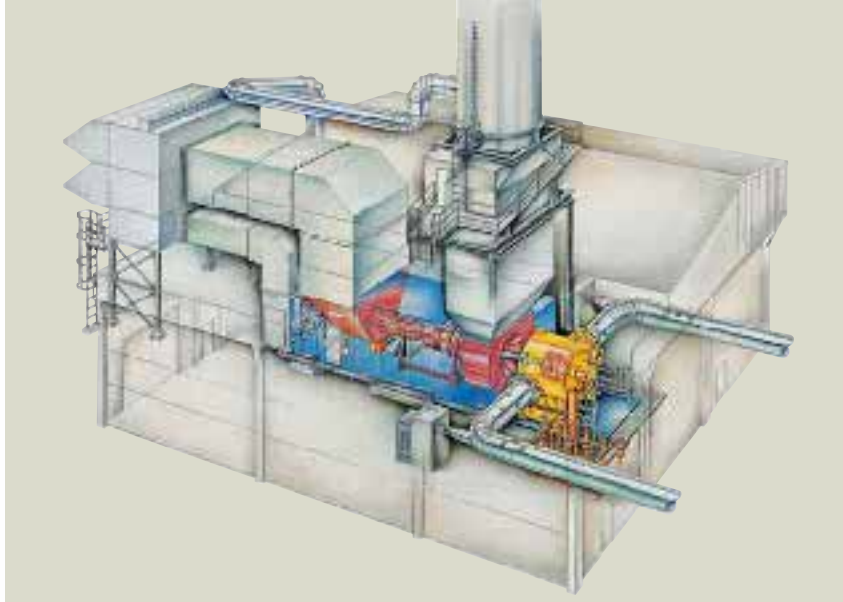


# Gas turbine-compressor unit for the Werne natural gas compressor station





1 FT8 Gas Turbine Package with Compressor Skid

The significance of natural gas, already regarded as a highly reliable and environmental friendly long-term source of energy, is increasing all the time.

Pipelines and distribution networks are basic requirements for securing natural gas supplies and developing user markets. And these in turn require compressor stations.

The compressor station of Ruhrgas AG in Werne, Germany, is a key installation for gas distribution within Germany.

In order to expand transport capacities, two gas turbine-compressor units in the 25 MW class were required to complement the compressor plant already installed.

At the beginning of 1994, therefore, MAN TURBO received an order from Ruhrgas AG for the supply, installation and commissioning of a gas turbine-compressor unit comprising a FT8-55 DLN gas turbine

and a RV090 pipeline compressor, complete with a full set of accessories. In 1998 MAN TURBO received a repeat order for the second unit.

#### Design data

The compressor was designed to operate with a power input from the gas turbine of up to 32 MW in winter service at low air inlet temperatures.

Normal operations were based on the following specifications:

Intake pressure	60 bar
Pressure ratio	1.45
Throughput	2,000,000 m <sup>3</sup> /h (STP)
Power input	25,000 kW
Speed	5,500 rpm
Design pressure	116 bar

The compressor is in operation within a 85 bar network.

#### The components

The scope of supply covered the following main components:

##### 1. Gas turbine

- FT8-55 gas turbine package
- Air inlet system (anti-icing with exhaust gas)
- Acoustic enclosure
- Exhaust gas system
- Oil system (synthetic oil)
- Electro-hydraulic starter
- Fuel gas system
- Instrumentation

##### 2. Compressor

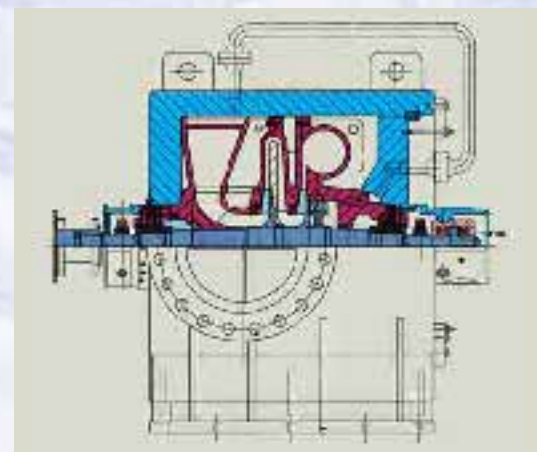
- Compressor with dry gas seals
- Baseframe with sealing panel
- Accessible machine platform
- Oil system (mineral oil)
- Instrumentation

##### 3. Accessories

- Unit control cabinet
- Motor control centre (MCC)
- Anti-Surge-Valve
- Instrumentation in the process lines

#### Erection & commissioning

- Installation of gas turbine and compressor
- Installation of accessories incl. signal lines and ventilation piping
- Complete cabling between unit and control station
- Cold and hot commissioning



2 RV090 Barrel Compressor

### The FT8-55 DLN Gas Turbine

Based on the two shaft-design of the gas generator and the use of latest developments in the aircraft industry the FT8 gas turbine offers the highest efficiency in the 25 MW class. The extremely robust Dry Low NO<sub>x</sub> (DLN) System allows quick load changes and is insensitive to changing gas compositions and ambient conditions.

### Pipeline compressor

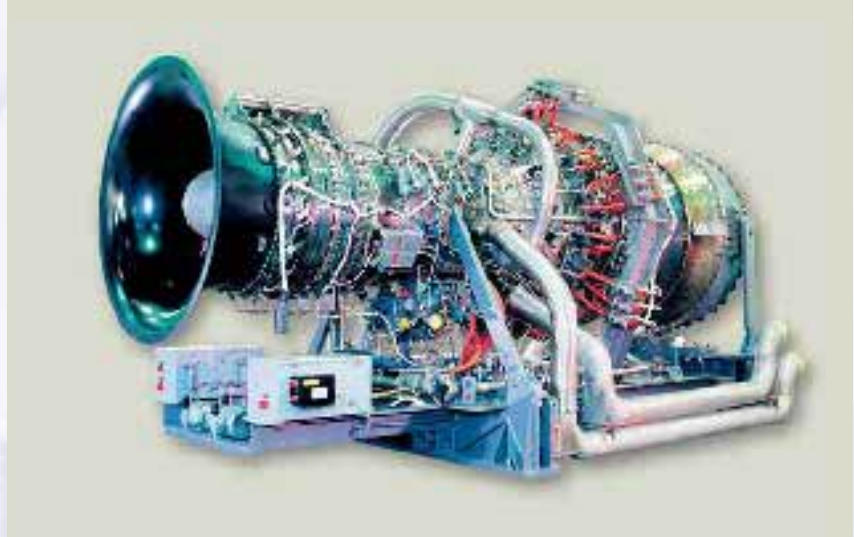
The most important design details of the RV090 pipeline compressor are as follows:

- Vertically split joint
- 36", 900 lbs flanges, lateral arrangement
- Withdrawable inner bundle with horizontally split joint
- Tilting pad journal and thrust bearings
- Tandem dry gas seal with intermediate labyrinth
- Diaphragm coupling with torquemeter

The compressor is directly installed in the main gas pipeline, and all its internals can be removed and inspected without having to disconnect the casing flanges from the inlet and discharge piping.



4 FT8 Gas Generator



3 FT8-55 DLN Gas Turbine

This ensures that replacement of the rotor assembly — for example to accommodate new operating parameters — can be performed in the shortest of time.

The compressors can be supplied as both single and multi-stage units.

### Range of models

The compressor series encompasses 5 different frame sizes: the RV035, RV050, RW63, RV080 and RV090, each in pressure classes corresponding to 600 or 900 lbs flanges, i.e. up to 100 bar or 150 bar.

Up to four impellers (in special cases up to six) can be installed in the standard casing.

Two single-stage models with axial intake are available, the RV63ax and the RV80ax.

The flanges at the intake and discharge ends have been standardised in line with the most common pipeline diameters.

### Capacity uprate

Compressor modification in order to uprate pipeline capacity is greatly facilitated by the fact that different numbers of impellers can be installed or retrofitted in the casing.

The compressor at the Werne station, for example can easily be adapted to a higher compression ratio by the installation of three impellers.

MAN TURBO pipeline compressors, although designed for today's operating parameters, are already capable of meeting even more demanding service requirements of future applications.

### Compact design

Pipeline compressors are supplied as package units, i.e. completely assembled on their baseframe, with their complete oil pipework, seal gas piping & instrumentation, and cabled up to integral terminal boxes.

This compact, sturdy construction results in reduced erection costs and easy maintenance.

The entire installation arrangement is designed to ensure effective absorption of the high forces which commonly emanate from the connected pipeline sections, without any impairment to the alignment between compressor and turbine.

Comprehensive model calculations using the finite element method ensure that all the load types and stress situations have been taken into account at the compressor design stage.



5 Inner bundle of RV090 Compressor



6 RV090 Pipeline Compressor

### Inner bundle

The inner bundle contains all the flow passages.

The internals are split into upper and lower sections which are bolted together during final assembly of the compressor at our factory.

Once the rotor has been placed in position, the upper and lower sections are bolted at the horizontal joint to form the inner bundle.

This is then inserted axially into the outer casing by means of an assembly rig.

The closure end wall is held in position by a so-called shear ring which consists of several segments.

This design results in much faster assembly than was the case with the bolting system previously employed.

### Shaft seal

The standard solutions available for sealing the shaft openings are the floating ring seal, the mechanical seal, and the dry gas seal.

The compressor in Werne is equipped with tandem dry gas seals with an intermediate internal labyrinth.

A sophisticated monitoring system ensures that the seal is constantly supplied with filtered gas and nitrogen as the sealing medium.

The residual leakage gas is processed in a downstream system.

### Testing

The gas generator of the turbine was subjected to shop testing at the Pratt & Whitney manufacturing plant in East Hartford, CT/USA.

The power turbine was manufactured and separately spin tested in Oberhausen.

The pipeline compressor was subjected to a comprehensive mechanical and thermodynamic closed loop test run at a reduced load.

### Unit Control Automation

The I & C configuration is based on a Teleperm M AS235 automation system from Siemens, and consists of a total of 4 cubicles.

A Woodward NetCon 5000 fuel gas control system, required for the gas turbine, is installed in one of the cubicles.

7 Pipeline Station Control Room



The control unit also includes all the components needed for open-loop, closed-loop, start-up and shutdown control of the gas turbine, all the start-up and shut-down sequential controls for the compressor, the unit valves with adjoining pipework, and all the facilities for monitoring and controlling the compressor such as the anti-surge control, vibration monitoring system, temperature indicators, annunciator panels, etc.

Suitable interfaces are provided for data transfer to the higher-level station automation system.



8 Compressor Test at MAN TURBO

9 Inside the Werne Facility





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