I/A Series®
Process NMR Analyzer
Model NMRB, Style C

INTRODUCTION
The Foxboro Process NMR (nuclear magnetic resonance) Analyzer offers, for the first time, on-line, NMR analysis of process fluids in refinery, chemical, pharmaceutical, dairy, and other plants.

With this new analytical system, users can operate process units much closer to design limits consistent with safe operation of the process, increase throughput, and maintain product quality. Savings in most applications typically pay for a system in less than one year.

The Foxboro system uses nuclear resonance technology to measure the chemical properties of multiple process fluid components directly in the process stream. It can also be used to measure some physical properties and computed variables such as ratios of two or more components.

BENEFITS
Continuous, timely measurement of process fluid component qualities and ratios permits you to:
- Reduce consumption of costly catalysts and reagents
- Enable the use of a wider range of feedstocks
- Improve product quality
- Maximize process throughput rates even with varying feed compositions
- Operate nearer design limits
- Obtain reliable results even with optically dense process samples
FEATURES
Key features of the Foxboro NMR process analyzer system are:
- Complete, integrated application solution
- Calibration model and application software included with system (models available for many applications)
- Standard Ethernet communication with external data and control systems
- Field-proven reliable operation, running continuously in refinery applications since 1995
- Multi-variable analysis from a single instrument and a single sample
- High measurement resolution
- Stable, homogeneous magnetic field, no fringe field
- No moving parts in the core NMR analyzer
- Variety of sample probes
- Built-in reference for measuring chemical shifts of all process components
- Automatic shim control ensures uniformity of magnetic field during measurement
- Availability of continuing service and support contracts
- Built-in manifold valves provide convenient purge, drain, and vent connections for cleaning sample line
- All system display, operation, and supervision performed from a remote computer

INTEGRATED APPLICATION SOLUTION
The Foxboro NMR analyzer, combined with advanced control tools, provides a turnkey, engineered solution for a specific process control improvement task. The analyzer, calibration model, data communication, advanced control, and follow-up support are all provided by Foxboro — one supplier for the entire package.

NMR chemometric models are available for specific process applications. All are designed and field tested to meet the operating goals of the particular process, such as to maintain product quality, maximize yield, and enhance feedstock flexibility.

PROPRIETARY APPLICATION SOFTWARE
The application software and calibration model supplied with the NMR analyzer have been developed by Foxboro for the specific type of process. On installation, parameter values are determined and customized for the particular process unit and feedstock. Continued evaluations and improvements of the model maintain conformance with ASTM and other standard methods.

HAZARDOUS AREA DESIGN
The Foxboro NMR system is housed in a stainless steel NEMA 4 enclosure, equipped with two sealed-unit air conditioners and an air purging package that meets Class I, Division 1/Zone 1, Groups C and D hazardous location operating requirements. A built-in flammable gas leak detector and automatic shutdown system continuously monitor the cabinet for possible leaks of the process sample fluid.

DATA COMMUNICATIONS
The system is designed to be operated from a remotely mounted PC via Ethernet console and/or a modem.

FIELD-PROVEN, RELIABLE OPERATION
Systems based on this design have been installed and operating successfully in oil refinery processes since 1995.
MULTI-VARIABLE ANALYSIS
The Foxboro NMR system gives continuous, simultaneous measurement and computation of one or multiple sample chemical properties. New readings are typically available at two-minute intervals.

NON-OPTICAL TECHNOLOGY
Optically dense samples do not affect the analytical results. This keeps the calibration models intact and predictable.

MULTIPLE PROBE TYPES
Different types of probes are available for various applications — standard temperature and pressure, or high temperature and standard pressure.

AUTOMATIC SHIM CONTROL
Program controlled shimming automatically detects and corrects non-uniformities in the field of the magnet by adjusting currents to 50 pairs of shim coils.

BUILT-IN REFERENCE SAMPLE
A capsule within the sample probe, typically filled with lithium chloride, is continuously monitored and used as a reference.

GLOBAL SUPPORT
Continuing contracts for local training, service, and technical support anywhere in the world are available from Foxboro.

APPLICATION SOLUTIONS
The Foxboro I/A Series Process NMR Analyzer can be combined with real time optimization and multi-variable predictive control (MPC) packages to enable better controller and optimizer model correction to compensate for current operating conditions.

MULTI-STREAM SAMPLE SWITCHING SYSTEM
An automatic sample switching system can be provided. This unit, which is mounted in a separate temperature controlled enclosure (230 x 120 x 35 cm), accepts samples from up to 5 process streams. It may also be specified to provide a 500 cc grab sample facility. The sample sequencing and timing is controlled by the NMR analyzer. The samples arriving at the sample switching system should meet the following conditions:

- Temperature between 5 and 70°C for “C” probe, 5 and 100°C for “D” probe, but all sample streams must be within 10°C of each other
- High pressure limit = 24 kg/cm² (350 psig)
- Upper viscosity limit = 40 cSt @ 50°C (122°F)

<table>
<thead>
<tr>
<th>Testing Laboratory, Types of Protection, and Area Classification</th>
<th>Application Conditions</th>
<th>Electrical Safety Design Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETL/ETL-C Type “X” purged for Class I, Division 1, Zone 1, Groups C and D</td>
<td>Temperature Class T3.</td>
<td>T</td>
</tr>
</tbody>
</table>

NOTE
This analyzer has been designed to meet the electrical safety descriptions listed above. For detailed information or status of testing laboratory approvals/certifications, contact Foxboro.
FUNCTIONAL SPECIFICATIONS

Nuclei Observed
H⁺ (primary), F₁⁹, P₃¹ (optional)

Operating Frequency
57±1.0 MHz for H⁺ (APPROX. 53 MHZ FOR F₁⁹, 23 MHZ FOR P₃¹)

Standard Probe (Type C)
Standard Type C Dewar Probe designed to handle liquids at 5 to 70°C (41 to 158°F) and at maximum pressure of 24.0 kg/cm² (350 psi).

Heavy Oil Probe (Type D)
Heavy Oil Type D Dewar Probe designed to handle liquids at 5 to 100°C (41 to 212°F) and at maximum pressure of 24.0 kg/cm² (350 psi).

Magnet System (Types C and D)
Temperature stabilized, self-condensed field, permanent (neodymium) magnet with integral field gradient (shim) coils and automatic shim control

Field strength
1.35 tesla at 45°C

Fringe field
Less than 1 gauss on external enclosure of magnet

Clear Bore Size Options
Standard Type C Dewar Probe — 4 mm (0.157 in) inside diameter
Heavy Oil Type D Dewar Probe — 7 mm (0.276 in) inside diameter

PHYSICAL SPECIFICATIONS

Enclosure
NEMA 4, 12 gauge stainless steel, air purged

Size
151.1 cm H x 179.6 cm W x 113.4 cm D
(59.5 in H x 70.9 in W x 44.7 in D)
Add 15 cm (6 in) to height for shipping pallet.

Weight
635 kg (1400 lb) net weight,
750 kg (1650 lb) gross shipping weight

Clearance
119 cm (26 in) recommended on all sides.
198 cm (78 in) recommended headroom.

Lifting Facilities
Four lifting lugs (eyes), 38 mm (1.5 in) diameter

Anchor Bolts
Four 11.9 mm (0.47 in) holes for 3/8 in anchor bolts.
(Refer to mounting pad drawing on page 8.)

Process Sample Probes
TYPE C LIQUID PROBE —
STANDARD TEMPERATURE AND PRESSURE
5 to 70°C (41 to 158°F), up to 24 kg/cm² (350 psi)

TYPE D HEAVY OIL PROBE —
HIGH TEMPERATURE, STANDARD PRESSURE
5 to 100°C, up to 24 kg/cm² (350 psi)

Utilities
POWER REQUIREMENTS
27 A, 230 ±10 V single phase 50/60 Hz ac line, typical.

ELECTRIC SERVICE REQUIREMENTS
230/240 V: One 40 A, single phase 50/60 Hz circuit
(USA: L1, L2, N, G; Europe: L1, N, G)

Remote Computer Requirements
Pentium™ processor with 128 MB RAM and Windows NT™ 4.0 operating system

Purging Gas Requirements
2.89 m³/h (1.7 cfm) dry instrument air during operation. 17 m³/h (10.0 cfm) of 7 kg/cm² (100 psi) instrument air (dry, oil-free) required during startup. A high purge time of approximately 30 minutes is required on startup.

Accessories
TEST FLUID
20 ml/min distilled water

LEAK DETECTOR TEST GAS
20% LEL Methane
0% Air

Environmental
TEMPERATURE
See page 5.
RELATIVE HUMIDITY
See page 5.
PHYSICAL SPECIFICATIONS (Continued)

**Electrical Connections**

**POWER**
Two 3/4 NPT conduit connections in explosionproof box.
Power cables terminate in box lugs. Box lugs accept cables up to 10 AWG in size. Earthing terminals require crimp connectors.

**Electrical Connections (Cont.)**

**COMMUNICATIONS**
Two 3/4 NPT conduit connections in explosionproof box.
Data communication cables terminate on screw terminals on isolation relays mounted inside explosionproof box.

**Process Connections**
13 mm (1/2 in) stainless steel lines from process to sample entrance and exit manifolds (1/2 NPT) connections.

OPERATING, STORAGE, AND TRANSPORTATION CONDITIONS

<table>
<thead>
<tr>
<th>Environmental Parameter</th>
<th>Normal Operating Conditions</th>
<th>Transportation and Storage Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
<td>0 to +45°C (32 to 113°F) ventilated to atmosphere and sheltered from direct sunlight</td>
<td>5 and 55°C (41 and 131°F) NOW: Failure to maintain magnet temperature of 4°C (41°F) causes permanent damage to the magnet.</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>5 to 95%, noncondensing</td>
<td>0 to 100%</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>230 ±10 V ac single phase</td>
<td>N/A</td>
</tr>
<tr>
<td>Supply Frequency</td>
<td>60 Hz ±0.1 Hz or 50 Hz ± 0.1 Hz</td>
<td>N/A</td>
</tr>
<tr>
<td>Vibration</td>
<td>Not more than 0.3 mm/sec² in all 3 axes</td>
<td>Not more than 0.3 mm/sec² in all 3 axes</td>
</tr>
<tr>
<td>Indirect Lightning Transients</td>
<td>Can withstand a transient surge up to 2000 V common mode or 1000 V normal mode without permanent damage.</td>
<td>N/A</td>
</tr>
<tr>
<td>RFI Effect</td>
<td>Output error is less than 0.1% of calibrated span for radio frequencies in the range of 27 to 1000 MHz and field intensity of 30 V/m when the analyzer is properly installed with shielded conduit and conductive door gaskets in place.</td>
<td>N/A</td>
</tr>
</tbody>
</table>
**MODEL CODE**

**Model NMRB, Style C**

<table>
<thead>
<tr>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/A Series Process NMR Analyzer – 230 V, Single Phase, 50/60 Hz</td>
<td>NMRB</td>
</tr>
<tr>
<td>NEMA 4/IP56 Enclosure</td>
<td></td>
</tr>
<tr>
<td>Shim Control Unit</td>
<td></td>
</tr>
<tr>
<td>Heater Control</td>
<td></td>
</tr>
<tr>
<td>Universal Power Supply</td>
<td></td>
</tr>
<tr>
<td>Process Computer</td>
<td></td>
</tr>
<tr>
<td>NT Operating System</td>
<td></td>
</tr>
<tr>
<td>Client/Server NMR Software</td>
<td></td>
</tr>
<tr>
<td>Remote Display/Control</td>
<td></td>
</tr>
<tr>
<td>Cable Kit</td>
<td></td>
</tr>
<tr>
<td>NMR Models Localized after Commissioning</td>
<td></td>
</tr>
<tr>
<td>Six Properties Included</td>
<td></td>
</tr>
<tr>
<td>First Year Maintenance Manager Agreement Contract and Start Up Services</td>
<td></td>
</tr>
<tr>
<td>(not including Transportation and Living Expenses)</td>
<td></td>
</tr>
</tbody>
</table>

**Packaging / Electrical Classification**

<table>
<thead>
<tr>
<th>Electrical Classification</th>
<th>Power Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETL/ETL-C, Class I, Division 1/Zone 1, Groups C and D</td>
<td>U.S., L1, L2, N, Gnd</td>
</tr>
<tr>
<td>CENELEC, Zone 1, Groups IIA and IIB</td>
<td>Europe, L1, N, Gnd</td>
</tr>
<tr>
<td>ETL/ETL-C, Class I, Division 1/Zone 1, Groups C and D</td>
<td>Europe, L1, N, Gnd</td>
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</table>

**Applications and Magnet Style**

<table>
<thead>
<tr>
<th>Application</th>
<th>Magnet Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline Blending</td>
<td>“C” Style, 60 Hz</td>
</tr>
<tr>
<td>Diesel Fuel Blending</td>
<td>“C” Style, 60 Hz</td>
</tr>
<tr>
<td>Fuel Oil Blending</td>
<td>“D” Style, 60 Hz</td>
</tr>
<tr>
<td>Naphtha Cracking</td>
<td>“C” Style, 60 Hz</td>
</tr>
<tr>
<td>FCCU Feed</td>
<td>“D” Style, 50 Hz</td>
</tr>
<tr>
<td>FCCU Distillates</td>
<td>“C” Style, 60 Hz</td>
</tr>
<tr>
<td>Sulfuric Acid Alkylation</td>
<td>“C” Style, 60 Hz</td>
</tr>
<tr>
<td>Crude Switching/Blending</td>
<td>“D” Style, 50 Hz</td>
</tr>
<tr>
<td>Catalytic Reforming</td>
<td>“C” Style, 60 Hz</td>
</tr>
<tr>
<td>CDU Distillates</td>
<td>“C” Style, 60 Hz</td>
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<tr>
<td>CDU Feed</td>
<td>“D” Style, 50 Hz</td>
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</table>

**Model License Fee**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Model Fee</th>
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<tbody>
<tr>
<td>0 to 6</td>
<td>1</td>
</tr>
<tr>
<td>7 to 12</td>
<td>2</td>
</tr>
<tr>
<td>13 to 18</td>
<td>3</td>
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</table>

**Communications and Remote PC**

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog and Discrete to DCS from Analyzer</td>
<td>A</td>
</tr>
<tr>
<td>Analog and Discrete to DCS from Remote Client PC</td>
<td>B</td>
</tr>
<tr>
<td>Modbus™ with RS485 Interface to DCS from Analyzer</td>
<td>C</td>
</tr>
<tr>
<td>Modbus with RS485 Interface to DCS from Remote Client PC</td>
<td>D</td>
</tr>
</tbody>
</table>

Example: NMRB–1A1A
DIMENSIONS – NOMINAL

ESD VALVE WITH 3/8 in SWAGELOCK PNEUMATIC COMPRESSION FITTING FOR PROCESS SAMPLE INPUT

5 SAMPLE SWITCHING PORTS (1/4 in SWAGELOCK PNEUMATIC COMPRESSION FITTINGS)

INPUT COMM. 3/4 NPT (SEE REAR VIEW ALSO)

POWER 3/4 NPT (SEE REAR VIEW ALSO)

TO GRAB SAMPLE VALVE (1/4 in SWAGELOCK FITTING)

CHECK VALVE WITH 3/8 in SWAGELOCK PNEUMATIC COMPRESSION FITTING FOR PROCESS SAMPLE OUTPUT

DOOR-TO-DOOR

CONCRETE MOUNTING SLAB PROVIDED BY USER (SEE PAGE 2)

MOUNTING HOLES (4) (SEE PAGE 2)

POWER 3/4 NPT (SEE REAR VIEW ALSO)
DIMENSIONS – NOMINAL (Cont.)

RIGHT SIDE VIEW

3/8 FPT TUBING CONNECTION (SWAGELOK COMPRESSION FITTING) FOR PURGE AIR SUPPLY

REAR VIEW

INPUT POWER JUNCTION BOX

INPUT COMM. JUNCTION BOX

3/4 NPT

MOUNTING SLAB

ANALYZER LOCATION

DIA. MOUNTING HOLES (4) FOR 3/8 in 0.47 BOLTS IN FEET OF ANALYZER

<table>
<thead>
<tr>
<th>Dimension</th>
<th>mm</th>
<th>in</th>
</tr>
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<tbody>
<tr>
<td>248</td>
<td>9.75</td>
<td></td>
</tr>
<tr>
<td>998</td>
<td>39.3</td>
<td></td>
</tr>
<tr>
<td>919</td>
<td>36.2</td>
<td></td>
</tr>
<tr>
<td>533</td>
<td>21.0</td>
<td></td>
</tr>
<tr>
<td>737</td>
<td>29.0</td>
<td></td>
</tr>
<tr>
<td>1270</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td>660</td>
<td>26.0</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>78.0</td>
<td></td>
</tr>
<tr>
<td>2743</td>
<td>108.0</td>
<td></td>
</tr>
</tbody>
</table>
DIMENSIONS – NOMINAL (Cont.)

5-VALVE MANIFOLD

3-VALVE MANIFOLD