

INSTRUCTION MANUAL

ROTOFLOW

TURBOEXPANDER

with

COMPRESSOR LOAD

Designed & Manufactured

for

SCHEDULE A, INC.

for installation in

HOBART RANCH, TEXAS

P.O.# 93340-503100-01

**ROTOFLOW JOB ACR00062
August, 1994**

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SECTION ONE

DESCRIPTION AND TECHNICAL DATA

1.1 INTRODUCTION

This instruction manual is for one ROTOFLOW turboexpander-compressor for processing natural gas. The unit consists of a single-stage turboexpander loaded by an integral, single-stage centrifugal compressor.

The turboexpander-compressor is provided with a nozzle actuator and speed probes. The necessary control system, lubrication system, seal gas system, and annunciator system are to be provided by the Customer.

This unit is designed exclusively for SCHEDULE A, INC., for installation in HOBART RANCH, TEXAS.

UNIT IDENTIFICATION

	<u>Model No.</u>	<u>Serial No.</u>
Turboexpander-Compressor	20-5E6C	20875
Spare Mechanical Center Section (MCS)	20-5E6C	20876

1.2 DESIGN SPECIFICATIONS

Condition:	<u>Off-DESIGN</u>	
	EXP	COMP
Molecular Weight	19.354	17.51
P ₁ , Psia	920	214
T ₁ , °F	-10	103
P ₂ , Psia	230	286
T ₂ , °F	-106	154
Flow, Lbs/hr	37,512	48,568
Power, HP	525	483
Speed, RPM	40,500	
Efficiency, %	82	75

AVOID SPEED TABLE

ORDER NUMBER	WHEEL TYPE	AVOID RANGE	PART NUMBER	REVISION
Main Order	Expander	None	6965040094	0
Main Order	Compressor	None	6965040091	0
Main Order (Spare MCS)	Expander	None	6965040094	0
Main Order (Spare MCS)	Compressor	None	6965040091	0

1.3 SEAL GAS REQUIREMENTS

Seal Gas Supply:

Gas:	Sales Gas
Molecular Weight:	17.51
Temperature:	32°F (Minimum) 70°F (Normal Operating) 100°F (Maximum)
Pressure:	296 Psia - Expander Side 235 Psia - Compressor Side (For Start Up Only)
Flow:	54 SCFM - Expander Side 62 SCFM - Compressor Side (For Start-Up Only)

1.4 LUBRICATION SYSTEM REQUIREMENTS

System Data:

Reservoir Pressure	214 Psia
Pump Differential Pressure	150 Psi
Oil Pressure To Bearings	364 Psia (Minimum)
Oil Flow Through Bearings	16 GPM
Cooler Heat Load (For Bearings Only)	138,000 Btu/Hr
Oil Temperature:	Inlet 110-120 °F Discharge 135-155 °F

Oil Specifications:

Type	Light, non-foaming turbine oil
Viscosity	150 SSU @ 100°F
Viscosity Index	75 or higher (Normal)
Pour Point	-26°F or lower
Additives	none required

1.5 RECOMMENDED CONTROL SETTINGS

The following settings are recommended for the proper operation and protection of the expander-compressor.

<u>Description</u>	<u>Item No.</u>	<u>Function</u>	<u>Setting</u>
<u>Actuator:</u>			
Regulated Air Supply to Positioner	A-1	Positioner Supply Pressure	35 Psig
Signal Pressure to Positioner		Signal to Positioner	3-15 Psig
Diaphragm Pressure		Stem Travel	6-30 Psig
Expected Stem Travel		Full Stroke	0.83 in.
<u>Bearings:</u>			
Excessive Thrust Load	DDPS-1	Alarm	100 Psid Increasing
<u>Accumulator:</u>			
Accumulator Charge Pressure	*	Emergency Oil Supply	458 Psig
<u>Seal Gas:</u>			
Low Seal Gas Diff. Pressure Across Expander Side (Behind Exp. Wheel)	*	Alarm	16 Psid Decreasing
	*	Shutdown	13.5 Psid Decreasing
<u>Speed:</u>			
Impending Overspeed	*	Alarm	42,530 RPM Increasing
Overspeed	*	Shutdown	44,550 RPM Increasing

RECOMMENDED CONTROL SETTINGS - Cont'd

<u>Description</u>	<u>Item No.</u>	<u>Function</u>	<u>Setting</u>
<u>Vibration:</u>			
Excessive Bearing Vibration	*	Alarm	1.0 Mils. Increasing
	*	Shutdown	1.5 Mils. Increasing
<u>Lube Oil:</u>			
Low Lube Oil Supply Across Bearings	*	Alarm	120 Psid Decreasing
	*	Shutdown	100 Psid Decreasing
High Lube Oil Bearing Housing Drain Temperature	*	Alarm	165°F Increasing
	*	Shutdown	175°F Increasing

EDUSA Rev. 12.2 CAD Drawing

CAD produced drawing originals shall be stored electrically and be accessible by the drawing number. No manually made changes are allowed on this drawing.

This document is our property and shall not without our permission be altered, copied, used for manufacturing or communicated to any other person or company.

UPDATE PER ECN#01614	1	ITEM 561	1b, 1.562" LG WAS 2.062" LG	8-4-94	7
	0	ITEM 565	1a, P/N 6965008880 WAS P/N 6965004252		
REASON	REV	ITEM/POS/SHT	DESCRIPTION	DATE	INITIAL
Tolerances, if not indicated, according to:		Machined Surfaces		DECIMALS	FRACTIONS
ATLAS COPCO STANDARD/class		N/A		.XXX ± .XXX .XX ± .XX	± X ANGLES ± X°
Name			152		
PARTS LIST			Material-Class		
Material			N/A		
File Location			Project Name		
DSA1: [USERS.WORK]			ACR00062		
 ROTOFLOW, Corp. LOS ANGELES, CA	Scale	NONE	Prev. Dwg.	Originated From: N/A	
	Drawn by	ARM	Next Dwg.	Replaces N/A	
	Std. Chk.	Blank Wt	Kg	Finished Wt	Kg
	Design Chk.	DATE	Approved	Date	
Drawing received from	J.M	4-26-94	JAMES HO	4-26-94	Dwg./Part No. 6965040953 (2) Sheet 1 (5)

08/04/94

CATALOG: ACR00062-152

BILL OF MATERIAL

DRAWING NO: 6965040953

REV: 0

PAGE 2

f	Description	Quantity	Part No.	Drawing No.
61	EXPANDER CASE FM	1.000	6965040848	6965040848
440	SCR CAP HEX SOC HD 1"-8 X 4 1/2" ASTM F837 GR 1	12.000	6965004481	
565	SCR SHOULDER HEX SOC HD 1/4"DIA X 3/8"LG (10-24 UNC X 3/8"LG)ASTM F837 GR 1 S STL	3.000	6965008880	
575	SCR CAP HEX SOC HD 1/4"-20 X 7/8" ASTM F837 GR 1	6.000	6965004253	
966	RACO SEAL 1190-451-1-0 FLUOROCARBON	1.000	6965004930	
126	SHAFT	1.000	6965005249	6965005249
127	BEARING THRUST WASHER & PINS	2.000	6965003968	6965003968
107	EXPANDER WHEEL FM	1.000	6965040094	6965040094
119	RETAINING WASHER	1.000	6965003967	6965003967
118	RETAINING SCREW 3/8-16 X 4 13/16"	1.000	6965005861	6965006794
154	KEY 1/4" SQ X 13/16" LG (ONE END ROUND)	4.000	6965038656	6965038656
170	COMPRESSOR WHEEL FM	1.000	6965040091	6965040091
180	RETAINING WASHER	1.000	6965003967	6965003967
179	RETAINING SCREW 3/8-16 X 4 9/16"	1.000	6965005862	6965006794
421	KEY 1/4" SQ X 13/16" LG (ONE END ROUND)	4.000	6965038656	6965038656
137	BEARING FRONT GROOVING	1.000	6965003817	6965003817
546	WASHER-FLAT AN960-616 (3/8" DIA) C STL	6.000	6965005194	
545	SCR CAP HEX SOC HD 3/8"-16 X 1" ASTM A574-87 ALLOY STL	6.000	6965003989	
138	BEARING BACK GROOVING	1.000	6965003819	6965003819
531	WASHER-FLAT AN960-616 (3/8" DIA) C STL	6.000	6965005194	
530	SCR CAP HEX SOC HD 3/8"-16 X 1" ASTM A574-87 ALLOY STL	6.000	6965003989	
185	COMPRESSOR WHEEL BACK SEAL	1.000	6965040089	6965040089
3	BACK ROTOR SEAL	1.000	6965003969	6965003969
160	COMPRESSOR SEAL ASSY	1.000	6965003816	6965003816

1/04/94

CATALOG: ACR00062-152

BILL OF MATERIAL
DRAWING NO: 6965040953

REV: 0

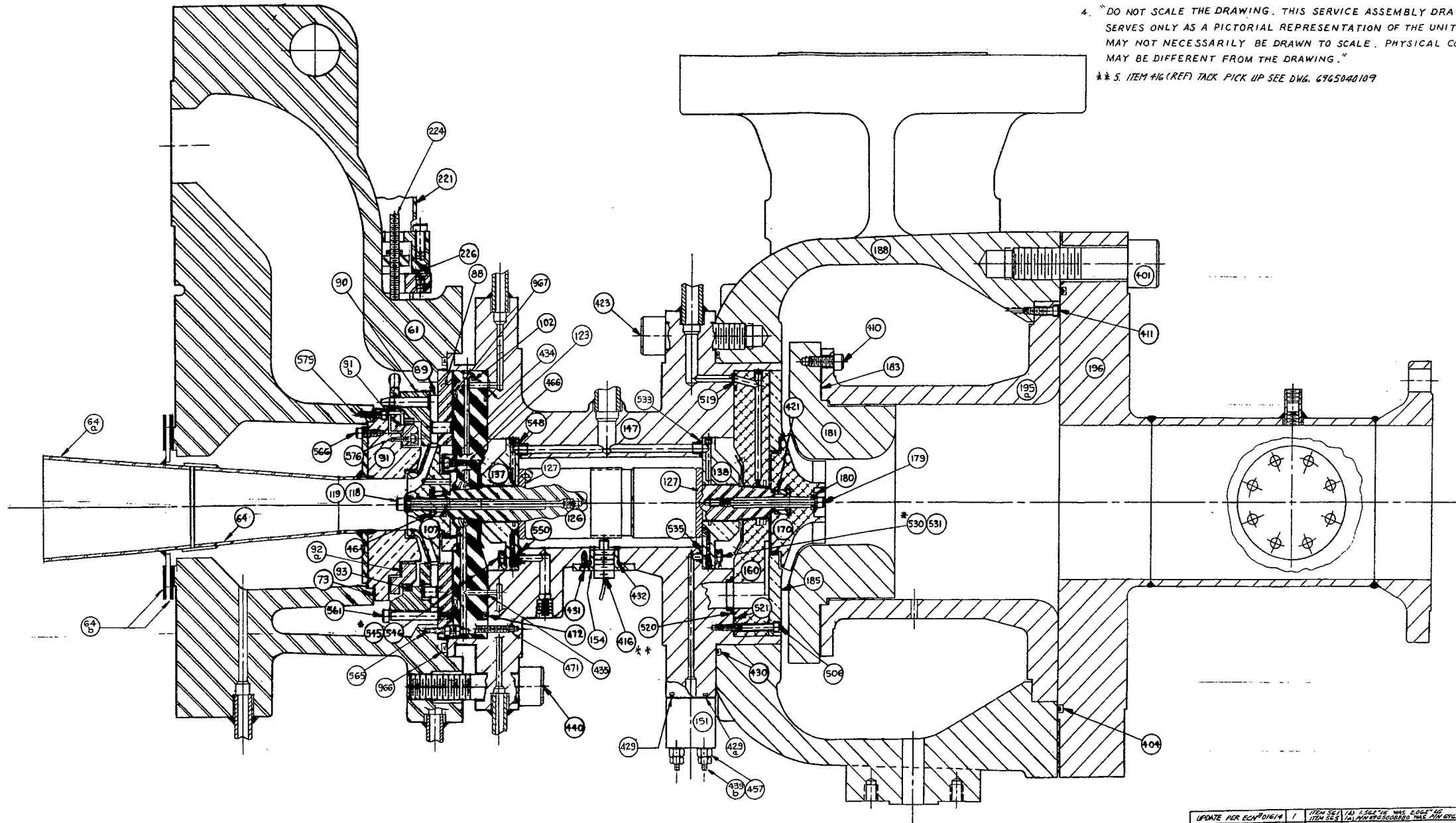
PAGE 3 OF 5

	Description	Quantity	Part No.	Drawing No.	/Rev
02	HEAT BARRIER WALL ASS'Y	1.000	6965004557	6965004557	/B
06	SCR CAP HEX SOC HD 1/4"-20 X 7/8" ASTM F837 GR 1	6.000	6965004253		
01	SCR CAP HEX SOC HD 1/4"-20 X 1 5/8" ASTM F837 GR 1	12.000	6965011493		
02	O-RING #2-174 NITRILE 70	1.000	6965003463		
06	SCR CAP HEX SOC HD 1/4"-20 X 2 1/4" ASTM A574 ALLOY STL	12.000	6965003774		
01	O-RING #2-175 NITRILE 70	1.000	6965003464		
07	RACO SEAL 1181-366-1-0 FURON	1.000	6965005099		
07	BEARING HOUSING DRILLING & TAPPING	1.000	6965040904	6965040904	/2
04	O-RING #2-011 NITRILE 70	1.000	6965003352		
05	O-RING #2-011 NITRILE 70	1.000	6965003352		
09	O-RING #2-011 NITRILE 70	1.000	6965003352		
00	O-RING #2-026 NITRILE 70	1.000	6965003366		
03	O-RING #2-014 NITRILE 70	1.000	6965003355		
05	O-RING #2-012 NITRILE 70	1.000	6965003353		
08	O-RING #2-014 NITRILE 70	1.000	6965003355		
00	O-RING #2-012 NITRILE 70	1.000	6965003353		
04	TACH PICK-UP INSERT (3/4-20 UNEF-2B THD)	1.000	6965000096	6965000096	/1
01	BEARING HOUSING DRAIN FM	1.000	6965024531	6965024531	/0
03	SCR CAP HEX SOC HD 1"-8 X 3 1/4" ASTM A574-87 ALLOY STL	12.000	6965004151		
09	O-RING #2-029 NITRILE 70	2.000	6965003369		
09A	O-RING #2-032 NITRILE 70	1.000	6965003372		
01	SCR CAP HEX SOC HD 1/4"-20 X 3/8" ASTM A574-87 ALLOY STL	4.000	6965003764		
02	O-RING #2-022 NITRILE 70	1.000	6965003362		

f	Description	Quantity	Part No.	Drawing No.	/Rev
39B	STUD FULL THD 3/8"-16 X 4 7/8" LG ASTM A193 GR B7	8.000	6965024555		
57	NUT HEX 3/8-16 UNC ASTM A563-84 GR A	16.000	6965024549		
4	EXPANDER CASE DIFFUSER	1.000	6965040914	6965040914	/B
4A	EXPANDER CASE DIFFUSER EXTENSION	1.000	6965040966	6965040966	/1
4B	GASKET - DURLON SHEET	2.000	6965002526	6965002406	/ K
66	SCR CAP HEX SOC HD 1/4"-20 X 5/8" ASTM F837 GR 1	6.000	6965004251		
96	COMPRESSOR INLET SPACER	1.000	6965040845	6965040845	/0
88	COMPRESSOR CASE FM	1.000	6965040828	6965040828	/0
95A	COMPRESSOR INLET FM	1.000	6965040949	6965040949	/B
01	SCR CAP HEX SOC HD 1 1/4"-7 X 3 1/2" ASTM A574 ALLOY STL	20.000	6965004174		
4	O-RING #2-461 NITRILE 70	1.000	6965003672		
10	SCR CAP HEX SOC HD 1/4"-20 X 7/8" ASTM A574-87 ALLOY STL	6.000	6965003768		
11	SCR CAP HEX SOC HD 1/4"-20 X 1 3/8" ASTM A574 ALLOY STL	4.000	6965029961		
30	O-RING #2-277 NITRILE 70	1.000	6965003544		
83	SHIM-COMPRESSOR FOLLOWER 1 SET = 3 REQ'D	1.000	6965003032		
81	COMPRESSOR FOLLOWER	1.000	6965040950	6965040950	/1
3	PISTON RING	1.000	6965040558	6965040558	/0
1B	NOZZLE FIXED RING SPACER	1.000	6965040561	6965040561	/0
2A	GASKET- NOZZLE FIXED RING SPACER	1.000	6965004562	6965004562	/A
9	NOZZLE SEGMENT & PIN	6.000	6965004561	6965004561	/D
8	NOZZLE COVER & PINS	1.000	6965004558	6965004558	/B
1	NOZZLE FIXED RING	1.000	6965004560	6965004560	/A
0	NOZZLE ADJUSTING RING AND PIN	1.000	6965040563	6965040563	/0
3	GASKET - NOZZLE FIXED RING	1.000	6965003011	6965003011	/B
61	SCR SHOULDER HEX SOC HD 3/8"DIA X 1.562" (5/16"-18 X 1/2"LG) ASTM F837 GR 1	3.000	6965027038		
76	SCR CAP HEX SOC HD 1/4"-20 X 5/8" ASTM F837 GR 1	12.000	6965004251		
21	NOZZLE ACTUATOR ASSY	1.000	6965040916	6965040916	/1
26	GASKET - DURLON SHEET	1.000	6965002117	6965001850	/ 1
24	NOZZLE ACTUATOR ROD LOWER	1.000	6965020203	6965020203	/B
NOTES:	SERVICE ASSY EXP-COMP MODEL NO 20-5E6C	0.000	6965040955	6965040955	/0

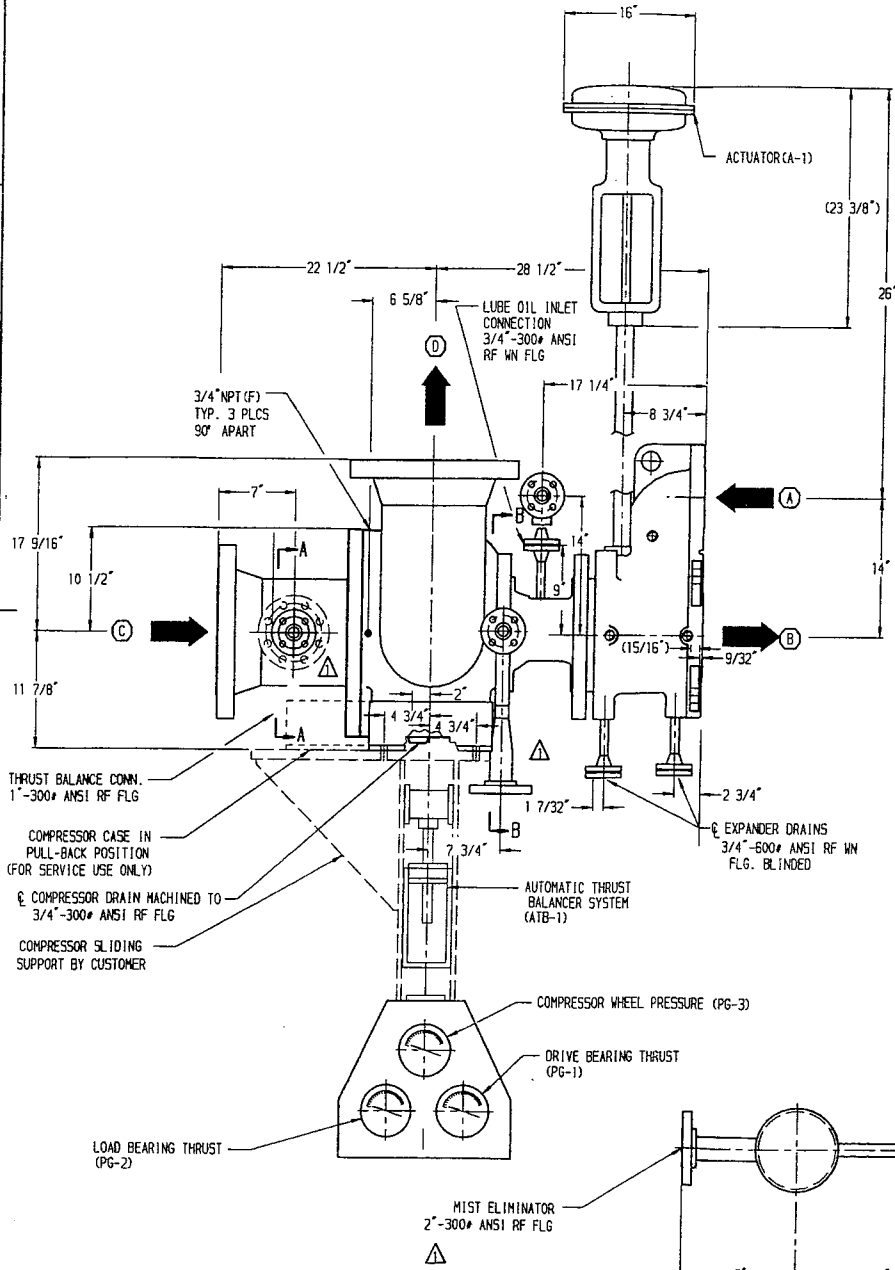
NOTES:

1. FOR PARTS LIST SEE: 6965040953 SHEET THRU 5
2. TORQUE ITEMS 118 & 179 TO 18.7 FT-LBS. LUBRICATED WITH MOLYBDENUM OR COPPER BEARING COMPOUNDS ON THREADS AND FACES.
- * 3. 5/64 (.078) DIA. DRILL 2 HOLES THRU HEAD OF EACH SCREW LOCK WIRE IN PAIRS USING .032 DIA WIRE.
4. "DO NOT SCALE THE DRAWING. THIS SERVICE ASSEMBLY DRAWING SERVES ONLY AS A PICTORIAL REPRESENTATION OF THE UNIT. IT MAY NOT NECESSARILY BE DRAWN TO SCALE. PHYSICAL CONFIGURATION MAY BE DIFFERENT FROM THE DRAWING."
- ** 5. ITEM #16 (REF) TACK PICK UP SEE DWG. 6965040109



UPDATE PER REV'D 01/14		1	ITEM 51	AD 1.562" DIA WAS 2.062" DIA	8-3-94	8
REASON		KEY	ITEM POSITION	DESCRIPTION	DATE	INITIAL
Tolerances, if not indicated, according to:		Machined Surfaces		DECIMALS	FRACTIONS	UNITS
ATLAS COPCO STANDARD/class		NOTED		.XX & .XXX	1/8	INCHES
SERV. ASS'Y EXPANDER-COMPRESSOR MODEL No. 20-960C				.XX & .XX	1/16	INCHES
152				152001		

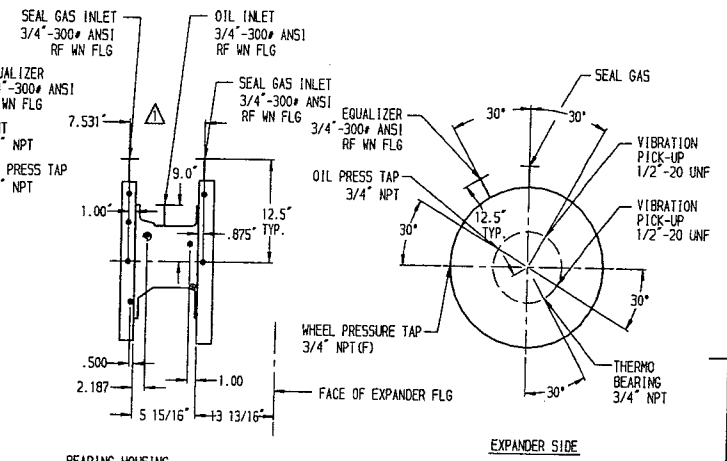
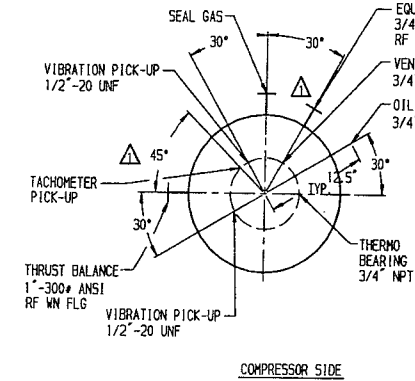
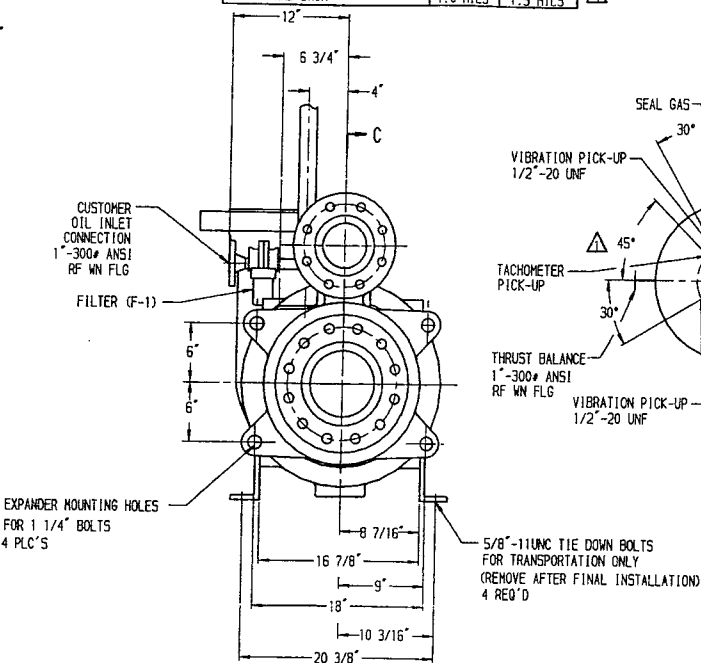
CUSTOMER INTERFACING CONNECTIONS		
CONN	LINE SERVICE	SIZE & RATING
(A)	EXPANDER INLET	4"-600# ANSI RF FLG
(B)	EXPANDER OUTLET	8"-600# ANSI RF FLG
(C)	COMPRESSOR SUCTION	10"-300# ANSI RF FLG
(D)	COMPRESSOR DISCHARGE	10"-300# ANSI RF FLG



LUBRICATION AND SEALING REQUIREMENTS

RESERVOIR OPERATING PRESSURE 214 PSIA
 Δ P ACROSS BEARING 150 PSI
 LUBE OIL PRESSURE TO BEARING 364 PSIA MIN.
 OIL FLOW THRU BEARING 16 GPM
 OIL TYPE (FRESH OIL) 150 SSG@100°F
 COOLER HEAT LOAD (FOR BRG. ONLY) 138,000 BTU/HR
 SEAL GAS 235 PSIA NORMAL OPERATION
 SEAL GAS PRESSURE TO EXPANDER 54 SCFM@70°F (NOR)
 SEAL GAS FLOW TO EXPANDER 235 PSIA
 SEAL GAS PRESSURE TO COMPRESSOR 62 SCFM@70°F (START-UP ONLY)
 SEAL GAS FLOW TO COMPRESSOR 296 PSIA MIN
 SEAL GAS FOR START UP PRESSURE 32°F MIN
 TEMPERATURE 70°F NOR
 100°F MAX

RECOMMENDED SET	ALARM	SHUTDOWN
SPEED (RPM)	42530	44550
BRG HOUSING OIL DRAIN		
TEMPERATURE °F	165	175
SEAL GAS DIFF. PRESS. (BEHIND EXP. WHEEL) PSID	16	13.5
LUBE OIL DIFF. PRESS. (ACROSS EXP. BRG) PSID	120	100
EXCESSIVE THRUST LOAD ALARM	100	N/A
VIBRATION LIMITS FRONT AND BACK	1.0 MILS	1.5 MILS

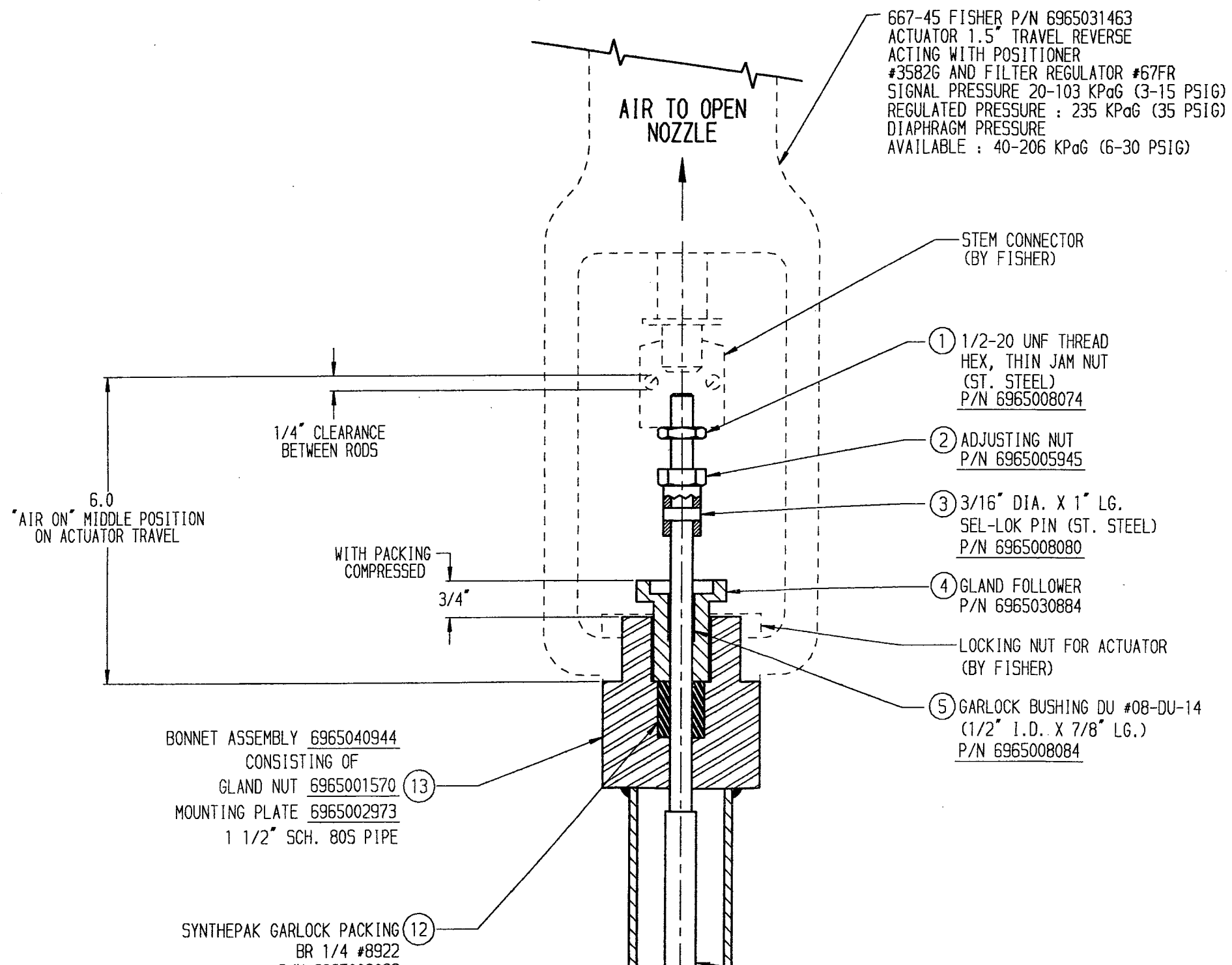


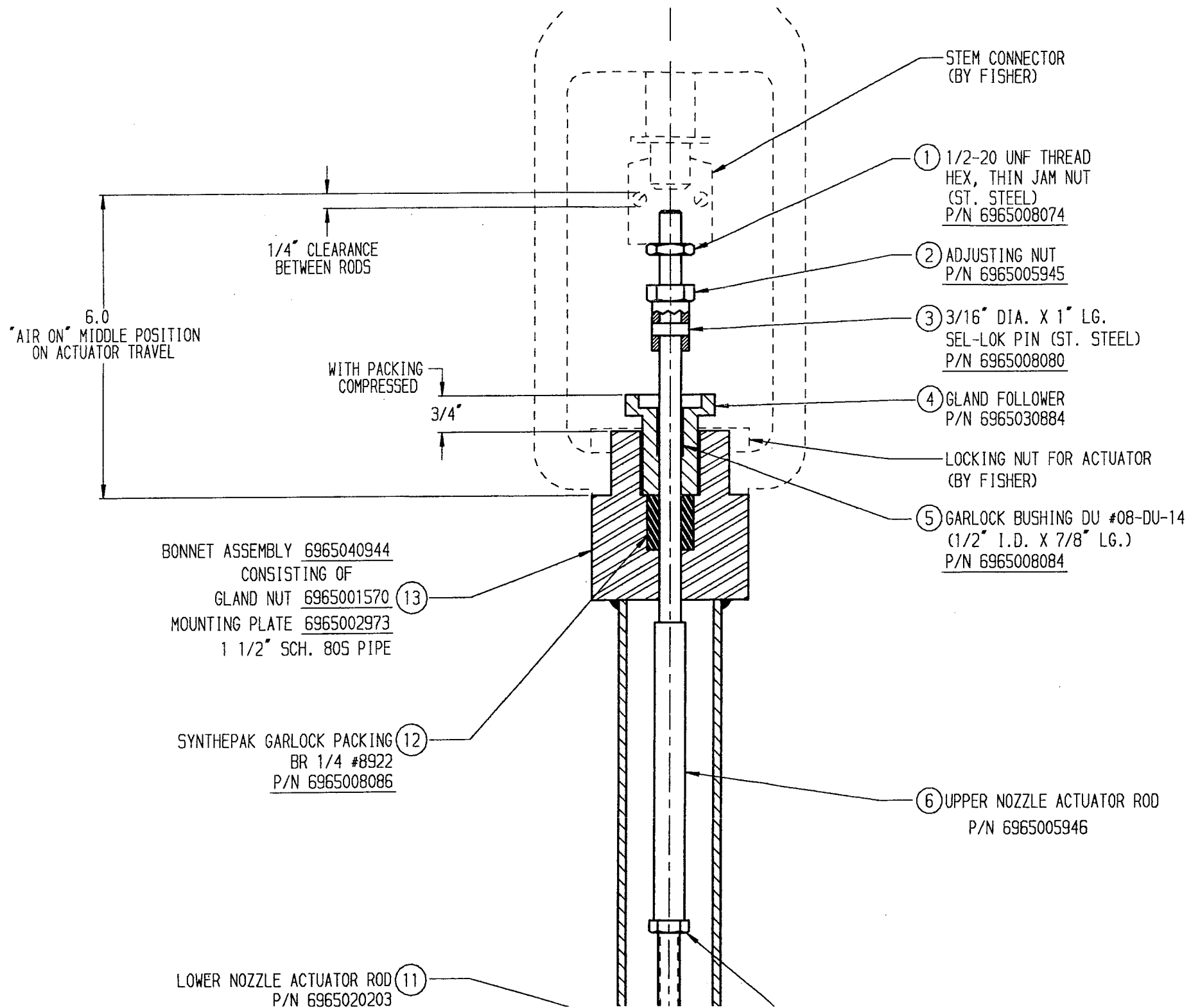
BEARING HOUSING
SECTION C-C

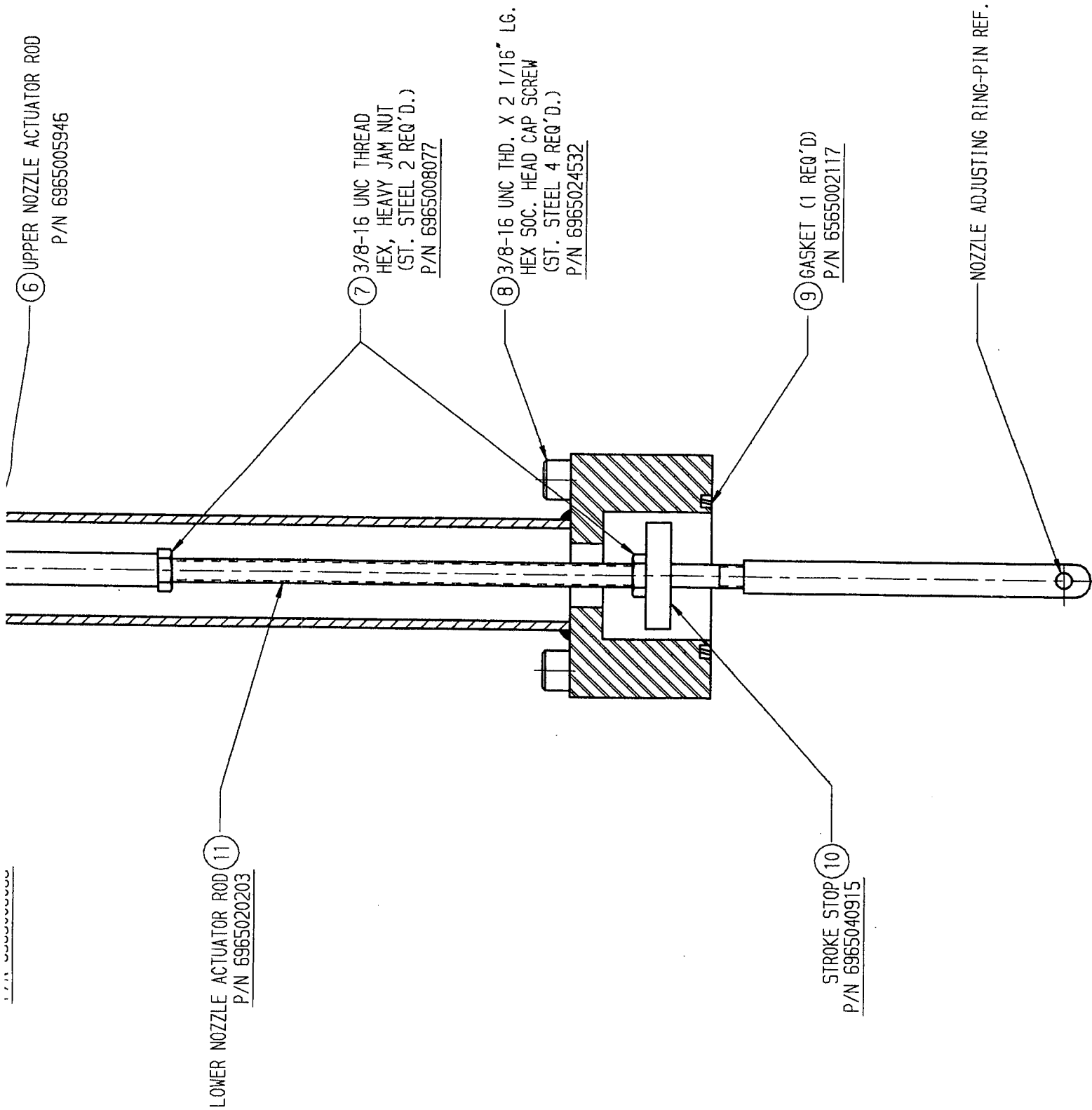
CERTIFIED CORRECT PRINT
 FOR SCHEDULE A, INC.
 P.O. 93340-503100-01
 ROTOFLOW
 JOB# ACRO0062
 BY L. B. Bred
 DATE 08-12-94
 LOCATION: HOBART RANCH TEXAS

UPDATE	4	C1, C4, C4	AS BUILT	10-AUG-94	LP
PER ROTOFLOW	3	D-4	42530 WAS 36750, 44550 WAS 38500	06-AUG-94	LP
UPDATE	2	D2	CHANGE GUARD FILTER	25-MAY-94	OF
UPDATE	1	OVERALL	REV. PER CUST. COMMENTS	28-APR-94	OF
REASON	REV	ITEM/REV/SH	DESCRIPTION	DATE	INITIAL
Tolerances, if not indicated, according to: Machined Surfaces DECIMALS .000 ± .000 FRACTIONS ± 1/16" UNLESS NOTED					

ANSI Y14.5M-1982







UPDATE		1	WAS 20R 3202C72;REVISED & REDRAWN	
REASON	REV	ITEM/POS/SHT	DESCRIPTION	
DESIGNS DRAWN ON CAD, ARE ONLY TO BE CHANGED ON THE CAD SYSTEM				
Tolerances, If not indicated, according to:		Machined Surfaces	DECIMALS	FRACTIONS
ATLAS COPCO STANDARD/Class		1254K / .	.XXX ± .XXX .XX ± .XX	± X ANGLES ±X°
Name	NOZZLE ACTUATOR ASS'Y			F.G. 162
Material	N/A			Material-Class 162003
File Location	DSA1: [USERS.WORK]			Project Name ACR00062
Scale NONE Fom N/A Drawn by ARM Blank No. N/A	Std. Chk.		Blank Wt	Kg
	Design Chk.		Prod. Chk.	Approved
	Drawing received from		Date	
Atlas Copco ROTOFLOW, Corp. LOS ANGELES, CA		4/22/94		4/22/94
Dwg/Part No.		69650409		