

## Qualification of mechanical connectors on large-size aluminum conductors for HV/EHV accessories based on TB 758 Cigré brochure

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### ABSTRACT

*This paper presents the results from the qualification test performed on connectors for large aluminum conductors both with stranded and segmental cable profiles. In particular, the mechanical connection technique, indent compression, is qualified to be used to connect 2500 mm<sup>2</sup> aluminum Milliken conductors according to TB 758 Cigré brochure. The brochure is guidance in development tests for verifying new conductor/connector combinations or changes in connector/conductor combinations in already qualified HV/EHV cable systems [1]. The test object successfully passed a complete program following the given order and all mentioned verification criteria described in TB 758 Cigré brochure.*

### KEYWORDS

HV/EHV cable systems, Network components, Conductor connector, Shear bolt connection, Welding connection technique, Indent compression technique, TB 758 Cigré brochure.

### INTRODUCTION

Modern technological developments have unlocked a vast variety of cable accessories, such as cable joints, terminations, and connectors, the usage of which depends on the function, cable type, and installation techniques. All the designs revolve around one of the most fundamental components present in all types of accessories - the conductor connector. Conductor connectors are responsible for carrying an electrical current from one cable length to another, or from a cable end to other electrical equipment (transformers, switchgear, or overhead lines). The choice of connector material, shape, and connection technique plays a major role in the reliability and effectiveness of the accessory.

Nowadays, there is a higher demand for aluminum (Al) cable systems. Cable manufacturing companies are moving towards Al conductors, which require a larger cross-section compared to the copper equivalent. Hence, it is evident that actions must be taken in the further development of conductor connection techniques for large Al cables to connect cables to each other, or to other electrical equipment. The most important parameters to consider when choosing a conductor connection type are reliability, longer lifespan, low costs of installation and tools required, and simplicity. Currently, there are many techniques available for connecting conductors, the most commonly used are welding and mechanical compression. Mechanical compression examples are shear bolt connection, indent compression, and hexagonal compression.

### Welded connectors

Welding has been vastly used for many decades due to the fact that this connection technique is stronger both mechanically and electrically. Despite the fact that specific workmanship and tools are required for the installation process, this method is still commonly used. However, the cable industry is moving towards simpler connection techniques to achieve less man-dependent and more HSE- (Health, Safety, and Environment) friendly solutions. Most European electricity transmission system operators are pushing against welding due to the above-described predispositions. The solution is to move from the welded connection to the mechanical connection. Therefore efforts have been concentrated on developing various alternative mechanical solutions to offer to the global market. The most commonly used are shear bolt and indent compression techniques (Appendix 1).

### Shear bolt connectors

A shear bolt connection technique is a mechanical connection between the sleeve (connector) and the conductor using bolts that shear off at a pre-determined torsional moment, forming a smooth conductor-connector connection by penetrating the conductor and allowing the current to flow through contact points at locations of the bolts and by pressing the conductor against the sleeve. It is a common solution in the industry because the process is stable (bolts shear off at a pre-determined torsional moment, eliminating potential handling errors) and the installation process is simple. However, the variety of designs available is very broad as each conductor needs a different design depending on the size, type, and material of the conductor, and the specifics of the network component design for which the connection is intended to be used limit its application. Another disadvantage of such connections is a limited contact area since it is linked to the size of a bolt, hence a large number of bolts is required, leading to a larger connector size overall (Appendix 2).

### Indent compression connectors

Indent compression technique, on the other hand, does not require additional non-reusable bolts as it is simply focused on penetrating the conductor-connector combination by punching it in multiple locations using a metal pin connected to the mould which is wrapped around the connector to guide the pin to be pressed using a pressure pump with a desired force. Such a technique breaks down the oxides and establishes an electrically and mechanically sound connection. The tools and pins reduce human elements during installation, allowing a more systematic performance of the connection. Based on market knowledge, it is one of the best-practiced techniques used across the industry.