

LEAN DUPLEX STAINLESS STEELS FOR SOUR SERVICE

By

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COMPOSITION

| ALLOY | NOMINAL COMPOSITION (wt%) | | | | | | | PREN* |
|-------------------------|---------------------------|----|-----|-----|------|-----|-----|-------|
| | Fe | Cr | Ni | Mo | N | Cu | W | |
| 22%Cr Duplex | Bal | 22 | 5 | 3 | 0.16 | - | - | 34 |
| AL2003™ (UNS S32003) | Bal | 21 | 3.5 | 1.8 | 0.17 | - | - | >30 |
| ZERON 21CLD | Bal | 21 | 4 | 1.8 | 0.17 | 0.3 | 0.3 | >30 |

- ALL OF THESE ALLOYS ARE APPROXIMATELY 50/50 AUSTENITE FERRITE.
- THE LEAN DUPLEX ALLOYS HAVE REDUCED NICKEL AND MOLYBDENUM TO REDUCE COSTS.
- BOTH LEAN DUPLEX ALLOYS HAVE A PREN>30.

MECHANICAL PROPERTIES

| FORM | ALLOY | 0.2% PROOF STRESS (MPa) | TENSILE STRENGTH (MPa) | ELONGATION (%) |
|---------|--------------|----------------------------------|------------------------------|-------------------|
| WROUGHT | 22%Cr Duplex | 450 | 620 | 25 |
| | AL2003 | 450 | 620 | 25 |
| CAST | 22%Cr Duplex | 415 | 620 | 25 |
| | ZERON 21 CLD | 420 | 650 | 25 |

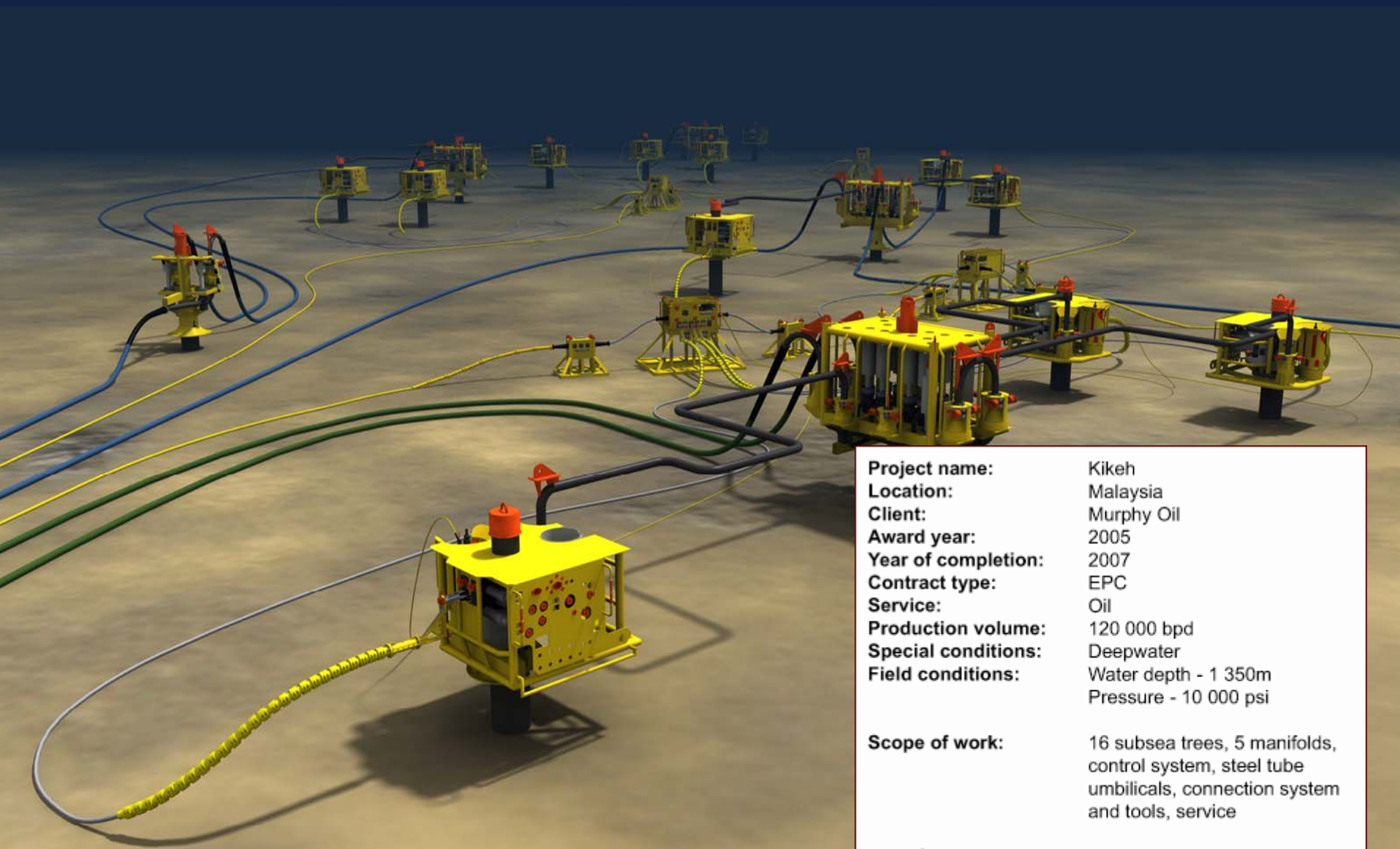
- THE LEAN DUPLEX ALLOYS OFFER EQUIVALENT OR SUPERIOR STRENGTH TO THE 22%Cr ALLOY AT ROOM TEMPERATURE.
- AT ELEVATED TEMPERATURES THE MECHANICAL PROPERTIES ARE ALSO SIMILAR.

CORROSION RESISTANCE

- **ISO 15156 PART 3 STATES THAT DUPLEX STAINLESS STEELS WITH A 30>PREN<40 ARE SATISFACTORY UP TO 0.1 bar H₂S.**
- **A SULPHIDE SCC TEST IN ACCORDANCE WITH EFC 17 WAS CARRIED OUT ON WROUGHT, CAST AND WELDED MATERIAL UNDER THE FOLLOWING CONDITIONS:**
 - **20% Sodium Chloride**
 - **0.1 bar H₂S**
 - **1.2bar CO₂**
 - **pH=3.5**

ALL OF THE MATERIALS RESISTED CRACKING WHEN STRESSED TO 100% OF THE ACTUAL 0.2% PROOF STRESS.

Kikeh Subsea Field Lay Out



| | |
|----------------------------|--------------------------------------------------------------------------------------------------------------------|
| Project name: | Kikeh |
| Location: | Malaysia |
| Client: | Murphy Oil |
| Award year: | 2005 |
| Year of completion: | 2007 |
| Contract type: | EPC |
| Service: | Oil |
| Production volume: | 120 000 bpd |
| Special conditions: | Deepwater |
| Field conditions: | Water depth - 1 350m Pressure - 10 000 psi |
| Scope of work: | 16 subsea trees, 5 manifolds, control system, steel tube umbilicals, connection system and tools, service |
| Manufacturing: | Malaysia, UK, Norway, USA |
| Service base: | Kuala Lumpur, Malaysia |

EXPERIENCE IN OIL & GAS

- ➔ **MORE THAN 15km OF PIPE WITH UNS S32003 CARCASS HAS ALREADY BEEN INSTALLED IN A MAJOR SUBSEA OIL FIELD (ref EUROCORR 07 Paper given by R. Clements from Wellstream).**
- ➔ **COST SAVINGS WERE ACHIEVED FOR THE PROJECT DUE TO THE MUCH LOWER ALLOY CONTENT COMPARED WITH 22Cr (which would have otherwise been necessary at the 1400m water depth).**

CONCLUSIONS

- ➔ **THESE LEAN DUPLEX STAINLESS STEELS OFFER THE STRENGTH OF 22%Cr DUPLEX STAINLESS STEEL.**
- ➔ **THESE LEAN DUPLEX STAINLESS STEELS OFFER THE SSCC RESISTANCE REQUIRED OF 22%Cr DUPLEX STAINLESS STEEL.**
- ➔ **LEAN DUPLEX IS AVAILABLE IN BOTH WROUGHT AND CAST FORMS.**
- ➔ **THE COST OF THESE LEAN DUPLEX IS ABOUT THE SAME AS 316L STAINLESS STEEL BUT THE STRENGTH ADVANTAGES OF LDSS MAY ALLOW FOR WEIGHT REDUCTIONS.**