# Table of Contents

# 1 Operating Parameters

| GENERAL SPECIFICATIONS | |
|---|---|
| RATED PULL | 25,000 lb |
| HYDRAULIC PRESSURE @ RATED PULL (not including charge pressure, at full displacement on motors) | 2,650 PSI |
| THEORETICAL PULL per PSI (differential across motors, charge pressure to be accounted for) | 9.4 lb/PSI |
| RATED PUSH | 25,000 lb |
| MAXIMUM SPEED | 200 ft/min |
| OIL FLOW @ MAXIMUM SPEED | 50 Usgpm |
| INJECTOR WIDTH | 32” |
| INJECTOR DEPTH (in direction of guide arch) | 42.5” |
| INJECTOR HEIGHT (base to top of cage not incl. lift eyes) | 62” |
| INJECTOR WEIGHT (incl. stripper, stripper mount, cage and 60”arch) | 2,800 lb<br>1,270 kg |
| **DRIVE HEAD SPECIFICATIONS** | |
| DRIVE RATIO | 29.37 : 1 |
| DRIVE SPROCKET TEETH | 13 |
| **DRIVE MOTORS SPECIFICATIONS** | |
| MAX DISPLACEMENT (slow speed, high torque) | 3.34 $in^3$/rev |
| MIN DISPLACEMENT (high speed, low torque) | 1.51 $in^3$/rev |
| DISPLACEMENT CONTROL PRESSURE (slow speed, high torque) | 0-75 PSI |
| DISPLACEMENT CONTROL RANGE (slow speed – high speed) | 75 – 435 PSI |
| DISPLACEMENT CONTROL PRESSURE (high speed, low torque) | over 435 PSI |
| MAX. ALLOWABLE DISPLACEMENT CONTROL PRESSURE | 1,450 PSI |
| CASE PRESSURE – MAX CONTINUOUS | 45 PSI |
| CASE PRESSURE – MAX t<= 5 min | 75 PSI |
| CASE PRESSURE – MAX COLD START | 90 PSI |
| **GRIPPER CHAIN SPECIFICATIONS** | |
| NUMBER OF BLOCKS PER CHAIN | 66 |
| TOTAL NUMBER OF GRIPPER BLOCKS | 132 |
| DRIVE CHAIN PITCH | 1.5” |
| GRIPPER BLOCK SIZES AVAILABLE | 1” to 2 ⅜” |

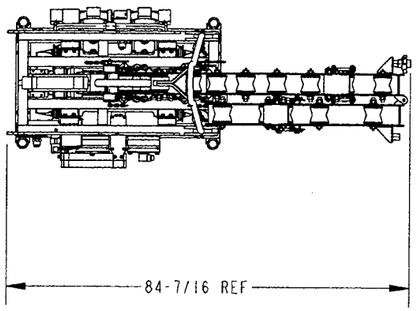
| TRACTION SKATE SPECIFICATIONS | |
|---|---|
| | |
| SKATE LENGTH | 23” |
| NUMBER OF SKATE CYLINDERS | 4 |
| NUMBER OF ROLLERS PER CHAIN | 56 |
| TOTAL NUMBER OF ROLLERS | 112 |
| ROLLER CHAIN PITCH | 1” |
| MAXIMUM SKATE PRESSURE | 3,000 PSI |
| SKATE ACCUMULATOR N2 PRECHARGE PRESSURE | 960 PSI |
| **BRAKE SYSTEM SPECIFICATIONS** | |
| BRAKE RELEASE PRESSURE – MINIMUM TO FULLY RELEASE | 190 PSI |
| BRAKE RELEASE PRESSURE – MAX ALLOWED | 3,000 PSI |
| SEQUENCE VALVE SETTING | 50 PSI above charge pressure |
| PRESSURE REDUCING VALVE SETTING | 250 PSI |

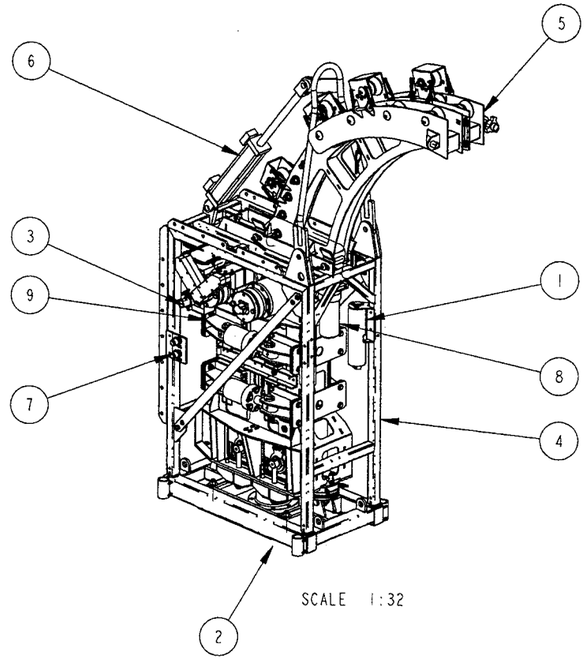
# 2 Drawings



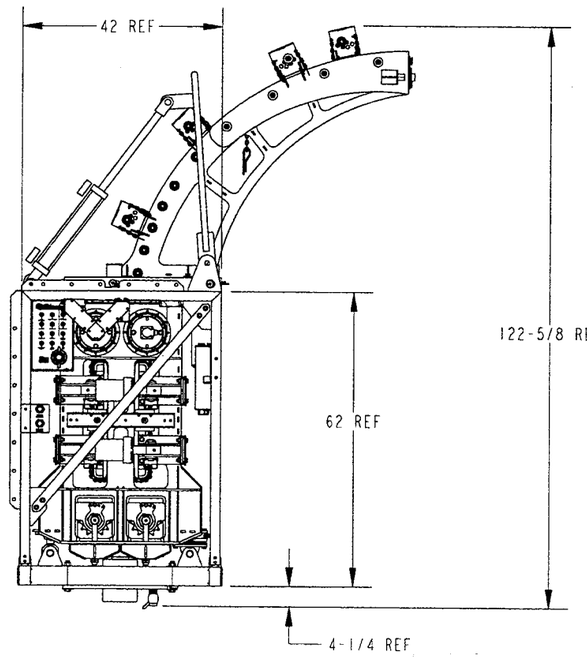
[1] Hydra Rig NOV cylinder part number. Please use for reordering.

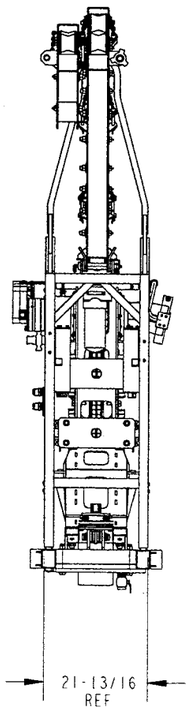
| BILL OF MATERIALS | | | |
|---|---|---|---|
| ITEM | PARTNO | DESCRIPTION | QTY |
| 1 | 310-B-304 | HYD ACCUMMULATOR ASSY | 2 |
| 2 | 310-B-660 | INJECTOR BASE ASSY 3 | 1 |
| 3 | 310-B-630 | BULKHEAD ASSY 2 | 1 |
| 4 | 310-B-160 | CAGE ASSY | 1 |
| 5 | 310-B-210 | GUIDE ARCH ASSY R60 | 1 |
| 6 | 310-B-315 | INJECTOR A-FRAME ASSY | 1 |
| 7 | 310-B-295 | INJECTOR IN-OUT BULKHD ASSY | 1 |
| 8 | 602-0255 | HYDRAULIC FILTER | 2 |
| 9 | 310-B-628 | INJECTOR INTERNAL ASSY RT-25 2 | 1 |
| 10 | 310-B-667 | MECHANICAL COUNTER ADAPTER | 1 |




SCALE 1:32




| REV | DESCRIPTION | DATE | APPVD |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±.01 .001=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES

THIRD ANGLE PROJECTION

| | |
|---|---|
| Drawn CT | Date 14-OCT-99 |
| Design LKJ | Date 14-OCT-99 |
| Checked CT | Date 19-MAR-2001 |
| Approved | Date 21-MAR-2001 |
| Mold By: CT | |
| Mold Date: 09-Aug-00 | |

MARITIME HYDRAULICS CANADA LTD.

Title: INJECTOR MODIFICATION ASSY ASSEMBLY
-

Dwg No: 310-B-625

Sheet: 1 of 1

Weight(lbs): 3173.114

Scale: 1:32

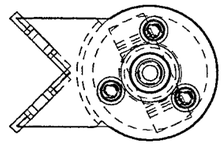
| MODEL | STATUS | PDMREV |
|---|---|---|
| INJECTOR_25_MOD_ASSY_2 | WIP | 1.5 |

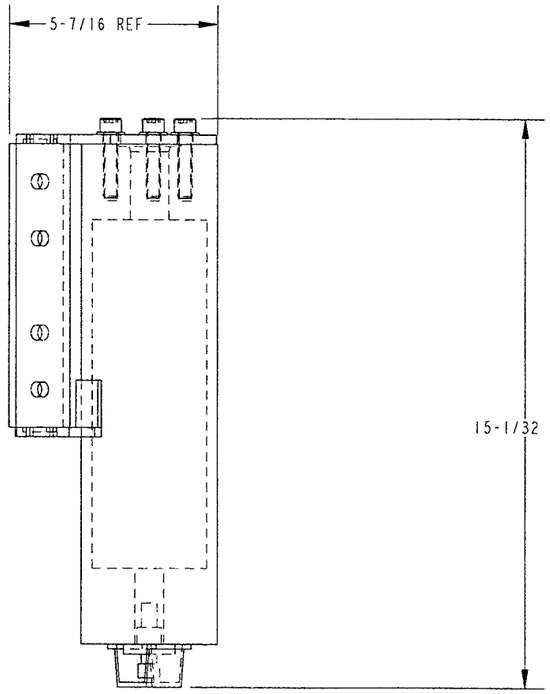
ENG-1002B REV-0

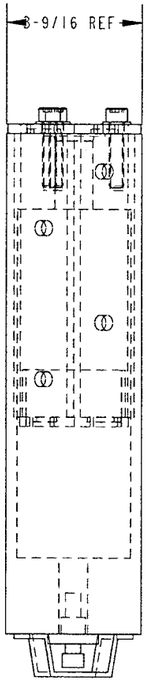
NOTE: PART NUMBERS PREFIXED BY '*' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.

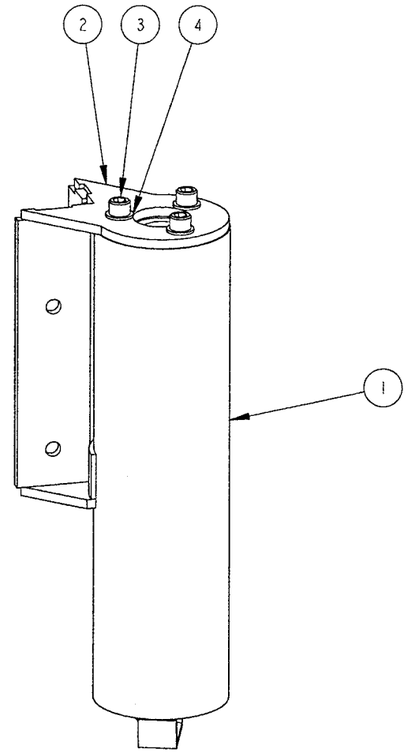
## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | *601-0028 | HYDRAULIC ACCUMULATOR | 1 |
| 2 | 310-B-305 | HYD ACCUMMULATOR MNT | 1 |
| 3 | N/A | HEX SOCK 3/8-16 UNC X 1-3/4 LG GR 8 | 3 |
| 4 | N/A | WASHER 3/8 NARROW | 3 |






SCALE 1:4

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

| | | |
|---|---|---|
| Drawn: CT | Date: 02-NOV-99 | |
| Designed: LKJ | Date: 02-NOV-99 | |
| Checked: | Date: 04-FEB-2004 | |
| Approved: | Date: 04-FEB-2004 | |
| Maintained: CT | Date: 23-DEC-2003 | |

Date:
HYD ACCUMMULATOR ASSY
ASSEMBLY
-

| Size: | Dwg No: | Sheet: | Rev: |
|---|---|---|---|
| B | 310-B-304 | 1 of 1 | - |

Weight: (est.) 23.498 lbs | Scale 1:4

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_ACCUM_BRKT_ASSY | WIP | 1.1 |



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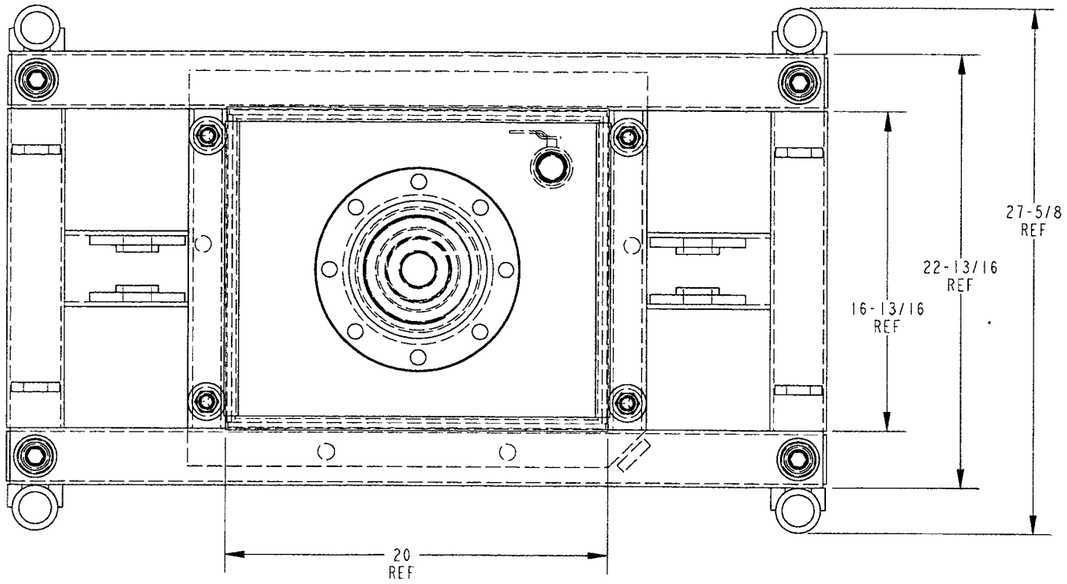
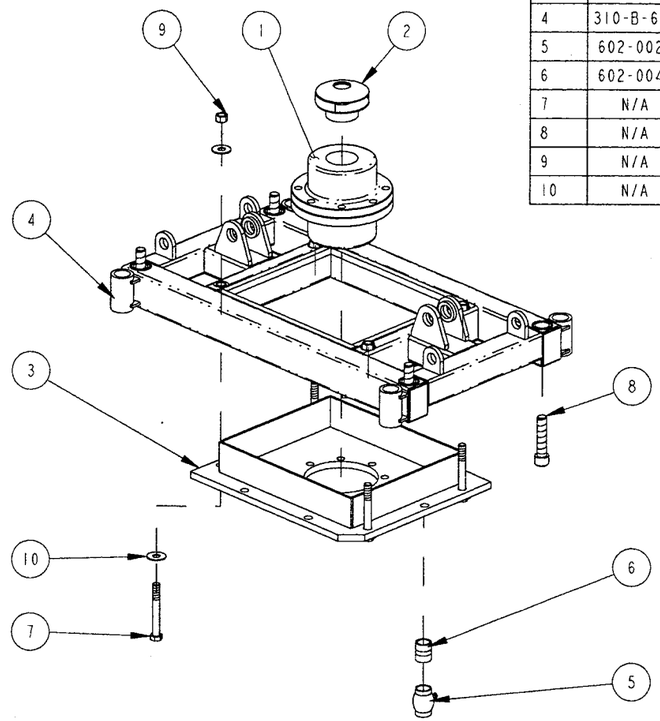
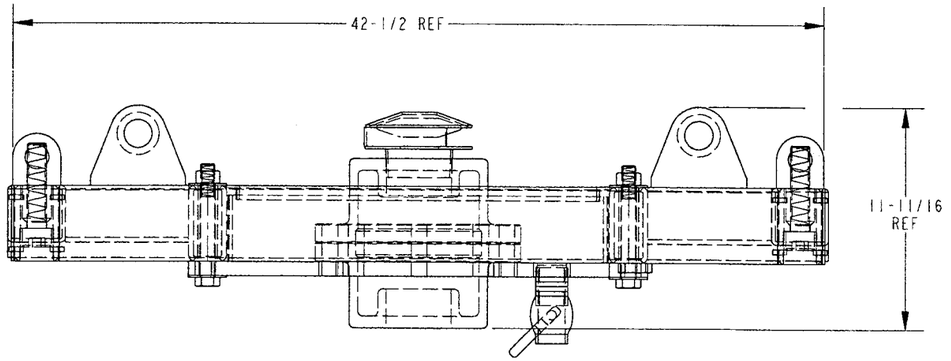


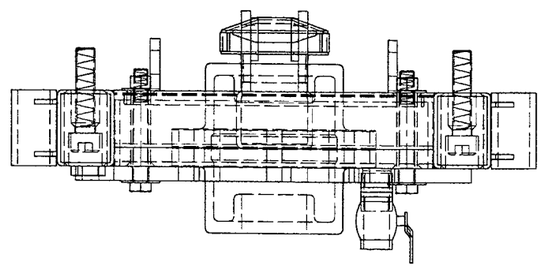




SCALE 1:16

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 203-0170 | STRIPPER KR3 | 1 |
| 2 | 218-C-040 | KR3 WIPER WELD | 1 |
| 3 | 310-B-150 | STRIPPER MOUNT WELD | 1 |
| 4 | 310-B-661 | INJECTOR BASE MODIFICATION 3 | 1 |
| 5 | 602-0022 | BALL VALVE 1-1/4 BRASS | 1 |
| 6 | 602-0045 | NIPPLE 1-1/4 NPT SCH 40 CLOSE | 1 |
| 7 | N/A | BOLT 3/4-10 UNC x 6 LG GR 5 | 4 |
| 8 | N/A | HEX SOCK 1-8UNC x 4-1/2 LONG | 4 |
| 9 | N/A | NUT 3/4 UNC GR 8 | 4 |
| 10 | N/A | WASHER 3/4 | 8 |



| REV √ | DESCRIPTION | DATE | APPVD |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±.01 .001=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES

THIRD ANGLE PROJECTION

| | | |
|---|---|---|
| Drawn: JJM | Date: 02-Aug-00 | MARITIME HYDRAULICS CANADA LTD. |
| Design: LKJ | Date: 02-Aug-00 | |
| Checked: CT | Date: 19-MAR-2001 | Title: INJECTOR BASE ASSY 3 ASSEMBLY - |
| Approved: [signature] | Date: 21-MAR-2001 | Dwg No: 310-B-660 |
| Mfd By: CT | Mfd Date: 23-Aug-00 | Weight(lbs): 349.932 |
| | | Sheet: 1 of 1 |
| | | Scale: 1:8 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_BASE_ASSEMBLY_3 | WIP | 1.10 |

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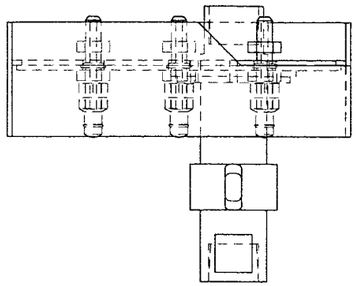
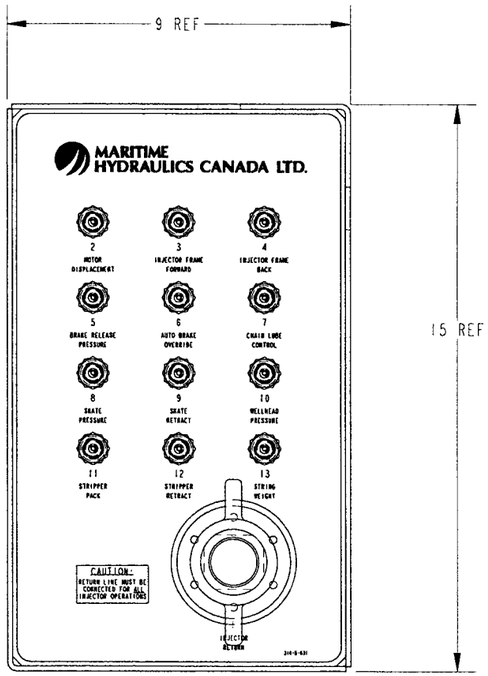
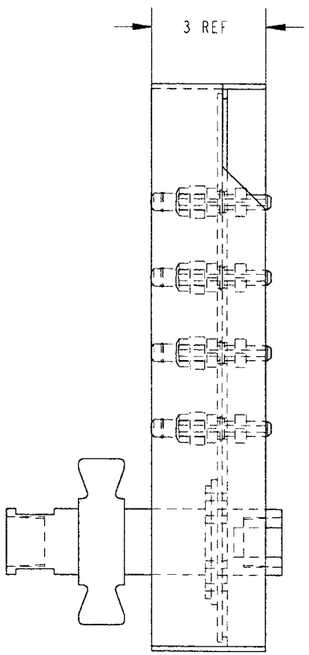
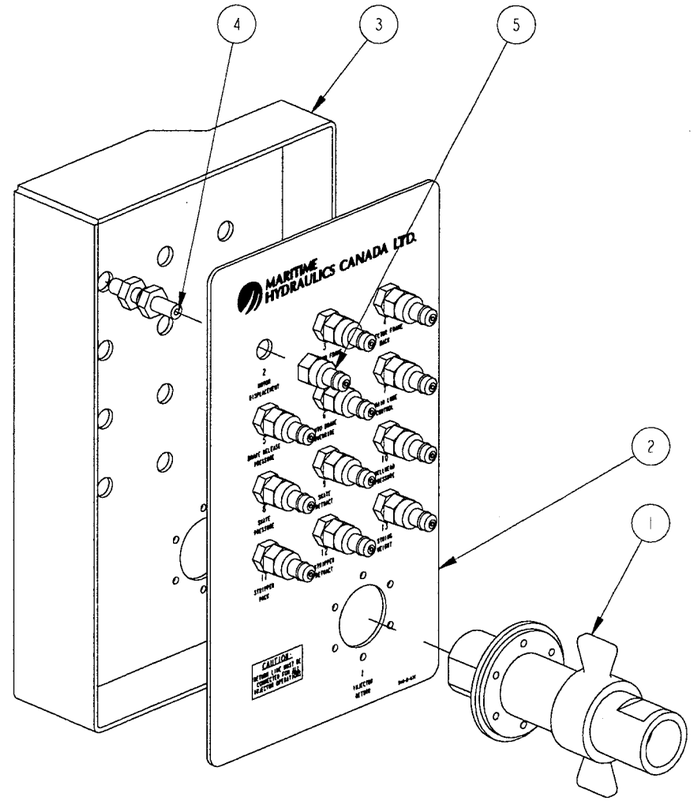
## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | - | HYDRAULIC COUPLER WING NUT TYPE | 1 |
| 2 | 310-B-631 | BULKHEAD PANEL | 1 |
| 3 | 310-B-632 | BULKHEAD WELD 2 | 1 |
| 4 | 604-0407 | ADAPTER 3/8 MALE 37 DEG - MALE NPTF | 12 |
| 5 | 604-0503 | BULKHEAD QD FITTING 1/4 (SNAP-TITE) | 12 |






SCALE 1:4

| REV | DESCRIPTION | DATE | APPVD |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±.01 .001=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES

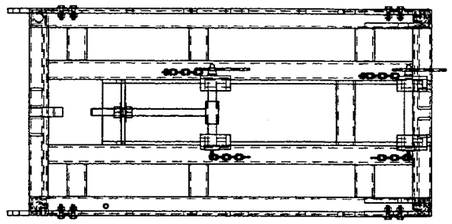
THIRD ANGLE PROJECTION

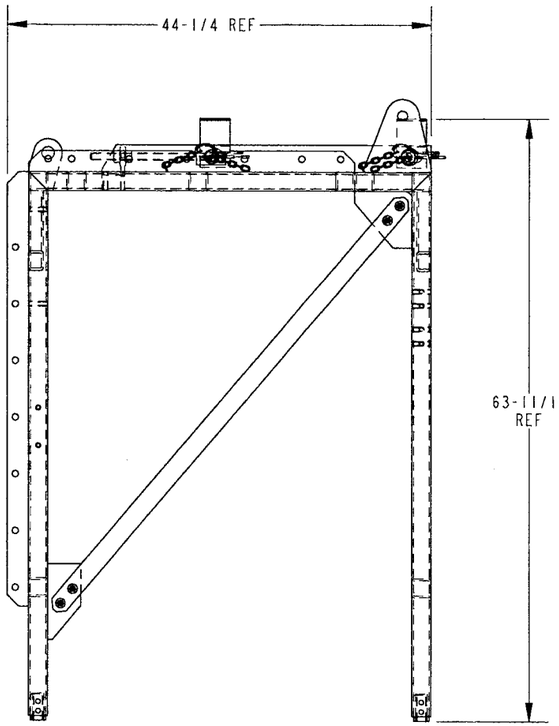
| | | |
|---|---|---|
| Drawn: CT | Date: 10-AUG-00 | MARITIME HYDRAULICS CANADA LTD. |
| Design: CT | Date: 19-JUL-00 | |
| Checked: CT | Date: 23-AUG-00 | Title: BULKHEAD ASSY 2 ASSEMBLY |
| Approved: | Date: 23-AUG-00 | Dwg No: 310-B-630 / Sheet: 1 of 1 |
| Mfd By: CT | | |
| Mfg Date: 23-AUG-00 | | Weight(lbs): 18.965 / Scale: 1:4 |

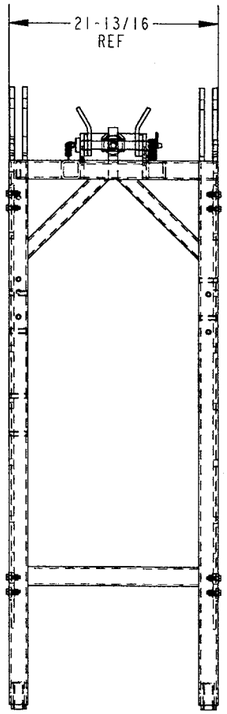
| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_BULKHD_ASSY_2 | WIP | 1.1+ |

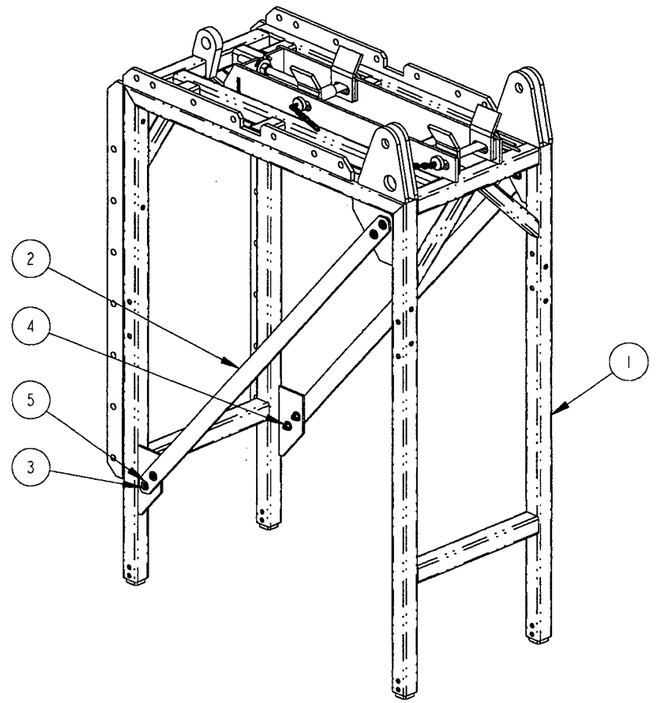
NG-1002B REV-0

| BILL OF MATERIALS | | | |
|---|---|---|---|
| ITEM | PARTNO | DESCRIPTION | QTY |
| 1 | 310-B-165 | CAGE MODIFICATION WELD | 1 |
| 2 | 310-B-181 | CAGE XBRACE | 2 |
| 3 | N/A | BOLT 3/8-16 UNC x 1-1/4 LG GR 5 | 8 |
| 4 | N/A | NUT 3/8 UNC GR 5 | 8 |
| 5 | N/A | WASHER 3/8 | 16 |






SCALE 1:16

| REV | DESCRIPTION | DATE | APPVD |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±.01 .001=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES

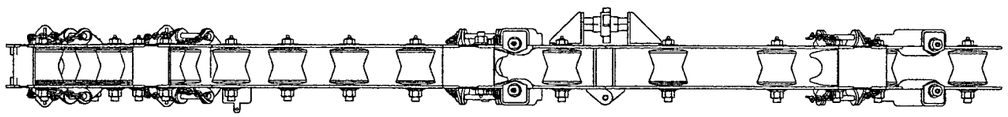
THIRD ANGLE PROJECTION

| | | |
|---|---|---|
| Drawn: CT | Date: 12-AUG-99 | MARITIME HYDRAULICS CANADA LTD. |
| Design: LKJ | Date: 30-JUL-99 | |
| Checked: BM | Date: 18 JUNE 2004 | Title: CAGE ASSY ASSEMBLY - |
| Approved: | Date: 18 JUNE 2004 | Dwg No: 310-B-160 / Sheet: 1 of 1 |
| Mntd By: CT | | |
| Mntd Date: 25-OCT-99 | | Weight(lbs): 334.892 / Scale: 1:16 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_CAGE_ASSY | RFP | 1.20 |

ENG-1002B rev. 0

NOTE: PART NUMBERS PREFIXED BY '*' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.

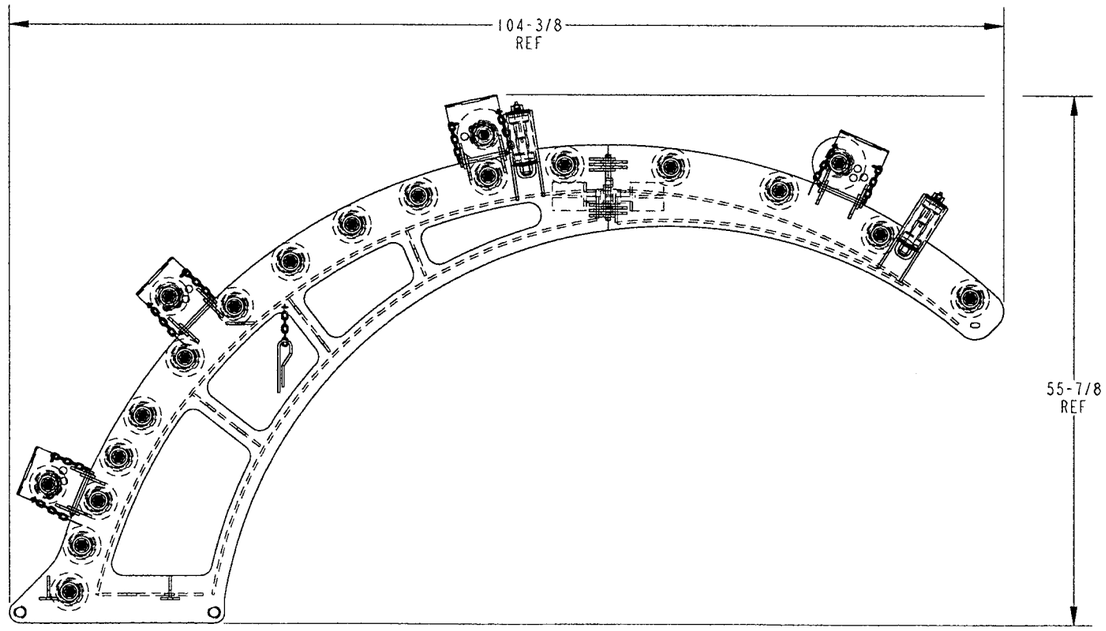


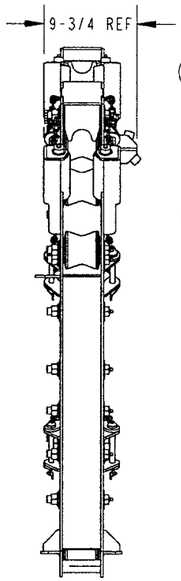
## ALIGNMENT ROLLER SELECTION

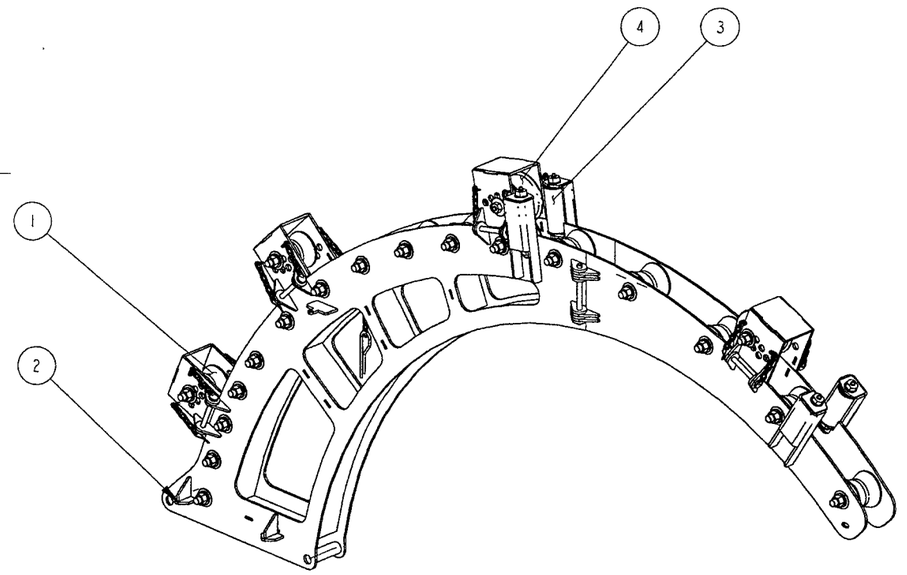
| | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| | 218-B-236 | ALIGNMENT ROLLER 1/4 ASSEMBLY | 2 |
| | 218-B-238 | ALIGNMENT ROLLER 3/8 ASSEMBLY | 2 |
| | 248-B-034 | ALIGNMENT ROLLER 3/4 ASSEMBLY | 2 |
| | 248-B-024 | ALIGNMENT ROLLER 1 ASSEMBLY | 2 |
| | 248-B-018 | ALIGNMENT ROLLER 1-1/4 ASSEMBLY | 2 |
| | 248-B-020 | ALIGNMENT ROLLER 1-1/2 ASSEMBLY | 2 |
| | 248-B-022 | ALIGNMENT ROLLER 1-3/4 ASSEMBLY | 2 |
| | 248-B-026 | ALIGNMENT ROLLER 2 ASSEMBLY | 2 |
| | 248-B-028 | ALIGNMENT ROLLER 2-3/8 ASSEMBLY | 2 |

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 248-B-001 | GUIDE ARCH ROLLER | 18 |
| 2 | 310-B-213 | GUIDE ARCH R60 MODIFICATION | 1 |
| 3 | 409-B-345 | CARRIAGE GUIDE ROLLER 1 | 4 |
| 4 | TBD | GUIDE ARCH TOP ROLLER [SELECT SIZE] | 2 |




SCALE 1:16

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| A | ADDED ALIGNMENT AND SIDE ROLLERS | 19-OCT-2001 | - |

REVISION HISTORY

Software: ProE | Version: 2001i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn: CT | Date: 14-SEP-99 | Date: GUIDE ARCH ASSY R60 ASSEMBLY |
| Designed: LKJ | Date: 30-JUL-99 | - |
| Checked: | Date: 06-FEB-2004 | Size: B \| Dwg No: 310-B-210 \| Sheet: 1 of 1 \| Rev: A |
| Maintained: CT | Date: 06-FEB-2004 | Approved: Date: 06 Feb 2004 |

Weight: (est.) 356.676 lbs | Scale: 1:16

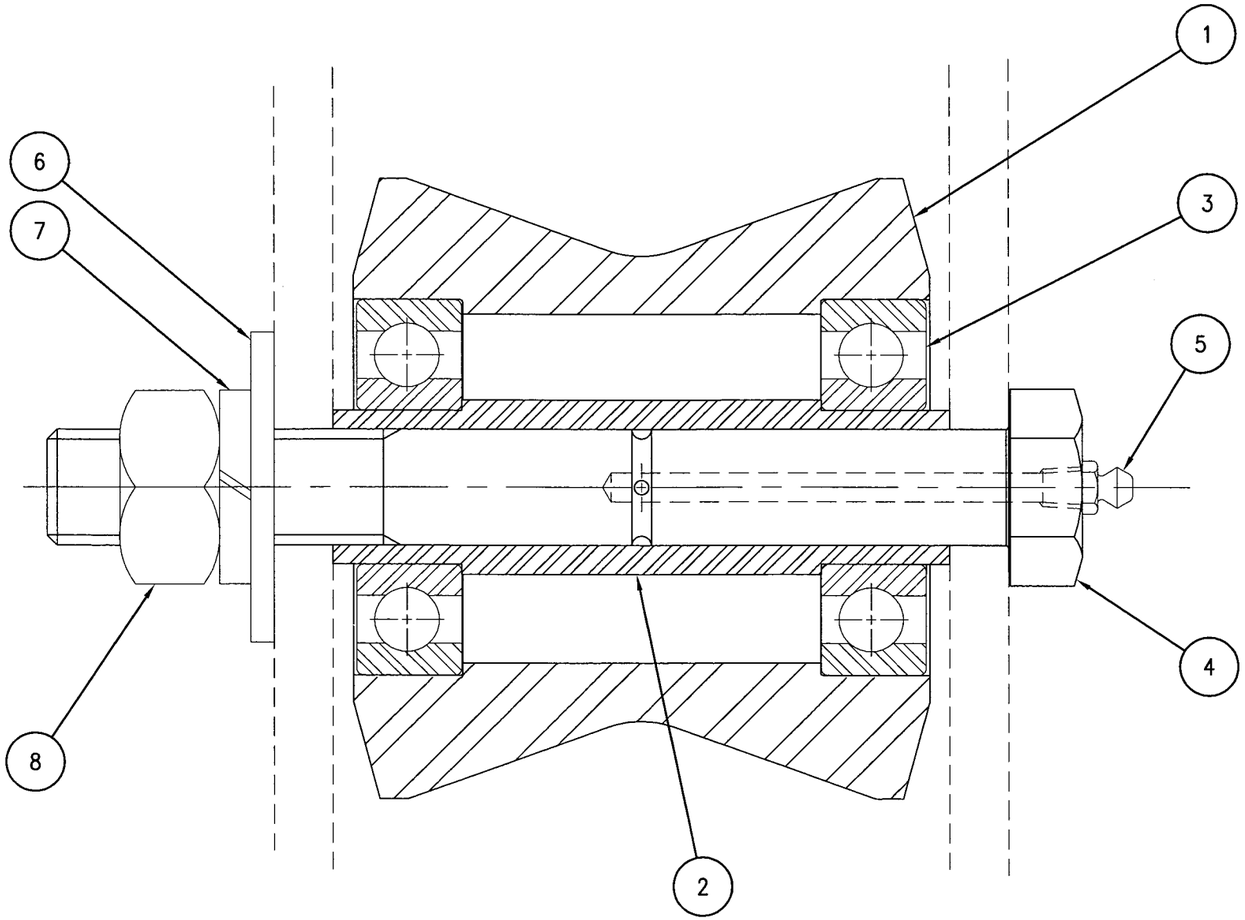
| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_GUIDE_ARCH_ASSY_60R | WIP | 1.18 |

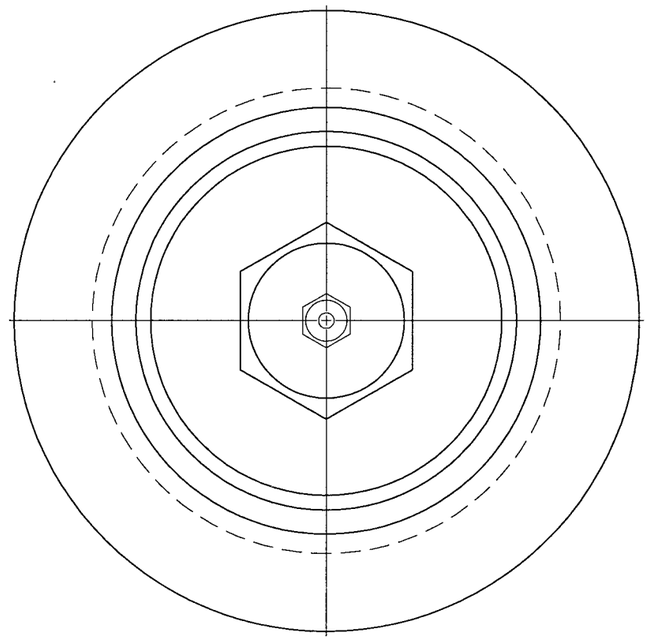


ENG-1002B REV-1

## BILL OF MATERIALS

| ITEM | PART NO. | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 248-B-002 | ROLLER | 1 |
| 2 | 248-B-003 | SHAFT | 1 |
| 3 | 201-0152 | BEARING | 2 |
| 4 | 248-B-004 | BOLT | 1 |
| 5 | – | GREASE NIPPLE 1/4-28NF TAPER | 1 |
| 6 | – | FLATWASHER 3/4" | 1 |
| 7 | – | LOCKWASHER 3/4" | 1 |
| 8 | – | NUT 3/4-10UNC | 1 |



| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| | REVISION HISTORY | | |

Software: Acad Version: 2002

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH = 125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

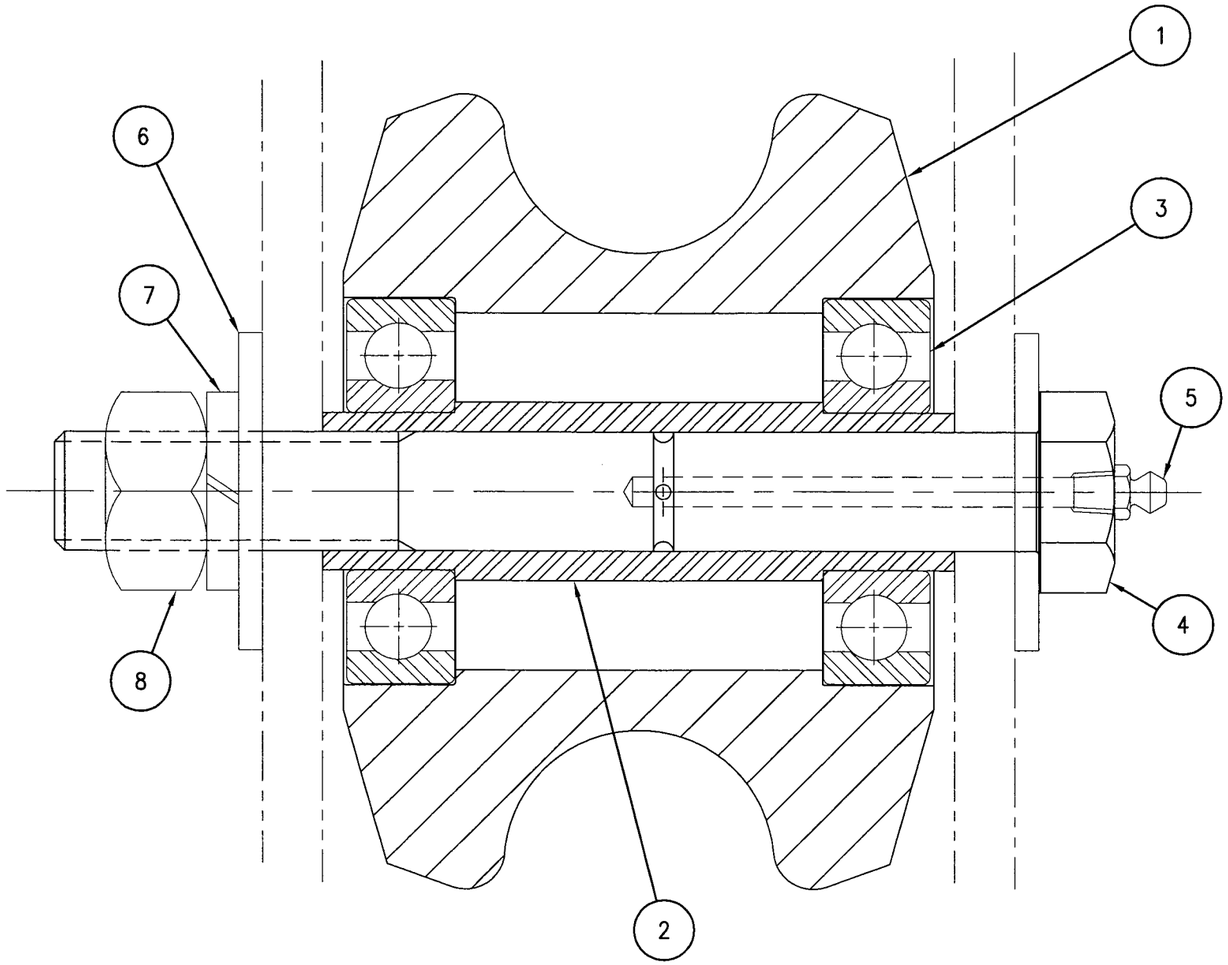
Maintained: JJM | Date: 10-MAY-2002

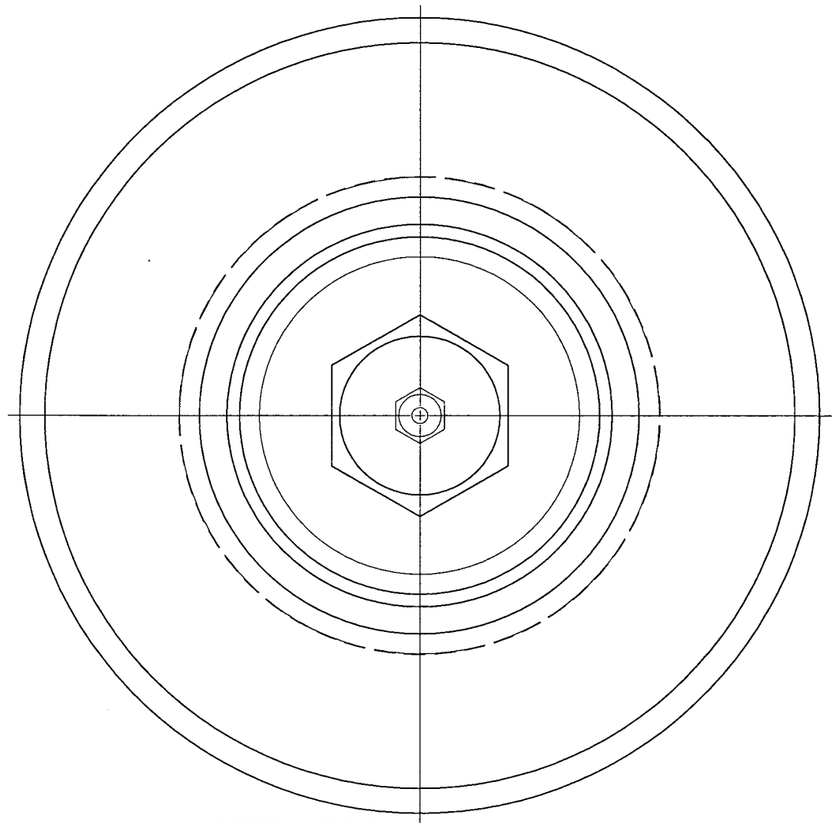
NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn: LS | Date: 12-SEP-1992 | Title: GUIDE ARCH ROLLER ASSEMBLY |
| Designed: LJ | Date: 12-SEP-1992 | |
| Checked | Date | Size: B \| Dwg No.: 248-B-001 \| Sheet: 1 of 1 \| Rev |
| Approved | Date | Weight (est.): lbs. \| Scale: 1:1 |

| BILL OF MATERIALS | | | |
|---|---|---|---|
| ITEM | PART NO. | DESCRIPTION | QTY |
| 1 | 248-B-019 | ALIGNMENT ROLLER ø1.50" | 1 |
| 2 | 248-B-003 | SHAFT | 1 |
| 3 | RM0015 | BEARING | 2 |
| 4 | 248-B-004 | BOLT | 1 |
| 5 | | GREASE NIPPLE 1/4" - 28 N.F.TAPER (SPAE-NAUR: GF-641) | 1 |
| 6 | | FLATWASHER 3/4" AW | 2 |
| 7 | | LOCKWASHER 3/4" RHS | 1 |
| 8 | | NUT 3/4-10UNC | 1 |



| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| REVISION HISTORY | | | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX = ±.01 .XXX = ±.005
FRACTIONS = ±1/16 ANGLES = ±.5°
SURFACE FINISH = 125 RMS
DEBURR SHARP EDGES

THIRD ANGLE PROJECTION

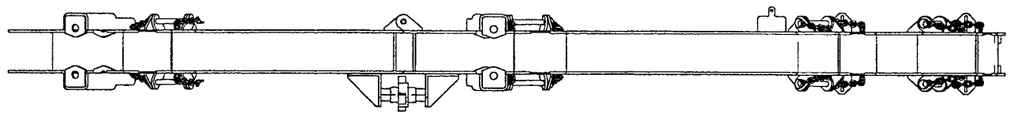
| | | |
|---|---|---|
| Drawn JJM | Date 09/20/1995 | |
| Designed LKJ | Date 09/20/1995 | |
| Checked | Date | |
| Approved | Date | |
| Maintained By DIB | | |
| Maintained 09/24/1997 | | |

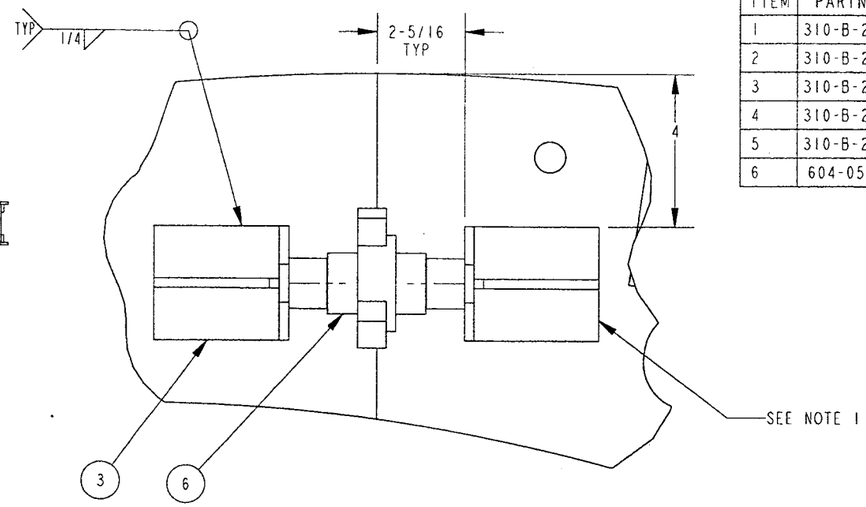
MARITIME HYDRAULICS (CANADA) LTD.
A DIVISION OF AKER MARITIME

Title: ALIGNMENT ROLLER ø1.50" ASSEMBLY

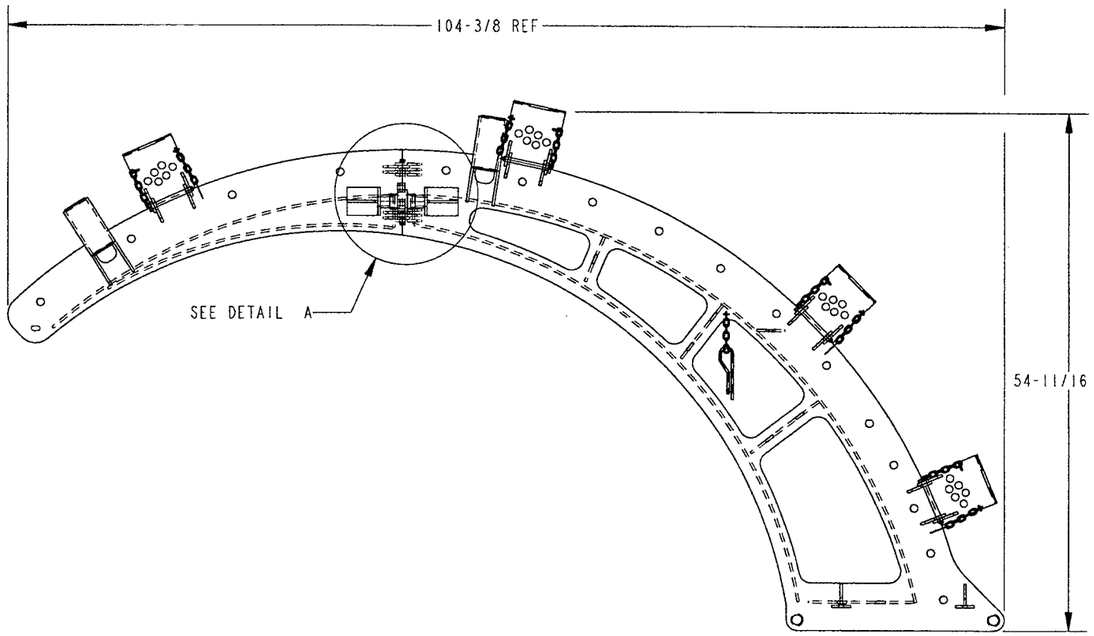
| Size | Dwg No. | Rev |
|---|---|---|
| B | 248-B-020 | |

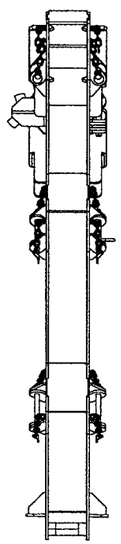
Scale 1:1 | Weight (est.) | Sheet 1 of 1

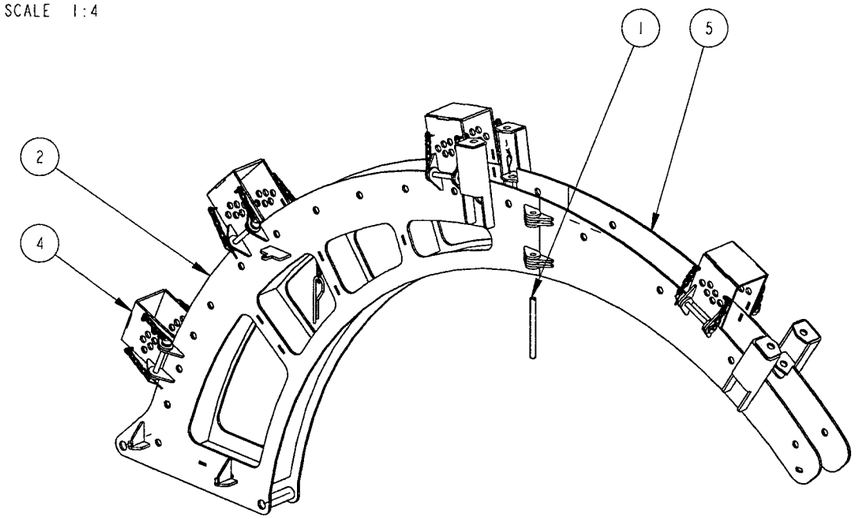





DETAIL A
SCALE 1:4






SCALE 1:16

BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 310-B-214 | GUIDE ARCH HINGE PIN | 1 |
| 2 | 310-B-222 | GUIDE ARCH MAIN WELD | 1 |
| 3 | 310-B-236 | GUIDE ARCH LOCK WELD | 2 |
| 4 | 310-B-240 | GUIDE ARCH ROLLER BRKT | 4 |
| 5 | 310-B-248 | GUIDE ARCH EXTENSION WELD | 1 |
| 6 | 604-0535 | HAMMER UNION 1 FIG 200 | 1 |

NOTES:
1. ASSEMBLE AND CHECK FIT BEFORE WELDING LOCK

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_ARCH_R60_MOD_ASSY | WIP | 1.13 |



Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

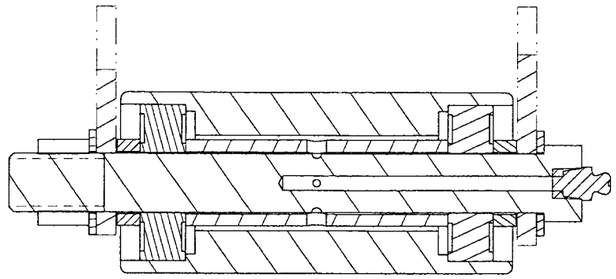
Maintained: CT | Date: 18-OCT-2001

NATIONAL OILWELL

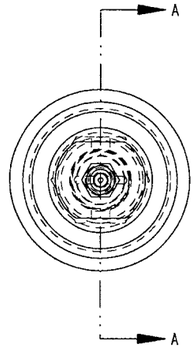
HITEC SYSTEMS AND CONTROLS INC.

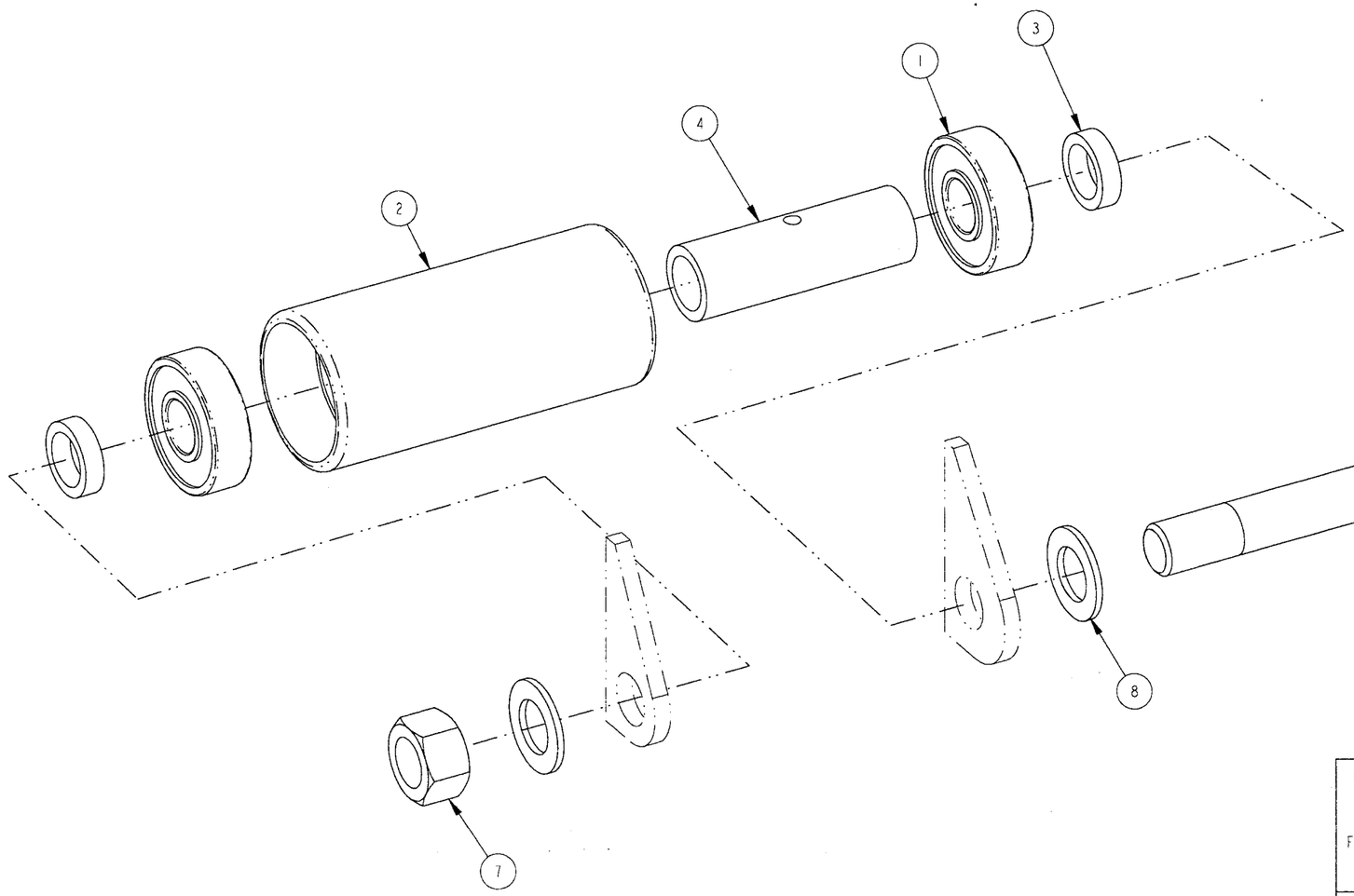
| | | |
|---|---|---|
| Drawn: CT | Date: 14-SEP-99 | Date: GUIDE ARCH R60 MODIFICATION ASSEMBLY |
| Designed: LKJ | Date: 30-JUL-99 | - |
| Checked: | Date: 08-MAY-2003 | Size: B \| Dwg No: 310-B-213 \| Sheet: 1 of 1 \| Rev: - |
| Approved: | Date: MAY 09/03 | Weight: (est.) 254.255 lbs \| Scale: 1:16 |

ENG-1002B REV-1



SECTION A-A




| BILL OF MATERIALS | | | |
|---|---|---|---|
| ITEM | PARTNO | DESCRIPTION | QTY |
| 1 | 201-0035 | DEEP GROOVE BALL BEARING | 2 |
| 2 | 409-B-276 | GUIDE ROLLER TUBE 2 | 1 |
| 3 | 409-B-341 | THRUST WASHER 1 | 2 |
| 4 | 409-B-342 | CARRIAGE ROLLER SPACER | 1 |
| 5 | 409-B-359 | CARRIAGE ROLLER SHAFT 1 | 1 |
| 6 | 606-1472 | GREASE NIPPLE 1/4-28N.F.TAPER | 1 |
| 7 | N/A | NUT 3/4 UNC GR 5 NYLOCK | 1 |
| 8 | N/A | WASHER 3/4 NARROW | 2 |

| REV | DESCRIPTION | DATE | APPVD |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±.01 .001=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES

THIRD ANGLE PROJECTION

| | | |
|---|---|---|
| Drawn JJM | Date 28-Apr-00 | MARITIME HYDRAULICS CANADA LTD. |
| Design JJM | Date 28-Apr-00 | |
| Checked [illegible] | Date 02-MAY-00 | Title: CARRIAGE GUIDE ROLLER 1 ASSEMBLY |
| Approved [illegible] | Date 02-MAY-00 | Dwg No: 409-B-345 Sheet: 1 of 1 |
| Mold By: JJM | | |
| Mold Date: 02-May-00 | Weight(lbs): 6.164 | Scale: 1:2 |

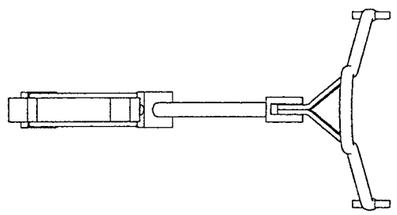
| MODEL | STATUS | PDMREV |
|---|---|---|
| CARR_GUIDE_ROLLER_ASSY | WIP | 1.2+ |

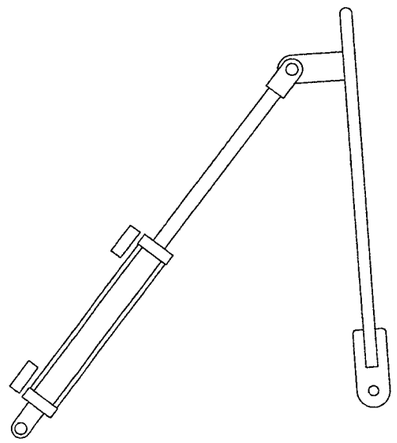
ENG-1002B REV 0

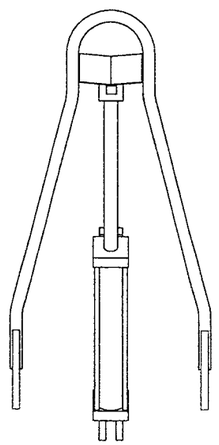
NOTE: PART NUMBERS PREFIXED BY '*' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.

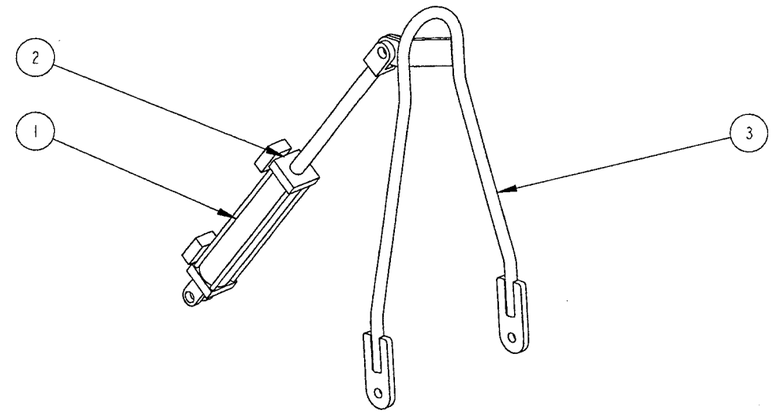
BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | *203-1232 | HYDRAULIC CYLINDER | 1 |
| 2 | *602-1072 | COUNTER BALANCE VALVE | 2 |
| 3 | 310-B-316 | A FRAME BAIL ARM WELD | 1 |










SCALE 1:16

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

Maintained: CT | Date: 23-DEC-2003

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn: CT | Date: 04-NOV-99 | Date: |
| Designed: LKJ | Date: 04-NOV-99 | INJECTOR A-FRAME ASSY ASSEMBLY |
| Checked: | Date: 04-FEB-2004 | |
| Approved: | Date: 04-FEB-2004 | Size: B \| Dwg No: 310-B-315 \| Sheet: 1 of 1 \| Rev: - |
| | | Weight: (est.) 132.312 lbs \| Scale: 1:16 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_INJ_A_FRAME_ASSY | WIP | 1.9 |

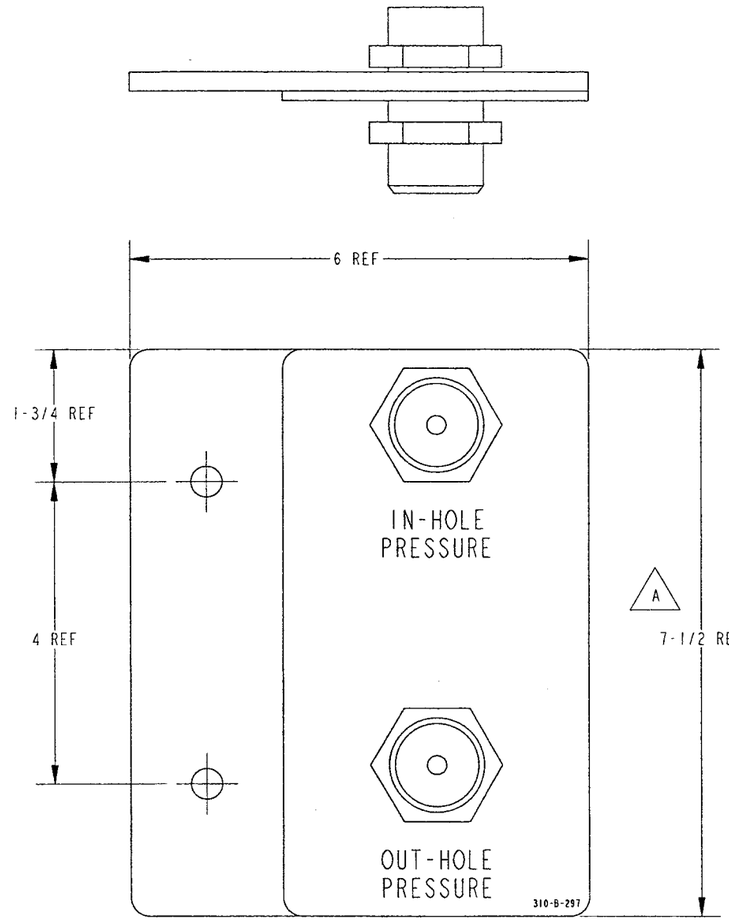


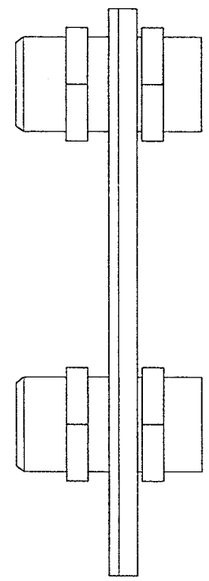
ENG-1002B REV-1

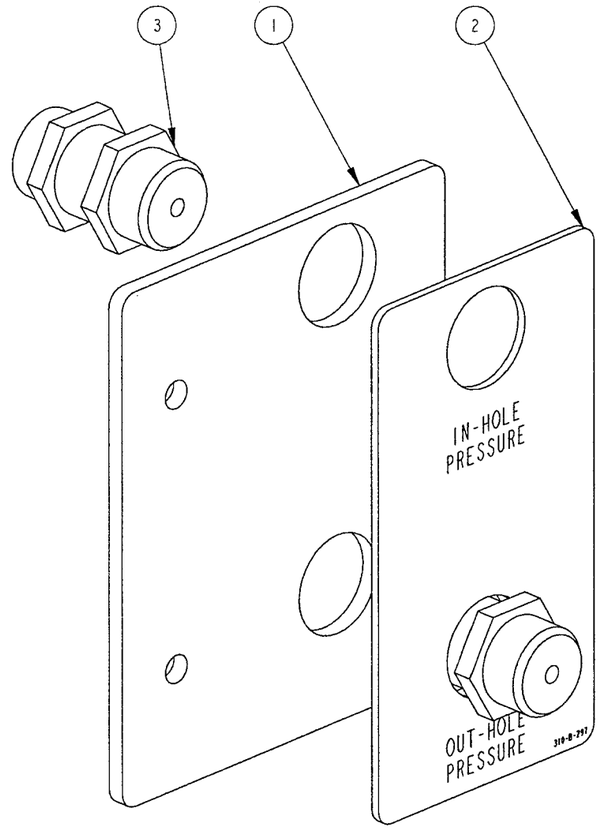
NOTE: PART NUMBERS PREFIXED BY '•' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.

BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 310-B-296 | INJECTOR IN-OUT BULKHD PL | 1 |
| 2 | 310-B-297 | INJECTOR IN-OUT BULKHD FACE | 1 |
| 3 | 604-0027 | ADAPT 1 MALE 37 DEG FLARE-MALE NPTF | 2 |






SCALE 1:2

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| A | INCREASED OD SPACING | 20-SEP-2002 | - |

REVISION HISTORY

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

Maintained: CT | Date: 19-DEC-2003

NATIONAL OILWELL

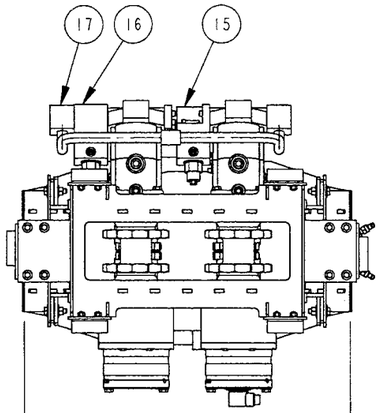
HITEC SYSTEMS AND CONTROLS INC.

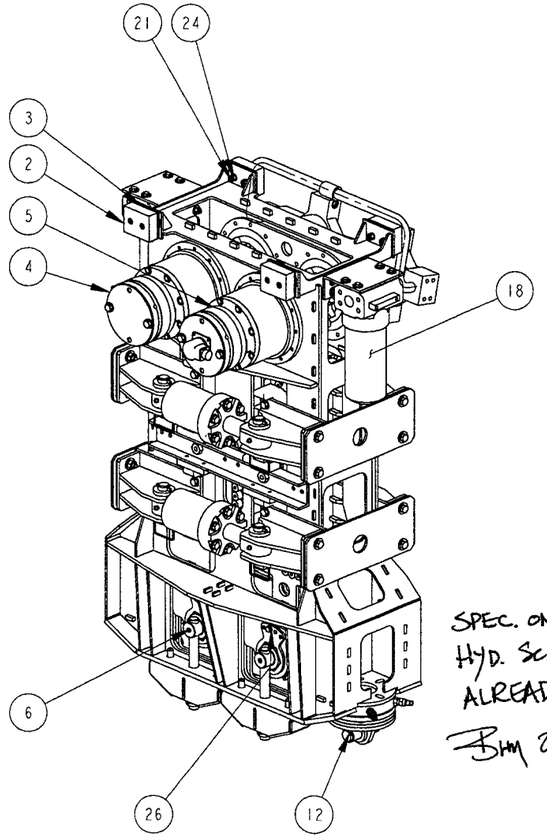
| | | |
|---|---|---|
| Drawn: CT | Date: 01-NOV-99 | Date: INJECTOR IN-OUT BULKHD ASSY ASSEMBLY |
| Designed: LKJ | Date: 29-OCT-99 | - |
| Checked: | Date: 19-DEC-2003 | Size: B \| Dwg No: 310-B-295 \| Sheet: 1 of 1 \| Rev: A |
| Approved: | Date: 19-DEC-2003 | Weight: (est.) 5.046 lbs \| Scale: 1:2 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_IN_OUT_BULK_ASSY | WIP | 1.7 |

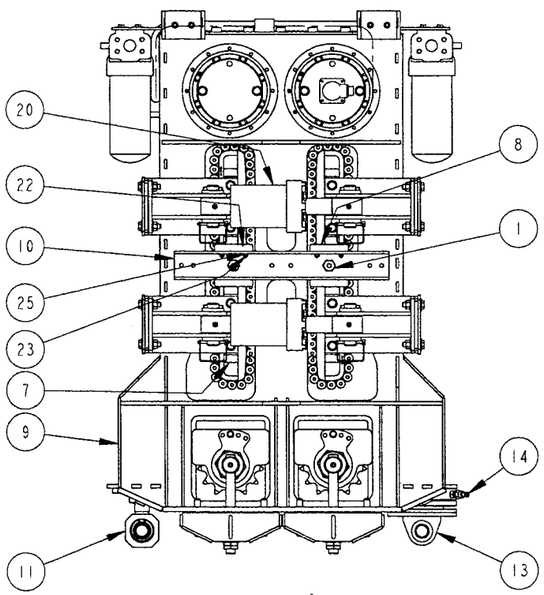


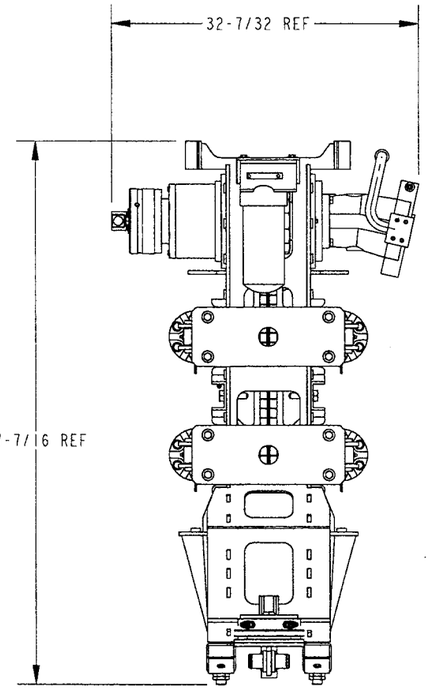
ENG-1002B REV-1




SPEC. ON HYD. SCHEMATIC ALREADY
BHM 29MAR05




SCALE 1:16

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 243-B-073 | CHAIN OILER | 4 |
| 2 | 300-B-238 | STABILIZER SUPPORT BLOCK | 4 |
| 3 | 300-B-239 | INJECTOR STABILIZER SHIM | 4 |
| 4 | 310-B-001 | DRIVE SHAFT ASSY 1 | 1 |
| 5 | 310-B-008 | DRIVE SHAFT ASSY 3 | 1 |
| 6 | 310-B-015 | IDLER SHAFT ASSY | 2 |
| 7 | 310-B-031 | INJECTOR SKATE ASSY 2 | 2 |
| 8 | 310-B-049 | SKATE SLIDING STRIP | 8 |
| 9 | 310-B-055 | CARCASS WELD 25 | 1 |
| 10 | 310-B-087 | SKATE MOUNT CHANNEL | 2 |
| 11 | 310-B-114 | INJECTOR MNT LUG ASSY 3 | 1 |
| 12 | 310-B-118 | INJECTOR MNT PIN | 2 |
| 13 | 310-B-119 | INJECTOR MNT LUG ASSY 2 | 1 |
| 14 | 310-B-122 | LOAD CELL ASSY 2 | 1 |
| 15 | *310-B-270 | HYD MOTION CONTROL ASSY | -O |
| 16 | *310-B-271 | HYD MOTION CONTROL ASSY 2 | -O |
| 17 | 310-B-280 | HYD TUBE WELD | 1 |
| 18 | 310-B-345 | HYDRAULIC FILTER ASSY | 2 |
| 19 | 310-B-359 | DRIVE CHAIN ORDER FORM | 1 |
| 20 | *400-0198 | SKATE CYLINDER | -O |
| 21 | N/A | HEX SOCK 3/8-16 UNC X 1-3/4 LG GR 8 | 8 |
| 22 | N/A | HEX SOCK FL HD 1/4-20 UNC X 1 LG | 4 |
| 23 | N/A | NUT 1/4 UNC GR 5 | 4 |
| 24 | N/A | NUT 3/8 UNC GR 5 | 16 |
| 25 | N/A | WASHER 1/4 NARROW | 4 |
| 26 | N/A | WASHER 3/8 NARROW | 16 |

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

| MODEL | STATUS | PDMREV |
|---|---|---|
| INJECTOR_INT_ASSY_RT25_2 | WIP | 1.23+ |



Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

NATIONAL OILWELL
HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn: CT | Date: 17-AUG-99 | Date: INJECTOR INTERNAL ASSY RT-25 2 ASSEMBLY |
| Designed: LKJ | Date: 30-JUL-99 | |
| Checked: | Date: 04-JUL-2001 | |
| Maintained: CT | Date: 04-JUL-2001 | Approved: Date: 04-JUL-2001 |

| Size: | Dwg No: | Sheet: | Rev: |
|---|---|---|---|
| B | 310-B-628 | 1 of 1 | - |

Weight: (est.) 1682.340 lbs | Scale: 1:16

E.N.G-1002B REV-1

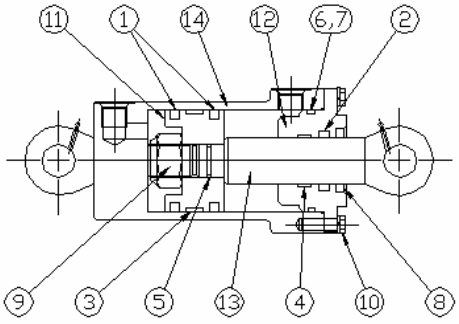
## SKATE CYLINDER ASSEMBLY COMPONENTS - MH CYLINDER #400-0198

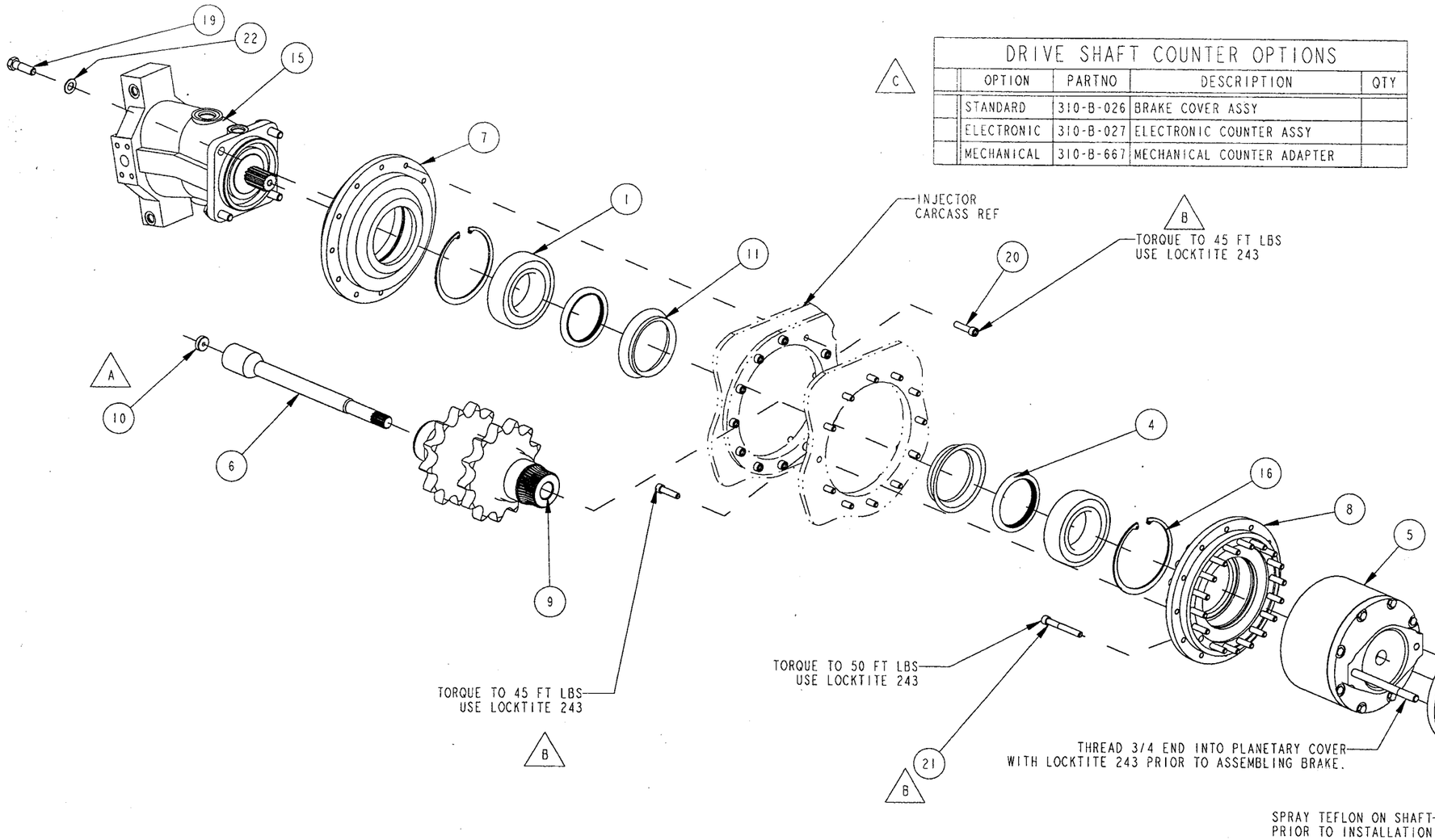
CYLINDER SPECIFICATIONS

| | |
|---|---|
| Bore Diameter | 4” |
| Rod Diameter | 1-3/4” |
| Stroke | 2-1/4” |
| Ports | -4 ORB |

## PARTS BREAKDOWN

| ITEM# | DESCRIPTION | PART# |
|---|---|---|
| 1 | PISTON SEAL | 400-0198-1 |
| 2 | ROD SEAL | 400-0198-2 |
| 3 | WEAR RING | 400-0198-3 |
| 4 | WEAR RING | 400-0198-4 |
| 5 | ‘O’ RING | 400-0198-5 |
| 6 | ‘O’ RING | 400-0198-6 |
| 7 | B/U RING | 400-0198-7 |
| 8 | WIPER | 400-0198-8 |
| 9 | LOCK NUT | 400-0198-9 |
| 10 | BOLT KIT | 400-0198-10 |
| 11 | PISTON | 400-0198-11 |
| 12 | HEAD | 400-0198-12 |
| 13 | ROD | 400-0198-13 |
| 14 | BARREL | 400-0198-14 |
| 15 | SEAL KIT (ITEMS 1-8) | 602-1499 |






## DRIVE SHAFT COUNTER OPTIONS

| | OPTION | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|---|
| | STANDARD | 310-B-026 | BRAKE COVER ASSY | |
| | ELECTRONIC | 310-B-027 | ELECTRONIC COUNTER ASSY | |
| | MECHANICAL | 310-B-667 | MECHANICAL COUNTER ADAPTER | |

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 201-0397 | SPHERICAL ROLLER BEARING | 2 |
| 2 | 201-0502 | DEEP GROOVE BALL BEARING | 2 |
| 3 | *203-1145 | BRAKE - B | +0 |
| 4 | 203-1149 | OIL SEAL 3.250 SHAFT 4.00 BORE | 2 |
| 5 | 301-0106 | PLANETARY GEARBOX | 1 |
| 6 | 310-B-003 | DRIVE INNER SHAFT | 1 |
| 7 | 310-B-004 | DRIVE MOTOR MOUNT | 1 |
| 8 | 310-B-005 | DRIVE PLANETARY MOUNT | 1 |
| 9 | 310-B-006 | DRIVE SHAFT AND SPROCKET | 1 |
| 10 | 310-B-016 | DRIVE SHAFT INNER SPACER | 1 |
| 11 | 310-B-020 | BOOT SEAL | 2 |
| 12 | 310-B-057 | BRAKE MOUNT STUD | 2 |
| 13 | 310-B-691 | BRAKE ADAPTER FLANGE | 1 |
| 14 | 310-B-692 | BRAKE ADAPTER SHAFT | 1 |
| 15 | *601-0759 | HYDRAULIC MOTOR | +0 |
| 16 | 802-0020 | RETAINING RING INTERNAL (N5000-500) | 2 |
| 17 | 802-0043 | RETAINING RING EXTERNAL (5100-100) | 1 |
| 18 | 802-0088 | RETAINING RING INTERNAL (N5000-187) | 1 |
| 19 | N/A | BOLT 1/2-13 UNC x 1-3/4 LG GR 5 | 4 |
| 20 | N/A | HEX SOCK 3/8-16 UNC X 1-1/2 LG GR 8 | 24 |
| 21 | N/A | HEX SOCK 3/8-24 UNF X 3 LG | 18 |
| 22 | N/A | WASHER 1/2 NARROW | 4 |

## REVISION HISTORY

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| E | ADDED BRAKE MOUNT STUDS | 01-MAY-2003 | - |
| D | ADDED BRAKE ADAPTER | 30-APR-2002 | - |
| C | ADDED COUNTER OPTIONS TABLE | 10-APR-2002 | - |
| B | ADDED TORQUE SPECIFICATIONS | 28-MAR-2002 | - |
| A | ADDED DRIVE SHAFT INNER SPACER | 18-MAR-2002 | - |

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

Maintained: CT | Date: 07-MAY-2003

NATIONAL OILWELL

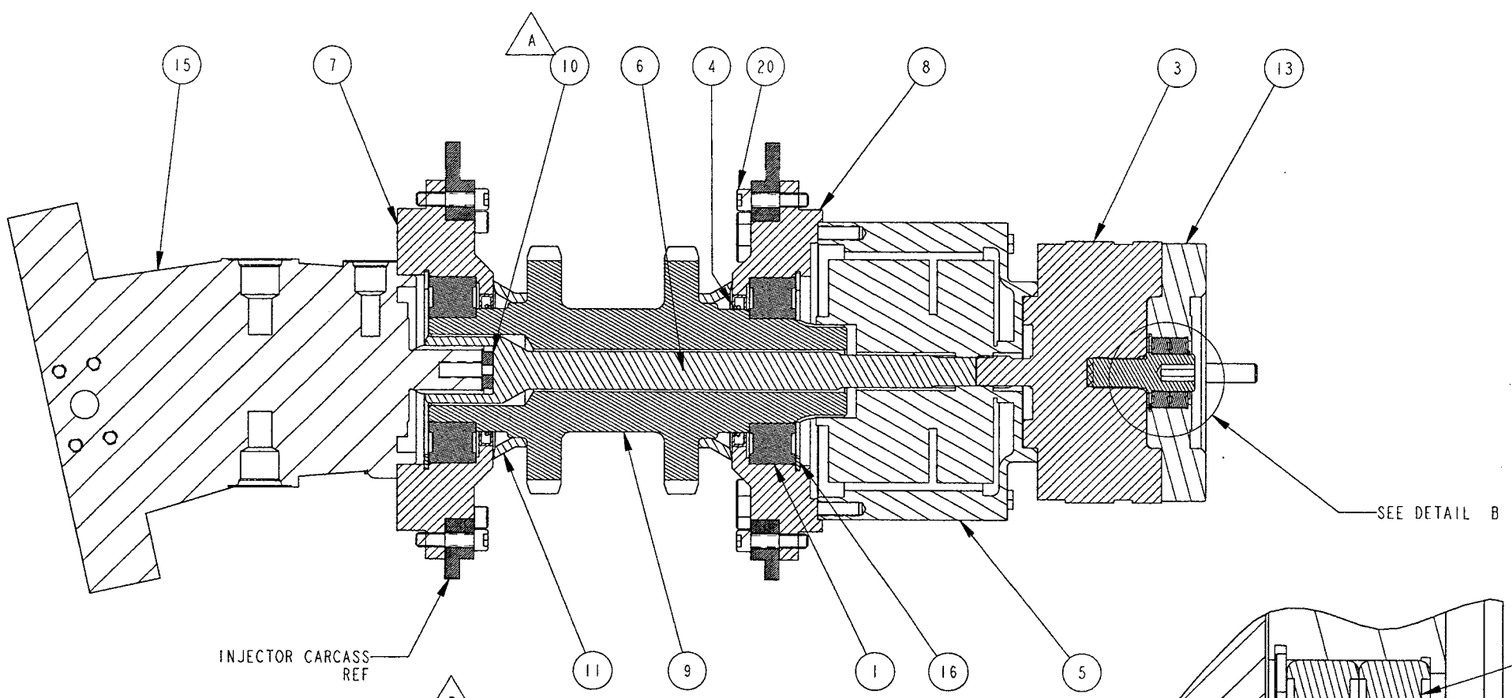
HITEC SYSTEMS AND CONTROLS INC.

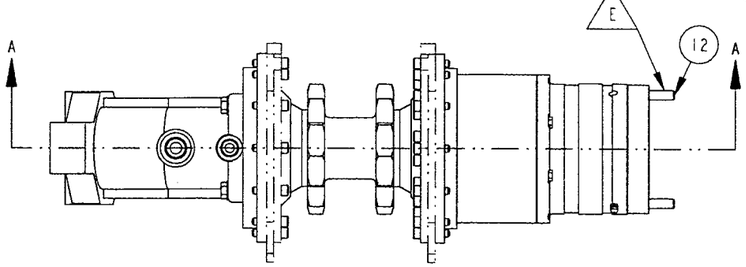
| | | |
|---|---|---|
| Drawn: CT | Date: 28-JUL-99 | Date: |
| Designed: LKJ | Date: - | DRIVE SHAFT ASSY 1 ASSEMBLY RT-25 INJECTOR |
| Checked: | Date: 07-MAY 2003 | |
| Approved: | Date: 7/4/09/03 | Size: B \| Dwg No: 310-B-001 \| Sheet: 1 of 2 \| Rev: E |
| | | Weight: (est.) 266.602 lbs \| Scale: 1:8 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| DRIVE_SHAFT_ASSY_RT25 | REV | 1.44+ |

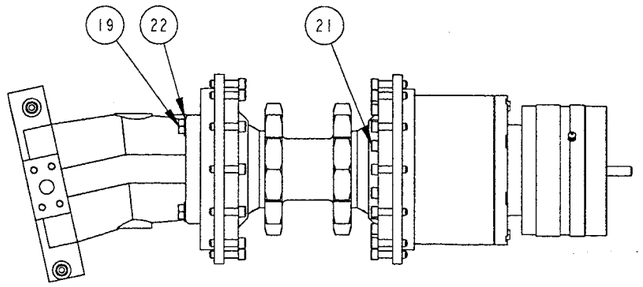


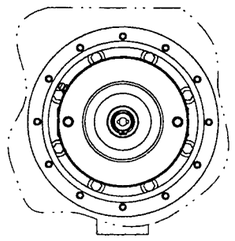
ENG-1002B REV-1

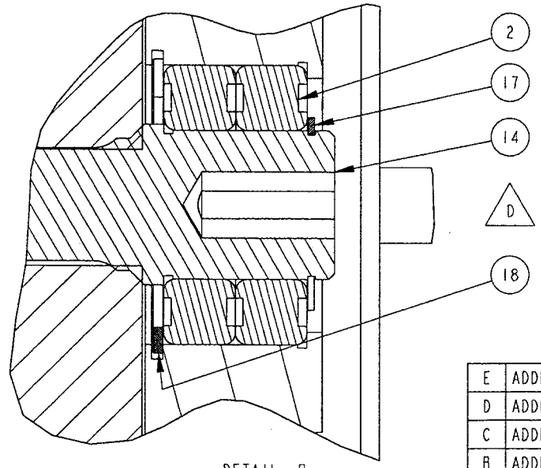



SECTION A-A
SCALE 1:4






DETAIL B
SCALE 1:1

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 201-0397 | SPHERICAL ROLLER BEARING | 2 |
| 2 | 201-0502 | DEEP GROOVE BALL BEARING | 2 |
| 3 | *203-1145 | BRAKE - B | +0 |
| 4 | 203-1149 | OIL SEAL 3.250 SHAFT 4.00 BORE | 2 |
| 5 | 301-0106 | PLANETARY GEARBOX | 1 |
| 6 | 310-B-003 | DRIVE INNER SHAFT | 1 |
| 7 | 310-B-004 | DRIVE MOTOR MOUNT | 1 |
| 8 | 310-B-005 | DRIVE PLANETARY MOUNT | 1 |
| 9 | 310-B-006 | DRIVE SHAFT AND SPROCKET | 1 |
| 10 | 310-B-016 | DRIVE SHAFT INNER SPACER | 1 |
| 11 | 310-B-020 | BOOT SEAL | 2 |
| 12 | 310-B-057 | BRAKE MOUNT STUD | 2 |
| 13 | 310-B-691 | BRAKE ADAPTER FLANGE | 1 |
| 14 | 310-B-692 | BRAKE ADAPTER SHAFT | 1 |
| 15 | *601-0759 | HYDRAULIC MOTOR | +0 |
| 16 | 802-0020 | RETAINING RING INTERNAL (N5000-500) | 2 |
| 17 | 802-0043 | RETAINING RING EXTERNAL (5100-100) | 1 |
| 18 | 802-0088 | RETAINING RING INTERNAL (N5000-187) | 1 |
| 19 | N/A | BOLT 1/2-13 UNC x 1-3/4 LG GR 5 | 4 |
| 20 | N/A | HEX SOCK 3/8-16 UNC X 1-1/2 LG GR 8 | 24 |
| 21 | N/A | HEX SOCK 3/8-24 UNF X 3 LG | 18 |
| 22 | N/A | WASHER 1/2 NARROW | 4 |

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| E | ADDED BRAKE MOUNT STUDS | 01-MAY-2003 | - |
| D | ADDED BRAKE ADAPTER | 30-APR-2002 | - |
| C | ADDED COUNTER OPTIONS TABLE | 10-APR-2002 | - |
| B | ADDED TORQUE SPECIFICATIONS | 28-MAR-2002 | - |
| A | ADDED DRIVE SHAFT INNER SPACER | 18-MAR-2002 | - |

REVISION HISTORY

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWING

THIRD ANGLE PROJECTION

Maintained: CT | Date: 08-MAY-2003

NATIONAL OILWELL

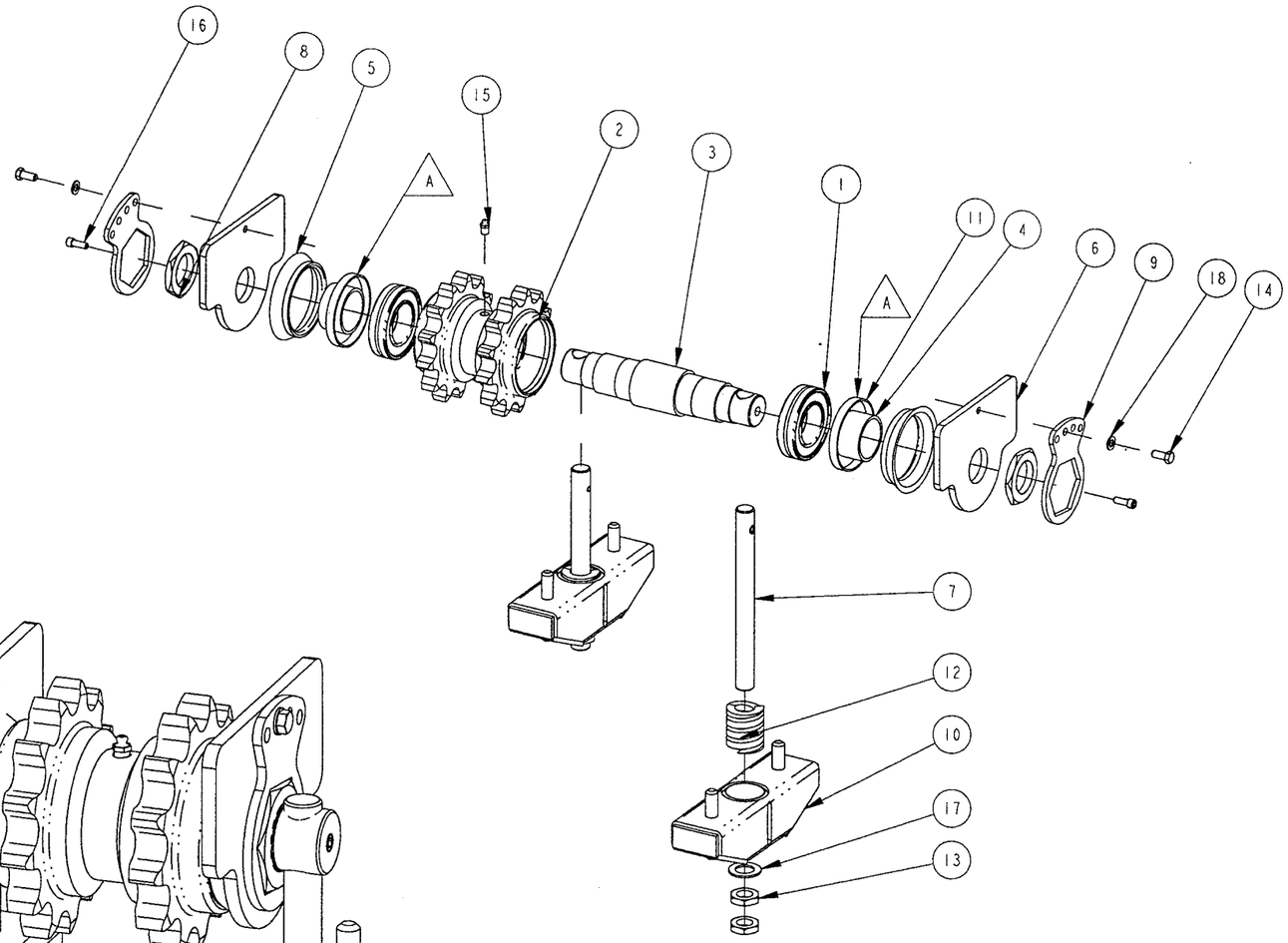
HITEC SYSTEMS AND CONTROLS INC.

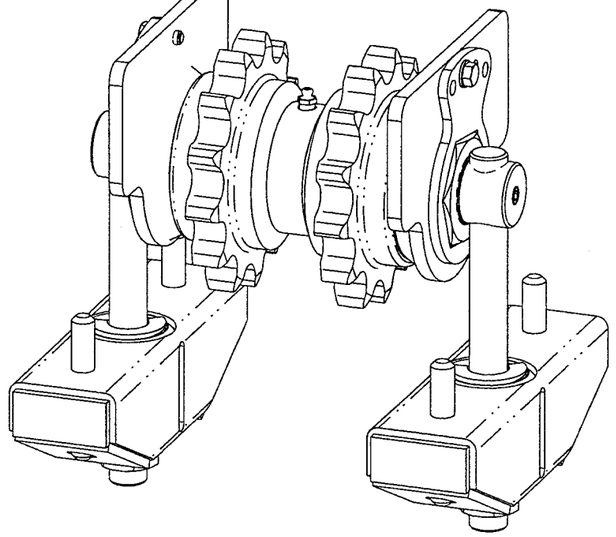
| | | |
|---|---|---|
| Drawn: CT | Date: 28-JUL-99 | Date: |
| Designed: LKJ | Date: - | DRIVE SHAFT ASSY 1 ASSEMBLY RT-25 INJECTOR |
| Checked: | Date: 08 MAY 2003 | |
| Approved: - | Date: MAY 09/03 | Size: B \| Dwg No: 310-B-001 \| Sheet: 2 of 2 \| Rev: E |
| | | Weight: (est.) 266.602 lbs \| Scale: 1:8 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| DRIVE_SHAFT_ASSY_RT25 | REV | 1.44+ |



ENG-1002B REV-1



SCALE 1:4

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 201-0051 | ROLLER BEARING SEALED ONE SIDE | 2 |
| 2 | 310-B-017 | IDLER SPROCKET | 1 |
| 3 | 310-B-018 | IDLER SHAFT | 1 |
| 4 | 310-B-019 | BEARING RETAINER | 2 |
| 5 | 310-B-020 | BOOT SEAL | 2 |
| 6 | 310-B-021 | IDLER TENSION MOUNT PLATE | 2 |
| 7 | 310-B-022 | IDLER TENSION ROD | 2 |
| 8 | 310-B-023 | IDLER SHAFT NUT | 2 |
| 9 | 310-B-024 | IDLER NUT RETAINER | 2 |
| 10 | 310-B-340 | IDLER TENSIONER | 2 |
| 11 | 310-B-849 | IDLER SHAFT BOOTSEAL SPACER | 2 |
| 12 | 400-0024 | CHAIN TENSION SPRING | 2 |
| 13 | 801-0040 | 1-12 UNF HEX JAM NUT | 4 |
| 14 | N/A | BOLT 3/8-16 UNC x 7/8 LG GR 5 | 2 |
| 15 | N/A | GREASE NIPPLE | 1 |
| 16 | N/A | HEX SOCK 5/16-24 UNF X 7/8 LG | 2 |
| 17 | N/A | WASHER 1 NARROW | 2 |
| 18 | N/A | WASHER 3/8 NARROW | 2 |

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| A | BOOTSEAL SPACERS ADDED FOR 51002 | 28-MAY-2003 | - |

REVISION HISTORY

| MODEL | STATUS | PDMREV |
|---|---|---|
| IDLER_SHAFT_ASSY_2 | REV | 1.27+ |



ENG-10028 REV-1.

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

Maintained: CT | Date: 28-MAY-2003

NATIONAL OILWELL

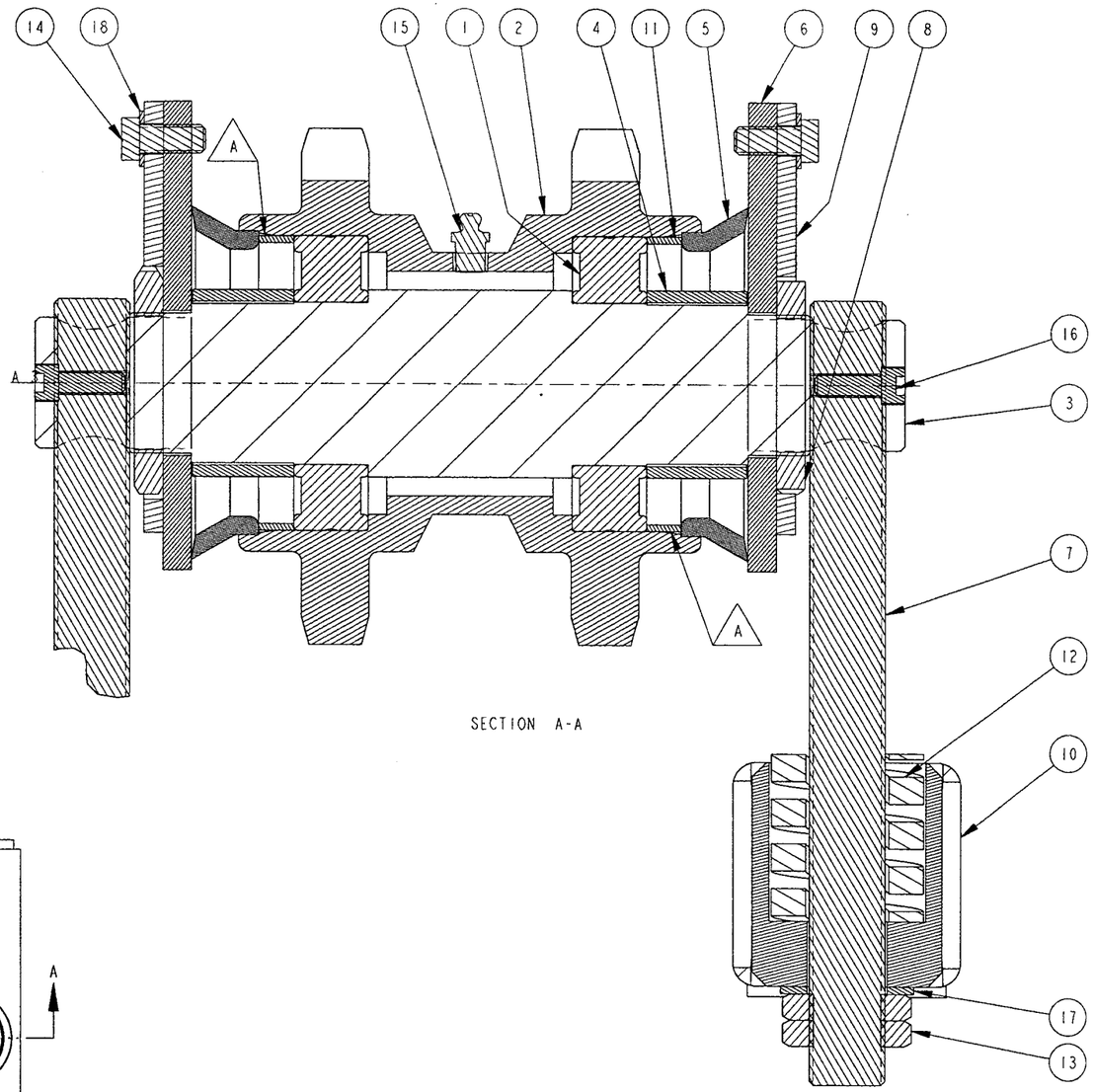
HITEC SYSTEMS AND CONTROLS INC.

Drawn: CT | Date: 22-JUL-99
Designed: LKJ | Date: 04-MAY-99
Checked: | Date: 28-MAY-2003
Approved: | Date: MAY 28/03

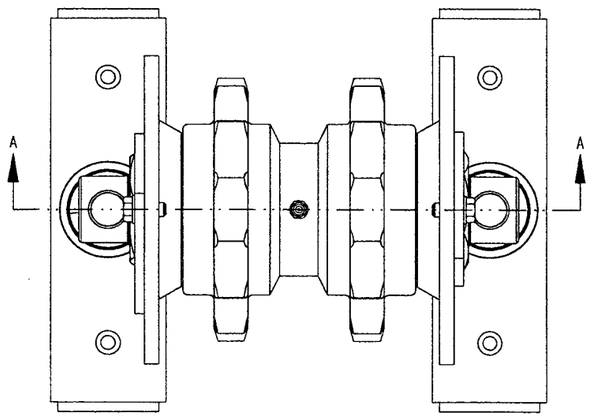
Date:

# IDLER SHAFT ASSY ASSEMBLY

Size: B | Dwg No: 310-B-015 | Sheet: 1 of 2 | Rev: A
Weight: (est.) 65.55 lbs | Scale: 1:8




SECTION A-A




SCALE 1:4

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 201-0051 | ROLLER BEARING SEALED ONE SIDE | 2 |
| 2 | 310-B-017 | IDLER SPROCKET | 1 |
| 3 | 310-B-018 | IDLER SHAFT | 1 |
| 4 | 310-B-019 | BEARING RETAINER | 2 |
| 5 | 310-B-020 | BOOT SEAL | 2 |
| 6 | 310-B-021 | IDLER TENSION MOUNT PLATE | 2 |
| 7 | 310-B-022 | IDLER TENSION ROD | 2 |
| 8 | 310-B-023 | IDLER SHAFT NUT | 2 |
| 9 | 310-B-024 | IDLER NUT RETAINER | 2 |
| 10 | 310-B-340 | IDLER TENSIONER | 2 |
| 11 | 310-B-849 | IDLER SHAFT BOOTSEAL SPACER | 2 |
| 12 | 400-0024 | CHAIN TENSION SPRING | 2 |
| 13 | 801-0040 | 1-12 UNF HEX JAM NUT | 4 |
| 14 | N/A | BOLT 3/8-16 UNC x 7/8 LG GR 5 | 2 |
| 15 | N/A | GREASE NIPPLE | 1 |
| 16 | N/A | HEX SOCK 5/16-24 UNF X 7/8 LG | 2 |
| 17 | N/A | WASHER 1 NARROW | 2 |
| 18 | N/A | WASHER 3/8 NARROW | 2 |

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| A | BOOTSEAL SPACERS ADDED FOR 51002 | 28-MAY-2003 | - |

REVISION HISTORY

Software: ProE | Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn: CT | Date: 22-JUL-99 | Date: |
| Designed: LKJ | Date: 04-MAY-99 | IDLER SHAFT ASSY ASSEMBLY |
| Checked: | Date: MAY.2003 | - |
| Approved: | Date: MAY 28/03 | Size: B \| Dwg No: 310-B-015 \| Sheet: 2 of 2 \| Rev: A |
| Maintained: CT | Date: 28-MAY-2003 | Weight: (est.) 65.551 lbs \| Scale: 1:2 |

| MODEL | STATUS | PDMREV |
|---|---|---|
| IDLER_SHAFT_ASSY_2 | REV | 1.27+ |

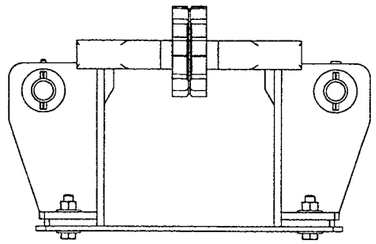


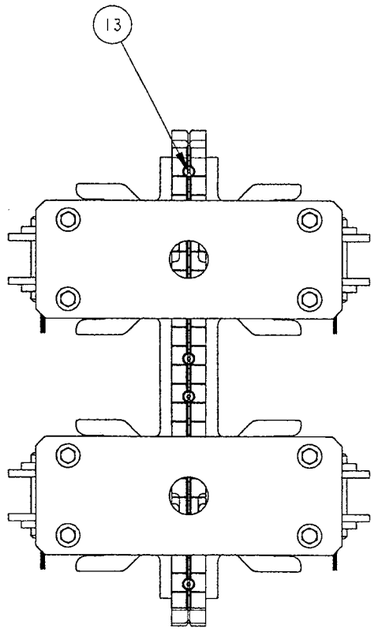
ENG-10028 REV-1

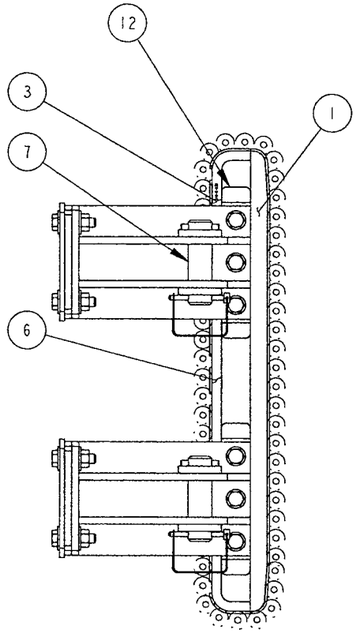
NOTE: PART NUMBERS PREFIXED BY '*' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.

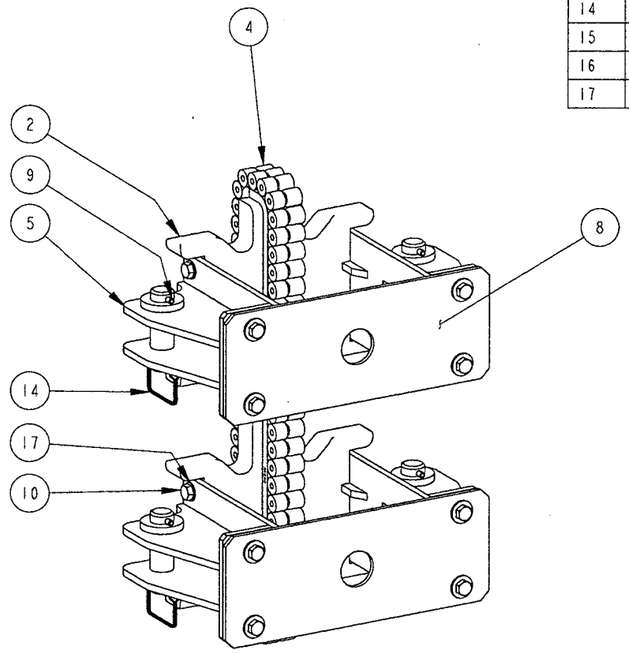
## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 310-B-033 | SKATE WEARPLATE 2 | 1 |
| 2 | 310-B-035 | SKATE PLATE 2 | 1 |
| 3 | 310-B-036 | SKATE BACK END | 2 |
| 4 | 310-B-038 | SKATE ROLLER CHAIN ASSY 2 | 1 |
| 5 | 310-B-040 | SKATE CYLMNT WELD | 4 |
| 6 | 310-B-044 | SKATE BACK 2 | 1 |
| 7 | 310-B-046 | SKATE CYLINDER PIN | 4 |
| 8 | 310-B-047 | SKATE CYLMNT TIE PLATE WELD | 2 |
| 9 | 802-0086 | SPRING TENSION PIN 5/16x2 LG | 4 |
| 10 | N/A | BOLT 1/2-13 UNC x 1-1/4 LG GR 5 | 12 |
| 11 | N/A | BOLT 1/2-13 UNC x 2 LG GR 5 | 8 |
| 12 | N/A | HEX SOCK 3/8-16 UNC X 1-1/2 LG GR 8 | 3 |
| 13 | N/A | HEX SOCK FL HD 1/4-20 UNC X 5/8 LG | 6 |
| 14 | N/A | LOCKPIN SAFETY LOCKING 1/4 X 2-1/2 | 4 |
| 15 | N/A | NUT 1/2 UNC GR 5 | 8 |
| 16 | N/A | WASHER 1/2 | 16 |
| 17 | N/A | WASHER 1/2 NARROW | 12 |






SCALE 1:8

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

| | |
|---|---|
| Software: Pro/E | Version: 2000i2 |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

| | | | |
|---|---|---|---|
| Maintained: CT | Date: 23-DEC-2003 | Approved: LKJ | Date: 13-MAY-2002 |

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | | |
|---|---|---|---|
| Drawn: CT | Date: 05-AUG-99 | Date: | |
| Designed: LKJ | Date: 30-JUL-99 | INJECTOR SKATE ASSY 2 ASSEMBLY | |
| Checked: CT | Date: 10-MAY-2002 | | |

| Size: | Dwg No: | Sheet: | Rev: |
|---|---|---|---|
| B | 310-B-031 | 1 of 1 | - |

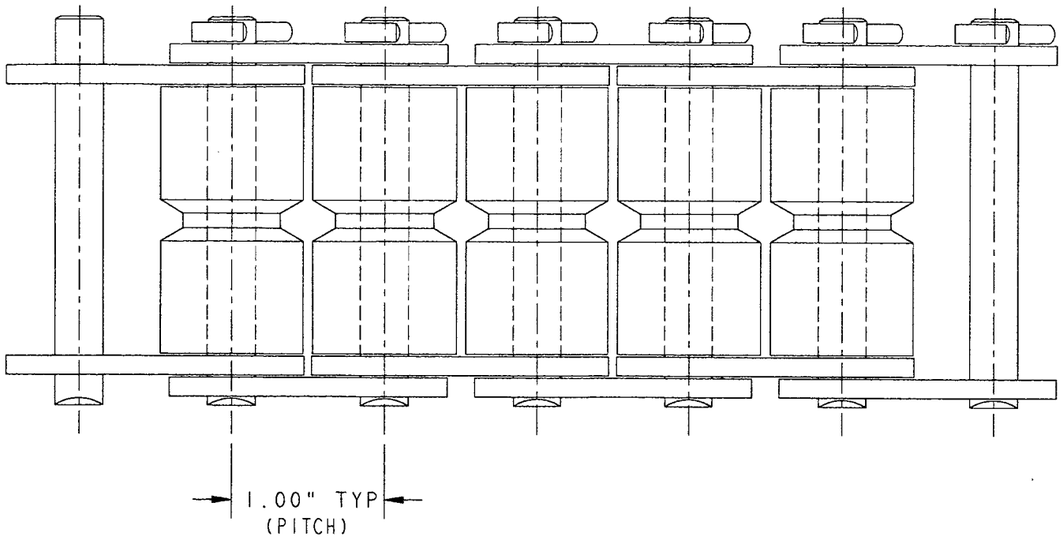
Weight: (est.) 269.498 lbs Scale: 1:8

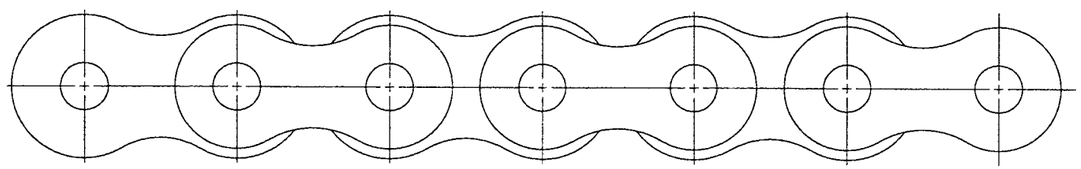
| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_SKATE_ASSY_25 | WIP | 1.27 |

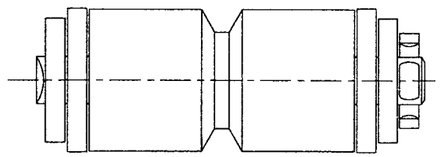


ENG-1002B REV-1

| BILL OF MATERIALS | | | |
|---|---|---|---|
| ITEM | PARTNO | DESCRIPTION | QTY |
| 1 | 202-0199 | LINK 80-2 DIAMOND CONNECTOR | 28 |
| 2 | 310-B-310 | SKATE ROLLER | 56 |





| REV | DESCRIPTION | DATE | APPVD |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±.01 .001=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES

THIRD ANGLE PROJECTION

| | |
|---|---|
| Drawn: CT | Date: 15-NOV-99 |
| Design: LKJ | Date: 30-JUL-99 |
| Checked | Date: 22-JAN-2001 |
| Approved | Date: 22-JAN-2001 |
| Mntd By: CT | |
| Mntd Date: 19-JAN-2001 | |

MARITIME HYDRAULICS CANADA LTD.

ISO 9001

Title: SKATE ROLLER CHAIN ASSY 2 ASSEMBLY
-

Dwg No: 310-B-038

Sheet: 1 of 1

Weight(lbs): 22.764

Scale: 1:4

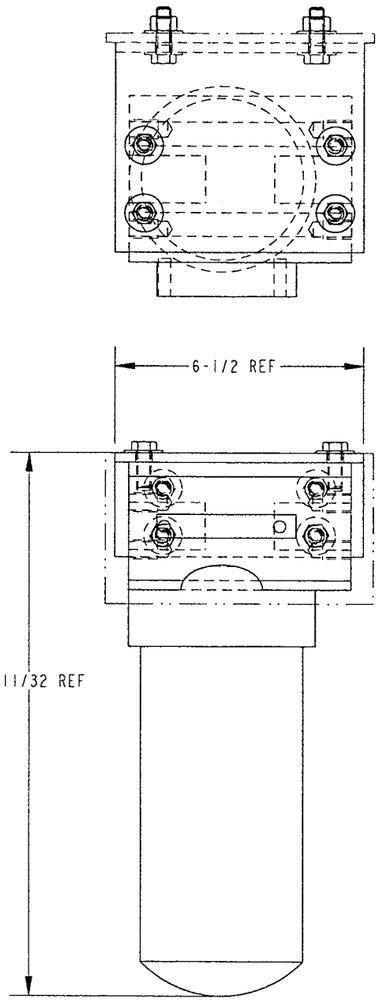
| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_RLR_CHAIN_ASSY_25 | WIP | 1.3+ |

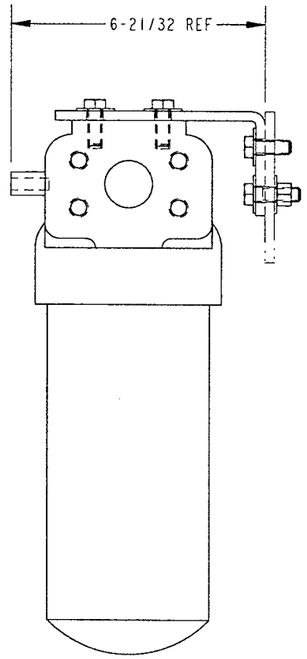
ENG-1002B REV-0

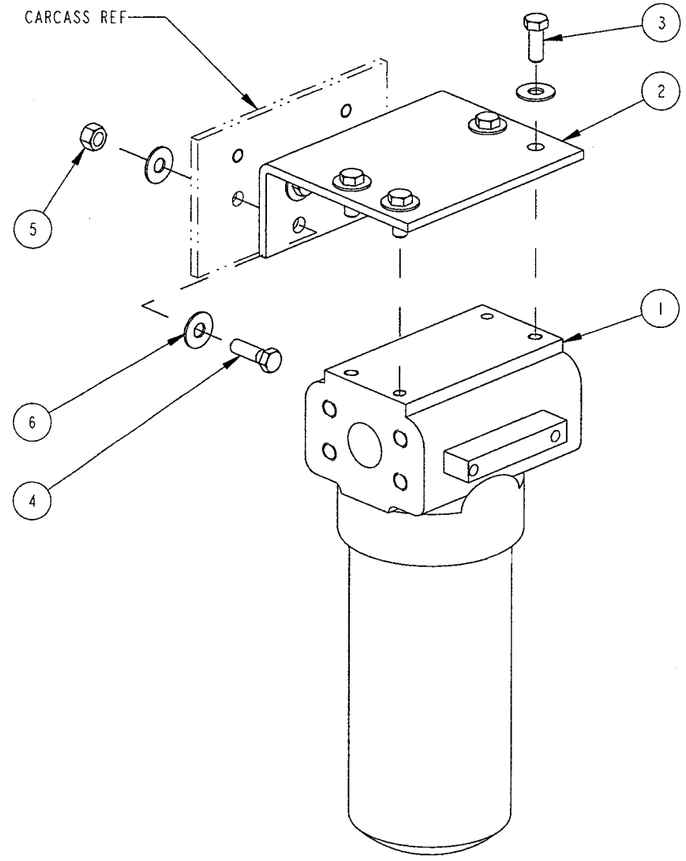
NOTE: PART NUMBERS PREFIXED BY '*' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.

## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | *602-0255 | HYDRAULIC FILTER | 1 |
| 2 | 310-B-346 | FILTER MOUNT 2 | 1 |
| 3 | N/A | BOLT 3/8-16 UNC x 1 LG GR 5 | 6 |
| 4 | N/A | BOLT 3/8-16 UNC x 1-1/4 LG GR 5 | 2 |
| 5 | N/A | NUT 3/8 UNC GR 5 | 2 |
| 6 | N/A | WASHER 3/8 | 10 |




SCALE 1:4

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| - | - | - | - |

REVISION HISTORY

Software: Pro/E | Version: 2000i2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

| | | |
|---|---|---|
| Maintained: CT | Date: 23-DEC-2003 | |
| Drawn: CT | Date: 03-JUL-2001 | |
| Designed: CT | Date: 03-JUL-2001 | |
| Checked: | Date: 04-FEB-2004 | |
| Approved: | Date: 04 FEB 2004 | |

NATIONAL OILWELL
HITEC SYSTEMS AND CONTROLS INC.

Date:
HYDRAULIC FILTER ASSY
ASSEMBLY
-

| Size: | Dwg No: | Sheet: | Rev: |
|---|---|---|---|
| B | 310-B-345 | 1 of 1 | - |

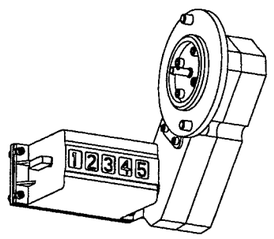
Weight: (est.) 43.628 lbs | Scale: 1:4

| MODEL | STATUS | PDMREV |
|---|---|---|
| GEN4_HYD_FILTER_ASSY | WIP | 1.1 |

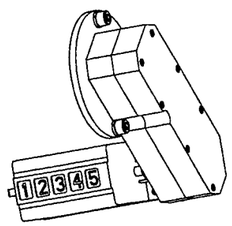


ENG-1002B REV-1

NOTE: PART NUMBERS PREFIXED BY '•' ARE INCLUDED IN THE APPLICABLE SCHEMATIC. DO NOT INCLUDE IN THIS BOM.




SCALE 1:8




SCALE 1:8




## BILL OF MATERIALS

| ITEM | PARTNO | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 201-0418 | 2mm O-RING STOCK 2' | 1 |
| 2 | 201-0458 | BALL BEARING | 6 |
| 3 | 203-1445 | TIMING BELT PULLEY 11G | 2 |
| 4 | 203-1545 | MECHANICAL COUNTER #4 ROTATION | 1 |
| 5 | 203-1546 | TIMING BELT 144 GRVS 1/4 x .080 | 1 |
| 6 | 203-1547 | TIMING BELT 130 GRVS 1/4 x .080 | 1 |
| 7 | 310-B-666 | BRAKE MECH COUNTER ADAPTER | 1 |
| 8 | 310-B-672 | COUNTER ADAPTER SHAFT 1 | 1 |
| 9 | 310-B-673 | COUNTER ADAPTER SHAFT 2 | 1 |
| 10 | 310-B-674 | COUNTER ADAPTER SHAFT 3 | 1 |
| 11 | 310-B-675 | COUNTER ADAPTER BODY | 1 |
| 12 | 310-B-676 | COUNTER ADAPTER BEARING COVER | 1 |
| 13 | 310-B-677 | MECHANICAL COUNTER MOUNT | 1 |
| 14 | 310-B-678 | COUNTER ADAPTER COUPLING | 1 |
| 15 | 310-B-679 | COUNTER ADAPTER COUPLING SCREW | 2 |
| 16 | 310-B-680 | COUNTER ADAPTER COVER | 1 |
| 17 | 310-B-684 | TIMING BELT PULLEY 80G x .080P | 1 |
| 18 | 310-B-685 | TIMING BELT PULLEY 90G x .080P | 1 |
| 19 | 802-0197 | SNAPRING N5000-112 | 6 |
| 20 | 802-0270 | SPRING TENSION PIN 1/8 x 1 LG | 1 |
| 21 | 802-0277 | SPRING TENSION PIN 1/8 x 5/8 LG | 1 |
| 22 | 802-0279 | SPRING TENSION PIN 1/8 x 1-3/8 LG | 1 |
| 23 | N/A | HEX SKT CAPSCREW 3/8-16 UNC X 1 LG | 2 |
| 24 | N/A | HEX SKT CAPSCREW 5/16-18UNC x 3/4 LG | 4 |
| 25 | N/A | HEX SOCK 1/2-13 UNC x 1 LG | 2 |
| 26 | N/A | HEX SOCK 1/4-20 UNC x 1/2 LG | 2 |
| 27 | N/A | HEX SOCK 1/4-20 UNC x 2 LG | 7 |
| 28 | N/A | HEX SOCK 1/4-20 UNC x 7/8 LG | 4 |
| 29 | N/A | LOCK WASHER 1/2 | 2 |
| 30 | N/A | LOCK WASHER 1/4 | 4 |
| 31 | N/A | LOCK WASHER 3/8 | 2 |
| 32 | N/A | NUT 1/4 UNC GR 5 | 4 |

| REV | DESCRIPTION | DATE | ECR# |
|---|---|---|---|
| B | CHANGED INTERFACE FOR BRAKE ADAPTER | 25-APR-2002 | - |
| 1 | REDESIGNED FOR RATIO CHANGE | 19-MAR-2001 | - |

REVISION HISTORY

| MODEL | STATUS | PDMREV |
|---|---|---|
| MECH_CNTR_ASSY | RFP | 1.13 |



Software: Pro/E Version: 2000i2

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH=125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

Maintained: CT Date: 25-APR-2002

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn: JJM | Date: 18-SEP-2000 | Date: |
| Designed: JJM | Date: 18-SEP-2000 | MECHANICAL COUNTER ADAPTER ASSEMBLY |
| Checked: JJM | Date: 25-APR-2002 | Size: B \| Dwg No: 310-B-667 \| Sheet: 1 of 1 \| Rev: B |
| Approved: LKJ | Date: 25-APR-2002 | Weight: (est.) 36.679 lbs \| Scale: 1:4 |

ENG-1002B REV-1

# 3 Schematics

FOR QD SPECIFICATIOIN SEE BULKHEAD ASSEMBLY DRAWING 310-B-630 AND 310-B-295

1/2" HOSE INTO PAN

65 psi

INJECTOR RETURN (1) — 1" — 1/2"

OUT-HOLE PRESSURE (-) — 1"

IN-HOLE PRESSURE (-) — 1"

8 13 18

MOTOR DISPLACEMENT (2) — 3/8"

MAXIMUM DISPLACEMENT PRESS. – 0 TO 75 PSI
MOTOR SHIFT PRESS. RANGE – 75 TO 435 PSI
MINIMUM DISPLACEMENT PRESS. – OVER 435 PSI
MAX ALLOWABLE DISPLACEMENT PRESS. – 1450 PSI

SPRING SETTING 4,500 PSI

SPRING SETTING 4,500 PSI

MOTOR ROTATION:

| FLOW | DIRECTION |
|---|---|
| A–B | CLOCKWISE |
| B–A | COUNTERCLOCKWISE |

250 psi

300 psi

BRAKE RELEASE PRESSURE (5) — 3/8"

AUTO BRAKE OVERRIDE (AUTO/ ON) (6) — 3/8"

SKATE PRESSURE (8) — 3/8"

INJECTOR SKATE CYLINDERS

1000 psi N2

1000 psi N2

SKATE PRESSURE TOP

SKATE PRESSURE BOTTOM

SKATE RETRACT (9) — 3/8"

STRING WEIGHT (13) — 3/8"

CHAIN LUBE CONTROL (7) — 3/8"

CHAIN OILER NOZZLES

CHAIN OILER NOZZLES

SPRING SETTING 4,000 PSI

NO LOAD PILOT PRESSURE 700 PSI

SPRING SETTING 4,000 PSI

NO LOAD PILOT PRESSURE 775 PSI

INJECTOR LIFT FRAME CYLINDER

WELLHEAD PRESSURE (10)

STRIPPER

STRIPPER PACK (11) — 3/8"

STRIPPER RETRACT (12)

INJECTOR FRAME FORWARD (3) — 3/8"

INJECTOR FRAME BACK (4) — 3/8"

BILL OF MATERIALS

| ITEM | PART NO. | DESCRIPTION | QTY |
|---|---|---|---|
| 1 | 601-0759 | HYDRAULIC MOTOR | 2 |
| 2 | 203-1145 | FAILSAFE BRAKE ASSEMBLY | 2 |
| 3 | 400-0198 | SKATE PRESSURE CYLINDER ASSEMBLY | 4 |
| 4 | 203-0170 | STRIPPER / ANNULAR BOP (CUSTOMER PROVIDE) [QTY: 1 REF] | 0 |
| 5 | 203-0564 | LOAD CELL (HYDRAULIC) | 1 |
| 6 | 203-1232 | HYDRAULIC CYLINDER | 1 |
| 7 | 287-B-800-04 | CABLE, LOAD CELL | 1 |
| 8 | 300-B-309 | HYDRAULIC FILTER BLANK PLATE MODIFICATION | 2 |
| 9 | 310-B-270 | MOTION CONTROL BLOCK INSIDE ASSY | 1 |
| 10 | 310-B-271 | MOTION CONTROL BLOCK OUTSIDE ASSY | 1 |
| 11 | 502-4137 | VELOCITY FUSE ( RATED FLOW 1 GPM ) | 2 |
| 12 | 601-0028 | PISTON ACCUMULATOR, 1 QT. | 2 |
| 13 | 602-0088 | HIGH PRESSURE FILTER ELEMENT [QTY: 2 REF] | 0 |
| 14 | 602-0108 | MOTION CONTROL CARTRIDGE | 2 |
| 15 | 602-0126 | 3-WAY BALL VALVE | 1 |
| 16 | 602-0181 | IN-LINE CHECK VALVE | 1 |
| 17 | 602-0190 | CHECK VALVE RELIEF | 1 |
| 18 | 602-0255 | HIGH PRESSURE FILTER ASSEMBLY | 2 |
| 19 | 602-0272 | SHUTTLE VALVE | 1 |
| 20 | 602-0294 | PRESSURE REDUCING VALVE | 1 |
| 21 | 602-0673 | PRESSURE GAUGE 0-5,000 psi | 2 |
| 22 | 602-0739 | SEQUENCE VALVE | 1 |
| 23 | 602-1062 | PILOT OPERATED DCV | 1 |
| 24 | 602-1072 | COUNTERBALANCE VALVE | 2 |
| 25 | -- | CHAIN OILER [QTY: 4 REF] | 0 |

| REV | DESCRIPTION | DATE | CR# |
|---|---|---|---|
| B | CORRECT IN/OUT-HOLE PLUMBING. ADD VEL FUSES & LOAD CELL CABLE. UPGRADE HOSES FROM #1/4". CHANGE ITEM #17 FROM 602-0210. | 30-MAR-2005 | - |
| A | SPRING SETTING NOTES ADDED | 09-OCT-2002 | - |

REVISION HISTORY

Software: Acad | Version: 2002

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X=±.03 .XX=±.01 .XXX=±.005
FRACTIONS=±1/16 ANGLES=±.5°
SURFACE FINISH = 125 RMS
DEBURR SHARP EDGES
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

NATIONAL OILWELL

HITEC SYSTEMS AND CONTROLS INC.

| | | |
|---|---|---|
| Drawn CT | Date 17-JUL-2000 | Title: INJECTOR HYDRAULIC SCHEMATIC RT25 GEN4 INJECTOR |
| Designed LKJ | Date 29-SEP-1999 | |
| Checked | Date 11 mar 05 | |
| Maintained BM | Date 30-MAR-2005 | Size D / Dwg No. 310-B-626 / Sheet 1 of 1 / Rev B |
| | | Weight (est.) lbs. / Scale N/A |

# 4 Maintenance

## *4.1 Maintenance Intervals*

| Check or Perform the Following Maintenance as Indicated Below | Daily Before Operation | Daily During Operation | Weekly or 75 Hours | Monthly or 300 Hours | Semi Annually or 1,800 Hours |
|---|---|---|---|---|---|
| Check injector lube tank level | ● | | | | |
| Check hydraulic tank level | ● | | | | |
| Check that quick disconnects are connected correctly | ● | | | | |
| Check injector drive chain tension | ● | | | | |
| Inspect drive chains for failing cotter pins / pin rivets | | | ● | | |
| Check for evidence of hydraulic leaks | ● | | | | |
| Grease injector head | Severe Service | | Normal Service | | |
| Check planetary gearbox oil level | | | ● | | |
| Clean inside and outside of injector, re-lube chains | Severe Service | | Normal Service | | |
| Ensure oiling system is functioning | | ● | | | |
| Check oiling system filter. Replace as required | | | | ● | |
| Check injector for wear and replace worn/damaged parts | | | ● | | |
| Drain and clean drip pans | | | ● | | |
| Check skate accumulator nitrogen pressure | | | ● | | |
| Check and adjust skate roller chain tension | | | ● | | |
| Inspect drive chains for failing cotter pins / pin rivets | | | ● | | |
| Check alignment of drive chains: must be central to injector side plates | | | | ● | |
| Replace high pressure filter element | | | | 300 Hours Severe Service | 500 Hours Normal Service |
| Check hoses for deterioration | | | | | ● |
| Drain, clean, refill lube tank | | | | | ● |

## *4.2 Lubrication Requirements*

The lubrication recommendations made here can be used as a guide to the use of other companies' products and should not be limited to the product examples herein enclosed.

**1. Hydraulic System Oil**

a. Esso – Univis Extra
b. Shell – Tellus 22

**2. Injector Bearing Grease**

a. Esso/Exxon – Unirex EP 2
b. Shell – Extrema EP 2

**3. Injector Chain Lubricating Oil System**

a. Esso/Exxon – Esso Extra/Grade SAE 10
b. Shell – Rotella S/Grade SAE 10

**4. Injector Planetary Gearbox Lubricating Oil**

a. Esso – Gear Oil LS 80W90 (GL-5)
b. API GL-5 Equivalent

## *4.3 Gripper Chain Tension Adjustment Procedure*

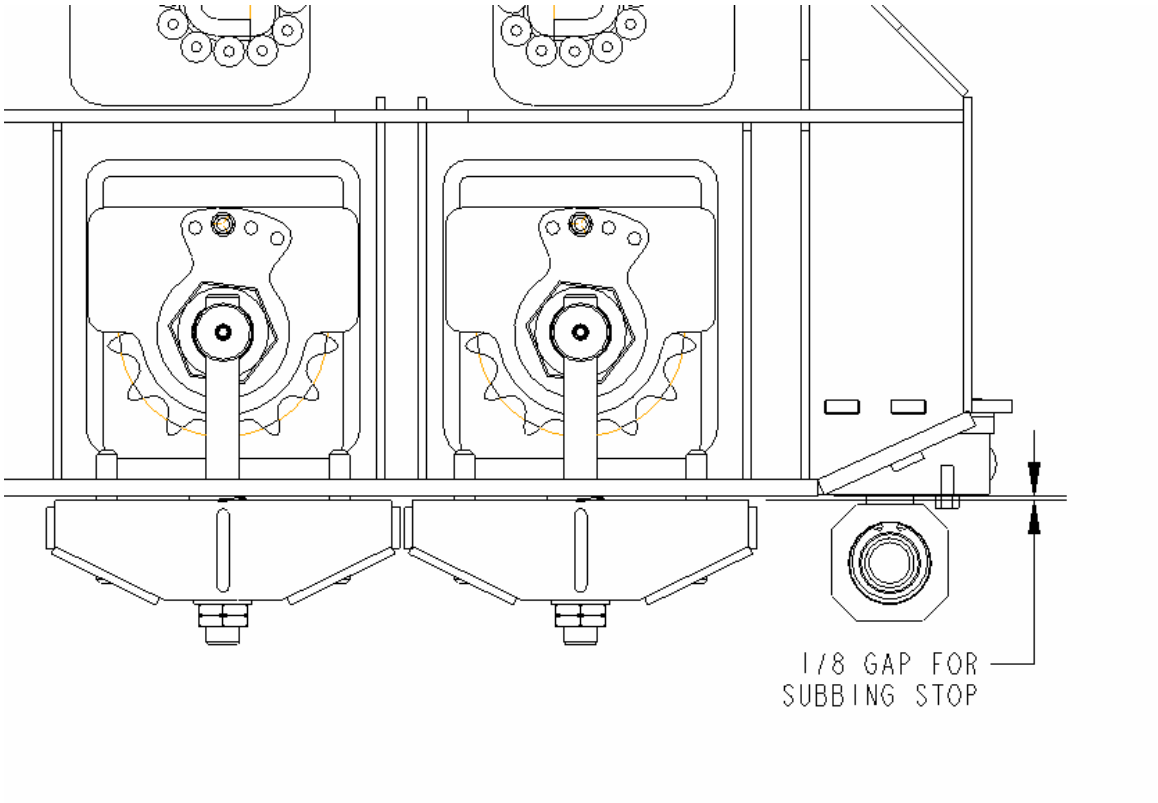



*Figure 4.1: Gripper Chain Assembly*

### 4.3.1 Adjustment 1

Please refer to the illustration above.

Loosen the hex jam nuts and adjust according to the dimensions indicated. Retighten the jam nuts securely after adjustment. A ⅛”(3 mm) gap must be maintained between the idler tensioner and the injector carcass.

Purpose: this is to provide clearance for bottom shaft movement due to chordal action as the chain moves around the sprockets. When the tubing load moves from pulling to a snubbing action, this top nut will be pulled up against the bottom housing to resist these forces. If this distance is not maintained, there will be too much slack chain building up between the tubing and the top sprocket during snubbing operations. This extra length may cause the chain to kink slightly and may cause damage to the chain, drive mechanism, and/or tubing.

### 4.3.2 Adjustment Interval

Check the adjustment before every job, and adjust when the distances change by more than $^{1}/_{16}$" (1.5 mm).

As the gripper chains wear, the bottom shafts will move down. Maintaining the specified distances on these adjustments will ensure that the injector operates correctly.

### 4.3.3 Tools

Tools required to make these adjustments are:

- Two 1 ½" (38.1 mm) open-end wrenches
- One Tensioner Gauge tool 300-B-179 – use gauge thickness for Adjustment 1. If you do not have this gauge, please contact our parts department.

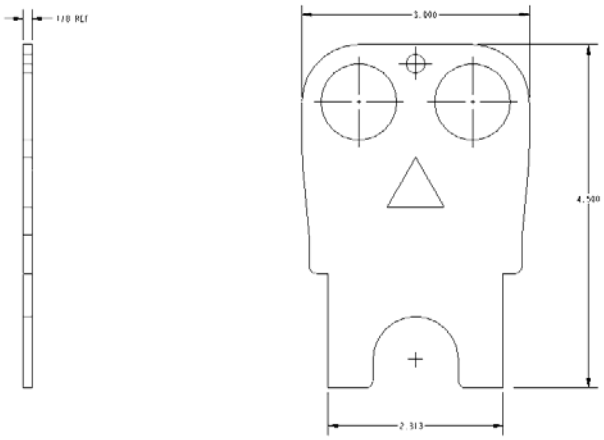


*Figure 4.2: Tensioner Gauge Tool (300-B-179)*

# 5 Troubleshooting

## 5.1 Noisy drive motor (unloaded)

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Low speed regular humming* | • Worn bearing. | • Replace bearing. |
| *High speed rattling* | • Charge pressure too low. | • Recalibrate charge pressure. |
| | • Check return pressures uneven. | • Reset relief valve. |
| *Cavitation* | • Restriction in supply line. | • Replace suction line to pumps. Open ball valves. |
| *Excessive leaks* | • Loose fittings or valving worn. | • Tighten fittings, check cylinder block, and repair worn valves. |

## 5.2 Noisy drive motor (loaded)

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Banging sound* | • Charge pressure too low. | • Recalibrate charge pressure. Check for corrosion on backpressure valve. |
| | • Binding inside the injector: broken, sheared, or twisted shaft, broken drive chain. | • Find out cause and repair. |
| *Popping sound* | • Cylinder block and/or distributor assemblies. | • Check or have checked the listed components. |

## 5.3 Motor does not rotate at its normal speed, or at all

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • No delivery. | • Check pump drive and its supply. |
| | • Oil level low. | • Fill to correct level. |
| | • Brakes not released. | • Adjust pressure on brake circuit. See schematic. |
| | • Damaged brakes. | • Replace or repair. |
| | • Main quick disconnects not hooked up properly. | • Connect correctly. |
| | • High pressure relief settings on motion control and lock valves not set. | • Set high-pressure relief settings on motion control and lock valves. Also check pump output pressures. |
| | • Remote relief pressures on control console not dialed in. | • Dial in pressure. |

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Binding inside injector* | • A broken drive chain. | • Find out cause and repair. |
| | • A broken inside roller chain. | • Find out cause and repair. |
| | • A broken, sheared, or twisted drive shaft. | • Find out the cause and repair. |
| | • Brakes locked on. | • Adjust pressures on brake circuit. See schematic. |
| | • The BOP slips have not released from the tubing. | • Release slips. |
| | • No system pressure. | • Check fluid in hydraulic tank. If low, fill.<br>• Check for damaged valve or for valve needing adjustment. On VDPs, check to see if there is charge pressure. See OEM manual for details.<br>• Inspect charge pressure on filters. Are they clogged, or are they the right micron? Replace if necessary. |
| | • One or both injector motors may be worn or damaged. | • Repair or replace. |
| | • Injector speed controller may be damaged. | • Check directional control valve (joystick) input and output pressures to see if the valve is defective. |
| | • Not enough charge pressure. | • Check charge pressure. Check OEM manual. If not within specifications, check charge relief valve at motor. If defective, repair or replace.<br>• Replace inlet filter and/or charge pressure filter.<br>• Inspect charge pump. If defective, repair or replace. See OEM manual for details. |
| | • Check system pressure. | • If low, inspect pressure limiters. If defective, repair or replace. See OEM manual for details.<br>• Worn or damaged VDP. Replace.<br>• Damaged quick disconnects at injector or power hose reel. Repair or replace.<br>• Spline on the drive shaft reel has been twisted off. Replace.<br>• Worn or damaged injector motor. Replace. |

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Quick disconnects not connected properly, or they are damaged. | • Reconnect properly, or replace. |
| | • Too much stripper pressure. | • Relieve stripper pressure. |
| *Excessive leaks* | • Cylinder block and valving leaking. | • Adjust, repair, or replace cylinder block and valving. |
| *Pressure too low* | • Relief valve pressure set wrong. | • Adjust relief valve setting, or replace relief valve. |

## *5.4 Injector motor turns unevenly (for units w/o timing gears)*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Irregular flow. | • Check pump delivery and motor drain delivery levels. |
| | • No skate pressure. | • Increase skate pressure. |
| | • Injector brake locking. | • Reset sequence and pressure reducing valve pressures. See schematic.<br>• Service injector motor. |

## *5.5 Injector surges*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Drivelines pulsate* | • Too much oil is being dumped out of the closed loop circuit. | • Reset the hot oil shuttle valve to the correct setting. |

## *5.6 Injector turns in one direction only*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • System pressure limits on main pump out of adjustment or worn. | • Repair or replace. |
| | • Shuttle valve inside pump is stuck. | • Repair or replace. |
| *Joystick is easy or difficult to move in one or both directions.* | • Possible weak spring. | • Replace. |
| | • Friction disc out of adjustment. | • Adjust friction disc. |
| | • Worn, damaged, or incorrect adjustment on joystick. | • Check input and output pressures for each direction. Repair/replace as necessary. |

## 5.7 External oil leaks on drive motor

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Case pressure too high. | • Check drain filter for cleanliness.<br>• Check return filter for cleanliness. |
| | • Drain line is obstructed. | • Remove, repair, or replace.<br>• Return ball valve to tank partially closed. Open. |
| | • Return line quick disconnect is not hooked up, or is damaged | • Inspect and repair or replace. |

## 5.8 Injector brake will not engage

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Injector joystick has not been brought back to neutral. | • Bring joystick to neutral. |
| | • Wrong pressure on sequence valve. | • Adjust. See schematic. |
| | • Pressure reducing valve not dumping oil to tank. | • Replace. |
| | • Blockage in line from tank. | • Clear blockage. |
| | • Damaged brakes. | • Find cause, replace or repair. |

## *5.9 Injector drive motor overheating*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Oil level in reservoir may be low. | • Refill to correct level. |
| | • Contamination in suction or high-pressure filters. | • Find reason for contamination and repair. Replace filters. |
| | • Main injector quick disconnects only partially coupled together. | • Reconnect properly. |
| | • Suction strainers or high-pressure filters contaminated. | • Replace if contaminated. |
| | • Inspect oil cooler for damage and contamination. | • If damaged, repair or replace. |
| | • Inspect thermostat valve for proper operation. | • If not functioning, replace. |
| | • Incorrect oil viscosity or contaminated oil. | • Replace oil with correct viscosity, and/or find source of contamination. |
| | • Hot oil shuttle valve is not set correctly or is defective. | • Reset valve or replace. |
| | • Injector brake will not release. | • Check the gauge for the pressure-reducing valve on the injector to make sure there is a maximum pressure as defined in the schematic. If not, adjust the pressure-reducing valve to the specified pressure. If this cannot be done, the valve may be worn or damaged. |

## 5.10 System operates erratically

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Pilot pressure on brake system not set up correctly, or damaged. | • Inspect and reset, or replace. |
| | • Oil viscosity too high. | • Replace with oil of proper viscosity. |
| | • Dirt in relief valves. | • Clean relief valves. |
| | • Suction line kinked or collapsed. | • Inspect and repair suction line. |
| *Foamy oil.* | • Leak on suction side of pump. | • Repair leak. |
| *Pump damage.* | • Oil contamination. | • Replace with clean oil, determine source of contamination and repair. |
| | • Broken or worn parts. | • Replace as required. |

## 5.11 System operates too fast

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Second speed is engaged. | • Move to a lower speed.<br>• Check that the quick disconnect on the motor shift line is connected.<br>• Check case drain on injector motors for blockage.<br>• Check that the injector return tank line has been properly connected.<br>• Check for a blockage in the tank return line. |

## *5.12 Load starts to slip with joystick in neutral position*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Swashplate on pump not centering. | • Apply backpressure on opposite side of in-hole/out-hole pressure control valve (control cab). |
| | • Injector brake not activating. | • Check pressures in injector brake circuit. Adjust if necessary.<br>• Pressure reducing valve defective: not dumping to tank. Replace. |
| | • Leaking or broken oil lines from console to skate cylinder. | • Check for leaks. Tighten or replace lines. Examine mating surfaces on couplers for irregularities. |
| | • Oil leaking past skate cylinder packing or O-rings. | • Replace worn parts. If wear is caused by contamination, clean hydraulic system and determine the source. |
| | • Oil leaking past injector control valve or relief valves. | • Clean or replace valves. If wear is caused by contamination, clean hydraulic system and determine the source. |
| | • Control lever not centering when released. | • Check linkage for binding. Make sure valve is properly adjusted and has no broken or binding parts. |

## *5.13 Injector chain traction (inside)*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Pressure does not register on gauge.* | • Skate dump needle valve is open. | • Close skate dump needle valve. |
| | • Faulty gauge. | • Replace. |
| | • Quick disconnects not connected properly or damaged. | • Reconnect properly or replace. |
| | • Needle valve damaged or faulty. | • Replace. |
| | • Pressure reducing valve setting moved. | • Reset pressure and/or replace. |

## 5.14 Injector chain tension (outside)

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Pressure does not register on gauge.* | • Chain tension (outside) dump needle valve is open. | • Close chain dump needle valve. |
| | • Faulty gauge. | • Replace. |
| | • Quick disconnects not connected properly. | • Reconnect properly, or replace. |
| | • Needle valve damaged or faulty. | • Replace. |
| | • Pressure reducing valve setting moved. | • Reset pressure and/or replace. |

## 5.15 Above circuits will not maintain pressure

| Symptom | Probable Cause | Remedy |
|---|---|---|
| | • Air may be trapped in cylinders. | • With the hydraulic system running and the injector motors NOT turning, loosen the fitting at the cylinder and, when the air bubbles stop and there is a steady stream of oil, retighten fitting.<br>• If after bleeding off air the circuits still don't hold pressure, see information on cylinders. |

## 5.16 Load cell

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *Load indication too high.* | • Zero adjust moved. | • Move to correct setting. |
| | • System charge over pressure. | • Bleed pressure to correct level. |
| *Load indication too low.* | • Zero adjust moved. | • Move to correct setting. |
| | • System charge not sufficient. | • Recharge. |
| | • Loose or leaking hose connection. | • Retighten or replace. |
| | • Obstruction or kink in hose. | • Repair or replace. |
| *Erratic or sluggish indication.* | • Not enough oil in the system. | • Recharge system. |
| | • Damper setting is closed. | • Adjust damper setting. |
| | • Obstruction or kink in hose. | • Repair or replace. |

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *No indication.* | • Damper is closed. | • Open damper. |
| | • Load cell gap incorrect. | • Charge system. |
| | • Obstruction or kink in hose. | • Repair or replace. |

## *5.17 Lube oil system*

| Symptom | Probable Cause | Remedy |
|---|---|---|
| *No oil to lube points* | • Oil tank empty. | • Fill tank. |
| | • Pump not running. | • Start pump. |
| | • Quick disconnect not connected. | • Connect properly. |
| | • Filter plugged. | • Clean or replace. |
| | • Control valve not functioning. | • Replace. |
| | • Lube distribution hose plugged. | • Determine which hose is plugged and repair/replace. |
| *Not enough oil to lube points* | • Pump output restricted. | • Repair. |
| | • Oil too thick. | • Replace with oil of proper viscosity. |
| | • Pump develops insufficient pressure. | • Troubleshoot pump. |
| | • Pump not cycled frequently enough. | • Increase pump cycle. |
| *Too much oil to lube points.* | • Pump output not restricted enough. | • Restrict pump output. |
| | • Pump cycled too frequently. | • Decrease pump cycle. |