PROJECT REPORT ON

QUALITY CONTROL PROCEDURES IN A CABLE INDUSTRY

BY

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92/ 2701

THIS PROJECT IS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING B.ENG IN ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA. NIGERIA

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CERTIFICATION

This is to certify that this project work was carried out by AJIYA SUNDAY JOHN and that the project has met the minimum standard acceptable by the Department of electrical and computer engineering, Federal university of technology, Minna

.... 30/03/2000 ....

Project supervisor Date

.... 6/4/2000 ....

HOD Date

.... 11/4/2000 ....

External Examiner Date

DEDICATION

First and fore most to God almighty for his faithfulness in my life. And for the undeserved Privileges and favours, unmerited mercy and undue providence.

To my parents, MR. & MRS JOHN AJIYA for given me the axis to rotate.

DECLARATION

I hereby declare that the project is an original concept carried out by me under the supervisor of Engr. Pinne kepnneth of the department of Electrical and computer Engineering, Federal university of technology, Minna.

30/03/2000

AJIYA SUNDAY JOHN

DATE

ACKNOW LEGMENT

Again, my heart beats with gratitude to Almighty God for the gift of life and strength to complete and achieve this level of knowledge in spite of initial setbacks.

Many thanks to my supervisor Engr. Pinne Kenneth, for sharing his knowledge, time and professional advise with me.

A big –thump-up to my friends who stood by me when I needed them most through this rather long academic journey, friends like Kenneth Ekhator Douglas Ewansiha, Thompson Daebi, Solomon ocheala okopi, Bulus Dyah Audu, Idris Aliyu Mamman , Istifanus Bahago, Joseph Ogwiji, Fredrick Ediale, Engr. Olatunde Oladotun, Engr. Olajide, Chris Obi and others which space will not allow me to mention here.

I also do appreciate the understanding of NOCACO Ltd, Kaduna especially the staff of Quality control department for ensuring that my project work becomes a success.

My warmest and most sincere adoration goes to my love one , Esther Inalegwu Ahmedu for believing in me despite my shortcomings.

My special thanks and appreciation goes to my parent MR. JOHN AJIYA and MRS ROSE JOHN AJIYA, Only God can reward you for not running out of patience with me.

Lastly to my younger ones: - Martins John Ajiya, Esther John Ajiya , Mary John Ajiya ,Emmanuel john Ajiya and Ishaya john Ajiya for confiding and believing that I am up to the task.

ABSTRACT

This project presents the Quality control procedures in a cable industry with Northern nigeria cable processing company NOCACO Ltd, Kaduna as case study.

Quality control involves some form of checks or tests during the processing of the cable at every stage of the production process to ensure that materials input, original design and the manufacturing process conform with the predetermined specification.

Quality controls mechanisms include various type of inspection and tests carried on the production line and on the finished goods.It involves design tests like measurement of diameter of single wire,core conductor diameter and outer diameter of sheath.Electrical test like testing of conductor resistance, insulation resistance and high voltage test Mechanical tests involves measuring of tensile strength and elongation at break of conductor or wire.

When a cable u ndergoes a test procedure and the values obtained fall within desired value according to specification and standard.The cable is certified for further processing or as a finished product. If the obtained values do not fall within desired value, the cable is either release on risk, sent back for remake or as a salvage material.

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CHAPTER 1

INTRODUCTION

Quality is fitness for use or the totality of features or feature, characteristics of a product that has a bearing on its ability to satisfy a need. It can also be the sum of the attributes or properties that describe a product. These are generally expressed in terms of specific product characteristics such as length, width and color.

To be meaningful in an industrial sense, these characteristics must be quantitatively expressed in terms that can be objectively measured or observed.

Quality control is the regulatory process through which we measure actual quality performance, compare it with standards and acts on the difference. It is the activities, which assure that quality creation is performed in such a manner that the resulting product will in fact perform its intended function

If plans, standards, drawings and specifications were not in need of review and are executed flawlessly by a perfectly balanced organization under the directive of an omnipotent leader, there would be no need for control. It is the control function to take the corrective action necessary to assure the production process and the product is in accordance with established standards

STEPS IN QUALITY CONTROL

The steps taken in quality Control includes: -

- Establishment of standard of performance.
- Measurement current performance in relation to established standards.
- Taking corrective action

Establishment of standards

The Establishment of standards defines the state of equilibrium. Standard is definition of the objective of an organization, bur it must be remembered that objectives can do change.

Measurement of current performances

Measurement of current performance requires that information be processed and interpreted by someone so that conclusion can be drawn concerning production position and performance.

Taking corrective action

Taking corrective action to bring performance in line with predetermined standard requires executive decision on making and realignment of company resources .

AREAS OF QUALITY CONTROL

The areas of quality controls are the stages where quality control are carried out these are :-

- Delivery control
- Process control
- Despatch control

Delivery control:-This recognises the fact that no one produce good quality product from bad materials,hence only satisfactory materials are authorised for use.Controls of incoming materials involves :-

a) Supply of material specification to supplier
b) Assessing the suppliers' capability in meeting the specification through vendor appraisal activities .
c) Selecting qualified sources of material supplied.
d) Inspecting and sampling test on each consignment of incoming materials.
e) Non conformance materials are control and corrective action instituted.
f) Control of materials in stock

Process Control:- Control of production process recognizes that the achievement of good quality depend on the effectiveness and efficiency of supervision, operator's skills and the appropriateness of the machines. Process control aims at preventing any wrong procedures from occurring or bad semi-finished products from being released for further process.

The method of approach to work – in-progress control are: -

a) Maintaining equipment and production facilities at optimum working conditions.
b) Routine sample inspection and test
c) Employee training and motivation
d) Non-conformance material controls

Despatch Control:-General inspection of the finished product tests not carried out during production are done at this stage are either rejected, scraped or return for re-work.

Despatch control involves:

a) Acceptable sampling.

b) Product quality audit

c) Product labeling.

d) Packaging and final control

e) Feeding of information to production.

NOCACO AS A CASE STUDY

NOCACO (northern cable processing and manufacturing company)was incorporated in June 1978, production started in July , 1980 with the aim of supplying vehicle assemble plants with locally made cables harnesses and to satisfy the Nigerian Market with all kinds of electric cables and wires .Due to its technical nature, the company's equity shares are distributed 40% to Nigerian shareholder 60% to the foreign partners as contained in schedule III of the enterprises promotion decree

NOCACO is recognized as the most important and No 1 cable manufactured in the Northern part of the country producing in accordance with National and international standard and to specific customers requirements.

The product range of NOCACO is approximately 300 different type of cables .It include the ordinary wiring cables, conduit cable, insulated aluminum service cables, aluminum overhead wire, both bare and steel reinforced, copper underground cables (armoured and non-armoured), as well as flexible cables and cords and drop wire for telecommunication purpose .

NOCACO is also producing complete assembled harnesses for the automobile industry and for the assemblers of air conditioners, fridge and freezers. NOCACO is the only manufacturing of harnesses in Nigeria .

In the area of Quality, NOCACO places a high premium on the quality of its products as it designs and produces high quality products in line with national and international standard such as : the Nigeria industrial standards (NIS) , international electro – technical commission (IEC), British standard (BS) and German industry standard (VDE, DIN) and to specific customer's requirements .

NOCACO carries out rigorous quality control tests on its products at every stage of production process rather than at the final inspection so that its high standards are maintained throughout the full length of the conductor or cable.

NOCACO also has a quality control system as contained in her quality assurance manual.

AS a proof of high quality ,NOCACO is an NIS Gold Award winner of PVC insulated(non-armoured) single core cables, Silver Award on PVC insulated (Non- armoured) multi-core cables, Silver award winner on all aluminum conductors and the NIS award winner on motor car cables in the country .

QUALITY CONTROL DEPARTMENT

RESPONSIBILITIES OF THE DEPARTMENT

The department performs the following functions :-

a) Establishment of the specification :
b) Development of test procedures and requirement
c) Development of sampling schedule (quality plans)
d) Recording and reporting quality controls forms
e) Project development and research.

PRODUCTION PROCESS

NOCACO has adequate production facilities for the production of cables in the 1000 volts range. The production flow chart is as shown below.

PRODUCTION PROGRAMME

Introduction

Northern cable processing and manufacturing company (NOCACO)Limited is a manufactured of electrical cables, mainly in the 1000 volts range and also offer high quality , processed cables and cable harnesses to the processing , manufacturing and assembly plants. Etc.

The conducting materials used in the 1000 volts range of cable are aluminum and copper . Insulating material is polyvinylchloride (PVC).

Galvanized steel wire is used for the mechanical protection of cable for underground application. Other auxiliary materials i.e. silicon oil, mica power etc are also used .

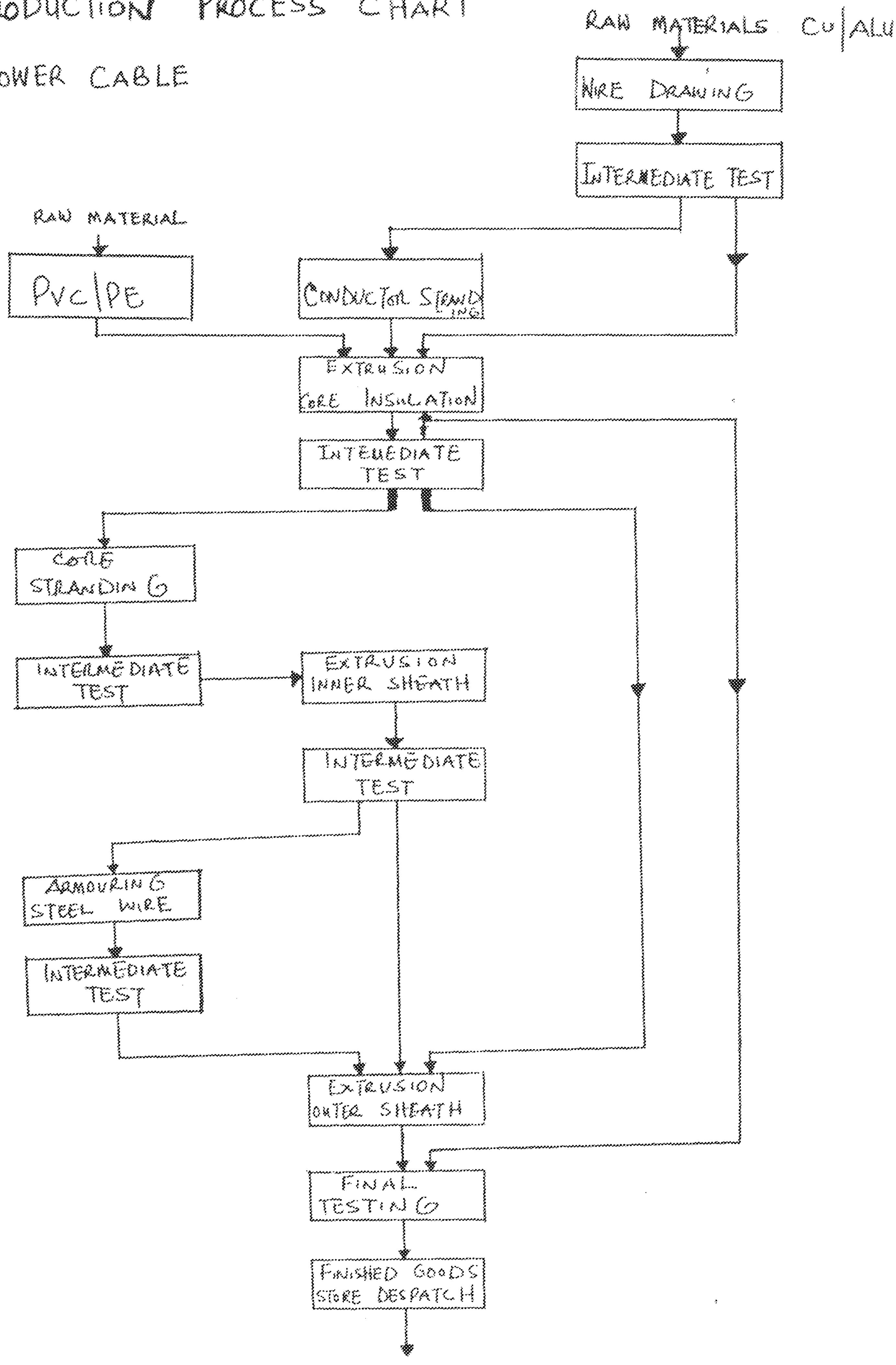
COPPER PRODUCTION PROGRAMME

There are classified into :

a) Wiring cables (single core PVC insulated , single core PVC insulated and sheathed, and flat surface wiring cables)
b) Mains cable (multi core armoured ,Non armoured)
c) Copper over head lines and earth conductor.
d) Control cables (Armoured and non –armoured)
e) Automobile cables
f) TeleCommunication cables.

PRODUCTION PROCESS CHART

POWER CABLE



ALUMINUM PRODUCTION PROGRAMME

These are classified into:-

a) Mains cables

b) Consumer's connections line (insulated and sheathed)

c) Aluminum over head lines

d) Aluminum conductors steel reinforced

CABLE HARNESSES PRODUCTION PROGAMME

These are classified into.-

a)Complete harnesses for Peugeot Automobile Nigeria. (PAN)

b)Battery cables for general motors and private customers.

c)Harnesses for ANNAMCO

d)Trucks harnesses.

e)Cable for refrigerator and air conditioners,

1.1 AIMS AND OBJECTIVES

a) Quality control is to maintain design standards.

b) To meet and satisfies customers specifications.

c) To produce a quality the can be achieved in time to meet delivery requirement

d) To spotlight and correct process discrepancies .

e) To find and correct causes of defective products .

1.2 METHODOLOGY

The set of methods used in obtaining my materials for these project work include working with staffs of the quality control department of Nocaco Ltd. Kaduna on every quality test carried out and obtaining results with close monitoring by the quality controllers and lastly , personal research through the used of relevant textbooks and the projects related journals to supplement the overall findings.

1.3 LITERATURE REVIEW

Human society has depended on quality since the dawn of history. In primitive society ,this dependence has been on quality of natural "goods and services".

Human life can exist only within rather narrow limits of climatic temperature , air quality ,food quality etc .For most primitive societies, life even within these narrow limits was marginal, despite extensive use of the human mental and physical faculties . Human adaptation to the natural environment has been based on two areas of response :-

1) Human senses are used to judge the quality of natural goods and services. The results is a form of incoming "Inspection" prior to use.

2) The experience of the past is condensed into lesson learned. These lessons learned are handed down from generation to generation.

From time immemorial "government" have established and enforced standards of quality. The governing bodies have attained a status which enables them to carried out programmes of regulation.

Until the early twentieth century, it was comparatively rare for users to file lawsuit based on injuries resulting from use of manufactured products . The basic defense against liability is to eliminate the causes of injuries at their source.

1.4 PROJECT OUTLINE

Quality control procedures in a cable industry is divided into different chapters based on different information in the test and techniques conducted in achieving standards and specification.

Chapter 1 introduces the topic, quality control in a cable Here the case study is Northern Nigeria cable processing company (Nocaco).It therefore became imperative to introduce Nocaco.

Chapter 2 explains the cable design and construction, basic design elements basic construction and also Article standard card preparation.

Chapter 3 deals on the manufacturing of quality. Here the quality control tests and techniques including procedure and results obtained.

Chapter 4 comprises the conclusion, recommendation, glossary and references. .

CHAPTER TWO

CABLE DESIGN AND CONSTRUCTION

Cable design can be defined as the interpretation of cable needs into sketches and dimensions taken due consideration of safety and regulation requirements.

Cable are designed to meet the same purpose in the whole universe. They form necessary connections in generations, transmission and distribution of electrical energy. They are also meant to be used for household, electrical appliances.

Cable construction is an exercise that involves consultation of standards so as to extract the necessary requirement expected to be met by cable at every stage of the production process .

In Nocaco, cables are constructed according to national and international standards and at times according to customers specification.

2.1 BASIC DESIGN ELEMENTS

(a) Conductors

(i) Copper

(ii) Aluminium

(iii) Copper crated steel wire (ccsw)

(iv) Copper clad alumunium etc.

(b) Insulation materials

(i) Polyvinyl chloride (pvc)

(ii) Polyethylene (PE)

(iii) Cross-linked polyethylene (PE)

(iv) Rubber (vulcanised)

(i) Optic fibre

(a) Armouring materials

(i) Galvanised mild steel (round or flat)

(ii) Copper coated steel wire (ccsw)

(iii) Flat steel tape

(b) Sheathing materials

(i) Polyvinyl Chloride (pvc)

(ii) Polyethylene (PE)

(iii) Rubber (vulcanised)

(iv) Cross linked polyethylene (PE)

2.2 BASIC CONSTRUCTION

Cable construction especially for armoured cable involves six stages .However some type of cables undergo two or three stages.

- Conductor stage
- Insulation stage
- Core standing
- Inner steath
- Armouring
- Outer sheath

CONDUCTOR STAGE.

CONSTRUCTION PARAMETERS	Work Description / references
1. Cross Sectional Area.	Conductor cross-sectional area in (mm^2)
2. Number and diameter of wire in conductor	See IEC 228, BS 6360 NIS 159 Example : for a cable size , $25mm^2$ $A = \frac{n\Pi d^2}{4}$

Where A= Area of the conductor

n = no of wire in the stranded conductor.

d = diameter of single wire

From the standard,

$A = 25\ mm^2$

$n = 7$

$\therefore 25 = \frac{7 \times 3.142 \times d^2}{4}$

$d^2 = \frac{25 \times 4}{7 \times 3.142}$

$d = \sqrt{\frac{25 \times 4}{7 \times 3.142}}$

$= 2.14 mmØ$

3. Material

Annealed conductor material

4. Diameter over stranded conductor. (Norminal – maximum)

1^{st} layer /7 strands

2^{nd} layer/19 strands

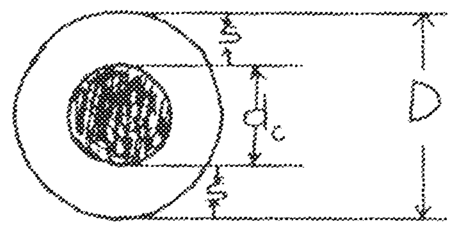
3^{rd} layer /37 strands----7x dc

hence general formular for diameter over stranded conductor is given asØ over stranded conductor =(2n+1)xdc where n = numbers of layers

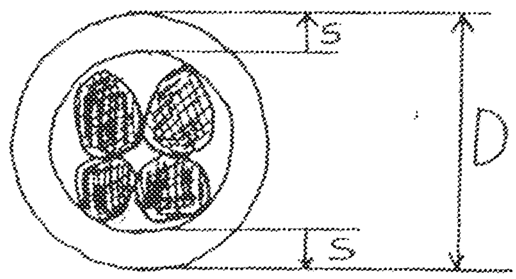
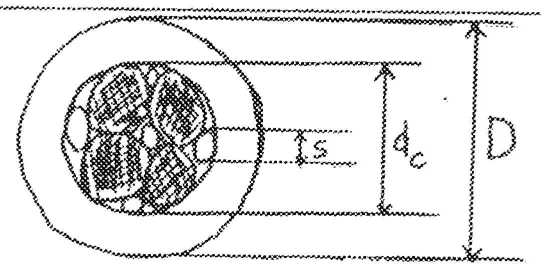
dc=diameter of single wire

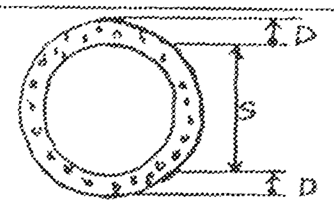
example, n =1 and d =2.14

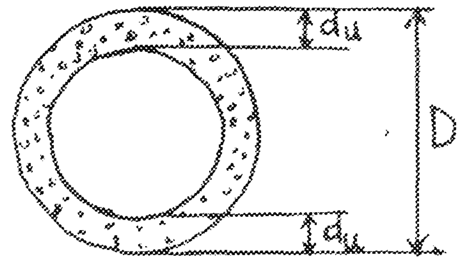
	Ø over stranded conductor = (2n +1)x dc = (2 x 1 +1)x2.14 =3 x2.14 = 6.42mm Ø
5 . Direction and pre-spiralling (lay parameters) (stranding parameters)	See IEC 207, for lay ratio or NSBS lay- length=s layratio =m Diameter over conductor =D M= S/D :-S =M X D IEC 207 will only specify lay ratio(m) Lay ratio for stranded conductor Single layer = 10 – 14 2-layers = 10-16, 10 – 14 3-layers =10-17 , 10-16, 10-14 4-layers = 10-17 , 10-16 ,10-15, 10-14 S =m x D :- s =10 xD = 10 x 6.4 =6 and 14 x D= 14 x 6.4 =90r Direction of lay :- outermost layer of any stranded conductor must be right handed.
INSULATION STAGE	
1. Wall thickness	See VDE 0250 operating voltage < 500v NIS 172 , BS 6004 ,BS 6346 VDE 0271

	(0.6 1kv.) pg 15 table IV IEC 502
2. Material	See NSBS 120, NIS 153 PVC , PE requirement
3. Diameter over insulation	 Diameter over Insulation , D= dc = 2s Where dc = diameter of conductor in (mm) S = insulation thickness in (mm) Example, dc = 6.4 S = 1.2 D = 6.4 + (2x1.2) =8.8 mm Ø
4. wall thickness tolerances	See KME 2.100612 Reference Noca co internal specification
5. Core colours, abbreviation	See KMR colour code table or NIS 172'97, BS 6004 , BS 6346, 6500
6. Volume of Insulation	Solid conductor, VRW = II s (d + s) Stranded conductor , VRS = II s(d+s) + d^2Z Shaped conductor ,Vss = (h + s)f xs NB See "material rating" for details Where d = conductor diameter (mm) S = insulation thickness (mm) Z = filler factor dc = diameter of a strand (mm)

CORE STRANDING STAGE	
1. Number of layers	See KME 2.1401
2. Number of core	write the Numbers of cores
3 Cental filler interstices	See Kme 2.1401 page 3 Example: 4 cores Cf : from the table 0.41d where dc diameter of a core in mm
4 length of lay direction.	See KME 2.1400-01 then , use S = MxD where S = cores lay length M = lay ratio D = Diameter over core standing in mm Here, M =20-25 for cable with round conductor M = 30- 40-for cable with speed conductor M = 14 –for flexible cord/cable N.B Outermost layer must be right handed
5. Diameter over core stranding	See KME 2.1401,then use D=factor x d From the table Refer to KME 2.1401 for factor in (mm) Where D=diameter over stranded core in mm d=diameter over a core in mm E.G d=7.1

	Factor for 4 cores = 2.414 D=7.1x2.14 =17.14mm
INNER SHEATH STAGE	
1. Diameter over core stranding	Diameter over core here
2. wall thickness (inner sheath)	See KMR –factory standard NIS 172' 97, BS 6346  Where S = sheath thickness in mm D = diameter of sheath in mm = du + 2s
3.Material	Recycled PVC
4. diameter over inner sheath .	 from the diagram D = diameter over inner sheath in mm Where, dc = diameter over core stranding in mm S = inner sheath thickness in mm

ARMOURING STAGE	
1.Diameter over inner sheath	write diameter over inner sheath here.
2.Size of steel wire armour	See BS 6346 , IEC 502 for size of steel wire
3.Number of steel wire armour	$n = \frac{D' \times 2.3\,713}{D\ steel}$ Where, D = du + dst (round) D = du + Sst (flat) n = number of steel wire du = diameter under armouring in mm for flat wire or gruong wire 50% overlap of BCP Where BCP = bitmus crepe paper (also for insulation in flat /round wire)
4. Diameter over armouring	 From the diagram, D = du + 2s Where D =diameter over armouring in mm S =diameter of steel wire/thickness of flat wire
OUTER SHEATH	
1. diameter over steel wire	write diameter over steel wire .
2. Wall thickness (outer sheath)	See VDE 0217 page 19 table 8
3. Material	See NSBS 120 (PVC type 1a or as required)

4. Colour of sheath	See KMR colour code table
5. Outer diameter (normal)	 from the diagram D = du + 2s Where D = outside diameter (normal) in mm du = diameter under / over armouring in mm
6. Sheath thickness tolerance	See KME 2.1006 /3 and use D = du +2s as abve
7. Volume of PVC for sheath	See material rating for details

2.3 ARTICLE STRANDED CARD PREPARATION

Article standard card preparation is a step by step computation of material consumed during the process of producing the product with reference to the information provided in the cable consruction form to enable for proper costing of the product after additional cost are taken into consideration e.g salaries and wages ,water and light bills ,taxes etc.

Acticle standard card preparation has the following aims:-

a) It ensures delivering of product in standard length.

b) To minimize the level of scrab produced.

c) It helps in calculating the weight of material at every stage of the production which helps during material costing .

The article standard card preparation can be best explained using Two or Three products as an example

An article standard card for NCY 1 x 2.5 mm² which most be delivered at standard length of 1000 m

The table below shows the maximum expected waste in (m) at every stage of the production process .

		additions	
PROCESSING STAGE	m/km	m/d elivery length	%
1.Drawing (coarse)			
2.Drawing (middle)			
3.Drawing (fine)			
4.Stranding (conductor)	3		
5.Coiling (wire)	3		
6.Extruding (core& sheath)	5		
7.Stranding (core)			
8.Armouring/screening		1	
9.Testing –cable	2		
10.Wrapping(coil or drum)	3	3	

Table 2 below shows the details information on the preparation of article standard card for NCY or 1 x 2.5 mm²

Name:- Ajiya S.J Date :- 20/08/99		NCY 1 x 2.5 mm² (0.6-1kv)		Weight = 31.88kg standard pack = 1000m	
Processing Stage	Additional lenght (m)	Length /stage (m)	Net weight kg/km	Gross weight (kg/km)	Copper waste kg
Conductor (drawing)	-	1010	22.15	22.37	0.22
Insulation (core)	5	1005		9.73	
Testing	2	1003			
Coiling & Wrapping	3	1000		31.88	
Store (delivery length)	-	1000			

Procedures in preparing the above table.

Step 1

Having known the size of cable in preparing the article standard card, find out the number of processing stages involve and look for the additional length at stage involved from table 1 above.

Step 2

The next stage is to calculate the length per stage as shown in the third column of table 2 .

To calculate this, it is advisable you start from the delivery length 1000m and add tolerance at every stage , moving in ascending order till you get to first stage (conductor drawing)

At this stage, you will know the amount of conductor to be drawn.

Step 3

Calculating weight in kg/mm or per unite length at every stage.

conductor stage

weight (1mm) = A x d

Where A = area of conductor

$= \frac{\Pi d^2}{4}$

D = density/ specific gravity of copper is g/cm³

= 8.9 (from kme 2.1004 table)

Weight $= \frac{\Pi d^2}{4}$ 8 x.9

$= \frac{3.142 \times (1.78)^2 \times 8.9}{4}$

(But the diameter for a 2.5 mm² cable is 1.78)

$= \frac{3.142 \times 3.1684 \times 8.9}{4}$

$= 2.4888 \times^2.9$

:- Net weight of conductor (nw) = 22.15 kg/km

Gross weight- this is the weight of drawn copper conductor i.e (1010m)

Gross weight of conductor (Gw) = A x d x 1.010km

= Nw x 1.010

= 22.15 x1.010

Copper conductor waste = Gw – Nw

= 22 .37-22.15

= 0.22kg

Step 4

Insulation stage

Calculating the weight of PVC material consumed in kg/km

Weight of PVC = V x d (g/cm³)x waste factor (wf) x L

Where V = volume of PVC consumed km

V = Π s(d+s)

s = insulation thickness in mm

d = conductor diameter in mm

d = density / specific gravity of Pvc in g/cm³

= 1.33 g/cm³

L =length at insulation stage

= 1.005 km

wf = waste factor

= 1.12

Note :- specific gravity of material and waste factor of material would be found in KME 2.1004

from the table ,

density/ specific gravity of PVC material = 1.33 g/cm³

PVC waste factor for power cable = 1.12

V = Π s(d+s)

= 3.142 x 0.8 (1.78 + 0.8)

=6.5

Now, Gross weight of PVC kg / km

$= V \times d \times wf \times L$

$= 6.5 \times 1.33 \times 1.12 \times 1.005$

$= 9.73$ kg/km

Step5

Calculating weight of 2.5 mm² cable in kg /km .

Total weight of conductor and insulation from step 3 and 4 will be the total weight of NCY 1x2.5 mm² in kg/km .

Total weight = conductor (Gw) + Insulation (Gw)- conductor (Cu) waste.

= (Gwc +Gwi -Cu (waste).)

$= 22.37 + 9.73 - 0.22$

= 31.88 kg/km

i.e weight of NCY 2.5mm² in kg/km is 31.88 kg/km

weight of 1 coil (100m) = 31.88 x100 /1000

= 3 .1 8 kg

Example 2

Prepare an Article standard card for NCY 1x 16mm² which must bed delivered at standard depth of 1000m.

Solution

Step1

NCY 16mm² involves six processing stages before it is delivered to store at 1000n 100m/ coil.

Look for additional length (i.e expected waste) at every stage from table 1

= 1000m

Name:- Ajiya S.J Date :- 20/08/99		Article standard card NCY 1 x 16mm² (0.6-1kv)		weight = 177.77 standard pack =1000 m	
Processing Stage	Additional length (m)	Length stage (m)	Net weight (kg/km)	Gross weight (kg/km)	Copper wast (kg)
Conductor (Drawing)	-	1010			
Conductor (Stranding)			143.34	144.77	1.43
Insulation (core)	5	1005		34.43	
coiling & Wrapping	2	1003			
Store (delivery length)	3	1000	177.77		

Step 2

For a stranded conductor of (7 x 1.70). The six stranded wires are always longer than inner single wire. In this case, a factor which will give us additional length of the six wires has to be known.

$f = s/Dm$

Where f = factor for tolerance

s = average lay length in mm

Dm = mid diameter of the stranded conductor in mm

For NCY 1 x 16 mm²

M = 10-14

D = 5.1

S = Dx M

5.1 x10 = 51 ⟹ 51- 71 R

5.1 x14 = 71

Average (s)

$= \frac{51 + 71}{2}$

= 61

Dm = 3d –d (since d = 1.70)

= 5.1 – 1.70

= 3.4

F =s/ Dm

= 61/3.4

= 17 .941

Now check a table in KME 2.1004 and look for 17.941 or a figure closest to it but greater than its corresponding value will give the additional length of a wire to be stranded

From the table in KME 2.1004, 17, 483 is found and 1, 016 is our additional length.

Now, net weight of a stranded conductor will be weight of single wire (1.70mm)

$= \frac{\Pi \times 1.70^2}{4} \times 8.9$

= 20.2 kg/km

:- weight of six wire to be stranded will be

= 6 x 20 .2

= 1.0 16

Net weight of wires = 143 .34 kg /km

Since an allowance of 3 meters must be given as expected waste at stranding stage from tab

1 Gw = 143 .34 x 1.003

= 143.77

Cu waste at stranding stage = Gw – nw

= 143.77-143.34

= 0.43

But, since the total length of stranded conductor to be insulated is 1.010 km from table 1

Gw = 143.34 x 1.010

= 143.77kg

= 144.77-143.43 =1.43kg

Step 3

Insulation stage

Calculating the weight of PVC material consumed in kg/km weight of

= V x d x waste factor (wf) x L.

Where, V = volume of PVC consumable per km

S = insulation thickness

d = conductor diameter

ds = diameter of single strand (wire)

Z = spacing factor

d = specific gravity of Pvc material = $1.33g/cm^3$

L = length of insulation stage (1.005)

Wf = 1.12

Now, since

$V = IIs (d + s) + d^2 z$

$= 3.142 \times 1.0 (5.1 + 1.0) (1.7)^2 \times 1.3289$

= 19.2 +3.8 = 23

:- Gw of Pvc = V x d x w f x L

= 23 x 1.33 x 1.12 x 1.005 =34.43kg

Step 4

Calculating weight of $16mm^2$ cable in kg /km will give the total weight of conductor and insulation from step 2 and 2 above, we have

TW = Gwc + gwi-cu (waste)

Where GWc + Gross weight of insulation

= 144. 77+ 34 – 1.43

= 177.77kg/km

weight of NCY of 16mm² in kg/km + 177.77kg/km

weight of 1 coil (100m) = $\frac{177.77}{1000}$ x 100

= 17.78 kg.

CHAPTER THREE

MANUFACTURING OF QUALITY

(i) NATURE OF THE PROCESS

In the manufacturing quality, the nature and purpose of the process must be spelt out to the quality controller so as to alert them to what their responsibilities are in the pursuit of quality in any control stage.

(ii) RAW MATERIAL CONTROL

This recognises the fact that no one can produce good quality items from bad material hence only satisfactory material are authorized for use. Suppliers of raw materials shall be required to submit certified test report, When necessary, showing conformance purchase specifications and/or purchase order of the company. These test reports, in themselves, do not necessarily constitute final acceptance of the material. Material shall be withheld from use pending completion of Quality control inspection and tests, when required or as directed by the quality manager and assurance that they meet all necessary requirements. Materials rejected as non-conforming shall be tagged with quality control inspection rejected tags and are held pending disposal instructions. The disposition of the material shall be handled by means of a quality control inspection "REPORT ON THE RAW MATERIAL" The report shall contain the description of the material, reason for refection and other pertinent data. The Quality control inspection department and other copies to be forward to the Quality manager for disposal instructions shall retain one copy.

The quality manager completes the disposal instructions and distributes a copy to the Quality control inspection, purchasing receiving and inventory control department.

The quality manager assist-purchasing department in initiating correction action with suppliers on discrepancies found upon receipt of materials. Materials found satisfactory are related by receiving Quality control inspector to draw materials stores as acceptable material. Material shall be stored in established store area in an orderly manner and where necessary precautions are taken to preserve them in good condition. Raw materials shall be periodically re-inspected.

(iii) PROCESS CONTROL

Process control is the regular inspection, measurement and test done on cable under process to ensure that they are produced according to specifications. At each stage of production, therefore some form of tests and measurements are carried out. Random samples are taken from production and the characteristics of an item are tested against the norm. However, in this control procedure, any necessary corrective measures are taken while the process is continuing rather than completion. Inspection stations are maintained in each manufacturing area to assure continuos control of quality of components and assemblies. A specification " work card" based on data supplied by the quality department, shall be issued to the appropriate production sections. Productions follows up these instructions when manufacturing the product The product after a given operation shall be checked to the specification "worn card' and /or governing specification by the quality control inspection department. The number and type of checks performed such as gaveling wire diameters, insulation thickness, overall diameter etc shall be recovered as a report.

(iv) CONTROL LABORATORY

It has the following functions

(a) Monitoring the performance of the manufacturing units to ensure conformance to established standards (process, final control, despatch control) e.t.c.

(b) Recording and reporting all observed deviations to management so that corrective measures are taken.

(c) Quality assurance activities

(d) Vendor appraisal activities

(e) Customer complaint

(f) Up keep of the laboratory equipment

The control laboratory is a laboratory where quality test on raw material, material in -process and finished goods are carried our and anaylse.

(v) FEEDBACK PRODUCTION

This involves the sending back of technical report or information from the quality control department to the production department on the behaviour of any product so as to acquaint them with the end state of the product in order to adjust their mode of operation incase of any deviation from the standard or to take any correction action where necessary.

vi) NON-CONFORMING MATERIAL CONTROL

All non-conforming material shall be identified with an inspection tag area pending disposition report by the quality control section.

The quality control department personnel only are permitted to attach or remove rejection tags and release material the quality control inspector shall institute a "Disposition of held material" form for material rejected. Details such as order number, description of material, stage of manufacture reason for rejection, quality rejected. Hold number etc shall be shown. This form shall be presented to the production department supervisor for his signature.

The Production Supervisor records the cause and remedy and then signs the form. The quality manager must be in agreement with the cause and remedy and counter signs the rejected form. The Quality manager, Quality inspector and Production Manager concur in classifying the rejected materials as:

a) concession/release on risk

b) Remake

c) Salvage material

a) The quality manager in collaboration with the quality control

Inspector is responsible for the decision whether or not to waiver the rejected material. If the "Concession/release on risk" is granted, he encircles the "Yes" under the heading "Concession/release on risk" assigns a hold number and the date and signs the form. If the "Concession/Release on risk" is refused, he encircles the word "No" assign a hold number and the date, fills in the "Disposition" and signs the form.

b) Remake – The quality manager fills in the "Disposition" and signs the form. The production manager or scheduler institutes a remake.

c) The Quality Manager in Collaboration with the Production managers fills in the necessary instruction for rewinding and signs the form. The Quality control inspector for follow retains one copy up during the rework to savage good material operation. Copies or records covering disposition of non-conforming materials shall be maintained on file in the Quality control inspection department.

- If, for any reason, non-confirming material has been dispatched, customer shall be notified at once.
- As a result of despatched, non-conforming material or upon receiving a customer's complaint, the following steps shall be taken:-

a) All stock on hand shall be checked for the condition in question.

b) Find disposition of any non-conforming material shall be made.

c) Investigation into the courses of the compliant shall be instituted.

d) Complete record of all steps taken is to be retained on file.

e) Format report is to be sent to the customer.

3.1 QUALITY CONTROL PROCEDURES.

If plans, standards, drawing and specifications were never in need of review and were executed flowlessly by a perfectly balanced organisation under the directive of an omnipotent leader. There would be no need for control. It is the purpose of the control function to take the corrective action necessary to assure the production process and the product is in accordance with established standard.

TESTS

It deals with measuring performance in relation with established standards, process quality control and defines the various steps taken when carrying out the tests.

Category of test: Test can be classified into three categories.

- Routine test (R)- These are tests to be mode at the manufacturer's works on all cables in the finished state or as appropriates during manufacture.

- Regular sample test (RS) – These are tests made at the manufacturer's work on representative sample selected regularly by the manufacturer or as specified by the purchases at the time of ordering.

Type tests: Tests to be made on specimen of cables as produced by a specific manufacturer to demonstrate the manufacturers ability to satisfactorily produce a range of cables designed to comply with the requirement of a standard. These tests after they have been successfully completed need not be repeated unless changes are made which might affect compliance with the requirement.

TYPES OF TESTS

Quality Control tests carried out on semi-finished and finished products can be classified as:-

a) Design test.
b) Electrical test.
c) Mechanical test.
d) Thermal test.
e) Optical test.

Design test:- involves the verification of

i) Dimension – Diameter of single wire, core/conductor diameter, and outer diameter of sheath.
ii) Testing of wall thickness of instruction/sheath
iii) Colour sequence of cores.

Electrical test: - It involves the

i) Testing of conductor resistance/conductivity
ii) Testing of insulation resistance and volume resistivity
iii) Voltage tests: High voltage (AC) test in free air DC voltage test during immersion in water at high temperature.

Mechanical test: - Involves the measuring of

i) Density measurement
ii) Tensile strength and Elongation at break of conductor/ wires.

iii) Loss of weight test of Pvc compound.

iv) Mechanical properties of insulation and sheath, before and after ageing.

v) Bending test

vi) Tear resistance test or flat cords.

Thermal Test: -:-It Involves

i) Heat shock and shrinkage

ii) Definition under pressure at high temperature

iii) Testing of flame resistance of insulation/sheath.

Optical test: - usual examination and inspection and inspection of the product to ensure that cables are free from notches, scratches and cuts i.e. general smoothness of surface.

3.2 CONTROL PROCEDURES

Due to the large number of quality control test carried out on semi-finished and finished products. The control procedures will be restricted to the very important tests.

1. Title:- Measurement of dimensions of wire and conductors
2. **Scope:** - This procedures covers method of measurement of dimensions of wires and conductors of electric cables and bare conductors as semi – finished or taken from a finished cable.
3. **Significance:** - Wires and conductors of electric cables have to perform the following functions:-

   a) To provide a conducting path for current.

   b) Ability to withstand pulling force while laying

   All these parameters have a bearing on the dimensions of the wire\conductor. This test is carried out to check that the wire/conductor. This test is carried out to check that the wire/conductor has the designed dimensions for any particular application.
4. **Responsibility:**- it shall be the responsibility of controllers on line to verify the dimensions of wires and conductors at every stage of the production process while the superior (Laboratory) and his technician shall verify the dimension of wires/conductors of all grounded or cable samples submitted for analysis.

5. It shall the overall responsibility of the QC Engineer ensure that this procedure is carried out, and all test results are verified for correctness and accuracy/

6. **Related Documents:** laboratory manuals: NIS 89 80, 155' 82 159'82 and Relevant cable standards.

7. **Apparatus:-**

7.1 Vernier calipers- Suitable for inside as well as outside measurements with at least count of 0.01mm

7.2 Micrometer screw gauge – Digital or plain, fitted with ratchet head with at least count of 0.01mm

8. Specimen.

8.1 The test specimen shall be free from scratches, dents and other external irregularities.

8.2 At least three samples shall be taken at points separated by at least 1m.

8.3 For standard conductors, the central wire shall be used for the dimensional clocks after carefully removing other wires

9. Procedure

9.1 The test specimen shall be cleaned to removed entraneous coatings, if any, without damaging the test specimen

9.2 If the test specimen is taken from a conductor, it shall be made reasonable straight to the extent possible without damaging it.

9.3 The test specimen shall be warned at three equidistant points (say 50mm) from the ends and at the middle. The set of measurements made at these points shall be recorded and used to determine the mean valve.

9.4 Measurement shall be made at the warned at the marked points in two directions at right angles to each other.

TABULATION OF RESULT

TEST:-	Measurement of Dimension of wires and conductors
CABLE TYPE:	NCY 1 X 4.0mm^2
SAMPLE :	COPPER conductor Material
TOLERANCE:	+ 1% of nominal value

SAMPLE	DIAMETER MEASURED (mm)	AVERAGE VALUE (mm)	DESIRED VALUE (mm)
SAMPLE 1	2.26 2.25 2.25	2.25	2.23-2.27
SAMPLE 2	2.24 2.25 2.26	2.265	2.23-2.27
SAMPLE 3	2.24 2.24 2.25	2.24	2.23-2.27

COMMENT: The measured values are okay according specification and standard as the values fall within the desired value.

TESTED BY: **AJIYA SUNDAY JOHN**

CHECKED /APPROVED BY: **ENGR. ABDULLAHI SHEHU**

1 Title:- Insulation Resistance test

2.Scope:- The procedure covers the methods of determination insulation resistance of the plastic materials employed the insulation of cable.

3. Significance: At high operating temperature under normal condition, the insulation characteristics of the insulating compound shall be such that it confines the flow of current within the conductor. Failure to fulfil this requirement results in short circuit and damage to the entire electrical system and appliances.

4. Responsibility: - It shall be the responsibility of the quality controllers to take sample of grounded cables for laboratory test while it is the responsibility of the laboratory technicians or the supervisor to carry out the test

The QC Engineer (Control laboratory0 has the overall responsibility that this procedure in carried out.

5 Related Document:-Laboratory manual: NIS 153' 82 NIS 246'88,

DIN 0472/9.1

6. Apparatus:

6.1. Water bath (Colour a thermostat)

6.2. Insulation resistance tester (terra ohm meter or megaohmtester)

6.3. Stop clock

6.4. DC voltage source (0-500v)

6.5. Thermometer

7. Specimen

The test specimen shall be a sample length of 5.5m taken from the insulated cable in the case of multi-core cables core being taken not to injure or damage the insulation. The sample shall be coiled with the two ends protruding above the water level to within 250mm. The ends of one of the protruding length shall be stripped off the insulation.

8. Procedure

8.1 The water bath shall be filled with water to the maximum permissible level.

8.2 The bath shall be switched ON and the water heated up to the desired temperature (i.e. 70^{oc} or 60^{oc} for MLCY).

The temperature of the water is checked with the aid of the thermometer before the sample in the bath. After inserting the sample in the bath, the sample is left in water for a period of 2hours

8.3 The supply to the bath shall be switched OFF after the desired temperature is reached or in case of a thermostatic control bath, the supply need not be switched OFF as the thermostat regulated the temperature automatically.

8.4 The positive terminal of the DC voltage source is connected to the stripped and of the sample and the negative terminal is connected to the body of the bath. A DC voltage of 500V shall be applied in turn for duration of limited.

8.5 The insulation resistance shall be measure with the use of terraohmeter or megaohmeter after successful application of the A/C voltage and the measurement obtained after 1 minute.

TABULATION OF RESULT

TEST: **INSULATION RESISTANCE**

CABLE TYPE: NCY 1 X 16 mm^2

SAMPLE LENGTH:: 5.5m

DIAMETER OF CORE: 7.32mm

DIAMETER OF CONDUCTOR: 1.70mm

CABLE TYPE (mm^2)	SAMPLE LENGTH (mm)	RINS AT 110OC (m x R)	INSULATION RESISTANCE CONSTANT K (m x ohm x km)	DIAMETER OF CONDUCTOR (mm)
NCY 1x16mm^2	5.5	7.32	15	1.70

. 10. CALCUATION OF RESULT

The insulation resistance constant (K) shall be computed from the formula

K=Rins x L
100 x log D/*d*
where K = Insulation resistance constant

Rins = Insulation resistance measured in MX ohm

L = Sample length in M

D = Diameter over insulation (core) in mm

d = Diameter of conductor in mm

K = 150 x 5.5
Log 7.32 /1.70 -: 100
= 1.30 1 M R/Km

1. TITLE:- METHOD FOR HIGH VOLTAGE TEST ON COMPLETED CABLES
2. **SCOPE:** The procedure covers the method for high voltage test on completed cables delivered on factory length.
3. **SIGNIFICANCE:** - The Test is carried out to ensure that the cable or cores can withstand any abnormal situation that very occurs as a result of a fault without substance damage to the cable before the protective devices are actuated to protect the system.

10.3The high voltage tester is operated with the safely key after satisfying compliance with safety guild line.

10.4 The test voltage shall be applied gradually. So as to arrive at the specified voltage value in about 25min. the duration of the test being counted from the movement full test voltage is arrived at.

TABULATION OF RESULT

TEST: High Voltage

CABLE TYPE : NCYRY 4 X 16 mm^2

SAMPLE: Completed Cable as deliver on drum

S/NO	CORES(colours)	VOLTAGE(kv)	DURATION(mins)
1	RED	4	15
2	YELLOW	4	15
3	BLUE	4	15
4	BLACK	4	15

EVALUATION OF RESULT

The test shall be considered successful if no break down occur on any of the cores or between cores and steel wires armoured in the case of armoured cables.

Comments: Successful or okay

Tested By: AJIYA SUNDAY JOHN

Checked and Approved by: Engr. ABDULLAHI SHEHU

CHAPTER 4

4.1 CONCLUSION

Having undertaking the quality control procedures in a cable industry, It could be concluded that all cables manufacturers as a matter of necessity make sure that all their products undergo the control test and techniques in ensuring that at the end of production, their products will meet customers specification and standards.

4.2 RECOMMENDATION

Human lives are increasingly dependent on the quality of products. Serious human inconvenience, economic waste of life and damage to the environment do occur as a result of quality failures of materials and products. Hence the need for manufacturers to build quality control into their product cannot be overemphasized. For a company to satisfy customers quality needs, its market research must firs of all identify the quality needs of the targeted customers, product development must create designs that are responsive to these needs, manufacturing planning must devise processes to achieve the desired qualities.

Therefore, quality control is recommended for all manufacturing companies in their production line and on the finished goods products, so as to meet standard and specification.

4.3 GLOSSARY

ITC - Electro – Technical Commission
NIS - Nigerian Industrial Standards
BS - British Standards
VDE, DIN- German Industrial Standards
N - Standard
C - Copper
A - Aluminum
Y - PVC insulation
R - Round (denote I) shape of the cable
F - Flat (denote ii) shape of the cable
E - Earth
F - flexible
M - Multi
Cc - Control cable
2Y - Polyethylene (PE)
2X - Cross-lined polyethylene (XLPE)
NCY - Standard Copper conductor with PVC insulation
NCYY - Standard copper conductor with PVC insulation and pre-sheath.
NCYRY - Armoured cable (standard copper conductor with pre-insulation, Round steel wi
Pre- sheathing
Armoured cable - A cable with steel wires round it for mechanical protection
Conductor-
Solid conductor- A conductor consisting of a single wire.
Stranded - A number of wires twisted together
Wire - Around solid section of not more than 10mm produced by drawing

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