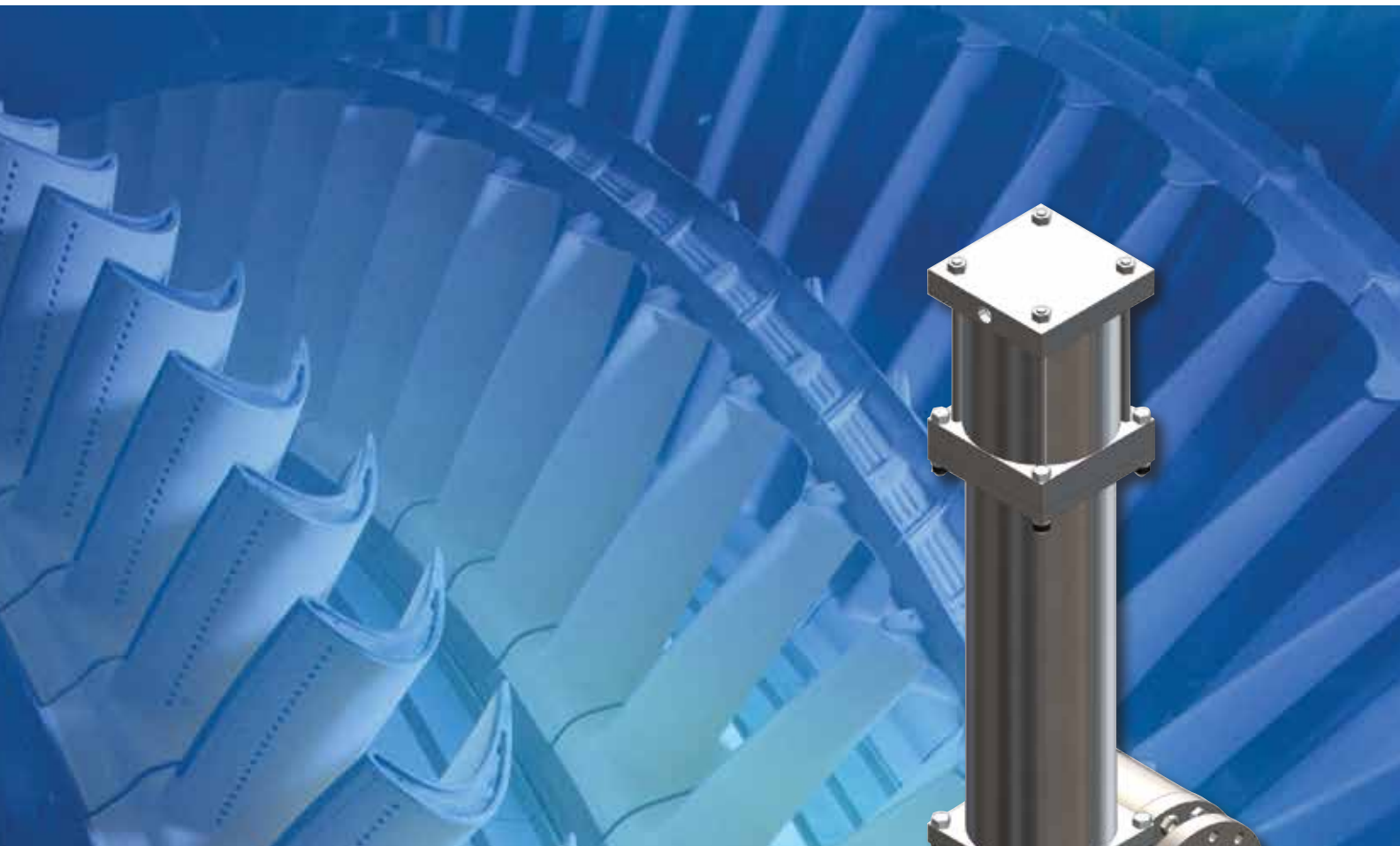


Becker* T-Ball* Anti-Surge Valve

High performance compressors require high performance surge protection





Background Image: Becker T-Ball® anti-surge valve installed in a Russian natural gas processing plant providing reliable protection for nearly a decade.

Becker T-Ball* Anti-Surge valves from GE Oil & Gas provide precise anti-surge protection and control for critical compressor applications across the oil and gas industry. Our patented rotary-control, non-clogging T-Ball design provides fast, low impact automation that helps eliminate potentially damaging pressure imbalances while reducing maintenance and increasing efficiency—all without compromising performance. And the T-Ball's unique combination of high capacity and high turndown offers superior control and protection throughout the compressor's speed range. The Becker T-Ball anti-surge valve is a complete anti-surge control solution that delivers high performance and reliable protection even in the most demanding operating environments.

Combined, these performance features provide the following added benefits:

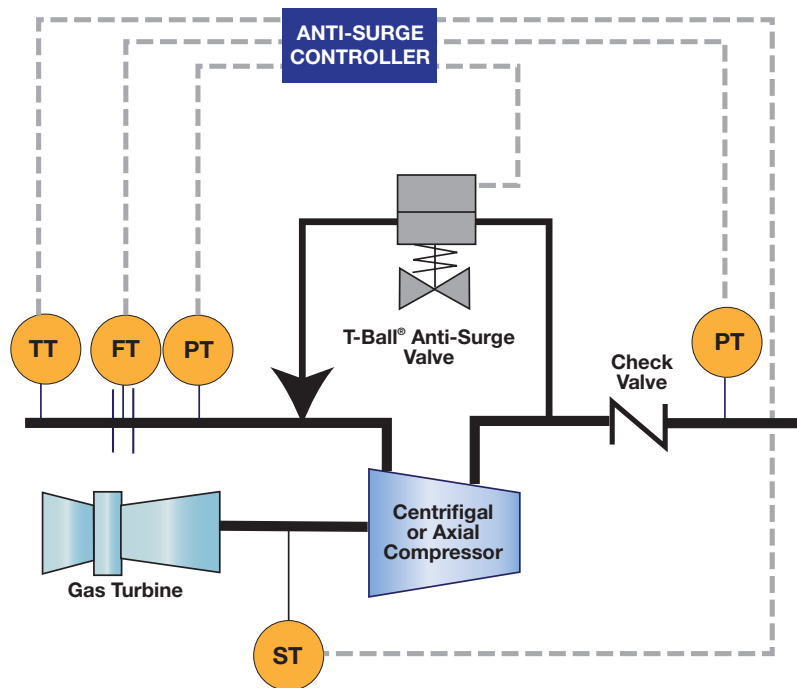
- Exceptional continuous control
- Fast response and protection of critical equipment
- Improved system operating efficiency
- Increased profitability with minimal energy loss
- Reduced maintenance and tuning



The patented rotary control T-Ball features a non-clogging quarter-turn design that provides quick and low impact automation. Its high capacity and rangeability combined with multi-stage noise attenuating trims makes it ideal for demanding anti-surge applications.

Designed for maximum reliability

Becker T-Ball Anti-Surge Valves can be custom designed for your application and manufactured with superior quality materials to deliver reliability and protection for your system.



Typical Anti-Surge System

Becker T-Ball Anti-Surge Valves can operate in the critical conditions compressor stations demand, from high pressure differentials, extreme temperatures to corrosive media.

| Product Range | |
|---------------------------|--|
| Valve Style | Rotary Control T-Ball |
| Actuator Type | Single-Acting/Double-Acting Rotary Piston |
| Pressure Ratings | ANSI Class 150 to 2500 |
| Sizes | NPS 2 to NPS 42 50 mm - 1,070 mm |
| Temperature Range | -76°F to 349°F -60°C to 176°C |
| Shut Off | Soft Seat - Tested Up to Class VI Metal Seat - Tested up to Class V |
| End Connections | RFFE, RTJ, Weld End |
| Performance | |
| Turndown | Over 300:1 |
| Maximum Noise Attenuation | Up to 50 dBA |
| Stroke Full Open | < 1 second** |
| Stroke Full Closed | < 5 seconds** |

** Larger valves may result in longer opening and closing times

Becker T-Ball Anti-Surge Valves are designed for the global oil and gas industry and can meet several international industry standards such as:

| Standard | Description |
|-------------------|--|
| CRN | Canadian Registration Number |
| NACE MR0175 | Petroleum and Natural Gas Industries - Materials for use in H ₂ S containing environments in oil and gas production |
| ATEX Dir. 94/9/EC | Equipment for use in Explosive Atmospheres |
| PED 27/23/EC | EU Pressure Equipment Directive |
| GOST-R | Russian Gosstandardt Certificate |
| RTN | Rostechnadzor |

NOTE: Due to GE's dedication to new product development and enhancement data provided is subject to change.

Each component is engineered to provide exceptional performance

Controlled Deceleration

A pneumatic cushion engaged in the last 10% of travel prevents impulse loading from a surge's quick, high force stroking speeds—reducing frictional effects that can occur within the unit.

Heavy Duty Pneumatic Cylinder

The Becker RPSR actuator assembly utilizes a high pressure durable steel pneumatic cylinder that offers very low break loss pressure.

Superb Fatigue Resistance

Heavy duty spring material manufactured from heat treated 6150H steel alloy provides a very long life.

Stable Operation

Rotary quarter-turn design provides quick, easy, and low impact automation; eliminating the pressure imbalances that are experienced with standard balanced valve plugs.

Robust Design

With a single rotating element the T-Ball is designed to withstand the vibrations exhibited within compressor piping systems.

Improved Safety

An all-welded spring cartridge configuration prevents operator injury as the design is factory configured and prohibits field disassembly.

Reduced Maintenance

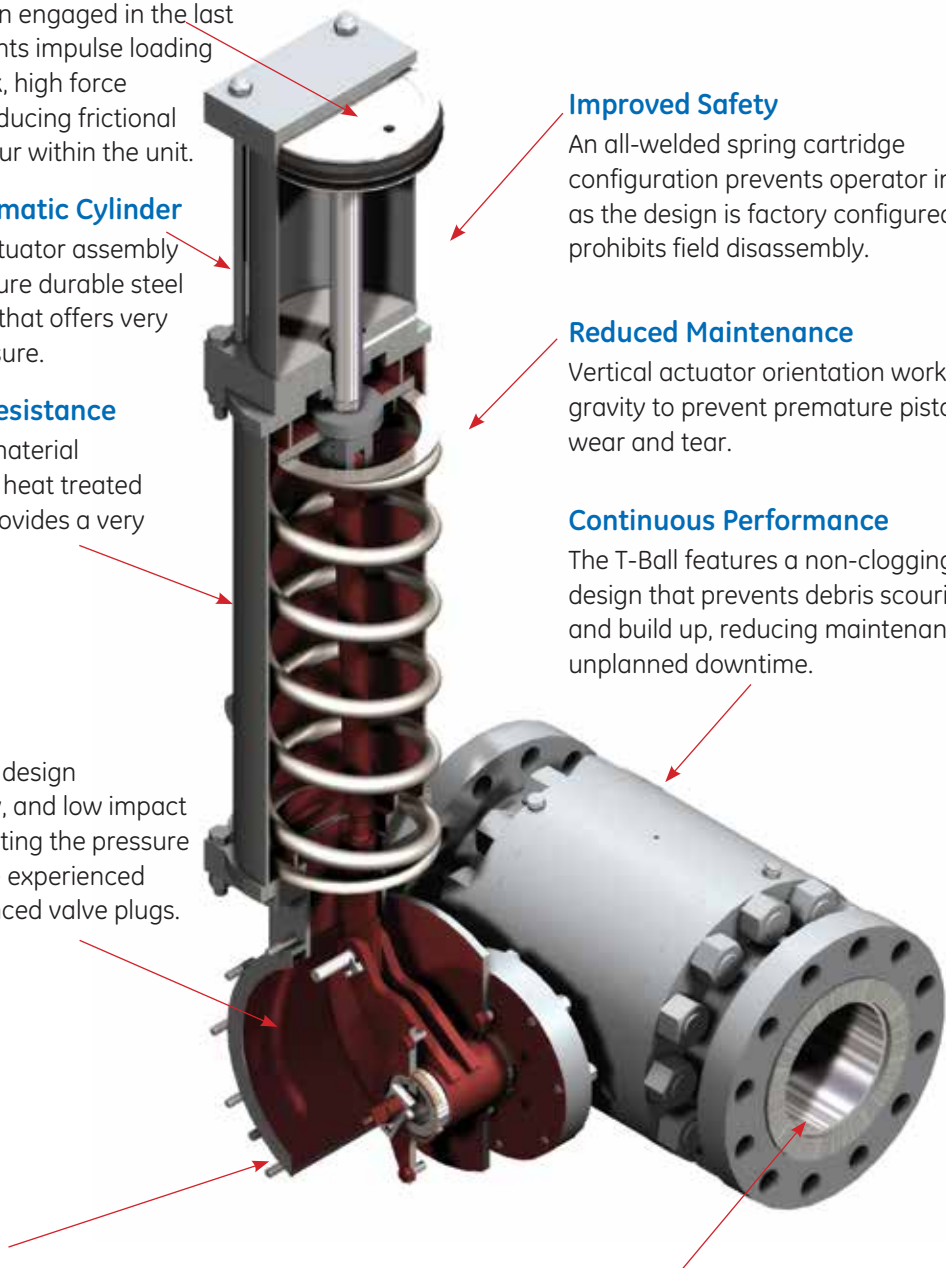
Vertical actuator orientation works with gravity to prevent premature piston seal wear and tear.

Continuous Performance

The T-Ball features a non-clogging design that prevents debris scouring and build up, reducing maintenance and unplanned downtime.

Low Emissions

Soft or hard seat options with up to Class VI or V minimizes lost energy and improves compressor efficiency. This long lasting shutoff is essential in providing critical equipment protection and maximizing revenue.



Improve compressor operating efficiency

Combining the superior control of a Becker T-Ball and rotary actuator with the speed and accuracy of a Becker HPP-SB or SVI® II AP positioner, provides the complete anti-surge valve solution. This enables your compressor to operate as close as possible to the surge line—maximizing efficiency without jeopardizing performance.



Becker HPP-SB Positioner

Features

- Pneumatic positioner
- Powered by pipeline gas
- High capacity (Cv)
- Rugged construction
- Frictionless design
- ZERO BLEED*

Benefits

- Additional equipment not required to power instrumentation
- Provides optimum speed of response and control required for anti-surge valves
- Vibration resistance maintains calibration, improving overall process performance
- Eliminates O-rings and shafts for greater reliability
- Standard zero emissions in steady state, full open and full closed control

Features

- Digital positioner
- Powered by instrument air
- HART® protocol
- Auto tuning function
- Modular construction
- Hazardous area approval

Benefits

- Versatile local or remote communication configurations
- Maintains accurate positioning while limiting service and repair visits
- Provides ease of maintenance as well as platform for upgrades
- Including but not limited to: ATEX, CSA, FM



SVI® II Positioner

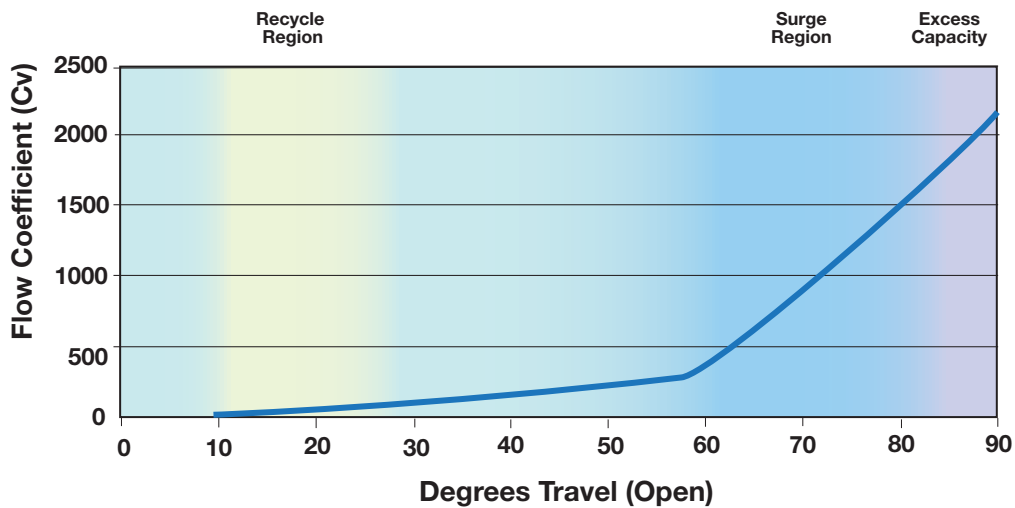
In 2007, a major Italy-based integrated energy company carried out a campaign to monitor fugitive emissions from three turbo-compression stations on one of their natural gas transmission pipelines. Engineers discovered that flanges and instrumentation were responsible for 80 percent of the station's emissions**.

The ZERO BLEED feature of the Becker HPP-SB can help eliminate a significant amount of compressor station emissions, protecting your assets and the environment.

**Categories monitored: valves, safety valves, flanges and instrumentation

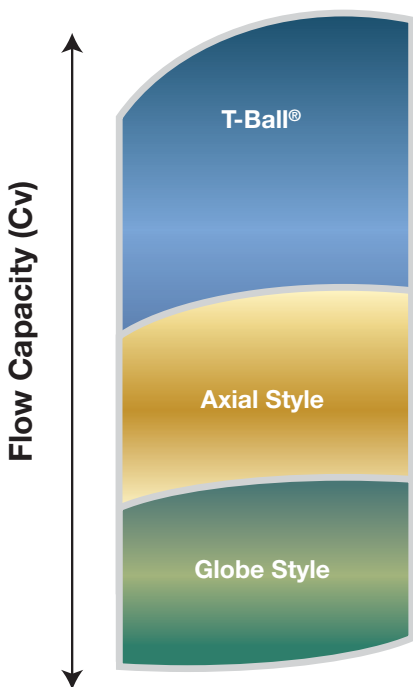
Maximized control and capacity

Flow Profile for 8" (200 mm) QTCV-T2



Many cage style valves achieve fast operating speeds by sacrificing the dynamic performance of the valve at low flow conditions. The equal percentage characteristic of a Becker T-Ball offers uncompromising control at both start-up (low flow/high) and surge.

Additionally, because of the T-Ball's unique flow characteristic it is able to perform the functions of both a recycle valve and an anti-surge valve, with excess capacity for the most extreme conditions.



One of the most common problems experienced with anti-surge valves is inadequate capacity for all service conditions. The high capacity Becker T-Ball design combined with high rangeability allows a single valve to accomplish what would typically require two or three valves.

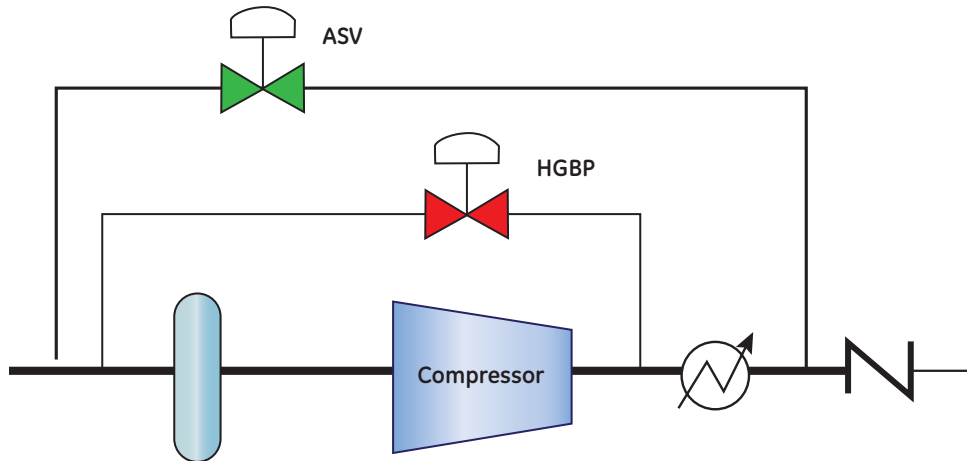
In fact major turbine and compressor manufacturers recommended ball style control valves for anti-surge control.

For equal percentage characteristic, globe valve capacity (Cv) is approximately equal to travel squared. Noise attenuating ball valves have a characteristic where capacity (Cv) is approximately equal to travel cubed. As such, noise attenuating ball valves are a superior single valve choice.

A single Becker T-Ball exhibits the same capacity as two axial or three globe valves.

Additional protection

Multiple valves may be used in the surge control system to meet the unique demands of both the process control and emergency shutdown operations. GE offers additional Becker valves such as the Hot Gas Bypass and Station Recycle Valves that can be used to meet the response time or flow rate requirements.



Hot Gas Bypass (HGBP) Valves are employed to provide additional protection against surge. During normal operation, the valve remains closed until a safety critical trip is detected requiring a compressor emergency shutdown. The HGBP valve then springs to open, depressurizing the system as quick as possible by displacing the hot discharge gas into the suction side further preventing compressor surge.

As with an Anti-Surge valve, the HGBP must be a reliable, fast acting device and sized to accommodate the compressor volume. The Becker HGBP features a trunnion-mounted ball valve combined with a fail-safe spring return actuator that can open within seconds when a safety critical trip is detected. Becker HGBP provides the following benefits:

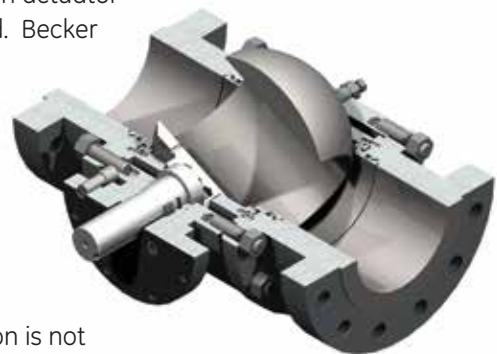
- Low emissions design
- Anti-blow out stem
- Suitable for use in SIL 3 applications
- High capacity to handle large flow

Station Recycle Valve (SRV)

The Station Recycle Valve (SRV) ensures that the compressor suction is not starved of gas. When the lower limit of the compressor's turndown is reached further flow control is done by modulating the Station Recycle Valve.

The SRV must be capable of handling services with varying flows and be sized to match the compressor characteristics. The Becker SRV features the Becker T-Ball design combined with a spring to close the actuator. The Becker SRV provides the following benefits:

- Equal percent flow characteristic
- Up to 300:1 turndown to handle process fluctuations
- Selection of noise attenuation trims



Meeting size requirements

Although all control valves are sized according to process conditions, anti-surge applications require particular attention.

Anti-surge valves typically must meet two sizing requirements:

1. Enough capacity to recycle the compressor, yet not be oversized which can choke the flow to the compressor
2. Capacity to depressurize the discharge in less than one second



Through taking your compressor's performance into account from start-up to surge, GE Oil & Gas has mastered the art and science of sizing anti-surge valves.

The T-Ball's combination of high capacity and high turndown allows a valve to meet both requirements providing the following benefits:

| Benefit | T-Ball® | Cage Style |
|---|---------|------------|
| Superior capacity protects equipment throughout the compressor's speed range | ✓ | |
| Exceptional turndown allows for the combination of the anti-surge and recycle valve functions into a single source | ✓ | |
| High reliability decreases downtime due to unplanned maintenance | ✓ | |
| Rotating control element eliminates pressure imbalances and excess vibration experienced with plug designs | ✓ | |
| Uncompromising control reduces depressurization time by 50% | ✓ | |
| Quarter-turn stroke enables precise control with fast speed of response | ✓ | |
| Compact design minimizes infrastructure size and weight issues | ✓ | |
| Robust construction provides extended service life in extreme conditions | ✓ | |

Optimized trim selection

The Becker T-Ball is offered in a series of noise attenuating trims to optimize performance and durability.



| Becker T-Ball Model | FPCV-T0 | QTCV-T1 | QTCV-T2 | QTCV-T4 | Attenujet® |
|---------------------|----------|---------|---------|---------|------------|
| Noise Attenuation | Baseline | 7 dBa | 17 dBa | 25 dBa | 20 dBa |

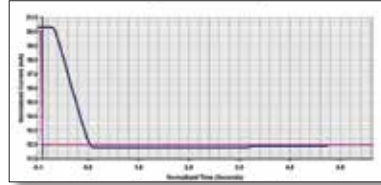
Assuring your needs are met

We understand how critical it is to keep your system up and running. When it comes to protecting your compressor, GE Oil & Gas makes no compromises.

In order to assure exceptional performance in the field, each Becker T-Ball anti-surge valve undergoes several validation tests before leaving our factory.

Upon test completion you will be provided with a customized performance analysis to confirm our anti-surge valve has met all performance requirements.

The table below provides a sample of our recommended dynamic parameters.



| Becker Control Valve | |
|--|-------------------|
| ACTUATION PERFORMANCE ANALYSIS Anti-Surge Control Valve | |
| Purchase Order Number: | B-830-M-34 |
| Drawing Number: | 52284 |
| Manufacturer Part Number: | 44-240125-2 |
| Serial Number: | 3208135A |
| Date: | 8-14-08 |
| Opening time resulting from an emergency stop solenoid valve: | |
| Requirement time (sec): | ≤ 10 milliseconds |
| Actual: | 347 milliseconds |
| Opening time resulting from a closed to full open command (20 to 10 mA) to positioner: | |
| Requirement time (sec): | ≤ 10 milliseconds |
| Actual: | 953 milliseconds |

| Test Parameter | Value |
|---|------------|
| Full opening by automatic control in response to step change from 20mA to 4mA | ≤ 2 sec. |
| Partial opening to 80% by automatic control in response to step change from 20 to 4mA | ≤ 1.5 sec. |
| Full closing by automatic control in response to step change from 4mA to 20 mA | ≤ 5 sec. |
| Full opening by solenoid valve trip | 1 sec |
| Opening dead time | ≤ 0.3 sec. |
| Maximum restriction of valve movement in response to continuous change of control signal from 4 to 20 and 20 to 4 mA. | ≤ 1% |

| Test Parameter | Value |
|---|------------|
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| Maximum restriction of valve movement in response to continuous change of control signal from 4 to 20 and 20 to 4 mA. | ≤ 1% |

See for yourself

Want to know more? We can arrange a live demonstration of Becker T-Ball Anti-Surge Valve via webcam.

This gives you the opportunity to see our anti-surge valve in action as well as have an in-depth technical discussion with our highly qualified engineers, without having to leave your office.

To arrange a demonstration, contact your local GE sales representative or e-mail: becker@ge.com





Field Proven in some of the most inhospitable environments

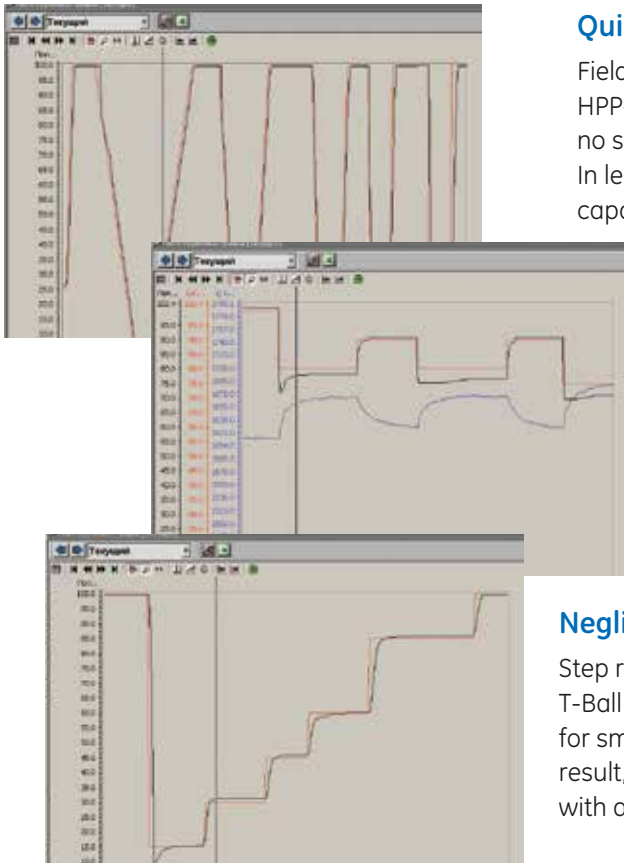
Location: Russia

Application: Natural Gas Production Field

Installation: (Qty. 4) 12" (300) 600 ANSI QTCV-T2

Becker T-Ball Anti-Surge Valves were selected to protect the compressors of one of the world's largest natural gas production fields. Located in the remote subarctic zone, temperatures are below freezing over 250 days of the year – it is not uncommon for temperatures to drop below -65°F (-55°C). For an operation of this scale, the customer relied on GE to provide the technology that is critical to maintaining continuous and stable control.

GE engineers traveled to the site to conduct a field test of the valves in service – the results further validated the T-Ball anti-surge valves' superior and reliable performance.



Quick Response

Field test data proved T-Ball anti-surge valves utilizing a HPP-SB pneumatic positioner maintain precise no stick, no slip control.

In less than a second, the anti-surge valve reached the capacity required to protect the compressor.

Nominal Turbulence

As soon as the compressor was brought on line, the Becker T-Ball anti-surge valve stabilized the flow without high turbulence.

The inherent rangeability of a T-Ball allows control at both start up and surge conditions.

Negligible Overshoot

Step response performance tests in the field proved Becker T-Ball anti-surge valves react quickly to the step changes for small and large steps with negligible overshoot. As a result, the installed valves met all stroke time requirements with accurate control.



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