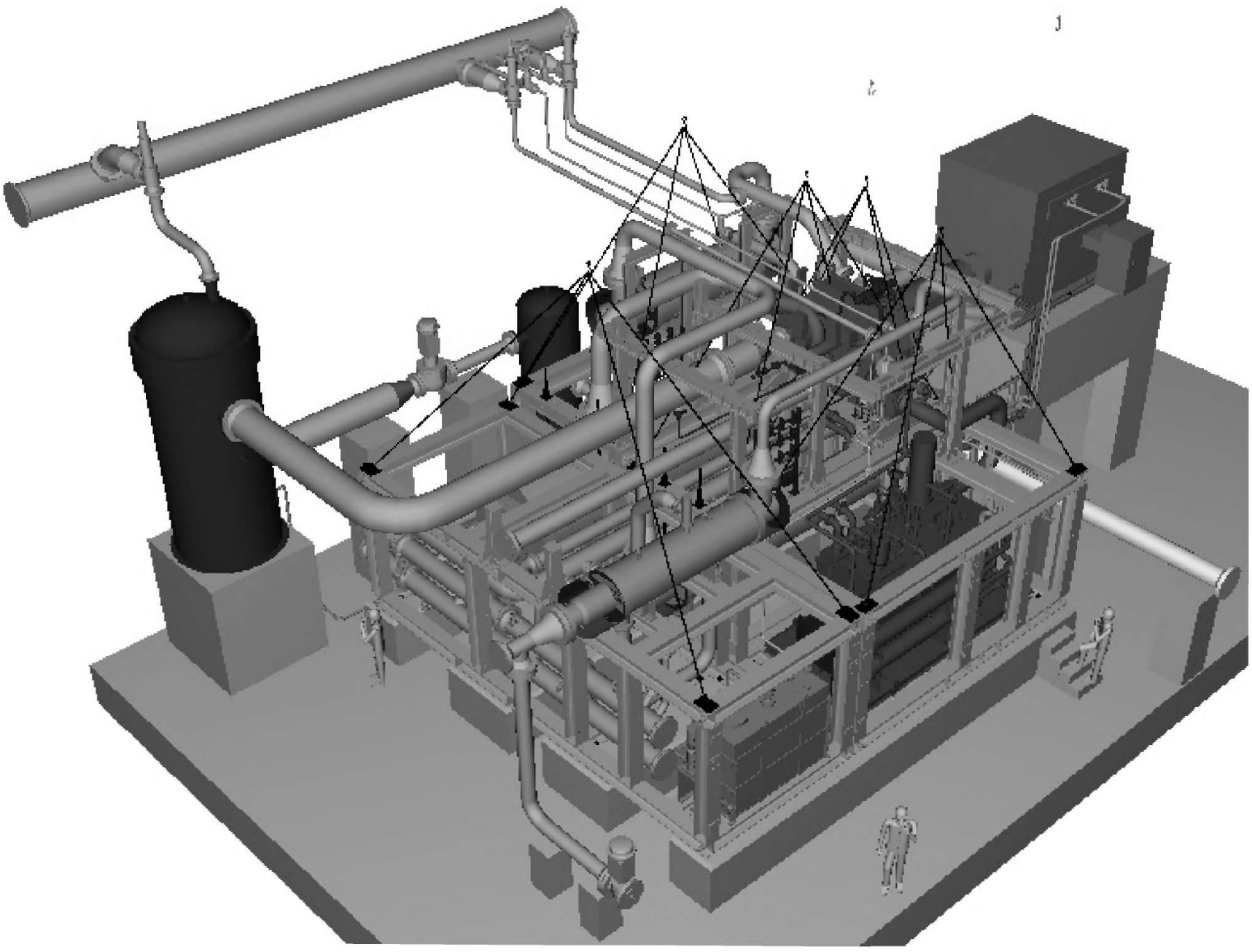
# Preliminary Proposal (for information only)

## for

## Three (3) Integrally Geared Centrifugal CO2 Compressor Trains

## Driven by Electric Motor



## GENERAL REMARKS

Our offer is based MAN Diesel & Turbo's (MDT) experience with similar high-pressure $CO_2$ Compressors. The compressor and oil system are manufacturers standard design, according to API-617, 7th edition, with some comments and exceptions.

The compressor is selected from our "Standard Compressors Manufacturing Program". All components are of proven design and execution for long term continuous operation and require the minimum supervision and maintenance. The quoted compressor is derived from an existing compressor design (comprising three identical units) which is operating successfully at the Great Plains Synfuels Plant near Beulah, North Dakota.

All impellers of this system are measured and guarantee accurate performance at the various operating conditions requested.

MAN Diesel & Turbo has supplied a large number of compressors with auxiliary equipment operating in a similar range and service as for this project, shown in our list of references.

### Design Basis

The gas mixtures as well as the thermodynamic and aerodynamic behavior of the gases during the compression procedure in the compressor are computer calculated according to the Lee-Kessler-Plöcker (LKP) method. The polytropic head is calculated with the isentropic volume exponent and the discharge temperature is calculated with the isentropic temperature exponents. From our point of view, the mentioned method gives the most realistic data.

The proposed $CO_2$ Compressor RG040-4 performs the compression in two process sections: the low pressure section upstream of the Dexpro Unit (by others), and the high-pressure section that handles the additional recirculation capacity from the Dexpro Unit. Compressor performance will be optimized for the amount & pressure of the recycle stream required by the Dexpro Unit.

### Compressor Design

The gearbox, make BHS or MAN Diesel & Turbo as per MAN Diesel & Turbo standard vendor list. The housing is horizontally split. The pinions are supported by tilting pad bearings and the bull gear shaft by multi-lobe bearings. The axial thrust of the impellers will be absorbed via thrust collar by a combined axial-radial bearing at the bull gear shaft.

The compressor is controlled by means of Inlet guide vanes which are adjustable with pneumatic actuator and positioner.

The compressor casings (volutes and inlet diaphragms) are flange-connected directly to the central gear casing. All nozzles can be arranged upwards, downwards or to the side as required or preferred. We have arranged the nozzles as shown in the arrangement plan.

### Shaft Sealing System

For the sealing of compression stages against atmosphere multi-chamber carbon ring seals on the pinion shaft ends are provided. This special MAN Diesel & Turbo sealing concept is employed for all of these process and compressor applications.

### Main Driver

MAN Diesel & Turbo will offer an electric motor driver selected from one of the worldwide well-known and reliable manufacturers.

### Base Frame

The compressor has a modular design in order to minimize site work. For Details refer to General Arrangement Drawing.

### Lube Oil System

The lube oil system will provide lube for the compressor and the driver. It is designed according to MAN Diesel & Turbo standard and will be installed as shown on the preliminary General Arrangement Plan.

### Spares

Spares have been included in the present tender as per our standard based on our operating experience. We remain open for any discussion regarding client's spares philosophy, and would adapt our proposal accordingly.

The technical data stated in the quotation and also in the attached data sheets is for information only unless not especially indicated as guaranteed or certified. During detailed engineering after contract award these figures may be altered unless the operation of the entire compressor unit is not affected. MAN Diesel & Turbo will stay fully responsible for the safe and proper function of the unit.

Basis for this Quotation are following documents created as results of the Engineering Only Phase:

Email from Christof Hüls dated 04th March 2014:

- Inspection and Test Plan (ITP)

Email from Christof Hüls dated 29th April 2014:

- API data sheet and performance curves

Email from Christof Hüls dated 05th May 2014:

- control philosophy and instrument list

Emails from Christof Hüls dated 06th May 2014:

- Arrangement plan
- Foundation plan
- Lifting drawings of modules
- PID's
- Comment response for PID
- Cooler data sheets
- Basis of design