Technical News

Device Substitution – AS/NZS 61439.1

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In May 2021, the Low Voltage Switchgear and Controlgear Assemblies Standards (AS/NZS 61439 series) superseded the previous AS/NZS 3439 series.

Most of the testing and compliance requirements are not substantially different, however it was recognised that interpretations of requirements and the methods to prove compliance to the old series varied widely.

The new series of standards goes to great lengths to address these issues and in the process, some new terminologies have been introduced in AS/NZS 61439.1 which help clarify key principles[1]. One such term is 'device substitution', which can become a topic of confusion for independent switchboard builders when considering a design verification plan.

Device Substitution

Switchboard builders often want the flexibility to construct assemblies using short-circuit protective devices from a variety of manufacturers to cater for varying client specifications. However, they do not want the expense of repeating tests with devices from each manufacturer.

So, is it acceptable under the AS/NZS 61439 series to test with devices from one manufacturer and then substitute these devices from a different manufacturer without re-testing?

AS/NZS 61439.1 addresses this question in two sections by looking at the comparison of temperature rise and short circuit withstand strength to reference designs.

Temperature rise

Under section 10.10, Temperature Rise clause 10.10.3.5 (Functional Units – Device Substitution) suggests that a device may be substituted with a similar device from a different manufacturer if:

1) The device rating does not exceed 3150A

2) The power loss is the same or lower

3) The terminal temperature rise (tested in accordance with the relevant product standard) is the same or lower

4) The physical arrangement within the functional unit and the rating of the functional unit are maintained or improved with respect to thermal considerations.

If items 1) and 4) are maintained, then items 2) and 3) can be determined by a comparison of technical data.

Information on power loss (watts loss) is commonly provided by manufacturers, however terminal temperature rise will be more difficult to obtain. This may necessitate a temperature rise test to be conducted on representative product samples to gain suitable data. Power loss testing can also be conducted if required. All testing of this nature should be done in accordance with the respective product standards for device comparisons.

1) It is assumed the reader has access to a copy of AS/NZS 61439.1 which should be referenced in conjunction with this paper for definitions of terms used, and completeness of understanding.

Short-circuit withstand strength

Clause 10.11.3 deals with short-circuit withstand strength comparison to a reference design by providing a checklist in Table 13[2]. This table can be largely broken up into sections covering consideration for conductors, devices and the enclosure.

- Table 13 items 1, 2, 3, 4 and 5 focus on busbars, busbar supports and mounting structures. If a device substitution is not going to cause changes to the busbar arrangement (or any main conductors), the requirements of these items will be satisfied.
- Item 8 is concerned with ensuring the length of any unprotected live conductors are less than or equal compared to those in reference testing. If the device substitution does not affect unprotected cable lengths, the requirements of this item will be satisfied.
- Items 9, 10, and 11 of Table 13 focus on the enclosure dimensions and mechanical construction within which the device is to be mounted. Again, the requirements of these items will be satisfied if the device substitution does not change the enclosure arrangement.

For device substitution of short circuit protective devices, items 6 and 7 are of particular interest.

Item 6 of Table 13 requires the assembly manufacturer (AM) to assess the suitability of the substituting device (SD) for the assembly at its rated operational voltage, as well as conducting some direct technical data comparisons between the SD and the tested device (TD). The checklist for Item 6 includes:

i) Confirm the breaking capacity of the SD is not less than the short-circuit rating of the assembly.

(Action: Assess assembly short-circuit rating).

ii) For a current limiting device, confirm the peak let-through current (I_{pk}) of the SD is equal to or smaller than the TD.

(Action: Comparison of manufacturers' technical data).

iii) For a current limiting device, confirm the let-through energy (I^2t) of the SD is equal to or smaller than the TD.

(Action: Comparison of manufacturers' technical data).

iv) For a non-current limiting device, confirm the short time withstand current (I_{cw}) of the SD is equal to or higher than the TD.

(Action: Comparison of manufacturers' technical data).

v) Confirm the SD fulfils the requirements of co-ordination with upstream and downstream devices.

(Action: Select upstream and downstream devices and assess suitability).

vi) Confirm the SD has equal or smaller critical distances to the reference design.

While the term 'critical distances' is not defined in the standard, it is taken to mean clearances from ionised gas venting ports on the device.

(Action: Compare manufacturers' installation clearances for SD to verified design).

vii) Confirm mechanical orientation, including direction and position of venting of arc chutes of the SD is the same as TD.

(Action: Comparison of manufacturers' technical data and assessment of assembly layout).

Item 7 of Table 13 of AS/NZS 61439.1 is the same as Item 6 of Table 13 from IEC 61439.1. It largely reinforces the key requirements of Item 6 (above) ensuring the SD has the same or better limitation characteristics (I^2t, I_{pk}) with the same orientation. It is qualified by Note[a] (see below) which tends to re-emphasise the requirements and reinforces the role that the AM has in declaring the SD suitable for use in the verified assembly.

3) AS NZS 61439.1-2016 Table 13 Note[a]

"Short-circuit protective devices from the same manufacturer but of a different series, or devices from a different manufacturer, may be considered equivalent and be substituted for the original device if the requirements of the device manufacturer are complied with and the assembly manufacturer declares the performance characteristics to be the same or better in all relevant respects to the series used for verification, e.g. breaking capacity, limitation characteristics (I^2t, I_{pk}) and the critical distances (safety perimeters)."

2) In AS/NZS 61439.1, Appendix ZA amends Table 13 by adding a new item 6 and renumbering the original items 6-10 to 7-11

3) Excerpt from AS/NZS 61439.1-2016, Appendix ZA, Table 13, item 1, Note[a]. Excerpts from the Standard are not to be used in substitution for referring to the full text in the Standard.

Internal arc fault tests

AS/NZS 61439.1 includes guidance on conducting internal arc fault testing of assemblies, as detailed in Appendix ZD. The results of these tests are very much dependent on the capability of circuit protective devices to interrupt and limit the energy let-through into the fault. Therefore, it can be expected that if a device that plays a key protective role in an internal arc fault test within an assembly design is then replaced with a substitute device, the new device will need to perform equivalently in order for the test integrity to be maintained. AS/NZS 61439.1 acknowledges this in clause ZD2.

"Any significant changes made to the design which might reduce the strength or arc resistance of components, or modify the venting provisions or the characteristics of protective devices, will require further tests to verify the security provided by the modified ASSEMBLY against the effects of internal arcing." [4]

For devices successfully verified through substitution per AS/NZS 61439.1, any deviations in performance characteristics and venting provisions between the devices have already been considered. It is then expected that any existing arc fault testing to Appendix ZD that utilises the original device would also be applicable when the substitute device is used in the same manner.

Conclusion

AS/NZS 61439.1 allows for short circuit protective devices tested as part of a verified reference design to be substituted with similar devices from the same or another manufacturer. While the process of verifying a substitution by comparison is likely to be less costly and time consuming than testing, there is still an essential process required of comparing technical data and assessing the suitability of substitute devices for the assembly. At the conclusion, the assembly manufacturer has an integral part to play in declaring the device performance characteristics are suitable for their assembly verification.

Interested in learning more?

Have a discussion with your local NHP Account Representative for advice and any queries you may have regarding device substitution and to evaluate some worked examples to help reinforce the principles. Remember, your NHP Account Representative is backed by a supporting team of technical and engineering professionals who can help with simple or complex applications.

4) Excerpt from AS/NZS 61439.1 Appendix ZD clause ZD2. Excerpts from the Standard are not to be used in substitution for referring to the full text in the Standard.

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