SECTION 2

CHAPTER 2

IDENTIFYING WIRE AND CABLE

INTRODUCTION

1. To make maintenance easier, each interconnecting wire and cable installed in aircraft should be marked with a combination of letters and numbers which identify the wire, the circuit it belongs to, its gauge size, and other information necessary to relate the wire to a wiring diagram. This marking is called the wire identification code. Wire, as received from the manufacturer, is printed with the manufacturer's code, in a contrasting colour, at intervals of one to five feet. This code consists of the specification or MS number and slash or dash number of the wire, and a one, two or three-digit number, indicating the colour of the basic wire insulation and the colour of the stripes (if present). The colour code is as follows:

Black	0	Blue	6
Brown	1	Violet	7
Red	2	Gray	8
Orange	3	White	9
Yellow	4	(includes also uncoloured insulations)	
Green	5		

2. For example, a wire printed with number M22759/34-22-948 would designate a wire constructed in accordance with MIL-W-22759/34, wire size 22, white insulation (9), first stripe yellow (4), and a second stripe of grey (8).

> NOTE
>
> When marking wire with the identification code described in this chapter, it is permissible to over-stamp the manufacturer's printing.

WIRE IDENTIFICATION CODE (BASIC)

3. The basic wire identification code used for all circuits (refer Table 2–1) is described in the following paragraphs and Figure 2–1.

Unit Number

4. Where two or more identical items of equipment are installed in the same aircraft, the unit numbers "1", "2", "3", "4", etc., may be prefixed to differentiate between wires and cables when it is desired that the equipment have the same basic cable identification. To facilitate interchangeability requirements, identical wiring located in left and right wings, nacelles, and major interchangeable structural assemblies may have identical cable identification and the unit number is not required. The unit numbers for circuit functions "R", "S", "T" and "Y", are used only where duplicate complete equipment is installed, and does not apply to duplicate components within a single complete equipment such as duplicate indicators or control boxes.

Circuit Function Letter

5. The circuit function letter is used to identify the circuit function specified in Table 2–1. Where a wire or cable is used for more than one circuit function, the circuit function that is predominant applies. When functional predominance is questionable, the circuit function letter for the wire or cable having the lowest wire number is used.

Wire Number

6. The wire number consisting of one or more digits is used to differentiate between wires in a circuit. A different number shall be used for wire not having a common terminal or connection.

7. Wires with the same circuit function having a common terminal connection or junction will have the same wire number but different segment letters.

8. Beginning with the lowest number, a number is assigned to each wire in numerical sequence, as far as practicable.

Wire Segment Letter

9. A wire segment is a conductor between two terminals or connections. The wire segment letter is used to differentiate between conductor segments in a particular circuit. A different letter is used for wire segments having a common terminal or connection. Wire segments are lettered in alphabetical sequence. The letter "A" identifies the first segment of each circuit starting at the power source. If a circuit contains only one wire segment, the wire segment is marked "A". The letters "I" and "O" are not used as segment letters. Double letters "AA, AB, AC", etc., are used when more than 24 segments are required. Two permanently spliced wires do not require separate segment letters if the splice is used for modification or repair.

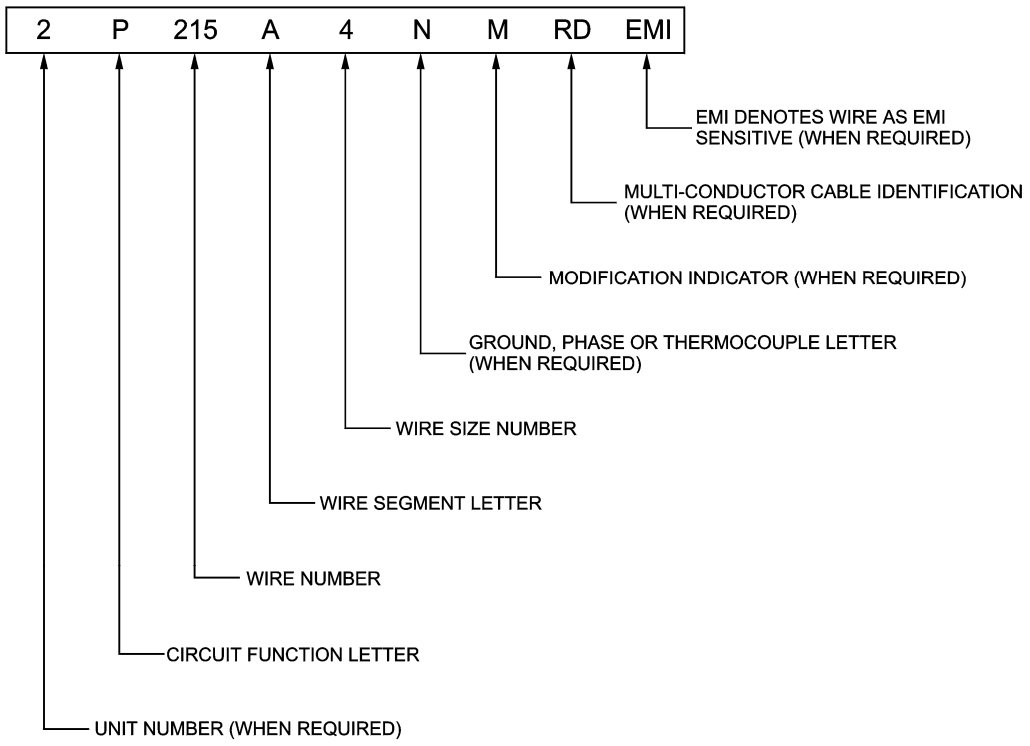

Figure 2–1 Example of Wire Identification Coding

Wire Size Number

10. The wire size number is used to identify the size (AWG) of the wire. For coaxial cables and thermocouple wires, a dash (-) is used in lieu of the wire size number.

Ground, Phase or Thermocouple Letter(s)

11. The letter “N” is used as a suffix to the wire identification code to identify any wire or cable that completes the circuit to the ground network (earth). Such wires and cables shall be capable of being connected to the ground network of aircraft electrical systems without causing malfunctioning of any circuit. For critical and sensitive electronic systems that have interconnecting “ground” leads, but only one segment actually grounded to structure, only the segment actually grounded to structure is identified with the “N” suffix.

12. Phase letter “A”, “B” or “C” shall be used as a suffix on the wire identification code to identify the phase of wires that are in the three-phase power distribution wiring of AC systems.

13. Phase letter “V” shall be used as a suffix on the cable identification code to identify the ungrounded wire or cable that is in a single-phase system.

14. For thermocouple wire, the following suffixes shall be used as applicable:

CHROM – Chromel
ALML – Alumel
IRON – Iron
CONS – Constantan
COP – Copper

Aluminium Wire

15. For aluminium wire, ALUMINIUM or ALUM shall be added as a suffix to the wire identification code.

Spare Contact Wire Identification

16. Wires attached to spare contacts shall be identified by the contact designation.

Harness Identification

17. When required, each harness shall be identified with the letter W and a distinct numerical suffix. Examples W-1, W-2, W-3, etc.

Wires Added at Modification

18. When additional wires are installed in aircraft during modification, they should be identified by including the letter M as a suffix to the wire

Multi-Conductor Cables

19. Wires within multi-conductor cables are identified with either solid colours or coloured stripe(s) on a white background. Mark these wires in accordance with paragraph 34.

Wires Sensitive to Electromagnetic Interference (EMI)

20. Sensitive wiring is defined as wiring that is especially susceptible to EMI, and is therefore more likely to create disruption of the equipment to which it is connected.

21. A current method for identifying EMI sensitive wires and cables consists of a suffix to the wire number that identifies the susceptibility to EMI and indicates that specific handling instructions are detailed in the aircraft wiring manual. This suffix shall remain at the end of the significant wire number regardless of the requirement for any other suffix. Figure 2–1 provides an example of a wire identification number with the EMI identifier included.

22. The identification of EMI sensitive wiring is dependent on the following:

- **a.** level of shielding or protection applied to the wire (eg. twisted pair, shielded wire etc);
- **b.** electromagnetic susceptibility of the coupled victim equipment;
- **c.** physical separation between the subject wiring and potential electromagnetic sources (including other wires); and/or
- **d.** the type of grounding/bonding methods utilised.

23. Audio and data signals are often the most susceptible to EMI. Other typical waveforms that are more susceptible to EMI have the following characteristics:

- **a.** low voltage,
- **b.** low current, and/or
- **c.** slow rise times.

24. SAE AS 50881 Wiring, Aerospace Vehicle, requires sensitive wiring to be routed to avoid electromagnetic interference. SAE AS 50881 Appendix B allows for, but does not mandate, the identification of EMI sensitive wires and cables with a category code added to the significant wire number. In the past, EMI sensitive wires and cables added during modification of aircraft have been isolated in accordance with the specification, however they have not been identified as EMI sensitive and therefore their integrity may be compromised during subsequent aircraft modification.

Safety of Flight (SOF) Critical EMI Sensitive Wire and Cable

25. Where wires and cables are susceptible to EMI and are identified as critical to the safety of flight (SOF) of the aircraft, they should be identified with red sleeves. (This is in addition to the EMI suffix on the wire identification code). The red sleeves (heat shrink is appropriate) should be a minimum of 50mm in length and positioned at intervals no greater than 375mm along the entire length of the wire or loom, utilising application methods detailed in this manual. Marking of the sleeving to further highlight the EMI sensitivity is optional, but should be consistent with existing aircraft labelling practices and clearly documented in wiring publications.

26. The sleeving procedure detailed above is also appropriate for non-SOF systems that are sensitive to EMI and where interference may affect the air-worthiness of the aircraft.

WIRE AND COMPONENT IDENTIFICATION CODES FOR MODIFICATION

Wire Numbers

27. When additional wires and cables are installed in aircraft during modification they should be appropriately identified in accordance with this publication. Wire numbers in the range 2000 to 4999 inclusive, should be allocated. All wire numbers allocated to modifications should be suffixed with the letter M (eg. L2001A20M). Wires installed within aircraft components and wires less than six inches long need not be numbered.

Electrical Component Numbers

28. Electrical components such as switches, lights, circuit breakers etc. which are installed during modification, should be identified on wiring diagrams using a code letter and sequential number. As different aircraft manufacturers use various code letters for similar components, it is recommended that the coding convention, used by the manufacturer on original aircraft wiring diagrams, be retained.

Table 2–1 Function and Designation Letters

Circuit Function Letter	Circuits
A	**UNASSIGNED**
B	**PHOTOGRAPHIC**
	Mapping camera
	Camera intervalometer
	Camera doors
	Camera heaters
	Warning
C	**CONTROL SURFACE**
	Automatic pilot
	Booster
	Control tabs
	Diving brakes
	Flight
	Horizontal stabilizer
	Landing flaps
	Water-rudder position
	Trim tabs
	Wing flaps
	Warning
D	**INSTRUMENT** (other than flight or engine instruments)
	Ammeter
	Oil-flap position
	Cowl-flap position
	Coolant-flap position
	Air pressure
	Free air temperature
	Landing gear position
	Hydraulic pressure
	Cabin pressure
	Carbon monoxide
	Landing-flap position
	Propeller pitch position
	Instrument vacuum pump
	Horizontal-stabilizer position
	Trim-tab position
	Water pressure
	Voltmeter
	Clock
	Cabin heater
	Cigarette lighter
	De-icing (general)
	Heated flying suits
	Gallery
	Windshield defroster
	Windshield defogger
	Windshield de-icer
	Heater blanket
	Oil immersion heater
	Refrigeration
	Cabin supercharger
	Ventilation
	Water heater
E	**ENGINE INSTRUMENT**
	Carburettor air pressure
	Bearing temperature
	Tailpipe temperature
	Carburettor anti-icing fluid quantity
	Fuel mixture
	Torque meter
	Brake mean effective pressure
	Fuel flow
	Fuel quantity
B	**PHOTOGRAPHIC**
	Oil pressure
	Manifold pressure
	Fuel pressure
	Propeller anti-icing fluid quantity
	Engine oil quantity
	Tachometer
	Synchroscope
	Warning
F	**FLIGHT INSTRUMENT**
	Bank and turn
	Rate of climb
	Directional gyro
	Air position
	Ground position
	Compass (including flux gate and other stabilized compasses)
	Gyro horizon
	Attitude gyro
	Driftmeter
	Altimeter
	Airspeed
	Accelerometer
	Pitot-static tube heater
	Warning
G	**LANDING GEAR, WING FOLDING**
	Actuator
	Retraction
	Wheel brakes
	Down lock
	Ground safety
	Wheel steering
	Up lock
	Wheel spinning
	Warning
H	**HEATING, VENTILATING, AND DE-ICING**
	Anti-icing (general)
	Battery heater
I	**UNASSIGNED**
J	**IGNITION**
	Booster
	Vibrator
	Distributor
	Electronic
	Magneto ground wiring
	Warning
K	**ENGINE CONTROL**
	Carburettor air flap
	Blower ratio
	Cowl flap, air shutter
	Intercooler flap
	Oil cooler shutter
	Propeller feathering
	Propeller synchronizer
	Propeller pitch
	Supercharger regulator
	Starter
	Warning
L	**LIGHTING**
	Approach

Circuit Function Letter	Circuits
E	**ENGINE INSTRUMENTS** (continued)
	Fuel capacity
	Cylinder head temperature
	Oil temperature
	Interior
	Instrument
	Section (fuselage)
	Landing
	Exterior
	Running, position, navigation
	Passing
	Search
	Taxi
	Anchor
	Warning
M	**MISCELLANEOUS ELECTRIC**
	Windshield spray
	Bilge pump
	Cargo door
	Water distillation
	Windshield wiper
	Hoist
	Positioner; seat, pedal
N	**UNASSIGNED**
	TW - Weather devices
	TX - Television transmitters
	TY - Television receivers
O	**UNASSIGNED**
P	**DC POWER**
	Wiring in the DC power or power-control system shall be identified by the circuit function letter "P".
Q	**FUEL AND OIL**
	Fuel valves
	Fuel booster-pump motor
	Mixture control
	Oil dilution
	Engine primer
	Fuel-transfer-pump motor and control
	Fuel-loading-pump motor
	Oil-transfer-pump motor and control
	Oxygen heater
R	**RADIO** (navigation and communication)
	RA – Instrument landing
	RD – Radio direction finding
	RF - VHF
	RH - Homing
	RM - Marker beacon
	RN - Navigation
	RX - Recorder
	RZ - Interphone, headphone
	RV - VHF command

Circuit Function Letter	Circuits
L	**LIGHTING** (continued)
	Cockpit
	Drift
	Cabin
S	**RADAR**
	SA - Altimeter
	SM - Mapping
	SN - Navigation
	SR - Recorder
	SS - Search
	SW - Warning
	SX – Recognition - transponder
T	**SPECIAL ELECTRONIC**
	TB - Radar control
	TC - Radio control
	TD - Airborne announcing
	TF - Repeat back
	TL - Attitude indicator
	TN - Navigation
	TP - Beacon (crash and locator)
	TQ - Transmitters and receivers
	TR - Receivers
	TT - Transmitters
U	**MISCELLANOUES ELECTRONIC**
	Oil-booster pump
	Oil-scavenger pump
	Throttle control
	Fuel-pump motor
	Oil diverter
	Oil valves
	Water injection
	Warning
V	**DC POWER** and DC control cables for AC systems shall be identified by the circuit function letter “V”. Wiring in the AC power system shall be identified by the circuit function letter “X”.
W	**WARNING AND EMERGENCY** (in addition to those listed under other circuit functions)
	Enclosure release and locks
	Fire extinguishers
	Flare release
	Fire detector
	Oxygen detector
	No-smoking sign
	Fasten-belts sign
	Intercrew buzzer or light
X	**AC POWER** power circuits common to more than one equipment or system.
Y	**UNASSIGNED**
Z	**UNASSIGNED**

Circuit function and circuit designation letters of electrical and electronic wires and cables should be as specified herein. Typical circuits are listed under their respective circuit functions.

IDENTIFICATION METHODS

29. The identification code, as shown in Figure 2–1 should be applied to wires either horizontally or vertically. The preferred method of identification is to apply the identification marking directly on the wire or cable with a laser wire-marking machine. Use this method wherever possible. If the wire insulation or outer covering will not mark clearly, lengths of insulating tubing (standard or heat shrink) may be laser marked or hot stamped with the identification code and installed on the wire or cable. The following types of wire may require identification by means of sleeves:

a. Unjacketed shielded wire.

b. Thermocouple wires.

c. Multi-conductor cable.

d. High temperature wire.

CAUTION

Do not use metallic markers or bands for identification. Do not use any method of marking that may damage or deform the wire or cable insulation.

NOTE

Use sleeves only if wire cannot be marked directly.

MARKING OBJECTIVES

30. Which ever method of marking is used, ensure marking is legible, and that colour of marking contrasts with the wire insulation or sleeve.

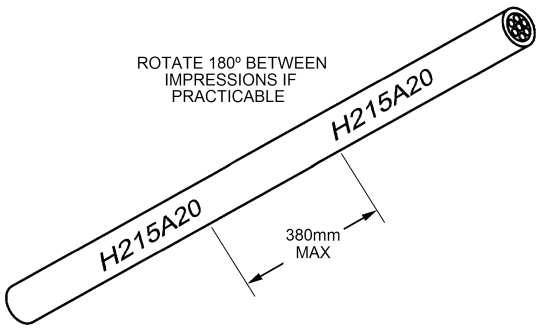

Figure 2–2 Spacing of Identification Marking on Wire and Cable

SPACING OF WIRE IDENTIFICATION

31. Mark wires and cables at intervals of not more than 38cm along their entire lengths (refer Figure 2–2). In addition, mark wires within 75mm of each junction (except permanent splices), and at each terminating point. Wires less than 15cm long need not be marked.

LOCATION OF SLEEVE MARKING

32. When wire or cable cannot be marked directly, install a sleeve, (refer Figure 2–3) marked with the identification number, over the outer covering at each terminating end and at not more than 90cm intervals along the entire length of the wire or cable.

NOTE

Do not use sleeves to change the identification of wire or cable that has already been marked, except in the case of spare wires in potted connectors.

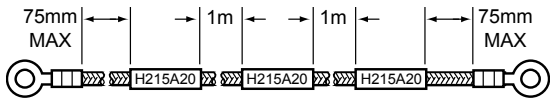

Figure 2–3 Location of Identification Sleeve

MULTICONDUCTOR CABLE IDENTIFICATION

33. Multi-conductor cables may be identified by marking directly onto the outer sheath using a laser marking machine or with pre-marked sleeves (refer Figure 2–4) installed as described in paragraph 44. Immediately following each wire identification number, indicate the colour of the individual conductor as detailed in Figure 2–1 using the following abbreviations:

Black	- BK	Blue	- BL
Brown	- BR	Violet	- VT
Red	- RD	Grey	- GY
Orange	OR	White	- WH
Yellow	- YE	Pink	- PK
Green	- GN	Purple	- PR

34. Individual wires within a cable shall be identified within 75mm of their termination.

COAXIAL CABLE IDENTIFICATION

35. Coaxial cable should NOT be hot-stamped directly. The marking pressure and stress (tension and torsion) applied while the cable moves through the machine can create electrical changes in cables and physical damage in miniature cables. When laser marking is unsuitable for marking coaxial cable, use pre-marked sleeves (refer Figure 2–5) as described in paragraph 43 and 44.

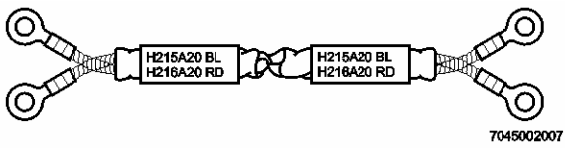

Figure 2–4 Multiconductor Cable Identification

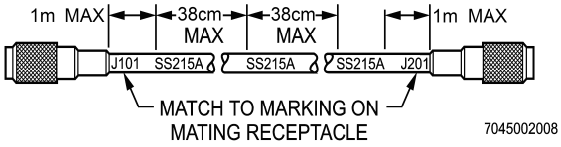

Figure 2–5 Coaxial Cable Identification

THERMOCOUPLE WIRE IDENTIFICATION

36. Thermocouple wire, which is usually duplexed (two insulated conductors laid side by side), may be difficult to mark legibly. Where sleeves are utilised, the wire size in the identification code should be replaced by a dash. The material designation shall be as follows:

CHROM – Chromel
ALML – Alumel
IRON – Iron
CONS – Constantan
COP – Copper

WIRE IDENTIFICATION AT TERMINAL BOARDS AND ENCLOSURES

37. If possible, mark wires attached to terminal boards and equipment terminals between termination and the point where wire enters the wire bundle (refer Figure 2–6). Identify wires terminating within an enclosure, inside the enclosure, if space permits.

SELECTION OF IDENTIFICATION SLEEVING

38. For general airframe wiring, in most applications, heat-shrinkable polyethylene tubing should be used to identify wire that cannot be marked directly. Available sizes are given in Section 2, Chapter 4.

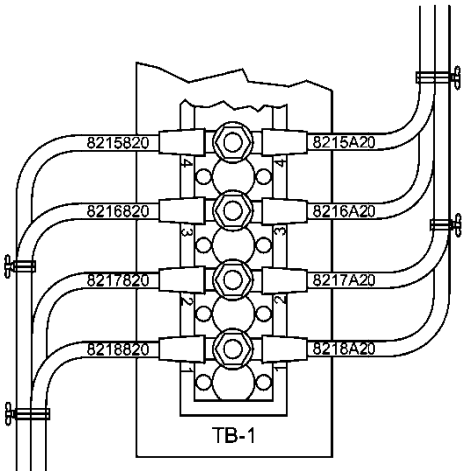

Figure 2–6 Wire Identification at Terminal Board

WIRE MARKING

39. Excimer Laser marking is the recommended wire marking method. It is a rapid, non-contact, non-aggressive printing technique that relies on alteration of the Titanium Dioxide (TiO_2) pigment present in the insulation material. This wire marking method produces a high contrast, high definition, permanent mark on most single wire and multi-core cables without any degradation of the insulation. Laser marking should be carried out in accordance with the manufacturer's instructions.

40. Hot stamp marking directly on to the insulation of aircraft electrical wire and cable is not recommended due to the degradation that may be caused to the insulation and because alternate, improved identification methods are available. Where hot stamp marking is determined to be the most appropriate marking method (eg large conductors and heat shrink sleeving) the details listed in Table 2–2 are provided to assist in the selection of the appropriate marking foil, marking temperature and dwell time.

> NOTE
>
> Store foils at approximately 22°C and 60% relative humidity.

SET-UP OF MARKING MACHINE FOR WIRE STAMPING

41. After selecting the proper machine for the job, set it up for the marking procedure as follows:

a. From Table 2–3, select the correct size type for the wire to be marked. Make up required identification code and insert into type holder,

centring type in holder. Use spacers to prevent crowding letters and numbers.

b. Select marking foil of correct width for length of identification code.

CAUTION

Use correct size guide. If guide is too large, wire will not be held firmly and marking will be off centre.

Table 2–2 Marking Foil Identification

Foil Part Number	Colour	Insulation Type	Marking Temperature	Dwell Time
KT26	Black	Teflon	210 to 227°C	Quick
K-36	Black	PVC, Nylon, Polyethylene	163 to 260°C	Medium
K520	Black	ETFE/ECTFE	150°C	Quick

c. Select wire guide into which wire will fit snugly.

d. Install wire guide and roll of marking foil on machine. Slide type holder into slot provided for it.

Table 2–3 Recommended Sizes of Marking Type

Wire Size (AWG)	Letter Height (mm)
26 thru 22	1.6
20 thru 14	2.0
12 thru 0000 & Coaxial Cable	2.8

SET-UP OF MARKING MACHINE FOR SLEEVE STAMPING

42. For stamping identification mark on tubing that has an OD of 6.3 mm or smaller, use the same machine that is used for stamping wire. Set up machine as follows:

a. Select type size and wire guide to suit OD of tubing.

b. Select mandrel (metal rod) of a diameter that will fit snugly inside tubing. Insert mandrel into tubing, and both into the wire guide. If a mandrel of proper size is not available, use a piece of insulated wire of suitable diameter and length.

c. Prepare type to provide required wire number.

d. Select foil and install wire guide, foil, and type holder on machine.

INSTALLING IDENTIFICATION SLEEVES ON WIRING

43. Cut marked tubing into lengths so that marking is approximately centred (refer to Figure 2–7). Install cut lengths of tubing over wire or cable at desired spacing, and tie at each end with clove hitch and square knot. Refer to Section 2, Chapter 8 for method of tying and knotting. When heat shrinkable tubing is used, ties are not required. Before installing heat shrinkable tubing on the wire, make sure that the wires are clean. Instructions for installation of heat shrink sleeving are provided in Section 2, Chapter 4.

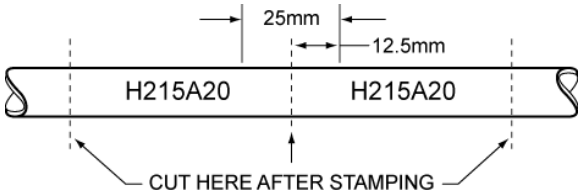

Figure 2–7 Marking on Sleeves

IDENTIFICATION OF WIRE BUNDLES AND HARNESSES

44. Identify wire bundles and harnesses (see Figure 2–8) by one of the following methods:

a. If bundle is not too large, select sleeving of proper size to fit snugly over wire bundle. Stamp with identification marking as described in paragraph 45 and install on bundle approximately 30cm from each terminating end. Tie securely at both ends.

NOTE

Sleeving must be installed on bundle before attaching wires to connectors.

b. Heat shrinkable tubing, marked with the identification code, may also be used, installed as described in Section 2, Chapter 4.

c. Wire bundles up to 100mm in diameter may be identified by means of an MS3368 cable identification strap that incorporates a marking tab (refer Figure 2–8). Install as follows:

(1) Stamp the wire identification code on the marking tab.

(2) Pass the strap around the bundle with the ribbed side of the strap inside.

(3) Insert the pointed end of the strap through the eye, and pull the strap snugly around the bundle.

(4) Feed the tail of the strap through MS90387-1 tool, and slide the tool up to the eye of the cable identification strap.

(5) Squeeze tool handles until strap is snug on the bundle.

(6) Close tool handles all the way to cut off the excess strap.

NOTE

Use of self clinching adjustable plastic cable straps and installing tools is described in Section 2, Chapter 8.

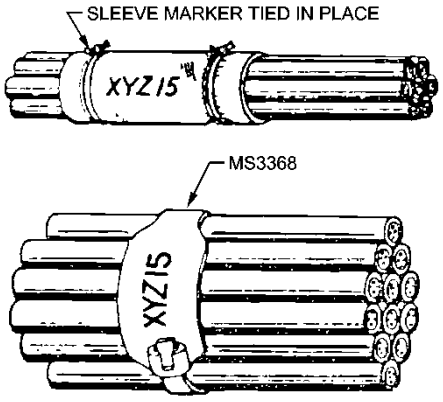

Figure 2–8 Identification of Wire Bundles and Harnesses

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