

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR THE FOLLOWING MODELS

ST3XX AND ST4XX

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111572

REVISION: "A"

DATE: August, 1993

1.0 **INTRODUCTION**

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis ST3XX and ST4XX Double Acting pneumatic series actuators. When the model number has a "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

1.2 **DEFINITIONS:**

WARNING: If not observed, user incurs a high risk of severe damage to actuator and/or fatal injury to personnel.

CAUTION: If not observed, user may incur damage to actuator and/or injury to personnel.

NOTE: Advisory and information comments provided to assist maintenance personnel to carry out maintenance procedures.

1.3 **SAFETY STATEMENT:** Products supplied by Bettis, in its "as shipped" condition, are intrinsically safe if the instructions contained within this Service Instruction are strictly adhered to and executed by a well trained, equipped, prepared and competent technician.

WARNING: For the protection of personnel working on Bettis actuators, this procedure should be reviewed and implemented for safe disassembly and reassembly. Close attention should be noted to the WARNINGS, CAUTIONS and NOTES contained in this procedure.

WARNING: This procedure should not supersede or replace any customers plant safety or work procedures. If a conflict arises between this procedure and the customers procedures the differences should be resolved in writing between an authorized customers representative and a authorized Bettis representative.

1.4 **BASIC SERVICE INFORMATION:** Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.

1.5 The maximum recommended service interval for this actuator series is five years. Storage time is counted as part of the service interval.

1.6 This procedure is applicable with the understanding that all electrical power and pneumatic pressure has been removed from the actuator. Also, it is understood that the actuator has been removed from the valve as well as all piping and accessories that are mounted on the actuator have been removed.

2.0 SUPPORT ITEMS AND TOOLS

- 2.1 Support Items - Service/Seal Kit, razor sharp cutting instrument, commercial leak testing solution, and non-hardening thread sealant.
- 2.2 Tools - All tools are American Standard inch. Two each medium screwdriver, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and torque wrench (up to 5,000 inch pounds). For recommended tool list refer to Chart No. 1 on last page of this procedure.

3.0 BETTIS REFERENCE MATERIALS

- 3.1 Assembly Drawing part number 104446 for ST3XX series actuators.
- 3.2 Assembly Drawing part number 103968 for ST4XX series actuators.

4.0 GENERAL DETAILS

- 4.1 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
- 4.2 Numbers in parentheses, () indicate the bubble number (reference number) used on the Bettis Assembly Drawing and Actuator Parts Lists.
- 4.3 This procedure is written using the stop screw side of housing (1-10) as a reference and this side will be considered the front of the actuator. Housing cover (1-20) will be the top of the actuator.
- 4.4 To help at re-assembly mark or tag all mating surfaces.
- 4.5 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp corners rounded off.
- 4.6 Use a non-hardening thread sealant on all pipe threads.

CAUTION: Apply the thread sealant per the manufacture's instructions.

- 4.7 Disassembly of actuator should be done in a clean area on a work bench.
- 4.8 Some components of this actuator are very heavy and will require a means of assistance. For actuator approximate weight refer the following chart.

ACTUATOR MODEL	WEIGHT (1)	ACTUATOR MODEL	WEIGHT (1)
ST310	208	ST410	270
ST312	237	ST412	298
ST316	284	ST416	351
	270	ST420	398

NOTES: (1) Weights listed for each actuator model are for bare actuators without accessories or valve mounting brackets.

4.9 Lubrication Requirements: Lubricants, other than those listed in steps 4.9.1, 4.9.2 and 4.9.3, should not be used without prior written approval of Bettis Product Engineering.

4.9.1 Standard temperature service (-20°F to +200°F) use Bettis ESL-5 lubricant. ESL-5 lubricant is contained in the Bettis Service/Seal Kit.

4.9.2 High temperature service (0°F to +350°F) use Bettis ESL-5, Kronaplate 100 lubricant. ESL-5 lubricant is contained in the Bettis Service/Seal Kit.

4.9.3 Low temperature service (-40°F to +150°F) use Kronaplate 50 lubricant. Kronaplate 50 is not contained in the Low Temperature Service/Seal Kit.

CAUTION: Pressure is not to exceed the maximum operating pressure rating listed on the name tag.

4.10 Before starting the general disassembly of the actuator, it is a good practice to operate the actuator with the pressure used by the customer to operate the actuator during normal operation. Notate and record any abnormal symptoms such as jerky or erratic operation.

5.0 GENERAL DISASSEMBLY

5.1 Mark or tag stop screw (1-60) left and right. Measure the exposed length of right and left stop screws (1-60) and record measurement before loosening or removal. The stop screws will be removed later in this procedure.

5.2 Remove snubber valves (1-190) from housing cover (1-20) and housing (1-10).

6.0 BLIND END CAP REMOVAL

6.1 Remove hex cap screws (6-20) from blind end cap (6-10).

6.2 Remove blind end cap (6-10).

7.0 PRESSURE CYLINDER DISASSEMBLY

7.1 Remove socket cap screw (2-120), lockwasher (2-110) and nut retainer (2-100) from outer end cap (2-30).

7.2 Remove hex nuts (2-90) from tie bars (2-60).

7.3 Remove outer end cap (2-30). NOTE: The fit between cylinder (2-10) and outer end cap (2-30) is very tight.

7.4 Pry inner end cap (2-40) away from housing (1-10).

7.5 Break inner end cap (2-40) free from cylinder (2-10).

NOTE: When removing the cylinder off of the piston, tilt the cylinder to the piston rod, approximately 15° to 30° degrees.

7.6 Remove cylinder (2-10) from the actuator.

CAUTION: Do not use a pipe wrench on tie bars (2-60) as it may mark the bars and cause seal leakage. Flats are provided on the outboard end of tie bars (2-60) for wrench placement.

7.7 Using tie bar flats for wrench placement, unscrew tie bars (2-60) from housing (1-10).

7.8 Pull tie bars (2-60) out from inner end cap (2-40) far enough to remove o-ring seals (3-30).

7.9 Remove bars (2-60) from piston (2-20).

NOTE: Keep split rings (2-70) in matched sets.

7.10 Remove split ring retainer (2-80) and split ring set (2-70) from outboard side of piston (2-20).

7.11 Remove piston (2-20) from piston rod (2-170).

7.12 Remove o-ring seal (3-40) from piston rod (2-170).

NOTE: Keep split rings (2-70) in matched sets.

7.13 Remove inboard split ring retainer (2-80) and split ring (2-70) from piston rod (2-170).

7.14 Remove inner end cap (2-40) from piston rod (2-170).

8.0 HOUSING DISASSEMBLY

8.1 Unscrew and remove piston rod (2-170) from yoke pin nut (1-30).

CAUTION: Do not use a pipe wrench to remove piston rod (2-170) as it may mark the rod and cause seal leakage. Flats are provided on the outboard end of piston rod (2-170) for wrench placement.

8.2 Remove rod bushing (2-50).

8.3 Remove position indicator pin (1-170) from position indicator drive assembly (1-230).

- 8.4 Unscrew and remove four hex cap screws* with gasket seals (3-100) from position indicator cover (1-210). *Item number for ST3 hex cap screws is (1-260) and for ST4 hex cap screws is (1-90).

- 8.5 Remove position indicator cover (1-210).
- 8.6 Mark and record the orientation of position indicator drive (1-230) relative to the top of yoke (1-160). Mark the "hole" location of set screw (1-180).
- 8.7 Unscrew and remove set screw (1-180) from position indicator drive (1-230).
- 8.8 Remove position indicator drive (1-230) from the top of yoke (1-160).
- 8.9 Remove hex cap screws (1-90) and gasket seals (3-100) from housing cover (1-10).
- 8.10 Remove the housing cover (1-20). NOTE: The cover will have a very tight fit.

NOTE: It is not necessary to remove cover pins (1-130).

- 8.11 Remove the upper two yoke rollers (1-50) from the top of yoke pin (1-40).
- 8.12 Remove yoke pin (1-40) from yoke pin nut (1-30).
- 8.13 Remove yoke pin nut (1-30) from the yoke (1-160).
- 8.14 Remove lower two yoke rollers (1-50) from the housing.
- 8.15 Remove the yoke (1-160) by lifting it from the housing.

CAUTION: The yoke/housing bearing area must be lubricated and inspected to extend service life and prevent degradation of torque output. This can only be accomplished by removing the yoke from the housing which requires removing the actuator from the valve.

- 8.16 Remove stop screws (1-60), jam nuts (1-120), thread seals (3-110) and countersunk washer (3-120). NOTE: Before removing stop screws verify that measurements were recorded per step 5.1.
- 8.17 It is not necessary to remove yoke bushings (1-200) from housing (1-10) or housing cover (1-20) unless these items are being replaced due damage or wear. It is not necessary to remove pipe plugs (1-80) or (1-250), to service the actuator.

9.0 GENERAL REASSEMBLY

- 9.1 Remove and discard all seals and gaskets.

CAUTION: Only new seals, that are still within the seals expectant shelf life, should be install into the actuator being refurbished.

- 9.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
- 9.3 All parts should be thoroughly inspected for excessive wear, stress cracking, galling and pitting. Attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding or rotating motion. Sealing surfaces of the cylinder, tie bars and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

CAUTION: Actuator parts that reflect any of the above listed characteristics must be replaced with new parts.

9.4 Before installation coat all moving parts with a complete film of lubricant. Coat all seals with a complete film of lubricant, before installing into seal grooves.

10.0 HOUSING REASSEMBLY

- 10.1 If removed install pipe plugs (1-80) and (1-250).
- 10.2 Coat one of the yoke o-ring seal (3-50) with lubricant and install into the housing (1-10).
- 10.3 If the yoke bushings (1-200) was removed then install one in the housing yoke bore and one in the housing cover yoke bore.
- 10.4 Inside the housing (1-10) apply lubricant to the tracks and yoke bore and arrange the housing with the yoke bore nearest you.
- 10.5 Apply lubricant to the slots in the upper and lower arms of the yoke (1-160).
- 10.6 Apply lubricant to the yoke (1-160) lower bearing surface and install into the housing (1-10) as follows: Position the yoke arm to approximately 45° degrees position in either direction and lower into the housing. NOTE: The hub with tapped holes faces up. Rotate the yoke back to approximately the mid-stroke (center) position.
- 10.7 Apply lubricant to all surfaces of all four yoke pin rollers (1-50). Place one yoke pin roller (1-50) in the track in the bottom of the housing and position it under the slot in the yoke arms. Place a second yoke pin roller (1-50) on top of the first yoke pin roller in the slot in the lower yoke arm and align the holes in the yoke pin rollers.
- 10.8 Coat the upper and lower surfaces of the yoke pin nut (1-30) with lubricant and insert into position between the yoke arms, parallel to the track in the housing. Align the yoke pin hole with the yoke pin rollers.
- 10.9 Lubricate yoke pin (1-40) and insert through the yoke pin nut (1-30) and the two yoke pin rollers (1-50).
- 10.10 Install the third yoke pin roller (1-50) over the yoke pin in the slot in the upper yoke arm and now install the fourth and last remaining yoke pin roller (1-50) on top of the yoke roller you just installed in the upper yoke arm slot. The top roller will remain partially above the yoke and will engage the cover track when cover is installed.
- 10.11 Apply lubricant to the rod bushing (2-50) and install the bushing into the right side of housing (1-10).
- 10.12 Apply Loctite - 242 to external threads on the piston rod (2-170). NOTE: Loctite cure time is 10 to 30 minutes.
- 10.13 Lubricate piston rod (2-170) and insert it into and through the rod bushing installed in step 10.11.

10.14 Screw piston rod (2-170) into yoke pin nut (1-30).

CAUTION: Do not tighten the piston rod until the housing cover is installed later in the procedure.

10.15 Install position indicator drive (1-230) onto the top of yoke (1-160) with the slot positioned over the hole that was marked in step 8.6.

10.16 Install and tighten set screw (1-180).

10.17 Install o-ring seal (3-150) over the position indicator drive shaft and down against the flat cover plate.

10.18 Prepare the mounting surfaces of housing cover (1-20) and housing (1-10) per master gasket instructions (reference note 5 on the assembly drawing).

10.19 Place housing cover gasket (3-20) onto master gasket prepared housing (1-10).

10.20 Install remaining o-ring seal (3-50) into cover (1-20).

10.21 Apply lubricant to the yoke bore and the track in housing cover (1-20).

10.22 Apply lubricant to the upper bearing surface of yoke (1-160).

10.23 Install housing cover (1-20), being careful not to damage gasket (3-20) or yoke o-ring (3-50).

10.24 Install cover screws (1-90) and seal gaskets (3-100). NOTE: Leave finger tight - do not tighten.

10.25 NOTE: Do this step only if you have pulled cover pins (1-130) or if you are replacing the cover pins. Drive four pins (1-130) through cover (1-20) and into housing (1-10) until the pin is flush with the cover. NOTE: The pins are deeply grooved at one end, tapering to a smooth diameter at the other end. The pin should be installed smooth end first.

10.26 Tighten cover screws (1-90).

NOTE: Flats are provided on the outboard end of the piston rod. These flats should be used to put a wrench on to tighten the piston rod.

10.27 Tighten piston rod (2-170) to a lubricated torque of 150 foot pounds $\pm 5\%$ percent.

CAUTION: Do not use a pipe wrench on the piston rod, as it may mark them and cause seal leakage.

10.28 Place thread seals (3-110), countersunk washers (3-120) and jam nuts (1-120) onto stop screws (1-60).

NOTE: Install stop screws (1-60) into the same stop screw holes as marked in step 8.16.

10.29 Install stop screws (1-60) into housing (1-10).

- 10.30 Prepare the mounting surface of position indicator cover (1-210) and housing cover (1-20) per master gasket instructions (reference note 5 on assembly drawing).
- 10.31 Install o-ring seal (3-140) into the bottom seal groove inside position indicator cover (1-210).
- 10.32 Install wiper ring (3-160) into the top groove inside position indicator cover (1-210).
- 10.33 Install o-ring seal (3-170) into the bottom seal groove on the bottom of position indicator cover (1-210).
- 10.34 Install position indicator cover (1-210), being careful not to damage o-ring seals (3-140), (3-170) and wiper ring (3-160).
- 10.35 Install new gasket seals (3-100) on to hex cap screws*. *Item number for ST3 hex cap screw is (1-260) and for ST4 hex cap screws is (1-90).
- 10.36 For ST3XX model actuators install four hex cap screws (1-260) into position indicator cover (1-210). For ST4XX model actuators install four hex cap screws (1-90) into position indicator cover (1-210).
- 10.37 For ST3XX model actuators torque tighten four hex cap screw (1-260) to a lubricated torque of 10 foot pounds $\pm 5\%$ percent. For ST4XX model actuators torque tighten four hex cap screw (1-90), installed in step 10.36, to a lubricated torque of 16 foot pounds $\pm 5\%$ percent.
- 10.38 Install position indicator pointer (1-170) into the taped hole in position indicator drive assembly (1-230).
- 10.39 Rotate the yoke to a position that will leave a minimum of piston rod (2-170) protruding from housing (1-10).

11.0 PRESSURE CYLINDER REASSEMBLY

- 11.1 Coat rod seal (3-70) with lubricant and install, lip first, into the recess provided in inner end cap (2-40).

CAUTION: Install with the rod seal's energizer ring facing into the end cap recess.

- 11.2 Install o-ring seal (3-10) into inner end cap (2-40).
- 11.3 Prepare the mounting surfaces of inner end cap (2-40) and inner end cap side of housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).
- 11.4 Install inner end cap (2-40) over piston rod (2-170) and rod bushing (2-50). Install inner end cap with the large raised boss toward housing (1-10), flat side outward. The end cap inlet port should be toward the top of the actuator.
- 11.5 Install o-ring seal (3-60) onto the outer diameter seal groove of inner end cap (2-40).
- 11.6 Install two sets of T-seal components (3-80) into the piston internal seal grooves. Refer to section 9 for proper T-seal installation instructions.

- 11.7 Coat the ends of piston rod (2-170) with lubricant.
- 11.8 Install o-ring seal (3-40) onto piston rod (2-170).
- 11.9 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with retaining ring (2-80).
- 11.10 Install piston (2-20) onto the piston rod against split ring (2-70). NOTE: Ribbed section of piston (2-20) should face away from housing (1-10).
- 11.11 Install a matched set of split rings (2-70) onto the piston rod and retain with retaining ring (2-80).
- 11.12 Apply lubricant to the threads and end of tie bars (2-60), end without wrench flat, and install the tie bars by carefully pushing them through piston (2-20).
- 11.13 Install o-ring seals (3-30) onto the seal grooves located on the inboard end of tie bars (2-60).
- 11.14 Insert the tie bars through inner end cap (2-40) and screw into housing (1-10).
- 11.15 Tighten tie bars (2-60) until threads bottom out, then back out a half-turn.
- 11.16 Apply lubricant to the entire bore of cylinder (2-10).
- 11.17 Install T-seal components (3-90) into outer diameter seal groove of piston (2-20). Refer to following steps for proper "T" seal installation.
 - NOTE: T Seal Set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.
 - 11.17.1 Install the T-seal into the seal groove.
 - 11.17.2 Install a back-up ring on each side of the T-seal.
 - 11.17.3 When installing the back-up rings, do not align the skive-cuts.
 - 11.17.4 If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor sharp instrument.
- 11.18 Install the lubricated cylinder (2-10) over piston (2-20) and onto inner end cap (2-40). NOTE: When installing the cylinder over T-seal (3-90), tilt cylinder 15° to 30° degrees to piston rod (2-170).

CAUTION: Hammer on the end of the cylinder only with a non metallic object.

CAUTION: Make certain the back-up rings (components of the piston seal) are seated into the seal groove. Should the back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

11.19 Install o-ring seals (3-30) into seal grooves on the outboard end of tie bars (2-60).

- 11.20 Install o-ring seal (3-60) into the outer diameter seal groove of outer end cap (2-30).
- 11.21 Install outer end cap (2-30) onto tie bars (2-60) and into the end of cylinder (2-10).
- 11.22 Install tie bar nuts (2-90) onto tie bars (2-60), using them to draw all of the cylinder components into position.

CAUTION: While nuts (2-90) are being tightened, do not allow tie bars (2-60) to turn.

- 11.23 Torque the tie bar nuts (2-90) alternately until a final torque of 65 ± 7 foot pounds has been achieved. NOTE: It is necessary that the flats on hex nuts (2-90) be aligned and parallel before nut retainer (2-100) can be installed.
- 11.24 Install nut retainer (2-100), securing in place with retainer screw (2-120) and lockwasher (2-110).

12.0 BLIND END CAP INSTALLATION

- 12.1 Install o-ring seal (3-10) into the seal groove of blind end cap (6-10).
- 12.2 Prepare the mounting surfaces of blind end cap (6-10) and blind end cap side of housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).
- 12.3 Install thread seals (3-110) and countersunk washers (3-120) onto hex cap screws (6-20).
- 12.4 Install blind end cap (6-10) onto housing (1-10) and retain with hex cap screws (6-20). NOTE: It is necessary that the flats on the hex cap screws be aligned and parallel before the nut retainer can be installed.

13.0 ACTUATOR TESTING

- 13.1 Leak Testing Criteria:
 - 13.1.1 In general all areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.
 - 13.1.2 Generally, a small bubble which breaks about three seconds after starting to form is considered acceptable.
 - 13.1.3 If excessive leakage is noted, the formed bubble breaks before three seconds, the actuator must be disassembled and the cause of leakage must be determined and corrected.

CAUTION: Pressure applied to the actuator is not to exceed the maximum operating pressure rating listed on the actuator name tag.

- 13.2 All leak testing will use 65 psig pneumatic pressure or the pressure used by the customer to operate the actuator during normal service operation.

CAUTION: Test the actuator using a properly adjusted self relieving regulator, with gauge.

- 13.3 Before testing for leaks, alternately apply and release 65 psi pressure to the each side of the piston to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.
- 13.4 Apply 65 psig pressure to the pressure port in the outer end cap (2-30).
- 13.5 Apply a leak testing solution to the following areas:
 - 13.5.1 Joint between outer end cap (2-30) and cylinder (2-10). Checks cylinder to end cap o-ring seal.
 - 13.5.2 Around tie bar nuts (2-90) on outer end cap (2-30). Checks tie bars to outer end cap o-ring seals.
 - 13.5.3 The pressure inlet port in inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.5.4 Remove pressure from pressure inlet port in the outer end cap.
- 13.6 Apply 65 psig pressure to the pressure port in inner end cap (2-40).
- 13.7 Apply a leak testing solution to the following areas:
 - 13.7.1 Joint between inner end cap (2-40) and cylinder (2-10). Checks cylinder to inner end cap o-ring seal.
 - 13.7.2 Around the joint of inner end cap (2-40) and housing (1-10). Checks tie bars to end cap o-ring seals and the inner end cap to housing o-ring seal.
 - 13.7.3 The snubber valve port hole in housing cover (1-20). Checks the rod seal and the tie bars to end cap o-ring seals.
 - 13.7.4 Remove pressure from pressure inlet port in the inner end cap.
- 13.8 If an actuator was disassembled and repaired, the above leakage test must be performed again.

14.0 RETURN TO SERVICE

- 14.1 Replace the software components of two snubber valves (1-190) and then install snubber valves into the port in housing cover (1-20) and the port in housing (1-10).
- 14.2 Adjust both stop screws (1-60) back to settings recorded in section 5 under General Disassembly.
- 14.3 Tighten both stop nuts (1-120), while holding stop screw (1-60).
- 14.4 After the actuator is installed on the equipment it is to operate, all accessories should be hooked up and tested for proper operation. If any accessories are found defective they should be replaced.

CHART NO. 1

RECOMMENDED TOOL STYLE AND WRENCH SIZES					
ITEM NO.	WRENCH SIZE (INCHES)	QTY PER ITEM	LOCATION	RECOMMENDED WRENCH STYLE	TORQUE FT-LBS (±5%)
1-60	1/2"	2	Stop Screw	Open End or Adjustable	(2)
1-80	9/16"	1	Housing Pipe Plug	Open End or Adjustable	(3)
1-90	1/2"	8	ST3 Cover Screws	Socket	10
1-90	9/16"	12	ST4 Cover Screws	Socket	10
1-120	1-5/16"	2	Stop Screw Nut	Box End (1)	240
1-170	3/16"	1	Position Indicator Pin	Pliers	(3)
1-180	3/16"	4	Weather Cover Screws	Allen	(3)
1-190	7/8"	1	Snubber Valve	Deep Socket	(3)
1-250	7/16"	1	Pipe Plug	Open End or Adjustable	(2)
1-260	9/16"	4	Position Indicator Screws	Socket or Box End	16
2-60	1/2"	2	Tie Bar Flats	Open End or Adjustable	(2)
2-90	1-7/16"	2	Tie Bar Nuts	Deep Socket	65
2-120	3/16"	1	Nut Retainer	Allen (1)	4
2-170	1-1/4"	1	Piston Rod Flats	Crows Foot (1)	150
6-20	1-7/16"	2	Blind End Cap Screw	Socket	240
(1) No alternate style tool recommended.					
(2) Not required.					
(3) Tight plus one 1/4 turn.					

ECN	DATE	REV	BY *	DATE	
Released	29 August 1993	A	COMPILED	BC	29 August 1993
			CHECKED	BJ	29 August 1993
			APPROVED	RMM	29 August 1993

* Signatures on file Bettis Actuator & Controls, Waller, Texas