MOTOROLA

M O S C A D A P P L I C A T I O N N O T E

OIL & GAS INDUSTRY

APPLICATION OVERVIEW

This application note describes:

- The oil and gas production and distribution process from drilling to customer delivery.
- Implementing SCADA (Supervisory Control & Data Acquisition) systems at various stages in the process.
- Intrinsic Safety (IS) aspects

SCADA plays a critical role at every stage of the oil recovery process: production, wellhead, transportation and distribution.

THE CHALLENGE

The petroleum industry is characterized by remote and widespread operations that include: drilling/production, distribution, transportation and refining. Each activity must be supervised from one or more control centers.

A well designed SCADA system must be able to control the following factors: flooding, leakage, fire, emergency shut-down (ESD), oil and gas flow rate and accumulated flow, line pressure, wellhead pressure, pump status, tank level, Gathering Station equipment status and other critical factors.

Due to the nature of the product, which must be transported from the well to final consumer, and the potential adverse environmental and effect of oil/petroleum accidents, SCADA systems are a necessity.

The multi-billion dollar Oil & Gas industry represents an important potential market for SCADA systems.

MOTOROLA's SCADA SOLUTION

Motorola's SCADA system, MOSCAD, offers a variety of new features and benefits that give oil and gas companies the ability to reliably gather more data and achieve more control.

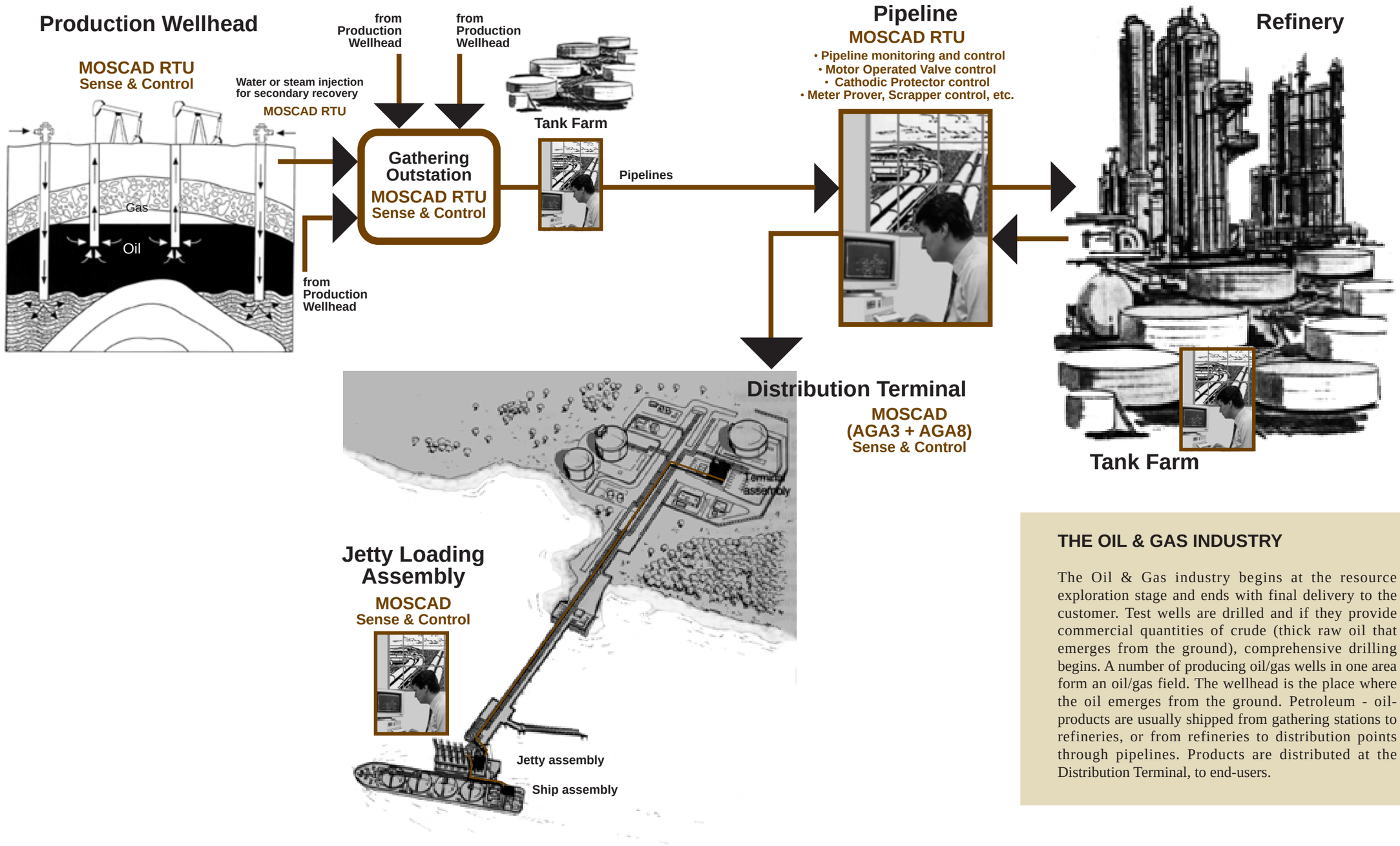
The typical MOSCAD system includes:

- Intelligent Remote Terminal Units (RTUs)
- Master Control Centers
- Communication Interfaces: Radio, Wire, Fiber optic and/or Microwave
- Sensors and Electro-Mechanical Devices.

MOSCAD can be easily implemented in the following critical stages in oil or gas production:

- Production Field
- Gathering Station
- Pipelines
- Pipeline Cathodic Protection
- Meter Calibration
- Scrapper Station
- Tank Farms
- Distribution Terminals

THE OIL & GAS INDUSTRY



THE OIL & GAS INDUSTRY

The Oil & Gas industry begins at the resource exploration stage and ends with final delivery to the customer. Test wells are drilled and if they provide commercial quantities of crude (thick raw oil that emerges from the ground), comprehensive drilling begins. A number of producing oil/gas wells in one area form an oil/gas field. The wellhead is the place where the oil emerges from the ground. Petroleum - oil-products are usually shipped from gathering stations to refineries, or from refineries to distribution points through pipelines. Products are distributed at the Distribution Terminal, to end-users.

1. PRODUCTION FIELD

The first step in oil production is recovery - removing the crude from the ground. There are two basic recovery methods: Primary Recovery and Secondary Recovery.

Primary Oil Production Stage

● ***Natural Lift*** - Normally, oil is under great underground pressure so that when a well is drilled, followed by the insertion of a production pipe, oil naturally moves to the upper zone which is under low pressure. The high pressure forces the oil to flow to the surface. This results in a reduction of pressure on the oil which causes gas to separate from the oil.

● ***Artificial lift*** - Oil can be raised by *pumps* or by *gas lift*. Electrical or hydraulic pumps are placed inside the well to force oil up. *Gas Lift* occurs when gas is pumped into the well forcing the oil to rise to the surface.

Secondary Recovery Methods

Once oil has stopped flowing in large quantities, the recovery stage uses a variety of methods to maximize the oil well's output:

● ***Water flooding*** - Water is pumped through separate injection wells at the site which forces the remaining oil to the surface.

● ***Chemical flooding*** is the same as *water flooding* but *chemicals* are added to expedite the flow.

● ***Miscible flooding*** uses carbon dioxide or other gases.

● ***Thermal recovery*** known as huff and puff uses on-site combustion. A fire is started underground which creates steam that forces oil to the surface.

2. GATHERING STATIONS

A. Oil Gathering Station

As the oil flows out of the well, it passes through a pipe arrangement that is connected to flow lines which bring the oil and gas to Gathering Stations where sediment, gas, salt water and oil are separated. The oil and gas is then prepared for shipment to the refinery where the oil is cracked or heated. As oil vaporizes, it separates into a variety of different petroleum products.

B. Gas Gathering Station

Natural gas is usually produced with some impurities that are treated in a gathering station. The first treatment is close to the well. The water is separated from the gas which flows to the gathering station through a pipe line. A second separation of water is made in the station by chemical interaction. Finally, the gas is monitored and sent through pipe lines to the clients.

At Gathering Stations, MOSCAD helps maintain smooth operations by monitoring and controlling pumps, pipelines, storage and distribution systems.

Table 1 presents typical SCADA activities as well as the I/Os used in production fields and gathering stations.

Detection & Control	I/O Type
Gas/Oil Pressures	Analog Inputs
Fire Alarm	Discrete Input
Emergency Shutdown ESD	Discrete Control Output
Pump Start/Stop	Discrete Control Output
Pump Control Remote/Local	Discrete Input
Pump Speed	Analog Input
Pump Run/Stop	Discrete Input
Motor Operated Valve (MOV) or Shut Down Valve (SDV)	Discrete Input
MOV/SDV Operation Remote/Local	Discrete Output
Choke Setpoint/Position	Analog Output/Input
Moisture (temperature)	Analog/Digital Input

Table 1. *Typical Production Field & Gathering Station I/Os*

3. PIPELINES

Petroleum - oil- products are usually shipped from gathering stations to refineries, or from refineries to distribution points through pipelines as well as on board tanker trucks, tanker ships or by rail.

Gas products are also shipped by pipeline or in a condensed liquid form called Liquid Petroleum Gas (LPG) or Liquid Natural Gas (LNG) which is loaded into special pressurized containers and shipped by rail or sea.

Pipelines must be monitored 24 hours a day, every day. They are usually located in remote areas where a minimal communication infrastructure exists.

In the event of a problem, instant cutoff is critical to preventing an ecological and economical disaster. An intelligent SCADA system like MOSCAD provides total system solutions for every phase of the pipeline operation including pumps, motor and valve operation, corrosion detection, leaks and fire detection.

Powerful pump stations are placed along the pipeline at regular intervals to ensure that the liquid flows forward. Table 2 details typical pipeline applications as well as the I/Os used in the monitoring process.

Detection & Control	I/O Type
Pump Run/Stop	Discrete Input
Pump Start/Stop	Discrete Control Outputs
Pump Control Remote/Local	Discrete Input
Pump Speed	Analog Input
Fire Alarm	Discrete Input
Flow Control	Analog Input/Output
Delivery Flow/Pressure Set Point	Analog Input/Output
Diesel Generator (D.G.) Low Oil/Fuel	Discrete Inputs
D.G. Set Start/Stop	Discrete Outputs
Emergency Shutdown-ESD of D.G.Set	Discrete Input
Station Power Fail	Discrete Input

Table 2 . *Typical Pipeline I/Os*

A Motor Operated Valve (MOV) controls petroleum/gas flow and closes off a pipe segment in the event of a leak or problem along the pipeline. Table 3 presents typical MOV I/Os used in the detection process.

Detect & Control	I/O Type
MOV Opened/Closed	Discrete Input
MOV Remote/Local Operation	Discrete Input
MOV Open/Close	Discrete Control Output

Table 3. *Typical Motor Operated Valves (MOV) I/Os*

4. PIPELINE CATHODIC PROTECTION

External Cathodic Protectors (C.P.) are used to protect against pipe corrosion. A smart RTU can monitor Cathodic Protection operation and prevent pipeline damage.

5. METER CALIBRATION

In order to calibrate the gas flow meters a special calibration meter prover is used. Several primary meter-related functions must be monitored locally or remotely.

Detection & Control	I/O Type
Meter Prover On line/By passed	Discrete Inputs
Meter Prover Reset	Discrete Input
Meter Prover Run/Stop	Discrete Inputs

Table 4. *Typical Calibration Meter Prover I/Os*

6. SCRAPPER STATION

When refined petroleum products are distributed via pipeline, different qualities or types of products are separated in the pipeline by a special cleaning technique called scrapper. A SCADA system can detect whether the scrapper has been launched or received at the Scrapper Station.

Detection & Control	I/O Type
Scrapper Launched/Not Launched	Discrete Inputs
Scrapper Received/Not Received	Discrete Inputs
Station Inlet Pressure	Analog Input
Station Outlet Pressure	Analog Input

Table 5. *Typical Scrapper Station I/Os*

7. TANK FARMS

Both crude oil and refined products are stored in large tanks in remote areas called Tank Farms. Tank Farms require highly precise and reliable systems that can prevent fires, spills or other accidents. Instant fire detection and extinguishing systems, alarm and siren equipment, tank valve open/close and pressure controls are a few of the systems that must be monitored and controlled using a highly intelligent and reliable RTU. Several typical I/Os are detailed in Table 6.

Detection & Control	**I/O**
Manifold Valve Opened/Closed	Discrete Inputs
Manifold Armed/Not Armed	Discrete Inputs
Working Tank Level Normal/High	Discrete Inputs
Tank Manifold Arming/Disarming	Discrete Control Outputs
Tank Levels	Analog Inputs
Input/Output Total Flow Meter	Pulse Inputs
Input/Output Flow Rate	Analog Inputs

Table 6. *Typical Storage Tank & Tank Farm I/Os*

8. DISTRIBUTION TERMINALS

Products are distributed at the Distribution Terminal, to end-users including heavy industry, service stations, home heating services etc. The distribution center needs safety control, fire detection and extinguishing, pumping and storage systems. It also requires precise measurement systems in order to correctly charge customers. The RTUs measurement capability must meet American Gas Association standards AGA3 and AGA8.

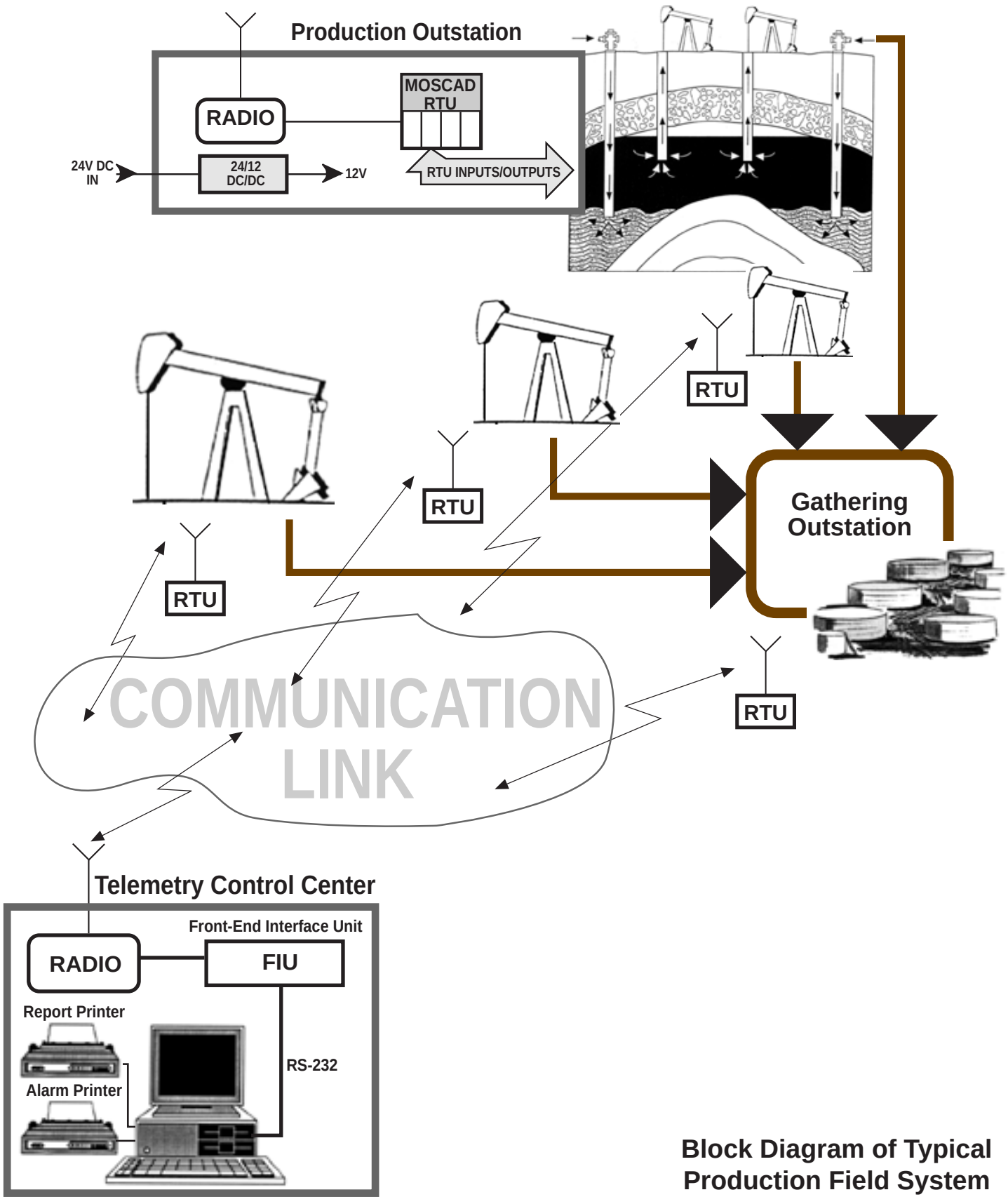
IS - INTRINSIC SAFETY

One of the most important factors in the Petroleum industry is safety. At every stage of the process, strict safety measures must be maintained to prevent fires, explosions, and ecological disasters.

Hazardous areas are defined as places where flammable materials are handled or mixed and any leak or spill can create an explosion. In order to protect equipment and personnel, precautions must be taken to prevent ignition.

Intrinsic Safety (IS) is based on the principle of restricting the electrical energy available in a hazardous area to levels that cannot cause ignition. This includes material that may cause sparks or heat up as the result of electrical faults. IS is recognized as the only safe level for equipment in hazardous areas.

Installing to Meet IS Requirements - In any IS installation there are two distinct zones, the Safe Zone where controllers and the Interface are placed, and the Hazardous Area where special sensors are connected through a Buffer composed of an IS-certified interface - to the Safe Area. The IS-certified interface is made up of discrete devices including shunt-diode, safety barriers, or isolating equivalents. Third party IS-certified buffers and sensors can be integrated with MOSCAD enabling the system to meet IS requirements on a system basis.



Block Diagram of Typical Production Field System

MOTOROLA's MOSCAD - BENEFITS

Motorola's MOSCAD system offers a complete system approach to the Oil and Gas Industry. Its intelligent RTUs can play a critical role at every stage of oil and gas production: production fields, gathering stations, pipelines, motor-operated valves, cathodic protection systems, scrapper stations, tank farms and distribution terminals.

MOSCAD offers these important features:

1. **Communication Flexibility** - MOSCAD can communicate over radio, wire line, fiber-optic cables, microwave, and dial-up or modems. This is important for oil & gas applications which are usually located at a great distance from a control center.
2. **MOSCAD** is compatible with most popular **Leak Detection** software packages (SSI, Nova Corp., DREM) - used in the Control Centers - which supervise distant RTUs placed at pipeline and tank sites.
3. **MOSCAD** calculates different gas flow parameters using AGA3 and AGA8 standards. For further information, refer to the MOSCAD TOOLBOX Manual.
4. **SMART RTUs** - MOSCAD RTUs have set new standards for the industry. They offer a wide variety of I/O options. Their 32-bit microprocessor and 13 bit analog resolution enables the RTU to solve most problem at the remote site without intervention.
5. **Compatible With Mature Platforms** - MOSCADs Control Center Software Packages are compatible with both DEC and IBM platforms which enables it to easily fit in most established computer environments.
6. **MOSCAD Toolbox**- Motorola offers a powerful tool to program the MOSCAD called the "TOOLBOX". The TOOLBOX software was designed to provide a single solution for the user to program and define all MOSCAD system functions remotely. TOOLBOX runs on a PC and operates through a communication link to the RTU. TOOLBOX creates site and network configurations, updates the system database, diagnoses the system and analyzes the 7- layer communication protocol. Using TOOLBOX, the user defines the RTU process, monitors and debugs RTU application programs, calibrates and tests RTU hardware, locally, or remotely from any site in the system.
7. **Modularity** - The Petroleum business is dynamic and MOSCAD can grow or change to meet the customer's needs. Modules, RTUs and control centers can be added easily and the radio- based infrastructure is very flexible.
8. **Upload and Download** - MOSCAD eliminates the need for frequent maintenance or service visits to RTUs. It lets users upload or download data from any RTU to any other RTU or the entire system.
9. **Remote Diagnostics** - MOSCAD's built-in diagnostic software helps maintenance teams identify and correct operational problems. Self-test and repair systems and local LEDs as well as snap-in, snap-out parts helps cut maintenance time and costs to a minimum.
10. **Store & Forward** - The MOSCAD RTU can relay messages between two RTUs that reside on the same communication link but cannot communicate directly because of path or propagation problems. In this case, the RTU acts as a store and forward repeater.

Motorola's MOSCAD can provide the cost-effective monitoring control features that the oil and gas industry is looking for today...and in the future.

Address:

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