

DRAWN DATE
MK 12-05-94

CHECKED
DN 12-05-94

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CARGOTEC

HIAB - KALMAR - MACGREGOR

Cargotec Solutions LLC.
415 E. Dundee
Ottawa, Ks. 66067, USA

REV.
18

SHEET
1 OF 8

ENGINEERING SPECIFICATIONS OR INSTRUCTIONS

ESN-0021

ELECTRICAL SPECIFICATION FOR WIRING HARNESSSES
REVISIONS

REV.	EO. NO.	INIT.	DATE	EXPLANATION
A	941901	DN	12-05-94	RELEASED
B	---	GJL	10- -95	REVISED PER HARNESS MANUFACTURER REVIEW
C	---	GJL	11-03-95	REVISED PER HARNESS MANUFACTURER REVIEW
D	961330	DN	10-03-96	ADDED REVISION SHEET, TOTAL NUMBER OF PAGES WAS 4 <u>SECT. B2</u> - ADDED (BULLET) TO DESCRIPTION <u>SECT. B5</u> - ADDED HEAT SHRINK REFERENCE <u>SECT. D1</u> - MINIMUM DISTORTION TEMPERATURE WAS 300°F. REFERENCE PART WAS PACKARD R-69246 FLAME RETARDENT POLYPROPYLENE. <u>SECT. G3</u> - ADDED CRIMPING, REMOVED 60/40 FROM SOLDERING SPEC., HEAT SHRINK TUBING WAS TO EXTEND PAST BOTH ENDS OF SPLICE, AND ADDED ULTRASONIC WELDING AS AN ALTERNATIVE.
E	970681	DN	05-13-97	ADDED <u>SECT D3</u> , ADDED SHEET 6
F	010316	DN	02-16-01	<u>SECT. H3</u> - ADDED WIRE NUMBER EXAMPLE
G	010478	DJB	03-14-01	ADDED <u>SECT G5</u> , <u>SECT. H1</u> , <u>SECT. H2</u> , <u>SECT. H3</u> - ADDED FUSIBLE LINK REFERENCE
H	011351	MLW	07-12-01	<u>SECT. E1</u> - ADDED COVERAGE OF MATING TERMINALS NOTE.
J	020478	DN	04-30-02	ADDED REVISION LEVEL TO EACH SHEET, TOTAL NUMBER OF PAGES WAS 6 <u>SECT. H3</u> - ADDED (PRE-2003) TO WIRE NUMBERS, ADDED WIRE CODE (2003-UP) SPECIFICATIONS. CHANGED NUMBER/CODE STAMPING DISTANCE TO 4" APART
K	021739	DN	06-05-03	<u>SECT. D</u> - D4 WAS D3; ADDED D3, BRAIDED SLEEVE SPECIFICATION ADDED <u>SECT. L</u> <u>SECT. H3</u> - DELETED UV CURING REQUIREMENT FOR INK JET PRINTING
L	041668	JBM	08-03-04	<u>SECT. D</u> - D2 REFERENCE, EY-1877 WAS X-1877
M	080791	DG	05-07-08	<u>SECT. H1</u> - ADDED PART NUMBER EQUIVALENCY.
N	090964	JLB	10-22-09	<u>SECT. D</u> - ADDED PARAGRAPHS 5A AND 5B. ADDED SHEET 8 UPDATED TITLE BLOCK TO CARGOTEC LOGO AND CHANGED "OTTAWA TRUCK" TO "CARGOTEC SOLUTIONS"
P	100031	MAI	18-JAN-10	<u>SECT. D (5)</u> - DELETED 5B, (INSTRUCTION TO TAPE WIRES TOGETHER AND THEN TO CONVOLUTE EVERY 6").
17	1036988	JBA	16-APR-18	<u>SECT. E</u> - DELETED REFERENCE TO SHRINK TUBE TYPES. ADDED APPROVED SHRINK TUBE AND SAME OR BETTER REFERENCE.
18	1058441	SMC	07-JUN-22	<u>SECT. H2</u> - ADDED WIRE COLOR CODE CHART.

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SCOPE: This is a specification which allows for a variety in material selection yet provides a uniform method of processing to ensure a consistent quality. Specifications are based on SAE references.

SAE REFERENCES:

- J163 LOW TENSION WIRING AND CABLE TERMINALS AND SPLICE CLIPS
- J561 ELECTRICAL TERMINALS – EYELET AND SPADE TYPE
- J562 NONMETALLIC LOOM
- J858 ELECTRICAL TERMINALS – BLADE TYPE
- J928 ELECTRICAL TERMINALS – PIN AND RECEPTACLE TYPE
- J1127 BATTERY CABLE
- J1128 LOW TENSION PRIMARY CABLE
- J1292 AUTOMOBILE, TRUCK, TRUCK-TRACTOR, TRAILER, AND MOTOR COACH WIRING

GENERAL SPECIFICATIONS

A. DIMENSIONS

1. All dimensions are shown in inches, unless otherwise specified.
2. Harness termination breakout dimensions are from end of covered or tied portion (shown as solid lines) to end of terminal, mating face of connector, or center of ring and spade terminals.
3. Dimension tolerances for assemblies are given in Table 1:

TABLE 1 WIRE HARNESS TOLERANCE CHART								
Length Inches Over To	Single Lead		Dimension Along Trunk Between Breakouts		Breakouts Extending From Assembly		Overall Length Of Assembly (See Note)	
	+	-	+	-	+	-	+	-
0-6	1/2	1/2	1	1	1	1/2	1	1
6-12	1	1/2	1	1	1	1/2	1	1
12-24	1	1/2	1	1	1	1/2	1	1
24-36	1	1/2	1	1	1	1/2	2	2
36-60	1	1/2	1	1	1	1/2	2	2
60-100	1	1/2	1	1	1	1/2	2	2
100-200	1	1/2	1-1/2	1-1/2	1	1/2	2	2
200-UP	1	1/2	2	2	1	1/2	2	2

NOTE: Overall length is defined as the sum of all segments between any two endpoints.

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B. TERMINALS AND CONNECTORS

1. Eyelet and spade type terminals shall conform to SAE J561.
2. Pin and receptacle (bullet) type terminals shall conform to SAE J928. The receptacle terminal shall be detented.
3. Male blade type terminals shall conform to SAE J858a, Type 1A or 1B. Female receptacles shall be capable of properly mating with appropriate size and type male terminal.
4. When hard-shell connectors are employed, terminals used shall be those recommended by the connector manufacturer.
5. All terminals not within connectors are to be insulated with heat shrink tubing, unless otherwise noted on harness drawing. Tubing to extend onto attached cable 1/4" minimum. Reference section E relating to heat shrink tubing.

C. CRIMPS

1. All terminals shall be crimped to the conductor. Tensile strength shall be as given in Table 2 before soldering, if soldering is required for type of terminal. All crimps shall be in compliance with SAE J163. For crimps of two or more conductors, 80% of the value for the smallest conductor in the terminal being crimped is permissible.
2. Crimps are to conform to the terminal manufacture's recommended practice for tooling and final crimp geometry.
3. Crimps for terminals need not be soldered if the crimp was made by machine; hand crimps shall be soldered.
4. Terminals conforming to Sections B1, B2, and B3 are to be crimped and soldered, regardless of crimp method, unless otherwise specified.

TABLE 2 -- CRIMP TENSILE STRENGTH								
WIRE GAUGE	20	18	16	14	12	10	8	6
MIN PULL (LBS)	20	25	35	60	70	80	90	100

D. HARNESS COVERING

1. Harness covering shall be high temperature, split side, convolute tubing for use in contact with the engine. Tube diameter shall be of appropriate size for the number of wires. Tubing must meet SAE J562 - Non-Metalic Loom, have a minimum continuous operating temperature rating of 248°F, and a minimum distortion temperature of 356°F.

Reference:

Packard Polyimide (Nylon) slit Black w/Gray stripe round convoluted conduit

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D. HARNESS COVERING (Cont)

2. When specified, braid type harness covering to be Hytrel Coated Nylon Braid. Braid is to have a minimum Continuous Operating Temperature of 300°F and a Min. Short Term Exposure rating of 325°F.

Reference: Engineered Yarns Inc. EY-1877 or equivalent.

3. When specified, braided sleeve type harness covering is to have a maximum operating temperature of 257°F and a melt temperature of 464°F.

Reference: Cary Industries CXpando FR or equivalent.

4. Wire ties are to be installed every 4"(100mm) on harnesses and sections of harnesses that have two or more wires that are not covered by convolute tubing or braid.

5. For harnesses covered by convolute tubing.

- a. Where wires emerge from the convolute tubing, the wires are to be taped together and then taped to the convolute tubing to prevent relative movement between the two. As an alternative construction, heat shrink tubing may be used.

E. HEAT SHRINK TUBING

1. Heat shrink tubing shall be fire retardent, flexible or semi-rigid, polyolefin tube with an integral internal layer of thermoplastic adhesive. Adhesive shall not interfere with normal insertion of mating terminal; shrink tubing with the above properties, but without adhesive may be substituted in these cases. Shrink tubing will provide complete coverage of the mating terminals without interfering with proper mating.

Approved:

Raychem SCT Series

Shrink tube with same or better characteristics and similar physical performance may be substituted. Glue content must remain unchanged or increased from product outlined.

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F. SOLDERING

1. General Requirements

- a. The solder deposit shall be metallurgically bonded by wetting the surfaces being joined.
- b. Solder deposits shall be reasonably uniform.
- c. Component leads, terminals, connectors, etc., may be pre tinned to improve solderability. If pre tinning strand wires, solder must penetrate to inner strands.
- d. The thermal cycle shall be controlled so as to avoid insufficient, excessive, or prolonged heating which would result in unreliable connections or otherwise damage the assembly components.

2. Unacceptable Conditions

- a. A grayish (dullness), porous, or granular appearance of the solder deposit.
- b. Inclusions or other defects in the solder deposit.
- c. Damage to insulation caused by the soldering thermal cycle.
- d. Solder deposit beneath insulation on insulated wires.
- e. Solder deposited by wicking in stranded wire or cable, outside of the connection area.
- f. Use of acid flux

G. SPLICES

1. Splices shall be situated in the main body of the harness and, if not located dimensionally on the drawing, are to be placed so as to require the minimum total amount of wire possible consistent with maintaining a balanced splice.
2. Splices shall not be located less than 2" from any breakout nor less than 2" from adjacent splices.
3. Splices shall be crimped, metal dipped in solder and insulated with a heat shrink tubing sleeve. Tubing to extend past bare wire by a minimum of 1/4". Ultrasonic welding may be used in place of crimping and soldering.
4. Unauthorized splices are prohibited.
5. Splices for fusible links are to be of the parallel design or ultrasonic welded.

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H. CABLE (Wire)

1. Type

- a. All low tension primary cable, 8 through 18 gauge, is to be Type GXL per SAE J1128, unless otherwise noted. Type SXL cable is acceptable if terminals and cable seals are resized as required.
- b. All low tension primary cable, 6 through 4/0 gauge, is to be Type SGX per SAE J1127, unless otherwise noted. Types STX & SXL are acceptable alternatives.
- c. Fusible link to be SXL wire only.
- d. All shielded twisted pair is to be equivalent to champlain part number 23-00028 or 23-00033.

2. COLOR

- a. Color code is to be in accordance with SAE J1128.
- b. Strip code application of two longitudinal stripes 180 degrees apart is preferred; one spiral stripe is acceptable.
- c. Fusible links to be white unless otherwise noted on drawing.

WIRE COLOR CODE

RD - RED
BK - BLACK
WE - WHITE
BE - BLUE
BN - BROWN
GN - GREEN

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H. CABLE (Wire) (Cont)

3. WIRE NUMBERS (PRE-2003)/CODES (2003-UP)

- a. Wire numbers (PRE-2003)/codes (2003-up) are to be hot stamped every 4" along the entire length of wire, except for fusible links. An acceptable alternative is ink jet printing. Ink color to provide adequate contrast with wire color. Wire destination characters (PRE-2003) may also be included at the harness manufacturer's option.

Wire Number (PRE-2003) Example: (Typical Wire Chart from Harness Drawing)

WIRE DESTINATION	WIRE GA	WIRE COLOR	WIRE DESCRIPTION
1111, A-B	GA	COLOR	DESCRIPTION*****

└─ WIRE DESTINATION (ALPHA CHARACTERS)
└─ WIRE NUMBER (2 TO 4 NUMBERS)

Wire Chart Symbol: J:\SYMB\FGE00099.DWG

Wire Code (2003-UP) Chart Example: (Typical Wire Chart from Harness Drawing)

WIRE CODE	WIRE GAUGE	WIRE COLOR	FROM		TO	
			NAME	PIN	NAME	PIN
CODE	GA	COLOR	FROM	PIN	TO	PIN

SEE J:\DRAWINGS,ECT\
ELECTRICAL\2003\WIRE CODES.XLS
FOR LIST OF WIRE CODES
& DESCRIPTIONS

└─ CAVITY DESIGNATION FOR "TO" CONNECTION
└─ "TO" CONNECTION NAME
└─ CAVITY DESIGNATION FOR "FROM" CONNECTION
└─ "FROM" CONNECTION NAME

Wire Chart Symbol: J:\SYMB\FGE00235.DWG

- b. Fusible links are to have "FUSELINKn" printed on the entire length of the link with a single character space between. The wire gauge is to be printed in place of the "n".

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I. ELECTRICAL CHECK

1. Finished harnesses are to be 100% tested to ensure proper orientation and continuity of all circuits.

J. IDENTIFICATION

Finished harnesses shall be tagged with the following:

1. Cargotec Solutions part number.
2. Engineering Change (Revision) Level
3. Date of Manufacture
4. Vendor Identification
5. The above is to be imprinted on adhesive backed tape and attached at the head of the assembly on the main body or connector.

K. DEVIATIONS

Deviations not permitted unless authorized in writing by Cargotec Solutions Engineering.

L. AMERICAN WIRE GAUGE (AWG) TO METRIC EQUIVALENT

AWG	mm ²
20	0.5
18	0.8
16	1
14	2
12	3
10	5
8	8
6	14-16
4	18-20
2	35
1	40
0	50
2/0	62-70
3/0	81-95
4/0	103-120