

# ANALYSIS AND QUALIFICATION





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# COMPANY

## AMR ELECTRONIQUE

Located in Saint just (FRANCE) over 35 years AMR Electronique develops and manufactures new production processes for winding trades. Our expertise which has steadily developed allows us to accompany our customers in areas such as :

- The agglomeration of winding wires with polymerization by Joule Effect
- Analysis and qualification of enameled wire (for new product)
- Connection without unenamelling with COSDEM
- Prototyping of specific products manufactured for the imposed constraints
- The qualification and validation of connections
- Bench Test motors



## QUALITY AND MEANS

Now present in 5 continents, we give special attention quality tools in both :

- Analysis and qualification means
- Production
- Production management of our equipment

## AREAS OF ACTIVITIES

AMR Electronique delivers reliable and sustainable business solutions to our partners in Aeronautics, Automotive, Energy, Medical, Nuclear, Railway ...



P R E S E N T A T I O N



# ENAMELLED WIRES

ENAMELLED WIRES

Our analysis laboratory allows to get all the qualifications required in the enamelled wires industries. Major magnet wires manufacturers have already used our knowledge and the qualifications conducted in the past used baseline today. This level of expertise has allowed AMR to be present in sectors such as Nuclear, Energy, Automotive and Aerospace.

## Provided test

Tests are driven according to the standards (IEC 60851 - IEC 60216, ...) or to the customers specified needs.






## Why wires analysis ?

Standard tests managed by wires manufacturers have shown their limitations as final customers can obviously notice. Analysis and tests processes must be defined in order to satisfy the specific customers needs. Tests procedures can be managed with a confidentiality contract with final customers or wires manufacturers.





# TEST RESOURCES



TEST RESOURCES (Mechanical test)		
Equipment for measuring the characteristics of enameled wires described by the standard IEC 60851-3		
<b>Test equipment spinginess</b>	BRAND : AMR Electronique	
	MODEL : AMRESSORT 1	
	N° : AMR 0882	
	DISPLAY : Angle °	
	CAPACITY : Ø of conductor ≤ 1,6 mm	
<b>Test equipment spinginess</b>	BRAND : AMR Electronique	
	MODEL : AMRESSORT 2	
	N° : AMR0883	
	DISPLAY : Angle °	
	CAPACITY : Ø of conductor ≤ 1,6 mm	
<b>Test equipment peel test</b>	BRAND : AMR Electronique	
	MODEL : AMRPEELTEST	
	N° : AMR1102	
	DISPLAY : NUMBER OF LAP	
	Ø de fil : de 1 à 4,5 mm	
<b>Test equipment dynamic coefficient of friction</b>	BRAND : AMR Electronique	
	MODEL : AMRGLISS	
	N° : AMR 1045	
	DISPLAY : Angle °	
<b>Test equipment breaking</b>	BRAND : AMR Electronique	
	MODEL : AMRUPT	
	N° : AMR1240	
	DISPLAY : Newton	
	CAPACITY : to 0 of 30 Newton	

ENAMELLED WIRES



# TEST RESOURCES

E N A M E L L E D W I R E S

TEST RESOURCES (Mechanical test)		
Control of gauges and measuring instrument	Calibration bar Standard weight	
<b>Steamed traction bench</b>	BRAND : AMR Electronique	
	MODEL : TRACTECTUVE	
	N° : AMR 0123	
	CAPACITY max : 200 N	
	ACQUISITION SYSTEM : Force / Time / temperature	
	PRECISION : ± 1 N	
	DIMENSION mm : 2020 x 360 x 100	
	INTERFACE : MAC OS 10.4-10.5-10.6...10.11	



# STANDARD

## Winding Wires

Binder N°12

### **NFC 31023**

Methods of test for winding wires

### **IEC 60851-1**

Methods of test for winding wires - Part 1: General

### **IEC 60851-3**

Winding wires - Test methods - Part 3: Mechanical properties

### **IEC 60851-5**

Winding wires - Test methods - Part 5: Electrical properties

### **IEC 60851-6**

Winding wires - Test methods - Part 6: Thermal properties

### **IEC 60172**

Test procedure for the determination of the temperature index of enamelled and tape wrapped winding wires

## Winding Wires

Binder N°13

### **IEC 60317-0-1**

Specifications for particular types of winding wires - Part 0-1: General requirements - Enamelled round copper wire

### **IEC 60317-0-2**

Specifications for particular types of winding wires - Part 0-2: General requirements - Enamelled rectangular copper wire

### **IEC 60317-0-2-A2**

Enamelled rectangular copper wire

### **IEC 60317-0-3**

Specifications for particular types of winding wires - Part 0-3: General requirements - Enamelled round aluminium wire

### **IEC 60317-0-6**

Specifications for particular types of winding wires - Part 0-6: General requirements - Glass-fibre wound resin or varnish impregnated, bare or enamelled round copper wire

### **IEC 60317-1**

Specifications for particular types of winding wires - Part 1: Polyvinyl acetal enamelled round copper wire, class 105

### **IEC 60317-2**

Specifications for particular types of winding wires - Part 2: Solderable polyurethane enamelled round copper wire, class 130, with a bonding layer

### **IEC 60317-3**

Specifications for particular types of winding wires - Part 3: Polyester enamelled round copper wire, class 155

### **IEC 60317-4**

Specifications for particular types of winding wires - Part 4: Solderable polyurethane enamelled round copper wire, class 130



# STANDARD

## Winding Wires

Binder N°14

### IEC 60317-7

Specifications for particular types of winding wires - Part 7: Polyimide enamelled round copper winding wire, class 220

### IEC 60317-8

Specifications for particular types of winding wires - Part 8: Polyesterimide enamelled round copper wire, class 180

### IEC 60317-12

Specifications for particular types of winding wires - Part 12: Polyvinyl acetal enamelled round copper wire, class 120

### IEC 60317-13

Specifications for particular types of winding wires - Part 13: Polyester or polyesterimide overcoated with polyamide-imide enamelled round copper wire, class 200

### IEC 60317-14

Specifications for particular types of winding wires - Part 14: Polyvinyl acetal enamelled round aluminium wire, class 105

### IEC 60317-15

Specifications for particular types of winding wires - Part 15: Polyesterimide enamelled round aluminium wire, class 180

### IEC 60317-19

Specifications for particular types of winding wires - Part 19: Solderable polyurethane enamelled round copper winding wire overcoated with polyamide, class 130

### IEC 60317-20

Specifications for particular types of winding wires - Part 20: Solderable polyurethane enamelled round copper wire, class 155

### IEC 60317-22

Specifications for particular types of winding wires - Part 22: Polyester or polyesterimide enamelled round copper wire overcoated with polyamide, class 180

## Winding Wires

Binder N°15

### IEC 60317-25

Specifications for particular types of winding wires. Part 25: Polyester or polyesterimide overcoated with polyamide-imide, enamelled round aluminium wire, class 200

### IEC 60317-26

Specifications for particular types of winding wires. Part 26: Polyamide-imide enamelled round copper wire, class 200

### IEC 60317-27

Paper tape covered rectangular copper wire

### IEC 60317-30

Specifications for particular types of winding wires. Part 30: Polyimide enamelled rectangular copper wire, class 220

### IEC 60317-32

Specifications for particular types of winding wires - Part 32: Glass fibre wound, resin or varnish impregnated, bare or enamelled rectangular copper wire, temperature index 155

### IEC 60317-34

Specifications for particular types of winding wires - Part 34: Polyester enamelled round copper wire, class 130L

### IEC 60317-39

Specifications for particular types of winding wires - Part 39: Glass-fibre braided resin or varnish-impregnated, bare or enamelled rectangular copper wire, temperature index 180

### IEC 60317-40

Specifications for particular types of winding wires - Part 40: Glass-fibre braided resin or varnish-impregnated, bare or enamelled rectangular copper wire, temperature index 200





# STANDARD

## Winding Wires

[Binder N°16](#)

### IEC 60317-43

Specifications for particular types of winding wires - Part 43: Aromatic polyimide tape wrapped round copper wire, class 240

### IEC 60317-44

Specifications for particular types of winding wires - Part 44: Aromatic polyimide tape wrapped rectangular copper wire, class 240

### IEC 60317-45

Specifications for particular types of winding wires - Part 45: Polyester enamelled round copper wire, class 130

### IEC 60317-47

Specifications for particular types of winding wires - Part 47: Aromatic polyimide enamelled rectangular copper wire, class 240

### IEC 60317-48

Specifications for particular types of winding wires - Part 48: Glass-fibre wound resin or varnish impregnated, bare or enamelled round copper wire, temperature index 155

### IEC 60317-49

Specifications for particular types of winding wires - Part 49: Glass-fibre wound high temperature resin or varnish impregnated, bare or enamelled round copper wire, temperature index 180

### IEC 60317-50

Specifications for particular types of winding wires - Part 50: Glass-fibre wound silicone resin or varnish impregnated, bare or enamelled round copper wire, temperature index 200

### IEC 60317-51

Specifications for particular types of winding wires - Part 51: Solderable polyurethane enamelled round copper wire, class 180

## Winding Wires

[Binder N°17](#)

### IEC 60317-52

Specifications for particular types of winding wires - Part 52: Aromatic polyamide (aramid) tape wrapped round copper wire, temperature index 220

### IEC 60317-53

Specifications for particular types of winding wires - Part 53: Aromatic polyamide (aramid) tape wrapped rectangular copper wire, temperature index 220

### IEC 60317-54

Specifications for particular types of winding wires - Part 54: Polyester enamelled round copper wire, class 155L

### IEC 60317-55

Specifications for particular types of winding wires - Part 55: Solderable polyurethane enamelled round copper wire overcoated with polyamide, class 180



# INSULATION

New developments today lead to increase the dielectric performance of the insulation. The increase in operating frequency causes accelerated aging. The life of insulation also requires an improvement . These new needs are growing day by day at the moment when the conversion of energy is undergoing a revolution.

## Partial discharges

Partial discharges are a consequence of a stress in a dielectric insulation during the high voltage application in high frequency. This is caused by several anomalies, among which the not homogeneous distribution of the electric field, the presence of bubbles within the insulation, the effect of spikes on the insulating material, the presence of moisture or cracks, the presence of surface contaminants insulators.

Partial discharges are present on insulation defects on joints type cables XLPE / EPR, elbows and terminations of cables in the electrical equipment MV and HV in metal casings (high voltage cells) and distribution transformers, or in all industrial facilities such as power switching systems (molded bridges transistors), rotating machines windings (asynchronous & synchronous machines) ...

The aim of these measures is the establishment of test campaigns for the purpose of safety and preventive maintenance or for the qualification of finished products after manufacture.






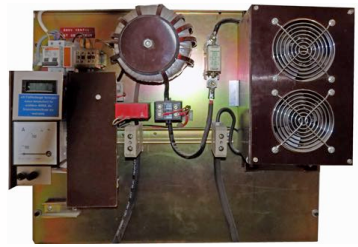
## « Corona » effect

The "corona" effects appear on a high electrical potential conductor. The electric field in the vicinity thereof may become intense enough to cause ionization of air molecules. It causes a chemical decomposition causing erosion and deterioration of the metal surfaces. This phenomenon is called "corona effect" or "crown" and it is still characterized by a bluish tint rich in ultraviolet around the conductors and sometimes emits an audible sound to the ear. One consequence of this is the loss of energy in electricity grids and reducing the lifetime of the insulation.










# TEST RESOURCES

TEST RESOURCES (Electrical test)		
Control of gauges and measuring instrument	<b>Standard shunts 1 A to 1500 A</b> <i>Precision : ± 1 %</i> <b>Standard resistances 9 mΩ to 56 Ω</b> <i>Precision : ± 0,5 %</i>	
Generator high voltage	BRAND : AMR Electronique	
	MODEL : Diélectrique / Diélectrique 2	
	N° : 0112 / 0114	
	TENSION RANGE : De 1 à 6000 V	
	PRECISION : ±1 %	
RESOLUTION :		
Voltage amplifier & DC Contrôler	BRAND : AMR Electronique	
	MODEL : AMPLITEN	
	N° : AMR 0541	
	POWER : 250W	
PRECISION : ± 1%		
Voltage amplifier & DC Contrôler	BRAND : AMR Electronique	
	MODEL : AMPLITEN	
	N° : AMR 0542	
	POWER : 6000W	
PRECISION : ± 1%		
Frequency generator	BRAND : MCP Instrument	
	MODEL : SG1639A	
	N° : 1204215536	
	FREQUENCY RANGE : 1Hz à 15 MHz	
	PRECISION : ± 0,003 % ± 1 Digit	
RESOLUTION : 5 Digits		
Current generator Ac	BRAND : AMR Electronique	
	MODEL : GENCOURALT	
	N° : AMR 0754	
	CURRENT max : 400 A	
PRECISION : Class 1,5		





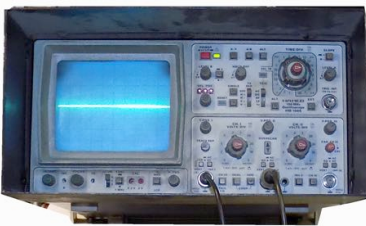


ELECTRICAL INSULATION

## TEST RESOURCES

TEST RESOURCES (Electrical test)		
Control of gauges and measuring instrument	<b>Standard shunts 1 A to 1500 A</b> <i>Precision : <math>\pm 1 \%</math></i> <b>Standard resistance 9 m<math>\Omega</math> to 56 <math>\Omega</math></b> <i>Precision : <math>\pm 0,5 \%</math></i>	
Micro-ohm meter	BRAND : ndp technologie	
	MODEL : DRM-10A	
	N° : AMR 1015	
	RANGE: 0,01 $\mu\Omega$ TO 200 $\mu\Omega$ Résolution: 0,01 $\mu\Omega$ PRECISION : 0,1 %	
Current generator Dc	BRAND : AMR Electronique	
	MODEL : GCC	
	N° : AMR 0712	
	RANGE : 0,01 / 0,1 / 1 / 10 A	
	MEASUREMENT : 4 WIRES	
PRECISION : $\pm 2\%$ de la lecture		
Multi-meter	BRAND : AGILENT	
	MODEL : U1273A	
	N° : MY54160047	
	MEASUREMENT RANGE cc: 300mV-1000V	
	PRECISION : 0,05%	
RESOLUTION : 0,001 mV-0,1 V		
Machine polymerization	BRAND : AMR Electronique	
	MODEL : GPROUVETTE	
	N° : 0212	
	POLYMERIZATION RANGE : de 10 m $\Omega$ à 2 $\Omega$	
	PRECISION : $\pm 0,5 \%$	
RESOLUTION :		





# TEST RESOURCES

TEST RESOURCES (Electrical test)		
Control of gauges and measuring instrument	<b>Voltage standard</b> <i>Precision : ± 0,02 %</i>	
LCR meter	BRAND : AMR Electronique	
	MODEL : LCR mètre	
	N° : 0976 & 0977	
	L : 0,1 nH à 100 H / C: 0,1 pF à 100 mP/ R: 0,1 Ω à 1GΩ	
	PRECISION : 0,05 %	
Oscilloscopes	BRAND : HAMEG	
	MODEL : HM 1005	
	N° : 8909F5256	
	CHOPPING FREQUENCY : 0,5 MHz	
	BANDWIDTH: 3X 0 à 100 MHZ	
	RELEASE : 0-130 MHz	
Distortion meter	BRAND : HAMEG	
	MODEL : HM8027	
	N° : 27911 P 3728	
	RATE DISTORTION mini : 0,005 %	
	FREQUENCY RANGE : De 20 Hz - 20 kHz	
	PRECISION : 0,01%	
Dielectric chamber	BRAND : AMR Electronique	
	MODEL : AMRDIELE	
	N° : 0934	
	MATERIAL : PA66	
	BALL CHARACTERISTIC : Ball 2 or 1,5 mm	
	VACUUM SYSTEM	
	CONTROL : Temperature and Humidity	

ELECTRICAL INSULATION



# TEST RESOURCES

TEST RESOURCES (Thermal test)		
PID controller with power limiting		
<b>High temperature furnace</b>	BRAND : BOREL	
	MODEL : FP 1100-10	
	N° : S12131	
	POWER : 2,9 KW	
	TEMPERATURE RANGE : 0 à 1100 °C	
	DIMENSION mm : 200 x 200 x 250	
	PRECISION : ± 1 °C	
<b>Steamed</b>	BRAND : AMR Electronique	
	MODEL : ETUVE1	
	N° : AMR1205	
	TEMPERATURE RANGE : 0 à 300°C	
	PRECISION : ± 1 °C	
	DIMENSION mm : 560 x 400 x 330	



# STANDARD

## [Insulation 1](#)

[Binder N°9](#)

### **IEC 60085**

Electrical insulation – Thermal evaluation and designation

### **IEC 60216-1**

Electrical insulating materials - Thermal endurance properties

### **IEC 60216-2**

Electrical insulating materials - Thermal endurance properties - Part 2: Determination of thermal endurance properties of electrical insulating materials - Choice of test criteria

### **IEC 61006**

Electrical insulating materials - Methods of test for the determination of the glass transition temperature

### **IEC 60626-1**

Combined flexible materials for electrical insulation - Part 1: Definitions and general requirements

### **IEC 60626-2**

Combined flexible materials for electrical insulation - Part 2: Methods of test

### **DIN EN ISO 6721**

Determination of dynamic mechanical properties-  
Part 2 : Torsion-pendulum method

### **DIN ISO 178**

Plastics- Determination of flexural properties

## [Insulation 2](#)

[Binder N°10](#)

### **IEC 60071-1**

Insulation co-ordination - Part 1: Definitions, principles and rules

### **IEC 60071-2**

Insulation co-ordination - Part 2: Application guide

### **IEC 61857-21**

Electrical insulation systems - Procedures for thermal evaluation - Part 21: Specific requirements for general-purpose models - Wire-wound applications

### **IEC 60343**

Recommended test methods for determining the relative resistance of insulating materials to breakdown by surface discharges

### **IEC 61857-22**

Electrical insulation systems - Procedures for thermal evaluation - Part 22: Specific requirements for encapsulated-coil model - Wire-wound electrical insulation system (EIS)

### **IEC 61858**

Electrical insulation systems - Thermal evaluation of modifications to an established wire-wound EIS

## [Insulation 3](#)

[Binder N°11](#)

### **IEC 60270**

High-voltage test techniques - Partial discharge measurements

### **IEC 60664-1**

Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests



# CALCULATION

**TEST RESOURCES (Calculation program)**

### Calculation copper and aluminium conductor

### Harmonic calculation

### Calculation Litz wires

### Calculation Arrhenius laws

### Calculation Pressure Temperature





# CONNECTION

ELECTRICAL CONNECTION

It is important to remember that an electrical connection is a set between :

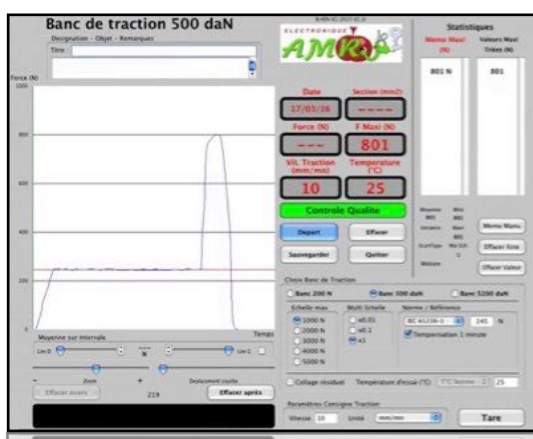
- An unanemelled standard cable
- A terminal of dimensions corresponding to the cable
- A crimping die which correspond to the cable and to the terminal



The use of enamel wires or conductor wrapped in winding wires requires a quality approach which has not always implemented. This forgetting frequently led to significant failures in electrical systems.


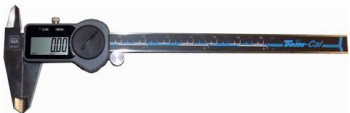


The use of a standardized terminal and a non-standard cable corresponds to an "invention" that must be qualified with :

- Mechanical tests
- Electrical tests
- Visual tests





# TEST RESOURCES




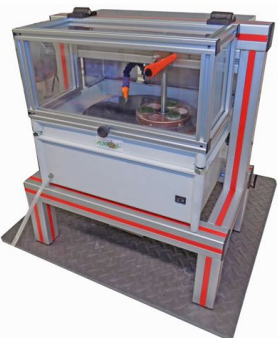


TEST RESOURCES (Dimensional control)		
<b>Control of gauges and measuring instrument</b>	<b>Set of parallel gauge blocks DIN 861 connected BNM COFRAC</b>	
<b>Sliding caliper</b>	BRAND : TESA	
	MODEL : 0-150 mm	
	N° : 11W50	
	DISPLAY : 0,01 mm	
	CAPACITY : 0-150 mm	
<b>Micro-meter</b>	BRAND : TESAMASTER	
	MODEL : DIGITMASTER	
	N° : 54.100000	
	LIMI ERROR : 2 μm	
	MEASUREMENT RANGE : 0-25 mm	
<b>Control gauge</b>	BRAND : AMR Electronique	
	MODEL : Matrix Hexagonal à 60°	
	N° : AMR 2815	
	DISPLAY : 0,01 mm	
<b>Measuring column</b>	BRAND : AMR Electronique	
	MODEL : Colonne de mesure	
	N° : AMR 0614	
	DISPLAY : 0,01 mm MEASUREMENT RANGE : 0-600 mm	
	SUPPORT : Marble precision class 0 DIMENSION (mm) : 800 x 500 x 100	



# TEST RESOURCES




ELECTRICAL CONNECTION

## TEST RESOURCES (Visual examination)

Control of gauges and measuring instrument		BLADE GLASS CALIBRATION Precision : 0,01 mm	 
<b>Pendulum saw</b>	BRAND : AMR Electronique		
	MODEL : AMR CUT		
	N° : AMR 1213		
	Saw teeth fine HSS		
	Nb of lap/min : 38		
<b>Polishing machine</b>	BRAND : AMR Electronique		
	MODEL : AMR POLISH		
	N° : AMR 1115		
	TRAY CAPACITY : 200 à 300 mm		
	CAPACITY POLISHING : 6 samples		
<b>Chemical polishing</b>	REVELATION AND NEUTRALIZATION		
	Iron Chloride 40 - 45 %, n° CE 231-729-4		
	Hydrochloric acide : 23 % min, n°CE 231-595-7		
	WATER		
<b>Digital microscope</b>	BRAND : AMR Electronique		
	MODEL : AM7013MZT4 AM7013MZT		
	N° : AMR 0314		
	MAGNIFICATION : 20-200x et 400-470x		
	CROSS TABLE Mitutoyo : Précision 0,005 mm		








# TEST RESOURCES

TEST RESOURCES (Tensile test)		
Control of gauges and measuring instrument	Calibration bar Standard weight	
<b>Traction bench</b>	BRAND : AMR Electronique	
	MODEL : BT1 & BT2	
	N° : AMR0856 - AMR0123	
	CAPACITY max : 5 000 N & 200 N	
	ACQUISITION SYSTEM : Force / Time / temperature	
	Accuray : $\pm 1$ N	
<b>Traction bench</b>	BRAND : AMR Electronique	
	MODEL : BT3	
	N° : AMR0427	
	CAPACITY max : 40 000 N	
	ACQUISITION SYSTEM : Force / temps	
	Accuray : $\pm 5$ N	









# TEST RESOURCES

ELECTRICAL CONNECTION

TEST RESOURCES (Electrical test)		
Control of gauges and measuring instrument	<b>Standard shunt 1 A to 1500 A</b> <i>Precision : ± 1 %</i> <b>Standard resistance 9 mΩ to 56 Ω</b> <i>Precision : ± 0,5 %</i>	
multi-muer	BRAND : AGILENT	
	MODEL : U1273A	
	N° : MY54160047	
	MEASUREMENT RANGE cc:300mV-1000V	
	Accuray : 0,05%	
	Résolution : 0,001 mV-0,1 V	
Current clamp	BRAND : ISO-TECH	
	MODEL : ICM 2000	
	N° : 13130789	
	Accuray ca : +-3% +-5digits	
	Accuray cc : +-2% de la lecture	
	Résolution ca et cc : 0,1-400 A	
Current generator DC	BRAND : AMR Electronique	
	MODEL : GCC	
	N° : AMR 0712	
	RANGE : 0,01 / 0,1 / 1 / 10 A	
	MEASUREMENT : 4 Wires	
	PRECISION : +-2% of read	
Micro-ohm meter	BRAND : ndp technologie	
	MODEL : DRM-10A	
	N° : AMR 1015	
	MEASUREMENT RANGE : 0,01 μΩ à 200 μΩ RESOLUTION: 0,01μΩ Accuray : 0,1 %	



# TEST RESOURCES

TEST RESOURCES (Electrical test)		
<b>Control of gauges and measuring instrument</b>	<b>Stallion shunt to 1 A of 1500 A</b> <i>Precision : ± 1 %</i> <b>Stallion resistance to 9 mΩ of 56 Ω</b>	
<b>AMR-SCOPE for temperature measurement</b>	BRAND : AMR Electronique	
	Modèle : AMR-SCOPE	
	N° : AMR0887	
	CHARACTERISTIC : Thermocouple K TIME MEASUREMENT: 1 mesure/ Sec COMPUTER : IMAC 2 GHz	
<b>Generator by Joule effect</b>	BRAND : AMR Electronique	
	MODEL : GEJ1	
	N° : AMR0876	
	HEATING RANGE : 0,5 to 16 mm2	
<b>Generator by Joule effect</b>	BRAND : AMR Electronique	
	MODEL : GEJ2-GEJ3	
	N° : AMR0877 - AMR0878	
	HEATING RANGE : 16 to 70mm2 - 70 to 300 mm2	
<b>Aging system</b>	BRAND : AMR Electronique	
	MODEL : TDV	
	N° : AMR0954	
	CHARACTERISTIC : Thermostaté Longueur : 7 mètres Mesure de chute de tension : Automatique	
<b>Short circuit bench</b>	BRAND : AMR Electronique	
	MODEL : BBC	
	N° : AMR0898	
	HEATING RANGE à 250°C : of 0,5 to 300mm2	



# CALCULATION

## TEST RESOURCES (Calculation program)

Calculation  
selecting  
connector

**AMCOX** Ca Maitrise de l'Effet Joule  
21 Les Rogères  
45, Allée du Petit Plan  
91190 Saint Just - France  
+33(0)1 48 23 23 06  
http://www.amr-electronique.com & http://tcondem.com/fr/index.html

Version 2. 98

### Calcul du choix des Cosses et des Mors

<b>Diamètre d'un Fil</b>	0,310 mm	<b>Taux de remplissage câble</b>	91%	<b>Normes et Sections Nominales des Cosses Cuivre correspondantes</b>			
<b>Nombre de Fils</b>	927	<b>Section Câble Cuivre</b>	69,97 mm <sup>2</sup>	2	3	4	5
<b>Cuivre Nu</b>		<b>Section Interne mini_cosse</b>	77,15 mm <sup>2</sup>	NFC 20-130	NFF 00363	DIN 46235	IEC 61138-1
<b>Tolérance dimensionnelle</b>	2%	<b>Ø Interne mini_Cosse</b>	9,91 mm	Scu	70,0 mm <sup>2</sup>	50,0 mm <sup>2</sup>	50,0 mm <sup>2</sup>
<b>Ø Int. Cosse</b>	10,0 mm	<b>Section interne corrigée</b>	78,69 mm <sup>2</sup>	S Int.	95,0 mm <sup>2</sup>	91,6 mm <sup>2</sup>	78,5 mm <sup>2</sup>
<b>Ø Ext. Cosse</b>	14,5 mm	<b>Si faut privilégier le choix de la Norme en Automatique</b>		Ø Ext.	15,0 mm	14,0 mm	14,5 mm
<b>S Ext. Cosse</b>	165,1 mm <sup>2</sup>	<b>Norme Définie Automatiquement</b>		Ø Int.	11,0 mm	10,8 mm	10,0 mm
<b>Rapport de sertissage</b>	Sr/Sc= 1,12	<b>Choix de la Norme</b>		a Int.	5,19 mm	Rapport Ø Int. Cosse / H Int. Totale	1,11
<b>Section Ext. sertissage</b>	147,11 mm <sup>2</sup>	<b>Automatique</b>		h Int.	4,49 mm	Section Ext. sertissage	148,43 mm <sup>2</sup>

Seules les cellules en vert sont modifiables

Il faut privilégier les mors 4 a-h lorsque le nombre de fils est inférieur à 200, et/ou, lorsque la cosse est trop grande par rapport au faisceau de fils.

<p>15,05 mm</p> <p>h1 = 6,52 mm</p> <p>a1 = 7,52 mm</p> <p>Mors Standards (type 6 = 3.a-h)</p>	<p>14,50 mm</p> <p>h2 = 6,34 mm</p> <p>a2 = 5,80 mm</p> <p>Mors Largés (type 6 = 4.a-h)</p>	<p>Mors à Privilégier</p> <p>15,12 mm</p> <p>h3 = 6,55 mm</p> <p>a3 = 7,56 mm</p> <p>Taux de sertissage 100%</p> <p>Calcul avec déformation intérieure hexagonale</p>
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Vérifier le taux de remplissage en

ELECTRICAL CONNECTION



# STANDARD

## Crimping

Binder N°1

### NF EN 61238-1

Compression and mechanical connectors for power cables for rated voltages up to 30 kV ( $U_m = 36$  kV) - Part 1: Test methods and requirements

### DIN 46235

Cable lugs for compression connections

### NF EN 60352-2

Solderless connections - Part 2: Crimped connections - General requirements, test methods and practical guidance

### IEC 60352-4

Solderless connections - Part 4: Solderless non-accessible insulation displacement connections - General requirements, test methods and practical guidance

### NF C20130

Cosse nues, à sertir, en cuivre ou en alliage de cuivre

### NFC 20131

Cossé à plage en cuivre ou en aluminium pour conducteurs en aluminium.

### NF C63-023

Embout à collerette isolante

### NF F00363

Produits à sertir pour connexion électriques

### NF F61-011

Assemblage vissées pour connexions électrique en cuivre

### BS EN 3373-014

Aerospace series- Terminal lugs and in-linesplices for crimping on electric conductors

## Connecting devices

Binder N°2

### IEC 61210

Connecting devices - Flat quick-connect terminations for electrical copper conductors - Safety requirements

### IEC 61545

Connecting devices - Devices for the connection of aluminium conductors in clamping units of any material and copper conductors in aluminium bodied clamping units

### IEC 60998-1

Connecting devices for low-voltage circuits for household and similar purposes - Part 1: General requirements

### IEC 60999-1

Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm<sup>2</sup> up to 35 mm<sup>2</sup> (included)

### IEC 60999-2

Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 2: Particular requirements for clamping units for conductors above 35 mm<sup>2</sup> up to 300 mm<sup>2</sup> (included)





# STANDARD

Connectors for electronic equipment

Binder N°3

## IEC 60512-1-1

Connectors for electronic equipment - Tests and measurements - Part 1-1: General examination - Test 1a: Visual examination

## IEC 60512-1-2

Connectors for electronic equipment - Tests and measurements - Part 1-2: General examination - Test 1b: Examination of dimension and mass

## IEC 60512-2-1

Connectors for electronic equipment - Tests and measurements - Part 2-1: Electrical continuity and contact resistance tests - Test 2a: Contact resistance - Millivolt level method

## IEC 60512-5-1

Connectors for electronic equipment - Tests and measurements - Part 5-1: Current-carrying capacity tests - Test 5a: Temperature rise

## IEC 60512-4-3

Connectors for electronic equipment - Tests and measurements - Part 4-3: Voltage stress tests - Test 4c: Voltage proof of pre-insulated crimp barrels

## IEC 60512-9-5

Connectors for electronic equipment - Tests and measurements - Part 9-4: Endurance tests - Test 9d: Durability of contact retention system and seals (maintenance, ageing)

## IEC 60512-11-1

Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 11: Climatic tests - Section 1: Test 11a - Climatic sequence

## IEC 60512-11-4

Connectors for electronic equipment - Tests and measurements - Part 11-4: Climatic tests - Test 11d: Rapid change of temperature

## IEC 60512-11-9

Connectors for electronic equipment - Tests and measurements - Part 11-9: Climatic tests - Test 11i: Dry heat

## IEC 60512-11-13

Connectors for electronic equipment - Tests and measurements - Part 11-13: Climatic tests - Test 11n: Gas tightness, solderless wrapped connections

## IEC 60512-16-1

Connectors for electronic equipment - Tests and measurements - Part 16-1: Mechanical tests on contacts and terminations - Test 16a: Probe damage

## IEC 60512-16-4

Connectors for electronic equipment - Tests and measurements - Part 16-4: Mechanical tests on contacts and terminations - Test 16d: Tensile strength (crimped connections)

## IEC 60512-16-8

Connectors for electronic equipment - Tests and measurements - Part 16-8: Mechanical tests on connections and terminations - Test 16h: Insulating grip effectiveness (crimped connections)

## IEC 60512-19-3

Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 19: Chemical resistance tests - Section 3: Test 19c - Fluid resistance



# STANDARD

**IEC 60068** *Environmental testing*

*Binder N°4*

**IEC 60068-2-1**

Test A : Cold

**IEC 60068-2-6**

Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)

**IEC 60068-2-18**

Environmental testing - Part 2-18: Tests - Test R and guidance: Water

**IEC 60068-2-21**

Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices

**IEC 60068-2-30**

Environmental testing –

Part 2-30: Tests – Test Db: Damp heat, cyclic (12 + 12 h cycle)

**IEC 60068-2-31**

Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens

**IEC 60068-2-42**

Environmental testing - Part 2-42: Tests - Test Kc: Sulphur dioxide test for contacts and connections

**IEC 60068-2-57**

Environmental testing - Part 2-57: Tests - Test Ff: Vibration - Time-history and sine-beat method

**IEC 60068-2-58**

Environmental testing - Part 2-58: Tests - Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)

**IEC 60068-2-75**

Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests

**IEC 60068-2-78**

Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state



# STANDARD



It is important to consider the application and the environment in which the product will evolve. This is why some standards show their limits in the constraints and requirements expected by customers.

We must therefore go further in the knowledge of standards and regulations related to electronic trade, electricity, rotating and static machines ...

This allows to provide a response tailored to customer demand.



**IEC 61000 CEM**

**Current and short circuit**

**IEC 60034 Rotating machine**

**IEC 60076 Transformers**

**Cable**

**Metrology and calibration**

**Insulation et rotating machine**

**Plastic and insulation**

**Plastic and thermoplastic**

**PEEK**

**Properties of metals**

**Technical engineering**

**Aluminum**

**Technical specifications**

**EDF Specifications**

Q U A L I F I C A T I O N



# STANDARD

IEC 61000 *ECM1*

Binder N°5

**IEC 61000-3-2**

Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase)

**IEC 61000-3-3**

Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current  $\leq 16$  A per phase and not subject to conditional connection

**IEC 61000-3-8**

Electromagnetic compatibility (EMC) - Part 3: Limits - Section 8: Signalling on low-voltage electrical installations - Emission levels, frequency bands and electromagnetic disturbance levels

**IEC 61000-4-2**

Electromagnetic compatibility (EMC) –  
Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

**IEC 61000-4-4**

Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test

**IEC 61000-4-5**

Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test

IEC 61000 *ECM2*

Binder N°6

**IEC 61000-4-11**

Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

**IEC 61000-4-30**

Electromagnetic compatibility (EMC) - Part 4-30: Testing and measurement techniques - Power quality measurement methods

**IEC 6000-6-2**

Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments

**ETSI EN 301 843-1**

Electromagnetic compatibility and radio spectrum matters  
Common technical requirement



# STANDARD

## Current and short circuit

Binder N°6

### IEC 60949

Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects

### IEC 60287-1-1

Electric cables - Calculation of the current rating - Part 1-1: Current rating equations (100 % load factor) and calculation of losses - General

### IEC 60287-2-1

Electric cables - Calculation of the current rating - Part 2-1: Thermal resistance - Calculation of the thermal resistance

### IEC 60865-1

Short-circuit currents - Calculation of effects - Part 1: Definitions and calculation methods

### 214

The mechanical effects of currents of short-circuit currents

## IEC 60034 Rotating machines

Binder N°7

### IEC 60034-1

Rotating electrical machines - Part 1: Rating and performance

### IEC 60034-2-2

Rotating electrical machines - Part 2-2: Specific methods for determining separate losses of large machines from tests - Supplement to IEC 60034-2-1

### IEC 60034-7

Rotating electrical machines - Part 7: Classification of types of constructions and mounting arrangements (IM Code)

### IEC 60034-12

Rotating electrical machines - Part 12: Starting performance of single-speed three-phase cage induction motors

### IEC 60034-14

Rotating electrical machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of vibration severity

### IEC 60034-18-22

Rotating electrical machines –Part 18-22:  
Functional evaluation of insulation systems – Test procedures for wire-wound windings – Classification of changes and insulation component substitutions

### IEC TS 60034-18-41

Rotating electrical machines - Part 18-41: Partial discharge free electrical insulation systems (Type I) used in rotating electrical machines fed from voltage converters - Qualification and quality control tests

### IEC 60034-30

Rotating electrical machines –  
Part 30-1: Efficiency classes of line operated AC motors (IE code)



# STANDARD

## IEC 60076 *Transformers*

*Binder N°8*

### IEC 60076-3

Insulation levels, dielectric tests and external clearance in air

### IEC 60076-4

Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors

### IEC 60076-5

Power transformers - Part 5: Ability to withstand short circuit

### IEC 60076-7

Laoding guide for oil-immersed power transformers

### IEC 60078-8

Power transformers – Application guide

### IEC 60076-10

Power transformers - Part 10: Determination of sound levels

### IEC 60076-11

Part 11: Dry-type transformers

## Cable

*Binder N°18*

### IEC 60228

Conductors of insulated cables

### IEC 60227-5

Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 5: Flexible cables (cords)

### IEC 61442

Test methods for accessories for power cables with rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)

### IEC 60502-1

Power cables with extruded insulation and their accessories for rated voltages from 1 kV ( $U_m = 1,2$  kV) up to 30 kV ( $U_m = 36$  kV) –

### IEC 60099-5

Surge arresters - Part 5: Selection and application recommendations

## Métrology and calibration

*Binder N°20*

### BS EN 10204

Metallic products-Type of inspection documents

### Guide d'accréditation Metrologie dimensionnelle

### Guide d'accréditation :

Metrologie des forces

### ISO 7500-1

Tension/compression testing machine- Verification and calibrationof the force-measuring system

### Recommandation internationale OIML R 65

Système de mesure de force des machines uniaxiales d'essai des matériaux

### Recommandation internationale OIML G 10

Equipement d'un service national de métrologie



# PRESCRIPTION

## Machine tournantes et Isolation

Binder N° 20

### Technique de l'ingénieur

Bobinage des machines tournantes à courant alternatif

#### Schneider

Démarrage et protection des moteurs

#### AMR

Guide utilisateur BEM

#### Schneider 207

Les moteurs électriques pour mieux les piloter et les protéger

#### Schneider 83

Pertes supplémentaires dans les conducteurs pour forte intensité par effet de peau et de proximité

#### Rocwell

Notions fondamentales sur la protection des moteurs

## Machine tournantes et Isolations

Binder N° 21

### Thèse Vasil MIHAILA

Nouvelle conception des bobinages statoriques des machines à courant alternatif pour réduire les effets négatifs de  $dV/dT$

### Thèse Fabrice AYMUNIMO

Etude du comportement des systèmes d'isolation des machines tournantes à courant alternatif fonctionnant sous hautes températures (200°C-400°C)

### Thèse d Walid BOUGHANMI

Eco-conception des motorisations électriques : Application à la machine asynchrone.

### Thèse Vincent BOUCHER

Etude du vieillissement de matériaux hautes températures pour machines tournantes et définition de méthodes d'essai accélérées.

### Thèse Benoit PETITGRAS

Origin of the failure occurring in high temperature electrical machine : a route to improve the electrical behavior of enamel wires.



# PRESCRIPTION

## Plastiques et Isolation

Binder N°22

### Thèse Paul SABATIER

Modélisation du vieillissement organique sous contrainte électrique  
Application à la fiabilité des matériaux

### Thèse Sébastien DOMINGUEZ

Relation structure / propriétés de polymères et mélange thermoplastiques thermostables-application aéronautique hautes température

### Thèse Piotr WERYNSKI

Vieillessement des diélectrique et surveillance in situ des machines électrique

### Science des matériaux de l'électrotechnique

Travaux pratiques et exercices

### Thèse Anh Tho VU THI

Etude de l'origine des décharges partielles sur les substrats céramiques enrobés

### Thèse Sergei SAVIN

Nouvel indicateur de vieillissement de l'isolation inter-spires des machines électriques utilisées en aéronautique

## Plastique et thermoplastique

Binder N°23

### Thèse Jean LAMETHE

Etude de l'adhésion de composites thermoplastiques semi-cristallins; application à la mise en oeuvre par soudure.

### Quadrant

Plastique technique

### AMR

Thermoplastique et thermodurcissable

### ISOSUD

Programme de livraison

## PEEK

Binder N°24

### Thèse Isabelle Giraug

Elaboration d'ensimages thermoplastiques thermostable :  
Influence sur le comportement mécanique des composites PEEK/ fibre de carbones

### Thèse Marion DASRIAUX

Evolutions microstructurales du PEEK au dessus de sa température de transition vitreuse lors de maintient sous pression et température

### Technique de l'ingénieur

PEEK

### VICTREX

Document action complète de la mise en oeuvre du PEEK





# PRESCRIPTION

## Spécifications techniques

Binder N°28

### TE Connectivity

Durable, fully automatic termination of Al stranded conductors using the LITEALUM crimp

### TECA

Technique de raccordement pour câble HT

### EUROAIRPORT

Cahier des directives technique pour l'exécution des armoires électrique basse tension

### Sertissage de contact électrique dans l'aéronautique

Modélisation, corrélation et étude paramétrique

### ST 128

Revêtement électrolytique de nickel et de chrome

### Spécification militaire

Terminal, Lugs, conductor crimp style, copper.

### MOLEX

Guide su sertissage

## Spécification EDF

Binder N°29

### HN 68-S-90

Raccordement par poinçonnage profond de câble isolés à âme en aluminium

### HN 63-S-61

Tableaux basse tension (TIPI) des postes HTA/BT de distribution publique à 440 V

### HN 20-S-62

Dispositions préventives contre la corrosion de l'aluminium et de ses alliages dans les matériels de postes



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COMMUNICATION