Hydraulics Seminar

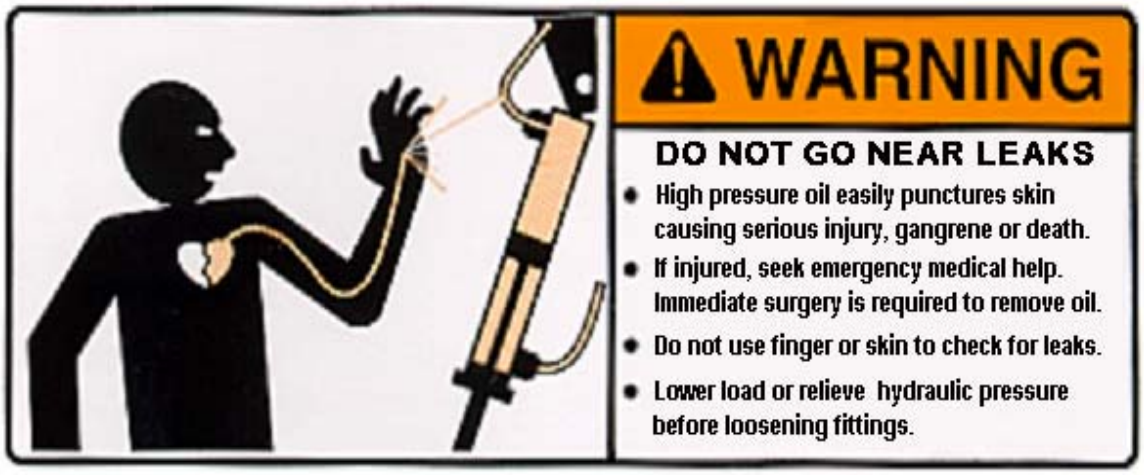
October 28-30, 2002

NAVTEC®

Rigging Solutions℠

October 25, 2002

INDEX



THINK SAFETY FIRST

For decades, labels on electrical equipment have warned operators, maintenance workers, or anyone else nearby of the potential dangers of electrical energy. Similarly, pressurized hydraulic fluid can pose a threat to health and safety if it is not contained within its conductors. However, many mechanics are unaware of how seriously they can be injured if hydraulic fluid penetrates their skin. Few of us would check for electrical shorts by using our fingers, or work on electrical equipment without shutting off the power. Accidents also can occur when the source of a hydraulic leak is sought by using the sense of touch, or when technicians neglect to relieve system pressure before loosening fittings.

Such accidents not only threaten life and limb, but often result in law suits. Warning stickers can help protect manufacturers from liability suits in two ways. First – and most important – warning stickers help prevent accidents by alerting people to potential dangers. Keeping accidents from happening certainly helps prevent litigation. Second, if an accident does occur, the presence of a warning sticker can imply that a manufacturer attempted to warn personnel of the potential danger. A jury could have difficulty finding a manufacturer negligent if an operator or mechanic ignored warning labels. The label is no guarantee, but it can help.

Just using warning labels may not be enough. Placement and content are important. Labels must be located near the source of danger and placed where they will be seen clearly. They should be eye-catching but not cartoonish – or they might not be taken seriously.

Energy Manufacturing Co., Inc., Monticello, Iowa, offers the label pictured above (which meets ANSI safety sign standard Z535.4) in four sizes. For details about the labels, phone Energy Mfg. at 319/465-3537 or visit their website at www.energymfg.com.

INTEGRAL – LE VERSION

JANUARY 2000 INTRODUCTION

Disassembly Procedure:

1. With piston rod extended and release valve open, remove port plug (4) between release knob and tube. Lay Integral horizontally to drain fluid.
2. Remove set screw (30) at body/cylinder connection and disconnect external feed tube connection at body (45, 46, 47).
3. Unscrew Body Assembly from Tube Assembly. Drain any excess oil.

Body Assembly Disassembly:

1. Remove check bob assemblies (4-8, 44, 45), relief valve assembly (28, 40-43) and port plugs (4, 8). (Be sure to use care not to lose springs and balls.)
2. Remove release valve assembly (17-20) by backing off set screw (18) and unscrewing assembly from body. (Be sure to use care not to lose ball)
3. Remove rocker/pump piston assembly (24-26, 37-39) by pushing rocker pin (3) past snap ring (16) with punch.
4. Remove all O-rings and seals. Clean all parts of dirt and debris.

Body Assembly Rebuilding Procedure:

1. Install pump piston rocker assembly.
    a) Install pump piston seal (39)
    b) Push piston into bore.
    c) Align holes of rocker (26), washer (2) and snap ring (16).
    d) Push rocker pin (3) through so that groove locks with snap ring.
2. Install release valve.
    a) Drop .218 dia. SS ball (17) into port. Inspect for wear/pitting prior to assembly. Replace if necessary.
    b) Install O-ring (20) onto relief valve knob (19)
    c) Screw relief valve knob into body. With valve finger tight, adjust setscrew (18)
3. Install relief valve.
    a) Inspect .156 dia. SS ball (43) for wear/pitting prior to assembly. Replace if necessary.
    b) Assemble relief valve and install (40-43). (Hint: use a little white grease to hold all pieces together)
    c) Install plug O-ring (29) and install plug (28) into body.
4. Install check valves.
    a) Install o-ring (7) on check bob nose (6).
    b) Install check bob. Inspect that check bobs seat correctly when inserted into port.
    c) For inlet check valve, install plug O-ring (8); place spring (5) in plug (4) and install. (Hint: use a little white grease to hold spring in place)
    d) For outlet check valve, place spring (5) in spacer (44) and install. (Hint: use a little white grease to hold spring in place) Install o-ring (45a) onto oil fitting (45) and install.
5. Install O-rings (8) onto remaining port plugs (4) and install plugs into body.
6. Install O-ring (31) and backup (32) to body. (Note: O-ring faces pressure side)
7. Put assembly aside.

Tube Assembly Disassembly:

1. Remove External Feed Tube (51), oil fitting (53) and gauge/cover (12, 60) from cylinder tube.
2. Remove cylinder cap set screw (30) and remove cylinder cap (56) using proper spanner wrench
3. Pull rod assembly from cylinder tube
4. Remove jaw (13), gland assembly (54) and rod stop bushing (34).
5. Remove piston bearing and seal, remove the piston locking pin (33) and unscrew piston (48) from rod (52). CAUTION: DO NOT score piston surface during removal of seals and bearings
6. Remove all o-rings, bearings and seals. Clean all parts of dirt and debris

CONTINUED NEXT PAGE (tube assembly rebuilding procedure and final assembly)
Tube Assembly Rebuilding Procedure:

1. Check cylinder bore for any uneven wear or scoring
2. Check piston rod for nicks or scratches. Minor scratches can be polished out with fine emery cloth.
3. Install the lower bearing (49). Install piston seal (50) onto piston (48) using piston seal installation tool. Leave alignment hole visible and put the assembly aside.
4. Clamp the piston rod horizontally in a non-marring vise with notch in the rod facing up
    a) Slide rod seal pusher tool, rod seal (35) and sleeve tool over the notched end of rod. (In this order).
    b) Install O-ring and O-ring back up (31, 32) onto gland and slide gland sub-assembly onto rod. (Note: O-ring faces the pressure side)
    c) Firmly squeeze gland and pusher tool together to seat rod seal into gland.
    d) Remove sleeve and pusher tool from rod.
    e) Install gland backup ring (55).
    f) Slide rod stop bushing (34) onto rod.
    g) Screw Piston back onto rod, insert locking pin and install upper bearing (49).
5. Using shim stock to cover oil-fitting hole, insert piston/rod/gland assembly into cylinder tube.
6. Install new wiper seal (36) into cylinder cap. Install cap into cylinder tube. Install cap set screw.
7. Install jaw (13) and cotter pin (15).
8. Install oil fitting (53) and gauge/foam spacer (12, 59) using Teflon tape on the threads. Install gauge cover (58, 60).
9. With piston rod extended, hold cylinder tube in non-marring vise jaw and add required amount of oil to cylinder tube. (-06/-10 = 12 ounces, -12/-17 = 22 ounces, -22 = 30 ounces)

Final Assembly:

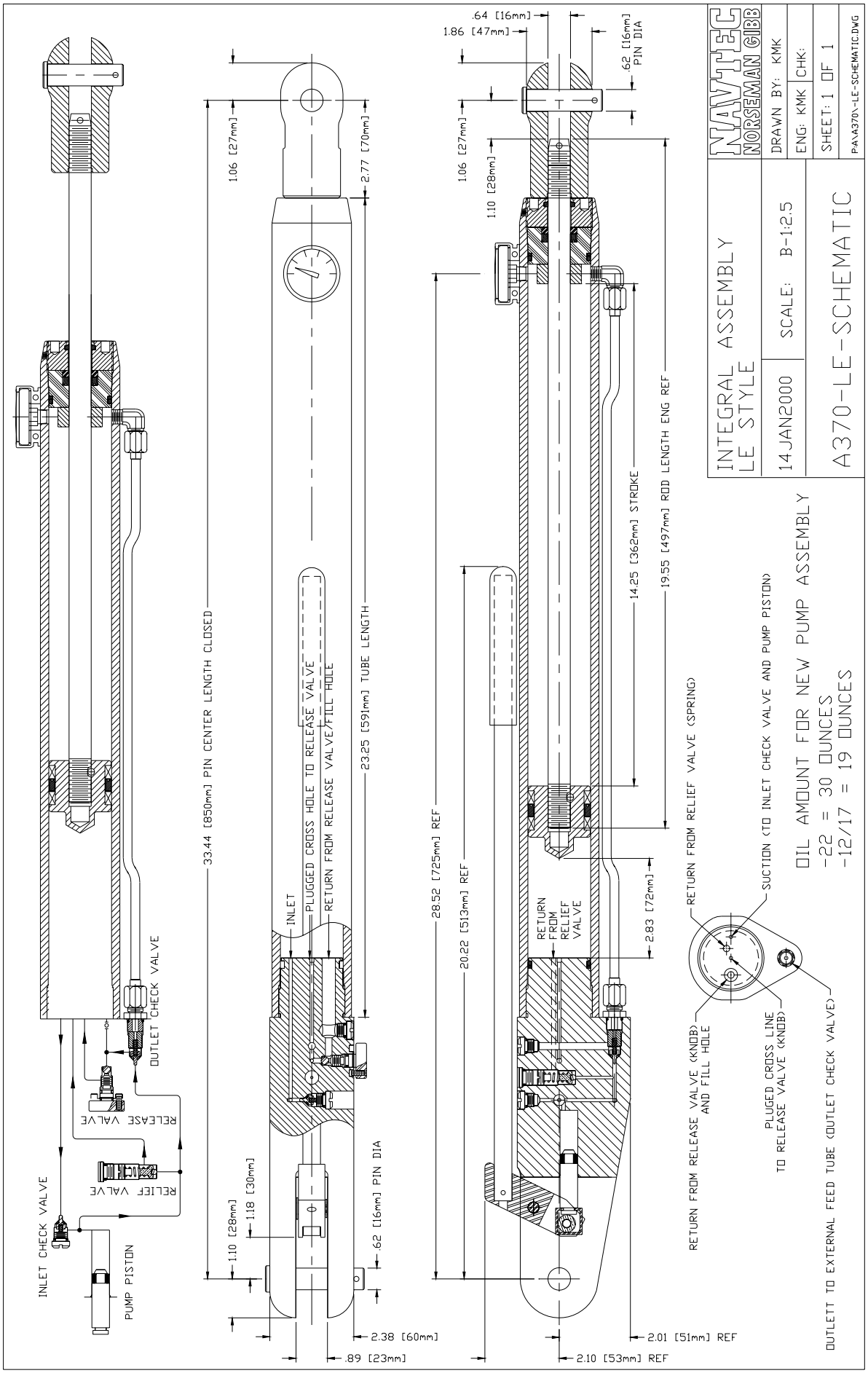
1. Screw body assembly onto tube assembly. Check for oil fitting alignment. Replace and tighten tube set screw (30).
2. Install external feed tube. (Note: Longer straight end should be connected to body side)
3. With Integral in holding fixture or non-marring vise, pump to pressure. Check for leaks and set relief pressure.
4. Q.C and Test.

Approximate amount of oil in integrals

Size	Ounces of Oil
-6	12
-10/Long	12/18
-12	22
-17	22
-22	30

Approximate factory bypass settings

Size	Pressure (psi)
-6	3000
-10	4000
-12	3000
-17	4000



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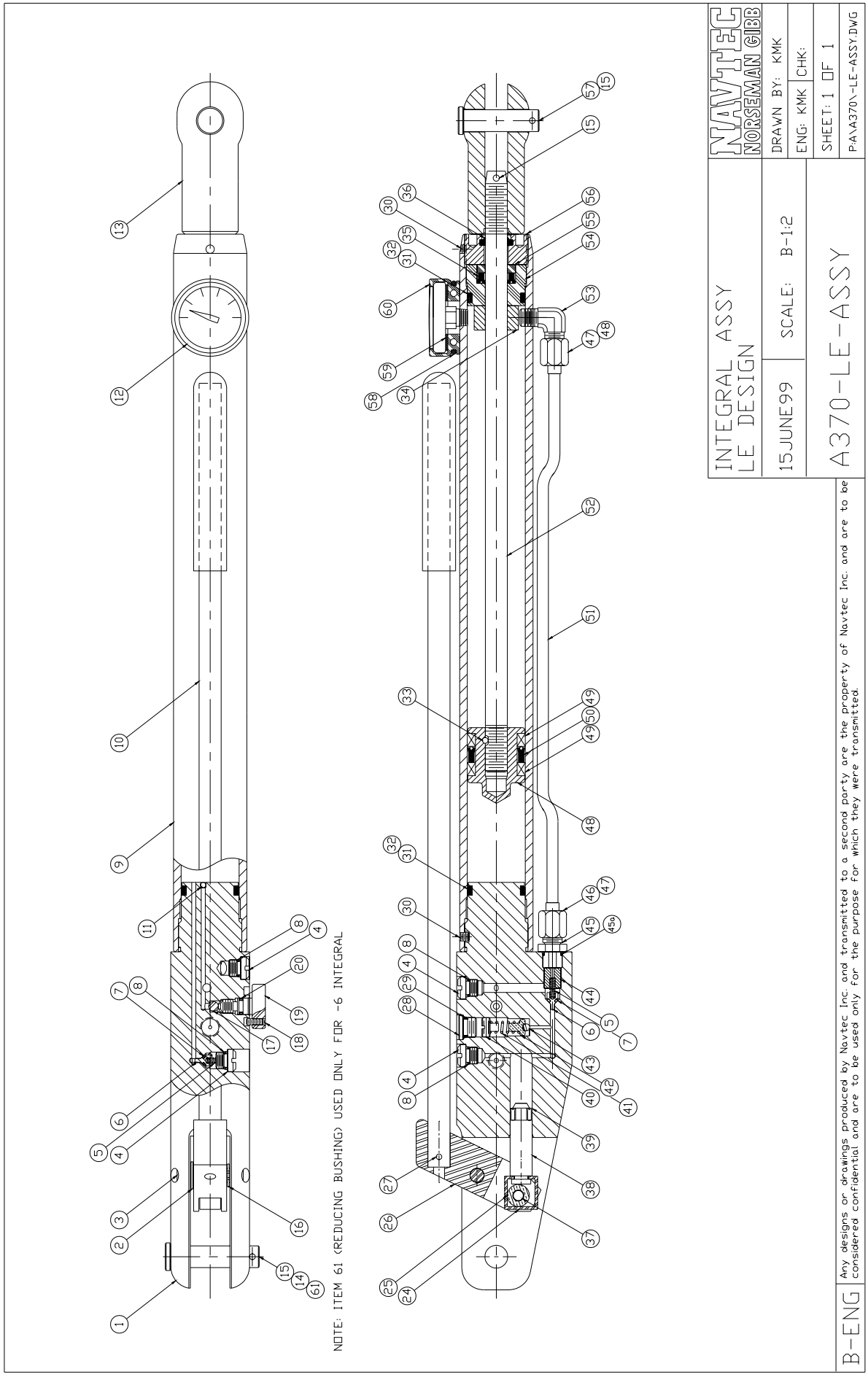

Source File: X:\P\A\A370\LE INTEGRAL\-ASSY.dwg

ASSEMBLY NO: A370-LE-006
DESCRIPTION: -6 LE INTEGRAL, 13.50 STROKE

PART NUMBER	DESCRIPTION	ITEM NUMBER	QUANTITY
A090-17-01	LABEL, NAVTEC, .65 X 1.50 (MED)	0	1
A090-21-09	LABEL, RELEASE	0	1
A090-22-01	LABEL, SERIAL	0	1
A371-31-010	BODY, -10 LE INTEGRAL	1	1
HR-015	5/16" WASHER #AN960C516	2	1
A371-14-01	ROCKER PIN, LE INTEGRAL	3	1
A031-19-02	PORT PLUG, HARDCOATED	4	1
A031-02-01	CHECK SPRING	5	2
A031-18-N	O-RING CHECK BOB W/NOSE	6	4
HJ-2-005	2-005	7	2
HJ-3-903	3-903	8	4
A371-32L010	TUBE, -10 LE INTEGRAL, 13.50 STK	9	1
A371-A25	HANDLE ASSEMBLY, LE INTEGRAL	10	1
HD-001	1/8 S.S. BALL	11	1
HC-077-06	MIJA GAGE#1-02252 W/316SS BAC	12	1
A371-20-06	JAW, INEGRAL -6	13	1
D600-07-180	CLEVIS PIN, 7/16 X 1.80	14	1
D660-0832	COTTER PIN, 1/8 X 1.00	15	3
HG-027	N5100-31-H SNAP RING, WALDES	16	1
HD-00-219	7/32" HARD STEEL BALL	17	1
HC-065	6-32 X 3/8 SSS NYLOK	18	1
A371-13-01	VALVE STEM, INTEGRAL	19	1
HJ-2-010	2-010	20	1
A031-04-01	PISTON RETRACTOR	24	1
A031-05-01	PIVOT SLEEVE	25	2
A371-03-01	PUMP ROCKER, INTEGRAL, MACH'D	26	1
A361-11-01	RELIEF VALVE PORT PLUG	28	1
HJ-3-904	3-904	29	1
HC-038	10-32 X 3/16 SSS-CUP POINT	30	2
HJ-2-215	2-215	31	2
HK-8-215	8-215	32	2
A251-08-010	PISTON LOCK PIN -10 1/8 X 5/8	33	1
A251-22C010	STOP BUSHING, LT CYL, .500 -10	34	1
HI-005	18700500 -10 ROD SEAL	35	1
HN-002	D0500 -10 ROD WIPER	36	1
A371-04-01	INTEGRAL PIVOT	37	1
A031-03P03	PUMP PISTON,1/2" LE INTEGRAL	38	1
HM-032	12500250-250B PUMP PISTON SEAL	39	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	40	1
HF-029	M-100 SPRING, DIECO	41	1
A361-13-01	RELIEF VALVE BALL GUIDE	42	1
HD-00-156	5/32" HARD STEEL BALL	43	1
A371-30-01	SPACER, CHECK VALVE, THRU FLOW	44	1
HB-283	4-F50X-SS SAE #4 STRAIGHT	45	1
HB-058	4-BTX-SS NUT	46	2
HB-102	4-TX-SS SLEEVE	47	2
A251-29-010	PISTON, LT CYL -10	48	1
A251-12-010	PISTON BEARING -10	49	2
HM-004	18700937-312B -10 PISTON SEAL	50	1
011-017	1/4 X .035 SEAMLESS 304 TUBE	51	1.568 ft
A371-36L010	ROD, -10 LE INTEGRAL, 13.50 STK	52	1
HB-069	4-CTX-SS ELBOW	53	1
A251-25C010	GLAND, LT CYL, DELRIN .500 -10	54	1
A251-24C010	GLAND BACK UP, DELRIN, .500 -10	55	1
A251-23C010	CAP, LT CYL, .500 -10	56	1
D600-07-129	CLEVIS PIN, 7/16 X 1.29	57	1
HJ-2-124-1	2-124 O-RING BLACK VITON	58	1
A371-33-01	FOAM SPACER, LE INTEGRAL GAGE	59	1
A371-37-010	GAGE COVER -10 LE INTEGRAL	60	1
A371-19-03	REDUCING BUSHING -6	61	2

HJ-2-012	2-012 (CONTAINED IN SEAL/REPAIR KIT)	45a	1

Source File: X:\P\A\A370\LE INTEGRAL\-LE-006.xls

ASSEMBLY NO: A370-LE-010
DESCRIPTION: -10 LE INTEGRAL, 13.50 STROKE

PART NUMBER	DESCRIPTION	ITEM NUMBER	QUANTITY
A090-17-01	LABEL, NAVTEC, .65 X 1.50 (MED)	0	1
A090-21-09	LABEL, RELEASE	0	1
A090-22-01	LABEL, SERIAL	0	1
A371-31-010	BODY, -10 LE INTEGRAL	1	1
HR-015	5/16" WASHER #AN960C516	2	1
A371-14-01	ROCKER PIN, LE INTEGRAL	3	1
A031-19-02	PORT PLUG, HARDCOATED	4	1
A031-02-01	CHECK SPRING	5	2
A031-18-N	O-RING CHECK BOB W/NOSE	6	4
HJ-2-005	2-005	7	2
HJ-3-903	3-903	8	4
A371-32L010	TUBE, -10 LE INTEGRAL, 13.50 STK	9	1
A371-A25	HANDLE ASSEMBLY, LE INTEGRAL	10	1
HD-001	1/8 S.S. BALL	11	1
HC-077-06	MIJA GAGE#1-02252 W/316SS BAC	12	1
A251-01-010	JAW, FLAT REEF -10	13	1
D600-08-180	CLEVIS PIN, 1/2 X 1.80	14	1
D660-0832	COTTER PIN, 1/8 X 1.00	15	3
HG-027	N5100-31-H SNAP RING, WALDES	16	1
HD-00-219	7/32" HARD STEEL BALL	17	1
HC-065	6-32 X 3/8 SSS NYLOK	18	1
A371-13-01	VALVE STEM, INTEGRAL	19	1
HJ-2-010	2-010	20	1
A031-04-01	PISTON RETRACTOR	24	1
A031-05-01	PIVOT SLEEVE	25	2
A371-03-01	PUMP ROCKER, INTEGRAL, MACH'D	26	1
A361-11-01	RELIEF VALVE PORT PLUG	28	1
HJ-3-904	3-904	29	1
HC-038	10-32 X 3/16 SSS-CUP POINT	30	2
HJ-2-215	2-215	31	2
HK-8-215	8-215	32	2
A251-08-010	PISTON LOCK PIN -10 1/8 X 5/8	33	1
A251-22C010	STOP BUSHING, LT CYL, .500 -10	34	1
HI-005	18700500 -10 ROD SEAL	35	1
HN-002	D0500 -10 ROD WIPER	36	1
A371-04-01	INTEGRAL PIVOT	37	1
A031-03P03	PUMP PISTON,1/2" LE INTEGRAL	38	1
HM-032	12500250-250B PUMP PISTON SEAL	39	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	40	1
HF-029	M-100 SPRING, DIECO	41	1
A361-13-01	RELIEF VALVE BALL GUIDE	42	1
HD-00-156	5/32" HARD STEEL BALL	43	1
A371-30-01	SPACER, CHECK VALVE, THRU FLOW	44	1
HB-283	4-F50X-SS SAE #4 STRAIGHT	45	1
HB-058	4-BTX-SS NUT	46	2
HB-102	4-TX-SS SLEEVE	47	2
A251-29-010	PISTON, LT CYL -10	48	1
A251-12-010	PISTON BEARING -10	49	2
HM-004	18700937-312B -10 PISTON SEAL	50	1
011-017	1/4 X .035 SEAMLESS 304 TUBE	51	1.568 ft
A371-36L010	ROD, -10 LE INTEGRAL, 13.50 STK	52	1
HB-069	4-CTX-SS ELBOW	53	1
A251-25C010	GLAND, LT CYL, DELRIN .500 -10	54	1
A251-24C010	GLAND BACK UP, DELRIN, .500 -10	55	1
A251-23C010	CAP, LT CYL, .500 -10	56	1
D600-08-154	CLEVIS PIN, 1/2 X 1.54	57	1
HJ-2-124-1	2-124 O-RING BLACK VITON	58	1
A371-33-01	FOAM SPACER, LE INTEGRAL GAGE	59	1
A371-37-010	GAGE COVER -10 LE INTEGRAL	60	1
HJ-2-012	2-012 (CONTAINED IN SEAL/REPAIR KIT)	45a	1

Source File: X:\P\A\A370\LE INTEGRAL\-LE-010.xls

ASSEMBLY NO: A370-LE-012
DESCRIPTION: -12 LE INTEGRAL, 14.25 STROKE

PART NUMBER	DESCRIPTION	ITEM NUMBER	QUANTITY
A090-17-01	LABEL, NAVTEC, .65 X 1.50 (MED)	0	1
A090-21-09	LABEL, RELEASE	0	1
A090-22-01	LABEL, SERIAL	0	1
A371-31-017	BODY, -17 LE INTEGRAL	1	1
HR-015	5/16" WASHER #AN960C516	2	1
A371-14-01	ROCKER PIN, LE INTEGRAL	3	1
A031-19-02	PORT PLUG, HARDCOATED	4	1
A031-02-01	CHECK SPRING	5	2
A031-18-N	O-RING CHECK BOB W/NOSE	6	4
HJ-2-005	2-005	7	2
HJ-3-903	3-903	8	4
A371-32L017	TUBE, -17 LE INTEGRAL, 13.50 STK	9	1
A371-A25	HANDLE ASSEMBLY, LE INTEGRAL	10	1
HD-001	1/8 S.S. BALL	11	1
HC-077-06	MIJA GAGE#1-02252 W/316SS BAC	12	1
A251-01-017	JAW, FLAT REEF -17	13	1
D600-10-240	CLEVIS PIN, 5/8 X 2.40	14	1
D660-0832	COTTER PIN, 5/32 1-1/4	15	3
HG-027	N5100-31-H SNAP RING, WALDES	16	1
HD-00-219	7/32" HARD STEEL BALL	17	1
HC-065	6-32 X 3/8 SSS NYLOK	18	1
A371-13-01	VALVE STEM, INTEGRAL	19	1
HJ-2-010	2-010	20	1
A031-04-01	PISTON RETRACTOR	24	1
A031-05-01	PIVOT SLEEVE	25	2
A371-03-01	PUMP ROCKER, INTEGRAL, MACH'D	26	1
A361-11-01	RELIEF VALVE PORT PLUG	28	1
HJ-3-904	3-904	29	1
HC-038	10-32 X 3/16 SSS-CUP POINT	30	2
HJ-2-222	2-222	31	2
HK-8-222	8-222	32	2
A251-08-017	PISTON LOCK PIN -17 3/16 X 1.00	33	1
A251-22C012	STOP BUSHING, LT CYL, .625 -12/-17	34	1
HI-006	18700625 -12/-17 ROD SEAL	35	1
HN-003	D0625 -12/-17 ROD WIPER	36	1
A371-04-01	INTEGRAL PIVOT	37	1
A031-03P03	PUMP PISTON,1/2" LE INTEGRAL	38	1
HM-032	12500250-250B PUMP PISTON SEAL	39	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	40	1
HF-029	M-100 SPRING, DIECO	41	1
A361-13-01	RELIEF VALVE BALL GUIDE	42	1
HD-00-156	5/32" HARD STEEL BALL	43	1
A371-30-01	SPACER, CHECK VALVE, THRU FLOW	44	1
HB-283	4-F50X-SS SAE #4 STRAIGHT	45	1
HB-058	4-BTX-SS NUT	46	2
HB-102	4-TX-SS SLEEVE	47	2
A251-29-017	PISTON, LT CYL -17	48	1
A251-12-017	PISTON BEARING -17	49	2
HM-006	18701375-312B -17 PISTON SEAL	50	1
011-017	1/4 X .035 SEAMLESS 304 TUBE	51	1.685
A371-36L017	ROD, -17 LE INTEGRAL, 13.50 STK	52	1
HB-069	4-CTX-SS ELBOW	53	1
A251-25C017	GLAND, LT CYL, DELRIN .625 -17	54	1
A251-24C012	GLAND BACK UP, DELRIN, .625 -12/-17	55	1
A251-23C017	CAP, LT CYL, .625 -17	56	1
D600-10-193	CLEVIS PIN, 5/8 X 1.93	57	1
HJ-2-124-1	2-124 O-RING BLACK VITON	58	1
A371-33-01	FOAM SPACER, LE INTEGRAL GAGE	59	1
A371-37-017	GAGE COVER -17 LE INTEGRAL	60	1
HJ-2-012	2-012 (CONTAINED IN SEAL/REPAIR KIT)	45a	1

Source File: X:\P\A\A370\LE INTEGRAL\-LE-012.xls

ASSEMBLY NO: A370-LE-017
DESCRIPTION: -17 LE INTEGRAL, 14.25 STROKE

PART NUMBER	DESCRIPTION	ITEM NUMBER	QUANTITY
A090-17-01	LABEL, NAVTEC, .65 X 1.50 (MED)	0	1
A090-21-09	LABEL, RELEASE	0	1
A090-22-01	LABEL, SERIAL	0	1
A371-31-017	BODY, -17 LE INTEGRAL	1	1
HR-015	5/16" WASHER #AN960C516	2	1
A371-14-01	ROCKER PIN, LE INTEGRAL	3	1
A031-19-02	PORT PLUG, HARDCOATED	4	1
A031-02-01	CHECK SPRING	5	2
A031-18-N	O-RING CHECK BOB W/NOSE	6	4
HJ-2-005	2-005	7	2
HJ-3-903	3-903	8	4
A371-32L017	TUBE, -17 LE INTEGRAL, 13.50 STK	9	1
A371-A25	HANDLE ASSEMBLY, LE INTEGRAL	10	1
HD-001	1/8 S.S. BALL	11	1
HC-077-06	MIJA GAGE#1-02252 W/316SS BAC	12	1
A251-01-017	JAW, FLAT REEF -17	13	1
D600-10-240	CLEVIS PIN, 5/8 X 2.40	14	1
D660-0832	COTTER PIN, 5/32 1-1/4	15	3
HG-027	N5100-31-H SNAP RING, WALDES	16	1
HD-00-219	7/32" HARD STEEL BALL	17	1
HC-065	6-32 X 3/8 SSS NYLOK	18	1
A371-13-01	VALVE STEM, INTEGRAL	19	1
HJ-2-010	2-010	20	1
A031-04-01	PISTON RETRACTOR	24	1
A031-05-01	PIVOT SLEEVE	25	2
A371-03-01	PUMP ROCKER, INTEGRAL, MACH'D	26	1
A361-11-01	RELIEF VALVE PORT PLUG	28	1
HJ-3-904	3-904	29	1
HC-038	10-32 X 3/16 SSS-CUP POINT	30	2
HJ-2-222	2-222	31	2
HK-8-222	8-222	32	2
A251-08-017	PISTON LOCK PIN -17 3/16 X 1.00	33	1
A251-22C012	STOP BUSHING, LT CYL, .625 -12/-17	34	1
HI-006	18700625 -12/-17 ROD SEAL	35	1
HN-003	D0625 -12/-17 ROD WIPER	36	1
A371-04-01	INTEGRAL PIVOT	37	1
A031-03P03	PUMP PISTON,1/2" LE INTEGRAL	38	1
HM-032	12500250-250B PUMP PISTON SEAL	39	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	40	1
HF-029	M-100 SPRING, DIECO	41	1
A361-13-01	RELIEF VALVE BALL GUIDE	42	1
HD-00-156	5/32" HARD STEEL BALL	43	1
A371-30-01	SPACER, CHECK VALVE, THRU FLOW	44	1
HB-283	4-F50X-SS SAE #4 STRAIGHT	45	1
HB-058	4-BTX-SS NUT	46	2
HB-102	4-TX-SS SLEEVE	47	2
A251-29-017	PISTON, LT CYL -17	48	1
A251-12-017	PISTON BEARING -17	49	2
HM-006	18701375-312B -17 PISTON SEAL	50	1
011-017	1/4 X .035 SEAMLESS 304 TUBE	51	1.685
A371-36L017	ROD, -17 LE INTEGRAL, 13.50 STK	52	1
HB-069	4-CTX-SS ELBOW	53	1
A251-25C017	GLAND, LT CYL, DELRIN .625 -17	54	1
A251-24C012	GLAND BACK UP, DELRIN, .625 -12/-17	55	1
A251-23C017	CAP, LT CYL, .625 -17	56	1
D600-10-193	CLEVIS PIN, 5/8 X 1.93	57	1
HJ-2-124-1	2-124 O-RING BLACK VITON	58	1
A371-33-01	FOAM SPACER, LE INTEGRAL GAGE	59	1
A371-37-017	GAGE COVER -17 LE INTEGRAL	60	1
HJ-2-012	2-012 (CONTAINED IN SEAL/REPAIR KIT)	45a	1

Source File: X:\P\A\A370\LE INTEGRAL\-LE-017.xls

ASSEMBLY NO: A370-LE-022
DESCRIPTION: -22 LE INTEGRAL, 15.00 STROKE

PART NUMBER	DESCRIPTION	ITEM NUMBER	QUANTITY
A090-17-01	LABEL, NAVTEC, .65 X 1.50 (MED)	0	1
A090-21-09	LABEL, RELEASE	0	1
A090-22-01	LABEL, SERIAL	0	1
A371-31-022	BODY, -22 LE INTEGRAL	1	1
HR-015	5/16" WASHER #AN960C516	2	1
A371-14-01	ROCKER PIN, LE INTEGRAL	3	1
A031-19-02	PORT PLUG, HARDCOATED	4	1
A031-02-01	CHECK SPRING	5	2
A031-18-N	O-RING CHECK BOB W/NOSE	6	4
HJ-2-005	2-005	7	2
HJ-3-903	3-903	8	4
A371-32L022	TUBE, -22 LE INTEGRAL, 13.50 STK	9	1
A371-A25	HANDLE ASSEMBLY, LE INTEGRAL	10	1
HD-001	1/8 S.S. BALL	11	1
HC-077-06	MIJA GAGE#1-02252 W/316SS BAC	12	1
A251-01-022	JAW, FLAT REEF -22	13	1
D600-12-268	CLEVIS PIN, 3/4 X 2.680	14	1
D660-1248	COTTER PIN, 3/16 X 1-1/2	15	3
HG-027	N5100-31-H SNAP RING, WALDES	16	1
HD-00-219	7/32" HARD STEEL BALL	17	1
HC-065	6-32 X 3/8 SSS NYLOK	18	1
A371-13-01	VALVE STEM, INTEGRAL	19	1
HJ-2-010	2-010	20	1
A031-04-01	PISTON RETRACTOR	24	1
A031-05-01	PIVOT SLEEVE	25	2
A371-03-01	PUMP ROCKER, INTEGRAL, MACH'D	26	1
A361-11-01	RELIEF VALVE PORT PLUG	28	1
HJ-3-904	3-904	29	1
HC-038	10-32 X 3/16 SSS-CUP POINT	30	2
HJ-2-224	2-224	31	2
HK-8-224	8-224	32	2
A251-08-022	PISTON LOCK PIN -22 3/16 X 1-1/4	33	1
A251-22C022	STOP BUSHING, LT CYL, .750 -22	34	1
HI-007	18700750 -22 ROD SEAL	35	1
HN-004	D0750 -22 ROD WIPER	36	1
A371-04-01	INTEGRAL PIVOT	37	1
A031-03P03	PUMP PISTON,1/2" LE INTEGRAL	38	1
HM-032	12500250-250B PUMP PISTON SEAL	39	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	40	1
HF-029	M-100 SPRING, DIECO	41	1
A361-13-01	RELIEF VALVE BALL GUIDE	42	1
HD-00-156	5/32" HARD STEEL BALL	43	1
A371-30-01	SPACER, CHECK VALVE, THRU FLOW	44	1
HB-283	4-F50X-SS SAE #4 STRAIGHT	45	1
HB-058	4-BTX-SS NUT	46	2
HB-102	4-TX-SS SLEEVE	47	2
A251-29-022	PISTON, LT CYL -22	48	1
A251-12-022	PISTON BEARING -22	49	2
HM-007	18701625-312B -22 PISTON SEAL	50	1
011-017	1/4 X .035 SEAMLESS 304 TUBE	51	1.802 ft
A371-36L022	ROD, -22 LE INTEGRAL, 13.50 STK	52	1
HB-069	4-CTX-SS ELBOW	53	1
A251-25C022	GLAND, LT CYL, DELRIN .750 -22	54	1
A251-24C022	GLAND BACK UP, DELRIN, .750 -22	55	1
A251-23C022	CAP, LT CYL, .750 -22	56	1
D600-12-230	CLEVIS PIN, 3/4 X 2.30	57	1
HJ-2-124-1	2-124 O-RING BLACK VITON	58	1
A371-33-01	FOAM SPACER, LE INTEGRAL GAGE	59	1
A371-37-022	GAGE COVER -22 LE INTEGRAL	60	1
HJ-2-012	2-012 (CONTAINED IN SEAL/REPAIR KIT)	45a	1

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INTEGRALS

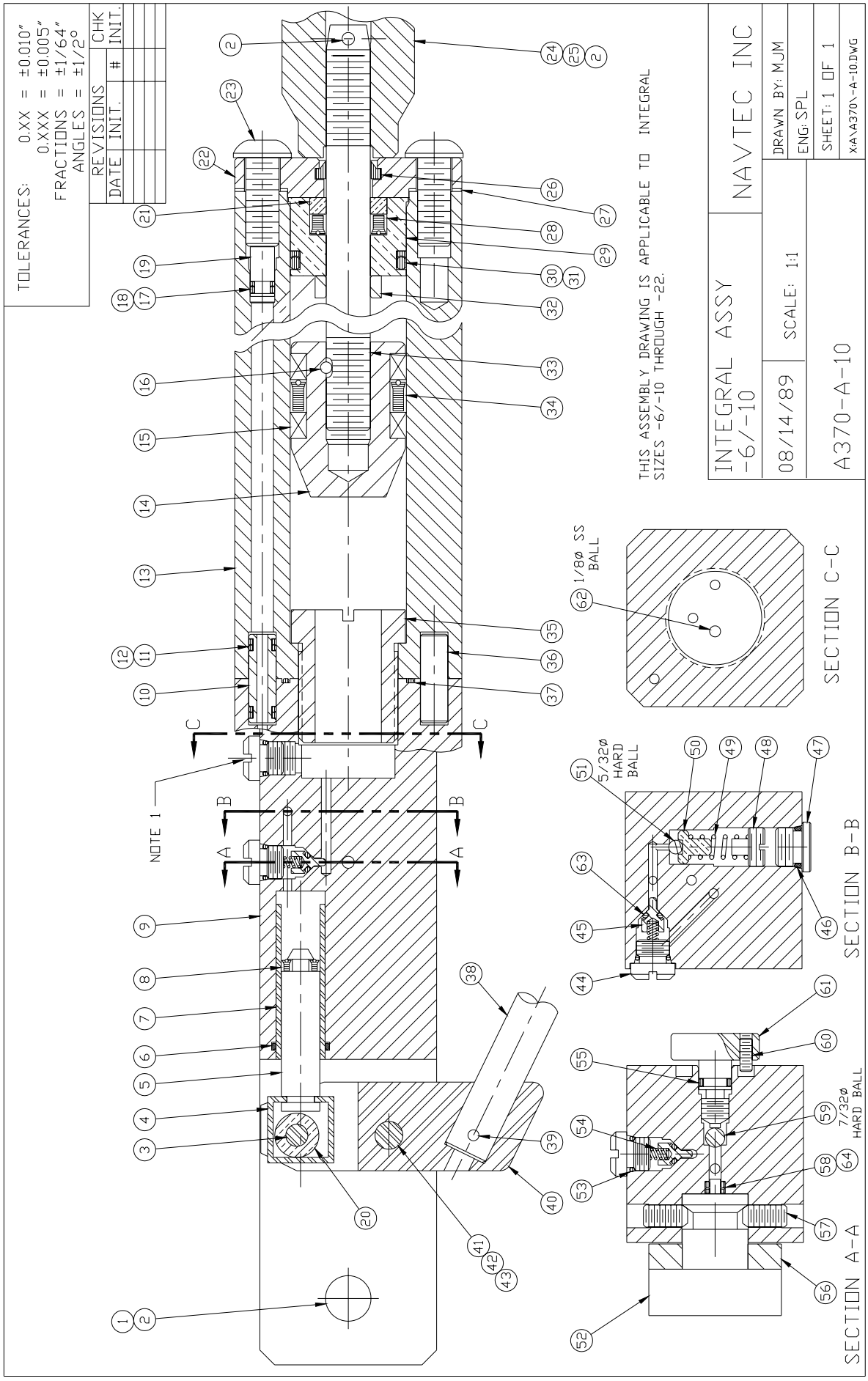
A370 VERSION

Disassembly Procedures:

1. Remove fill port (see note 1) and set integral horizontally to drain fluid.
2. Remove top cap bolts (23), top cap (22) and piston/rod assembly (14, 33).
3. Remove coupler bushing (35) and part cylinder tube from pump body.
4. Remove lower pump rocker assembly (3-5, 40-43), check bob assemblies (44, 45, 63), relief valve assembly (55, 61), relief port plug (47) and gauge (52). Use care not to lose springs/balls. The gauge is removed by loosening the 2 set screws (57).

Rebuilding Procedures:

1. Check cylinder bore for uneven wear or scoring.
2. Cylinder rod should not have any nicks or scratches. Minor scratching can be polished out with fine emery cloth.
3. All parts should be cleaned of dirt and debris and all o-rings and seals should be removed and discarded. Note: Do not score piston during removal or seals and bearings.
4. Remove upper end fitting (24), gland (29), and rod stop bushing (32). Remove the piston locking pin and unscrew the piston rod from the piston.
5. Install new piston seal (34) and lower bearing (15), leaving alignment hole visible, and put assembly aside.
6. Clamp rod horizontally in a non-marring vise with notch in rod facing up, and slide the rod seal pusher tool, rod seal (28), then the sleeve over the rod (in this order). Install the o-ring and backup ring on the gland (30, 31) and slide the gland onto the rod. Firmly squeeze gland and pusher tool together to seat rod seal into gland, and remove sleeve and pusher tools from rod. Install gland backup ring (21).
7. Screw the piston back onto the rod, insert the locking pin (16) and then the upper bearing.
8. Install new o-rings and backups onto the feed tube (11, 12, 17, 18) and new pump body-to-cylinder o-ring (37) and re-install coupler bushing nut. Tighten until gap between tube and pump body is closed.
9. Insert piston/rod assembly and gland assembly into cylinder tube.
10. Insert new rod wiper (26) into cap and re-install using a new cork gasket (27).
11. Install new pump piston seal (8) and re-install pump rocker assembly.
12. Inspect SS relief valve ball for signs of pitting/wear and replace if necessary. Install ball into valve. Install new o-ring (55) and screw relief knob (61) into pump body. Adjust relief knob set screw (60) with valve finger tight.
13. Install new check bob springs and o-rings onto the caps and re-install. Be sure the check bobs seat correctly when inserting into cavity.
14. Inspect relief valve port ball (51) and re-install assembly with new o-ring (46).
15. Install new o-ring and backup (58,64) (be sure the old ones are not left in the body) and install gauge. Note: o-ring faces the pressure side.
16. Fill integral with hydraulic oil, pump to pressure and check for leaks. Release pressure and top off fill port.



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7/22/98 ASSEMBLY NUMBER: A370-A-10 DESCRIPTION: INTERGRAL ASS'Y –6-10

PART NUMBER	DESCRIPTION	ITEM	QTY
A090-22-01	LABEL, SERIAL	0	1
A090-09-010	LABEL, TRANSPARENT-010	0	1
A090-17-01	LABLE, NAVTEC,.65X1.50 (MED)	0	1
A090-21-09	LABLE, RELEASE	0	1
A370-A-10#	DRAWING, INTEGRAL ASSY.-10	0	1
D600-08-206	CLEVIS PIN, 1/2X2.06	1	1
D660-0832	COTTER PINS, 1/8X1	2	3
A371-04-01	INTEGRAL PIVOT	3	1
A031-04-01	PISTON RETRACTOR	4	1
A031-03P01	PUMP PISTON, TYPE VI 7/16"	5	1
HJ-2-015	2-015	6	1
A031-17-01	PUMP LINER, 7/16" BORE	7	1
HM-001	12500187 PIST SEAL - PMP	8	1
A371-01-10	INTEGRAL BODY -10	9	1
A371-16-01	INTG. FEED TUBE COUPLER	10	1
HJ-2-008	2-008	11	2
HK-8-008	8-008	12	2
A371-02-10	INTEGRAL TUBE -10	13	1
A251-29-010	PISTON, LT CYL -10	14	1
A251-12-010	PISTON BEARING -10	15	2
A251-08-010	PISTON LOCK PIN -10 1/8X5/8	16	1
HJ-2-007	2-007	17	1
HK-8-007	8-007	18	1
A371-05-01	FEED TUBE PLUG, INTG.	19	1
A031-05-01	PIVOT SLEEVE	20	1
A251-04C010	GLAND BACKUP, CYL -10	21	1
A031-05-01	PIVOT SLEEVE	22	1
HC-042	3/8-16 X 1 BSHCS SS	23	4
A251-01-010	JAW, FLAT. REEF -10	24	1
D600-08-154	CLEVIS PIN, 1/2X1.54	25	1
HN-002	D0500 -10 ROD WIPER	26	1
A371-10-10	CYL CAP GASKET, INTG. -10	27	1
HI-005	18700500 -10 ROD SEAL	28	1
A251-05C010	GLAND, CYL -10	29	1
HJ-2-215	2-215	30	1
HK-8-215	8-215	31	1
A371-05A10	ROD STOP BUSH, INTG. -10	32	1
A371-06-10	PISTON ROD, INTG. -10	33	1
HM-004	18700937-312B -10 PIST SEAL	34	1
A371-15-10	COUPL. BUSH. INTG. -10	35	1
A371-17-01	INTG. ALIGN. PIN	36	1
HJ-2-028	2-028	37	1
A371-A24	PUMP HANDLE ASSY, INTEGRAL	38	1
D662-000	ROLL PIN	39	1
A371-03-01	PUMP ROCKER,INTG.-MACH'D	40	1
A371-14-10	ROCKER PIN, INTG. -10	41	1
HG-026	N5000-31-H SNAP RING, WALDES	42	1
HR-015	5/16" FLAT WASHER MS811	43	2
A031-19-02	PORT PLUG, HARDCOATED	44	3
A031-18-N	O-RING CHECK BOB W/NOSE	45	2
HJ-3-904	3-904	46	1
A361-11-01	RELEIF VALVE PORT PLUG	47	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	48	1
HF-029	M-100 SPRING, DIECO	49	1
A361-13-01	RELIEF BALL GUIDE	50	1
HD-00-156	5/32" HARD STEEL BALL	51	1
A060-01-00	GAUGE ASS'Y	52	1
HJ-3-903	3-903	53	3
A031-02-01	CHECK SPRING	54	2
HJ-2-010	2-010	55	1
A351-30-00	GAUGE SPACER	56	1
HC-007	1/4-20X1/2 CONE POINT SSS	57	2
HJ-2-006	2-006	58	1
HD-00-219	7/32" HARD CHROME BALL	59	1
HC-065	6-32X3/8 SSS NYLOK	60	1
A371-13-01	VALVE STEM, INTG. & RELEASE VALVE	61	1
HD-001	1/8 SS BALLS	62	1
HJ-2-005	2-005	63	2
HK-8-006	8-006	64	1

7/22/98 ASSEMBLY NUMBER: A370-A-17 DESCRIPTION: INTERGRAL ASS'Y –12-17

PART NUMBER	DESCRIPTION	ITEM	QTY
A090-09-017	LABEL, TRANSPARENT-017	0	1
A090-17-01	LABEL,NAVTEC,.65X1.50 (MED)	0	1
A090-22-01	LABLE, SERIAL	0	1
A090-21-09	LABLE, RELEASE	0	1
A370-A-10#	DRAWING, INTEGRAL ASSY.-10	0	1
D600-10-280	CLEVIS PIN, 5/8X2.80	1	1
D660-1040	COTTER PINS, 5/32X1 1/4	2	3
A371-04-01	INTEGRAL PIVOT	3	1
A031-04-01	PISTON RETRACTOR	4	1
A031-03P01	PUMP PISTON, TYPE VI 7/16"	5	1
HJ-2-015	2-015	6	1
A031-17-01	PUMP LINER, 7/16" BORE	7	1
HM-001	12500187 PIST SEAL - PMP	8	1
A371-01-17	INTEGRAL BODY -17	9	1
A371-16-01	INTG. FEED TUBE COUPLER	10	1
HJ-2-008	2-008	11	2
HK-8-008	8-008	12	2
A371-02-17	INTEGRAL TUBE -17	13	1
A251-29-017	PISTON, LIGHT, -17	14	1
A251-12-017	PISTON BEARING -17	15	2
A251-08-017	PISTON LOCK PIN -17 3/16X1	16	1
HJ-2-007	2-007	17	1
HK-8-007	8-007	18	1
A371-05-01	FEED TUBE PLUG, INTG.	19	1
A031-05-01	PIVOT SLEEVE	20	1
A251-04C012	GLAND BACKUP, CYL -12	21	1
A031-05-01	PIVOT SLEEVE	22	1
HC-001	1/2-13X1-1/2 BSHCS	23	4
A251-01-017	JAW, FLAT. REEF -17	24	1
D600-10-193	CLEVIS PIN, 5/8X1.93	25	1
HN-003	D0625 -12/17 ROD WIPER	26	1
A371-10-17	CYL CAP GASKET, INTG. -17	27	1
HI-006	18700625 -12/-17 ROD SEAL	28	1
A251-05C017	GLAND, CYL -17	29	1
HJ-2-222	2-222	30	1
HK-8-222	8-222	31	1
A251-02C012	ROD STOP BUSH. CYL. -12/-17	32	1
A371-06-17	PISTON ROD, INTG. -17	33	1
HM-006	18701375-312B -17 PIST SEAL	34	1
A371-15-17	COUPL. BUSH. INTG. -17	35	1
A371-17-01	INTG. ALIGN. PIN	36	1
HJ-2-032	2-032	37	1
A371-A24	PUMP HANDLE ASSY, INTEGRAL	38	1
D662-000	ROLL PIN	39	1
A371-03-01	PUMP ROCKER,INTG.-MACH'D	40	1
A371-14-22	ROCKER PIN, INTG. -17 & -22	41	1
HG-026	N5000-31-H SNAP RING, WALDES	42	1
HR-015	5/16" FLAT WASHER MS811	43	2
A031-19-02	PORT PLUG, HARDCOATED	44	3
A031-18-N	O-RING CHECK BOB W/NOSE	45	2
HJ-3-904	3-904	46	1
A361-11-01	RELIEF VALVE PORT PLUG	47	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	48	1
HF-029	M-100 SPRING, DIECO	49	1
A361-13-01	RELIEF BALL GUIDE	50	1
HD-00-156	5/32" HARD STEEL BALL	51	1
A060-01-00	GAUGE ASS'Y	52	1
HJ-3-903	3-903	53	3
A031-02-01	CHECK SPRING	54	2
HJ-2-010	2-010	55	1
HC-007	1/4-20X1/2 CONE POINT SSS	57	2
HJ-2-006	2-006	58	1
HD-00-219	7/32" HARD CHROME BALL	59	1
HC-065	6-32X3/8 SSS NYLOK	60	1
A371-13-01	VALVE STEM, INTG. & RELEASE VALVE	61	1
HD-001	1/8 SS BALLS	62	2
HJ-2-005	2-005	63	2
HK-8-006	8-006	64	1

7/22/98 ASSEMBLY NUMBER: A370-A-22 DESCRIPTION: INTERGRAL ASS'Y –22

PART NUMBER	DESCRIPTION	ITEM	QTY
A090-09-022	LABEL. TRANSPARENT-022	0	1
A090-17-01	LABEL,NAVTEC,.65X1.50 (MED)	0	1
A090-22-01	LABEL, SERIAL	0	1
A090-21-09	LABEL, RELEASE	0	1
A370-A-10#	DRAWING, INTEGRAL ASSY.-10	0	1
D600-12-305	CLEVIS PIN, 3/4X3.05	1	1
D660-1248	COTTER PINS, 3/16X1 1/2	2	3
A371-04-01	INTEGRAL PIVOT	3	1
A031-04-01	PISTON RETRACTOR	4	1
A031-03P01	PUMP PISTON, TYPE VI 7/16"	5	1
HJ-2-015	2-015	6	1
A031-17-01	PUMP LINER, 7/16" BORE	7	1
HM-001	12500187 PIST SEAL - PMP	8	1
A371-01-22	INTEGRAL BODY -22	9	1
A371-16-01	INTG. FEED TUBE COUPLER	10	1
HJ-2-008	2-008	11	2
HK-8-008	8-008	12	2
A371-02-22	INTEGRAL TUBE -22	13	1
A251-29-022	PISTON, LT CYL. -22	14	1
A251-12-022	PISTON BEARING -22	15	2
A251-08-022	PIST LOK PIN -22 3/16X1-1/4	16	1
HJ-2-007	2-007	17	1
HK-8-007	8-007	18	1
A371-05-01	FEED TUBE PLUG, INTG.	19	1
A031-05-01	PIVOT SLEEVE	20	1
A251-04C022	GLAND BACKUP, CYL -22	21	1
A031-05-01	PIVOT SLEEVE	22	1
HC-069	9/16-12 X 1 1/2 BSHCS SS	23	4
A251-01-022	JAW, FLAT. REEF -22	24	1
D600-12-230	CLEVIS PIN, 3/4X2.30	25	1
HN-004	D0750 -22 ROD WIPER	26	1
A371-10-22	CYL CAP GASKET, INTG. -22	27	1
HI-007	18700750 -22 ROD SEAL	28	1
A251-05C022	GLAND, CYL -22	29	1
HJ-2-224	2-224	30	1
HK-8-224	8-224	31	1
A251-02C022	ROD STOP BUSH. CYL -22	32	1
A371-06-22	PISTON ROD, INTG. -22	33	1
HM-007	18701625-375B -22 PIST SEAL	34	1
A371-15-22	COUPL. BUSH. INTG. -22	35	1
A371-17-01	INTG. ALIGN. PIN	36	1
HJ-2-034	2-034	37	1
A371-A24	PUMP HANDLE ASSY, INTEGRAL	38	1
D622-000	ROLL PIN	39	1
A371-03-01	PUMP ROCKER,INTG.-MACH'D	40	1
A371-14-22	ROCKER PIN, INTG. -17 & -22	41	1
HG-026	N5000-31-H SNAP RING, WALDES	42	1
HR-015	5/16" FLAT WASHER MS811	43	2
A031-19-02	PORT PLUG, HARDCOATED	44	3
A031-18-N	O-RING CHECK BOB W/NOSE	45	2
HJ-3-904	3-904	46	1
A361-11-01	RELEIF VALVE PORT PLUG	47	1
A361-12-01	RELIEF VALVE ADJUSTING SCREW	48	1
HF-029	M-100 SPRING, DIECO	49	1
A361-13-01	RELIEF BALL GUIDE	50	1
HD-00-156	5/32" HARD STEEL BALL	51	1
A060-01-00	GAUGE ASS'Y	52	1
HJ-3-903	3-903	53	3
A031-02-01	CHECK SPRING	54	2
HJ-2-010	2-010	55	1
HC-007	1/4-20X1/2 CONE POINT SSS	57	2
HJ-2-006	2-006	58	1
HD-00-219	7/32" HARD CHROME BALL	59	1
HC-065	6-32X3/8 SSS NYLOK	60	1
A371-13-01	VALVE STEM, INTG.	61	1
HD-001	1/8 SS BALLS	62	0
HJ-2-005	2-005	63	2
HK-8-006	8-006	64	1

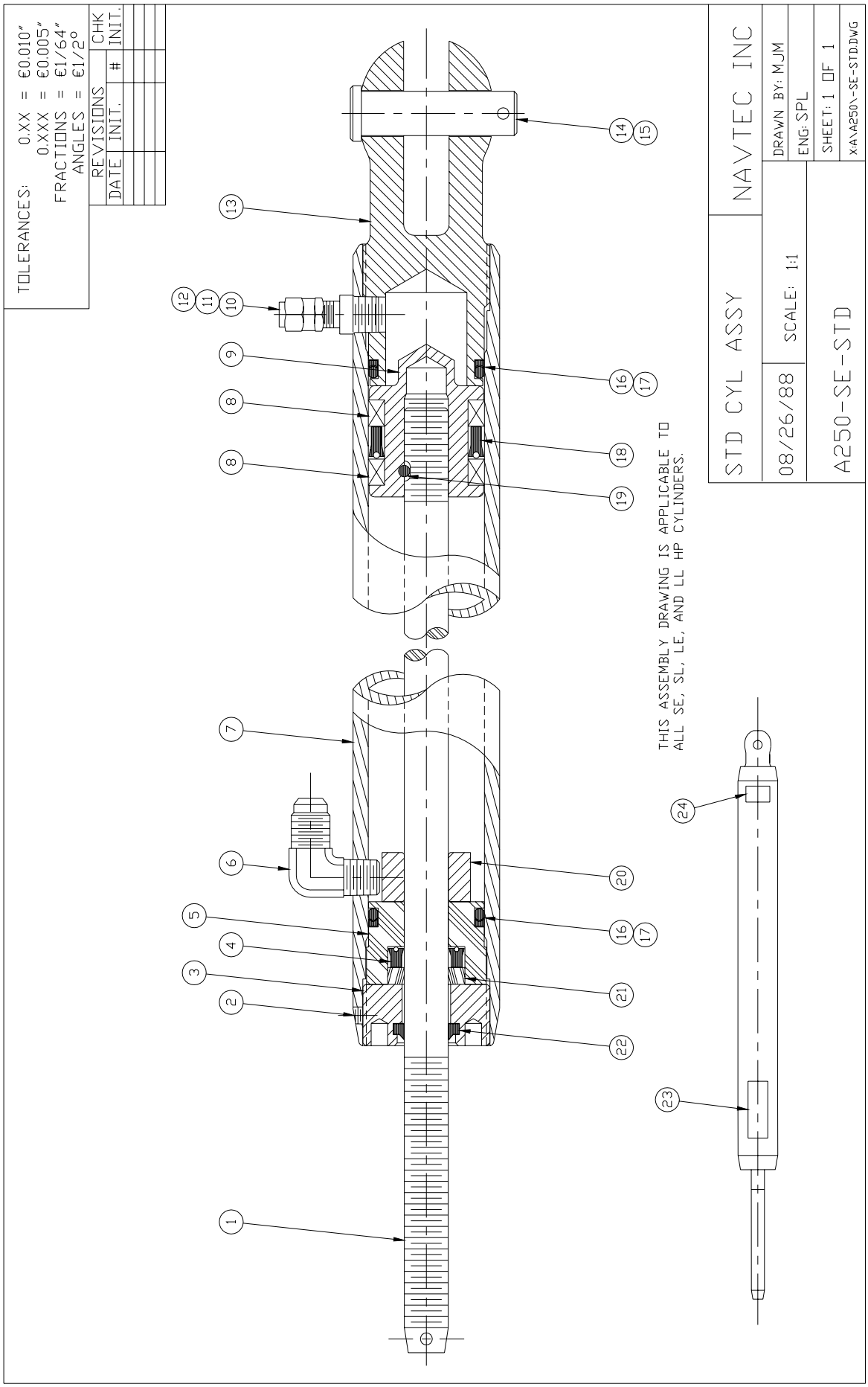
CYLINDERS

Disassembly Procedures:

1. Remove upper end fitting from rod (if applicable) and release air from cylinder by depressing Schrader valve (10, 11, 12).
2. Remove Schrader valve core (11), then remove valve stem (12)
3. Tap rod on ground to be sure pressure is relieved. If rod returns, check for blockage in valve stem port which will not allow the air to be removed.
4. Remove oil port fitting (6) from cylinder body.
5. Once you are sure the air pressure is relieved, remove cylinder cap set screw (2) and unscrew cylinder cap (3) using proper spanner wrench.
6. Drain any remaining oil and pull rod assembly from cylinder tube. Note: If cylinder is fully extended, there is no oil in tube.
7. Remove Schrader valve body from clevis (13), and remove clevis from tube.

Rebuilding Procedures:

1. Check cylinder bore for any uneven wear or scoring.
2. Cylinder rod should not have any nicks or scratches. Minor scratching can be polished out with fine emery cloth.
3. All parts should be cleaned of dirt and debris and all O-ring, bearing and seals should be removed and discarded. Note: Do not score piston during removal of seals and bearings.
4. Remove gland (5), and rod stop bushing (20). Remove the piston locking pin (19) and unscrew the piston from the rod.
5. Install the piston seal and lower bearing (18, 19), leaving alignment hole visibly, and put the assembly aside.
6. Clamp the rod horizontally in a non-marring vise with notch in rod facing up, and slide the rod seal pusher tool, rod seal (4), then sleeve tool over the rod (in this order). Install the O-rings on gland (16, 17) and slide gland onto rod. Firmly squeeze gland and pusher tool together to seat rod seal into gland, and remove sleeve and pusher tools from rod and install rod stop bushing (20), and gland backup ring (21).
7. Screw piston back onto rod, insert the locking pin, and install the upper bearing.
8. Using shim stock to cover oil fitting hole, insert piston/rod assembly and gland assembly into cylinder tube.
9. Install new wiper seal (22) into cylinder cap and re-install. Re-install rod cap set screw (2).
10. Install new O-ring and backup (16, 17) onto lower clevis (13) and screw into tube, centering the air valve hole with the cylinder tube hole.
11. Re-install the Schrader valve assembly (10, 11, 12) and oil fitting (6), using Teflon tape on the threads.
12. Charge the cylinder Schrader port with approximately 100 psi air pressure.



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4/22/98 ASSEMBLY NUMBER: A370-SE-012 DESCRIPTION: E CYL. ASS'Y, STD –12

PART NUMBER	DESCRIPTION	ITEM	QTY
A250-SE-012	DWG. E CYL. -12S	0	1
A251-37-012	PIST ROD C CYL, -12/-17S	1	1
HC-0381	10-32X3/16 SSS - CUP POINT	2	1
A251-23C012	CAP, LIGHT CYL. .625 -12	3	1
H1-006	18700625 -12/-17 ROD SEAL	4	1
A251-35C012	GLAND, LIGHT CYL. .625 -12	5	1
HB-069	4-CTX-SS ELB	6	1
A251-26-012	TUBE, LIGHT CYL. -12	7	1
A251-12-012	PISTON BEARING -12	8	2
A251-29-012	PISTON, LIGHT CYL. -12	9	1
HC-073	2525 SCHR- VLV CAP	10	1
HC-072	9914A SCHR VLV CORE	11	1
HC-071	9166 - 1 SCHR VLV STEM, BRS	12	1
A251-30-012	CLEVIS, LIGHT CYL. -121	13	1
D600-10-175	CLEVIS PIN, 5/8 X 1.75	14	1
D600-1040	COTTER PINS, 5/32 X 1 1/4	15	1
HJ-2-218	2-218	16	2
HK-8-218	8-218	17	2
HM-005	18701125-312B - 12 PIST SEAL	18	1
A251-08-012	PIST LOCK PIN -12 3/16X3/4	19	1
A251-22C012	STOP BUSH D-GLND. CYL. -12/-17	20	1
A251-24C012	GLAND BKUP -DELRIN, CL. -12/-17	21	1
HN-003	DO625 -12/17 ROD WIPER	22	1
A090-16-01	LABEL, NAVTEC. 90X2.40 (LG)	23	1
A090-19-01	LABEL, DANGER, W/SER.NO.	24	1

DISASSEMBLY OF CYLINDERS

WARNING WARNING WARNING WARNING WARNING WARNING

Disassembly of any pressurized vessel can be dangerous or fatal if the pressure has not been released before disassembly. Assume all Navtec vangs and cylinders are pressurized vessels and handle them accordingly. Be certain that the high pressure gas used to make the vang or cylinder self-extending is completely discharged before beginning disassembly. Also, disconnect the cylinder or vang from the hydraulic systems and disconnect it mechanically from its end mountings.

IF YOU HAVE ANY DOUBT OR QUESTIONS, PLEASE CALL NATVEC.

Depressurization

Cylinders are depressurized by removing the yellow cap on the valve at the clevis end, depressing the valve stem, and waiting for the gas to fully escape. The fitting is very similar to a standard automobile tire valve. After the gas stops escaping, it is a good idea to remove the core from the valve body. Alternatively the valve body can be removed from the clevis body. Note: Teflon tape and care is required to get a good seal when reassembling the body in the clevis body.

Confirming Depressurization

To be sure the cylinder is fully depressurized, with it disconnected from the hydraulic system, tap the rod into the cylinder several inches. More gas should be heard escaping as the rod is tapped into the cylinder. If the rod pushes back out, the cylinder or vang is not fully depressurized and further attempts must be made to allow the gas to escape.

> Note: If the rod is bent or damaged and does not move easily into cylinder, this test cannot be used and other tests are necessary. Removal of the "tire" type valve body from the clevis assures that the gas end of the cylinder is depressurized. But, be sure that the passage below the valve port into the cylinder tube is not blocked.

Disassembly - Cautions

When disassembling either end of a cylinder, be sure that the tube is well clamped and that the end being disassembled is not pointed toward anyone. Treat it as you would a gun barrel. The clevis end of a cylinder should unscrew easily - strong resistance when it is nearly unscrewed may well indicate gas pressure remaining inside. When unscrewing the rod end cap, the rod should not follow the cap out as you unscrew it. If it does, this probably indicates internal pressure. If it is difficult to unscrew, either end and all efforts to depressurize it indicate that it is depressurized, aim the end being disassembled into a suitable backstop such as a barrel full of rags and hold the spanner or tool being used to unscrew it in such a manner that if there is in fact pressure, the tool and cylinder parts will leave your hand without injury to you and fly into the backstop.

IN GENERAL, BE CAREFUL. IF YOU HAVE ANY QUESTIONS, PLEASE CALL NAVTEC FOR ADVICE.

CYLINDER TROUBLESHOOTING

Navtec cylinders are pressurized and can fire their rods when disassembled if not depressurized! Many special tools are required to successfully service Navtec hydraulics. These tools are available only from Navtec and must be used by your authorized Navtec Hydraulic Service Center. There is little chance of fixing your hydraulic system yourself, so please avoid doing more damage to your system and possible yourself by calling the nearest Navtec agent for help.

A cylinder consists of several components: a tube, a piston, a piston rod, piston seals and bearings, rod seal and rod wiper, and a gland which guides the rod and contains the rod seal. Most problems arise from the rod being damaged. Any scratch you can feel with your fingernail is bad enough to warrant fixing the rod. This is because the rod cycles back and forth past the seal and wiper and any roughness will abrade the seal and cause leakage. Replacing the seal will be a very temporary fix. The seals rarely fail unless they are torn up by the surfaces they run on or unless some incompatible oil such as brake fluid is used. Similarly, if the piston seals give out a very careful inspection of the bore should be done.

Pressure loss during use does not necessarily indicate a cylinder problem. A loose fitting which leaks even a tiny amount of oil can be responsible for major pressure loss. The pump is also suspect, as are the control valves. Your Navtec service center can test all of these components for you.

PROBLEM	CAUSE	SOLUTION
Pressure Loss	Bad Valve	Isolate and test each item
Pressure Loss	Loose Fitting	Look for leakage, tighten as required
Pressure Loss	Piston or Rod Seal	Inspect bore and rod, replace if required, and replace seal
Minor Scratch on Rod	Dirt, etc.	Sand with 600 grit and oil, blend carefully
Cylinder Jerks while being bumped	Air in cylinder or hydraulic lines	Bleed cylinder and lines

VANGS

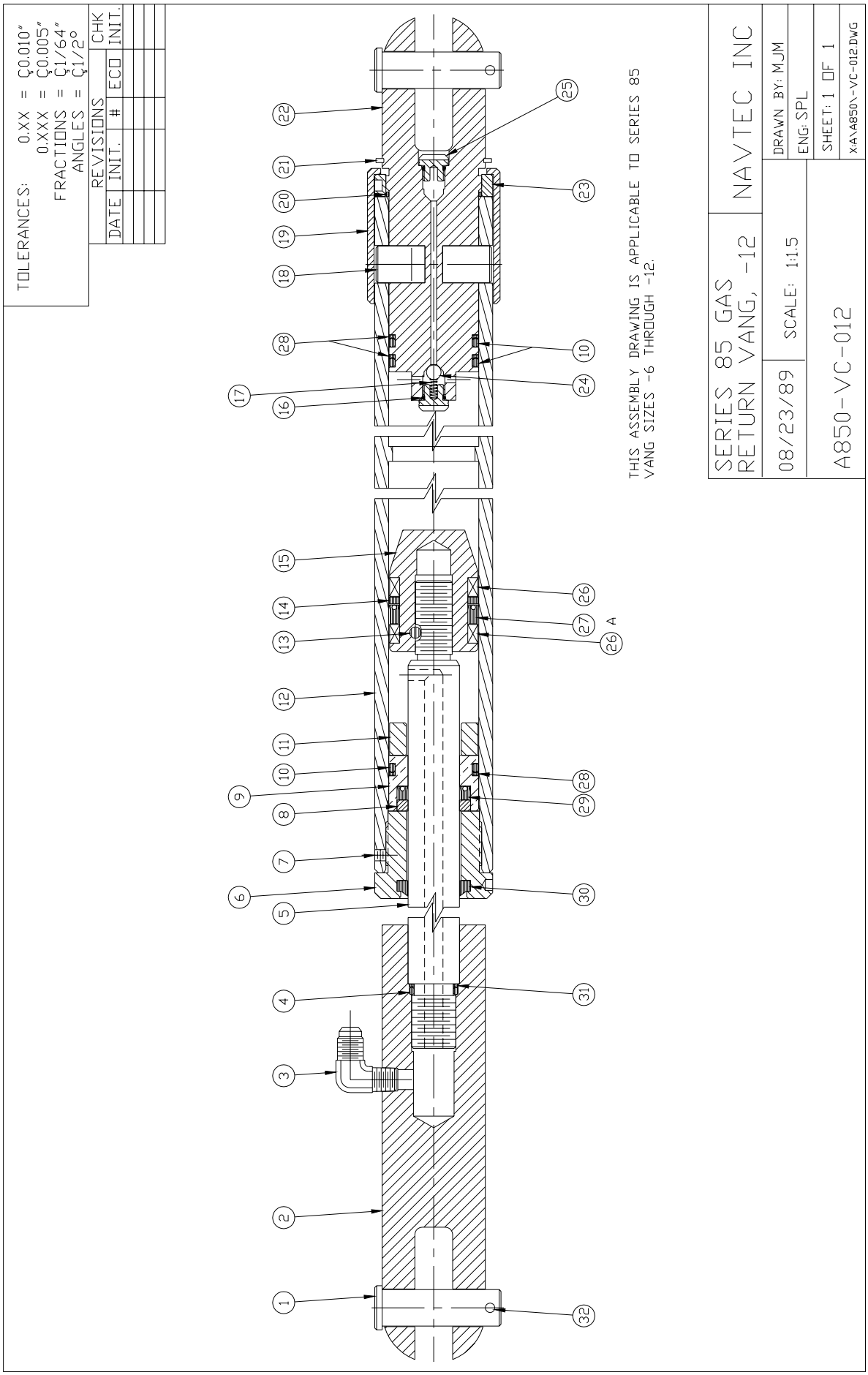
Disassembly Procedures:

WARNING: VANG IS CHARGED WITH HIGH PRESSURE. PLEASE READ AND FOLLOW DISASSEMBLY PROCEDURES CAREFULLY

1. Remove SAE valve port plug (25), insert vang discharging tool into valve and discharge gas. (See depressurizing procedures).
2. It is very important to be sure gas is completely discharged before proceeding, Vangs are potentially lethal if disassembled while charged.
3. Carefully remove retaining ring (21). Remove vang sleeve (19). This is siliconed on and you may need a torch to heat up the sealant and remove the sleeve. Note: Be sure oil jaw end is facing down at approximately a 45 degree angle.
4. Back off retaining nut (23) a few turns.
5. Remove tube pins (18). These can be a tight fit, if so use compressed air and blow into the plug crevice to dislodge pin. Note: If tube pins are extremely tight, this may be a sign the vang is still charged. Re-check that the vang is discharged. If all the gas has been removed, you may have to drill and tap to pull the pins out.
6. Once pins are removed, pull gas clevis (22) out of vang extension tube. Drain oil from tube into cup. This can be re-used upon assembly.
7. Fasten vang tube (-17 or larger size vangs) in non-marring vise and use a strap wrench to unscrew the extension tube (see drawing A850-VC-030 attached).
8. Unscrew oil jaw (2) while the rod is still installed in the tube. The jaw is installed with locktite, so heat will be necessary to soften the locktite. (Jaw can be re-installed to facilitate removal of piston/rod assembly).
9. Remove tube cap set screw (7) and unscrew tube cap (6).
10. Drain any remaining oil and pull rod assembly from vang tube.

Reassembly Procedures:

1. Check cylinder bore for any uneven wear or scoring.
2. Cylinder rod should not have any nicks or scratches. Minor scratches can be polished out with fine emery cloth.
3. All parts should be cleaned of dirt and debris and all O-rings and seals should be removed and discarded. Note: Do not score piston during removal of seals and bearings.
4. Remove gland (9) and rod stop bushing (11). Remove piston locking pin and unscrew piston from the rod.
5. Using the piston seal pusher and seal mounting nose (if required) tools, install the lower bearing, piston seal, and pip ring (27,14,26A), leaving the alignment hole visible, and screw the assembly onto the piston rod. Insert locking pin (13), and install upper piston bearing (26).
6. Oil the piston and seals with 80/90 weight gear lube, and with the appropriate piston insertion tool, insert assembly into tube using a soft head dead blow hammer and drive the assembly ¼ the way into the tube.
7. Slide rod stop bushing onto rod (11) following into tube. Place gland (9) on rod so large hole is facing out (toward oil jaw) and slide on rod seal insertion sleeve tool, then rod seal (29) with O-ring facing gland (8), and rod seal pusher tool (in this order), Place all 4 items together and firmly squeeze together to seat the rod seal into the gland.
8. Remove tooling, reinstall pusher onto rod. Oil gland seals (10,28) and use pusher to insert gland into tube. Install new wiper (30) into tube cap (6) and re-install cap and set screw.
9. Install oil jaw onto rod without the O-ring and backup installed and tighten till jaw “bottoms out”. Mark the rod at the oil jaw with the marker.
10. Remover oil jaw, install O-ring, locktite the threads and install the oil jaw until it bottoms out at your mark.
11. Install and oil new O-rings and screw extension tube back onto vang tube, then tighten set screw, Note: Once installed do not twist.
12. Tilt vang back into 45 degree position (with oil jaw facing down) and put oil back into tube. Amount of oil varies with vang size use approximately 2 ounces less than vang size. Example: –22 vang = 20 oz oil, -30 vang= 28 oz. oil. Install O-rings on gas clevis and insert into extension tube.
13. Re-install tube pins and tighten locknut with spanner type wrench.
14. Coat lower end with silicon to just past the tube pins and slide vang sleeve over clevis.
15. Re-install spiral lock rings.
16. Insert vang charging tool and carefully charge vang with nitrogen to 600 psi. When vang charging tool is removed the SAE valve may leak slightly. The port plug is designed to seal against such small leaks (see pressurizing procedure).



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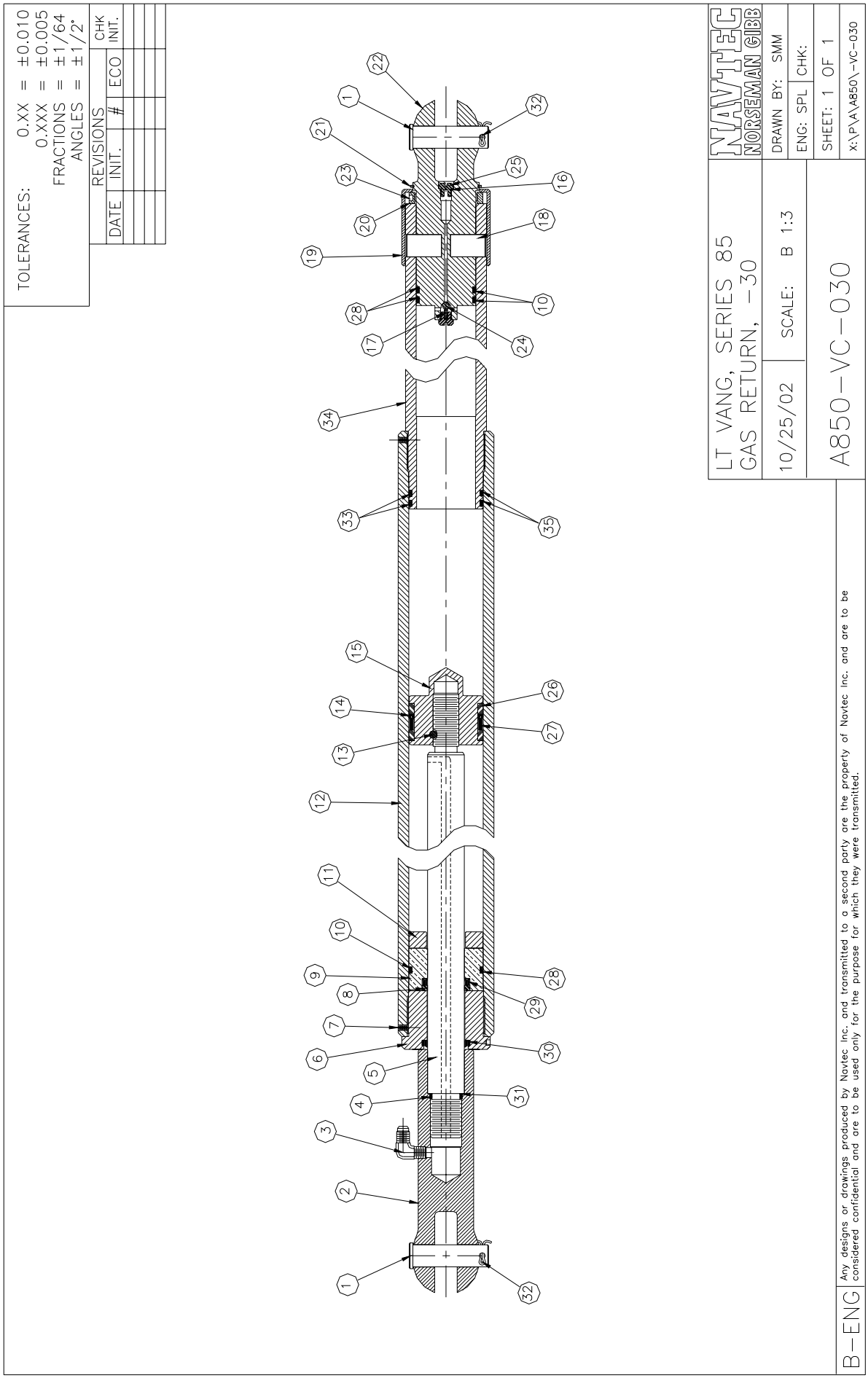

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4/10/02 ASSEMBLY NUMBER: A850-VC-012 DESCRIPTION: VANG ASS'Y-12

PART NUMBER	DESCRIPTION	ITEM	QTY
A090-16-01	LABEL,NAVTEC,.90X2.40 (LG)	0	1
A090-19-01	LABEL,DANGER, W/SER.NO.	0	1
A850-VC-012#	DWG, VANG ASSY, -12	0	1
D600-10-175	CLEVIS PIN, 5/8X1.75	1	2
A851-01-012	OIL JAW, VANG -12	2	1
HB-069	4-CTX-SS ELB.	3	1
HJ-2-114	2-114	4	1
A851-07-012	ROD, VANG -12	5	1
A251-03V012	CAP, VANG -12	6	1
HC-038	10-32X3/16 SSS-CUP POINT	7	1
A251-04C030	GLAND BACKUP, CYL. -30	8	1
A251-05V012	GLAND, VANG -12	9	1
HJ-2-218	2-218	10	3
A251-02V012	ROD STOP BUSH. VANG -12	11	1
A851-06-012	TUBE, VANG -12	12	1
A251-08-012	PISTON LOCK PIN -12 3/16X3/4	13	1
HL-003	18701125 -12 PIP RING	14	1
A251-29-012	PISTON, LIGHT CYL. -12	15	1
HJ-3-903	3-903	16	2
A031-02-01	CHECK SPRING	17	1
A851-10-012	TUBE PIN, VANG -12/17	18	2
A851-08-012	SLEEVE, VANG -12/17	19	1
HJ-2-029	2-029	20	1
HG-014	SPIRS175S -12/-17V RET RING	21	1
A851-05-012	PRES CLEVIS,FOR -12&-17 VANG	22	1
A851-09-012	LOCK NUT, FOR -12&-17 VANG	23	1
HD-00-250	1/4" HARD STEEL BALL	24	1
A031-19-02	PORT PLUG, HARDCOATED	25	2
A251-12-012P	PIST BEAR/PIP RING -12	26	2
HM-005	18701125-312B -12 PIST SEAL	27	1
HK-8-218	8-218	28	3
HI-008	18700875 -30 ROD SEAL	29	1
HN-005	D0875 -30 ROD WIPER	30	1
HK-8-114	8-114	31	1
D660-1040	COTTER PINS, 5/32X1 1/4	32	2

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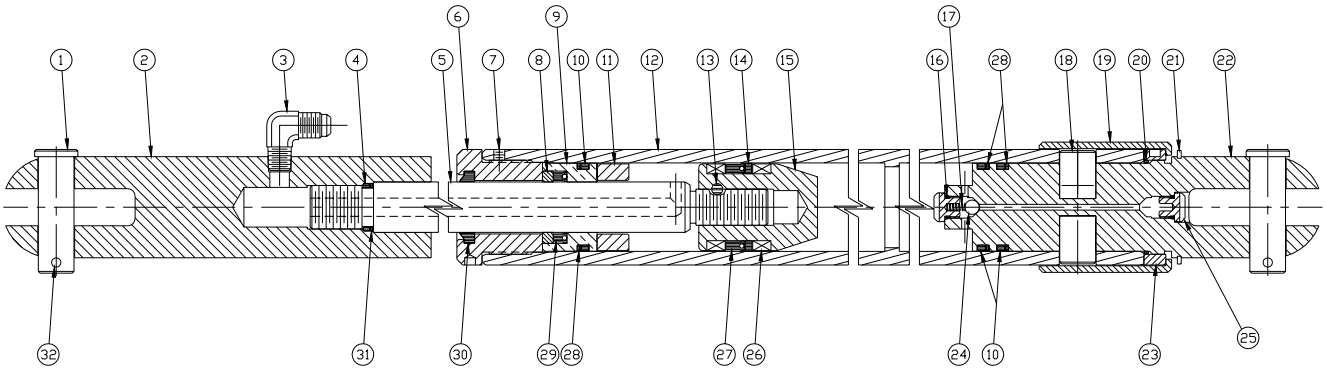
SERIES 85 VANG - DEPRESSURIZING

WARNING: USE EXTREME CAUTION.
THE VANG IS SHIPPED CHARGED WITH 600 PSI PRESSURE.

At no time should anyone be in line with the clevis end of the vang. Treat as you would a gun barrel.

1. Place the vang in a vise with the rod end tilting down.
2. Slowly unscrew the port plug in the clevis jaw (see #25 in drawing 85A). If you hear gas escaping, stop until hissing stops. Then continue until port plug is fully removed.
3. Remove the ¼ - 20 screw from the discharge tool body.
4. Screw discharge body into the port.
5. Insert 3/32 rod into the discharge tube.
6. Screw the ¼ - 20 screw into the body until it causes the check valve (#17 on drawing) to unseat and vang completely discharges.
7. Leave the depressurization too engaged while disassembling the vang.

DRAWING 85A



THIS ASSEMBLY DRAWING IS APPLICABLE TO SERIES 85 VANG SIZES -6 THROUGH -12.

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SERIES 85 VANG - PRESSURIZING

Pressurize the vang or increase the pressure as follows:

1. Determine the desired vang return force reading the required gas pressure from Table B. The maximum gas pressure is 1000 psi.

2. Remove the port plug from between the clevis jaws (already removed if the vang has been shortened). See #2 under Depressurizing Instructions.

3. Be sure the vang is fully extended. (If not, it will extend suddenly when pressurized).

4. Screw the charging tool into the port and connect the charging systems.

5. Crack the valve on the nitrogen cylinder to allow nitrogen to fill the vang slowly. Close the nitrogen valve when the desired pressure is reached. (Argon, which is readily available in welding shops, is also acceptable). Do not use oxygen.

6. Keeping the piston rod end down, detach the hose from the charging tube, slowly at first, then quickly, until depressurization of the hose is complete. Pressure is maintained by a check valve, but there may be a small amount of leakage until the port plug is in place.

7. Remove the charging tool and re-insert the prot plug. Charge is now complete.

8. Check for leaks.

TABLE B – GAS PRESSURE REQUIRED FOR VARIOUS VANG RETURN FORCES

	Cylinder	Theoretical Return Force Desired (LB)					
Size	Area (in)	300	500	1000	2000	3000	4000
-6	.785	382	637	1273*	N.A.	N.A.	N.A.
-10	1.352	222	370	740	1079*	N.A.	N.A.
-12	1.827	164	274	547	1094*	N.A.	N.A.
-17	2.474	121	202	404	808	1213*	N.A.
-22	3.221	93	155	310	621	931	1242*
-30	4.065	72	123	246	492	738	948
-40	7.211	42	138	138	277	416	554

*Pressures over 1000 shown for interpolation purposes only. Navtec does not recommend pressures exceeding 1000 psi

SERIES 85 VANG – TESTING RETURN FORCE

To test vang return force, disconnect from the boom (if installed) and determine from the gage the pressure required to move the rod (which is the pressure required to overcome the return force). With this observation and the vang size, you can then determine the theoretical return force (ignoring friction) from Table C.

TABLE C – RETURN FORCE VS RETURN PRESSURE

		GAUGE PRESSURE (PSI)					
SIZE	PISTON AREA (in2)	300	500	750	1000	1500	RETURN FORCE (LB)
-6	.479	144	239	359	479	719	
-10	.910	273	455	683	910	1365	
-12	1.225	368	613	919	1225	1838	
-17	1.689	507	845	1267	1689	2534	
-22	2.435	731	1218	1826	2435	3653	
-30	3.280	984	1640	2460	3280	4920	
-40	5.983	1795	2292	4487	5983	8975	

Positioning Indicating (PI) Vang

WARNING: It is strongly recommended that Navtec repair all PI Vangs. These instructions are only provided as a last resort when servicing by Navtec is unavailable. Performing these repairs may compromise the functionality of the product.

Disassembly:

1. Depressurize the push end (and pull end if necessary) of the vang.
2. Unscrew the electrical connector and cut the wires near the plug. Push the wires into the port and be sure they will pull through inside as the internal assembly is pulled out the other end.
3. Remove the anchor locating plug on the outside of the cylinder tube.
4. Unscrew the rod cap and slide it up the rod.
5. Carefully pull the piston rod and piston assembly out of the tube. Be careful that it does not drop down as it comes out and damage the PI assembly attached to the end of the piston. It is important to keep the piston assembly aligned with the bore until the PI assembly is disconnected from the piston.

   NOTE: It will take a large force to pull the piston out (300-600 pounds). It is necessary to provide some fairly stiff mechanical pulling mechanism such as a hydraulic cylinder or lead screw puller to smoothly remove the piston assembly. If the piston is pulled out with a slide hammer or other impact or jerky method the seal and especially the PI mechanism may be damaged. Do not push it out with hydraulic pressure from the push end of the cylinder.
6. Disconnect the delrin link from the PI adapter cap on the end of the piston. This is done by removing the cross pin in the cap. Keep in end of the PI assembly centered in the tube to avoid bending it.
7. Gently pull the PI assembly from the end of the tube. If the anchor disk does not come easily out of the tube it may be necessary to remove the extension tube to allow access to the anchor end of the PI assembly. In this case, the PI assembly can be taken out of either end of the cylinder tube. The PI assembly can be pulled apart (slider comes off transducer bar) but great care must be used. Do not force it if it does not come very easily! Note that while the cylinder assembly is very robust and heavy and large forces are needed in its disassembly, the PI assembly is very light and delicate and can be very easily damaged.
8. Disassembly of piston assembly:

   A. Oil jaw removal: As this is secured with loctite it must be heated to moderate temperature (350 F or so) to release the loctite. It can then be unscrewed from the rod.

   B. Piston removal:

      1. Remove piston bearing nearest rod.
      2. Remove lock pin under piston bearing.
      3. Unscrew piston from rod.

   C. Piston seal removal:

      Generally the piston seal and pip rings cannot be removed without destroying them. They can be cut off the piston but it is very important not to mark or scratch the seal surface (OD of groove where the seal lips reside) or the new seal will leak. One method is to move the seal to the end of the groove so that the seal is in the area where the bearing was before it was removed. The seal can then be carefully cut over a part of the piston where the seal does not normally rest.

      For the -110 size, it may be possible to work the seal over the rod end of the piston using smooth ended stretching tools. Again it is very important not to scratch the seal surface on the piston.

Reassembly:

NOTES: It is extremely important to keep all components clean during assembly.

Special attention should be paid to sealing components to ensure that they do not have nicks or scratches. Do no use seals that have visible nicks or scratches on or near their contacting surfaces.

Threads between mating stainless steel parts are to be coated with molybdenum disulfide before assembly unless these parts are to be locked together with loctite. Aluminum threaded components and the threads of mating parts of dissimilar metals should be lightly coated with hydraulic oil prior to assembly.

1. Assemble the position indicating assembly including the delrin link at one end and the anchor disk and wires at the other end:

   A. The tapped hole in the cylinder tube, which accommodates the anchor locating plug, must be completely de-burred on the ID of the tube. To do this generally requires the use of a die grinder.

   B. Verify that both the aluminum mounting anchor and the round delrin centering support fit inside the tube properly. Both pieces should slide inside the tube without significant resistance and without significant perceptible radial play. They must pass by the hole for the locating plug mentioned in A.

   C. The position sensor is shipped with the sliding contact assembly already in place on the I-beam rod. The slider is retained on the I-beam with an o-ring. Remove the o-ring and discard it. Remove the sliding contact assembly and carefully set it aside.

   D. Feed the position sensor's electrical leads through the center hole in the aluminum mounting anchor and seat the end of the position indicator into the hole's counterbore. Slide a wave washer, then a flat washer, and finally a snap ring over the I-beam and down into the mounting anchor recess. **Make certain that the snap ring is fully engaged in its groove.**

   E. Install the sliding contact assembly into the end of the aluminum cover tube – making absolutely certain that the small copper fingers inside the sliding contact assembly point in (towards the far end of the tube. **The assembly will be destroyed if installed backwards!** Position a flat washer, a wave washer, a flat washer, and finally a snap ring into the recess to secure the contact assembly in the end of the aluminum cover tube. **Make certain that the snap ring is fully engaged in its groove.**

   F. Slide the round delrin centering support over the end of the aluminum cover tube. Secure support on aluminum tube with a spiral retaining ring.

   G. Slide the cover tube over the position indicator's I-beam being very careful to guide the end of the I-beam into the sliding contact assembly.

   H. Cut appropriate lengths of black, brown, and blue lead wires to extend the position sensor leads to about one foot beyond the cylinder's clevis end. (Use high quality - silver coated fine stranded wire with Teflon insulation). After sliding lengths of heat shrink tubing over each wire; strip, splice, and solder the lead wires to the new longer wires. Center the heat shrink tubing pieces over the splices and shrink in place with a heat gun.

   DO NOT USE ELECTRICAL TAPE!

   NOTE: Connect the leads as follows:

Position Sensor Lead	→	Extension Wires
Black	→	Black
Red	→	White
Blue	→	Red

2. Slide the entire position indicating sub-assembly into the back end of the cylinder tube. Carefully push the sub-assembly through until the delrin link protrudes from the rod end of the cylinder tube. Verify that the position indicating sub-assembly slides past the tapped hole near the center of the tube without hanging up or snagging. If any resistance is noticed as the assembly slides up to and past the tapped hole - the position indicator should immediately be removed and the hole de-burred. Temporarily install the PI lock port plug in the tube wall when the position indicator is located in the tube as described.

3. Assemble the piston, piston seal, pip ring, piston rod, lock pin, and piston bearings.

A. Gas return vang: Install the piston seal and PIP ring with the seal lips facing toward the gas side of the cylinder (away from the rod).

B. Push-pull vang: Install the piston seal and PIP ring with the seal lips toward the piston rod (standard cylinder mode).

4. Install the PI adapter cap on the piston. Note that the piston must be drilled to provide shallow recesses for the two setscrews, which lock the adapter cap in place. Use Loctite to secure the setscrews holding the adapter cap on the end of the piston.

5. Holding the piston assembly in alignment with the bore, just outside the cylinder tube, connect it to the delrin link on the end of the PI assembly. The delrin link is locked in place by a pin, which is captured by a 1/16 npt plug. Grease the plug but do not use teflon tape. Tighten the npt plug moderately. Note that it is very important to keep the piston assembly aligned with the PI assembly during installation of the piston assembly. Failure to do so will result in the PI assembly being bent and destroyed.

NOTE: Clean hydraulic oil should be used to lubricate parts as they are assembled in the steps to follow (Steps 5-8).

6. Insert the piston assembly into the cylinder tube being careful to push it in smoothly keeping it aligned with the tube bore. The standard vang assembly special tools are required to protect the piston seal as it enters the tube:

   A. Gas return vang: You must use the piston seal insertion tools for a boom vang due to the forward facing seal lips on a standard vang.

   B. Push-pull vang with the pull oil fitting in the tube wall: You must use a piece of 0.002" shim stock against the tube wall to cover the fitting hole inside the tube to prevent the seal lip from damage as it passes the fitting hole. The shim stock strip should protrude outside the tube end where it can be held to prevent it from moving into the tube with the piston. Push the piston past the shim strip and remove the shim stock. Do not push the piston any further into the tube than necessary.

      NOTE: It takes considerable force to push the piston with its seals into the cylinder tube. To protect the seals and PI assembly this push must be smooth - IT CANNOT BE HAMMERED IN !! The force is probably in the range of 300-600 pounds and must be done using a hydraulic cylinder, lead screw, or some other fairly stiff mechanical driving mechanism.

7. Install the stop tube and gland with its outside o-ring and backup ring into the cylinder tube.

8. Using the rod seal tools, install the piston rod seal. The seal lips should face the pressure inside the tube.

9. Install the rod seal backup ring and the cylinder cap and lock the cap with the setscrews.

10. Remove the anchor lock plug from the outside of the tube and reach inside the cylinder tube from the back end and carefully pull the anchor further out of the tube until the groove in the outside of the anchor disk lines up with the port in the outside of the tube and install the lock plug. Be very careful not to pull the anchor disk too far out (beyond the final location) as this may disengage the PI assembly. If this happens, the PI system must be removed, and the entire piston assembly and the half of the PI assembly attached to it must be removed before the PI assembly can be re-engaged.

11. Where extension tubes are used: Pull the wires through the extension tube and screw the extension tube into the cylinder tube and assemble and tighten the locking collets at the joint.

12. Pull the wires through the clevis. Rotate the clevis counter-clockwise approximately a number of turns equal to the number of threads on the clevis. Then screw the clevis into the extension tube. By doing the counter rotation before screwing the clevis in the wires should not be very twisted after assembly. Lock the clevis in place with a setscrew.

    Gas Return Vangs: Prior to installing the clevis into the end of the cylinder tube, install the check ball, spring and retaining screw in the end of the clevis.

13. Solder the wires to the connector plug. When stripping the individual wires for soldering, remove only the minimum amount of jacket necessary. Before soldering, install short pieces of shrink tubing

over each wire. After soldering, move the shrink tubes over the soldered connections and shrink them to protect the soldered joints.

Match the colors from the transducer long extension leads to the short leads on the on the port plug. Connect (solder) the wires as follows:

Transducer Extension Wire	→	Port Plug Lead Wire
Black	→	Black
White	→	Brown
Red	→	Blue

If other colors of wire were used for extending the transducer leads, make sure to correctly identify them when connecting to the port plug. Consult PI Manual for details.

14. Using the same technique as in 11, first counter rotate the connector plug to compensate for the correct number of threads and then screw the connector plug into its port and tighten it.

15. Assemble any remaining parts - fittings (see 15.), rod jaw, etc.

16. Carefully bleed the system - filling the pull end of the vang with oil. It is important to start with the rod fully extended and then fill that end with oil first. It is important to avoid compressing air in the oil end (pull end) of the vang. If there is air in the pull end of the vang when the push end is pressurized with nitrogen, the nitrogen pressure will rise until it overcomes the seal friction. At this point, the piston will jump violently until it compresses the air and impacts the oil in the pull end. This shock is very likely to damage the Position Indicating assembly. It is a good idea to fill the rod end from the oil-fitting hole before installing the oil fitting to remove all air from that end.

    A. Gas Return vang: Pump or pour oil into the rod end of the cylinder. Install the oil fitting and pump oil into the rod end. Continue pumping the rod end with oil until the rod retracts completely and the rated pressure is reached. Verify that pressure can be maintained for some period of time to ensure seal performance. Inspect the cylinder around the cap for leaks. Do not remove the oil charging hose from the rod end until the cylinder is fully charged and the rod is fully extended.

        Add a quantity of oil to the gas side of the cylinder. Roughly, the quantity of oil to add, in ounces, is equal to the cylinder size minus two. (For example: a –90 cylinder should have 88 ounces of oil added to its gas side.) After adding oil, connect the clevis gas port to a nitrogen bottle and charge to 600 PSI or the custom pressure specified in the work order if it is specified. With the gas side charged to 600 PSI – remove the charging fitting and install the o-ring plug.

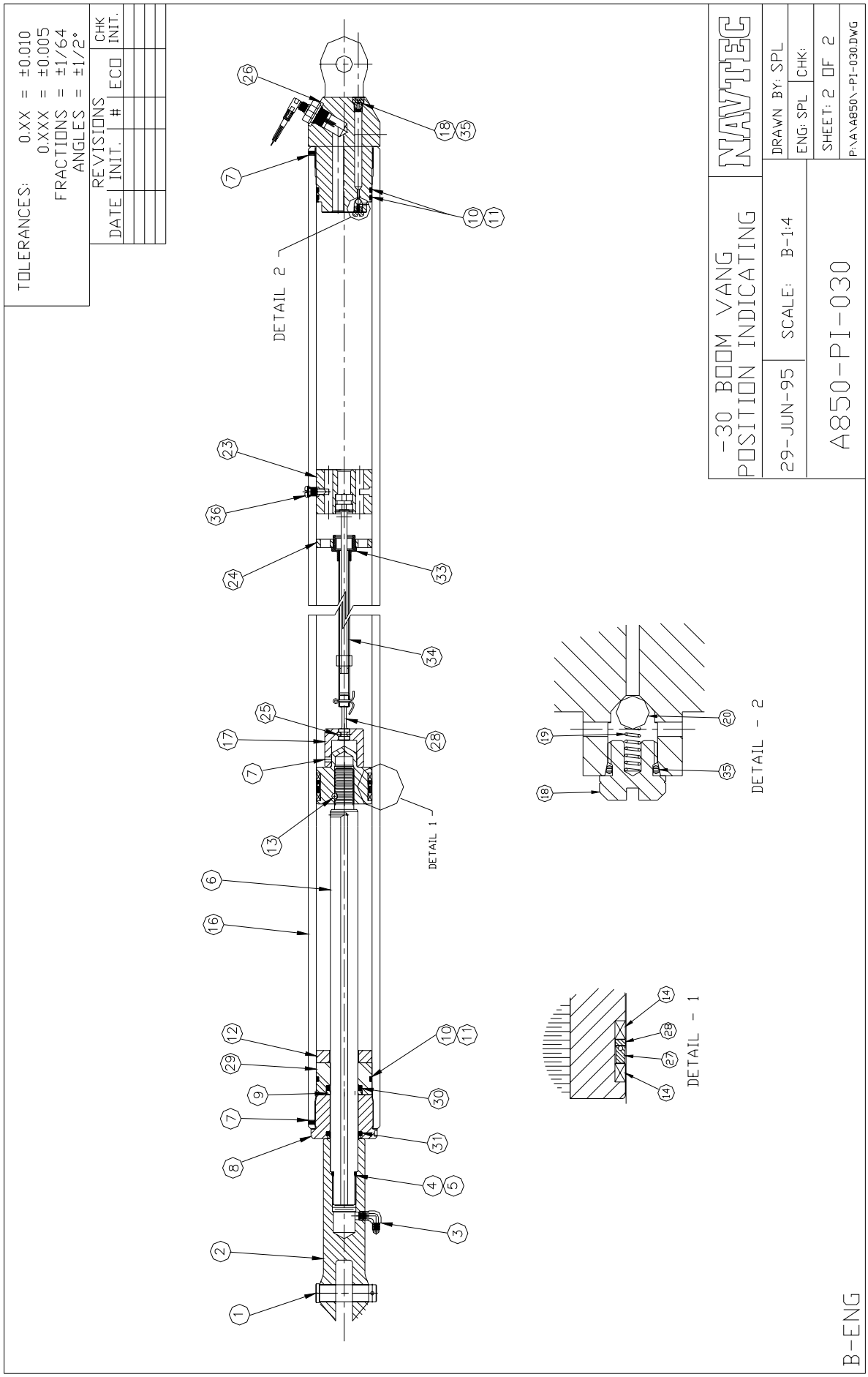
        Crack open the valve on the rod side, allowing oil to vent out of the cylinder as the rod extends. When the rod is fully extended, cap the oil fitting.

    B. Push - pull vang: The push end will be completely filled with oil and must be correctly orientated to remove all air during bleeding.

17. After assembly, connect a multi-tester to the transducer leads and check that the resistance varies fairly smoothly as the vang is operated throughout its travel. (As indicated in the PI Manual.) This is a very rough test and if the change is not very smooth or linear, the problem is probably simply varying contact resistance. In this case, go to step 17 to test the unit.

Optional: To rigorously test the PI system for linearity and smooth operation, it must be set up as a voltage divider. This can be done as follows:

- Connect a 6 volt battery – to black, + to blue.
- Set the multi-tester to read voltage and connect it: - to black, + to brown.
- As the vang rod is moved through its travel, the voltage should change linearly with rod position.



Source file: X:\P\A\A850\-PI-030.dwg

6/11/08 ASSEMBLY NUMBER: A850-PI-030 DESCRIPTION: VANG, -30, POSITION INDICATING

PART NUMBER	DESCRIPTION	ITEM NUMBER	QUANTITY
A090-19-01	LABEL,DANGER, W/SER.NO.	0	1
A090-34-01	LABEL, NAVTEC 1.08 X 2.95	0	1
A850-PI-MANUAL	MANUAL - P.I. VANG AND DISPLAY	0	1
D600-12-225	CLEVIS PIN, 3/4X2.25	1	2
A851-01-030	OIL JAW, VANG -30	2	1
HB-069	4-CTX-SS ELB.	3	1
HJ-2-119	2-119	4	1
HK-8-119	8-119	5	1
A851-07-030	ROD, VANG -30	6	1
HC-038	10-32X3/16 SSS-CUP POINT	7	6
A251-03V030	CAP, VANG -30	8	1
A251-04C060	GLAND BACKUP, CYL.-60	9	1
HJ-2-228	2-228	10	3
HK-8-228	8-228	11	3
A251-02V030	ROD STOP BUSH. VANG -30	12	1
A251-08-030	PIST LOK PIN -30 1/4X1-3/4	13	1
A251-12-030P	PIST BEAR/PIP RING -30	14	2
A251-29-030	PISTON, LT CYL. -30	15	1
A851-06PI030	TUBE,-30 VANG,POSITION IND.	16	1
A851-29-030	-30 PI VANG PISTON ADAPTOR	17	1
A031-19-02	PORT PLUG, HARDCOATED	18	2
A031-02-01	CHECK SPRING	19	1
HD-00-250	1/4" HARD STEEL BALL	20	1
A851-31-01A	TUBE CONN POS IND VANG	21	1
D660-0832	COTTER PINS, 1/8X1	22	1
A851-30-030	-30 PI HEADER MOUNTING ANCHOR	23	1
A851-34-030	-30 PI SLIDER MOUNT BEARING	24	1
A851-36-02	PI VANG LOCK PIN, 3/16 X 1.00	25	1
A851-05PI030	GAS CLEVIS,-30 VANG,POS. IND.	26	1
HM-009	18702125-375B -30 PIST SEAL	27	1
HL-009	18702125 -30 PIP RING	28	1
A251-05V030	GLAND, VANG -30	29	1
HI-010	18701250 1 1/4"ROD SEAL	30	1
HN-007	D1250 1 1/4" ROD WIPER	31	1
D660-1248	COTTER PIN, 3/16 X 1-1/2	32	2
A851-32-01	POS IND VANG WIPER MOUNT	33	1
A851-33-01	SLIDER MOUNT TUBE POS IND VNG	34	1
HJ-3-903	3-903	35	3
A851-35-01	PI ALUM HDR ANCHOR PIN	36	1
HH-006	PPS-1/16 PLUG STAINLESS STEEL	37	1
A851-37-550	DUNCAN POS IND MOD 6311H001	38	1
HG-008	SPIRS100S RET RING	39	1
A851-50-01	NZ P.I. PLUG & CABLE ASSY	40	1

VANG SIZING

This section includes 2 vang sizing sheets. The first is a simplified version which can be found through our website. This allows you to approximate the size of the vang with the least number of variables. The second sheet calls for many more factors and therefore allows Navtec to more accurately determine the size of the vang required. The second sheet should be completed and then faxed to Navtec for sizing.

Shortened Vang Sizing Sheet

W = weight.	Includes boom, sail and men needed to furl.
E = boom length	Standard rig "E" measurement.
R = Moment arm	Distance between vang and gooseneck pin. Measured perpendicular from vang.
H = gooseneck to boom lug pin	
V = gooseneck to mast swivel lug pin	

Data sheet

W =		Measured in lbs.
E =		Measured in feet.
H=		Measured in inches.
V=		Measured in inches.
R=V*SIN(ATAN(H/V))=		Can also be measured in inches
F = W*E/R=		Includes a 2x safety factor to ensure the boom is held steady when sheeted in.
VANG SIZE		Find force in table below for vang size.

Vang Size	500 psi	600 psi	700 psi	800 psi
-6	394	473	552	630
-10	678	814	949	1085
-12	916	1099	1282	1466
-17	1240	1488	1736	1984
-22	1613	1936	2258	2581
-30	2508	3010	3511	4013
-40	3610	4332	5054	5776
-60	4899	5879	6859	7838
-90	6400	7680	8960	10240
-110	8000	9600	11200	12800
-150	10000	12000	14000	16000

CONVERSIONS

	Metric	Conversion	English
W= Kg		*2.205	
E= M		*3.281	
H= mm		*0.0394	
V= mm		*0.0394	

NAVTEC VANG SIZING DATA SHEET

BOAT NAME				X	Default
Designer					
Builder					
Model					
Type					
Use					
Date					
LOA		ft		X	
Displacement		Klbs			
RM @ 1 deg		Klb-ft			
Or					
RM max		Klb-ft			
SAIL INFORMATION					
E		ft		X	
P		ft		X	
Leech		ft			
Fully battened sail?		no/yes		X	No
Max wind velocity for full main		Kts		X	20
Maximum upwind leach load					
Vang moment required					
Leach angle relative to perpendicular to boom		deg			
Percent of upwind leach load carried by vang					50%
Vang moment arm calculation (see drawing)					
V	Goose pin abv Vang goose pin (vert. comp.)	in		X	
H	Vang horizontal pin dist (horiz. comp.)	in		X	
A	Goose pin abv vang lug pin (vert. component)	in		X	
Or		in			
R	Vang moment arm R (meas. perp. to vang)	in			
WEIGHTS TO BE SUPPORTED BY PUSH CAPABILITY OF VANG					
Boom Weight (total)		lbs		X	
Location of C.G. (% of E from gooseneck)		%			50%
Sail Weight carried furled on boom		lbs		X	
Location of C.G. (% of E from gooseneck)		%			40%
Weight of men leaning on boom to furl/reef		lbs		X	
Location of C.G. (% of E from gooseneck)		%			50%
Will topping lift be used during reefing and furling? (Y/N)			n	X	
YACHT HYDRAULIC SYSTEM OPERATING VANG					
Navtec Hand Pumped System (YES) or other (Specify)				X	YES
Maximum relief valve setting					
Maximum pressure available from pump					

Instructions:

1 Please fill in all boxes marked with an X to their right. Otherwise we will make our best guess.

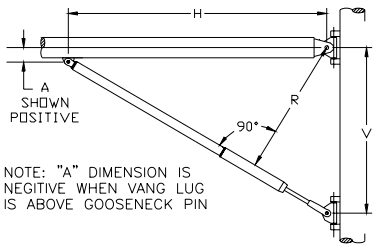
2 Fill in any other boxes if you have information and want us to us it in making our vang size remommendation.

3 Please label your units of measure! We normaly use the units the left of the box. We will be happy to use your units however.

4 Mail or fax the completed data sheet to Navtec.

Navtec. Inc. Phone 203-458-31

Guilford, CT 06437-0388 Fax 203-458-92



SYSTEM V VALVE

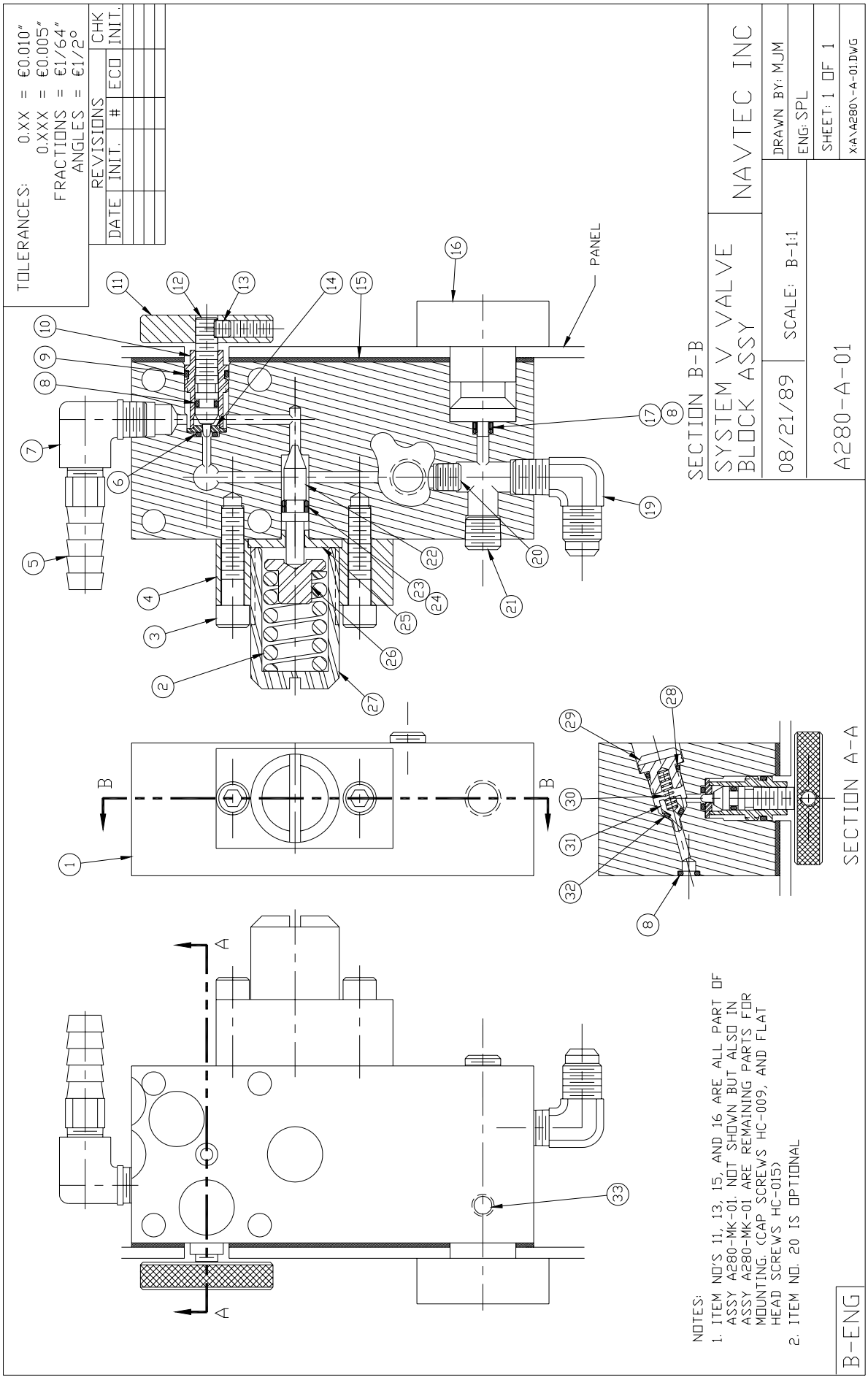
Disassembly Procedures:

1. Remove valve block from panel. You must first remove gauge by backing out set screw (33) on top and bottom of valve. Then remove release valve knob (11) and Phillips head screw, which ties the block to the panel. Remove the 4 allen head cap screws on top of valve block to separate the valve from the pump.
2. Unscrew needle valve plug (10) and pull needle valve assembly from block. Screw needle valve "in" to the needle valve plug and separate the pieces.
3. Remove check valve port plug (29) and remove spring and check bob, Note: Spring is loaded and may shoot from your grasp (Use Caution).
4. Unscrew relief valve cap (27), and remove spring/cap assembly. Remove allen head cap bolts (3), and remove relief valve base, locating washer (25), and relief valve needle (22).

Rebuilding Procedures:

1. All parts should be cleaned of dirt and debris and all O-rings and seals should be removed and discarded.
2. Install new O-rings onto relief valve needle (22) and insert into valve block. Install locating washer (25) and re-fasten relief valve base (4). Insert relief valve spring guide (26), spring (2), and screw cap back into valve block (27).
3. Install new check bob O-rings onto check bobs, then install check springs (30) into port plug using a small dab of lithium grease to hold spring in place. Install check bobs and springs into pump body and screw back down. Note: Be careful to seat the springs into the check bobs before tightening them down. If the plugs bind, it may be a sign the springs have not seated.
4. Install new O-rings onto release valve needle (12) and housing (10) and screw them together. Install assembly back into valve block.
5. Install valve block back onto pump body/panel. Note: be sure to change the O-ring between the pump and the valve.

Note: System 50 uses a release valve, which is similar to the integral release valve.



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6/11/02 ASSEMBLY NUMBER: A280-A-01 DESCRIPTION: SYS. V MANIFOLD ASSY

PART NUMBER	DESCRIPTION	ITEM	QTY
A280-A-01	DRWG.SYS.V MANIFOLD ASSY	0	1
A280-01-01	BODY, COMPACT SYSTEM	1	1
HF-033	SPRING, HX-2, GREEN	2	1
HC-025	1/4-20 X 1 1/8 SHCS	3	2
A041-07-01	RELIEF VALVE BASE	4	1
HB-025	125HBL-6-2 HS. BARB STRT	5	1
HJ-2-007	2-007	6	2
HB-022	120P-2-2 ELB. BRASS	7	1
HJ-2-012	2-006	8	3
A351-26-01	2-012	9	1
A351-29-01	PLUG, NEEDLE VALVE	10	1
A351-28-00	STEM VALVE	11	1
A351-27-00	SEAT, NEEDLE VALVE	12	1
HK-8-006	8-006	14	1
HB-068	4-CTX-S ELB.	17	1
HH-005	PPB- 1/8 PLUG BRASS #11004	19	2
A041-03-01	NEEDLE, RELIEF VALVE	21	1
HJ-2-008	2-008	22	1
HK-8-008	8-008	23	1
A041-06-01	LOCATING WSHR, REL VLV, TYPE III	24	1
A041-04-01	SPRING GUIDE REL VLV TYPE III	25	1
A041-05-01	CAP, RELIEF VLV, TYPE III	26	1
HJ-3-903	3-903	27	1
A031-19-02	PORT PLUG, HARDCOATED	28	1
A031-02-01	CHECK SPRING	29	1
A031-18-N	O-RING CHECK BOB W/NOSE	30	1
HJ-2-005	2-005	31	1
HC-007	1/4-20X1/2 CONE POINT SSS	32	2
HC-038	SET SCREWS	33	1
A280-05-01	SYSTEM V VALVE GASKET	13	1
8060-01-00	GUAGE	15	1
HH-008	1/8-27 NPT	16	1

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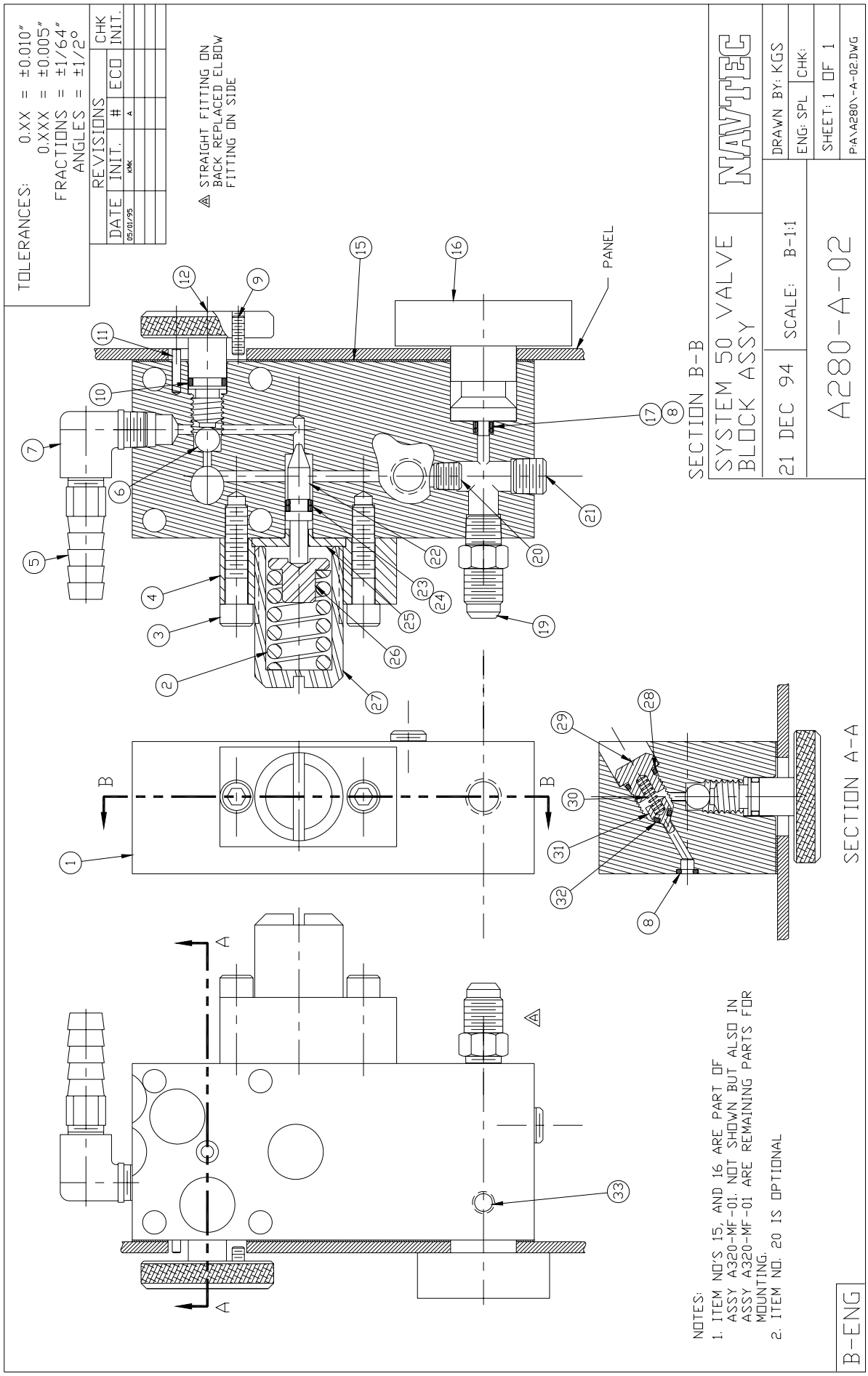

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6/11/02 ASSEMBLY NUMBER: A280-A-02 DESCRIPTION: SYS. 50 MANIFOLD ASSY

PART NUMBER	DESCRIPTION	ITEM	QTY.
A280-A-02#	DRWG.SYS. 50 MANIFOLD ASSY	0	1
A-280-01-03	BODY, COMPACT SYSTEM 50	1	1
HF-003	SPRING, HX-2, GREEN	2	1
HC-025	1/4-20 X 1 1/8 SHCS	3	2
A041-07-01	RELIEF VALVE BASE	4	1
HB-025	125 HBL-6-2 HS. BARB STRT	5	1
HD-00-281	9/32" HARD CHROME BALL	6	1
HB-022	1202P-2-2 ELB. BRASS	7	1
HJ-2-006	2-006	8	2
HC-065	6-32 X 3/8 SSS NYLOCK	9	1
HJ-2-108	2-108	10	1
D662-009	SPIROL PIN, 3/32 X 1/2	11	1
A281-07-01	VALVE SYSTEM, SYS. 50	12	1
A280-05-01	COMPACT VALVE FRONT GASKET	15	1
A060-02-03	2" GUAGE ASSEMBLY	16	1
HK-8-006	8-006	17	1
HB-078	4-FXT-S STRT	19	1
HH-003	PPB-1/16 PLUG BRASS #11002	20	OPTIONAL
HH-005	PPB-1/8 PLUG BRASS #11004	21	2
A041-03-01	NEEDLE, RELIEF VALVE	22	1
HJ-2-008	2-008	23	1
HK-8-008	8-008	24	1
A041-06-01	LOCATING WSHR, REL VLV, TYPE III	25	1
A041-04-01	SPRING GUIDE REL VLV TYPE III	26	1
A041-05-01	CAP, RELIEF VLV, TYPE III	27	1
HJ-3-903	3-903	28	1
A031-19-02	PORT PLUG, HARDCOATED	29	1
A031-02-01	CHECK SPRING	30	1
A031-18-N	O-RING CHECK BOB W/NOSE	31	1
HJ-2-005	2-005	32	1
HC-007	1/4-20 X 1/2 CONE POINT SSS	33	2

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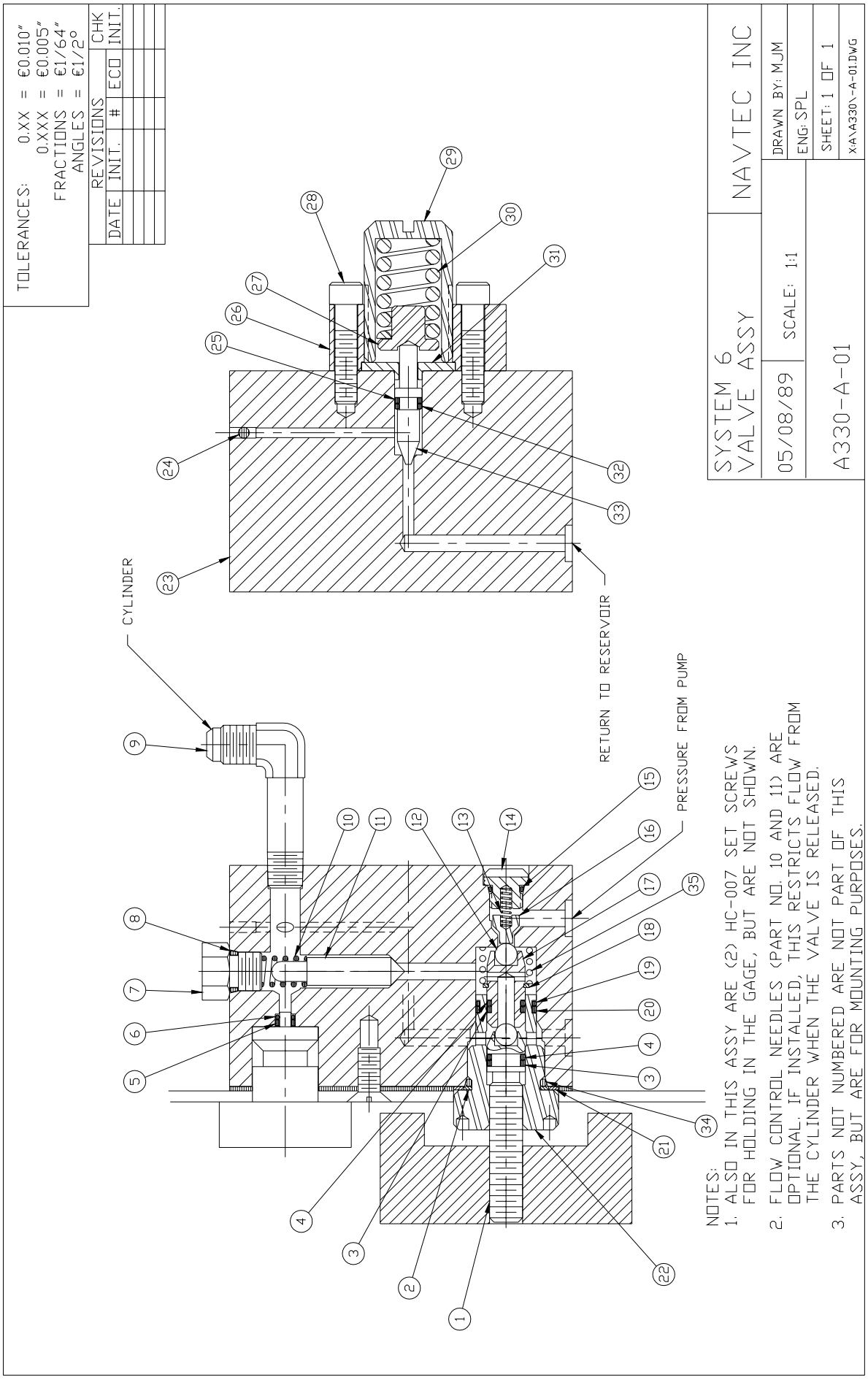

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4/10/92 ASSEMBLY NUMBER: A330-A-01 DESCRIPTION: VALVE ASS'Y, SYS V1

PART NUMBER	DESCRIPTION	ITEM	QTY
A330-A-01	DWG, VALVE ASSY, SYS. V1	0	0
HC-007	1/4-20X1/2 CONE POINT SSS	0	2
A331-06-01	VALVE STEM	1	1
HK-8-116	8-116	2	1
HK-8-011	8-011	3	2
HJ-2-011	2-011	4	2
HK-8-006	8-006	5	1
HJ-2-006	2-006	6	1
HB-092	4-P50N-S PLUG	7	1
HJ-3-904	3-904	8	1
HB-065	4-CCTX-SS ELB. X-LNG	9	1
HD-00-250	1/4" HARD STEEL BALL	12	2
A031-02-01	CHECK SPRING	13	1
A031-19-02	PORT PLUG, HARDCOATED	14	1
HJ-3-903	3-903	15	1
A331-11-01	CHECK VALVE, ANTI-INTERFLOW	16	1
A331-07-01	POPPET ASS'Y	17	1
HG-007	5160-42 SNAP RING	18	1
HJ-2-015	2-015	19	1
HK-8-015	8-015	20	1
A331-12-01	VLV PLUG SPAVER, NON-INTERCONN	21	1
A331-04-01	PLUG, SYS VI	22	1
A331-01-01	NON INTER VALVE BLOCK, TYPE VI	23	1
HD-001	1/8 SS BALLS	24	1
HK-8-008	8-008	25	1
A041-07-01	RELIEF VALVE BASE	26	1
A-041-04-01	SPRING GUIDE REL VLV TYPE III	27	1
HC-025	1/4-20X1 1/8 SHCS	28	2
A041-05-01	CAP, RELIEF VLV, TYPE III	29	1
HF-033	SPRING, HX-2, GREEN	30	1
A041-06-01	LOCATING WSHR, REL VLV, TYPE III	31	1
HJ-2-008	2-008	32	1
A041-03-01	NEEDLE, RELIEF VALVE	33	1
HJ-3-910	3-910	34	1
HF-021	LC067-H-2 SPRING	35	1

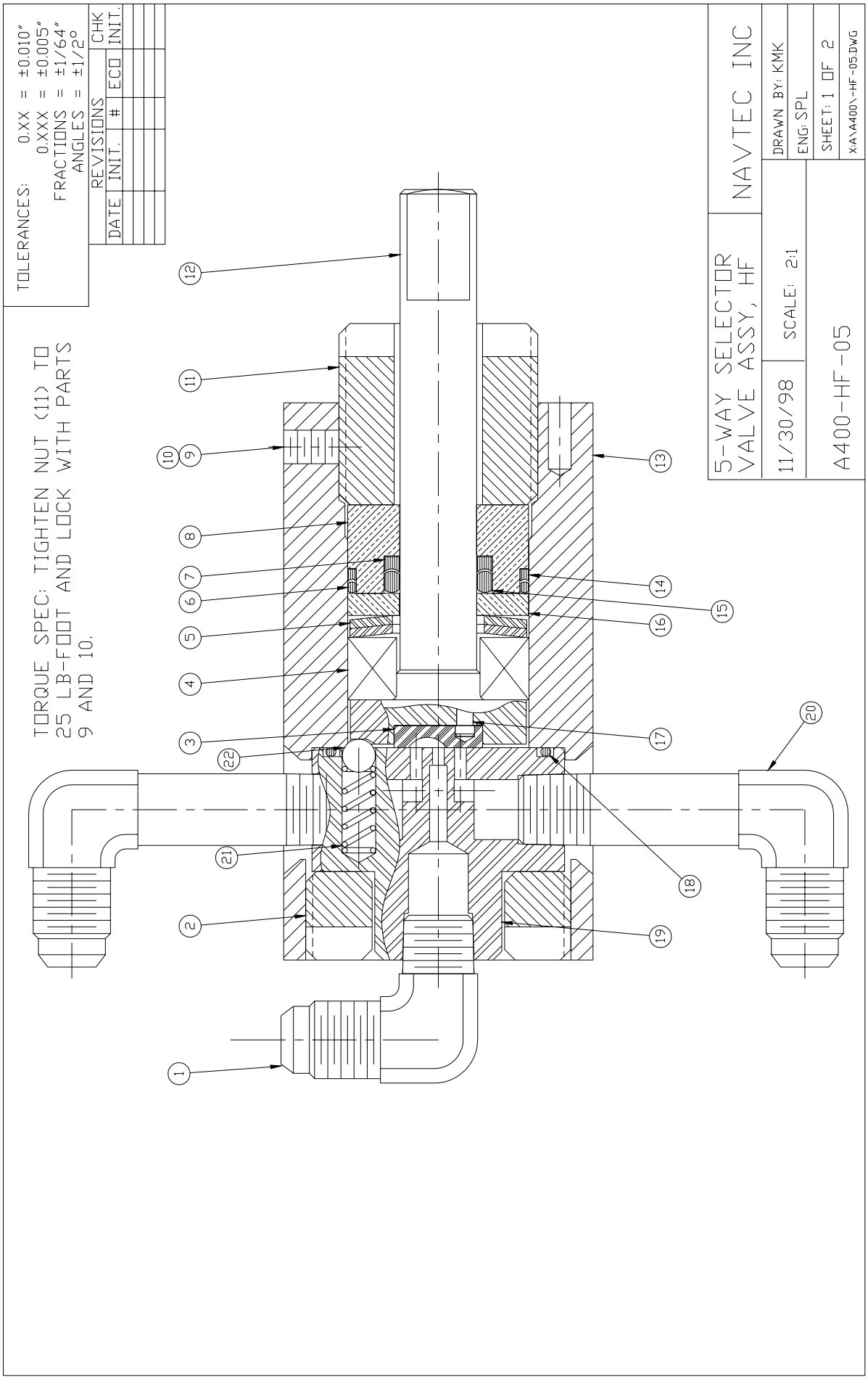
5 WAY SELECTOR VALVE

Disassembly Procedures:

1. Remove 5 way (Loutrel) valve from panel. You must first remove the selector valve knob, then the outer nut, which fastens the valve to the panel. Unscrew the feed lines at the valve (1).
2. Loosen the stem nut screw (10), and unscrew the stem nut (11) with the appropriate stem nut tool.
3. Remove shaft assembly (12) from valve body and remove gland (8), washer (16), spring (5), and thrust bearing assembly (4).

Rebuilding Procedures:

1. All parts should be cleaned of dirt and debris and all O-rings and seals should be removed and discarded.
2. Inspect face block (19) for signs of wearing, pitting, or scoring. If the face block is not worn it is not necessary to remove from the valve body.
3. To remove face block: Remove oil input and output elbows. Unscrew backnut (2) and pull face block from valve body. If the wearing is slight, you may be able to polish the face block and reuse. Be sure to install a new O-ring (18) when installing back into valve body.
4. Inspect selector disk for signs of wear, replace is necessary. To remove disk, pry at edge with a sharp pick or blade. Press new disk into place.
5. Slide thrust bearing assembly (4) over shaft. Note the orientation of the ball guides in the washers. Slide springs over shaft (5), note the orientation of the bends. Install washer (15) over the shaft.
6. Install new O-rings and backups onto the gland (14,15,6,7) and slide gland assembly onto shaft. Install shaft into valve body and tighten stem nut (11) to 25 ft/lbs.
7. Tighten set screw (10), and install valve back into panel.



Source file: X:\P\A\A400\-HF-05.dwg

6/11/02 ASSEMBLY NUMBER: A400-HF-05 DESCRIPTION: 5 WAY SELECTOR VALVE, HIGH FLOW

PART NUMBER	DESCRIPTION	ITEM	QTY
HB-068	4-CTX-S ELB.	1	1
A401-09-01	BACK NUT, SELECT. VLV	2	1
A401-07-03	HF DISC, SELECT. VLV, 5 WAY	3	1
HA-008	51101 BRNG. THRST.	4	1
HF-006	B1000-050 SPRING	5	2
HJ-2-020	2-020	6	1
HK-8-111	8-111	7	1
A401-04-01	GLAND, SELECT. VLV	8	1
HC-038	10-32X3/16 SSS-CUP POINT	9	1
HD-002	1/8 NYL BALLS	10	1
A401-10-01	STD STEM NUT, SELECT. VLV	11	1
A401-06-02	SHAFT W/DETENTS, HF SELECT. VLV	12	1
A401-01-01	HOUSING, SELECTOR VALVE	13	1
HK-8-020	8-020	14	1
HJ-2-111	2-111	15	1
A401-05-01	WASHER, SELECT. VLV	16	1
A401-11-01	DISC PIN, SELECT. VLV	17	1
HJ-2-024	2-024	18	1
A401-08-02	HF FACE BLOCK, SELECT. VLV	19	1
HB-066	4-CCTX-S ELB. LNG.	20	4
HF-040	LCO32B-7	21	4
HD-013	3/16 NYLPTRON BALL	22	4

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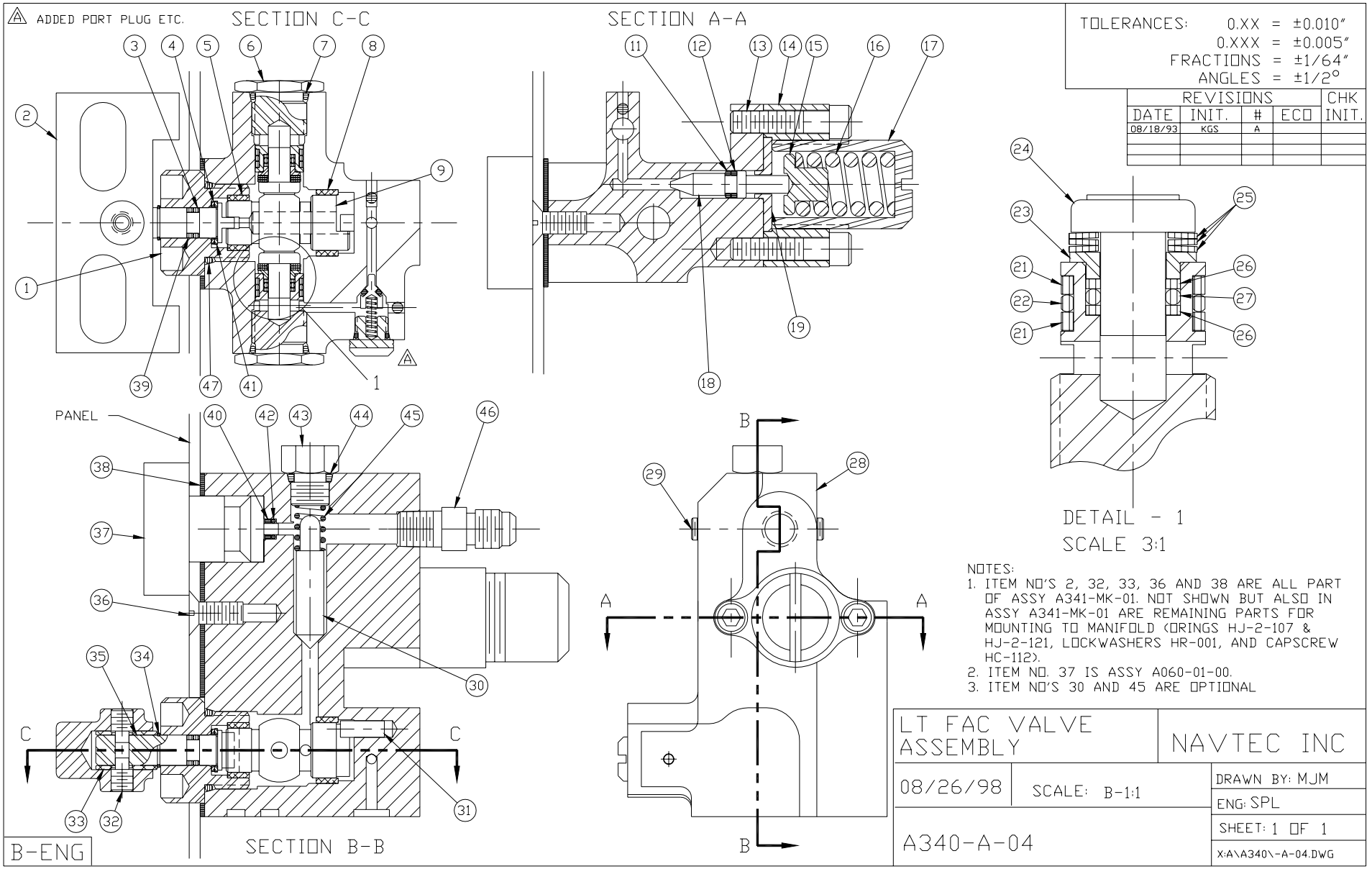
FAC VALVE

Disassembly Procedures:

1. Remove valve block from panel/manifold. You must first remove gauge by backing out set screws (29) on side of valve. Then remove knob (2), and Phillips head screw (36) on front of valve, and two hex bolts on bottom of manifold. Using a spanner wrench, remove the port plug (1) from the valve block. Remove snap ring (34) and slide stem (35) out of port plug (1).
2. Unscrew and remove cross port plugs (6) and remove hoke seat (24) {see Detail 1}. Pull trunion ball (9) from valve block.
3. Unscrew relief valve cap (17) from back of valve and remove spring/guide (16, 15). Remove socket head cap screws (13), and remove relief valve base (14), locating washer (19), and relief valve needle (18).
4. Remove top port plug (43). Under the top port plug there may be an optional flow control spring (45) and needle (30).

Rebuilding Procedures:

1. All parts should be cleaned of dirt and debris and all O-rings and seals should be removed and discarded. Check trunion ball and hoke seat for signs of scoring/wearing and replace if necessary.
2. Install new O-rings onto relief valve needle (18), and insert into valve block. Install locating washer (19), and re-fasten relief valve base (14). Insert relief valve spring guide (15), spring (16), and cap onto valve block (17).
3. Install new stem washer, thrust washer, and O-ring (41, 4, 3) {in this order} onto FAC valve stem (35). Insert back into port plug as shown. Slide snap ring (34) back onto the stem to lock into port plug.
4. Note assembly detail 1 for cross port plug assembly. Install new O-ring and backups (21, 22, 7) onto cross port plug as shown. Install new O-ring and Teflon seals (26, 27) into cross port plug and reinstall seat guide (23), spring washers (25), and hoke seat (24). Note: Be sure to install springs as shown in Detail 1 for proper loading against hoke seat.
5. Install trunion ball (9) into valve block, and tighten cross port plugs (6) snug against trunion ball. Install port plug stem assembly slowly, locating stem with trunion ball slot. Once engaged, tighten port plug with proper wrench to 100 ft/lbs.
6. Tighten each cross port plug to 55 ft/lbs.
7. Install new “race track” O-rings in the bottom groove of the valve and install valve back onto manifold using hex bolts.
8. Reinstall Phillips head screw (36) to attach valve to panel and insert the gauge (37) through panel, fastening it with two set screws (29).



TOLERANCES: 0.XX = ±0.010″
0.XXX = ±0.005″
FRACTIONS = ±1/64″
ANGLES = ±1/2°

REVISIONS				CHK
DATE	INIT.	#	ECO	INIT.
08/18/93	KGS	A		

NOTES:
1. ITEM NO'S 2, 32, 33, 36 AND 38 ARE ALL PART OF ASSY A341-MK-01. NOT SHOWN BUT ALSO IN ASSY A341-MK-01 ARE REMAINING PARTS FOR MOUNTING TO MANIFOLD (ORINGS HJ-2-107 & HJ-2-121, LOCKWASHERS HR-001, AND CAPSCREW HC-112).
2. ITEM NO. 37 IS ASSY A060-01-00.
3. ITEM NO'S 30 AND 45 ARE OPTIONAL

LT FAC VALVE ASSEMBLY	NAVTEC INC
08/26/98 SCALE: B-1:1	DRAWN BY: MJM
	ENG: SPL
A340-A-04	SHEET: 1 OF 1
	X:A\A340\-A-04.DWG

PART NUMBER	DESCRIPTION	ITEM	QTY
A031-02-01	CHECK SPRING	0	1
HJ-3-903	3-903	0	1
A031-18-N	O-RING CHECK BOB W/NOSE	0	1
HJ-2-005	2-005	0	1
A031-19-02	PORT PLUG, HARDCOATED	0	1
A340-A-04#	DWG. LT. FAC VALVE ASSY.	0	0
A341-03-01	STEM PORT PLUG, FAC VALVE	1	1
HJ-2-009	2-009	3	1
A341-06-01	THRUST WASHER, FAC VALVE (NYLATRON)	4	1
A341-14-01	BEARING, FAC VALVE	5	1
A341-04-01	CROSS PORT PLUG, FAC VALVE	6	2
HJ-3-907	3-907	7	2
A341-15-01	BEARING, FAC VALVE	8	1
A341-02-01	TRUNION BALL, FAC VALVE	9	1
HD-001	1/8 SS BALLS	10	4
HJ-2-008	2-008	11	1
HK-8-008	8-008	12	1
HC-025	1/4-20 X 1 1/8 SHCS	13	2
A041-07-02	RELIEF VLV. BASE SPECIAL	14	1
A041-04-01	SPRING GUIDE REL VLV TYPE III	15	1
HF-033	SPRING, HX-2, GREEN	16	1
A041-05-03	RELIEF VLV. CAP, ALUMINUM	17	1
A041-03-01	NEEDLE, RELIEF VALVE	18	1
A041-06-01	LOCATING WSHR,REL VLV,TYPE III	19	1
HK-8-013	8-013	21	4
HJ-2-013	2-013	22	2
A341-08-01	SEAT GUIDE, FAC VALVE	23	2
HC-085	80711 -2 HOKE SEAT ASS'Y	24	2
HF-005	B0500-022-S SPRING	25	6
A341-13-01	BKUP,TFLN FOR SEAL RET,FAC VLV	26	4
HJ-2-010	2-010	27	2
A341-01-10B	F.A.C.BODY, LT.(REV.6/28/89)	28	1
HC-007	1/4-20X1/2 CONE POINT SSS	29	2
HC-134	3/16" X 1/2" ROLL PIN SS.	31	1
HG-001	5100-34H SNAP RING,WALDES	34	1
A341-05-01	STEM, FAC VALVE, STD & 1/4"	35	1
HK-042	TF 74-009 F.A.C.BACKUP	39	1
HK-8-006	8-006	40	1
A341-07-01	STEM WASHER, FAC VALVE (S.S.)	41	1
HJ-2-006	2-006	42	1
HB-092	4-P50N-S PLUG	43	1
HJ-3-904	3-904	44	1
HB-079	4-FTX-SS STRT	46	1
HJ-3-910	3-910	47	1

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PUSH BUTTON QUICK RELEASE VALVE

A440-A-01A Push Button Quick Release Valve Assembly

Insert o-ring (20) into bottom of check port as shown in Figure 3. Inspect check seats for good finish. Test seat by dropping a check ball onto seat. Ensure that check ball can come off seat in all 4 directions before hitting sidewalls. The ball should make a line contact along the edge of the seat where it meets the flat bottom of the recess (largest diameter edge of the cone). If you are re-using an old seat that was functioning properly when you took it apart or are using a new seat, the following may not be necessary. If the seat is leaking you can test it by applying dy-chem blue to the seat area and then running the ball in the seat by running the ball against a high friction surface. You can do many seats with one steel ball. If the surface is a piece of #320 grit or finer SiC abrasive paper it will slightly lap the seat. If this is done, do not use the same ball at valve assembly. If this procedure is done, it is very important to clean the seat of all debris, or you risk getting contaminants in the valve and throughout your hydraulic system.

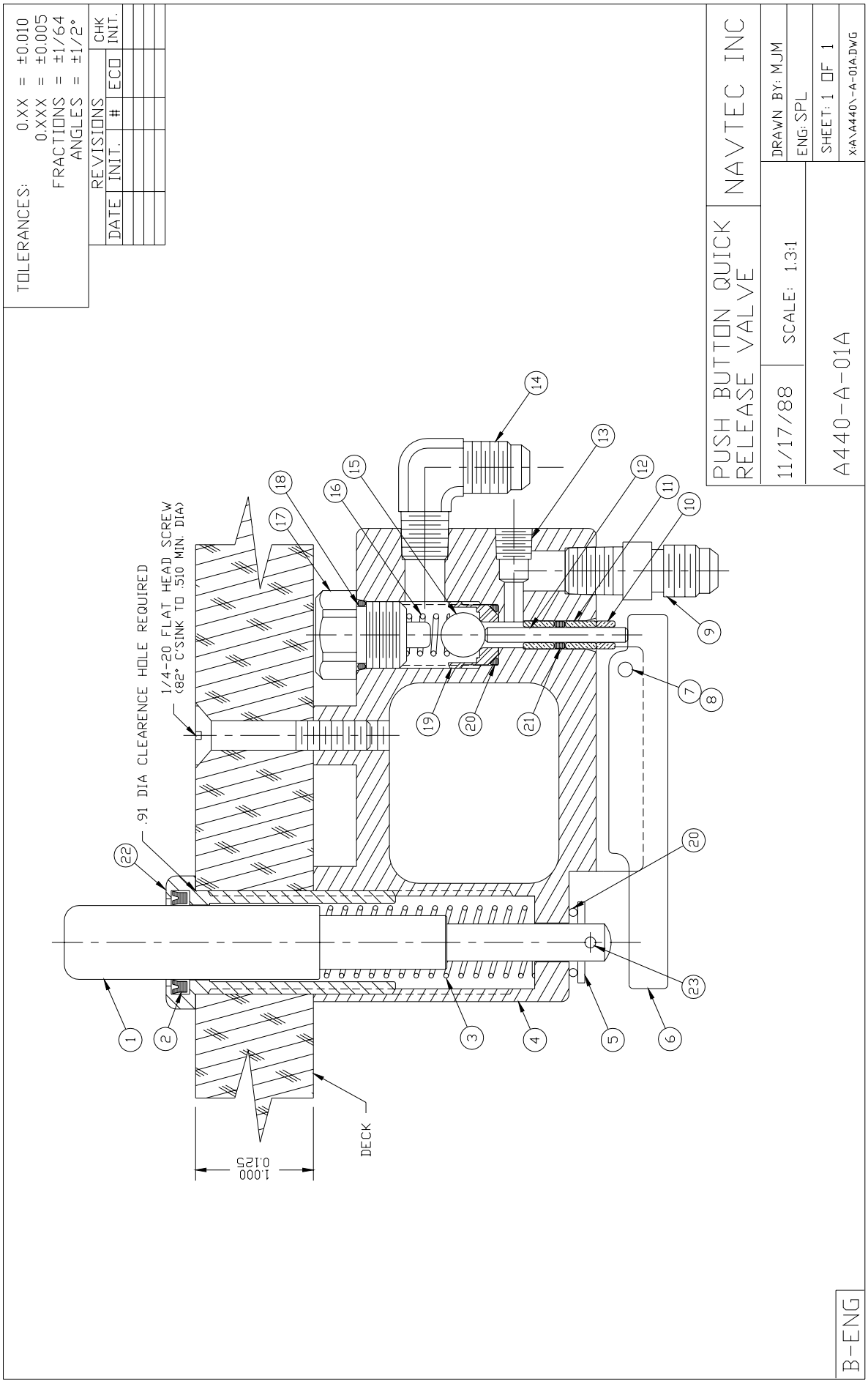
Grease check seat (19) threads and install into ports. Torque to 15 ft-lbs and inspect to ensure check seats are fully seated in head. The most reliable method of determining whether the check seat is fully seated is to measure the port depth and seat length before installing the seat. After installing the seat, measure the depth to the edge of the seat plug. This depth should be equal to the port depth minus the seat plug length. Also, you can feel the squishing of the o-ring and a point at which the seat makes contact with the bottom of the port. This is where the 15 ft-lbs should be applied.

Roll o-ring (18) onto check plug (17). Put a dab of grease onto the tip of the plug. Install the check spring (16) onto the tip of the plug. Insert check ball (15) into seat after inspecting for surface flaws. Install plug / spring assemblies. Torque to 45 ft-lbs. This torque is important to prevent accelerated fatigue failure of the port plug.

Next assemble one of the shift poppet sleeves (11), the o-ring (21), the other shift poppet sleeve (11), and the support sleeve (10) onto the shift poppet (12). Lubricate the o-ring with 90 weight oil and insert the subassembly into the passageway below the check port. This assembly is held into the valve body by the lever (6). Attach the lever to the body by using the clevis pin (8) and the 1/16 x ½ cotter pin (7).

Now wrap the NPT threads of the hydraulic fittings (9, 14) and plug (13) with Teflon tape according to "Navtec Teflon Taping Instructions" and install into the valve body.

Insert the plunger seal (2) into the plunger guide (22). Next, slide the plunger (1) through the seal. Be sure to install the plunger from the side opposite the seal, as to not damage the seal with the sharp corners of the plunger. Now add the plunger spring (3) to the assembly and by screwing plunger guide into corresponding hole in the body. Now slide o-ring (20) and flat washer (5) onto the end of the plunger and secure with 3/32 x ¾ cotter pin (23).



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7/22/98 ASSEMBLY NUMBER: A440-A-01A DESCRIPTION: PBR VALVE ASS'Y

PART NUMBER	DESCRIPTION	ITEM	QTY
A441-02-01B	PLUNGER, PBV REV 11/88	1	1
HM-023-0062	4180-8404-0062	2	1
HF-LC045H-10	LC-045H-10SS STAINLESS SPRING	3	1
A441-01-01B	BODY,PUSH. BUT.VLV. REV 11/88	4	1
HR-015	5/16" FLAT WASHER MS811	5	1
A441-04-01A	LEVER,PBV	6	1
D660-0416	COTTER PINS, 1/16X1/2	7	1
D600-02-078	CLEVIS PIN, 1/8 X .78	8	1
HB-079	4-FTX-SS STRT	9	1
A441-09-01	SUPPORT SLEEVE, PBV	10	1
A021-14-01	POPPET GUIDE	11	2
A441-07-01	SHIFT POPPET, PBV	12	1
HH-006	PPS-1/16 PLUG STAINLESS STEEL	13	1
HB-069	4-CTX-SS ELB.	14	1
HD-00-375	3/8 HARD STEEL BALLS	15	1
HF-035	LC-045E-2 STAINLESS SPRING	16	1
A601-19-02	3/8" BALL CHECK PORT PLUG	17	1
HJ-3-906	3-906	18	1
A601-20-01	3/8 CK PORT INSERT,ROT'RY PMP	19	1
HJ-2-012	2-012	20	2
HJ-2-006	2-006	21	1
A441-10-01	PLUNGER GUIDE, PB VALVE	22	1
D660-0624	COTTER PINS, 3/32X3/4	23	1

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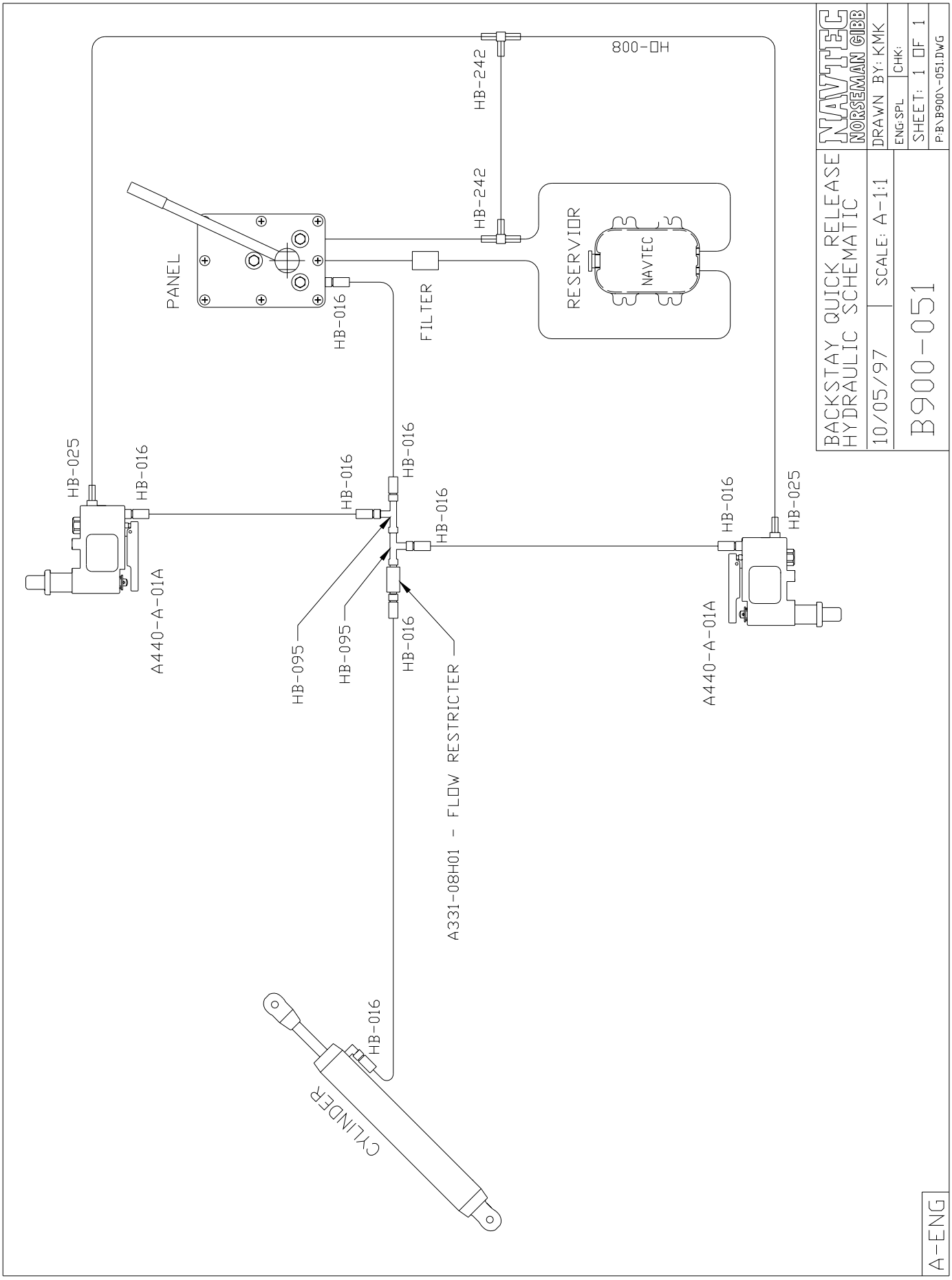

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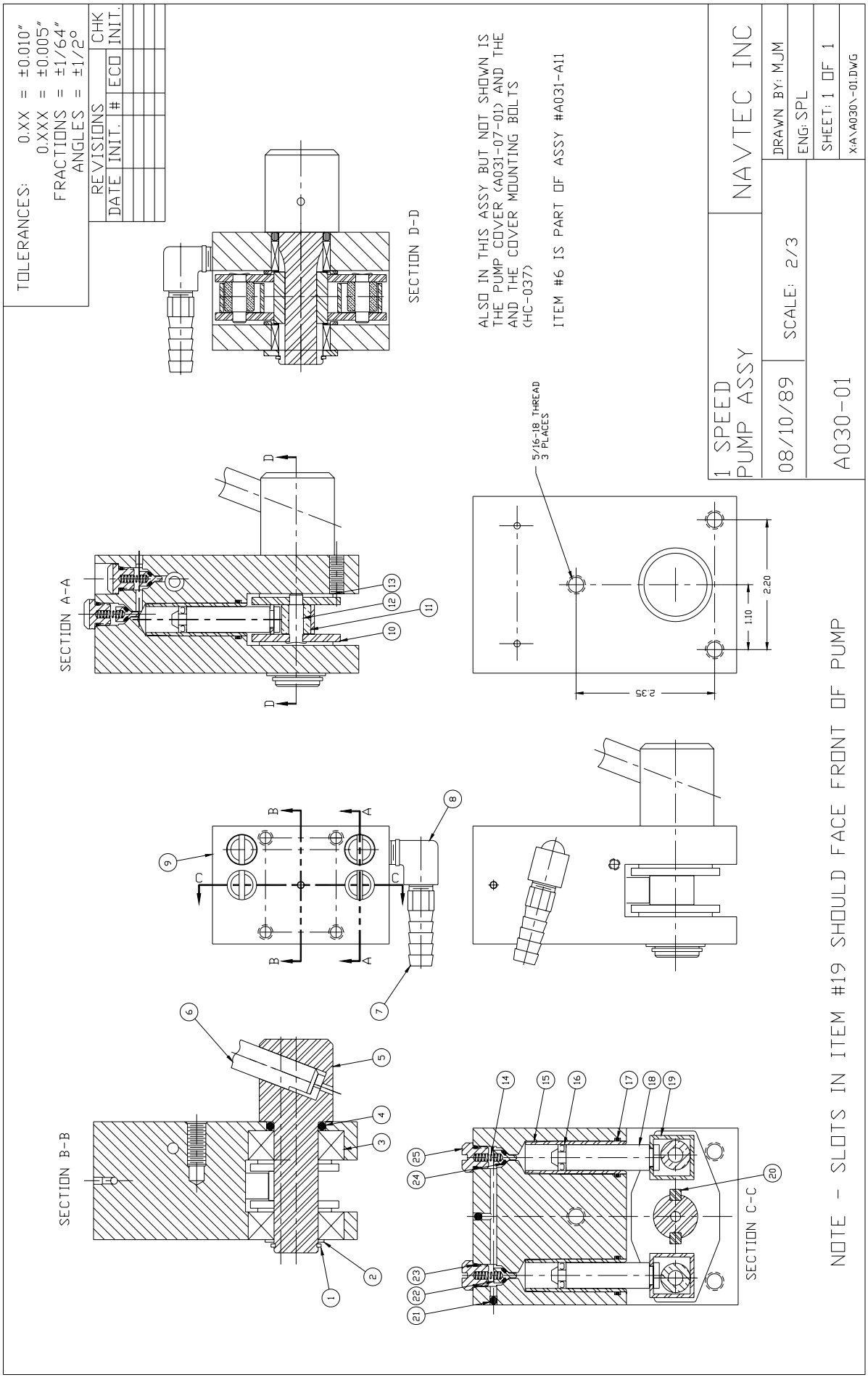
SINGLE SPEED PUMP

Disassembly Procedures:

1. Remove pump body from panel and separate valve block from pump.
2. Remove pump piston cover screws and pump piston cover (not shown).
3. Remove pump shaft snap ring (1) and shaft end washer (2), and slide pump shaft (5) out of pump housing.
4. Remove piston keys (20) and keyed spacer washers (13). Slide piston assembly out of bottom of pump. Piston end rocker arms (10) can be removed and piston pivots and sleeves (11, 12) can be removed and pistons separated from this assembly. Carefully remove piston seals (16) from pistons.
5. Remove the 4 port plugs (25) on top of pump body. Note: Springs inside are loaded and may shoot from your grasp if not careful. Remove check bobs (22) either by carefully turning pump upside down or with the use of small needle nose pliers.

Rebuilding Procedures:

1. All parts should be cleaned of dirt and debris and all O-rings and seals should be removed and discarded.
2. Install new O-rings (24) onto check bob noses (22) and install into pump body. Make sure bobs seat properly into cavity. Install new O-rings (23) onto check port plugs (25), and install check springs (14) into port plugs using a small dab of lithium grease to hold spring in place. Install check port plugs with springs into pump body and screw back down. Note: Be careful to seat the spring into the check bobs before tightening them down. If the plugs bind, it may be a sign the springs have not seated.
3. Check bore liners for signs of scratching or wear.
4. Install new piston seals (16) onto pistons (18) and re-install onto pump rocker assembly (reverse of the disassembly procedure #4.)
5. Oil the pump pistons and slide assembly back into pump body.
6. Install front most keyed spacer (13) and center this and the pump rocker with the front bearing hole. Slide the pump shaft (5) {be sure it is oriented correctly} through the bearing and spacer. Continue to slide pump shaft through rocker assembly. Note: Removal of rear pump shaft bearing (3) will ease the assembly of pump shaft (5) and keys (20). Install rear most keyed spacer and slide keys into pump shaft grooves. Re-install rear bearing (3), washer (2), and snap ring (1).
7. Install pump piston cover and screws.



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6/11/08 ASSEMBLY NUMBER: A030-01 DESCRIPTION: PUMP ASSY, 1 SPEED

PART NUMBER	DESCRIPTION	ITEM	QTY
HC-037	10-32X1/4 PAN HEAD SLOTTED	0	2
A030-01#	DRAWING, 1SPD PUMP ASSY.	0	1
A031-07-01	COVER, PUMP	0	1
HG-002	5100-75H SNAP RING, WALDES	1	1
A031-14-01	SPACER	2	1
HA-012	GEN-22612-88 PUMP BEARING	3	2
HJ-2-210	2-210	4	1
A031-12-01	PUMPSHAFT TYPE 1V, 21 DEG.	5	1
A031-A11	PUMP HANDLE (SOLD SEPARATELY)	6	1
HB-025	125HBL-6-2 HS. BARB STRT	7	1
HB-022	1202P-2-2 ELB. BRASS	8	1
A031-01-01	PUMP BODY, SYSTEM V	9	1
A031-09-01	END ROCKER ARM	10	2
A031-05-01	PIVOT SLEEVE	11	2
A031-06-01	PIVOT	12	2
A031-13-01	SPACER, KEYED	13	2
A031-02-01	CHECK SPRING	14	4
A031-17-01	PUMP LINER, 7/16" BORE	15	2
HM-001	12500187 PIST SEAL - PMP	16	2
HJ-2-015	2-015	17	2
A031-03P01	PUMP PISTON, TYPE VI 7/16"	18	2
A031-04-01	PISTON RETRACTOR	19	2
A031-08-01	KEY	20	2
HD-001	1/8 SS BALLS	21	4
A031-18-N	O-RING CHECK BOB W/NOSE	22	4
HJ-3-903	3-903	23	4
HJ-2-005	2-005	24	4
A031-19-02	PORT PLUG, HARDCOATED	25	4

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2 SPEED AUTOSHIFT PUMP

Disassembly Procedures:

1. Remove feed pipe from pump body and remove pump from panel.
2. Remove pump shaft snap rig (13) and shaft end washer (14), and slide pump shaft (18) out of pump housing
3. Remove piston keys (47) and keyed spacer washers (38). Slide piston assembly out of bottom of pump. Slide piston end rocker arms (23), large bore piston assemblies (24), rocker mid spacer (34), mid rocker arm (36), and small bore piston assembly off pump pivot (35). Pistons can then be removed from assembly, and piston seals (28, 43) can be carefully removed from pistons.
4. Remove the 9 port plugs (33, 53) from top and front of pump. Note: Springs inside are loaded and may shoot from your grasp if not careful. Remove check bobs (50) either by carefully turning pump upside down, or with small needle nose pliers. Remove the balls (29) from the pump body.
5. Unscrew shifting valve adjusting cap (3) {you may need to release the spring compression by backing off the socket head cap screw (1)}, and remove spring (4), spring poppet (6), ball (11), and sensing poppet (20).
6. Carefully remove the ball seat (12) and sensing poppet (20).

Rebuilding Procedures:

1. All parts should be cleaned of dirt and debris and all O-rings and seals should be removed and discarded.
2. Install new O-rings (52) onto check bob noses (50) and install into pump body. Make sure bobs seat properly into cavity. Install new O-rings (51) onto check port plugs (53), and install check springs (41) into port plugs using a small dab of lithium grease to hold spring in place. Install check port plugs with springs into pump body and screw back down. Note: Be careful to seat the spring into the check bobs before tightening them down. If the plugs bind, it may be a sign the springs have not seated.
3. Install new glyde ring (9) and O-ring (10) onto sensing poppet (20), and slide unit back into pump body. Install O-ring (7), ball seat (12), and ball (11) into pump body. Install spring poppet (6), insert spring (4) into shifting valve cap (3), and screw cap into pump body.
4. Check bore liners for signs of scratching or wear.
5. Install new piston seals (28, 43) onto pistons and re-install onto pump rocker assembly (reverse of the disassembly procedure #3)
6. Oil the pump pistons and slide assembly back into pump body.
7. Install front most keyed spacer (38) and center this and the pump rocker (36) with the front bearing hole. Replace the O-ring (17) on the pump shaft. Slide the pump shaft (18) {be sure it is oriented correctly} through the spacer (38), then rocker arms (36). Continue to slide pump shaft through rocker assembly. Install rear most spacer (38) and slide keys (47) into pump shaft grooves. Re-install rear bearing (15), washer (14), and snap ring (13).

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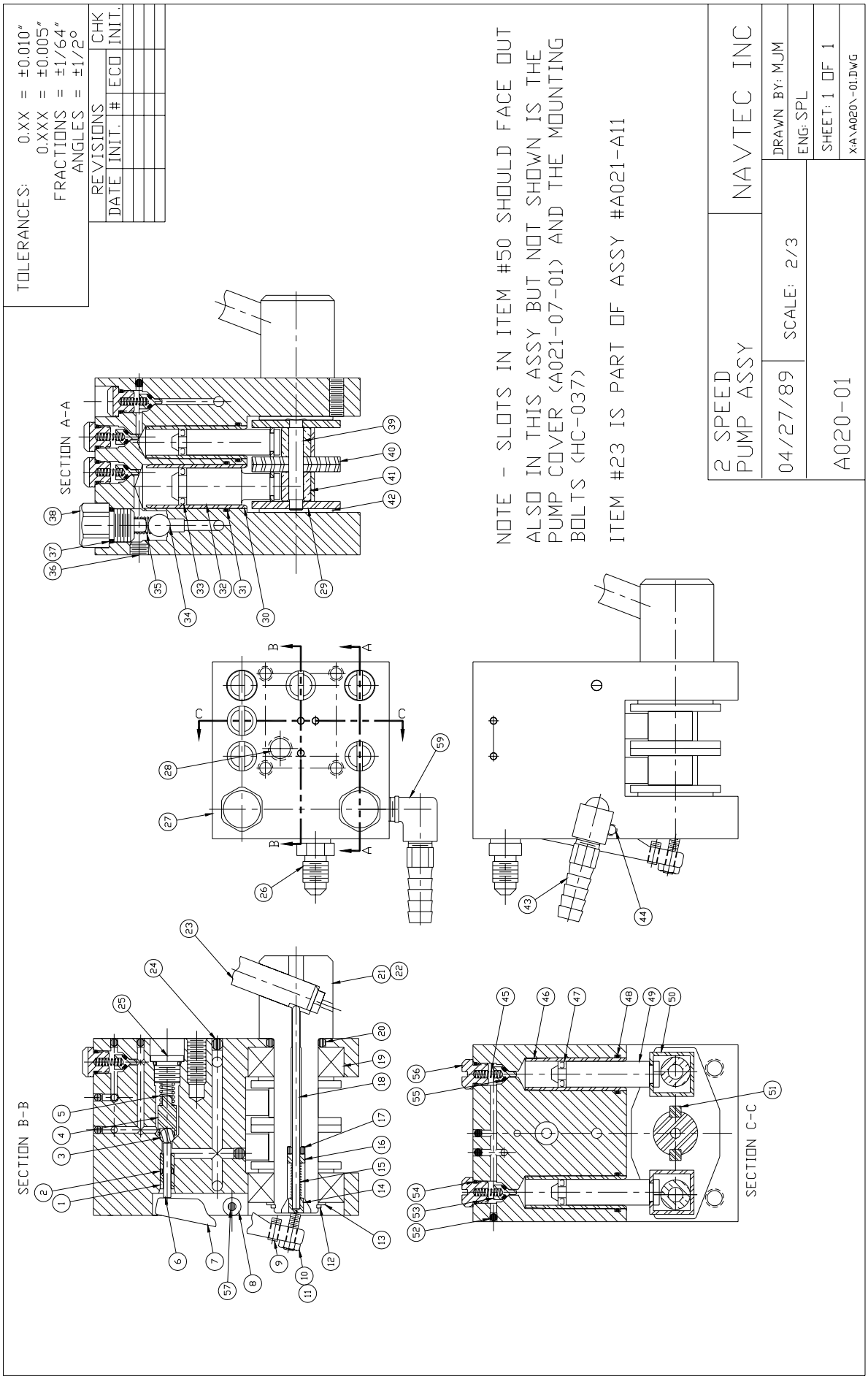

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PART NUMBER	DESCRIPTION	ITEM	QTY.
A031A03-P11	ASSY, 7/16 PUMP PISTON	0	2
A031A03-P12	ASSY, 5/8 PUMP PISTON	0	2
HC-043	3/8 -16 X 1 SHCS	0	1
A090-29	TITANIUM CYL. LABEL	0	1
A625A03-01	ASSY, SENSE POPPET, SHIFT VLV	0	1
HC-043	RELIEF VALVE SCREW	1	1
HJ-2-113	2-113	2	1
A625-02-01	ADJUSTING CAP, SHIFT VALVE	3	1
HF-033	SPRING, HX-2, GREEN	4	1
HJ-2-117	2-117	5	1
A625-04-01	SPRING POPPET, SHIFT VALVE	6	1
HJ-2-014	2-014	7	1
HH-008	PPS-1/8 PLUG STAINLESS STEEL	8	2
HI-003-01	28G00375 -51 GLYDE RNG SHAMBAN	9	1
HJ-2-008	2-008	10	1
HD-011-01	1/2 DIA. HARD STEEL BALL	11	1
A625-06-01	BALL SEAT, SHIFT VALVE	12	1
HG-002	5100-75H SNAP RING, WALDES	13	1
A021-17-01	SHAFT END WASHER	14	1
HC-107	BEARING FCJ12F 16-4	15	2
HD-004	3/16 SS BALLS	16	2
HJ-2-210	2-210	17	1
A021-12-003	PUMP SHAFT, AUTOSHIFT 21^, TI.	18	1
A625-03-01	SENSING POPPET, SHIFT VALVE	20	1
HB-079	4-FTX-SS STRT	21	1
A021-01-41	LT 2S AUTOSHIFT PUMP BODY, W/BL	22	1
A031-09-01	END ROCKER ARM	23	2
A031-03-P12	PUMP PISTON TYPE VI SPECIAL	24	2
A031-17-02	PUMP LINER, 5/8" BORE	25	2
HJ-2-018	2-018	26	2
A031-03P121	PISTON SLEEVE 5/8"	27	2
HM-002	12500375 PISTON SEAL -PUMP	28	2
HD-00-375	3/8 HARD STEEL BALLS	29	2
A031-02-02	CHECK SPRING(R'RY PMP & 2 SPD)	30	2
HH-006	PPS- 1/16 PLUG STAINLESS STEEL	31	2
HJ-3-906	3-906	32	2
A601-19-01	3/8 CK PORT PLUG, ROTARY PUMP	33	2
A021-19-01	ROCKER MID SPACER	34	2
A021-06-01A	2 SPD PUMP PIVOT -REV 12/88	35	2
A021-09-01	MID ROCKER ARM	36	1
A031-05-01	PIVOT SLEEVE	37	4
A021-18-01	SPACER WASHER	38	2
A625-05-01	SPRING GUIDE/SEAL SHIFT VALVE	39	1
HB-025	125HBL -6 -2 HS. BARB STRT	40	2
A031-02-01	CHECK SPRING	41	7
A031-17-01	PUMP LINER, 7/16" BORE	42	2
HM-001	12500 187 PIST SEAL -PMP	43	2
HJ-2-015	2-015	44	2
A031-03P111	PISTON SLEEVE 7/16"	45	2
A031-04-01	PISTON RETRACTOR	46	4
A021-08-01	KEY	47	2
A031-03-P11	PUMP PISTON TYPE VI SPECIAL	48	2
HD-001	1/8 SS BALLS	49	7
A031-18-N	O-RING CHECK BOB W?NOSE	50	7
HJ-3-903	3-903	51	7
HJ-2-005	2-005	52	7
A031-19-02	PORT PLUG, HARDCOATED	53	7
HB-022	1202P-2-2 ELB. BRASS	54	1

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HAND ROCKER PUMPS

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			Std.	Lg. Bore	Millenium	Old
PUMP		Single Speed	2-S Auto	2-S Auto	Integral	Integral
Assy #		A030-02-01	A020-0301	A020-0401	A370-LE-???	A370-A-???
Action (Single or Double)		Double	Double	Double	Single	Single
Small Bore diameter	in	0.440	0.440	0.440	0.500	0.440
Large Bore diameter	in		0.628	0.878	0	
Crank Arm		1.042	1.042	1.042	1.042	1.042
Crank half angle		21.3	21.3	21.3	23.5	23.5
Stroke (Ideal)		0.757	0.757	0.757	0.831	0.831
Mech stroke loss		0.025	0.025	0.025	0.025	0.025
Stroke (actual)		0.732	0.732	0.732	0.806	0.806
Vol/cycle						
Small bore	cu-in	0.223	0.223	0.223	0.158	0.123
Large bore	cu-in		0.454	0.886		
Both	cu-in	0.223	0.676	1.109	0.158	0.123
	ml	3.648	11.079	18.173	2.593	2.008
Typical shift pressure.	psi		1000	600		
		One cycle equals two strokes			One cycle equals one stroke	

ROTARY PUMP

Part number A614

Max. RPM 200

	Output flow		Theoretical Input Torque		5000 psi pump	7500 psi pump
					Bank shift out	Bank shift -out
Banks	cu-in/rev	L/rev	#-in/psi	M-Nt/Pa	psi (typ.)	psi (typ.)
HP	0.285	0.005	0.045	7.42659E-07	5000	7500
2HP	0.570	0.009	0.091	1.48532E-06	2600	3900
2HP+LP	1.167	0.019	0.186	3.04311E-06	1267	1900
2HP+2LP	1.764	0.029	0.281	4.60091E-06	833	1250

OPEERATING NAVTEC PUMPS UNDER CONDITIONS OF SUCTION LIFT

Stephen P, Loutrel, Ph.D.
Director of Engineering
12 Feb. 2001

For optimum trouble-free operation, Navtec recommends that the hydraulic reservoir be mounted so that the oil level is above the top of the pump. However, this is difficult or impossible to achieve in some applications. A good example is a system that combines both a powered pump that is mounted in the engine room and a Navtec panel that is mounted on deck. As the systems are interconnected, they must use a common reservoir. Generally the powered pump reservoir is down in the engine room. If certain guidelines are met, this system can operate satisfactorily.

1. Choice of Navtec pump: Due to its larger displacement at low pressure, Navtec recommends that in cases of significant suction lift the two speed pump be used.
2. Hose run: The hose should generally be 3/8" I.D. hose and as short as possible. The hose should be routed so that it slopes upward to the pump with as few dips as possible. Any dips will tend to trap air bubbles that may be released due to boat motion and then reach the pump- causing it to lost suction.
3. The suction line and return line must be completely separate all the way into the reservoir. Air coming back into the reservoir from the return line must not be pulled into the suction line.
4. The suction and return connections must go into the reservoir near the bottom in a location such that they will always be covered with a significant depth of oil.
5. Provision should be made for bleeding air from the suction line should it collect there – either due to back flow at the pump or air entrapped in the oil coming out of solution.
    a. A system 50 panel with a selector valve can be bled by putting the 4-way valve in an intermediate position to hold the cylinder loads. The release valve can then be opened and the pump can be operated until it clears the air.
    b. A FAC valve system has no built in way to bleed it. The standard method is to remove a cylinder hose and pump oil from it until the air is removed. This is not practical as a quick operational fix. There are at least too alternatives:
        i. Choose the FAC panel with an extra valve. The output (cylinder connection) of this valve can be connected to the return line. To bleed the pump suction, turn the bleed FAC valve to the pump position and pump until the pump is cleared of air.
        ii. Add a "T" in the line from the pump to the manifold or use one of the extra connections in the manifold to connect a high pressure (5000 psi) valve between the pump high-pressure output line and the return line. To bleed the pump, open this valve and pump until the pump is cleared of air.

PUMP BLEEDING THEORY:

When the Navtec pump is operating at high pressure, if air enters the pump chamber from the supply line, it is compressed on the discharge stroke. If the volume of air in the chamber (at the suction pressure) is slightly more than the displacement of the piston, it is compressed on the discharge stroke but does not reach sufficient pressure to open the output check valve against system pressure. In this case, the air is not expelled and simply expands and is compressed at each successive stroke. For the pump to pump air (required to clear air or to gain suction if the line is empty of oil) it must be pumping to a discharge pressure that is only a few psi above atmospheric. This requires a clear return passage back to the reservoir.

We have run tests on suction lift using a standard Navtec 2-speed pump with the following results:

Test series #1:

1. Suction lift = 9 feet (pump is 9 feet above the oil level in the reservoir)
2. Hose length = 10 feet
3. To clear the pump – no oil in the hose at start – took 48 pump cycles (strokes). After it was cleared the first time, we tested it after it had been unused for a day and then after 5 more days and it pumped immediately in both cases – no air.

Test series #2:

1. We then increased the hose length to 26 feet with the same suction lift. There were two long horizontal runs – they did not slope upwards as recommended. It took 81 strokes to fill the empty suction line and start pumping at pressure.
2. A day later it took 8 strokes with the bleed valve open to clear the air.
3. The next day it took 7 strokes with the bleed valve open to clear the air.
4. For the next 3 days it took a decreasing number of bleeding strokes to get it started. Each time the pump was bled for an additional 60 strokes to clear any trapped air. Finally after these extra bleedings the response was immediate – the air had been cleared. If the runs had all been uphill, I suspect the first startup bleeding might have been sufficient. This sequence of steps strongly supports the desirability of including a build in bleeding system such as an extra FAC valve on any pump that is subjected to significant suction lift. A bleed valve is also a good idea for a system with a long suction line, especially if it has dips in it even if there is little or no suction lift.

The problem is less severe with a lower suction lift, a shorter hose run, and a smoothly upward hose run. Conservatively, putting in a bleed valve anytime there is any suction lift will make the system very reliable and easy to bleed even in the event that air enters the suction line. In practice, there are many successful Navtec hydraulic systems without bleed valves, which have suction lifts of up to three feet (1 meter), hose lengths of up to 10 feet (3 meters), and a smooth rise, without dips in the suction line.

ALTERNATIVES:

It is sometimes possible to mount an auxiliary reservoir above the Navtec pump. The pump draws suction from this reservoir and all returns from the Navtec system go into this reservoir. Any fluid to the Navtec system from the powered system in the engine room will also end up in the lower reservoir causing it to overflow. For this reason, there must be a large overflow line down to the lower reservoir. This line must be straight enough and big enough to also work as an air vent to the lower reservoir. For this to happen, it must all drain down to the lower reservoir leaving the tube empty.

HYDRAULIC OIL

Navtec specifies Shell Tellus T15 hydraulic fluid for its hydraulic equipment. This is a premium, anti-wear oil with a viscosity grade of ISO 15. The following lists oil manufacturers and their products, which are comparable to Shell Tellus T15 and meet the following general specifications:

Hydraulic oils used with Navtec equipment should be premium petroleum based, anti-wear oils that have anti-foam and anti-corrosion additives. They should be suitable for in-line piston pumping systems at high pressure and high flow rates. They should have the following minimum properties: viscosity grade or ISO 15, viscosity index of 95 and a pour point of –10 degrees F (-20 degrees C)

Navtec Brand Oil, Starting JANUARY 2003
Contact your Navtec supplier.

	Viscosity cST	
	@ 60F	@ 30F
Navtec Oil	35	76

Suitable Oils – standard systems, normal temperature range – including Whitbread (Volvo) race boats.

Shell Tellus T15	35	76
Texaco Rando HDZ15	37	100
Mobil DTE11M	37	87
Royal Purple Syndraulic 15	38	93

For use on very small, long passages such as jumper cylinders with 1/8"od tube or extremely low temperatures:

MIL 5606 - Aircraft/missle oil.	24	41	Low lubricity – will give shorter seal and bearing life.
Royal Purple Syndraulic 10 (ISO 10 oil)	23	51	Not tested by Navtec, probably reduced lubricity

In warm climates the following are acceptable:

MANUFACTURER	AREA	BRAND NAMES
Castrol	Europe	Hyspin AWS 32
Chevron	North America & Europe	EP Hyd. 32
Gulf	North America & Europe	Harmony AW 32
Shell	Europe	Tellus Oil 37
Texaco	North America	Rando Oil HD 32

Emergency use if no approved fluid is available:

Dextron III Automatic Transmission Fluid	May reduce seal life, viscosities estimated

NAVTEC RESERVOIRS

SPECIFICATIONS

Navtec supplies a 2 or 4 quart reservoir with all hydraulic panels, other sizes are available by request as well as kits to build custom pressurized reservoirs. When selling large cylinders or vangs, we must ask if the customer wishes us to provide the required larger reservoir. When sizing a reservoir and specifying the amount of oil to be added to the system the rule of thumb is: with all functions filled with oil, there should be 0.6 times the total system volume left in the reservoir. With all functions extended (empty of oil), the reservoir will have 1.6 times the total system volume of oil in it. The reservoir must be about 2 times the total system volume to allow for airspace above the oil so oil is not lost in a seaway as the it sloshes around.

AVAILABLE RESERVOIRS

BLOW MOLDED:

1 qt. A290-A-MR02
2 qt. A290-A-MR04

PVC PIPE, 5":

Length sized to system (up to 10 feet) A290-A-05

PVC PIPE, 8":

Length sized to system (up to 10 feet) A290-A-08

COMPOSITE:

10.4 qt. A290-CF-04
15.6 qt. A290-CF-02

PRESSURIZED:

These welded reservoirs require custom engineering for every application.

RESERVOIR SIZING CALCULATIONS

Total System Volume (Vs)= Cylinders+Vangs+Hoses (neglect volume in filters and panels).
Mathematically this means Vs=Vc+Vv+Vh

HOSE VOLUMES (Vh)

-3 Hose: .028*INCHES of length= Vh
-4 Hose: .049*INCHES of length= Vh
-6 Hose: .110*INCHES of length= Vh

CYLINDER VOLUMES (Vc)

From Catalog, divide maximum force in POUNDS by 5000 to get square inches of area on rod side of piston. Multiply this by the stroke and you have the volume of a pull cylinder.

VANG VOLUMES (Vv)

Same procedure as cylinder.

RESERVOIR VOLUME REQUIRED=Vr=2*(Vh+Vc+Vv) or 2*Vs

OIL VOLUME REQUIRED FOR A SYSTEM=1.6*(Vh+Vc+Vv) or 1.6*Vs

Source:
N:\Marketing\Manuals\Tech Manual\1998 Version\Section 4 Installation and Instructions\Not checked or formatted\4.14

HYDRAULICS REPAIR TOOLS

Cylinders

PART NUMBER	DESCRIPTION
A251-51-006	-6 Piston Seal Pusher (Cylinder & Vang)
A251-51-010	-10 Piston Seal Pusher (Cylinder & Vang)
A251-51-012	-12 Piston Seal Pusher (Cylinder & Vang)
A251-51-017	-17 Piston Seal Pusher (Cylinder & Vang)
A251-51-022	-22 Piston Seal Pusher (Cylinder & Vang)
A251-51-030	-30 Piston Seal Pusher (Cylinder & Vang)
A251-51-040	-40 Piston Seal Pusher (Cylinder & Vang)
A251-51-060	-60 Piston Seal Pusher (Cylinder & Vang)
A251-51-090	-90 Piston Seal Pusher (Cylinder & Vang)
A251-51-120	-120 Piston Seal Pusher (Cylinder & Vang)
A251-52P-01	-6 Cylinder Rod Seal Insertion Tool Pusher
A251-52P-02	-10 Cylinder Rod Seal Insertion Tool Pusher
A251-52P-03	-6 Vang Rod Seal Insertion Tool Pusher
A251-52P-04	-12/17 Cylinder Rod Seal Insertion Tool Pusher
A251-52P-05	-22 Cylinder / -10 Vang Rod Seal Insertion Tool Pusher
A251-52P-06	-30 Cylinder / -12 Vang Rod Seal Insertion Tool Pusher
A251-52P-07	-40 Cylinder / -17 & -22 Vang Rod Seal Insertion Tool Pusher
A251-52P-08	-30 & -40 Vang / -60 Cylinder Rod Seal Insertion Tool Pusher
A251-52P-09	-60 Vang Rod Seal Insertion Tool Pusher
A251-52P-10	-90 Vang Rod Seal Insertion Tool Pusher
A251-52S-01	-6 Cylinder Rod Seal Insertion Tool Sleeve
A251-52S-02	-10 Cylinder Rod Seal Insertion Tool Sleeve
A251-52S-03	-6 Vang Rod Seal Insertion Tool Sleeve
A251-52S-04	-12/17 Cylinder Rod Seal Insertion Tool Sleeve
A251-52S-05	-22 Cylinder / -10 Vang Rod Seal Insertion Tool Sleeve
A251-52S-06	-30 Cylinder / -12 Vang Rod Seal Insertion Tool Sleeve
A251-52S-07	-40 Cylinder / -17 & -22 Vang Rod Seal Insertion Tool Sleeve
A251-52S-08	-30 & -40 Vang / -60 Cylinder Rod Seal Insertion Tool Sleeve
A251-52S-09	-60 Vang Rod Seal Insertion Tool Sleeve
A251-29T006	-6 Seal Mounting Nose Tool
A251-29T010	-10 Seal Mounting Nose Tool
A251-29T012	-12 Seal Mounting Nose Tool
A251-29T017	-17 Seal Mounting Nose Tool
A251-29T022	-22 Seal Mounting Nose Tool
A251-29T030	-30 Seal Mounting Nose Tool
A251-29T040	-40 Seal Mounting Nose Tool
A251-29T060	-60 Seal Mounting Nose Tool

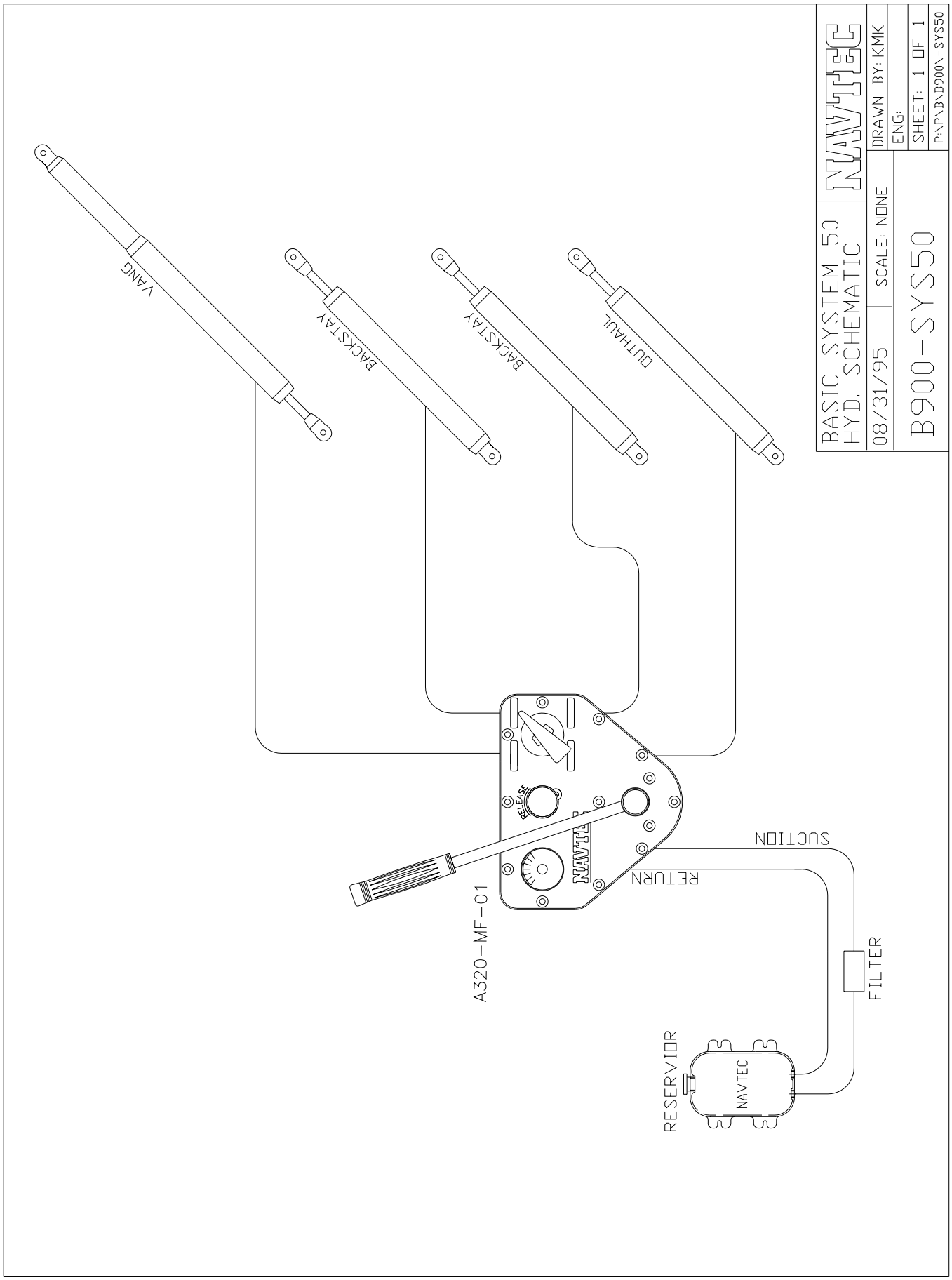
	PART NUMBER	DESCRIPTION
Vangs	A851-TI-006	-6 Piston Insertion Tool
	A851-TI-010	-10 Piston Insertion Tool
	A851-TI-012	-12 Piston Insertion Tool
	A851-TI-017	-17 Piston Insertion Tool
	A851-TI-022	-22 Piston Insertion Tool
	A851-TI-030	-30 Piston Insertion Tool
	A851-TI-040	-40 Piston Insertion Tool
	A851-TI-060	-60 Piston Insertion Tool
	A851-TI-090	-90 Piston Insertion Tool
	A851-TI-120	-120 Piston Insertion Tool
	A851-TI-140	-140 Piston Insertion Tool
	A851-TC-A	Vang Charging Tool
	A851-TD-A	Vang Discharging Tool
Integrals	A370-15H	Integral Coupler Bushing Tool Handle w/ Locking Pin
	A370-151-6/10	-6/10 Coupler Bushing Tool End Fittings
	A370-151-17	-17 Coupler Bushing Tool End Fittings
	A370-151-22	-22 Coupler Bushing Tool End Fittings
	A061-01-ST	Gauge O-ring Insertion Tool (can be used on panels as well)
Valves	A341-03-T1	Fac Valve Port Plug Wrench
	A351-2T-01	Sys V Release Valve Plug Tool
Push Buttons	A601-20B01	A440 Check Port Insert Tool

SOURCE: S:\SALES TOOLS\HYDRAULIC REPAIR TOOLS.xls

SEAL KITS

	PART NUMBER	DESCRIPTION
Pump Seal & Repair Kits	A020-SK-01	Seal Kit, Two Speed Pump
	A020-SK-02	Seal Kit, Autoshift Pump
	A020-SK-03	Seal Kit, 7/8 Bore Pump
	A020-RK-01	Repair Kit, Two Speed Pump
	A020-RK-02	Repair Kit, Lt Autoshift Pump
	A020-RK-03	Repair Kit, 7/8 Bore Pump
	A030-SK-01	Seal Kit, One Speed Pump
	A030-RK-01	Repair Kit, One Speed Pump
Valve Seal & Repair Kits	A280-SK-02	Seal Kit, System 50 Valve Block
	A310-SK-01	Seal Kit, System V Valve
	A310-RK-01	Repair Kit, System V Valve
	A400-01-SK	Seal Kit, System 50 Valve
	A330-SK-01	Seal Kit, System VI Valve
	A330-RK-01	Repair Kit, System VI Valve
	A340-SK-01	Seal Kit, 5000/7500 FAC Valve
	A340-RK-01	Repair Kit, 5000/7500 FAC Valve
	A440-SK-01	Seal Kit, Push Button Quick Release Valve
	A311-RVA-01	System V Release Valve
Cylinder Seal Kits	A250-CSK-006	Seal Kit, -6 Cylinder
	A250-CSK-010	Seal Kit, -10 Cylinder
	A250-CSK-012	Seal Kit, -12 Cylinder
	A250-CSK-017	Seal Kit, -17 Cylinder
	A250-CSK-022	Seal Kit, -22 Cylinder
	A250-CSK-030	Seal Kit, -30 Cylinder
	A250-CSK-040	Seal Kit, -40 Cylinder
	A250-CSK-060	Seal Kit, -60 Cylinder
	A250-CSK-090	Seal Kit, -90 Cylinder
	A250-CSK-110	Seal Kit, -110 Cylinder
	A250-CSK-150	Seal Kit, -150 Cylinder
Vang Seal Kits	A850-SK-006	Seal Kit, -6 Vang
	A850-SK-010	Seal Kit, -10 Vang
	A850-SK-012	Seal Kit, -12 Vang
	A850-SK-017	Seal Kit, -17 Vang
	A850-SK-022	Seal Kit, -22 Vang
	A850-SK-030	Seal Kit, -30 Vang
	A850-SK-040	Seal Kit, -40 Vang
	A850-SK-060	Seal Kit, -60 Vang
	A850-SK-060B	Seal Kit, -60B Vang
	A850-SK-090	Seal Kit, -90 Vang
	A850-SK-110	Seal Kit, -110 Vang
	A850-SK-110B	Seal Kit, -110B Vang
Integral Seal Kits	A370-SK-010	Seal Kit, -6/10 Integral
	A370-SK-017	Seal Kit, -12/17 Integral
	A370-SK-022	Seal Kit, -22 Integral
	A370-SKLE-010	Seal Kit, LE Integral, -6/-10
	A370-SKLE-017	Seal Kit, LE Integral, -12/-17
	A370-SKLE-022	Seal Kit, LE Integral, -22

SOURCE: S:\SALES TOOLS\SEAL KITS.xls..



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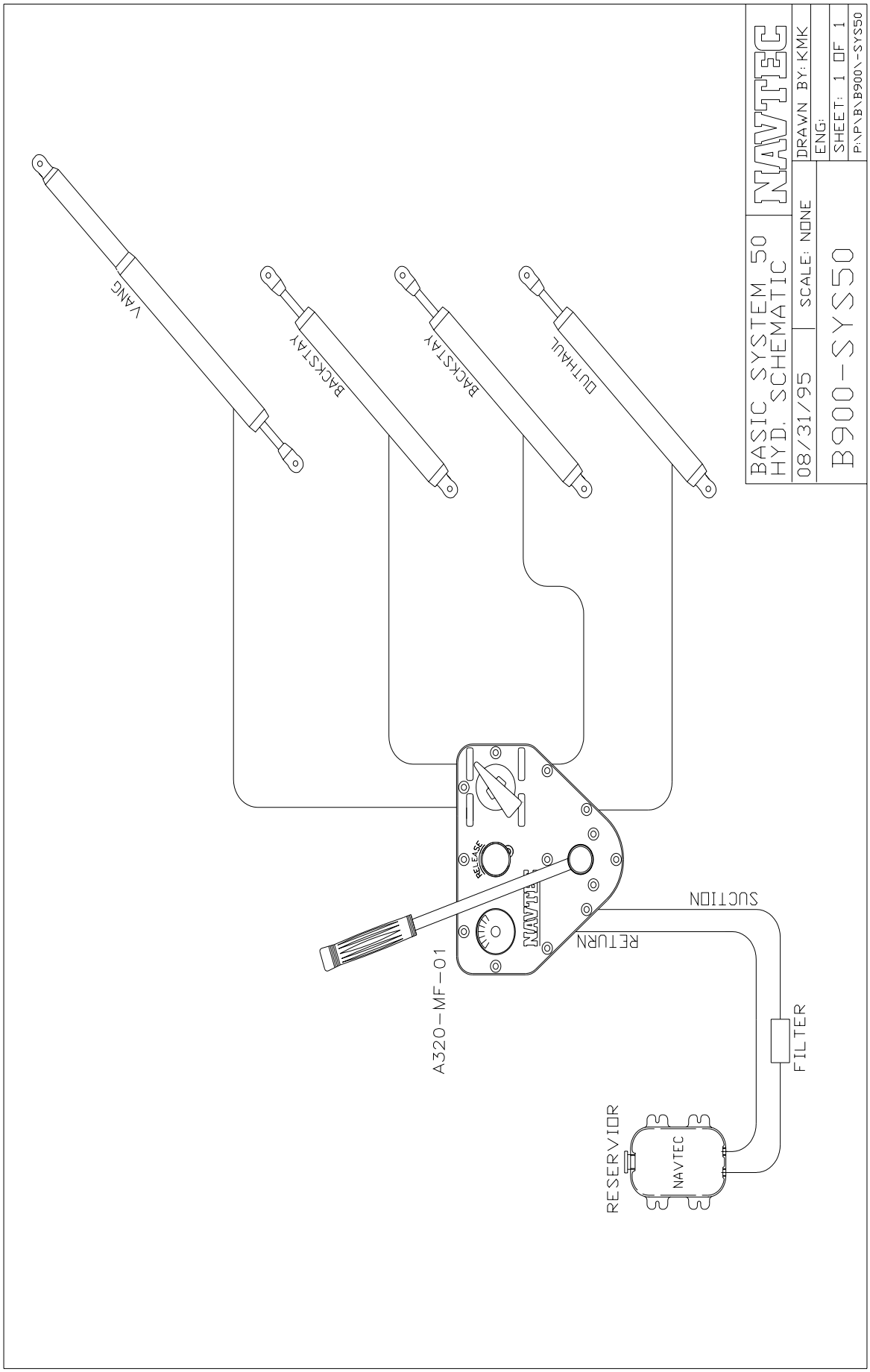

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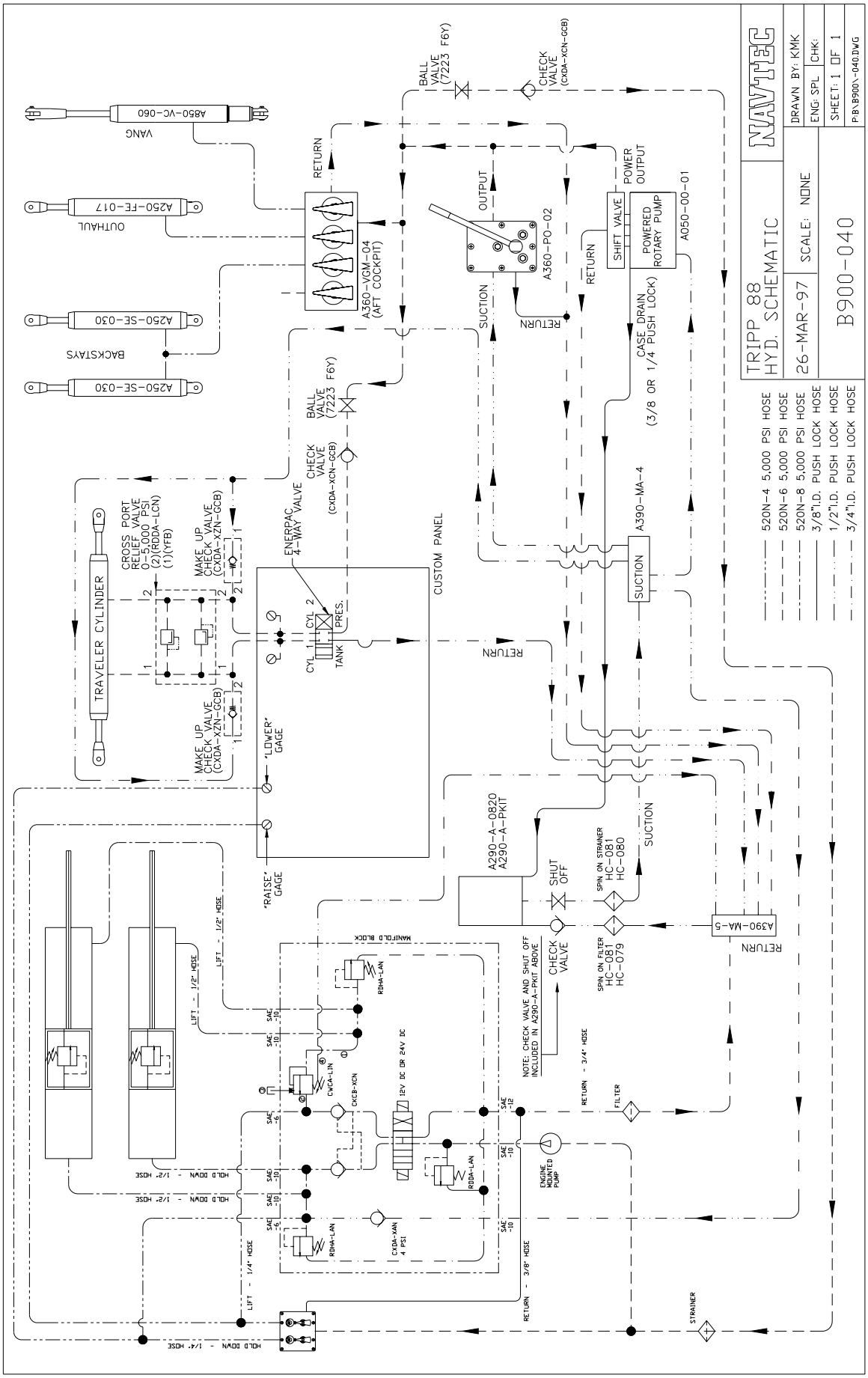

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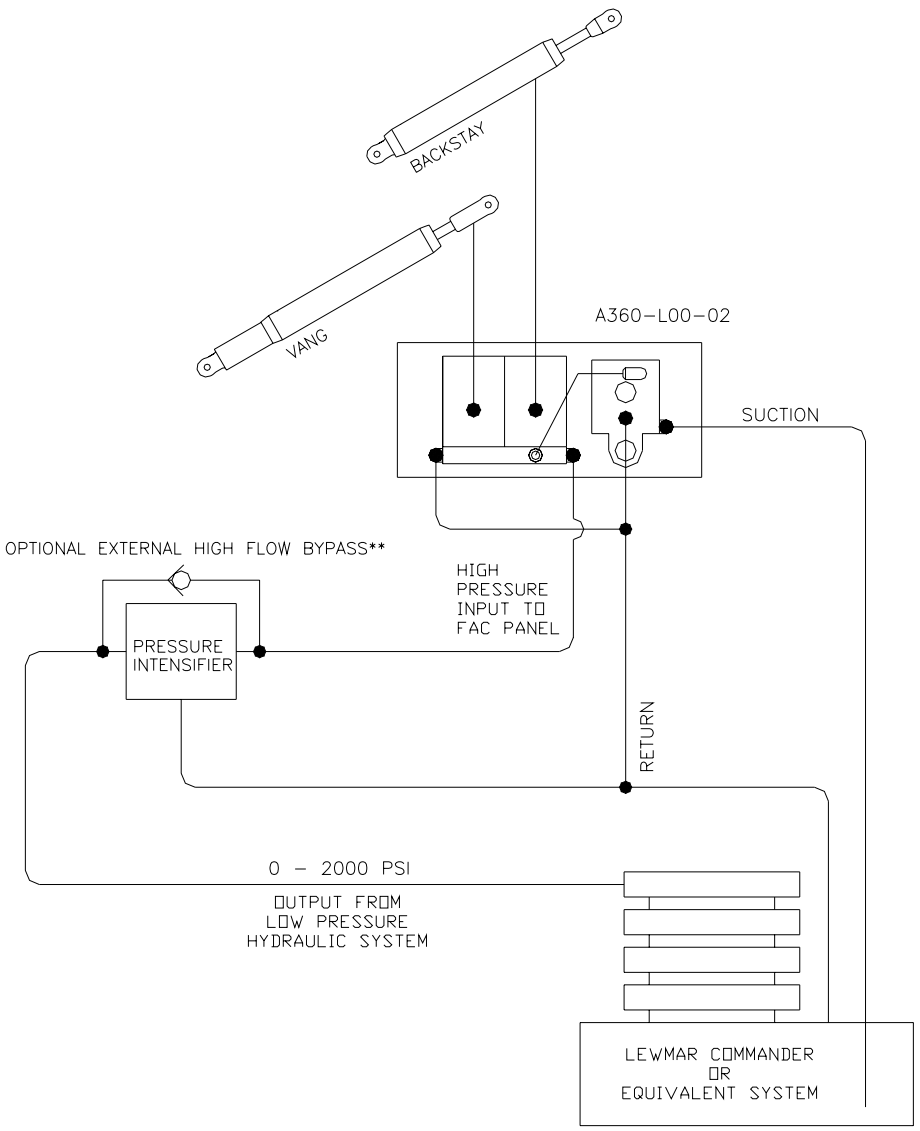


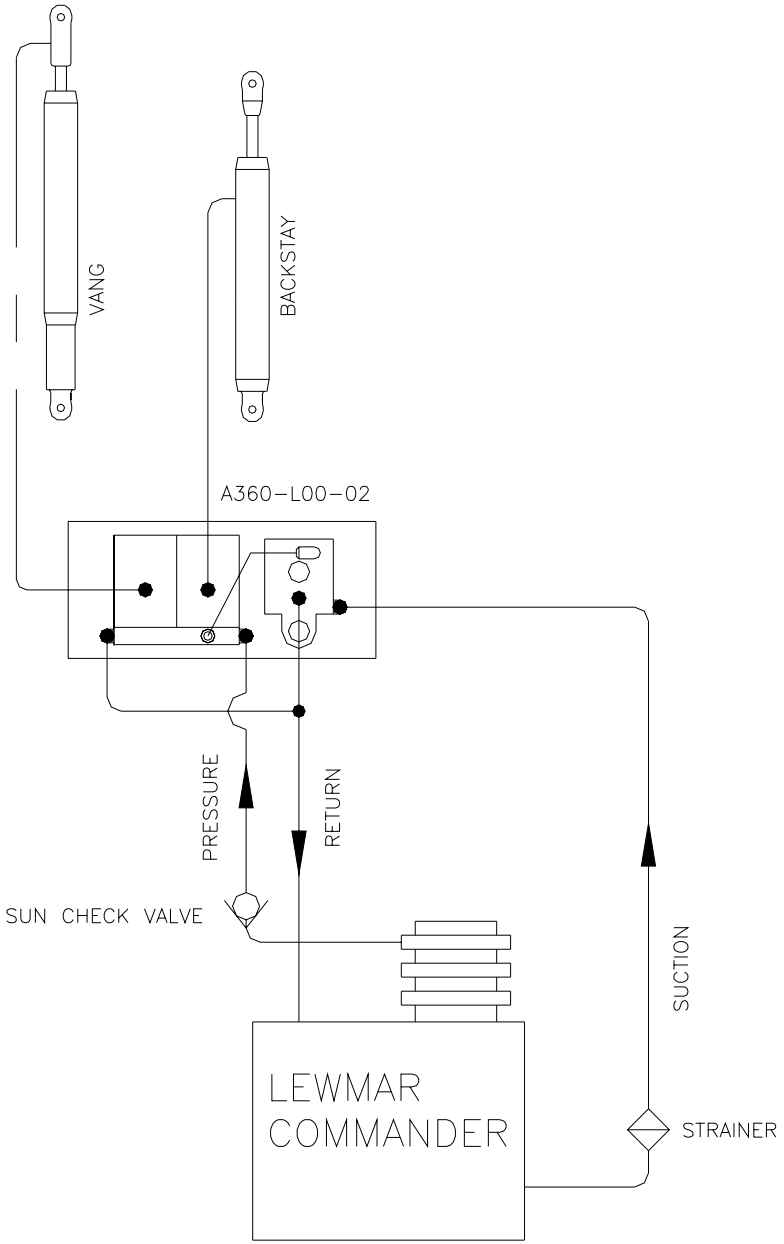
TOLERANCES:	
X.XX	= ± 0.010"
X.XXX	= ± 0.005"
FRACTIONS	= ± 1/64"
ANGLES	= ± 1/2°

REVISIONS			CHK
DATE	INIT.	#	INIT.

**
INTENSIFIER HAS A BUILT IN BYPASS CIRCUT
WHICH WILL HANDLE BYPASS FLOW TO 6 G.P.M.
FOR HIGHER BYPASS FLOWS USE AN EXTERNAL BYPASS CIRCUT

HYD SCHEMATIC COMDR,INTSFR,PNL/PMP	NAVTEC NORSEMAN GIBB
17OCT2000 / SCALE: 1:1	DRAWN BY: KMK
	ENG: SPL
B900-093	SHEET: 1 OF 1
	P:.DWG

A-ENG



LEGEND

520N-3 KEVLAR HOSE

520N-4 KEVLAR HOSE

3/8"I.D. PUSH LOCK HOSE

HYD SCHEMATIC COMMANDER, PANEL/PUMP	NAVTEC NORSEMAN GIBB
23FEB2000 SCALE: 1:1	DRAWN BY: KMK
	ENG: SPL
B900-093	SHEET: 1 OF 1
	P:.DWG

Source file: X:\PA\B900\-093.dwg

\A250\SPECS

25-Oct-02

NAVTEC HYDRAULIC CYLINDER BASIC SPECIFICATIONS

S. P. Loutrel

			ROD	PRESS	**PRESSURE (psi)**						**XL & Mast Jack only**			Rod	Rod
			DIA	AREA	500	1,000	2,000	3,000	4,000	5,000	6,000	7,000	7,500	% Load	Str.
SIZE	M19	P	0.000	0.474	240	470	950	1,420	1,900	2,370	2,850	3,300	3,600	@ 5kpsi	
TUBE ID	0.777	M	0.313	0.397	200	400	790	1,190	1,590	1,990	2,380	2,780	2,980		
TUBE OD (not M)	1.315	C													
PIN	0.375	V			**FORCES AT ABOVE PRESSURES**										
SIZE	-6, M25	P	0.000	0.789	390	790	1,580	2,370	3,200	3,900	4,700	5,500	5,900		
TUBE ID	1.002	M	0.375	0.678	340	680	1,360	2,030	2,710	3,400	4,100	4,700	5,100		
TUBE OD (not M)	1.315	C	0.437	0.639	320	640	1,280	1,920	2,550	3,200	3,800	4,500	4,800	51%	6,300
PIN	0.437	V	0.625	0.482	240	480	960	1,450	1,930	2,410	2,890	3,400	3,600		
SIZE	-10, M33	P	0.000	1.356	680	1,360	2,710	4,100	5,400	6,800	8,100	9,500	10,200		
TUBE ID	1.314	M	0.438	1.206	600	1,210	2,410	3,600	4,800	6,000	7,200	8,400	9,000		
TUBE OD (not M)	1.660	C	0.500	1.160	580	1,160	2,320	3,500	4,600	5,800	7,000	8,100	8,700	56%	10,300
PIN	0.500	V	0.750	0.914	460	910	1,830	2,740	3,700	4,600	5,500	6,400	6,900		
SIZE	-12, M39	P	0.000	1.831	920	1,830	3,700	5,500	7,300	9,200	11,000	12,800	13,700		
TUBE ID	1.527	M	0.500	1.635	820	1,630	3,300	4,900	6,500	8,200	9,800	11,400	12,300		
TUBE OD (not M)	2.000	C	0.625	1.525	760	1,520	3,000	4,600	6,100	7,600	9,100	10,700	11,400	61%	12,500
PIN	0.625	V	0.875	1.230	620	1,230	2,460	3,700	4,900	6,200	7,400	8,600	9,200		
SIZE	-17, M45	P	0.000	2.480	1,240	2,480	5,000	7,400	9,900	12,400	14,900	17,400	18,600		
TUBE ID	1.777	M	0.625	2.173	1,090	2,170	4,300	6,500	8,700	10,900	13,000	15,200	16,300		
TUBE OD (not M)	2.250	C	0.625	2.173	1,090	2,170	4,300	6,500	8,700	10,900	13,000	15,200	16,300	62%	17,500
PIN	0.625	V	1.000	1.695	850	1,690	3,400	5,100	6,800	8,500	10,200	11,900	12,700		
SIZE	-22, M52	P	0.000	3.227	1,610	3,200	6,500	9,700	12,900	16,100	19,400	22,600	24,200		
TUBE ID	2.027	M	0.688	2.856	1,430	2,860	5,700	8,600	11,400	14,300	17,100	20,000	21,400		
TUBE OD (not M)	2.500	C	0.750	2.785	1,390	2,790	5,600	8,400	11,100	13,900	16,700	19,500	20,900	62%	22,500
PIN	0.750	V	1.000	2.442	1,220	2,440	4,900	7,300	9,800	12,200	14,600	17,100	18,300		
SIZE	-30, M64	P	0.000	5.015	2,510	5,000	10,000	15,000	20,100	25,100	30,100	35,100	37,600		
TUBE ID	2.527	M	0.813	4.497	2,250	4,500	9,000	13,500	18,000	22,500	27,000	31,500	33,700		
TUBE OD (not M)	3.250	C	0.875	4.414	2,210	4,400	8,800	13,200	17,700	22,100	26,500	30,900	33,100	74%	30,000
PIN	0.875	V	1.250	3.788	1,890	3,800	7,600	11,400	15,200	18,900	22,700	26,500	28,400		
SIZE	-40, M77	P	0.000	7.220	3,600	7,200	14,400	21,700	28,900	36,100	43,300	50,500	54,200		
TUBE ID	3.032	M	1.000	6.435	3,200	6,400	12,900	19,300	25,700	32,200	38,600	45,000	48,300		
TUBE OD (not M)	4.000	C	1.000	6.435	3,200	6,400	12,900	19,300	25,700	32,200	38,600	45,000	48,300	89%	36,000
PIN	1.000	V	1.250	5.993	3,000	6,000	12,000	18,000	24,000	30,000	36,000	42,000	44,900		
SIZE	-60	P	0.000	9.798	4,900	9,800	19,600	29,400	39,200	49,000	58,800	68,600	73,500		
TUBE ID	3.532	M													
TUBE OD (not M)	4.500	C	1.250	8.571	4,300	8,600	17,100	25,700	34,300	42,900	51,400	60,000	64,300	73%	59,000
PIN	1.250	V	1.500	8.031	4,000	8,000	16,100	24,100	32,100	40,200	48,200	56,200	60,200		

\A250\SPECS

25-Oct-02

NAVTEC HYDRAULIC CYLINDER BASIC SPECIFICATIONS

S. P. Loutrel

			ROD	PRESS	PRESSURE (psi)						XL & Mast Jack only			Rod	Rod
			DIA	AREA	500	1,000	2,000	3,000	4,000	5,000	6,000	7,000	7,500	% Load	Str.
SIZE	-90	P	0.000	12.768	6,400	12,800	25,500	38,300	51,100	63,800	76,600	89,400	95,800		
TUBE ID	4.032	M													
TUBE OD	5.500	C	1.250	11.541	5,800	11,500	23,100	34,600	46,200	57,700	69,200	80,800	86,600	64%	90,000
PIN	1.375	V	1.875	10.007	5,000	10,000	20,000	30,000	40,000	50,000	60,000	70,000	75,100		
SIZE	-110	P	0.000	16.131	8,100	16,100	32,300	48,400	64,500	80,700	96,800	112,900	121,000		
TUBE ID	4.532	M													
TUBE OD	6.000	C	1.375	14.646	7,300	14,600	29,300	43,900	58,600	73,200	87,900	102,500	109,800	63%	117,000
PIN	1.520	V	2.125	12.585	6,300	12,600	25,200	37,800	50,300	62,900	75,500	88,100	94,400		
SIZE	-150	P	0.000	19.887	9,900	19,900	39,800	59,700	79,500	99,400	119,300	139,200	149,200		
TUBE ID	5.032	M													
TUBE OD	7.000	C	1.500	18.120	9,100	18,100	36,200	54,400	72,500	90,600	108,700	126,800	135,900	60%	150,000
PIN	1.750	V	2.375	15.457	7,700	15,500	30,900	46,400	61,800	77,300	92,700	108,200	115,900		
SIZE *	-195	P	0.000	25.967	13,000	26,000	51,900	77,900	103,900	129,800	155,800	181,800	194,800		
TUBE ID	5.750	M													
TUBE OD	8.000	C	1.875	23.206	11,600	23,200	46,400	69,600	92,800	116,000	139,200	162,400	174,000	59%	195,000
PIN	2.125	V	2.750	20.028	10,000	20,000	40,100	60,100	80,100	100,100	120,200	140,200	150,200		
SIZE *	-260	P	0.000	33.511	16,800	33,500	67,000	100,500	134,000	167,600	201,100	234,600	251,300		
TUBE ID	6.532	M													
TUBE OD	9.000	C	2.125	29.964	15,000	30,000	59,900	89,900	119,900	149,800	179,800	209,700	224,700	58%	260,000
PIN	2.437	V	3.125	25.841	12,900	25,800	51,700	77,500	103,400	129,200	155,000	180,900	193,800		

														MJ only
MAST JACKS														10,000
SIZE	-40	P	0.000	3.987	1,990	4,000	8,000	12,000	15,900	19,900	23,900	27,900	29,900	39,900
TUBE ID	2.253													
TUBE OD	4.000													
SIZE	-70	P	0.000	7.225	3,600	7,200	14,400	21,700	28,900	36,100	43,300	50,600	54,200	72,200
TUBE ID	3.033													
TUBE OD	5.250													
SIZE	-125	P	0.000	12.775	6,400	12,800	25,500	38,300	51,100	63,900	76,600	89,400	95,800	127,700
TUBE ID	4.033													
TUBE OD	7.000													

* These sizes are tentative or subject to change based on tube availability. Consult Navtec for availability

P = PUSH SIDE, M = M CYL PULL SIDE, C = STD. CYL PULL SIDE, V = VANG PULL SIDE