

## NICALC

Nickel coating applied on aluminium or aluminium-alloy parts for optimal electrical conductivity.

### Characteristics:

- Globular structure that offers a great number of contact sites between connected surfaces (reduced contact resistance)
- High ductility and low residual stress
- Highly stable conductivity at temperature

### Materials that can be treated:

- Pure aluminium
- Type 6060 aluminium alloys (AGS)

### Sample applications:

- Electrical connections for weak signals • Copper-aluminium electrical connections • Power current transmissions for fly-by-wire aircraft and rolling stock • Automotive connections

### Description

Aluminium and its alloys are the materials of choice for implementing connections because of their electrical conduction properties, associated with the characteristics:

- solderability
- ductility

The electrical properties of aluminium are enhanced through application of the Nicalc treatment, which prevents formation of an oxide layer on its surface. The coating is applied directly to the surface of the aluminium and its alloys, guaranteeing optimum adhesion from the lowest operating temperatures up to the melting point of the substrate metal.

### Sample applications

- Terminals
- Link bars
- Weld-on earth studs
- Locking nuts
- Fuse connectors

### References

This solution, which has been approved for use on fly-by-wire aircraft and on rolling stock, is so reliable that it is used to transmit the electrical power of this equipment without any risk of environmental interference.

### Materials suitable for treatment

To a great extent the NICALC process can be enhanced by using pure aluminium (alloy 1050) or by using aluminium alloy, type AGS (6101, 6060). Avoid using series 5000 alloys.

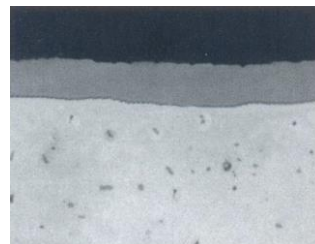
### Thickness of the deposition

$15 \pm 5 \mu\text{m}$

### Deposition characteristics

- Globular structure: The globular structure allows a great number of electrical contact sites between the connected surfaces, and thus reduces contact resistance.
- High ductility and low residual stress: These properties guarantee good deformability under mechanical stress, for example when clamping electrical contacts.

Temperature stability: NICALC maintains the contact resistance of connections subjected to repeated thermal cycles. See the test below:



## Thermal cycling ageing tests

(As stipulated in French standard NFC 63.061)

### Description of a cycle

- Temperature rise (10°C/mn) by means of alternating current
- Maintained for 20' at  $210 \pm 1^\circ\text{C}$
- Power cut-off and forced-air cooling to ambient temperature + 5°C
- Contact resistance measurements taken at ambient temperature at the end of each heating cycle using a 50 A direct current through the circuit (measurement of the voltage drops thus created). (Fig. 2)

### Cycling parameters

- Number of cycles: 500
- Current density: 80 to 250 A/cm<sup>2</sup>
- Connectors crimped on NICALLEC-treated aluminium cables (Fig. 1)
- Cables connected in series by bolted connections (Fig. 1)

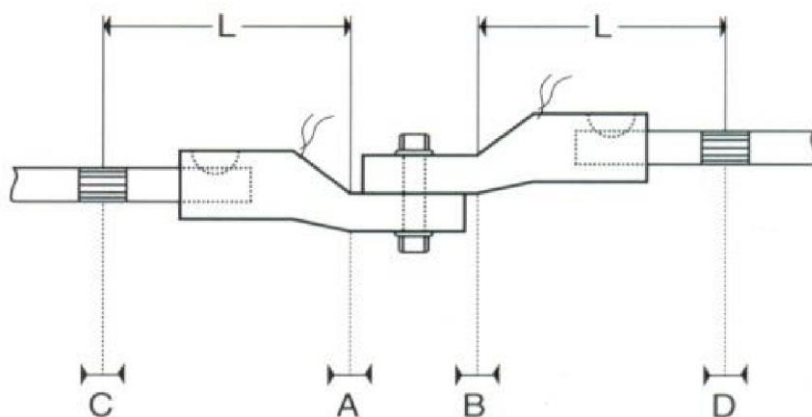


Figure 1:  
Diagram of measurements taken on each connection during the thermal cycle.

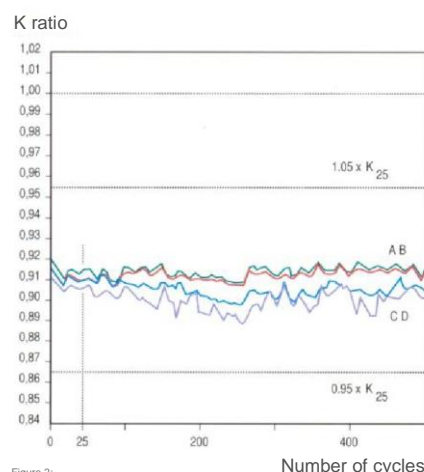


Figure 2:

Development of contact resistance between connector and cable, during the thermal cycle for the same connector ferrule, expressed as a ratio:

$$\text{Ratio K} = \frac{\text{Contact resistance}}{\text{Resistance of a fixed length of reference cable}}$$

- Measurements taken in A
- Measurements taken in B
- Measurements taken in C
- Measurements taken in D

Retention for 500 ratio cycles K measured after 25 cycles ( $K_{25}$ ) with tolerance less than 5%.