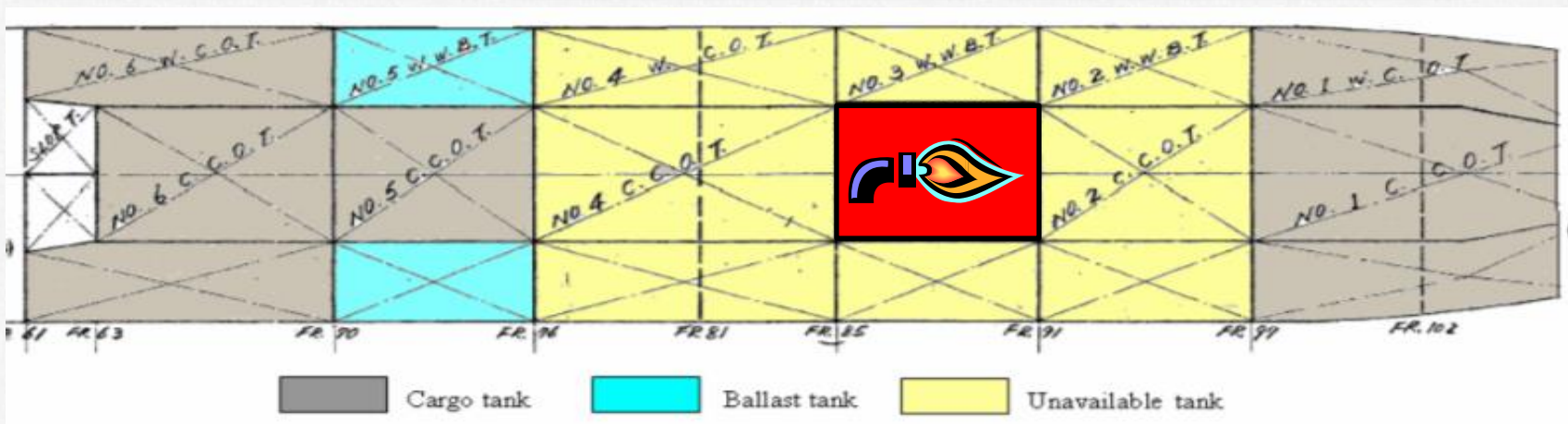
Hulls = Oil Storage → particularly sensitive



Compromise on safety or Production

# Current Challenges

## Hot Work Incidence



Ref: ISGOTT (International Safety Guide for Oil Tankers and Terminals)

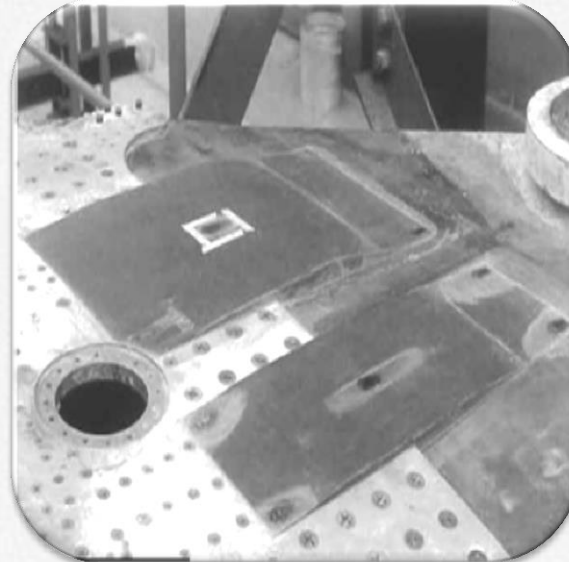
# Cold Structural Repair

## *Classical composite Reinforcement*

**STRONG POINTS: RELIABLE AND USED IN OTHER INDUSTRIES**

Cold Technology extensively used in aerospace & civil industries for the past 40y

Reliable, Proven & Certified – Installed in controlled atmosphere



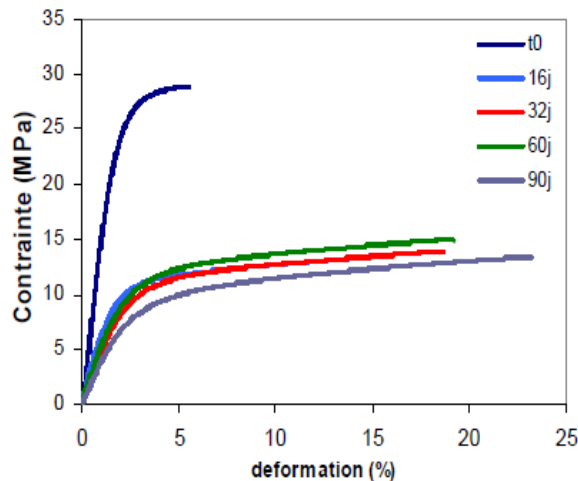


## Sensitive to Marine Environment

**OBSTACLE TO OFFSHORE UTILIZATION: NOT ADAPTED TO MARINE ENVIRONMENT**

**Critical: INSTALLATION must be done in a CONTROLLED ATMOSPHERE (T° & Humidity)**

**Polymers are subject to DEGRADATION when EXPOSED to MARINE ENVIRONMENT**

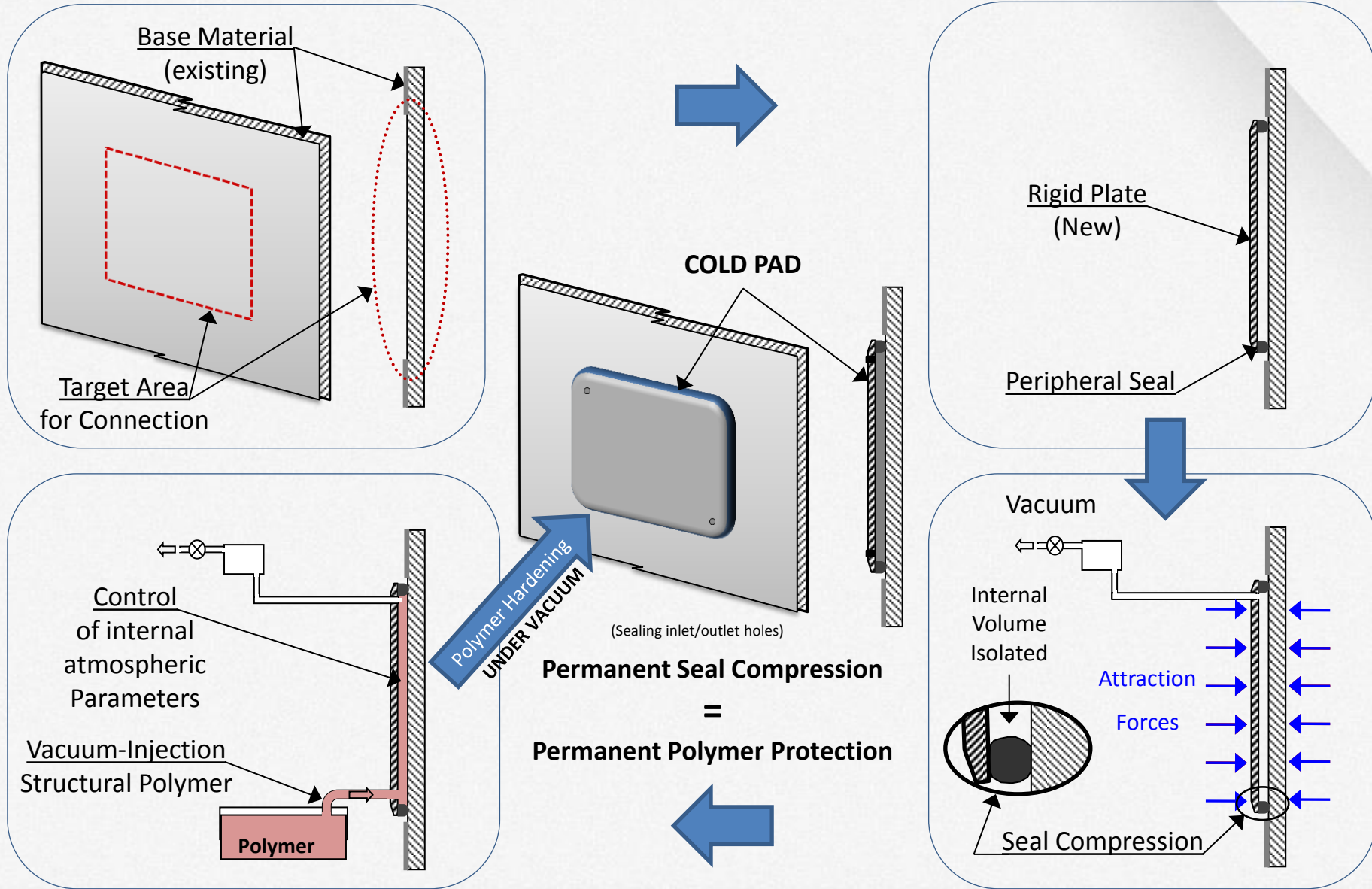


*Courbes contrainte - déformation de l'adhésif époxy à différents temps de vieillissement en eau déionisée à 20°C*

**MARINE ENVIRONMENT = OBSTACLE  
for Bonded Composite reinforcement  
Development in Offshore Industry**

**WHERE COLD PAD PROVIDES THE SOLUTION**

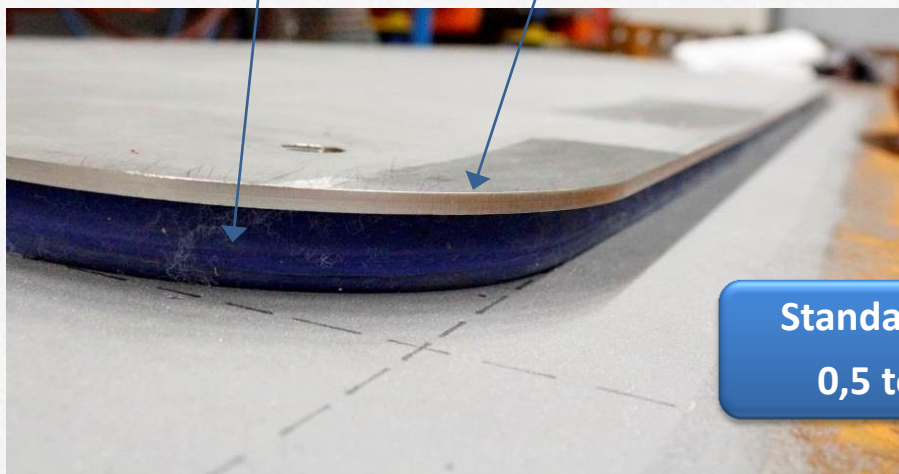
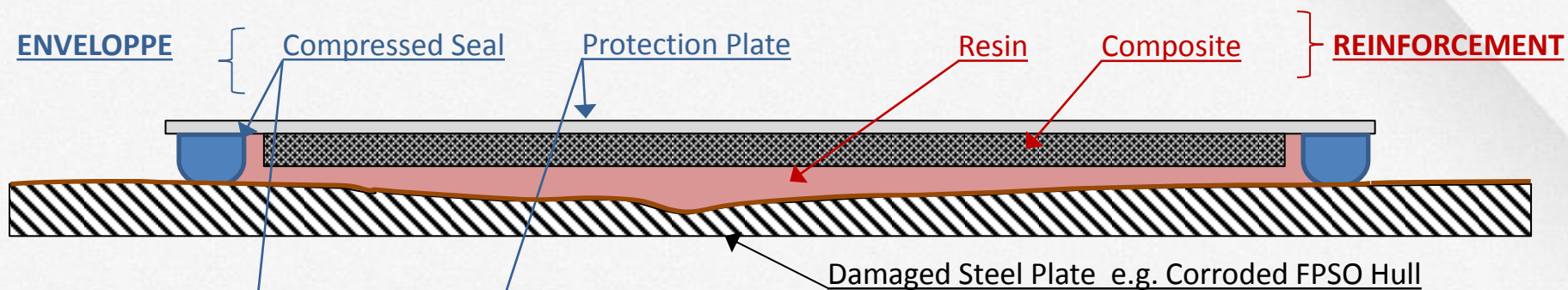
# ColdPad General Principle





# First Industrial Development

## ColdShield



Standard shape  
0,5 to 5 m<sup>2</sup>



Artistic View

Target Application :  
Locally Corroded Plating of FPSO Hulls

Functions :  
- Restore Initial Structural Capacity  
- Protect Against Further Corrosion

# 1<sup>st</sup> Product Industrial Development

## Technical & Financial Partnership

### Technical



- Technical Partner for
  - Expertise
  - Seal performance tests
  - Large scale tests



- Head Office : TEC/STR & TEC/COR
- Total R&D
- Total E&P Angola

### Financial

Overall R&D till Industrialisation



Elaborated with 4 French laboratories incl. RESCOLL

## *Laboratory stage @ RESCOLL*

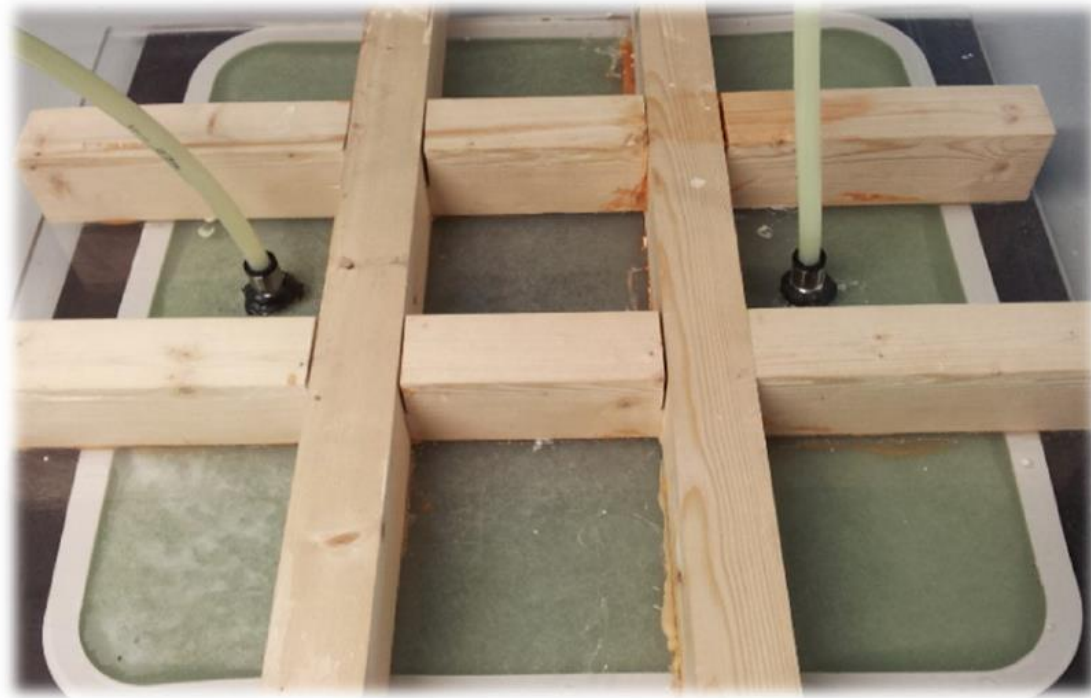
- **Resin Selection – specification:**
  - Working thicknesses range
  - Injection temperature range
  - Service temperature range
  - Open time: 1 hour
  - Low viscosity (infusion type)
  - High Tg
  - High mechanical performances (Strength, Strain, Adhesion)
- **Commercial References Selection:**
  - 20 references screened (mainly epoxies)
  - 12 references tested mechanically
  - 6 references tested for injection trial
- **Resin Selection – preliminary trial:**
  - On dummy resin (cellulosic blend)
  - On the “short list” selected resin (6 ref)



## Laboratory stage @ RESCOLL



### Essais de mise en œuvre



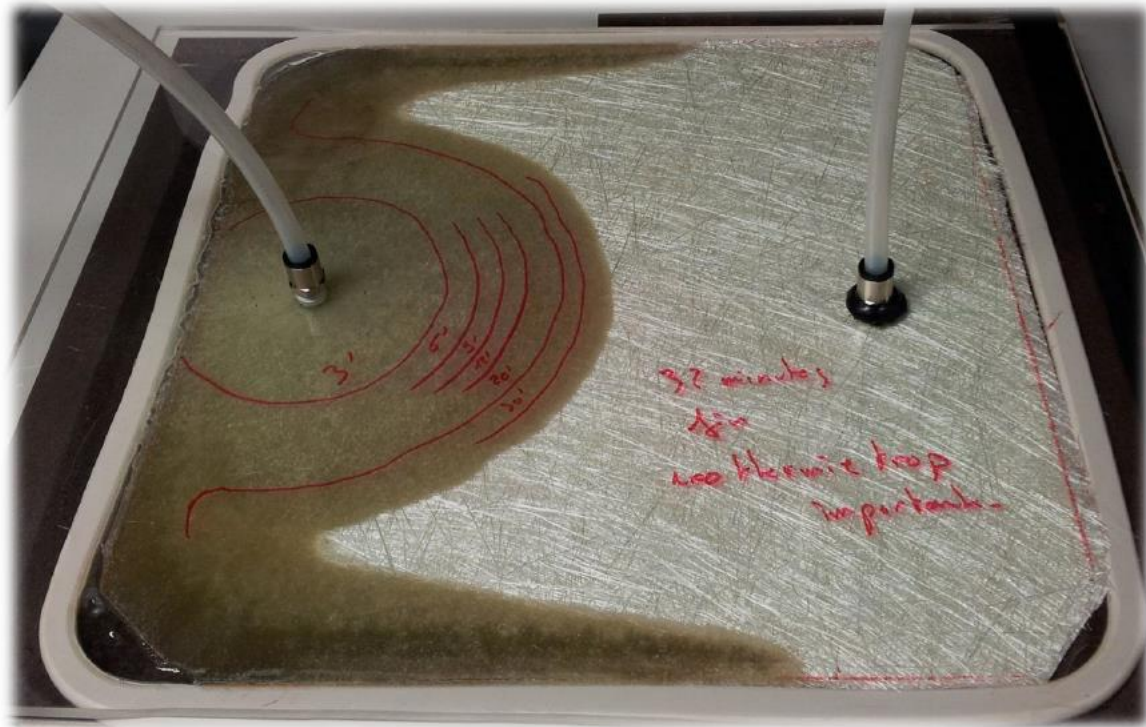
Mélange eau + cellulose+ fluorescéine / 1 plis de tissu PE

## Laboratory stage @ RESCOLL



### Essais de mise en œuvre

- Sikadur 52 / 10 plis de mat de verre 600g/m<sup>2</sup>



## Laboratory stage @ RESCOLL



### Essais de mise en œuvre

- Sikadur 52 / 4 plis de mat de verre 600g/m<sup>2</sup>



Infusion OK en 15 minutes à -0,6 bars

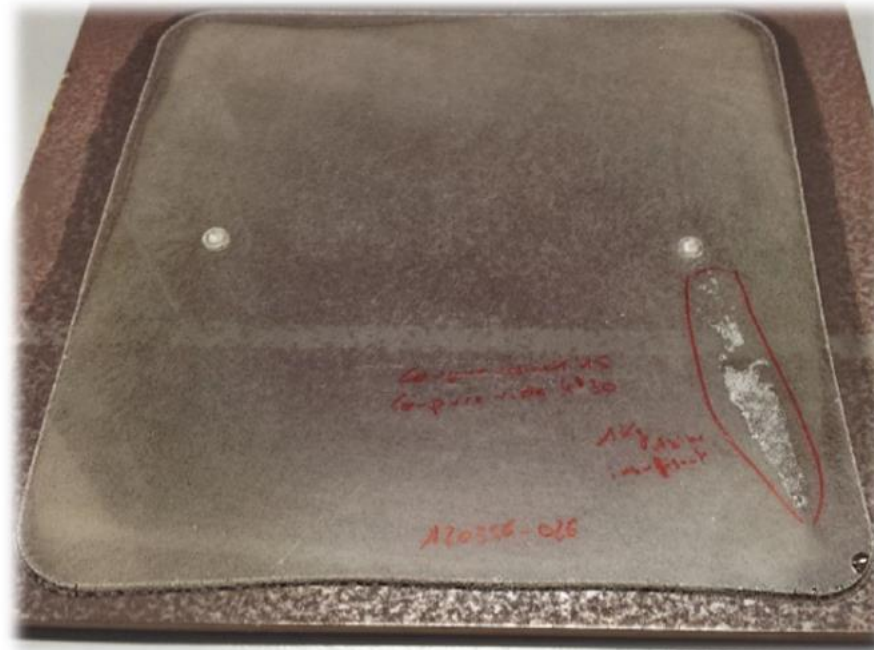


## Laboratory stage @ RESCOLL



### Essais de mise en œuvre

- Sikadur 52 / 1 pli de tissu PE



Infusion OK en 3 minutes à -0,3 bars  
Le manque est due à un manque matière à l'origine

# ColdShield Qualification – Installation Process



## Laboratory stage @ RESCOLL



<http://www.cold-pad.com> | [contact@cold-pad.com](mailto:contact@cold-pad.com)

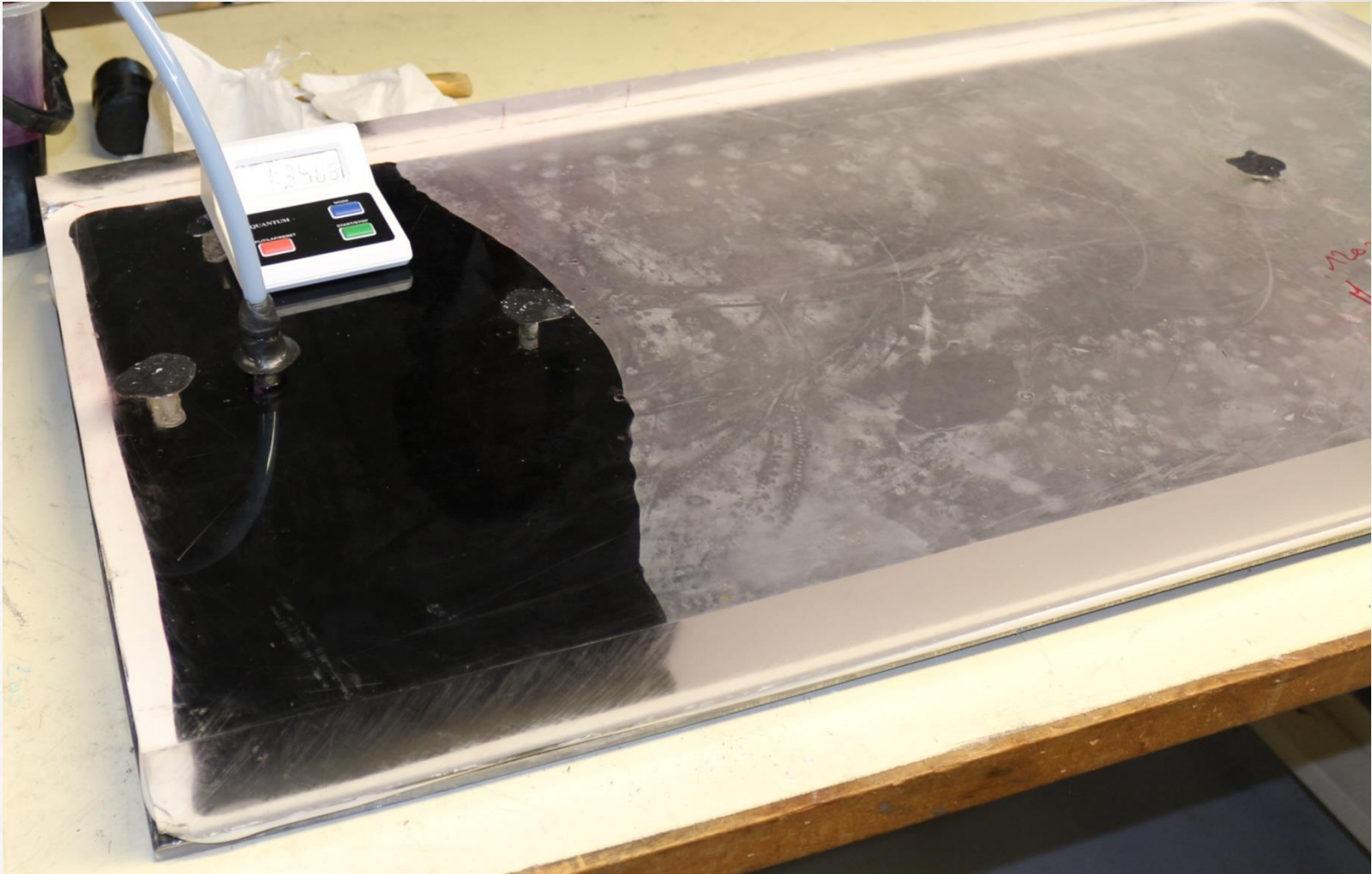
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# ColdShield Qualification – Installation Process



## *Laboratory stage @ RESCOLL*



<http://www.cold-pad.com> | [contact@cold-pad.com](mailto:contact@cold-pad.com)

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# ColdShield Qualification – Installation Process

## *Pre-industrial stage @ DOPAG with RESCOLL*

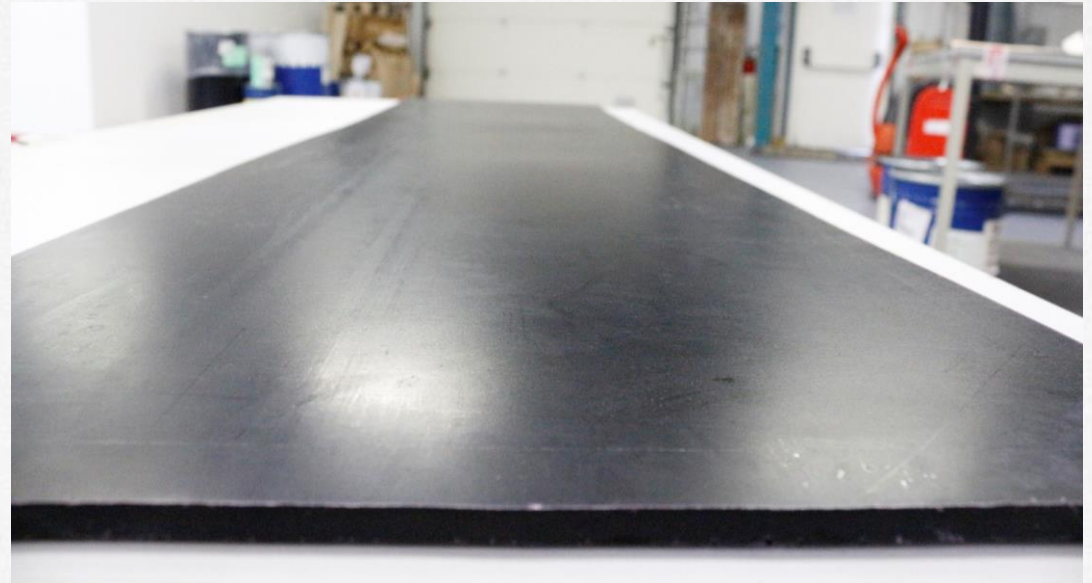
- Vacuum assisted injection procedure
- Industrial tool for installation (test machine)



# ColdShield Qualification – Installation Process

## *Pre-industrial stage*

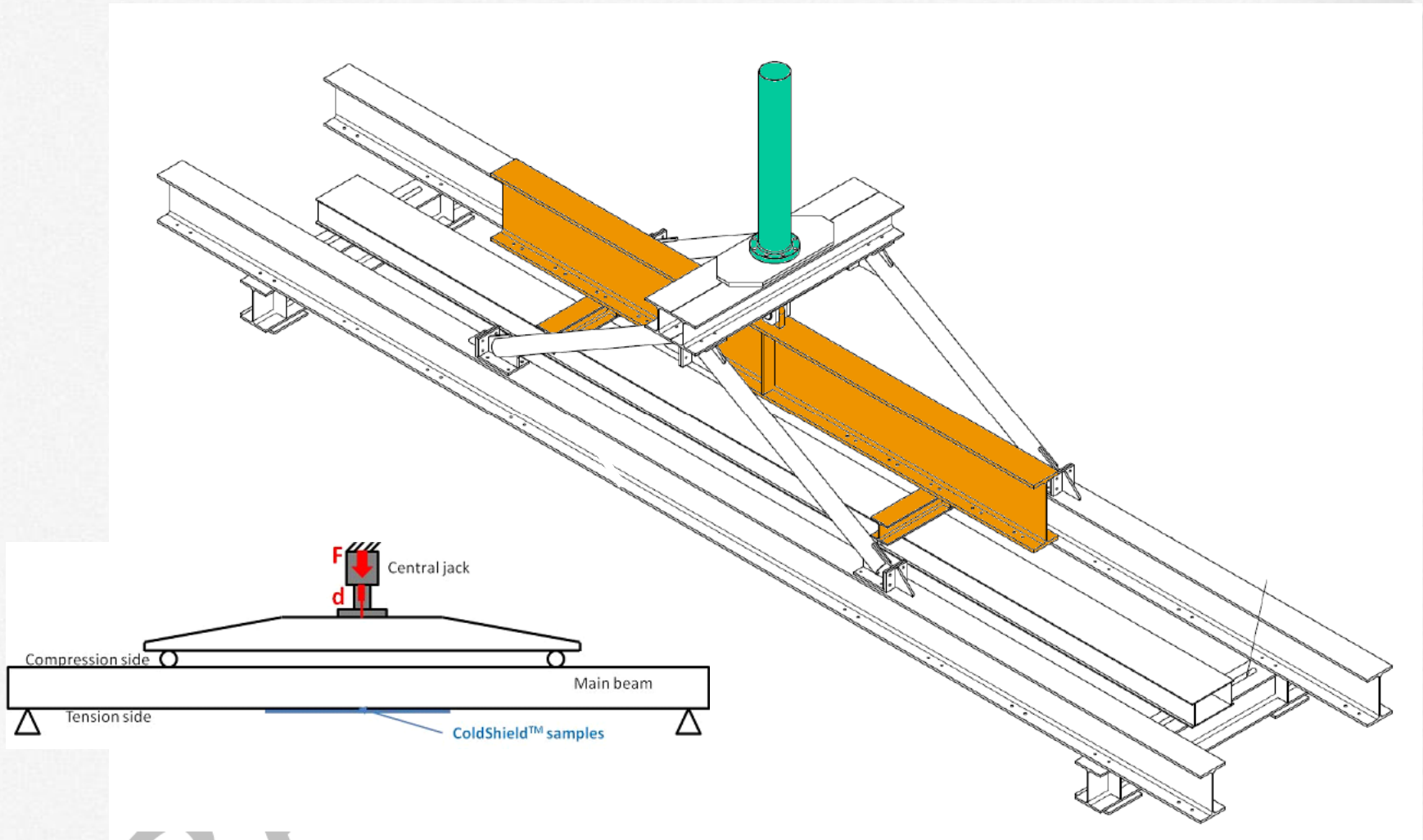
- **Satisfactory Tests Result with the industrial tool**





# ColdShield Qualification – 4Pt Bending Test Setup

## Full Scale Test – Bench Design



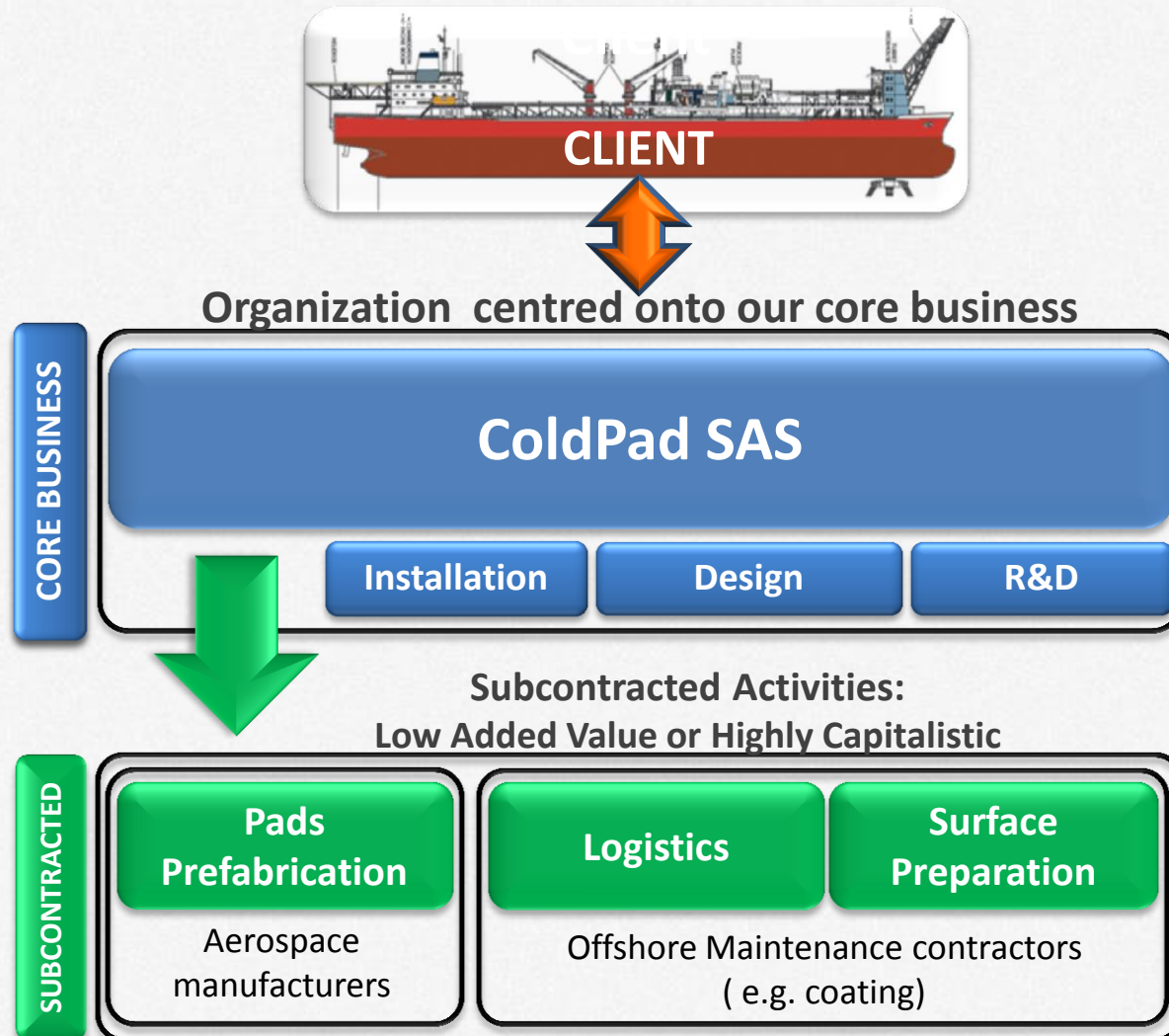


# ColdShield Qualification – 4Pt Bending Test Setup

## *Full Scale Test Bench*



## *Privileged Business Model*





# Subcontractors profile – Pads Prefabrication

## *Pads manufacturer*

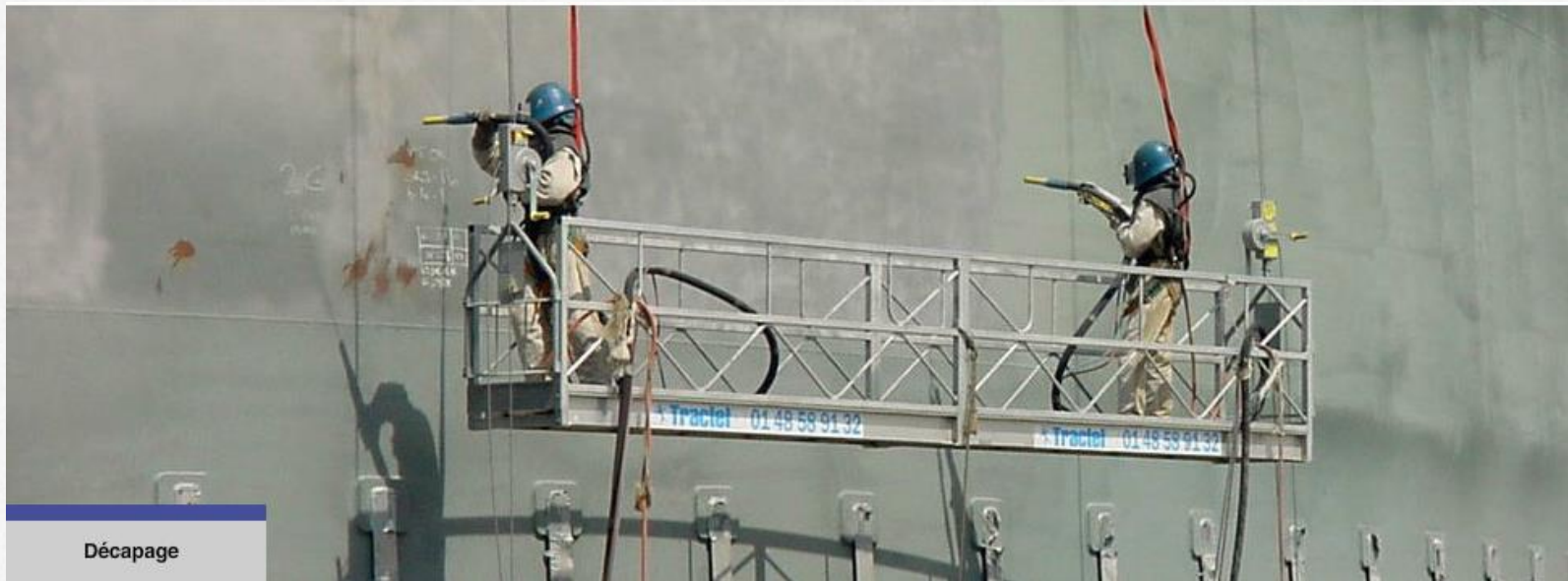
- Qualification process → highest industry standards for composites
  - Aerospace manufacturers





## Installation Subcontractors

- **Abrasive surface preparation to the Oil & Gas Standards**
  - To Total Specification : GS-COR-450 (painting maintenance on site)
- **Vessel Support & Logistics**



Décapage

# ColdShield Qualification - Outcomes

## *Innovative Performances*

Installation Process → Repeatability → Reliability → Safety

Unique Encapsulation System → Ultra High Durability in Offshore Environment

Structural Performances → Remarkable Mechanical Contribution & Resistance

TECHNOLOGICAL  
BREAKTHROUGH

3 Patents

DESIGN techniques using latest numerical development

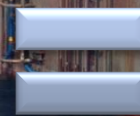
Industrial Installation Tool Especially developed

Certifications

Technological Breakthrough



Enhanced Reliability



New Technology Available





*Coldpad*  
SEAL BONDED

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