INTRODUCTION TO AUTOMATED ROTARY SELECTOR VALVE (RSV), SPILL PREVENTION CONTAINMENT SKID and OPTIONAL (MPFM) MULTI PHASE FLOW METER

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ABSTRACT
This paper will provide a basic understanding of the Multiport Selector Valve (MSV) also known as Rotary Selector Valve (RSV), Controller, Environmentally-Friendly Spill Prevention Skid, Design Analysis, Usage and Dynamic Fundamentals; Highlighting the technical capabilities to manifold multiple wells from a single unit. Automation – Local/Remote Port Selection / Positioning, Monitoring Via; Modbus/RTU/485/TCP/IP protocol and integration with DNOC / SCADA / PLC.

BACKGROUND
The RSV was developed in the early 1900's for use in irrigation systems. By the late 1940's, the product found favor in the growing oil and gas industry throughout Texas and California. The purpose of the unit was to manifold multiple wells into a single group flowline to feed a various containment vessels or production facilities and maintain the ability to test single specific wells or sources on command.

Today the RSV is used widely throughout the oil and gas industry in addition to chemical, refinery, water treatment, pulp and paper, cementing, food production and general industry applications.

DISCUSSION
Improvements to the RSV continue as needs of the client base require with respect to metallurgy, flow, line-pigging characteristics, valve size, pressure classes, seals, differentials, controllers, communication protocols, serviceability, metering capabilities and spill prevention or containment.
Additionally, we are faced with the task of ensuring each design supports ergonomic operation, safety, simplified integration and environmental protection from leakage, such as H^2S fluids or gas.

WHAT IS A ROTARY SELECTOR VALVE (RSV)
The RSV supports the capability of diverting multiple inlet ports, allowing each port to flow uninterrupted into a single chamber known as the body of the valve and out though a single group outlet port. A rotor stem, positioned in the center of the bowl, allows for the selection of a single inlet source to be diverted through a 1.2 D or 1.5 D flow line elbow and out through a single test outlet port.
The valve position is controlled by manual or automatic operation. Manual operation requires placing an indexing wrench directly on the outer stem of the rotor and rotating to the selected stopping position. Automatic operation uses a hydraulic, pneumatic or electrical controller that attaches directly to the outer stem of the rotor allowing for local or remote positioning of the rotor to a selected port. (See Figures 1 & 2)

DESIGN CRITERIA

- ASME B16.34 (American Society of Mechanical Engineers)
- ASME Sec. VIII, Division 1 / Division 2 (FCI- Fluid Control Institute)
- ASME B16.5 (FCC-Fluid Catalytic Cracking)
- NACE MR 0175 / ISO 15156 (National Association of Corrosion Engineers)
- API 598 (American Petroleum Institute)
- ANSI/FCI 70-2-2006 (American National Standards Institute)
- MSS SP-55 (Manufactures Standardization Society)

ANSYS finite element analysis software is employed for the main components of the RSV. Working and test conditions are analyzed and utilization factors (safety factors) to code allowables are verified.
Standard approach is to utilize the ASME VIII Division 1 design creteria and always employ the casting quality factor unless the design is unique, limited in quantity and customized for specific applications. (See Figures 3 - 5)

Skid analysis would also be verified by FEA methods if needed.

Foundation (skid):

- Based on the results of the analysis conducted using FEA, the Sled meets the requirements of AISC with a safety factor greater than 1.5 for all loading conditions and a safety factor greater than 3 for the Lifting Eyes. (See Figures 6 & 7)

The RSV OPERATION

The RSV can be operated in a clockwise or counter clockwise direction.
As the rotor passes each port a spring loaded wiper is engaged against the valve body seal seating surface. This creates a self-cleaning action and removes accumulated debris that might restrict proper operation. It also increases the life of the port seal and valve body.
An adjustable, spring loaded Carbon Teflon Port Seal serves as a soft-seal that prevents leakage at the test line and valve body junction. Back-up rings located on the port seal are designed to accommodate excess pressure, higher temperatures or chemical presence.
The Port Seal can be adjusted with a specially designed tool. The tool has two retractable spring loaded pins that engage and disengaged via a pistol grip trigger. Each pin fits into a slot located on either side of the adjusting nut. (See Fig 10)

Specially designed O-Rings prevent external leakage through the valve body or head.
Emergency shutdown facilities; shut down upstream inlet ports in a single or group. Downstream control valve can be remotely and automatically connected to the upstream setting point based on user requirements. The control system can be operated locally or remotely.
Optional quick disconnect fittings at all inlet/outlet flanges allow simple removal or relocation of the skid.
Note: Special coatings are applied for offshore or extreme conditions.

IQTF ACTUATOR

The (IQTF) Intelligent Quarter Turn Full is a quarter turn actuator with a multiport board allowing 360˚ clockwise or counter clockwise rotation. (See Figure 13)
The IQTF Actuator provides a simple, programmable, interface for local or remote operation even in the event of power loss. (See Figure 14)

COMMUNICATIONS AND CONTROL

Input Voltage Options
- 24Vdc
- 100-690Vac 50/60Hz

Operating Current
- 24 Vdc – 13 Amps
- 120 Vac – 3.7 amps

Temperature Rating
- 40°C to 85°C

Duty Rating
- 20% at rated torque

Positioning Accuracy
- 0.5°

The IQTF Actuator can be controlled remotely via: Modbus, RTU 485 protocol, (See Figure 20)
Modbus is a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers (PLCs).

- A **RTU** (remote terminal unit) is a microprocessor-controlled electronic device used to interface with a system or object.
- **SCADA** (supervisory control and data acquisition system) by transmitting telemetry data to the system, and by using messages from the supervisory system to control connected objects.
- **TCP/IP** (Transmission Control Protocol / Internet Protocol) used for the internet and other similar networks.
- **DNOC** (Digital Network Oil Computer) used to interface with equipment and SCADA/PLC program.
- **RS-232/485** – Serial communication for computers and devices.
- **IrDA – (**Infrared Data Association) used to communicate and transmit data via Ir technology or optical wireless technology.

SPILL CONTAINMENT SKID

*The multiport modular skid system utilizes a simple, design that saves time, money and human resources. The system accommodates quick connect expandability for future field growth or quick disconnect to move those resources to other areas for improved utilization. (See Figures 11 & 12)
Examples of the Multiport Skids vs. Standard Manifold as built can be seen in Figure's 21 & 22

OPTIONAL MULTI PHASE FLOW METER

The PhaseWatcher permanent multiphase flowmeter (MPFM) uses Vx technology for continuous flow rate measurements. The PhaseWatcher flowmeter operates equally well in both oil and dry gas environments, making it possible to monitor and test dry gas, condensate and oil wells with a single meter.
Via a remote data link to the PhaseWatcher multiphase meter, users can validate well data, perform quality control, generate well test reports, analyze well data, diagnose production, and interpret reservoir intervals. By eliminating the need for separators and their associated support systems or controls, the PhaseWatcher system is ideal for land, satellite, or unmanned locations, including subsea installations.
Since the need for a separator has been eliminated, the requirements for space, load, and maintenance are reduced. Continuous, highly accurate flow rate measurements allow for quicker response time to production anomalies. The PhaseWatcher has no moving parts and is essentially maintenance free. Remote monitoring increases the safety of field personnel and allows for better utilization of human resources.

CONCLUSION

The RSV Multiport Skid provides a simple, cost effective solution to manifold fluids in a low maintenance, environmentally friendly package. The compact design reduces capital costs, while the quick connect/disconnect system allows for better utilization of resources when and where they are needed. The latest data communication technologies provide continuous feedback to help maintain a high level of operational efficiency and ensure quicker response time to production anomalies.

REFERENCES

Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both	ASTM A 194
Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service	ASTM A 234
Steel Bars, Carbon, Cold-Finished, Standard Quality	ASTM A 108
Steel Bars, Alloy, Standard Grades	ASTM A 322

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)	
Valves-Flanged, Threaded, and Welded End	ASME B16.34
Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids	ASME B31.4
Gas Transmission and Distribution Piping Systems	ASME B31.8
Rules for Construction of Pressure Vessels	ASME VIII
Non-Destructive Examination	ASME V
Plain Washers	ASME/ANSI B18.22.1
Standardization of Valves, Flanges, Fittings, and Gaskets	ASME/ANSI B16.5
AMERICAN WELDING SOCIETY (AWS)	
Structural Welding Code – Steel	AWS D1.1
AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)	
Manual of Steel Construction, Allowable Stress Design	AISC
NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)	
Petroleum and natural gas industries – Materials for use in H_2S-containing environments in oil and gas production	NACE MR0175/ ISO 15156-1
American National Standard – Control Valve Seat Leakage	ANSI/FCI 70-2-2006

Specification Data Sheet

Model		2 inch NPT ANSI Class 300/600	2 - 3 inch NPT ANSI Class 300	2 - 3 inch NPT ANSI Class 600	3 inch Flanged ANSI Class 300/600/900	3 inch Flanged ANSI Class 1500	4 inch Flanged ANSI Class 300/600/900	6 inch Flanged ANSI Class 600/900
Item		04295-12XX	04295-03XX	04295-03XX	04295-03XX	04295-03XX	04295-04XX	04295-06XX
Inlet Size		2 inch	2 inch & 3 inch	2 inch & 3 inch	3 inch	3 inch	4 inch	6 inch
Working Pressure (psi)		1000/1480	1000	1480	1110/1480/2225	3333	1110/1480/ 2225	1480/2225
Max Port Seal Differential Press. (psi)		1000	800	800	1000	1000	1000	1000
Standard Maximum Temp (°F)		225	225	225	225	225	225	225
Hi-Temp Maximum Temp (°F)		400/500	400	500	400/500	500	500	500
Flow	Test Outlet Cv (gpm)	290	725	725	725	725	1160	2403
	Group Outlet Cv (gpm)	423	1058	1058	1058	1058	1693	3167/4949
Valve Head Material		ASTM A-516 Grade 70	ASTM A-516 Grade 70	ASTM A-516 Grade 70	ASTM A-516 Grade 70	SAE 4130 Grade 75	ASTM A-516 Grade 70	ASTM A-487 Grade 4A
Valve Body Material		ASTM A-216 WCB	ASTM A-216 WCB	ASTM A-216 WCB	ASTM A-216 WCB	ASTM A-487 Grade 4	ASTM A-216 WCB	ASTM A-487 Grade 4A
Rotor Material		ASTM A-216 WCB	ASTM A-216 WCB	ASTM A-216 WCB	ASTM A-216 WCB	ASTM A-487 Grade 4	ASTM A-216 WCB	ASTM A-487 Grade 4
Bolting		ASTM A193 B7M	ASTM A193 B7M	ASTM A193 B7M	ASTM A193 B7M	ASTM A193 B7M	ASTM A193 B7M	ASTM A193 B7M
Number of Inlets		8	8	8	8	8	8	8
Test Outlet Size		2 inch	2 inch/ 3 inch	2 inch/3 inch	3 inch	3 inch	4 inch	6 inch
Group Outlet Size		4 inch	6 inch	6 inch	6 inch	6 inch	8 inch	16 inch
Weight		154 lbs	200 lbs	200 lbs	850/950 lbs	1150	1875	4750

*** Optional 2" flanged (1.5D) * Optional Coating or Cladding (All) * Optional Trim Materials (All) * Optional Specialized Materials (All) * Optional Extreme Temperature Seal Kits (All)**

Figure 1

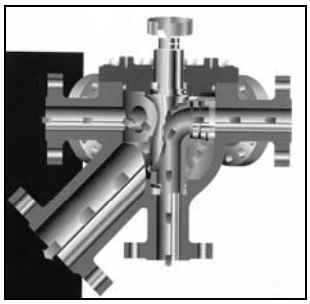

Figure 2

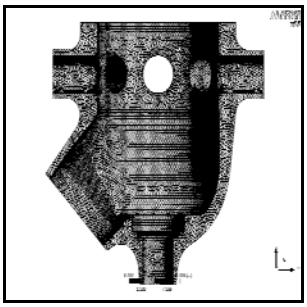

Figure 3 - Body Mesh

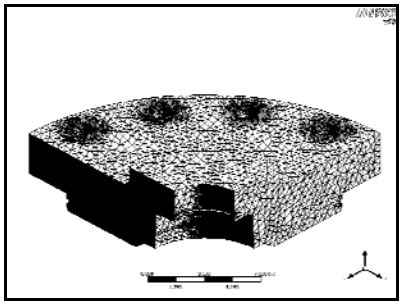

Figure 4 - Bonnet Mesh

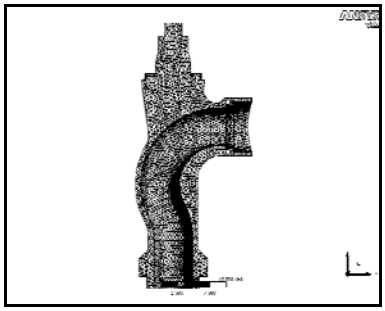

Figure 5 - Rotor Mesh

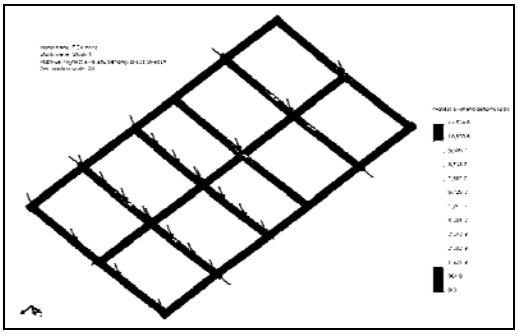

Figure 6

Component	Material	SMYS (psi)	SMTS (psi)	S allowable (psi)
I-Beams W8x28	ASTM A 572 GR. 50	50,000	65,000	33,330
Lift Eyes	ASTM A 572 GR. 50	50,000	65,000	33,330

Figure 7 - Typical Mechanical Properties of Foundation Skid

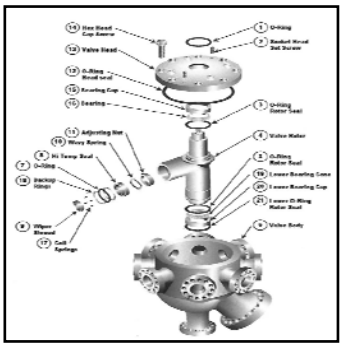

Figure 8 - RSV Components

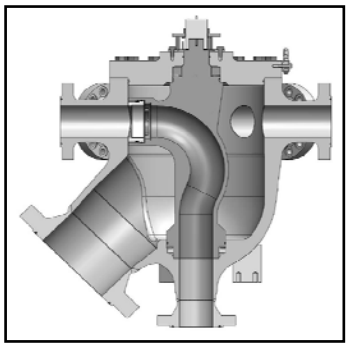

Figure 9 - 1.5 D Pigging Characteristics

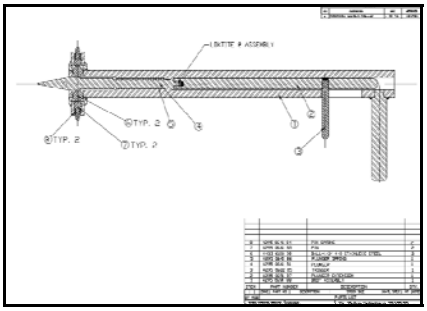

Figure - 10 RSV Seal Adjustment Tool

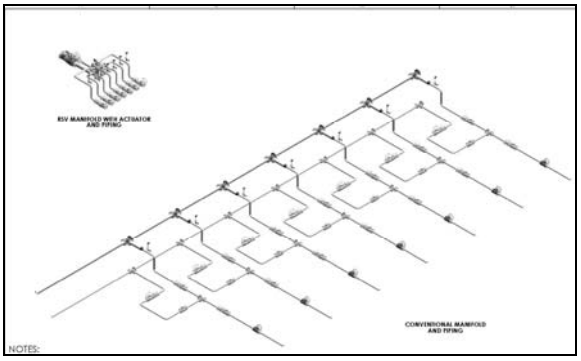

Figure 11 - Conventional Manifold vs. RSV Manifold

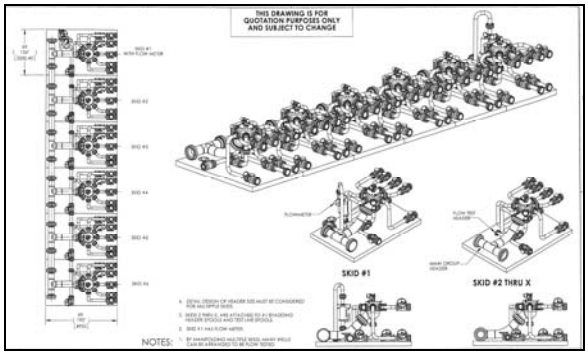

Figure 12 - RSV Spill Containment Manifold

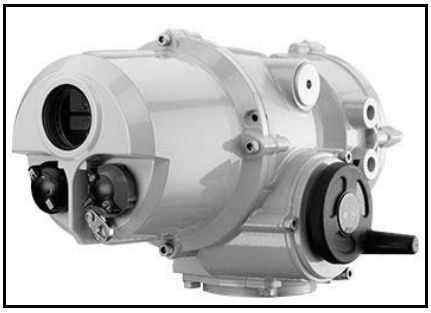

Figure 13 - Local Remote Control

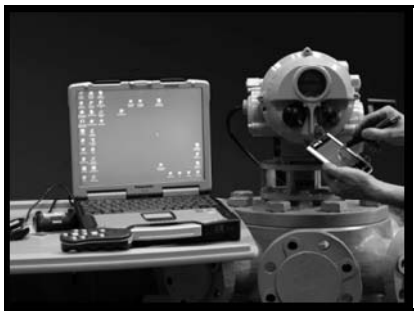

Figure 14 - Programmable

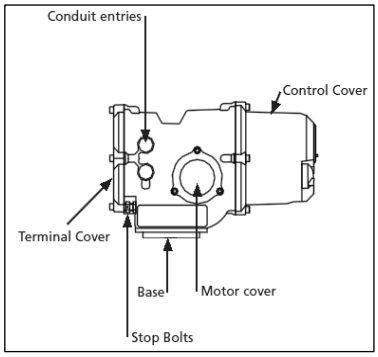

Figure 15 - IQTF Actuator Side View

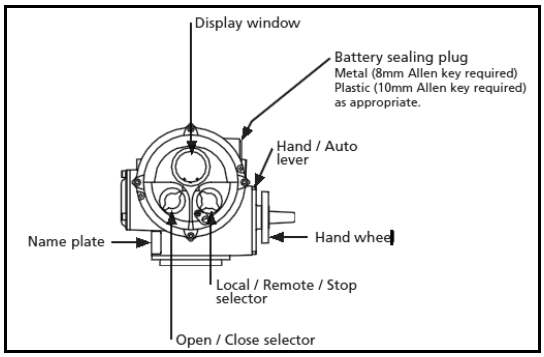

Figure 16 - IQTF Actuator Front View

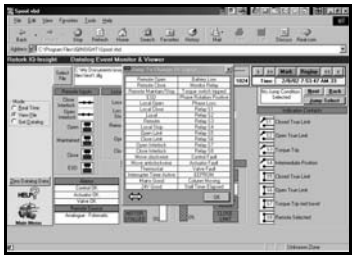

Figure 17 - Monitor Switch's

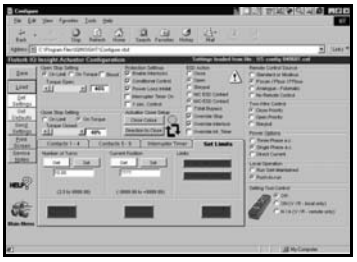

Figure 18 - Data Logging

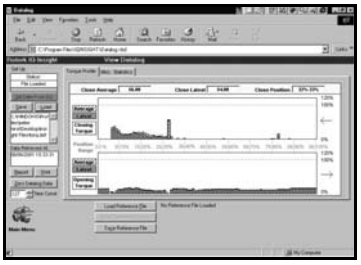

Figure 19 - Torque Values

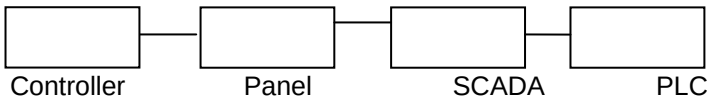

Figure 20 - Typical Modbus Communication Format

Figure 21 - 3 X 6 X 3 CL 600 Skid Mounted RSV

Figure 22 - 6 X 16 X 6 CL 600 Skid Mounted RSV

Figure 23 - Standard Manifold