LEAN SIX SIGMA IMPLEMENTATION IN CABLE HARNESS MANUFACTURING

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Abstract—The cable harness manufacturing industry has been growing in a fast pace during the recent years in India. Cable harnesses are used to link together all the electrical components scattered throughout any electrical equipment. Cable harness manufacturing involves a series of operations which are to be carried out in a proper sequence to make a good quality harness. In real time scenario, high volume production of cable harness with consistent good quality is a difficult target to achieve. This paper is directed at the efforts intended to improve the quality of cable harness manufacturing using six sigma methodologies. It includes collection of defects data, analysis of the defects data using FMEA methodology, determining the causes and taking corrective actions to eliminate the defects. Process flow chart and manufacturing lead time are also determined and lean tools such as one-piece flow and job instruction are also used.

Keywords*- Cable Harness Manufacturing; Failure Mode and Effect Analysis; Risk Priority Number(RPN); defects.; one piece flow.*

I. INTRODUCTION

Cable harness manufacturing is one of the fast growing industries in today's world. The good quality industrial grade cable harness acts as the central nervous system to many device and vehicle electronics designs, particularly in the automobile and military aerospace segments. As applications become increasingly complex, innovations in cable harness design and manufacturing techniques become more and more critical. Manufacturing cable harnesses with good quality is the need of the hour. Six sigma promises good quality when properly applied to cable harness manufacturing.

II. CABLE HARNESS PRODUCTION

Cable harness is often designed according to geometric and electrical requirements. A diagram is then provided (either on paper or on a monitor) for the assembly preparation and assembly.

The wires are first cut manually or using a special wire-cutting machine. After this, the ends of the wires are stripped to expose the metal (or core) of the wires, which are soldered or crimped to terminals or connector housings. The cables are assembled and clamped together on a special workbench, or onto a pin board (assembly board), according to the design specification to form the cable harness. After fitting any protective sleeves, conduit, or extruded yarn, the harness is either fitted directly in the vehicle or shipped.

In spite of increasing automation in general cable harnesses continue to be manufactured by hand, and this likely is the case for the foreseeable future. In part, this is due to the many different processes involved, such as,

- routing wires through sleeves
- taping with fabric tape, in particular on branch-outs from wire strands,
- crimping terminals onto wires, particularly for so-called multiple crimps (more than one wire into one terminal),
- inserting one sleeve into another
- fastening strands with tape, clamps or cable ties.

The picture of a cable harness is shown in Fig.1 below.

Fig. 1.1 Cable Harness

It is difficult to automate these processes. However, these processes can be learned relatively quickly, even without professional qualifications. Thus, manual production remains more cost effective than automation. For certain vehicles, such as trucks there are a large number of variants (due to different configurations and length of the vehicle).In spite of this, different variants are produced on the same assembly board. Even here, man has an advantage over machine, since he can change over to the different variants (no reprogramming required).

Pre-production, however, can be automated in part. The following processes can be automated.

- Cutting individual wires(cutting machine)
- Stripping the outer individual jacket(stripping machine)
- Crimping terminals onto one or more sides of the wire,
- Partial plugging of wires prefitted with terminals into connector housings,
- Soldering of wire ends(solder machine), and
- Twisting wires.

Manufacturing high volume of cable harnesses with consistent good quality is a tough task. Cable harness manufacturing involves much complexity. To produce quality we depend on the six sigma methodology.

III. LEAN SIX SIGMA FRAMEWORK

The activities that cause the customer's critical to quality issue and creates the longest time delays in any process offer the greatest opportunity for improvement in cost, quality, capital and lead time. It is the synergy of lean and sig sigma that has helped companies to reduce manufacturing overhead and quality costs by 20% and inventory by 50% in less than 2 years. The fundamental principle of six sigma is to take an organization to an improved level of sigma capability through the rigorous application of statistical tools and techniques. Six Sigma simply means to reduce variation in product and process characteristics.

IV. FMEA METHODOLOGY

Whenever any industry is going to design or redesign its manufacturing process, measuring its reliability is an essential part of TQM. The ability of measuring the new process or new products reliability is the strength of TQM. One of the important tools for measuring the reliability of the product or process is FMEA. Failure Mode Effect Analysis (FMEA) is utilized to identify the various failure modes of the products or processes or systems. It also analyses the causes of this failures and identify the failure causes. With a prioritization method, it tries to eliminate the failure modes at the design stage of the product or process. Therefore, the FMEA is classified as Design FMEA and Process FMEA. FMEA is an analytical technique that combines the technology and experience of people in identifying failure modes of a product or process and planning for its elimination [3]. Each potential type of failure of a product or process is assessed relative to three criteria on a scale of 1 to 10.

- The likelihood that something will go wrong (1=not likely; 10=almost certain).
- The detect ability of failure (1=likely to detect; 10=very unlikely to detect).
- The severity of a failure (1=little impact; 10= extreme impact, such as personal injury or high financial loss).

The three scores for each potential failure are multiplied together to produce a combined rating known as the Risk Priority Number (RPN): those with the highest RPNs provide the focus for further process/redesign efforts.

V. DATA COLLECTION AND ANALYSIS

A. *Defects Data*

The defects that have occurred in the manufacturing of cable harness are collected over a period of three months and are tabulated here. The defects are plotted in a histogram to get a visual idea of their occurrence and frequencies as shown in Fig. 1.2. The defect values are also represented in the form of a histogram as shown in Fig. 1.3.

REJECTED CABLE HARNESS REASONS				
SL. NO.	Problem	Count	Percent of Total	Cumulative Percent
1	COPPER WIRE FOR STEEL WIRE(WIRELOCK)	107	16.02	16.02
2	BRAID LENGTH SHORT	90	13.47	29.49
3	CONNECTOR END LOOSE	56	8.38	37.87
4	INNER HEAT SHRINK VISIBLE	52	7.78	45.66
5	HEAT SHRINK SLEEVE LENGTH SHORT	40	5.99	51.65
6	ID PLATE TIES NOT TIGHTENED	40	5.99	57.63
7	WIRELOCK RUSTED	40	5.99	63.62
8	WRONG WIRE TERMINATION PREPARATION	40	5.99	69.61
9	CONNECTOR BACKSHELL LOOSE	31	4.64	74.25
10	LOW INSULATION RESISTANCE	30	4.49	78.74
11	CABLE LENGTH SHORT	20	2.99	81.74
12	CONNECTOR BODY HAS SCRATCHES.	20	2.99	84.73
13	HEAT SHRINK SLEEVE DAMAGE	20	2.99	87.72
14	CONNECTOR ORIENTATION	16	2.40	90.12
15	SLEEVE ELASTER DAMAGED	16	2.40	92.51
16	BRAID DAMAGE	11	1.65	94.16
17	SLEEVE ELASTER LENGTH SHORT	10	1.50	95.66
18	WRONG WIRING	7	1.05	96.71
19	IR SHORT	6	0.90	97.60
20	PART NO. AND ID PLATE MISSING	3	0.45	98.05
21	CONTINUITY OPEN	3	0.45	98.50
22	END NUT SCREW NOT TIGHTENED	2	0.30	98.80
23	WIRE-LOCK NOT PROVIDED	2	0.30	99.10
24	PART NO. AND ID PLATE DAMAGED	1	0.15	99.25
25	BAD CONNECTOR BINDING	1	0.15	99.40
26	IMPROPER FILLING UP OF RTV	1	0.15	99.55
27	NO HEAT SHRINK SLEEVE	1	0.15	99.70
28	IMPROPER SHRINKING OF HEAT SHRINK SLEEVES	1	0.15	99.85
29	WRONG FIXING OF ENDNUT SCREW	1	0.15	100.00
		668	100.00	

Fig. 1.2 Rejected Cable Harness Reasons

The defects have occurred in 11 different parts of the cable harness and therefore the FMEA was carried out for all the 11 items to determine the causes and therefore the Risk Priority Number (RPN).The corrective actions were taken for all of these defects and the improvement achieved were denoted in the form of improved RPN values.

The eleven different items which are causing defects in the cable harness are (1) heat shrink sleeves,(2) Soldering, (3) Connector, (4)ID-Plates, (5)Wire locking,(6)Bush and ring soldered Braid,(7) Sleeve Elaster,(8)Braid,(9)Wire termination,(10) Endnut screw and (11)Cables.

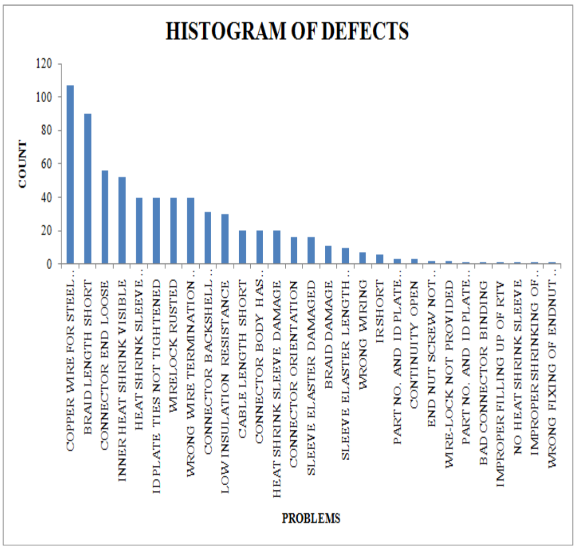

Fig. 1.3 Histogram of Defects

There are two heat shrink sleeves (inner and outer) available over the lug. Fig. 1 shows the picture of heat shrink sleeve on lug.

Fig. 1.4 Heat Shrink sleeves on lug.

FAILURE MODE AND EFFECTS ANALYSIS

Item: Heat Shrinking of sleeves on lug
Responsibility:
Model: Cable harness - 1
Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Heat Shrinking of inner and outer sleeves on lug.	Inner Heat shrink sleeve visible.	Aesthetics affected.	2		Inner Sleeve shrink at incorrect location.	8	Final Sample Inspection.	4	64	Operator Training and Instructions and checksheet.
	Heat Shrink Sleeve length short.	Inner sleeve may get exposed.	4		Operator's mistake.	6	Final Sample Inspection.	5	270	Operator Training and Instructions and checksheet.
	Heat Shrink Sleeve damaged.	Lug may get damaged.	5		Improper handling	8	Final Sample Inspection.	5	200	Introducing Twisters and checksheet.
	No heat shrink sleeves.	Lug may get damaged.	5		Operator's mistake.	6	Final Sample Inspection.	5	150	Operator Training and Instructions and checksheet.
	Improper Shrinking of Heat shrink sleeves	Lug may get damaged.	5		Non-uniform heating in all directions around the sleeve.	5	Final Sample Inspection.	5	125	Operator Training and Instructions and checksheet.

Fig. 1.5 FMEA for Heat Shrinking of sleeves on lug.

Fig 1.6 Connector with many sockets.

FAILURE MODE AND EFFECTS ANALYSIS

Item: Soldered connections
Responsibility:
Model: Cable harness - 1
Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Soldering	Low Insulation resistance	Functionality affected.	5		Soldering improper.	8	Final Testing.	4	160	Operator training and instructions, testing at two levels and checksheet.
	Wrong Wiring	Functionality affected.	4		Operator's mistake.	8	Final Testing.	5	160	Operator training and instructions, testing at two levels and checksheet.
	Continuity Open	Functionality affected.	4		Soldering improper.	6	Final Testing.	5	120	Operator training on soldering process.
	IR Short	Functionality affected.	4		Soldered connection is defective.	7	Final Testing.	4	112	Operator training on soldering process.

Fig. 1.7 FMEA for Soldered Connections

Fig. 1.8 Connector with cables.

Fig. 1.9 Connector with RTV filled up.

FAILURE MODE AND EFFECTS ANALYSIS

Item: Connector Responsibility:
Model: Cable harness - 1 Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Connector has pins on which wires are soldered.	Connector End Loose.	Soldered wires may get cut.	5		Hand Tightening insufficient torque.	9	Final Sample Inspection.	6	270	Tightening tool to be used.
	Connector Backshell Loose.	Soldered wires may get cut.	5		Hand Tightening insufficient torque.	6	Final Sample Inspection.	6	180	Tightening tool to be used.
	Connector Body has Scratches.	Aesthetics get affected.	3		Tool jaws damages connector.	8	Final Sample Inspection.	3	72	Wind protective tapes around the tool jaws.
	Connector Orientation wrong.	Doesnot get connected.	5		Operator's mistake.	7	Final Sample Inspection.	5	175	Operator training and instructions and checksheet.
	Improper filling up of RTV	Short connections occur.	5		Air holes exist within RTV filled.	6	Final Sample Inspection.	5	150	Operator instructions on correct combination of RTV preparation.

Fig. 1.10 FMEA for connector

Fig. 1.11 Cable with ID-Plates

FAILURE MODE AND EFFECTS ANALYSIS

Item: ID-Plates Responsibility:
Model: Cable harness - 1 Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
ID-Plates	ID plates ties not tightened.	ID plate may get cut.	3		Operator's mistake.	8	Final Sample Inspection.	6	144	Operator training and instructions and checksheet.
	Part No. and ID Plate missing.	Connector will go unidentified.	6		Operator's mistake.	6	Final Sample Inspection.	5	180	Operator training and instructions and checksheet.
	Part No. and ID Plate damaged.	Cable goes unidentified.	4		Damaged during transit.	6	Final Sample Inspection.	6	144	Operator training and instructions and checksheet.

Fig. 1.12 FMEA for ID-Plates

FAILURE MODE AND EFFECTS ANALYSIS

Item: Wire-locking Responsibility:
Model: Cable harness - 1 Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Wire-locking	Copper wire used instead of steel wire.	Wirelock get cut easily.	6		Drawing not studied fully.	10	None	6	360	Create a process flowchart for handling new job.
	Wirelock rusted.	Wirelock get cut easily.	6		Procured material is low quality.	9	Operator training and instructions	5	270	Create a process flowchart for procuring items.
	Wirelock not provided.	Connector gets loose on vibration.	6		Operator's mistake.	6	Sample inspection	6	216	Create a checklist.

Fig. 1.13 FMEA for Wire-locking

FAILURE MODE AND EFFECTS ANALYSIS

Item: Bush and Ring soldering Responsibility:
Model: Cable harness - 1 Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Braids soldered onto Bush and Ring	Braid length short	Insufficient braid length.	8		Incorrect cut length.	9	Final Sample Inspection.	6	432	Operator Instructed on correct cut length.
			8		Operator's mistake.	7	Final Sample Inspection.	6	336	Operator Training and Instructions.
	Bad connector binding.	Wire gets damaged.	6		Binding improper.	6	Final Sample Inspection.	5	180	Operator Training and Instructions.
	Braid Damage	Wire gets damaged.	4		cable tangled.	7	Final Sample Inspection.	6	168	Twisters to be used to prevent untangling.

Fig. 1.14 FMEA for Bush and Ring soldering

FAILURE MODE AND EFFECTS ANALYSIS

Item: Sleeve Elaster Responsibility:
Model: Cable harness - 1 Prepared by: Balaji
Core Team:

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Sleeve Elaster - For braid protection.	Sleeve Elaster Damaged.	No wire protection.	8		Cable harness is loose and piled up.	7	Final Sample Inspection.	6	336	Introduce twisters and prepare checklist for sleeve elaster damage.
	Sleeve Elaster Length short.	Wire gets exposed.	6		Operator's mistake.	6	Final Sample Inspection.	5	180	Operator Training and Instructions.

Fig. 1.15 FMEA for Sleeve Elaster

FAILURE MODE AND EFFECTS ANALYSIS

Item: Braids
Model: Cable harness - 1
Core Team:
Responsibility:
Prepared by: Balaji

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Braids - protective covering for cables.	Braid Damage	Wire gets damaged.	4		cable tangled.	7	Final Sample Inspection.	6	168	Twisters to be used to prevent untangling.

Fig. 1.16 FMEA for Braids

Fig. 1.17 Wire Termination

FAILURE MODE AND EFFECTS ANALYSIS

Item: Wire Termination
Model: Cable harness - 1
Core Team:
Responsibility:
Prepared by: Balaji

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Wire Termination - way of teminating wire end.	Wrong Wire Termination preparation	Appearance affected.	4		Drawing not studied well.	8	Final Sample Inspection.	6	192	Operator Training and Instructions and checklist.

Fig. 1.18 FMEA for Wire Termination

FAILURE MODE AND EFFECTS ANALYSIS

Item: End Nut Screw
Model: Cable harness - 1
Core Team:
Responsibility:
Prepared by: Balaji

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
End nut screw - for fixing connector.	End nut screw not tightened	Connector gets disconnected.	3		Operator's mistake.	7	Final Sample Inspection.	6	126	Operator Training and Instructions and checklist.
	Wrong fixing of End nut screw	Appearance is affected.	3		Operator's mistake.	6	Final Sample Inspection.	6	108	Operator Training and Instructions and checklist.

Fig. 1.19 FMEA for End Nut Screw

FAILURE MODE AND EFFECTS ANALYSIS

Item: Cables
Model: Cable harness - 1
Core Team:
Responsibility:
Prepared by: Balaji

Process Function	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	RPN	Recommended Action(s)
Cables - used to connect different components.	Cable length short.	Harness cannot be connected.	8		Operator's mistake.	7	Final Sample Inspection.	6	336	Operator Training and Instructions and checklist.

Fig. 1.20 FMEA for Cables

Problems	RPN Before Corrective Action	RPN After Corrective Action
1	64	16
2	270	40
3	200	150
4	150	125
5	125	100
6	160	100
7	160	100
8	270	192
9	180	120
10	72	54
11	175	125
12	144	108
13	180	150
14	144	120
15	360	18
16	270	18
17	216	30
18.a	432	48
18.b	336	48
19	180	30
20	336	240
21	180	120
22	192	120
23	168	120
24	126	90
25	108	90
26	150	125
27	336	192
28	112	96
29	120	100

Fig. 1.21 RPN values before and after corrective actions

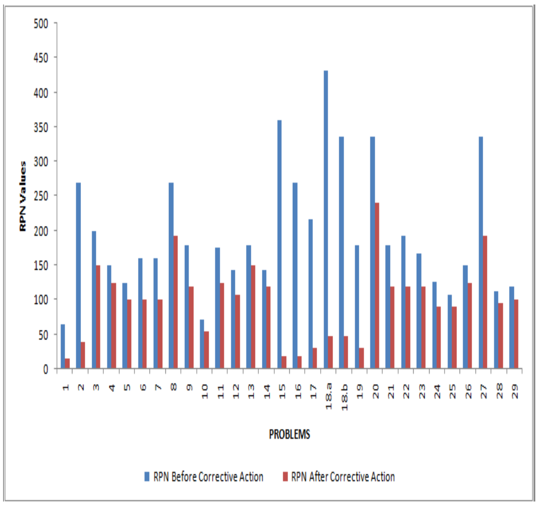

Fig.1.22 Bar chart showing RPN values for problems before and after improvements.

The process flow charts and the checklist which have brought these improvements are listed below.

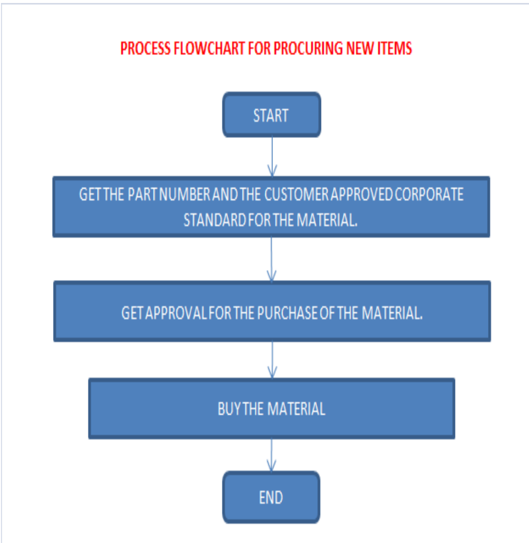

Fig.1.23 Process Flowchart for procuring new items.

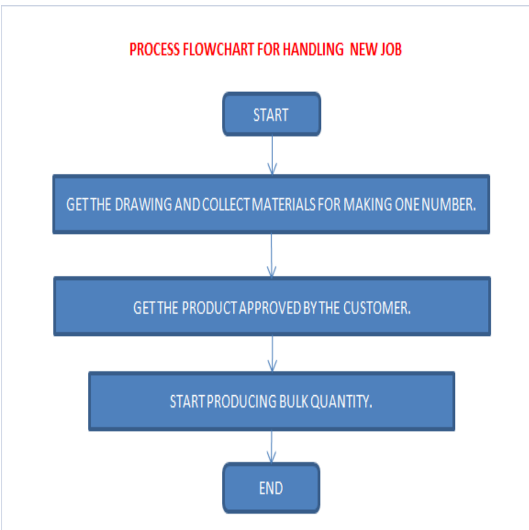

Fig. 1.24 Process Flowchart for handling new job.

CABLE HARNESS
CHECKLIST FOR CABLES

PROJECT:	PART NO.:
DESCRIPTION : CABLE HARNESS	QTY.:
	DATE:

1 **DRAWING:**
a. Check the latest issue level of drawing.
b. Preparation of cable layout as per drawing.

2 **FOR ALL CONNECTORS USED:**
a. Orientations as per drawing and clear existence of RTV hole.
b. Physical damages/chipping observed.
c. Tightness of NUT/CLAMP
d. RTV FILLING LEVEL - HOLE FILLED
e. RTV filling - cleaning outside connector and pins.
f. Wire Sealing carried out properly.
g. Rusting of wire sealing material.
h. Wire Soldering/ Crimping quality to connector pins proper(before RTV).
i. Removal of insulation wire which is to be soldered to connector pins<2 mm as given in drawings.
j. Binding of wires bunch near connector pins end as per drawing using lacing cord\tape.
k. Presence of sealing ring(free from damage) in the connectors.
l. Proper tinning of wires and soldering to connector pins satisfactory.
m. Tinning of lugs shall be uniform and shiny.
n. No gap shall be present in the lugs soldered:(uniform soldering and NO gap).

3 **CABLE / BRAID / HEAT SHRINK SLEEVE**
a. Physical damages observed on braid.
b. Heat shrink sleeve shrinked properly.
c. No gap shall be present between heat shrink sleeve and cable.
d. Junctions on braid/heat shrink sleeve to be proper.

4 **ID SLEEVES/NAME PLATES**
a. Id sleeves/name plate marking(cat part no.,bel part no,sl.no) asper drawing.
b. Positions of Id sleeves / name plate from connector.
c. Erasing of marking on Id sleeves/ name plates.
d. Id sleeves/name plates are fixed rigid or loose.
e. ID, OD. Length of sleeves used as per drawing.

5 **LUGS USED TO BE VERIFIED AS GIVEN BELOW**
a. Check for physical damages etc.
b. Check for tinning,burr etc.

6 **JUNCTION BINDING AND SOLDERING AS PER DRG:**
a. Length of junction binding & soldering from connector end to be as per drg.
b. Incase of earth wire preparation loop to be visible as per drg.
c. Wire termination is to be as per drg.

7 **NOTES AS PER DRAWING IS TO BE FOLLOWED**
a. SPL. INSTRUCTIONS given in drg if any to be followed.
b. Shielded cable/wire to be used as per drg.

8 **LENGTH MEASUREMENTS**
TO BE RECORDED FOR ALL CABLES after writing Sl.No.

9 **CONTINUITY CHECK:**
As per drg. To be checked.

10 **IR TEST @ 500V, DC>20MEG> OHMS: RECORD THE VALUE**

11 **DIELECTRIC TEST @500V, AC/650V AC(withstood for ONE minute)**

Fig. 1.25 Checklist for Cables

VI. LEAN IMPLEMENTATION

The first towards speeding up the process is to determine the process flow chart. The next step is to determine the manufacturing lead time. Then studying the data will reveal the delay in the process. Lean tools such as one piece flow and Job instruction (training within industry) were applied to reduce the wastage of time and increase the speed of the process.

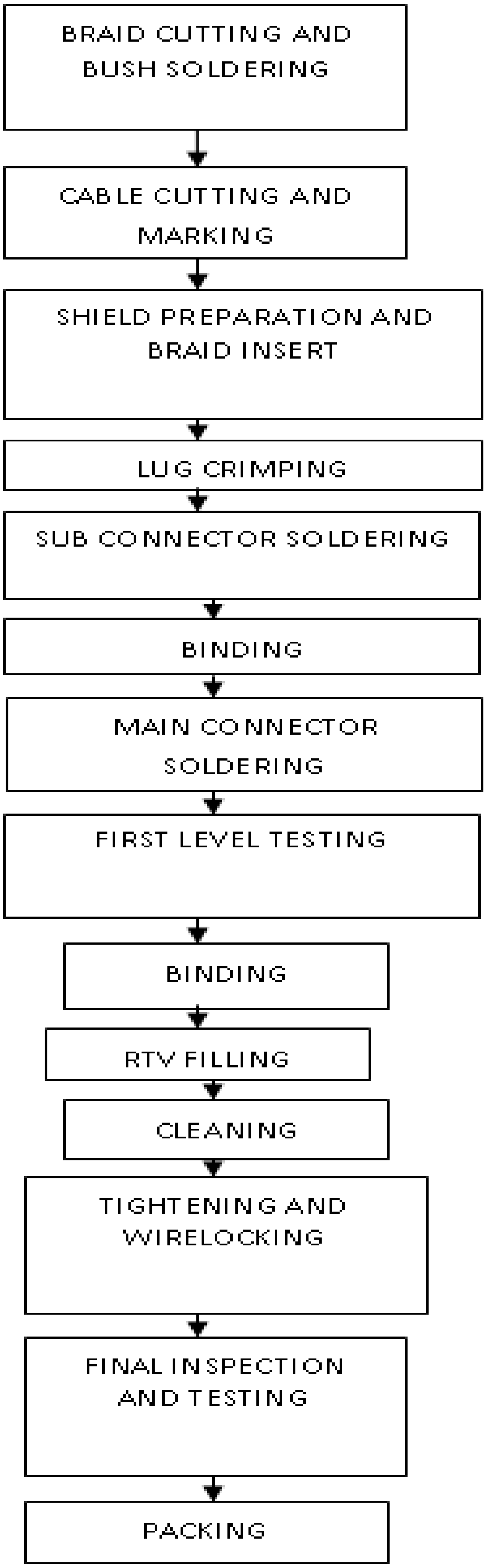

Fig. 1.26 Process Flow chart for cable harness manufacturing

SL.No.	PROCESSES	TIME TAKEN
1	BRAID CUTTING AND BUSH SOLDERING	55 MINS.
2	CABLE CUTTING AND MARKING	6 MINS.
3	SHIELD PREPARATION AND BRAID INSERTION	50 MINS.
4	LUG CRIMPING	15 MINS
5	SUBCONNECTOR SOLDERING	15 MINS
6	BINDING	12 MINS
7	MAIN CONNECTOR SOLDERING	12 MINS
8	FIRST LEVEL TESTING	10 MINS
9	BINDING(MAIN)	12 MINS
10	RTV FILLING	10 MINS
11	CLEANING	15 MINS
12	TIGHTENING AND WIRELOCKING	15 MINS
13	FINAL INSPECTION AND TESTING	12 MINS
14	PACKING	2 MINS
	TOTAL	241 MINS

Fig. 1.27. Time taken for different processes.

So, from the above table it is noticed that the manufacturing lead time is 241 minutes or 4 hours, with a maximum braid cutting and bush soldering time of 55 minutes.

B. One Piece Flow

	BUSH	RING		
	2	A(2)	B(1)	C(1)
1 SET	20 MINS	20 MINS	6 MINS	8 MINS

Fig. 1.28 Time taken for making one set.

The total time for making one set is 54 minutes. The current batch size is 5 and it was consuming 270 minutes. The shield preparation and braid insertion process was waiting to receive material from bush soldering process. So, this wastage was reduced by decreasing the batch size from 5 to 2.

C. Job Instruction

The testing department had only one technician to do the process of testing the test equipment HP network analyzer 8714ET. Therefore, two more people were given training so that the process will not get delayed due to the absence or non-availability of one of them.

CONCLUSION

The defect analysis and corrective actions have improved the processes by eliminating the defect causing elements. The improvement is easily sustainable and so quality has improved permanently. The FMEA methodology has helped in determining the reliability and finally in ensuring the good reliability of the system. The process flow chart is drawn and the manufacturing lead time is determined as 4 hours. A lean tool such as one-piece flow was applied to reduce wastage of time. Training within industry was also provided to eliminate unwanted delays in processes.

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