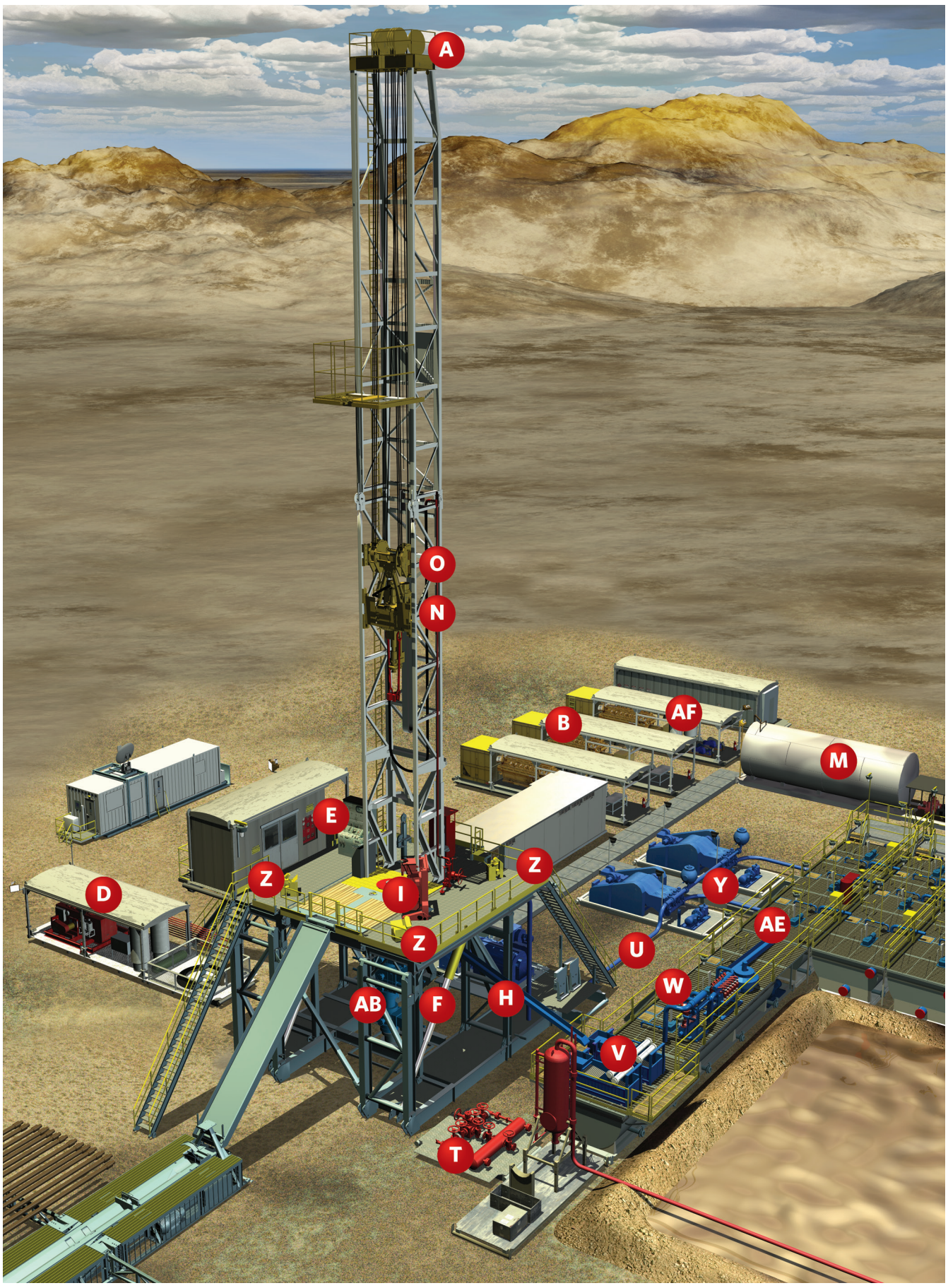
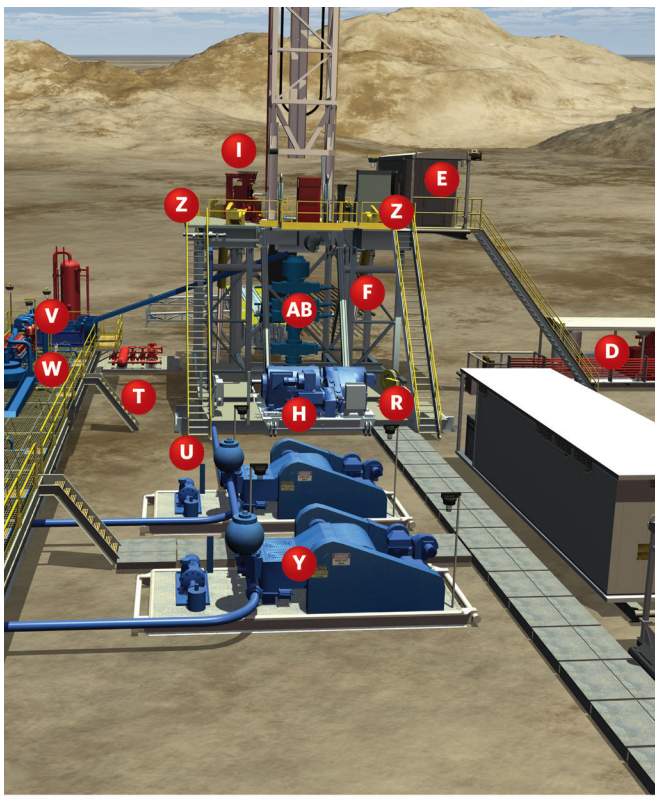
SENSORS AND SWITCHES IN OIL RIG APPLICATIONS

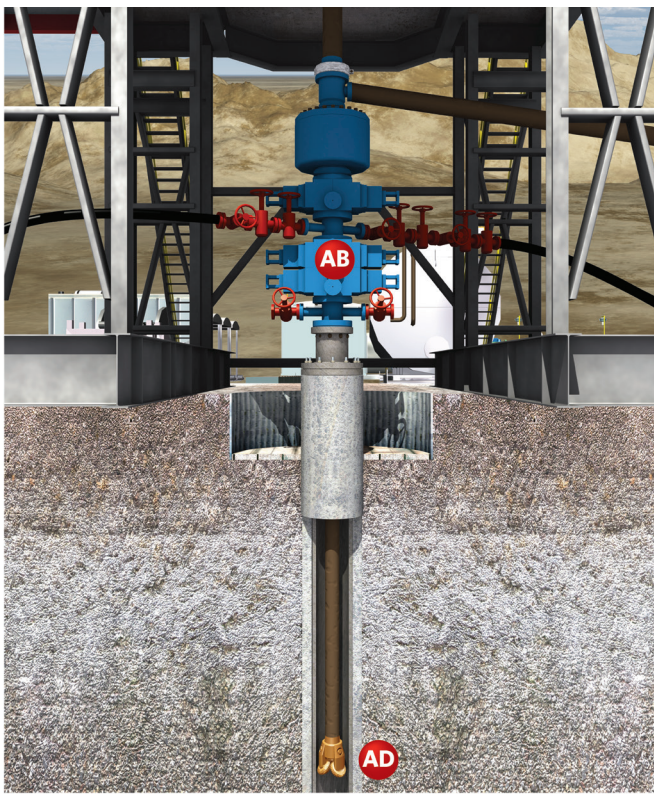
A **Crown Block**	Measure weight on drill line via cable tension **Load cells:** 41, RM
B **Power Generation Unit**	Measure oil, water, and hydraulic fluid pressure **Pressure sensors:** FP2000, MLH, IP IS, PX2, PX3, SPT Emergency shutdown **Switches for ESD:** e-stop custom
D **Accumulator Unit**	Measure inlet/outlet pressure with high accuracy **Pressure sensors:** FP2000, STJE
E **Drilling Cab**	Control/monitor operations activity **MICRO SWITCH basic switches:** BZ, V7, V15W, SX **MICRO SWITCH toggle switches:** TL, NT, TS, TW, ET, AT **Key, rotary, and e-stop switches:** custom
F **Rig Hydraulic Lift**	Measure hydraulic pressure, weight, force/strain or movement, monitor raising or lowering deck for directional drilling **Pressure sensors:** FP2000, IP IS **Load cells:** 41
H **Drawworks**	Measure torque, load/weight/position while guiding pipe into position **Load cells:** 41, RM **MICRO SWITCH switches:** BX, LSX
I **Iron Roughneck**	Measure torque while attaching pipe using hydraulic pressure or load measurements **Load cells:** 41 **Pressure sensors:** FP2000, IP IS
M **Water/ Storage Tank**	Measure tank liquid levels **Switches:** HDLS **Pressure sensors:** MLH, LL-V, SPT, PX2
N **Top Drive**	Monitor torque/twisting movement to ensure right amount of force is applied **Torque sensors:** custom Measure weight on drill bit **Load cells:** 41 Measure hydraulic pressure and feed information into control system **Pressure sensors:** FP2000, 811FM
O **Traveling Block**	Measure weight on the drill line via cable tension **Load cells:** 41
R **Deadline Anchor**	Measure tension on deadline/drilling line cable **Load cells:** 41, RM
T **Choke Manifold**	Measure valve position/choke valves **MICRO SWITCH hazardous area switch:** CX, VPX
U **Mud Return Line**	Measure drilling mud pressure to monitor and control mud flow **Wing Union sensors:** 434, 435, 437
V **Mud Shaker**	Position sensing or on/off applications **Switches:** HDLS
W **Mud Cleaner**	Position sensing or on/off applications **Limit switches:** HDLS
Y **Mud Pump**	Measure pressure and flow of mud media **Wing Union sensors:** 434, 435, 437 Mud pump stroke count, position sensing, or on/off applications **MICRO SWITCH limits:** EX, BX, HDLS
Z **Winch**	Measure direct and indirect loads **Canister load cells:** MPB, 3130, 3156, 3127



AB **BlowOut Preventor**	Monitor RAM position via hydraulic volumetric or pressure behind the piston ("pinch offs") **Pressure sensors:** A-105, TJE
AD **Drill Bit**	Measure pressure or differential pressure at high temperature and pressure ranges **Pressure sensors:** S

AE **Fluid Manifold**	Measure drilling fluid pressure **Pressure sensors:** FP2000 **Wing Union sensors:** 434, 435, 437 Measure valve position **Limit switches:** CX, WCX, VPX
AF **Mud Tank/ Reservoir**	Measure tank liquid levels **Pressure sensors:** FP2000, IP IS, SPT Monitor tank valve position **Limit switches:** BX, LSX, HDLS





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SENSORS AND SWITCHES IN OIL RIG APPLICATIONS

PRESSURE SENSORS

FP2000 Series
- All-welded, stainless steel construction
- Gage, absolute, barometric, vacuum, differential pressure
- Range: 0.5 psi to 10,000 psi
- Accuracy range of 0.1 % or 0.25 %
- Intrinsically safe options available

MLH Series
- All metal wetted parts for use in wide variety of fluid applications
- No internal elastomeric seals mean no o-ring compatibility issues
- Range: 50 psi to 8000 psi (inclusive)
- Accuracy: ±0.25 %FS BFSL
- Rated IP65 or better for protection from harsh environments

IP IS Series
- Rugged, all-welded stainless steel and Hastelloy® wetted parts for durability
- Compatible with a wide variety of media
- Range: 7 bar to 350 bar | 100 psi to 5,000 psi
- Accuracy: ±0.15 %, ±0.25 % BFSL
- Fully configurable

PX2 and PX3 Series
- Cost effective, highly configurable and highly durable
- Compatible with a wide variety of harsh media
- Broad compensated temperature range with industry-leading Total Error Band
- Range: 1 bar to 46 bar | 100 kPa to 4.6 MPa | 15 psi to 667 psi (PX2)
- Range: 1 bar to 46 bar | 15 psi to 667 psi (PX3)
- Accuracy ±0.25 %FSS; TEB ±2 %FSS (-40°C to 125°C [-40°F to 257°F])

SPT Series
- Rugged, stainless steel in a small size package
- Absolute, gage, sealed gage, vacuum gage
- Range: 0 psi to 3 psi, 0 psi to 5000 psi; ±0.25 % accuracy
- Reliable semiconductor technology, NEMA 4 design
- Calibrated and temperature compensated

Model TJE
- Rugged, all-welded, stainless steel construction
- Built for applications requiring high accuracy and temperature stability
- Unique “true gage” design hermetically sealed against atmospheric contamination
- Range: 1 psig/a to 60000 psig/a; accuracy: ±0.10 %
- Intrinsically safe available

Super TJE Series
- Ultra precision pressure sensors with up to ±0.05 % accuracy
- True gage, absolute and differential (wet/wet)
- Durable, stainless steel for use in rugged environments
- Range: 10 psig to 7500 psig (pressure); 50 psid to 750 psid (differential)
- Intrinsically safe options available

811FM Series
- All-welded, stainless steel construction for use with liquid, gas or corrosive vapors
- Range: 2 psig/a to 10000 psig/a
- Accuracy: ±0.25 %
- Dual pipe thread pressure fitting for easy bulkhead mounting
- Explosion proof

Model S
- Rugged, high-frequency stainless steel
- Extremely small size, fits into tight spaces
- Range: 100 psig to 15,000 psig
- Operating temperature range: -54°C to 149°C [-65°F to 300°F]
- Accuracy: ±1.0 %

Model A-105
- Rugged, unitized stainless steel design with heavy sidewalls
- Thin diaphragm design able to measure low pressures
- Flush mount design with miniature footprint
- Can be used in corrosive fluid environments
- Range: 100 psig to 15,000 psig; accuracy: ±0.5 %

LL-V Series
- Designed for vertical entry into a tank
- Complete fluid submersion; corrosion resistant to most fluids
- True gage design with all welded stainless steel construction
- Range: 20 in-H_2O to 50 psig; accuracy: ±0.1 %

Models 434, 435, 437 Wing Union Pressure Sensors
- Rugged design with Inconel® X-750 or NACE-compliant Inconel® 718 wetted parts
- Built to provide durability with abrasive or corrosive media
- Accuracy: ±0.1 %FSS BFSL (Model 435) high accuracy, or ±0.2 %FSS BFSL (Model 434, 437) standard accuracy
- Wide port aperture (Model 437) for use with more viscous media
- Compatible with WECO® 1502, 2002, 2202; intrinsically safe option available
- Protective cage option (Model 434, 435, 437)

TORQUE SHAFTS

Custom Torque Shaft
- Modify/design existing top drive shafts to measure torque
- Strain-gauge the complex large shafts found in top drives
- Calibrating to torque levels required on a top drive
- Modify/adapt the calibration rig flanges to the custom flanges on a top drive shaft

OPERATOR CONTROLS

Rotary Switches
- 3- and 4-position options
- May be engineered with lever or knob actuator
- Integral connectors (Metripak 280 and Sumitomo)
- Environmentally sealed design

e-Stop Switches
- Provides positive contact closure and opening when the switch is operated
- Environmentally sealed design (IP67 sealing)
- UV-resistant knob for outdoor use
- Knob available in a variety of colors

MICRO SWITCH Toggle Switches (Sealed and Unsealed), TL, NT, TS, TW, ET, AT Series
- Broad product range meets a variety of electrical and load requirements
- Sealed models built to withstand harsh, wet, dusty, and dirty environments
- 2 or 3 position, momentary and/or maintained action; 1-, 2- or 4-pole circuitries
- IWTS (integrated wire termination system) for ease of assembly & maintainability

LOAD CELLS

Model 41
- Rugged, low profile pancake style
- All-welded stainless steel with double diaphragm design
- Load ranges of 5 lb to 500,000 lb; Accuracy: ±0.1 %
- Low sensitivity to extraneous loads
- Intrinsically safe option available

Model RM
- Rod end in-line tension load cell
- Rugged design with stainless steel, all-welded construction
- Load ranges from 2000 lb to 200,000 lb; ±0.22 % to 0.29 % accuracy
- Low sensitivity to extraneous loads

Model MPB
- High capacity load measurements in a small size load cell
- Rugged stainless steel construction
- Load ranges from 15,000 lb to 2,000,000 lb
- Accuracy: ±0.25 % full scale

Model 3130
- Carbon steel, fatigue-resistant load cell
- Extremely resistant to extraneous bending and side loading forces
- Load ranges of 500,000 lb to 1,000,000 lb
- Accuracy: ±0.30 % full scale

Model 3156
- Carbon steel, fatigue-resistant load cell
- Extremely resistant to extraneous bending and side loading forces
- Load ranges of 25,000 lb to 150,000 lb
- Accuracy: ±0.30 % full scale

Model 3127
- Carbon steel, fatigue-resistant load cell
- Extremely resistant to extraneous bending and side loading forces
- Load ranges up to 2,000,000 lb
- Accuracy: ±0.30 % full scale

MICRO SWITCH BASIC SWITCHES

MICRO SWITCH Premium Large Basic Switches, BZ Series
- Accepted as the world-wide standard snap-action switch
- Best suited for high cost-of-failure applications
- Designed for 100k operations at full load or 10M for mechanical life
- Current ratings from 10 A to 25 A
- UL/CSA, CE, UKCA, ENEC approvals

MICRO SWITCH Premium V-Basic Switches, V7 Series
- Best suited for higher cost-of-failure applications
- Designed for 100k operations at full load or 10M for mechanical life
- Current ratings from 0.1 A to 25 A
- UL/CSA, CE, UKCA, ENEC approvals

MICRO SWITCH Premium Miniature/Subminiature Basic Switches, SX Series
- Best suited for higher cost-of-failure applications
- Small size and light weight
- Current ratings from 0.1 A to 25 A
- UL/CSA, CE, UKCA, ENEC approvals

MICRO SWITCH Watertight Miniature Switches, V15W Series
- Miniature-sized basic switch designed for harsh-duty, wash down areas
- Rugged, highly accurate machine control for turning circuits on and off
- Compact, lightweight, and long-lasting
- UL, cUL, CE, UKCA, ENEC, CQC approvals

MICRO SWITCH LIMIT SWITCHES

MICRO SWITCH Hazardous Area Switches, BX and LSX Series
- Designed specifically for dangerous indoor or outdoor locations
- Superior reliability and repeatability
- Explosion-proof design with flame path to contain and cool escaping hot gases
- O-ring seals render switches weather-proof, water-tight, dust-tight
- UL, CSA (BX, LSX Series); ATEX, IEC EX, NEPSI, European approvals (BX Series)

MICRO SWITCH Hazardous Area Switches, CX Series
- Hazardous atmosphere outdoor use – watertight, dust-tight
- Superior reliability and repeatability
- Rotary converts in seconds to clockwise, counter-clockwise, or both-way operation
- IP66; NEMA 1, 3, 4, 4X, 6, 6P, 13 sealing
- UL, CSA, ATEX, IEC Ex approvals

MICRO SWITCH Hazardous Area Valve Position Indicator, VPX Series
- Certified for ATEX, IEC Ex, CE, and cULus specifications for global applications
- Die-cast aluminum housing and various sealing (NEMA 4, 4X, 6, and 13)
- Versions available in both snap-action switches and intrinsically safe inductive proximity switches
- Versions of the VPX with proximity switches carry an Intrinsically Safe (IS) rating

MICRO SWITCH Hazardous Area Switches, EX Series
- Designed for dangerous indoor or outdoor locations
- Superior reliability and repeatability
- Smallest UL-listed housings available for use in hazardous locations
- O-ring seals render switches weather-proof, water-tight, dust-tight
- UL, CSA, ATEX, IEC EX approvals

MICRO SWITCH Heavy-Duty Limit Switches, HDLS Series
- Three series offer rugged, die-cast body and epoxy coating
- Boss-and-socket head design for secure head-to body retention
- Multiple mounting and actuator options
- UL, CSA, CE, UKCA, CCC approvals

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