

SLEIPNER CO2 INJECTION COMPRESSOR

First CO2 re-injection project for the purpose of mitigating greenhouse emissions
9 Million TONS CO2 injected

Harald Underbakke Statoil



ExxonMobil



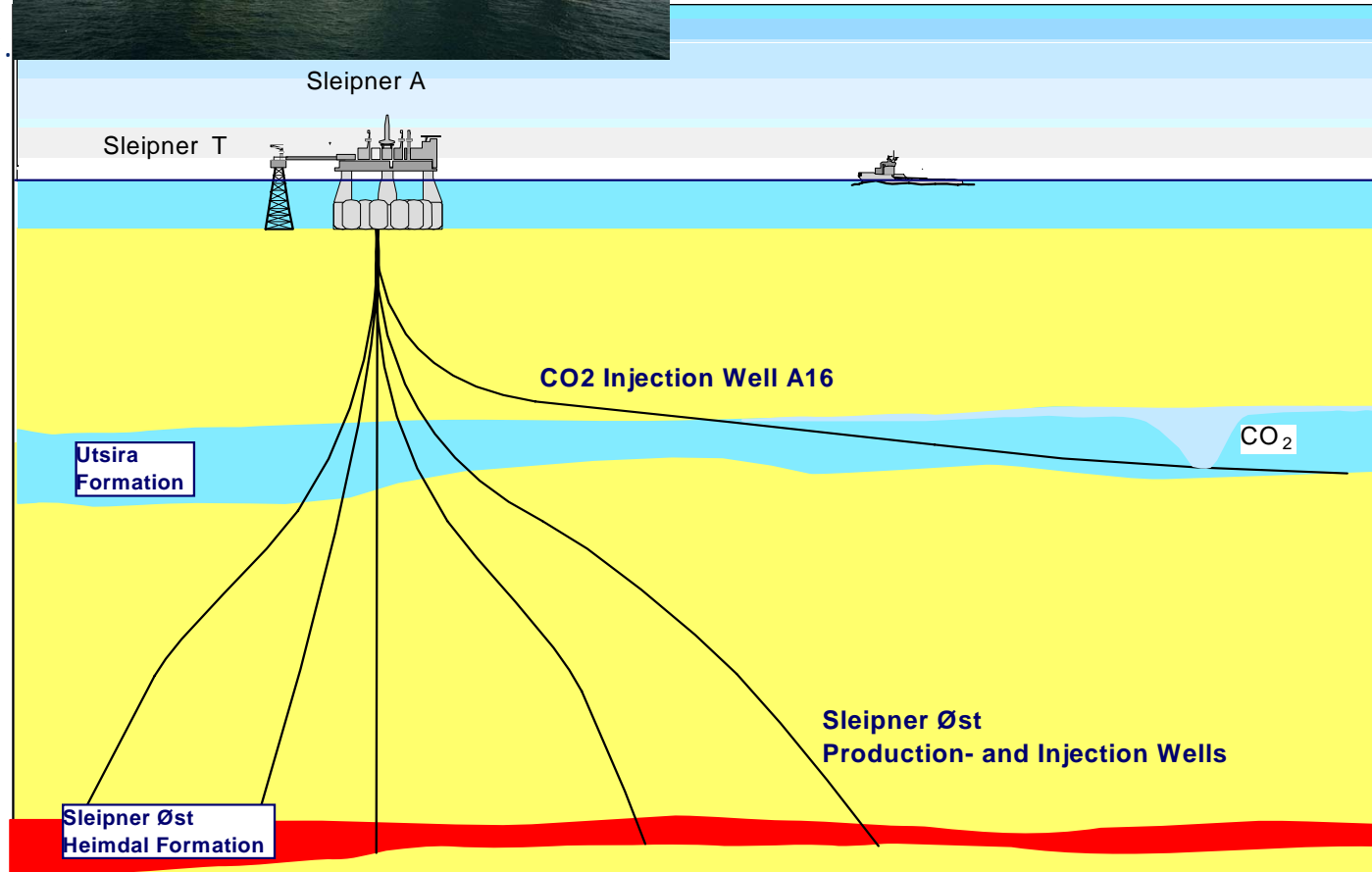
TOTAL



HYDRO

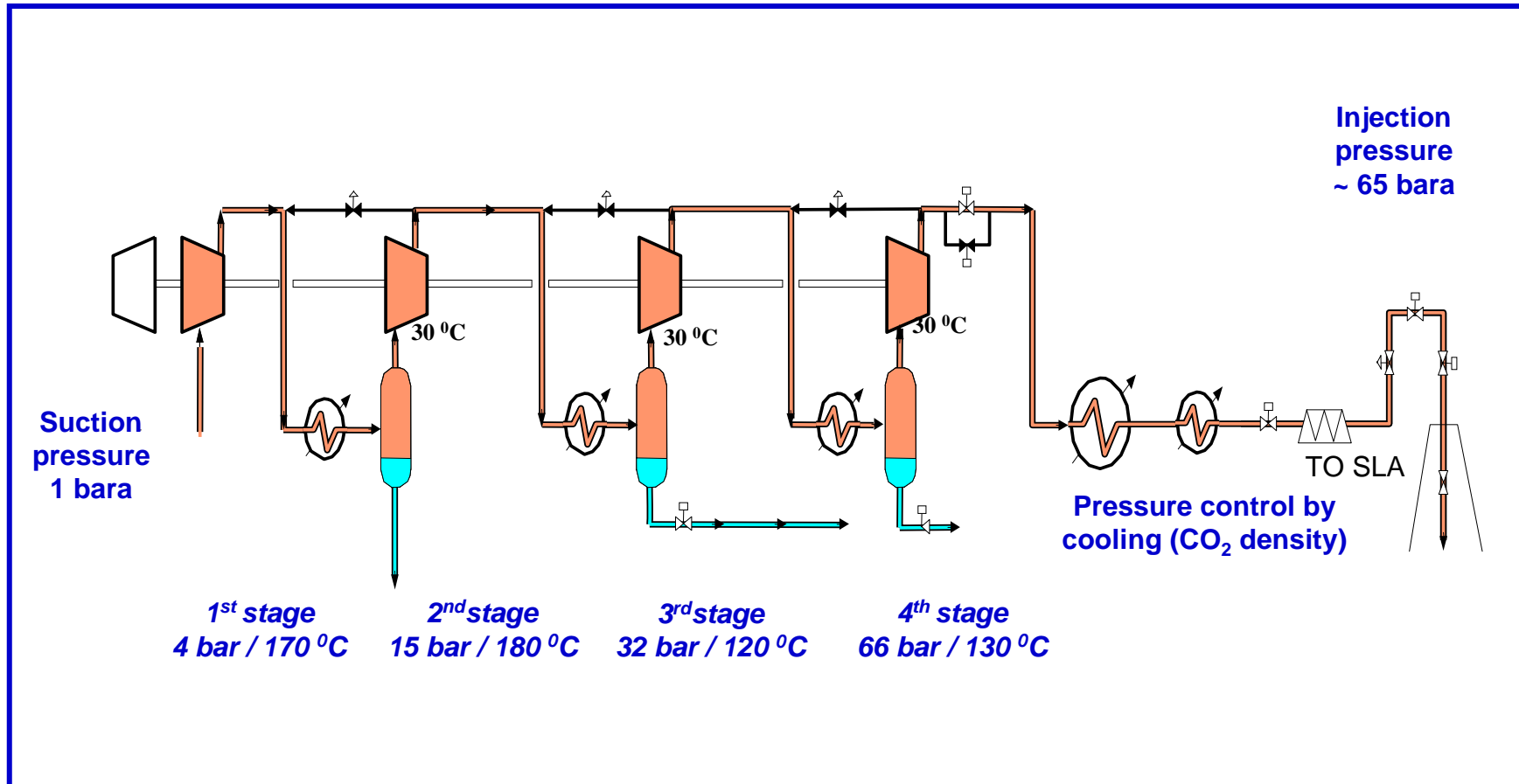
Sleipner CO2 Injection

- Objective: Reduce the CO2 content from 9% to 2.5% (sale spec.)
- Capture the CO2 by an amin plant
- CO2 storage in an aquifer
- Start up: Aug 1996
- Injection: ~ 1 mill ton CO2/yr
- Regularity: 98-99%

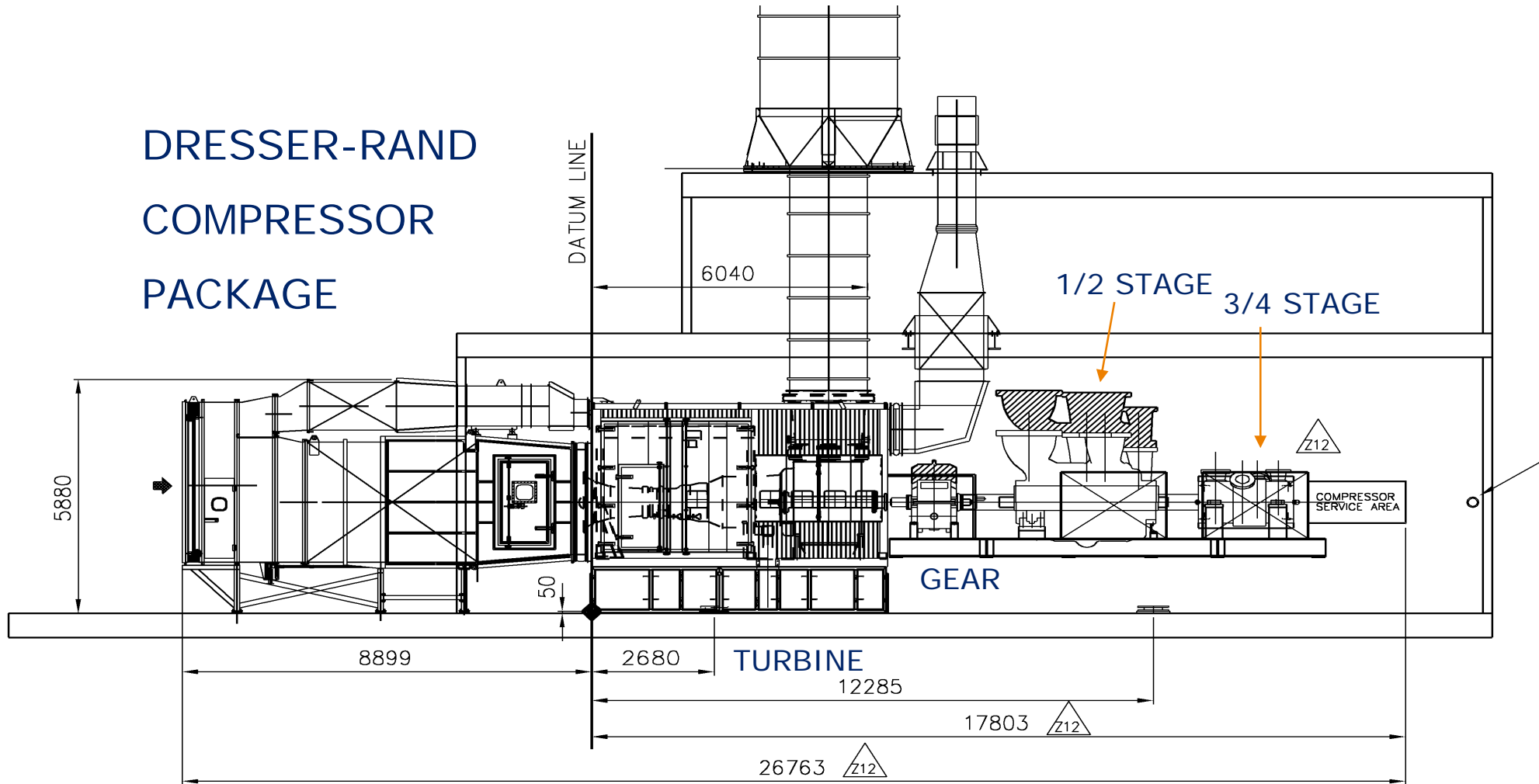


Statoil is operator

CO₂ Compression and Injection Systems



COMPRESSOR GENERAL ARRANGEMENT



Secret Information is the property of Dresser-Rand A/S and is provided to the receiver

PLATFORM AND INJECTION MODULE



1 AND 2 STAGE COMPRESSOR



IMPELLER LEADING EDGE 2 STAGE



COMPRESSOR SELECTION BASIS

- CO₂ WITH MINOR AMOUNT OF HYDROCARBON GAS (1-3%)
- DRIVER STANDARDISATION (30%+ POWER MARGIN)
- 1X100% TRAIN – HIGH AVAILABILITY REQUIRED
- SINGLE SHAFT - SAME SPEED ALL STAGES
- OPTIMUM NUMBER OF STAGES (COST VS RISK)

DESIGN CHARACTERISTICS

- AERO GAS TURBINE DRIVEN CENTRIFUGALS WITH GEAR
- 4 PROCESS STAGES IN 2 CASINGS. 3+4+5+5 IMPELLERS
- HIGH HEAD/TIP SPEED (UP TO 4000 M/STAGE, 280 M/S)
- ½ STAGE HORIZONTAL SPLIT INLINE
- ¾ STAGE VERTICAL SPLIT BACK TO BACK
- STAINLESS STEEL INTERNALS AND CASING WELD OVERLAY
- TANDEM DRY GAS SEALS WITH SEAL GAS FROM DISCHARGE
- NITROGEN PURGED SEPARATION SEAL

EXPERIENCE

- TBO 10 YEARS OR MORE FEASIBLE
- TWO-PHASE FLOW IN INJECTION WELL IS ACCEPTABLE
- DEPRESSURISATION FROM LIQUID PHASE – MAY FORM DRY ICE
- HYDRATES MAY FORM IF COOLED AT HIGH PRESSURE
- HSE -PRECAUTIONS NEEDED TO PREVENT HUMAN CO2 EXPOSURE

POWER CONSUMPTION REDUCTION OPPORTUNITIES

- MAXIMIMISE COOLING - UTILISE MARGINS IN COOLING SYSTEM
- INJECTION IN TWO-PHASE REGIME (BEWARE DRY ICE/HYDRATES)
- MINIMISE PRESSURE DROP 1ST STAGE
- CONSIDER DIRECT DRIVE WITHOUT GEARBOX

CONCLUDING REMARKS

- WELL PROVEN ROBUST DESIGN SELECTED
- HIGH AVAILABILITY ACHIEVED OVER 10 YEARS
- MATERIAL SELECTION HAS PROVED ADEQUATE
- CO₂ EXTRACTED FROM EXHAUST GAS IS DIFFERENT FROM CO₂ EXTRACTED FROM NATURAL GAS WITH RESPECT TO CONTAMINANTS