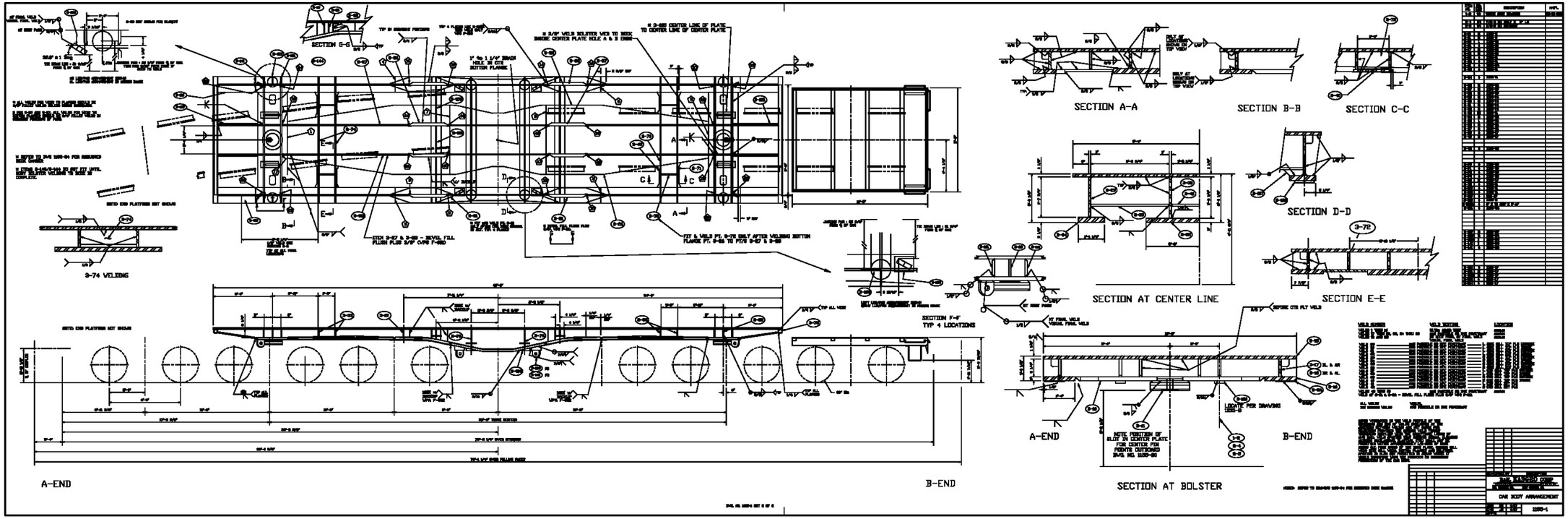
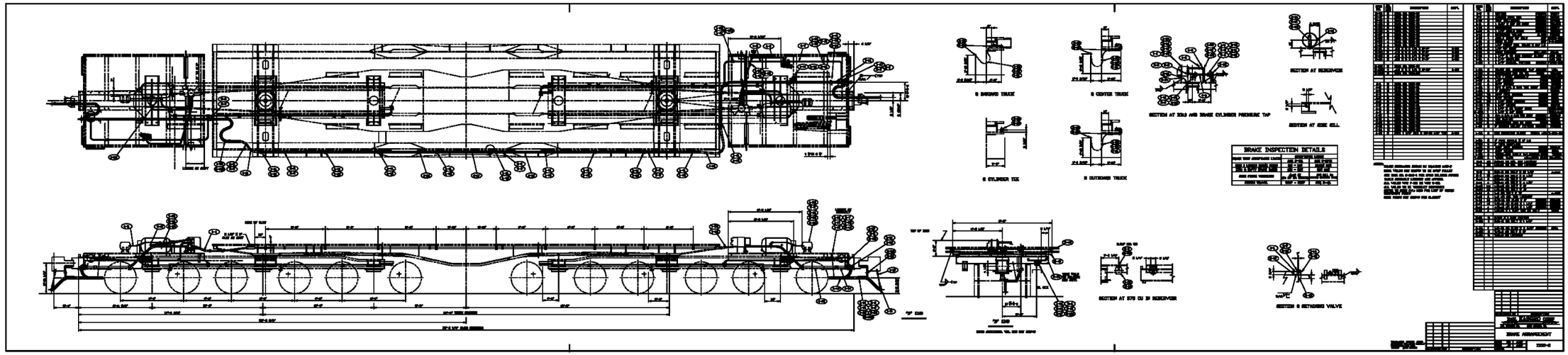
Appendix G – Preliminary Atlas Prototype Railcar Deliverables

APPENDIX G-1
ATLAS RAILCAR PRELIMINARY FABRICATION DRAWINGS

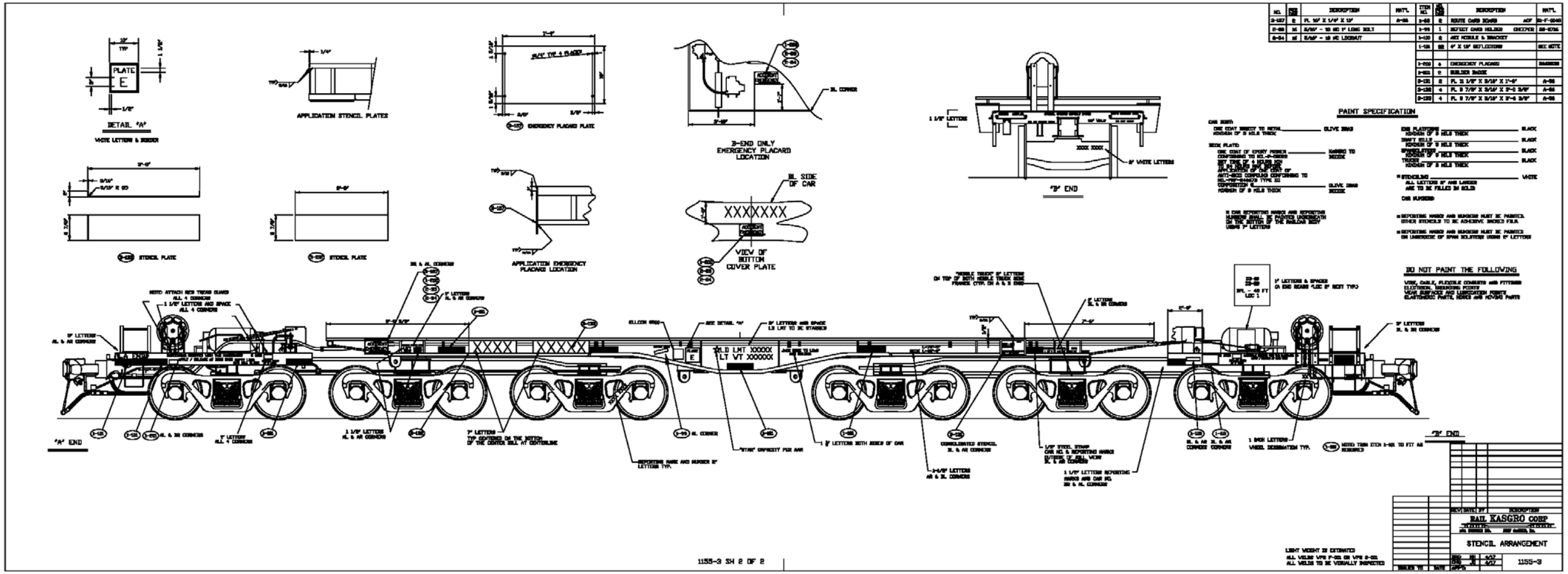
APPENDIX G-1.1 GENERAL ARRANGEMENT



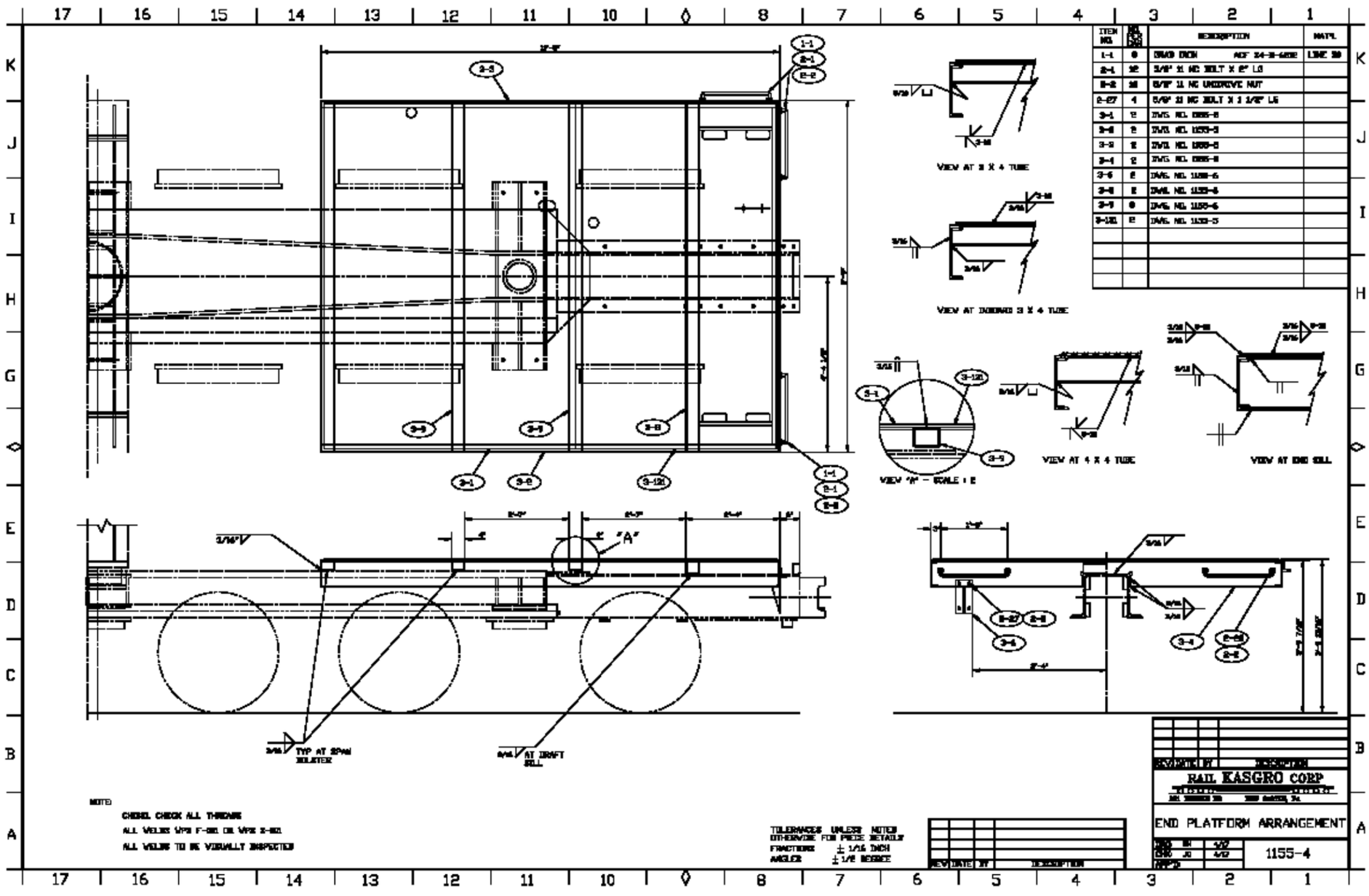
APPENDIX G-1.2 BRAKE ARRANGEMENT



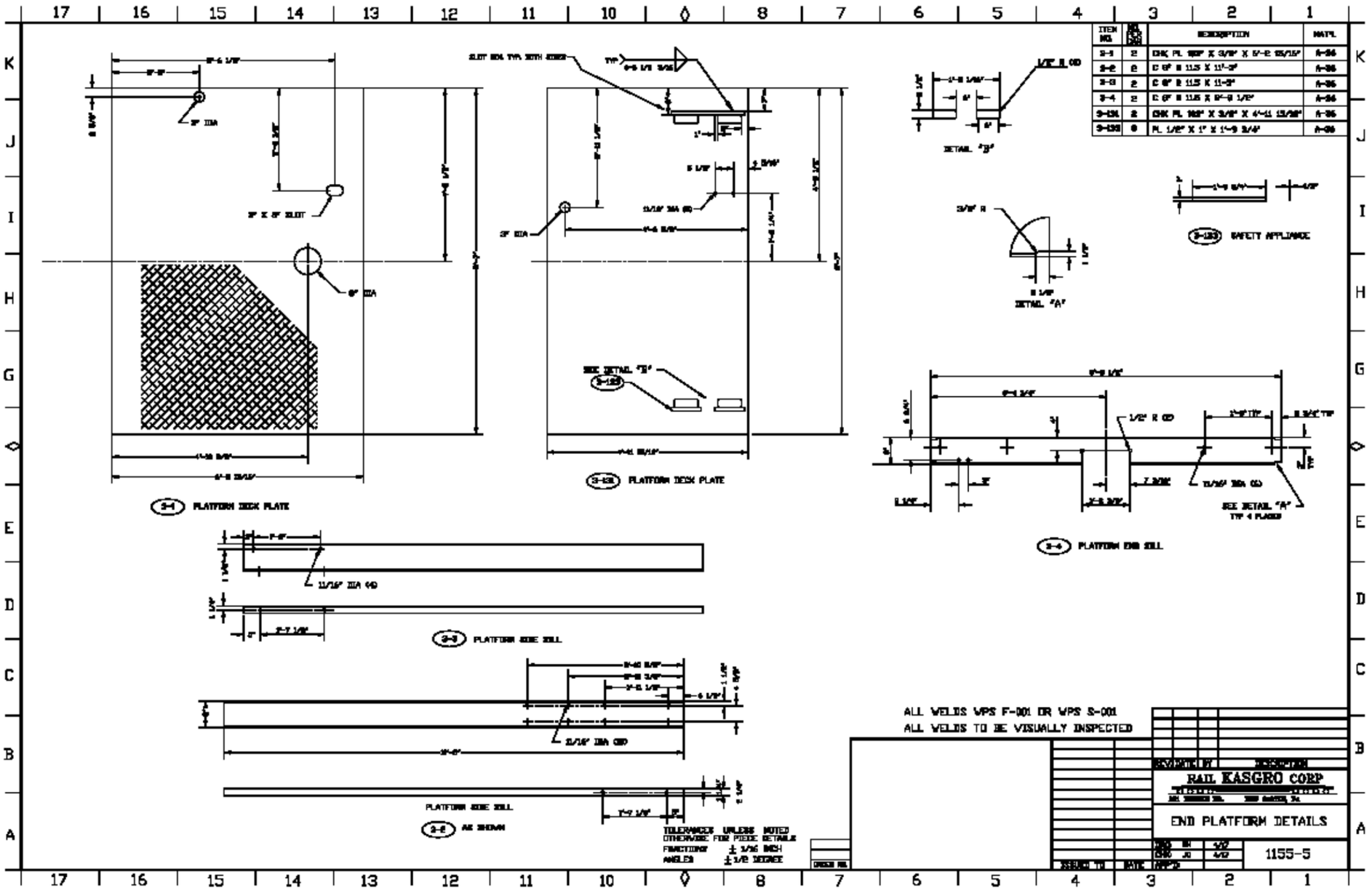
APPENDIX G-1.3 STENCIL ARRANGEMENT



APPENDIX G-1.4 END PLATFORM ARRANGEMENT

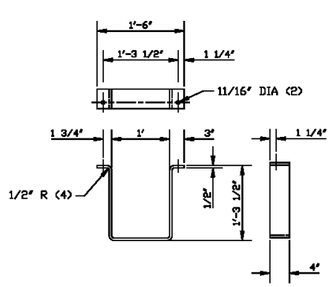


APPENDIX G-1.5 END PLATFORM DETAILS

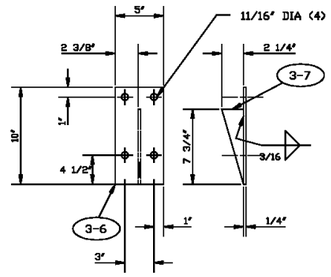


APPENDIX G-1.6 END PLATFORM DETAILS

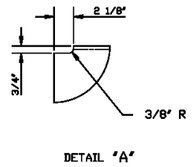
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-5	4	BAR 4" X 1/2" X 3-10 3/4"	A-36
3-6	2	BAR 5" X 1/4" X 0'-10"	A-36
3-7	2	BAR 2 1/4" X 1/4" X 0'-7 3/4"	A-36
3-8	2	TS 4" X 4" X 1/4" X 8'-8 1/2"	A-500
3-9	6	TS 4" X 3" X 1/4" X 8'-8 1/2"	A-500



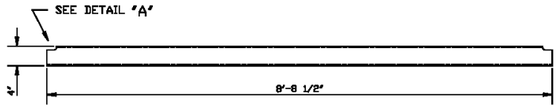
3-5 SILL STEP



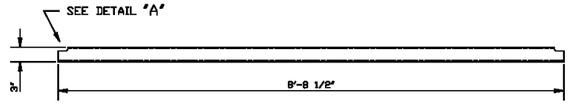
3-6 UNCOUPLING BRACKET



DETAIL "A"



3-8 STRINGER



3-9 STRINGER

ALL WELDS WPS F-001 OR WPS S-001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

REV	DATE	BY	DESCRIPTION

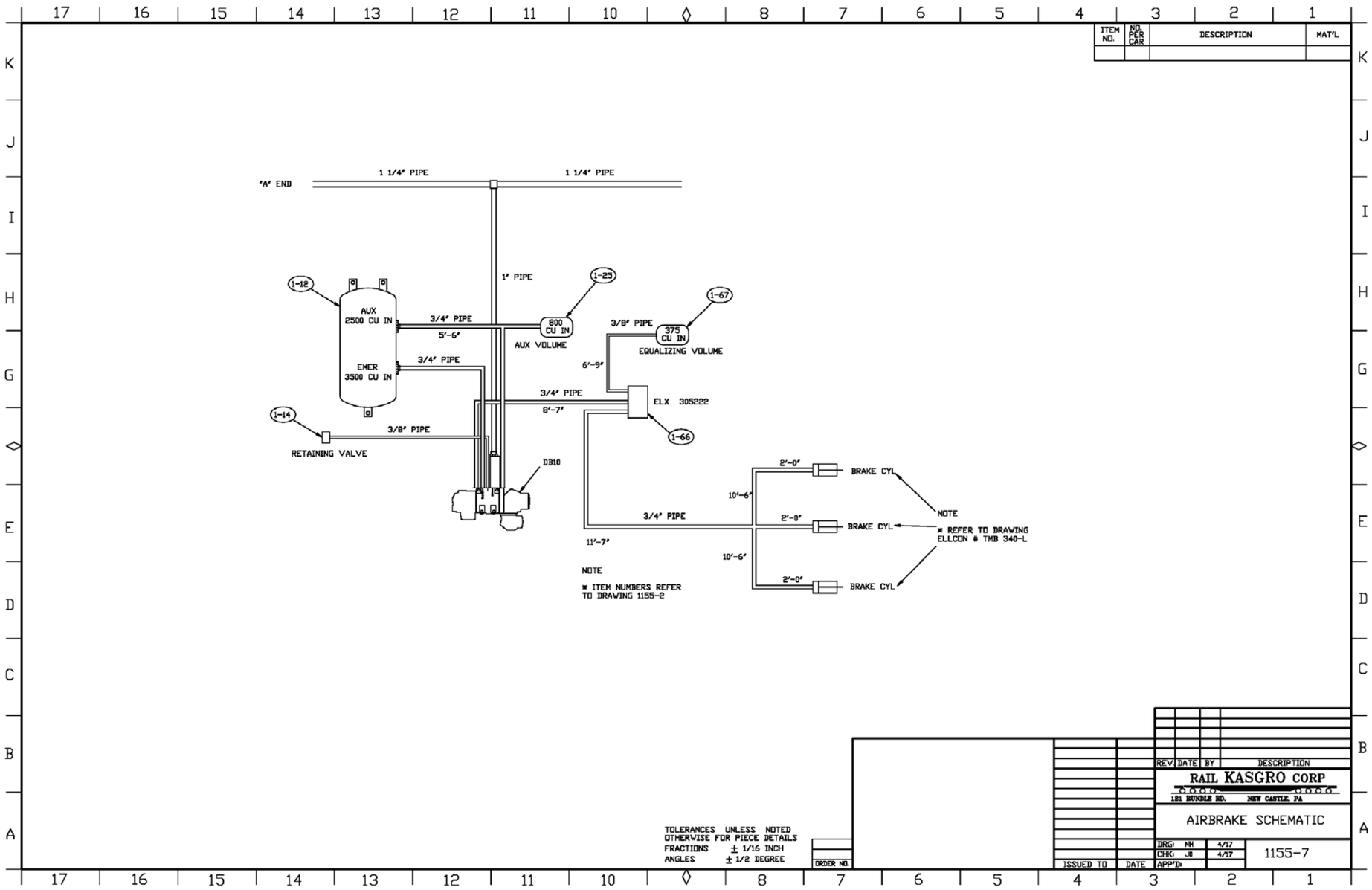
RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

END PLATFORM DETAILS

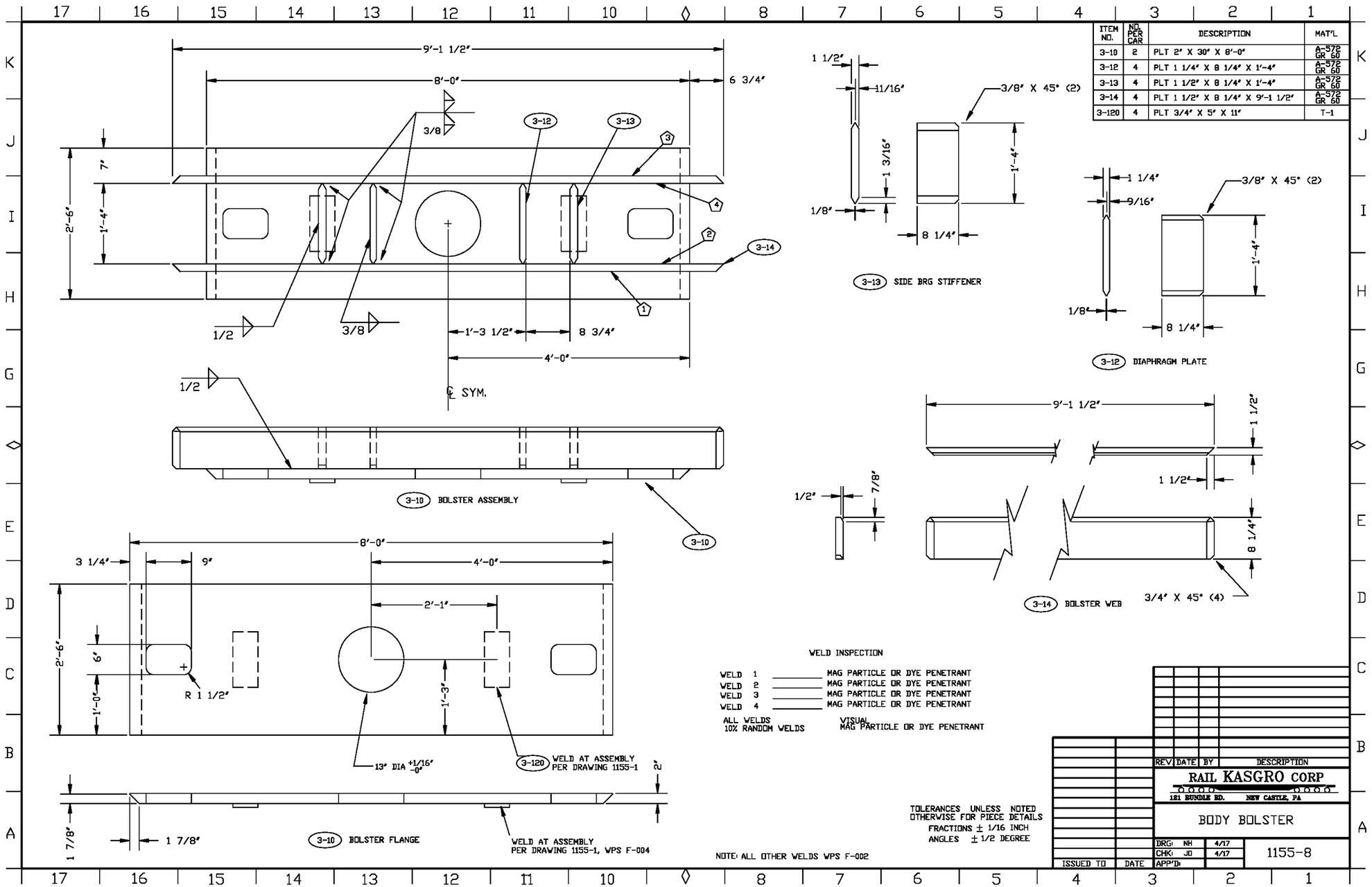
DRG:	NH	4/17	1155-6
CHK:	JD	4/17	
APP'D:			

ISSUED TO | DATE

APPENDIX G-1.7 AIR BRAKE SCHEMATIC



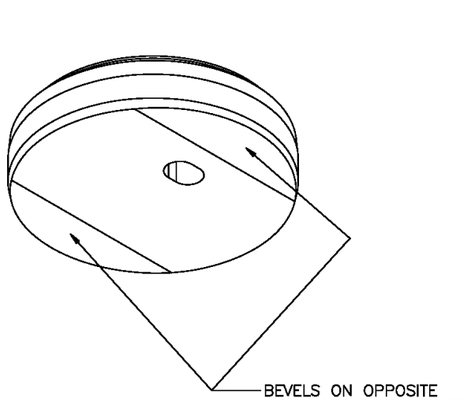
APPENDIX G-1.8 BODY BOLSTER

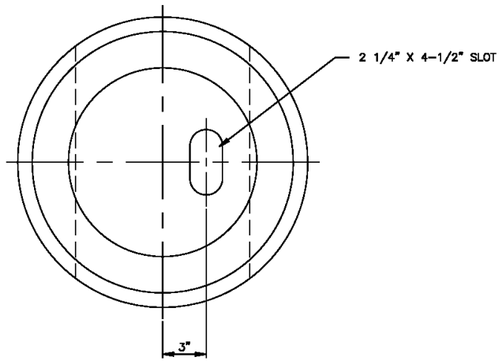


ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-10	2	PLT 2" X 30" X 8'-0"	A-572 GR 60
3-12	4	PLT 1 1/4" X 8 1/4" X 1'-4"	A-572 GR 60
3-13	4	PLT 1 1/2" X 8 1/4" X 1'-4"	A-572 GR 60
3-14	4	PLT 1 1/2" X 8 1/4" X 9'-1 1/2"	A-572 GR 60
3-120	4	PLT 3/4" X 5" X 11"	T-1

APPENDIX G-1.9 CENTER PLATE

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–11	2	PL 7" X 20 5/16" DIA	1045





3–11 CENTER PLATE

NOTES:
1) MACHINE AND SURFACE ONLY THOSE SURFACES TO BE FLAME HARDENED
2) COMPLETE THE FLAME HARDENTING OPERATION
3) MACHINE AND FINISH SURFACES WHICH ARE NOT TO BE HARDENED
4) HARDENED SURFACES MUST BE FINISHED TO 250 RMS MAX
5) BEVELS ARE ON OPPOSITE SIDES OF CENTER PLATES. A LATHE SHOULD NOT BE USED IN THE MACHINING PROCESS.

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO. | ISSUED TO | DATE

REV.	DATE	BY	DESCRIPTION

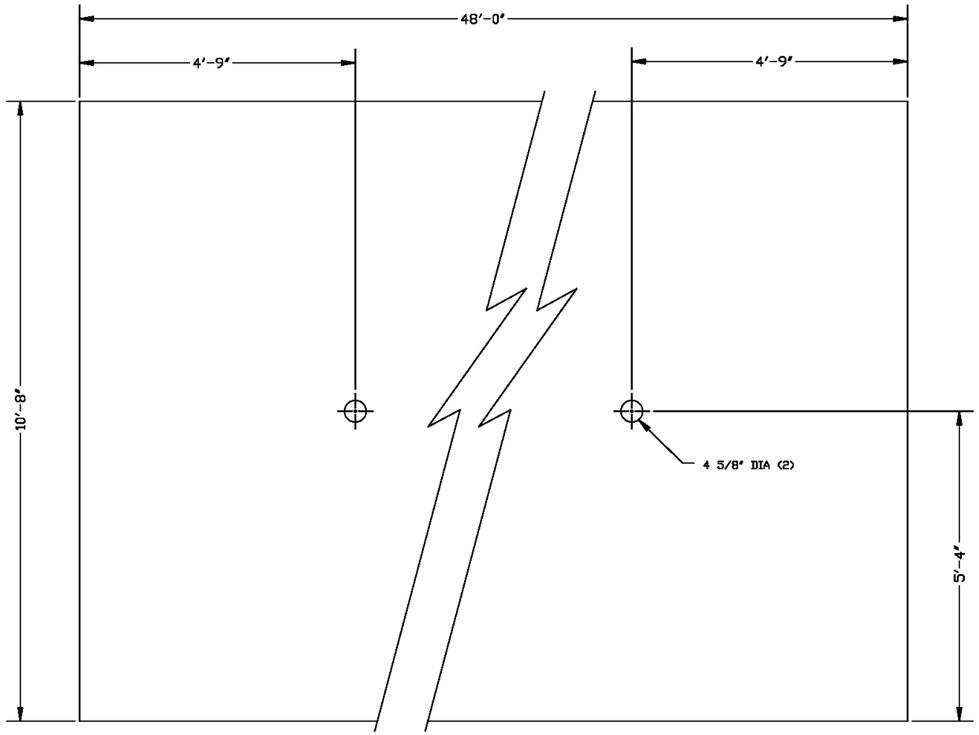
RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

CENTER PLATE

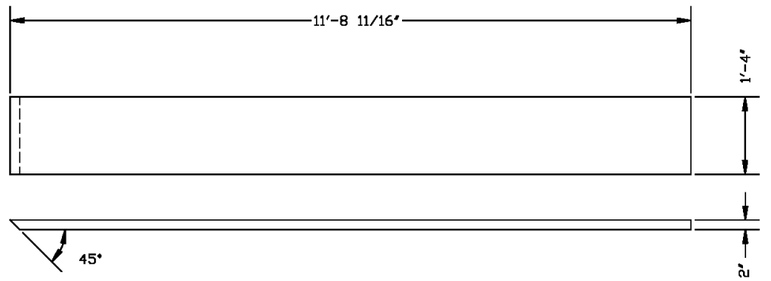
DRG: NH	4/17	1155–9
CHK: JO	4/17	
APP'D:		

APPENDIX G-1.10 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-15	1	PLT 1 1/2" X 128" X 48'-0"	A-572 GR 60
3-16	4	PLT 2" X 16" X 11'-8 11/16"	A-572 GR 60
3-17	2	PLT 1 1/4" X 8 1/4" X 16'-2 3/16"	A-572 GR 60
3-18	2	PLT 1 1/4" X 8 1/4" X 16'-2 3/16"	A-572 GR 60



3-15 DECK PLATE

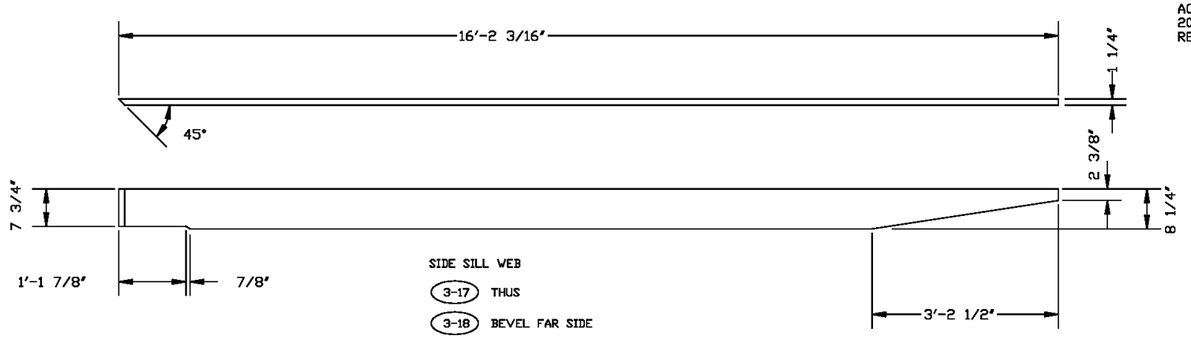


3-16 SIDE SILL BOTTOM FLANGE

NOTES:

1. FOR ITEM 3-16, THE USE OF ASTM A572 GRADE 50 MATERIAL IS ACCEPTABLE PROVIDED THE MECHANICAL PROPERTIES FOR GRADE 60 MATERIAL ARE SATISFIED (I.E., 60 KSI MINIMUM YIELD AND 75 KSI MINIMUM TENSILE).

2. FOR ITEM 3-16, CHARPY IMPACT TESTING OF THE MATERIAL IS REQUIRED IN ACCORDANCE WITH ASTM A673. THE MINIMUM AVERAGE ABSORBED ENERGY SHALL BE 20 FT-LBS AT ZERO (0) DEGREES F. TRANSVERSE IMPACT TEST ORIENTATION IS REQUIRED FOR PLATE WIDTHS OVER 24 INCHES.



SIDE SILL WEB
3-17 THUS
3-18 BEVEL FAR SIDE

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

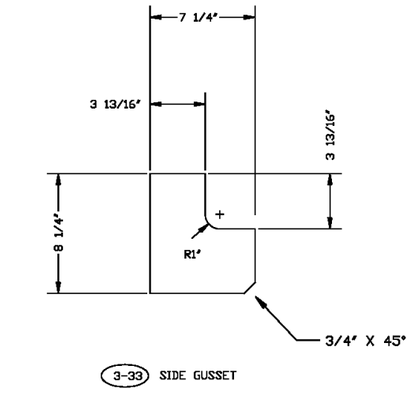
RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

STEEL DETAILS

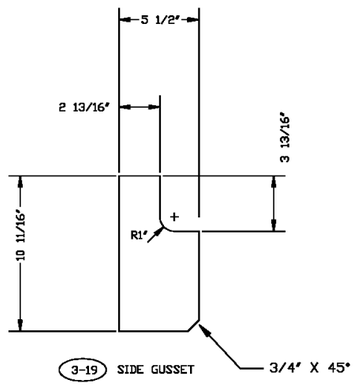
DRG:	NH	4/17	1155-10
CHK:	JD	4/17	
APP'D:			

APPENDIX G-1.11 STEEL DETAILS

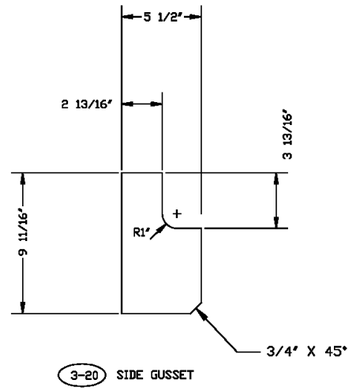
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-19	4	PLT 3/4" X 10 11/16" X 0'-5 1/2"	A-572 GR 60
3-20	4	PLT 3/4" X 9 11/16" X 0'-5 1/2"	A-572 GR 60
3-22	4	PLT 3/4" X 8 3/4" X 0'-5 1/2"	A-572 GR 60
3-24	4	PLT 1/2" X 10" DIA	A-572 GR 60
3-33	12	PLT 1" X 8 1/4" X 0'-7 1/4"	A-572 GR 60
3-76	2	PLT 1" X 7 1/2" X 1'-4 3/8"	A-572 GR 60
3-107	4	PLT 1" X 3" X 0'-10"	A-572 GR 60
3-109	4	10" DIA X 0'-2 1/2"	A-572 GR 60



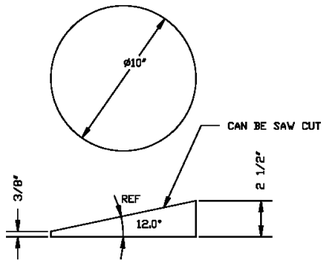
3-33 SIDE GUSSET



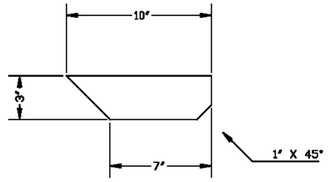
3-19 SIDE GUSSET



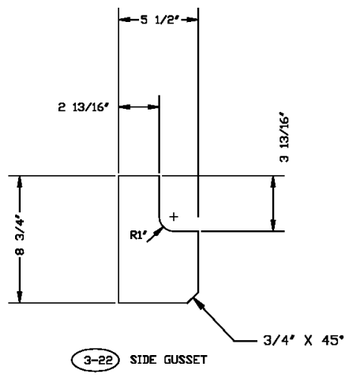
3-20 SIDE GUSSET



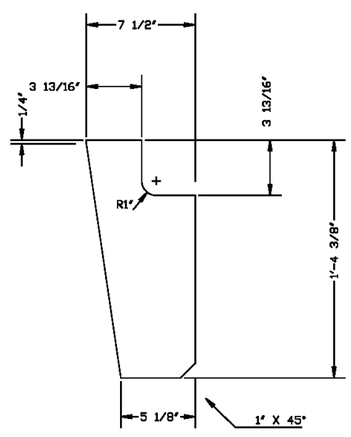
3-109 JACKING PAD



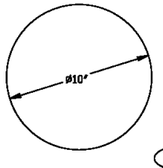
3-107 STIFFENER



3-22 SIDE GUSSET



3-76 SIDE GUSSET



3-24 SUPT PAD

TOLERANCES UNLESS NOTED
OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

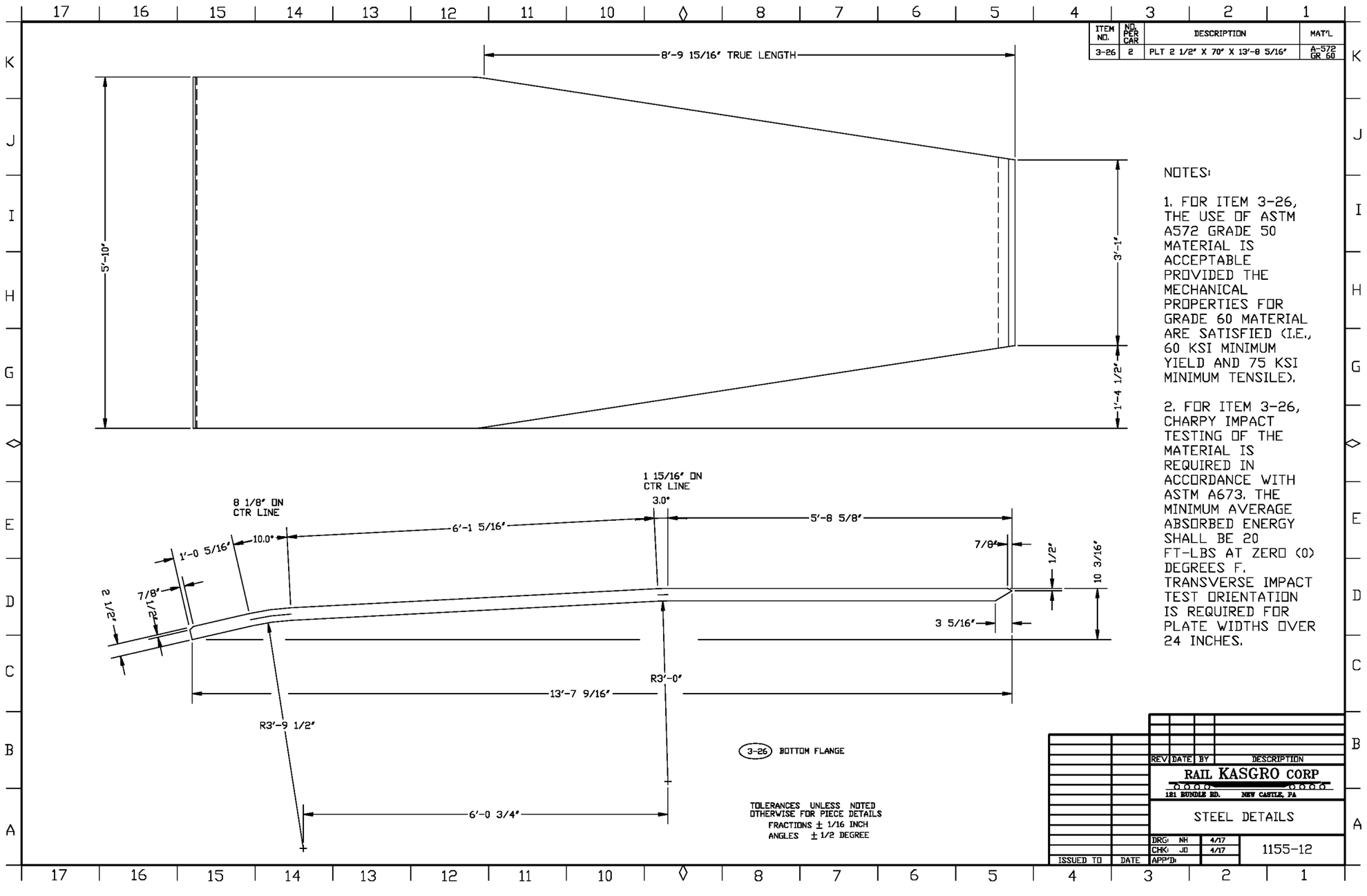
RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

STEEL DETAILS

ISSUED TO	DATE	APP'D
DRG: NH	4/17	
CHK: JD	4/17	

1155-11

APPENDIX G-1.12 STEEL DETAILS



ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-26	2	PLT 2 1/2" X 70" X 13'-8 5/16"	A-572 GR 60

NOTES:

1. FOR ITEM 3-26, THE USE OF ASTM A572 GRADE 50 MATERIAL IS ACCEPTABLE PROVIDED THE MECHANICAL PROPERTIES FOR GRADE 60 MATERIAL ARE SATISFIED (I.E., 60 KSI MINIMUM YIELD AND 75 KSI MINIMUM TENSILE).

2. FOR ITEM 3-26, CHARPY IMPACT TESTING OF THE MATERIAL IS REQUIRED IN ACCORDANCE WITH ASTM A673. THE MINIMUM AVERAGE ABSORBED ENERGY SHALL BE 20 FT-LBS AT ZERO (0) DEGREES F. TRANSVERSE IMPACT TEST ORIENTATION IS REQUIRED FOR PLATE WIDTHS OVER 24 INCHES.

REV	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

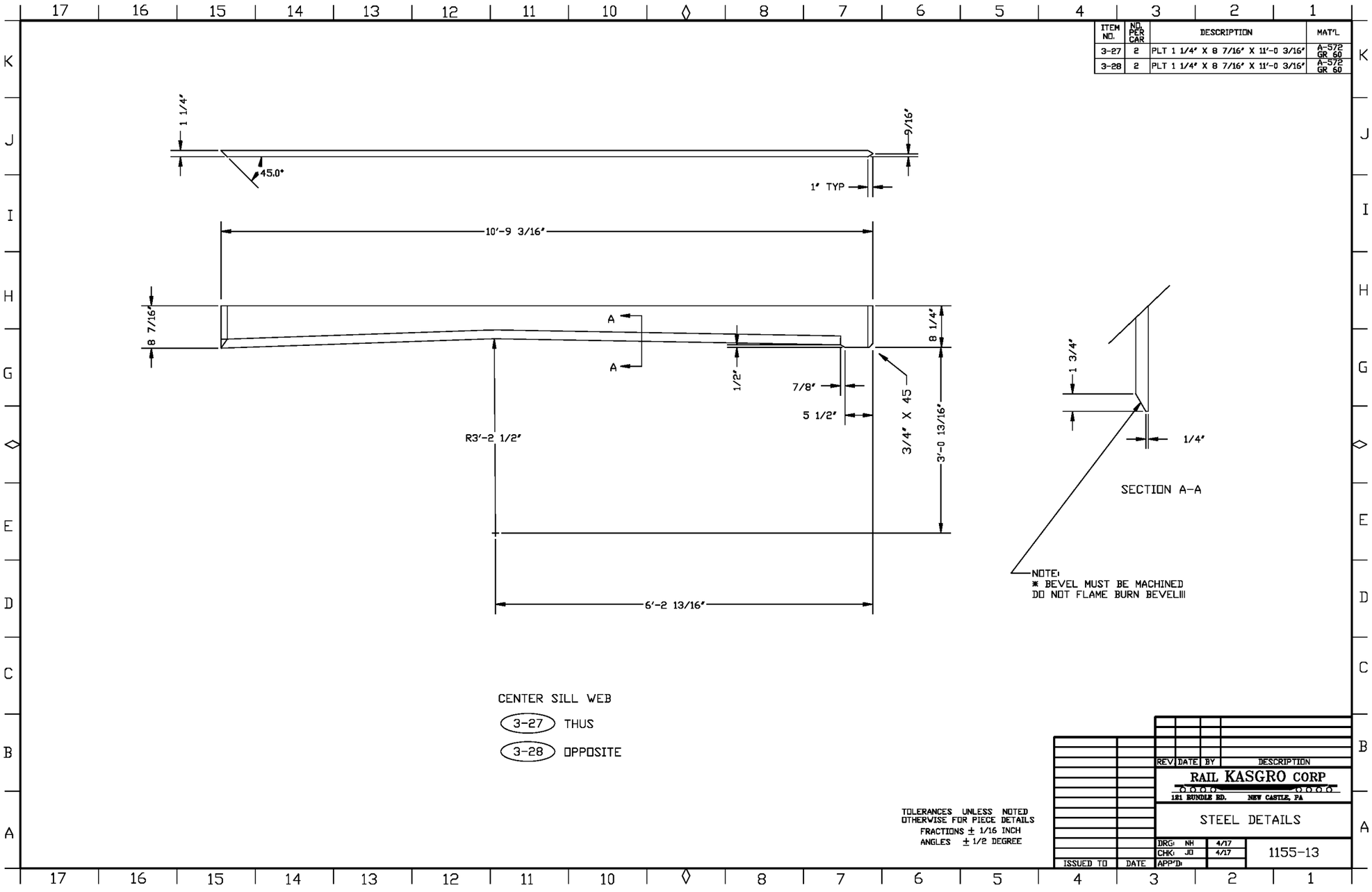
STEEL DETAILS

DRG	NH	4/17	1155-12
CHK	JD	4/17	
APP'D			

ISSUED TO | DATE

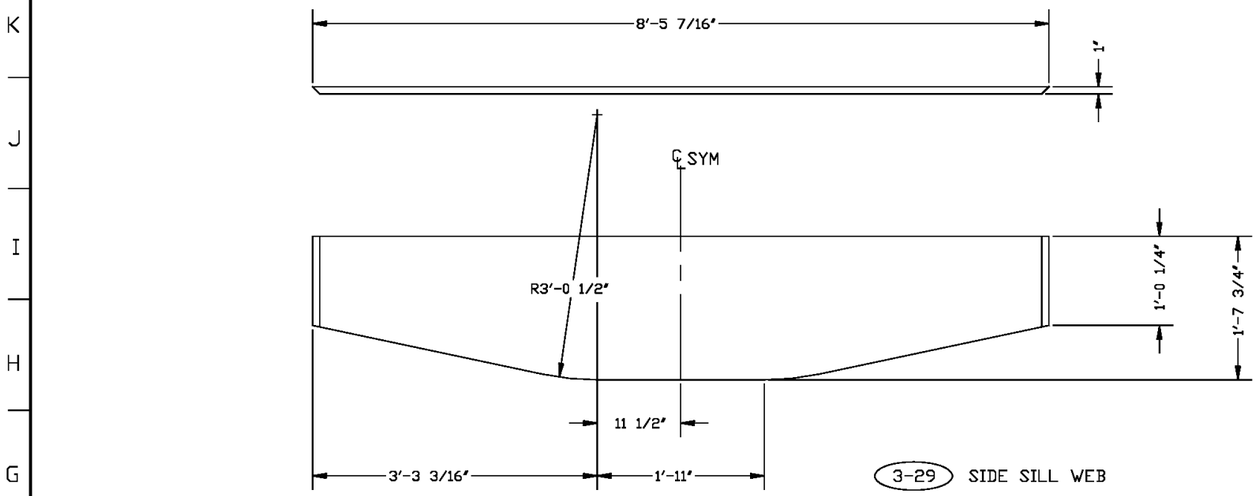
APPENDIX G-1.13 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-27	2	PLT 1 1/4" X 8 7/16" X 11'-0 3/16"	A-572 GR 60
3-28	2	PLT 1 1/4" X 8 7/16" X 11'-0 3/16"	A-572 GR 60

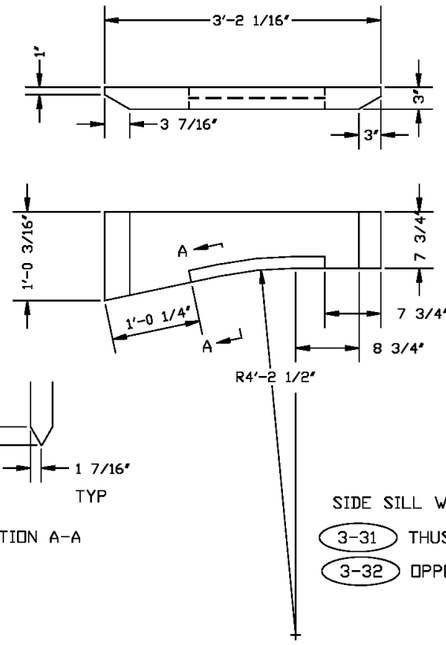


APPENDIX G-1.14 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-29	2	PLT 1" X 19 3/4" X 8'-5 7/16"	A-572 GR 60
3-30	2	PLT 1" X 20 1/4" X 8'-5 7/16"	A-572 GR 60
3-31	2	PLT 3" X 12 3/16" X 3'-2 1/16"	A-572 GR 60
3-32	2	PLT 3" X 12 3/16" X 3'-2 1/16"	A-572 GR 60

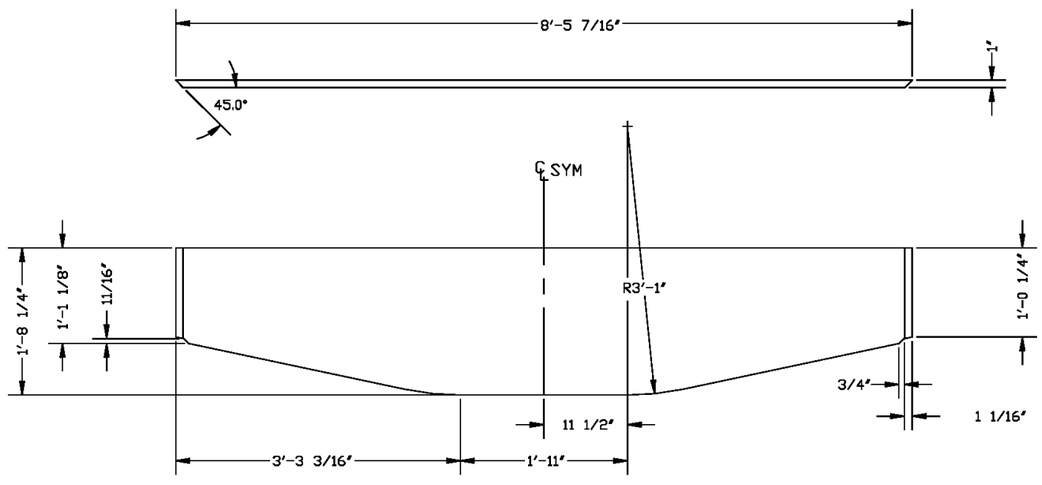


3-29 SIDE SILL WEB



SECTION A-A

SIDE SILL WEB
3-31 THUS
3-32 OPPOSITE



3-30 CTR SILL WEB

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

STEEL DETAILS

DRG: NH	4/17	1155-14	
CHK: JO	4/17		
APP'D:			

ISSUED TO | DATE

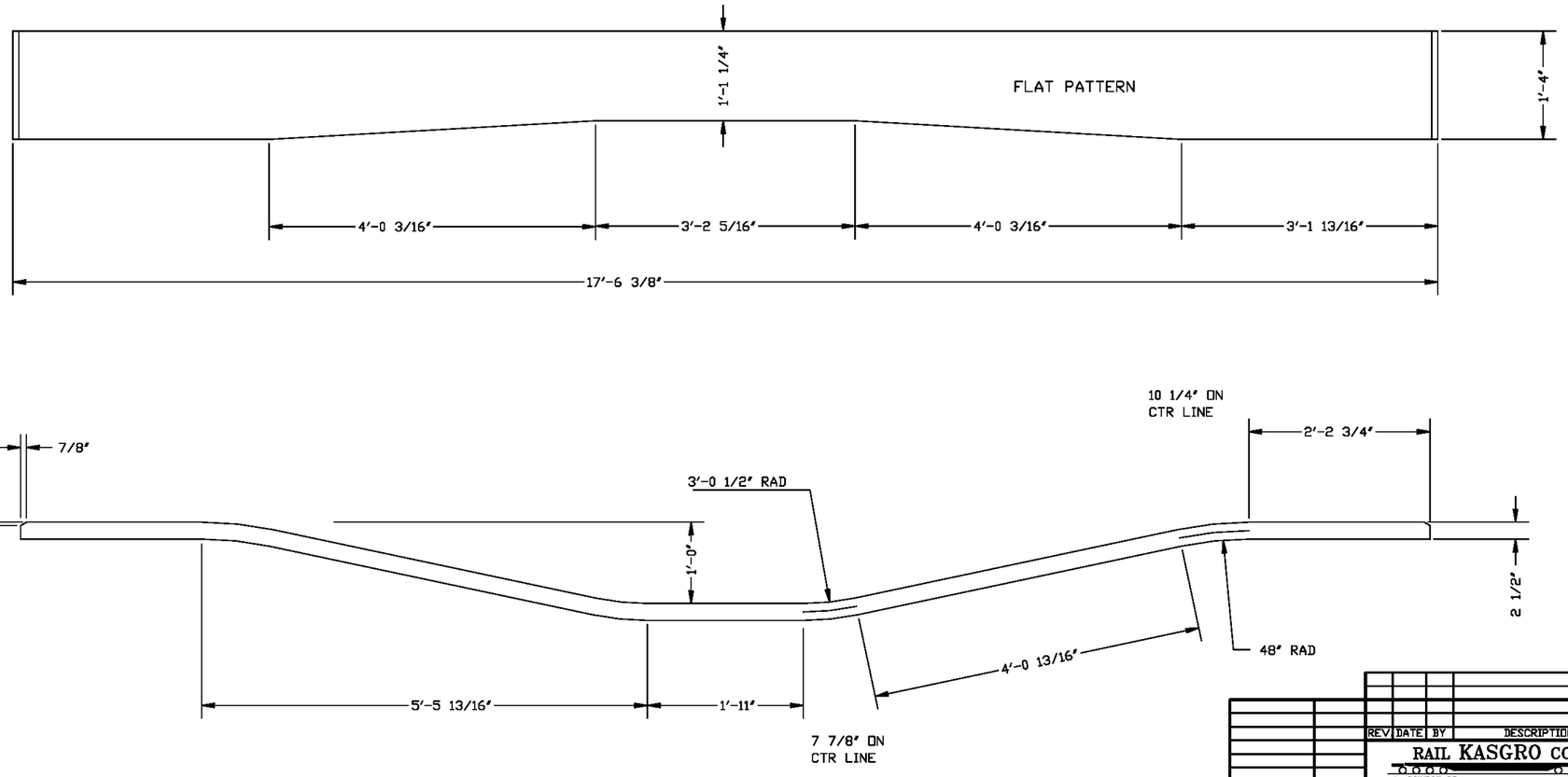
APPENDIX G-1.15 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-34	2	PLT 2 1/2" X 16" X 17'-6 3/8"	A-572 GR 60

NOTES:

1. FOR ITEM 3-34, THE USE OF ASTM A572 GRADE 50 MATERIAL IS ACCEPTABLE PROVIDED THE MECHANICAL PROPERTIES FOR GRADE 60 MATERIAL ARE SATISFIED (I.E., 60 KSI MINIMUM YIELD AND 75 KSI MINIMUM TENSILE).

2. FOR ITEM 3-34, CHARPY IMPACT TESTING OF THE MATERIAL IS REQUIRED IN ACCORDANCE WITH ASTM A673. THE MINIMUM AVERAGE ABSORBED ENERGY SHALL BE 20 FT-LBS AT ZERO (0) DEGREES F. TRANSVERSE IMPACT TEST ORIENTATION IS REQUIRED FOR PLATE WIDTHS OVER 24 INCHES.



3-34 SIDE SILL FLANGE

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

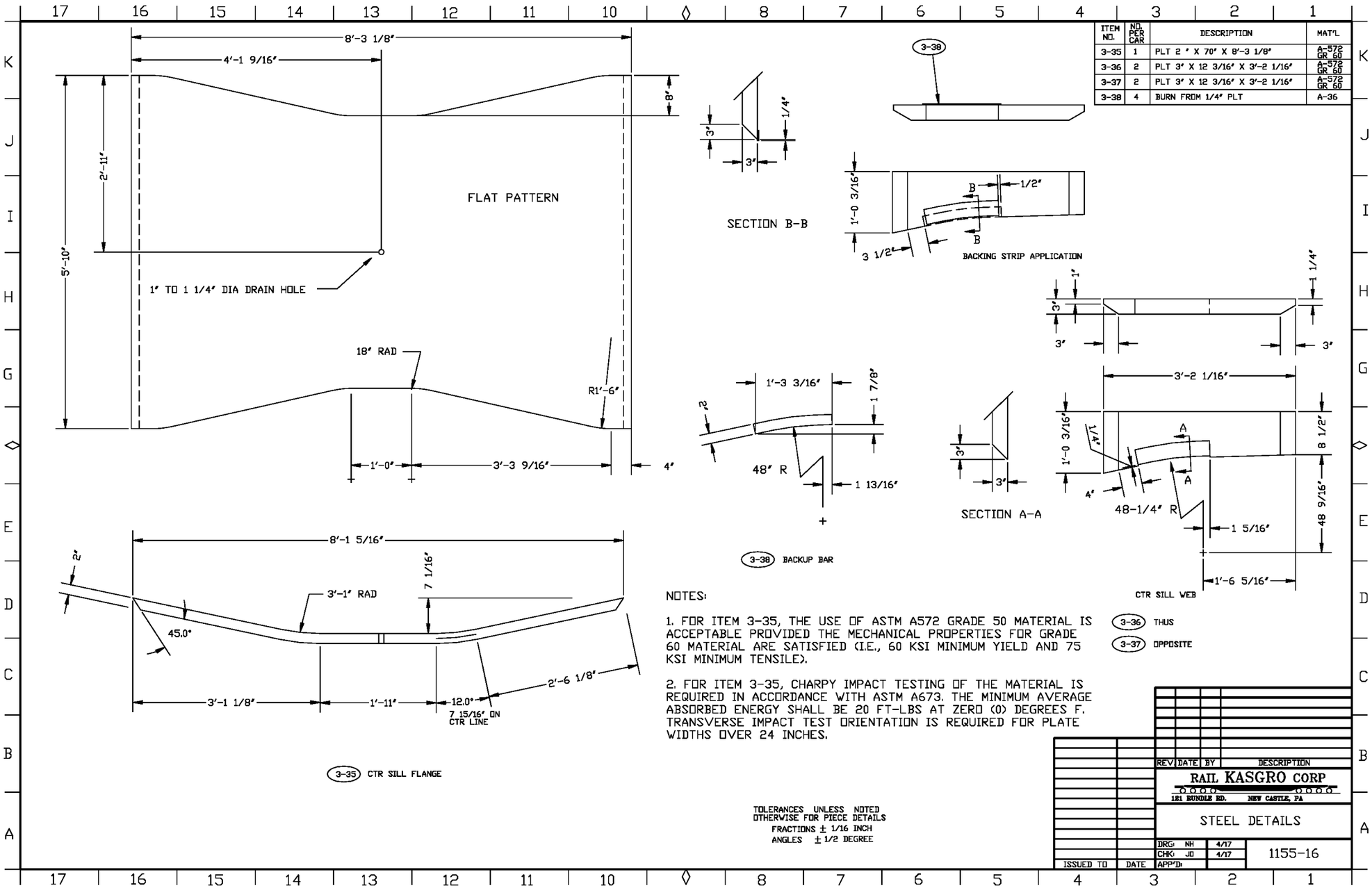
STEEL DETAILS

DRG: NH	4/17	1155-15	
CHK: JD	4/17		
APP'D:			

ISSUED TO | DATE

APPENDIX G-1.16 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-35	1	PLT 2 " X 70" X 8'-3 1/8"	A-572 GR 60
3-36	2	PLT 3" X 12 3/16" X 3'-2 1/16"	A-572 GR 60
3-37	2	PLT 3" X 12 3/16" X 3'-2 1/16"	A-572 GR 60
3-38	4	BURN FROM 1/4" PLT	A-36



NOTES:

1. FOR ITEM 3-35, THE USE OF ASTM A572 GRADE 50 MATERIAL IS ACCEPTABLE PROVIDED THE MECHANICAL PROPERTIES FOR GRADE 60 MATERIAL ARE SATISFIED (I.E., 60 KSI MINIMUM YIELD AND 75 KSI MINIMUM TENSILE).

2. FOR ITEM 3-35, CHARPY IMPACT TESTING OF THE MATERIAL IS REQUIRED IN ACCORDANCE WITH ASTM A673. THE MINIMUM AVERAGE ABSORBED ENERGY SHALL BE 20 FT-LBS AT ZERO (0) DEGREES F. TRANSVERSE IMPACT TEST ORIENTATION IS REQUIRED FOR PLATE WIDTHS OVER 24 INCHES.

3-36 THUS

3-37 OPPOSITE

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

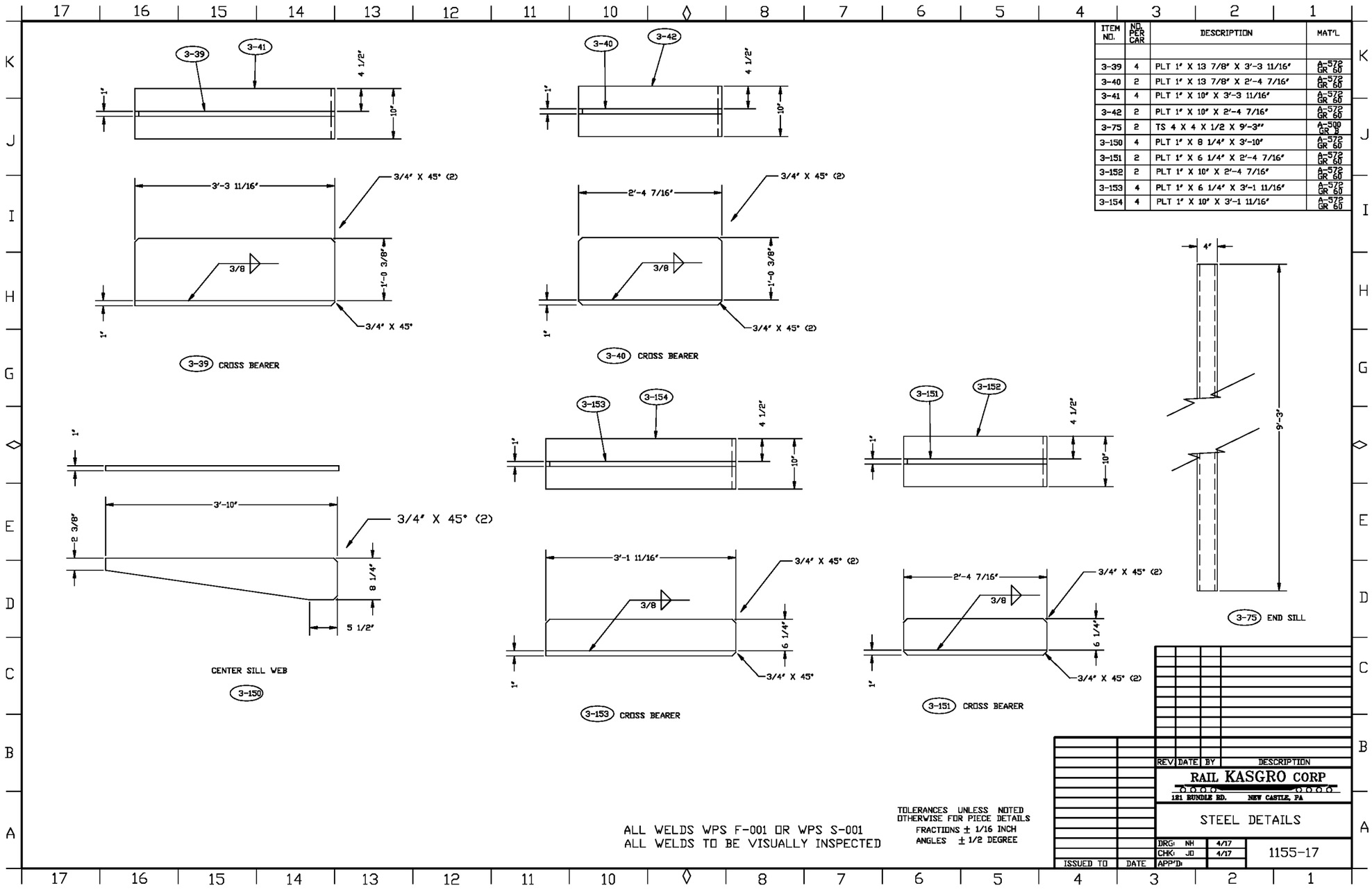
STEEL DETAILS

DRG:	NH	4/17	1155-16
CHK:	JD	4/17	
APP'D:			

ISSUED TO | DATE

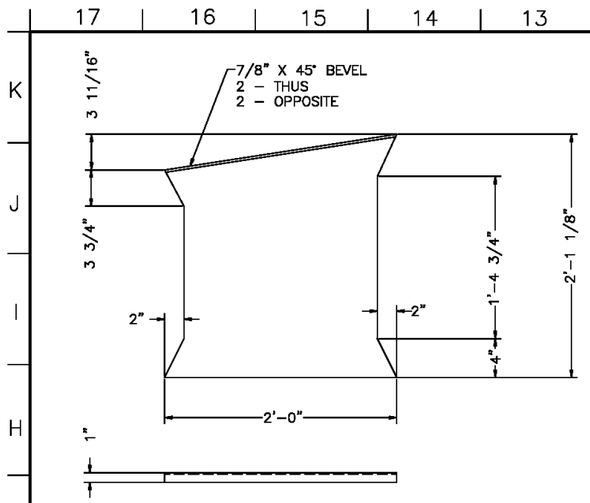
APPENDIX G-1.17 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-39	4	PLT 1" X 13 7/8" X 3'-3 11/16"	A-572 GR 60
3-40	2	PLT 1" X 13 7/8" X 2'-4 7/16"	A-572 GR 60
3-41	4	PLT 1" X 10" X 3'-3 11/16"	A-572 GR 60
3-42	2	PLT 1" X 10" X 2'-4 7/16"	A-572 GR 60
3-75	2	TS 4 X 4 X 1/2 X 9'-3"	A-500 GR B
3-150	4	PLT 1" X 8 1/4" X 3'-10"	A-572 GR 60
3-151	2	PLT 1" X 6 1/4" X 2'-4 7/16"	A-572 GR 60
3-152	2	PLT 1" X 10" X 2'-4 7/16"	A-572 GR 60
3-153	4	PLT 1" X 6 1/4" X 3'-1 11/16"	A-572 GR 60
3-154	4	PLT 1" X 10" X 3'-1 11/16"	A-572 GR 60

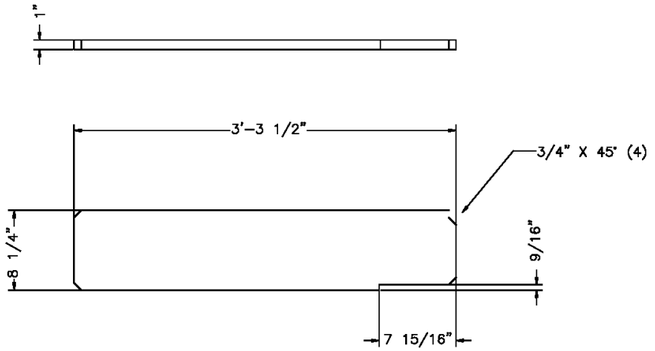


APPENDIX G-1.18 STEEL DETAILS

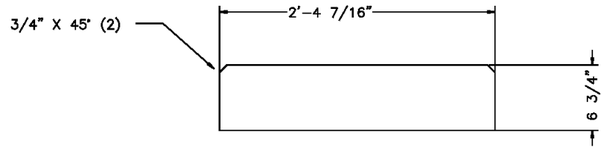
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–45	4	PLT 1" X 24" X 2'–1 1/8"	A–572 GR 60
3–70	4	PLT 1" X 8 1/4" X 3'–3 1/2"	A–572 GR 60
3–71	4	PLT 1" X 8 1/4" X 3'–3 1/2"	A–572 GR 60
3–72	4	PLT 1" X 7 3/4" X 1'–4"	A–572 GR 60
3–74	4	PLT 1" X 6 3/4" X 2'–4 7/16"	A–572 GR 60



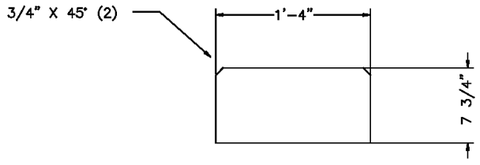
3–45 CROSS BEARER FLANGE



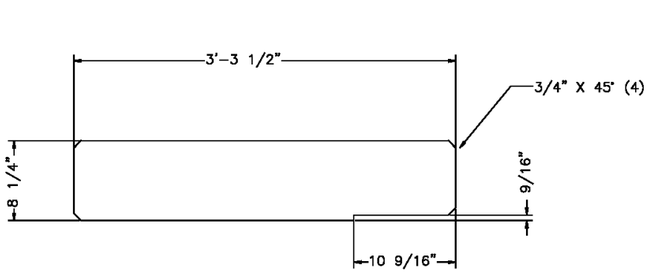
3–71 CROSS BEARER WEB



3–74 CROSS BEARER WEB



3–72 STIFFENER



3–70 CROSS BEARER WEB

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

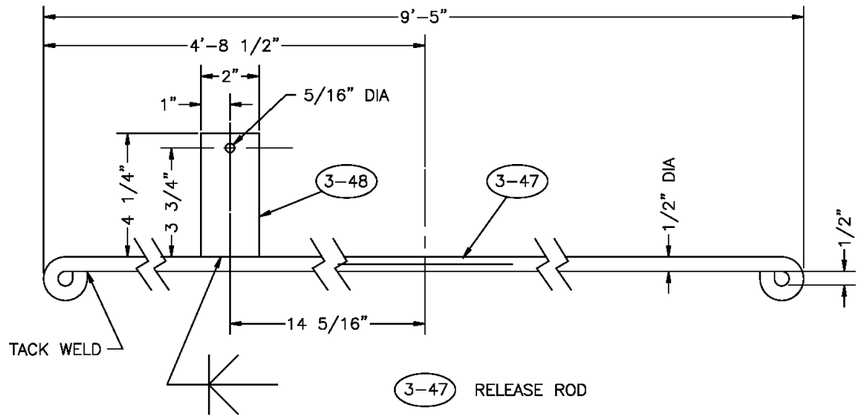
STEEL DETAILS

ORDER NO.	ISSUED TO	DATE

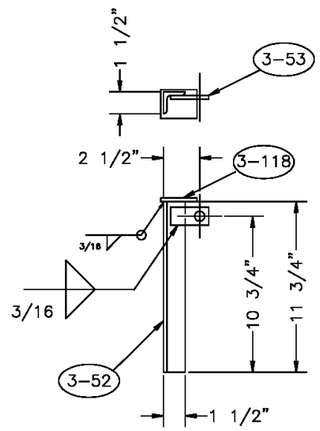
DRG: NH	4/17	1155–18	
CHK: JO	4/17		
APP'D:			

APPENDIX G-1.19 BRAKE STEEL DETAILS

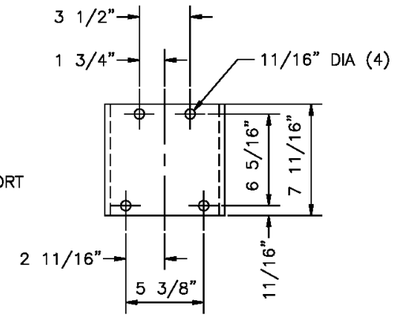
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–46	2	∠ 1.5 X 1.5 X 1/4" X 0'–5"	A–36
3–47	2	BAR 1/2" DIA X 9'–8 3/4"	A–36
3–48	2	BAR 2" X 1/2" X 0'–4 1/4"	A–36
3–49	4	∠ 3 X 3 X 1/4" X 2'–0"	A–36
3–50	8	BAR 3" X 1/4" X 0'–3 1/4"	A–36
3–52	2	∠1.5 X 1.5 X 1/4" X 0'–11 3/4"	A–36
3–53	2	BAR 1 1/4" X 1/4" X 0'–2 5/8"	A–36
3–54	2	PLT 7 11/16" X 3/8" X 1'–9 1/2"	A–36
3–118	2	PLT 2" X 1/4" X 2 1/2"	A–36

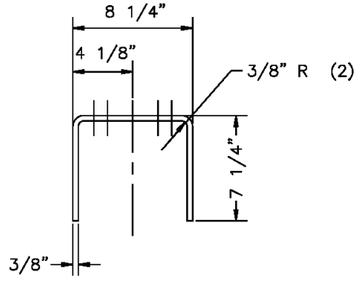


3–47 RELEASE ROD

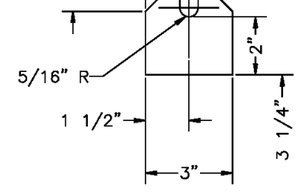


3–52 BRANCH PIPE TEE SUPPORT

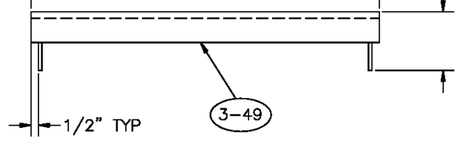




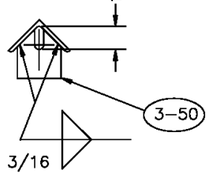
3–54 VALVE SUPPORT

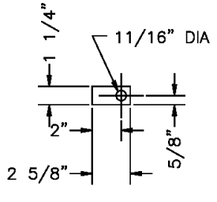


3–50 GUIDE BAR

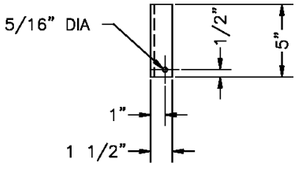


3–49 RELEASE ROD GUIDE





3–53 BRANCH PIPE TEE LUG



3–46 CHAIN SUPPORT

ALL WELDS WPS F–001 OR WPS S–001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

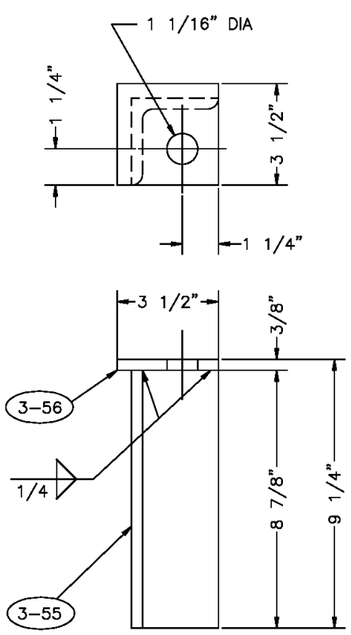
BRAKE STEEL DETAILS

DRG: NH	4/17	1155–19	
CHK: JO	4/17		
APP'D:			

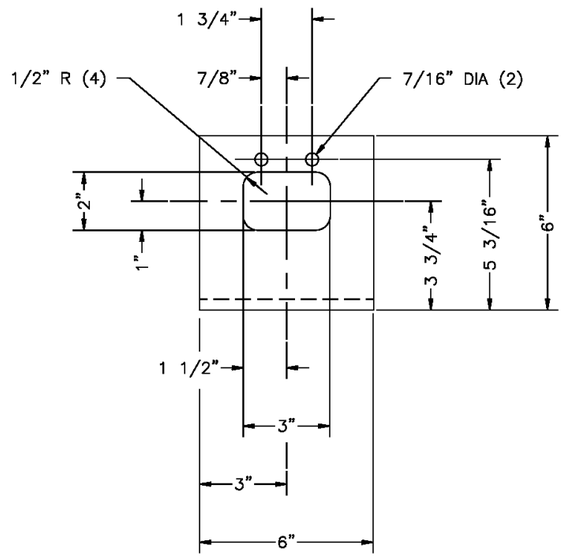
ISSUED TO DATE

APPENDIX G-1.20 BRAKE STEEL DETAILS

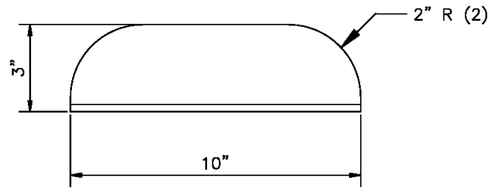
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–55	6	∠ 3 X 3 X 3/8 X 0'–8 7/8"	A–36
3–56	6	BAR 3 1/2" X 3/8" X 0'–3 1/2"	A–36
3–57	2	∠ 6 X 6 X 3/8 X 0'–6"	A–36
3–58	2	∠ 2 1/2 X 2 1/2 X 1/4 X 1'–6"	A–36
3–59	4	∠ 2 1/2 X 2 1/2 X 1/4 X 0'–8"	A–36
3–60	4	∠ 3 X 3 X 1/4 X 0'–10"	A–36
3–108	2	BAR 4" X 1/4" X 1'–5 1/8"	A–36



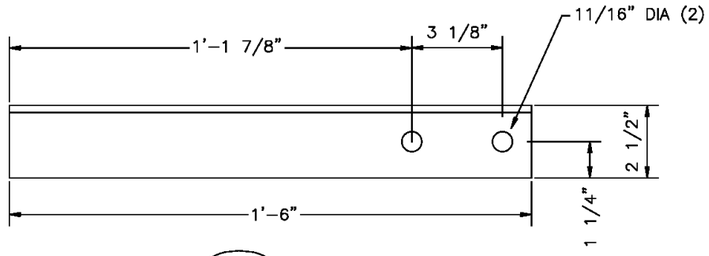
3–55 RESERVOIR SUPPORT



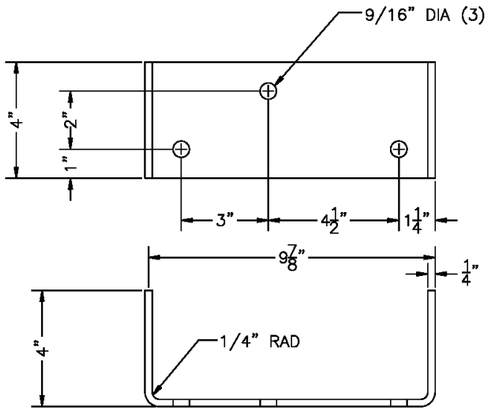
3–57 RETAINING VALVE SUPPORT



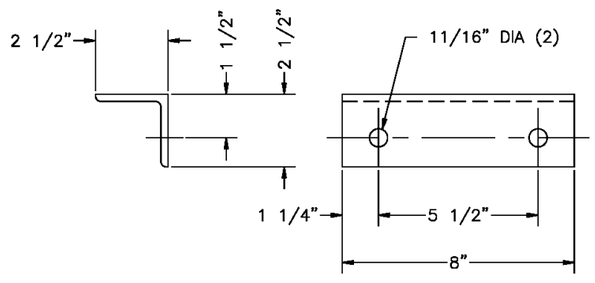
3–60 GUARD ANGLE



3–58 ANGLE COCK SUPPORT



3–108 ELX SUPPORT BRKT



3–59 RESERVOIR SUPPORT

ALL WELDS WPS F–001 OR WPS S–001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

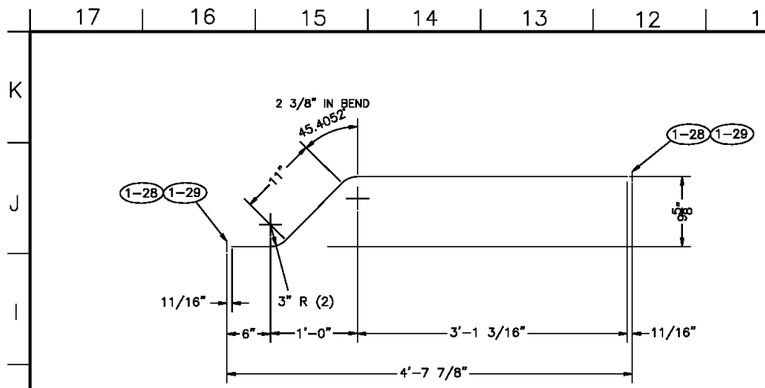
BRAKE STEEL DETAILS

DRG: NH 4/17
CHK: JO 4/17
APP'D:

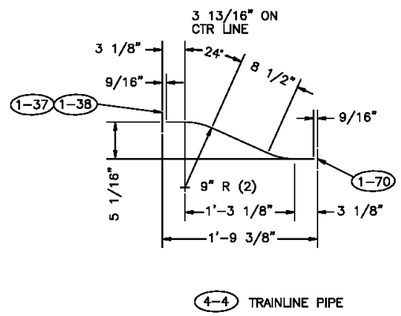
1155–20

ISSUED TO DATE

APPENDIX G-1.21 PIPE DETAILS

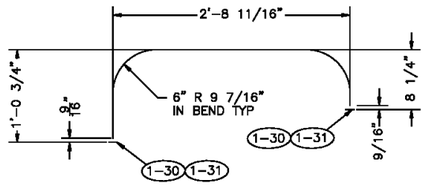


4-1 RETAINING VELVE PIPE

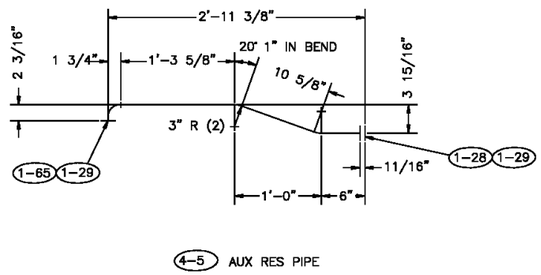


4-4 TRAINLINE PIPE

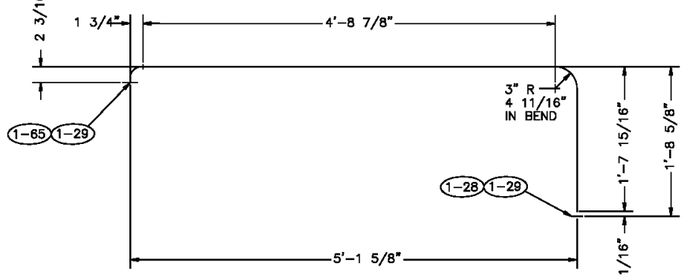
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
1-28	8	3/8" SOCKET WELD FITTING	565252
1-29	12	3/8" GASKET	93839
1-30	8	3/4" SOCKET WELD FITTING	565256
1-31	8	3/4" GASKET	93841
1-35	4	1" SOCKET WELD FITTING	565259
1-36	4	1" GASKET	93986
1-37	1	1 1/4" SOCKET WELD FITTING	565262
1-38	1	1 1/4" GASKET	94790
1-65	4	3/8 90 DEG SOCKET WELD FTG	578319
1-70	1	1 1/4 SOCK WELD FTG NO GASKET	579687
4-1	2	PIPE 3/8" EX-HVY X 4'-10 1/2"	A-53
4-2	2	PIPE 3/4" EX-HVY X 3'-11 7/16"	A-53
4-3	2	PIPE 3/4" EX-HVY X 5'-10 9/16"	A-53
4-4	1	PIPE 1 1/4" EX-HVY X 1'-9 1/4"	A-53
4-5	2	PIPE 3/8" EX-HVY X 2'-9 9/16"	A-53
4-6	2	PIPE 1" EX-HVY X 1'-1 9/16"	A-53
4-7	2	PIPE 3/8" EX HVY X 6'-6 1/2"	A-53



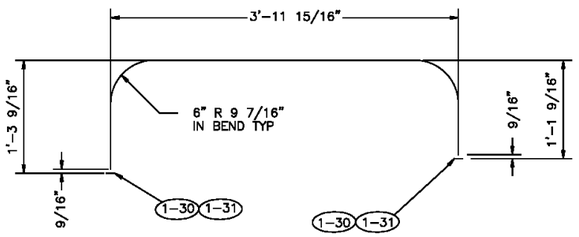
4-2 AUX RES PIPE



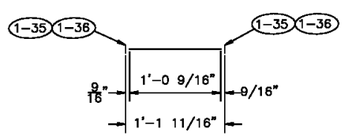
4-5 AUX RES PIPE



4-7 DUMMY RESERVOIR PIPE



4-3 EMER RES PIPE



4-6 BRANCH PIPE

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO | DATE | APP'D:

REV.	DATE	BY	DESCRIPTION

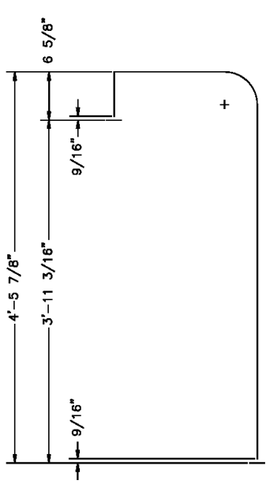
RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

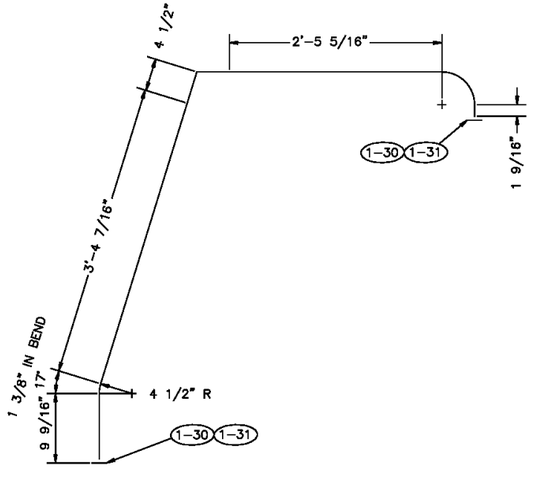
PIPE DETAILS

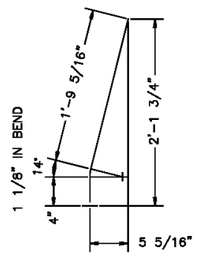
DRG: NH	4/17	1155-21
CHK: JO	4/17	
APP'D:		

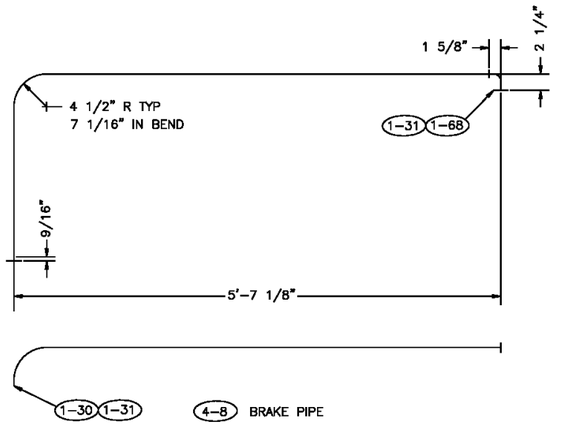
APPENDIX G-1.22 PIPE DETAILS

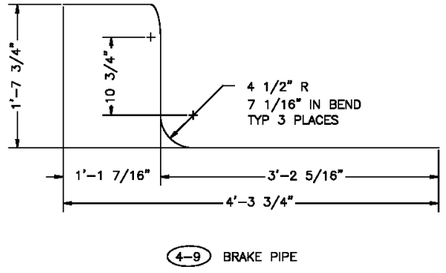
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
1–30	6	3/4" SOCKET WELD FITTING	565256
1–31	8	3/4" GASKET	93841
1–68	2	3/4" SOCK WELD FITTING 90°	578321
4–8	2	PIPE 3/4 EX–HVY X 7'–5 7/16"	A–53
4–9	2	PIPE 3/4 EX–HVY X 9'–5 5/8"	A–53











ALL WELDS WPS F–001 OR WPS S–001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO

DATE

REV.	DATE	BY	DESCRIPTION

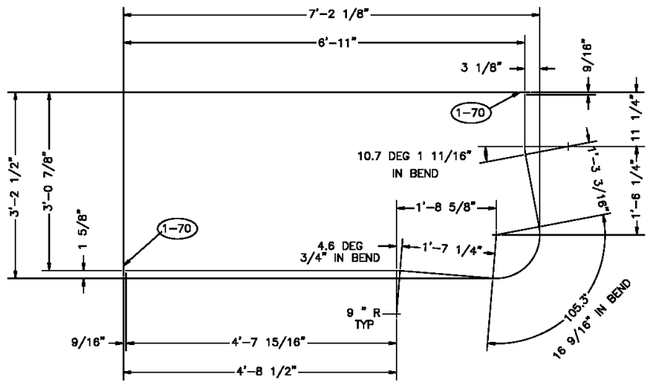
RAIL KASGRO CORP
181 BONDLE RD. NEW CASTLE, PA.

PIPE DETAILS

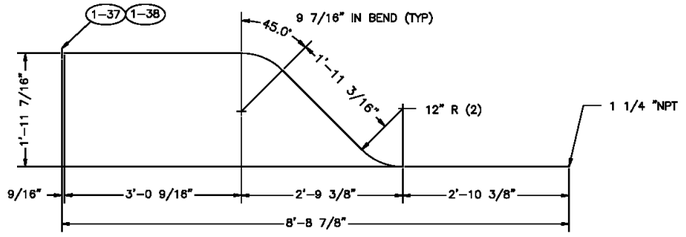
DRG: NH	4/17	1155–22	
CHK: JO	4/17		
APP'D:			

APPENDIX G-1.23 BRAKE PIPES

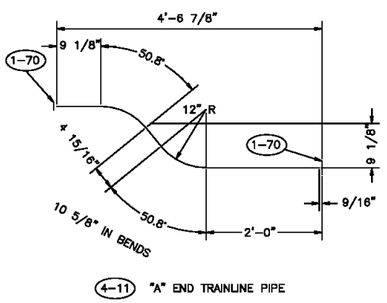
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
1–37	6	1 1/4" SOCKET WELD FITTING	565262
1–38	6	1 1/4" GASKET	94790
1–70	6	1 1/4 SOCK WELD FTG NO GASKET	579687
4–10	1	PIPE 1 1/4" EX–HVY X 10'–0 1/16"	A–53
4–11	1	PIPE 1 1/4" EX–HVY X 4–10 13/16"	A–53
4–12	2	PIPE 1 1/4" EX–HVY X 13'–7 15/16"	A–53
4–13	2	PIPE 1 1/4" EX–HVY X 9'–5"	A–53
4–14	2	PIPE 1 1/4" STD X 0'–10"	A–53
4–17	1	PIPE 1 1/4" EX–HVY X 6'–9 3/4"	A–53



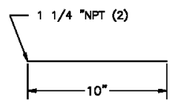
4–10 "B" END TRAINLINE PIPE



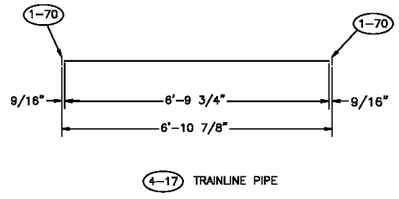
4–13 TRAINLINE PIPE



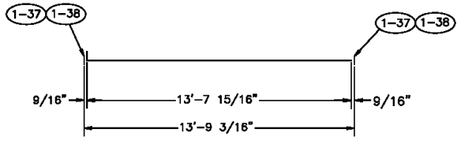
4–11 "A" END TRAINLINE PIPE



4–14 NIPPLE



4–17 TRAINLINE PIPE



4–12 TRAINLINE PIPE

ALL WELDS WPS F–001 OR WPS S–001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

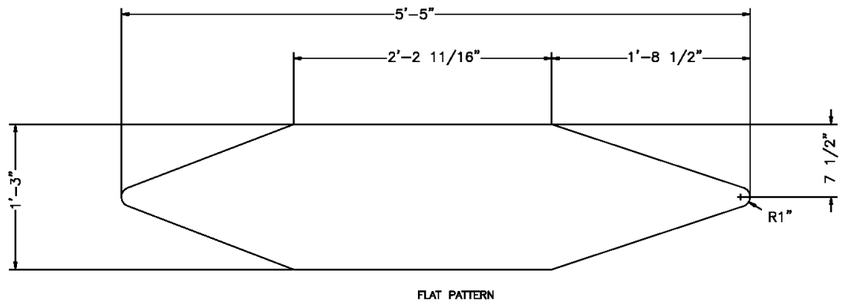
BRAKE PIPES

DRG: NH	4/17	1155–23	
CHK: JO	4/17		
APP'D:			

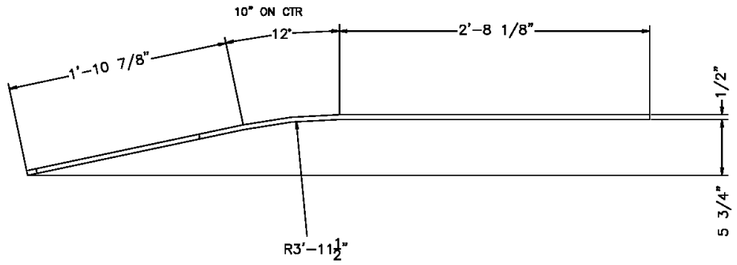
ISSUED TO | DATE

APPENDIX G-1.24 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–21	4	PLT 1/2" X 15" X 5'–5"	A–656 GR 80



FLAT PATTERN



3–21 COVER PLATE

NOTES:

1. FOR ITEM 3–21, CHARPY IMPACT TESTING OF THE MATERIAL IS REQUIRED IN ACCORDANCE WITH ASTM A673. THE MINIMUM AVERAGE ABSORBED ENERGY SHALL BE 20 FT–LBS AT ZERO (0) DEGREES F. TRANSVERSE IMPACT TEST ORIENTATION IS REQUIRED FOR PLATE WIDTHS OVER 24 INCHES.

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO | DATE

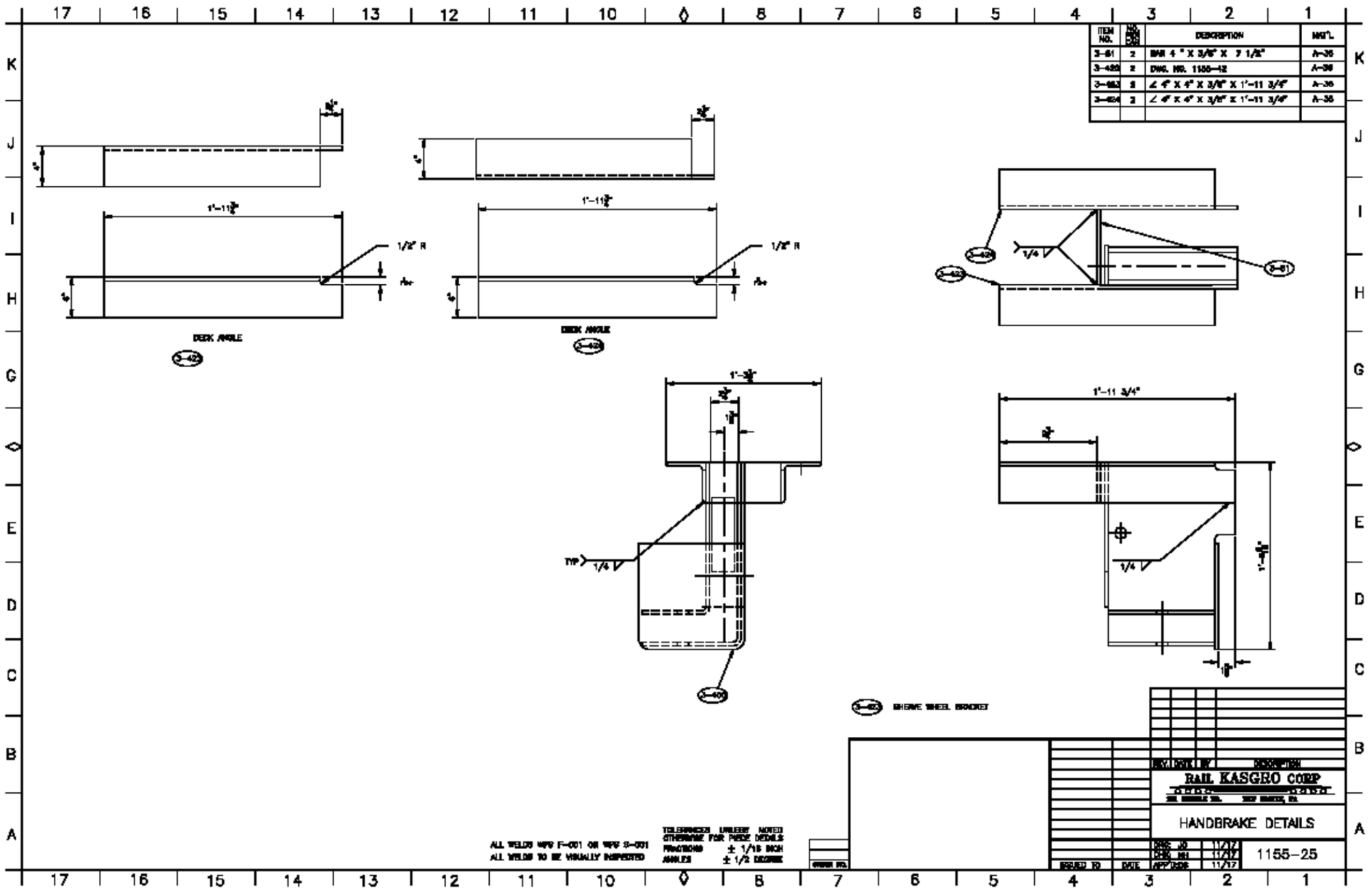
REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

STEEL DETAILS

DRG: NH	4/17	1155–24
CHK: JO	4/17	
APP'D:		

APPENDIX G-1.25 HAND BRAKE DETAILS



APPENDIX G-1.26 HAND BRAKE DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–82	2	BAR 4 1/2" X 1/2" X 2'–9"	A–36
3–83	2	BAR 3" X 5/8" X 2'–8 3/4"	A–36
3–84	4	BAR 2 3/4 " X 3/8" X 1'–6"	A–36
3–85	8	PL 10 7/8" X 1/2" X 1'–6"	A–36
3–86	4	BAR 3 1/4 " X 1/4" X 1'–6"	A–36
3–87	4	∠ 3" X 2" X 3/8" X 1'–6"	A–36
3–88	4	BAR 3/4 " X 1/4" X 1'–6"	A–36
3–89	4	BAR 1/2 " X 1/4" X 2'–9"	A–36
3–90	4	∠ 2" X 1 3/4" X 3/8" X 2'–9"	A–36
3–91	4	BAR 1/2 " X 1/4" X 1'–6"	A–36
3–92	4	∠ 3" X 2" X 3/8" X 1'–6"	A–36
3–158	4	BAR 1 3/32" DIA X 5 3/4"	A–36
3–159	8	BAR 2" X 2" X 5/16"	A–36
3–160	4	BAR 2" X 2 9/16" X 1"	A–36
3–161	4	BAR 3 7/8" X 1 3/16" X 1"	A–36
3–162	4	BAR 1" DIA X 2 1/8"	A–36
3–163	2	BAR 3" X 4" X 3/8"	A–36

3–83 SHEAVE WHEEL SUPPORT

3–87 SHEAVE WHEEL CARRIER

3–158 SHEAVE WHEEL PIN

3–159 SHEAVE WHEEL PIN RETAINER

3–160 SLIDE PIVOT BASE

3–161 SLIDE PIVOT

3–85 SHEAVE WHEEL BRACKET

3–90 SHEAVE WHEEL CARRIER

3–92 SHEAVE WHEEL CARRIER

3–163 SHEAVE WHEEL STOP

NOTE: 3–90 SHOULD BE INSTALLED WITH SPAN BOLSTER FIT/WELD. REF. DWG. E–1118–1 (2OF2)

ALL WELDS TO BE VISUALLY INSPECTED
ALL WELDS WPS F–001 OR WPS S–001

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO | DATE

REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BONDLE RD. NEW CASTLE, PA

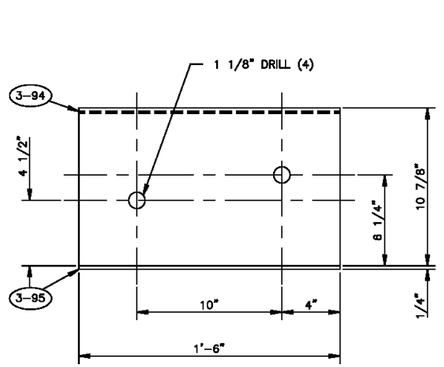
HANDBRAKE DETAILS

DRG: NH 4/17
CHK: JO 4/17
APP'D:

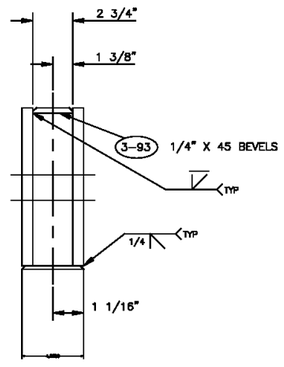
1155–26

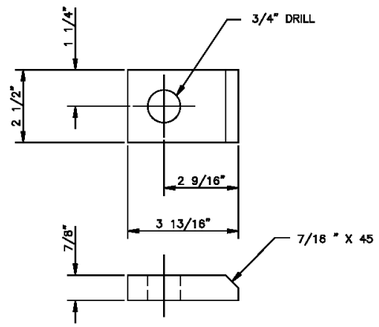
APPENDIX G-1.27 HAND BRAKE DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–93	2	BAR 2 3/4 " X 3/8" X 1'–6"	A–36
3–94	4	PL 10 7/8" X 3/4" X 1'–6"	A–36
3–95	2	BAR 4 1/4 " X 1/4" X 1'–6"	A–36
3–97	2	BAR 2 1/2 " X 7/8" X 0'–3 13/16"	A–36
3–98	2	BAR 3/4" X 1/2" X 1'–0 5/8"	A–36
3–99	2	BAR 3/4" X 1/2" X 1'–3 7/16"	A–36

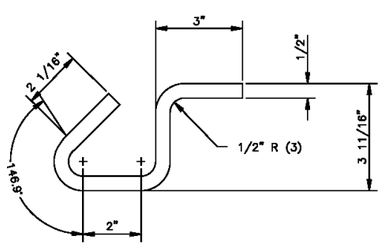


3–94 SHEAVE WHEEL BRACKET

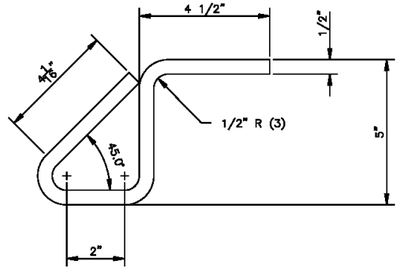




3–97 BRAKE PIN BRACKET



3–98 ROD CARRIER



3–99 ROD CARRIER

ALL WELDS WPS F–001 OR WPS S–001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO

REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
191 BONDLE RD. NEW CASTLE, PA

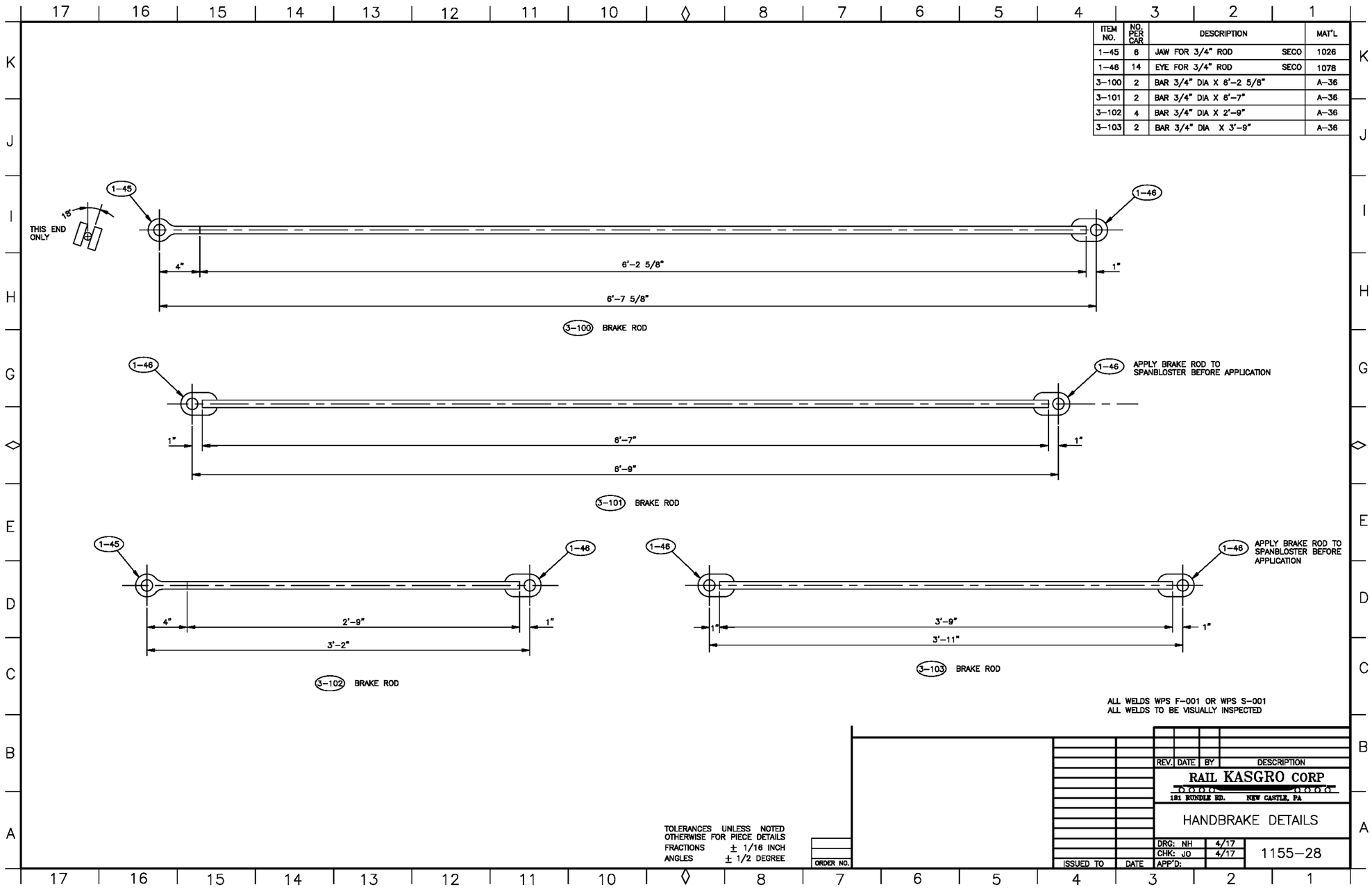
HANDBRAKE DETAILS

DRG: NH	4/17	1155–27	
CHK: JO	4/17		
APP'D:			

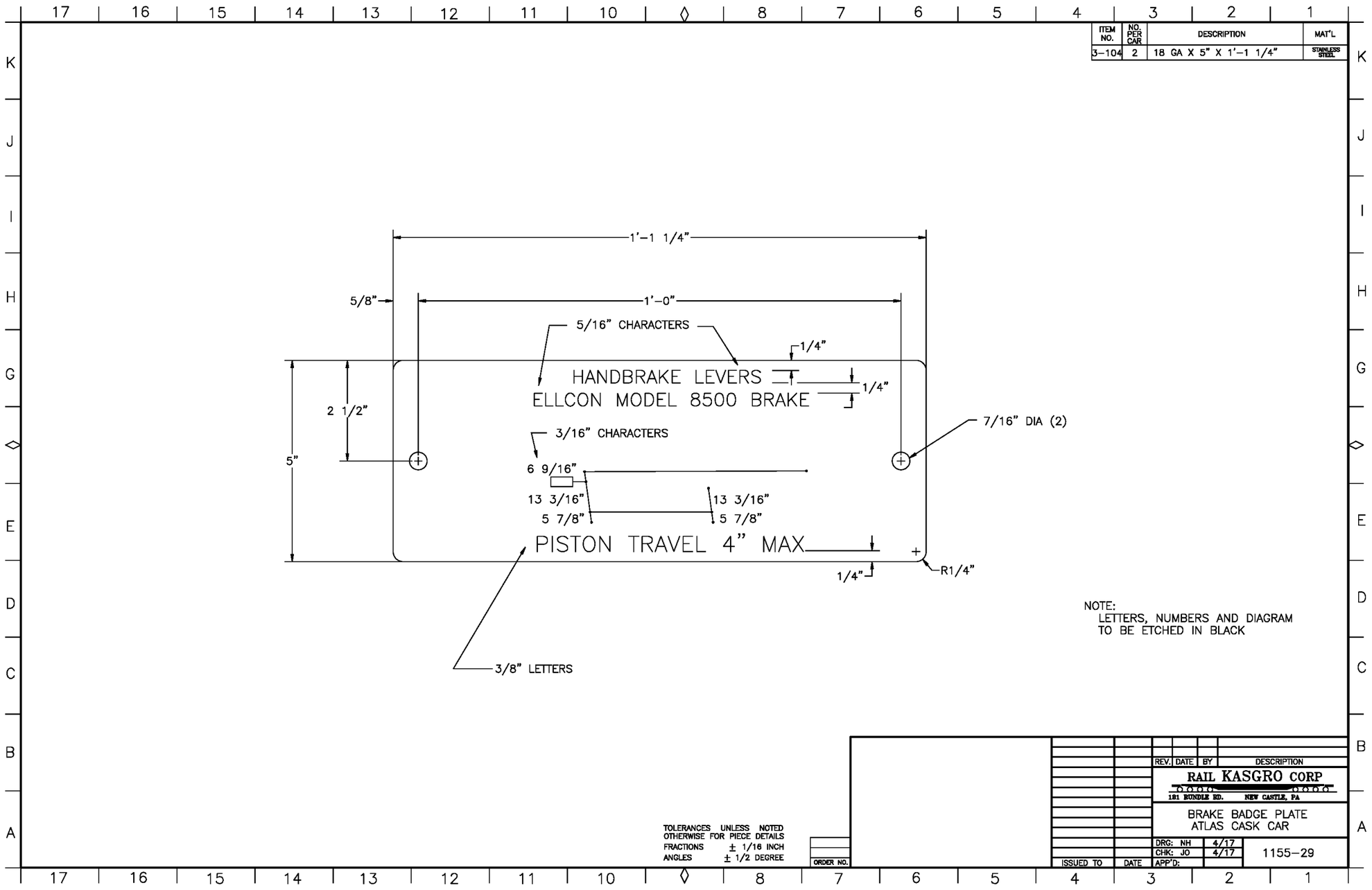
DATE

APPENDIX G-1.28 HAND BRAKE DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
1–45	6	JAW FOR 3/4" ROD SECO	1026
1–46	14	EYE FOR 3/4" ROD SECO	1078
3–100	2	BAR 3/4" DIA X 6'–2 5/8"	A–36
3–101	2	BAR 3/4" DIA X 6'–7"	A–36
3–102	4	BAR 3/4" DIA X 2'–9"	A–36
3–103	2	BAR 3/4" DIA X 3'–9"	A–36

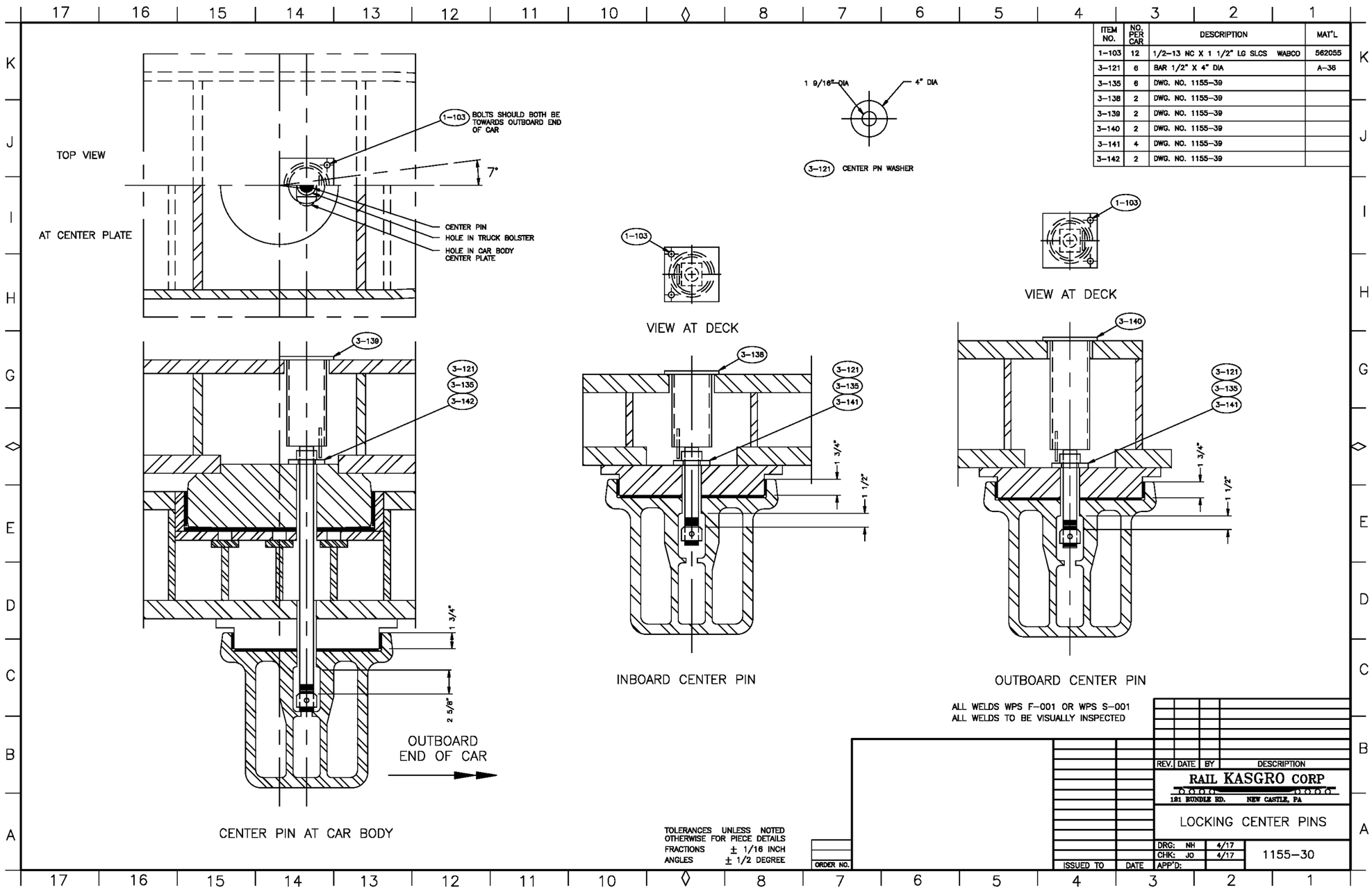


APPENDIX G-1.29 BRAKE BADGE PLATE

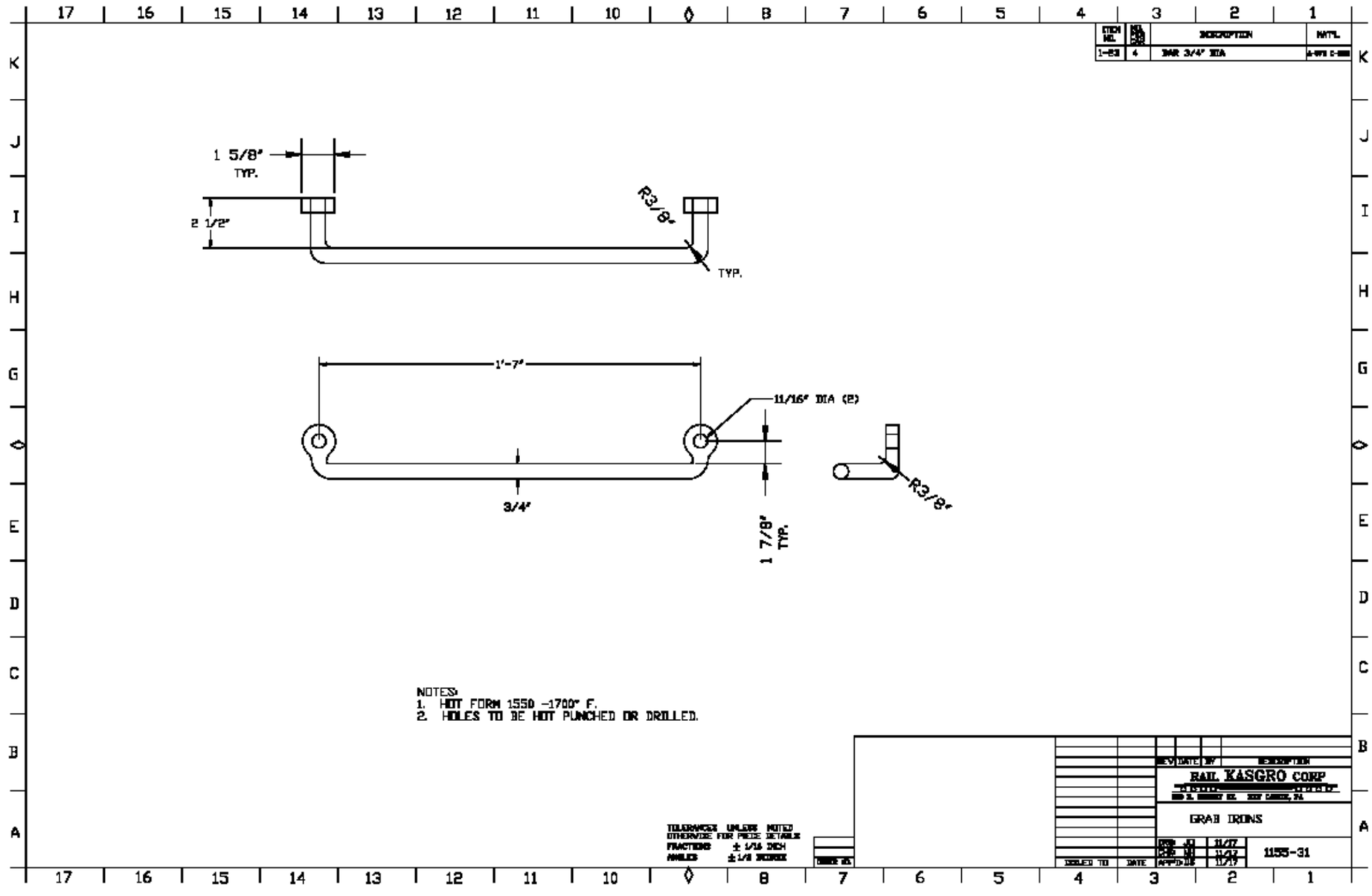


APPENDIX G-1.30 LOCKING CENTER PINS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
1–103	12	1/2–13 NC X 1 1/2" LG SLCS WABCO	562055
3–121	6	BAR 1/2" X 4" DIA	A–36
3–135	6	DWG. NO. 1155–39	
3–138	2	DWG. NO. 1155–39	
3–139	2	DWG. NO. 1155–39	
3–140	2	DWG. NO. 1155–39	
3–141	4	DWG. NO. 1155–39	
3–142	2	DWG. NO. 1155–39	



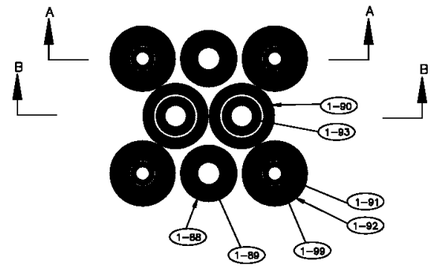
APPENDIX G-1.31 HAND BRAKE DETAILS



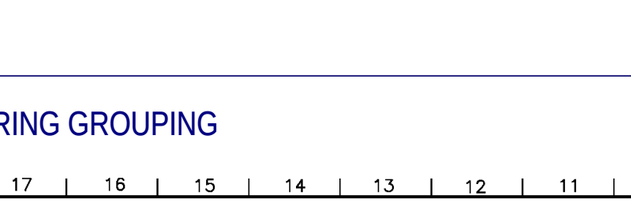
APPENDIX G-1.32 SPRING GROUPING

ITEM	QTY/ CAR	SPRING	BAR DIA	INNER DIA	OUTER DIA	FREE HT	SOLID HT	SPR RATE	SOLID CAPY	CAR CAPY
1–88	8	CONTROL COIL OUTER	0.781	3.19	4.75	11.72	6.69	1161	5841	46,728
1–89	8	CONTROL COIL INNER	0.500	1.94	2.94	11.72	6.69	500	2517	20,136
1–90	8	EMPTY COIL OUTER	0.844	3.81	5.50	13.00	6.69	1074	6781	54,248
1–91	16	EMPTY COIL INNER	0.50	2.25	3.25	13.00	6.69	348	2197	35,152
1–92	16	LOADED COIL OUTER	1.063	3.38	5.50	9.25	6.69	4183	10719	171,504
1–93	8	LOADED COIL INNER	0.688	1.88	3.25	9.25	6.69	2219	5686	45,488
1–99	16	LOAD COIL INNER INNER	0.375	1.188	1.94	7.50	5.375	555	1180	18,880
										392,136

MIDDLE TRUCKS
290 TON STRAIGHT DECK FLAT



SPRING GROUP
TYP 4 PLACES

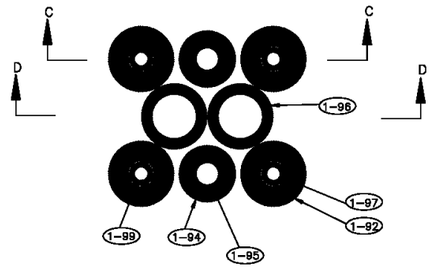


SECTION A–A SECTION B–B

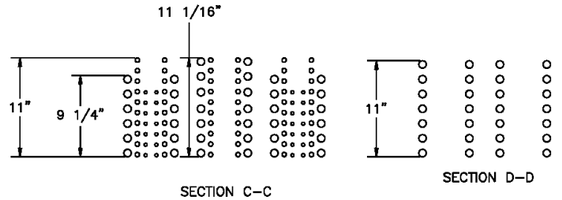
SPRING RATE CTR = 121,008 #/in
SPRING RATE OUTER = 251,792 #/in
TOTAL SPRING RATE = 372,800 #/in

ITEM	QTY/ CAR	SPRING	BAR DIA	INNER DIA	OUTER DIA	FREE HT	SOLID HT	SPR RATE	SOLID CAPY	CAR CAPY
1–94	16	CONTROL COIL OUTER	0.813	3.25	4.88	11.09	6.69	1328	5847	93,552
1–95	16	CONTROL COIL INNER	0.531	1.94	3.00	11.09	6.69	656	2891	46,256
1–96	16	EMPTY COIL OUTER	0.969	3.56	5.50	11.00	6.69	2409	10389	166,224
1–97	32	EMPTY COIL INNER	0.594	2.06	3.25	11.00	6.69	934	4028	128,896
1–92	32	LOAD COIL	1.063	3.37	5.50	9.25	6.69	4183	10719	343,008
1–99	32	LOAD COIL INNER INNER	0.375	1.188	1.94	7.50	5.375	555	1180	37,760
										815,696

END TRUCKS
290 TON STRAIGHT DECK FLAT



SPRING GROUP
TYP 8 PLACES



SECTION C–C SECTION D–D

GRL 789,000
SPR WT 727,050
RATIO 1,207,832/727,050 = 1.66

290 TON STRAIGHT DECK FLAT
END TRUCKS

NOTES:
1. ALL SPRINGS NOT LABELED AS A CONTROL COIL ARE LOAD COILS
2. QUANTITIES ARE PER CAR
3. MATERIAL SHALL BE GRADE 5160H PER ASTM A304, EXCEPT ITEM 1–99 SHALL BE CHROMIUM–SILICON ALLOY PER ASTM A401. THE USE OF ALTERNATE MATERIALS SHALL BE APPROVED BY KASGRO RAIL.
4. SPRING MANUFACTURE SHALL BE IN ACCORDANCE WITH AAR SPECIFICATION M–114 AND ASTM A125
5. SPRING END CONSTRUCTION SHALL BE TAPERED SQUARED AND WET GROUND.
6. INNER SPRING (ITEMS 1–89, 1–91, 1–93, 1–95 AND 1–97) SHALL BE WOUND CLOCKWISE (RIGHT–HAND). OUTER SPRINGS AND INNER–INNER SPRINGS (ITEMS 1–88, 1–90, 1–92, 1–94, 1–96 AND 1–99) SHALL BE WOUND COUNTER–CLOCKWISE (LEFT–HAND).
7. WET FLORESCENT MAGNETIC PARTICLE TESTING SHALL BE PERFORMED ON THE FLAT END AND THE FIRST ACTIVE COIL OF EACH SPRING (BOTH ENDS) IN ACCORDANCE WITH ASTM E709. THE ACCEPTANCE CRITERIA SPECIFIED IN KASGRO PROCEDURE NO.12 SHALL APPLY.
8. SPRINGS SHALL BE DEMAGNETIZED FOLLOWING MT EXAMINATION. MAXIMUM RESIDUAL MAGNETISM SHALL NOT EXCEED 5 GAUSS.
9. THE ENTIRE SURFACE OF EACH SPRING SHALL BE SHOT PEENED. THE GROUND ENDS OF THE SPRINGS SHALL BE PEENED AFTER WET FLORESCENT MAGNETIC PARTICLE TESTING.
10. SPRING TOLERANCES AND LOAD TESTING SHALL BE AS SPECIFIED BY KASGRO PROCEDURE NO. 12. THIS TESTING SHALL BE PERFORMED AFTER ALL SURFACES HAVE BEEN SHOT PEENED.

REV.	DATE	BY	DESCRIPTION

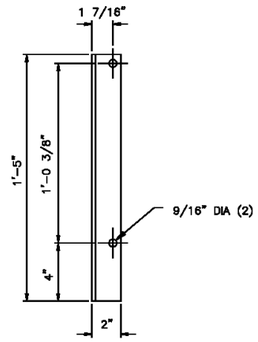
RAIL KASGRO CORP
121 BURDLE RD. NEW CASTLE, PA

SPRING GROUPING
290 TON STRAIGHT DECK FLAT CAR

DRG: NH	4/17	1155–32	
CHK: JO	4/17		
ISSUED TO	DATE	APP'D:	

APPENDIX G-1.33 BRAKE STEEL DETAILS

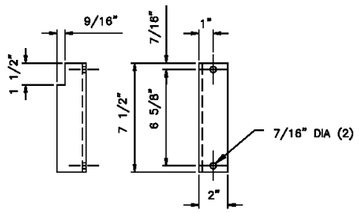
ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–124	2	∠ 2" X 2" X 1/4" X 1'–5"	A–36
3–125	2	∠ 2" X 2" X 1/4" X 1'–5"	A–36
3–126	2	∠ 2" X 2" X 1/4" X 0'–7 1/2"	A–36
3–127	2	∠ 2" X 2" X 1/4" X 0'–7 1/2"	A–36
3–128	4	∠ 2" X 2" X 1/4" X 0'–7 1/2"	A–36
3–129	6	PL 9 7/8" X 3/8" X 0'–11 1/4"	A–36
3–130	2	C 4" ⌀ 7.25 X 0'–5 1/2"	A–36
3–152	2	PLT 1/4" X 8 1/8" X 0'–9 1/4"	A–36



CCD VALVE SUPPORT

(3–124) AS SHOWN

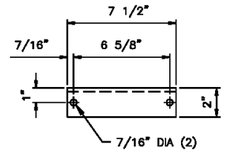
(3–125) IN REVERSE



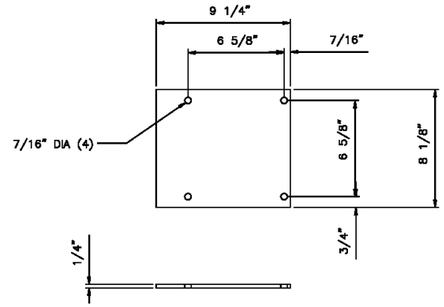
JUNCTION BOX SUPPORT

(3–126) AS SHOWN

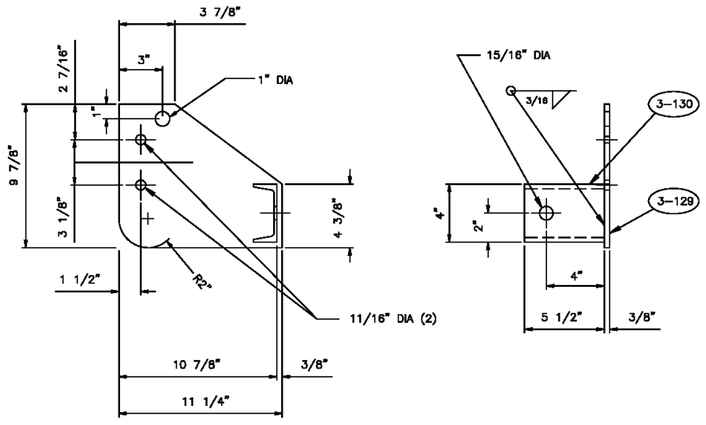
(3–127) IN REVERSE



(3–128) JUNCTION BOX SUPPORT



(3–152) JUNCTION BOX SUPPORT



(3–129) HOSE & EOC BLOCK SUPPORT

ALL WELDS WPS F–001 OR WPS S–001
ALL WELDS TO BE VISUALLY INSPECTED

TOLERANCES UNLESS NOTED
OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO

DATE

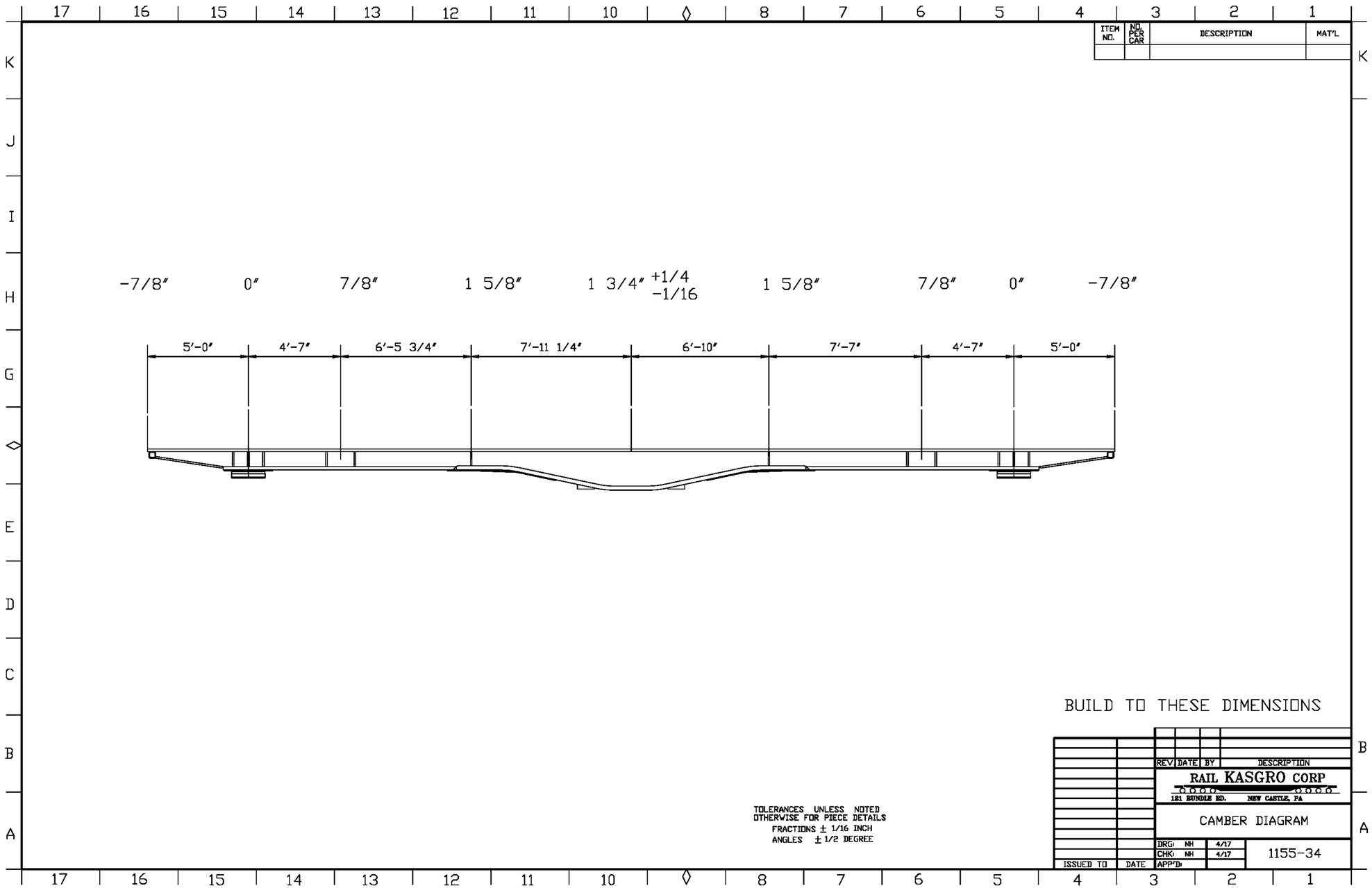
REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
191 BUNDLE RD. NEW CASTLE, PA

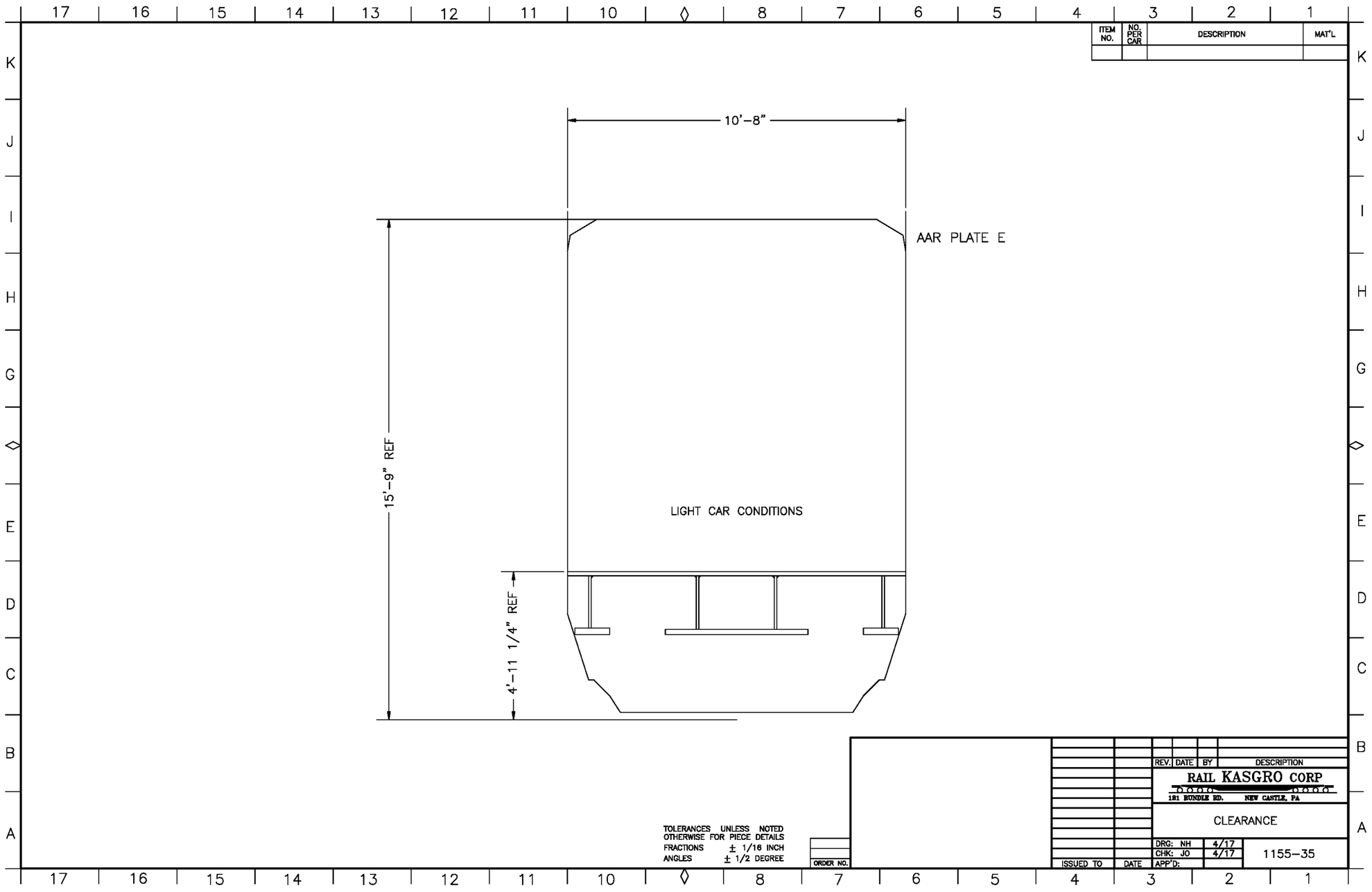
BRAKE STEEL DETAILS

DRG: NH	4/17	1155–33
CHK: JO	4/17	
APP'D:		

APPENDIX G-1.34 CAMBER DIAGRAM

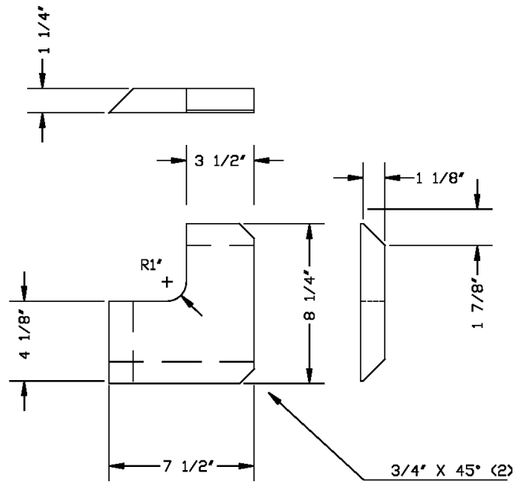


APPENDIX G-1.35 CLEARANCE



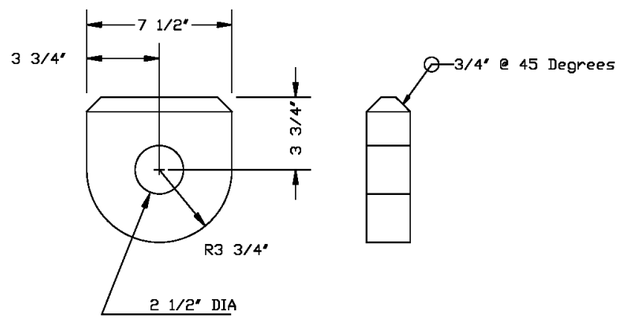
APPENDIX G-1.36 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-131	4	PLT 1 1/4" x 7 1/2" x 0'-8 1/4"	A-572 GR 60
3-138	8	PLT 2 1/4" X 7 1/2" X 0'-7 1/2"	A-572 GR 60
3-141	4	PLT 1 1/4" x 7 1/2" x 0'-8 1/4"	A-572 GR 60



(3-141) THUS

(3-131) BEVEL NEAR SIDE



(3-138) TIE DOWN LUG

TOLERANCES UNLESS NOTED
OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

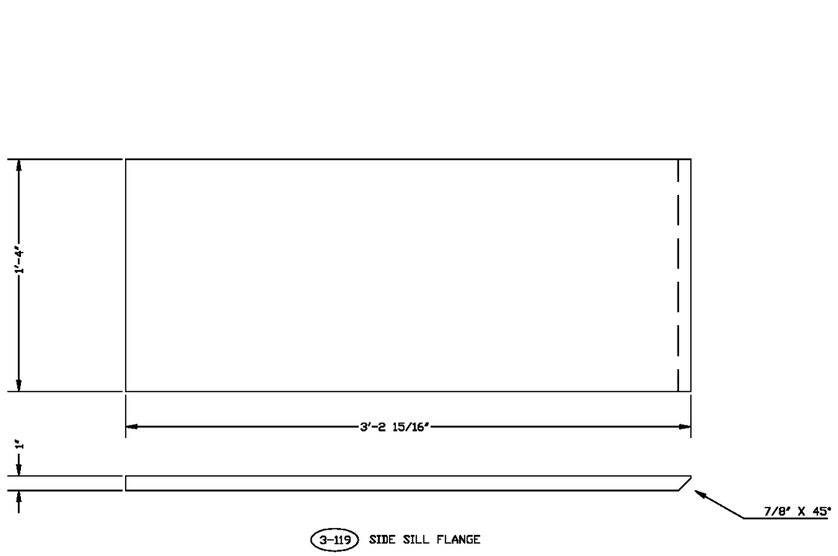
RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

STEEL DETAILS

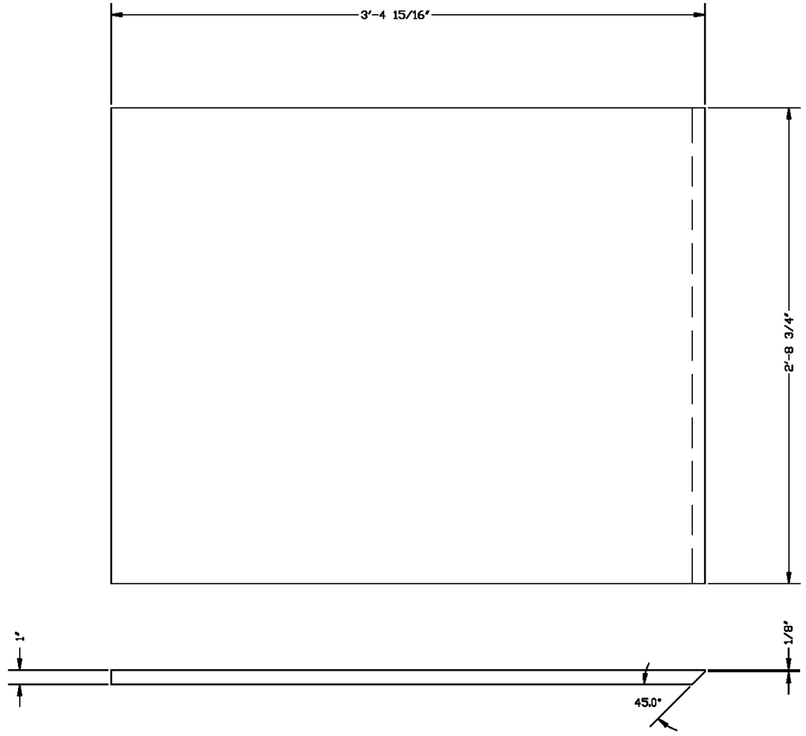
DRG: NH		4/17	1155-36
CHK: JD		4/17	
ISSUED TO	DATE	APP'D:	

APPENDIX G-1.37 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-137	2	PLT 1" X 32 3/4" X 3'-4 15/16"	A-572 GR 60
3-119	4	PLT 1" X 16 X 3'-2 15/16"	A-572 GR 60



3-119 SIDE SILL FLANGE



3-137 CENTER SILL FLANGE

NOTES:

1. FOR ITEMS 3-119 & 3-137, CHARPY IMPACT TESTING OF THE MATERIAL IS REQUIRED IN ACCORDANCE WITH ASTM A673. THE MINIMUM AVERAGE ABSORBED ENERGY SHALL BE 20 FT-LBS AT ZERO (0) DEGREES F. TRANSVERSE IMPACT TEST ORIENTATION IS REQUIRED FOR PLATE WIDTHS OVER 24 INCHES.

TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

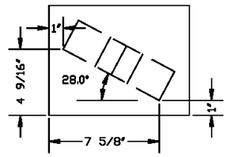
RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

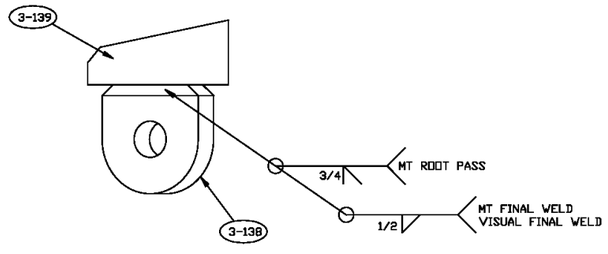
STEEL DETAILS

DRG: NH	4/17	1155-37	
CHK: JD	4/17		
APP'D:			
ISSUED TO	DATE		

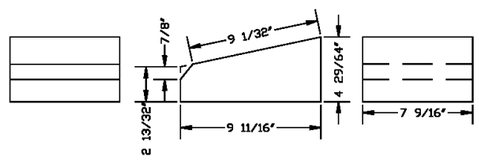
APPENDIX G-1.38 STEEL DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3-138	8	DRAWING 1155-36	
3-139	4	PLT 5" X 9-11/16" X 7-9/16"	A-572 GR 42





3-139 THUS
3-140 OPPOSITE



3-139 SUPPORT PLATE

NOTE: WELDS PER WPS F-001 OR S-001

TOLERANCES UNLESS NOTED
OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

REV	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
121 BUNDLE RD. NEW CASTLE, PA

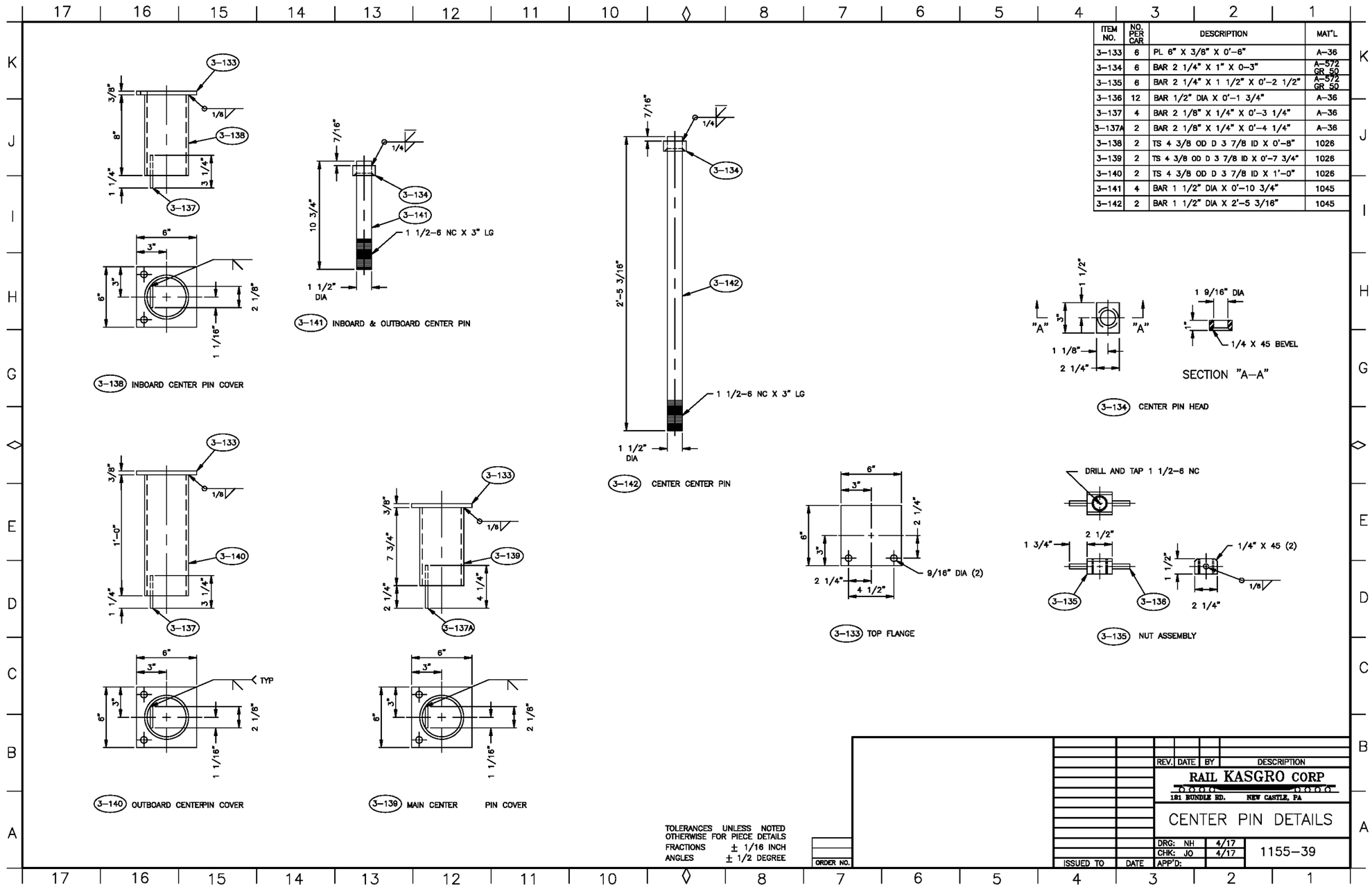
STEEL DETAILS

DRG:	NH	4/17	1155-38
CHK:	JG	4/17	
APP'D:			

ISSUED TO	DATE

APPENDIX G-1.39 CENTER PIN DETAILS

ITEM NO.	NO. PER CAR	DESCRIPTION	MAT'L
3–133	6	PL 6" X 3/8" X 0'–6"	A–36
3–134	6	BAR 2 1/4" X 1" X 0–3"	A–572 GR 50
3–135	6	BAR 2 1/4" X 1 1/2" X 0'–2 1/2"	A–572 GR 50
3–136	12	BAR 1/2" DIA X 0'–1 3/4"	A–36
3–137	4	BAR 2 1/8" X 1/4" X 0'–3 1/4"	A–36
3–137A	2	BAR 2 1/8" X 1/4" X 0'–4 1/4"	A–36
3–138	2	TS 4 3/8 OD D 3 7/8 ID X 0'–8"	1026
3–139	2	TS 4 3/8 OD D 3 7/8 ID X 0'–7 3/4"	1026
3–140	2	TS 4 3/8 OD D 3 7/8 ID X 1'–0"	1026
3–141	4	BAR 1 1/2" DIA X 0'–10 3/4"	1045
3–142	2	BAR 1 1/2" DIA X 2'–5 3/16"	1045



TOLERANCES UNLESS NOTED OTHERWISE FOR PIECE DETAILS
FRACTIONS ± 1/16 INCH
ANGLES ± 1/2 DEGREE

ORDER NO.

ISSUED TO

DATE

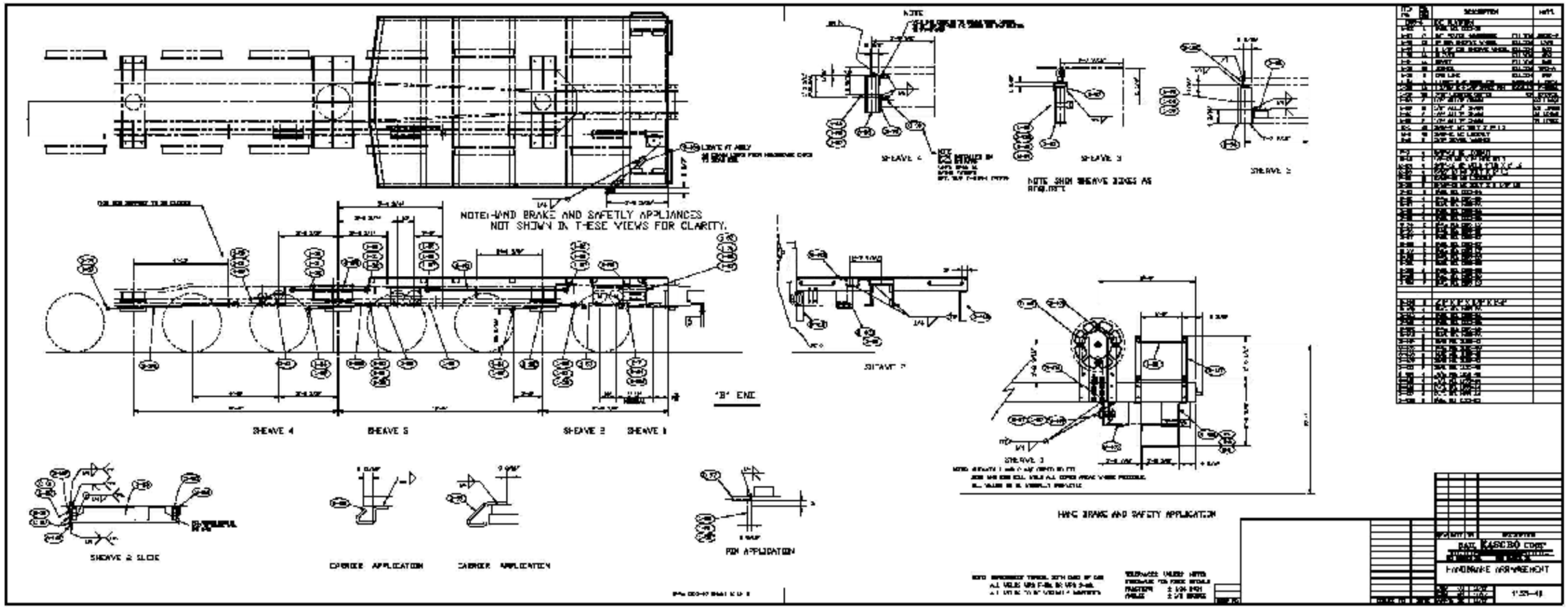
REV.	DATE	BY	DESCRIPTION

RAIL KASGRO CORP
181 BUNDLE RD. NEW CASTLE, PA

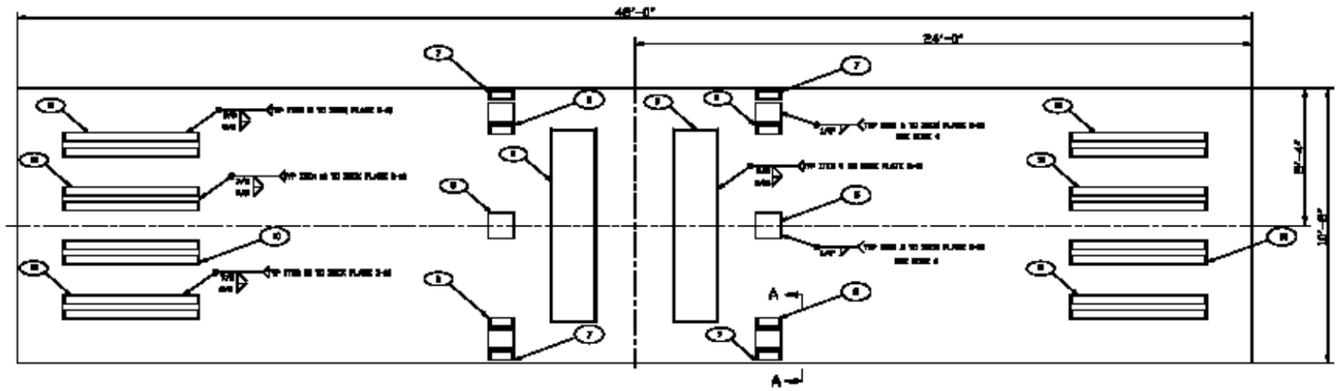
CENTER PIN DETAILS

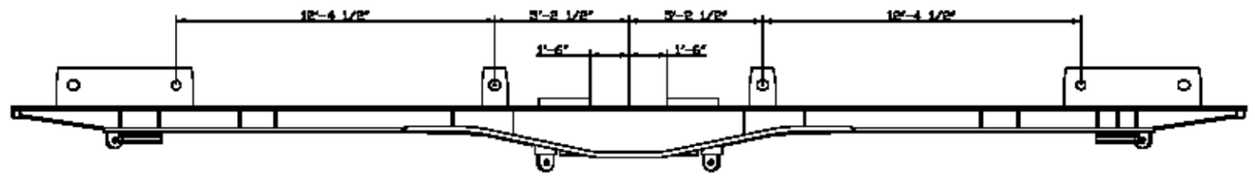
DRG: NH	4/17	1155–39
CHK: JO	4/17	
APP'D:		

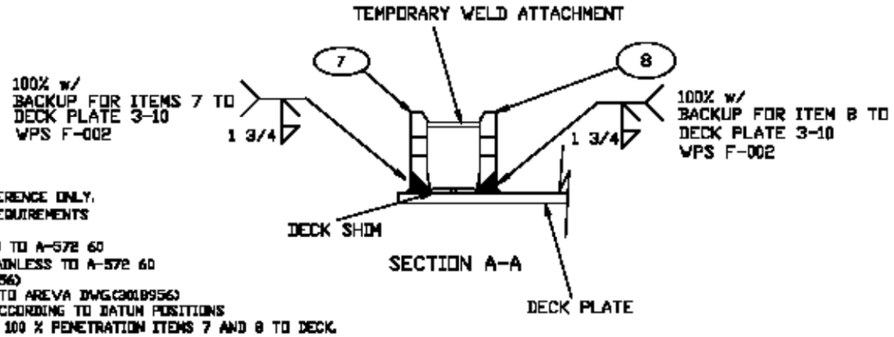
APPENDIX G-1.40 HANDBRAKE ARRANGEMENT



APPENDIX G-1.41 ATTACHMENT ARRANGEMENT







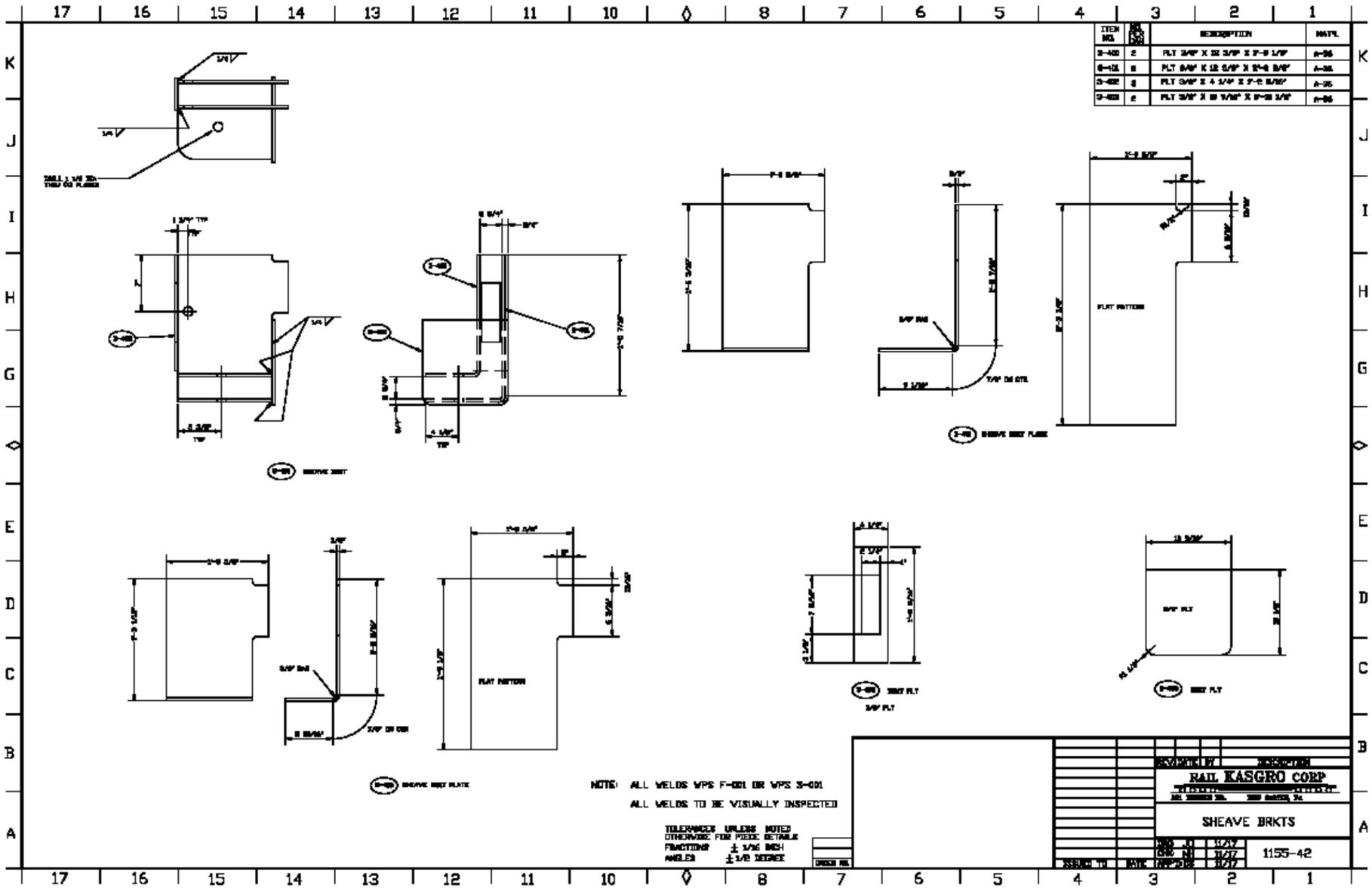
NOTES:
1. ALL DIMENSIONS SHOWN ARE FOR REFERENCE ONLY.
2. WELD INSPECTION SHALL MEET THE REQUIREMENTS OF AAR-S-2043 SECTION 4.1.10.4.
3. WPS F-002 FOR ALL WELDS A-572 50 TO A-572 60
4. 19 KRF-1067 FOR ALL WELDS 304 STAINLESS TO A-572 60
5. ALL ITEM DETAILS: AREVA DWG.(3018956)
6. ALL ATTACHMENT POSITIONING REFER TO AREVA DWG.(3018956)
7. DECK SHIMS TO BE TRIMMED TO FIT ACCORDING TO DATUM POSITIONS AREVA DWG.(3018956) AND TO ENSURE 100 % PENETRATION ITEMS 7 AND 8 TO DECK.

RAIL KASGRO CORP
121 HUNDLE RD. NEW CASTLE, PA

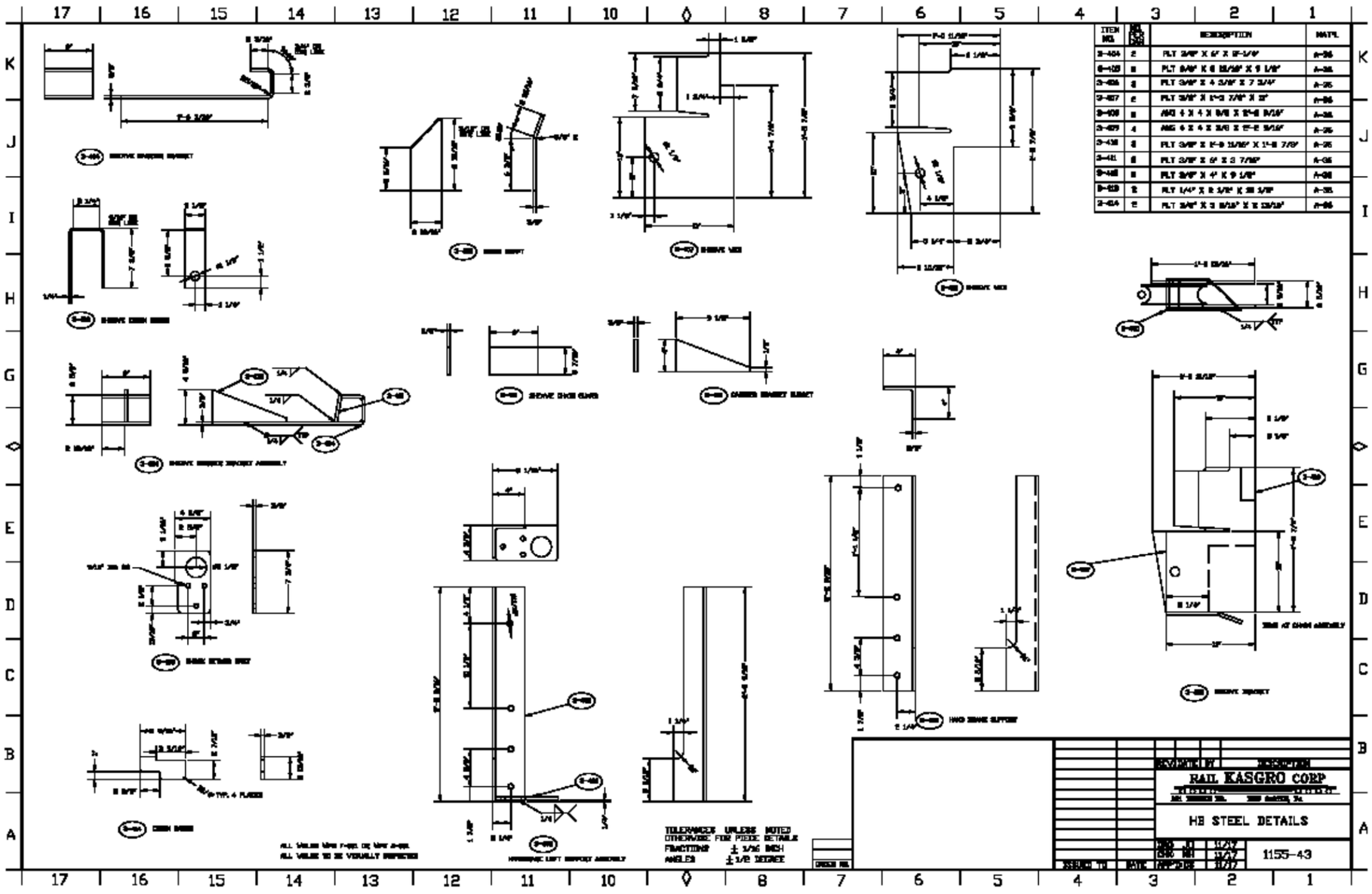
ATTACHMENT ARRANGEMENT

DRG: NH	8/16	1155-41
CHK: JD	8/16	
APP'D:		

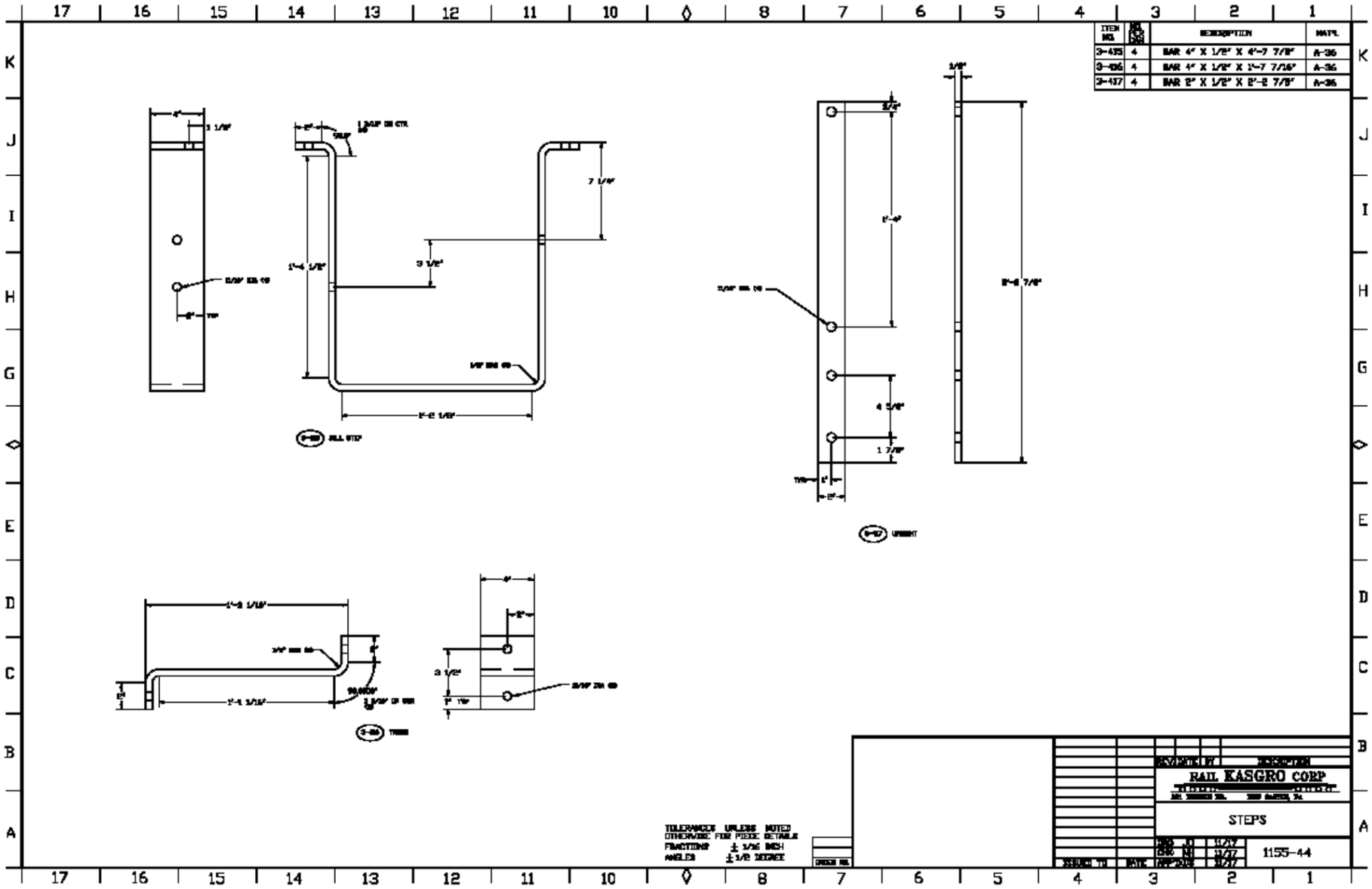
APPENDIX G-1.42 SHEAVE BRKTS



APPENDIX G-1.43 HB STEEL DETAILS



APPENDIX G-1.44 STEPS



APPENDIX G-1.45 ATLAS CASK RAILCAR STRUCTURAL ANALYSIS

KASGRO RAIL

ATLAS 12 AXLE FLAT CAR

S-2043 4.1 Structural Analysis

HLRM Service

November 2017

Prepared by:

Nicholas Hinsch

Checked by:

Jon Odden

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Introduction:

The 12 axle flat car is made up of a flat car body, two tri-spans and end platforms. The car body has been analyzed in FEA and classical methods. Classical methods are used to determine normal stresses. FEA was used to verify and refine the classical method.

The classical method was done using spreadsheets and hand calculations. Input data and output data are explained prior to the center line calculations. There are hand calculations shown to verify the spread sheet and show how the numbers are derived.

The finite element analysis was done first by modeling one quarter of the car body using Autodesk Inventor version 10. The model then was exported to Algor finite element analysis software 19.1. Symmetry was used to minimize model size. Models are shown prior to each input.

Component Stenciling: Refer to drawing 1155-3 for stencil details. (S-2043 4.1.7.2)

Material:

Multiple materials have been used for the car body including ASTM 1045, A-572 60 and A-656 80. Material selection has been assigned according to all stress results.

Top Flange (deck plate): A-572 60

Bolster Assembly: A-572 60

Center and side sill webs: A-572 60

Cross members: A-572 60

Center and side sill bottom flanges: A-572 60

Side Sill Cover Plate: A-656 80

Centers plates: ASTM 1045

Weld Rod Material:

All material is to be welded with E80XX weld wire. Majority of the car body and tri-span will be fabricated out of A-572 Grade 60 material.

Design Parameters:

The 12 axle analysis consists of the following for the car body: (S-2043 4.1.5) AAR Standard Load Cases

Vertical and longitudinal loads and forces are applied per AAR MSRP Section C Part II.

- Dead and Live Loads (S-2043 4.1.5.1,4.1.5.2) (M-1001, paragraph 4.1.2)
- Buff Load (350-kip compressive force applied at coupler and 517 kip vertical) (S-2043 4.1.5.1) (M-1001, paragraph 4.1.2)
- Draft Load (350-kip tension force applied at coupler and 517-kip vertical) (S-2043 4.1.5.6) (M-1001, paragraph 4.1.9)

- Squeeze Load (1,000-kip compression force applied at coupler and 517-kip vertical) (S-2043 4.1.5.7) (M-1001, paragraph 4.1.9)
- Dead and Live Load deflections (517-kip vertical) (S-2043 4.1.5.1-4.1.5.2)
- The 517-kip vertical load will be applied at inboard and outboard attachments. The total vertical load consists of the Hi-Star 190 cask and cradle, the weight of the end stops and all attachments. However, the distributed dead load is shown in the shear and moments diagrams. The attachment weight will also be included in the light weight of the car.

A load factor of 1.8 will be applied to the live, dead, buff and draft loads. The squeeze load will only have a load factor of 1.0. Deflections will not include a load factor.

All stresses were below yield to where each steel grade was applied in both FEA and classical methods.

Margin of Safety: (S-2043 4.1.5.9)

This is a summary of maximum stresses and minimum margins of safety. Members of the car body with max stresses are made from A-572 Grade 60 and A-656-80 material. There are higher stresses found in the transition area. The car body bolsters are made from A-572 60, however the stresses in the bolster sections are well below the yield. The max stresses for each cross section of the car body were derived from the finite element analysis of both symmetrical and unsymmetrical loading. (S-2043 4.1.5.9)

Mechanical Properties of A-572 60: Yield = 60 ksi min, Ultimate Tensile = 75 ksi min

Mechanical Properties of A-572 60: Yield = 60 ksi min, Ultimate Tensile = 75 ksi min

Mechanical Properties of A-656 80: Yield = 80 ksi min, Ultimate Tensile = 90 ksi min

(T) – Member in Tension (C) – Member in Compression

AAR Section 4.2.2.1.2 (The allowable design stress shall be the yield or 80% of ultimate, whichever is lower.)

M.S. = (Allowable stress/Actual stress) -1

Member	Max Stress	Allowable Stress	Margin of Safety	Pg.
Top Flange (C)	51.1 ksi	60 ksi	0.17	25
Cover Plate (T)	49.7 ksi	72 ksi	0.45	26
Side Sill flange (T)	54 ksi	60 ksi	0.11	26
Center Sill Flange (T)	47.9ksi	60 ksi	0.25	27
Body Bolster Webs (Shear)	12.9 ksi	29 ksi	1.24	16
Body Bolster Flange (T)	27.6 ksi	60 ksi	1.17	16
Car Body Web (Shear)	9.46 ksi	29 ksi	2.07	12
Cross Bearer (Shear)	11.16 ksi	29 ksi	1.60	19

Spreadsheet Analysis Comments:

Section properties, bending stress, axial stress, combined stress, shear flow, and shear stress are calculated using an excel spreadsheet.

Inputs:

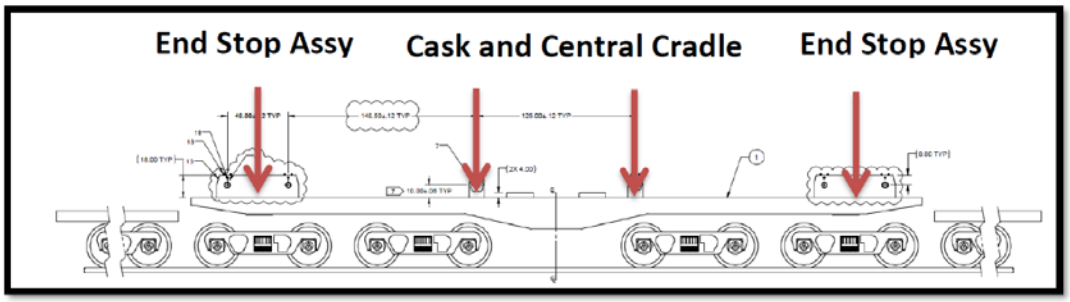
CG	Distance from element cg to top fiber
Deck Height	Section Height
Moment	Bending Moment (ft.-kips)
Shear	Vertical Shear Force (kips)
Axial	Axial Load (kips)
Load Factor	Applied Load Factor to Stresses

Outputs:

Q-Full	Static moment of section area about neutral axis using full section (in^3)
Shear Flow	Load factor (usually1.8) times shear divided by moment of inertia (k/in). Used for weld sizes
Total Area	Section Area (in^2)
Inertia	Moment of inertia (in^4)
Eccentric	Eccentricity between neutral axis and force applied at center plate
Induced moment	Eccentric distance time axial for applied at center plate
M/S	Stress due to moment (ksi)
P/A	Stress due to axial load (ksi)
M/S + P/A	Total combined stress (ksi)
VQ/IT	Shear stress at neutral axis (ksi)
T	Thickness of a member

All stresses were below yield to where each steel grade was applied in both FEA and classical methods.

Model for Analysis:



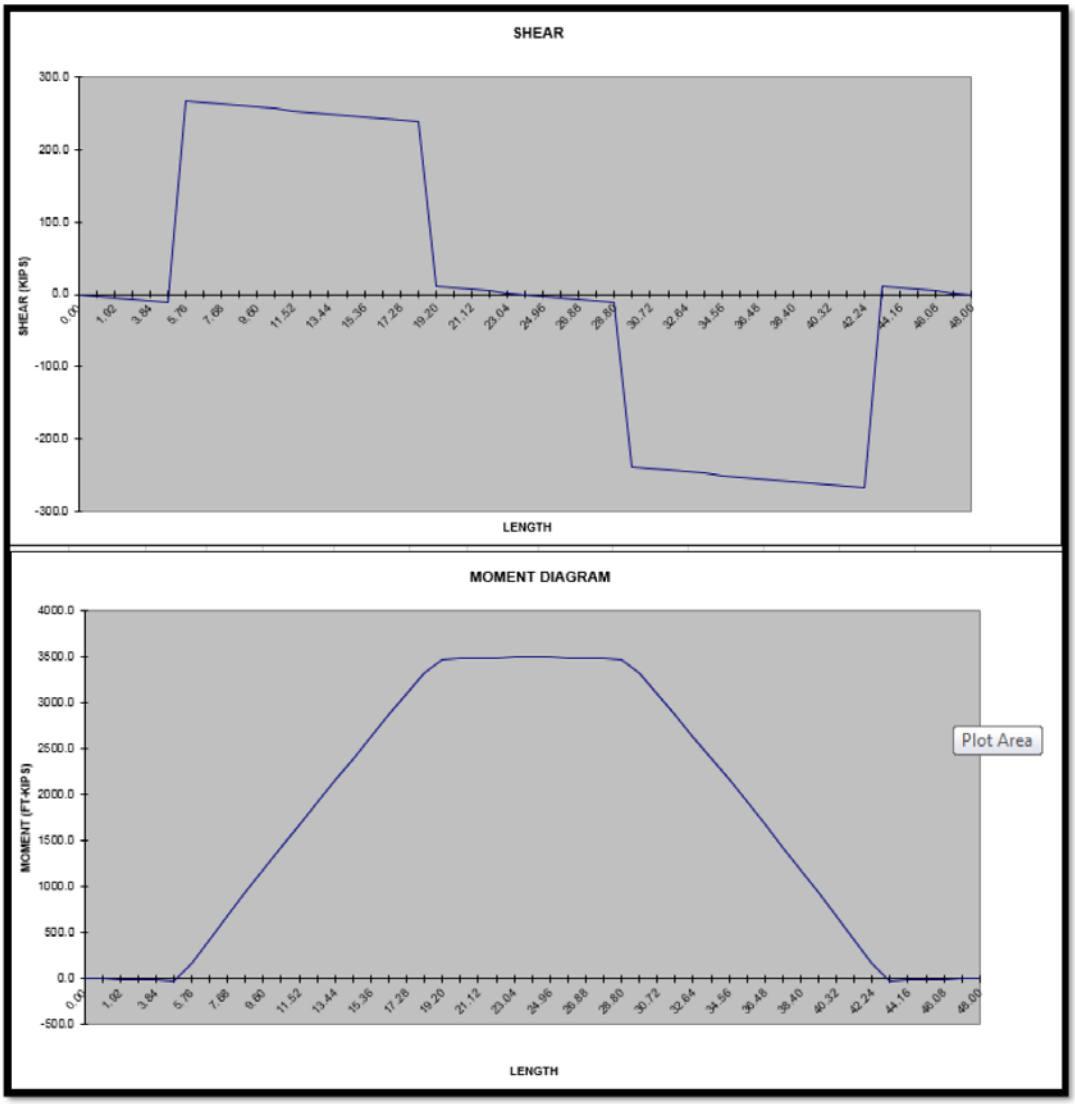
Free Body Diagram for Different Cask Families

The Atlas rail car loading is shown in the figures above and below. A shear and moment diagram was created to show the HI-Star 190 loading on the car body of the Atlas rail car. The weight of the cask and cradle was applied at the inboard attachments shown below. The car body distributed load including attachment weight is shown in the uniform load columns. The car body comes out to 48 ft. in length and estimated at 2.34 kip/ft. which was derived from the FEA model. Concentrated loading of the cask and cradle of the HI- Star 190 are shown, due to symmetry, a vertical load of 112.5 kip was applied at each inboard attachment. This is done to find the max bending moment and shear force subjected to the car body. The distance between vertical supports (truck centers) is 38 ft. which is shown on the left. That leaves an overhang of 5 ft. on each side of the railcar. The concentrated loads occur 62.5 inches each way off center, dimensions (x) shown below are distances shown from left edge of the car body for hand calculation purposes.

SHEAR AND MOMENT DIAGRAMS

		CONCENTRATED LOAD		UNIFORM LOAD		
		P	X	w	X1	X2
OH1=	5	225	18.8	2.34	0	48
TC=	38.0000	225	29.2	0	0	0
OH2=	5					
RL=	281.16					
RR=	281.16					
	SUM	450				

Car Body Shear and Moment Diagram for Symmetrical Loading of HI- Star 190 on Center



Loading Summary:

Concentrated loading at pin connections

Horizontal distances from left side of car body: 18.8125ft. and 29.1825ft.

Overhang from left center plate (left vertical reaction) to left side of car: 5 ft.

Overhang from right center plate (right vertical reaction) to right side of car: 5 ft.

Vertical supports (5 ft. from each end): 38 ft.

Overall Length: 48 ft.

Dead Load: Distributed uniform over 48 ft.

Live Load: Concentrated loads applied on pin connections

Live Load: 450 kip (conservative for cask and cradle)

Dead Load: 112.32 kip (2.34 kip/ft. including weight of attachments)

Vertical Reaction Left: 281.16 lbs.

Vertical Reaction Right: 281.16 lbs.

Max Moment: 3500 kip-ft. on centerline.

Max Vertical Shear Force on car body under symmetrical loading: 267.7 kip at vertical supports. (Just inboard of body bolsters)

Note: The HI-Star 190 loading of 450 kip is the max vertical loading of the railcar combined with the AAR train action forces. The HI-Star 180 loading (referred on page 34) is the max unsymmetrical loading while the car is being unloaded. The car will not experience train action forces but the load will be rotated off of centerline of the Atlas railcar.

Section Elements and Properties on Center Line

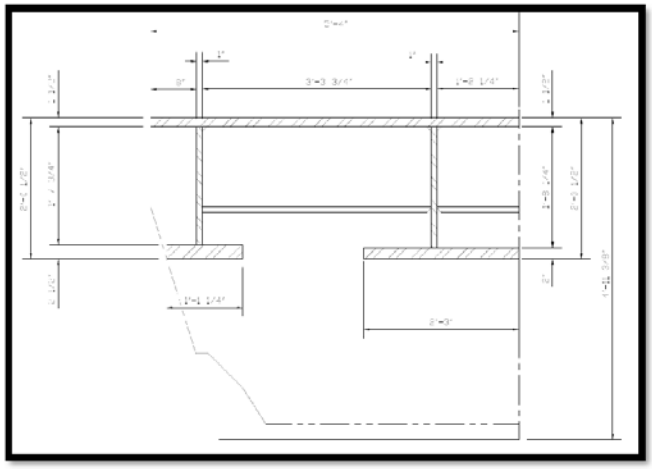
This section of the car will be analyzed with the moment of the static HI-Star 190 loading scenario (worst case) along with the AAR Buff, Draft and Squeeze loading. Below is the base, height and centroid of each member in the cross section. A general image of the cross section is shown below. Refer to drawing 1155-1 for further cross section details.

Parallel Axis Theorem:

Part	Thickness (in)	CG (in)	Height (in)
Top Flange	128.00	0.75	1.50
Center Webs	2.00	11.63	20.25
Bottom Flange	54.00	22.75	2.00
Side Sill Webs	2.00	11.38	19.75
Side Sill Bottom Flanges	26.50	22.13	2.50

Section Properties and Plate E:

N-A (from top)	11.18 (in)
Total Area	446.25 (in^2)
Deck Height	23.75 (in)
Eccentric	4.57 (in)
Moment	3500.0 (kip-ft)
Section Modulus Top	-4122.04(in^3)
Section Modulus Bottom	3663.21(in^3)
Inertia	46064.33 (in^4)



Normal Stresses:

AXIAL (kip)	MOMENT (kip-ft)	INDUCED MOMEMNT (kip-ft)	M/S (ksi)		P/A (ksi)	COMBINED LOADING	
0	3500.00	0.00	top	-18.34	0.00	-18.34	ksi
350	3500.00	133.29	bottom	20.64	0.00	20.64	ksi
-350	3500.00	-133.29	top	-19.04	1.41	-17.63	ksi
-1000	3500.00	-380.83	bottom	21.42	1.41	22.84	ksi
			top	-17.64	-1.41	-19.05	ksi
			bottom	19.85	-1.41	18.44	ksi
			top	-9.08	-2.24	-11.32	ksi
			bottom	10.22	-2.24	7.98	ksi

Shear stress on centerline cross section: (S-2043 4.1.10)

Max vertical shear force center cross section: 9.0 kip

Max vertical shear force between truck centers: 267.7 kip (Just Inboard of body bolster)

Vertical shearing stress = VQ/IT

V= 9.0 kip

I=46064.33 in^4

Q-value for cross section:

$Q= A_pY$

Q-Deck plate (128 in x 1.5 in) (11.18in-.75in) = 2002.56 in^3

Q-NA: 2002.56in^3 + (11.18in-1.5in) (4in) (4.84in) =2248in^3

Shear flow for deck plate:

Q-deck= (1.8(2002.56in^3) (9.0 kip))/46064.33in^4 = 0.70 k/in

Shear stress at neutral axis:

1.8(9.0 kip) (2248in^3)/((46064.33in^4) (4in)) = 0.20 ksi

Welding deck to webs:

Shear flow = (0.70 k/in)/4 =0.18 k/in per web

Use 3/8 double sided fillet per web good for 0.375 (0.707) (33.06) (2) = 17.5 k/in

Where:

0.375 = weld size (conservative)

0.707 = effective throat at 45 deg angle

33.06 = allowable weld shear stress per AAR Section C table 4.3.4.1.3

2 = double sided fillet

Check whether throat or leg of weld is stronger

Throat strength = 17.5 k/in from above

Leg to base metal strength = 60 (0.58) (0.375) (2) = 26.1 k/in

60 = base material yield stress

2 = double sided fillet

.58 = AAR conversion factor for shear stress

0.375 = weld throat size

Therefore throat calculation governs for Grade 60 Steel

Section Elements and Properties Above Inboard Wheel:

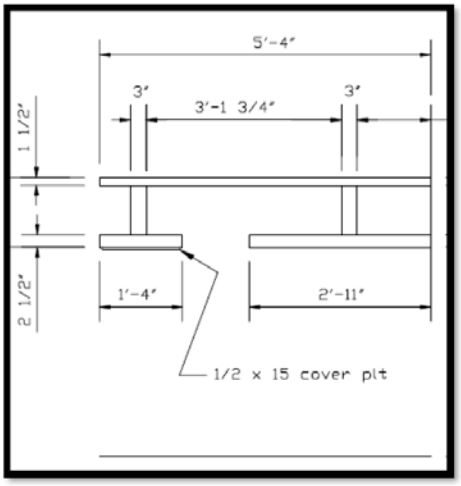
This section of the car will be analyzed with the moment of the static HI-Star 190 loading scenario (worst case) along with the AAR Buff, Draft and Squeeze loading. Below is the base, height and centroid of each member in the cross section. A general image of the cross section is shown below. Refer to drawing 1155-1 for further cross section details.

Parallel Axis Theorem:

Part	Thickness (in)	CG (in)	Height (in)
Top Flange	128.00	0.75	1.50
Center Webs	12	5.75	9.50
Bottom Flange	70.00	11.25	2.50
Side Flange	32.00	11.25	2.50
Cover Plate	30	12.50	0.50

Section Properties:

N-A (from top)	6.71 (in)
Total Area	564.00 (in^2)
Deck Height	13.00 (in)
Eccentric	8.25 (in)
Moment (HI-Star190)	3100.0 (kip-ft)
Section Modulus Top	-2004.17(in^3)
Section Modulus Bottom	2140.70(in^3)
Inertia	13456.21 (in^4)



Normal Stresses:

AXIAL (kip)	MOMENT (kip-ft)	INDUCED MOMEMNT (kip-ft)	M/S (ksi)		P/A (ksi)	COMBINED LOADING	
0	3100.00	0.00	top	-33.41	0.00	-33.41	ksi
350	3100.00	240.63	bottom	31.28	0.00	31.28	ksi
-350	3100.00	-240.63	top	-36.00	1.12	-34.89	ksi
-1000	3100.00	-687.50	bottom	33.71	1.12	34.82	ksi
			top	-30.82	-1.12	-31.93	ksi
			bottom	28.85	-1.12	27.73	ksi
			top	-14.44	-1.78	-16.22	ksi
			bottom	13.52	-1.78	11.74	ksi

Shear stress above inboard wheel cross section:

(S-2043 4.1.10)

Max vertical shear force at section (Hi Star 190): 256.40 kip

Vertical shearing stress = VQ/IT = 4.62 ksi

V= 256.40 kip

Q-NA = 1307.67

I=11088.00in^4

Q-full deck plate: 1144.48 in^3 Shear flow= 47.64 k/in

Q-full center and side sill bottom flanges: 1285.20 in^3 Shear flow = 53.49 k/in

Q-full cover plate 87.00 in^3 Shear flow = 3.62 k/in

Welding deck to webs:

Shear flow = (47.64 k/in)/4 =11.91 k/in per web

Use 3/8 double sided fillet per web good for 0.375 (0.707) (33.06) (2) = 17.5 k/in

Welding flanges to webs: = (53.49 k/in)/4 = 13.37 k/in per web

Side sills use 3/8" double sided fillet per web good for = 17.5 k/in

Center Sill use 3/4" single sided fillet per web good for 17.5 k/in (refer to drawing 1155-1)

Where:

0.375 = weld size (conservative)

0.707 = effective throat at 45 deg angle

33.06 = allowable weld shear stress per AAR Section C table 4.3.4.1.3

2 = double sided fillet

Check whether throat or leg of weld is stronger

Throat strength = 17.5 k/in from above

Leg to base metal strength = 60 (0.58) (0.375) (2) = 26.1 k/in

Where:

60 = base material yield stress 2 = double sided fillet

.58 = AAR conversion factor for shear stress

0.375 = weld throat size Therefore throat calculation governs for Grade 60 Steel

Shear stress at 10 ft. inboard of body bolster:

(S-2043 4.1.10) Refer to drawing 1155-1 for further cross section details.

Max vertical shear force at section (Hi Star 190): 267.70 kip

Vertical shearing stress = VQ/IT = 9.46 ksi

V= 267.70 kip

Q-NA = 935.10 in^3

I=9527.00in^4

Q-full deck plate: 891.00 in^3 Shear flow= 45.07 k/in

Q-full side sill bottom flanges: 88.32in^3 Shear flow = 17.56 k/in

Q-full bottom flange: 724.5 in^3 Shear flow = 36.64 k/in

Welding deck to webs:

Shear flow = (45.07 k/in)/4 =11.26 k/in per web

Use 3/8 double sided fillet per web good for 0.375 (0.707) (33.06) (2) = 17.5 k/in

Welding side sill flanges to webs: = (17.56 k/in)/2 = 8.75 k/in per web, Center sill: (36.64 k/in)/2 =18.32 k/in

Side sills use 3/8" double sided fillet per web good for = 17.5 k/in

Center Sill use 3/8" single sided fillet plus 1" 60 deg bevel per web good for 29 k/in (refer to drawing 1155-1)

Where:

0.375 = weld size (conservative)

0.707 = effective throat at 45 deg angle

33.06 = allowable weld shear stress per AAR Section C table 4.3.4.1.3

2 = double sided fillet

Check whether throat or leg of weld is stronger

Throat strength = 17.5 k/in from above

Leg to base metal strength = 60 (0.58) (0.375) (2) = 26.1 k/in

Where:

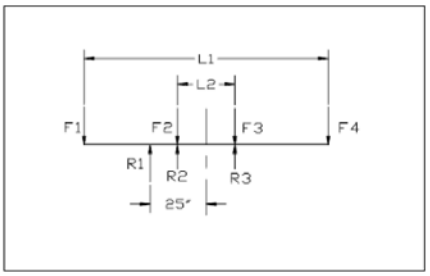
60 = base material yield stress 2 = double sided fillet

.58 = AAR conversion factor for shear stress

0.375 = weld throat size Therefore throat calculation governs for Grade 60 Steel

Bolster Analysis:

BODY BOLSTER

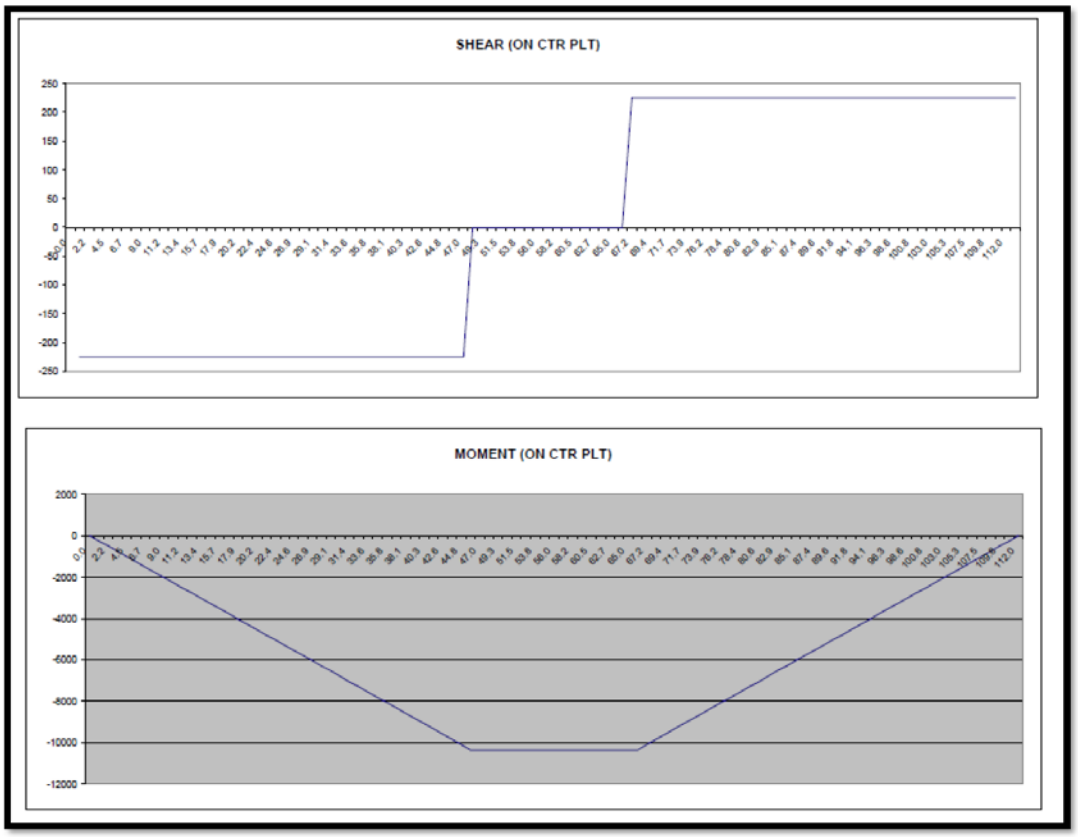


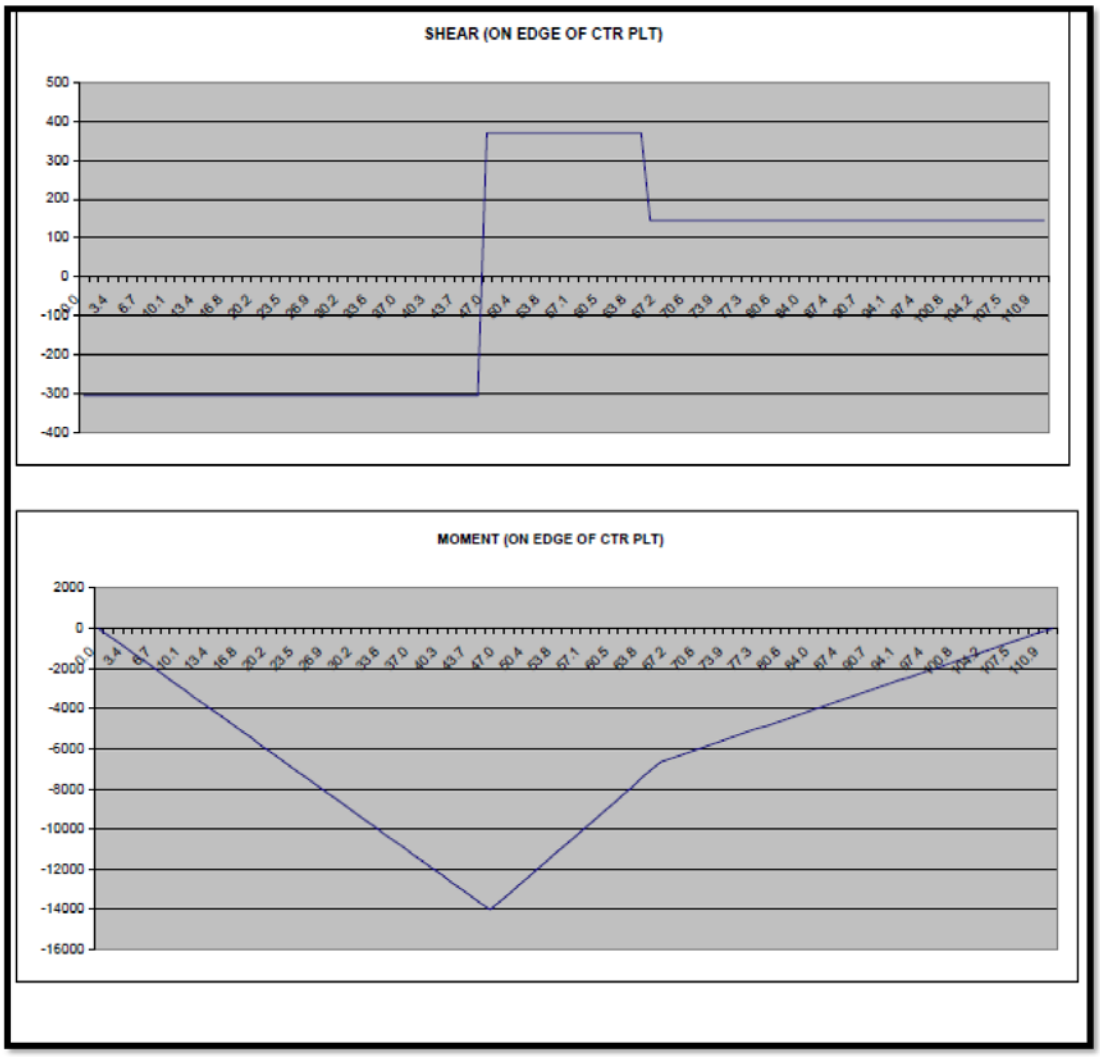
REFERENCE	CTR SILL LOAD	EDGE OF CTR SILL	SIDE BRG LOAD
70 TON TRUCKS	230	230	144
100 TON TRUCKS	300	300	188
125 TON TRUCKS	325	325	207
2-70 TON TRUCKS	460	460	288
2-100 TON TRUCKS	600	600	376
2-125 TON TRUCKS	650	650	414

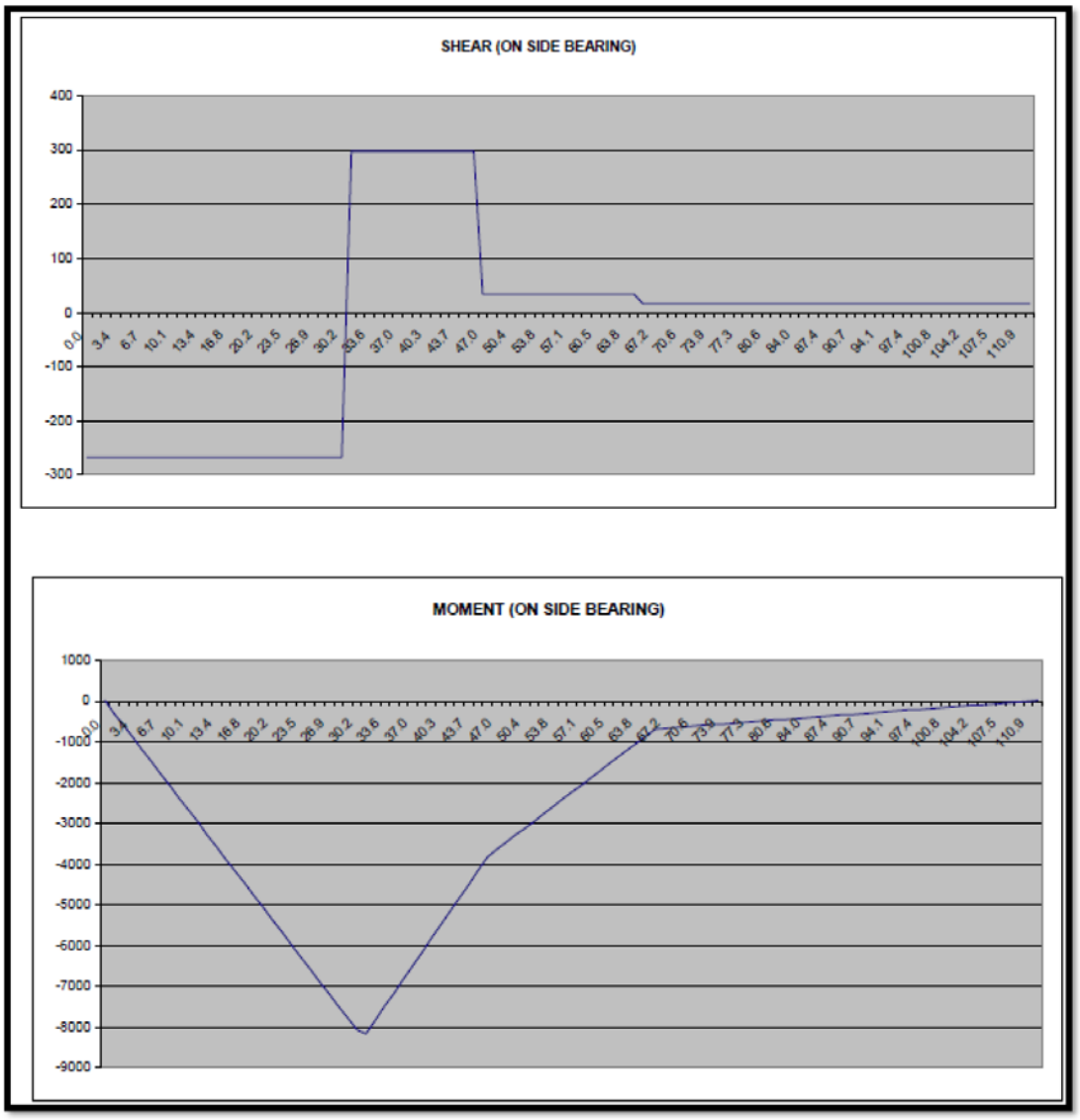
LENGTH (L2)	20	INCHES
LENGTH (L1)	112	INCHES
% CARRIED BY CENTER SILL	50	%
CTR PLT LOAD	900	KIPS
SIDE BEARING LOAD	564	KIPS

Conservative because wheels not fully loaded and lower span is quite heavy.

REACTIONS AND FORCES	LOAD ON CTR PLT	LOAD ON EDGE OF CTR PLT	LOAD ON SIDE BRG
F1	225.0	305.4	266.9
F2	225.0	225.0	141.0
F3	225.0	225.0	141.0
F4	225.0	144.6	15.1
R1	0.0	0.0	564.0
R2	450.0	900.0	0.0
R3	450.0	0.0	0.0


SHEAR (ON CTR PLT)
MOMENT (ON CTR PLT)


SHEAR (ON EDGE OF CTR PLT)
500
400
300
200
100
0
-100
-200
-300
-400
0.0
3.4
6.7
10.1
13.4
16.8
20.2
23.5
26.9
30.2
33.6
37.0
40.3
43.7
47.0
50.4
53.8
57.1
60.5
63.8
67.2
70.6
73.9
77.3
80.6
84.0
87.4
90.7
94.1
97.4
100.8
104.2
107.5
110.9
MOMENT (ON EDGE OF CTR PLT)
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
-16000


SHEAR (ON SIDE BEARING)
400
300
200
100
0
-100
-200
-300
0.0
3.4
6.7
10.1
13.4
16.8
20.2
23.5
26.9
30.2
33.6
37.0
40.3
43.7
47.0
50.4
53.8
57.1
60.5
63.8
67.2
70.6
73.9
77.3
80.6
84.0
87.4
90.7
94.1
97.4
100.8
104.2
107.5
110.9
MOMENT (ON SIDE BEARING)
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000

Bolster Analysis:

This section of the car will be analyzed to AAR M-1001 (4.4.8). Below is the base, height and centroid of each member in the cross section. A general image of the cross section is shown below. A general cross section of the bolster is shown below. All data was taken from the shear and moment diagrams shown above. Refer to drawing 1155-1 for further cross section details.

The bolsters were analyzed using the loading for 100 ton trucks.

Thus,

V= 375 kip
Q-top = 249.75 in^3
Q-bottom = 267.00 in^3

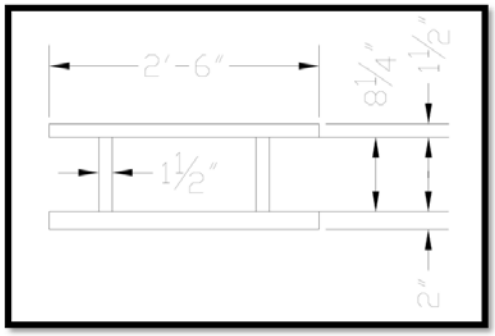
Shear flow top = (375 kip (249.75 in^3))/ 2754.35 in^4 = 34 k/in
Shear flow bottom = (375 kip (267.00in^3))/ 2754.35 in^4 =36.35 k/in

(S-2043 4.1.10)

Shear (VQ/IT) = (375 kip) (284.31 in^3) / ((2754.35 in^4) (3 in)) = 12.9 ksi @ neutral axis

M/S top = -32.03 ksi
M/S bottom= 27.66 ksi

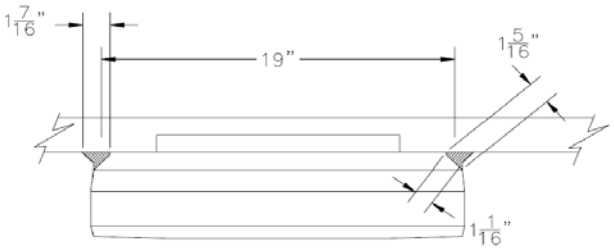
N-A (from top)	6.30 (in)
Total Area	129.75(in^2)
Deck Height	11.75 (in)
Eccentric	0 (in)
Moment	1166 (ft-kip)
Section Modulus Top	-436.91(in^3)
Section Modulus Bottom	505.77(in^3)
Inertia	2754.35 (in^4)



Refer to drawings 1155-1 and 1155-8 for welding instructions

CENTER PLATE WELD

Weld shown in cross-hatched area



Check for weakest throat (based on base material or weld material)

1 7/16" q = 1.4375 x 29 = 41.7 k/in

1.3125" q = 1.3125 x 20.88 = 27.7 k/in ← governs

1 1/16" q = 1.0625 x 33.06 = 35.1 k/in

Center plate connection good for (27.7) (pi) (19) = 1653 kips

(Does not include mechanical connection.)

Cross Bearer Analysis:

This section of the car will be analyzed to AAR M-1001. Below is the base, height and centroid of each member in the cross section. A general image of the cross section is shown below. A general cross section of the bolster is shown below. All data was taken from the shear and moment diagrams shown above. Refer to drawing 1155-1 for further cross section details.

Cross bearer must carry 37.5% of the live load (450 kip), less that carried by the side sill, back to the center sill.

Estimate that 50% of the load is carried by the center sill and each side sill carries 25%.

Thus,

450 kip (.375) (0.5) = 84.36 kip
Length of Cross Bearer= 40 in

Moment = 40in (84.36 kip) = 3374 in-k = 281.17 ft-kip

V= 84.36 kip

Max Stress on top = 1.8 (3374 in-k / 252.70 $in^{3)}$ = 24.03 ksi tension on top flange

Max Stress bottom flange = 1.8 (3374 in-k / 184.44in^3) = 32.9 ksi compression on bottom flange

Shear (VQ/IT) = 1.8 (84.36 kip) (128.34 in^3) / ((1745.91 in^4) (1 in)) = 11.16 ksi @ neutral axis

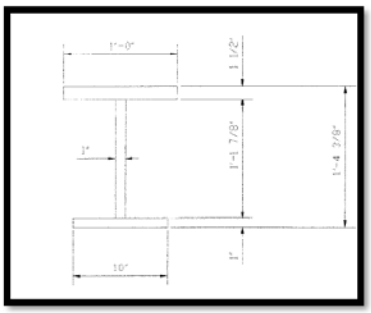
Q top flange =110.90 in^3

V= 84.36 kip

Shear Flow = q= 1.8 84.36 kip (110.9 in^3) / 1745.91 in^4 = 9.55 k/in
(S-2043 4.1.10)

Use 0.375 fillet weld both sides to both top and bottom flange (17.5 k/in)

N-A (from top)	6.91 (in)
Total Area	41.88 (in^2)
Deck Height	16.38 (in)
Eccentric	0 (in)
Moment	281.17 (ft-kip)
Section Modulus Top	-252.70(in^3)
Section Modulus Bottom	184.44(in^3)
Inertia	1745.91 (in^4)



COOPER RATING
KASGRO RAIL CORP
Atlas Cask Car (S-2043 4.7.9.2)

LOAD	AXLE SPACING
65.75	6
65.75	4.5
65.75	6
65.75	4.5
65.75	6
65.75	11.5
65.75	6
65.75	4.5
65.75	6
65.75	4.5
65.75	6
65.75	0

SPAN	BENDING		END SHEAR		FLOOR BEAM REACTION	
FT	FT-KIPS	E	KIPS	E	KIPS	E
6	99	65.7	80	68.7	82	61.6
8	136	67.9	94	68.3	111	63.2
10	197	70.2	101	67.3	128	64.0
12	260	65.1	112	64.1	156	66.9
13	297	62.5	120	65.2	169	68.8
14	346	62.9	126	65.3	180	69.2
15	395	63.3	131	65.3	191	69.8
16	445	63.5	137	64.3	199	70.1
18	543	63.9	150	64.5	219	72.2
20	654	63.4	160	63.9	237	72.2
25	1019	66.8	192	67.5	276	72.9
30	1430	69.7	217	68.8	316	73.2
35	1899	72.6	241	69.6	361	74.1
40	2389	72.9	259	68.6	409	75.6
45	2880	72.0	283	69.4	451	75.8
50	3452	73.0	308	70.4	485	75.1
60	4751	73.4	364	73.8	536	69.7
70	6347	74.3	417	75.5	572	64.4
80	8267	76.4	459	73.9	599	60.0
90	10230	76.4	497	72.4	620	56.4
100	12195	75.5	525	70.0	637	53.4
110	14162	70.8	552	68.3	651	51.0
120	16130	69.9	571	65.7	662	48.4

130	18099	66.4	584	63.1	672	46.4
140	20067	64.5	603	61.3	681	44.0
150	22036	63.0	616	59.9	688	42.3
160	24005	60.1	622	56.8	694	40.2
170	25975	58.0	635	55.7	700	38.6
180	27946	56.5	642	53.4	705	36.8
200	31888	53.5	656	50.1	713	33.9
225	36816	50.2	670	46.4	721	30.8
250	41744	47.2	683	43.5	728	28.2
275	46673	44.5	692	40.7	734	26.0
300	51601	42.1	702	38.4	738	24.1
350	61461	37.6	713	34.2	746	21.0
400	71322	33.9	720	30.8	751	18.5

FEA INTRODUCTION:

FEA was used to verify the classical analysis of the car body. Also, to get an accurate analysis of deflections, stresses and transition areas. The car body was modeled with quarter symmetry. The model was created in Autodesk inventor and analyzed in Algor FEA software. (S-2043 4.1.3)

Car Body Weight: 83,000 lbs. (EST. 112,000 lbs. with attachments) Material: A572 60

Element Type: Brick

Meshed Model of car body with quarter symmetry:

Translational (Z), Rotational (X) and Rotational (Y) on Longitudinal Centerline

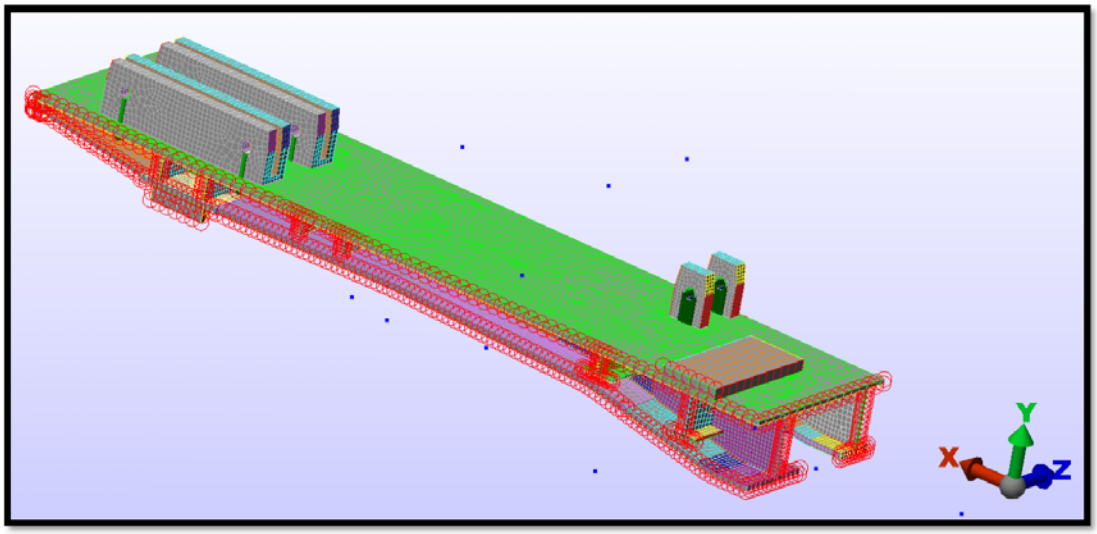
Translational (X), Rotational (Y) and Rotational (Z) on Lateral Centerline

Loads applied at inboard and outboard attachments

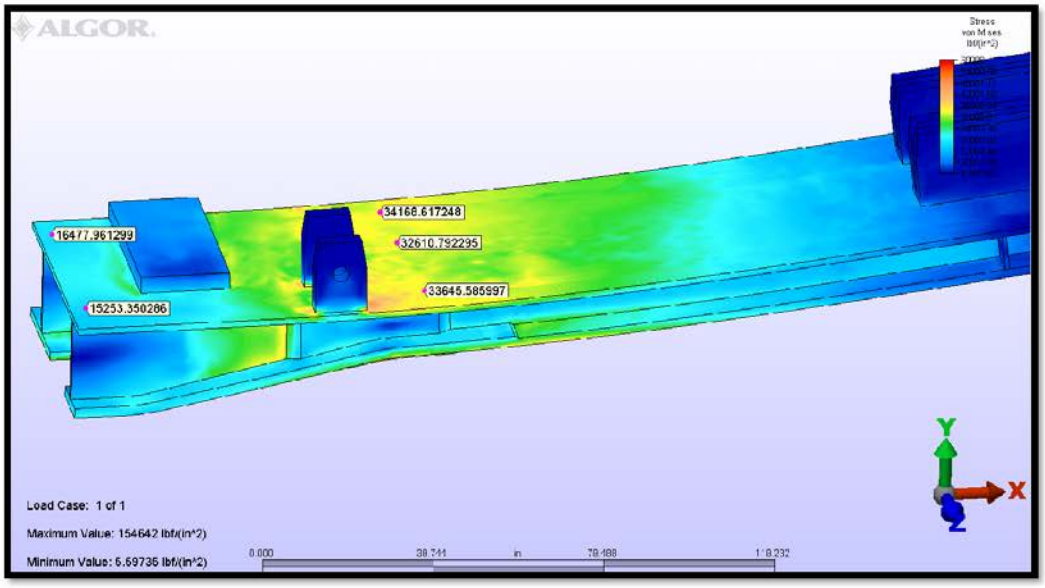
Translational (Y) constraint on center plate

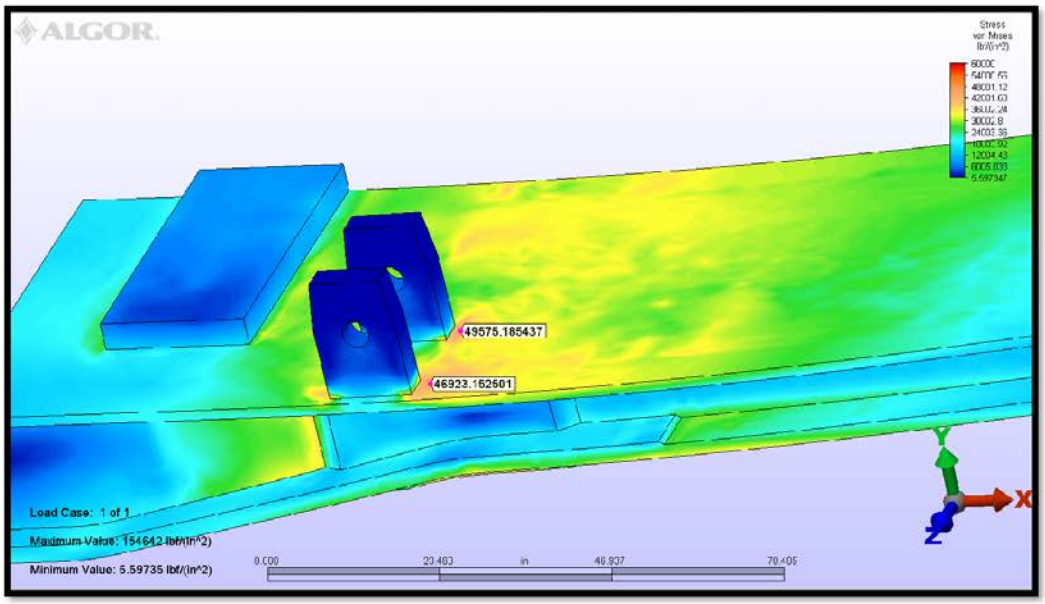
Jacking Load: Half symmetry, Translational (Z), Rotational (X) and Rotational (Y) with Translation (Y) constraints on all jacking pads.

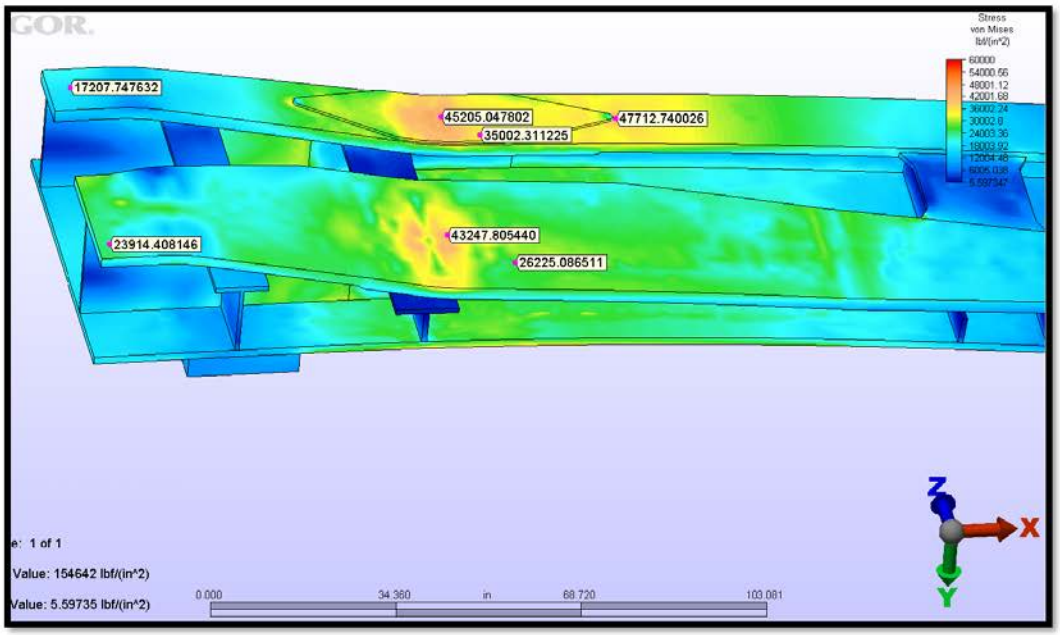
Refer to drawing 1155-1 for Jacking Pad locations.



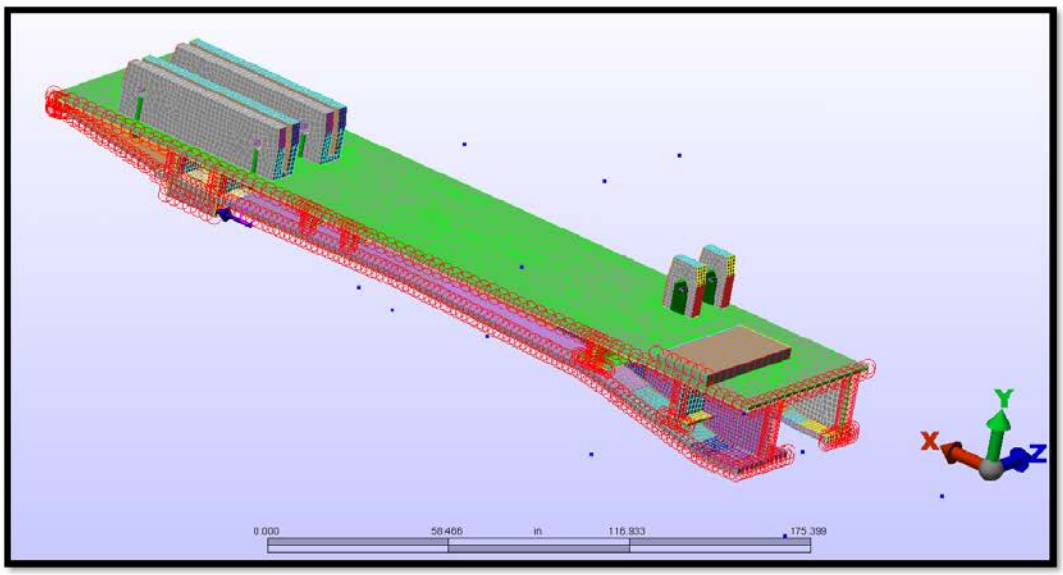
No axial load applied at coupler:

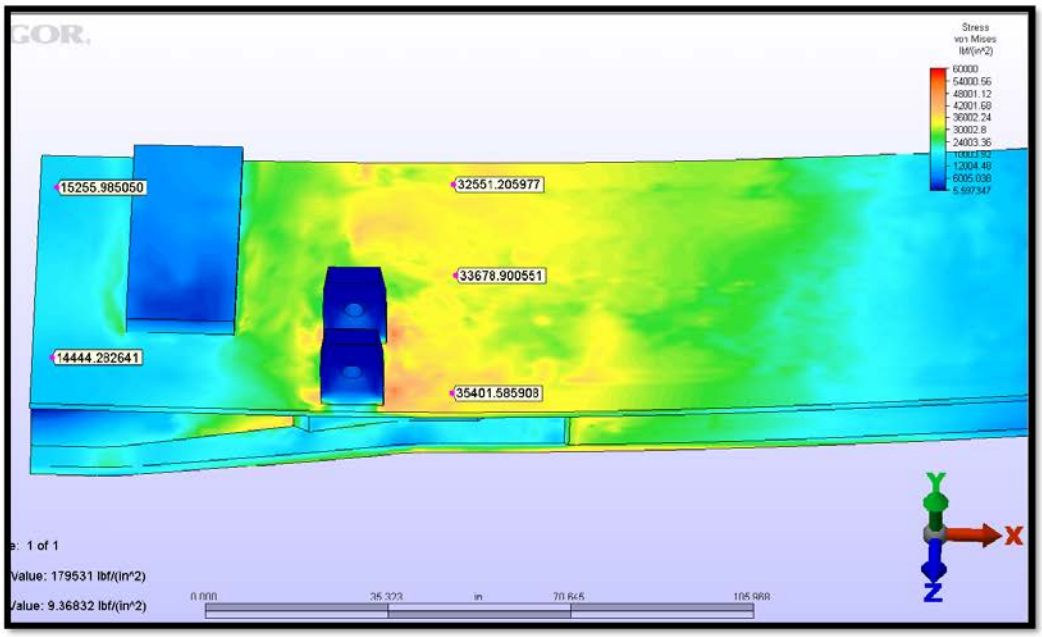


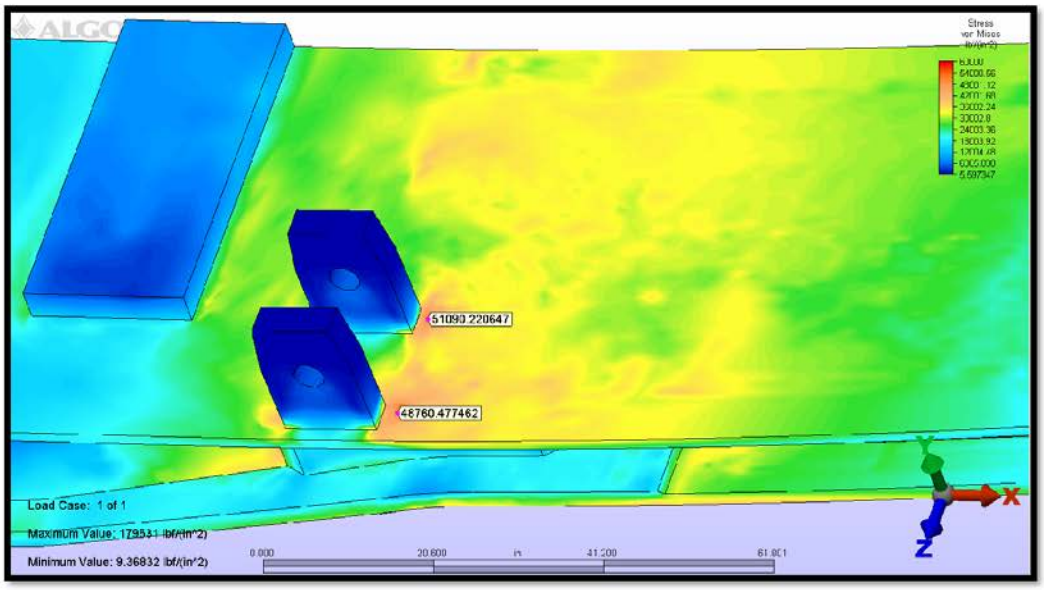


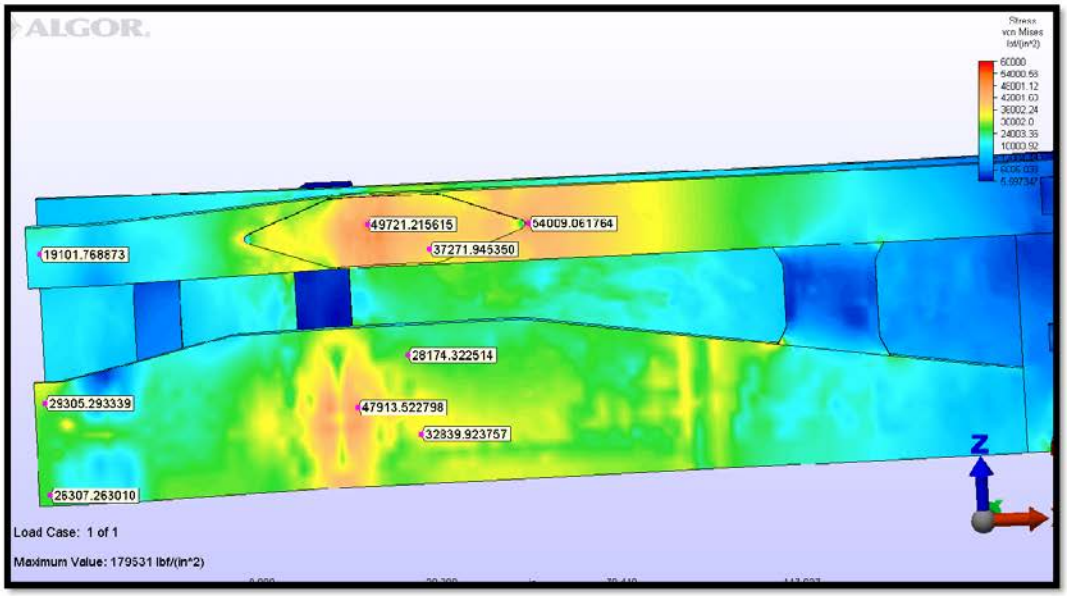

Stress
von Mises
lbf/(in^2)
60000
54000.66
48001.12
42001.68
36002.24
30002.8
24003.36
18003.92
12004.48
6005.036
5.59735
17207.747632
45205.047802
47712.740026
35002.311225
23914.408146
43247.805440
26225.086511
e: 1 of 1
Value: 154642 lbf/(in^2)
Value: 5.59735 lbf/(in^2)
0.000
34.360
in
68.720
103.081
Z
X
Y

Draft Load:

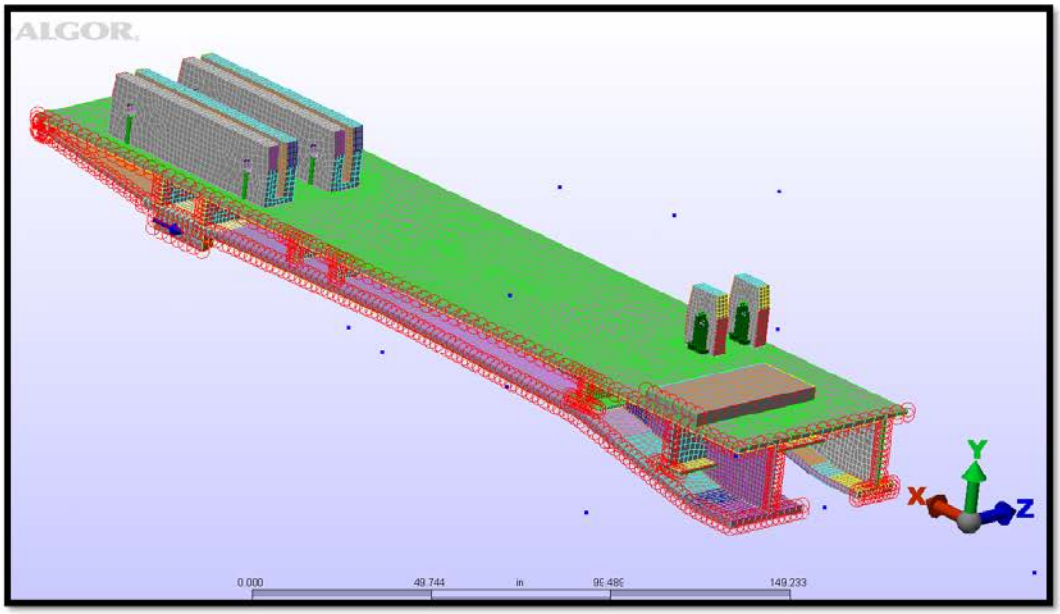

0.000
58.466
in
116.933
175.399
Y
X
Z

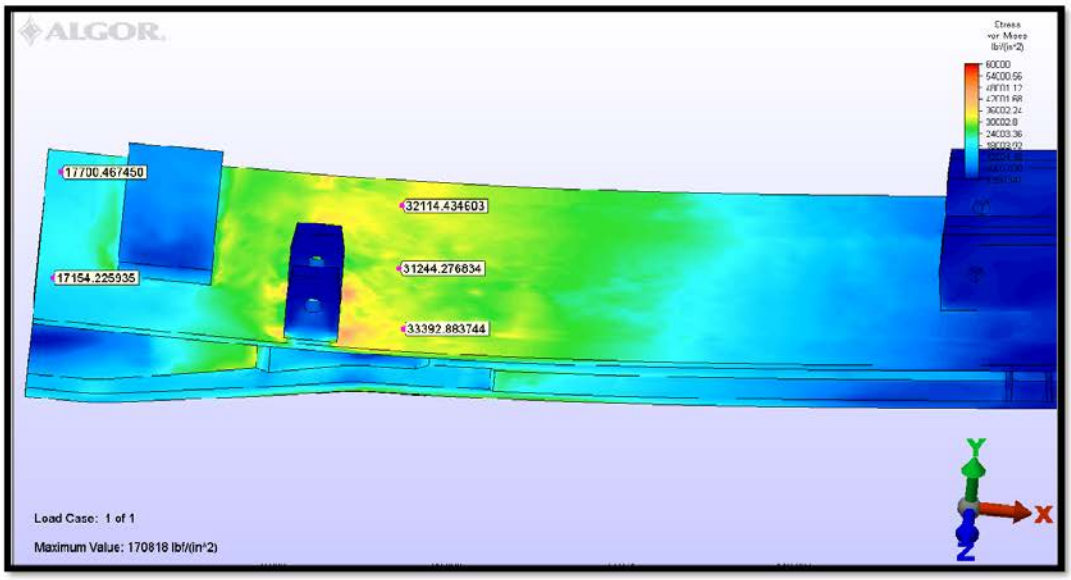

Stress
von Mises
lbf/(in^2)
60000
54000.56
48001.12
42001.68
36002.24
30002.8
24003.36
18003.92
12004.48
6005.038
5.597347
15255.985050
32551.205977
33678.900551
14444.282641
35401.585908
Y
X
Z
e: 1 of 1
Value: 179531 lbf/(in^2)
/alue: 9.36832 lbf/(in^2)
0.000
35.323
in
70.645
105.968

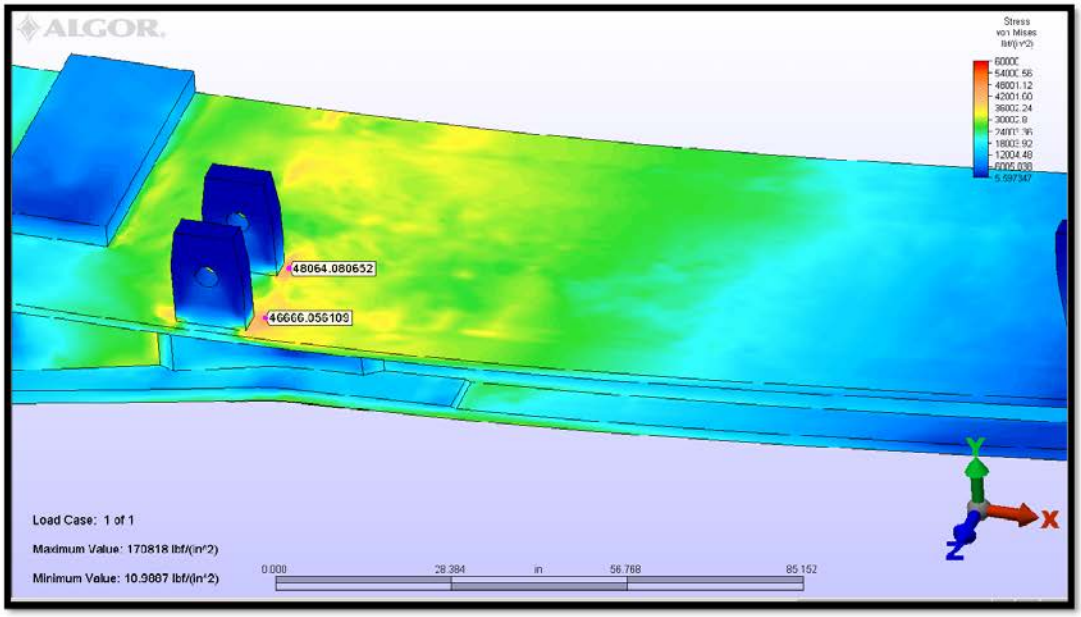

Stress
von Mises
51090.220647
48760.477462
Y
X
Z
Load Case: 1 of 1
Maximum Value: 179531 lbf/(in^2)
Minimum Value: 9.36832 lbf/(in^2)
0.000
20.600
in
41.200
61.801

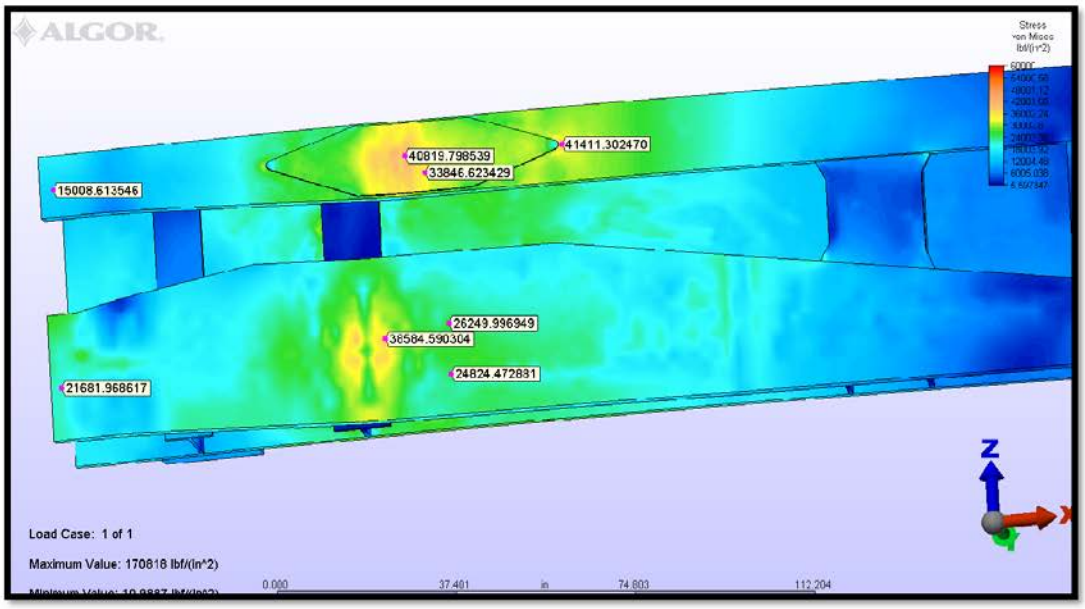

ALGOR
Stress
von Mises
lbf/(in^2)
60000
54000.68
48001.12
42001.60
36002.24
30002.0
24003.35
18003.92
12004.48
6005.039
5.697345
49721.215615
54009.061764
19101.768873
37271.945350
28174.322514
29305.293339
47913.522798
32839.923757
26307.263010
Z
Load Case: 1 of 1
Maximum Value: 179531 lbf/(in^2)

Buff Load:

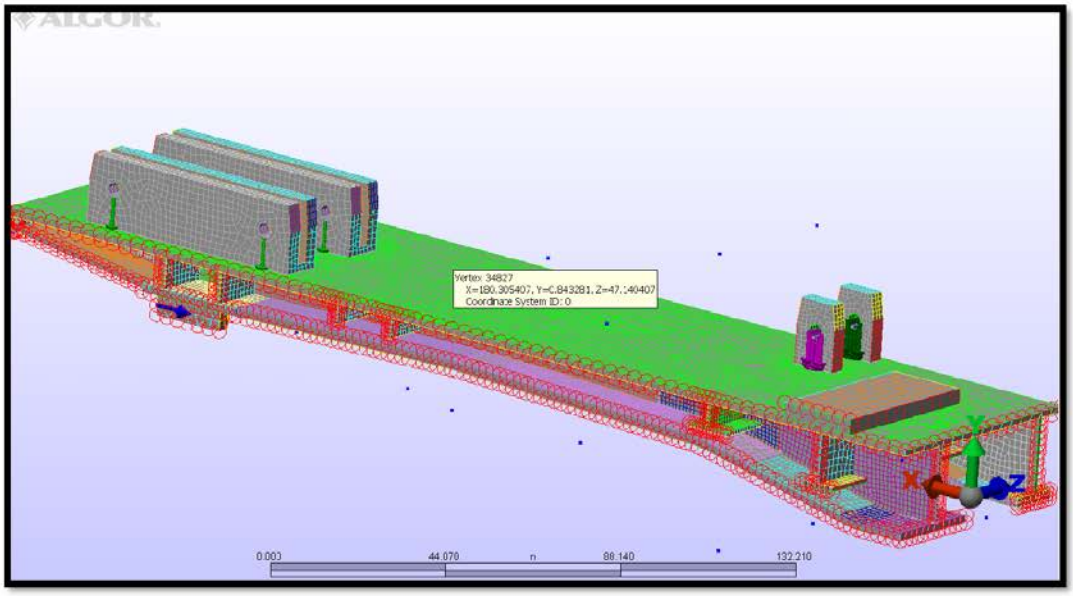

ALGOR
Y
X
Z
0.000
49.744
in
99.489
149.233

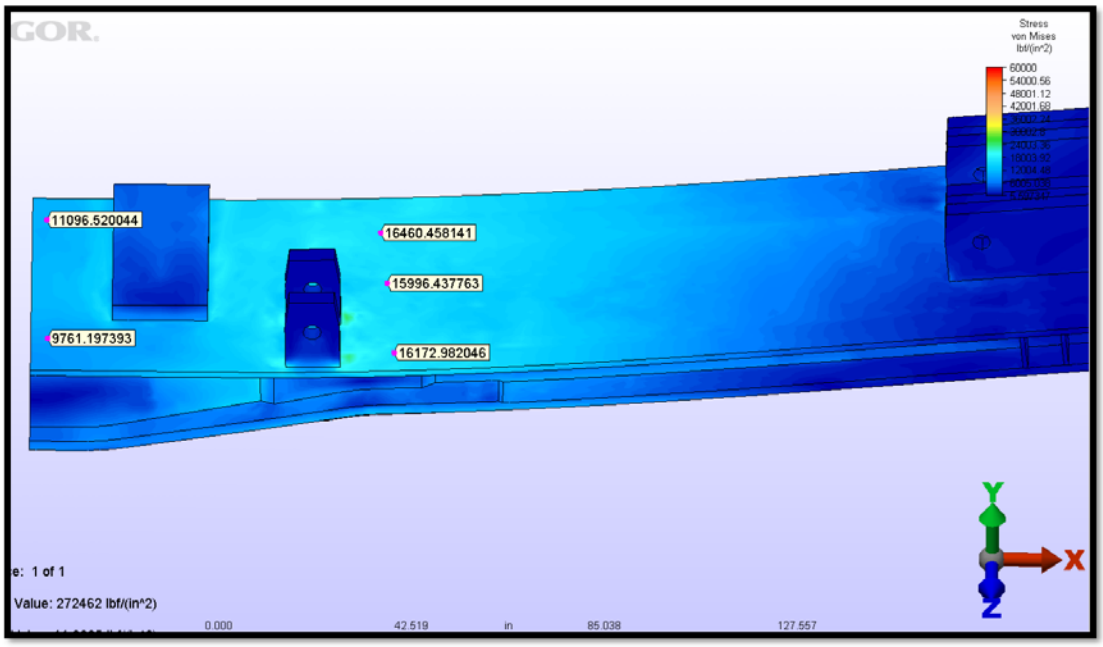

ALGOR
17700.467450
32114.434603
31244.276834
17154.225935
33392.883744
Load Case: 1 of 1
Maximum Value: 170818 lbf/(in^2)

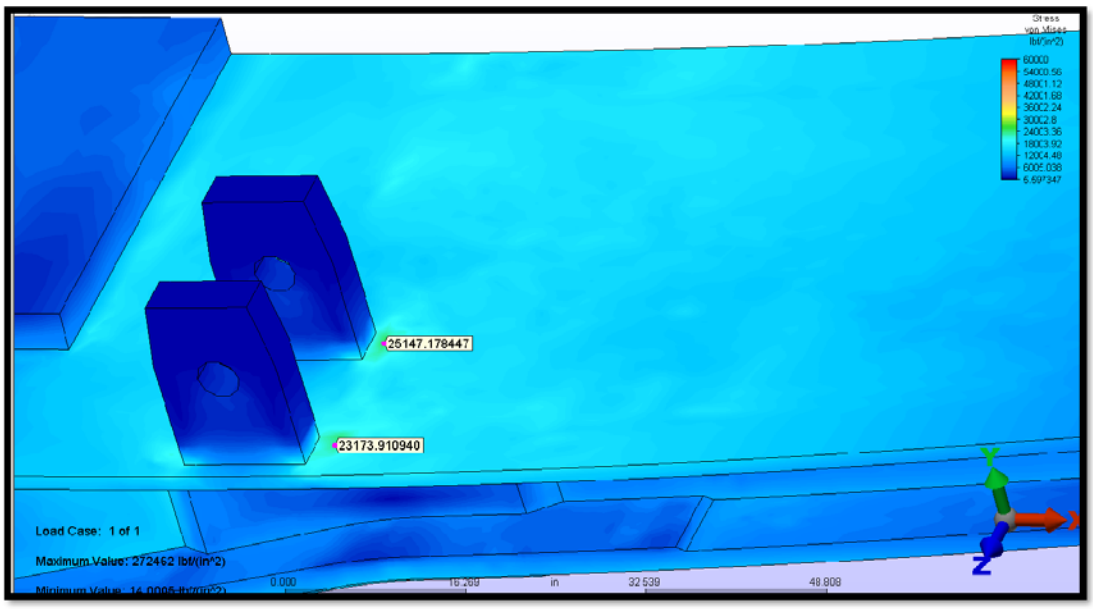

ALGOR
48064.080652
46666.056109
Load Case: 1 of 1
Maximum Value: 170818 lbf/(in^2)
Minimum Value: 10.9887 lbf/(in^2)
0.000
28.384
in
56.768
85.152

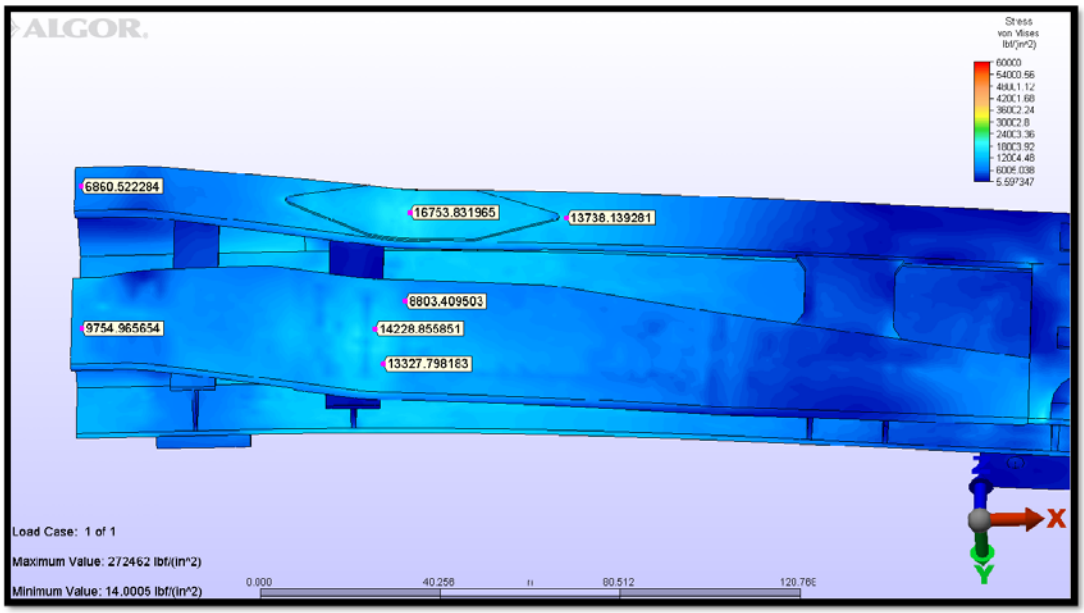


Squeeze Load:

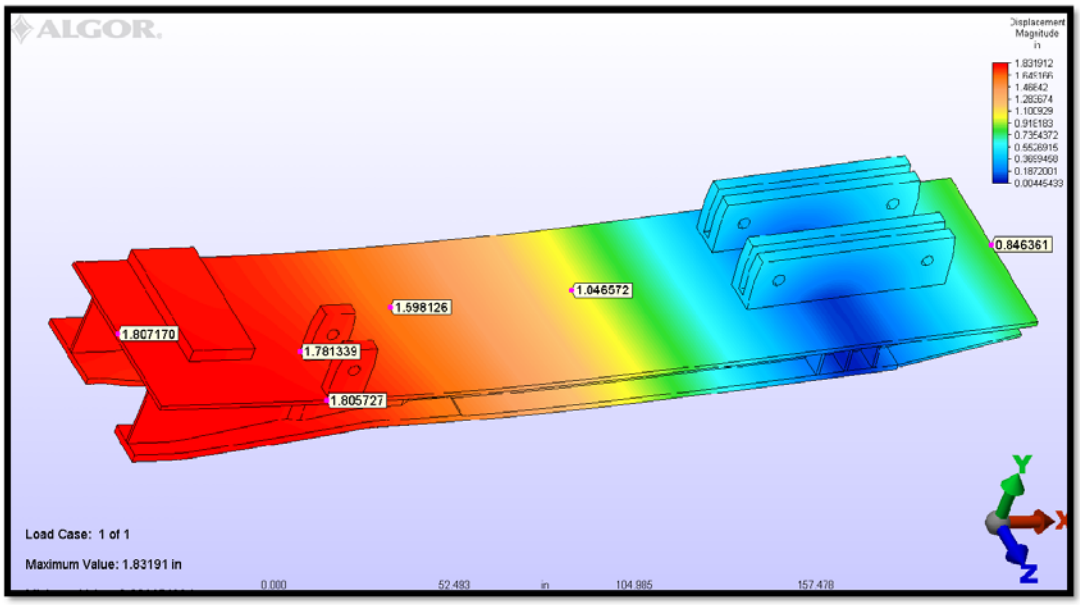



Stress
von Mises
lbf/(in^2)
60000
54000.56
48001.12
42001.68
11096.520044
16460.458141
15996.437763
9761.197393
16172.982046
Y
X
Z
e: 1 of 1
Value: 272462 lbf/(in^2)
0.000
42.519
in
85.038
127.557

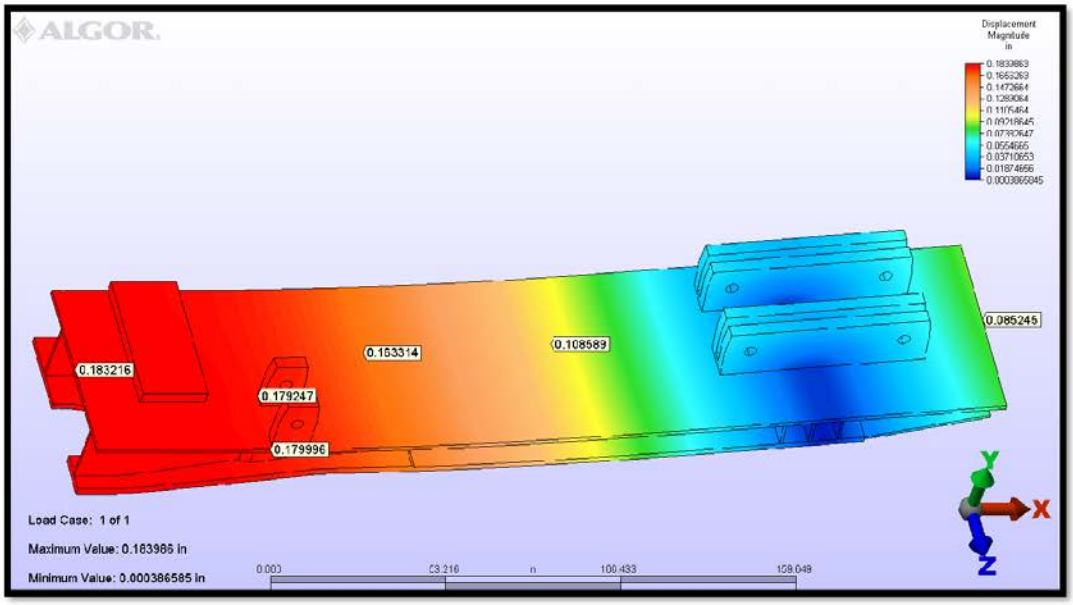

60000
54000.56
48001.12
42001.68
36002.24
30002.8
24003.36
18003.92
12004.48
6005.038
6.597347
25147.178447
23173.910940
Load Case: 1 of 1
Maximum Value: 272462 lbf/(in^2)
0.000
16.269
in
32.539
48.808



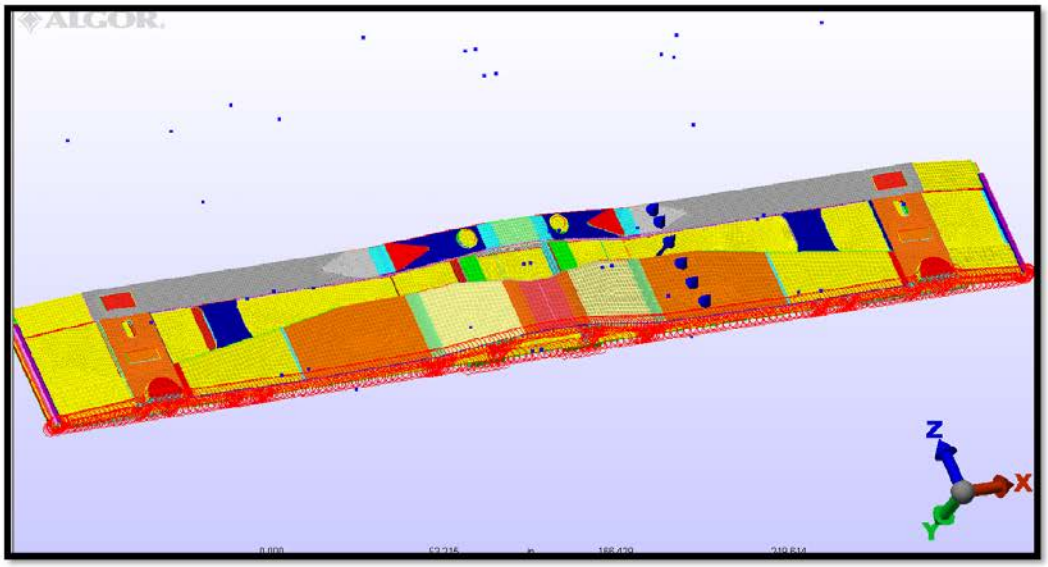
Live Load Deflection:

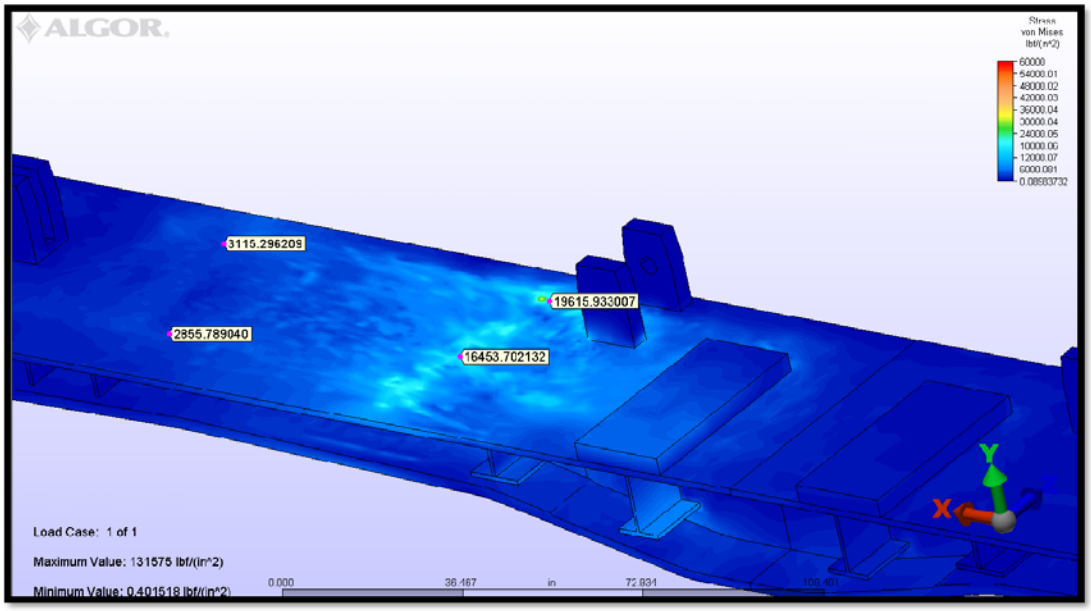


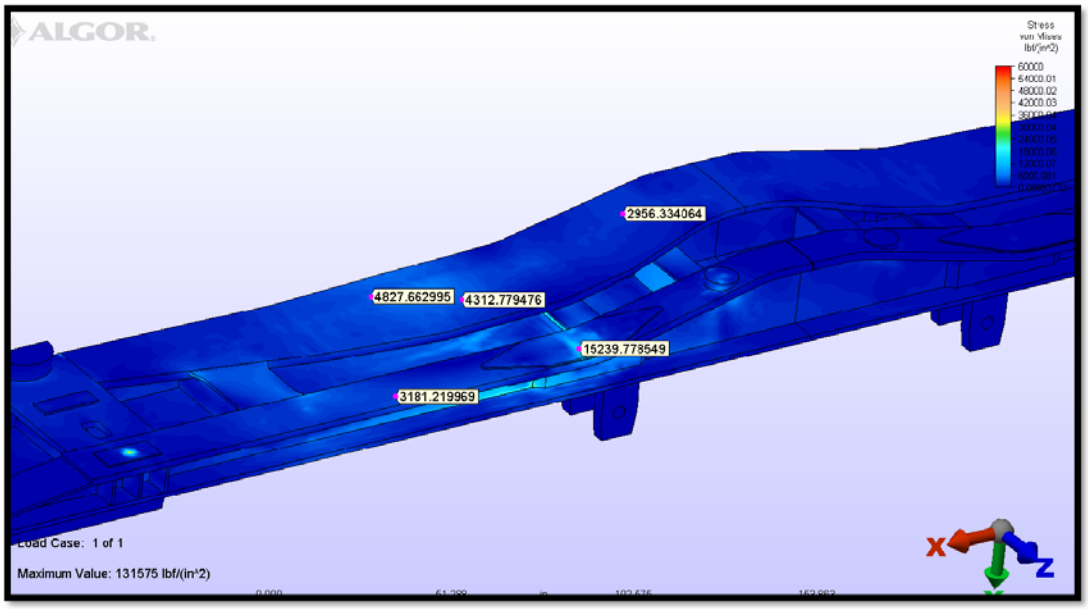
Dead Load Deflection:

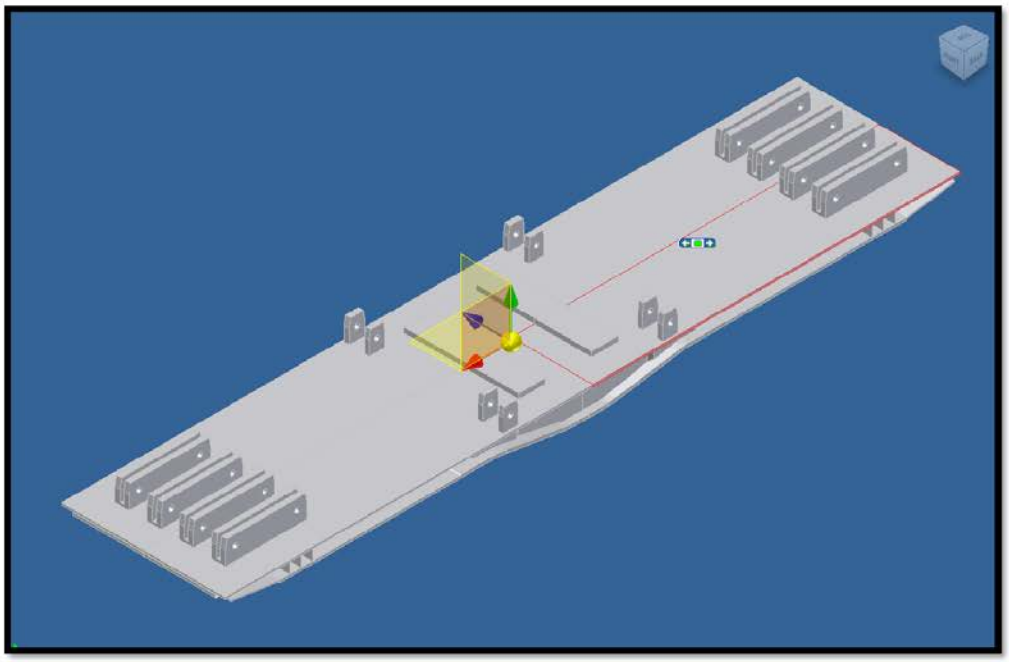


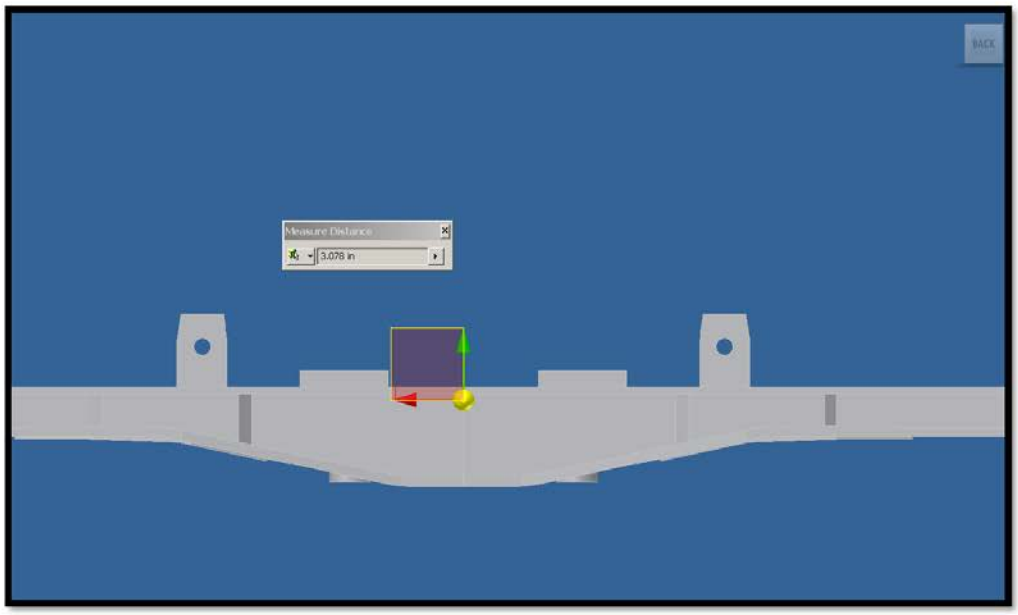
Jacking Load (HI-Star 180):




ALGOR
Stress
von Mises
lbf/(in^2)
60000
54000.01
48000.02
42000.03
36000.04
30000.04
24000.05
18000.06
12000.07
6000.091
0.00583732
3115.296209
19615.933007
2855.789040
16453.702132
Load Case: 1 of 1
Maximum Value: 131575 lbf/(in^2)
Minimum Value: 0.401518 lbf/(in^2)
0.000
36.467
in
72.934
109.401
Y
X


ALGOR
Stress
von Mises
lbf/(in^2)
60000
54000.01
48000.02
42000.03
2956.334064
4827.662995
4312.779476
15239.778549
3181.219969
Load Case: 1 of 1
Maximum Value: 131575 lbf/(in^2)
X
Z




Measure Distance
3.078 in
BACK

Maximum Vertical Load Location

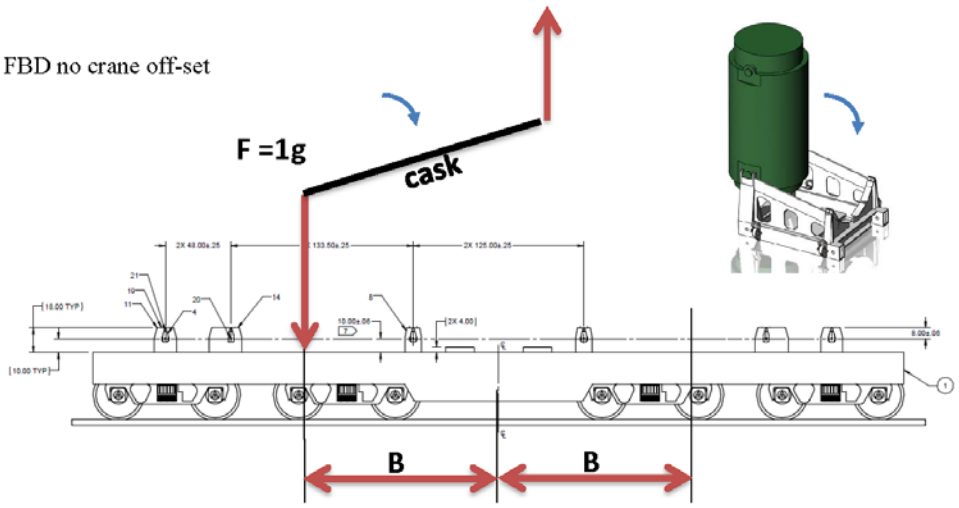
Slade Klein, Engineer, AFS

The maximum vertical loads and locations are shown in the table below:

Cask rotated on cradle	Load "F" on Railcar (lb.)	Horizontal distance "B" from load to center of railcar (in.)
TN-68	299,500	63.5
HI-STAR 60	234,400	67.56
NAC-STC	298,600	78.6
HI-STAR 180	371,347	81.75
NAC MAGNATRAN	356,000	89.3
NAC-UMS	299,000	89.3
TS-125	315,910	98

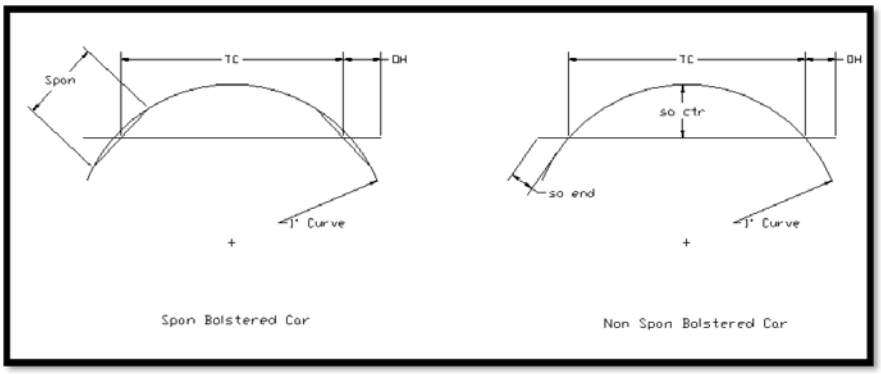
The dimensions are shown in the figure below for clarity. Note that the maximum vertical load could occur on either side of the railcar centerline at any location "B". The load "F" is applied in the vertical direction. There also can be some side load depending on the crane off-set applied.

FBD no crane off-set



The HI-Star 180 was analyzed in the unsymmetrical loading for worst case. Distances and weights are shown above. The model had all 4 jacking locations constrained in the vertical direction (8 in reality). A load factor of 1.8 was applied to the HI-Star 180 along with gravitational loads. Stress is all areas were rather low. Screen plots are shown on pages 31-32.

Swing Out:



Span = 21 ft

Truck Center = 38 ft

Over Hang = 5 ft

Swing out at center = 0.493 inches per degree of curvature

Swing out at ends = 0.110 inches per degree of curvature

Weight and Center of Gravity AREVA 12 Axle Cask Car (Loaded at 55.375 deck Height)

The CG of the Atlas Car body is separated into 5 sections listed below. Each section has its own CG and distance to the top of the rail. 34.6 inches is the CG while the car is fully loaded with the HI-Star 190. That is with spring and car body deflection.

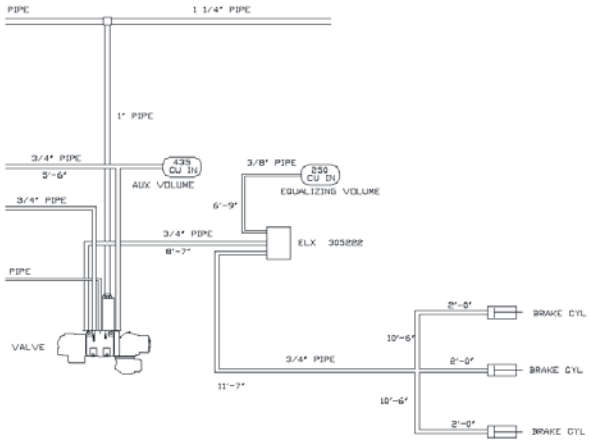
Item of Rail Car	Weight (lbs.)	Distance of CG to Rail (in.)	Weight * CG Distance
Car Body	83k	48.63	4036.29
Trucks	66k	18	1188
Spans	33k	32.8	1082.4
End Platforms	12k	40	480
Misc.	5k	18	90
Totals:	199k		6876.69
		CG Loaded:	34.6

Weight and Center of Gravity AREVA 12 Axle Cask Car (Unloaded with Car Body Fully Cambered 59.25 deck height)

Item of Rail Car	Weight (lbs.)	Distance of CG to Rail (in.)	Weight * CG Distance
Car Body	83k	51.0	4233
Trucks	66k	18	1188
Spans	33k	34.8	1148.4
End Platforms	12k	42	504
Misc.	5k	18	90
Totals:	199k		7225.65
		CG Unloaded:	35.9

These are the final estimated CG distances for the Atlas Cask Car loaded and unloaded. All distances are to the top of the rail. These final estimates will not impact the loaded, partially loaded and unloaded decks heights of the Atlas Cask Car.

Brake Schematic: (S-2043 4.7.7)



Brake equalization pressure: (S-2043 4.7.7)

KASGRO 12-AXLE FLAT
EQUALIZATION PRESSURE CALCULATOR
Aug-16

INPUT:

initial charge (psig)	reservoir volume (in3)	Aux reservoir (in3)	pipe brkt clear vol (in3)	clearance vol/cyl (in3)	cyl dia (in)	no. of cyls	piston travel (in)	3/8" pipe lenngth (ft)	1/2" brk cyl pipe lgth (ft)	3/4" brk cyl pipe lgth (ft)	1" brk cyl pipe lgth (ft)	1 1/4" brk cyl pipe lgth (ft)
90	2503	435	175	18	9	3	2.75	2	0	52.7	0	0

RESULTS:

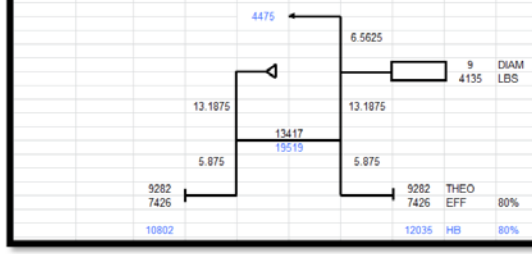
piston area (in2)	piston displ vol (in3)	bc pipe volume (in3)	qualization pressure (psi)
63.62	174.95	276.83	64.68

Note:
Clearance volume of relay valve and vent valve included n pipe bracket clearance volume above.

REQ'D EQUALIZATION 63.5 TO 66.5 PSI

BRAKE CYLINDER CLEARANCE VOLUMES

Type/size	in3	
TMX 7"	10.0	
TMX 8"	12.0	
TMX 9.25 "	14.0	
Elcon 7.5"	11.5	
Elcon 8.5"	13.0	
Elcon 9.5	18.0	est
Elcon 10"	25.5	
Thrall - # 36	?	
Thrall - # 50	44.0	
Thrall - # 60	73.0	
ABU 10x12"	18.0	
ABU 8.5x12"	215.0	



			ELLCON NATL TRUCK MTD BRAKE 340L MODIFIED FOR 9.5" DIA CYL				
			HAND BRAKE 33000				
GRL	789,000		LT WT =	199000		LIGHT WT WITH CASK =	716000 *
# OF AXLES	12						
HAND BRAKE FORCE		137,024	17.4%		>10%		
AIR BRAKE FORCE		89107	11.3%		11-13%		
EMPTY CAR RATIO AT 30 PSI REDUCTION			26.7%				
S-2043 REQUIREMENT AT 30 PSI REDUCTION	*		12.4%		<28%	S-2043 REQUIREMENT	

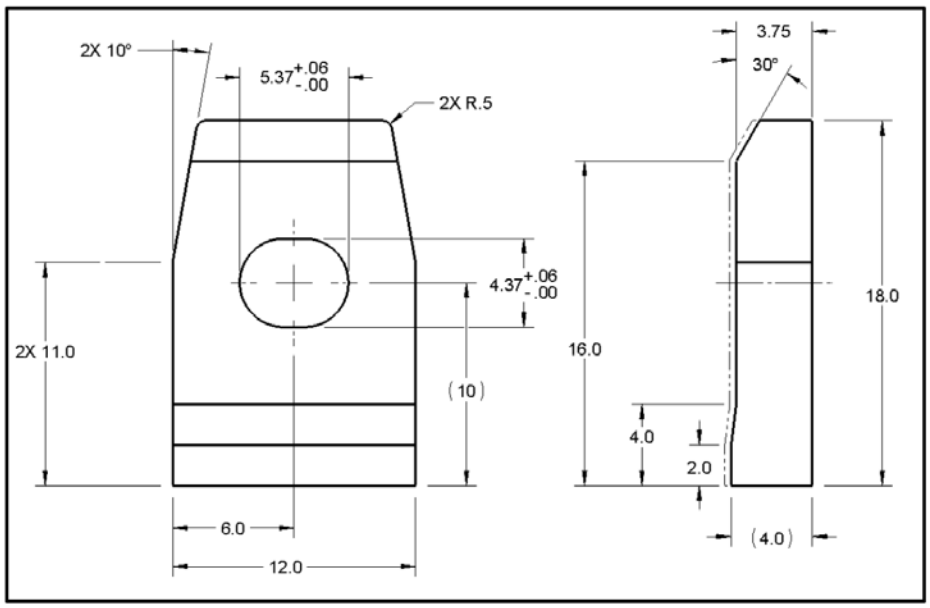


Figure 5-1: Center Pin Attachment Block

S-2043 (4.1.8.1) Loads provided from Areva.

Vertical Load Weld Calculations on Pin Attachments:

All attachments are to be welded to the deck plate.

Assuming 100 % Weld Lateral Load = 611kip Vertical Load = 312 kip
Stress from Doc./Rev.: Calc-3015276-002 (Rule 88 A.15.c)

Tensile = 3.50 ksi

Shear = 13.2 ksi

Bending = 26.3 ksi

Combined = 37.6 ksi < 50 ksi

Stress from Doc./Rev.: Calc-3015276-002 (10 CFR 71.45)

Tensile = 3.50 ksi

Shear = 13.2 (5/2) = 33 ksi

Bending = 26.3 (5/2) = 65.75 ksi

Combined = 89.8 ksi > 65 ksi

From the stress results listed above, 100% penetration weld will be required on all attachments to the railcar deck plate.

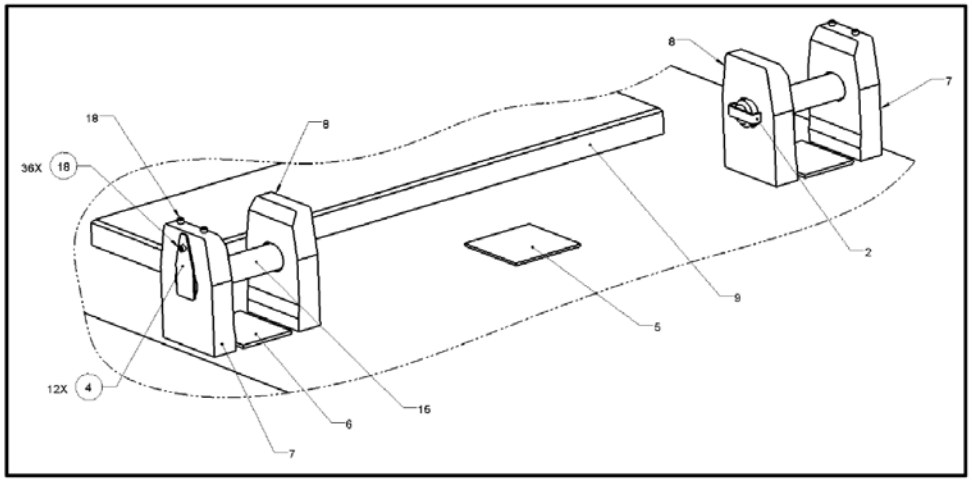


Figure 5-2: Shear Blocks

Shear Block Weld Calculations:

All attachments are to be welded to the deck plate.

Longitudinal Load 2,921 kips

Length of shear block = (21in + 90 in) 2 = 222 inches

q = P/L = 2921 kip / 222 inches = 13.2 k/in (Rule 88 A.15.c)

q = P (10/7.5)/L = 2921 kip (10/7.5) / 222 inches = 17.5 k/in (10 CFR 71.45)

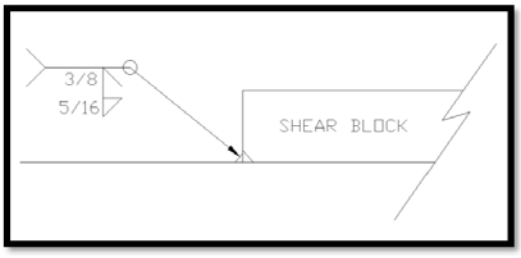
Throat size for bevel and fillet weld shown below:

Throat = $((5/16)^2 + (3/8)^2)^{1/2}$ = 0.49

(0.49) (33.06) =16.2 k/in

16.2 k/in > 13.2 k/in (Rule 88 A.15.c)

16.2 k/in < 17.5 k/in (10 CFR 71.45)



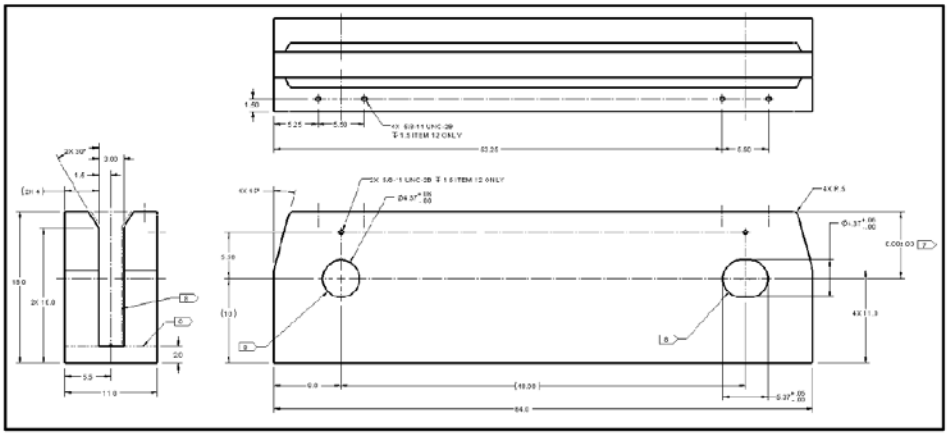


Figure 5-9: Outer Pin Attachment Block

Outer Pin Block Attachment Weld Calculations: (10 CFR 71.45)

All attachments are to be welded to the deck plate.

Longitudinal Load 944 (10/7.5) =1258.7 kip

Vertical Loads 1077 kip

The moment was taken about the CG of the weld.

t = thickness of weld

Moment = 1258.7 kip (10 in) + 2 1077 kip (24 in) = 64,283 in-k

A= (128 + 22) t = 150 t

I_{yy} = 1/12 (2) $(64in)^3$ t + 2 (11 in) t $(32 in)^2$

I = 43690t + 22528t = 66218t

S = (t)66218/ 32 = 2069.3t

F' = 1258.7/150t = 8.4/t

F" = M/S = 64,283/2069.3=31.07/t

F = $((8.4/t)^2 + (31.07/t)^2)^{1/2}$ = 32.2/t

32.2/33.06 = t = 0.97 which is required

7/8" bevel with 3/8" fillet = t = $((7/8)^2 + (3/8)^2)^{1/2}$ = 0.95 in < 0.97 required to fail. (10 CFR 71.45)

Outer Pin Block Attachment Weld Calculations: (Rule 88 A.15.c)

All attachments are to be welded to the deck plate.

Longitudinal Load 944 kip

Vertical Loads 1077 kip

The moment was taken about the CG of the weld.

t = thickness of weld

Moment = 944 kip (10 in) + 2 (1077 kip) (24 in) = 61,136 in-k

A= (128 + 22) t = 150 t

I_{yy} =1/12 (2) $(64in)^3$ t + 2 (11 in) t $(32 in)^2$

I = 43690t + 22528t = 66218t

S = (t)66218/ 32 = 2069.3t

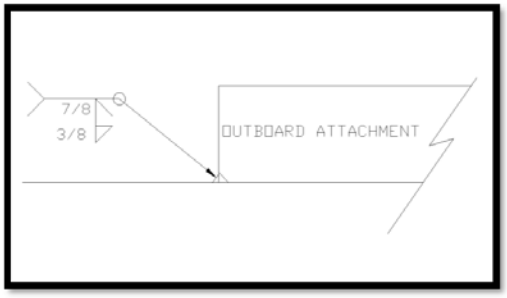
F' = 944/150t = 6.3/t

F" = M/S = 61,136/2069.3t = 29.54/t

F = $((6.3/t)^2 + (29.54/t)^2)^{1/2}$ = 30.2/t

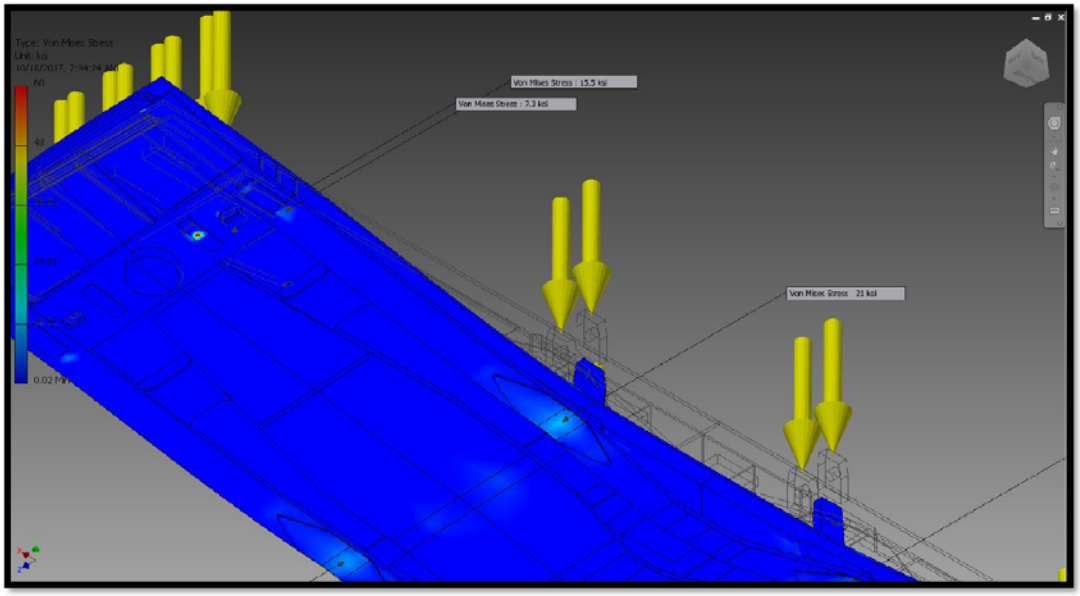
30.2/33.06 = t = 0.91 which is required

7/8" bevel with 3/8" fillet = t = $((7/8)^2 + (3/8)^2)^{1/2}$ = 0.95 in > 0.91 which is required (Rule 88 A.15.c)



Twist Load:

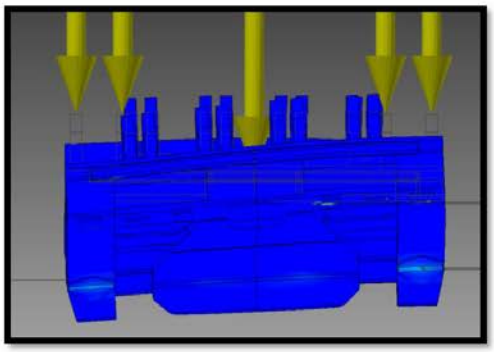
(AAR M-1001 11.3.3.5) (S-2043 4.1.5.5)



The twist load was analyzed by applying a fixed vertical constraint on one side bearing pad of the car body A-End while constraining the B-End of the car body's center plate. This is to simulate a vertical jacking load applied to a truck at one end of the car. The force flow will go through the Tri-Span body side bearing to the car body side bearing causing the car structure to twist. The HI-Star 190 load was applied to the inboard load attachments considering that it is the max vertical load on the car. The end stop load was applied to the outboard attachments just like the other FEA models.

The twist load FEA was performed in Autodesk Inventor Professional 2014.

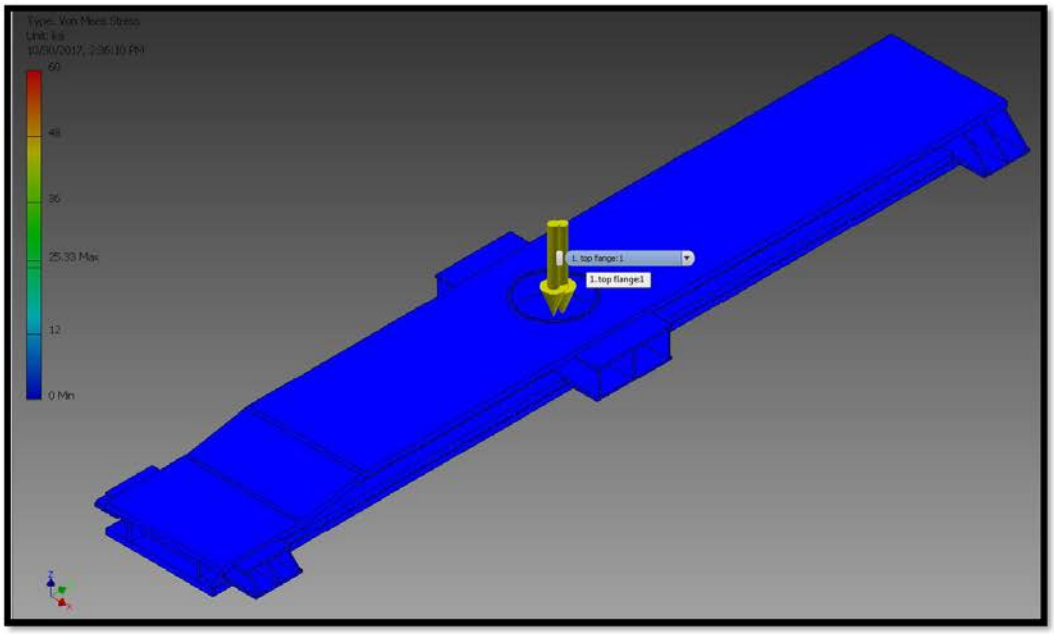
Car Body Twist View:

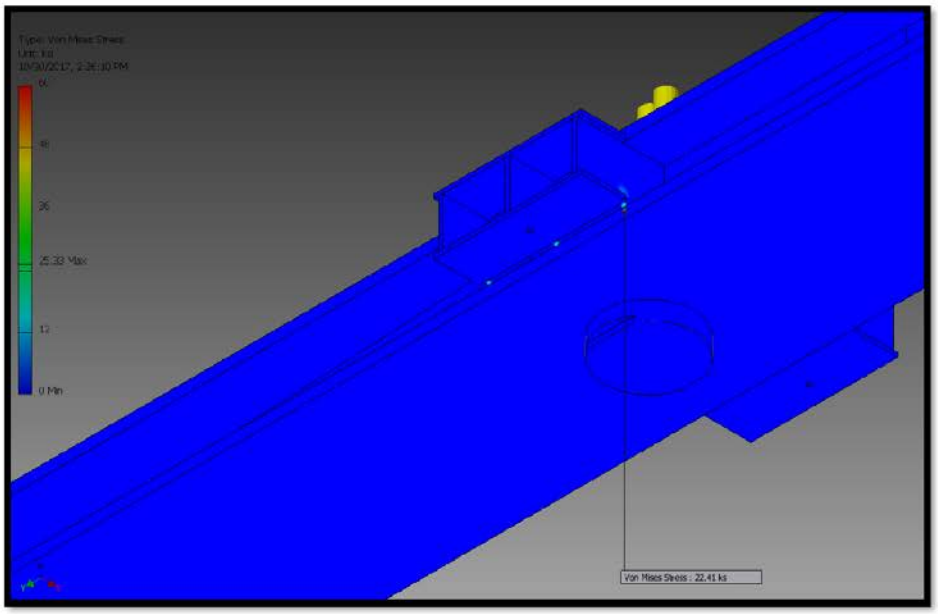


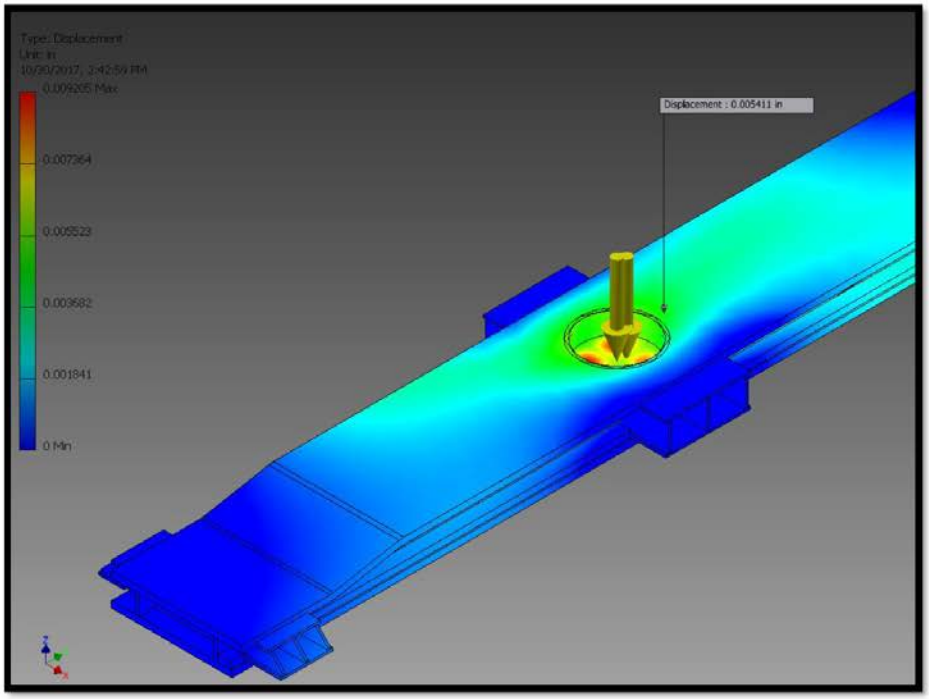
Twist Load: Tri-Span

(AAR M-1001 11.3.3.5) (S-2043 4.1.5.5)

The Tri-Span twist load was analyzed by applying a vertical constraint on one side bearing pad on the left side of the span. The right side of the span had all three side bearing plates constrained vertically. A Live Load of 300,000 lbs. was applied at the center plate bowl. The Tri-Span is made of A-572 Grade 60 material. The max stress was roughly 25 ksi.

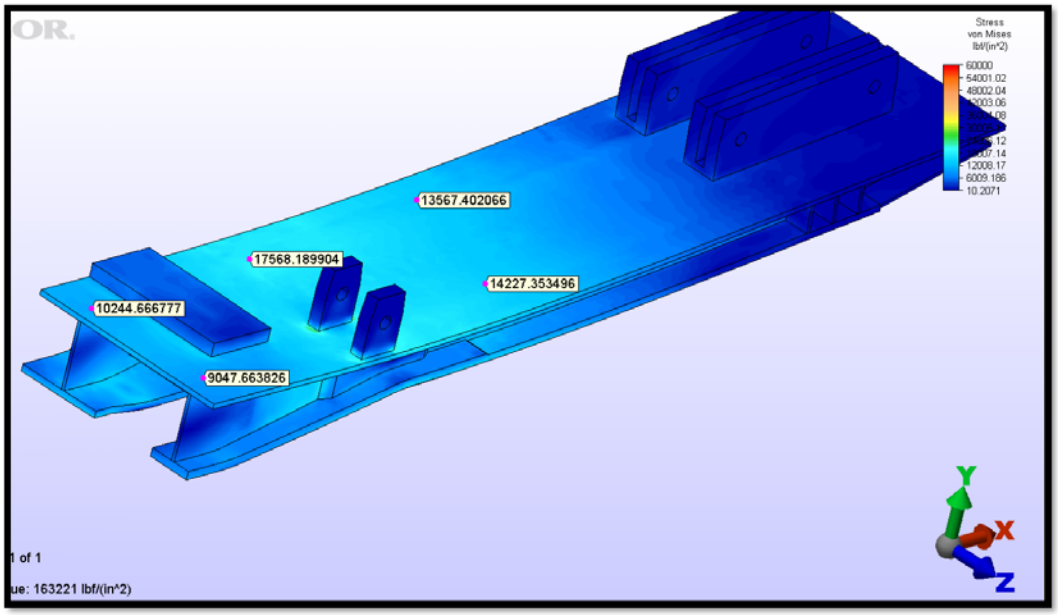


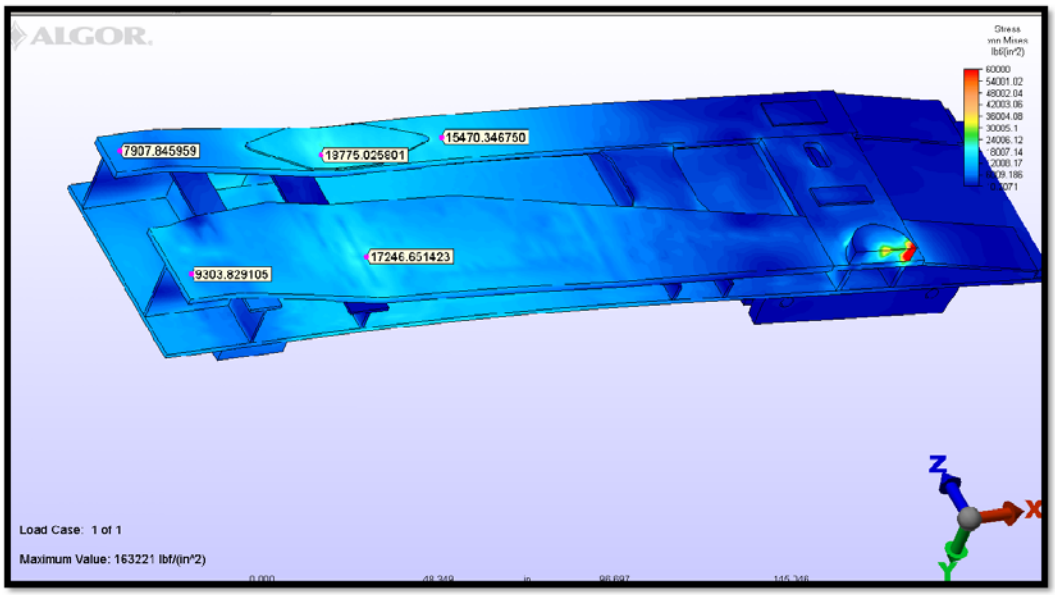

Type: Von Mises Stress
Unit: ksi
10/30/2017, 2:26:10 PM
26
25.33 Max
12
0 Min
Von Mises Stress : 22.41 ks


Type: Displacement
Unit: in
10/30/2017, 2:42:59 PM
0.009205 Max
0.007364
0.005523
0.003682
0.001841
0 Min
Displacement : 0.005411 in

Impact Load: (M-1001 4.1.10) (S-2043 4.1.5.8)

The Atlas railcar is equipped with an EOC cushioning unit with 15 inches of travel. Table 4.3 structural requirements for EOC-equipped cars states length of travel greater than 14 inches requires a coupler force of 600,000 lbs. to be applied.

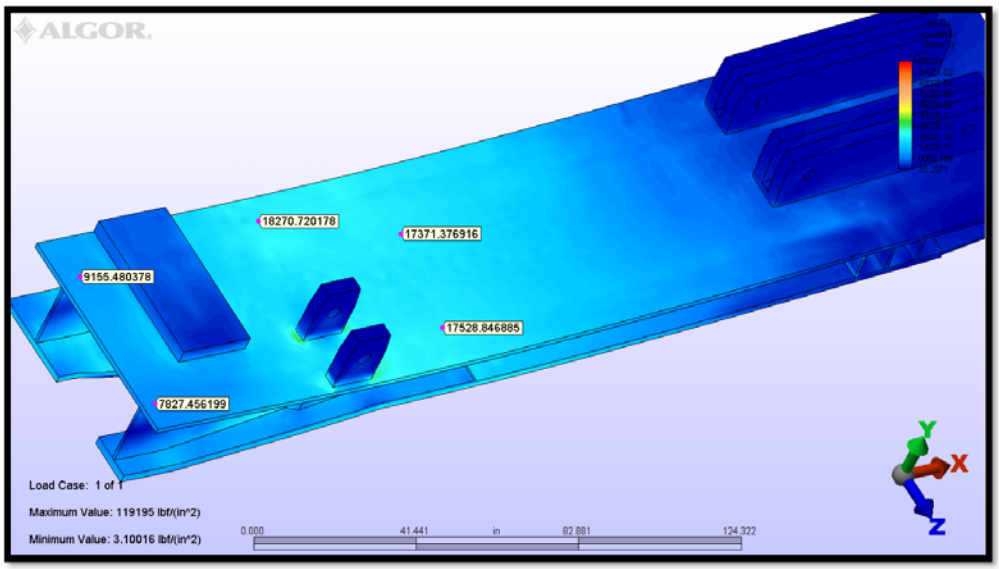


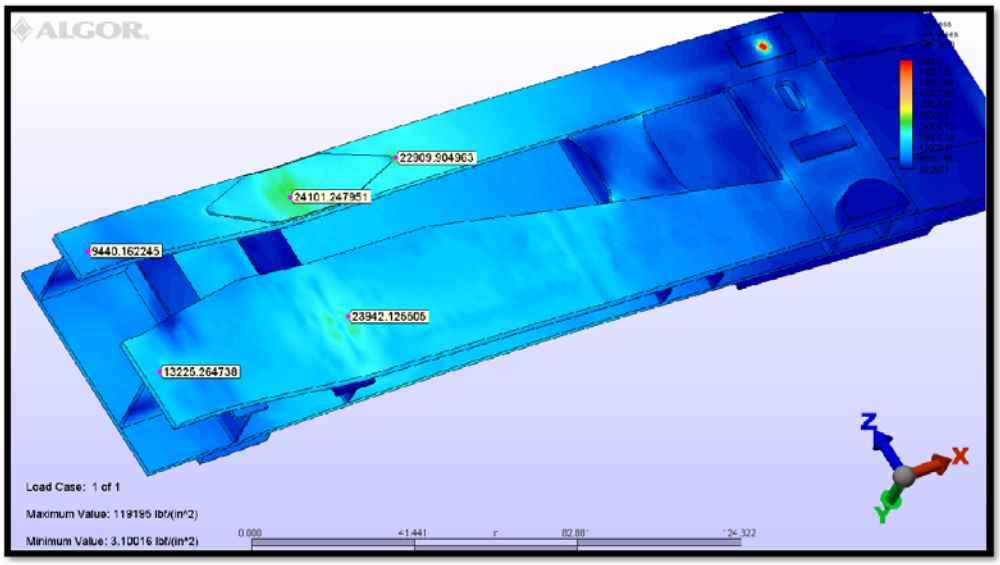


Jacking Load:

(M-1001 4.1.6) (S-2043 4.1.5.4)

A vertical constraint was applied at the car body jacking pad. This is to simulate jacks placed under the portion of the car extending outside of the rails. The car was fully loaded with the HI Star 190 applied to the inboard attachments with the end stops applied at the outboard attachments.





Vertical Loads on Coupler:

(M-1001 4.1.5) (S-2043 4.1.5.3)

The Vertical loads on coupler have been tested and proven on the M-290 by TTCI. No further analysis has been done.

S-234 Lifting Freight Cars

M-1001 4.1.6 & Office Manual Rule 88.C.3.c (10) (B)

Lifting loading analysis is the same as Jacking. Provisions are detailed into the car body to allow the AAR standard hook to be attached to the underside of the car body bolster. Local deformation will occur if the car is lifted no gross yielding of the overall structure will happen.

Fatigue Introduction:

Fatigue Analysis is based on the AAR METHOD AS DOCUMENTED IN THE MSRP Section C, Part II.

The spreadsheet is based on the AAR method as shown in Table 7.1 and Table 7.2 of the above referenced specification. No data is published for a general service flat car with a steel deck. In lieu of this the data for a high-sided gondola is used.

The only area examined was the center sill bottom flange splice. This will give a more conservative result than the side sill spice because of the nominal stress. The bolster has relatively low nominal stresses and is similar in design as other general service flat cars in use.

Stresses used are from the FEA. The car is fully loaded with the HI-Star 190 and end stops.

FATIGUE DATA FOR CENTER SILL AT SPLICE

(Coupler Load 110 Ton High-sided Gon)

Max	Min	No.	α Pct	Static Stress	Dynamic Stress Max	Dynamic Stress Min	Max Adjusted	R Min/Max	Endurance Limit	Cycles to Failure N	α/N		
												cycles per mile	153.8
												Yield stress	60 ksi
												Y-int (b)	17.1
												slope	1
												k	0.29
430	-250	1	0.00007	18.3	23.1	15.5	23.1	0.672	52.1	NO DAMAGE			
410	390	1	0.00007	18.3	22.9	22.6	22.9	0.990	1754.7	NO DAMAGE			
410	310	1	0.00007	18.3	22.9	21.8	22.9	0.951	350.9	NO DAMAGE			
395	365	2	0.00015	18.3	22.7	22.4	22.7	0.985	1161.3	NO DAMAGE			
385	365	1	0.00007	18.3	22.6	22.4	22.6	0.990	1733.3	NO DAMAGE			
380	250	1	0.00007	18.3	22.5	21.1	22.5	0.936	266.0	NO DAMAGE			
380	300	1	0.00007	18.3	22.3	21.6	22.3	0.970	570.7	NO DAMAGE			
380	290	1	0.00007	18.3	22.3	21.5	22.3	0.965	489.1	NO DAMAGE			
380	-130	1	0.00007	18.3	22.3	16.9	22.3	0.755	69.9	NO DAMAGE			
380	-230	1	0.00007	18.3	22.3	15.7	22.3	0.705	58.0	NO DAMAGE			
350	220	1	0.00007	18.3	22.2	20.8	22.2	0.935	262.1	NO DAMAGE			
350	-230	1	0.00007	18.3	22.2	15.7	22.2	0.709	58.7	NO DAMAGE			
340	320	3	0.00022	18.3	22.1	21.9	22.1	0.990	1694.9	NO DAMAGE			
340	-120	1	0.00007	18.3	22.1	17.0	22.1	0.768	73.7	NO DAMAGE			
340	-150	1	0.00007	18.3	22.1	16.6	22.1	0.753	69.2	NO DAMAGE			
330	-120	1	0.00007	18.3	22.0	17.0	22.0	0.772	74.9	NO DAMAGE			
320	310	2	0.00015	18.3	21.9	21.8	21.9	0.995	3355.5	NO DAMAGE			
320	250	1	0.00007	18.3	21.9	21.1	21.9	0.964	479.4	NO DAMAGE			
310	290	2	0.00015	18.3	21.8	21.5	21.8	0.990	1669.2	NO DAMAGE			
310	-210	1	0.00007	18.3	21.8	16.0	21.8	0.734	64.2	NO DAMAGE			
310	-290	1	0.00007	18.3	21.8	15.1	21.8	0.693	55.6	NO DAMAGE			
280	-210	1	0.00007	18.3	21.4	16.0	21.4	0.745	67.1	NO DAMAGE			
270	200	1	0.00007	18.3	21.3	20.5	21.3	0.963	467.1	NO DAMAGE			
270	110	1	0.00007	18.3	21.3	19.5	21.3	0.916	204.4	NO DAMAGE			
270	100	1	0.00007	18.3	21.3	19.4	21.3	0.911	192.4	NO DAMAGE			
270	-10	1	0.00007	18.3	21.3	18.2	21.3	0.854	116.8	NO DAMAGE			
270	-80	1	0.00007	18.3	21.3	17.4	21.3	0.817	93.4	NO DAMAGE			
265	-255	1	0.00007	18.3	21.3	15.5	21.3	0.727	62.7	NO DAMAGE			
260	220	2	0.00015	18.3	21.2	20.8	21.2	0.979	813.2	NO DAMAGE			
260	20	1	0.00007	18.3	21.2	18.5	21.2	0.874	135.5	NO DAMAGE			
260	-150	1	0.00007	18.3	21.2	16.6	21.2	0.784	79.3	NO DAMAGE			
260	-220	1	0.00007	18.3	21.2	15.8	21.2	0.748	67.8	NO DAMAGE			
260	-240	1	0.00007	18.3	21.2	15.6	21.2	0.737	65.1	NO DAMAGE			
260	-260	1	0.00007	18.3	21.2	15.4	21.2	0.727	62.6	NO DAMAGE			
250	240	1	0.00007	18.3	21.1	21.0	21.1	0.995	3235.8	NO DAMAGE			
250	230	9	0.00067	18.3	21.1	20.9	21.1	0.989	1617.9	NO DAMAGE			
250	220	2	0.00015	18.3	21.1	20.8	21.1	0.984	1078.6	NO DAMAGE			
250	190	1	0.00007	18.3	21.1	20.4	21.1	0.968	539.3	NO DAMAGE			
250	90	1	0.00007	18.3	21.1	19.3	21.1	0.915	202.2	NO DAMAGE			
250	-50	1	0.00007	18.3	21.1	17.7	21.1	0.841	107.9	NO DAMAGE			
250	-100	1	0.00007	18.3	21.1	17.2	21.1	0.815	92.5	NO DAMAGE			
250	-160	1	0.00007	18.3	21.1	16.5	21.1	0.783	78.9	NO DAMAGE			
250	-180	1	0.00007	18.3	21.1	16.3	21.1	0.773	75.3	NO DAMAGE			
250	-220	1	0.00007	18.3	21.1	15.8	21.1	0.752	68.8	NO DAMAGE			
250	-410	1	0.00007	18.3	21.1	13.7	21.1	0.651	49.0	36700336	2.72E-10		
245	225	1	0.00007	18.3	21.0	20.8	21.0	0.989	1613.6	NO DAMAGE			
245	155	1	0.00007	18.3	21.0	20.0	21.0	0.952	358.6	NO DAMAGE			
245	-315	1	0.00007	18.3	21.0	14.8	21.0	0.703	57.6	NO DAMAGE			
240	230	5	0.00037	18.3	21.0	20.9	21.0	0.995	3218.7	NO DAMAGE			
240	220	2	0.00015	18.3	21.0	20.8	21.0	0.989	1609.4	NO DAMAGE			
240	210	2	0.00015	18.3	21.0	20.6	21.0	0.984	1072.9	NO DAMAGE			
240	180	1	0.00007	18.3	21.0	20.3	21.0	0.968	536.5	NO DAMAGE			
240	140	1	0.00007	18.3	21.0	19.9	21.0	0.947	321.9	NO DAMAGE			
240	110	1	0.00007	18.3	21.0	19.5	21.0	0.931	247.6	NO DAMAGE			
240	70	1	0.00007	18.3	21.0	19.1	21.0	0.910	189.3	NO DAMAGE			
240	-70	1	0.00007	18.3	21.0	17.5	21.0	0.835	103.8	NO DAMAGE			
240	-110	1	0.00007	18.3	21.0	17.1	21.0	0.814	92.0	NO DAMAGE			
240	-120	1	0.00007	18.3	21.0	17.0	21.0	0.809	89.4	NO DAMAGE			
240	-160	1	0.00007	18.3	21.0	16.5	21.0	0.787	80.5	NO DAMAGE			
240	-170	1	0.00007	18.3	21.0	16.4	21.0	0.782	78.5	NO DAMAGE			
240	-210	1	0.00007	18.3	21.0	16.0	21.0	0.761	71.5	NO DAMAGE			
240	-240	1	0.00007	18.3	21.0	15.6	21.0	0.745	67.1	NO DAMAGE			
235	225	13	0.00097	18.3	20.9	20.8	20.9	0.995	3210.2	NO DAMAGE			
235	215	9	0.00067	18.3	20.9	20.7	20.9	0.989	1605.1	NO DAMAGE			
230	220	2	0.00015	18.3	20.9	20.8	20.9	0.995	3201.6	NO DAMAGE			
230	200	2	0.00015	18.3	20.9	20.5	20.9	0.984	1067.2	NO DAMAGE			
230	190	2	0.00015	18.3	20.9	20.4	20.9	0.979	800.4	NO DAMAGE			
230	170	1	0.00007	18.3	20.9	20.2	20.9	0.968	533.6	NO DAMAGE			
230	-10	1	0.00007	18.3	20.9	18.2	20.9	0.872	133.4	NO DAMAGE			
230	-90	1	0.00007	18.3	20.9	17.3	20.9	0.829	100.1	NO DAMAGE			
230	-110	1	0.00007	18.3	20.9	17.1	20.9	0.818	94.2	NO DAMAGE			
230	-160	1	0.00007	18.3	20.9	16.5	20.9	0.792	82.1	NO DAMAGE			
230	-180	1	0.00007	18.3	20.9	16.3	20.9	0.781	78.1	NO DAMAGE			
230	-200	1	0.00007	18.3	20.9	16.1	20.9	0.770	74.5	NO DAMAGE			
230	-205	1	0.00007	18.3	20.9	16.0	20.9	0.768	73.6	NO DAMAGE			
230	-260	1	0.00007	18.3	20.9	15.4	20.9	0.738	65.3	NO DAMAGE			
230	-270	1	0.00007	18.3	20.9	15.3	20.9	0.733	64.0	NO DAMAGE			
225	215	22	0.00164	18.3	20.8	20.7	20.8	0.995	3193.1	NO DAMAGE			
225	205	8	0.00060	18.3	20.8	20.6	20.8	0.989	1596.5	NO DAMAGE			
225	-385	1	0.00007	18.3	20.8	14.0	20.8	0.673	52.3	NO DAMAGE			
220	210	10	0.00075	18.3	20.8	20.6	20.8	0.995	3184.5	NO DAMAGE			
220	200	6	0.00045	18.3	20.8	20.5	20.8	0.989	1592.3	NO DAMAGE			
220	190	4	0.00030	18.3	20.8	20.4	20.8	0.984	1061.5	NO DAMAGE			
220	180	2	0.00015	18.3	20.8	20.3	20.8	0.979	796.1	NO DAMAGE			
220	170	3	0.00022	18.3	20.8	20.2	20.8	0.973	636.9	NO DAMAGE			
220	150	1	0.00007	18.3	20.8	20.0	20.8	0.962	454.9	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
220	140	1	0.00007	18.3	20.8	19.9	20.8	0.957	398.1	NO DAMAGE			
220	130	1	0.00007	18.3	20.8	19.7	20.8	0.952	353.8	NO DAMAGE			
220	70	1	0.00007	18.3	20.8	19.1	20.8	0.919	212.3	NO DAMAGE			
220	30	1	0.00007	18.3	20.8	18.6	20.8	0.898	167.6	NO DAMAGE			
220	-70	1	0.00007	18.3	20.8	17.5	20.8	0.844	109.8	NO DAMAGE			
220	-90	1	0.00007	18.3	20.8	17.3	20.8	0.834	102.7	NO DAMAGE			
220	-110	1	0.00007	18.3	20.8	17.1	20.8	0.823	96.5	NO DAMAGE			
220	-130	1	0.00007	18.3	20.8	16.9	20.8	0.812	91.0	NO DAMAGE			
220	-135	1	0.00007	18.3	20.8	16.8	20.8	0.809	89.7	NO DAMAGE			
220	-180	3	0.00022	18.3	20.8	16.3	20.8	0.785	79.6	NO DAMAGE			
220	-190	1	0.00007	18.3	20.8	16.2	20.8	0.780	77.7	NO DAMAGE			
220	-220	2	0.00015	18.3	20.8	15.8	20.8	0.764	72.4	NO DAMAGE			
220	-230	1	0.00007	18.3	20.8	15.7	20.8	0.758	70.8	NO DAMAGE			
215	205	14	0.00104	18.3	20.7	20.6	20.7	0.995	3176.0	NO DAMAGE			
215	195	32	0.00239	18.3	20.7	20.5	20.7	0.989	1588.0	NO DAMAGE			
215	185	1	0.00007	18.3	20.7	20.4	20.7	0.984	1058.7	NO DAMAGE			
215	165	2	0.00015	18.3	20.7	20.1	20.7	0.973	635.2	NO DAMAGE			
215	-175	1	0.00007	18.3	20.7	16.4	20.7	0.790	81.4	NO DAMAGE			
215	-225	2	0.00015	18.3	20.7	15.8	20.7	0.763	72.2	NO DAMAGE			
215	-325	1	0.00007	18.3	20.7	14.7	20.7	0.709	58.8	NO DAMAGE			
210	200	12	0.00089	18.3	20.6	20.5	20.6	0.995	3167.4	NO DAMAGE			
210	190	17	0.00127	18.3	20.6	20.4	20.6	0.989	1583.7	NO DAMAGE			
210	180	13	0.00097	18.3	20.6	20.3	20.6	0.984	1055.8	NO DAMAGE			
210	170	2	0.00015	18.3	20.6	20.2	20.6	0.978	791.9	NO DAMAGE			
210	160	1	0.00007	18.3	20.6	20.1	20.6	0.973	633.5	NO DAMAGE			
210	130	1	0.00007	18.3	20.6	19.7	20.6	0.957	395.9	NO DAMAGE			
210	70	1	0.00007	18.3	20.6	19.1	20.6	0.924	226.2	NO DAMAGE			
210	60	1	0.00007	18.3	20.6	19.0	20.6	0.919	211.2	NO DAMAGE			
210	30	1	0.00007	18.3	20.6	18.6	20.6	0.903	176.0	NO DAMAGE			
210	20	1	0.00007	18.3	20.6	18.5	20.6	0.897	166.7	NO DAMAGE			
210	10	1	0.00007	18.3	20.6	18.4	20.6	0.892	158.4	NO DAMAGE			
210	-10	2	0.00015	18.3	20.6	18.2	20.6	0.881	144.0	NO DAMAGE			
210	-30	1	0.00007	18.3	20.6	18.0	20.6	0.870	132.0	NO DAMAGE			
210	-90	1	0.00007	18.3	20.6	17.3	20.6	0.838	105.6	NO DAMAGE			
210	-130	2	0.00015	18.3	20.6	16.9	20.6	0.816	93.2	NO DAMAGE			
210	-150	5	0.00037	18.3	20.6	16.6	20.6	0.806	88.0	NO DAMAGE			
210	-160	1	0.00007	18.3	20.6	16.5	20.6	0.800	85.6	NO DAMAGE			
210	-190	1	0.00007	18.3	20.6	16.2	20.6	0.784	79.2	NO DAMAGE			
210	-200	2	0.00015	18.3	20.6	16.1	20.6	0.779	77.3	NO DAMAGE			
210	-210	1	0.00007	18.3	20.6	16.0	20.6	0.773	75.4	NO DAMAGE			
210	-220	2	0.00015	18.3	20.6	15.8	20.6	0.768	73.7	NO DAMAGE			
210	-230	1	0.00007	18.3	20.6	15.7	20.6	0.762	72.0	NO DAMAGE			
205	195	56	0.00417	18.3	20.6	20.5	20.6	0.995	3158.9	NO DAMAGE			
205	185	48	0.00358	18.3	20.6	20.4	20.6	0.989	1579.4	NO DAMAGE			
205	180	2	0.00015	18.3	20.6	20.3	20.6	0.986	1263.6	NO DAMAGE			
205	175	11	0.00082	18.3	20.6	20.3	20.6	0.984	1053.0	NO DAMAGE			
205	165	2	0.00015	18.3	20.6	20.1	20.6	0.978	789.7	NO DAMAGE			
205	155	1	0.00007	18.3	20.6	20.0	20.6	0.973	631.8	NO DAMAGE			
205	150	1	0.00007	18.3	20.6	20.0	20.6	0.970	574.3	NO DAMAGE			
205	140	1	0.00007	18.3	20.6	19.9	20.6	0.965	486.0	NO DAMAGE			
205	135	1	0.00007	18.3	20.6	19.8	20.6	0.962	451.3	NO DAMAGE			
205	-85	1	0.00007	18.3	20.6	17.4	20.6	0.843	108.9	NO DAMAGE			
205	-115	1	0.00007	18.3	20.6	17.0	20.6	0.827	98.7	NO DAMAGE			
205	-165	1	0.00007	18.3	20.6	16.5	20.6	0.800	85.4	NO DAMAGE			
205	-180	1	0.00007	18.3	20.6	16.3	20.6	0.792	82.0	NO DAMAGE			
205	-195	1	0.00007	18.3	20.6	16.1	20.6	0.783	79.0	NO DAMAGE			
205	-210	1	0.00007	18.3	20.6	16.0	20.6	0.775	76.1	NO DAMAGE			
205	-220	1	0.00007	18.3	20.6	15.8	20.6	0.770	74.3	NO DAMAGE			
205	-235	1	0.00007	18.3	20.6	15.7	20.6	0.762	71.8	NO DAMAGE			
205	-245	1	0.00007	18.3	20.6	15.6	20.6	0.756	70.2	NO DAMAGE			
205	-285	2	0.00015	18.3	20.6	15.1	20.6	0.735	64.5	NO DAMAGE			
200	190	37	0.00276	18.3	20.5	20.4	20.5	0.995	3150.3	NO DAMAGE			
200	185	11	0.00082	18.3	20.5	20.4	20.5	0.992	2100.2	NO DAMAGE			
200	180	48	0.00358	18.3	20.5	20.3	20.5	0.989	1575.2	NO DAMAGE			
200	175	2	0.00015	18.3	20.5	20.3	20.5	0.986	1260.1	NO DAMAGE			
200	170	22	0.00164	18.3	20.5	20.2	20.5	0.984	1050.1	NO DAMAGE			
200	165	3	0.00022	18.3	20.5	20.1	20.5	0.981	900.1	NO DAMAGE			
200	160	10	0.00075	18.3	20.5	20.1	20.5	0.978	787.6	NO DAMAGE			
200	155	2	0.00015	18.3	20.5	20.0	20.5	0.976	700.1	NO DAMAGE			
200	150	3	0.00022	18.3	20.5	20.0	20.5	0.973	630.1	NO DAMAGE			
200	140	4	0.00030	18.3	20.5	19.9	20.5	0.967	525.1	NO DAMAGE			
200	135	2	0.00015	18.3	20.5	19.8	20.5	0.965	484.7	NO DAMAGE			
200	110	1	0.00007	18.3	20.5	19.5	20.5	0.951	350.0	NO DAMAGE			
200	100	2	0.00015	18.3	20.5	19.4	20.5	0.946	315.0	NO DAMAGE			
200	60	1	0.00007	18.3	20.5	19.0	20.5	0.924	225.0	NO DAMAGE			
200	30	1	0.00007	18.3	20.5	18.6	20.5	0.908	185.3	NO DAMAGE			
200	20	2	0.00015	18.3	20.5	18.5	20.5	0.902	175.0	NO DAMAGE			
200	0	1	0.00007	18.3	20.5	18.3	20.5	0.891	157.5	NO DAMAGE			
200	-80	2	0.00015	18.3	20.5	17.4	20.5	0.848	112.5	NO DAMAGE			
200	-100	1	0.00007	18.3	20.5	17.2	20.5	0.837	105.0	NO DAMAGE			
200	-110	1	0.00007	18.3	20.5	17.1	20.5	0.832	101.6	NO DAMAGE			
200	-130	2	0.00015	18.3	20.5	16.9	20.5	0.821	95.5	NO DAMAGE			
200	-135	1	0.00007	18.3	20.5	16.8	20.5	0.818	94.0	NO DAMAGE			
200	-150	1	0.00007	18.3	20.5	16.6	20.5	0.810	90.0	NO DAMAGE			
200	-170	1	0.00007	18.3	20.5	16.4	20.5	0.799	85.1	NO DAMAGE			
200	-180	1	0.00007	18.3	20.5	16.3	20.5	0.794	82.9	NO DAMAGE			
200	-220	2	0.00015	18.3	20.5	15.8	20.5	0.772	75.0	NO DAMAGE			
200	-240	1	0.00007	18.3	20.5	15.6	20.5	0.761	71.6	NO DAMAGE			
200	-260	2	0.00015	18.3	20.5	15.4	20.5	0.750	68.5	NO DAMAGE			
200	-265	1	0.00007	18.3	20.5	15.3	20.5	0.748	67.7	NO DAMAGE			
195	185	174	0.01297	18.3	20.5	20.4	20.5	0.995	3141.8	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
195	180	10	0.00075	18.3	20.5	20.3	20.5	0.992	2094.5	NO DAMAGE			
195	175	103	0.00768	18.3	20.5	20.3	20.5	0.989	1570.9	NO DAMAGE			
195	170	6	0.00045	18.3	20.5	20.2	20.5	0.986	1256.7	NO DAMAGE			
195	165	30	0.00224	18.3	20.5	20.1	20.5	0.984	1047.3	NO DAMAGE			
195	160	5	0.00037	18.3	20.5	20.1	20.5	0.981	897.7	NO DAMAGE			
195	155	21	0.00157	18.3	20.5	20.0	20.5	0.978	785.4	NO DAMAGE			
195	150	2	0.00015	18.3	20.5	20.0	20.5	0.976	698.2	NO DAMAGE			
195	145	4	0.00030	18.3	20.5	19.9	20.5	0.973	628.4	NO DAMAGE			
195	140	3	0.00022	18.3	20.5	19.9	20.5	0.970	571.2	NO DAMAGE			
195	135	3	0.00022	18.3	20.5	19.8	20.5	0.967	523.6	NO DAMAGE			
195	125	1	0.00007	18.3	20.5	19.7	20.5	0.962	448.8	NO DAMAGE			
195	115	2	0.00015	18.3	20.5	19.6	20.5	0.956	392.7	NO DAMAGE			
195	95	1	0.00007	18.3	20.5	19.4	20.5	0.946	314.2	NO DAMAGE			
195	85	2	0.00015	18.3	20.5	19.2	20.5	0.940	285.6	NO DAMAGE			
195	75	1	0.00007	18.3	20.5	19.1	20.5	0.935	261.8	NO DAMAGE			
195	55	1	0.00007	18.3	20.5	18.9	20.5	0.924	224.4	NO DAMAGE			
195	45	2	0.00015	18.3	20.5	18.8	20.5	0.918	209.5	NO DAMAGE			
195	35	1	0.00007	18.3	20.5	18.7	20.5	0.913	196.4	NO DAMAGE			
195	5	1	0.00007	18.3	20.5	18.4	20.5	0.897	165.4	NO DAMAGE			
195	-75	1	0.00007	18.3	20.5	17.5	20.5	0.853	116.4	NO DAMAGE			
195	-105	1	0.00007	18.3	20.5	17.1	20.5	0.837	104.7	NO DAMAGE			
195	-125	1	0.00007	18.3	20.5	16.9	20.5	0.826	98.2	NO DAMAGE			
195	-135	1	0.00007	18.3	20.5	16.8	20.5	0.820	95.2	NO DAMAGE			
195	-145	1	0.00007	18.3	20.5	16.7	20.5	0.815	92.4	NO DAMAGE			
195	-155	2	0.00015	18.3	20.5	16.6	20.5	0.810	89.8	NO DAMAGE			
195	-165	1	0.00007	18.3	20.5	16.5	20.5	0.804	87.3	NO DAMAGE			
195	-195	1	0.00007	18.3	20.5	16.1	20.5	0.788	80.6	NO DAMAGE			
195	-235	1	0.00007	18.3	20.5	15.7	20.5	0.766	73.1	NO DAMAGE			
195	-245	2	0.00015	18.3	20.5	15.6	20.5	0.761	71.4	NO DAMAGE			
195	-255	2	0.00015	18.3	20.5	15.5	20.5	0.755	69.8	NO DAMAGE			
195	-265	1	0.00007	18.3	20.5	15.3	20.5	0.750	68.3	NO DAMAGE			
195	-275	1	0.00007	18.3	20.5	15.2	20.5	0.744	66.8	NO DAMAGE			
195	-595	1	0.00007	18.3	20.5	11.7	20.5	0.570	39.8	19743211	5.07E-10		
190	180	141	0.01051	18.3	20.4	20.3	20.4	0.995	3133.2	NO DAMAGE			
190	175	31	0.00231	18.3	20.4	20.3	20.4	0.992	2088.8	NO DAMAGE			
190	170	117	0.00872	18.3	20.4	20.2	20.4	0.989	1566.6	NO DAMAGE			
190	165	17	0.00127	18.3	20.4	20.1	20.4	0.986	1253.3	NO DAMAGE			
190	160	45	0.00335	18.3	20.4	20.1	20.4	0.984	1044.4	NO DAMAGE			
190	155	4	0.00030	18.3	20.4	20.0	20.4	0.981	895.2	NO DAMAGE			
190	150	8	0.00060	18.3	20.4	20.0	20.4	0.978	783.3	NO DAMAGE			
190	145	1	0.00007	18.3	20.4	19.9	20.4	0.975	696.3	NO DAMAGE			
190	140	5	0.00037	18.3	20.4	19.9	20.4	0.973	626.6	NO DAMAGE			
190	120	2	0.00015	18.3	20.4	19.6	20.4	0.962	447.6	NO DAMAGE			
190	115	1	0.00007	18.3	20.4	19.6	20.4	0.959	417.8	NO DAMAGE			
190	110	3	0.00022	18.3	20.4	19.5	20.4	0.956	391.7	NO DAMAGE			
190	100	2	0.00015	18.3	20.4	19.4	20.4	0.951	348.1	NO DAMAGE			
190	80	1	0.00007	18.3	20.4	19.2	20.4	0.940	284.8	NO DAMAGE			
190	75	1	0.00007	18.3	20.4	19.1	20.4	0.937	272.5	NO DAMAGE			
190	70	1	0.00007	18.3	20.4	19.1	20.4	0.935	261.1	NO DAMAGE			
190	50	2	0.00015	18.3	20.4	18.9	20.4	0.924	223.8	NO DAMAGE			
190	40	1	0.00007	18.3	20.4	18.7	20.4	0.918	208.9	NO DAMAGE			
190	30	2	0.00015	18.3	20.4	18.6	20.4	0.913	195.8	NO DAMAGE			
190	25	1	0.00007	18.3	20.4	18.6	20.4	0.910	189.9	NO DAMAGE			
190	10	1	0.00007	18.3	20.4	18.4	20.4	0.902	174.1	NO DAMAGE			
190	-10	1	0.00007	18.3	20.4	18.2	20.4	0.891	156.7	NO DAMAGE			
190	-20	1	0.00007	18.3	20.4	18.1	20.4	0.885	149.2	NO DAMAGE			
190	-45	1	0.00007	18.3	20.4	17.8	20.4	0.872	133.3	NO DAMAGE			
190	-50	1	0.00007	18.3	20.4	17.7	20.4	0.869	130.6	NO DAMAGE			
190	-90	1	0.00007	18.3	20.4	17.3	20.4	0.847	111.9	NO DAMAGE			
190	-100	3	0.00022	18.3	20.4	17.2	20.4	0.842	108.0	NO DAMAGE			
190	-130	2	0.00015	18.3	20.4	16.9	20.4	0.825	97.9	NO DAMAGE			
190	-165	1	0.00007	18.3	20.4	16.5	20.4	0.806	88.3	NO DAMAGE			
190	-190	3	0.00022	18.3	20.4	16.2	20.4	0.793	82.5	NO DAMAGE			
190	-195	1	0.00007	18.3	20.4	16.1	20.4	0.790	81.4	NO DAMAGE			
185	175	578	0.04309	18.3	20.4	20.3	20.4	0.995	3124.7	NO DAMAGE			
185	170	102	0.00760	18.3	20.4	20.2	20.4	0.992	2083.1	NO DAMAGE			
185	165	566	0.04220	18.3	20.4	20.1	20.4	0.989	1562.3	NO DAMAGE			
185	160	5	0.00037	18.3	20.4	20.1	20.4	0.986	1249.9	NO DAMAGE			
185	155	142	0.01059	18.3	20.4	20.0	20.4	0.984	1041.6	NO DAMAGE			
185	150	4	0.00030	18.3	20.4	20.0	20.4	0.981	892.8	NO DAMAGE			
185	145	38	0.00283	18.3	20.4	19.9	20.4	0.978	781.2	NO DAMAGE			
185	140	1	0.00007	18.3	20.4	19.9	20.4	0.975	694.4	NO DAMAGE			
185	135	9	0.00067	18.3	20.4	19.8	20.4	0.973	624.9	NO DAMAGE			
185	130	1	0.00007	18.3	20.4	19.7	20.4	0.970	568.1	NO DAMAGE			
185	125	1	0.00007	18.3	20.4	19.7	20.4	0.967	520.8	NO DAMAGE			
185	120	1	0.00007	18.3	20.4	19.6	20.4	0.964	480.7	NO DAMAGE			
185	115	4	0.00030	18.3	20.4	19.6	20.4	0.962	446.4	NO DAMAGE			
185	105	5	0.00037	18.3	20.4	19.5	20.4	0.956	390.6	NO DAMAGE			
185	95	1	0.00007	18.3	20.4	19.4	20.4	0.951	347.2	NO DAMAGE			
185	85	1	0.00007	18.3	20.4	19.2	20.4	0.945	312.5	NO DAMAGE			
185	80	1	0.00007	18.3	20.4	19.2	20.4	0.943	297.6	NO DAMAGE			
185	75	1	0.00007	18.3	20.4	19.1	20.4	0.940	284.1	NO DAMAGE			
185	65	1	0.00007	18.3	20.4	19.0	20.4	0.934	260.4	NO DAMAGE			
185	60	1	0.00007	18.3	20.4	19.0	20.4	0.932	250.0	NO DAMAGE			
185	55	2	0.00015	18.3	20.4	18.9	20.4	0.929	240.4	NO DAMAGE			
185	35	2	0.00015	18.3	20.4	18.7	20.4	0.918	208.3	NO DAMAGE			
185	25	3	0.00022	18.3	20.4	18.6	20.4	0.912	195.3	NO DAMAGE			
185	20	1	0.00007	18.3	20.4	18.5	20.4	0.910	189.4	NO DAMAGE			
185	15	2	0.00015	18.3	20.4	18.5	20.4	0.907	183.8	NO DAMAGE			
185	5	3	0.00022	18.3	20.4	18.4	20.4	0.901	173.6	NO DAMAGE			
185	-5	1	0.00007	18.3	20.4	18.2	20.4	0.896	164.5	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
185	-15	1	0.00007	18.3	20.4	18.1	20.4	0.891	156.2	NO DAMAGE			
185	-65	1	0.00007	18.3	20.4	17.6	20.4	0.863	125.0	NO DAMAGE			
185	-95	1	0.00007	18.3	20.4	17.2	20.4	0.847	111.6	NO DAMAGE			
185	-100	1	0.00007	18.3	20.4	17.2	20.4	0.844	109.6	NO DAMAGE			
185	-105	1	0.00007	18.3	20.4	17.1	20.4	0.841	107.7	NO DAMAGE			
185	-115	1	0.00007	18.3	20.4	17.0	20.4	0.836	104.2	NO DAMAGE			
185	-120	1	0.00007	18.3	20.4	17.0	20.4	0.833	102.4	NO DAMAGE			
185	-125	3	0.00022	18.3	20.4	16.9	20.4	0.830	100.8	NO DAMAGE			
185	-145	1	0.00007	18.3	20.4	16.7	20.4	0.819	94.7	NO DAMAGE			
185	-155	2	0.00015	18.3	20.4	16.6	20.4	0.814	91.9	NO DAMAGE			
185	-160	1	0.00007	18.3	20.4	16.5	20.4	0.811	90.6	NO DAMAGE			
185	-165	5	0.00037	18.3	20.4	16.5	20.4	0.808	89.3	NO DAMAGE			
185	-170	1	0.00007	18.3	20.4	16.4	20.4	0.806	88.0	NO DAMAGE			
185	-175	2	0.00015	18.3	20.4	16.4	20.4	0.803	86.8	NO DAMAGE			
185	-180	1	0.00007	18.3	20.4	16.3	20.4	0.800	85.6	NO DAMAGE			
185	-190	1	0.00007	18.3	20.4	16.2	20.4	0.795	83.3	NO DAMAGE			
185	-195	2	0.00015	18.3	20.4	16.1	20.4	0.792	82.2	NO DAMAGE			
185	-200	2	0.00015	18.3	20.4	16.1	20.4	0.789	81.2	NO DAMAGE			
185	-205	1	0.00007	18.3	20.4	16.0	20.4	0.787	80.1	NO DAMAGE			
185	-215	2	0.00015	18.3	20.4	15.9	20.4	0.781	78.1	NO DAMAGE			
185	-235	2	0.00015	18.3	20.4	15.7	20.4	0.770	74.4	NO DAMAGE			
185	-245	3	0.00022	18.3	20.4	15.6	20.4	0.765	72.7	NO DAMAGE			
185	-275	1	0.00007	18.3	20.4	15.2	20.4	0.748	67.9	NO DAMAGE			
185	-355	1	0.00007	18.3	20.4	14.3	20.4	0.704	57.9	NO DAMAGE			
180	170	389	0.02900	18.3	20.3	20.2	20.3	0.995	3116.1	NO DAMAGE			
180	165	84	0.00626	18.3	20.3	20.1	20.3	0.992	2077.4	NO DAMAGE			
180	160	216	0.01610	18.3	20.3	20.1	20.3	0.989	1558.1	NO DAMAGE			
180	155	23	0.00171	18.3	20.3	20.0	20.3	0.986	1246.5	NO DAMAGE			
180	150	53	0.00395	18.3	20.3	20.0	20.3	0.984	1038.7	NO DAMAGE			
180	145	4	0.00030	18.3	20.3	19.9	20.3	0.981	890.3	NO DAMAGE			
180	140	42	0.00313	18.3	20.3	19.9	20.3	0.978	779.0	NO DAMAGE			
180	135	7	0.00052	18.3	20.3	19.8	20.3	0.975	692.5	NO DAMAGE			
180	130	8	0.00060	18.3	20.3	19.7	20.3	0.973	623.2	NO DAMAGE			
180	125	2	0.00015	18.3	20.3	19.7	20.3	0.970	566.6	NO DAMAGE			
180	120	1	0.00007	18.3	20.3	19.6	20.3	0.967	519.4	NO DAMAGE			
180	110	3	0.00022	18.3	20.3	19.5	20.3	0.962	445.2	NO DAMAGE			
180	105	2	0.00015	18.3	20.3	19.5	20.3	0.959	415.5	NO DAMAGE			
180	95	1	0.00007	18.3	20.3	19.4	20.3	0.953	366.6	NO DAMAGE			
180	90	2	0.00015	18.3	20.3	19.3	20.3	0.951	346.2	NO DAMAGE			
180	80	5	0.00037	18.3	20.3	19.2	20.3	0.945	311.6	NO DAMAGE			
180	75	1	0.00007	18.3	20.3	19.1	20.3	0.942	296.8	NO DAMAGE			
180	60	2	0.00015	18.3	20.3	19.0	20.3	0.934	259.7	NO DAMAGE			
180	45	1	0.00007	18.3	20.3	18.8	20.3	0.926	230.8	NO DAMAGE			
180	40	1	0.00007	18.3	20.3	18.7	20.3	0.923	222.6	NO DAMAGE			
180	30	2	0.00015	18.3	20.3	18.6	20.3	0.918	207.7	NO DAMAGE			
180	20	1	0.00007	18.3	20.3	18.5	20.3	0.912	194.8	NO DAMAGE			
180	0	2	0.00015	18.3	20.3	18.3	20.3	0.901	173.1	NO DAMAGE			
180	-5	1	0.00007	18.3	20.3	18.2	20.3	0.898	168.4	NO DAMAGE			
180	-10	3	0.00022	18.3	20.3	18.2	20.3	0.896	164.0	NO DAMAGE			
180	-45	1	0.00007	18.3	20.3	17.8	20.3	0.877	138.5	NO DAMAGE			
180	-60	3	0.00022	18.3	20.3	17.6	20.3	0.868	129.8	NO DAMAGE			
180	-70	2	0.00015	18.3	20.3	17.5	20.3	0.863	124.6	NO DAMAGE			
180	-80	2	0.00015	18.3	20.3	17.4	20.3	0.857	119.9	NO DAMAGE			
180	-90	2	0.00015	18.3	20.3	17.3	20.3	0.852	115.4	NO DAMAGE			
180	-100	2	0.00015	18.3	20.3	17.2	20.3	0.846	111.3	NO DAMAGE			
180	-110	4	0.00030	18.3	20.3	17.1	20.3	0.841	107.5	NO DAMAGE			
180	-120	1	0.00007	18.3	20.3	17.0	20.3	0.835	103.9	NO DAMAGE			
180	-130	2	0.00015	18.3	20.3	16.9	20.3	0.830	100.5	NO DAMAGE			
180	-140	1	0.00007	18.3	20.3	16.7	20.3	0.824	97.4	NO DAMAGE			
180	-145	1	0.00007	18.3	20.3	16.7	20.3	0.822	95.9	NO DAMAGE			
180	-150	3	0.00022	18.3	20.3	16.6	20.3	0.819	94.4	NO DAMAGE			
180	-160	1	0.00007	18.3	20.3	16.5	20.3	0.813	91.7	NO DAMAGE			
180	-170	2	0.00015	18.3	20.3	16.4	20.3	0.808	89.0	NO DAMAGE			
180	-185	1	0.00007	18.3	20.3	16.2	20.3	0.800	85.4	NO DAMAGE			
180	-190	1	0.00007	18.3	20.3	16.2	20.3	0.797	84.2	NO DAMAGE			
180	-200	2	0.00015	18.3	20.3	16.1	20.3	0.791	82.0	NO DAMAGE			
180	-210	1	0.00007	18.3	20.3	16.0	20.3	0.786	79.9	NO DAMAGE			
180	-215	1	0.00007	18.3	20.3	15.9	20.3	0.783	78.9	NO DAMAGE			
180	-230	1	0.00007	18.3	20.3	15.7	20.3	0.775	76.0	NO DAMAGE			
180	-240	1	0.00007	18.3	20.3	15.6	20.3	0.770	74.2	NO DAMAGE			
175	165	835	0.06225	18.3	20.3	20.1	20.3	0.994	3107.6	NO DAMAGE			
175	160	85	0.00634	18.3	20.3	20.1	20.3	0.992	2071.7	NO DAMAGE			
175	155	529	0.03944	18.3	20.3	20.0	20.3	0.989	1553.8	NO DAMAGE			
175	150	20	0.00149	18.3	20.3	20.0	20.3	0.986	1243.0	NO DAMAGE			
175	145	231	0.01722	18.3	20.3	19.9	20.3	0.983	1035.9	NO DAMAGE			
175	140	21	0.00157	18.3	20.3	19.9	20.3	0.981	887.9	NO DAMAGE			
175	135	40	0.00298	18.3	20.3	19.8	20.3	0.978	776.9	NO DAMAGE			
175	130	6	0.00045	18.3	20.3	19.7	20.3	0.975	690.6	NO DAMAGE			
175	125	8	0.00060	18.3	20.3	19.7	20.3	0.972	621.5	NO DAMAGE			
175	120	2	0.00015	18.3	20.3	19.6	20.3	0.970	565.0	NO DAMAGE			
175	115	6	0.00045	18.3	20.3	19.6	20.3	0.967	517.9	NO DAMAGE			
175	105	3	0.00022	18.3	20.3	19.5	20.3	0.961	443.9	NO DAMAGE			
175	65	1	0.00007	18.3	20.3	19.0	20.3	0.939	282.5	NO DAMAGE			
175	45	1	0.00007	18.3	20.3	18.8	20.3	0.928	239.0	NO DAMAGE			
175	35	1	0.00007	18.3	20.3	18.7	20.3	0.923	222.0	NO DAMAGE			
175	25	1	0.00007	18.3	20.3	18.6	20.3	0.917	207.2	NO DAMAGE			
175	20	1	0.00007	18.3	20.3	18.5	20.3	0.915	200.5	NO DAMAGE			
175	15	2	0.00015	18.3	20.3	18.5	20.3	0.912	194.2	NO DAMAGE			
175	5	2	0.00015	18.3	20.3	18.4	20.3	0.906	182.8	NO DAMAGE			
175	0	2	0.00015	18.3	20.3	18.3	20.3	0.904	177.6	NO DAMAGE			
175	-15	1	0.00007	18.3	20.3	18.1	20.3	0.895	163.6	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
175	-35	1	0.00007	18.3	20.3	17.9	20.3	0.884	148.0	NO DAMAGE			
175	-55	1	0.00007	18.3	20.3	17.7	20.3	0.873	135.1	NO DAMAGE			
175	-65	1	0.00007	18.3	20.3	17.6	20.3	0.868	129.5	NO DAMAGE			
175	-75	1	0.00007	18.3	20.3	17.5	20.3	0.862	124.3	NO DAMAGE			
175	-80	1	0.00007	18.3	20.3	17.4	20.3	0.860	121.9	NO DAMAGE			
175	-85	1	0.00007	18.3	20.3	17.4	20.3	0.857	119.5	NO DAMAGE			
175	-95	3	0.00022	18.3	20.3	17.2	20.3	0.851	115.1	NO DAMAGE			
175	-105	1	0.00007	18.3	20.3	17.1	20.3	0.846	111.0	NO DAMAGE			
175	-115	1	0.00007	18.3	20.3	17.0	20.3	0.840	107.2	NO DAMAGE			
175	-125	1	0.00007	18.3	20.3	16.9	20.3	0.835	103.6	NO DAMAGE			
175	-135	1	0.00007	18.3	20.3	16.8	20.3	0.829	100.2	NO DAMAGE			
175	-145	3	0.00022	18.3	20.3	16.7	20.3	0.824	97.1	NO DAMAGE			
175	-155	1	0.00007	18.3	20.3	16.6	20.3	0.818	94.2	NO DAMAGE			
175	-165	3	0.00022	18.3	20.3	16.5	20.3	0.813	91.4	NO DAMAGE			
175	-185	1	0.00007	18.3	20.3	16.2	20.3	0.802	86.3	NO DAMAGE			
175	-195	3	0.00022	18.3	20.3	16.1	20.3	0.796	84.0	NO DAMAGE			
175	-215	2	0.00015	18.3	20.3	15.9	20.3	0.785	79.7	NO DAMAGE			
175	-225	1	0.00007	18.3	20.3	15.8	20.3	0.780	77.7	NO DAMAGE			
175	-235	1	0.00007	18.3	20.3	15.7	20.3	0.774	75.8	NO DAMAGE			
175	-245	1	0.00007	18.3	20.3	15.6	20.3	0.769	74.0	NO DAMAGE			
175	-255	1	0.00007	18.3	20.3	15.5	20.3	0.763	72.3	NO DAMAGE			
170	160	397	0.02960	18.3	20.2	20.1	20.2	0.994	3099.0	NO DAMAGE			
170	155	85	0.00634	18.3	20.2	20.0	20.2	0.992	2066.0	NO DAMAGE			
170	150	301	0.02244	18.3	20.2	20.0	20.2	0.989	1549.5	NO DAMAGE			
170	145	34	0.00253	18.3	20.2	19.9	20.2	0.986	1239.6	NO DAMAGE			
170	140	140	0.01044	18.3	20.2	19.9	20.2	0.983	1033.0	NO DAMAGE			
170	135	10	0.00075	18.3	20.2	19.8	20.2	0.981	885.4	NO DAMAGE			
170	130	30	0.00224	18.3	20.2	19.7	20.2	0.978	774.8	NO DAMAGE			
170	125	4	0.00030	18.3	20.2	19.7	20.2	0.975	688.7	NO DAMAGE			
170	120	11	0.00082	18.3	20.2	19.6	20.2	0.972	619.8	NO DAMAGE			
170	115	2	0.00015	18.3	20.2	19.6	20.2	0.970	563.5	NO DAMAGE			
170	110	8	0.00060	18.3	20.2	19.5	20.2	0.967	516.5	NO DAMAGE			
170	100	7	0.00052	18.3	20.2	19.4	20.2	0.961	442.7	NO DAMAGE			
170	90	9	0.00067	18.3	20.2	19.3	20.2	0.956	387.4	NO DAMAGE			
170	80	7	0.00052	18.3	20.2	19.2	20.2	0.950	344.3	NO DAMAGE			
170	70	3	0.00022	18.3	20.2	19.1	20.2	0.945	309.9	NO DAMAGE			
170	65	1	0.00007	18.3	20.2	19.0	20.2	0.942	295.1	NO DAMAGE			
170	40	1	0.00007	18.3	20.2	18.7	20.2	0.928	238.4	NO DAMAGE			
170	30	3	0.00022	18.3	20.2	18.6	20.2	0.923	221.4	NO DAMAGE			
170	25	1	0.00007	18.3	20.2	18.6	20.2	0.920	213.7	NO DAMAGE			
170	20	3	0.00022	18.3	20.2	18.5	20.2	0.917	206.6	NO DAMAGE			
170	0	2	0.00015	18.3	20.2	18.3	20.2	0.906	182.3	NO DAMAGE			
170	-10	1	0.00007	18.3	20.2	18.2	20.2	0.901	172.2	NO DAMAGE			
170	-40	1	0.00007	18.3	20.2	17.9	20.2	0.884	147.6	NO DAMAGE			
170	-50	1	0.00007	18.3	20.2	17.7	20.2	0.879	140.9	NO DAMAGE			
170	-70	1	0.00007	18.3	20.2	17.5	20.2	0.868	129.1	NO DAMAGE			
170	-90	1	0.00007	18.3	20.2	17.3	20.2	0.857	119.2	NO DAMAGE			
170	-100	2	0.00015	18.3	20.2	17.2	20.2	0.851	114.8	NO DAMAGE			
170	-105	1	0.00007	18.3	20.2	17.1	20.2	0.848	112.7	NO DAMAGE			
170	-110	3	0.00022	18.3	20.2	17.1	20.2	0.846	110.7	NO DAMAGE			
170	-115	1	0.00007	18.3	20.2	17.0	20.2	0.843	108.7	NO DAMAGE			
170	-120	1	0.00007	18.3	20.2	17.0	20.2	0.840	106.9	NO DAMAGE			
170	-130	2	0.00015	18.3	20.2	16.9	20.2	0.834	103.3	NO DAMAGE			
170	-140	2	0.00015	18.3	20.2	16.7	20.2	0.829	100.0	NO DAMAGE			
170	-150	1	0.00007	18.3	20.2	16.6	20.2	0.823	96.8	NO DAMAGE			
170	-160	2	0.00015	18.3	20.2	16.5	20.2	0.818	93.9	NO DAMAGE			
170	-180	1	0.00007	18.3	20.2	16.3	20.2	0.807	88.5	NO DAMAGE			
170	-210	3	0.00022	18.3	20.2	16.0	20.2	0.790	81.6	NO DAMAGE			
170	-230	1	0.00007	18.3	20.2	15.7	20.2	0.779	77.5	NO DAMAGE			
165	155	845	0.06300	18.3	20.1	20.0	20.1	0.994	3090.5	NO DAMAGE			
165	150	95	0.00708	18.3	20.1	20.0	20.1	0.992	2060.3	NO DAMAGE			
165	145	957	0.07135	18.3	20.1	19.9	20.1	0.989	1545.2	NO DAMAGE			
165	140	52	0.00388	18.3	20.1	19.9	20.1	0.986	1236.2	NO DAMAGE			
165	135	293	0.02184	18.3	20.1	19.8	20.1	0.983	1030.2	NO DAMAGE			
165	130	13	0.00097	18.3	20.1	19.7	20.1	0.981	883.0	NO DAMAGE			
165	125	39	0.00291	18.3	20.1	19.7	20.1	0.978	772.6	NO DAMAGE			
165	120	6	0.00045	18.3	20.1	19.6	20.1	0.975	686.8	NO DAMAGE			
165	115	12	0.00089	18.3	20.1	19.6	20.1	0.972	618.1	NO DAMAGE			
165	105	4	0.00030	18.3	20.1	19.5	20.1	0.967	515.1	NO DAMAGE			
165	95	1	0.00007	18.3	20.1	19.4	20.1	0.961	441.5	NO DAMAGE			
165	85	3	0.00022	18.3	20.1	19.2	20.1	0.956	386.3	NO DAMAGE			
165	70	1	0.00007	18.3	20.1	19.1	20.1	0.947	325.3	NO DAMAGE			
165	60	1	0.00007	18.3	20.1	19.0	20.1	0.942	294.3	NO DAMAGE			
165	55	1	0.00007	18.3	20.1	18.9	20.1	0.939	281.0	NO DAMAGE			
165	40	1	0.00007	18.3	20.1	18.7	20.1	0.931	247.2	NO DAMAGE			
165	35	2	0.00015	18.3	20.1	18.7	20.1	0.928	237.7	NO DAMAGE			
165	25	3	0.00022	18.3	20.1	18.6	20.1	0.923	220.7	NO DAMAGE			
165	15	2	0.00015	18.3	20.1	18.5	20.1	0.917	206.0	NO DAMAGE			
165	-5	2	0.00015	18.3	20.1	18.2	20.1	0.906	181.8	NO DAMAGE			
165	-30	1	0.00007	18.3	20.1	18.0	20.1	0.892	158.5	NO DAMAGE			
165	-55	1	0.00007	18.3	20.1	17.7	20.1	0.878	140.5	NO DAMAGE			
165	-105	1	0.00007	18.3	20.1	17.1	20.1	0.851	114.5	NO DAMAGE			
165	-125	1	0.00007	18.3	20.1	16.9	20.1	0.840	106.6	NO DAMAGE			
165	-135	1	0.00007	18.3	20.1	16.8	20.1	0.834	103.0	NO DAMAGE			
165	-140	1	0.00007	18.3	20.1	16.7	20.1	0.831	101.3	NO DAMAGE			
165	-145	1	0.00007	18.3	20.1	16.7	20.1	0.828	99.7	NO DAMAGE			
165	-165	2	0.00015	18.3	20.1	16.5	20.1	0.817	93.7	NO DAMAGE			
165	-185	1	0.00007	18.3	20.1	16.2	20.1	0.806	88.3	NO DAMAGE			
165	-190	1	0.00007	18.3	20.1	16.2	20.1	0.804	87.1	NO DAMAGE			
165	-205	1	0.00007	18.3	20.1	16.0	20.1	0.795	83.5	NO DAMAGE			
165	-215	1	0.00007	18.3	20.1	15.9	20.1	0.790	81.3	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
165	-225	2	0.00015	18.3	20.1	15.8	20.1	0.784	79.2	NO DAMAGE			
165	-255	1	0.00007	18.3	20.1	15.5	20.1	0.768	73.6	NO DAMAGE			
165	-275	1	0.00007	18.3	20.1	15.2	20.1	0.757	70.2	NO DAMAGE			
160	150	611	0.04555	18.3	20.1	20.0	20.1	0.994	3081.9	NO DAMAGE			
160	145	158	0.01178	18.3	20.1	19.9	20.1	0.992	2054.6	NO DAMAGE			
160	140	378	0.02818	18.3	20.1	19.9	20.1	0.989	1541.0	NO DAMAGE			
160	135	41	0.00306	18.3	20.1	19.8	20.1	0.986	1232.8	NO DAMAGE			
160	130	113	0.00842	18.3	20.1	19.7	20.1	0.983	1027.3	NO DAMAGE			
160	125	20	0.00149	18.3	20.1	19.7	20.1	0.981	880.6	NO DAMAGE			
160	120	53	0.00395	18.3	20.1	19.6	20.1	0.978	770.5	NO DAMAGE			
160	115	2	0.00015	18.3	20.1	19.6	20.1	0.975	684.9	NO DAMAGE			
160	110	24	0.00179	18.3	20.1	19.5	20.1	0.972	616.4	NO DAMAGE			
160	105	4	0.00030	18.3	20.1	19.5	20.1	0.969	560.4	NO DAMAGE			
160	100	12	0.00089	18.3	20.1	19.4	20.1	0.967	513.7	NO DAMAGE			
160	95	3	0.00022	18.3	20.1	19.4	20.1	0.964	474.1	NO DAMAGE			
160	90	10	0.00075	18.3	20.1	19.3	20.1	0.961	440.3	NO DAMAGE			
160	80	4	0.00030	18.3	20.1	19.2	20.1	0.956	385.2	NO DAMAGE			
160	75	1	0.00007	18.3	20.1	19.1	20.1	0.953	362.6	NO DAMAGE			
160	70	3	0.00022	18.3	20.1	19.1	20.1	0.950	342.4	NO DAMAGE			
160	60	4	0.00030	18.3	20.1	19.0	20.1	0.945	308.2	NO DAMAGE			
160	50	2	0.00015	18.3	20.1	18.9	20.1	0.939	280.2	NO DAMAGE			
160	45	1	0.00007	18.3	20.1	18.8	20.1	0.936	268.0	NO DAMAGE			
160	40	3	0.00022	18.3	20.1	18.7	20.1	0.933	256.8	NO DAMAGE			
160	30	5	0.00037	18.3	20.1	18.6	20.1	0.928	237.1	NO DAMAGE			
160	20	2	0.00015	18.3	20.1	18.5	20.1	0.922	220.1	NO DAMAGE			
160	10	2	0.00015	18.3	20.1	18.4	20.1	0.917	205.5	NO DAMAGE			
160	0	5	0.00037	18.3	20.1	18.3	20.1	0.911	192.6	NO DAMAGE			
160	-10	2	0.00015	18.3	20.1	18.2	20.1	0.906	181.3	NO DAMAGE			
160	-15	1	0.00007	18.3	20.1	18.1	20.1	0.903	176.1	NO DAMAGE			
160	-30	1	0.00007	18.3	20.1	18.0	20.1	0.895	162.2	NO DAMAGE			
160	-40	1	0.00007	18.3	20.1	17.9	20.1	0.889	154.1	NO DAMAGE			
160	-70	3	0.00022	18.3	20.1	17.5	20.1	0.872	134.0	NO DAMAGE			
160	-80	2	0.00015	18.3	20.1	17.4	20.1	0.867	128.4	NO DAMAGE			
160	-90	5	0.00037	18.3	20.1	17.3	20.1	0.861	123.3	NO DAMAGE			
160	-100	4	0.00030	18.3	20.1	17.2	20.1	0.856	118.5	NO DAMAGE			
160	-110	6	0.00045	18.3	20.1	17.1	20.1	0.850	114.1	NO DAMAGE			
160	-115	1	0.00007	18.3	20.1	17.0	20.1	0.847	112.1	NO DAMAGE			
160	-120	1	0.00007	18.3	20.1	17.0	20.1	0.845	110.1	NO DAMAGE			
160	-130	3	0.00022	18.3	20.1	16.9	20.1	0.839	106.3	NO DAMAGE			
160	-135	1	0.00007	18.3	20.1	16.8	20.1	0.836	104.5	NO DAMAGE			
160	-140	4	0.00030	18.3	20.1	16.7	20.1	0.834	102.7	NO DAMAGE			
160	-150	1	0.00007	18.3	20.1	16.6	20.1	0.828	99.4	NO DAMAGE			
160	-160	3	0.00022	18.3	20.1	16.5	20.1	0.822	96.3	NO DAMAGE			
160	-170	2	0.00015	18.3	20.1	16.4	20.1	0.817	93.4	NO DAMAGE			
160	-175	1	0.00007	18.3	20.1	16.4	20.1	0.814	92.0	NO DAMAGE			
160	-180	2	0.00015	18.3	20.1	16.3	20.1	0.811	90.6	NO DAMAGE			
160	-185	1	0.00007	18.3	20.1	16.2	20.1	0.809	89.3	NO DAMAGE			
160	-190	1	0.00007	18.3	20.1	16.2	20.1	0.806	88.1	NO DAMAGE			
155	145	1673	0.12473	18.3	20.0	19.9	20.0	0.994	3073.4	NO DAMAGE			
155	140	205	0.01528	18.3	20.0	19.9	20.0	0.992	2048.9	NO DAMAGE			
155	135	1264	0.09423	18.3	20.0	19.8	20.0	0.989	1536.7	NO DAMAGE			
155	130	69	0.00514	18.3	20.0	19.7	20.0	0.986	1229.4	NO DAMAGE			
155	125	323	0.02408	18.3	20.0	19.7	20.0	0.983	1024.5	NO DAMAGE			
155	120	17	0.00127	18.3	20.0	19.6	20.0	0.981	878.1	NO DAMAGE			
155	115	108	0.00805	18.3	20.0	19.6	20.0	0.978	768.3	NO DAMAGE			
155	110	5	0.00037	18.3	20.0	19.5	20.0	0.975	683.0	NO DAMAGE			
155	105	15	0.00112	18.3	20.0	19.5	20.0	0.972	614.7	NO DAMAGE			
155	100	1	0.00007	18.3	20.0	19.4	20.0	0.969	558.8	NO DAMAGE			
155	95	15	0.00112	18.3	20.0	19.4	20.0	0.967	512.2	NO DAMAGE			
155	85	2	0.00015	18.3	20.0	19.2	20.0	0.961	439.1	NO DAMAGE			
155	80	1	0.00007	18.3	20.0	19.2	20.0	0.958	409.8	NO DAMAGE			
155	75	6	0.00045	18.3	20.0	19.1	20.0	0.955	384.2	NO DAMAGE			
155	65	3	0.00022	18.3	20.0	19.0	20.0	0.950	341.5	NO DAMAGE			
155	55	1	0.00007	18.3	20.0	18.9	20.0	0.944	307.3	NO DAMAGE			
155	50	2	0.00015	18.3	20.0	18.9	20.0	0.942	292.7	NO DAMAGE			
155	45	2	0.00015	18.3	20.0	18.8	20.0	0.939	279.4	NO DAMAGE			
155	35	2	0.00015	18.3	20.0	18.7	20.0	0.933	256.1	NO DAMAGE			
155	25	3	0.00022	18.3	20.0	18.6	20.0	0.928	236.4	NO DAMAGE			
155	15	2	0.00015	18.3	20.0	18.5	20.0	0.922	219.5	NO DAMAGE			
155	5	3	0.00022	18.3	20.0	18.4	20.0	0.917	204.9	NO DAMAGE			
155	0	3	0.00022	18.3	20.0	18.3	20.0	0.914	198.3	NO DAMAGE			
155	-5	1	0.00007	18.3	20.0	18.2	20.0	0.911	192.1	NO DAMAGE			
155	-15	1	0.00007	18.3	20.0	18.1	20.0	0.905	180.8	NO DAMAGE			
155	-25	2	0.00015	18.3	20.0	18.0	20.0	0.900	170.7	NO DAMAGE			
155	-55	1	0.00007	18.3	20.0	17.7	20.0	0.883	146.4	NO DAMAGE			
155	-80	1	0.00007	18.3	20.0	17.4	20.0	0.869	130.8	NO DAMAGE			
155	-95	1	0.00007	18.3	20.0	17.2	20.0	0.861	122.9	NO DAMAGE			
155	-105	1	0.00007	18.3	20.0	17.1	20.0	0.855	118.2	NO DAMAGE			
155	-115	1	0.00007	18.3	20.0	17.0	20.0	0.850	113.8	NO DAMAGE			
155	-120	1	0.00007	18.3	20.0	17.0	20.0	0.847	111.8	NO DAMAGE			
155	-125	2	0.00015	18.3	20.0	16.9	20.0	0.844	109.8	NO DAMAGE			
155	-130	1	0.00007	18.3	20.0	16.9	20.0	0.841	107.8	NO DAMAGE			
155	-135	5	0.00037	18.3	20.0	16.8	20.0	0.839	106.0	NO DAMAGE			
155	-145	4	0.00030	18.3	20.0	16.7	20.0	0.833	102.4	NO DAMAGE			
155	-150	2	0.00015	18.3	20.0	16.6	20.0	0.830	100.8	NO DAMAGE			
155	-165	1	0.00007	18.3	20.0	16.5	20.0	0.822	96.0	NO DAMAGE			
155	-175	1	0.00007	18.3	20.0	16.4	20.0	0.816	93.1	NO DAMAGE			
155	-185	2	0.00015	18.3	20.0	16.2	20.0	0.811	90.4	NO DAMAGE			
155	-195	1	0.00007	18.3	20.0	16.1	20.0	0.805	87.8	NO DAMAGE			
155	-220	1	0.00007	18.3	20.0	15.8	20.0	0.791	82.0	NO DAMAGE			
155	-235	1	0.00007	18.3	20.0	15.7	20.0	0.783	78.8	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
150	140	773	0.05763	18.3	20.0	19.9	20.0	0.994	3064.8	NO DAMAGE			
150	135	220	0.01640	18.3	20.0	19.8	20.0	0.992	2043.2	NO DAMAGE			
150	130	550	0.04100	18.3	20.0	19.7	20.0	0.989	1532.4	NO DAMAGE			
150	125	117	0.00872	18.3	20.0	19.7	20.0	0.986	1225.9	NO DAMAGE			
150	120	210	0.01566	18.3	20.0	19.6	20.0	0.983	1021.6	NO DAMAGE			
150	115	22	0.00164	18.3	20.0	19.6	20.0	0.980	875.7	NO DAMAGE			
150	110	108	0.00805	18.3	20.0	19.5	20.0	0.978	766.2	NO DAMAGE			
150	105	4	0.00030	18.3	20.0	19.5	20.0	0.975	681.1	NO DAMAGE			
150	100	48	0.00358	18.3	20.0	19.4	20.0	0.972	613.0	NO DAMAGE			
150	95	3	0.00022	18.3	20.0	19.4	20.0	0.969	557.2	NO DAMAGE			
150	90	21	0.00157	18.3	20.0	19.3	20.0	0.967	510.8	NO DAMAGE			
150	85	2	0.00015	18.3	20.0	19.2	20.0	0.964	471.5	NO DAMAGE			
150	80	7	0.00052	18.3	20.0	19.2	20.0	0.961	437.8	NO DAMAGE			
150	70	12	0.00089	18.3	20.0	19.1	20.0	0.955	383.1	NO DAMAGE			
150	65	1	0.00007	18.3	20.0	19.0	20.0	0.953	360.6	NO DAMAGE			
150	60	6	0.00045	18.3	20.0	19.0	20.0	0.950	340.5	NO DAMAGE			
150	50	6	0.00045	18.3	20.0	18.9	20.0	0.944	306.5	NO DAMAGE			
150	45	1	0.00007	18.3	20.0	18.8	20.0	0.941	291.9	NO DAMAGE			
150	40	2	0.00015	18.3	20.0	18.7	20.0	0.939	278.6	NO DAMAGE			
150	30	3	0.00022	18.3	20.0	18.6	20.0	0.933	255.4	NO DAMAGE			
150	20	6	0.00045	18.3	20.0	18.5	20.0	0.927	235.8	NO DAMAGE			
150	10	7	0.00052	18.3	20.0	18.4	20.0	0.922	218.9	NO DAMAGE			
150	5	1	0.00007	18.3	20.0	18.4	20.0	0.919	211.4	NO DAMAGE			
150	0	6	0.00045	18.3	20.0	18.3	20.0	0.916	204.3	NO DAMAGE			
150	-10	8	0.00060	18.3	20.0	18.2	20.0	0.911	191.6	NO DAMAGE			
150	-20	1	0.00007	18.3	20.0	18.1	20.0	0.905	180.3	NO DAMAGE			
150	-25	1	0.00007	18.3	20.0	18.0	20.0	0.902	175.1	NO DAMAGE			
150	-30	1	0.00007	18.3	20.0	18.0	20.0	0.900	170.3	NO DAMAGE			
150	-40	2	0.00015	18.3	20.0	17.9	20.0	0.894	161.3	NO DAMAGE			
150	-50	1	0.00007	18.3	20.0	17.7	20.0	0.888	153.2	NO DAMAGE			
150	-60	3	0.00022	18.3	20.0	17.6	20.0	0.883	145.9	NO DAMAGE			
150	-70	2	0.00015	18.3	20.0	17.5	20.0	0.877	139.3	NO DAMAGE			
150	-80	4	0.00030	18.3	20.0	17.4	20.0	0.872	133.3	NO DAMAGE			
150	-100	3	0.00022	18.3	20.0	17.2	20.0	0.861	122.6	NO DAMAGE			
150	-105	1	0.00007	18.3	20.0	17.1	20.0	0.858	120.2	NO DAMAGE			
150	-110	5	0.00037	18.3	20.0	17.1	20.0	0.855	117.9	NO DAMAGE			
150	-115	1	0.00007	18.3	20.0	17.0	20.0	0.852	115.7	NO DAMAGE			
150	-120	4	0.00030	18.3	20.0	17.0	20.0	0.849	113.5	NO DAMAGE			
150	-125	2	0.00015	18.3	20.0	16.9	20.0	0.847	111.4	NO DAMAGE			
150	-130	3	0.00022	18.3	20.0	16.9	20.0	0.844	109.5	NO DAMAGE			
150	-135	1	0.00007	18.3	20.0	16.8	20.0	0.841	107.5	NO DAMAGE			
150	-140	3	0.00022	18.3	20.0	16.7	20.0	0.838	105.7	NO DAMAGE			
150	-150	2	0.00015	18.3	20.0	16.6	20.0	0.833	102.2	NO DAMAGE			
150	-160	1	0.00007	18.3	20.0	16.5	20.0	0.827	98.9	NO DAMAGE			
150	-165	1	0.00007	18.3	20.0	16.5	20.0	0.824	97.3	NO DAMAGE			
150	-170	1	0.00007	18.3	20.0	16.4	20.0	0.821	95.8	NO DAMAGE			
150	-180	1	0.00007	18.3	20.0	16.3	20.0	0.816	92.9	NO DAMAGE			
150	-220	1	0.00007	18.3	20.0	15.8	20.0	0.794	82.8	NO DAMAGE			
150	-230	1	0.00007	18.3	20.0	15.7	20.0	0.788	80.7	NO DAMAGE			
145	135	2125	0.15842	18.3	19.9	19.8	19.9	0.994	3056.3	NO DAMAGE			
145	130	317	0.02363	18.3	19.9	19.7	19.9	0.992	2037.5	NO DAMAGE			
145	125	1702	0.12689	18.3	19.9	19.7	19.9	0.989	1528.1	NO DAMAGE			
145	120	76	0.00567	18.3	19.9	19.6	19.9	0.986	1222.5	NO DAMAGE			
145	115	343	0.02557	18.3	19.9	19.6	19.9	0.983	1018.8	NO DAMAGE			
145	110	20	0.00149	18.3	19.9	19.5	19.9	0.980	873.2	NO DAMAGE			
145	105	62	0.00462	18.3	19.9	19.5	19.9	0.978	764.1	NO DAMAGE			
145	100	9	0.00067	18.3	19.9	19.4	19.9	0.975	679.2	NO DAMAGE			
145	95	17	0.00127	18.3	19.9	19.4	19.9	0.972	611.3	NO DAMAGE			
145	90	2	0.00015	18.3	19.9	19.3	19.9	0.969	555.7	NO DAMAGE			
145	85	10	0.00075	18.3	19.9	19.2	19.9	0.966	509.4	NO DAMAGE			
145	75	4	0.00030	18.3	19.9	19.1	19.9	0.961	436.6	NO DAMAGE			
145	70	1	0.00007	18.3	19.9	19.1	19.9	0.958	407.5	NO DAMAGE			
145	65	2	0.00015	18.3	19.9	19.0	19.9	0.955	382.0	NO DAMAGE			
145	55	6	0.00045	18.3	19.9	18.9	19.9	0.950	339.6	NO DAMAGE			
145	45	6	0.00045	18.3	19.9	18.8	19.9	0.944	305.6	NO DAMAGE			
145	35	3	0.00022	18.3	19.9	18.7	19.9	0.938	277.8	NO DAMAGE			
145	30	1	0.00007	18.3	19.9	18.6	19.9	0.936	265.8	NO DAMAGE			
145	25	3	0.00022	18.3	19.9	18.6	19.9	0.933	254.7	NO DAMAGE			
145	20	2	0.00015	18.3	19.9	18.5	19.9	0.930	244.5	NO DAMAGE			
145	15	4	0.00030	18.3	19.9	18.5	19.9	0.927	235.1	NO DAMAGE			
145	10	1	0.00007	18.3	19.9	18.4	19.9	0.924	226.4	NO DAMAGE			
145	5	4	0.00030	18.3	19.9	18.4	19.9	0.922	218.3	NO DAMAGE			
145	0	1	0.00007	18.3	19.9	18.3	19.9	0.919	210.8	NO DAMAGE			
145	-5	3	0.00022	18.3	19.9	18.2	19.9	0.916	203.8	NO DAMAGE			
145	-35	2	0.00015	18.3	19.9	17.9	19.9	0.899	169.8	NO DAMAGE			
145	-75	1	0.00007	18.3	19.9	17.5	19.9	0.877	138.9	NO DAMAGE			
145	-85	1	0.00007	18.3	19.9	17.4	19.9	0.871	132.9	NO DAMAGE			
145	-95	3	0.00022	18.3	19.9	17.2	19.9	0.866	127.3	NO DAMAGE			
145	-100	1	0.00007	18.3	19.9	17.2	19.9	0.863	124.7	NO DAMAGE			
145	-105	1	0.00007	18.3	19.9	17.1	19.9	0.860	122.3	NO DAMAGE			
145	-115	3	0.00022	18.3	19.9	17.0	19.9	0.855	117.5	NO DAMAGE			
145	-135	3	0.00022	18.3	19.9	16.8	19.9	0.843	109.2	NO DAMAGE			
145	-145	3	0.00022	18.3	19.9	16.7	19.9	0.838	105.4	NO DAMAGE			
145	-155	1	0.00007	18.3	19.9	16.6	19.9	0.832	101.9	NO DAMAGE			
145	-165	3	0.00022	18.3	19.9	16.5	19.9	0.827	98.6	NO DAMAGE			
145	-185	1	0.00007	18.3	19.9	16.2	19.9	0.815	92.6	NO DAMAGE			
145	-195	2	0.00015	18.3	19.9	16.1	19.9	0.810	89.9	NO DAMAGE			
145	-215	2	0.00015	18.3	19.9	15.9	19.9	0.799	84.9	NO DAMAGE			
145	-265	1	0.00007	18.3	19.9	15.3	19.9	0.771	74.5	NO DAMAGE			
140	130	1518	0.11317	18.3	19.9	19.7	19.9	0.994	3047.7	NO DAMAGE			
140	125	298	0.02222	18.3	19.9	19.7	19.9	0.992	2031.8	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
140	120	667	0.04973	18.3	19.9	19.6	19.9	0.989	1523.9	NO DAMAGE			
140	115	88	0.00656	18.3	19.9	19.6	19.9	0.986	1219.1	NO DAMAGE			
140	110	316	0.02356	18.3	19.9	19.5	19.9	0.983	1015.9	NO DAMAGE			
140	105	35	0.00261	18.3	19.9	19.5	19.9	0.980	870.8	NO DAMAGE			
140	100	185	0.01379	18.3	19.9	19.4	19.9	0.978	761.9	NO DAMAGE			
140	95	18	0.00134	18.3	19.9	19.4	19.9	0.975	677.3	NO DAMAGE			
140	90	67	0.00500	18.3	19.9	19.3	19.9	0.972	609.5	NO DAMAGE			
140	85	3	0.00022	18.3	19.9	19.2	19.9	0.969	554.1	NO DAMAGE			
140	80	41	0.00306	18.3	19.9	19.2	19.9	0.966	508.0	NO DAMAGE			
140	75	5	0.00037	18.3	19.9	19.1	19.9	0.964	468.9	NO DAMAGE			
140	70	30	0.00224	18.3	19.9	19.1	19.9	0.961	435.4	NO DAMAGE			
140	65	2	0.00015	18.3	19.9	19.0	19.9	0.958	406.4	NO DAMAGE			
140	60	13	0.00097	18.3	19.9	19.0	19.9	0.955	381.0	NO DAMAGE			
140	55	1	0.00007	18.3	19.9	18.9	19.9	0.952	358.6	NO DAMAGE			
140	50	5	0.00037	18.3	19.9	18.9	19.9	0.950	338.6	NO DAMAGE			
140	45	3	0.00022	18.3	19.9	18.8	19.9	0.947	320.8	NO DAMAGE			
140	40	12	0.00089	18.3	19.9	18.7	19.9	0.944	304.8	NO DAMAGE			
140	35	1	0.00007	18.3	19.9	18.7	19.9	0.941	290.3	NO DAMAGE			
140	30	7	0.00052	18.3	19.9	18.6	19.9	0.938	277.1	NO DAMAGE			
140	20	8	0.00060	18.3	19.9	18.5	19.9	0.933	254.0	NO DAMAGE			
140	10	7	0.00052	18.3	19.9	18.4	19.9	0.927	234.4	NO DAMAGE			
140	5	1	0.00007	18.3	19.9	18.4	19.9	0.924	225.8	NO DAMAGE			
140	0	10	0.00075	18.3	19.9	18.3	19.9	0.921	217.7	NO DAMAGE			
140	-5	1	0.00007	18.3	19.9	18.2	19.9	0.919	210.2	NO DAMAGE			
140	-10	9	0.00067	18.3	19.9	18.2	19.9	0.916	203.2	NO DAMAGE			
140	-20	3	0.00022	18.3	19.9	18.1	19.9	0.910	190.5	NO DAMAGE			
140	-25	1	0.00007	18.3	19.9	18.0	19.9	0.907	184.7	NO DAMAGE			
140	-30	2	0.00015	18.3	19.9	18.0	19.9	0.905	179.3	NO DAMAGE			
140	-40	3	0.00022	18.3	19.9	17.9	19.9	0.899	169.3	NO DAMAGE			
140	-50	3	0.00022	18.3	19.9	17.7	19.9	0.893	160.4	NO DAMAGE			
140	-60	2	0.00015	18.3	19.9	17.6	19.9	0.888	152.4	NO DAMAGE			
140	-70	3	0.00022	18.3	19.9	17.5	19.9	0.882	145.1	NO DAMAGE			
140	-80	5	0.00037	18.3	19.9	17.4	19.9	0.877	138.5	NO DAMAGE			
140	-90	5	0.00037	18.3	19.9	17.3	19.9	0.871	132.5	NO DAMAGE			
140	-95	1	0.00007	18.3	19.9	17.2	19.9	0.868	129.7	NO DAMAGE			
140	-100	9	0.00067	18.3	19.9	17.2	19.9	0.865	127.0	NO DAMAGE			
140	-110	4	0.00030	18.3	19.9	17.1	19.9	0.860	121.9	NO DAMAGE			
140	-115	1	0.00007	18.3	19.9	17.0	19.9	0.857	119.5	NO DAMAGE			
140	-120	7	0.00052	18.3	19.9	17.0	19.9	0.854	117.2	NO DAMAGE			
140	-130	2	0.00015	18.3	19.9	16.9	19.9	0.849	112.9	NO DAMAGE			
140	-140	5	0.00037	18.3	19.9	16.7	19.9	0.843	108.8	NO DAMAGE			
140	-145	2	0.00015	18.3	19.9	16.7	19.9	0.840	106.9	NO DAMAGE			
140	-150	2	0.00015	18.3	19.9	16.6	19.9	0.837	105.1	NO DAMAGE			
140	-155	1	0.00007	18.3	19.9	16.6	19.9	0.834	103.3	NO DAMAGE			
140	-160	1	0.00007	18.3	19.9	16.5	19.9	0.832	101.6	NO DAMAGE			
140	-170	2	0.00015	18.3	19.9	16.4	19.9	0.826	98.3	NO DAMAGE			
140	-190	1	0.00007	18.3	19.9	16.2	19.9	0.815	92.4	NO DAMAGE			
140	-200	1	0.00007	18.3	19.9	16.1	19.9	0.809	89.6	NO DAMAGE			
140	-210	1	0.00007	18.3	19.9	16.0	19.9	0.804	87.1	NO DAMAGE			
140	-260	1	0.00007	18.3	19.9	15.4	19.9	0.776	76.2	NO DAMAGE			
135	125	2305	0.17184	18.3	19.8	19.7	19.8	0.994	3039.2	NO DAMAGE			
135	120	236	0.01759	18.3	19.8	19.6	19.8	0.992	2026.1	NO DAMAGE			
135	115	1901	0.14172	18.3	19.8	19.6	19.8	0.989	1519.6	NO DAMAGE			
135	110	117	0.00872	18.3	19.8	19.5	19.8	0.986	1215.7	NO DAMAGE			
135	105	472	0.03519	18.3	19.8	19.5	19.8	0.983	1013.1	NO DAMAGE			
135	100	55	0.00410	18.3	19.8	19.4	19.8	0.980	868.3	NO DAMAGE			
135	95	122	0.00910	18.3	19.8	19.4	19.8	0.977	759.8	NO DAMAGE			
135	90	11	0.00082	18.3	19.8	19.3	19.8	0.975	675.4	NO DAMAGE			
135	85	59	0.00440	18.3	19.8	19.2	19.8	0.972	607.8	NO DAMAGE			
135	80	6	0.00045	18.3	19.8	19.2	19.8	0.969	552.6	NO DAMAGE			
135	75	28	0.00209	18.3	19.8	19.1	19.8	0.966	506.5	NO DAMAGE			
135	70	2	0.00015	18.3	19.8	19.1	19.8	0.963	467.6	NO DAMAGE			
135	65	11	0.00082	18.3	19.8	19.0	19.8	0.961	434.2	NO DAMAGE			
135	60	1	0.00007	18.3	19.8	19.0	19.8	0.958	405.2	NO DAMAGE			
135	55	11	0.00082	18.3	19.8	18.9	19.8	0.955	379.9	NO DAMAGE			
135	50	2	0.00015	18.3	19.8	18.9	19.8	0.952	357.6	NO DAMAGE			
135	45	6	0.00045	18.3	19.8	18.8	19.8	0.949	337.7	NO DAMAGE			
135	35	3	0.00022	18.3	19.8	18.7	19.8	0.944	303.9	NO DAMAGE			
135	30	1	0.00007	18.3	19.8	18.6	19.8	0.941	289.4	NO DAMAGE			
135	25	6	0.00045	18.3	19.8	18.6	19.8	0.938	276.3	NO DAMAGE			
135	20	1	0.00007	18.3	19.8	18.5	19.8	0.935	264.3	NO DAMAGE			
135	15	5	0.00037	18.3	19.8	18.5	19.8	0.932	253.3	NO DAMAGE			
135	5	11	0.00082	18.3	19.8	18.4	19.8	0.927	233.8	NO DAMAGE			
135	0	4	0.00030	18.3	19.8	18.3	19.8	0.924	225.1	NO DAMAGE			
135	-5	1	0.00007	18.3	19.8	18.2	19.8	0.921	217.1	NO DAMAGE			
135	-15	1	0.00007	18.3	19.8	18.1	19.8	0.916	202.6	NO DAMAGE			
135	-35	1	0.00007	18.3	19.8	17.9	19.8	0.904	178.8	NO DAMAGE			
135	-40	1	0.00007	18.3	19.8	17.9	19.8	0.902	173.7	NO DAMAGE			
135	-45	3	0.00022	18.3	19.8	17.8	19.8	0.899	168.8	NO DAMAGE			
135	-65	1	0.00007	18.3	19.8	17.6	19.8	0.887	152.0	NO DAMAGE			
135	-85	2	0.00015	18.3	19.8	17.4	19.8	0.876	138.1	NO DAMAGE			
135	-95	1	0.00007	18.3	19.8	17.2	19.8	0.871	132.1	NO DAMAGE			
135	-100	1	0.00007	18.3	19.8	17.2	19.8	0.868	129.3	NO DAMAGE			
135	-105	4	0.00030	18.3	19.8	17.1	19.8	0.865	126.6	NO DAMAGE			
135	-115	3	0.00022	18.3	19.8	17.0	19.8	0.859	121.6	NO DAMAGE			
135	-125	6	0.00045	18.3	19.8	16.9	19.8	0.854	116.9	NO DAMAGE			
135	-135	4	0.00030	18.3	19.8	16.8	19.8	0.848	112.6	NO DAMAGE			
135	-145	3	0.00022	18.3	19.8	16.7	19.8	0.842	108.5	NO DAMAGE			
135	-155	3	0.00022	18.3	19.8	16.6	19.8	0.837	104.8	NO DAMAGE			
135	-160	2	0.00015	18.3	19.8	16.5	19.8	0.834	103.0	NO DAMAGE			
135	-165	2	0.00015	18.3	19.8	16.5	19.8	0.831	101.3	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
135	-175	2	0.00015	18.3	19.8	16.4	19.8	0.826	98.0	NO DAMAGE			
135	-185	2	0.00015	18.3	19.8	16.2	19.8	0.820	95.0	NO DAMAGE			
135	-195	2	0.00015	18.3	19.8	16.1	19.8	0.814	92.1	NO DAMAGE			
135	-205	1	0.00007	18.3	19.8	16.0	19.8	0.809	89.4	NO DAMAGE			
135	-235	1	0.00007	18.3	19.8	15.7	19.8	0.792	82.1	NO DAMAGE			
130	120	1350	0.10065	18.3	19.7	19.6	19.7	0.994	3030.6	NO DAMAGE			
130	115	357	0.02662	18.3	19.7	19.6	19.7	0.992	2020.4	NO DAMAGE			
130	110	1062	0.07918	18.3	19.7	19.5	19.7	0.989	1515.3	NO DAMAGE			
130	105	197	0.01469	18.3	19.7	19.5	19.7	0.986	1212.3	NO DAMAGE			
130	100	540	0.04026	18.3	19.7	19.4	19.7	0.983	1010.2	NO DAMAGE			
130	95	69	0.00514	18.3	19.7	19.4	19.7	0.980	865.9	NO DAMAGE			
130	90	301	0.02244	18.3	19.7	19.3	19.7	0.977	757.7	NO DAMAGE			
130	85	20	0.00149	18.3	19.7	19.2	19.7	0.975	673.5	NO DAMAGE			
130	80	166	0.01238	18.3	19.7	19.2	19.7	0.972	606.1	NO DAMAGE			
130	75	15	0.00112	18.3	19.7	19.1	19.7	0.969	551.0	NO DAMAGE			
130	70	66	0.00492	18.3	19.7	19.1	19.7	0.966	505.1	NO DAMAGE			
130	65	7	0.00052	18.3	19.7	19.0	19.7	0.963	466.3	NO DAMAGE			
130	60	35	0.00261	18.3	19.7	19.0	19.7	0.961	432.9	NO DAMAGE			
130	55	6	0.00045	18.3	19.7	18.9	19.7	0.958	404.1	NO DAMAGE			
130	50	34	0.00253	18.3	19.7	18.9	19.7	0.955	378.8	NO DAMAGE			
130	45	2	0.00015	18.3	19.7	18.8	19.7	0.952	356.5	NO DAMAGE			
130	40	12	0.00089	18.3	19.7	18.7	19.7	0.949	336.7	NO DAMAGE			
130	35	1	0.00007	18.3	19.7	18.7	19.7	0.946	319.0	NO DAMAGE			
130	30	6	0.00045	18.3	19.7	18.6	19.7	0.944	303.1	NO DAMAGE			
130	25	1	0.00007	18.3	19.7	18.6	19.7	0.941	288.6	NO DAMAGE			
130	20	10	0.00075	18.3	19.7	18.5	19.7	0.938	275.5	NO DAMAGE			
130	10	11	0.00082	18.3	19.7	18.4	19.7	0.932	252.6	NO DAMAGE			
130	0	11	0.00082	18.3	19.7	18.3	19.7	0.927	233.1	NO DAMAGE			
130	-5	2	0.00015	18.3	19.7	18.2	19.7	0.924	224.5	NO DAMAGE			
130	-10	8	0.00060	18.3	19.7	18.2	19.7	0.921	216.5	NO DAMAGE			
130	-20	1	0.00007	18.3	19.7	18.1	19.7	0.915	202.0	NO DAMAGE			
130	-30	5	0.00037	18.3	19.7	18.0	19.7	0.910	189.4	NO DAMAGE			
130	-35	1	0.00007	18.3	19.7	17.9	19.7	0.907	183.7	NO DAMAGE			
130	-40	2	0.00015	18.3	19.7	17.9	19.7	0.904	178.3	NO DAMAGE			
130	-50	2	0.00015	18.3	19.7	17.7	19.7	0.898	168.4	NO DAMAGE			
130	-60	8	0.00060	18.3	19.7	17.6	19.7	0.893	159.5	NO DAMAGE			
130	-70	5	0.00037	18.3	19.7	17.5	19.7	0.887	151.5	NO DAMAGE			
130	-80	4	0.00030	18.3	19.7	17.4	19.7	0.882	144.3	NO DAMAGE			
130	-90	6	0.00045	18.3	19.7	17.3	19.7	0.876	137.8	NO DAMAGE			
130	-100	4	0.00030	18.3	19.7	17.2	19.7	0.870	131.8	NO DAMAGE			
130	-110	5	0.00037	18.3	19.7	17.1	19.7	0.865	126.3	NO DAMAGE			
130	-120	2	0.00015	18.3	19.7	17.0	19.7	0.859	121.2	NO DAMAGE			
130	-130	2	0.00015	18.3	19.7	16.9	19.7	0.853	116.6	NO DAMAGE			
130	-140	1	0.00007	18.3	19.7	16.7	19.7	0.848	112.2	NO DAMAGE			
130	-150	1	0.00007	18.3	19.7	16.6	19.7	0.842	108.2	NO DAMAGE			
130	-160	3	0.00022	18.3	19.7	16.5	19.7	0.836	104.5	NO DAMAGE			
130	-170	1	0.00007	18.3	19.7	16.4	19.7	0.831	101.0	NO DAMAGE			
130	-205	1	0.00007	18.3	19.7	16.0	19.7	0.811	90.5	NO DAMAGE			
130	-215	1	0.00007	18.3	19.7	15.9	19.7	0.805	87.8	NO DAMAGE			
130	-220	1	0.00007	18.3	19.7	15.8	19.7	0.803	86.6	NO DAMAGE			
125	115	3294	0.24558	18.3	19.7	19.6	19.7	0.994	3022.1	NO DAMAGE			
125	110	660	0.04920	18.3	19.7	19.5	19.7	0.992	2014.7	NO DAMAGE			
125	105	2822	0.21039	18.3	19.7	19.5	19.7	0.989	1511.0	NO DAMAGE			
125	100	259	0.01931	18.3	19.7	19.4	19.7	0.986	1208.8	NO DAMAGE			
125	95	752	0.05606	18.3	19.7	19.4	19.7	0.983	1007.4	NO DAMAGE			
125	90	87	0.00649	18.3	19.7	19.3	19.7	0.980	863.5	NO DAMAGE			
125	85	266	0.01983	18.3	19.7	19.2	19.7	0.977	755.5	NO DAMAGE			
125	80	34	0.00253	18.3	19.7	19.2	19.7	0.975	671.6	NO DAMAGE			
125	75	137	0.01021	18.3	19.7	19.1	19.7	0.972	604.4	NO DAMAGE			
125	70	14	0.00104	18.3	19.7	19.1	19.7	0.969	549.5	NO DAMAGE			
125	65	87	0.00649	18.3	19.7	19.0	19.7	0.966	503.7	NO DAMAGE			
125	60	9	0.00067	18.3	19.7	19.0	19.7	0.963	464.9	NO DAMAGE			
125	55	39	0.00291	18.3	19.7	18.9	19.7	0.960	431.7	NO DAMAGE			
125	50	2	0.00015	18.3	19.7	18.9	19.7	0.958	402.9	NO DAMAGE			
125	45	22	0.00164	18.3	19.7	18.8	19.7	0.955	377.8	NO DAMAGE			
125	40	4	0.00030	18.3	19.7	18.7	19.7	0.952	355.5	NO DAMAGE			
125	35	8	0.00060	18.3	19.7	18.7	19.7	0.949	335.8	NO DAMAGE			
125	25	6	0.00045	18.3	19.7	18.6	19.7	0.943	302.2	NO DAMAGE			
125	15	8	0.00060	18.3	19.7	18.5	19.7	0.938	274.7	NO DAMAGE			
125	5	14	0.00104	18.3	19.7	18.4	19.7	0.932	251.8	NO DAMAGE			
125	0	4	0.00030	18.3	19.7	18.3	19.7	0.929	241.8	NO DAMAGE			
125	-5	5	0.00037	18.3	19.7	18.2	19.7	0.926	232.5	NO DAMAGE			
125	-15	1	0.00007	18.3	19.7	18.1	19.7	0.921	215.9	NO DAMAGE			
125	-20	1	0.00007	18.3	19.7	18.1	19.7	0.918	208.4	NO DAMAGE			
125	-25	1	0.00007	18.3	19.7	18.0	19.7	0.915	201.5	NO DAMAGE			
125	-35	1	0.00007	18.3	19.7	17.9	19.7	0.909	188.9	NO DAMAGE			
125	-55	3	0.00022	18.3	19.7	17.7	19.7	0.898	167.9	NO DAMAGE			
125	-65	1	0.00007	18.3	19.7	17.6	19.7	0.892	159.1	NO DAMAGE			
125	-75	2	0.00015	18.3	19.7	17.5	19.7	0.887	151.1	NO DAMAGE			
125	-85	3	0.00022	18.3	19.7	17.4	19.7	0.881	143.9	NO DAMAGE			
125	-95	7	0.00052	18.3	19.7	17.2	19.7	0.876	137.4	NO DAMAGE			
125	-100	3	0.00022	18.3	19.7	17.2	19.7	0.873	134.3	NO DAMAGE			
125	-105	3	0.00022	18.3	19.7	17.1	19.7	0.870	131.4	NO DAMAGE			
125	-115	3	0.00022	18.3	19.7	17.0	19.7	0.864	125.9	NO DAMAGE			
125	-120	2	0.00015	18.3	19.7	17.0	19.7	0.861	123.4	NO DAMAGE			
125	-125	3	0.00022	18.3	19.7	16.9	19.7	0.859	120.9	NO DAMAGE			
125	-135	1	0.00007	18.3	19.7	16.8	19.7	0.853	116.2	NO DAMAGE			
125	-145	1	0.00007	18.3	19.7	16.7	19.7	0.847	111.9	NO DAMAGE			
125	-155	1	0.00007	18.3	19.7	16.6	19.7	0.842	107.9	NO DAMAGE			
125	-165	2	0.00015	18.3	19.7	16.5	19.7	0.836	104.2	NO DAMAGE			
125	-190	1	0.00007	18.3	19.7	16.2	19.7	0.822	95.9	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
125	-205	3	0.00022	18.3	19.7	16.0	19.7	0.813	91.6	NO DAMAGE			
125	-225	2	0.00015	18.3	19.7	15.8	19.7	0.802	86.3	NO DAMAGE			
120	110	2455	0.18303	18.3	19.6	19.5	19.6	0.994	3013.5	NO DAMAGE			
120	105	678	0.05055	18.3	19.6	19.5	19.6	0.991	2009.0	NO DAMAGE			
120	100	1649	0.12294	18.3	19.6	19.4	19.6	0.989	1506.8	NO DAMAGE			
120	95	334	0.02490	18.3	19.6	19.4	19.6	0.986	1205.4	NO DAMAGE			
120	90	851	0.06344	18.3	19.6	19.3	19.6	0.983	1004.5	NO DAMAGE			
120	85	101	0.00753	18.3	19.6	19.2	19.6	0.980	861.0	NO DAMAGE			
120	80	398	0.02967	18.3	19.6	19.2	19.6	0.977	753.4	NO DAMAGE			
120	75	38	0.00283	18.3	19.6	19.1	19.6	0.974	669.7	NO DAMAGE			
120	70	202	0.01506	18.3	19.6	19.1	19.6	0.972	602.7	NO DAMAGE			
120	65	15	0.00112	18.3	19.6	19.0	19.6	0.969	547.9	NO DAMAGE			
120	60	115	0.00857	18.3	19.6	19.0	19.6	0.966	502.3	NO DAMAGE			
120	55	12	0.00089	18.3	19.6	18.9	19.6	0.963	463.6	NO DAMAGE			
120	50	63	0.00470	18.3	19.6	18.9	19.6	0.960	430.5	NO DAMAGE			
120	45	2	0.00015	18.3	19.6	18.8	19.6	0.957	401.8	NO DAMAGE			
120	40	37	0.00276	18.3	19.6	18.7	19.6	0.955	376.7	NO DAMAGE			
120	35	3	0.00022	18.3	19.6	18.7	19.6	0.952	354.5	NO DAMAGE			
120	30	27	0.00201	18.3	19.6	18.6	19.6	0.949	334.8	NO DAMAGE			
120	25	3	0.00022	18.3	19.6	18.6	19.6	0.946	317.2	NO DAMAGE			
120	20	15	0.00112	18.3	19.6	18.5	19.6	0.943	301.4	NO DAMAGE			
120	15	1	0.00007	18.3	19.6	18.5	19.6	0.940	287.0	NO DAMAGE			
120	10	13	0.00097	18.3	19.6	18.4	19.6	0.938	274.0	NO DAMAGE			
120	5	5	0.00037	18.3	19.6	18.4	19.6	0.935	262.0	NO DAMAGE			
120	0	23	0.00171	18.3	19.6	18.3	19.6	0.932	251.1	NO DAMAGE			
120	-5	4	0.00030	18.3	19.6	18.2	19.6	0.929	241.1	NO DAMAGE			
120	-10	19	0.00142	18.3	19.6	18.2	19.6	0.926	231.8	NO DAMAGE			
120	-20	3	0.00022	18.3	19.6	18.1	19.6	0.921	215.3	NO DAMAGE			
120	-30	7	0.00052	18.3	19.6	18.0	19.6	0.915	200.9	NO DAMAGE			
120	-40	1	0.00007	18.3	19.6	17.9	19.6	0.909	188.3	NO DAMAGE			
120	-45	1	0.00007	18.3	19.6	17.8	19.6	0.906	182.6	NO DAMAGE			
120	-50	6	0.00045	18.3	19.6	17.7	19.6	0.904	177.3	NO DAMAGE			
120	-55	1	0.00007	18.3	19.6	17.7	19.6	0.901	172.2	NO DAMAGE			
120	-60	3	0.00022	18.3	19.6	17.6	19.6	0.898	167.4	NO DAMAGE			
120	-70	9	0.00067	18.3	19.6	17.5	19.6	0.892	158.6	NO DAMAGE			
120	-80	5	0.00037	18.3	19.6	17.4	19.6	0.887	150.7	NO DAMAGE			
120	-85	1	0.00007	18.3	19.6	17.4	19.6	0.884	147.0	NO DAMAGE			
120	-90	8	0.00060	18.3	19.6	17.3	19.6	0.881	143.5	NO DAMAGE			
120	-100	6	0.00045	18.3	19.6	17.2	19.6	0.875	137.0	NO DAMAGE			
120	-110	7	0.00052	18.3	19.6	17.1	19.6	0.869	131.0	NO DAMAGE			
120	-115	1	0.00007	18.3	19.6	17.0	19.6	0.867	128.2	NO DAMAGE			
120	-120	3	0.00022	18.3	19.6	17.0	19.6	0.864	125.6	NO DAMAGE			
120	-130	2	0.00015	18.3	19.6	16.9	19.6	0.858	120.5	NO DAMAGE			
120	-135	1	0.00007	18.3	19.6	16.8	19.6	0.855	118.2	NO DAMAGE			
120	-140	5	0.00037	18.3	19.6	16.7	19.6	0.852	115.9	NO DAMAGE			
120	-145	1	0.00007	18.3	19.6	16.7	19.6	0.850	113.7	NO DAMAGE			
120	-150	2	0.00015	18.3	19.6	16.6	19.6	0.847	111.6	NO DAMAGE			
120	-155	1	0.00007	18.3	19.6	16.6	19.6	0.844	109.6	NO DAMAGE			
120	-160	2	0.00015	18.3	19.6	16.5	19.6	0.841	107.6	NO DAMAGE			
120	-180	2	0.00015	18.3	19.6	16.3	19.6	0.830	100.5	NO DAMAGE			
120	-235	1	0.00007	18.3	19.6	15.7	19.6	0.799	84.9	NO DAMAGE			
115	105	4703	0.35062	18.3	19.6	19.5	19.6	0.994	3005.0	NO DAMAGE			
115	100	908	0.06769	18.3	19.6	19.4	19.6	0.991	2003.3	NO DAMAGE			
115	95	3914	0.29180	18.3	19.6	19.4	19.6	0.989	1502.5	NO DAMAGE			
115	90	307	0.02289	18.3	19.6	19.3	19.6	0.986	1202.0	NO DAMAGE			
115	85	2643	0.19704	18.3	19.6	19.2	19.6	0.983	1001.7	NO DAMAGE			
115	80	181	0.01349	18.3	19.6	19.2	19.6	0.980	858.6	NO DAMAGE			
115	75	676	0.05040	18.3	19.6	19.1	19.6	0.977	751.2	NO DAMAGE			
115	70	90	0.00671	18.3	19.6	19.1	19.6	0.974	667.8	NO DAMAGE			
115	65	334	0.02490	18.3	19.6	19.0	19.6	0.972	601.0	NO DAMAGE			
115	60	32	0.00239	18.3	19.6	19.0	19.6	0.969	546.4	NO DAMAGE			
115	55	129	0.00962	18.3	19.6	18.9	19.6	0.966	500.8	NO DAMAGE			
115	50	13	0.00097	18.3	19.6	18.9	19.6	0.963	462.3	NO DAMAGE			
115	45	39	0.00291	18.3	19.6	18.8	19.6	0.960	429.3	NO DAMAGE			
115	40	5	0.00037	18.3	19.6	18.7	19.6	0.957	400.7	NO DAMAGE			
115	35	21	0.00157	18.3	19.6	18.7	19.6	0.954	375.6	NO DAMAGE			
115	30	1	0.00007	18.3	19.6	18.6	19.6	0.952	353.5	NO DAMAGE			
115	25	10	0.00075	18.3	19.6	18.6	19.6	0.949	333.9	NO DAMAGE			
115	20	2	0.00015	18.3	19.6	18.5	19.6	0.946	316.3	NO DAMAGE			
115	15	11	0.00082	18.3	19.6	18.5	19.6	0.943	300.5	NO DAMAGE			
115	5	18	0.00134	18.3	19.6	18.4	19.6	0.937	273.2	NO DAMAGE			
115	0	4	0.00030	18.3	19.6	18.3	19.6	0.935	261.3	NO DAMAGE			
115	-5	5	0.00037	18.3	19.6	18.2	19.6	0.932	250.4	NO DAMAGE			
115	-15	2	0.00015	18.3	19.6	18.1	19.6	0.926	231.2	NO DAMAGE			
115	-20	3	0.00022	18.3	19.6	18.1	19.6	0.923	222.6	NO DAMAGE			
115	-25	2	0.00015	18.3	19.6	18.0	19.6	0.920	214.6	NO DAMAGE			
115	-35	2	0.00015	18.3	19.6	17.9	19.6	0.915	200.3	NO DAMAGE			
115	-40	2	0.00015	18.3	19.6	17.9	19.6	0.912	193.9	NO DAMAGE			
115	-45	2	0.00015	18.3	19.6	17.8	19.6	0.909	187.8	NO DAMAGE			
115	-50	1	0.00007	18.3	19.6	17.7	19.6	0.906	182.1	NO DAMAGE			
115	-55	1	0.00007	18.3	19.6	17.7	19.6	0.903	176.8	NO DAMAGE			
115	-65	2	0.00015	18.3	19.6	17.6	19.6	0.898	166.9	NO DAMAGE			
115	-75	2	0.00015	18.3	19.6	17.5	19.6	0.892	158.2	NO DAMAGE			
115	-85	2	0.00015	18.3	19.6	17.4	19.6	0.886	150.2	NO DAMAGE			
115	-95	3	0.00022	18.3	19.6	17.2	19.6	0.880	143.1	NO DAMAGE			
115	-105	4	0.00030	18.3	19.6	17.1	19.6	0.875	136.6	NO DAMAGE			
115	-115	2	0.00015	18.3	19.6	17.0	19.6	0.869	130.7	NO DAMAGE			
115	-125	3	0.00022	18.3	19.6	16.9	19.6	0.863	125.2	NO DAMAGE			
115	-135	1	0.00007	18.3	19.6	16.8	19.6	0.858	120.2	NO DAMAGE			
115	-155	1	0.00007	18.3	19.6	16.6	19.6	0.846	111.3	NO DAMAGE			
115	-170	1	0.00007	18.3	19.6	16.4	19.6	0.838	105.4	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
115	-190	1	0.00007	18.3	19.6	16.2	19.6	0.826	98.5	NO DAMAGE			
115	-195	1	0.00007	18.3	19.6	16.1	19.6	0.824	96.9	NO DAMAGE			
115	-215	1	0.00007	18.3	19.6	15.9	19.6	0.812	91.1	NO DAMAGE			
110	100	3541	0.26399	18.3	19.5	19.4	19.5	0.994	2996.4	NO DAMAGE			
110	95	922	0.06874	18.3	19.5	19.4	19.5	0.991	1997.6	NO DAMAGE			
110	90	2060	0.15358	18.3	19.5	19.3	19.5	0.989	1498.2	NO DAMAGE			
110	85	527	0.03929	18.3	19.5	19.2	19.5	0.986	1198.6	NO DAMAGE			
110	80	1233	0.09192	18.3	19.5	19.2	19.5	0.983	998.8	NO DAMAGE			
110	75	313	0.02334	18.3	19.5	19.1	19.5	0.980	856.1	NO DAMAGE			
110	70	677	0.05047	18.3	19.5	19.1	19.5	0.977	749.1	NO DAMAGE			
110	65	107	0.00798	18.3	19.5	19.0	19.5	0.974	665.9	NO DAMAGE			
110	60	289	0.02155	18.3	19.5	19.0	19.5	0.971	599.3	NO DAMAGE			
110	55	26	0.00194	18.3	19.5	18.9	19.5	0.969	544.8	NO DAMAGE			
110	50	126	0.00939	18.3	19.5	18.9	19.5	0.966	499.4	NO DAMAGE			
110	45	5	0.00037	18.3	19.5	18.8	19.5	0.963	461.0	NO DAMAGE			
110	40	74	0.00552	18.3	19.5	18.7	19.5	0.960	428.1	NO DAMAGE			
110	35	6	0.00045	18.3	19.5	18.7	19.5	0.957	399.5	NO DAMAGE			
110	30	32	0.00239	18.3	19.5	18.6	19.5	0.954	374.6	NO DAMAGE			
110	25	2	0.00015	18.3	19.5	18.6	19.5	0.951	352.5	NO DAMAGE			
110	20	28	0.00209	18.3	19.5	18.5	19.5	0.949	332.9	NO DAMAGE			
110	15	1	0.00007	18.3	19.5	18.5	19.5	0.946	315.4	NO DAMAGE			
110	10	26	0.00194	18.3	19.5	18.4	19.5	0.943	299.6	NO DAMAGE			
110	5	1	0.00007	18.3	19.5	18.4	19.5	0.940	285.4	NO DAMAGE			
110	0	47	0.00350	18.3	19.5	18.3	19.5	0.937	272.4	NO DAMAGE			
110	-5	2	0.00015	18.3	19.5	18.2	19.5	0.934	260.6	NO DAMAGE			
110	-10	22	0.00164	18.3	19.5	18.2	19.5	0.932	249.7	NO DAMAGE			
110	-20	4	0.00030	18.3	19.5	18.1	19.5	0.926	230.5	NO DAMAGE			
110	-30	5	0.00037	18.3	19.5	18.0	19.5	0.920	214.0	NO DAMAGE			
110	-35	1	0.00007	18.3	19.5	17.9	19.5	0.917	206.7	NO DAMAGE			
110	-40	2	0.00015	18.3	19.5	17.9	19.5	0.914	199.8	NO DAMAGE			
110	-50	5	0.00037	18.3	19.5	17.7	19.5	0.909	187.3	NO DAMAGE			
110	-60	6	0.00045	18.3	19.5	17.6	19.5	0.903	176.3	NO DAMAGE			
110	-70	6	0.00045	18.3	19.5	17.5	19.5	0.897	166.5	NO DAMAGE			
110	-80	6	0.00045	18.3	19.5	17.4	19.5	0.892	157.7	NO DAMAGE			
110	-90	8	0.00060	18.3	19.5	17.3	19.5	0.886	149.8	NO DAMAGE			
110	-100	9	0.00067	18.3	19.5	17.2	19.5	0.880	142.7	NO DAMAGE			
110	-110	6	0.00045	18.3	19.5	17.1	19.5	0.874	136.2	NO DAMAGE			
110	-120	5	0.00037	18.3	19.5	17.0	19.5	0.869	130.3	NO DAMAGE			
110	-130	1	0.00007	18.3	19.5	16.9	19.5	0.863	124.9	NO DAMAGE			
110	-135	1	0.00007	18.3	19.5	16.8	19.5	0.860	122.3	NO DAMAGE			
110	-140	2	0.00015	18.3	19.5	16.7	19.5	0.857	119.9	NO DAMAGE			
110	-150	2	0.00015	18.3	19.5	16.6	19.5	0.852	115.2	NO DAMAGE			
110	-160	1	0.00007	18.3	19.5	16.5	19.5	0.846	111.0	NO DAMAGE			
110	-170	1	0.00007	18.3	19.5	16.4	19.5	0.840	107.0	NO DAMAGE			
110	-180	1	0.00007	18.3	19.5	16.3	19.5	0.835	103.3	NO DAMAGE			
110	-210	1	0.00007	18.3	19.5	16.0	19.5	0.817	93.6	NO DAMAGE			
105	95	10845	0.80852	18.3	19.5	19.4	19.5	0.994	2987.9	NO DAMAGE			
105	90	1293	0.09640	18.3	19.5	19.3	19.5	0.991	1991.9	NO DAMAGE			
105	85	5514	0.41108	18.3	19.5	19.2	19.5	0.989	1493.9	NO DAMAGE			
105	80	765	0.05703	18.3	19.5	19.2	19.5	0.986	1195.2	NO DAMAGE			
105	75	2419	0.18034	18.3	19.5	19.1	19.5	0.983	996.0	NO DAMAGE			
105	70	358	0.02669	18.3	19.5	19.1	19.5	0.980	853.7	NO DAMAGE			
105	65	920	0.06859	18.3	19.5	19.0	19.5	0.977	747.0	NO DAMAGE			
105	60	78	0.00582	18.3	19.5	19.0	19.5	0.974	664.0	NO DAMAGE			
105	55	262	0.01953	18.3	19.5	18.9	19.5	0.971	597.6	NO DAMAGE			
105	50	22	0.00164	18.3	19.5	18.9	19.5	0.969	543.3	NO DAMAGE			
105	45	100	0.00746	18.3	19.5	18.8	19.5	0.966	498.0	NO DAMAGE			
105	40	4	0.00030	18.3	19.5	18.7	19.5	0.963	459.7	NO DAMAGE			
105	35	54	0.00403	18.3	19.5	18.7	19.5	0.960	426.8	NO DAMAGE			
105	30	1	0.00007	18.3	19.5	18.6	19.5	0.957	398.4	NO DAMAGE			
105	25	20	0.00149	18.3	19.5	18.6	19.5	0.954	373.5	NO DAMAGE			
105	20	4	0.00030	18.3	19.5	18.5	19.5	0.951	351.5	NO DAMAGE			
105	15	18	0.00134	18.3	19.5	18.5	19.5	0.948	332.0	NO DAMAGE			
105	10	1	0.00007	18.3	19.5	18.4	19.5	0.946	314.5	NO DAMAGE			
105	5	22	0.00164	18.3	19.5	18.4	19.5	0.943	298.8	NO DAMAGE			
105	0	2	0.00015	18.3	19.5	18.3	19.5	0.940	284.6	NO DAMAGE			
105	-5	4	0.00030	18.3	19.5	18.2	19.5	0.937	271.6	NO DAMAGE			
105	-10	1	0.00007	18.3	19.5	18.2	19.5	0.934	259.8	NO DAMAGE			
105	-15	3	0.00022	18.3	19.5	18.1	19.5	0.931	249.0	NO DAMAGE			
105	-20	1	0.00007	18.3	19.5	18.1	19.5	0.928	239.0	NO DAMAGE			
105	-25	2	0.00015	18.3	19.5	18.0	19.5	0.926	229.8	NO DAMAGE			
105	-35	4	0.00030	18.3	19.5	17.9	19.5	0.920	213.4	NO DAMAGE			
105	-45	3	0.00022	18.3	19.5	17.8	19.5	0.914	199.2	NO DAMAGE			
105	-55	1	0.00007	18.3	19.5	17.7	19.5	0.908	186.7	NO DAMAGE			
105	-65	1	0.00007	18.3	19.5	17.6	19.5	0.903	175.8	NO DAMAGE			
105	-75	2	0.00015	18.3	19.5	17.5	19.5	0.897	166.0	NO DAMAGE			
105	-85	6	0.00045	18.3	19.5	17.4	19.5	0.891	157.3	NO DAMAGE			
105	-95	6	0.00045	18.3	19.5	17.2	19.5	0.886	149.4	NO DAMAGE			
105	-105	3	0.00022	18.3	19.5	17.1	19.5	0.880	142.3	NO DAMAGE			
105	-110	2	0.00015	18.3	19.5	17.1	19.5	0.877	139.0	NO DAMAGE			
105	-120	2	0.00015	18.3	19.5	17.0	19.5	0.871	132.8	NO DAMAGE			
105	-125	1	0.00007	18.3	19.5	16.9	19.5	0.868	129.9	NO DAMAGE			
105	-145	3	0.00022	18.3	19.5	16.7	19.5	0.857	119.5	NO DAMAGE			
105	-165	1	0.00007	18.3	19.5	16.5	19.5	0.845	110.7	NO DAMAGE			
105	-185	1	0.00007	18.3	19.5	16.2	19.5	0.834	103.0	NO DAMAGE			
105	-195	1	0.00007	18.3	19.5	16.1	19.5	0.828	99.6	NO DAMAGE			
105	-225	1	0.00007	18.3	19.5	15.8	19.5	0.811	90.5	NO DAMAGE			
105	-255	1	0.00007	18.3	19.5	15.5	19.5	0.794	83.0	NO DAMAGE			
100	90	4690	0.34965	18.3	19.4	19.3	19.4	0.994	2979.3	NO DAMAGE			
100	85	1557	0.11608	18.3	19.4	19.2	19.4	0.991	1986.2	NO DAMAGE			
100	80	3257	0.24282	18.3	19.4	19.2	19.4	0.989	1489.7	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
100	75	901	0.06717	18.3	19.4	19.1	19.4	0.986	1191.7	NO DAMAGE			
100	70	1551	0.11563	18.3	19.4	19.1	19.4	0.983	993.1	NO DAMAGE			
100	65	248	0.01849	18.3	19.4	19.0	19.4	0.980	851.2	NO DAMAGE			
100	60	739	0.05509	18.3	19.4	19.0	19.4	0.977	744.8	NO DAMAGE			
100	55	63	0.00470	18.3	19.4	18.9	19.4	0.974	662.1	NO DAMAGE			
100	50	318	0.02371	18.3	19.4	18.9	19.4	0.971	595.9	NO DAMAGE			
100	45	22	0.00164	18.3	19.4	18.8	19.4	0.968	541.7	NO DAMAGE			
100	40	168	0.01252	18.3	19.4	18.7	19.4	0.966	496.6	NO DAMAGE			
100	35	5	0.00037	18.3	19.4	18.7	19.4	0.963	458.4	NO DAMAGE			
100	30	90	0.00671	18.3	19.4	18.6	19.4	0.960	425.6	NO DAMAGE			
100	25	11	0.00082	18.3	19.4	18.6	19.4	0.957	397.2	NO DAMAGE			
100	20	55	0.00410	18.3	19.4	18.5	19.4	0.954	372.4	NO DAMAGE			
100	15	1	0.00007	18.3	19.4	18.5	19.4	0.951	350.5	NO DAMAGE			
100	10	42	0.00313	18.3	19.4	18.4	19.4	0.948	331.0	NO DAMAGE			
100	5	2	0.00015	18.3	19.4	18.4	19.4	0.945	313.6	NO DAMAGE			
100	0	58	0.00432	18.3	19.4	18.3	19.4	0.943	297.9	NO DAMAGE			
100	-5	1	0.00007	18.3	19.4	18.2	19.4	0.940	283.7	NO DAMAGE			
100	-10	32	0.00239	18.3	19.4	18.2	19.4	0.937	270.8	NO DAMAGE			
100	-15	1	0.00007	18.3	19.4	18.1	19.4	0.934	259.1	NO DAMAGE			
100	-20	5	0.00037	18.3	19.4	18.1	19.4	0.931	248.3	NO DAMAGE			
100	-30	7	0.00052	18.3	19.4	18.0	19.4	0.925	229.2	NO DAMAGE			
100	-40	2	0.00015	18.3	19.4	17.9	19.4	0.920	212.8	NO DAMAGE			
100	-45	1	0.00007	18.3	19.4	17.8	19.4	0.917	205.5	NO DAMAGE			
100	-50	7	0.00052	18.3	19.4	17.7	19.4	0.914	198.6	NO DAMAGE			
100	-60	8	0.00060	18.3	19.4	17.6	19.4	0.908	186.2	NO DAMAGE			
100	-70	3	0.00022	18.3	19.4	17.5	19.4	0.902	175.3	NO DAMAGE			
100	-80	2	0.00015	18.3	19.4	17.4	19.4	0.897	165.5	NO DAMAGE			
100	-90	9	0.00067	18.3	19.4	17.3	19.4	0.891	156.8	NO DAMAGE			
100	-100	4	0.00030	18.3	19.4	17.2	19.4	0.885	149.0	NO DAMAGE			
100	-110	3	0.00022	18.3	19.4	17.1	19.4	0.879	141.9	NO DAMAGE			
100	-120	1	0.00007	18.3	19.4	17.0	19.4	0.874	135.4	NO DAMAGE			
100	-125	1	0.00007	18.3	19.4	16.9	19.4	0.871	132.4	NO DAMAGE			
100	-130	3	0.00022	18.3	19.4	16.9	19.4	0.868	129.5	NO DAMAGE			
100	-140	2	0.00015	18.3	19.4	16.7	19.4	0.862	124.1	NO DAMAGE			
100	-150	2	0.00015	18.3	19.4	16.6	19.4	0.857	119.2	NO DAMAGE			
100	-160	1	0.00007	18.3	19.4	16.5	19.4	0.851	114.6	NO DAMAGE			
100	-180	2	0.00015	18.3	19.4	16.3	19.4	0.839	106.4	NO DAMAGE			
100	-190	2	0.00015	18.3	19.4	16.2	19.4	0.834	102.7	NO DAMAGE			
100	-200	3	0.00022	18.3	19.4	16.1	19.4	0.828	99.3	NO DAMAGE			
100	-205	1	0.00007	18.3	19.4	16.0	19.4	0.825	97.7	NO DAMAGE			
100	-210	1	0.00007	18.3	19.4	16.0	19.4	0.822	96.1	NO DAMAGE			
95	85	7900	0.58897	18.3	19.4	19.2	19.4	0.994	2970.8	NO DAMAGE			
95	80	1725	0.12860	18.3	19.4	19.2	19.4	0.991	1980.5	NO DAMAGE			
95	75	6072	0.45268	18.3	19.4	19.1	19.4	0.988	1485.4	NO DAMAGE			
95	70	643	0.04794	18.3	19.4	19.1	19.4	0.986	1188.3	NO DAMAGE			
95	65	2494	0.18593	18.3	19.4	19.0	19.4	0.983	990.3	NO DAMAGE			
95	60	216	0.01610	18.3	19.4	19.0	19.4	0.980	848.8	NO DAMAGE			
95	55	984	0.07336	18.3	19.4	18.9	19.4	0.977	742.7	NO DAMAGE			
95	50	63	0.00470	18.3	19.4	18.9	19.4	0.974	660.2	NO DAMAGE			
95	45	319	0.02378	18.3	19.4	18.8	19.4	0.971	594.2	NO DAMAGE			
95	40	22	0.00164	18.3	19.4	18.7	19.4	0.968	540.1	NO DAMAGE			
95	35	103	0.00768	18.3	19.4	18.7	19.4	0.965	495.1	NO DAMAGE			
95	30	19	0.00142	18.3	19.4	18.6	19.4	0.963	457.0	NO DAMAGE			
95	25	38	0.00283	18.3	19.4	18.6	19.4	0.960	424.4	NO DAMAGE			
95	20	2	0.00015	18.3	19.4	18.5	19.4	0.957	396.1	NO DAMAGE			
95	15	11	0.00082	18.3	19.4	18.5	19.4	0.954	371.3	NO DAMAGE			
95	5	28	0.00209	18.3	19.4	18.4	19.4	0.948	330.1	NO DAMAGE			
95	0	7	0.00052	18.3	19.4	18.3	19.4	0.945	312.7	NO DAMAGE			
95	-5	5	0.00037	18.3	19.4	18.2	19.4	0.942	297.1	NO DAMAGE			
95	-15	1	0.00007	18.3	19.4	18.1	19.4	0.937	270.1	NO DAMAGE			
95	-25	2	0.00015	18.3	19.4	18.0	19.4	0.931	247.6	NO DAMAGE			
95	-35	3	0.00022	18.3	19.4	17.9	19.4	0.925	228.5	NO DAMAGE			
95	-45	1	0.00007	18.3	19.4	17.8	19.4	0.919	212.2	NO DAMAGE			
95	-55	1	0.00007	18.3	19.4	17.7	19.4	0.914	198.1	NO DAMAGE			
95	-70	1	0.00007	18.3	19.4	17.5	19.4	0.905	180.0	NO DAMAGE			
95	-75	6	0.00045	18.3	19.4	17.5	19.4	0.902	174.8	NO DAMAGE			
95	-85	5	0.00037	18.3	19.4	17.4	19.4	0.896	165.0	NO DAMAGE			
95	-95	4	0.00030	18.3	19.4	17.2	19.4	0.891	156.4	NO DAMAGE			
95	-100	1	0.00007	18.3	19.4	17.2	19.4	0.888	152.3	NO DAMAGE			
95	-105	5	0.00037	18.3	19.4	17.1	19.4	0.885	148.5	NO DAMAGE			
95	-110	3	0.00022	18.3	19.4	17.1	19.4	0.882	144.9	NO DAMAGE			
95	-115	3	0.00022	18.3	19.4	17.0	19.4	0.879	141.5	NO DAMAGE			
95	-125	1	0.00007	18.3	19.4	16.9	19.4	0.873	135.0	NO DAMAGE			
95	-135	2	0.00015	18.3	19.4	16.8	19.4	0.868	129.2	NO DAMAGE			
95	-140	1	0.00007	18.3	19.4	16.7	19.4	0.865	126.4	NO DAMAGE			
95	-145	1	0.00007	18.3	19.4	16.7	19.4	0.862	123.8	NO DAMAGE			
95	-165	3	0.00022	18.3	19.4	16.5	19.4	0.850	114.3	NO DAMAGE			
95	-225	1	0.00007	18.3	19.4	15.8	19.4	0.816	92.8	NO DAMAGE			
95	-280	1	0.00007	18.3	19.4	15.2	19.4	0.784	79.2	NO DAMAGE			
90	80	6066	0.45224	18.3	19.3	19.2	19.3	0.994	2962.2	NO DAMAGE			
90	75	1408	0.10497	18.3	19.3	19.1	19.3	0.991	1974.8	NO DAMAGE			
90	70	3591	0.26772	18.3	19.3	19.1	19.3	0.988	1481.1	NO DAMAGE			
90	65	591	0.04406	18.3	19.3	19.0	19.3	0.986	1184.9	NO DAMAGE			
90	60	1593	0.11876	18.3	19.3	19.0	19.3	0.983	987.4	NO DAMAGE			
90	55	275	0.02050	18.3	19.3	18.9	19.3	0.980	846.4	NO DAMAGE			
90	50	789	0.05882	18.3	19.3	18.9	19.3	0.977	740.6	NO DAMAGE			
90	45	83	0.00619	18.3	19.3	18.8	19.3	0.974	658.3	NO DAMAGE			
90	40	470	0.03504	18.3	19.3	18.7	19.3	0.971	592.4	NO DAMAGE			
90	35	20	0.00149	18.3	19.3	18.7	19.3	0.968	538.6	NO DAMAGE			
90	30	188	0.01402	18.3	19.3	18.6	19.3	0.965	493.7	NO DAMAGE			
90	25	8	0.00060	18.3	19.3	18.6	19.3	0.962	455.7	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
90	20	113	0.00842	18.3	19.3	18.5	19.3	0.960	423.2	NO DAMAGE			
90	15	4	0.00030	18.3	19.3	18.5	19.3	0.957	395.0	NO DAMAGE			
90	10	68	0.00507	18.3	19.3	18.4	19.3	0.954	370.3	NO DAMAGE			
90	5	2	0.00015	18.3	19.3	18.4	19.3	0.951	348.5	NO DAMAGE			
90	0	78	0.00582	18.3	19.3	18.3	19.3	0.948	329.1	NO DAMAGE			
90	-5	2	0.00015	18.3	19.3	18.2	19.3	0.945	311.8	NO DAMAGE			
90	-10	32	0.00239	18.3	19.3	18.2	19.3	0.942	296.2	NO DAMAGE			
90	-15	1	0.00007	18.3	19.3	18.1	19.3	0.939	282.1	NO DAMAGE			
90	-20	4	0.00030	18.3	19.3	18.1	19.3	0.937	269.3	NO DAMAGE			
90	-30	4	0.00030	18.3	19.3	18.0	19.3	0.931	246.9	NO DAMAGE			
90	-40	6	0.00045	18.3	19.3	17.9	19.3	0.925	227.9	NO DAMAGE			
90	-45	1	0.00007	18.3	19.3	17.8	19.3	0.922	219.4	NO DAMAGE			
90	-50	7	0.00052	18.3	19.3	17.7	19.3	0.919	211.6	NO DAMAGE			
90	-60	14	0.00104	18.3	19.3	17.6	19.3	0.913	197.5	NO DAMAGE			
90	-70	8	0.00060	18.3	19.3	17.5	19.3	0.908	185.1	NO DAMAGE			
90	-80	13	0.00097	18.3	19.3	17.4	19.3	0.902	174.2	NO DAMAGE			
90	-90	6	0.00045	18.3	19.3	17.3	19.3	0.896	164.6	NO DAMAGE			
90	-95	1	0.00007	18.3	19.3	17.2	19.3	0.893	160.1	NO DAMAGE			
90	-100	7	0.00052	18.3	19.3	17.2	19.3	0.890	155.9	NO DAMAGE			
90	-110	2	0.00015	18.3	19.3	17.1	19.3	0.885	148.1	NO DAMAGE			
90	-115	2	0.00015	18.3	19.3	17.0	19.3	0.882	144.5	NO DAMAGE			
90	-120	3	0.00022	18.3	19.3	17.0	19.3	0.879	141.1	NO DAMAGE			
90	-140	2	0.00015	18.3	19.3	16.7	19.3	0.867	128.8	NO DAMAGE			
90	-145	1	0.00007	18.3	19.3	16.7	19.3	0.864	126.1	NO DAMAGE			
90	-150	2	0.00015	18.3	19.3	16.6	19.3	0.861	123.4	NO DAMAGE			
90	-160	3	0.00022	18.3	19.3	16.5	19.3	0.856	118.5	NO DAMAGE			
90	-170	1	0.00007	18.3	19.3	16.4	19.3	0.850	113.9	NO DAMAGE			
90	-180	1	0.00007	18.3	19.3	16.3	19.3	0.844	109.7	NO DAMAGE			
90	-190	1	0.00007	18.3	19.3	16.2	19.3	0.838	105.8	NO DAMAGE			
85	75	8202	0.61148	18.3	19.2	19.1	19.2	0.994	2953.7	NO DAMAGE			
85	70	1902	0.14180	18.3	19.2	19.1	19.2	0.991	1969.1	NO DAMAGE			
85	65	6590	0.49130	18.3	19.2	19.0	19.2	0.988	1476.8	NO DAMAGE			
85	60	711	0.05301	18.3	19.2	19.0	19.2	0.986	1181.5	NO DAMAGE			
85	55	3052	0.22754	18.3	19.2	18.9	19.2	0.983	984.6	NO DAMAGE			
85	50	292	0.02177	18.3	19.2	18.9	19.2	0.980	843.9	NO DAMAGE			
85	45	792	0.05905	18.3	19.2	18.8	19.2	0.977	738.4	NO DAMAGE			
85	40	65	0.00485	18.3	19.2	18.7	19.2	0.974	656.4	NO DAMAGE			
85	35	260	0.01938	18.3	19.2	18.7	19.2	0.971	590.7	NO DAMAGE			
85	30	14	0.00104	18.3	19.2	18.6	19.2	0.968	537.0	NO DAMAGE			
85	25	111	0.00828	18.3	19.2	18.6	19.2	0.965	492.3	NO DAMAGE			
85	20	1	0.00007	18.3	19.2	18.5	19.2	0.962	454.4	NO DAMAGE			
85	15	71	0.00529	18.3	19.2	18.5	19.2	0.959	422.0	NO DAMAGE			
85	5	72	0.00537	18.3	19.2	18.4	19.2	0.954	369.2	NO DAMAGE			
85	0	6	0.00045	18.3	19.2	18.3	19.2	0.951	347.5	NO DAMAGE			
85	-5	6	0.00045	18.3	19.2	18.2	19.2	0.948	328.2	NO DAMAGE			
85	-15	5	0.00037	18.3	19.2	18.1	19.2	0.942	295.4	NO DAMAGE			
85	-20	1	0.00007	18.3	19.2	18.1	19.2	0.939	281.3	NO DAMAGE			
85	-25	2	0.00015	18.3	19.2	18.0	19.2	0.936	268.5	NO DAMAGE			
85	-35	2	0.00015	18.3	19.2	17.9	19.2	0.931	246.1	NO DAMAGE			
85	-45	6	0.00045	18.3	19.2	17.8	19.2	0.925	227.2	NO DAMAGE			
85	-50	2	0.00015	18.3	19.2	17.7	19.2	0.922	218.8	NO DAMAGE			
85	-55	2	0.00015	18.3	19.2	17.7	19.2	0.919	211.0	NO DAMAGE			
85	-65	4	0.00030	18.3	19.2	17.6	19.2	0.913	196.9	NO DAMAGE			
85	-70	1	0.00007	18.3	19.2	17.5	19.2	0.910	190.6	NO DAMAGE			
85	-75	5	0.00037	18.3	19.2	17.5	19.2	0.907	184.6	NO DAMAGE			
85	-85	4	0.00030	18.3	19.2	17.4	19.2	0.902	173.7	NO DAMAGE			
85	-90	1	0.00007	18.3	19.2	17.3	19.2	0.899	168.8	NO DAMAGE			
85	-95	5	0.00037	18.3	19.2	17.2	19.2	0.896	164.1	NO DAMAGE			
85	-100	1	0.00007	18.3	19.2	17.2	19.2	0.893	159.7	NO DAMAGE			
85	-105	3	0.00022	18.3	19.2	17.1	19.2	0.890	155.5	NO DAMAGE			
85	-110	3	0.00022	18.3	19.2	17.1	19.2	0.887	151.5	NO DAMAGE			
85	-115	1	0.00007	18.3	19.2	17.0	19.2	0.884	147.7	NO DAMAGE			
85	-135	1	0.00007	18.3	19.2	16.8	19.2	0.873	134.3	NO DAMAGE			
85	-145	1	0.00007	18.3	19.2	16.7	19.2	0.867	128.4	NO DAMAGE			
85	-165	1	0.00007	18.3	19.2	16.5	19.2	0.855	118.1	NO DAMAGE			
85	-215	1	0.00007	18.3	19.2	15.9	19.2	0.826	98.5	NO DAMAGE			
80	70	7655	0.57070	18.3	19.2	19.1	19.2	0.994	2945.1	NO DAMAGE			
80	65	1558	0.11615	18.3	19.2	19.0	19.2	0.991	1963.4	NO DAMAGE			
80	60	4677	0.34868	18.3	19.2	19.0	19.2	0.988	1472.6	NO DAMAGE			
80	55	681	0.05077	18.3	19.2	18.9	19.2	0.985	1178.1	NO DAMAGE			
80	50	2097	0.15634	18.3	19.2	18.9	19.2	0.983	981.7	NO DAMAGE			
80	45	222	0.01655	18.3	19.2	18.8	19.2	0.980	841.5	NO DAMAGE			
80	40	927	0.06911	18.3	19.2	18.7	19.2	0.977	736.3	NO DAMAGE			
80	35	49	0.00365	18.3	19.2	18.7	19.2	0.974	654.5	NO DAMAGE			
80	30	460	0.03429	18.3	19.2	18.6	19.2	0.971	589.0	NO DAMAGE			
80	25	16	0.00119	18.3	19.2	18.6	19.2	0.968	535.5	NO DAMAGE			
80	20	239	0.01782	18.3	19.2	18.5	19.2	0.965	490.9	NO DAMAGE			
80	15	7	0.00052	18.3	19.2	18.5	19.2	0.962	453.1	NO DAMAGE			
80	10	110	0.00820	18.3	19.2	18.4	19.2	0.959	420.7	NO DAMAGE			
80	5	4	0.00030	18.3	19.2	18.4	19.2	0.956	392.7	NO DAMAGE			
80	0	129	0.00962	18.3	19.2	18.3	19.2	0.954	368.1	NO DAMAGE			
80	-5	2	0.00015	18.3	19.2	18.2	19.2	0.951	346.5	NO DAMAGE			
80	-10	63	0.00470	18.3	19.2	18.2	19.2	0.948	327.2	NO DAMAGE			
80	-15	1	0.00007	18.3	19.2	18.1	19.2	0.945	310.0	NO DAMAGE			
80	-20	4	0.00030	18.3	19.2	18.1	19.2	0.942	294.5	NO DAMAGE			
80	-25	1	0.00007	18.3	19.2	18.0	19.2	0.939	280.5	NO DAMAGE			
80	-30	5	0.00037	18.3	19.2	18.0	19.2	0.936	267.7	NO DAMAGE			
80	-35	1	0.00007	18.3	19.2	17.9	19.2	0.933	256.1	NO DAMAGE			
80	-40	7	0.00052	18.3	19.2	17.9	19.2	0.930	245.4	NO DAMAGE			
80	-50	15	0.00112	18.3	19.2	17.7	19.2	0.925	226.5	NO DAMAGE			
80	-55	1	0.00007	18.3	19.2	17.7	19.2	0.922	218.2	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
80	-60	12	0.00089	18.3	19.2	17.6	19.2	0.919	210.4	NO DAMAGE			
80	-70	10	0.00075	18.3	19.2	17.5	19.2	0.913	196.3	NO DAMAGE			
80	-75	1	0.00007	18.3	19.2	17.5	19.2	0.910	190.0	NO DAMAGE			
80	-80	13	0.00097	18.3	19.2	17.4	19.2	0.907	184.1	NO DAMAGE			
80	-85	1	0.00007	18.3	19.2	17.4	19.2	0.904	178.5	NO DAMAGE			
80	-90	8	0.00060	18.3	19.2	17.3	19.2	0.901	173.2	NO DAMAGE			
80	-95	1	0.00007	18.3	19.2	17.2	19.2	0.898	168.3	NO DAMAGE			
80	-100	4	0.00030	18.3	19.2	17.2	19.2	0.895	163.6	NO DAMAGE			
80	-110	2	0.00015	18.3	19.2	17.1	19.2	0.890	155.0	NO DAMAGE			
80	-120	4	0.00030	18.3	19.2	17.0	19.2	0.884	147.3	NO DAMAGE			
80	-130	1	0.00007	18.3	19.2	16.9	19.2	0.878	140.2	NO DAMAGE			
80	-140	1	0.00007	18.3	19.2	16.7	19.2	0.872	133.9	NO DAMAGE			
80	-150	3	0.00022	18.3	19.2	16.6	19.2	0.866	128.0	NO DAMAGE			
80	-170	1	0.00007	18.3	19.2	16.4	19.2	0.855	117.8	NO DAMAGE			
80	-220	1	0.00007	18.3	19.2	15.8	19.2	0.826	98.2	NO DAMAGE			
75	65	8167	0.60887	18.3	19.1	19.0	19.1	0.994	2936.6	NO DAMAGE			
75	60	1797	0.13397	18.3	19.1	19.0	19.1	0.991	1957.7	NO DAMAGE			
75	55	5826	0.43434	18.3	19.1	18.9	19.1	0.988	1468.3	NO DAMAGE			
75	50	731	0.05450	18.3	19.1	18.9	19.1	0.985	1174.6	NO DAMAGE			
75	45	2118	0.15790	18.3	19.1	18.8	19.1	0.983	978.9	NO DAMAGE			
75	40	220	0.01640	18.3	19.1	18.7	19.1	0.980	839.0	NO DAMAGE			
75	35	882	0.06576	18.3	19.1	18.7	19.1	0.977	734.1	NO DAMAGE			
75	30	70	0.00522	18.3	19.1	18.6	19.1	0.974	652.6	NO DAMAGE			
75	25	369	0.02751	18.3	19.1	18.6	19.1	0.971	587.3	NO DAMAGE			
75	20	19	0.00142	18.3	19.1	18.5	19.1	0.968	533.9	NO DAMAGE			
75	15	148	0.01111	18.3	19.1	18.5	19.1	0.965	489.4	NO DAMAGE			
75	10	6	0.00045	18.3	19.1	18.4	19.1	0.962	451.8	NO DAMAGE			
75	5	111	0.00828	18.3	19.1	18.4	19.1	0.959	419.5	NO DAMAGE			
75	0	15	0.00112	18.3	19.1	18.3	19.1	0.956	391.5	NO DAMAGE			
75	-5	10	0.00075	18.3	19.1	18.2	19.1	0.953	367.1	NO DAMAGE			
75	-15	4	0.00030	18.3	19.1	18.1	19.1	0.948	326.3	NO DAMAGE			
75	-25	4	0.00030	18.3	19.1	18.0	19.1	0.942	293.7	NO DAMAGE			
75	-35	1	0.00007	18.3	19.1	17.9	19.1	0.936	267.0	NO DAMAGE			
75	-45	1	0.00007	18.3	19.1	17.8	19.1	0.930	244.7	NO DAMAGE			
75	-55	3	0.00022	18.3	19.1	17.7	19.1	0.924	225.9	NO DAMAGE			
75	-65	3	0.00022	18.3	19.1	17.6	19.1	0.918	209.8	NO DAMAGE			
75	-75	3	0.00022	18.3	19.1	17.5	19.1	0.913	195.8	NO DAMAGE			
75	-85	2	0.00015	18.3	19.1	17.4	19.1	0.907	183.5	NO DAMAGE			
75	-90	1	0.00007	18.3	19.1	17.3	19.1	0.904	178.0	NO DAMAGE			
75	-95	2	0.00015	18.3	19.1	17.2	19.1	0.901	172.7	NO DAMAGE			
75	-105	2	0.00015	18.3	19.1	17.1	19.1	0.895	163.1	NO DAMAGE			
75	-110	1	0.00007	18.3	19.1	17.1	19.1	0.892	158.7	NO DAMAGE			
75	-115	3	0.00022	18.3	19.1	17.0	19.1	0.889	154.6	NO DAMAGE			
75	-135	1	0.00007	18.3	19.1	16.8	19.1	0.878	139.8	NO DAMAGE			
75	-145	1	0.00007	18.3	19.1	16.7	19.1	0.872	133.5	NO DAMAGE			
75	-160	1	0.00007	18.3	19.1	16.5	19.1	0.863	125.0	NO DAMAGE			
75	-215	2	0.00015	18.3	19.1	15.9	19.1	0.831	101.3	NO DAMAGE			
75	-235	1	0.00007	18.3	19.1	15.7	19.1	0.819	94.7	NO DAMAGE			
70	60	8507	0.63422	18.3	19.1	19.0	19.1	0.994	2928.0	NO DAMAGE			
70	55	1533	0.11429	18.3	19.1	18.9	19.1	0.991	1952.0	NO DAMAGE			
70	50	5273	0.39312	18.3	19.1	18.9	19.1	0.988	1464.0	NO DAMAGE			
70	45	696	0.05189	18.3	19.1	18.8	19.1	0.985	1171.2	NO DAMAGE			
70	40	2334	0.17401	18.3	19.1	18.7	19.1	0.982	976.0	NO DAMAGE			
70	35	258	0.01923	18.3	19.1	18.7	19.1	0.980	836.6	NO DAMAGE			
70	30	1115	0.08313	18.3	19.1	18.6	19.1	0.977	732.0	NO DAMAGE			
70	25	49	0.00365	18.3	19.1	18.6	19.1	0.974	650.7	NO DAMAGE			
70	20	562	0.04190	18.3	19.1	18.5	19.1	0.971	585.6	NO DAMAGE			
70	15	11	0.00082	18.3	19.1	18.5	19.1	0.968	532.4	NO DAMAGE			
70	10	276	0.02058	18.3	19.1	18.4	19.1	0.965	488.0	NO DAMAGE			
70	5	7	0.00052	18.3	19.1	18.4	19.1	0.962	450.5	NO DAMAGE			
70	0	205	0.01528	18.3	19.1	18.3	19.1	0.959	418.3	NO DAMAGE			
70	-5	3	0.00022	18.3	19.1	18.2	19.1	0.956	390.4	NO DAMAGE			
70	-10	102	0.00760	18.3	19.1	18.2	19.1	0.953	366.0	NO DAMAGE			
70	-20	8	0.00060	18.3	19.1	18.1	19.1	0.947	325.3	NO DAMAGE			
70	-30	7	0.00052	18.3	19.1	18.0	19.1	0.942	292.8	NO DAMAGE			
70	-40	11	0.00082	18.3	19.1	17.9	19.1	0.936	266.2	NO DAMAGE			
70	-45	2	0.00015	18.3	19.1	17.8	19.1	0.933	254.6	NO DAMAGE			
70	-50	13	0.00097	18.3	19.1	17.7	19.1	0.930	244.0	NO DAMAGE			
70	-55	1	0.00007	18.3	19.1	17.7	19.1	0.927	234.2	NO DAMAGE			
70	-60	15	0.00112	18.3	19.1	17.6	19.1	0.924	225.2	NO DAMAGE			
70	-70	13	0.00097	18.3	19.1	17.5	19.1	0.918	209.1	NO DAMAGE			
70	-75	1	0.00007	18.3	19.1	17.5	19.1	0.915	201.9	NO DAMAGE			
70	-80	7	0.00052	18.3	19.1	17.4	19.1	0.912	195.2	NO DAMAGE			
70	-90	7	0.00052	18.3	19.1	17.3	19.1	0.907	183.0	NO DAMAGE			
70	-95	3	0.00022	18.3	19.1	17.2	19.1	0.904	177.5	NO DAMAGE			
70	-100	7	0.00052	18.3	19.1	17.2	19.1	0.901	172.2	NO DAMAGE			
70	-105	1	0.00007	18.3	19.1	17.1	19.1	0.898	167.3	NO DAMAGE			
70	-110	3	0.00022	18.3	19.1	17.1	19.1	0.895	162.7	NO DAMAGE			
70	-120	1	0.00007	18.3	19.1	17.0	19.1	0.889	154.1	NO DAMAGE			
70	-125	1	0.00007	18.3	19.1	16.9	19.1	0.886	150.2	NO DAMAGE			
70	-130	2	0.00015	18.3	19.1	16.9	19.1	0.883	146.4	NO DAMAGE			
70	-135	1	0.00007	18.3	19.1	16.8	19.1	0.880	142.8	NO DAMAGE			
70	-140	4	0.00030	18.3	19.1	16.7	19.1	0.877	139.4	NO DAMAGE			
65	55	7279	0.54267	18.3	19.0	18.9	19.0	0.994	2919.5	NO DAMAGE			
65	50	1741	0.12980	18.3	19.0	18.9	19.0	0.991	1946.3	NO DAMAGE			
65	45	6262	0.46685	18.3	19.0	18.8	19.0	0.988	1459.7	NO DAMAGE			
65	40	731	0.05450	18.3	19.0	18.7	19.0	0.985	1167.8	NO DAMAGE			
65	35	2747	0.20480	18.3	19.0	18.7	19.0	0.982	973.2	NO DAMAGE			
65	30	194	0.01446	18.3	19.0	18.6	19.0	0.979	834.1	NO DAMAGE			
65	25	998	0.07440	18.3	19.0	18.6	19.0	0.977	729.9	NO DAMAGE			
65	20	64	0.00477	18.3	19.0	18.5	19.0	0.974	648.8	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
65	15	357	0.02662	18.3	19.0	18.5	19.0	0.971	583.9	NO DAMAGE			
65	10	15	0.00112	18.3	19.0	18.4	19.0	0.968	530.8	NO DAMAGE			
65	5	243	0.01812	18.3	19.0	18.4	19.0	0.965	486.6	NO DAMAGE			
65	0	10	0.00075	18.3	19.0	18.3	19.0	0.962	449.2	NO DAMAGE			
65	-5	12	0.00089	18.3	19.0	18.2	19.0	0.959	417.1	NO DAMAGE			
65	-15	5	0.00037	18.3	19.0	18.1	19.0	0.953	364.9	NO DAMAGE			
65	-25	2	0.00015	18.3	19.0	18.0	19.0	0.947	324.4	NO DAMAGE			
65	-35	4	0.00030	18.3	19.0	17.9	19.0	0.941	291.9	NO DAMAGE			
65	-45	4	0.00030	18.3	19.0	17.8	19.0	0.936	265.4	NO DAMAGE			
65	-50	1	0.00007	18.3	19.0	17.7	19.0	0.933	253.9	NO DAMAGE			
65	-55	1	0.00007	18.3	19.0	17.7	19.0	0.930	243.3	NO DAMAGE			
65	-65	3	0.00022	18.3	19.0	17.6	19.0	0.924	224.6	NO DAMAGE			
65	-75	2	0.00015	18.3	19.0	17.5	19.0	0.918	208.5	NO DAMAGE			
65	-80	3	0.00022	18.3	19.0	17.4	19.0	0.915	201.3	NO DAMAGE			
65	-85	4	0.00030	18.3	19.0	17.4	19.0	0.912	194.6	NO DAMAGE			
65	-95	3	0.00022	18.3	19.0	17.2	19.0	0.906	182.5	NO DAMAGE			
65	-125	2	0.00015	18.3	19.0	16.9	19.0	0.889	153.7	NO DAMAGE			
65	-135	1	0.00007	18.3	19.0	16.8	19.0	0.883	146.0	NO DAMAGE			
65	-145	1	0.00007	18.3	19.0	16.7	19.0	0.877	139.0	NO DAMAGE			
65	-155	2	0.00015	18.3	19.0	16.6	19.0	0.871	132.7	NO DAMAGE			
65	-195	1	0.00007	18.3	19.0	16.1	19.0	0.848	112.3	NO DAMAGE			
65	-205	1	0.00007	18.3	19.0	16.0	19.0	0.842	108.1	NO DAMAGE			
60	50	9784	0.72942	18.3	19.0	18.9	19.0	0.994	2910.9	NO DAMAGE			
60	45	1627	0.12130	18.3	19.0	18.8	19.0	0.991	1940.6	NO DAMAGE			
60	40	7071	0.52716	18.3	19.0	18.7	19.0	0.988	1455.5	NO DAMAGE			
60	35	637	0.04749	18.3	19.0	18.7	19.0	0.985	1164.4	NO DAMAGE			
60	30	2949	0.21986	18.3	19.0	18.6	19.0	0.982	970.3	NO DAMAGE			
60	25	225	0.01677	18.3	19.0	18.6	19.0	0.979	831.7	NO DAMAGE			
60	20	1559	0.11623	18.3	19.0	18.5	19.0	0.977	727.7	NO DAMAGE			
60	15	59	0.00440	18.3	19.0	18.5	19.0	0.974	646.9	NO DAMAGE			
60	10	740	0.05517	18.3	19.0	18.4	19.0	0.971	582.2	NO DAMAGE			
60	5	16	0.00119	18.3	19.0	18.4	19.0	0.968	529.3	NO DAMAGE			
60	0	419	0.03124	18.3	19.0	18.3	19.0	0.965	485.2	NO DAMAGE			
60	-5	3	0.00022	18.3	19.0	18.2	19.0	0.962	447.8	NO DAMAGE			
60	-10	132	0.00984	18.3	19.0	18.2	19.0	0.959	415.8	NO DAMAGE			
60	-15	1	0.00007	18.3	19.0	18.1	19.0	0.956	388.1	NO DAMAGE			
60	-20	7	0.00052	18.3	19.0	18.1	19.0	0.953	363.9	NO DAMAGE			
60	-25	1	0.00007	18.3	19.0	18.0	19.0	0.950	342.5	NO DAMAGE			
60	-30	11	0.00082	18.3	19.0	18.0	19.0	0.947	323.4	NO DAMAGE			
60	-40	7	0.00052	18.3	19.0	17.9	19.0	0.941	291.1	NO DAMAGE			
60	-50	10	0.00075	18.3	19.0	17.7	19.0	0.935	264.6	NO DAMAGE			
60	-55	1	0.00007	18.3	19.0	17.7	19.0	0.932	253.1	NO DAMAGE			
60	-60	10	0.00075	18.3	19.0	17.6	19.0	0.930	242.6	NO DAMAGE			
60	-70	14	0.00104	18.3	19.0	17.5	19.0	0.924	223.9	NO DAMAGE			
60	-80	9	0.00067	18.3	19.0	17.4	19.0	0.918	207.9	NO DAMAGE			
60	-90	7	0.00052	18.3	19.0	17.3	19.0	0.912	194.1	NO DAMAGE			
60	-100	6	0.00045	18.3	19.0	17.2	19.0	0.906	181.9	NO DAMAGE			
60	-110	3	0.00022	18.3	19.0	17.1	19.0	0.900	171.2	NO DAMAGE			
60	-120	4	0.00030	18.3	19.0	17.0	19.0	0.894	161.7	NO DAMAGE			
60	-130	3	0.00022	18.3	19.0	16.9	19.0	0.888	153.2	NO DAMAGE			
60	-140	2	0.00015	18.3	19.0	16.7	19.0	0.883	145.5	NO DAMAGE			
60	-220	1	0.00007	18.3	19.0	15.8	19.0	0.836	104.0	NO DAMAGE			
55	45	8119	0.60529	18.3	18.9	18.8	18.9	0.994	2902.4	NO DAMAGE			
55	40	1589	0.11846	18.3	18.9	18.7	18.9	0.991	1934.9	NO DAMAGE			
55	35	6838	0.50979	18.3	18.9	18.7	18.9	0.988	1451.2	NO DAMAGE			
55	30	654	0.04878	18.3	18.9	18.6	18.9	0.985	1161.0	NO DAMAGE			
55	25	2920	0.21769	18.3	18.9	18.6	18.9	0.982	967.5	NO DAMAGE			
55	20	269	0.02005	18.3	18.9	18.5	18.9	0.979	829.3	NO DAMAGE			
55	15	1189	0.08864	18.3	18.9	18.5	18.9	0.976	725.6	NO DAMAGE			
55	10	61	0.00455	18.3	18.9	18.4	18.9	0.973	645.0	NO DAMAGE			
55	5	597	0.04451	18.3	18.9	18.4	18.9	0.971	580.5	NO DAMAGE			
55	0	26	0.00194	18.3	18.9	18.3	18.9	0.968	527.7	NO DAMAGE			
55	-5	38	0.00283	18.3	18.9	18.2	18.9	0.965	483.7	NO DAMAGE			
55	-10	1	0.00007	18.3	18.9	18.2	18.9	0.962	446.5	NO DAMAGE			
55	-15	6	0.00045	18.3	18.9	18.1	18.9	0.959	414.6	NO DAMAGE			
55	-25	7	0.00052	18.3	18.9	18.0	18.9	0.953	362.8	NO DAMAGE			
55	-35	2	0.00015	18.3	18.9	17.9	18.9	0.947	322.5	NO DAMAGE			
55	-45	4	0.00030	18.3	18.9	17.8	18.9	0.941	290.2	NO DAMAGE			
55	-55	1	0.00007	18.3	18.9	17.7	18.9	0.935	263.9	NO DAMAGE			
55	-65	3	0.00022	18.3	18.9	17.6	18.9	0.929	241.9	NO DAMAGE			
55	-70	1	0.00007	18.3	18.9	17.5	18.9	0.926	232.2	NO DAMAGE			
55	-75	1	0.00007	18.3	18.9	17.5	18.9	0.923	223.3	NO DAMAGE			
55	-85	1	0.00007	18.3	18.9	17.4	18.9	0.918	207.3	NO DAMAGE			
55	-95	3	0.00022	18.3	18.9	17.2	18.9	0.912	193.5	NO DAMAGE			
55	-105	3	0.00022	18.3	18.9	17.1	18.9	0.906	181.4	NO DAMAGE			
55	-110	1	0.00007	18.3	18.9	17.1	18.9	0.903	175.9	NO DAMAGE			
55	-115	1	0.00007	18.3	18.9	17.0	18.9	0.900	170.7	NO DAMAGE			
55	-135	2	0.00015	18.3	18.9	16.8	18.9	0.888	152.8	NO DAMAGE			
55	-150	1	0.00007	18.3	18.9	16.6	18.9	0.879	141.6	NO DAMAGE			
55	-165	1	0.00007	18.3	18.9	16.5	18.9	0.870	131.9	NO DAMAGE			
50	40	12549	0.93556	18.3	18.9	18.7	18.9	0.994	2893.8	NO DAMAGE			
50	35	1846	0.13762	18.3	18.9	18.7	18.9	0.991	1929.2	NO DAMAGE			
50	30	10880	0.81113	18.3	18.9	18.6	18.9	0.988	1446.9	NO DAMAGE			
50	25	787	0.05867	18.3	18.9	18.6	18.9	0.985	1157.5	NO DAMAGE			
50	20	5251	0.39148	18.3	18.9	18.5	18.9	0.982	964.6	NO DAMAGE			
50	15	264	0.01968	18.3	18.9	18.5	18.9	0.979	826.8	NO DAMAGE			
50	10	2229	0.16618	18.3	18.9	18.4	18.9	0.976	723.5	NO DAMAGE			
50	5	56	0.00417	18.3	18.9	18.4	18.9	0.973	643.1	NO DAMAGE			
50	0	885	0.06598	18.3	18.9	18.3	18.9	0.970	578.8	NO DAMAGE			
50	-5	9	0.00067	18.3	18.9	18.2	18.9	0.968	526.2	NO DAMAGE			
50	-10	181	0.01349	18.3	18.9	18.2	18.9	0.965	482.3	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
50	-20	15	0.00112	18.3	18.9	18.1	18.9	0.959	413.4	NO DAMAGE			
50	-25	1	0.00007	18.3	18.9	18.0	18.9	0.956	385.8	NO DAMAGE			
50	-30	12	0.00089	18.3	18.9	18.0	18.9	0.953	361.7	NO DAMAGE			
50	-40	17	0.00127	18.3	18.9	17.9	18.9	0.947	321.5	NO DAMAGE			
50	-45	1	0.00007	18.3	18.9	17.8	18.9	0.944	304.6	NO DAMAGE			
50	-50	20	0.00149	18.3	18.9	17.7	18.9	0.941	289.4	NO DAMAGE			
50	-60	19	0.00142	18.3	18.9	17.6	18.9	0.935	263.1	NO DAMAGE			
50	-65	1	0.00007	18.3	18.9	17.6	18.9	0.932	251.6	NO DAMAGE			
50	-70	9	0.00067	18.3	18.9	17.5	18.9	0.929	241.2	NO DAMAGE			
50	-75	2	0.00015	18.3	18.9	17.5	18.9	0.926	231.5	NO DAMAGE			
50	-80	8	0.00060	18.3	18.9	17.4	18.9	0.923	222.6	NO DAMAGE			
50	-90	6	0.00045	18.3	18.9	17.3	18.9	0.917	206.7	NO DAMAGE			
50	-100	4	0.00030	18.3	18.9	17.2	18.9	0.911	192.9	NO DAMAGE			
50	-105	1	0.00007	18.3	18.9	17.1	18.9	0.908	186.7	NO DAMAGE			
50	-110	2	0.00015	18.3	18.9	17.1	18.9	0.905	180.9	NO DAMAGE			
50	-120	2	0.00015	18.3	18.9	17.0	18.9	0.900	170.2	NO DAMAGE			
50	-130	2	0.00015	18.3	18.9	16.9	18.9	0.894	160.8	NO DAMAGE			
50	-140	1	0.00007	18.3	18.9	16.7	18.9	0.888	152.3	NO DAMAGE			
50	-210	1	0.00007	18.3	18.9	16.0	18.9	0.846	111.3	NO DAMAGE			
45	35	8451	0.63005	18.3	18.8	18.7	18.8	0.994	2885.3	NO DAMAGE			
45	30	1938	0.14448	18.3	18.8	18.6	18.8	0.991	1923.5	NO DAMAGE			
45	25	7167	0.53432	18.3	18.8	18.6	18.8	0.988	1442.6	NO DAMAGE			
45	20	859	0.06404	18.3	18.8	18.5	18.8	0.985	1154.1	NO DAMAGE			
45	15	3380	0.25199	18.3	18.8	18.5	18.8	0.982	961.8	NO DAMAGE			
45	10	291	0.02169	18.3	18.8	18.4	18.8	0.979	824.4	NO DAMAGE			
45	5	1312	0.09781	18.3	18.8	18.4	18.8	0.976	721.3	NO DAMAGE			
45	0	52	0.00388	18.3	18.8	18.3	18.8	0.973	641.2	NO DAMAGE			
45	-5	25	0.00186	18.3	18.8	18.2	18.8	0.970	577.1	NO DAMAGE			
45	-15	13	0.00097	18.3	18.8	18.1	18.8	0.964	480.9	NO DAMAGE			
45	-25	5	0.00037	18.3	18.8	18.0	18.8	0.959	412.2	NO DAMAGE			
45	-30	1	0.00007	18.3	18.8	18.0	18.8	0.956	384.7	NO DAMAGE			
45	-35	2	0.00015	18.3	18.8	17.9	18.8	0.953	360.7	NO DAMAGE			
45	-45	5	0.00037	18.3	18.8	17.8	18.8	0.947	320.6	NO DAMAGE			
45	-55	1	0.00007	18.3	18.8	17.7	18.8	0.941	288.5	NO DAMAGE			
45	-60	1	0.00007	18.3	18.8	17.6	18.8	0.938	274.8	NO DAMAGE			
45	-65	1	0.00007	18.3	18.8	17.6	18.8	0.935	262.3	NO DAMAGE			
45	-75	2	0.00015	18.3	18.8	17.5	18.8	0.929	240.4	NO DAMAGE			
45	-85	2	0.00015	18.3	18.8	17.4	18.8	0.923	221.9	NO DAMAGE			
45	-90	1	0.00007	18.3	18.8	17.3	18.8	0.920	213.7	NO DAMAGE			
45	-95	1	0.00007	18.3	18.8	17.2	18.8	0.917	206.1	NO DAMAGE			
45	-105	1	0.00007	18.3	18.8	17.1	18.8	0.911	192.4	NO DAMAGE			
45	-115	1	0.00007	18.3	18.8	17.0	18.8	0.905	180.3	NO DAMAGE			
45	-135	1	0.00007	18.3	18.8	16.8	18.8	0.893	160.3	NO DAMAGE			
45	-145	2	0.00015	18.3	18.8	16.7	18.8	0.887	151.9	NO DAMAGE			
45	-165	1	0.00007	18.3	18.8	16.5	18.8	0.876	137.4	NO DAMAGE			
40	30	17965	1.33934	18.3	18.7	18.6	18.7	0.994	2876.7	NO DAMAGE			
40	25	2047	0.15261	18.3	18.7	18.6	18.7	0.991	1917.8	NO DAMAGE			
40	20	18409	1.37244	18.3	18.7	18.5	18.7	0.988	1438.4	NO DAMAGE			
40	15	1038	0.07739	18.3	18.7	18.5	18.7	0.985	1150.7	NO DAMAGE			
40	10	6033	0.44978	18.3	18.7	18.4	18.7	0.982	958.9	NO DAMAGE			
40	5	221	0.01648	18.3	18.7	18.4	18.7	0.979	821.9	NO DAMAGE			
40	0	1756	0.13091	18.3	18.7	18.3	18.7	0.976	719.2	NO DAMAGE			
40	-5	10	0.00075	18.3	18.7	18.2	18.7	0.973	639.3	NO DAMAGE			
40	-10	261	0.01946	18.3	18.7	18.2	18.7	0.970	575.3	NO DAMAGE			
40	-20	31	0.00231	18.3	18.7	18.1	18.7	0.964	479.5	NO DAMAGE			
40	-25	2	0.00015	18.3	18.7	18.0	18.7	0.961	442.6	NO DAMAGE			
40	-30	18	0.00134	18.3	18.7	18.0	18.7	0.958	411.0	NO DAMAGE			
40	-40	15	0.00112	18.3	18.7	17.9	18.7	0.952	359.6	NO DAMAGE			
40	-50	21	0.00157	18.3	18.7	17.7	18.7	0.947	319.6	NO DAMAGE			
40	-60	11	0.00082	18.3	18.7	17.6	18.7	0.941	287.7	NO DAMAGE			
40	-65	1	0.00007	18.3	18.7	17.6	18.7	0.938	274.0	NO DAMAGE			
40	-70	10	0.00075	18.3	18.7	17.5	18.7	0.935	261.5	NO DAMAGE			
40	-80	8	0.00060	18.3	18.7	17.4	18.7	0.929	239.7	NO DAMAGE			
40	-90	4	0.00030	18.3	18.7	17.3	18.7	0.923	221.3	NO DAMAGE			
40	-100	3	0.00022	18.3	18.7	17.2	18.7	0.917	205.5	NO DAMAGE			
40	-110	1	0.00007	18.3	18.7	17.1	18.7	0.911	191.8	NO DAMAGE			
40	-120	3	0.00022	18.3	18.7	17.0	18.7	0.905	179.8	NO DAMAGE			
40	-130	3	0.00022	18.3	18.7	16.9	18.7	0.899	169.2	NO DAMAGE			
40	-140	1	0.00007	18.3	18.7	16.7	18.7	0.893	159.8	NO DAMAGE			
35	25	8887	0.66255	18.3	18.7	18.6	18.7	0.994	2868.2	NO DAMAGE			
35	20	2334	0.17401	18.3	18.7	18.5	18.7	0.991	1912.1	NO DAMAGE			
35	15	8440	0.62923	18.3	18.7	18.5	18.7	0.988	1434.1	NO DAMAGE			
35	10	748	0.05577	18.3	18.7	18.4	18.7	0.985	1147.3	NO DAMAGE			
35	5	2726	0.20323	18.3	18.7	18.4	18.7	0.982	956.1	NO DAMAGE			
35	0	130	0.00969	18.3	18.7	18.3	18.7	0.979	819.5	NO DAMAGE			
35	-5	46	0.00343	18.3	18.7	18.2	18.7	0.976	717.0	NO DAMAGE			
35	-10	1	0.00007	18.3	18.7	18.2	18.7	0.973	637.4	NO DAMAGE			
35	-15	10	0.00075	18.3	18.7	18.1	18.7	0.970	573.6	NO DAMAGE			
35	-20	1	0.00007	18.3	18.7	18.1	18.7	0.967	521.5	NO DAMAGE			
35	-25	15	0.00112	18.3	18.7	18.0	18.7	0.964	478.0	NO DAMAGE			
35	-35	25	0.00186	18.3	18.7	17.9	18.7	0.958	409.7	NO DAMAGE			
35	-40	1	0.00007	18.3	18.7	17.9	18.7	0.955	382.4	NO DAMAGE			
35	-45	10	0.00075	18.3	18.7	17.8	18.7	0.952	358.5	NO DAMAGE			
35	-55	2	0.00015	18.3	18.7	17.7	18.7	0.946	318.7	NO DAMAGE			
35	-65	3	0.00022	18.3	18.7	17.6	18.7	0.940	286.8	NO DAMAGE			
35	-75	1	0.00007	18.3	18.7	17.5	18.7	0.934	260.7	NO DAMAGE			
35	-85	2	0.00015	18.3	18.7	17.4	18.7	0.928	239.0	NO DAMAGE			
35	-95	3	0.00022	18.3	18.7	17.2	18.7	0.922	220.6	NO DAMAGE			
35	-100	1	0.00007	18.3	18.7	17.2	18.7	0.920	212.5	NO DAMAGE			
35	-105	4	0.00030	18.3	18.7	17.1	18.7	0.917	204.9	NO DAMAGE			
35	-115	1	0.00007	18.3	18.7	17.0	18.7	0.911	191.2	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
35	-120	1	0.00007	18.3	18.7	17.0	18.7	0.908	185.0	NO DAMAGE			
35	-170	1	0.00007	18.3	18.7	16.4	18.7	0.878	139.9	NO DAMAGE			
30	20	22074	1.64568	18.3	18.6	18.5	18.6	0.994	2859.6	NO DAMAGE			
30	15	2052	0.15298	18.3	18.6	18.5	18.6	0.991	1906.4	NO DAMAGE			
30	10	16038	1.19568	18.3	18.6	18.4	18.6	0.988	1429.8	NO DAMAGE			
30	5	628	0.04682	18.3	18.6	18.4	18.6	0.985	1143.9	NO DAMAGE			
30	0	5070	0.37798	18.3	18.6	18.3	18.6	0.982	953.2	NO DAMAGE			
30	-5	24	0.00179	18.3	18.6	18.2	18.6	0.979	817.0	NO DAMAGE			
30	-10	474	0.03534	18.3	18.6	18.2	18.6	0.976	714.9	NO DAMAGE			
30	-15	1	0.00007	18.3	18.6	18.1	18.6	0.973	635.5	NO DAMAGE			
30	-20	25	0.00186	18.3	18.6	18.1	18.6	0.970	571.9	NO DAMAGE			
30	-25	1	0.00007	18.3	18.6	18.0	18.6	0.967	519.9	NO DAMAGE			
30	-30	35	0.00261	18.3	18.6	18.0	18.6	0.964	476.6	NO DAMAGE			
30	-40	27	0.00201	18.3	18.6	17.9	18.6	0.958	408.5	NO DAMAGE			
30	-50	23	0.00171	18.3	18.6	17.7	18.6	0.952	357.5	NO DAMAGE			
30	-60	20	0.00149	18.3	18.6	17.6	18.6	0.946	317.7	NO DAMAGE			
30	-65	1	0.00007	18.3	18.6	17.6	18.6	0.943	301.0	NO DAMAGE			
30	-70	9	0.00067	18.3	18.6	17.5	18.6	0.940	286.0	NO DAMAGE			
30	-80	5	0.00037	18.3	18.6	17.4	18.6	0.934	260.0	NO DAMAGE			
30	-90	6	0.00045	18.3	18.6	17.3	18.6	0.928	238.3	NO DAMAGE			
30	-95	2	0.00015	18.3	18.6	17.2	18.6	0.925	228.8	NO DAMAGE			
30	-100	2	0.00015	18.3	18.6	17.2	18.6	0.922	220.0	NO DAMAGE			
30	-110	2	0.00015	18.3	18.6	17.1	18.6	0.916	204.3	NO DAMAGE			
30	-120	1	0.00007	18.3	18.6	17.0	18.6	0.910	190.6	NO DAMAGE			
30	-125	1	0.00007	18.3	18.6	16.9	18.6	0.907	184.5	NO DAMAGE			
30	-135	1	0.00007	18.3	18.6	16.8	18.6	0.901	173.3	NO DAMAGE			
30	-140	1	0.00007	18.3	18.6	16.7	18.6	0.898	168.2	NO DAMAGE			
30	-145	1	0.00007	18.3	18.6	16.7	18.6	0.895	163.4	NO DAMAGE			
30	-200	1	0.00007	18.3	18.6	16.1	18.6	0.862	124.3	NO DAMAGE			
30	-210	1	0.00007	18.3	18.6	16.0	18.6	0.856	119.2	NO DAMAGE			
30	-270	1	0.00007	18.3	18.6	15.3	18.6	0.821	95.3	NO DAMAGE			
25	15	9878	0.73628	18.3	18.6	18.5	18.6	0.994	2851.1	NO DAMAGE			
25	10	1825	0.13606	18.3	18.6	18.4	18.6	0.991	1900.7	NO DAMAGE			
25	5	7958	0.59329	18.3	18.6	18.4	18.6	0.988	1425.5	NO DAMAGE			
25	0	410	0.03057	18.3	18.6	18.3	18.6	0.985	1140.4	NO DAMAGE			
25	-5	105	0.00783	18.3	18.6	18.2	18.6	0.982	950.4	NO DAMAGE			
25	-10	1	0.00007	18.3	18.6	18.2	18.6	0.979	814.6	NO DAMAGE			
25	-15	33	0.00246	18.3	18.6	18.1	18.6	0.976	712.8	NO DAMAGE			
25	-20	3	0.00022	18.3	18.6	18.1	18.6	0.973	633.6	NO DAMAGE			
25	-25	317	0.02363	18.3	18.6	18.0	18.6	0.970	570.2	NO DAMAGE			
25	-30	1	0.00007	18.3	18.6	18.0	18.6	0.967	518.4	NO DAMAGE			
25	-35	89	0.00664	18.3	18.6	17.9	18.6	0.964	475.2	NO DAMAGE			
25	-40	2	0.00015	18.3	18.6	17.9	18.6	0.961	438.6	NO DAMAGE			
25	-45	11	0.00082	18.3	18.6	17.8	18.6	0.958	407.3	NO DAMAGE			
25	-65	3	0.00022	18.3	18.6	17.6	18.6	0.946	316.8	NO DAMAGE			
25	-70	1	0.00007	18.3	18.6	17.5	18.6	0.943	300.1	NO DAMAGE			
25	-75	3	0.00022	18.3	18.6	17.5	18.6	0.940	285.1	NO DAMAGE			
25	-85	1	0.00007	18.3	18.6	17.4	18.6	0.934	259.2	NO DAMAGE			
25	-95	3	0.00022	18.3	18.6	17.2	18.6	0.928	237.6	NO DAMAGE			
25	-105	6	0.00045	18.3	18.6	17.1	18.6	0.922	219.3	NO DAMAGE			
25	-125	3	0.00022	18.3	18.6	16.9	18.6	0.910	190.1	NO DAMAGE			
25	-135	1	0.00007	18.3	18.6	16.8	18.6	0.904	178.2	NO DAMAGE			
25	-145	1	0.00007	18.3	18.6	16.7	18.6	0.898	167.7	NO DAMAGE			
25	-155	1	0.00007	18.3	18.6	16.6	18.6	0.892	158.4	NO DAMAGE			
20	10	22202	1.65522	18.3	18.5	18.4	18.5	0.994	2842.5	NO DAMAGE			
20	5	1921	0.14322	18.3	18.5	18.4	18.5	0.991	1895.0	NO DAMAGE			
20	0	21178	1.57888	18.3	18.5	18.3	18.5	0.988	1421.3	NO DAMAGE			
20	-5	101	0.00753	18.3	18.5	18.2	18.5	0.985	1137.0	NO DAMAGE			
20	-10	1141	0.08506	18.3	18.5	18.2	18.5	0.982	947.5	NO DAMAGE			
20	-15	4	0.00030	18.3	18.5	18.1	18.5	0.979	812.2	NO DAMAGE			
20	-20	49	0.00365	18.3	18.5	18.1	18.5	0.976	710.6	NO DAMAGE			
20	-25	1	0.00007	18.3	18.5	18.0	18.5	0.973	631.7	NO DAMAGE			
20	-30	47	0.00350	18.3	18.5	18.0	18.5	0.970	568.5	NO DAMAGE			
20	-40	39	0.00291	18.3	18.5	17.9	18.5	0.964	473.8	NO DAMAGE			
20	-45	1	0.00007	18.3	18.5	17.8	18.5	0.961	437.3	NO DAMAGE			
20	-50	22	0.00164	18.3	18.5	17.7	18.5	0.958	406.1	NO DAMAGE			
20	-55	1	0.00007	18.3	18.5	17.7	18.5	0.955	379.0	NO DAMAGE			
20	-60	12	0.00089	18.3	18.5	17.6	18.5	0.952	355.3	NO DAMAGE			
20	-65	1	0.00007	18.3	18.5	17.6	18.5	0.949	334.4	NO DAMAGE			
20	-70	10	0.00075	18.3	18.5	17.5	18.5	0.946	315.8	NO DAMAGE			
20	-80	10	0.00075	18.3	18.5	17.4	18.5	0.940	284.3	NO DAMAGE			
20	-85	1	0.00007	18.3	18.5	17.4	18.5	0.937	270.7	NO DAMAGE			
20	-90	6	0.00045	18.3	18.5	17.3	18.5	0.934	258.4	NO DAMAGE			
20	-100	2	0.00015	18.3	18.5	17.2	18.5	0.928	236.9	NO DAMAGE			
20	-110	2	0.00015	18.3	18.5	17.1	18.5	0.922	218.7	NO DAMAGE			
20	-130	1	0.00007	18.3	18.5	16.9	18.5	0.910	189.5	NO DAMAGE			
20	-185	1	0.00007	18.3	18.5	16.2	18.5	0.877	138.7	NO DAMAGE			
15	5	10885	0.81151	18.3	18.5	18.4	18.5	0.994	2834.0	NO DAMAGE			
15	0	1626	0.12122	18.3	18.5	18.3	18.5	0.991	1889.3	NO DAMAGE			
15	-5	1500	0.11183	18.3	18.5	18.2	18.5	0.988	1417.0	NO DAMAGE			
15	-10	1	0.00007	18.3	18.5	18.2	18.5	0.985	1133.6	NO DAMAGE			
15	-15	1448	0.10795	18.3	18.5	18.1	18.5	0.982	944.7	NO DAMAGE			
15	-20	7	0.00052	18.3	18.5	18.1	18.5	0.979	809.7	NO DAMAGE			
15	-25	657	0.04898	18.3	18.5	18.0	18.5	0.976	708.5	NO DAMAGE			
15	-30	1	0.00007	18.3	18.5	18.0	18.5	0.973	629.8	NO DAMAGE			
15	-35	14	0.00104	18.3	18.5	17.9	18.5	0.970	566.8	NO DAMAGE			
15	-40	2	0.00015	18.3	18.5	17.9	18.5	0.967	515.3	NO DAMAGE			
15	-45	5	0.00037	18.3	18.5	17.8	18.5	0.964	472.3	NO DAMAGE			
15	-55	3	0.00022	18.3	18.5	17.7	18.5	0.958	404.9	NO DAMAGE			
15	-65	3	0.00022	18.3	18.5	17.6	18.5	0.952	354.2	NO DAMAGE			
15	-70	1	0.00007	18.3	18.5	17.5	18.5	0.949	333.4	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
15	-75	1	0.00007	18.3	18.5	17.5	18.5	0.946	314.9	NO DAMAGE			
15	-80	1	0.00007	18.3	18.5	17.4	18.5	0.943	298.3	NO DAMAGE			
15	-85	3	0.00022	18.3	18.5	17.4	18.5	0.940	283.4	NO DAMAGE			
15	-95	5	0.00037	18.3	18.5	17.2	18.5	0.934	257.6	NO DAMAGE			
15	-100	1	0.00007	18.3	18.5	17.2	18.5	0.931	246.4	NO DAMAGE			
15	-105	8	0.00060	18.3	18.5	17.1	18.5	0.928	236.2	NO DAMAGE			
15	-125	2	0.00015	18.3	18.5	16.9	18.5	0.916	202.4	NO DAMAGE			
15	-155	2	0.00015	18.3	18.5	16.6	18.5	0.897	166.7	NO DAMAGE			
15	-195	1	0.00007	18.3	18.5	16.1	18.5	0.873	135.0	NO DAMAGE			
15	-235	1	0.00007	18.3	18.5	15.7	18.5	0.849	113.4	NO DAMAGE			
10	0	37244	2.77664	18.3	18.4	18.3	18.4	0.994	2825.4	NO DAMAGE			
10	-5	1213	0.09043	18.3	18.4	18.2	18.4	0.991	1883.6	NO DAMAGE			
10	-10	11887	0.88621	18.3	18.4	18.2	18.4	0.988	1412.7	NO DAMAGE			
10	-15	26	0.00194	18.3	18.4	18.1	18.4	0.985	1130.2	NO DAMAGE			
10	-20	95	0.00708	18.3	18.4	18.1	18.4	0.982	941.8	NO DAMAGE			
10	-25	2	0.00015	18.3	18.4	18.0	18.4	0.979	807.3	NO DAMAGE			
10	-30	77	0.00574	18.3	18.4	18.0	18.4	0.976	706.4	NO DAMAGE			
10	-35	3	0.00022	18.3	18.4	17.9	18.4	0.973	627.9	NO DAMAGE			
10	-40	38	0.00283	18.3	18.4	17.9	18.4	0.970	565.1	NO DAMAGE			
10	-50	25	0.00186	18.3	18.4	17.7	18.4	0.964	470.9	NO DAMAGE			
10	-55	1	0.00007	18.3	18.4	17.7	18.4	0.961	434.7	NO DAMAGE			
10	-60	7	0.00052	18.3	18.4	17.6	18.4	0.958	403.6	NO DAMAGE			
10	-70	11	0.00082	18.3	18.4	17.5	18.4	0.952	353.2	NO DAMAGE			
10	-75	2	0.00015	18.3	18.4	17.5	18.4	0.949	332.4	NO DAMAGE			
10	-80	9	0.00067	18.3	18.4	17.4	18.4	0.946	313.9	NO DAMAGE			
10	-90	7	0.00052	18.3	18.4	17.3	18.4	0.939	282.5	NO DAMAGE			
10	-95	1	0.00007	18.3	18.4	17.2	18.4	0.936	269.1	NO DAMAGE			
10	-100	6	0.00045	18.3	18.4	17.2	18.4	0.933	256.9	NO DAMAGE			
10	-110	1	0.00007	18.3	18.4	17.1	18.4	0.927	235.5	NO DAMAGE			
10	-160	1	0.00007	18.3	18.4	16.5	18.4	0.897	166.2	NO DAMAGE			
10	-175	1	0.00007	18.3	18.4	16.4	18.4	0.888	152.7	NO DAMAGE			
10	-190	2	0.00015	18.3	18.4	16.2	18.4	0.879	141.3	NO DAMAGE			
10	-255	1	0.00007	18.3	18.4	15.5	18.4	0.840	106.6	NO DAMAGE			
5	-5	8727	0.65062	18.3	18.4	18.2	18.4	0.994	2816.9	NO DAMAGE			
5	-10	15	0.00112	18.3	18.4	18.2	18.4	0.991	1877.9	NO DAMAGE			
5	-15	4923	0.36702	18.3	18.4	18.1	18.4	0.988	1408.4	NO DAMAGE			
5	-20	5	0.00037	18.3	18.4	18.1	18.4	0.985	1126.8	NO DAMAGE			
5	-25	386	0.02878	18.3	18.4	18.0	18.4	0.982	939.0	NO DAMAGE			
5	-30	4	0.00030	18.3	18.4	18.0	18.4	0.979	804.8	NO DAMAGE			
5	-35	51	0.00380	18.3	18.4	17.9	18.4	0.976	704.2	NO DAMAGE			
5	-40	1	0.00007	18.3	18.4	17.9	18.4	0.973	626.0	NO DAMAGE			
5	-45	17	0.00127	18.3	18.4	17.8	18.4	0.970	563.4	NO DAMAGE			
5	-50	3	0.00022	18.3	18.4	17.7	18.4	0.967	512.2	NO DAMAGE			
5	-55	17	0.00127	18.3	18.4	17.7	18.4	0.964	469.5	NO DAMAGE			
5	-60	1	0.00007	18.3	18.4	17.6	18.4	0.961	433.4	NO DAMAGE			
5	-65	4	0.00030	18.3	18.4	17.6	18.4	0.958	402.4	NO DAMAGE			
5	-75	7	0.00052	18.3	18.4	17.5	18.4	0.951	352.1	NO DAMAGE			
5	-85	4	0.00030	18.3	18.4	17.4	18.4	0.945	313.0	NO DAMAGE			
5	-90	1	0.00007	18.3	18.4	17.3	18.4	0.942	296.5	NO DAMAGE			
5	-95	4	0.00030	18.3	18.4	17.2	18.4	0.939	281.7	NO DAMAGE			
5	-110	1	0.00007	18.3	18.4	17.1	18.4	0.930	244.9	NO DAMAGE			
5	-115	2	0.00015	18.3	18.4	17.0	18.4	0.927	234.7	NO DAMAGE			
5	-125	1	0.00007	18.3	18.4	16.9	18.4	0.921	216.7	NO DAMAGE			
5	-145	1	0.00007	18.3	18.4	16.7	18.4	0.909	187.8	NO DAMAGE			
5	-155	1	0.00007	18.3	18.4	16.6	18.4	0.903	176.1	NO DAMAGE			
5	-165	1	0.00007	18.3	18.4	16.5	18.4	0.897	165.7	NO DAMAGE			
5	-175	1	0.00007	18.3	18.4	16.4	18.4	0.891	156.5	NO DAMAGE			
5	-255	1	0.00007	18.3	18.4	15.5	18.4	0.842	108.3	NO DAMAGE			
5	-285	1	0.00007	18.3	18.4	15.1	18.4	0.824	97.1	NO DAMAGE			
0	-10	9883	0.73680	18.3	18.3	18.2	18.3	0.994	2808.3	NO DAMAGE			
0	-15	1482	0.11049	18.3	18.3	18.1	18.3	0.991	1872.2	NO DAMAGE			
0	-20	595	0.04436	18.3	18.3	18.1	18.3	0.988	1404.2	NO DAMAGE			
0	-25	59	0.00440	18.3	18.3	18.0	18.3	0.985	1123.3	NO DAMAGE			
0	-30	122	0.00910	18.3	18.3	18.0	18.3	0.982	936.1	NO DAMAGE			
0	-35	15	0.00112	18.3	18.3	17.9	18.3	0.979	802.4	NO DAMAGE			
0	-40	36	0.00268	18.3	18.3	17.9	18.3	0.976	702.1	NO DAMAGE			
0	-45	5	0.00037	18.3	18.3	17.8	18.3	0.973	624.1	NO DAMAGE			
0	-50	35	0.00261	18.3	18.3	17.7	18.3	0.970	561.7	NO DAMAGE			
0	-55	4	0.00030	18.3	18.3	17.7	18.3	0.967	510.6	NO DAMAGE			
0	-60	13	0.00097	18.3	18.3	17.6	18.3	0.963	468.1	NO DAMAGE			
0	-65	2	0.00015	18.3	18.3	17.6	18.3	0.960	432.1	NO DAMAGE			
0	-70	12	0.00089	18.3	18.3	17.5	18.3	0.957	401.2	NO DAMAGE			
0	-75	2	0.00015	18.3	18.3	17.5	18.3	0.954	374.4	NO DAMAGE			
0	-80	7	0.00052	18.3	18.3	17.4	18.3	0.951	351.0	NO DAMAGE			
0	-85	3	0.00022	18.3	18.3	17.4	18.3	0.948	330.4	NO DAMAGE			
0	-90	5	0.00037	18.3	18.3	17.3	18.3	0.945	312.0	NO DAMAGE			
0	-95	2	0.00015	18.3	18.3	17.2	18.3	0.942	295.6	NO DAMAGE			
0	-100	9	0.00067	18.3	18.3	17.2	18.3	0.939	280.8	NO DAMAGE			
0	-105	2	0.00015	18.3	18.3	17.1	18.3	0.936	267.5	NO DAMAGE			
0	-110	4	0.00030	18.3	18.3	17.1	18.3	0.933	255.3	NO DAMAGE			
0	-120	3	0.00022	18.3	18.3	17.0	18.3	0.927	234.0	NO DAMAGE			
0	-125	3	0.00022	18.3	18.3	16.9	18.3	0.924	224.7	NO DAMAGE			
0	-140	1	0.00007	18.3	18.3	16.7	18.3	0.915	200.6	NO DAMAGE			
0	-155	1	0.00007	18.3	18.3	16.6	18.3	0.906	181.2	NO DAMAGE			
0	-180	1	0.00007	18.3	18.3	16.3	18.3	0.890	156.0	NO DAMAGE			
-5	-15	19509	1.45445	18.3	18.2	18.1	18.2	0.994	2799.8	NO DAMAGE			
-5	-20	1685	0.12562	18.3	18.2	18.1	18.2	0.991	1866.5	NO DAMAGE			
-5	-25	7756	0.57823	18.3	18.2	18.0	18.2	0.988	1399.9	NO DAMAGE			
-5	-30	412	0.03072	18.3	18.2	18.0	18.2	0.985	1119.9	NO DAMAGE			
-5	-35	2199	0.16394	18.3	18.2	17.9	18.2	0.982	933.3	NO DAMAGE			
-5	-40	111	0.00828	18.3	18.2	17.9	18.2	0.979	799.9	NO DAMAGE			

					Dynamic Stress					to			
			α	Static			Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-5	-45	789	0.05882	18.3	18.2	17.8	18.2	0.976	699.9	NO DAMAGE			
-5	-50	49	0.00365	18.3	18.2	17.7	18.2	0.973	622.2	NO DAMAGE			
-5	-55	349	0.02602	18.3	18.2	17.7	18.2	0.969	560.0	NO DAMAGE			
-5	-60	12	0.00089	18.3	18.2	17.6	18.2	0.966	509.1	NO DAMAGE			
-5	-65	127	0.00947	18.3	18.2	17.6	18.2	0.963	466.6	NO DAMAGE			
-5	-70	11	0.00082	18.3	18.2	17.5	18.2	0.960	430.7	NO DAMAGE			
-5	-75	45	0.00335	18.3	18.2	17.5	18.2	0.957	400.0	NO DAMAGE			
-5	-80	6	0.00045	18.3	18.2	17.4	18.2	0.954	373.3	NO DAMAGE			
-5	-85	41	0.00306	18.3	18.2	17.4	18.2	0.951	350.0	NO DAMAGE			
-5	-90	5	0.00037	18.3	18.2	17.3	18.2	0.948	329.4	NO DAMAGE			
-5	-95	47	0.00350	18.3	18.2	17.2	18.2	0.945	311.1	NO DAMAGE			
-5	-100	7	0.00052	18.3	18.2	17.2	18.2	0.942	294.7	NO DAMAGE			
-5	-105	13	0.00097	18.3	18.2	17.1	18.2	0.939	280.0	NO DAMAGE			
-5	-110	1	0.00007	18.3	18.2	17.1	18.2	0.936	266.6	NO DAMAGE			
-5	-115	14	0.00104	18.3	18.2	17.0	18.2	0.933	254.5	NO DAMAGE			
-5	-125	4	0.00030	18.3	18.2	16.9	18.2	0.927	233.3	NO DAMAGE			
-5	-135	3	0.00022	18.3	18.2	16.8	18.2	0.921	215.4	NO DAMAGE			
-5	-145	3	0.00022	18.3	18.2	16.7	18.2	0.914	200.0	NO DAMAGE			
-5	-155	1	0.00007	18.3	18.2	16.6	18.2	0.908	186.7	NO DAMAGE			
-5	-165	1	0.00007	18.3	18.2	16.5	18.2	0.902	175.0	NO DAMAGE			
-5	-175	1	0.00007	18.3	18.2	16.4	18.2	0.896	164.7	NO DAMAGE			
-5	-185	1	0.00007	18.3	18.2	16.2	18.2	0.890	155.5	NO DAMAGE			
-5	-205	2	0.00015	18.3	18.2	16.0	18.2	0.878	140.0	NO DAMAGE			
-5	-215	1	0.00007	18.3	18.2	15.9	18.2	0.872	133.3	NO DAMAGE			
-5	-235	1	0.00007	18.3	18.2	15.7	18.2	0.860	121.7	NO DAMAGE			
-10	-20	31560	2.35289	18.3	18.2	18.1	18.2	0.994	2781.2	NO DAMAGE			
-10	-25	5740	0.42793	18.3	18.2	18.0	18.2	0.991	1860.8	NO DAMAGE			
-10	-30	19970	1.48882	18.3	18.2	18.0	18.2	0.988	1395.6	NO DAMAGE			
-10	-35	956	0.07127	18.3	18.2	17.9	18.2	0.985	1116.5	NO DAMAGE			
-10	-40	5567	0.41504	18.3	18.2	17.9	18.2	0.982	930.4	NO DAMAGE			
-10	-45	300	0.02237	18.3	18.2	17.8	18.2	0.979	797.5	NO DAMAGE			
-10	-50	1639	0.12219	18.3	18.2	17.7	18.2	0.975	697.8	NO DAMAGE			
-10	-55	37	0.00276	18.3	18.2	17.7	18.2	0.972	620.3	NO DAMAGE			
-10	-60	645	0.04809	18.3	18.2	17.6	18.2	0.969	558.2	NO DAMAGE			
-10	-65	11	0.00082	18.3	18.2	17.6	18.2	0.966	507.5	NO DAMAGE			
-10	-70	300	0.02237	18.3	18.2	17.5	18.2	0.963	465.2	NO DAMAGE			
-10	-75	2	0.00015	18.3	18.2	17.5	18.2	0.960	429.4	NO DAMAGE			
-10	-80	215	0.01603	18.3	18.2	17.4	18.2	0.957	398.7	NO DAMAGE			
-10	-85	7	0.00052	18.3	18.2	17.4	18.2	0.954	372.2	NO DAMAGE			
-10	-90	114	0.00850	18.3	18.2	17.3	18.2	0.951	348.9	NO DAMAGE			
-10	-95	1	0.00007	18.3	18.2	17.2	18.2	0.948	328.4	NO DAMAGE			
-10	-100	63	0.00470	18.3	18.2	17.2	18.2	0.945	310.1	NO DAMAGE			
-10	-105	2	0.00015	18.3	18.2	17.1	18.2	0.942	293.8	NO DAMAGE			
-10	-110	46	0.00343	18.3	18.2	17.1	18.2	0.939	279.1	NO DAMAGE			
-10	-115	3	0.00022	18.3	18.2	17.0	18.2	0.936	265.8	NO DAMAGE			
-10	-120	21	0.00157	18.3	18.2	17.0	18.2	0.933	253.7	NO DAMAGE			
-10	-125	1	0.00007	18.3	18.2	16.9	18.2	0.930	242.7	NO DAMAGE			
-10	-130	12	0.00089	18.3	18.2	16.9	18.2	0.926	232.6	NO DAMAGE			
-10	-140	6	0.00045	18.3	18.2	16.7	18.2	0.920	214.7	NO DAMAGE			
-10	-150	6	0.00045	18.3	18.2	16.6	18.2	0.914	199.4	NO DAMAGE			
-10	-155	2	0.00015	18.3	18.2	16.6	18.2	0.911	192.5	NO DAMAGE			
-10	-160	2	0.00015	18.3	18.2	16.5	18.2	0.908	186.1	NO DAMAGE			
-10	-170	5	0.00037	18.3	18.2	16.4	18.2	0.902	174.5	NO DAMAGE			
-10	-180	1	0.00007	18.3	18.2	16.3	18.2	0.896	164.2	NO DAMAGE			
-10	-190	1	0.00007	18.3	18.2	16.2	18.2	0.890	155.1	NO DAMAGE			
-10	-195	1	0.00007	18.3	18.2	16.1	18.2	0.887	150.9	NO DAMAGE			
-10	-200	1	0.00007	18.3	18.2	16.1	18.2	0.884	146.9	NO DAMAGE			
-10	-210	1	0.00007	18.3	18.2	16.0	18.2	0.877	139.6	NO DAMAGE			
-10	-220	1	0.00007	18.3	18.2	15.8	18.2	0.871	132.9	NO DAMAGE			
-15	-25	15612	1.16392	18.3	18.1	18.0	18.1	0.994	2782.7	NO DAMAGE			
-15	-30	4802	0.35800	18.3	18.1	18.0	18.1	0.991	1855.1	NO DAMAGE			
-15	-35	11214	0.83603	18.3	18.1	17.9	18.1	0.988	1391.3	NO DAMAGE			
-15	-40	1636	0.12197	18.3	18.1	17.9	18.1	0.985	1113.1	NO DAMAGE			
-15	-45	2753	0.20524	18.3	18.1	17.8	18.1	0.982	927.6	NO DAMAGE			
-15	-50	106	0.00790	18.3	18.1	17.7	18.1	0.978	795.1	NO DAMAGE			
-15	-55	686	0.05114	18.3	18.1	17.7	18.1	0.975	695.7	NO DAMAGE			
-15	-60	20	0.00149	18.3	18.1	17.6	18.1	0.972	618.4	NO DAMAGE			
-15	-65	218	0.01625	18.3	18.1	17.6	18.1	0.969	556.5	NO DAMAGE			
-15	-70	12	0.00089	18.3	18.1	17.5	18.1	0.966	505.9	NO DAMAGE			
-15	-75	106	0.00790	18.3	18.1	17.5	18.1	0.963	463.8	NO DAMAGE			
-15	-80	3	0.00022	18.3	18.1	17.4	18.1	0.960	428.1	NO DAMAGE			
-15	-85	68	0.00507	18.3	18.1	17.4	18.1	0.957	397.5	NO DAMAGE			
-15	-90	1	0.00007	18.3	18.1	17.3	18.1	0.954	371.0	NO DAMAGE			
-15	-95	28	0.00209	18.3	18.1	17.2	18.1	0.951	347.8	NO DAMAGE			
-15	-100	3	0.00022	18.3	18.1	17.2	18.1	0.948	327.4	NO DAMAGE			
-15	-105	13	0.00097	18.3	18.1	17.1	18.1	0.945	309.2	NO DAMAGE			
-15	-110	1	0.00007	18.3	18.1	17.1	18.1	0.942	292.9	NO DAMAGE			
-15	-115	5	0.00037	18.3	18.1	17.0	18.1	0.939	278.3	NO DAMAGE			
-15	-120	1	0.00007	18.3	18.1	17.0	18.1	0.935	265.0	NO DAMAGE			
-15	-125	3	0.00022	18.3	18.1	16.9	18.1	0.932	253.0	NO DAMAGE			
-15	-135	2	0.00015	18.3	18.1	16.8	18.1	0.926	231.9	NO DAMAGE			
-15	-145	4	0.00030	18.3	18.1	16.7	18.1	0.920	214.1	NO DAMAGE			
-15	-155	1	0.00007	18.3	18.1	16.6	18.1	0.914	198.8	NO DAMAGE			
-15	-160	1	0.00007	18.3	18.1	16.5	18.1	0.911	191.9	NO DAMAGE			
-15	-165	3	0.00022	18.3	18.1	16.5	18.1	0.908	185.5	NO DAMAGE			
-15	-170	2	0.00015	18.3	18.1	16.4	18.1	0.905	179.5	NO DAMAGE			
-15	-185	1	0.00007	18.3	18.1	16.2	18.1	0.896	163.7	NO DAMAGE			
-15	-205	1	0.00007	18.3	18.1	16.0	18.1	0.883	146.5	NO DAMAGE			
-15	-240	1	0.00007	18.3	18.1	15.6	18.1	0.862	123.7	NO DAMAGE			
-15	-245	1	0.00007	18.3	18.1	15.6	18.1	0.859	121.0	NO DAMAGE			
-20	-30	30520	2.27535	18.3	18.1	18.0	18.1	0.994	2774.1	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-20	-35	6326	0.47162	18.3	18.1	17.9	18.1	0.991	1849.4	NO DAMAGE			
-20	-40	18311	1.36514	18.3	18.1	17.9	18.1	0.988	1387.1	NO DAMAGE			
-20	-45	518	0.03862	18.3	18.1	17.8	18.1	0.985	1109.7	NO DAMAGE			
-20	-50	5081	0.37880	18.3	18.1	17.7	18.1	0.982	924.7	NO DAMAGE			
-20	-55	59	0.00440	18.3	18.1	17.7	18.1	0.978	792.6	NO DAMAGE			
-20	-60	1465	0.10922	18.3	18.1	17.6	18.1	0.975	693.5	NO DAMAGE			
-20	-65	29	0.00216	18.3	18.1	17.6	18.1	0.972	616.5	NO DAMAGE			
-20	-70	431	0.03213	18.3	18.1	17.5	18.1	0.969	554.8	NO DAMAGE			
-20	-75	8	0.00060	18.3	18.1	17.5	18.1	0.966	504.4	NO DAMAGE			
-20	-80	196	0.01461	18.3	18.1	17.4	18.1	0.963	462.4	NO DAMAGE			
-20	-85	3	0.00022	18.3	18.1	17.4	18.1	0.960	426.8	NO DAMAGE			
-20	-90	52	0.00388	18.3	18.1	17.3	18.1	0.957	396.3	NO DAMAGE			
-20	-95	2	0.00015	18.3	18.1	17.2	18.1	0.954	369.9	NO DAMAGE			
-20	-100	34	0.00253	18.3	18.1	17.2	18.1	0.951	346.8	NO DAMAGE			
-20	-110	11	0.00082	18.3	18.1	17.1	18.1	0.945	308.2	NO DAMAGE			
-20	-120	13	0.00097	18.3	18.1	17.0	18.1	0.938	277.4	NO DAMAGE			
-20	-130	4	0.00030	18.3	18.1	16.9	18.1	0.932	252.2	NO DAMAGE			
-20	-150	1	0.00007	18.3	18.1	16.6	18.1	0.920	213.4	NO DAMAGE			
-20	-155	1	0.00007	18.3	18.1	16.6	18.1	0.917	205.5	NO DAMAGE			
-20	-160	3	0.00022	18.3	18.1	16.5	18.1	0.914	198.2	NO DAMAGE			
-20	-170	1	0.00007	18.3	18.1	16.4	18.1	0.908	184.9	NO DAMAGE			
-25	-35	14163	1.05589	18.3	18.0	17.9	18.0	0.994	2765.6	NO DAMAGE			
-25	-40	2509	0.18705	18.3	18.0	17.9	18.0	0.991	1843.7	NO DAMAGE			
-25	-45	7096	0.52903	18.3	18.0	17.8	18.0	0.988	1382.8	NO DAMAGE			
-25	-50	460	0.03429	18.3	18.0	17.7	18.0	0.985	1106.2	NO DAMAGE			
-25	-55	2477	0.18467	18.3	18.0	17.7	18.0	0.981	921.9	NO DAMAGE			
-25	-60	92	0.00686	18.3	18.0	17.6	18.0	0.978	790.2	NO DAMAGE			
-25	-65	885	0.06598	18.3	18.0	17.6	18.0	0.975	691.4	NO DAMAGE			
-25	-70	46	0.00343	18.3	18.0	17.5	18.0	0.972	614.6	NO DAMAGE			
-25	-75	446	0.03325	18.3	18.0	17.5	18.0	0.969	553.1	NO DAMAGE			
-25	-80	10	0.00075	18.3	18.0	17.4	18.0	0.966	502.8	NO DAMAGE			
-25	-85	155	0.01156	18.3	18.0	17.4	18.0	0.963	460.9	NO DAMAGE			
-25	-90	4	0.00030	18.3	18.0	17.3	18.0	0.960	425.5	NO DAMAGE			
-25	-95	55	0.00410	18.3	18.0	17.2	18.0	0.957	395.1	NO DAMAGE			
-25	-100	1	0.00007	18.3	18.0	17.2	18.0	0.954	368.7	NO DAMAGE			
-25	-105	13	0.00097	18.3	18.0	17.1	18.0	0.951	345.7	NO DAMAGE			
-25	-115	10	0.00075	18.3	18.0	17.0	18.0	0.944	307.3	NO DAMAGE			
-25	-120	2	0.00015	18.3	18.0	17.0	18.0	0.941	291.1	NO DAMAGE			
-25	-125	9	0.00067	18.3	18.0	16.9	18.0	0.938	276.6	NO DAMAGE			
-25	-135	2	0.00015	18.3	18.0	16.8	18.0	0.932	251.4	NO DAMAGE			
-25	-145	2	0.00015	18.3	18.0	16.7	18.0	0.926	230.5	NO DAMAGE			
-25	-155	3	0.00022	18.3	18.0	16.6	18.0	0.920	212.7	NO DAMAGE			
-25	-165	1	0.00007	18.3	18.0	16.5	18.0	0.913	197.5	NO DAMAGE			
-25	-180	1	0.00007	18.3	18.0	16.3	18.0	0.904	178.4	NO DAMAGE			
-25	-205	1	0.00007	18.3	18.0	16.0	18.0	0.889	153.6	NO DAMAGE			
-25	-225	1	0.00007	18.3	18.0	15.8	18.0	0.876	138.3	NO DAMAGE			
-25	-235	1	0.00007	18.3	18.0	15.7	18.0	0.870	131.7	NO DAMAGE			
-30	-40	19532	1.45616	18.3	18.0	17.9	18.0	0.994	2757.0	NO DAMAGE			
-30	-45	2909	0.21687	18.3	18.0	17.8	18.0	0.991	1838.0	NO DAMAGE			
-30	-50	13716	1.02257	18.3	18.0	17.7	18.0	0.988	1378.5	NO DAMAGE			
-30	-55	553	0.04123	18.3	18.0	17.7	18.0	0.984	1102.8	NO DAMAGE			
-30	-60	3849	0.28695	18.3	18.0	17.6	18.0	0.981	919.0	NO DAMAGE			
-30	-65	168	0.01252	18.3	18.0	17.6	18.0	0.978	787.7	NO DAMAGE			
-30	-70	1165	0.08685	18.3	18.0	17.5	18.0	0.975	689.3	NO DAMAGE			
-30	-75	39	0.00291	18.3	18.0	17.5	18.0	0.972	612.7	NO DAMAGE			
-30	-80	266	0.01983	18.3	18.0	17.4	18.0	0.969	551.4	NO DAMAGE			
-30	-85	5	0.00037	18.3	18.0	17.4	18.0	0.966	501.3	NO DAMAGE			
-30	-90	68	0.00507	18.3	18.0	17.3	18.0	0.963	459.5	NO DAMAGE			
-30	-95	2	0.00015	18.3	18.0	17.2	18.0	0.960	424.2	NO DAMAGE			
-30	-100	35	0.00261	18.3	18.0	17.2	18.0	0.957	393.9	NO DAMAGE			
-30	-110	12	0.00089	18.3	18.0	17.1	18.0	0.950	344.6	NO DAMAGE			
-30	-120	3	0.00022	18.3	18.0	17.0	18.0	0.944	306.3	NO DAMAGE			
-30	-125	1	0.00007	18.3	18.0	16.9	18.0	0.941	290.2	NO DAMAGE			
-30	-130	5	0.00037	18.3	18.0	16.9	18.0	0.938	275.7	NO DAMAGE			
-30	-140	5	0.00037	18.3	18.0	16.7	18.0	0.932	250.6	NO DAMAGE			
-30	-145	2	0.00015	18.3	18.0	16.7	18.0	0.929	239.7	NO DAMAGE			
-30	-150	1	0.00007	18.3	18.0	16.6	18.0	0.926	229.8	NO DAMAGE			
-30	-160	1	0.00007	18.3	18.0	16.5	18.0	0.919	212.1	NO DAMAGE			
-30	-170	1	0.00007	18.3	18.0	16.4	18.0	0.913	196.9	NO DAMAGE			
-30	-180	1	0.00007	18.3	18.0	16.3	18.0	0.907	183.8	NO DAMAGE			
-30	-190	1	0.00007	18.3	18.0	16.2	18.0	0.901	172.3	NO DAMAGE			
-30	-195	1	0.00007	18.3	18.0	16.1	18.0	0.898	167.1	NO DAMAGE			
-30	-200	1	0.00007	18.3	18.0	16.1	18.0	0.895	162.2	NO DAMAGE			
-30	-215	1	0.00007	18.3	18.0	15.9	18.0	0.885	149.0	NO DAMAGE			
-30	-255	1	0.00007	18.3	18.0	15.5	18.0	0.860	122.5	NO DAMAGE			
-35	-45	12272	0.91491	18.3	17.9	17.8	17.9	0.994	2748.5	NO DAMAGE			
-35	-50	2344	0.17475	18.3	17.9	17.7	17.9	0.991	1832.3	NO DAMAGE			
-35	-55	8732	0.65099	18.3	17.9	17.7	17.9	0.988	1374.2	NO DAMAGE			
-35	-60	676	0.05040	18.3	17.9	17.6	17.9	0.984	1099.4	NO DAMAGE			
-35	-65	3860	0.28777	18.3	17.9	17.6	17.9	0.981	916.2	NO DAMAGE			
-35	-70	154	0.01148	18.3	17.9	17.5	17.9	0.978	785.3	NO DAMAGE			
-35	-75	1443	0.10758	18.3	17.9	17.5	17.9	0.975	687.1	NO DAMAGE			
-35	-80	32	0.00239	18.3	17.9	17.4	17.9	0.972	610.8	NO DAMAGE			
-35	-85	453	0.03377	18.3	17.9	17.4	17.9	0.969	549.7	NO DAMAGE			
-35	-90	6	0.00045	18.3	17.9	17.3	17.9	0.966	499.7	NO DAMAGE			
-35	-95	105	0.00783	18.3	17.9	17.2	17.9	0.963	458.1	NO DAMAGE			
-35	-100	4	0.00030	18.3	17.9	17.2	17.9	0.960	422.8	NO DAMAGE			
-35	-105	28	0.00209	18.3	17.9	17.1	17.9	0.956	392.6	NO DAMAGE			
-35	-115	14	0.00104	18.3	17.9	17.0	17.9	0.950	343.6	NO DAMAGE			
-35	-120	1	0.00007	18.3	17.9	17.0	17.9	0.947	323.4	NO DAMAGE			
-35	-125	4	0.00030	18.3	17.9	16.9	17.9	0.944	305.4	NO DAMAGE			

					Dynamic Stress					to Failure			
Max	Min	No.	α Pct	Static Stress	Max	Min	Max Adjusted	R Min/Max	Endurance Limit	N	α/N	cycles per mile	153.8
												Yield stress	60 ksi
-35	-130	1	0.00007	18.3	17.9	16.9	17.9	0.941	289.3	NO DAMAGE			
-35	-135	5	0.00037	18.3	17.9	16.8	17.9	0.938	274.8	NO DAMAGE			
-35	-150	1	0.00007	18.3	17.9	16.6	17.9	0.928	239.0	NO DAMAGE			
-35	-165	2	0.00015	18.3	17.9	16.5	17.9	0.919	211.4	NO DAMAGE			
-35	-175	1	0.00007	18.3	17.9	16.4	17.9	0.913	196.3	NO DAMAGE			
-35	-180	1	0.00007	18.3	17.9	16.3	17.9	0.910	189.6	NO DAMAGE			
-35	-215	1	0.00007	18.3	17.9	15.9	17.9	0.888	152.7	NO DAMAGE			
-40	-50	14077	1.04948	18.3	17.9	17.7	17.9	0.994	2739.9	NO DAMAGE			
-40	-55	2298	0.17132	18.3	17.9	17.7	17.9	0.991	1826.6	NO DAMAGE			
-40	-60	10806	0.80562	18.3	17.9	17.6	17.9	0.988	1370.0	NO DAMAGE			
-40	-65	770	0.05741	18.3	17.9	17.6	17.9	0.984	1096.0	NO DAMAGE			
-40	-70	2852	0.21262	18.3	17.9	17.5	17.9	0.981	913.3	NO DAMAGE			
-40	-75	135	0.01006	18.3	17.9	17.5	17.9	0.978	782.8	NO DAMAGE			
-40	-80	567	0.04227	18.3	17.9	17.4	17.9	0.975	685.0	NO DAMAGE			
-40	-85	32	0.00239	18.3	17.9	17.4	17.9	0.972	608.9	NO DAMAGE			
-40	-90	154	0.01148	18.3	17.9	17.3	17.9	0.969	548.0	NO DAMAGE			
-40	-95	8	0.00060	18.3	17.9	17.2	17.9	0.966	498.2	NO DAMAGE			
-40	-100	43	0.00321	18.3	17.9	17.2	17.9	0.963	456.7	NO DAMAGE			
-40	-105	5	0.00037	18.3	17.9	17.1	17.9	0.959	421.5	NO DAMAGE			
-40	-110	13	0.00097	18.3	17.9	17.1	17.9	0.956	391.4	NO DAMAGE			
-40	-115	2	0.00015	18.3	17.9	17.0	17.9	0.953	365.3	NO DAMAGE			
-40	-120	7	0.00052	18.3	17.9	17.0	17.9	0.950	342.5	NO DAMAGE			
-40	-125	1	0.00007	18.3	17.9	16.9	17.9	0.947	322.3	NO DAMAGE			
-40	-130	7	0.00052	18.3	17.9	16.9	17.9	0.944	304.4	NO DAMAGE			
-40	-140	2	0.00015	18.3	17.9	16.7	17.9	0.938	274.0	NO DAMAGE			
-40	-160	2	0.00015	18.3	17.9	16.5	17.9	0.925	228.3	NO DAMAGE			
-40	-165	1	0.00007	18.3	17.9	16.5	17.9	0.922	219.2	NO DAMAGE			
-40	-180	1	0.00007	18.3	17.9	16.3	17.9	0.913	195.7	NO DAMAGE			
-45	-55	13228	0.98618	18.3	17.8	17.7	17.8	0.994	2731.4	NO DAMAGE			
-45	-60	2591	0.19317	18.3	17.8	17.6	17.8	0.991	1820.9	NO DAMAGE			
-45	-65	13577	1.01220	18.3	17.8	17.6	17.8	0.987	1365.7	NO DAMAGE			
-45	-70	751	0.05599	18.3	17.8	17.5	17.8	0.984	1092.6	NO DAMAGE			
-45	-75	4721	0.35196	18.3	17.8	17.5	17.8	0.981	910.5	NO DAMAGE			
-45	-80	159	0.01185	18.3	17.8	17.4	17.8	0.978	780.4	NO DAMAGE			
-45	-85	1270	0.09468	18.3	17.8	17.4	17.8	0.975	682.8	NO DAMAGE			
-45	-90	32	0.00239	18.3	17.8	17.3	17.8	0.972	607.0	NO DAMAGE			
-45	-95	224	0.01670	18.3	17.8	17.2	17.8	0.969	546.3	NO DAMAGE			
-45	-100	7	0.00052	18.3	17.8	17.2	17.8	0.966	496.6	NO DAMAGE			
-45	-105	59	0.00440	18.3	17.8	17.1	17.8	0.962	455.2	NO DAMAGE			
-45	-110	6	0.00045	18.3	17.8	17.1	17.8	0.959	420.2	NO DAMAGE			
-45	-115	31	0.00231	18.3	17.8	17.0	17.8	0.956	390.2	NO DAMAGE			
-45	-120	5	0.00037	18.3	17.8	17.0	17.8	0.953	364.2	NO DAMAGE			
-45	-125	12	0.00089	18.3	17.8	16.9	17.8	0.950	341.4	NO DAMAGE			
-45	-135	7	0.00052	18.3	17.8	16.8	17.8	0.944	303.5	NO DAMAGE			
-45	-145	3	0.00022	18.3	17.8	16.7	17.8	0.937	273.1	NO DAMAGE			
-45	-175	1	0.00007	18.3	17.8	16.4	17.8	0.919	210.1	NO DAMAGE			
-45	-215	1	0.00007	18.3	17.8	15.9	17.8	0.894	160.7	NO DAMAGE			
-45	-230	1	0.00007	18.3	17.8	15.7	17.8	0.884	147.6	NO DAMAGE			
-50	-60	13667	1.01891	18.3	17.7	17.6	17.7	0.994	2722.8	NO DAMAGE			
-50	-65	2746	0.20472	18.3	17.7	17.6	17.7	0.991	1815.2	NO DAMAGE			
-50	-70	9048	0.67455	18.3	17.7	17.5	17.7	0.987	1361.4	NO DAMAGE			
-50	-75	799	0.05957	18.3	17.7	17.5	17.7	0.984	1089.1	NO DAMAGE			
-50	-80	1862	0.13882	18.3	17.7	17.4	17.7	0.981	907.6	NO DAMAGE			
-50	-85	159	0.01185	18.3	17.7	17.4	17.7	0.978	778.0	NO DAMAGE			
-50	-90	403	0.03004	18.3	17.7	17.3	17.7	0.975	680.7	NO DAMAGE			
-50	-95	32	0.00239	18.3	17.7	17.2	17.7	0.972	605.1	NO DAMAGE			
-50	-100	122	0.00910	18.3	17.7	17.2	17.7	0.969	544.6	NO DAMAGE			
-50	-105	12	0.00089	18.3	17.7	17.1	17.7	0.965	495.1	NO DAMAGE			
-50	-110	33	0.00246	18.3	17.7	17.1	17.7	0.962	453.8	NO DAMAGE			
-50	-115	2	0.00015	18.3	17.7	17.0	17.7	0.959	418.9	NO DAMAGE			
-50	-120	11	0.00082	18.3	17.7	17.0	17.7	0.956	389.0	NO DAMAGE			
-50	-125	2	0.00015	18.3	17.7	16.9	17.7	0.953	363.0	NO DAMAGE			
-50	-130	5	0.00037	18.3	17.7	16.9	17.7	0.950	340.4	NO DAMAGE			
-50	-135	1	0.00007	18.3	17.7	16.8	17.7	0.947	320.3	NO DAMAGE			
-50	-140	2	0.00015	18.3	17.7	16.7	17.7	0.943	302.5	NO DAMAGE			
-50	-150	1	0.00007	18.3	17.7	16.6	17.7	0.937	272.3	NO DAMAGE			
-50	-160	3	0.00022	18.3	17.7	16.5	17.7	0.931	247.5	NO DAMAGE			
-50	-170	1	0.00007	18.3	17.7	16.4	17.7	0.925	226.9	NO DAMAGE			
-50	-180	2	0.00015	18.3	17.7	16.3	17.7	0.918	209.4	NO DAMAGE			
-50	-215	1	0.00007	18.3	17.7	15.9	17.7	0.896	165.0	NO DAMAGE			
-55	-65	16459	1.22706	18.3	17.7	17.6	17.7	0.994	2714.3	NO DAMAGE			
-55	-70	2658	0.19816	18.3	17.7	17.5	17.7	0.991	1809.5	NO DAMAGE			
-55	-75	14709	1.09660	18.3	17.7	17.5	17.7	0.987	1357.1	NO DAMAGE			
-55	-80	1037	0.07731	18.3	17.7	17.4	17.7	0.984	1085.7	NO DAMAGE			
-55	-85	3097	0.23089	18.3	17.7	17.4	17.7	0.981	904.8	NO DAMAGE			
-55	-90	215	0.01603	18.3	17.7	17.3	17.7	0.978	775.5	NO DAMAGE			
-55	-95	683	0.05092	18.3	17.7	17.2	17.7	0.975	678.6	NO DAMAGE			
-55	-100	56	0.00417	18.3	17.7	17.2	17.7	0.972	603.2	NO DAMAGE			
-55	-105	306	0.02281	18.3	17.7	17.1	17.7	0.969	542.9	NO DAMAGE			
-55	-110	6	0.00045	18.3	17.7	17.1	17.7	0.965	493.5	NO DAMAGE			
-55	-115	132	0.00984	18.3	17.7	17.0	17.7	0.962	452.4	NO DAMAGE			
-55	-120	3	0.00022	18.3	17.7	17.0	17.7	0.959	417.6	NO DAMAGE			
-55	-125	30	0.00224	18.3	17.7	16.9	17.7	0.956	387.8	NO DAMAGE			
-55	-135	4	0.00030	18.3	17.7	16.8	17.7	0.950	339.3	NO DAMAGE			
-55	-145	3	0.00022	18.3	17.7	16.7	17.7	0.943	301.6	NO DAMAGE			
-55	-155	1	0.00007	18.3	17.7	16.6	17.7	0.937	271.4	NO DAMAGE			
-55	-160	1	0.00007	18.3	17.7	16.5	17.7	0.934	258.5	NO DAMAGE			
-55	-165	1	0.00007	18.3	17.7	16.5	17.7	0.931	246.8	NO DAMAGE			
-55	-195	1	0.00007	18.3	17.7	16.1	17.7	0.912	193.9	NO DAMAGE			
-55	-205	1	0.00007	18.3	17.7	16.0	17.7	0.906	181.0	NO DAMAGE			
-55	-225	1	0.00007	18.3	17.7	15.8	17.7	0.893	159.7	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-55	-235	1	0.00007	18.3	17.7	15.7	17.7	0.887	150.8	NO DAMAGE			
-55	-270	1	0.00007	18.3	17.7	15.3	17.7	0.865	126.2	NO DAMAGE			
-60	-70	12251	0.91335	18.3	17.6	17.5	17.6	0.994	2705.7	NO DAMAGE			
-60	-75	2961	0.22075	18.3	17.6	17.5	17.6	0.991	1803.8	NO DAMAGE			
-60	-80	7155	0.53342	18.3	17.6	17.4	17.6	0.987	1352.9	NO DAMAGE			
-60	-85	1139	0.08492	18.3	17.6	17.4	17.6	0.984	1082.3	NO DAMAGE			
-60	-90	1533	0.11429	18.3	17.6	17.3	17.6	0.981	901.9	NO DAMAGE			
-60	-95	213	0.01588	18.3	17.6	17.2	17.6	0.978	773.1	NO DAMAGE			
-60	-100	311	0.02319	18.3	17.6	17.2	17.6	0.975	676.4	NO DAMAGE			
-60	-105	44	0.00328	18.3	17.6	17.1	17.6	0.972	601.3	NO DAMAGE			
-60	-110	70	0.00522	18.3	17.6	17.1	17.6	0.968	541.1	NO DAMAGE			
-60	-115	11	0.00082	18.3	17.6	17.0	17.6	0.965	492.0	NO DAMAGE			
-60	-120	23	0.00171	18.3	17.6	17.0	17.6	0.962	451.0	NO DAMAGE			
-60	-125	1	0.00007	18.3	17.6	16.9	17.6	0.959	416.3	NO DAMAGE			
-60	-130	3	0.00022	18.3	17.6	16.9	17.6	0.956	386.5	NO DAMAGE			
-60	-140	3	0.00022	18.3	17.6	16.7	17.6	0.949	338.2	NO DAMAGE			
-60	-150	1	0.00007	18.3	17.6	16.6	17.6	0.943	300.6	NO DAMAGE			
-60	-160	3	0.00022	18.3	17.6	16.5	17.6	0.937	270.6	NO DAMAGE			
-60	-170	2	0.00015	18.3	17.6	16.4	17.6	0.930	246.0	NO DAMAGE			
-60	-190	1	0.00007	18.3	17.6	16.2	17.6	0.918	208.1	NO DAMAGE			
-60	-195	1	0.00007	18.3	17.6	16.1	17.6	0.915	200.4	NO DAMAGE			
-65	-75	16359	1.21961	18.3	17.6	17.5	17.6	0.994	2697.2	NO DAMAGE			
-65	-80	3270	0.24379	18.3	17.6	17.4	17.6	0.990	1798.1	NO DAMAGE			
-65	-85	10064	0.75030	18.3	17.6	17.4	17.6	0.987	1348.6	NO DAMAGE			
-65	-90	1010	0.07530	18.3	17.6	17.3	17.6	0.984	1078.9	NO DAMAGE			
-65	-95	2428	0.18101	18.3	17.6	17.2	17.6	0.981	899.1	NO DAMAGE			
-65	-100	173	0.01290	18.3	17.6	17.2	17.6	0.978	770.6	NO DAMAGE			
-65	-105	939	0.07001	18.3	17.6	17.1	17.6	0.975	674.3	NO DAMAGE			
-65	-110	22	0.00164	18.3	17.6	17.1	17.6	0.971	599.4	NO DAMAGE			
-65	-115	235	0.01752	18.3	17.6	17.0	17.6	0.968	539.4	NO DAMAGE			
-65	-125	34	0.00253	18.3	17.6	16.9	17.6	0.962	449.5	NO DAMAGE			
-65	-130	1	0.00007	18.3	17.6	16.9	17.6	0.959	415.0	NO DAMAGE			
-65	-135	4	0.00030	18.3	17.6	16.8	17.6	0.956	385.3	NO DAMAGE			
-65	-140	1	0.00007	18.3	17.6	16.7	17.6	0.952	359.6	NO DAMAGE			
-65	-145	4	0.00030	18.3	17.6	16.7	17.6	0.949	337.1	NO DAMAGE			
-65	-155	1	0.00007	18.3	17.6	16.6	17.6	0.943	299.7	NO DAMAGE			
-65	-160	2	0.00015	18.3	17.6	16.5	17.6	0.940	283.9	NO DAMAGE			
-65	-165	2	0.00015	18.3	17.6	16.5	17.6	0.937	269.7	NO DAMAGE			
-65	-175	2	0.00015	18.3	17.6	16.4	17.6	0.930	245.2	NO DAMAGE			
-65	-195	1	0.00007	18.3	17.6	16.1	17.6	0.918	207.5	NO DAMAGE			
-65	-205	1	0.00007	18.3	17.6	16.0	17.6	0.911	192.7	NO DAMAGE			
-65	-215	1	0.00007	18.3	17.6	15.9	17.6	0.905	179.8	NO DAMAGE			
-70	-80	10471	0.78064	18.3	17.5	17.4	17.5	0.994	2688.6	NO DAMAGE			
-70	-85	3301	0.24610	18.3	17.5	17.4	17.5	0.990	1792.4	NO DAMAGE			
-70	-90	5651	0.42130	18.3	17.5	17.3	17.5	0.987	1344.3	NO DAMAGE			
-70	-95	952	0.07097	18.3	17.5	17.2	17.5	0.984	1075.5	NO DAMAGE			
-70	-100	1144	0.08529	18.3	17.5	17.2	17.5	0.981	896.2	NO DAMAGE			
-70	-105	124	0.00924	18.3	17.5	17.1	17.5	0.978	768.2	NO DAMAGE			
-70	-110	229	0.01707	18.3	17.5	17.1	17.5	0.975	672.2	NO DAMAGE			
-70	-115	16	0.00119	18.3	17.5	17.0	17.5	0.971	597.5	NO DAMAGE			
-70	-120	40	0.00298	18.3	17.5	17.0	17.5	0.968	537.7	NO DAMAGE			
-70	-125	2	0.00015	18.3	17.5	16.9	17.5	0.965	488.8	NO DAMAGE			
-70	-130	9	0.00067	18.3	17.5	16.9	17.5	0.962	448.1	NO DAMAGE			
-70	-140	3	0.00022	18.3	17.5	16.7	17.5	0.955	384.1	NO DAMAGE			
-70	-150	2	0.00015	18.3	17.5	16.6	17.5	0.949	336.1	NO DAMAGE			
-70	-160	1	0.00007	18.3	17.5	16.5	17.5	0.943	298.7	NO DAMAGE			
-70	-165	1	0.00007	18.3	17.5	16.5	17.5	0.940	283.0	NO DAMAGE			
-70	-170	1	0.00007	18.3	17.5	16.4	17.5	0.936	268.9	NO DAMAGE			
-70	-180	2	0.00015	18.3	17.5	16.3	17.5	0.930	244.4	NO DAMAGE			
-70	-190	1	0.00007	18.3	17.5	16.2	17.5	0.924	224.1	NO DAMAGE			
-70	-200	3	0.00022	18.3	17.5	16.1	17.5	0.917	206.8	NO DAMAGE			
-75	-85	14182	1.05731	18.3	17.5	17.4	17.5	0.994	2680.1	NO DAMAGE			
-75	-90	2967	0.22120	18.3	17.5	17.3	17.5	0.990	1786.7	NO DAMAGE			
-75	-95	9334	0.69588	18.3	17.5	17.2	17.5	0.987	1340.0	NO DAMAGE			
-75	-100	735	0.05480	18.3	17.5	17.2	17.5	0.984	1072.0	NO DAMAGE			
-75	-105	2065	0.15395	18.3	17.5	17.1	17.5	0.981	893.4	NO DAMAGE			
-75	-110	86	0.00641	18.3	17.5	17.1	17.5	0.978	765.7	NO DAMAGE			
-75	-115	338	0.02520	18.3	17.5	17.0	17.5	0.974	670.0	NO DAMAGE			
-75	-120	14	0.00104	18.3	17.5	17.0	17.5	0.971	595.6	NO DAMAGE			
-75	-125	45	0.00335	18.3	17.5	16.9	17.5	0.968	536.0	NO DAMAGE			
-75	-130	3	0.00022	18.3	17.5	16.9	17.5	0.965	487.3	NO DAMAGE			
-75	-135	5	0.00037	18.3	17.5	16.8	17.5	0.962	446.7	NO DAMAGE			
-75	-140	1	0.00007	18.3	17.5	16.7	17.5	0.959	412.3	NO DAMAGE			
-75	-145	2	0.00015	18.3	17.5	16.7	17.5	0.955	382.9	NO DAMAGE			
-75	-150	1	0.00007	18.3	17.5	16.6	17.5	0.952	357.3	NO DAMAGE			
-75	-155	1	0.00007	18.3	17.5	16.6	17.5	0.949	335.0	NO DAMAGE			
-75	-160	3	0.00022	18.3	17.5	16.5	17.5	0.946	315.3	NO DAMAGE			
-75	-165	2	0.00015	18.3	17.5	16.5	17.5	0.943	297.8	NO DAMAGE			
-75	-195	2	0.00015	18.3	17.5	16.1	17.5	0.923	223.3	NO DAMAGE			
-75	-205	1	0.00007	18.3	17.5	16.0	17.5	0.917	206.2	NO DAMAGE			
-75	-215	1	0.00007	18.3	17.5	15.9	17.5	0.911	191.4	NO DAMAGE			
-80	-90	8101	0.60395	18.3	17.4	17.3	17.4	0.994	2671.5	NO DAMAGE			
-80	-95	2409	0.17960	18.3	17.4	17.2	17.4	0.990	1781.0	NO DAMAGE			
-80	-100	3830	0.28554	18.3	17.4	17.2	17.4	0.987	1335.8	NO DAMAGE			
-80	-105	649	0.04838	18.3	17.4	17.1	17.4	0.984	1068.6	NO DAMAGE			
-80	-110	766	0.05711	18.3	17.4	17.1	17.4	0.981	890.5	NO DAMAGE			
-80	-115	61	0.00455	18.3	17.4	17.0	17.4	0.978	763.3	NO DAMAGE			
-80	-120	135	0.01006	18.3	17.4	17.0	17.4	0.974	667.9	NO DAMAGE			
-80	-125	1	0.00007	18.3	17.4	16.9	17.4	0.971	593.7	NO DAMAGE			
-80	-130	33	0.00246	18.3	17.4	16.9	17.4	0.968	534.3	NO DAMAGE			
-80	-135	2	0.00015	18.3	17.4	16.8	17.4	0.965	485.7	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-80	-140	10	0.00075	18.3	17.4	16.7	17.4	0.962	445.3	NO DAMAGE			
-80	-145	2	0.00015	18.3	17.4	16.7	17.4	0.958	411.0	NO DAMAGE			
-80	-150	2	0.00015	18.3	17.4	16.6	17.4	0.955	381.6	NO DAMAGE			
-80	-170	1	0.00007	18.3	17.4	16.4	17.4	0.942	296.8	NO DAMAGE			
-80	-180	1	0.00007	18.3	17.4	16.3	17.4	0.936	267.2	NO DAMAGE			
-80	-200	1	0.00007	18.3	17.4	16.1	17.4	0.923	222.6	NO DAMAGE			
-85	-95	13290	0.99081	18.3	17.4	17.2	17.4	0.994	2663.0	NO DAMAGE			
-85	-100	2275	0.16961	18.3	17.4	17.2	17.4	0.990	1775.3	NO DAMAGE			
-85	-105	6479	0.48303	18.3	17.4	17.1	17.4	0.987	1331.5	NO DAMAGE			
-85	-110	483	0.03601	18.3	17.4	17.1	17.4	0.984	1065.2	NO DAMAGE			
-85	-115	766	0.05711	18.3	17.4	17.0	17.4	0.981	887.7	NO DAMAGE			
-85	-120	50	0.00373	18.3	17.4	17.0	17.4	0.978	760.9	NO DAMAGE			
-85	-125	69	0.00514	18.3	17.4	16.9	17.4	0.974	665.7	NO DAMAGE			
-85	-130	7	0.00052	18.3	17.4	16.9	17.4	0.971	591.8	NO DAMAGE			
-85	-135	8	0.00060	18.3	17.4	16.8	17.4	0.968	532.6	NO DAMAGE			
-85	-140	2	0.00015	18.3	17.4	16.7	17.4	0.965	484.2	NO DAMAGE			
-85	-145	2	0.00015	18.3	17.4	16.7	17.4	0.961	443.8	NO DAMAGE			
-85	-150	1	0.00007	18.3	17.4	16.6	17.4	0.958	409.7	NO DAMAGE			
-85	-155	8	0.00060	18.3	17.4	16.6	17.4	0.955	380.4	NO DAMAGE			
-85	-160	1	0.00007	18.3	17.4	16.5	17.4	0.952	355.1	NO DAMAGE			
-85	-165	2	0.00015	18.3	17.4	16.5	17.4	0.949	332.9	NO DAMAGE			
-85	-175	1	0.00007	18.3	17.4	16.4	17.4	0.942	295.9	NO DAMAGE			
-85	-205	2	0.00015	18.3	17.4	16.0	17.4	0.923	221.9	NO DAMAGE			
-90	-100	5702	0.42510	18.3	17.3	17.2	17.3	0.994	2654.4	NO DAMAGE			
-90	-105	1616	0.12048	18.3	17.3	17.1	17.3	0.990	1769.6	NO DAMAGE			
-90	-110	2362	0.17609	18.3	17.3	17.1	17.3	0.987	1327.2	NO DAMAGE			
-90	-115	348	0.02594	18.3	17.3	17.0	17.3	0.984	1061.8	NO DAMAGE			
-90	-120	508	0.03787	18.3	17.3	17.0	17.3	0.981	884.8	NO DAMAGE			
-90	-125	42	0.00313	18.3	17.3	16.9	17.3	0.977	758.4	NO DAMAGE			
-90	-130	85	0.00634	18.3	17.3	16.9	17.3	0.974	663.6	NO DAMAGE			
-90	-135	5	0.00037	18.3	17.3	16.8	17.3	0.971	589.9	NO DAMAGE			
-90	-140	17	0.00127	18.3	17.3	16.7	17.3	0.968	530.9	NO DAMAGE			
-90	-145	3	0.00022	18.3	17.3	16.7	17.3	0.965	482.6	NO DAMAGE			
-90	-150	5	0.00037	18.3	17.3	16.6	17.3	0.961	442.4	NO DAMAGE			
-90	-155	2	0.00015	18.3	17.3	16.6	17.3	0.958	408.4	NO DAMAGE			
-90	-160	6	0.00045	18.3	17.3	16.5	17.3	0.955	379.2	NO DAMAGE			
-90	-170	2	0.00015	18.3	17.3	16.4	17.3	0.948	331.8	NO DAMAGE			
-90	-180	1	0.00007	18.3	17.3	16.3	17.3	0.942	294.9	NO DAMAGE			
-90	-190	2	0.00015	18.3	17.3	16.2	17.3	0.936	265.4	NO DAMAGE			
-90	-200	1	0.00007	18.3	17.3	16.1	17.3	0.929	241.3	NO DAMAGE			
-90	-250	1	0.00007	18.3	17.3	15.5	17.3	0.897	165.9	NO DAMAGE			
-95	-105	8428	0.62833	18.3	17.2	17.1	17.2	0.994	2645.9	NO DAMAGE			
-95	-110	1303	0.09714	18.3	17.2	17.1	17.2	0.990	1763.9	NO DAMAGE			
-95	-115	3709	0.27652	18.3	17.2	17.0	17.2	0.987	1322.9	NO DAMAGE			
-95	-120	265	0.01976	18.3	17.2	17.0	17.2	0.984	1058.4	NO DAMAGE			
-95	-125	319	0.02378	18.3	17.2	16.9	17.2	0.981	882.0	NO DAMAGE			
-95	-130	31	0.00231	18.3	17.2	16.9	17.2	0.977	756.0	NO DAMAGE			
-95	-135	43	0.00321	18.3	17.2	16.8	17.2	0.974	661.5	NO DAMAGE			
-95	-140	3	0.00022	18.3	17.2	16.7	17.2	0.971	588.0	NO DAMAGE			
-95	-145	6	0.00045	18.3	17.2	16.7	17.2	0.968	529.2	NO DAMAGE			
-95	-150	4	0.00030	18.3	17.2	16.6	17.2	0.964	481.1	NO DAMAGE			
-95	-155	5	0.00037	18.3	17.2	16.6	17.2	0.961	441.0	NO DAMAGE			
-95	-160	3	0.00022	18.3	17.2	16.5	17.2	0.958	407.1	NO DAMAGE			
-95	-165	3	0.00022	18.3	17.2	16.5	17.2	0.955	378.0	NO DAMAGE			
-95	-175	1	0.00007	18.3	17.2	16.4	17.2	0.948	330.7	NO DAMAGE			
-95	-195	1	0.00007	18.3	17.2	16.1	17.2	0.935	264.6	NO DAMAGE			
-95	-225	1	0.00007	18.3	17.2	15.8	17.2	0.916	203.5	NO DAMAGE			
-100	-110	4039	0.30112	18.3	17.2	17.1	17.2	0.994	2637.3	NO DAMAGE			
-100	-115	1147	0.08551	18.3	17.2	17.0	17.2	0.990	1758.2	NO DAMAGE			
-100	-120	1845	0.13755	18.3	17.2	17.0	17.2	0.987	1318.7	NO DAMAGE			
-100	-125	199	0.01484	18.3	17.2	16.9	17.2	0.984	1054.9	NO DAMAGE			
-100	-130	436	0.03251	18.3	17.2	16.9	17.2	0.981	879.1	NO DAMAGE			
-100	-135	20	0.00149	18.3	17.2	16.8	17.2	0.977	753.5	NO DAMAGE			
-100	-140	67	0.00500	18.3	17.2	16.7	17.2	0.974	659.3	NO DAMAGE			
-100	-145	2	0.00015	18.3	17.2	16.7	17.2	0.971	586.1	NO DAMAGE			
-100	-150	14	0.00104	18.3	17.2	16.6	17.2	0.968	527.5	NO DAMAGE			
-100	-160	7	0.00052	18.3	17.2	16.5	17.2	0.961	439.6	NO DAMAGE			
-100	-170	1	0.00007	18.3	17.2	16.4	17.2	0.955	376.8	NO DAMAGE			
-100	-175	1	0.00007	18.3	17.2	16.4	17.2	0.951	351.6	NO DAMAGE			
-100	-180	2	0.00015	18.3	17.2	16.3	17.2	0.948	329.7	NO DAMAGE			
-100	-185	1	0.00007	18.3	17.2	16.2	17.2	0.945	310.3	NO DAMAGE			
-100	-190	1	0.00007	18.3	17.2	16.2	17.2	0.942	293.0	NO DAMAGE			
-105	-115	6351	0.47348	18.3	17.1	17.0	17.1	0.993	2628.8	NO DAMAGE			
-105	-120	994	0.07411	18.3	17.1	17.0	17.1	0.990	1752.5	NO DAMAGE			
-105	-125	2749	0.20495	18.3	17.1	16.9	17.1	0.987	1314.4	NO DAMAGE			
-105	-130	177	0.01320	18.3	17.1	16.9	17.1	0.984	1051.5	NO DAMAGE			
-105	-135	305	0.02274	18.3	17.1	16.8	17.1	0.980	876.3	NO DAMAGE			
-105	-140	16	0.00119	18.3	17.1	16.7	17.1	0.977	751.1	NO DAMAGE			
-105	-145	18	0.00134	18.3	17.1	16.7	17.1	0.974	657.2	NO DAMAGE			
-105	-150	4	0.00030	18.3	17.1	16.6	17.1	0.971	584.2	NO DAMAGE			
-105	-155	4	0.00030	18.3	17.1	16.6	17.1	0.967	525.8	NO DAMAGE			
-105	-160	2	0.00015	18.3	17.1	16.5	17.1	0.964	478.0	NO DAMAGE			
-105	-165	5	0.00037	18.3	17.1	16.5	17.1	0.961	438.1	NO DAMAGE			
-105	-175	3	0.00022	18.3	17.1	16.4	17.1	0.954	375.5	NO DAMAGE			
-105	-185	2	0.00015	18.3	17.1	16.2	17.1	0.948	328.6	NO DAMAGE			
-105	-190	2	0.00015	18.3	17.1	16.2	17.1	0.945	309.3	NO DAMAGE			
-105	-195	1	0.00007	18.3	17.1	16.1	17.1	0.941	292.1	NO DAMAGE			
-105	-210	1	0.00007	18.3	17.1	16.0	17.1	0.932	250.4	NO DAMAGE			
-110	-120	3584	0.26720	18.3	17.1	17.0	17.1	0.993	2620.2	NO DAMAGE			
-110	-125	852	0.06352	18.3	17.1	16.9	17.1	0.990	1746.8	NO DAMAGE			
-110	-130	1577	0.11757	18.3	17.1	16.9	17.1	0.987	1310.1	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-110	-135	127	0.00947	18.3	17.1	16.8	17.1	0.984	1048.1	NO DAMAGE			
-110	-140	260	0.01938	18.3	17.1	16.7	17.1	0.980	873.4	NO DAMAGE			
-110	-145	13	0.00097	18.3	17.1	16.7	17.1	0.977	748.6	NO DAMAGE			
-110	-150	38	0.00283	18.3	17.1	16.6	17.1	0.974	655.1	NO DAMAGE			
-110	-155	5	0.00037	18.3	17.1	16.6	17.1	0.971	582.3	NO DAMAGE			
-110	-160	10	0.00075	18.3	17.1	16.5	17.1	0.967	524.0	NO DAMAGE			
-110	-165	1	0.00007	18.3	17.1	16.5	17.1	0.964	476.4	NO DAMAGE			
-110	-170	2	0.00015	18.3	17.1	16.4	17.1	0.961	436.7	NO DAMAGE			
-110	-175	2	0.00015	18.3	17.1	16.4	17.1	0.958	403.1	NO DAMAGE			
-110	-180	2	0.00015	18.3	17.1	16.3	17.1	0.954	374.3	NO DAMAGE			
-110	-205	2	0.00015	18.3	17.1	16.0	17.1	0.938	275.8	NO DAMAGE			
-115	-125	5236	0.39036	18.3	17.0	16.9	17.0	0.993	2611.7	NO DAMAGE			
-115	-130	840	0.06262	18.3	17.0	16.9	17.0	0.990	1741.1	NO DAMAGE			
-115	-135	1968	0.14672	18.3	17.0	16.8	17.0	0.987	1305.8	NO DAMAGE			
-115	-140	141	0.01051	18.3	17.0	16.7	17.0	0.984	1044.7	NO DAMAGE			
-115	-145	138	0.01029	18.3	17.0	16.7	17.0	0.980	870.6	NO DAMAGE			
-115	-150	9	0.00067	18.3	17.0	16.6	17.0	0.977	746.2	NO DAMAGE			
-115	-155	21	0.00157	18.3	17.0	16.6	17.0	0.974	652.9	NO DAMAGE			
-115	-160	2	0.00015	18.3	17.0	16.5	17.0	0.971	580.4	NO DAMAGE			
-115	-165	8	0.00060	18.3	17.0	16.5	17.0	0.967	522.3	NO DAMAGE			
-115	-170	1	0.00007	18.3	17.0	16.4	17.0	0.964	474.9	NO DAMAGE			
-115	-175	5	0.00037	18.3	17.0	16.4	17.0	0.961	435.3	NO DAMAGE			
-115	-185	1	0.00007	18.3	17.0	16.2	17.0	0.954	373.1	NO DAMAGE			
-115	-245	1	0.00007	18.3	17.0	15.6	17.0	0.915	200.9	NO DAMAGE			
-120	-130	2973	0.22165	18.3	17.0	16.9	17.0	0.993	2603.1	NO DAMAGE			
-120	-135	831	0.06195	18.3	17.0	16.8	17.0	0.990	1735.4	NO DAMAGE			
-120	-140	1120	0.08350	18.3	17.0	16.7	17.0	0.987	1301.6	NO DAMAGE			
-120	-145	100	0.00746	18.3	17.0	16.7	17.0	0.984	1041.3	NO DAMAGE			
-120	-150	164	0.01223	18.3	17.0	16.6	17.0	0.980	867.7	NO DAMAGE			
-120	-155	8	0.00060	18.3	17.0	16.6	17.0	0.977	743.8	NO DAMAGE			
-120	-160	25	0.00186	18.3	17.0	16.5	17.0	0.974	650.8	NO DAMAGE			
-120	-170	2	0.00015	18.3	17.0	16.4	17.0	0.967	520.6	NO DAMAGE			
-120	-180	3	0.00022	18.3	17.0	16.3	17.0	0.961	433.9	NO DAMAGE			
-120	-190	1	0.00007	18.3	17.0	16.2	17.0	0.954	371.9	NO DAMAGE			
-120	-200	1	0.00007	18.3	17.0	16.1	17.0	0.947	325.4	NO DAMAGE			
-120	-205	1	0.00007	18.3	17.0	16.0	17.0	0.944	306.3	NO DAMAGE			
-120	-215	1	0.00007	18.3	17.0	15.9	17.0	0.938	274.0	NO DAMAGE			
-125	-135	4276	0.31879	18.3	16.9	16.8	16.9	0.993	2594.6	NO DAMAGE			
-125	-140	683	0.05092	18.3	16.9	16.7	16.9	0.990	1729.7	NO DAMAGE			
-125	-145	1552	0.11571	18.3	16.9	16.7	16.9	0.987	1297.3	NO DAMAGE			
-125	-150	97	0.00723	18.3	16.9	16.6	16.9	0.984	1037.8	NO DAMAGE			
-125	-155	88	0.00656	18.3	16.9	16.6	16.9	0.980	864.9	NO DAMAGE			
-125	-160	17	0.00127	18.3	16.9	16.5	16.9	0.977	741.3	NO DAMAGE			
-125	-165	13	0.00097	18.3	16.9	16.5	16.9	0.974	648.6	NO DAMAGE			
-125	-170	4	0.00030	18.3	16.9	16.4	16.9	0.970	576.6	NO DAMAGE			
-125	-175	3	0.00022	18.3	16.9	16.4	16.9	0.967	518.9	NO DAMAGE			
-125	-180	1	0.00007	18.3	16.9	16.3	16.9	0.964	471.7	NO DAMAGE			
-125	-185	3	0.00022	18.3	16.9	16.2	16.9	0.960	432.4	NO DAMAGE			
-125	-190	1	0.00007	18.3	16.9	16.2	16.9	0.957	399.2	NO DAMAGE			
-125	-195	1	0.00007	18.3	16.9	16.1	16.9	0.954	370.7	NO DAMAGE			
-130	-140	2817	0.21002	18.3	16.9	16.7	16.9	0.993	2586.0	NO DAMAGE			
-130	-145	656	0.04891	18.3	16.9	16.7	16.9	0.990	1724.0	NO DAMAGE			
-130	-150	896	0.06680	18.3	16.9	16.6	16.9	0.987	1293.0	NO DAMAGE			
-130	-155	95	0.00708	18.3	16.9	16.6	16.9	0.983	1034.4	NO DAMAGE			
-130	-160	94	0.00701	18.3	16.9	16.5	16.9	0.980	862.0	NO DAMAGE			
-130	-165	10	0.00075	18.3	16.9	16.5	16.9	0.977	738.9	NO DAMAGE			
-130	-170	15	0.00112	18.3	16.9	16.4	16.9	0.974	646.5	NO DAMAGE			
-130	-175	4	0.00030	18.3	16.9	16.4	16.9	0.970	574.7	NO DAMAGE			
-130	-180	2	0.00015	18.3	16.9	16.3	16.9	0.967	517.2	NO DAMAGE			
-130	-185	1	0.00007	18.3	16.9	16.2	16.9	0.964	470.2	NO DAMAGE			
-130	-190	2	0.00015	18.3	16.9	16.2	16.9	0.960	431.0	NO DAMAGE			
-130	-195	1	0.00007	18.3	16.9	16.1	16.9	0.957	397.9	NO DAMAGE			
-130	-220	1	0.00007	18.3	16.9	15.8	16.9	0.940	287.3	NO DAMAGE			
-130	-230	1	0.00007	18.3	16.9	15.7	16.9	0.934	258.6	NO DAMAGE			
-135	-145	3311	0.24684	18.3	16.8	16.7	16.8	0.993	2577.5	NO DAMAGE			
-135	-150	514	0.03832	18.3	16.8	16.6	16.8	0.990	1718.3	NO DAMAGE			
-135	-155	1106	0.08248	18.3	16.8	16.6	16.8	0.987	1288.7	NO DAMAGE			
-135	-160	58	0.00432	18.3	16.8	16.5	16.8	0.983	1031.0	NO DAMAGE			
-135	-165	81	0.00604	18.3	16.8	16.5	16.8	0.980	859.2	NO DAMAGE			
-135	-170	10	0.00075	18.3	16.8	16.4	16.8	0.977	736.4	NO DAMAGE			
-135	-175	14	0.00104	18.3	16.8	16.4	16.8	0.973	644.4	NO DAMAGE			
-135	-180	3	0.00022	18.3	16.8	16.3	16.8	0.970	572.8	NO DAMAGE			
-135	-185	4	0.00030	18.3	16.8	16.2	16.8	0.967	515.5	NO DAMAGE			
-135	-190	1	0.00007	18.3	16.8	16.2	16.8	0.964	468.6	NO DAMAGE			
-135	-195	1	0.00007	18.3	16.8	16.1	16.8	0.960	429.6	NO DAMAGE			
-140	-150	1992	0.14851	18.3	16.7	16.6	16.7	0.993	2568.9	NO DAMAGE			
-140	-155	454	0.03385	18.3	16.7	16.6	16.7	0.990	1712.6	NO DAMAGE			
-140	-160	517	0.03854	18.3	16.7	16.5	16.7	0.987	1284.5	NO DAMAGE			
-140	-165	61	0.00455	18.3	16.7	16.5	16.7	0.983	1027.6	NO DAMAGE			
-140	-170	54	0.00403	18.3	16.7	16.4	16.7	0.980	856.3	NO DAMAGE			
-140	-175	20	0.00149	18.3	16.7	16.4	16.7	0.977	734.0	NO DAMAGE			
-140	-180	20	0.00149	18.3	16.7	16.3	16.7	0.973	642.2	NO DAMAGE			
-140	-185	1	0.00007	18.3	16.7	16.2	16.7	0.970	570.9	NO DAMAGE			
-140	-190	1	0.00007	18.3	16.7	16.2	16.7	0.967	513.8	NO DAMAGE			
-140	-195	1	0.00007	18.3	16.7	16.1	16.7	0.963	467.1	NO DAMAGE			
-140	-200	1	0.00007	18.3	16.7	16.1	16.7	0.960	428.2	NO DAMAGE			
-140	-210	1	0.00007	18.3	16.7	16.0	16.7	0.953	367.0	NO DAMAGE			
-145	-155	2955	0.22030	18.3	16.7	16.6	16.7	0.993	2560.4	NO DAMAGE			
-145	-160	431	0.03213	18.3	16.7	16.5	16.7	0.990	1706.9	NO DAMAGE			
-145	-165	765	0.05703	18.3	16.7	16.5	16.7	0.987	1280.2	NO DAMAGE			
-145	-170	78	0.00582	18.3	16.7	16.4	16.7	0.983	1024.2	NO DAMAGE			

					Dynamic Stress					to			
			α	Static			Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-145	-175	50	0.00373	18.3	16.7	16.4	16.7	0.980	853.5	NO DAMAGE			
-145	-180	16	0.00119	18.3	16.7	16.3	16.7	0.977	731.5	NO DAMAGE			
-145	-185	6	0.00045	18.3	16.7	16.2	16.7	0.973	640.1	NO DAMAGE			
-145	-190	4	0.00030	18.3	16.7	16.2	16.7	0.970	569.0	NO DAMAGE			
-145	-195	8	0.00060	18.3	16.7	16.1	16.7	0.967	512.1	NO DAMAGE			
-145	-205	2	0.00015	18.3	16.7	16.0	16.7	0.960	426.7	NO DAMAGE			
-145	-225	1	0.00007	18.3	16.7	15.8	16.7	0.947	320.0	NO DAMAGE			
-150	-160	1535	0.11444	18.3	16.6	16.5	16.6	0.993	2551.8	NO DAMAGE			
-150	-165	428	0.03191	18.3	16.6	16.5	16.6	0.990	1701.2	NO DAMAGE			
-150	-170	353	0.02632	18.3	16.6	16.4	16.6	0.987	1275.9	NO DAMAGE			
-150	-175	44	0.00328	18.3	16.6	16.4	16.6	0.983	1020.7	NO DAMAGE			
-150	-180	54	0.00403	18.3	16.6	16.3	16.6	0.980	850.6	NO DAMAGE			
-150	-185	5	0.00037	18.3	16.6	16.2	16.6	0.977	729.1	NO DAMAGE			
-150	-190	10	0.00075	18.3	16.6	16.2	16.6	0.973	638.0	NO DAMAGE			
-150	-195	1	0.00007	18.3	16.6	16.1	16.6	0.970	567.1	NO DAMAGE			
-150	-200	4	0.00030	18.3	16.6	16.1	16.6	0.966	510.4	NO DAMAGE			
-150	-210	2	0.00015	18.3	16.6	16.0	16.6	0.960	425.3	NO DAMAGE			
-155	-165	2322	0.17311	18.3	16.6	16.5	16.6	0.993	2543.3	NO DAMAGE			
-155	-170	392	0.02922	18.3	16.6	16.4	16.6	0.990	1695.5	NO DAMAGE			
-155	-175	511	0.03810	18.3	16.6	16.4	16.6	0.987	1271.6	NO DAMAGE			
-155	-180	47	0.00350	18.3	16.6	16.3	16.6	0.983	1017.3	NO DAMAGE			
-155	-185	35	0.00261	18.3	16.6	16.2	16.6	0.980	847.8	NO DAMAGE			
-155	-190	2	0.00015	18.3	16.6	16.2	16.6	0.976	726.7	NO DAMAGE			
-155	-195	6	0.00045	18.3	16.6	16.1	16.6	0.973	635.8	NO DAMAGE			
-155	-200	1	0.00007	18.3	16.6	16.1	16.6	0.970	565.2	NO DAMAGE			
-155	-205	4	0.00030	18.3	16.6	16.0	16.6	0.966	508.7	NO DAMAGE			
-155	-210	1	0.00007	18.3	16.6	16.0	16.6	0.963	462.4	NO DAMAGE			
-155	-215	2	0.00015	18.3	16.6	15.9	16.6	0.960	423.9	NO DAMAGE			
-155	-225	1	0.00007	18.3	16.6	15.8	16.6	0.953	363.3	NO DAMAGE			
-160	-170	1521	0.11339	18.3	16.5	16.4	16.5	0.993	2534.7	NO DAMAGE			
-160	-175	311	0.02319	18.3	16.5	16.4	16.5	0.990	1689.8	NO DAMAGE			
-160	-180	371	0.02766	18.3	16.5	16.3	16.5	0.987	1267.4	NO DAMAGE			
-160	-185	35	0.00261	18.3	16.5	16.2	16.5	0.983	1013.9	NO DAMAGE			
-160	-190	29	0.00216	18.3	16.5	16.2	16.5	0.980	844.9	NO DAMAGE			
-160	-200	8	0.00060	18.3	16.5	16.1	16.5	0.973	633.7	NO DAMAGE			
-160	-205	1	0.00007	18.3	16.5	16.0	16.5	0.970	563.3	NO DAMAGE			
-160	-210	4	0.00030	18.3	16.5	16.0	16.5	0.966	506.9	NO DAMAGE			
-160	-215	1	0.00007	18.3	16.5	15.9	16.5	0.963	460.9	NO DAMAGE			
-160	-220	1	0.00007	18.3	16.5	15.8	16.5	0.960	422.5	NO DAMAGE			
-160	-240	1	0.00007	18.3	16.5	15.6	16.5	0.946	316.8	NO DAMAGE			
-160	-300	1	0.00007	18.3	16.5	15.0	16.5	0.906	181.1	NO DAMAGE			
-165	-175	1805	0.13457	18.3	16.5	16.4	16.5	0.993	2526.2	NO DAMAGE			
-165	-180	295	0.02199	18.3	16.5	16.3	16.5	0.990	1684.1	NO DAMAGE			
-165	-185	382	0.02848	18.3	16.5	16.2	16.5	0.986	1263.1	NO DAMAGE			
-165	-190	19	0.00142	18.3	16.5	16.2	16.5	0.983	1010.5	NO DAMAGE			
-165	-195	11	0.00082	18.3	16.5	16.1	16.5	0.980	842.1	NO DAMAGE			
-165	-200	4	0.00030	18.3	16.5	16.1	16.5	0.976	721.8	NO DAMAGE			
-165	-205	10	0.00075	18.3	16.5	16.0	16.5	0.973	631.5	NO DAMAGE			
-165	-210	1	0.00007	18.3	16.5	16.0	16.5	0.970	561.4	NO DAMAGE			
-165	-215	1	0.00007	18.3	16.5	15.9	16.5	0.966	505.2	NO DAMAGE			
-165	-225	4	0.00030	18.3	16.5	15.8	16.5	0.959	421.0	NO DAMAGE			
-165	-235	2	0.00015	18.3	16.5	15.7	16.5	0.953	360.9	NO DAMAGE			
-165	-245	1	0.00007	18.3	16.5	15.6	16.5	0.946	315.8	NO DAMAGE			
-165	-255	1	0.00007	18.3	16.5	15.5	16.5	0.939	280.7	NO DAMAGE			
-170	-180	1099	0.08193	18.3	16.4	16.3	16.4	0.993	2517.6	NO DAMAGE			
-170	-185	240	0.01789	18.3	16.4	16.2	16.4	0.990	1678.4	NO DAMAGE			
-170	-190	237	0.01767	18.3	16.4	16.2	16.4	0.986	1258.8	NO DAMAGE			
-170	-195	21	0.00157	18.3	16.4	16.1	16.4	0.983	1007.1	NO DAMAGE			
-170	-200	32	0.00239	18.3	16.4	16.1	16.4	0.980	839.2	NO DAMAGE			
-170	-205	6	0.00045	18.3	16.4	16.0	16.4	0.976	719.3	NO DAMAGE			
-170	-210	3	0.00022	18.3	16.4	16.0	16.4	0.973	629.4	NO DAMAGE			
-170	-215	3	0.00022	18.3	16.4	15.9	16.4	0.969	559.5	NO DAMAGE			
-170	-220	1	0.00007	18.3	16.4	15.8	16.4	0.966	503.5	NO DAMAGE			
-175	-185	1609	0.11996	18.3	16.4	16.2	16.4	0.993	2509.1	NO DAMAGE			
-175	-190	240	0.01789	18.3	16.4	16.2	16.4	0.990	1672.7	NO DAMAGE			
-175	-195	304	0.02266	18.3	16.4	16.1	16.4	0.986	1254.5	NO DAMAGE			
-175	-200	10	0.00075	18.3	16.4	16.1	16.4	0.983	1003.6	NO DAMAGE			
-175	-205	16	0.00119	18.3	16.4	16.0	16.4	0.980	836.4	NO DAMAGE			
-175	-210	5	0.00037	18.3	16.4	16.0	16.4	0.976	716.9	NO DAMAGE			
-175	-215	6	0.00045	18.3	16.4	15.9	16.4	0.973	627.3	NO DAMAGE			
-175	-225	2	0.00015	18.3	16.4	15.8	16.4	0.966	501.8	NO DAMAGE			
-175	-235	3	0.00022	18.3	16.4	15.7	16.4	0.959	418.2	NO DAMAGE			
-175	-255	1	0.00007	18.3	16.4	15.5	16.4	0.945	313.6	NO DAMAGE			
-180	-190	1003	0.07478	18.3	16.3	16.2	16.3	0.993	2500.5	NO DAMAGE			
-180	-195	213	0.01588	18.3	16.3	16.1	16.3	0.990	1667.0	NO DAMAGE			
-180	-200	183	0.01364	18.3	16.3	16.1	16.3	0.986	1250.3	NO DAMAGE			
-180	-205	19	0.00142	18.3	16.3	16.0	16.3	0.983	1000.2	NO DAMAGE			
-180	-210	18	0.00134	18.3	16.3	16.0	16.3	0.979	833.5	NO DAMAGE			
-180	-215	1	0.00007	18.3	16.3	15.9	16.3	0.976	714.4	NO DAMAGE			
-180	-220	1	0.00007	18.3	16.3	15.8	16.3	0.973	625.1	NO DAMAGE			
-180	-240	1	0.00007	18.3	16.3	15.6	16.3	0.959	416.8	NO DAMAGE			
-185	-195	1474	0.10989	18.3	16.2	16.1	16.2	0.993	2492.0	NO DAMAGE			
-185	-200	295	0.02199	18.3	16.2	16.1	16.2	0.990	1661.3	NO DAMAGE			
-185	-205	300	0.02237	18.3	16.2	16.0	16.2	0.986	1246.0	NO DAMAGE			
-185	-210	14	0.00104	18.3	16.2	16.0	16.2	0.983	996.8	NO DAMAGE			
-185	-215	15	0.00112	18.3	16.2	15.9	16.2	0.979	830.7	NO DAMAGE			
-185	-220	2	0.00015	18.3	16.2	15.8	16.2	0.976	712.0	NO DAMAGE			
-185	-225	10	0.00075	18.3	16.2	15.8	16.2	0.973	623.0	NO DAMAGE			
-185	-235	11	0.00082	18.3	16.2	15.7	16.2	0.966	498.4	NO DAMAGE			
-185	-245	2	0.00015	18.3	16.2	15.6	16.2	0.959	415.3	NO DAMAGE			
-190	-200	1217	0.09073	18.3	16.2	16.1	16.2	0.993	2483.4	NO DAMAGE			

					Dynamic Stress					to Failure			
			α	Static			Max	R	Endurance			cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-190	-205	282	0.02102	18.3	16.2	16.0	16.2	0.990	1655.6	NO DAMAGE			
-190	-210	125	0.00932	18.3	16.2	16.0	16.2	0.988	1241.7	NO DAMAGE			
-190	-215	10	0.00075	18.3	16.2	15.9	16.2	0.983	993.4	NO DAMAGE			
-190	-220	6	0.00045	18.3	16.2	15.8	16.2	0.979	827.8	NO DAMAGE			
-190	-230	2	0.00015	18.3	16.2	15.7	16.2	0.972	620.9	NO DAMAGE			
-190	-400	1	0.00007	18.3	16.2	13.8	16.2	0.855	118.3	NO DAMAGE			
-195	-205	1915	0.14277	18.3	16.1	16.0	16.1	0.993	2474.9	NO DAMAGE			
-195	-210	306	0.02281	18.3	16.1	16.0	16.1	0.990	1649.9	NO DAMAGE			
-195	-215	280	0.02087	18.3	16.1	15.9	16.1	0.988	1237.4	NO DAMAGE			
-195	-220	2	0.00015	18.3	16.1	15.8	16.1	0.983	990.0	NO DAMAGE			
-195	-225	15	0.00112	18.3	16.1	15.8	16.1	0.979	825.0	NO DAMAGE			
-195	-235	5	0.00037	18.3	16.1	15.7	16.1	0.972	618.7	NO DAMAGE			
-195	-240	1	0.00007	18.3	16.1	15.6	16.1	0.969	550.0	NO DAMAGE			
-195	-245	5	0.00037	18.3	16.1	15.6	16.1	0.965	495.0	NO DAMAGE			
-195	-255	1	0.00007	18.3	16.1	15.5	16.1	0.959	412.5	NO DAMAGE			
-200	-210	1092	0.08141	18.3	16.1	16.0	16.1	0.993	2466.3	NO DAMAGE			
-200	-215	185	0.01379	18.3	16.1	15.9	16.1	0.990	1644.2	NO DAMAGE			
-200	-220	66	0.00492	18.3	16.1	15.8	16.1	0.986	1233.2	NO DAMAGE			
-200	-225	2	0.00015	18.3	16.1	15.8	16.1	0.983	986.5	NO DAMAGE			
-200	-230	1	0.00007	18.3	16.1	15.7	16.1	0.979	822.1	NO DAMAGE			
-205	-215	1078	0.08037	18.3	16.0	15.9	16.0	0.993	2457.8	NO DAMAGE			
-205	-220	63	0.00470	18.3	16.0	15.8	16.0	0.990	1638.5	NO DAMAGE			
-205	-225	152	0.01133	18.3	16.0	15.8	16.0	0.986	1228.9	NO DAMAGE			
-205	-230	4	0.00030	18.3	16.0	15.7	16.0	0.983	983.1	NO DAMAGE			
-205	-235	15	0.00112	18.3	16.0	15.7	16.0	0.979	819.3	NO DAMAGE			
-205	-245	15	0.00112	18.3	16.0	15.6	16.0	0.972	614.4	NO DAMAGE			
-205	-255	6	0.00045	18.3	16.0	15.5	16.0	0.965	491.6	NO DAMAGE			
-210	-220	338	0.02520	18.3	16.0	15.8	16.0	0.993	2449.2	NO DAMAGE			
-210	-225	56	0.00417	18.3	16.0	15.8	16.0	0.990	1632.8	NO DAMAGE			
-210	-230	23	0.00171	18.3	16.0	15.7	16.0	0.986	1224.6	NO DAMAGE			
-210	-240	4	0.00030	18.3	16.0	15.6	16.0	0.979	816.4	NO DAMAGE			
-210	-360	1	0.00007	18.3	16.0	14.3	16.0	0.895	163.3	NO DAMAGE			
-215	-225	503	0.03750	18.3	15.9	15.8	15.9	0.993	2440.7	NO DAMAGE			
-215	-230	11	0.00082	18.3	15.9	15.7	15.9	0.989	1627.1	NO DAMAGE			
-215	-235	172	0.01282	18.3	15.9	15.7	15.9	0.986	1220.3	NO DAMAGE			
-215	-245	29	0.00216	18.3	15.9	15.6	15.9	0.979	813.6	NO DAMAGE			
-215	-250	1	0.00007	18.3	15.9	15.5	15.9	0.975	697.3	NO DAMAGE			
-215	-255	4	0.00030	18.3	15.9	15.5	15.9	0.972	610.2	NO DAMAGE			
-220	-230	89	0.00664	18.3	15.8	15.7	15.8	0.993	2432.1	NO DAMAGE			
-220	-235	12	0.00089	18.3	15.8	15.7	15.8	0.989	1621.4	NO DAMAGE			
-220	-240	33	0.00246	18.3	15.8	15.6	15.8	0.986	1216.1	NO DAMAGE			
-220	-250	9	0.00067	18.3	15.8	15.5	15.8	0.979	810.7	NO DAMAGE			
-220	-260	1	0.00007	18.3	15.8	15.4	15.8	0.972	608.0	NO DAMAGE			
-225	-235	732	0.05457	18.3	15.8	15.7	15.8	0.993	2423.6	NO DAMAGE			
-225	-240	11	0.00082	18.3	15.8	15.6	15.8	0.989	1615.7	NO DAMAGE			
-225	-245	260	0.01938	18.3	15.8	15.6	15.8	0.986	1211.8	NO DAMAGE			
-225	-255	3	0.00022	18.3	15.8	15.5	15.8	0.979	807.9	NO DAMAGE			
-225	-260	1	0.00007	18.3	15.8	15.4	15.8	0.975	692.5	NO DAMAGE			
-225	-270	1	0.00007	18.3	15.8	15.3	15.8	0.968	538.6	NO DAMAGE			
-230	-240	86	0.00641	18.3	15.7	15.6	15.7	0.993	2415.0	NO DAMAGE			
-230	-245	12	0.00089	18.3	15.7	15.6	15.7	0.989	1610.0	NO DAMAGE			
-230	-250	14	0.00104	18.3	15.7	15.5	15.7	0.986	1207.5	NO DAMAGE			
-230	-265	1	0.00007	18.3	15.7	15.3	15.7	0.975	690.0	NO DAMAGE			
-230	-320	1	0.00007	18.3	15.7	14.7	15.7	0.936	268.3	NO DAMAGE			
-235	-245	440	0.03280	18.3	15.7	15.6	15.7	0.993	2406.5	NO DAMAGE			
-235	-250	5	0.00037	18.3	15.7	15.5	15.7	0.989	1604.3	NO DAMAGE			
-235	-255	45	0.00335	18.3	15.7	15.5	15.7	0.986	1203.2	NO DAMAGE			
-235	-260	1	0.00007	18.3	15.7	15.4	15.7	0.982	962.6	NO DAMAGE			
-235	-265	1	0.00007	18.3	15.7	15.3	15.7	0.979	802.2	NO DAMAGE			
-240	-250	42	0.00313	18.3	15.6	15.5	15.6	0.993	2397.9	NO DAMAGE			
-240	-255	2	0.00015	18.3	15.6	15.5	15.6	0.989	1598.6	NO DAMAGE			
-240	-260	8	0.00060	18.3	15.6	15.4	15.6	0.986	1199.0	NO DAMAGE			
-240	-270	2	0.00015	18.3	15.6	15.3	15.6	0.979	799.3	NO DAMAGE			
-240	-280	1	0.00007	18.3	15.6	15.2	15.6	0.971	599.5	NO DAMAGE			
-245	-255	86	0.00641	18.3	15.6	15.5	15.6	0.993	2389.4	NO DAMAGE			
-245	-260	6	0.00045	18.3	15.6	15.4	15.6	0.989	1592.9	NO DAMAGE			
-245	-265	12	0.00089	18.3	15.6	15.3	15.6	0.986	1194.7	NO DAMAGE			
-245	-270	1	0.00007	18.3	15.6	15.3	15.6	0.982	955.8	NO DAMAGE			
-250	-260	25	0.00186	18.3	15.5	15.4	15.5	0.993	2380.8	NO DAMAGE			
-250	-265	5	0.00037	18.3	15.5	15.3	15.5	0.989	1587.2	NO DAMAGE			
-250	-270	2	0.00015	18.3	15.5	15.3	15.5	0.986	1190.4	NO DAMAGE			
-250	-280	1	0.00007	18.3	15.5	15.2	15.5	0.978	793.6	NO DAMAGE			
-255	-265	49	0.00365	18.3	15.5	15.3	15.5	0.993	2372.3	NO DAMAGE			
-255	-270	8	0.00060	18.3	15.5	15.3	15.5	0.989	1581.5	NO DAMAGE			
-255	-275	6	0.00045	18.3	15.5	15.2	15.5	0.986	1186.1	NO DAMAGE			
-255	-285	1	0.00007	18.3	15.5	15.1	15.5	0.978	790.8	NO DAMAGE			
-255	-315	1	0.00007	18.3	15.5	14.8	15.5	0.957	395.4	NO DAMAGE			
-255	-535	2	0.00015	18.3	15.5	12.3	15.5	0.798	84.7	NO DAMAGE			
-260	-270	13	0.00097	18.3	15.4	15.3	15.4	0.993	2363.7	NO DAMAGE			
-260	-275	3	0.00022	18.3	15.4	15.2	15.4	0.989	1575.8	NO DAMAGE			
-260	-310	2	0.00015	18.3	15.4	14.8	15.4	0.964	472.7	NO DAMAGE			
-265	-275	22	0.00164	18.3	15.3	15.2	15.3	0.993	2355.2	NO DAMAGE			
-265	-280	3	0.00022	18.3	15.3	15.2	15.3	0.989	1570.1	NO DAMAGE			
-265	-285	1	0.00007	18.3	15.3	15.1	15.3	0.985	1177.6	NO DAMAGE			
-265	-295	1	0.00007	18.3	15.3	15.0	15.3	0.978	785.1	NO DAMAGE			
-265	-300	1	0.00007	18.3	15.3	15.0	15.3	0.975	672.9	NO DAMAGE			
-270	-280	6	0.00045	18.3	15.3	15.2	15.3	0.993	2346.6	NO DAMAGE			
-270	-285	2	0.00015	18.3	15.3	15.1	15.3	0.989	1564.4	NO DAMAGE			
-270	-290	1	0.00007	18.3	15.3	15.1	15.3	0.985	1173.3	NO DAMAGE			
-270	-295	1	0.00007	18.3	15.3	15.0	15.3	0.982	938.7	NO DAMAGE			
-275	-285	12	0.00089	18.3	15.2	15.1	15.2	0.993	2338.1	NO DAMAGE			

					Dynamic					to			
			α	Static	Stress		Max	R	Endurance	Failure		cycles per mile	153.8
Max	Min	No.	Pct	Stress	Max	Min	Adjusted	Min/Max	Limit	N	α/N	Yield stress	60 ksi
-275	-290	11	0.00082	18.3	15.2	15.1	15.2	0.989	1558.7	NO DAMAGE			
-275	-295	3	0.00022	18.3	15.2	15.0	15.2	0.985	1169.0	NO DAMAGE			
-275	-300	1	0.00007	18.3	15.2	15.0	15.2	0.982	935.2	NO DAMAGE			
-275	-305	1	0.00007	18.3	15.2	14.9	15.2	0.978	779.4	NO DAMAGE			
-275	-345	1	0.00007	18.3	15.2	14.5	15.2	0.949	334.0	NO DAMAGE			
-280	-290	19	0.00142	18.3	15.2	15.1	15.2	0.993	2329.5	NO DAMAGE			
-280	-295	4	0.00030	18.3	15.2	15.0	15.2	0.989	1553.0	NO DAMAGE			
-285	-295	8	0.00060	18.3	15.1	15.0	15.1	0.993	2321.0	NO DAMAGE			
-285	-300	1	0.00007	18.3	15.1	15.0	15.1	0.989	1547.3	NO DAMAGE			
-285	-315	2	0.00015	18.3	15.1	14.8	15.1	0.978	773.7	NO DAMAGE			
-285	-325	1	0.00007	18.3	15.1	14.7	15.1	0.971	580.2	NO DAMAGE			
-285	-335	4	0.00030	18.3	15.1	14.6	15.1	0.963	464.2	NO DAMAGE			
-290	-300	3	0.00022	18.3	15.1	15.0	15.1	0.993	2312.4	NO DAMAGE			
-295	-305	6	0.00045	18.3	15.0	14.9	15.0	0.993	2303.9	NO DAMAGE			
-295	-315	11	0.00082	18.3	15.0	14.8	15.0	0.985	1151.9	NO DAMAGE			
-295	-325	16	0.00119	18.3	15.0	14.7	15.0	0.978	768.0	NO DAMAGE			
-295	-335	14	0.00104	18.3	15.0	14.6	15.0	0.970	576.0	NO DAMAGE			
-300	-315	1	0.00007	18.3	15.0	14.8	15.0	0.989	1530.2	NO DAMAGE			
-305	-315	63	0.00470	18.3	14.9	14.8	14.9	0.993	2286.8	NO DAMAGE			
-305	-325	124	0.00924	18.3	14.9	14.7	14.9	0.985	1143.4	NO DAMAGE			
-305	-335	25	0.00186	18.3	14.9	14.6	14.9	0.978	762.3	NO DAMAGE			
-305	-345	8	0.00060	18.3	14.9	14.5	14.9	0.970	571.7	NO DAMAGE			
-315	-325	133	0.00992	18.3	14.8	14.7	14.8	0.992	2269.7	NO DAMAGE			
-315	-335	114	0.00850	18.3	14.8	14.6	14.8	0.985	1134.8	NO DAMAGE			
-315	-345	13	0.00097	18.3	14.8	14.5	14.8	0.977	756.6	NO DAMAGE			
-325	-335	32	0.00239	18.3	14.7	14.6	14.7	0.992	2252.6	NO DAMAGE			
-325	-345	2	0.00015	18.3	14.7	14.5	14.7	0.985	1126.3	NO DAMAGE			
-345	-385	1	0.00007	18.3	14.5	14.0	14.5	0.969	554.6	NO DAMAGE			
-355	-375	1	0.00007	18.3	14.3	14.1	14.3	0.984	1100.6	NO DAMAGE			
-365	-385	2	0.00015	18.3	14.2	14.0	14.2	0.984	1092.1	NO DAMAGE			
-375	-385	1	0.00007	18.3	14.1	14.0	14.1	0.992	2167.1	NO DAMAGE			
		1341324.00000	99.99940								Sum	7.79E-10	
											N	1.28E+09	
											Miles	8.35E+06	

APPENDIX G-2
ATLAS RAILCAR SPECIAL PURPOSE SPECIFICATIONS

APPENDIX G-2.1

ATLAS RAILCAR WELDING PROCEDURE QUALIFICATIONS AND SPECIFICATIONS

Appendix G-2.1.1 Procedure Qualification Record Example

AWS D16.1/D15.1M:2012 ANNEX D

PROCEDURE QUALIFICATION RECORD (PQR)

PROCEDURE SPECIFICATION

Material specification A572 Grade 50
Welding process FCAW
Manual or machine Both (Semi-Automatic)
Position of welding Vertical
Filler metal specification AWS A5.20
Filler metal classification E71T-1
Weld metal grade*
Shielding gas CO2 Flow rate 35 cfh
Single or multiple pass Multiple
Single or multiple arc Single
Welding current DCEP
Welding progression Uphill
Preheat temperature 70 deg.
Postheat treatment N/A
Welder's name Triston Mills - Clock #821
*Applicable when filler metal has no AWS classification.

VISUAL INSPECTION

Appearance Acceptable
Undercut NONE
Piping porosity NONE

Test date July 10, 2014
Witnessed by Daniel S. Gjurich

GROOVE WELD TEST RESULTS

Tensile strength, psi
1. (A) 78026
2. (B) 77322

Guided-bend tests (2 root-, 2 face-, or 4 side-bend)

Root	Face
1. Side- Pass	1. Side- Pass
2. Side- Pass	2. Side- Pass

Radiographic-ultrasonic examination

RT report no. N/A
UT report no. #256

FILLET WELD TEST RESULTS

Minimum size multiple pass — Macroetch: 1. N/A 2. N/A 3. N/A

Maximum size single pass — Macroetch: 1. N/A 2. N/A 3. N/A

All-weld-metal tension test

Tensile strength, psi N/A
Yield point/strength, psi N/A
Elongation in 2 in, % N/A
Laboratory test no. N/A

WELDING PROCEDURE

Pass No.	Electrode Size	Electrical Characteristics: Amperes	Electrical Characteristics: Volts	Travel Speed	Joint Detail
All	1/16"	255	26	4 ipm	See Attached: Thickness of weld layers not to exceed 1/4"

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of AWS D15.1; (2012 (year)) *Railroad Welding Specification for Cars and Locomotives.*

Procedure no. F-001
Revision no. 3
Form D-2

Manufacturer or Contractor Kasgro Rail Corp.
Authorized by
Date 7-16-14

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Appendix G-2.1.2 Prequalified Welding Procedure Specifications

ANNEX D AWS D15.1/D15.1M:2012

TEST QUALIFIED WELDING PROCEDURE SPECIFICATION (WPS)

Qualified by procedure qualification no. F-001
Material specification Class 1 & 2 (A36, A572/gr42&50, A500 gr B, A216/gr WCC, etc.)
Welding process FCAW
Manual or machine Both
Position of welding Flat, Horizontal, Vertical, Overhead
Filler metal specification A5.20
Filler metal classification E71T-1
Flux N/A
Weld metal grade* N/A
Shielding gas CO2 Flow rate 35-50 cfh
Single or multiple pass Both
Single or multiple arc
Welding current Direct
Polarity DCEP
Welding progression Vertical (3G) - Uphill
Root treatment Clean to sound metal
Preheat and interpass temperature See attached report
Postweld Heat Treatment None
*Applicable only when filler metal has no AWS classification.

WELDING PROCEDURE

Pass No.	Electrode Size	Electrical Characteristics		Travel Speed	Joint Detail
		Amperes	Volts		
As	Required				See attached details
F-1G	.045"	180-280	27-32	8-13 ipm	
	1/16"	200-400	25-31	8-13 ipm	
	3/32"	250-400	17-32	6-13 ipm	
H-2G	1/16"	200-400	25-31	8-13 ipm	
	3/32"	250-400	17-32	6-13 ipm	
V-3G	.045"	160-210	24-39	4-9 ipm	
	1/16"	180-250	25-30	6-11 ipm	
O-4G	.045"	180-240	24-29	8-13 ipm	
	1/16"	200-270	26-30	8-13 ipm	
					Thickness of weld layers not to exceed 1/4"

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in AWS D15.1: (2012 (year)) *Railroad Welding Specification for Cars and Locomotives.*

Procedure no. F-001
Revision no. 3
Form D-3

Manufacturer or Contractor KASGRO RAIL CORP.
Authorized by Mark Zajac
Date 11/25/13

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ANNEX D

PREQUALIFIED WELDING PROCEDURE SPECIFICATION (WPS)

Material specification: A 572 Grade 50 and A52 Grade 60
Welding process: F.C.A.W.
Manual or machine: Manual
Position of welding: Flat, Horizontal, Vertical, Overhead
Filler metal specification: A5.29
Filler metal classification: E81T-1 - Ni-TGU H8
Flux: N/A
Weld metal grade*: N/A
Shielding gas: C02 Flow rate: 35 - 50 CFH
Single or multiple pass: Single/Multiple
Single or multiple arc: Single
Welding current: Direct
Polarity: Reverse
Welding progression: Vertical (3G) - Uphill
Root treatment: Clean to sound metal
Preheat and interpass temperature: See attached report
Postweld Heat Treatment: None None X

*Applicable only when filler metal has no AWS classification.

WELDING PROCEDURE

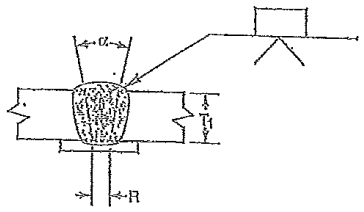
Pass No.	Electrode Size	Welding Current Amperes	Welding Current Volts	Travel Speed	Joint Detail
As Required					* See Attached Report
T-1G	1/16"	200-400	25-31	8-13 ipm	
H-2G	1/16"	180-250	24-39	8-13 ipm	
V-3G	1/16"	180-250	24-39	6-11 ipm	
O-4G	1/16"	200-270	26-30	8-13 ipm	
					Thickness of weld layers not to exceed 1/4"

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in AWS D15.1, (2012) Railroad Welding Specification—Cars and Locomotives.
(year)

Procedure no.: T-002
Revision no.: 3
Form D-1

Manufacturer or Contractor: KASGRO RAIL CORP.
Authorized by:
Date: 6-10-14

Single-V-groove weld (2)
Butt joint (B)



Tolerances	
As Detailed (see 7.5.2)	As Fit-Up (see 6.3)
R = +1/16, −0 [+2, −0]	+1/4, −1/16 [+6, −2]
α = +10°, −0°	+10°, −5°

All dimensions are in [mm]

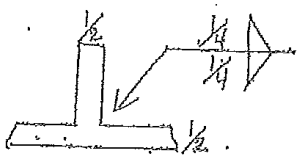
Welding Process	Joint Designation	Base Metal Thickness (U = Unlimited) T_1	Base Metal Thickness (U = Unlimited) T_2	Groove Preparation: Root Opening	Groove Preparation: Groove Angle	Permitted Welding Positions	Gas Shielding for FCAW	Notes
SMAW	B-U2a	U	—	R = 1/4 [6]	α = 45°	All	—	g
				R = 3/8 [10]	α = 30°	F, OH, V	—	g
				R = 1/2 [13]	α = 20°	F, OH, V	—	g
GMAW FCAW	B-U2a-GF	U	—	R = 3/16 [5]	α = 30°	F, OH, V	Required	a, g
				R = 3/8 [10]	α = 30°	F, OH, V	Not Required	a, g
				R = 1/4 [6]	α = 45°	F, OH, V	Not Required	a, g
SAW	B-L2a-S	2 [51] max.	—	R = 1/4 [6]	α = 30°	F	—	g
SAW	B-U2-S	U	—	R = 5/8 [16]	α = 20°	F	—	g

Figure 7.1B—Prequalified Complete Joint Penetration (CJP) Groove Welded Joint Details

TEST QUALIFIED WELDING PROCEDURE SPECIFICATION (WPS)

Material specification A572 grade 60 to A656 grade 80
Welding process F.C.A.W.
Manual or machine Manual
Position of welding Flat, Horizontal, Vertical, Overhead
Filler metal specification A5.29
Filler metal classification E81T1-Ni1CJ H8
Flux N/A
Weld metal grade N/A
Shielding gas C02 Flow rate 35 to 50 CFH
Single or multiple pass Single/Multiple
Single or multiple arc Single
Welding current Direct
Polarity Reverse
Welding progression Vertical - Uphill
Heat treatment Clean to sound metal
Preheat and interpass temperature 250° F
Postweld Heat Treatment None None X
*Applicable only when filler metal has no AWS classification.

WELDING PROCEDURE

Pass no.	Electrode size	Welding current		Travel speed	Joint detail
		Amperes	Volts		
All	1/16"	See attached report		8-11 ipm	

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in AWS D1.1, (2012 Year).

Procedure no. P-003 Rev 1
Revision no.
Form D-1

Manufacturer or contractor Kasgro Rail Corp
Authorized by
Date 11/25/13

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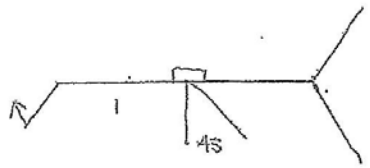
TEST QUALIFIED WELDING PROCEDURE SPECIFICATION (WPS)

Qualified by procedure qualification # 09KRC-1092
Material specification A514T1 to A572 Grade 60
Welding process F.C.A.W.
Manual or machine Manual
Position of welding Vertical
Filler metal specification A5.29
Filler metal classification E111T1-K3
Flux
Weld metal grade*
Shielding gas 75% Argon 25% C02 Flow rate 40 CFH
Single or multiple pass Multiple
Single or multiple arc Single
Welding current Direct
Polarity Reverse
Welding progression Uphill
Root treatment Clean to sound metal
Preheat and interpass temperature See attached report
Postweld Heat Treatment None

*Applicable only when filler metal has no AWS classification.

WELDING PROCEDURE

Pass no.	Electrode size	Welding current		Travel speed	Joint detail
		Amperes	Volts		
All	.062"	190–300	27–30	8–11 ipm	

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in AWS D15.1, (2012 year).

Procedure no. F-004
Revision no. 1
Form D-3

Manufacturer or contractor KASGRO RAIL CORP.
Authorized by
Date 11/25/13

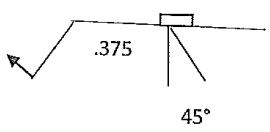
ANNEX D

AWS D15.1/D15.1M:2012

TEST QUALIFIED WELDING PROCEDURE SPECIFICATIONS (WPS)

Qualified by procedure qualification no. O8KRF-1087-6/30/08/ AND 15KR-F1087-1/14/15.
Material specification A572 GRADE 60 TO A240 GRADE 304
elding process F.C.A.W.
anual or machine Manual
sition of welding 1G Flat
Filler metal specification 5.22
Filler metal classification DW-309L
Flux
Weld metal grade*
Shielding gas C02 . Flow rate 40 – 50 CFH
Single or multiple pass Multiple
Single or multiple arc Single
Welding current DCEP
Polarity Reverse
Welding progression Forehand
Root treatment Clean to sound metal
Preheat and interpass temperature 50°F
Post weld Heat Treatment None . None x
*Applicable only when filler metal has no aws classification.

WELDING PROCEDURE

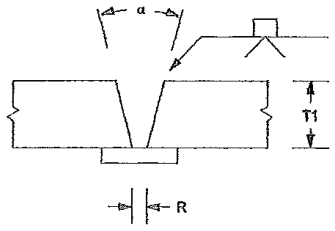
ass o.	Electrode Size	Welding Current		Travel Speed	Joint Detail
		Amperes	Volts		
ALL	.062"	240-280	29-33	15-18 imp	

This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in AWS D15.1, (2012) Railroad Welding Specification for Cars and Locomotives.
(Year)

Procedure no. 08KR-F1087
vision no. 2
)-1

Manufacturer or Contractor KASGRO RAIL CORP.
Authorized by
Date 07/27/15

Single-V-groove weld (2)
Butt joint (B)



Welding Process	Joint Designation	Base Metal Thickness (Unlimited) T1	T2	Groove Preparation: Root Opening	Groove Angle	Tolerances: As Detailed (see 3.13.1)	As Fit Up (see 3.13.1)
GMAW FCAW	B-U2a-GF	U	-	R = 3/16	α = 30°	R = +1/16, -0	+1/4, -1/16
				R = 3/8	α = 30°	α = +10°, -0°	+10°, -5°
				R = 1/4	α = 45°		

b-u2a-gf.gif

Preheat

Less than or = to 3/4"	50 deg.
Over 3/4" thru 1-12"	150 deg.
Over 1-1/2" thru 2-1/2"	225 deg.
Over 2-1/2"	300 deg.

ANNEX D

AWS D15.1/D15.1M:2012

TEST QUALIFIED WELDING PROCEDURE SPECIFICATION (WPS)

Qualified by procedure qualification no. 15KR-F1087
Material specification A572 Gr. 65 to A240 Gr. 304
Welding process FCAW
Manual or machine Both (Semi-Automatic)
Position of welding Flat, Horizontal,
Filler metal specification AWS A5.22
Filler metal classification DW-309L
Flux N/A
Weld metal grade* N/A
Shielding gas CO2 - Welding Grade Flow rate 30 to 50
Single or multiple pass Multiple
Single or multiple arc DCEP
Welding current DCEP
Polarity DCEP
Welding progression N/A
Root treatment Grind, chip and wire brush
Preheat and interpass temperature See Attached
Postweld Heat Treatment N/A
*Applicable only when filler metal has no AWS classification.

WELDING PROCEDURE

Pass No.	Electrode Size	Electrical Characteristics		Travel Speed	Joint Detail
		Amperes	Volts		
All	1/16"	229-281	26-30	Various	See Attached: Thickness of weld layers not to exceed 1/4"

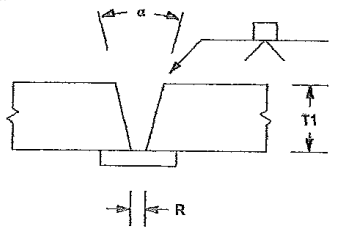
This procedure may vary due to fabrication sequence, fit-up, pass size, etc., within the limitation of variables given in AWS D15.1: (2012 (year)) *Railroad Welding Specification for Cars and Locomotives.*

Procedure no. 15KR-F1087
Revision no. 2
Form D-3

Manufacturer or Contractor Kasgro Rail Car
Authorized by
Date 1-14-15

182

Single-V-groove weld (2)
Butt joint (B)



Welding Process	Joint Designation	Base Metal Thickness (Unwelded) T1	T2	Groove Preparation: Root Opening	Groove Angle	Tolerances: As Detailed (see 3.13.1)	As Fit Up (see 3.13.1)
GMAW FCAW	B-U2a-GF	U	-	R = 3/16	α = 30°	R = +1/16, -0	+1/4, -1/16
				R = 3/8	α = 30°	α = +10°, -0°	+10°, -5°
				R = 1/4	α = 45°		

b-u2a-gf.gif

Preheat

Less than or = to 3/4"	50 deg.
Over 3/4" thru 1-12"	150 deg.
Over 1-1/2" thru 2-1/2"	225 deg.
Over 2-1/2"	300 deg.

APPENDIX G-2.2

ATLAS RAILCAR SECUREMENT AND JACKING LUGS PROOF TESTING

Appendix G-2.2.1 Procedure #11 Lug Proof Test Procedure, Rev 5

Kasgro Rail Corp
Procedure # 11
Lug Proof Test Procedure

Revision: 5 JULY 28, 2017

Scope: Procedure Proof Test Tie Down Lugs
Component: S-2043 Shipping Container Railcar
Drawing: Car Body Arrangement Drawing No.:
Standard Identifier:
For Proof Test Apparatus and Component Assembly Refer to
Drawings D-1128-1, 3, 4 and 5

Lug Proof Test Procedure
Position the Car Body on Lay Out Table in the Inverted Position Against Stops on Lay Out Table
A-End Lugs – Orient the Fixture Such That the Applied Load is in-line with the Plane of the Lugs and is $39^0 \pm 1^0$ From Horizontal
Center Lugs – Orient the Fixture Such That the Applied Load is in-line With the Plane of the Lugs and is $29^0 \pm 1^0$ From Horizontal.
Bolt Lug Test Fixtures to the Layout Table as Required by Drawing D-1128-1
Pin Hydraulic Cylinder to Fixtures at Both Ends

Test Procedure – End Lugs
Pressurize Rod End of Cylinder to 3000 P.S.I. + 45 P.S.I. – 140 P.S.I.
To Obtain a Test Load of 66800 LBS + 4452 - 0
Maintain Pressure for 10 minutes
Release
Repeat At Other Lug. As an Option, Both Lugs May be Tested Simultaneously.
Record Information on the Proof Test Certification Form

Test Procedure – Center Lugs
Pressurize Rod End of Cylinder to 3000 P.S.I. + 45 P.S.I. – 140 P.S.I.
To Obtain a Test Load of 66800 LBS + 4452 - 0
Maintain Pressure for 10 minutes
Release
Repeat At Other Lug. As an Option, Both Lugs May be Tested Simultaneously.
Record Information on the Proof Test Certification Form

NDT Requirements
Acceptance Criteria Per AWS D 15.1
Magnetic Particle Test – Final Weld
Visual Inspect – Final Weld
Visual Inspect Weld After Proof Testing
Magnetic Particle Test Final Weld After Proof of Testing
Visually Inspect the Attachment Lug and Lug Eye for Damage and Deformation

Equipment to be Used

1) Penincular Hydraulic Cylinder, Model 1-P3600A, or equivalent, With a 6" Bore and 2.5" Rod and a Working Pressure of 5000 P.S.I.
2) Calibrated Pressure Gage

Test Records:
The results of each load test are to be recorded and certified on the "Component/Equipment Proof Test Certification" sheet.

Seller's Authorized Representative: _____Signature

_____ Typed Name

_____Date

Appendix G-2.2.2 Securing and Jacking Lug Proof Test Certification Form, Form 45, Rev 1

3

SECURING AND JACKING LUG PROOF TEST CERTIFICATION FORM

Form 45 Rev 1 7-15-2015

Component – Tie Down Lugs
Drawing Number – D – 1114-37
Part Number – 3-138
Standard Identifier –
Car # _____
Use Lug Proof Test Procedure # 11

Lug Location	Test Pressure	Test Load in Pounds	Minutes Tested	Post Test Inspection	Date
CL					
CR					
AL					
AR					

Securing and Jacking Lug Proof Test to be performed using Kasgro Rail Corp Lug Test Fixture Drawing D-1128-1

The securing and jacking lugs have been proof tested in strict accordance with all applicable specifications, drawings, procedures and contract requirements, including amendments / change notices.

Proof Test Certification covering compliance to this specification, Proof Test Procedure and results of pre-and post-proof test NDT inspection results are on file at Kasgro Rail Corp.

Seller's Authorized Representative: _____

Date:

Sellers Name: KASGRO RAIL CORP

Note: The recording of false, fictitious, or fraudulent statements on this document may be punishable as a felony under federal statues

APPENDIX G-2.3

ATLAS RAILCAR SPRING PROPERTIES REQUIREMENT

SPRING TEST REQUIREMENTS AND TOLERANCES PROCEDURE #12, REV 3

Spring Test Requirements and Tolerances Procedure #12 Rev. 3 23 February 2016

Kasgro Rail Corporation Spring Testing

290-ton flatcar springs shall be manufactured in accordance with the Association of American Railroads Specification M-114, ASTM A125, Kasgro Rail Corporation (Kasgro) Drawing D-1114-33, and the requirements specified herein. Kasgro reserves the right to reject springs not meeting the below stated requirements. All criteria herein shall be met unless otherwise approved or authorized by Kasgro.

Subsequent to end grinding, wet florescent magnetic particle testing of each spring shall be performed as specified on Drawing D-1114-33. Test and acceptance criteria shall be as follows:

> Examination shall be by the continuous method.

> Indications less than 1/64 inch shall be disregarded.

> There shall be no linear indications 1/32 inch or greater. A linear indication is any indication where the length of the major axis is at least three times the length of the minor axis.

> Rounded indications larger than 1/16 are cause for rejection.

> Linearly disposed rounded indications shall be cause for rejection. Linearly disposed indications are three or more indications where adjacent indications are separated by less than 1/8 inch and a straight line can be drawn touching all three indications.

> Surface indications that are not crack-like in appearance and are due to surface roughness may be accepted provided that at least 10 percent of each type of indication is removed and the indications do not reappear upon re-examination.

> Local material removal (reworked surfaces) to determine the relevancy of an indication or to evaluate surface roughness shall be limited to a depth of 1/64 inch. Material may be removed by polishing or hand grinding (e.g., 100 grit stone).

> Reworked surfaces shall be blended. Blended contours shall have no discontinuities or lapped-over surfaces. The bottom radius of a blended cavity shall be at least three times

the depth of the cavity, and the edges of the cavity shall be blended into the surrounding surfaces. All reworked and blended areas shall be re-wet florescent magnetic particle tested to confirm defect removal.

> All indications revealed by magnetic particle inspection do not necessarily represent defects since non-relevant indications are sometimes encountered. Indications caused by approved marking methods may be considered non-relevant. Examples of other such indications are as follows:

(a) Magnetic Writing. These indications are caused by contact with other steel or magnets while magnetized. They may be fuzzy and will be destroyed by demagnetization. They shall be verified as non-relevant by demagnetizing and re-examination.

(b) Change in Section. Indications which are broad and fuzzy may be caused by a concentration of the magnetic field coincident with a change in section. Non-relevancy shall be verified by a visual examination of the section and re-examination at a lower magnetizing current.

(c) Flow Lines. These are large groups of parallel indications which may occur in wrought material under excessive currents. Non-relevancy shall be determined by demagnetization and re-examination at a lower current.

Spring measurement and load test requirements and tolerances are defined as follows:

1. All springs are to be tested with the following values to be recorded.

1.1. Free Height – Spring height in inches under zero load. If heights are measured in fractions of an inch, minimum data resolution is to be 0.03125 inches (1/32). If heights are measured digitally, minimum data resolution is to be 0.02 inches.

1.2. Solid Height – Spring height in inches under a load which forces all or most coils into contact. If heights are measured in fractions of an inch, minimum data resolution is to

be 0.03125 inches (1/32). If heights are measured digitally, minimum data resolution is to be 0.02 inches.

1.3. Load at Test Height 1 – Spring load in pounds at a defined test height (Test Height 1). Actual test height is to be within ±0.0625 inches (1/16) of the defined test height. Minimum data resolution is to be to 1 pound.

1.4. Load at Test Height 2 – Spring load in pounds at a defined test height (Test Height 2). Actual test height is to be within ±0.0625 inches (1/16) of the defined test height. Minimum data resolution is to be 1 pound.

2. Springs are to be compressed to solid height three (3) times before start of the above tests.

3. Testing is to be performed using industry-accepted methods. All gages, test machines, load cells, or other test equipment are to be properly maintained and have current calibration certificates. Evidence of such calibration is to be provided on request.

4. Results are to be provided in the form of a Microsoft Excel spreadsheet. The spreadsheet is to include header lines clearly identifying the spring tested and the test equipment used. Test results are to then follow in tabular form. Data are to include: Spring Serial Number, Free Height, Solid Height, Load at Test Height 1, Load at Test Height 2, Test Date, and Test Operator. Average and standard deviation values for each of the numeric data are to be calculated (using the Microsoft Excel AVERAGE and STDEVP functions). These values are to be followed by lines providing the minimum and maximum accepted value for each measurement as per the tables given in Paragraphs 5 and 6 below. A sample spreadsheet meeting the above requirements will be provided. A signed and dated **paper** copy of the spreadsheet is to be provided attesting that the measurements are accurate and have been performed according to the stated requirements.

5. Test heights and acceptance tolerances for individual springs are as shown in Table 1. Minimum and maximum accepted values are given in the shaded columns. Solid Height max-

imum tolerances must be maintained per values listed in Table 1. * Solid height minimum dimensions are shown as desired values only and it is not required to have all springs meet the minimum value.

Table 1. Spring Test Heights and Acceptance Tolerances

	Free Height (inches)			Solid Height (inches)			Test Heights		Load (lbs) at Height 1			Load (lbs) at Height 2		
Spring		Min	Max		Min*	Max	1	2		Min	Max		Min	Max
1-88	11.720	11.501	11.939	6.690	6.250	6.750	10.250	8.000	1707	1415	1999	4320	4028	4612
1-89	11.720	11.501	11.939	6.690	6.250	6.750	10.250	8.000	736	610	861	1861	1736	1987
1-90	13.000	12.750	13.250	6.690	6.250	6.750	10.250	8.000	2955	2616	3294	5373	5034	5712
1-91	13.000	12.750	13.250	6.690	6.250	6.750	10.250	8.000	957	848	1067	1741	1631	1851
1-92	9.250	9.125	9.375	6.690	6.250	6.750	9.000	8.000	1047	511	1583	5234	4698	5770
1-93	9.250	9.125	9.375	6.690	6.250	6.750	9.000	8.000	555	271	840	2776	2492	3061
1-94	11.090	10.903	11.278	6.690	6.250	6.750	10.250	8.000	1116	824	1409	4106	3814	4399
1-95	11.090	10.903	11.278	6.690	6.250	6.750	10.250	8.000	552	407	696	2030	1886	2175
1-96	11.000	10.813	11.188	6.690	6.250	6.750	10.250	8.000	1808	1288	2327	7231	6712	7751
1-97	11.000	10.813	11.188	6.690	6.250	6.750	10.250	8.000	701	500	902	2804	2602	3005
1-99	7.500	7.375	7.625	5.375	4.935	5.435	7.250	6.250	139	80	198	694	635	753

6. Table 2 provides acceptance tolerance per spring population (i.e., all springs of one type). The given tolerance ranges apply to the average value for a population. This requirement is intended to ensure that springs within a population do not cluster to one side or other of the tolerance range for individual springs. Minimum and maximum accepted values are again given in the shaded columns.

Table 2. Spring Population Acceptance Tolerances

	Free Height (inches)			Load (lbs) at Height 1			Load (lbs) at Height 2		
Spring		Min	Max		Min	Max		Min	Max
1-88	11.720	11.647	11.793	1707	1610	1804	4320	4222	4417
1-89	11.720	11.647	11.793	736	694	778	1861	1820	1903
1-90	13.000	12.917	13.083	2955	2842	3068	5373	5260	5486
1-91	13.000	12.917	13.083	957	921	994	1741	1704	1778
1-92	9.250	9.208	9.292	1047	868	1225	5234	5055	5413
1-93	9.250	9.208	9.292	555	461	650	2776	2682	2871
1-94	11.090	11.028	11.153	1116	1019	1214	4106	4009	4204
1-95	11.090	11.028	11.153	552	504	600	2030	1982	2078
1-96	11.000	10.938	11.063	1808	1635	1981	7231	7058	7404
1-97	11.000	10.938	11.063	701	634	768	2804	2737	2871
1-99	7.500	7.458	7.542	139	119	158	694	674	714

APPENDIX G-2.4

ATLAS RAILCAR WEIGHTING

Appendix G-2.4.1 Procedure #13, Car Weighting Procedure, Rev 5

Kasgro Rail Corp
Procedure # 13
Car Weighing Procedure

Revision: 5 7-28-2017
Scope: Procedure for Weighing a Loaded Car
Component: S-2043 Shipping Container Railcar
Drawing: General Arrangement

Test Procedure:

1) Determine the weight of the empty car by centering each truck on the scale and recording the weight at each location (trucks A through F).
2) Load the car with weights to simulate the weight of a shipping container and securement cradle (approximately 480,000 lbs). This may be accomplished by using test weight components as illustrated in Exhibit F, or equivalent.
   All weights shall be positioned on the car body so that the combined center-of-gravity is located over the center of the rail car (i.e. approximately equal weight on each span bolster.)
3) Determine the weight distribution of the loaded car by centering each truck on the scale and recording the weight at each location (trucks A through F).

Equipment to be used:

1) Calibrated 2000 series Fairbanks Rail Scale

Test Records:

The results of each load test are to be recorded and certified on the Railcar Weighing Form.

Seller's Authorized Representative: _____Signature

_____Typed Name

_____Date

EXHIBIT F

Actual amount of weight to be applied to Cask Car Deck and applicable shop test weights to be used, to be decided later.

Component	Unit	Quantity	Total Wt.
		Total	

Appendix G-2.4.2 Railcar Weighting Form, Form 46, Rev 3

RAILCAR WEIGHING FORM
Form 46 Rev 3

7-7-2015

Drawing Number – D-1114-40
Standard Identifier –
Car #
Use Car Weighing Procedure # 13

Truck	Weight of Empty Car Pounds	Weight of Loaded Car Pounds	Percentage of Total weight	Shims Applied
A				
F				
E				
D				
C				
B				
TOTAL				

Acceptance Criteria:

1) The percentage of the weight on individual trucks shall range from 15.75% to 18% of the total weight.
2) The greater weight must be on the outboard trucks (trucks A & B)
3) Shims shall be installed beneath the span bolster center plates to obtain the required load distribution; refer to Drawing D-1118-SHIM-2.

Seller's Authorized Representative: _____

Sellers Name: KASGRO RAIL CORP

Note: The recording of false, fictitious, or fraudulent statements on this document may be punishable as a felony under federal tues

Appendix G-2.4.3 Kasgro Track Scale Calibration Form, Form 14, Rev 2

KASGRO RAIL CORP
FORM 14
MEASURING AND TEST EQUIPMENT
CALIBRATION RECORD

Revision "2" 6/5/03

Equipment Type	Track Scale		**Serial No. 100470050013**	
Calibration Frequency	**Annually**	**Acceptance Criteria NIST**		
Check Method	Test Car# WC210500			
Action to take when results are unsatisfactory per 2.8 of Quality Manual				
Location	**Date Cal.**	**Date Next Cal.**	**As Found Condition**	**Calibrated By**
Kas 1	5/25/2016	5/25/2017	OK	Rail Scale Inc

Appendix G-2.4.4 Railscale, Inc. Track Scale – Test and Inspection Report 10/14/2015

RAILSCALE, INC.

TRACK SCALE - TEST AND INSPECTION REPORT

As per NIST Handbook 44 Testing Standards

DATE OF TEST

05/25/2016

Railroad ID #: None

Location Information
Railroad
CSX
City/State
New Castle, PA
Owner/Industry Name
Kasgro Rail Corp. (Plt 1)

Location Information	
House Condition	Good
Pit Condition	Good
Pit Foundation Type	Concrete
Pit Drainage Type	Drain

Location Information			
Manufacturer	Length of Weight Rail		Date of Last RSI Test
Fairbanks Scale	10ft		06/17/2015
Instrument Serial Number	# of Sections	Total Capacity	Sectional Capacity
100470050013	2	125	85

Type/Condition of Scale			
Operation Type	Static	Display Type	Digital
Control Type	Digital	Dead Rail	No
Girder Type	Continuous	Girder Condition	Good
Deck Type	Live	Deck Condition	Good
Condition of Pivots and Bearings or Load Cells			Good
Condition of Approach Rail Right End			Good
Condition of Approach Rail Left End			Good

Test Vehicle Information				
Test Car #	Nominal Weight	Wheel Base	Jacks	Calibation Date
WC210500	80,000 lbs.	5'3"	N/A	10/14/2015

Balance as Found		S.R. Test (Beam Scale Only)			
Indicator Reading (lbs.)	0	SR at Zero Load		SR at M Load	
		SR Meets Requirements?		N/A	
Master Scale Location		State of Minnesota W & M			

Strain/Buildup Test	
Sub. Weight	
Cal. Weight	80000
Total Weight	
Disp. Weight	
Error	
Complies?	See Remarks

TEST RESULTS

First 2 Runs As Found		Sections												
Run Info	Test Load	Zero	1	2	Zero									
——>	80,000 lbs.	0	0	0	0									
<——	80,000 lbs.	0	0	0	0									

Weather Conditions: Clear Wind Factor: None Temperature: Warm

REMARKS

No Adjustments needed. No power available for a strain test.

Test is billable by RSI to: Industry Industry PO #: K16-0139 This test is: Annual

UNDER CONDITIONS STATED ABOVE THIS TEST HAS BEEN LEFT Weighing Within Tolerance

Owner/Industry Representative
Bill Baker

State Representative
Not Available

Scale Company Representative
Frank Spencer

RSI Representative
Michael Hamrick

APPENDIX G-2.5

ATLAS RAILCAR BRAKE TESTING

Appendix G-2.5.1 Static Force Brake Test Data, Form 36-A, Rev 1

KASGRO RAIL CORP

FORM 36-A **STATIC FORCE BRAKE TEST DATA** Rev 1 10/27/2008

Brake System:	DB-60 / EP-60	Date:	November 20, 2008
Brake Rigging:	Ellcon National 8500	Product Order:	[redacted]
Slack Adjuster:	Ellcon National 7100-33	Car Type:	290 Ton FM
Handbrake:	Ellcon National 33000-2	For:	[redacted]
Bell Crank:	N/A	Car Series:	39470-39488
Sheave Wheel:	8"	Test Car No:	[redacted]
Brake Shoe:	2" true Guard	Date Built:	Jul-08

Air Brake Force (Gross):	N/A #	Light Weight:	195,600 #
Brake Lever Ratio:	N/A :1	Gross Rail Load:	789,000 #
Handbrake Force (Gross):	4475 Vert. #	Brake Force Schem.:	TMB 341-L
EMPTY LOAD %:	40 %	Brake Arrangement:	E1114-2

MEASURED BRAKE SHOE FORCE (IN NET POUNDS)

Brake Cylinder Pressure (psig):

	WHEEL	CHANNEL	Min red 6-7 UNTAPPED	Light Car: UNTAPPED	27.25 TAPPED	Loaded Car: UNTAPPED	64.5 TAPPED	FORCE H	3350 lbs. on Vert. Chain
P	L-1	1	405	1335	1708	3656	4107	A	4328
N	R-1	2	428	1508	1913	4175	4488	N	4804
E	L-2	3	472	1524	1853	4118	4510	D	5308
U	R-2	4	432	1552	1816	4241	4534	B	5442
M	L-3	1	372	1382	1751	3934	4203	R	3250
A	R-3	2	443	1559	1916	4537	4634	A	3691
T	L-4	3	468	1456	1783	3925	4283	K	3738
I	R-4	4	489	1564	1825	4336	4479	E	3956
C	L-5	1	460	1350	1760	3730	4130		2430
	R-5	2	490	1440	1810	3820	4340		2900
	L-6	3	480	1430	1800	3910	4210		2590
	R-6	4	580	1600	1950	4130	4670		3110
	L-7	1	630	1470	1660	4350	4700		3610
	R-7	2	520	1380	1570	3970	4470		3390
	L-8	3	360	1500	1730	4670	4740		3340
	R-8	4	510	1270	1440	3990	4120		2820
	L-9	1	520	1500	1680	3920	4400		3900
	R-9	2	530	1470	1710	3800	4380		3850
	L-10	3	470	1520	1770	3970	4210		3520
	R-10	4	440	1320	1683	3621	4161		3165
	L-11	1	470	1540	1790	4174	4753		5327
	R-11	2	392	1423	1756	3927	4674		5179
	L-12	3	392	1361	1690	3996	4583		4358
	R-12	4	443	1269	1572	3653	4202		3963
	TOTALS:		11196		41936		105981		91969
	BCP @ Min. Red.	"A" End	(AVERAGE) 468.50	"B" End		(MINIMUM) 3863.9	(AVERAGE) 4415.9	(MAXIMUM) 4967.9	

PISTON Loaded	B23/4"C23/4"D27/8"E23/4"F27/8"A23/4"	Brake Cylinder Pressure, Min. 30psig Reduction:	64.50
TRAVEL: Empty	B21/4"C23/8"D25/16"E21/4"F25/16"A21/4"	Emergency Application:	75

	Pneumatic Loaded %		Handbrake Loaded %		Pneumatic Light %	
NET SHOE FORCE x100 / LIGHT WEIGHT					41936 x 100 / 195600	= 21.44
NET SHOE FORCE x100 / GROSS RAIL LOAD	105981 / 789000	= 13.43	91869 x 100 / 789000	= 11.66		
NET SHOE FORCE x100 / GROSS SHOE FORCE	105981 / N/A	= #VALUE!	91869 x 100 / 4475 Vert.	= #VALUE!	41936 x 100 / #VALUE!	= #VALUE!

BRAKE PIPE CHARGE OF 90 psig ATTESTED: [redacted]

Appendix G-2.5.2 Air Brake Test Report, Form 6-A, Rev 1

Rev.1

Kasgro Rail Corp

FORM 6-A 2/25/2016

Air Brake Test Report
(X=Tested)

CAR NUMBER [redacted]

Single Car Test, 1Set		Single Car Test, 2 Sets	
Single Car Test (includes B.C. Pressrure Test)		Single Car Test (includes B.C. Pressure Test), 2 Sets	X
Slack Adjuster Test	X	Retainer Valve Test	X
Empty / Load Valve Test	X	Brake Pipe Leakage Test	X
System Leakage Test	X	Equailization Pressure	X
Piston Travel (Unit Brakes)		If Equipped With Load Sensor	X
Piston Travel (Trk MTD Brakes)	X	Equailization Pressure Load Sensor	X
WABCOPAC / NYPOAC Piston Travel Adjustment		Equailization Pressure Loaded	X
(Truck Mounted Brakes with Slack Adjuster	X	Equailization Pressure Empty	X
#1 #2 #3 #4		Slack Adjuster Rack Measurement	
Lube Handbrake	X		
		EMERGENCY PRESSURE	X

SYSTEM REPAIRS- List repairs, parts replaced, Location, and why made.

Piston Travels

B-END: (1) 2¾ (2) 2⅞ (3) 2¾ — B-END: SERVICE LOADED — 64 PSI
DB-10 — DB-20 — EMERGENCY — 75 PSI
40% LOAD SENSOR — EMPTY — 25 PSI

A-END: (4) 2¾ (5) 2¾ (6) 3 — A-END: SERVICE LOADED — 63 PSI
DB-10 — DB-20 — EMERGENCY — 74 PSI
40% LOAD SENSOR — EMPTY — 24 PSI

Signature of Tester [redacted] Date 1-4-17

Note: The recording of false, fictitious, or fraudulent statements on this document may be punishable as a felony under federal statues.

Appendix G-2.5.3 EP-60 Single Car Test Results

[redacted] B 20170105 13.48

EP-60 Single Car Test Results: Passed

EPSCTD Version 2.20
EPSCTD Support Files Version 2.25
EPSCTD Language Files Version 1.6

Tester ID: 0164

Road Number: [redacted]
Car Type: Kasgro
12 Axle Spent Fuel Car

CCD Type: Overlay

Test Date and time: 1/5/2017 1:35:04 PM to 1/5/2017 1:47:31 PM

No.	Test	Step	Expected	Actual	P/F
2.2	AAR Standard S-486	Single Car Test	Yes	Yes	P
2.5	Charging Brake Pipe	Verify User entered BCP	0.0 to 3.0 psi	0.0 psi	P
2.6	Empty/Load Valve	Set E/L Valve(s) to Loaded	Yes	Yes	-
2.8	Release Test	Verify CCD Rel BCP	0.0 to 3.0 psi	0.4 psi	P
2.9	Loaded Full Service Test	Verify Reservoir pressure	88.0 psi min	91.5 psi	-
2.11	Loaded Full Service Test	Verify CCD Loaded FS BCP	62.0 to 68.0 psi	65.6 psi	P
2.13	Loaded Full Service Test	Verify User entered BCP	62.0 to 68.0 psi	65.0 psi	P
2.17	Min Service Test	Verify CCD Min BCP	7.0 to 13.0 psi	10.4 psi	P
2.19	Min Service Test	Verify User entered BCP	7.0 to 13.0 psi	10.0 psi	P
2.22	Loaded Emergency Test	Verify Reservoir pressure	88.0 psi min	90.4 psi	-
2.24	Loaded Emergency Test	Verify CCD Loaded Emer BCP	75.0 to 81.0 psi	77.5 psi	P
2.26	Loaded Emergency Test	Verify User entered BCP	75.0 to 81.0 psi	77.0 psi	P
2.28	Release from EP Emergency	Verify CCD Rel BCP	0.0 to 3.0 psi	0.4 psi	P
2.30	Release from EP Emergency	Verify User entered BCP	0.0 to 3.0 psi	0.0 psi	P
2.31	Empty/Load Valve	Set E/L Valve(s) to Empty	Yes	Yes	-
2.34	Empty/Load Valve	Verify CCD Empty FS BCP	62.0 to 68.0 psi	63.7 psi	P
2.37	Empty/Load Valve	Verify User entered BCP	-	24.0 psi	-
2.37	Empty/Load Valve	Empty FS BCP Acceptable	Yes	Yes	P
2.40	Empty Emergency Test	Verify CCD Empty Emer BCP	75.0 to 81.0 psi	78.0 psi	P
2.42	Empty Emergency Test	Verify User entered BCP	-	30.0 psi	-
2.43	Battery Test	Verifying battery voltage	11 vdc min	12.6 vdc	P

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Appendix G-2.5.4 Example of AAR Air Brake Test Witness Letter
TTCI Letter #CC-209.221 datd January 17, 2017

TTCI Transportation Technology Center, Inc.

Kenneth Pfahler
Field Inspector - MID/QA Auditor
427 North 3rd Street, Ext.
Bellwood, PA 16617
Cell: 814-515-3803
Email: ken_pfahler@ttci.aar.com

January 17, 2017

File: CC-209.221

Subject: Single Car Air Brake Test Observations Results / Kasgro Rail Corporation, New Castle, PA / Specifications S-2043 & S-486 -- H/D Flat Car ([redacted]) used to carry High-Level Radioactive Material

Mr. David L. Cackovic
Chief – Technical Standards & Inspections
Transportation Technology Center, Inc.
P.O. Box 11130
Pueblo, CO 81001
E-mail: David_Cackovic@aar.com

Dear Mr. Cackovic,

Specification testing of [redacted] Heavy Duty Flat Car, specifically the Single Car Air Brake Test has been completed. Testing was done at the Kasgro Rail Corporation facility in New Castle, Pennsylvania on January 17, 2017 to comply with Specification S-2043 and S-486.

I was present (test witness) for the required Single Car Air Brake Test and can conclude that applicable requirements of AAR Specification S-486 have been satisfactorily addressed. I also witnessed the Brake Pipe Restriction Test and can conclude that the AAR Specification S-471 appeared to have been satisfactorily addressed. Additionally, per an email from Mr. Belport dated July 27, 2010 a Brake Shoe Force Measurement Test was to be performed on two (2) cars, this has been satisfactory completed on KRL 39470 and [redacted].

Attached information was supplied by the Kasgro Rail Corporation in support of the approval process. Should you need any additional information, please do not hesitate to call.

Sincerely,

Kenneth Pfahler
Kenneth Pfahler

cc: [redacted], TTCI
[redacted], Kasgro

Appendix G-2.5.5 Wabtec Corporation Practice Test and Practical Exam per AAR Standard S-486-13

Reference available upon request for pages G.2-35 to G.2-45

APPENDIX G-2.6

ATLAS RAILCAR NDE EXAMINATIONS AND TESTING

Appendix G-2.6.1 TUV Rheinland Industrial Solutions, Non-Destructive Testing Group Work Instruction No. PA-WI-08-005, Rev No. 1 Ultrasonic Testing to AWS D15.1 Railroad Welding Specification

Reference available upon request

Appendix G-2.6.2 TUV Rheinland Industrial Solutions Procedure TRIS NDE-VT-4, Rev No. 0
Visual Inspection Technical Publications T9074-AS-GIB 010/271

Reference available upon request

Appendix G-2.6.3 TUV Rheinland Industrial Solutions, Non-Destructive Testing Group, Work Instruction No. WI-08-001, Rev No. 1 Liquid Penetrant Examination

Reference available upon request

Appendix G-2.6.4 TUV Rheinland Industrial Solutions, Non-Destructive Testing Group, Work Instruction No. WI-08-002, Rev No. 1
Magnetic Particle Examination of Ferromagnetic Materials

Reference available upon request