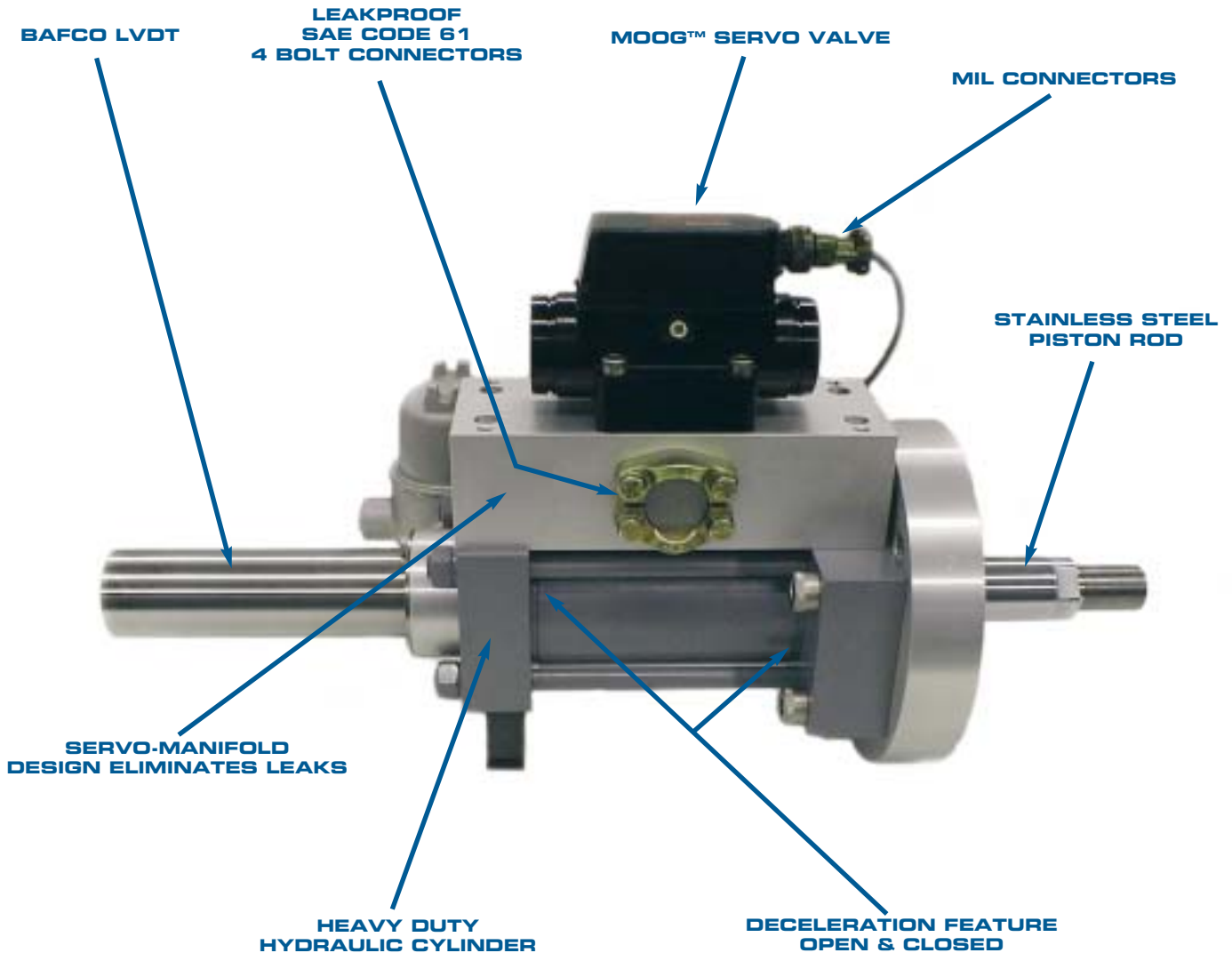


# BAFCO MODEL 773 LINEAR ACTUATORS

THE **NEXT** GENERATION OF  
HIGH THRUST - HIGH RESPONSE  
ELECTRO-HYDRAULIC ACTUATORS  
FOR **INDUSTRIAL USE**



DESIGNED IN CONJUNCTION WITH NASA  
UNDER "DUAL USE" COOPERATIVE AGREEMENT  
NOTICE NCC13-00007 TITLED "IMPROVEMENT OF QUALITY/  
REDUCTION OF COST - VALVE ACTUATOR"

BULLETIN DU

**BAFCO, INC.** P.O. BOX 2428, 717 MEARNS ROAD, WARMINSTER, PA 18974 USA

TELEPHONE 215-674-1700 TELEFAX 215-675-1571 e-mail [bafco@bafcoinc.com](mailto:bafco@bafcoinc.com)



For over 40 years, BAFCO has supplied thousands of special systems to NASA and other aerospace providers. These special systems have been configured into the BAFCO Model 773 linear actuator ... a high quality product, marketable to General Industry.

### **NOW YOU TOO CAN HAVE THE BEST OF BOTH WORLDS**



### **LEGENDARY BAFCO QUALITY AND COST COMPETITIVENESS**

The applications requiring controllable linear motion with high accuracy, high reliability, high repeatability, high degree of stiffness and fast operating speeds are infinite:

- ❖ **Linear valve actuators**
- ❖ **Steam turbine valves**
- ❖ **Linear drives for louvers**
- ❖ **Furnace damper actuators**
- ❖ **Vane controls - larger axial compressors**
- ❖ **Pilot plants**
- ❖ **Any device requiring high accuracy of linear motion**

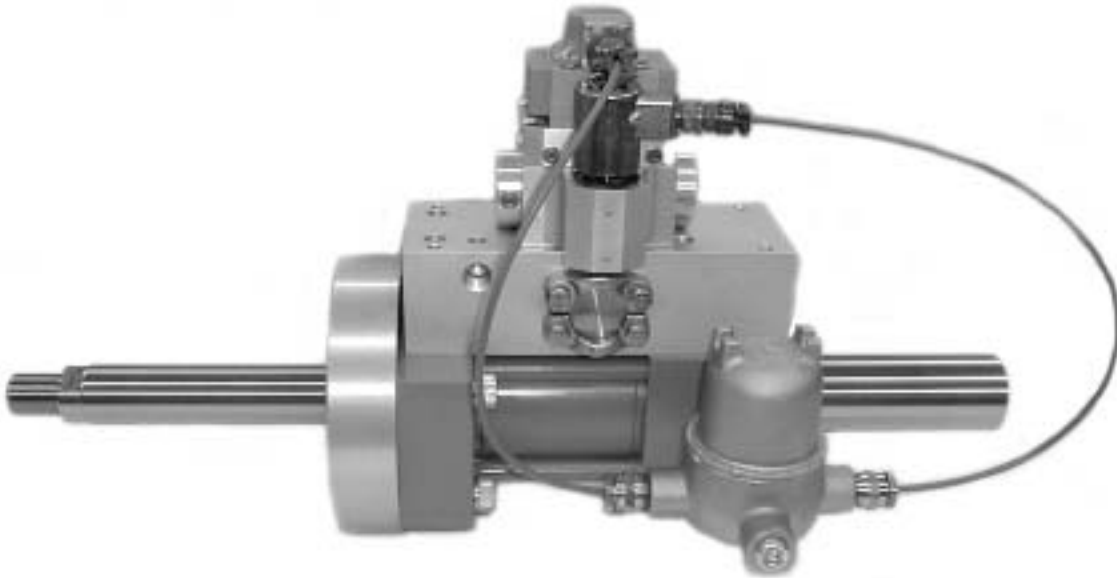
**MAKE NO MISTAKE ABOUT IT; THE BAFCO 773 ACTUATOR SYSTEM IS VERY COST COMPETITIVE, WELL WITHIN THE MOST STRINGENT BUDGETS!**

No longer will you be forced to accept the inaccuracies of pneumatics or the undependability of electrics! Get the unsurpassable benefits of BAFCO Electro-Hydraulic linear actuators.

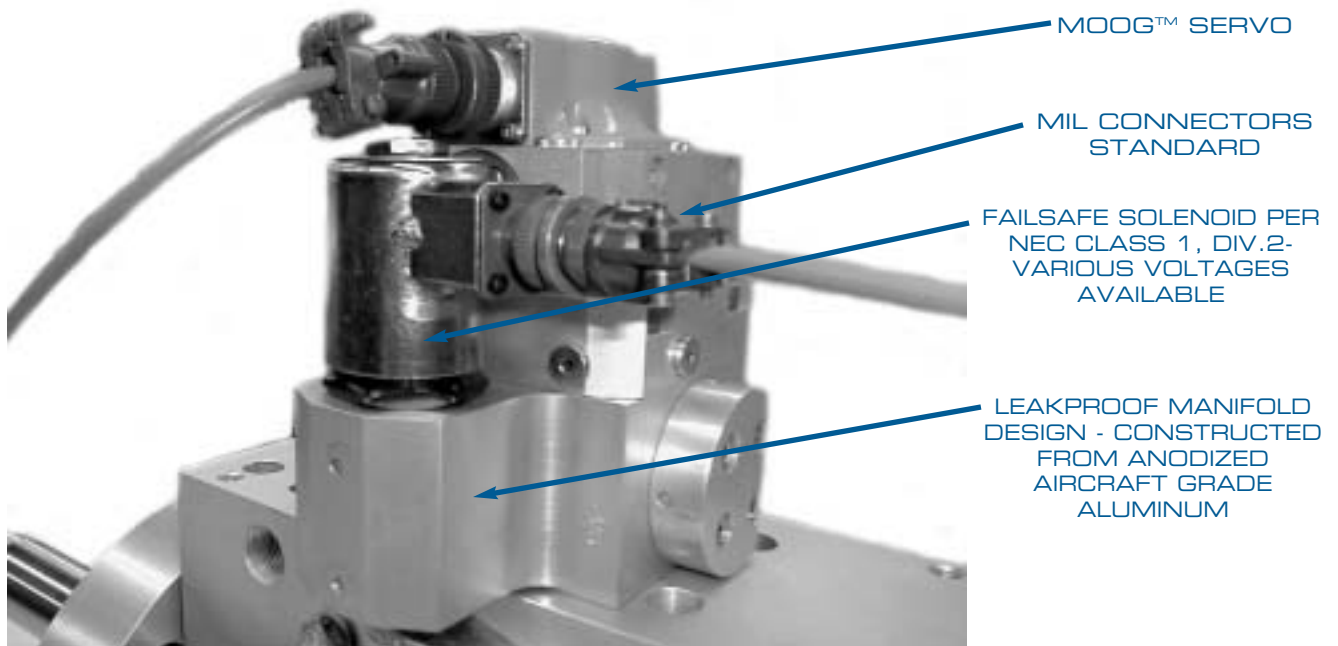
**BAFCO**

**Functionality by Design**  
**Dependability by Experience**

In addition to its high degree of controllability, the BAFCO Model 773 Linear Actuator can be configured with BAFCO's **Model 708 or 739 Failsafe Valve** for the utmost in dependability and true **FAILSAFE ACTION** for control override shutdown.



Developed in the early 1960's, BAFCO has supplied thousands of the **MODEL 708 or 739 FAILSAFE VALVE** and its progeny to NASA and the FCC Refining and Petrochemical Processing Industries worldwide.

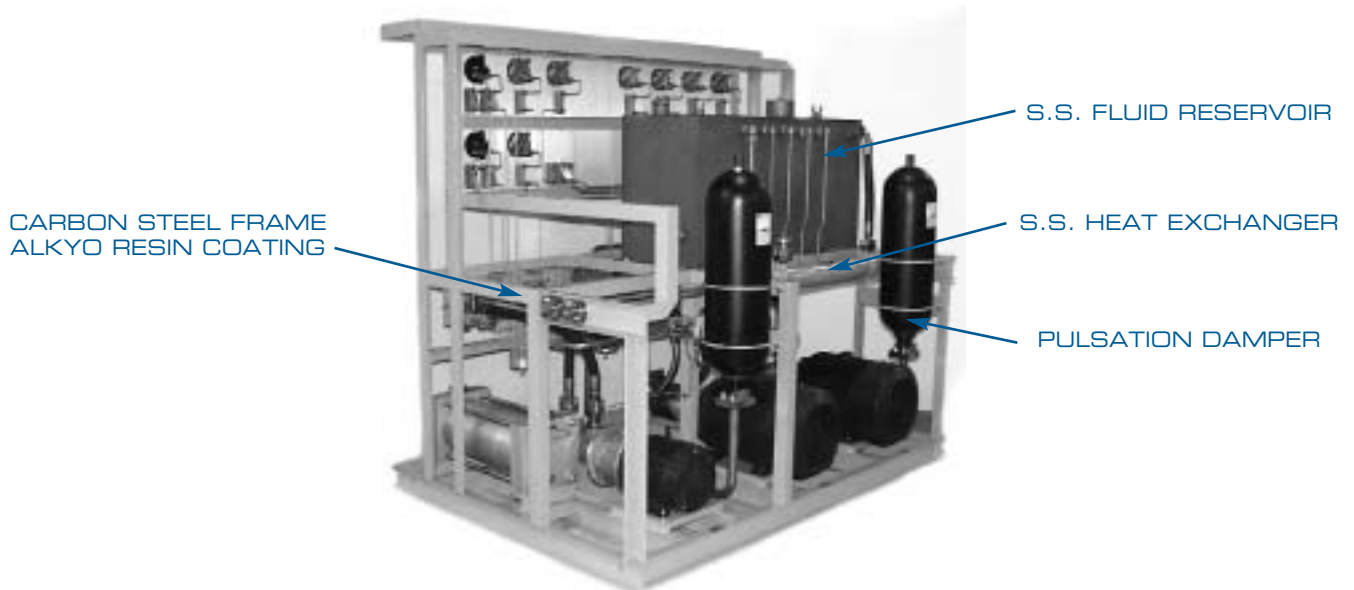
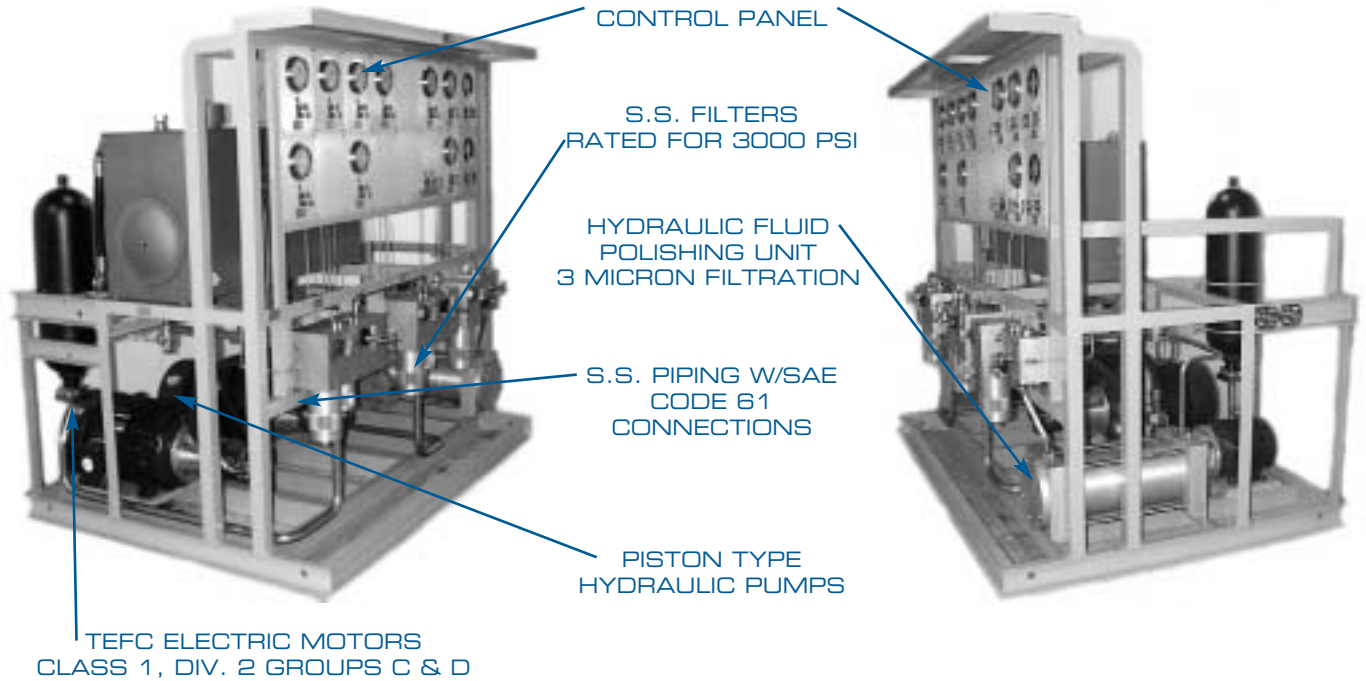


**BAFCO**

**Functionality by Design**  
**Dependability by Experience**

To complete the package, **BAFCO's Model 717 Hydraulic Pumping Units** can be added to provide a perfect stand-alone package for the control of any device requiring linear motion.

The system shown below provides 9.0 gpm at 3,000 psi with filtration to 3 micron. **Other designs and sizes are available ..... from 5 gpm to over 500 gpm at 3,000 psi.**

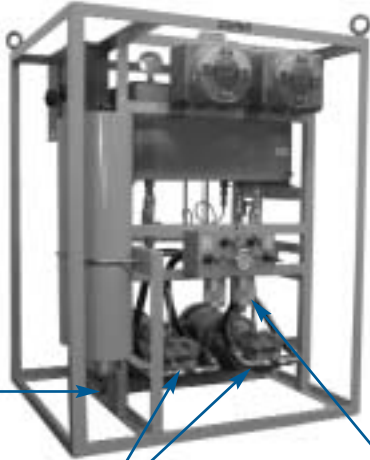


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**Dependability by Experience**

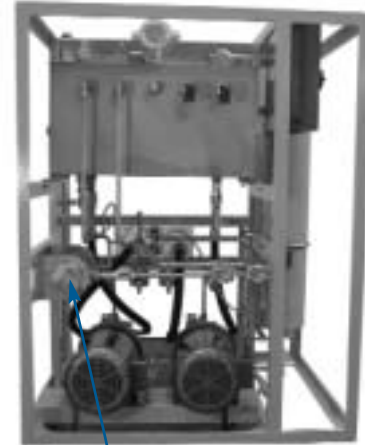
In addition to the **DELUXE HYDRAULIC PUMPING UNIT** show on the opposite page, BAFCO manufactures **STANDARD HYDRAULIC PUMPING UNITS** as shown below. The system below provides **2.0 gpm at 3,000 psi** with filtration to 3 micron. The unit includes all components necessary for basic electro-hydraulic applications..... **AT LESS THAN 1/3 THE COST!!!!**

Numerous options available in sizes of 2 gpm to over 500 gpm at 3,000 psi.



PRESSURE COMPENSATED  
VARIABLE VOLUME  
PISTON PUMPS

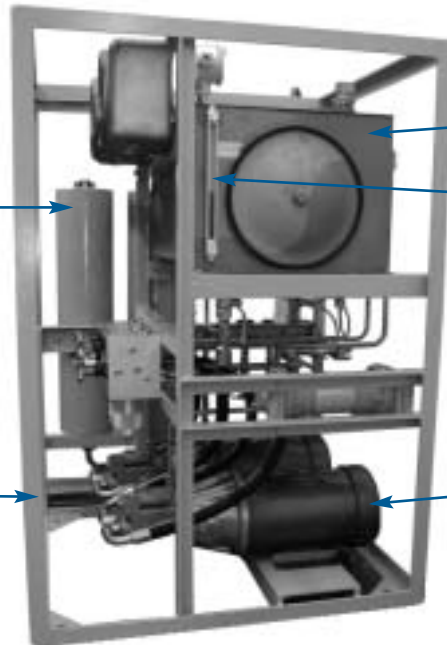
DUPLEX FILTER  
WITH ALL S.S. ELEMENTS



S.S. HEAT EXCHANGER

S.S. PIPING  
W/SAE CODE 61  
CONNECTORS

ACCUMULATORS



S.S. FLUID RESERVOIR

RESERVOIR LEVEL  
INDICATOR

HEAVY STRUCTURE STEEL  
FRAME WITH INDUSTRIAL  
ALKYD RESIN COATING

TEFC ELECTRIC MOTORS  
CL. 1, DIV. 2, GRP. C & D

**BAFCO**

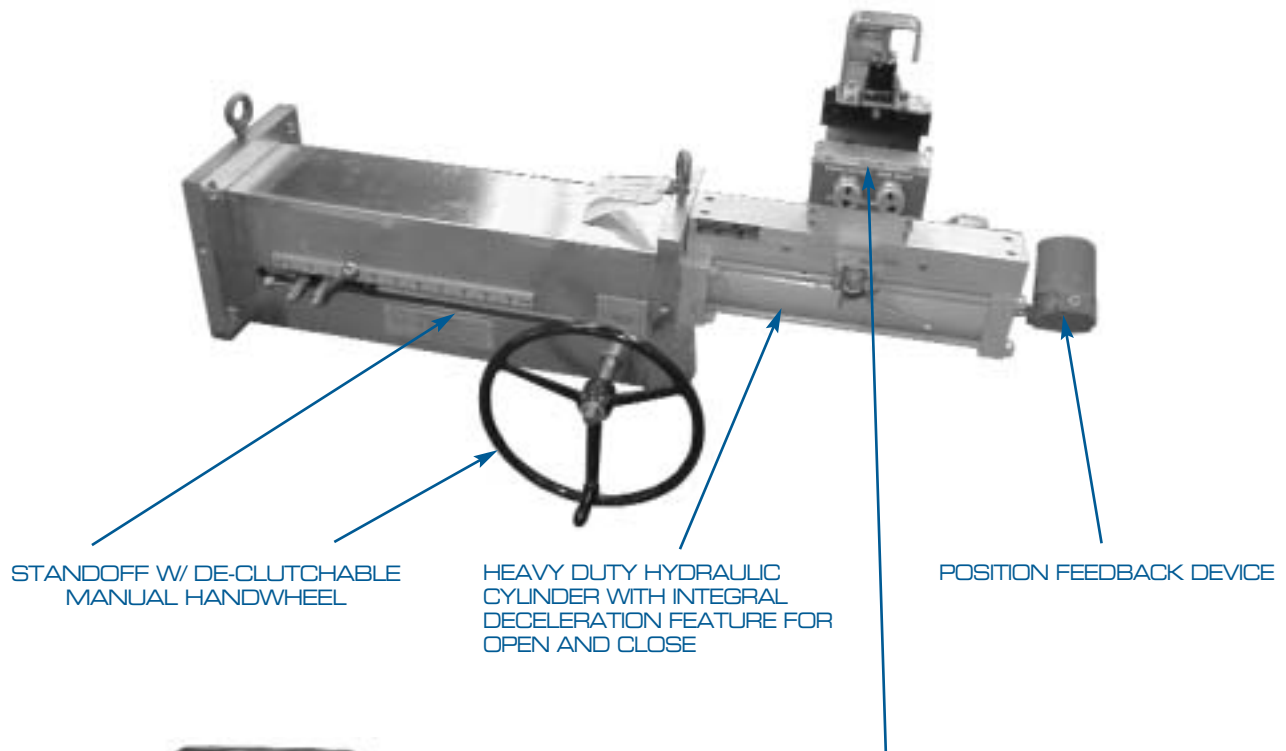
**Functionality by Design**  
**Dependability by Experience**

# BAFCO MODEL 773 LINEAR ACTUATORS

## For use in FCCU Refineries

### AN ULTRA-LOW COST ALTERNATIVE TO CURRENT DESIGNS

- for catalyst control slide valves
- for single or double disk flue gas valves
- for diverter valves

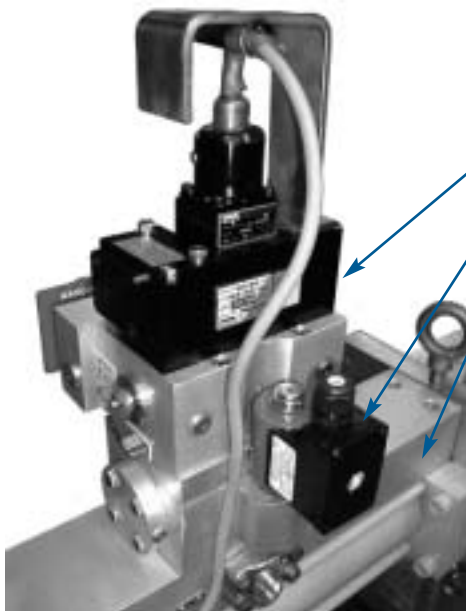


### BAFCO MOTION CONTROL UNIT

- SERVO VALVE for Modulating Control
- FAILSAFE VALVE with TRIP SOLENOID
- MANIFOLD for component mounting and field connections

### CONTROL TYPES AVAILABLE

- THROTTLING
- FAILSAFE
- ON-OFF
- **SPECIAL CONTROL CONFIGURATIONS** per **CUSTOMER SPECIFICATIONS** are also available



**BAFCO**

**Functionality by Design**  
**Dependability by Experience**

The **BAFCO 773 family of LINEAR ACTUATORS** has been expanded to include **BAFCO Model 775 ROTARY ACTUATORS**. Designed as a **cost competitive alternative to pneumatic or electric actuators**, these units operate 90° rotation valves or dampers in modulating, on-off or failsafe applications.

#### **BAFCO Model 775 Rotary Actuator**

Mounted on a 60" Damper  
For SCR Service - NOx Reduction

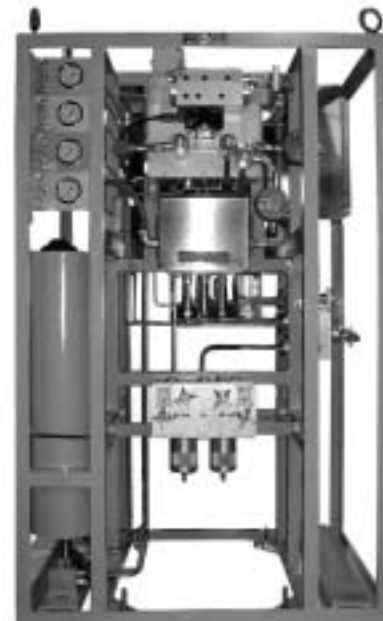


#### **ACTUATOR DESIGN FEATURES**

- Rack and Pinion Actuator
- Heavy duty Hydraulic - To 3,000 psi
- Torque Range - 900 to 600,000 in. lbs.
- 90, 180 or 360 Degrees Rotation
- Zero Leakage
- High External Stern Load Capabilities
- End of Stroke Cushioning
- Configured with **0% BACKLASH**
- BAFCO LVDT For Position Feedback
- De-clutchable manual handwheel
- Electro-Hydraulic control system can be direct mounted on the actuator or can be off-mounted on the Field Panel or on the Hydraulic Power Unit

#### **BAFCO Model 713-X Field Panel**

with Throttling Control  
and Failsafe Feature



#### **FIELD PANEL/CONTROL FEATURES**

- Servo System for Modulating Service
- Solenoid Trip for Failsafe Operation
- Accumulator(s) for Reserve Power
- Heavy Structure Steel Frame with Industrial Alkyd REsin Coating
- Duplex Filters with all S.S. Elements
- Receives hydraulic power from an external source
- **Optionally, BAFCO can supply the complete HYDRAULIC POWER/CONTROL SYSTEM**

# **BAFCO**

**Functionality by Design**  
**Dependability by Experience**

# BAFCO FILTER MANIFOLDS & FIELD PANELS

For ultra clean hydraulic fluid demanded by critical components

## BAFCO 714 DUAL FILTER MANIFOLD



- Designed and fabricated from aircraft grade aluminum with hard anodized coating for corrosion resistance
- Cartridge type metal seated isolated valves
- Leak proof SAE code 61, flat flange 4-bolt connection

## BAFCO 713 SINGLE FILTER MANIFOLD



## 304 S.S. FILTER ELEMENTS



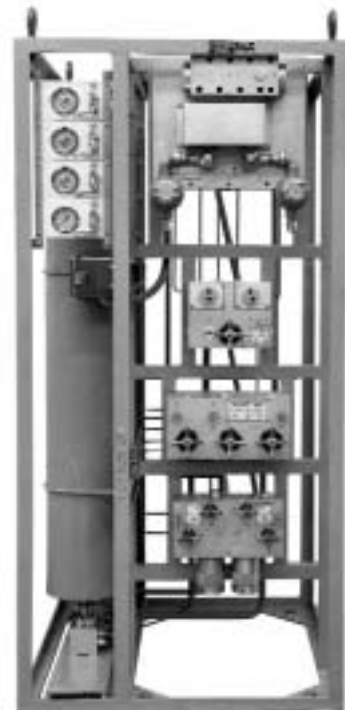
- Suitable for 3,000 psi differential pressure
- 3, 5, 10 & 25 micron ratings
- Single and double lengths available
- Flow rates up to 180 gpm on single filter elements
- Multiple elements available

## BAFCO 722 FIELD PANEL

- Heavy structure steel frame - skid mounted - with alkyd resin coating
- Model 714 Duplex Filter Manifold
- Pressure accumulators for reserve power
- Servo System for Modulating service
- Solenoid for Failsafe Operation
- Pressure gauges
- Receives hydraulic pressure from an external source
- Local/Remote hydraulic manifold

## OPTIONAL EQUIPMENT & ACCESSORIES

- Pressure gauges for pressure & return
- Filter differential pressure sensor & alarm
- Flow rates from 1 to 200 gpm
- Pressure & return accumulators
- Hydraulic hoses for pressure and return
- Flushing block for header system cleaning



**BAFCO**

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**Dependability by Experience**



## SERVOAMPLIFIER

Designed and manufactured by **BAFCO**, the **Model 852 Servoamplifier** provides optimum drive capabilities for the **MOOG™** or other manufacturer's servovalve.

- Receives and conditions a 4-20 ma signal from an external control system
- Receives and conditions output signal from the LVDT position feedback device
- Sends appropriate output signals to the servovalve
- Includes an integral power supply, which requires 110 or 220 vac, at 50/60 hz or 24 vdc at 1 amp.
- Analog or digital multi-meter for valve position, servo output and command signal
- Provides adjustable minimum closed position and maximum linear stroke length
- Many other styles available such as multiple servoamplifiers in one enclosure



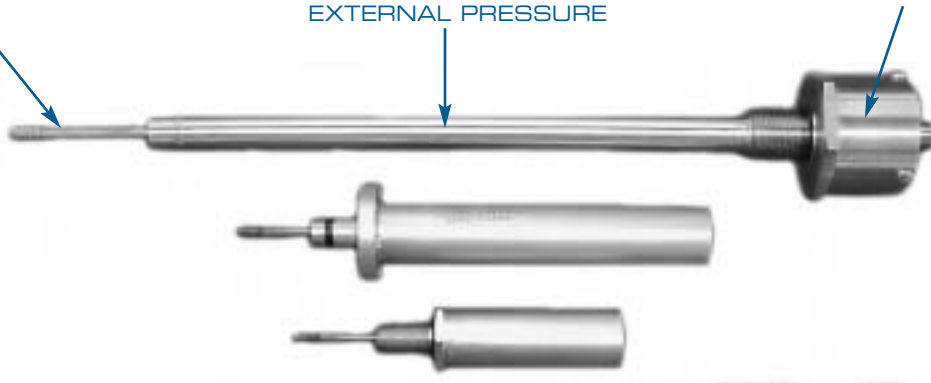
## POSITION FEEDBACK (LVDT)

The accuracy of any positioning system is dependent on the accuracy of the position feedback device. The BAFCO Model 773 Linear Actuator incorporates BAFCO's own **Model 642 LVDT (Linear Variable Differential Transformer)**, which provides effective infinite resolution, extremely high accuracy, linearity and repeatability... and can be used in extremely hostile environments at temperatures from  $-40^{\circ}\text{F}$  to  $+200^{\circ}\text{F}$  with a temperature shift of  $< 0.5\%$  per  $100^{\circ}\text{F}$  max.

MOVABLE PROBE ASS'Y  
CONNECTS DIRECTLY TO  
THE ACTUATOR PISTON

304 S.S. HOUSING -  
FULLY ANNEALED AND  
SUITABLE FOR 3,000 PSI  
EXTERNAL PRESSURE

POTTED ELECTRONICS  
PACKAGE - INCLUDES  
PROTECTION DIODES



### AVAILABLE EXCITATION VOLTAGES:

- $\pm 12$  VDC ( $\pm 8$  to  $\pm 18$  vdc range)
- $\pm 24$  VDC
- Other voltages available

### AVAILABLE OUTPUTS:

- $+3$  to  $+7$  vdc
- $+0.5$  to  $+9.5$  vdc
- $-3$  to  $+3$  vdc
- $-2$  to  $+2$  vdc
- $+4$  to  $+20$  ma

**BAFCO**

Functionality by Design  
Dependability by Experience

# BAFCO 773 ACTUATORS

## MORE CHOICE - LESS COMPROMISE

### SPECIFICATIONS

Thrust output	8,000 to 200,000 lbs.
Stroke Length	¼" to 10" - longer if necessary
Speed - Full Stroke - Throttling	up to 25 msec.
Speed - Full Stroke - Failsafe	up to 25 msec
Hydraulic Pressure	3,000 psi max.
Throttling Command	±10 to ±40 ma
Failsafe Command	12, 24, 48, 115 vdc
Failsafe Reset Speed	0.5 sec. typical
Position Feedback Signal (LVDT)	+3 to +7 vdc
“	+0.5 to +9.5 vdc
“	-3 to +3 vdc
“	-2 to +2 vdc
“	+4 to +20 ma
Resolution	< 0.1%
Repeatability	< 0.1%
Linearity	< 0.3%
Hysteresis	< .5%
Frequency Response	to 30 Hz. or higher if needed
Temperature range	-40° to +180° or higher if needed
Deceleration feature*	.005 to .10 in. - open and closed
Mounting yokes	available for any linear device
Materials of construction	
❖ Cylinder	Carbon Steel
❖ Servo Manifold	Aircraft Grade Aluminum
❖ Piston Rod	Stainless Steel
❖ Bearings	Alloy Bronze
Electrical Classification	NEC Class 1, Div. 2
Electrical Wiring Terminations	Mil Connectors - Standard Terminal Boxes - Optional
Hydraulic Connections	SAE Code 61 - 4 Bolt
Hydraulic Fluid	Any standard mineral base or compatible synthetic fluid

**Deceleration feature\*** - Snubbing rings are internal to the actuators at the end of both open and closed stroke. The snubbers use hydraulic fluid viscous frictional forces to rapidly decelerate the actuator the last .005" to .100" of travel, thus protecting the system from damage due to its high velocity. The deceleration feature has no moving parts and never requires adjustment.

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Dependability by Experience

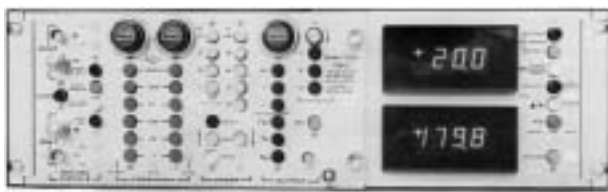
# OTHER BAFCO PRODUCTS



**SLIDE & PLUG VALVE ACTUATORS**  
For FCC Refineries



**BUTTERFLY VALVE ACTUATORS**  
For Expander Turbines



**FREQUENCY RESPONSE ANALYZERS**



**WEDGE TYPE GATE ACTUATORS**



**FURNACE DAMPER ACTUATORS**



**STEAM THROTTLE VALVE CONTROLS**  
For STEAM TURBINES

**BAFCO**

**Functionality by Design**  
**Dependability by Experience**



# **BAFCO, INC.**

**P.O. BOX 2428  
717 MEARNS ROAD  
WARMINSTER, PA 18974**

**TELEPHONE 215-674-1700  
TELEFAX 215-675-1571  
e-mail [bafco@bafcoinc.com](mailto:bafco@bafcoinc.com)**

**HYDRAULIC ACTUATORS,  
ELECTRONIC POSITIONING CONTROLS  
AND  
HYDRAULIC PUMPING UNITS**



# NASA Office of Technology Transfer

*John C. Stennis Space Center*

**NASA Dual-Use Partnership Delivers Improved Linear Actuator**  
***A high thrust, high performance electro-hydraulic actuator now being manufactured quicker at a reduced price.***



Developed by BAFCO Inc., under a Dual-Use Cooperative Agreement with the Office of Technology Transfer at Stennis Space Center, the Model 773 is a next generation linear actuator displaying increased accuracy, precision and operating speeds. Primarily designed to operate in systems that contain gases, liquids, or cryogenic materials the Model 773 has application in the aerospace or petro-chemical industries.

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A Dual-Use Cooperative Agreement between the Office of Technology Transfer at Stennis Space Center (SSC) and BAFCO Inc., of Warminster, Pennsylvania, produced an improved linear actuator for use on the rocket engine test stands at Stennis. A linear actuator is the servomechanism that supplies or transmits a measured amount of energy for the operation of another mechanical system; accuracy, reliability and speed of the actuator are critical to proper performance of the entire system. The BAFCO Model 773 is a next generation, high thrust, high response electro-hydraulic actuator designed to meet identified performance standards in aerospace, industrial and petro-chemical applications. "This actuator is the result of a focused partnership between NASA and our company to resolve production problems as well as high unit costs," said Jim Hamtil, President of BAFCO Inc.

## **HOT** Points

- **High thrust, high performance linear actuator.**
- **Increased accuracy and precision, operating speed and life expectancy.**
- **Application areas include aerospace, petro-chemical and industrial.**
- **Makes use of commercial off the shelf (COTS) components.**
- **Reduced manufacturing and delivery time.**
- **Reduced unit costs.**

“The Model 773 meets National Fluid Power Association (NFPA) standards for cylinder performance along with U.S. and European standards for electrical component functions. It is a unique piece of equipment, which meets or exceeds established performance standards at a mid-range pricing levels.”

## THE PROJECT AND RESULTS

Stennis Space Center provides testing of Space Shuttle Main Engines, rocket propulsion systems and related rocket components. Stennis maintains several test facilities with a number of cells, or positions, to perform propulsion testing. As the testing facilities continue to age, maintenance costs have increased. In an attempt to control component replacement costs, NASA partnered with BAFCO to resolve questions regarding manufacturing processes, delivery lead-time and high unit costs.

BAFCO identified four suppliers that manufactured components meeting the performance standards required by NASA. “We no longer have to individually engineer each component,” said Hamtil. “Our company has been able to purchase commercial off the shelf (COTS) components then modify them using BAFCO technology and expertise. Subsequently, production and delivery lead-time have been reduced. Production to delivery, the entire process has been reduced from 14 weeks to between four and eight weeks. Correspondingly, the unit price has been lowered.”

NASA purchased 30 of BAFCO’s Model 773 at a savings of more than **\$250,000**. Prior to the project, purchase costs per unit ran between **\$20,000 and \$22,000**; upon completion, the cost per unit was reduced to between **\$11,000 and \$13,000**. According to Nickey Raines, E-1 stand director, the results of this project provided NASA with maximum benefit; an improved product, delivered quicker at a reduced cost.

To date, all 30 of the actuators have been installed in the E-Complex at Stennis; performance levels have met or exceeded those of all previously used actuators. “Performance and costs are always elements of concern to the Stennis Test Directorate,” said Haynes Haselmaier, a Mississippi Space Services support contractor. “Performance of test articles is dependent on the support systems surrounding them. We must have quality components to support rocket engine testing, but the delays we experienced in receiving units were constant and the costs involved seemed to be continually mounting. The successful completion of this project has provided NASA with a high performance actuator at a lower cost, significantly faster.”

## COMMERCIALIZATION

Primarily designed to operate in systems that contain gases, liquids or cryogenic materials, the BAFCO Model 773 offers several advantages over previously produced linear actuators. These advantages include increased accuracy and precision, increased operating speeds and increased life expectancy. These advantages combined with the reduction in production and delivery lead-time and lower unit pricing will allow broader application of BAFCO’s Model 773.

BAFCO’s Model 773 sales, mostly to aerospace and petro-chemical customers who have installed the units in testing and production facilities, total almost \$500,000. “Being mid-range in price with high-end performance, the BAFCO Model 773 has seen increased interest from aerospace, industrial and petro-chemical companies,” said Hamtil. “We are seeing increased interest and activity from domestic companies as well as international corporations. Domestically, several companies have requested specifications and price quotes on the Model 773 for installation in their facilities. Internationally, we have sold 4 actuators to a petroleum company in Yugoslavia and have quoted numerous other companies. Even other government agencies have shown interest; for example the United States Air Force has requested a quote on this particular actuator for application within a test facility presently under construction at Edwards Air Force Base in California.”

## WHY DUAL-USE WAS IMPORTANT

“This agreement allowed our company to not only address a government need, but also to enhance our commercial product at the same time. As a result, the Model 773 is receiving increased interest from companies outside the traditional applications areas,” says Hamtil. “This Dual-Use project is an excellent example of how NASA and industry can partner to develop a NASA needed technology while at the same time help fulfill a commercial market place need,” said John Bailey, NASA Office of Technology Transfer Dual-Use manager. The Dual-Use concept of product development is based on the sharing of costs, risks and successes between the government and a commercial partner. In these projects, NASA can contribute technology development, unique facilities and know-how, engineering resources and funding. In turn, the commercial partner contributes unique expertise, facilities, manufacturing, marketing capabilities and potential cash resources. The result is an approach that provides flexibility and draws upon the capabilities of both parties.

### Points of Contact

- **NASA Office of Technology Transfer**  
Stennis Space Center, MS  
PH – 228-688-1929  
Web – [technology.ssc.nasa.gov](http://technology.ssc.nasa.gov)  
E-Mail – [technology@ssc.nasa.gov](mailto:technology@ssc.nasa.gov)
- **BAFCO, Inc.**  
Warminster, PA  
PH – 215 674-1700  
E-Mail – [bafco@bafcoinc.com](mailto:bafco@bafcoinc.com)

# NASA News

National Aeronautics and  
Space Administration



**John C. Stennis Space Center**  
Stennis Space Center, MS 39529-6000  
(228) 688-3341

MWS-02-159  
Oct. 18, 2002

Lanee Cooksey  
NASA News Chief  
(228) 688-3341

FOR IMMEDIATE RELEASE

## **NASA ENGINE TESTING IMPROVED BY DUAL-USE PROJECT**

**HANCOCK COUNTY, Miss.** —A recently completed Dual-Use Cooperative Agreement between NASA's Office of Technology Transfer at Stennis Space Center and BAFCO Inc. of Warminster, Penn., has produced an improved product for use on the rocket engine test stands at Stennis. The BAFCO Model 773 is a next-generation valve element designed to enhance performance in aerospace, industrial and chemical applications.

Stennis provides testing of Space Shuttle Main Engines, rocket propulsion systems and related rocket parts. The space center maintains several test facilities with a number positions for engine testing. To control the cost to replace parts, NASA partnered with BAFCO to improve manufacturing processes and delivery time.

"We no longer have to individually engineer each component," said BAFCO President Jim Hamtil. "Our company has been able to purchase commercial off-the-shelf components, then modify them using BAFCO technology and expertise. Subsequently, production and delivery lead-time have been reduced. Correspondingly, the unit price has been lowered. Production to delivery, the entire process has been reduced from 14 weeks to between four and eight weeks."

"This product is the result of a partnership between NASA and our company to resolve production problems and lower unit costs. It is a unique piece of equipment, which meets or exceeds established performance standards at mid-range pricing levels," said Hamtil.

NASA purchased 30 of BAFCO's Model 773 at a savings of more than \$250,000.

-MORE-

All 30 of the units have been installed in the E-Complex at Stennis, and performance levels have met or exceeded those of all such products used before.

“Performance and costs are always elements of concern,” said Haynes Haselmaier, a Mississippi Space Services support contractor. “Performance of test articles is dependent on the support systems surrounding them. We must have quality components to support rocket engine testing, but the delays we experienced in receiving units were constant, and the costs involved seemed to be continually mounting. The successful completion of this project has provided NASA with a high performance actuator at a lower cost significantly faster.”

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Dual-use product development is based on the sharing of costs, risks and successes between the government and a commercial partner. In dual-use projects, NASA contributes technology development, facilities and know-how, engineering resources and funding. The commercial partner contributes unique expertise, facilities, manufacturing, marketing capabilities and potential cash resources. The result is an approach that provides flexibility and draws upon the capabilities of both parties.

“This dual-use project is an excellent example of how NASA and industry can partner to develop a NASA-needed technology while at the same time, help fulfill a commercial marketplace need,” said NASA’s John Bailey, Office of Technology Transfer Dual-Use manager.

For more information about NASA’s Dual-Use Technology Development Program at Stennis, call (228) 688-1929 or visit the Web site at <http://technology.ssc.nasa.gov>.

-END-





## Partnership Improves Actuator, Saves Money

A Dual-Use Cooperative Agreement between the Office of Technology Transfer at Stennis Space Center (SSC) and BAFCO Inc. of Warminster, PA has produced an improved linear actuator for use on the rocket engine test stands at Stennis Space Center.

A linear actuator is the servomechanism that supplies or transmits a measured amount of energy for the operation of another mechanical system; accuracy, reliability and speed of the actuator are critical to proper performance of the entire system. The BAFCO Model 773 is a next-generation, high-thrust, high-response electro-hydraulic actuator designed to meet identified performance standards in aerospace, industrial and petro-chemical applications.

"This actuator is the result of a focused partnership between NASA and our company to resolve production problems, as well as high unit costs," said Jim Hamtil, president of BAFCO Inc. "The Model 773 meets National Fluid Power Association (NFPA) standards for cylinder performance, along with US and European standards for electrical component functions. It is a unique piece of equipment that meets or exceeds established performance standards at mid-range pricing levels."

Stennis provides testing of space shuttle main engines, rocket propulsion systems and related rocket components. Stennis maintains several test facilities with a number of cells, or positions, to perform propulsion testing. As the testing facilities continue to age, maintenance costs have increased. In an attempt to control component replacement costs, NASA partnered with BAFCO to resolve questions regarding manufacturing processes, delivery lead-time and high unit costs.

BAFCO identified four suppliers that manufactured components meeting the performance standards required by NASA. "We no longer have to individually engineer each component," said Hamtil. "Our company has been able to purchase commercial off-the-shelf (COTS) components and modify them using BAFCO technology and expertise. Subsequently, production and delivery lead-time have been reduced. Production to delivery, the entire process has been reduced from 14 weeks to between four and eight weeks. Correspondingly, the unit price has been lowered."

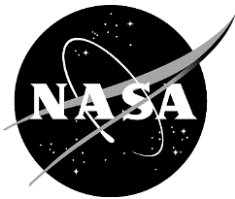
To date, all 30 of the actuators Stennis purchased from BAFCO have been installed in the E-Complex at Stennis, with performance levels having met or exceeded those of all previously used actuators.

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A Dual-Use Cooperative Agreement between Stennis Space Center and BAFCO, Inc. has produced an improved linear actuator for use at Stennis. Artwork courtesy of Stennis Space Center.



National Aeronautics and  
Space Administration

Oct. 18, 2002

**John C. Stennis Space Center**  
Stennis Space Center, MS 39529-6000  
(228) 688-3341



Haynes Haselmaier, left, propulsion test technologist for the University of Southern Mississippi at Stennis Space Center, and Jonathan Dickey, Mississippi Space Services engineer, explain the BAFCO Model 773 linear actuator installed in the E-3 test stand at Stennis. The BAFCO valve part, developed through a recently completed Dual-Use Cooperative Agreement between the Office of Technology Transfer at Stennis Space Center and BAFCO Inc. of Warminster, Penn., has improved rocket engine testing at Stennis.