

- 連接 2 個終端點之導體，應不具有中間點，例：接合或焊接。
- 僅具有基本絕緣之導體，應防止與不同電位之裸帶電零件接觸。
- 應防止與邊緣銳利之導體接觸。
- 在外蓋及門中，至設備及量測儀器之電源導體應予妥善安裝，使得導體不會因此等外蓋或門移動而受到機械性損壞。
- 僅當針對與設備之銲接型連接有規定時，始容許在組裝品中有此型式之連接。
- 對於非上述之設備，在重度振動情況下，不容許絞線導體之銲接電纜掛耳或銲接端。在正常操作期間存在重度振動之位置，例：在挖泥船及起重機操作之情況下，在船上、吊運設備及火車頭上之操作，宜留意導體之支撐物。
- 通常，僅宜 1 個導體連接至端子；僅在端子係設定供此種用途時，始容許 2 個或多個導體連接至端子。

獨立電路之間的實心絕緣，其尺寸應以最高額定絕緣電壓之電路為基礎。

8.6.4 Selection and installation of non-protected live conductors to reduce the possibility of short-circuits

Live conductors in an ASSEMBLY that are not protected by short-circuit protective devices (see 8.6.1 and 8.6.2) shall be selected and installed throughout the entire ASSEMBLY in such a manner that an internal short-circuit between phases or between phase and earth is a remote possibility. Examples of conductor types and installation requirements are given in Table 4. Non-protected live conductors selected and installed as in Table 4 shall have a total length not exceeding 3 m between the main busbar and each respective SCPD.

8.6.4 非保護性帶電導體之選擇及安裝，以降低短路之可能性

組裝品中，未受短路保護裝置所保護之帶電導體(參照 8.6.1 及 8.6.2)，應透過整個組裝品加以選擇及安裝，使得相間或相與地間發生內部短路之可能性極小。導體之型式及安裝要求之範例，如表 4 所示。依表 4 所選擇及安裝之未受保護的帶電導體，其主匯流排與每一個別短路保護裝置之間的總長度不應超過 3 m。

8.6.5 Identification of the conductors of main and auxiliary circuits

With the exception of the cases mentioned in 8.6.6, the method and the extent of identification of conductors, for example by arrangement, colours or symbols, on the terminals to which they are connected or on the end(s) of the conductors themselves, is the responsibility of the ASSEMBLY manufacturer and shall be in agreement with the indications on the wiring diagrams and drawings. Where appropriate, identification according to IEC 60445 shall be applied.

8.6.5 主電路及輔助電路之識別

除 8.6.6 所述之情況外，導體之識別方法及範圍(例：以配置、顏色或符號之方式，於導體所連接之端子或於導體本身之尾端)係屬組裝品製造廠商之責任，且應與配線圖及圖面之指示一致。若適合時，應採用 IEC 60445 所規定之識別。

8.6.6 Identification of the protective conductor (PE, PEN) and of the neutral conductor (N) of the main circuits

The protective conductor shall be readily distinguishable by location and/or marking or colour. If identification by colour is used, it shall only be green and yellow (twin-coloured), which is strictly reserved for the protective conductor. When the protective conductor is an insulated single-core cable, this colour identification shall be used, preferably throughout the whole length.

Any neutral conductor of the main circuit shall be readily distinguishable by location and/or marking or colour (see IEC 60445 where blue is required).

NOTE In some countries (e.g. USA, Australia, South Africa) other colours for the neutral conductor are required.

8.6.6 保護性導體(PE、PEN)及主電路中性導體之識別

應以位置及/或標示或顏色，使保護性導體易於區分。若使用顏色之識別，其應僅為綠色及黃色(雙色)，其完全保留給保護性導體。當保護性導體為絕緣單心電纜，應使用此顏色識別，最好在整個長度內。

應以位置及/或標示或顏色(當有需要使用藍色時，參照 IEC 60445)，使主電路之任何中性導體易於區分。

備考：在某些國家(例：美國、澳洲、南非)，中性導體需要使用其他顏色。

8.7 Cooling

ASSEMBLIES can be provided with natural cooling and/or active cooling (e.g. forced cooling, internal air conditioning, heat exchanger etc.). If special precautions are required at the place of installation to ensure proper cooling, the ASSEMBLY manufacturer shall furnish the necessary information (for instance indication of the need for spacing with respect to parts that are liable to impede the dissipation of heat or produce heat themselves).

8.7 冷卻

組裝品可備有自然冷卻及/或主動冷卻(例：強制冷卻、內部空調、熱交換器等)。

在安裝之位置若需要特殊預防措施以確保有適當之冷卻，則組裝品製造廠商應提供必要之資訊(例：對於易阻礙散熱或本身會產生熱之零件，指示其所需要之間隔)。

8.8 Terminals for external conductors

The ASSEMBLY manufacturer shall indicate whether the terminals are suitable for connection of copper or aluminium conductors, or both. The terminals shall be such that the external conductors may be connected by a means (screws, connectors, etc.) which ensures that the necessary contact pressure corresponding to the current rating and the short-circuit strength of the apparatus and the circuit is maintained.

In the absence of a special agreement between the ASSEMBLY manufacturer and the user, terminals shall be capable of accommodating copper conductors from the smallest to the largest cross-sectional areas corresponding to the appropriate rated current (see Annex A).

Where aluminium conductors are to be terminated, the type, size and termination method of the conductors shall be as agreed between the ASSEMBLY manufacturer and the user.

In the case where external conductors for electronic circuits with low level currents and voltages (less than 1 A and less than 50 V a.c. or 120 V d.c.) have to be connected to an ASSEMBLY, Table A.1 does not apply.

8.8 外部導體用之端子

組裝品製造廠商應指示端子是否適合用於連接銅或鋁導體或銅與鋁兩者。端子應使得外部導體可藉由裝置(螺釘、連接器等)予以連接，此裝置確保可維持設備及電路之對應電流定額及短路強度所必要之接觸壓力。

在組裝品製造廠商與使用者之間無特殊協議之情況下，端子應能容納對應於適合之額定電流的最小至最大截面積之銅導體(參照附錄 A)。

當鋁導體須予以端接時，導體之型式、大小及終端應依組裝品製造廠商與使用者之協議。

在低位準電流及電壓(小於 1 A 且小於交流 50 V 或直流 120 V)之電子電路用的外部導體必須連接至組裝品的情況中，不適用 A.1。

The available wiring space shall permit proper connection of the external conductors of the indicated material and, in the case of multicore cables, spreading of the cores.

NOTE 1 In the United States of America (USA) and Mexico National Electrical Codes should be used for determining the minimum wire bending space requirements. In the USA NFPA 70, Article 312 is applicable. In Mexico NOM-001-SEDE is applicable. In Canada, wire space and wire bending space is prescribed in the Canadian Electrical Code, Part 2 Standard, C22.2 No. 0.12, Wire Space and Wire Bending Space in Enclosures for Equipment Rated 750 V or Less.

The conductors shall not be subjected to stresses, which are likely to reduce their normal life expectancy.

Unless otherwise agreed between the ASSEMBLY manufacturer and the user, on three-phase and neutral circuits, terminals for the neutral conductor shall allow the connection of copper conductors having a minimum cross-sectional area:

- equal to half the cross-sectional area of the phase conductor, with a minimum of 16 mm², if the size of the phase conductor exceeds 16 mm²;
- equal to the full cross-sectional area of the phase conductor, if the size of the latter is less than or equal to 16 mm².

NOTE 2 For conductors other than copper conductors, the above cross-sections should be replaced by cross-sections of equivalent conductivity, which may require larger terminals.

NOTE 3 For certain applications which lead to high values of zero sequence harmonics (e.g. 3rd order harmonics) higher cross-sections of the N conductor might be required as these harmonics of the phases are added in the N conductor and lead to high current load at higher frequencies. This is subject to special agreement between the ASSEMBLY manufacturer and the user.

If connecting facilities for incoming and outgoing neutral, protective and PEN conductors are provided; they shall be arranged in the vicinity of the associated phase conductor terminals.

可用之配線空間應能容許已指示之材料之外部導體進行適當之連接，且多芯電纜應容許各芯延展。

備考 1. 在美國及墨西哥，國家電氣法規宜用於決定最小配線彎曲空間之要求。在美國，可適用 NFPA 第 312 條。在墨西哥，可適用 NOM-001-SEDE。在加拿大，配線空間及配線彎曲空間敘述於加拿大電氣法規第 2 部標準 C22.2 No. 012 “歐洲額定為 750 V 以下之設備的配線空間及配線彎曲空間” 中。

導體不應遭受應力，應力有可能降低其正常壽命預期值。

除非組裝品製造廠商與使用者另有協議，在三相及中性電路上，中性點導體用之端子應容許連接下列截面積之銅導體。

- 若相導體之大小超過 16 mm²，則截面積等於相導體截面積之一半，但最小值為 16 mm²。
- 若相導體之大小在 16 mm² 以下，則截面積等於相導體之全部截面積。


備考 2. 對於銅導體除外之導體，上述截面積宜相同導電率之截面積取代，其可能需要較大之端子。

備考 3. 對於會導致高的零序諧波(例：3 次諧波)值之某些應用，可能需要較大截面之 N 導體，因為此等相諧波加總至 N 導體中，並導致在較高頻率下有高電流負載。此須由組裝品製造廠商與使用者進行特殊協議。

若備有內向及外向中性、保護及 PEN 導體用之連接設施，其應配置於相關聯之相導體端子之附近。

NOTE 4 IEC 60204-1 requires a minimum cross-section of the conductor and does not allow the connection of PEN into the electrical equipment of the machinery.

Openings in cable entries, cover plates, etc., shall be so designed that, when the cables are properly installed, the stated protective measures against contact and degree of protection shall be obtained. This implies the selection of means of entry suitable for the application as stated by the ASSEMBLY manufacturer.


The terminals for external protective conductors shall be marked according to IEC 60445. As an example see graphical symbol  No. 5019 of IEC 60417. This symbol is not required where the external protective conductor is intended to be connected to an internal protective conductor, which is clearly identified with the colours green and yellow.

The terminals for external protective conductors (PE, PEN) and metal sheathing of connecting cables (steel conduit, lead sheath, etc.) shall, where required, be bare and, unless otherwise specified, suitable for the connection of copper conductors. A separate terminal of adequate size shall be provided for the outgoing protective conductor(s) of each circuit.

Unless otherwise agreed between the ASSEMBLY manufacturer and the user, terminals for protective conductors shall allow the connection of copper conductors having a cross-section depending on the cross-section of the corresponding phase conductors according to Table 5.

備考 4. IEC 60204-1 要茄最小截面積之導體，且不容許 PEN 與機械裝置之電氣設備連接。

電纜入口、外蓋板等之開口，應予以妥善設計，使得當電纜經適當安裝後，應獲得防止接觸之指定保護措施及保護等級。此意味選擇適合於組裝品製造廠商所指定之應用的入口裝置。

外部保護性導體用之端子應依 IEC 60445 標示。有關範例，參照 IEC 60417 之 No. 5019 圖形符號 。當外部保護性導體係用於連接至內部保護性導體時，不需要此符號，該情況係以綠色及黃色識別。

外部保護性導體(PE、PEN)用之端子及連接電纜之金屬護套(鋼導管、鉛護套等)當有需要時，應為裸露，且除非另有規定，應適合於連接銅導體之用。應對外向保護性導體提供大小足夠之個別端子。

除非組裝品製造廠商與使用者另有協議，保護性導體用之端子應容許截面積取決於表 5 之相對應相導體截面積的銅導體之連接。

In the case of enclosures and conductors of aluminium or aluminium alloys, particular consideration shall be given to the danger of electrolytic corrosion. The connecting means to ensure the continuity of the conductive parts with external protective conductors shall have no other function.

NOTE 5 Special precautions may be necessary with metal parts of the ASSEMBLY, particularly gland plates, where abrasion resistant finishes, for example powder coatings, are used.

Identification of terminals shall comply with IEC 60445 unless otherwise stated.

在鋁或鋁合金製之箱體及導體方面，對於電解腐蝕之危險，應有特別考量。確保具有外部保護性導體之導電零件的連續性之連接裝置，應無其他功能。

備考 5. 組裝品之金屬零件，尤其是壓蓋板，當使用使用耐磨面漆(例：粉末塗層)時，可能需要特殊預防措施。

端子之識別應符合 IEC 60445 之規定，除非另有聲明。

9 Performance requirements

9.1 Dielectric properties

9.1.1 General

Each circuit of the ASSEMBLY shall be capable of withstanding:

- temporary overvoltages;
- transient overvoltages.

The ability to withstand temporary overvoltages, and the integrity of solid insulation, is verified by the power-frequency withstand voltage and the ability to withstand transient overvoltages is verified by the impulse withstand voltage.

9. 性能要求

9.1 電介質特性

9.1.1 一般

組裝品之每一電路應能耐受下列電壓。

- 暫時過電壓。
- 暫態過電壓。

以商頻耐電壓查證耐受暫時過電壓之能力及固態絕緣之完整性，並以衝擊耐電壓查證耐受暫態過電壓之能力。

9.1.2 Power-frequency withstand voltage

The circuits of the ASSEMBLY shall be capable of withstanding the appropriate power-frequency withstand voltages given in Tables 8 and 9 (see 10.9.2.1). The rated insulation voltage of any circuit of the ASSEMBLY shall be equal to or higher than its maximum operational voltage.

9.1.2 商頻耐電壓

組裝品之電路應能耐受表 8 及表 9 所示之適當商頻耐電壓(參照 10.9.2.1)。組裝品之任何電路的額定絕緣電壓，應等於或高於其最高操作電壓。

9.1.3 Impulse withstand voltage

9.1.3.1 Impulse withstand voltages of main circuits

Clearances from live parts to exposed conductive parts and between live parts of different potential shall be capable of withstanding the test voltage given in Table 10 appropriate to the rated impulse withstand voltage.

The rated impulse withstand voltage for a given rated operational voltage shall not be less than that corresponding in Annex G to the nominal voltage of the supply system of the circuit at the point where the ASSEMBLY is to be used and the appropriate overvoltage category.

9.1.3 衝擊耐電壓

9.1.3.1 主電路之衝擊耐電壓

從帶電零件至暴露性導電零件及不同電位之帶電零件之間的空間距離，應能耐受表 10 所示適合於額定衝擊耐電壓之試驗電壓。

對於已知之額定操作電壓，其額定衝擊耐電壓不應小於附錄 G 中當須使用組裝品之點及適當過電壓類別下所對應於電路之電源系統標稱電壓電壓。

9.1.3.2 Impulse withstand voltages of auxiliary circuits

- a) Auxiliary circuits that are connected to the main circuit and operate at the rated operational voltage without any means for reduction of overvoltage shall comply with the requirements of 9.1.3.1.

- b) Auxiliary circuits that are not connected to the main circuit may have an overvoltage withstand capacity different from that of the main circuit. The clearances of such circuits – a.c. or d.c. – shall be capable of withstanding the appropriate impulse withstand voltage in accordance with Annex G.

9.1.3.2 輔助電路之衝擊耐電壓

- (a) 連接至主電路並在額定操作電壓下操作而無任何降低過電壓之裝置的輔助電路，應符合 9.1.3.1 之要求。
- (b) 未連接至主電路之輔助電路，可具有不同於主電路之過電壓耐受容量的過電壓耐受容量。此電路之空間距離 – 交流或直流 – 應能耐受附錄 G 之適當衝擊耐電壓。

9.1.4 Protection of surge protective devices

When overvoltage conditions require surge protective devices (SPD's) to be connected to the main circuit, such SPD's shall be protected to prevent uncontrolled short-circuit conditions as specified by the SPD manufacturer.

9.1.4 突波保護裝置之保護

當過電壓條件需要使突波保護裝置連接至主電路時，此種突波保護裝置應予以保護，以避免突波保護裝置製造廠商所規定之不受控制的短路條件。

9.2 Temperature rise limits

The ASSEMBLY and its circuits shall be able to carry their rated currents under specified conditions (see 5.3.1, 5.3.2 and 5.3.3), taking into consideration the ratings of the components, their disposition and application, without exceeding the limits given in Table 6 when verified in accordance with 10.10. The temperature rise limits given in Table 6 apply for a mean ambient air temperature up to 35 °C.

The temperature rise of an element or part is the difference between the temperature of this element or part measured in accordance with 10.10.2.3.3 and the ambient air temperature outside the ASSEMBLY. If the mean ambient air temperature is higher than 35 °C, then the temperature rise limits have to be adapted for this special service condition, so that the sum of the ambient temperature and the individual temperature rise limit remains the same. If the mean ambient air temperature is lower than 35 °C the same adaptation of the temperature rise limits is allowed subject to agreement between the user and ASSEMBLY manufacturer.

The temperature rise shall not cause damage to current-carrying parts or adjacent parts of the ASSEMBLY. In particular, for insulating materials, the original manufacturer shall demonstrate compliance either by reference to the insulation temperature index (determined for example by the methods of IEC 60216) or by compliance with IEC 60085.

9.2 溫升限制

在規定之條件下，考量組件定額、組件排列及應用，當依 10.10 進行查證而未超過表 6 所示之限制值時，組裝品及其電路應能承載其額定電流。表 6 所示之溫升限制適用於平均周圍空氣溫度在 35°C 以下。

元件或零件之溫升係依 10.10.2.3.3 所測得此元件或零件之溫度與組裝品外部周圍空氣溫度的差。若平均周圍空氣溫度高於 35°C，則必須針對此特殊使用條件調整溫升限制，使得周圍溫度與個別溫升限制之總和保持相同。若平均周圍空氣溫度低於 35°C，則在使用者與組裝品製造廠商之協議下，容許溫升限制進行相同之調整。

溫升不應使組裝品之載流零件或鄰近零件造成損壞。尤其是對於絕緣材料，原始製造廠商應參考絕緣溫度指數(例：以 IEC 60216 之方法決定)或依 IEC 60085，以證明符合性。

NOTE 1 If the temperature rise limits have been changed to cover a different ambient temperature, then the rated current of all busbars, functional units etc. may need to be changed accordingly. The original manufacturer should state the measures to be taken, if any, to ensure compliance with the temperature limits. For ambient temperatures up to 50 °C this can be done by calculation, assuming that the over temperature of each component or device is proportional to the power loss generated in this component. There are devices where the power loss is substantially proportional to I^2 and others that have substantially fixed losses.

NOTE 2 In the United States of America (USA) and Mexico National Electrical Codes, are used to specify maximum temperature rises. In the USA, NFPA 70, Article 110.14C is applicable. In Mexico NOM-001-SEDE is applicable. For these applications, temperature rises should be selected using Annex M, Table M.1 of this standard. In Canada, maximum temperature rise is prescribed in the Canadian Electrical Code, Part 2, Product Safety Standards.

備考 1. 若溫升限制已改變，並包含不同之周圍溫度，則所有匯流排、功能性單元等，其額定電流可能需要配合改變。原始製造廠商宜指明所須採取之措施（若有時），以確保符合溫度限制。關於周圍溫度在 50°C 以下之情況，可藉由計算方式達成，並假定每一組件或裝置之最終溫度與該組件所產生之功率損失成正比。有些裝置之功率損失大致上與 I^2 成正比，其他裝置則大致為固定之功率損失。

備考 2. 在美國及墨西哥，使用國家電氣法規規定最大溫升。在美國，可適用 NFPA 70 第 110.14C 條。在墨西哥，可適用 NOM-001-DEDE。關於此等應用，宜使用本標準附錄 M 之表 M.1 選擇溫升。在加拿大，最大溫升係敘述於加拿大電氣法規第 2 部“產品安全標準”。

9.3 Short-circuit protection and short-circuit withstand strength

9.3.1 General

ASSEMBLIES shall be capable of withstanding the thermal and dynamic stresses resulting from short-circuit currents not exceeding the rated values.

NOTE 1 The short-circuit stresses may be reduced by the use of current-limiting devices e.g. inductance, current-limiting fuses or other current-limiting switching devices.

ASSEMBLIES shall be protected against short-circuit currents by means of, for example, circuit-breakers, fuses or combinations of both, which may either be incorporated in the ASSEMBLY or arranged outside it.

NOTE 2 For ASSEMBLIES intended for use in IT systems (see IEC 60364-5-52), the short-circuit protective device should have a sufficient breaking capacity on each single pole at line-to-line voltage to clear a double earth fault.

NOTE 3 Unless otherwise specified in the ASSEMBLY manufacturer's operating and maintenance instructions ASSEMBLIES that have been subjected to a short circuit may not be suitable for future service without inspection and/or maintenance by skilled personnel.

9.3 短路保護及短路耐受強度

9.3.1 一般

組裝品應能耐受未超過額定值之短路電流所產生的熱動及動態應力。

備考 1. 可使用限流裝置(例：電感、限流熔線或其他限流開關操作裝置)，以降低短路應力。

組裝品應以裝置(例：斷路器、熔線或前述兩者之組合)予以保護，防止短路電流，此等裝置可併入組裝品中，或配置在組裝品之外。

備考 2. 對於預定使用在 IT 系統(參照 IEC 60364-5-52)之組裝品，短路保護裝置在線對線電壓之每一單極上，宜具有充分之啟斷容量，以清除雙重接地故障。

備考 3. 除非組裝品製造廠商之操作及維護說明書另有規定外，已遭受短路之組

裝品未受專業人員檢驗及/或維護時，可能不適合用於未來之使用。

9.3.2 Information concerning short-circuit withstand strength

For ASSEMBLIES with a short-circuit protective device (SCPD) incorporated in the incoming unit, the ASSEMBLY manufacturer shall indicate the maximum allowable value of prospective short-circuit current at the input terminals of the ASSEMBLY. This value shall not exceed the appropriate rating(s) (see 5.3.3, 5.3.4 and 5.3.5). The corresponding power factor and peak values shall be those shown in 9.3.3.

If a circuit breaker with time-delay release is used as the short-circuit protective device, the ASSEMBLY manufacturer shall state the maximum time-delay and the current setting corresponding to the indicated prospective short-circuit current.

9.3.2 有關短路耐受強度之資訊

關於短路保護裝置(SCPD)合併於內向單元之組裝品，組裝品製造廠商應指示在組裝品輸入端子之預期短路電流的最高可容許值。此值不應超過適當之定額(參照 5.3.5、5.3.4 及 5.3.5)。相對應之功率因數及峰值，應如 9.3.3 所示之值。

若使用具有時間延遲釋放器之斷路器作為短路保護裝置，組裝品製造廠商應敘明對應於所指示之預期短路電流的最大時間延遲及電流設定。

For ASSEMBLIES where the short-circuit protective device is not incorporated in the incoming unit, the ASSEMBLY manufacturer shall indicate the short-circuit withstand strength in one or more of the following ways:

- a) rated short-time withstand current (I_{cw}) together with the associated duration (see 5.3.4) and rated peak withstand current (I_{pk}) (see 5.3.3);
- b) rated conditional short-circuit current (I_{cc}) (see 5.3.5).

對於短路保護裝置未合併於內向單元中之組裝品，組裝品製造廠商應以下列 1 種或多種方式指示短路耐受強度。

(a) 額定短時間耐受電流(I_{cw})連同相關聯之持續時間(參照 5.3.4)及額定峰值耐電流(I_{pk}) (參照 5.3.5)。

(b) 額定條件短路電流(I_{cc}) (參照 5.3.5)。

For times up to a maximum of 3 s, the relationship between the rated short-time current and the associated duration is given by the formula $I^2t = \text{constant}$, provided that the peak value does not exceed the rated peak withstand current.

The ASSEMBLY manufacturer shall indicate the characteristics of the short-circuit protective devices necessary for the protection of the ASSEMBLY.

For an ASSEMBLY having several incoming units which are unlikely to be in operation simultaneously, the short-circuit withstand strength can be indicated for each of the incoming units in accordance with the above.

For an ASSEMBLY having several incoming units which are likely to be in operation simultaneously, and for an ASSEMBLY having one incoming unit and one or more outgoing high-power units likely to contribute to the short-circuit current, it is necessary to determine the values of the prospective short-circuit current in each incoming unit, in each outgoing unit and in the busbars based on data provided by the user.

時間之最大值為 3 s 者，倘若峰值不超過額定峰值耐電流，則其額定短時間電流與相關聯之持續時間之間的關係，如公式 $I^2t = \text{定值}$ 所示。

組裝品製造廠商應指示保護組裝品所必要之短路保護裝置的特性。

對於具有數個有可能同時操作之內向單元的組裝品，可依上述規定針對每一內向單元指示其短路耐受強度。

對於具有數個有可能同時操作之內向單元的組裝品，以及對於具有有可能提供短路電流之 1 個內向單元及 1 個或多個外向高功率單元的組裝品，有必要決定

每個內向單元、每個外向單元及以使用者所提供之資料為基礎之匯流排的預期短路電流值。

9.3.3 Relationship between peak current and short-time current

For determining the electrodynamic stresses, the value of peak current shall be obtained by multiplying the r.m.s. value of the short-circuit current by the factor n . The values for the factor n and the corresponding power factor are given in Table 7.

9.3.3 峰值電流與短時間電流之關係

關於決定電動力學應力時，應將短路電流均方根值乘上因數 n ，以獲得峰值電流值。因數 n 之值及相對應之功率因數值，如表 7 所示。

9.3.4 Co-ordination of protective devices

The co-ordination of protective devices within the ASSEMBLY with those to be used external to the ASSEMBLY shall be the subject of an agreement between the ASSEMBLY manufacturer and the user. Information given in the ASSEMBLY manufacturer's catalogue may take the place of such an agreement.

If the operating conditions require maximum continuity of supply, the settings or selection of the short-circuit protective devices within the ASSEMBLY should, where possible, be so co-ordinated that a short circuit occurring in any outgoing circuit is cleared by the switching device installed in the circuit without affecting the other outgoing circuits, thus ensuring selectivity of the protective system.

Where short-circuit protective devices are connected in series and are intended to operate simultaneously to reach the required short-circuit switching capability (i.e. back-up protection), the ASSEMBLY manufacturer shall inform the user (e.g. by a warning label in the ASSEMBLY or in the operating instructions, see 6.2) that none of the protective devices are allowed to be replaced by another device which is not of identical type and rating, unless the device is tested and approved in combination with the back-up device since the switching capability of the whole combination may otherwise be compromised.

9.3.4 保護性裝置之協調

組裝品內之保護裝置與組裝品外部所使用之保護裝置，其之間的協調應由組裝品製造廠商與使用者協議。組裝品製造廠商之型錄所示之資訊，可取代此協議。若操作條件需要最大連續性之電源，組裝品內短路保護裝置之設定或選擇，宜儘可能加以協調，使得能藉由安裝在電路中之開關操作裝置清除在任何外向電路中所發生之短路，以確保保護系統之選擇性。

當短路保護裝置串聯連接且預定同時操作，以達到所要求之短路開關操作能力時(亦即，備分保護)，組裝品製造廠商應通知使用者(例：以組裝品或操作說明書之警告標籤，參照 6.2)不容許以型式及定額不相同之其他裝置取代任一保護裝置，除非裝置結合備分裝置已進行試驗並獲核可，因為整個組合之開關操作能力可能另外受危及。

9.4 Electromagnetic compatibility (EMC)

For EMC related performance requirements, see J.9.4 of Annex J.

9.4 電磁相容(EMC)

有關 EMC 相關之性能要求，參照附錄 J.9.4。

10 Design verification

10.1 General

Design verification is intended to verify compliance of the design of an ASSEMBLY or ASSEMBLY system with the requirements of this series of standards.

10. 設計查證

10.1 一般

設計查證係用於查證組裝品或組裝品系統之設計與本系列標準之要求的符合性。

Where tests on the ASSEMBLY have been conducted in accordance with the IEC 60439 series, and the test results fulfill the requirements of the relevant part of IEC 61439, the verification of these requirements need not be repeated.

Repetition of verifications in the product standards of switching devices or components incorporated in the ASSEMBLY, which have been selected in accordance with 8.5.3 and installed in accordance with the instructions of their manufacturer is not required. Tests on individual devices to their respective product standards are not an alternative to the design verifications in this standard for the ASSEMBLY.

If modifications are made to a verified ASSEMBLY, Clause 10 shall be used to check if these modifications affect the performance of the ASSEMBLY. New verifications shall be carried out if an adverse effect is likely.

The various methods include:

- verification testing;
- verification comparison with a tested reference design;
- verification assessment, i.e. confirmation of the correct application of calculations and design rules, including use of appropriate safety margins.

See Annex D.

When there is more than one method for the same verification, they are considered equivalent and the selection of the appropriate method is the responsibility of the original manufacturer.

The tests shall be performed on a representative sample of an ASSEMBLY in a clean and new condition.

The performance of the ASSEMBLY may be affected by the verification tests (e.g. short-circuit test). These tests should not be performed on an ASSEMBLY that is intended to be placed in service.

當已依 IEC 60439 系列 IEC 61439 系列於組裝品上進行試驗，且試驗結果達到 IEC 61439 系列相關標準之要求，則不需要重複進行此等要求之查證。

合併於組裝品中之開關操作裝置或組件，已依 8.5.3 之規定選擇並已依其製造廠商之說明書安裝，不需要採用產品標準進行重複查證。於個別裝置上依其個別產品標準所進行之試驗，非為本標準組裝品之設計查證的替代方案。

若對已查證過之組裝品進行修改，若此等修改影響組裝品之性能，則應使用第 10 節檢查。或可能有不利之影響，應進行新的查證。

各種方法包括下列項目。

- 查證試驗。
- 與經試驗過之參考設計的查證比較。
- 查證評鑑，亦即確認計算及設計規則之正確應用，包括使用適當之安全邊際。

參照附錄 D。

對於相同之查證，當有超過 1 種方法時，其視為等同，且選擇適當之方法係為原始製造廠商之責任。

應於乾淨且新的條件中，於代表性之組裝品樣本上進行試驗。

組裝品之性能可能受查證試驗(亦即，短路試驗)之影響。此等試驗不宜在預定投

入使用之組裝品上進行。

An ASSEMBLY which is verified in accordance with this standard by an original manufacturer (see 3.10.1) and manufactured or assembled by another does not require the original design verifications to be repeated if all the requirements and instructions specified and provided by the original manufacturer are met in full. Where the ASSEMBLY manufacturer incorporates their own arrangements not included in the original manufacturer's verification, the ASSEMBLY manufacturer is deemed to be the original manufacturer in respect of these arrangements.

Design verification shall comprise the following:

a) Construction:

- 10.2 Strength of materials and parts;
- 10.3 Degree of protection of enclosures;
- 10.4 Clearances and creepage distances;
- 10.5 Protection against electric shock and integrity of protective circuits;
- 10.6 Incorporation of switching devices and components;
- 10.7 Internal electrical circuits and connections;
- 10.8 Terminals for external conductors.

b) Performance:

- 10.9 Dielectric properties;
- 10.10 Verification of temperature rise;
- 10.11 Short-circuit withstand strength;
- 10.12 Electromagnetic compatibility;
- 10.13 Mechanical operation.

若完全符合所有要求及原始製造廠商所規定及提供之說明書，則依據本標準由原始製造廠商(3.10.1)查證並由其他製造廠商製造或組裝之組裝品，不需要重複原始設計查證。當組裝品製造廠商合併其本身之配置，而該配置未包含在原始製造廠商之查證中，則組裝品製造廠商視為原始製造廠商。

設計查證應包括下列項目。

(a) 構造

- 10.2 材料及零件之強度。
- 10.3 箱體之保護等級。
- 10.4 空間距離及沿面距離。
- 10.5 防電擊之保護及保護性電路之完整性。
- 10.6 開關操作裝置及組件之合併。
- 10.7 內部電氣電路及連接。
- 10.8 外部導體用之端子。

(b) 性能

- 10.9 電介質特性。
- 10.10 溫升之查證。
- 10.11 短路耐受強度。
- 10.12 電磁相容。
- 10.13 機械操作。

The reference designs, the number of ASSEMBLIES or parts thereof used for verification, the selection of the verification method when applicable, and the order in which the verification is carried out shall be at the discretion of the original manufacturer.

The data used, calculations made and comparison undertaken for the verification of ASSEMBLIES shall be recorded in verification reports.

參考設計、組裝品或用於查證之零件的數量、可適用之查證方法的選擇及進行查證之順序，應由原始製造廠商決定。

查證組裝品時所使用之資料、進行之計算及所從事之比較，應記錄於查證報告中。

10.2 Strength of materials and parts

10.2.1 General

The mechanical, electrical and thermal capability of constructional materials and parts of the ASSEMBLY shall be deemed to be proven by verification of construction and performance characteristics.

Where an empty enclosure in accordance with IEC 62208 is used, and it has not been modified so as to degrade the performance of the enclosure, no repetition of the enclosure testing to 10.2 is required.

10.2 材料及零件之強度

10.2.1 一般

組裝品之構造型材料及零件的機械、電氣及熱能力，應視為須以構造及性能特性查證加以查驗。

當使用 IEC 62208 之空箱體時，且未修改該箱體以致降低箱體性能，則不需要重複 10.2 之箱體試驗。

10.2.2 Resistance to corrosion

10.2.2.1 Test procedure

The resistance to corrosion of representative samples of ferrous metallic enclosures including internal and external ferrous metallic constructional parts of the ASSEMBLY shall be verified.

The test shall be carried out on:

- an enclosure or representative sample enclosure with representative internal parts in place and door(s) closed as in normal use, or
- representative enclosure parts and internal parts separately.

In all cases hinges, locks and fastenings shall also be tested unless they have previously been subjected to an equivalent test and their resistance to corrosion has not been compromised by their application.

10.2.2 耐蝕

10.2.2.1 試驗程序

應查證含鐵金屬箱體(包括組裝品之內部及外部含鐵金屬構造之零件)之代表性樣品的耐蝕性。

應於下列箱體或零件上進行試驗。

- 箱體或代表性樣品相體上，其具有代表性內部零件且門如正常使用時閉合。或
- 分別於代表性之箱體組件及內部零件上。

在所有情況中，鉸鏈、鎖及緊固件亦應進行試驗，除非其先前已進行同等試驗，且其應用未危及其耐蝕性。

Where the enclosure is subjected to the test it shall be mounted as for normal use according to the original manufacturer's instructions.

The test specimens shall be new and in a clean condition and shall be subjected to severity test A or B, as detailed in 10.2.2.2 and 10.2.2.3.

NOTE The salt mist test provides an atmosphere that accelerates corrosion and does not imply that the ASSEMBLY is suitable for salt laden atmosphere.

當箱體進行試驗時，其應如同正常使用般，依原始製造廠商說明書裝設。

試驗樣本應為新的並處於乾淨之情況中，且應進行嚴苛度試驗 A 或 B，詳如 10.2.2.2 及 10.2.2.3。

備考：鹽霧試驗提供加速腐蝕之環境，且不意味組裝品適合於鹽滿載之環境。

10.2.2.2 Severity test A

This test is applicable to:

- metallic indoor enclosures;
- external metallic parts of indoor ASSEMBLIES;
- internal metallic parts of indoor and outdoor ASSEMBLIES upon which intended mechanical operation may depend.

The test consists of:

6 cycles of 24 h each to damp heat cycling test according to IEC 60068-2-30 (Test Db) at $(40 \pm 3)^\circ\text{C}$ and relative humidity of 95 %

and

2 cycles of 24 h each to salt mist test according to IEC 60068-2-11; (Test Ka: Salt mist), at a temperature of $(35 \pm 2)^\circ\text{C}$.

10.2.2.2 嚴苛度試驗 A

本試驗可適用於

- 金屬屋外用箱體。
- 屋內用組裝品之外部金屬零件。
- 預應之機械操作可能倚賴之屋內用及屋外用組裝品的內部金屬零件。

試驗包括

在 $(40 \pm 3)^\circ\text{C}$ 及相對濕度 95 % 下，依 IEC 60068-2-30 進行濕熱循環試驗(試驗 Db) 6 個循環，每個循環 24 h。

及

在 $(35 \pm 2)^\circ\text{C}$ 下，依 IEC 60068-2-11 進行鹽霧試驗(試驗 Ka：鹽霧) 2 個循環，每個循環 24 h。

10.2.2.3 Severity test B

This test is applicable to:

- metallic outdoor enclosures;
- external metallic parts of outdoor ASSEMBLIES.

The test comprises two identical 12 day periods.

10.2.2.3 嚴苛度試驗 B

本試驗可適用於

- 金屬屋外用箱體。
- 屋內用組裝品之外部金屬零件。

試驗包括 2 個相同之 12 天週期。

Each 12 day period comprises:

5 cycles of 24 h each to damp heat cycling test according to IEC 60068-2-30 (Test Db) at $(40 \pm 3) ^\circ\text{C}$ and relative humidity of 95 %

and

7 cycles of 24 h each to salt mist test according to IEC 60068-2-11; (Test Ka: Salt mist), at a temperature of $(35 \pm 2) ^\circ\text{C}$.

每個 12 天週期包括

在 $(40 \pm 3)^\circ\text{C}$ 及相對濕度 95 % 下，依 IEC 60068-2-30 進行濕熱循環試驗(試驗 Db) 5 個循環，每個循環 24 h。

及

在 $(35 \pm 2)^\circ\text{C}$ 下，依 IEC 60068-2-11 進行鹽霧試驗(試驗 Ka：鹽霧) 7 個循環，每個循環 24 h。

10.2.2.4 Results to be obtained

After the test, the enclosure or samples shall be washed in running tap water for 5 min, rinsed in distilled or demineralized water then shaken or subjected to air blast to remove water droplets. The specimen under test shall then be stored under normal service conditions for 2 h.

Compliance is checked by visual inspection to determine that:

- there is no evidence of iron oxide, cracking or other deterioration more than that allowed by ISO 4628-3 for a degree of rusting Ri1. However surface deterioration of the protective coating is allowed. In case of doubt associated with paints and varnishes, reference shall be made to ISO 4628-3 to verify that the samples conform to the specimen Ri1;
- the mechanical integrity is not impaired;
- seals are not damaged,
- doors, hinges, locks, and fastenings work without abnormal effort.

10.2.2.4 待獲得之結果

試驗後，應以流動之自來水洗滌箱體或樣品 5 min，以蒸餾水或去礦物質水沖洗，然後抖動或噴氣器移除水滴。受試驗之樣品隨後應儲存在正常使用條件中 2 h。

以目視檢驗檢查其符合性，以決定下列情況。

- 關於銹蝕等級 Ri1，無氧化鐵之跡象、超過 ISO 4628-3 所容許之破裂或其他劣化。然而，容許保護性塗層有表面劣化。倘與油漆及清漆有雙重關聯時，應參考 ISO 4628-3，以查證樣品符合樣本 Ri1。
- 未損害機械完整性。
- 密封未受損壞。
- 門、鉸鏈、鎖及緊固工作無異常情況。

10.2.3 Properties of insulating materials

10.2.3.1 Verification of thermal stability of enclosures

The thermal stability of enclosures manufactured from insulating material shall be verified by the dry heat test. The test shall be carried out according to IEC 60068-2-2 Test Bb, at a temperature of 70 °C, with natural air circulation, for a duration of 168 h and with a recovery of 96 h.

Parts, intended for decorative purposes that have no technical significance shall not be considered for the purpose of this test.

The enclosure, mounted as for normal use, is subjected to a test in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation. If the dimensions of the enclosure are too large for the available heating cabinet, the test may be carried out on a representative sample of the enclosure.

The use of an electrically heated cabinet is recommended.

Natural circulation may be provided by holes in the walls of the cabinet.

The enclosure or sample shall show no crack visible to normal or corrected vision without additional magnification nor shall the material have become sticky or greasy, this being judged as follows:

With the forefinger wrapped in a dry piece of rough cloth, the sample is pressed with a force of 5 N.

NOTE The force of 5 N can be obtained in the following way: the enclosure or sample is placed on one of the pans of a balance and the other pan is loaded with a mass equal to the mass of the sample plus 500 g. Equilibrium is then restored by pressing the sample with the forefinger wrapped in a dry piece of rough cloth.

No traces of the cloth shall remain on the sample and the material of the enclosure or sample shall not stick to the cloth.

10.2.3 絕緣材料之特性

10.2.3.1 箱體之熱穩定性的查證

以絕緣材料製造之箱體，其熱穩定性應以乾熱試驗查證。應在空氣自然流通情況下，於溫度 70°C 依 IEC 60068-2-2 之試驗 Bb 進行試驗，持續時間為 168 h，恢復時間為 96 h。

供無技術上意義之裝飾用途的零件，不應視為本試驗之用途。

如正常使用般裝設箱體，使箱體在加熱櫃中進行試驗，加熱櫃之大氣之組成及壓力與周圍空氣相同，並以自然流通方式循環。若箱體之尺寸對於可取得之加熱櫃而言太大的話，則可在代表性之箱體樣品上進行試驗。

建議使用電氣加熱櫃。

可在加熱櫃之壁上的孔洞中，提供自然循環。

在無額外放大情況下，箱體或樣品不應顯現出正常視力或經矯正視力可見之破裂，且材料亦不應變成黏的或油膩的，此判斷如下。

食指纏繞 1 片乾的粗糙之布，以 5 N 之力量壓樣品。

備考：可用下列方式獲得 5 N 之力：將箱體或樣品放置於天平之其中 1 個

秤盤中，且另 1 個秤盤裝載重量為樣品重量加上 500 g 之重物。以 1

片乾的粗糙之布纏繞食指並施力於樣品上，隨後使天平恢復平衡。

在樣品上不應留有布的痕跡，且箱體或樣品之材料不應刺到布。

10.2.3.2 Verification of resistance of insulating materials to abnormal heat and fire due to internal electric effects

The glow-wire test principles of IEC 60695-2-10 and the details given in IEC 60695-2-11 shall be used to verify the suitability of materials used:

- a) on parts of ASSEMBLIES, or
- b) on parts taken from these parts.

The test shall be carried out on material with the minimum thickness used for the parts in a) or b).

If an identical material having representative cross-sections as the parts has already satisfied the requirements of 8.1.3.2.3 then the test need not be repeated. It is the same for all parts which have been previously tested according to their own specifications.

For a description of the test, see Clause 4 of IEC 60695-2-11:2000. The apparatus to be used shall be as described in Clause 5 of IEC 60695-2-11:2000.

The temperature of the tip of the glow-wire shall be as follows:

- 960 °C for parts necessary to retain current-carrying parts in position;
- 850 °C for enclosures intended for mounting in hollow walls;
- 650 °C for all other parts, including parts necessary to retain the protective conductor.

As an alternative the original manufacturer shall provide data on the suitability of materials from the insulating material supplier to demonstrate compliance with the requirements of 8.1.3.2.3.

10.2.3.2 絕緣材料耐受因內部電效應產生之異常熱及火的查證

應使用 IEC 60695-2-10 之熾熱線試驗原理及 IEC 60695-2-11 所述之細節，以查證使用在下列零件之材料的適合性。

- (a) 於組裝品之零件上。或
- (b) 從此等零件所取出之零件。

應於(a)或(b)之零件所使用之最小厚度的材料上進行試驗。

若代表性之橫截面與零件相同的材料已滿足 8.1.3.2.3 之要求，則不需要重複進行試驗。對於先前已依其本身規格進行試驗之所有零件，亦相同。

關於試驗之敘述，參照 IEC 60695-2-11:2000 第 4 節。須使用之設備應如 IEC 60695-2-11:2000 第 5 節所述。

熾熱線之跳脫溫度應如下。

- 960°C：使載流零件保持在適當位置所必要之零件。
- 850°C：供裝設在空心牆之箱體。
- 960°C：所有其他零件，包括保留保護性導體所必要之零件。

作為一種替代方案。關於絕緣材料供應商之材料的適合性，原始製造廠商應提供資料，以證明其符合 8.1.3.2.3 之要求。

10.2.4 Resistance to ultra-violet (UV) radiation

This test applies only to enclosures and external parts of ASSEMBLIES intended to be installed outdoors and which are constructed of insulating materials or metals that are entirely coated by synthetic material. Representative samples of such parts shall be subjected to the following test:

10.2.4 耐紫外線(UV)輻射

本試驗僅適用於預定安裝在屋外，且以絕緣材料或完全以合成材料塗敷材料建

構的組裝品之箱體及外部零件。此零件之代表性樣品，應進行下列試驗。

UV test according to ISO 4892-2 Method A, Cycle 1 providing a total test period of 500 h. For enclosures constructed of insulating materials compliance is checked by verification that the flexural strength (according to ISO 178) and Charpy impact (according to ISO 179) of insulating materials have 70 % minimum retention.

The test shall be made on six test specimens of standard size according to ISO 178 and on six test specimens of standard size according to ISO 179. The test specimens shall be made under the same conditions as those used for the manufacture of the enclosure concerned.

For the test carried out in accordance with ISO 178, the surface of the sample exposed to UV shall be turned face down and the pressure applied to the non exposed surface.

For the test carried out in accordance with ISO 179 for materials whose impact bending strength cannot be determined prior to exposure because no rupture has occurred, not more than three of the exposed test specimens shall be allowed to break.

For compliance, enclosures constructed of metals entirely coated by synthetic material, the adherence of the synthetic material shall have a minimum retention of category 3 according to ISO 2409.

Samples shall not show cracks or deterioration visible to normal or corrected vision without additional magnification.

This test need not be carried out if the original manufacturer can provide data from the material supplier to demonstrate that material of the same type and thickness or thinner complies with this requirement.

ISO 4892-2 方法 A 循環 1 之 UV 試驗，提供 500 h 之總試驗期間。對於以絕緣材料建構之箱體，以絕緣材料之彎曲強度(依 ISO 178)及沙比衝擊(Charpy impact，依 ISO 179)至少保留 70 %之查證，檢查符合性。

應於 ISO 178 之標準大小的 6 個試驗樣品及 ISO 179 之標準大小的 6 個試驗樣品上進行試驗。應於與製造相關箱體時之相同條件下，製造試驗樣品。

關於依 ISO 178 進行之試驗，暴露於 UV 之樣品的表面，應面向下，且壓力應施於非暴露性一面。

關於依 ISO 179 針對未發生破裂而無法在暴露前決定衝擊抗彎強度之材料所進行之試驗，不容許超過 3 個暴露性試驗樣本破裂。

關於符合性，以金屬建構並完全以合成材料塗敷之箱體，其合成材料之黏附性應具有最低為 ISO 2409 之類別 3 的保留性。

在無額外放大情況下，樣品不應顯現出正常視力或經矯正視力可見之破裂或劣化。

若原始製造廠商能提供來自材料供應商之資料，證明相同型式之材料及厚度符合本標準要求時，則不需要進行本試驗。

10.2.5 Lifting

For ASSEMBLIES with provision for lifting means compliance is verified by the following tests.

The maximum number of sections allowed by the original manufacturer to be lifted together shall be equipped with components and/or weights to achieve a weight of 1,25 times its maximum shipping weight. With doors closed it shall be lifted with the specified lifting means and in the manner defined by the original manufacturer.

10.2.5 吊運

對於具有吊運裝置之組裝品，以下列試驗查證其符合性。

原始製造廠商所容許可一同吊運之最大數量的區段，應配備組件及/或重物，以達到其最大運輸重量之 1.25 倍重量。應在門閉合之情況下，以規定之吊運工具並以原始製造廠商所定義之方式吊運。

From a standstill position, the ASSEMBLY shall be raised smoothly without jerking in a vertical plane to a height of ≥ 1 m and lowered in the same manner to a standstill position. This test is repeated a further two times after which the ASSEMBLY is raised up and suspended clear of the floor for 30 min without any movement.

Following this test the ASSEMBLY shall be raised smoothly without jerking from a standstill position to a height of ≥ 1 m and moved (10 ± 0.5) m horizontally, then lowered to a standstill position. This sequence, shall be carried out three times at uniform speed, each sequence being carried out within 1 min.

After the test, with the test weights in place, the ASSEMBLY shall show no cracks or permanent distortions visible to normal or corrected vision without additional magnification, which could impair any of its characteristics.

應在垂直平面未猛然施力之情況下，從靜止狀態將組裝品平順地抬舉至高於或等於 1 m 之高度處，並以相同方式降低至靜止狀態。再重複此試驗 2 次，之後抬舉組裝品並離開地面懸掛 30 min 且勿移動。

此試驗後，應在未猛然施力之情況下，從靜止狀態將組裝品平順地抬舉至高於或等於 1 m 之高度處，並水平移動 (10 ± 0.5) m，隨後降低至靜止狀態。應以一致之速度進行此順序 3 次，每個順序進行 1 min 以內。

試驗後，在試驗重物置於適當位置之情況下，組裝品應未顯現出正常視力或經矯正之視力在無額外放大情況下可見之裂縫或永久變形，其可能損害任何特性。

10.2.6 Mechanical impact

Mechanical impact tests where required by the specific ASSEMBLY standard are to be carried out in accordance with IEC 62262.

10.2.6 機械撞擊

特定組裝品標準所要求之機械撞擊試驗，須依 IEC 62262 進行。

10.2.7 Marking

Marking made by moulding, pressing, engraving or similar, including labels with a laminated plastic covering, shall not be submitted to the following test.

The test is made by rubbing the marking by hand for 15 s with a piece of cloth soaked in water and then for 15 s with a piece of cloth soaked with petroleum spirit.

NOTE The petroleum spirit is defined as a solvent hexane with a content of aromatics of maximum 0,1 % in volume, a kauributanol value of 29, an initial boiling point of 65 °C, a final boiling point of 69 °C and a density of approximately 0,68 g/cm³.

After the test the marking shall be legible to normal or corrected vision without additional magnification.

10.2.7 標示

以鑄模、沖壓，雕刻或類似方式(包括層壓塑料被覆之標籤)製成之標示，不應進行下列試驗。

使用浸泡水之布，以手磨擦該標示 15 s，隨後以浸泡石油精(petroleum spirit)之布磨擦該標示 15 s。

備考：石油精係定義為正己烷溶劑，其芳烴含量最高為 0.1%體積、貝殼松脂丁醇值(kauributanol value)為 29、初沸點為 65℃、終沸點為 69℃及密度約 0.68 g/cm³。

試驗後在無額外放大情況下，對於正常視力或經矯正視力，該標示應清楚可見。

10.3 Degree of protection of ASSEMBLIES

The degree of protection provided in accordance with 8.2.2, 8.2.3 and 8.4.2.3 shall be verified in accordance with IEC 60529; the test may be carried out on one representative equipped ASSEMBLY in a condition stated by the original manufacturer. Where an empty enclosure in accordance with IEC 62208 is used, a verification assessment shall be performed to ensure that any external modification that has been carried out does not result in a deterioration of the degree of protection. In this case no further testing is required.

IP tests shall be carried out:

- with all covers and doors in place and closed as in normal service;
- in a de-energised state unless stated otherwise by the original manufacturer.

ASSEMBLIES having a degree of protection of IP 5X shall be tested according to category 2 in 13.4 of IEC 60529:1989.

ASSEMBLIES having a degree of protection of IP 6X shall be tested according to category 1 in 13.4 of IEC 60529:1989.

The test device for IP X3 and IP X4 as well as the type of support for the enclosure during the IP X4 test shall be stated in the test report.

The IP X1 test may be carried out by moving the drip box instead of rotating the ASSEMBLY.

Ingress of water in the IP X1 to IP X6 tests on an ASSEMBLY is permissible only if its route of entry is obvious and the water is only in contact with the enclosure at a location where it will not impair safety.

The IP 5X test is deemed to be a failure if harmful amount of dust is visible on electrical equipment housed within the enclosure.

10.3 組裝品之保護等級

依照 8.2.2、8.2.3 及 8.4.2.3 提供之保護等級，應依 IEC 60529 查證；可在原始製造廠商指定之條件中，於 1 個代表性配備之組裝品上進行試驗。當使用 IEC 62208 之空箱體時，應執行查證評鑑，以確保已進行之外部修改不會造成保護等級惡化。在此情況中，不需要進一步試驗。

IP 試驗應在下列情況中進行。

- 所有外蓋及門處於適當位置，且如正常使用般閉合。
- 於斷電狀態下，除非原始製造廠商另有指定。

保護等級為 IP 5X 之組裝品，應依 IEC 60529:1989 之 13.4 的類別 2 進行試驗。

保護等級為 IP 6X 之組裝品，應依 IEC 60529:1989 之 13.4 的類別 1 進行試驗。

應在試驗報告中敘明 IP X3 及 IP X4 用之試驗裝置，以及 IP X4 試驗期間箱體之支撐物的型式。

可藉由移動滴水箱代替旋轉組裝品之方式，進行 IP X1 試驗。

在 IP X1 至 IP X6 試驗中侵入組裝品之水，若其進入之路線明顯，且水僅在不損害安全性之位置與箱體接觸，則容許水侵入組裝品。

若覆蓋在箱體內之電氣設備上有顯而易見之有害粉塵量時，則 IP 5X 試驗視為失效。

10.4 Clearances and creepage distances

It shall be verified that the clearances and creepage distances comply with the requirements of 8.3.

The clearances and creepage distances shall be measured in accordance with Annex F.

10.4 空間距離及沿面距離

應查證空間距離及沿面距離是否符合 8.3 之要求。

應依附錄 F 量測空間距離及沿面距離。

10.5 Protection against electric shock and integrity of protective circuits

10.5.1 Effectiveness of the protective circuit

The effectiveness of protective circuit is verified for the following functions:

- a) protection against the consequences of a fault within the ASSEMBLY (internal faults) as outlined in 10.5.2, and
- b) protection against the consequences of faults in external circuits supplied through the ASSEMBLY (external faults) as outlined in 10.5.3.

10.5 防電擊之保護及保護性電路之完整性

10.5.1 保護性電路之有效性

針對下列功能，查證保護性電路之有效性。

- (a) 防止組裝品內之故障結果的保護(內部故障)，如 10.5.2 所概述。
- (b) 防止透過組裝品供電之外部電路中的故障結果之保護(外部故障)，如 10.5.3 所概述。

10.5.2 Effective earth continuity between the exposed conductive parts of the ASSEMBLY and the protective circuit

It shall be verified that the different exposed conductive parts of the ASSEMBLY are effectively connected to the terminal for the incoming external protective conductor and that the resistance of the circuit does not exceed 0,1 Ω .

Verification shall be made using a resistance measuring instrument which is capable of driving a current of at least 10 A (a.c. or d.c.). The current is passed between each exposed conductive part and the terminal for the external protective conductor. The resistance shall not exceed 0,1 Ω .

NOTE It is recommended to limit the duration of the test where low-current equipment otherwise may be adversely affected by the test.

10.5.2 於組裝品之暴露的導電零件與保護性電路之間的有效接地連續性

應查證組裝品不同之暴露的導電零件為有效連接至內向外部保護性導體用之端子，並查證電路之電阻不超過 0.1 Ω 。

應使用能驅動至少 10 A (交流或直流)電流之電阻量測儀進行查證。針對外部保護性導體，使電流通過每一暴露性導電零件及端子。電阻不應超過 0.1 Ω 。

備考：當低電流設備在其他方面可能受試驗不利地影響時，建議限制試驗之持續時間。

10.5.3 Short-circuit withstand strength of the protective circuit

10.5.3.1 General

The rated short-circuit withstand strength shall be verified. Verification may be by comparison with a reference design or by test as detailed in 10.5.3.3 to 10.5.3.5.

The original manufacturer shall determine the reference design(s) that will be used in 10.5.3.3 and 10.5.3.4.

10.5.3 保護性電路之短路耐受強度

10.5.3.1 一般

應查證額定短路耐受強度。可藉由比較參考設計之方式，或藉由 10.5.3.3 至 10.5.3.5 所述之試驗進行查證。

原始製造廠商應決定 10.5.3.3 及 10.5.3.4 將使用之參考設計。

10.5.3.2 Protective circuits that are exempted from short-circuit withstand verification

Where a separate protective conductor is provided in accordance with 8.4.3.2.3, short-circuit testing is not required if one of the conditions of 10.11.2. is fulfilled.

10.5.3.2 從短路耐受查證中排除之保護性電路

當依據 8.4.3.2.3 提供個別之保護性導體時，若達到 10.11.2 之其中 1 個條件，則不需要短路試驗。

10.5.3.3 Verification by comparison with a reference design – Utilising a check list

Verification is achieved when comparison of the ASSEMBLY to be verified with an already tested design utilising items 1 to 6 and 8 to 10 of the check list in Table 13 shows no deviations.

To ensure the same current carrying capacity for that portion of the fault current that flows through the exposed conductive parts, the design, number and arrangement of the parts that provide contact between the protective conductor and the exposed conductive parts, shall be the same as in the tested reference design.

10.5.3.3 藉由比較參考設計之查證－使用查檢表

當使用表 13 查檢表之第 1 項至第 6 項及第 8 項至第 10 項比較待查證之組裝品及已進行試驗之設計時，即完成查證。

為確保通過暴露性導電零件的故障電流具有相同電流承載容量，使保護性導體與暴露性導電零件接觸之零件，其設計、數量及配置，應與受試驗之參考設計相同。

10.5.3.4 Verification by comparison with a reference design – Utilising calculation

Verification by comparison with a reference design based on calculation is to be in accordance with 10.11.4

To ensure the same current carrying capacity for that portion of the fault current that flows through the exposed conductive parts, the design, number and arrangement of the parts that provide contact between the protective conductor and the exposed conductive parts, shall be the same as in the tested reference design.

10.5.3.4 藉由比較參考設計之查證－使用計算方式

藉由以計算為基礎之參考設計的比較查證，如 10.11.4 所示。

為確保通過暴露性導電零件的故障電流具有相同電流承載容量，使保護性導體與暴露性導電零件接觸之零件，其設計、數量及配置，應與受試驗之參考設計相同。

10.5.3.5 Verification by test

Subclause 10.11.5.6 applies.

10.5.3.5 以試驗查證

適用 10.11.5.6。

10.6 Incorporation of switching devices and components

10.6.1 General

Compliance with the design requirements of 8.5 for the incorporation of switching devices and components shall be confirmed by the original manufacturer's inspection.

10.6.2 Electromagnetic compatibility

The performance requirements of J.9.4 for electromagnetic compatibility shall be confirmed by inspection or where necessary by test (see J.10.12).

10.6 開關操作裝置與組件之合併

10.6.1 一般

關於開關操作裝置與組件之合併，應以原始製造廠商之檢驗，確認與 8.5 之設計要求的符合性。

10.6.2 電磁相容

關於電磁相容，應以檢驗或當有必要時以試驗(參照 J.10.12)，確認與 J.9.4 之性能要求的符合性。

10.7 Internal electrical circuits and connections

Compliance with the design requirements of 8.6 for internal electrical circuits and connections shall be confirmed by the original manufacturer's inspection.

10.8 Terminals for external conductors

Compliance with the design requirements of 8.8 for terminals for external conductors shall be confirmed by the original manufacturer's inspection.

10.7 內部電路及連接

關於內部電路及連接，應以原始製造廠商之檢驗，確認與 8.6 之設計要求的符合性。

10.8 外部導體用之端子

關於外部導體用之端子，應以原始製造廠商之檢驗，確認與 8.8 之設計要求的符合性。

10.9 Dielectric properties

10.9.1 General

For this test, all the electrical equipment of the ASSEMBLY shall be connected, except those items of apparatus which, according to the relevant specifications, are designed for a lower test voltage; current-consuming apparatus (e.g. windings, measuring instruments, voltage surge suppression devices) in which the application of the test voltage would cause the flow of a current, shall be disconnected. Such apparatus shall be disconnected at one of their terminals unless they are not designed to withstand the full test voltage, in which case all terminals may be disconnected.

For test voltage tolerances and the selection of test equipment, see IEC 61180.

10.9 電介質特性

10.9.1 一般

關於本試驗，組裝品之所有電氣設備應予以連接，但依據相關規範設計供較低試驗電壓之設備的項目除外；施加試驗電壓將產生電流之消耗電流的設備(例：繞組、量測儀器、電壓突波抑制裝置)，應予以切離。此設備在其中的 1 個端子上予以切離，除非其係非設計用於耐受整個試驗電壓，在此種情形中，所有端子可予以切離。

有關試驗電壓許可差及試驗設備之選擇，參照 IEC 61180。

10.9.2 Power-frequency withstand voltage

10.9.2.1 Main, auxiliary and control circuits

Main circuits as well as auxiliary and control circuits that are connected to the main circuit shall be subjected to the test voltage according to Table 8.

Auxiliary and control circuits, whether a.c. or d.c., that are not connected to the main circuit shall be subjected to the test voltage according to Table 9.

10.9.2 商頻耐電壓

10.9.2.1 主電路、輔助電路及控制電路

主電路及連接至主電路之輔助電路與控制電路，應依表 8 施加電壓。

未連接至主電路之輔助電路及控制電路，無論其為交流或直流，應依表 9 施加電壓。

10.9.2.2 Test voltage

The test voltage shall have a substantially sinusoidal waveform and a frequency between 45 Hz and 65 Hz.

The high-voltage transformer used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current shall be at least 200 mA.

The overcurrent relay shall not trip when the output current is less than 100 mA.

The value of the test voltage shall be that specified in Table 8 or 9 as appropriate with a permitted tolerance of $\pm 3\%$.

10.9.2.2 試驗電壓

試驗電壓應具有實質正弦波形，且頻率應介於 45 Hz 與 65 Hz 之間。

試驗時所使用之高電壓變壓器應予妥善設計，使得當輸出端子在輸出電壓已調整至適當試驗電壓之後短路時，輸出電流應至少 200 mA。

當輸出電流小於 100 mA 時，過電流電驛不應跳脫。

試驗電壓值應如表 8 或表 9 之規定，容許之許可差以 $\pm 3\%$ 較適合。

10.9.2.3 Application of the test voltage

The power frequency voltage at the moment of application shall not exceed 50 % of the full test value. It shall then be increased progressively to this full value and maintained for $5 \left(\begin{smallmatrix} +2 \\ 0 \end{smallmatrix} \right)$ s as follows:

10.9.2.3 試驗電壓之施加

於施加電壓之瞬間，商頻電壓不應超過整個試驗值之 50 %。隨後應逐漸增加至最大值，並維持 $5 \left(\begin{smallmatrix} +2 \\ 0 \end{smallmatrix} \right)$ s，方法如下。

- a) between all live parts of the main circuit connected together (including the control and auxiliary circuits connected to the main circuit) and exposed conductive parts, with the main contacts of all switching devices in the closed position or bridged by a suitable low resistance link;
 - b) between each live part of different potential of the main circuit and, the other live parts of different potential and exposed conductive parts connected together, with the main contacts of all switching devices in the closed position or bridged by a suitable low resistance link;
 - c) between each control and auxiliary circuit not normally connected to the main circuit and the
 - main circuit;
 - other circuits;
 - exposed conductive parts.
- (a) 連接在一起之主電路的所有帶電零件(包括連接至主電路之控制及輔助電路)，其與暴露性導電零件之間。開關操作裝置之主接點位於閉合位置或以適合之低電阻鏈橋接。
- (b) 主電路之不同電位之每一帶電零件，其與連接在一起之不同電位的其他帶電零件與暴露性導電零件之間。開關操作裝置之主接點位於閉合位置或以適合之低電阻鏈橋接。
- (c) 正常中不連接至主電路之每一控制及輔助電路，其與下列電路/零件之間。
- 主電路。
 - 其他電路。
 - 暴露性導電零件。

10.9.2.4 Acceptance criteria

The overcurrent relay shall not operate and there shall be no disruptive discharge (see 3.6.17) during the tests.

10.9.2.4 允收準則

試驗期間，過電流電驛不應動作，且不應有迅裂放電(參照 3.6.17)。

10.9.3 Impulse withstand voltage

10.9.3.1 General

Verification shall be made by test or by assessment.

In place of the impulse withstand voltage test the original manufacturer may perform, at his discretion, an equivalent a.c. or d.c. voltage test, in accordance with 10.9.3.3 or 10.9.3.4.

10.9.3 衝擊耐電壓

10.9.3.1 一般

應藉由試驗或評鑑，以進行查證。

原始製造廠商可自行酌情決定，依 10.9.3.3 或 10.9.3.4 執行等效之交流或直流電壓試驗，以代替衝擊耐電壓試驗。

10.9.3.2 Impulse withstand voltage test

The impulse voltage generator shall be adjusted to the required impulse voltage with the ASSEMBLY connected. The value of the test voltage shall be that specified in 9.1.3. The accuracy of the applied peak voltage shall be $\pm 3\%$.

10.9.3.2 衝擊耐電壓試驗

應在衝擊電壓產生器與組裝品連接之情況下，將衝擊電壓產生器調整至所需要之電壓。試驗電壓值應如 9.1.3 之規定。所施加之峰值電壓，其正確度應為 $\pm 3\%$ 。

Auxiliary circuits not connected to main circuits shall be connected to earth. The 1,2/50 μs impulse voltage shall be applied to the ASSEMBLY five times for each polarity at intervals of 1 s minimum as follows:

- a) between all the live parts of different potential of the main circuit connected together (including the control and auxiliary circuits connected to the main circuit) and exposed conductive parts, with the main contacts of all switching devices in the closed position or bridged by a suitable low resistance link;
- b) between each live part of different potential of the main circuit and, the other live parts of different potential and exposed conductive parts connected together, with the main contacts of all switching devices in the closed position or bridged by a suitable low resistance link.
- c) between each control and auxiliary circuit not normally connected to the main circuit and the
 - main circuit;
 - other circuits;
 - exposed conductive parts.

For an acceptable result there shall be no disruptive discharge during the tests.

未連接至主電路之輔助電路，應連接至地。1.2/50 μs 衝擊電壓應施加至組裝品 5 次，每種極性之時間間隔至少 1 s。

- (a) 連接在一起之主電路的不同電位之所有帶電零件(包括連接至主電路之控制及輔助電路)，其與暴露性導電零件之間。開關操作裝置之主接點位於閉合位置或以適合之低電阻鏈橋接。
- (b) 主電路之不同電位之每一帶電零件，其與連接在一起之不同電位的其他帶電零件與暴露性導電零件之間。開關操作裝置之主接點位於閉合位置或以適合之低電阻鏈橋接。
- (c) 正常中不連接至主電路之每一控制及輔助電路，其與下列電路/零件之間。
 - 主電路。
 - 其他電路。
 - 暴露性導電零件。

關於可接受之結果，試驗期間不應有迅裂放電。

10.9.3.3 Alternative power-frequency voltage test

The test voltage shall have a substantially sinusoidal waveform and a frequency between 45 Hz and 65 Hz.

The high-voltage transformer used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current shall be at least 200 mA.

The overcurrent relay shall not trip when the output current is less than 100 mA.

The value of the test voltage shall be that specified in 9.1.3 and Table 10 as appropriate with a permitted tolerance of $\pm 3\%$.

The power-frequency voltage shall be applied once, at full value, for a duration sufficient for the magnitude to be ascertained, but it shall not be less than 15 ms.

It shall be applied to the ASSEMBLY in the manner described in 10.9.3.2. a) b) and c) above.

For an acceptable result the overcurrent relay shall not operate and there shall be no disruptive discharge during the tests.

10.9.3.3 替代之商頻電壓試驗

試驗電壓應具有實質正弦波形，且頻率應介於 45 Hz 與 65 Hz 之間。

試驗時所使用之高電壓變壓器應予妥善設計，使得當輸出端子在輸出電壓已調整至適當試驗電壓之後短路時，輸出電流應至少 200 mA。

當輸出電流小於 100 mA 時，過電流電驛不應跳脫。

試驗電壓值應如 9.1.3 及表 10 之規定，容許之許可差以 $\pm 3\%$ 較適合。

商頻電壓應全值施加 1 次，其持續時間應足以確定大小，但不應小於 15 ms。

應以上述 10.9.3.2(a)、(b)及(c)所述之方法，施加至組裝品。

關於可接受之結果，試驗期間，過電流電驛不應動作，且不應有迅裂放電。

10.9.3.4 Alternative d.c. voltage test

The test voltage shall have negligible ripple.

The high-voltage source used for the test shall be so designed that, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current shall be at least 200 mA.

The overcurrent relay shall not trip when the output current is less than 100 mA.

The value of the test voltage shall be that specified in 9.1.3 and Table 10 as appropriate with a permitted tolerance of $\pm 3\%$.

The d.c. voltage shall be applied once for each polarity for a duration sufficient for the magnitude to be ascertained, but it shall not be less than 15 ms or greater than 100 ms.

It shall be applied to the ASSEMBLY in the manner of 10.9.3.2. a) and b) above.

For an acceptable result the overcurrent relay shall not operate and there shall be no disruptive discharge during the tests.

10.9.3.4 替代之直流電壓試驗

試驗電壓應具有可予忽略之漣波。

試驗時所使用之高電壓源應予妥善設計，使得當輸出端子在輸出電壓已調整至適當試驗電壓之後短路時，輸出電流應至少 200 mA。

當輸出電流小於 100 mA 時，過電流電驛不應跳脫。

試驗電壓值應如 9.1.3 及表 10 之規定，容許之許可差以 $\pm 3\%$ 較適合。

直流電壓應對每一極性施加 1 次，其持續時間應足以確定大小，但不應小於 15 ms 或大於 10 ms。

應以上述 10.9.3.2(a)、(b)及(c)所述之方法，施加至組裝品。

關於可接受之結果，試驗期間，過電流電驛不應動作，且不應有迅裂放電。

10.9.3.5 Verification assessment

Clearances shall be verified by measurement, or verification of measurements on design drawings, employing the measurement methods stated in Annex F. The clearances shall be at least 1,5 times the values specified in Table 1.

NOTE The 1,5 factor to values in Table 1 is applied to avoid impulse withstand voltage tests for design verification. It is a safety factor that takes into consideration manufacturing tolerances.

It shall be verified by assessment of the device manufacturer's data that all incorporated devices are suitable for the specified rated impulse withstand voltage (U_{imp}).

10.9.3.5 查證評鑑

應利用附錄 F 所述之量測法，以量測查證空間距離，或於設計圖面上進行量測之查證。空間距離應至少為表 1 所規定之值的 1.5 倍。

備考：對表 1 之值施以 1.5 倍之因數，係為避免設計查證之衝擊耐電壓試驗。

應評鑑裝置製造廠商之資料，以查證所有合併之裝置適合於所規定之額定衝擊耐電壓 (U_{imp})。

10.9.4 Testing of enclosures made of insulating material

For ASSEMBLIES with enclosures made of insulating material, an additional dielectric test shall be carried out by applying an a.c. test voltage between a metal foil laid on the outside of the enclosure over openings and joints, and the interconnected live and exposed conductive parts within the ASSEMBLY located next to the openings and joints. For this additional test, the test voltage shall be equal to 1,5 times the values indicated in Table 8.

10.9.5 External operating handles of insulating material

In the case of handles made of or covered by insulating material, a dielectric test shall be carried out by applying a test voltage equal to 1,5 times the test voltage indicated in Table 8 between the live parts and a metal foil wrapped round the whole surface of the handle. During this test, the exposed conductive parts shall not be earthed or connected to any other circuit.

10.9.4 絕緣材料製之箱體的試驗

對於箱體係以絕緣材料製之組裝品，應在置於開口與接合點上方之箱體外側的金屬箔，與置於開口與接合點旁邊之組裝品內的互連帶電與暴露導電零件之間施加交流試驗電壓，以進行額外之電介質試驗。關於此額外之試驗，試驗電壓應等於表 8 所示之值的 1.5 倍。

10.9.5 絕緣材料製之外部操作把手

關於絕緣材料製或以絕緣材料覆蓋之把手，應於帶電零件與纏繞整個把手表面之金屬箔之間，施加表 8 所示試驗電壓之 1.5 倍的電壓，以進行電介質試驗。於此試驗期間，暴露性導電零件不應接地或連接至任何其他電路。

10.10 Verification of temperature rise

10.10.1 General

It shall be verified that the temperature-rise limits specified in 9.2 for the different parts of the ASSEMBLY or ASSEMBLY system will not be exceeded.

Verification shall be made by one or more of the following methods (see Annex O for guidance):

- a) testing (10.10.2);
- b) derivation (from a tested design) of ratings for similar variants (10.10.3);
- c) calculation for a single compartment ASSEMBLY not exceeding 630 A according to 10.10.4.2 or for ASSEMBLIES not exceeding 1600 A according to 10.10.4.3.

In ASSEMBLIES rated for frequencies above 60 Hz verification of temperature rise by test (10.10.2) or by derivation from a similar design tested at the same intended frequency (10.10.3) is always required.

The current carrying capability of the circuits to be verified is determined by the rated current (see 5.3.2) and the RDF (see 5.4).

10.10 溫升之查證

10.10.1 一般

應查證不會超過 9.2 針對組裝品或組裝品組裝品系統之不同零件所規定之溫升限制。

應以下列 1 種或多種方法進行查證(有關指引，參照附錄 O)。

- (a) 試驗(10.10.2)。
- (b) 類似變體之定額的偏差(與受試驗之設計的偏差)(10.10.3)。
- (c) 針對不超過 630 A 之單一分隔室組裝品依 10.10.4.2 計算，或針對不超過 1,600 A 之單一分隔室組裝品依 10.10.4.3 計算。

額定頻率超過 60 Hz 之組裝品中，需要以試驗(10.10.2)或將類似設計在相同預定之頻率下進行試驗所產生之偏差(10.10.3)，以進行溫升查證。

由額定電流(參照 5.3.2)及 RDF(參照 5.4)決定待查證之電路的電流承載能力。

10.10.2 Verification by testing

10.10.2.1 General

Verification by test comprises the following:

- a) If the ASSEMBLY system to be verified comprises a number of variants, the most onerous arrangement(s) of the ASSEMBLY system shall be selected according to 10.10.2.2.
- b) The ASSEMBLY variant(s) selected shall be verified by one of the following methods(see Annex O):
 - 1) considering individual functional units, the main and distribution busbars and the ASSEMBLY collectively according to 10.10.2.3.5;
 - 2) considering individual functional units separately and the complete ASSEMBLY including the main and distribution busbars according to 10.10.2.3.6;
 - 3) considering individual functional units and the main and distribution busbars separately as well as the complete ASSEMBLY according to 10.10.2.3.7.
- c) When the ASSEMBLY variant(s) tested are the most onerous variants out of an ASSEMBLY system then the test results can be used to establish the ratings of similar variants without further testing. Rules for such derivations are given in 10.10.3.

10.10.2 以試驗進行之查證

10.10.2.1 一般

以試驗進行之查證包括下列項目。

- (a) 若待查證之組裝品系統包括若干變體、則組裝品系統之最不利配置應依 10.10.2.2 選擇。
- (b) 所選擇之組裝品變體，應以下列其中 1 種方法查證(參照附錄 O)。
 - (1) 依 10.10.2.3.5，整體考量個別功能性單元、主匯流排與配電匯流排及組裝品。
 - (2) 依 10.10.2.3.6，分別考量個別功能性單元，並考量整個組裝品(包括主匯流排與配電匯流排)。

(3) 依 10.10.2.3.7，分別考量個別功能性單元及主匯流排與配電匯流排，並考量整個組裝品。

(c) 當受試驗之組裝品變體為組裝品系統之最繁苛變體時，則可使用試驗結果建立類似變體之定額，無需進一步試驗。有關此等偏差之規則，如 10.10.3 所示。

10.10.2.2 Selection of the representative arrangement

10.10.2.2.1 General

The test shall be made on one or more representative arrangements loaded with one or more representative load combinations chosen to obtain with reasonable accuracy the highest possible temperature rise.

The selection of the representative arrangements to be tested is given in 10.10.2.2.2 and 10.10.2.2.3 and is the responsibility of the original manufacturer. The original manufacturer shall take into consideration in his selection for test, the configurations to be derived from the tested arrangements according to 10.10.3.

10.10.2.2 代表性配置之選擇

10.10.2.2.1 一般

應於承載 1 個或多個代表性負載組合之 1 個或多個代表性配置上進行試驗，以獲得具合理正確性之最高可能溫升。

有關須進行試驗之代表性配置的選擇，如 10.10.2.2.2 及 10.10.2.2.3 所示，且係屬原始製造廠商之責任。在試驗之選擇方面，原始製造廠商應考量須依 10.10.3 從受試驗之配置導出之架構。

10.10.2.2.2 Busbars

For busbar systems consisting of single or multiple rectangular sections of conductor, where the variants differ only in the reduction of one or more of

- height,
- thickness,
- quantity of bars per conductor,

and have the same

- arrangement of bars,
- center line spacing of conductors,
- enclosure and
- busbar compartment (if any),

the busbars with the greatest cross-sectional area shall be selected as the representative arrangement as a minimum for the test. For ratings of smaller busbar size variants or other materials see 10.10.3.3.

10.10.2.2.2 匯流排

關於包括單一或多重矩形部分之導體的匯流排系統，其變體僅在下列 1 項或多項中有差異，

- 高度。
- 厚度。
- 每個導體之匯流排數量。

且在下列項目皆相同，

- 匯流排之配置。
- 導體之中心線間隔。
- 箱體。及
- 匯流排分隔室(若有時)。

則應選擇具有最大截面積之匯流排，作為試驗時最低之代表性配置。關於較小匯流排變體之定額或其他材料，參照 10.10.3.3。

10.10.2.2.3 Functional units

a) Selection of comparable functional unit groups

Functional units intended to be used at different rated currents can be considered to have a similar thermal behaviour and form a comparable range of units, if they fulfil the following conditions:

- 1) the function and basic wiring diagram of the main circuit is the same (e.g. incoming unit, reversing starter, cable feeder);
- 2) the devices are of the same frame size and belong to the same series;
- 3) the mounting structure is of the same type;
- 4) the mutual arrangement of the devices is the same;
- 5) the type and arrangement of conductors is the same;
- 6) the cross-section of the main circuit conductors within a functional unit shall have a rating at least equal to that of the lowest rated device in the circuit. Selection of cables shall be as tested or in accordance with IEC 60364-5-52. Examples on how to adapt this standard for conditions inside an ASSEMBLY are given in the tables included in Annex H. The cross-section of bars shall be as tested or as given in Annex N.

10.10.2.2.3 功能性單元

(a) 可比較之功能性單元群組的選擇

預定使用於不同額定電流之功能性單元，若符合下列條件，可視為具有相同熱行為(thermal behavior)，並形成可比較之單元範圍。

- (1) 主電路之功能及基本配線圖相同(例：內向單元、反向啟動器、電纜饋送器)。
- (2) 裝置為相同外框大小，且屬於相同系列。
- (3) 裝設結構為相同型式。
- (4) 裝置之相互配置相同。
- (5) 導體之型式及配置相同。
- (6) 功能性單元內之主電路導體的截面積，其定額應至少等於電路中最低額定裝置之定額。電纜之選擇應如同試驗時，或依 IEC 60364-5-52 之規定。有關如何針對組裝品內之條件調整本標準之範例，如附錄 H 之表所示。匯流排截面應如同試驗時，或依附錄 H 所示。

b) Selection of a critical variant out of each comparable group as a specimen for test

For the critical variant the most onerous compartment (where applicable) and enclosure conditions (with respect to shape, size, design of partitions and enclosure ventilation) shall be tested.

The maximum possible current rating for each variant of functional unit is established. For functional units containing only one device this is the rated current of the device. For functional units with several devices, it is that of the device with the lowest rated current. If a combination of devices connected in series is intended to be used at a lower current (e.g. motor starter combination), this lower current shall be used.

For each functional unit the power loss is calculated at the maximum possible current using the data given by the device manufacturer for each device together with the power losses of the associated conductors.

For functional units with currents up to and including 630 A, the critical unit in each range is the functional unit with the highest total power loss.

For functional units with currents above 630 A the critical unit in each range is that which has the highest rated current. This ensures that additional thermal effects relating to eddy currents and current displacement are taken into consideration.

The critical functional unit shall at least be tested:

- inside the smallest compartment (if any) which is intended for this functional unit; and
- with the worst variant of internal separation (if any) with respect to size of ventilation openings; and
- with the enclosure with the highest installed power loss per volume; and
- with the worst variant of ventilation of the enclosure with respect to the kind of ventilation (natural or forced convection) and size of ventilation openings.

(b) 在每一可比較之群組中選擇一關鍵性變體，以作為試驗樣本

關於關鍵性變體，應對最繁苛分隔室(若適用時)及箱體條件(在隔板之形狀、大小、設計及箱體通風方面)進行試驗。

針對功能性單元之每一變體，建立最大可能之電流定額。關於僅含有 1 個裝置之功能性單元，其為裝置之額定電流。關於含有數個裝置之功能性單元，其為額定電流最小之裝置的額定電流。若欲在較低電流下使用串聯連接之裝置的組合(例：電動機啟動器組合)，則應使用此較低電流。

關於每一功能性單元，使用裝置製造廠商針對每一裝置所提供之資料，以及相聯結之導體的功率損失，於最大可能之電流下計算功率損失。

關於電流在 630 A 以下之功能性單元，每一範圍之關鍵性單元為具有最高總功率損失之功能性單元。

關於電流超過 630 A 之功能性單元，每一範圍之關鍵性單元為具有最高額定電流之功能性單元。其確保與渦電流及電流位移有關之額外熱動效應已列入考量。

關鍵性功能性單元應至少在下列情況中進行試驗。

- 在供此功能性單元用之最小分隔室(若有時)內。及
- 在通風口大小方面，以內部分隔(若有時)之最糟變體。及
- 在每單位體積下有最大安裝功率損失之箱體。
- 在通風種類(自然或強制對流)及通風口大小方面，以箱體通風之最糟變體。

If the functional unit can be arranged in different orientations (horizontal, vertical), then the most onerous arrangement shall be tested.

NOTE Additional test may be made on the discretion of the original manufacturer for less critical arrangements and variants of functional units.

若功能性單元可配置在不同方向(水平、垂直)，則應對最嚴苛之配置進行試驗。

備考：可在原始製造廠商謹慎考量下，對較不具關鍵性配置及功能性單元變體進行額外試驗。

10.10.2.3 Methods of test

10.10.2.3.1 General

In 10.10.2.3.5 to 10.10.2.3.7 three methods for test are given, which differ in the number of tests needed and in the range of applicability of the test results, an explanation is provided in Annex O.

The temperature-rise test on the individual circuits shall be made with the type of current for which they are intended, and at the design frequency. Any convenient value of the test voltage may be used to produce the desired current. Coils of relays, contactors, releases, etc., shall be supplied with rated operational voltage.

The ASSEMBLY shall be mounted as in normal use, with all covers including bottom cover plates, etc., in place.

10.10.2.3 試驗法

10.10.2.3.1 一般

於 10.10.2.3.5 至 10.10.2.3.7 中列出 3 種試驗法，其差異在所需要之試驗編號及試驗結果之可適用性範圍，其說明如附錄 O 所示。

於個別電路上進行之溫升試驗，應以其預定之電流型式並在設計頻率下進行試驗。可使用任何適當之試驗電壓值，以產生所希望之電流。電驛之線圈、接觸器、釋放器等，應以額定操作電壓供電。

組裝品應如同正常使用般裝設，所有外蓋(包括底部外蓋板等)應位於適當位置。

If the ASSEMBLY includes fuses, these shall be fitted for the test with fuse-links as specified by the manufacturer. The power losses of the fuse-links used for the test shall be stated in the test report. Fuse-link power loss may be determined by measurement or alternatively as declared by the fuse-link manufacturer.

The size and the disposition of external conductors used for the test shall be stated in the test report.

The test shall be made for a time sufficient for the temperature rise to reach a constant value. In practice, this condition is reached when the variation at all measured points (including the ambient air temperature) does not exceed 1 K/h.

To shorten the test, if the devices allow it, the current may be increased during the first part of the test, it being reduced to the specified test current afterwards.

若組裝品含有熔線，試驗時，此等熔線應裝配製造廠商所規定之熔線鏈。

試驗時所使用之熔線鏈，其功率損失應記載於試驗報告中。熔線鏈之功率損失可藉由量測方式決定，或由熔線鏈製造廠商宣告。

試驗時所使用之外部導體，其大小及排列應於試驗報告中敘明。

應進行試驗一段充分時間，其足以使溫升達到恆定值。實務上，當在所

有量測點之變化量不超過 1 K/h 時，即達到此條件。

為縮短試驗，若裝置容許，於試驗之第 1 部分期間，電流可增加，之後降低試規定之試驗電流。

When a control electro-magnet is energized during the test, the temperature is measured when thermal equilibrium is reached in both the main circuit and the control electro-magnet.

The average value of the actual incoming test currents shall be between -0 % and +3 % of the intended value. Each phase shall be within ± 5 % of the intended value.

Tests on an individual section of the ASSEMBLY are acceptable. To make the test representative the external surfaces at which additional sections may be connected shall be thermally insulated with a covering to prevent any undue cooling.

When testing individual functional units within a section or a complete ASSEMBLY, the adjacent functional units can be replaced by heating resistors if the rating of each does not exceed 630 A and their rating is not to be verified with this test.

In ASSEMBLIES where there is a possibility that additional control circuits or devices may be incorporated, heating resistors shall simulate the power dissipation of these additional items.

試驗期間，當對控制電磁鐵供電時，於主電路及控制電磁鐵兩者達到熱平衡時，量測溫度。

實際之內向試驗電流平均值，應介於預期值之-0 %與+3 %之間。每相應在預期值之 ± 5 %之內。

可接受在組裝品之個別區段上進行試驗。為使試驗具有代表性，額外區段可能連接之外部表面，應以覆蓋物絕緣熱量，以防止過度冷卻。

當在一區段或整組組裝品內對個別功能性單元進行試驗時，若每一功能性單元之定額不超過 630 A，且其定額不須以本試驗進行查證，則可用熱電阻器取代鄰近之功能性單元。

當組裝品中有可能含有額外之控制電路或裝置時，熱電阻器應模擬此等額外物品之消耗功率。

10.10.2.3.2 Test conductors

In the absence of detailed information concerning the external conductors and the service conditions, the cross-section of the external test conductors shall be chosen considering the rated current of each circuit as follows:

a) For values of rated current up to and including 400 A:

- 1) the conductors shall be single-core, copper cables or insulated wires with cross-sectional areas as given in Table 11;
- 2) as far as practicable, the conductors shall be in free air;
- 3) the minimum length of each temporary connection from terminal to terminal shall be:
 - 1 m for cross-sections up to and including 35 mm²;
 - 2 m for cross-sections larger than 35 mm².

10.10.2.3.2 試驗導體

在無有關外部導體及使用條件之詳細資訊的情況下，應考量下述每一電路之額定電壓，以選擇外部試驗導體之截面積。

(a) 額定電流值在 400 A 以下

- (1) 導體應為表 11 所示之截面積的單芯銅電纜或絕緣配線。
- (2) 導體應儘可能在自由空氣中。

(3) 從端子至端子之每一暫時性連接，其最小長度應如下。

- 截面積在 35 mm^2 以下：1 m。
- 截面積大於 35 mm^2 ：2 m。

b) For values of rated current higher than 400 A but not exceeding 800 A:

- 1) The conductors shall be single-core copper cables with cross-sectional areas as given in Table 12, or the equivalent copper bars given in Table 12 as specified by the original manufacturer.
- 2) Cables or copper bars shall be spaced at approximately the distance between terminals. Multiple parallel cables per terminal shall be bunched together and arranged with approximately 10 mm air space between each other. Multiple copper bars per terminal shall be spaced at a distance approximately equal to the bar thickness. If the sizes stated for the bars are not suitable for the terminals or are not available, it is allowed to use other bars having the same cross-sectional dimensions $\pm 10 \%$ and the same or smaller cooling surfaces. Cables or copper bars shall not be interleaved.
- 3) For single-phase or multi-phase tests, the minimum length of any temporary connection to the test supply shall be 2 m. The minimum length to a star point may be reduced to 1.2 m where agreed by the original manufacturer.

(b) 額定電流值高於 400 A，但未超過 800 A

- (1) 導體應為表 12 所示之截面積的單芯銅電纜，或為原始製造廠商所規定於表 12 所列之同等銅排。
- (2) 電纜或銅排應分隔大約端子之間的距離。每端子之多條平行電纜應束在一起，且每束之間應配置約 10 mm 之空氣空間。每端子之多條銅排應分隔一段距離，其大約為銅排之厚度。若對銅排所指定之大小不適合端子或無法取得時，容許使用相同截面積 $\pm 10 \%$ 且相同或較小冷卻表面之其他銅排。電纜或銅排不應交錯。
- (3) 對於單相或多相試驗，與試驗電源之任何暫時連接之最小長度，應為 2 m。當原始製造廠商同意時，至星形點之最小長度可降至 1.2 m。

c) For values of rated current higher than 800 A but not exceeding 4 000 A:

- 1) The conductors shall be copper bars of the sizes stated in Table 12 unless the ASSEMBLY is designed only for cable connection. In this case, the size and arrangement of the cables shall be as specified by the original manufacturer.
- 2) Copper bars shall be spaced at approximately the distance between terminals. Multiple copper bars per terminal shall be spaced at a distance approximately equal to the bar thickness. If the sizes stated for the bars are not suitable for the terminals or are not available, it is allowed to use other bars having the same cross-sectional dimensions $\pm 10 \%$ and the same or smaller cooling surfaces. Copper bars shall not be interleaved.
- 3) For single-phase or multi-phase tests, the minimum length of any temporary connection to the test supply shall be 3 m, but this can be reduced to 2 m provided that the temperature rise at the supply end of the connection is not more than 5 K below the temperature rise in the middle of the connection length. The minimum length to a star point shall be 2 m.

(c) 額定電流值高於 800 A，但未超過 4,000 A

- (1) 導體應為表 12 指定之大小的銅排，除非組裝品係設計僅供電纜連接用。在此情況中，電纜之大小及配置應依原始製造廠商之規定。
- (2) 銅排應分隔大約端子之間的距離。每端子之多條銅排應分隔一段

距離，其大約為銅排之厚度。若對銅排所指定之大小不適合端子或無法取得時，容許使用相同截面積 $\pm 10\%$ 且相同或較小冷卻表面之其他銅排。電纜或銅排不應交錯。

- (3) 對於單相或多相試驗，與試驗電源之任何暫時連接之最小長度，應為 3 m，但倘若連接之電源端的溫升不超過連接長度之中點的溫升減 5 K 時，其可降至 2 m。至星形點之最小長度應為 2 m。

d) For values of rated current higher than 4 000 A:

The original manufacturer shall determine all relevant items of the test, such as type of supply, number of phases and frequency (where applicable), cross-sections of test conductors, etc. This information shall form part of the test report.

(d) 額定電流值高於 4,000 A

原始製造廠商應決定試驗之所有相關項目，例：電源型式、相數及頻率(若適用時)、試驗導體截面積等。此資訊應為試驗報告之一部分。

10.10.2.3.3 Measurement of temperatures

Thermocouples or thermometers shall be used for temperature measurements. For windings, the method of measuring the temperature by resistance variation shall generally be used.

The thermometers or thermocouples shall be protected against air currents and heat radiation.

The temperature shall be measured at all points where a temperature-rise limit (see 9.2) must be observed. Particular attention shall be given to joints in conductors and terminals within the main circuits. For measurement of the temperature of air inside an ASSEMBLY, several measuring devices shall be arranged in convenient places.

10.10.2.3.3 溫度之量測

量測溫度時，應使用熱電偶或溫度計。對於繞組，一般應使用以電阻變化量測溫度之方法。

溫度計或熱電偶應予以保護，防止氣流及熱輻射。

應於必須觀察溫升限制(參照 9.2)之所有點量測溫度。應特別注意導體之接合處及主電路內之端子。於組裝品內部量測溫度時，應在適當位置配置數個量測裝置。

10.10.2.3.4 Ambient air temperature

The ambient air temperature shall be measured by means of at least two thermometers or thermocouples equally distributed around the ASSEMBLY at approximately half its height and at a distance of approximately 1 m from the ASSEMBLY. The thermometers or thermocouples shall be protected against air currents and heat radiation.

The ambient temperature during the test shall be between $+10\text{ }^{\circ}\text{C}$ and $+40\text{ }^{\circ}\text{C}$.

10.10.2.3.4 周圍空氣溫度

應將至少 2 個溫度計或熱電偶平均分配於組裝品周圍，使其位於組裝品高度約一半且離組裝品約 1 m 之處，以量測周圍空氣溫度。溫度計或熱電偶應予以保護，防止氣流及熱輻射。

試驗期間，周圍空氣溫度應介於 $+10^{\circ}\text{C}$ 與 $+40^{\circ}\text{C}$ 之間。

10.10.2.3.5 Verification of the complete ASSEMBLY

Incoming and outgoing circuits of the ASSEMBLY shall be loaded with their rated currents (see 5.3.2) being equivalent to a rated diversity factor of 1 (see 5.4 and Annex O).

If the rated current of the incoming circuit or distribution busbar system is less than the sum of the rated currents of all outgoing circuits, then the outgoing circuits shall be split into groups corresponding to the rated current of the incoming circuit or distribution busbar system. The groups shall be formed in a manner so that the highest possible temperature rise is obtained. Sufficient groups shall be formed and tests undertaken so as to include all different variants of functional units in at least one group.

Where the fully loaded circuits do not distribute exactly the total incoming current, the remaining current shall be distributed via any other appropriate circuit. This test shall be repeated until all types of outgoing circuit have been verified at their rated current.

Change in the arrangement of functional units within a verified ASSEMBLY, or section of an ASSEMBLY may necessitate additional tests as the thermal influence of the adjacent units may differ significantly.

NOTE 10.10.2.3.6 provides a means of testing an ASSEMBLY with diversity factor less than one and fewer tests than specified in 10.10.2.3.7.

10.10.2.3.5 整組組裝品之查證

組裝品之內向及外向電路應承載其額定電流(參照 5.3.2)，其等同額定多樣性因數 1(參照 5.4 及附錄 O)。

若內向電路或配電匯流排系統之額定電流小於所有外向電路之額定電流的總和時，則應對應於內向電路或配電匯流排系統之額定電流，將外向電路分成數個群組。應以能取得最高可能溫度之方式分組。應形成足夠之群組，應進行試驗，以便在至少 1 個群組中能包括功能性單元之所有不同變體。

當完全負載之電路並未剛好分配所有內向電流，則剩餘電流應透過其他適合之單元分配。應重複此試驗，直到所有型式之外向電路已在其額定電流下進行查證為止。

在已進行查證之組裝品內，其功能性單元之配置改變或組裝品之區段有改變時，可能需要進行額外之試驗，因為鄰近單元之熱影響可能有顯著不同。

備考：對於多樣性因數小於 1 之組裝品，10.10.2.3.6 提供進行試驗之方式，且其試驗較 10.10.2.3.7 所規定之試驗為少。

10.10.2.3.6 Verification considering individual functional units separately and the complete ASSEMBLY

The rated currents of the circuits according to 5.3.2 and the rated diversity factor according to 5.4 shall be verified in two stages.

The rated current of each critical variant functional unit (10.10.2.2.3.b)) shall be verified separately in accordance with 10.10.2.3.7 c).

10.10.2.3.6 分別考量個別功能性單元及整組組裝品之查證

應分 2 階段查證 5.3.2 之電路額定電流及 5.4 之額定多樣性因數。

應依 10.10.2.3.7(c)分別查證每一關鍵性變體功能性單元(10.10.2.2.3 (b))之額定電流。

The ASSEMBLY is verified by loading the incoming circuit to its rated current and all outgoing functional units collectively to their rated current multiplied by the diversity factor.

If the rated current of the incoming circuit or distribution busbar system is less than the sum of the test currents of all outgoing circuits (i.e. the rated currents multiplied by the diversity factor), then the outgoing circuits shall be split into groups corresponding to the rated current of the incoming circuit or distribution busbar system. The groups shall be formed in a manner so that the highest possible temperature rise is obtained. Sufficient groups shall be formed and tests undertaken so as to include all different variants of functional units in at least one group.

Where the fully loaded circuits do not distribute exactly the total incoming current, the remaining current shall be distributed via any other appropriate circuit. This test shall be repeated until all types of outgoing circuit have been verified at their test current.

Change in the arrangement of functional units within a verified ASSEMBLY, or section of an ASSEMBLY may necessitate additional tests as the thermal influence of the adjacent units may differ significantly.

使內向電路承載其額定電流，並使所有外向功能性單元共同承載其額定電流乘上多樣性因數之電流，以查證組裝品。

若內向電路或配電匯流排系統之額定電流小於所有外向電路之試驗電流的總和時(亦即，額定電流乘以多樣性因數)，則應對應於內向電路或配電匯流排系統之額定電流，將外向電路分成數個群組。應以能取得最高可能溫度之方式分組。應形成足夠之群組，應進行試驗，以便在至少 1 個群組中能包括功能性單元之所有不同變體。

當完全負載之電路並未剛好分配所有內向電流，則剩餘電流應透過其他適合之單元分配。應重複此試驗，直到所有型式之外向電路已在其額定電流下進行查證為止。

在已進行查證之組裝品內，其功能性單元之配置改變或組裝品之區段有改變時，可能需要進行額外之試驗，因為鄰近單元之熱影響可能有顯著不同。

10.10.2.3.7 Verification considering individual functional units and the main and distribution busbars separately as well as the complete ASSEMBLY

ASSEMBLIES shall be verified by separate verification of standard elements a) to c) as selected in accordance with 10.10.2.2.2 and 10.10.2.3, and verification of a complete ASSEMBLY d) under worst case conditions as detailed below:

10.10.2.3.7 考量個別功能性單元，並分別考量主匯流排與配電匯流排及整組組裝品之查證

應藉由對依 10.10.2.2.2 及 10.10.2.3 所選取之標準元件(a)至(c)進行分別查證，並於下列所述之最壞情況下對整組組裝品進行查證，以查證組裝品。

- a) Main busbars shall be tested separately. They shall be mounted in the ASSEMBLY enclosure as in normal use with all covers and all partitions that separate the main busbars from other compartments, in place. If the main busbar has joints, then they shall be included in the test. The test shall be carried out at rated current. The test current shall pass through the full length of the busbars. Where the design of the ASSEMBLY permits, and, to minimise the influence of the external test conductors on the temperature rise, the length of the main busbar within the enclosure for the test shall be a minimum of 2 m and include a minimum of one joint when the busbars are extendable.

- (a) 主匯流排應分別進行試驗。其應如同正常使用般裝設在組裝品箱體中，所有外蓋及用以分隔主匯流排與其他分隔室之所有隔板皆位於適當位置。若主匯流排有接合點，則其應包含於試驗中。應於額定電流下進行試驗。試驗電流應通過匯流排之整個長度。當組裝品之設計容許時，且為了使外部試驗導體對溫升之影響降至最低，試驗時在箱體內之主匯流排長度應至少為 2 m，且當匯流排為可延伸時，應包括至少 1 個接合點。
- b) Distribution busbars shall be tested separately from the outgoing units. They shall be mounted in the enclosure as in normal use with all covers and all partitions that separate the busbar from other compartments, in place. Distribution busbars shall be connected to the main busbar. No other conductors, e.g. connections to functional units, shall be connected to the distribution busbar. In order to consider the most onerous condition, the test shall be carried out at rated current and the test current shall pass through the full length of the distribution busbar. If the main busbar is rated for a higher current, it shall be fed with additional current so that it carries its rated current to its junction with the distribution busbar.
- (b) 配電匯流排應與外向單元分開進行試驗。其應如同正常使用般裝設在箱體中，所有外蓋及用以分隔匯流排與其他分隔室之所有隔板皆位於適當位置。配電匯流排應連接至主匯流排。其他導體(例：至功能性單元之連接)不應連接至配電匯流排。為了考量最繁重之條件，試驗應於額定電流下進行，且試驗電流應通過配電匯流排之整個長度。若主匯流排額定於較高電流，其應以額外電流饋送，使得其以配電匯流排將其額定電流承載至其接面(junction)。
- c) Functional units shall be tested individually. The functional unit shall be mounted in the enclosure as in normal use with all covers and all internal partitions in place. If it can be mounted at different places the most unfavourable place shall be used. It shall be connected to the main or the distribution busbar as in normal use. If the main busbar and/or the distribution busbar (if any) are rated for a higher current, they shall be fed with additional currents so that they carry their individual rated currents to the respective junction points. The test shall be carried out at rated current for the functional unit.
- (c) 功能性單元應個別進行試驗。功能性單元應如同正常使用般裝設在箱體中，所有外蓋及所有內部隔板皆位於適當位置。若其能裝設於不同位置，則應使用最不利之位置。其應如同正常使用般連接至主匯流排或配電匯流排。若主匯流排及/或配電匯流排(若有時)額定於較高電流，其應以額外電流饋送，使得其將其個別額定電流承載至個別之接面點(junction point)。試驗應於功能性單元之額定電流下進行。
- d) The complete ASSEMBLY shall be verified by temperature rise testing of the most onerous arrangement(s) possible in service and as defined by the original manufacturer. For this test the incoming circuit is loaded to its rated current and each outgoing functional unit to its rated current multiplied by the rated diversity factor. If the rated current of the incoming circuit or distribution busbar system is less than the sum of the test currents of all outgoing circuits (i.e. the rated currents multiplied by the diversity factor), then the outgoing circuits shall be split into groups corresponding to the rated current of the incoming circuit or distribution busbar system. The groups shall be formed in a manner so that the highest possible temperature rise is obtained. Sufficient groups shall be formed and tests undertaken so as to include all different variants of functional units in at least one group.

(d) 應以使用中可能發生之最不利配置之溫升試驗及原始製造廠商所定義者，對整組組裝品進行查證。關於此試驗，使內向電路承載其額定電流，並使每一外向功能性單元承載其額定電流乘上額定多樣性因數。若內向電路或配電匯流排系統之額定電流小於所有外向電路之試驗電流的總和(亦即，額定電流乘上額定多樣性因數)，則應對應於內向電路或配電匯流排系統之額定電流，將外向電路應分成數個群組。應以某種方式形成群組，以獲得最高可能之溫升。應形成足夠之群組且進行試驗，以便在至少 1 個群組中能包括功能性單元之所有不同變體。

10.10.2.3.8 Results to be obtained

At the end of the test, the temperature rise shall not exceed the values specified in Table 6. The apparatus shall operate satisfactorily within the voltage limits specified for them at the temperature inside the ASSEMBLY.

10.10.2.3.8 待獲得之結果

試驗結束時，溫升不應超過表 6 所規定之值。設備應於組裝品內之溫度下，於針對該設備所規定之電壓限制範圍內圓滿操作。

10.10.3 Derivation of ratings for similar variants

10.10.3.1 General

The following sub-clauses define how the rated currents of variants can be verified by derivation from similar arrangements verified by test.

Temperature-rise tests on the circuit(s) carried out at 50 Hz are applicable to 60 Hz for rated currents up to and including 800 A. In the absence of tests at 60 Hz for currents above 800 A, the rated current at 60 Hz shall be reduced to 95 % of that at 50 Hz. Alternatively, where the maximum temperature rise at 50 Hz does not exceed 90 % of the permissible value, then derating for 60 Hz is not required. Tests carried out at a particular frequency are applicable at the same current rating to lower frequencies including d.c.

10.10.3 類似變體之定額推導

10.10.3.1 一般

下列次類別定義如何能藉由從經試驗查證過之類似配置的推導來查證變體之額定電流。

對於額定電流在 800 A 以下者，在 50 Hz 下於電路上所進行之溫升試驗，可適用於 60 Hz。對於電流超過 800 A 未於 60 Hz 下進行試驗者，於 60 Hz 下之額定電流應降低至 50 Hz 額定電流之 95 %。或者，當 50 Hz 下之最高溫升未超過可容許值之 90 %，則不需要針對 60 Hz 降低定額。於特別頻率下所進行之試驗，在相同電流定額下，可適用於較低之頻率(包括直流)。

10.10.3.2 ASSEMBLIES

ASSEMBLIES verified by derivation from a similar tested arrangement shall comply with the following:

- a) the functional units shall belong to the same group as the functional unit selected for test (see 10.10.2.2.3);
- b) the same type of construction as used for the test;
- c) the same or increased overall dimensions as used for the test;

10.10.3.2 組裝品

藉由從類似已受試驗配置之推導而進行查證之組裝品，應符合下列規定。

(a) 功能性單元應與供試驗而選擇之功能性單元屬於相同之群組(參照 10.10.2.2.3)。

(b) 與試驗時所使用之構造具有相同型式。

(c) 與試驗時所使用之整體尺寸相同或增加。

d) the same or increased cooling conditions as used for the test (forced or natural convection, same or larger ventilation openings);

e) the same or reduced internal separation as used for the test (if any);

f) the same or reduced power losses in the same section as used for the test.

The ASSEMBLY being verified may comprise all or only part of the electrical circuits of the ASSEMBLY previously verified. Alternative arrangement(s) of functional units within the ASSEMBLY or section compared to the tested variant is allowed as long as the thermal influences of the adjacent units are not more severe.

Thermal tests performed on 3-phase, 3-wire ASSEMBLIES are considered as representing 3-phase, 4-wire and single-phase, 2-wire or 3-wire ASSEMBLIES, provided that the neutral conductor is sized equal to or greater than the phase conductors arranged in the same manner.

(d) 與試驗時所使用之冷卻條件相同或增加(強制或自然通風，相同或較大之通風開口)。

(e) 與試驗時所使用之內部間隔(若有時)相同或降低。

(f) 在相同區段中，與試驗時所使用之功率損失相同或降低。

經查證過之組裝品，可包含先前已查證過之組裝品的全部或僅包含一部分。

只要鄰近單元之熱影響不嚴重，組裝品或區段內與受試驗之變體相比較的功能性單元，容許採用替代之配置。

倘若中性導體之大小等於或大於以相同方式配置之相導體，於三相三線組裝品上執行之熱試驗，視為能代表三相四線及單相二線或三線組裝品。

10.10.3.3 Busbars

Ratings established for aluminium busbars are valid for copper busbars with the same cross sectional dimensions and configuration. However, ratings established for copper busbars shall not be used to establish ratings of aluminium busbars.

The ratings of variants not selected for test according to 10.10.2.2.2 shall be determined by multiplying their cross-section with the current density of a larger cross-section busbar of the same design that has been verified by test.

If additionally a smaller cross-section than the one to be derived has been tested, which also fulfils the conditions of 10.10.2.2.2, then the rating of the intermediate variants may be established by interpolation.

10.10.3.3 匯流排

針對鋁匯流排所建立之定額，適用於相同截面積及架構之銅匯流排。然而，針對銅匯流排所建立之定額，不應使用於建立鋁匯流排之定額。

非針對 10.10.2.2.2 之試驗所選擇之變體，應將其截面積乘上經試驗查證過之相同設計的較大截面積匯流排之電流密度，以決定其變體之定額。

此外，若較待推導之截面積為小的截面積已進行過試驗，且其亦符合 10.10.2.2.2 之條件，則可用內插法建立中間變體之定額。

10.10.3.4 Functional units

After the critical variant of each group of comparable functional units (see 10.10.2.2.3 a)) has been subjected to a test for verification of temperature rise, the actual rated currents of all other functional units in the group shall be calculated using the results of these tests.

For each functional unit tested a de-rating factor (rated current, resulting from the test divided by the maximum possible current of this functional unit, see 10.10.2.2.3 b)) shall be calculated.

The rated current of each non-tested functional unit in the range shall be the maximum possible current of the functional unit multiplied by the de-rating factor established for the variant tested in the range.

10.10.3.4 功能性單元

在每群組可比較之功能性單元(參照 10.10.2.2.3(a))的關鍵變體已針對溫升之查證進行試驗後，應使用此等試驗之結果，計算群組中所有其他功能性單元之實際額定電流。

對於每一已試驗過之功能性單元，應計算降額因數(額定電流，依此功能性單元之最大可能電流分割之試驗所產生，參照 10.10.2.2.3(b))。

範圍內每一非受試驗之功能性單元的額定電流，應為功能性單元之最大可能電流乘上針對該範圍內經試驗過之變體所建立的降額因數。

10.10.3.5 Functional units – Device substitution

A device may be substituted with a similar device from another series to that used in the original verification, provided that the power loss and terminal temperature rise of the device, when tested in accordance with its product standard, is the same or lower. In addition, the physical arrangement within the functional unit and the rating of the functional unit shall be maintained.

NOTE In addition to temperature rise other requirements are considered including the short-circuit requirements, see Table 13.

10.10.3.5 功能性單元－裝置替換

倘若當裝置依其產品標準進行試驗時，裝置之功率損失及端子溫升相同或較低，可用其他系列之類似裝置代替原始查證中所使用之裝置。此外，功能性單元內之實體配置及功能性單元之定額，應予以維持。

備考：除了溫升試驗之外，考量其他要求，包括短路要求。參照表 13。

10.10.4 Verification assessment

10.10.4.1 General

Two calculation methods are provided. Both determine the approximate air temperature rise inside the enclosure, which is caused by the power losses of all circuits, and compare this temperature with the limits for the installed equipment. The methods differ only in the way the relationship between the delivered power loss and the air temperature rise inside the enclosure is ascertained.

Because the actual local temperatures of the current-carrying parts cannot be calculated by these methods, some limits and safety margins are necessary and are included.

10.10.4 查證評鑑

10.10.4.1 一般

提供 2 種計算方法。此 2 種方法皆決定箱體內之近似溫升(該溫升係由所有電路之功率損失所造成)，並比較此溫度與安裝之設備的限制。此等方法僅差異在確認輸出功率損失與箱體內部空氣溫升之間的關係之方式。

因為無法藉由此等方法計算載流零件之實際局部溫度，某些限制及安全邊際是有必要的，且包括在內。

10.10.4.2 Single compartment assembly with rated current not exceeding 630 A

10.10.4.2.1 Verification method

Verification of the temperature rise of a single compartment ASSEMBLY with the total supply current not exceeding 630 A and for rated frequencies up to and including 60 Hz may be made by calculation if all the following conditions are fulfilled:

- a) the power loss data for all built-in components is available from the component manufacturer;
- b) there is an approximately even distribution of power losses inside the enclosure;
- c) the rated current of the circuits of the ASSEMBLY to be verified (see 10.10.1) shall not exceed 80 % of the rated conventional free air thermal current (I_{th}) if any, or the rated current (I_n) of the switching devices and electrical components included in the circuit. Circuit protection devices shall be selected to ensure adequate protection to outgoing circuits, e.g. thermal motor protection devices at the calculated temperature in the ASSEMBLY;

NOTE 1 There is no common characteristic for switching devices and electrical components that describes the value of current to be used here. For the purpose of verifying the temperature rise limits the value of current is used, which describes the maximum continuous operational current that can be carried without overheating. This is e.g. for contactors the rated operational current I_e AC1 and for circuit breakers the rated current I_n .

- d) the mechanical parts and the installed equipment are so arranged that air circulation is not significantly impeded;
- e) conductors carrying currents in excess of 200 A, and the adjacent structural parts are so arranged that eddy-current and hysteresis losses are minimised;

10.10.4.2 額定電流不超過 630 A 之單一分隔室組裝品

10.10.4.2.1 查證法

若符合所有下列條件，則可用計算方式，查證總電源電流不超過 630 A 且額定頻率在 60 Hz 以下之單一分隔室組裝品。

- (a) 所有內建式組見之功率損失資料，可從組件製造廠商取得。
- (b) 箱體內之功率損失，呈近似平均分配。
- (c) 待進行查證之組裝品(參照 10.10.1)，其額定電流不應超過額定慣用自由空氣熱動電流(I_{th}) (若有時)或電路所包含之開關操作裝置及電氣組件的額定電流(I_n)。應選擇電路保護裝置，以確保電外向電路有足夠之保護，例：在組裝品中於計算所得之溫度下的熱動電動機保護裝置。
備考 1. 對於開關操作裝置及電氣組件，並無敘述此處所須使用之電流值的共同特性。關於查證溫升限制之目的，使用該電流值，其敘述所能承載且不會過熱之最大連續操作電流。舉例而言，對於接觸器，此為額定操作電流 I_e AC1，對於斷路器則為額定電流 I_n 。
- (d) 機械零件及所安裝之設備經適當配置，使得空氣流通未明顯受阻。
- (e) 導體承載電流超過 200 A，且鄰近結構零件經適當配置，使得渦電流及磁滯損失降至最低。

- f) all conductors shall have a minimum cross-sectional area based on 125 % of the permitted current rating of the associated circuit. Selection of cables shall be in accordance with IEC 60364-5-52. Examples on how to adapt this standard for conditions inside an ASSEMBLY are given in Annex H. The cross-section of bars shall be as tested or as given in Annex N. Where the device manufacturer specifies a conductor with a larger cross-sectional area this shall be used;
- g) the temperature rise depending on the power loss installed in the enclosure for the different installation methods (e.g. flush mounting, surface mounting), is:
 - available from the enclosure manufacturer;
 - determined in accordance with 10.10.4.2.2; or
 - in accordance with performance and installation criteria from the cooling equipment manufacturer when active cooling (e.g. forced cooling, internal air conditioning, heat exchanger etc.) is incorporated.

The effective power losses of all circuits including interconnecting conductors shall be calculated based on rated current of the circuits. The total power loss of the ASSEMBLY is calculated by adding the power losses of the circuits taking additionally into account that the total load current is limited to the rated current of the ASSEMBLY. The power losses of the conductors are determined by calculation (see Annex H).

(f) 所有導體應具有最小截面積，其係以相聯結之電路所容許的電流定額之 125 % 為基礎。電纜之選擇應依 IEC 60364-5-52。有關如何針對組裝品內之條件調整本標準之範例，如附錄 H 所示。排之截面應與進行試驗時相同，或如附錄 N 所示。當裝置製造廠商規定較大截面積之導體時，應使用該截面積。

(g) 針對不同之安裝方法，溫升取決於安裝在箱體中之功率損失，且以下列方式決定。

- 可從箱體製造廠商取得。
- 依 10.10.4.2.2 決定。
- 當含有主動冷卻(例：強制冷卻、內部空調、熱交換等)時，依冷卻設備製造廠商提供之性能及安裝準則。

應以電路之額定電流為基礎，計算所有電路(包括互連導體)之有效功率損失。增加電路之功率損失，並同時考量總負載電流係受限於組裝品之額定電流，以計算組裝品之總功率損失。以計算方式決定導體之功率損失(參照附錄 H)。

NOTE 2 There are devices where the power loss is substantially proportional to I^2 and others that have substantially fixed losses.

NOTE 3 Example: A single compartment ASSEMBLY with a rated current of 100 A (limited by the distribution bars) is equipped with 20 outgoing circuits. The assumed rated current for each circuit is 8 A. The total effective power loss should be calculated for 12 outgoing circuits loaded with 8 A each.

The temperature rise within the ASSEMBLY is then determined from the total power loss using the data mentioned in g).

備考 2. 有些裝置之功率損失大致上與 I^2 成正比，其他裝置則大致為固定之功率損失。

備考 3. 範例：額定電流 100 A (以配電排限制)之單一分隔室組裝品，配備 20 個外向電路。每個電路所假定之額定電流為 8 A。宜針對 12 個外向電路且每個電路承載 8 A，計算總有效功率損失。

隨後，使用(g)所述之資料，從總功率損失決定組裝品內之溫升。

10.10.4.2.2 Determination of the power loss capability of an enclosure by test

The power loss shall be simulated by means of heating resistors that produce heat equivalent to the intended power loss capability of the enclosure. The heating resistors shall be distributed evenly over the height of the enclosure and installed in suitable places inside the enclosure.

The cross-section of the leads to these resistors shall be such that no appreciable amount of heat is conducted away from the enclosure.

The test shall be carried out in accordance with 10.10.2.3.1 to 10.10.2.3.4 and the air temperature rise shall be measured in the top of the enclosure. Enclosure temperatures shall not exceed the values given in Table 6.

10.10.4.2.2 以試驗決定箱體之功率損失容量

應以熱電阻模擬功率損失，該熱電阻係產生相當於預定之箱體功率損失能力。熱電阻應平均分布在箱體之高度上，並安裝於箱體內之適合位置中。連接至此等電阻之導線，其截面應未顯現明顯之熱量從箱體導離。應依 10.10.2.3.1 至 10.10.2.3.4 進行試驗，且應於箱體頂部量測空氣溫升。箱體溫度不應超過表 6 所示之值。

10.10.4.2.3 Results to be obtained

The ASSEMBLY is verified if the air temperature determined from the calculated power loss does not exceed the permissible operating air temperature as declared by the device manufacturer. This means for switching devices or electrical components in the main circuits that the continuous load does not exceed its permissible load at the calculated air temperature and not more than 80 % of its rated current (see 10.10.4.2.1 c).

10.10.4.2.3 待獲得之結果

從計算而得之功率損失所決定的空氣溫度，若未超過裝置製造廠商所宣告之可容許的操作空氣溫度，則查證組裝品。對於在主電路內之開關操作裝置或電氣組件，此表示在計算而得之空氣溫度下，連續之負載並未超過在經計算而得之空氣溫度下的可容許負載，且未高於其額定電流之 80 % (參照 10.10.4.2.1 (c))。

10.10.4.3 ASSEMBLY with rated current not exceeding 1 600 A

10.10.4.3.1 Verification method

Verification of the temperature-rise of a single or multiple compartment ASSEMBLY with the total supply current not exceeding 1 600 A and for rated frequencies up to and including 60 Hz, may be made by calculation in accordance with the method of IEC 60890 if all the following conditions are fulfilled:

- a) the power loss data for all built-in components is available from the component manufacturer;
- b) there is an approximately even distribution of power losses inside the enclosure;

10.10.4.3 額定電流不超過 1,600 A 之組裝品

10.10.4.3.1 查證法

若符合下列所有條件時，總電源電流未超過 1,600 A 且額定頻率在 60 Hz 以下之單一或多重分隔室組裝品，應依 IEC 60890 之方法以計算查證其溫升。

- (a) 所有內建式組件之功率損失資料，可從組件製造廠商取得。
- (b) 箱體內之功率損失，呈近似平均分配。

- c) the rated current of the circuits of the ASSEMBLY to be verified (see 10.10.1) shall not exceed 80 % of the rated conventional free air thermal current (I_{th}) if any, or the rated current (I_n) of the switching devices and electrical components included in the circuit. Circuit protection devices shall be selected to ensure adequate protection to outgoing circuits, e.g. thermal motor protection devices at the calculated temperature in the ASSEMBLY;

NOTE 1 There is no common characteristic for switching devices and electrical components that describes the value of current to be used here. For the purpose of verifying the temperature rise limits the value of current is used, which describes the maximum continuous operational current that can be carried without overheating. This is e.g. for contactors the rated operational current I_e AC1 and for circuit breakers the rated current I_n .

- d) the mechanical parts and the installed equipment are so arranged that air circulation is not significantly impeded;
- e) conductors carrying currents in excess of 200 A, and the adjacent structural parts are so arranged that eddy-current and hysteresis losses are minimised;
- f) all conductors shall have a minimum cross-sectional area based on 125 % of the permitted current rating of the associated circuit. Selection of cables shall be in accordance with IEC 60364-5-52. Examples on how to adapt this standard for conditions inside an ASSEMBLY are given in Annex H. The cross-section of bars shall be as tested or as given in Annex N. Where the device manufacturer specifies a conductor with a larger cross-sectional area this shall be used;

(c) 待進行查證之組裝品(參照 10.10.1)，其額定電流不應超過額定慣用自由空氣熱動電流(I_{th}) (若有時)或電路所包含之開關操作裝置及電氣組件的額定電流(I_n)。應選擇電路保護裝置，以確保電外向電路有足夠之保護，例：在組裝品中於計算所得之溫度下的熱動電動機保護裝置。

備考 1. 對於開關操作裝置及電氣組件，並無敘述此處所須使用之電流值的共同特性。關於查證溫升限制之目的，使用該電流值，其敘述所能承載且不會過熱之最大連續操作電流。舉例而言，對於接觸器，此為額定操作電流 I_e AC1，對於斷路器則為額定電流 I_n 。

(d) 機械零件及所安裝之設備經適當配置，使得空氣流通未明顯受阻。

(e) 導體承載電流超過 200 A，且鄰近結構零件經適當配置，使得渦電流及磁滯損失降至最低。

(f) 所有導體應具有最小截面積，其係以相聯結之電路所容許的電流定額之 125 % 為基礎。電纜之選擇應依 IEC 60364-5-52。有關如何針對組裝品內之條件調整本標準之範例，如附錄 H 所示。排之截面應與進行試驗時相同，或如附錄 N 所示。當裝置製造廠商規定較大截面積之導體時，應使用該截面積。

- g) for enclosures with natural ventilation, the cross-section of the air outlet openings is at least 1,1 times the cross section of the air inlet openings;

- h) there are no more than three horizontal partitions in the ASSEMBLY or a section of an ASSEMBLY;

- i) for enclosures with compartments and natural ventilation the cross section of the ventilating openings in each horizontal partition is at least 50 % of the horizontal cross section of the compartment.

(g) 對於自然通風之箱體，空氣出口之截面，至少為空氣入口截面之 1.1 倍。

(h) 組裝品或組裝品區段中，不超過 3 個水平隔板。

- (i) 對於具有分隔室及自然通風之箱體，每個水平隔板中，通風口之截面至少為分隔室截面之 50 %。

The effective power losses of all circuits including interconnecting conductors shall be calculated based on rated current of the circuits. The total power loss of the ASSEMBLY is calculated by adding the power losses of the circuits taking additionally into account that the total load current is limited to the rated current of the ASSEMBLY. The power losses of the conductors are determined by calculation (see Annex H).

NOTE 2 There are devices where the power loss is substantially proportional to I^2 and others that have substantially fixed losses.

NOTE 3 Example: A single compartment ASSEMBLY with a rated current of 100 A (limited by the distribution bars) is equipped with 20 outgoing circuits. The assumed rated current for each circuit is 8 A. The total effective power loss should be calculated for 12 outgoing circuits loaded with 8 A each.

The temperature rise within the ASSEMBLY is then determined from the total power loss using the method of IEC 60890.

應以電路之額定電流為基礎，計算所有電路(包括互連導體)之有效功率損失。增加電路之功率損失，並同時考量總負載電流係受限於組裝品之額定電流，以計算組裝品之總功率損失。以計算方式決定導體之功率損失(參照附錄 H)。

備考 2. 有些裝置之功率損失大致上與 I^2 成正比，其他裝置則大致為固定之功率損失。

備考 3. 範例：額定電流 100 A (以配電排限制)之單一分隔室組裝品，配備 20 個外向電路。每個電路所假定之額定電流為 8 A。宜針對 12 個外向電路且每個電路承載 8 A，計算總有效功率損失。

隨後，使用(g)所述之資料，從總功率損失決定組裝品內之溫升。

10.10.4.3.2 Results to be obtained

The ASSEMBLY is verified if the calculated air temperature at the mounting height of any device does not exceed the permissible ambient air temperature as declared by the device manufacturer.

This means for switching devices or electrical components in the main circuits that the continuous load does not exceed its permissible load at the calculated local air temperature and not more than 80 % of its rated current (see 10.10.4.3.1 c).

10.10.4.3.2 待獲得之結果

在任何裝置之裝設高度所計算而得之空氣溫度，若未超過裝置製造廠商所宣告之可容許的周圍空氣溫度，則查證組裝品。

對於在主電路內之開關操作裝置或電氣組件，此表示在計算而得之空氣溫度下，連續之負載並未超過在經計算而得之當地空氣溫度下的可容許負載，且未高於其額定電流之 80 %(參照 10.10.4.3.1 (c))。

10.11 Short-circuit withstand strength

10.11.1 General

The short-circuit current ratings declared shall be verified except where exempt, see 10.11.2. Verification may be, by comparison with a reference design (10.11.3 and 10.11.4.) or by test (10.11.5). For verification the following applies:

10.11 短路耐受強度

10.11.1 一般

應查證所宣告之短路電流定額，獲免除者除外，參照 10.11.2。可藉由比較參考設計(10.11.3 及 10.11.4)或以試驗方式進行查證。關於查證，適用下列規定。

- a) If the ASSEMBLY system to be verified comprises a number of variants, the most onerous arrangement(s) of the ASSEMBLY shall be selected, taking into account the rules in 10.11.3.
- b) The ASSEMBLY variants selected for test shall be verified according to 10.11.5.
- c) When the ASSEMBLIES tested are the most onerous variants of the larger product range of an ASSEMBLY system then the test results can be used to establish the ratings of similar variants without further testing. Rules for such derivations are given in 10.11.3 and 10.11.4.
 - (a) 若待查證之組裝品系統係由若干變體組成，則考量 10.11.3 之規則，應選擇最不利之組裝品配置。
 - (b) 針對試驗所選擇之組裝品變體，應依 10.11.5 查證。
 - (c) 當受試驗之組裝品為組裝品系統之大產品範圍的最不利變體，則可使用試驗結果建立類似變體之定額，而無須進一步試驗。此等推導之規則，如 10.11.3 及 10.11.4 所示。

10.11.2 Circuits of ASSEMBLIES which are exempted from the verification of the short-circuit withstand strength

A verification of the short-circuit withstand strength is not required for the following:

- a) ASSEMBLIES having a rated short-time withstand current (see 5.3.4) or rated conditional short-circuit current (see 5.3.5) not exceeding 10 kA r.m.s;
- b) ASSEMBLIES, or circuits of ASSEMBLIES, protected by current-limiting devices having a cut-off current not exceeding 17 kA with the maximum allowable prospective short-circuit current at the terminals of the incoming circuit of the ASSEMBLY;
- c) Auxiliary circuits of ASSEMBLIES intended to be connected to transformers whose rated power does not exceed 10 kVA for a rated secondary voltage of not less than 110 V, or 1,6 kVA for a rated secondary voltage less than 110 V, and whose short-circuit impedance is not less than 4 %.

All other circuits shall be verified.

10.11.2 免除查證短路耐受強度之組裝品電路

下列項目不需要查證短路耐受強度。

- (a) 額定短時間耐電流(參照 5.3.4)或額定操作短路電流(參照 5.3.5)不超過 10 kA 均方根之組裝品。
- (b) 受截止電流不超過 17 A 之限流裝置保護，並在組裝品內向電路之端子具有最大可容許預期短路電流的組裝品或組裝品電路。
- (c) 預定連接至變壓器之組裝品輔助電路，該變壓器在額定二次電壓不小於 110 V 時額定功率不超過 10 kVA，或在額定二次電壓小於 110 V 時額定功率不超過 1.6 kVA，且短路阻抗不小於 4 %。

應查證所有其他電路。

10.11.3 Verification by comparison with a reference design – Utilising a check list

Verification is undertaken by comparison of the ASSEMBLY to be verified with an already tested design using the check list provided in Table 13.

Should any elements identified in the check list not comply with the requirements of the check list and be marked 'NO', one of the following means of verification shall be used (see 10.11.4 and 10.11.5).

10.11.3 藉由比較參考設計之查證－使用查檢表

使用表 13 提供之查檢表，比較待查證之組裝品與已試驗之設計，以進行查證。

萬一查檢表所識別之任何元件不符合查檢表之要求並標示“否”，則應使用下列其中 1 種查證方式(參照 10.11.4 及 10.11.5)。

10.11.4 Verification by comparison with a reference design – Utilising calculation

Assessment of the rated short-time withstand current of an ASSEMBLY and its circuits, by calculation, shall be undertaken by a comparison of the ASSEMBLY to be assessed with an ASSEMBLY, already verified by test. The assessment to verify the main circuits of an ASSEMBLY shall be in accordance with Annex P. In addition each of the circuits of the ASSEMBLY to be assessed shall meet the requirements of items 6, 8, 9 and 10 in Table 13.

The data used, calculations made and comparison undertaken shall be recorded.

If the assessment in accordance with Annex P is not passed or any of the items listed above are not fulfilled then the ASSEMBLY and its circuits shall be verified by test in accordance with 10.11.5.

10.11.4 藉由比較參考設計之查證－使用計算

應比較待評鑑之組裝品與已以試驗查證過之組裝品，以計算方式評鑑組裝品及其電路之額定短時間耐電流。查證組裝品主電路之評鑑，應依附錄 P 之規定。除此之外，待評鑑之組裝品的每一電路，應符合表 13 第 6 項、第 8 項、第 9 項及第 10 項之要求。

應記錄所使用之資料、所進行之計算及比較。

若未通過附錄 P 之評鑑或不符合上述任何項目，則應依 10.11.5 之試驗查證組裝品及其電路。

10.11.5 Verification by test

10.11.5.1 Test arrangements

The ASSEMBLY or its parts as necessary to complete the test shall be mounted as in normal use. It is sufficient to test a single functional unit if the remaining functional units are of the same construction. Similarly it is sufficient to test a single busbar configuration if the remaining busbar configurations are of the same construction. Table 13 provides clarification on items not requiring additional tests.

10.11.5 以試驗查證

10.11.5.1 試驗配置

完成試驗所必要之組裝品或其零件，應如正常使用般裝設。若剩餘之功能性單元為相同構造，則對單一功能性單元進行試驗已足夠。同樣地，若剩餘之匯流排架構為相同構造，則對單一匯流排架構進行試驗已足夠。表 13 提供不需要額外試驗之項目的說明。

10.11.5.2 Performance of the test – General

If the test circuit incorporates fuses, fuse-links with the maximum let-through current and, if required, of the type indicated by the original manufacturer as being acceptable, shall be used.

The supply conductors and the short-circuit connections required for testing the ASSEMBLY shall have sufficient strength to withstand short-circuits and be so arranged that they do not introduce any additional stresses on the ASSEMBLY.

Unless otherwise agreed, the test circuit shall be connected to the input terminals of the ASSEMBLY. Three-phase ASSEMBLIES shall be connected on a three-phase basis.

10.11.5.2 試驗之性能 — 一般

若試驗電路包含熔線，則應使用具有最大允通電流且若(有需要時)具有原始製造廠商所指定可接受之型式的熔線鏈。

對組裝品進行試驗時所需要之電源導體及短路連接，應具有充分強度以耐受短路，並予以適當配置，使其不會在組裝品上產生任何額外應力。

除非另有協議，試驗電路應連接至組裝品之輸入端子。三相組裝品應在三相基礎上予以連接。

All parts of the equipment intended to be connected to the protective conductor in service, including the enclosure, shall be connected as follows:

- a) for ASSEMBLIES suitable for use on three-phase four-wire systems (see also IEC 60038) with an earthed star point and marked accordingly, to the neutral point of supply or to a substantially inductive artificial neutral permitting a prospective fault current of at least 1 500 A;
- b) for ASSEMBLIES also suitable for use in three-phase three-wire as well as on three-phase four-wire systems and marked accordingly, to the phase conductor least likely to arc to earth.

Except for ASSEMBLIES according to 8.4.4, the connection mentioned in a) and b) shall include a fusible element consisting of a copper wire of 0,8 mm diameter and at least 50 mm long, or of an equivalent fusible element for the detection of a fault current. The prospective fault current in the fusible element circuit shall be $1\,500\text{ A} \pm 10\%$, except as stated in Notes 2 and 3. If necessary, a resistor limiting the current to that value shall be used.

預定連接至使用中之保護性導體的設備之所有零件(包括箱體)，應依下列方式連接。

(a) 對於適合使用在具接地星形中性點之三相四線系統(參照 IEC 60038)並因此標示的組裝品，連接至容許至少 1,500 A 預期故障電流之電源中性點或連接至實質上感應式人工中性點。

(b) 對於亦適合使用在三相三線及三相四線系統並因此標示的組裝品，連接至最不能電弧接地之相導體。

除 8.4.4 之組裝品外，(a)及(b)所提之連接，應包括由直徑 0.8 mm 且長度至少 50 mm 之銅線組成的可熔斷元件，或包括偵測故障電流用之等效可熔斷元件。可熔斷元件電路中，預期故障電流應為 $1,500\text{ A} \pm 10\%$ ，備考 2 及備考 3 所述者除外。若有必要時，應使用將電流限制在該值的電阻。

NOTE 1 A copper wire of 0,8 mm diameter will melt at 1 500 A, in approximately half a cycle, at a frequency between 45 Hz and 67 Hz (or 0,01 s for d.c.).

NOTE 2 The prospective fault current may be less than 1 500 A in the case of small equipment, according to the requirements of the relevant product standard, with a smaller diameter copper wire (see Note 4) corresponding to the same melting time as in Note 1.

NOTE 3 In the case of a supply having an artificial neutral, a lower prospective fault current may be accepted, subject to the agreement of the ASSEMBLY manufacturer, with a smaller diameter copper wire (see Note 4) corresponding to the same melting time as in Note 1.

NOTE 4 The relationship between the prospective fault current in the fusible element circuit and the diameter of the copper wire is given in Table 14.

備考 1. 直徑 0.8 mm 之銅線，將在 1,500 A 於 45 Hz 與 67 Hz 之間的頻率下，於大約 0.5 個循環(或直流時為 0.01 s)內熔斷。

備考 2. 依相關產品標準之要求，關於小型設備，在使用相對應於備考 1 之相同熔斷時間的較小直徑銅線下，預期故障電流可小於 1,500 A。

備考 3. 關於具有人工中性點之電源，在組裝品製造廠商之同意及使用相對應於備考 1 之相同熔斷時間的較小直徑銅線下，可容許較低之預期故障電流。

備考 4. 可熔斷元件之預期故障電流與銅線直徑之間的關係，如表 14 所示。

10.11.5.3 Testing of main circuits

10.11.5.3.1 General

Circuits shall be tested with the highest thermal and dynamic stresses that may result from short circuit currents up to the rated values for one or more of the following conditions as declared by the original manufacturer.

- a) Not dependent upon a SCPD. The ASSEMBLY shall be tested with the rated peak withstand current and the rated short-time withstand current for the specified duration (see 5.3 and 9.3.2 a)).
- b) Dependent upon an incoming SCPD included within the ASSEMBLY. The ASSEMBLY shall be tested with an incoming prospective short-circuit current for a period of time that is limited by the incoming SCPD.
- c) Dependent upon an upstream SCPD. The ASSEMBLY shall be tested to the let through values permitted by the upstream SCPD as defined by the original manufacturer.

Where an incoming or outgoing circuit includes a SCPD that reduces the peak and/or duration of the fault current, then the circuit shall be tested allowing the SCPD to operate and interrupt the fault current (see 5.3.5 rated conditional short-circuit current I_{cc}). If the SCPD contains an adjustable short-circuit release, then this shall be set to the maximum allowed value (see 9.3.2, second paragraph).

One of each type of circuit shall be subject to a short-circuit test as described in 10.11.5.3.2 to 10.11.5.3.5.

10.11.5.3 主電路之試驗

10.11.5.3.1 一般

應以短路電流至額定值所可能產生之最大熱動及動態應力，針為原始製造廠商所宣告之下列 1 種或多種條件，對電路進行試驗。

- (a) 非取決於 SCPD。應以額定峰值耐電流及額定短時間耐電流，對組裝品進行試驗，試驗時間為所規定之持續時間。
- (b) 取決於組裝品內所包括之內向 SCPD。應以內向預期短路電流，對組裝品進行試驗，試驗時間為內向 SCPD 所限制之時間間隔。
- (c) 取決於上游 SCPD。組裝品應進行試驗至原始製造廠商定義之上游 SCPD 所容許的允通值。

當內向或外向電路包括會降低故障電流之峰值及/或持續時間的 SCPD 時，電路應進行試驗，容許 SCPD 操作及中斷故障電流(參照 5.3.5 額定條件短路電流 I_{cc})。若 SCPD 含有可調整之短路釋放器，則其應設定至最大容許值(參照 9.3.2 第 2 段)。

每型式電路之其中之 1，應進行 10.11.5.3.2 至 10.11.5.3.5 所述之短路試驗。

10.11.5.3.2 Outgoing circuits

The outgoing terminals of outgoing circuits shall be provided with a bolted short-circuit connection. When the protective device in the outgoing circuit is a circuit-breaker, the test circuit may include a shunting resistor in accordance with 8.3.4.1.2 b) of IEC 60947-1:2007 in parallel with the reactor used to adjust the short-circuit current.

For circuit-breakers having a rated current up to and including 630 A, a conductor 0,75 m in length having a cross-sectional area corresponding to the rated current (see Tables 11 and 12) shall be included in the test circuit. At the original manufacturer's discretion a shorter connection than 0,75 m may be used.

The switching device shall be closed and held closed in the manner normally used in service. The test voltage shall then be applied once and,

- a) for a time sufficiently long to enable the short-circuit protective device in the outgoing unit to operate to clear the fault and, in any case, for not less than 10 cycles (test voltage duration), or
- b) in cases where the outgoing circuit does not include a SCPD, for a magnitude and duration as specified for the busbars by the original manufacturer. Testing of outgoing circuits may also result in the operation of the incoming circuit SCPD.

10.11.5.3.2 外向電路

外向電路之外向端子應備有螺栓式短路連接。當外向電路中之保護裝置為斷路器時，試驗電路可包括 IEC 60947-1:2007 之 8.3.4.1.2(b) 的分流電阻器並聯用於調整短路電流之電抗器。

對於額定電流在 630 A 以下之斷路器，試驗電路中應包括長度 0.75 m、截面積相對應於額定電流(參照表 11 及表 12)之導體。在原始製造廠商之斟酌下，可使用短於 0.75 m 之連接。

開關操作裝置應閉合，且以運轉中通常所使用之方式保持閉合。隨後應施加試驗電壓 1 次，且

- (a) 時間足夠長，使外向單元中之短路保護裝置能操作，以清除故障，且在任何情況中，不小於 10 個循環(試驗電壓持續時間)。或
- (b) 在外向電不包括 SCPD 之情況中，振幅及持續時間依原始製造廠商對匯流排之規定。外向電路之試驗亦可能造成內向電路 SCPD 操作。

10.11.5.3.3 Incoming circuit and main busbars

ASSEMBLIES containing main busbars shall be tested to prove the short-circuit withstand strength of the main busbars and the incoming circuit including at least one joint where the busbars are intended to be extendable. The short-circuit shall be placed such that the length of main busbar included in the test is $(2 \pm 0,4)$ m. For the verification of rated short-time withstand current (see 5.3.4) and rated peak withstand current (see 5.3.3), this distance may be increased and the test conducted at any convenient voltage providing the test current is the rated value (see 10.11.5.4 b)). Where the design of the ASSEMBLY is such that the length of the busbars to be tested is less than 1,6 m and the ASSEMBLY is not intended to be extended, then the complete length of busbar shall be tested, the short-circuit being established at the end of these busbars. If a set of busbars consists of different sections (as regards cross-sections, center line spacing of the conductors, type and number of supports per metre), each section shall be tested separately or concurrently, provided that the above conditions are met.

10.11.5.3.3 內向電路及主匯流排

含有主匯流排之組裝品應進行試驗，以證明主匯流排及內向電路(包括匯流排預定可延伸之至少 1 個接合)之短路耐受強度。短路應置於適當位置，使得試驗中所包括之主匯流排的長度為 (2 ± 0.4) m。關於額定短時間

耐電流(參照 5.3.4)及額定峰值耐電流(參照 5.3.3)之查證，此距離可增加，且在任何適當電壓下執行之試驗所提供之試驗電流為額定值(參照 10.11.5.4(b))。當組裝品之設計使得待試驗之匯流排的長度小於 1.6 m，且組裝品未預期延伸，則匯流排之整個長度應進行試驗，短路建立在此等匯流排之尾端。若 1 組匯流排包括不同區段(關於截面，導體之中心線間隔、每公尺支撐物之型式及數量)，則倘若符合上述條件時，每區段應分別或同時進行試驗。

10.11.5.3.4 Connections to the supply side of outgoing units

Where an ASSEMBLY contains conductors, including distribution busbars, if any, between a main busbar and the supply side of outgoing functional units that do not fulfil the requirements of 8.6.4 one circuit of each type shall be subject to an additional test.

A short-circuit is obtained by bolted connections on the conductors connecting the busbars to a single outgoing unit, as near as practicable to the terminals on the busbar side of the outgoing unit. The value and duration of the short-circuit current shall be the same as that for the main busbars.

10.11.5.3.4 連接至外向單元之電源側

在匯流排與外向功能性單源電源側之間，當組裝品含有不符合 8.6.4 要求之導體(包括配電匯流排，若有時)時，每個型式之 1 個電路應進行額外之試驗。

在導體上以螺栓連接連接匯流排與單一外向單元，並儘可能接近外向單元之匯流排側的端子，以獲得短路。短路電流之值及持續時間應與主匯流排相同。

10.11.5.3.5 Neutral conductor

If a neutral conductor exists within a circuit it shall be subjected to one test to prove its short-circuit withstand strength in relation to the nearest phase conductor of the circuit under test including any joints. Phase to neutral short-circuit connections shall be applied as specified in 10.11.5.3.3.

Unless otherwise agreed between the original manufacturer and the user, the value of the test current in the neutral shall be at least 60 % of the phase current during the three-phase test.

The test need not be executed if the test is intended to be made with a current of 60 % of the phase current and if the neutral conductor is:

- the same shape and cross-section as the phase conductors;
- supported in an identical manner as the phase conductors and with support centres along the length of the conductor not greater than that of the phases;
- spaced at a distance from the nearest phase(s) not less than that between phases;
- spaced at a distance from earthed metalwork not less than the phase conductors.

10.11.5.3.5 中性導體

若中性導體存在於電路內，其應進行 1 項試驗，以證明其短路耐受強度與試驗中電路之最接近的相導體(包括任何接合點)有關。應依 10.11.5.3.3 之規定採用相至中性短路連接。

除非原始製造廠商與使用者之間另有協議，中性點中試驗電流值應至少為三相試驗期間相電流之 60 %。

若預定以相電流之 60%的電流進行試驗，且若中性導體如下所述，則不

需要執行試驗。

- 形狀及截面與相導體相同。
- 與相導體之支撐方式相同，且沿著導體長度之支撐中心不大於相之中心。
- 與最近之相的距離，不小於相間之距離。
- 與接地網路的距離，不小於與相導體之距離。

10.11.5.4 Value and duration of the short-circuit current

For all short-circuit withstand ratings, the dynamic and thermal stresses shall be verified with a prospective current, at the supply side of the specified protective device, if any, equal to the value of the rated short-time withstand current, rated peak withstand current or rated conditional short-circuit current assigned.

For the verification of all the short-circuit withstand ratings (see 5.3.3 to 5.3.5 inclusive), the value of the prospective short-circuit current at a test voltage equal to 1,05 times the rated operational voltage shall be determined from a calibration oscillogram which is taken with the supply conductors to the ASSEMBLY short-circuited by a connection of negligible impedance placed as near as possible to the input supply of the ASSEMBLY. The oscillogram shall show that there is a constant flow of current such that it is measurable at a time equivalent to the operation of the protective device incorporated in the ASSEMBLY or for the specified duration (see 9.3.2. a)).

The value of current during the calibration is the average of the r.m.s. values of the a.c. component in all phases. When making the tests at maximum operational voltage, the calibration current in each phase shall be equal to the rated short-circuit current within a $\begin{smallmatrix} +5 \\ 0 \end{smallmatrix}$ % tolerance and the power factor shall be within a $\begin{smallmatrix} 0,00 \\ -0,05 \end{smallmatrix}$ tolerance.

All tests shall be made at the rated frequency of the ASSEMBLY with a tolerance of ± 25 %, and at the power factor appropriate to the short-circuit current in accordance with Table 7.

10.11.5.4 短路電流之值及持續時間

關於所有短路耐受定額，應在規定之保護裝置(若有時)的電源側下，以等於所指定之額定短時間耐電流、峰值耐電流或額定條件短路電流之值的預期電流，查證動態及熱動應力。

關於所有短路耐受定額(參照 5.3.3 至 5.3.5)之查證，於試驗電壓等於額定操作電壓之 1.05 倍下的預期短路電流之值，應從校正波形圖決定，該波形圖之取得，係將幾乎無阻抗之連接置於儘可能接近組裝品輸入電源端之處使組裝品短路。波形圖顯示有恆定之電流，使得可在相當於組裝品所包含之保護裝置操作時或規定之持續時間內量測(參照 9.3.2(a))。

校正期間之電流值，為所有各相之交流分量的均方根值的平均。當於最大操作電壓下進行試驗時，每相之校正電流應等於許可差在 $\begin{smallmatrix} +5 \\ 0 \end{smallmatrix}$ %內之額定短路電流，且功率因數之許可差應在 $\begin{smallmatrix} 0,00 \\ -0,05 \end{smallmatrix}$ %內。

所有試驗應在組裝品之額定頻率(許可差為 ± 25 %)及適合於表 7 之短路電流的功率因數下進行。

- a) For a test at rated conditional short circuit current I_{cc} , whether the protective devices are in the incoming circuit of the ASSEMBLY or elsewhere, the test voltage shall be applied for a time sufficiently long to enable the short-circuit protective devices to operate to clear the fault and, in any case, for not less than 10 cycles. The test shall be conducted at 1.05 times the rated operational voltage with prospective short circuit currents, at the supply side of the specified protective device, equal to the value of the rated conditional short-circuit current. Tests at lower voltages are not permitted.

NOTE In South Africa (ZA) National Electrical Code SANS 10142-1, Subclause 6.8, requires that the supply voltage be equal to 1.1 times the nominal voltage where the rated operational voltage is up to and including 500 V.

- b) For a test at rated short-time withstand current and rated peak withstand current, the dynamic and thermal stresses shall be verified with a prospective current equal to the value of rated short-time withstand current and rated peak withstand current declared. The current shall be applied for the specified time during which the r.m.s. value of its a.c. component shall remain constant.

In the case of test station difficulty of making the short-time or peak withstand tests at the maximum operational voltage, the tests according to 10.11.5.3.3, 10.11.5.3.4 and 10.11.5.3.5 may be made at any convenient voltage, with the original manufacturer's agreement, the actual test current being, in this case, equal to the rated short-time current or peak withstand current. This shall be stated in the test report. If, however, momentary contact separation occurs in the protective device, if any, during the test, the test shall be repeated at the maximum operational voltage.

If necessary, due to test limitations, a different test period is permissible; in such a case, the test current should be modified in accordance with the formula $I^2t = \text{constant}$, provided that the peak value does not exceed the rated peak withstand current without the original manufacturer's consent and that the r.m.s. value of the short-time current is not less than the rated value in at least one phase for at least 0.1 s after current initiation.

- (a) 關於在額定條件短路電流 I_{cc} 下之試驗，不管保護裝置是在組裝品之內向電路中或是在其他處，試驗電壓應施加足夠長之時間，使短路保護裝置能操作，以清除故障，且在任何情況中，不小於 10 個循環。應於 1.05 倍額定操作電壓下，於規定之保護裝置的電源側，以等於額定條件短路電流值之預期短路電流執行試驗。不容許在較低電壓下之試驗。

備考：在南非(ZA)，國家電氣法規 SANS 10142-1 第 6.8 節要求當額定操作電壓在 500 V 以下時，電源電壓等於 1.1 倍標稱電壓。

- (b) 關於在額定短時間耐電流及額定峰值耐電流下之試驗，應以等於所宣告之額定短時間耐電流及峰值耐電流之值的預期電流，查證動態及熱動應力。電流應施加一段規定之時間，在施加期間，其交流分量之均方根值應維持恆定。

在試驗站於最大操作電壓下進行短時間或峰值耐受試驗有困難之情況中，在原始製造廠商同意下，10.11.5.3.3、10.11.5.3.4 及 10.11.5.3.5 之試驗可在任何適當電壓下進行，在此情況中，實際試驗等於額定短時間電流或額定耐電流。試驗報告中應記載此情況。然而，試驗期間若保護裝置(若有時)中發生瞬間接觸分離，則應於最大操作電壓下重複進行試驗。

若有必要時，由於試驗限制，可容許不同之試驗期間。在此情況中，倘若未在原始製造廠商同意下，峰值未超過額定峰值耐電流，且倘若在電流起始後短時間電流之均方根值不大於短時間電流試驗之等效值，則試驗電流宜依公式 $I^2t = \text{定值}$ 加以修正。

The peak current withstand test and the short-time current test may be separated. In this case, the time during which the short-circuit is applied for the peak current withstand test shall be such that the value I^2t is not larger than the equivalent value for the short-time current test, but it shall be not less than three cycles.

Where the required test current in each phase cannot be achieved the positive tolerance may be exceeded with the agreement of the original manufacturer.

峰值電流耐受試驗與短時間電流試驗可分開。在此情況中，針對峰值電流耐受試驗施以短路之時間，應使得 I^2t 不大於短時間電流試驗之等效值，但其不應小於 3 個循環。

當每相中所需要之試驗電流無法達到時，在原始製造廠商之同意下，可超過正許可差。

10.11.5.5 Results to be obtained

After the test deformation of busbars and conductors is acceptable provided that the clearances and creepage distances specified in 8.3 are still complied with. In case of any doubt clearances and creepage distances shall be measured (see 10.4).

The characteristics of the insulation shall remain such that the mechanical and dielectric properties of the equipment satisfy the requirements of the relevant ASSEMBLY standard. A busbar insulator or support or cable restraint has not separated into two or more pieces. Also there shall be no cracks appearing on opposite sides of a support and no cracks, including surface cracks, running the full length or width of the support. In case of any doubt that the insulation properties of the ASSEMBLY are not maintained an additional power frequency test at two times U_e with a minimum of 1 000 V shall be performed in accordance with 10.9.2.

There shall be no loosening of parts used for the connection of conductors and the conductors shall not separate from the outgoing terminals.

Distortion of the busbars or structure of the ASSEMBLY that impairs its normal use shall be deemed a failure.

Any distortion of the busbars or structure of the ASSEMBLY that impairs normal insertion or removal of the removable parts shall be deemed a failure.

10.11.5.5 待獲得之結果

試驗後，倘若仍符合 8.3 規定之空間距離及沿面距離，可接受匯流排及導體之變形。若有任何疑義，應量冊空間距離及沿面距離(參照 10.4)。

應維持絕緣特性，使得設備之機械及電介質特性滿足相關組裝品標準之要求。匯流排絕緣器或支撐物或電纜限制器未分割成 2 片或多片。支撐物之對向側亦不應出現裂縫，且在支撐物之整個長度或寬度上不應有裂縫(包括表面裂縫)蔓延。若有對於組裝品之絕緣特性未能維持之任何疑義，應依 10.9.2 於 2 倍 U_e (但最小為 1,000 V)下執行額外之商頻試驗。

用於連接導體之零件不應鬆動，且導體不應與外向端子分離。

匯流排或組裝品結構的扭曲若損害其正常使用時，應視為失效。

匯流排或組裝品結構之扭曲若損害可動零件之正常插入或移除時，應視為失效。

Deformation of the enclosure or of the internal partitions, barriers and obstacles due to short-circuit is permissible to the extent that the degree of protection is not apparently impaired and the clearances or creepage distances are not reduced to values, which are less than those specified in 8.3. Additionally after the tests of 10.11.5.3 incorporating short-circuit protective devices, the tested equipment shall be capable of withstanding the dielectric test of 10.9.2, at a value of voltage for the "after test" condition prescribed in the relevant short-circuit protective device standard for the appropriate short-circuit test, as follows:

- a) between all live parts and the exposed conductive parts of the ASSEMBLY, and
- b) between each pole and all other poles connected to the exposed conductive parts of the ASSEMBLY.

If tests a) and b) above are conducted, they shall be carried out with any fuses replaced and with any switching device closed.

The fusible element (see 10.11.5.2.), if any, shall not indicate a fault current.

In case of any doubt, it shall be checked that the apparatus incorporated in the ASSEMBLY are in a condition as prescribed in the relevant specifications.

箱體之變形，或內部隔板、障壁及障礙物因短路而造成之變形，其可容許之程度為保護等級未明顯受損害，以及空間距離或沿面距離未降低至小於 8.3 所規定之值。此外於 10.11.5.3 合併短路保護裝置之試驗後，於適當短路試驗之相關短路保護裝置標準所述之“試驗後”條件的電壓值下，受試驗之設備應能耐受 10.9.2 之電介質試驗。

(a) 於組裝品之所有帶電零件與外露導電零件之間。及

(b) 於每一極與連接至組裝品外露導電零件之所有其他極之間。

若進行上述試驗(a)及試驗(b)，應於任何熔線均被取代且任何開關操作裝置均閉合之情況下進行試驗。

若有易熔元件(參照 10.11.5.2)，其不應顯示故障電。

若有任何疑問，應檢查組裝品內所包含之設備是否處於相關規範所述之條件。

10.11.5.6 Testing of the protective circuit

10.11.5.6.1 General

This test does not apply for circuits according to 10.11.2.

A single-phase test supply shall be connected to the incoming terminal of one phase and to the terminal for the incoming protective conductor. When the ASSEMBLY is provided with a separate protective conductor, the nearest phase conductor shall be used. For each representative outgoing unit, a separate test shall be made with a bolted short-circuit connection between the corresponding outgoing phase terminal of the unit and the terminal for the relevant outgoing protective conductor.

10.11.5.6 保護電路之試驗

10.11.5.6.1 一般

本試驗不適用於 10.11.2 之電路。

單相試驗電源應連接至一相之內向端子，以及內向保護性導體用之端子。當組裝品備有獨立之保護性導體時，應使用最接近之相導體。對於每一代表性外向單元，應於單元之相對應外相端子與相關外相保護性導體用之端子之間施以螺栓式短路連接，並進行獨立試驗。

Each outgoing unit on test shall be fitted with its intended protective device. Where alternative protective devices can be incorporated in the outgoing unit, the protective device which lets through the maximum values of peak current and I^2t shall be used.

For this test, the frame of the ASSEMBLY shall be insulated from earth. The test voltage shall be equal to 1,05 times the single-phase value of the rated operational voltage. Unless otherwise agreed between the original manufacturer and the user, the value of the test current in the protective conductor shall be at least 60 % of the phase current during the three-phase test of the ASSEMBLY.

NOTE In South Africa (ZA) National Electrical Code SANS 10142-1, Subclause 6.8, requires that the supply voltage be equal to 1,1 times the nominal voltage where the rated operational voltage is up to and including 500 V.

All other conditions of this test shall be analogous to 10.11.5.2 to 10.11.5.4 inclusive.

試驗時每一外向單元應裝配其預定之保護裝置。當替代之保護裝置可併於外向單元時，應使用使最大峰值電流值及 I^2t 通過之保護裝置。

關於此試驗，組裝品之外框應與地絕緣。試驗電壓應等於額定操作電壓之單相值的 1.05 倍。除非原始製造廠商與使用者另有協議，保護性導體中之試驗電流值應至少為組裝品三相試驗期間之相電流的 60 %。

備考：在南非(ZA)，國家電氣法規 SANS 10142-1 第 6.8 節要求當額定操作電壓在 500 V 以下時，電源電壓等於 1.1 倍標稱電壓。

本試驗之所有其他條件應類似於 10.11.5.2 至 10.11.5.4。

10.11.5.6.2 Results to be obtained

The continuity and the short-circuit withstand strength of the protective circuit, whether it consists of a separate conductor or the frame, shall not be significantly impaired. Besides visual inspection, this may be verified by measurements with a current in the order of the rated current of the relevant outgoing unit. Deformation of the enclosure or of the internal partitions, barriers and obstacles due to short-circuit is permissible to the extent that the degree of protection is not apparently impaired and the clearances or creepage distances are not reduced to values, which are less than those specified in 8.3.

NOTE 1 Where the frame is used as a protective conductor, sparks and localized heating at joints are permitted, provided they do not impair the electrical continuity and provided that adjacent flammable parts are not ignited.

NOTE 2 A comparison of the resistances measured before and after the test, between the terminal for the incoming protective conductor and the terminal for the relevant outgoing protective conductor, gives an indication of conformity with this condition.

10.11.5.6.2 待獲得之結果

保護電路之連續性及短路耐受強度，無論其是否包括獨立導體或外框，不應明顯受損害。除了目視檢驗外，可藉由以相關外向單元之額定電流的順序量測，予以查證。箱體之變形，或內部隔板、障壁及障礙物因短路而造成之變形，其可容許之程度為保護等級未明顯受損害，以及空間距離或沿面距離未降低至小於 8.3 所規定之值。

備考 1. 當使用外框作為保護性導體時，倘若在接合點之火花及局部加熱不會損害電氣連續性，且鄰近之易燃性零件不會引燃，則容許此等火花及局部加熱。

備考 2. 試驗前及試驗後，於內向保護性導體之端子與相關外向保護性導體之端子之間所測得之電阻，兩者間的比較提供此條件之連續性的指示。

10.12 Electromagnetic compatibility (EMC)

For EMC tests, see J.10.12.

10.12 電磁相容性(EMC)

有關電磁相容性，參照附錄 J.10.12。

10.13 Mechanical operation

This verification test shall not be made on such devices (e.g. withdrawable circuit breaker) of the ASSEMBLY which have already been type tested according to their relevant product standard unless their mechanical operation has been modified by their mounting.

For parts, which need verification by test (see 8.1.5), satisfactory mechanical operation shall be verified after installation in the ASSEMBLY. The number of operating cycles shall be 200.

At the same time, the operation of the mechanical interlocks associated with these movements shall be checked. The test is passed if the operating conditions of the apparatus, interlocks, specified degree of protection etc., have not been impaired and if the effort required for operation is practically the same as before the test.

10.13 機械操作

此查證試驗不應於組裝品之此種裝置(例：可抽出式斷路器)上進行，該裝置已依其相關產品標準進行過型式試驗，除非已藉由其裝設修正過其機械操作。

對於需要以試驗進行查證之零件(參照 8.1.5)，在安裝於組裝品中之後，應查證機械操作是否圓滿。操作循環次數應為 200。

同時間，應檢查與此等移動相聯結之機械互鎖的操作。若設備之操作條件、所規定之保護等級等，未受損害，且若操作所需之工作實際上與試驗前所需者相同，則通過試驗。

11 Routine verification

11.1 General

Routine verification is intended to detect faults in materials and workmanship and to ascertain proper functioning of the manufactured ASSEMBLY. It is made on every ASSEMBLY. The ASSEMBLY manufacturer shall determine if routine verification is carried out during and/or after manufacture. Where appropriate, routine verification shall confirm that design verification is available.

Routine verification is not required to be carried out on devices and self-contained components incorporated in the ASSEMBLY when they have been selected in accordance with 8.5.3 and installed in accordance with the instructions of the device manufacturer.

Verification shall comprise the following categories:

a) Construction (see 11.2 to 11.8):

- 1) degree of protection of enclosures;
- 2) clearances and creepage distances;

11. 例行查證

11.1 一般

例行查證係用於偵測材料及手藝之故障，並確定所組裝之組裝品可正常運作。

此查證係於每一組裝品上進行。組裝品製造廠商應決定是否在製造期間及/或製造之後進行查證。若適當時，例行查證應確認可取得設計查證。

合併於組裝品內之裝置及獨立性之組件當已依 8.5.3 選擇並依裝置製造廠商之說明書安裝時，不需要在此等裝置及組件上進行例行查證。

查證應包含下列種類。

- (a) 構造(參照 11.2 至 11.8)。
 - (1) 箱體之保護等級。
 - (2) 空間距離及沿面距離。
 - 3) protection against electric shock and integrity of protective circuits;
 - 4) incorporation of built-in components;
 - 5) internal electrical circuits and connections;
 - 6) terminals for external conductors;
 - 7) mechanical operation.
- b) Performance (see 11.9 to 11.10):
 - 1) dielectric properties;
 - 2) wiring, operational performance and function.
 - (3) 防電擊之保護及保護性電路之完整性。
 - (4) 內建式組件之合併。
 - (5) 內部電氣電路及連接。
 - (6) 外部導體用之端子。
 - (7) 機械操作。
- (b) 性能(參照 11.9 至 11.10)。
 - (1) 電介質特性。
 - (2) 配線、操作性能及功能。

11.2 Degree of protection of enclosures

A visual inspection is necessary to confirm that the prescribed measures to achieve the designated degree of protection are maintained.

11.3 Clearances and creepage distances

Where the clearances are:

- less than the values given in Table 1, an impulse voltage withstand test in accordance with 10.9.3 shall be carried out;
- not evident by visual inspection to be larger than the values given in Table 1 (see 10.9.3.5) verification shall be by physical measurement or by an impulse voltage withstand test in accordance with 10.9.3.

The prescribed measures with regard to creepage distances (see 8.3.3) shall be subject to a visual inspection. Where it is not evident by visual inspection verification shall be by physical measurement.

11.2 箱體之保護等級

有必要使用目視檢驗，以確認有維持用以達成所指定之保護等級的規定措施。

11.3 空間距離及沿面距離

當空間距離有下列情形時，

- 小於表 1 所示之值時，應進行 10.9.3 之衝擊耐電壓試驗。
- 經目視檢驗後，其未明顯大於表 1 所示之值時(參照 10.9.3.5)，應以物理量測或 10.9.3 之衝擊耐電壓試驗進行查證。

關於沿面距離(參照 8.3.3)之指定措施，應進行目視檢驗。經目視檢驗後，若其不明顯，應以物理量測或進行查證。

11.4 Protection against electric shock and integrity of protective circuits

The prescribed protective measures with regard to basic protection and fault protection (see 8.4.2 and 8.4.3) shall be subject to a visual inspection.

The protective circuits shall be checked by visual inspection to ascertain that the measures prescribed in 8.4.3 are verified.

Screwed and bolted connections shall be checked for the correct tightness on a random basis.

11.5 Incorporation of built-in components

The installation and identification of built-in components shall be in accordance with the ASSEMBLY manufacturing instructions.

11.6 Internal electrical circuits and connections

The connections, especially screwed and bolted connections, shall be checked for the correct tightness on a random basis.

Conductors shall be checked in accordance with the ASSEMBLY manufacturing instructions.

11.7 Terminals for external conductors

The number, type and identification of terminals shall be checked in accordance with the ASSEMBLY manufacturing instructions.

11.4 防電擊之保護及保護性電路之完整性

關於基本保護及故障保護參照 8.4.2 及 8.4.3 之指定的保護措施，應進行目視檢驗。

應以目視檢驗檢查保護性電路，以確認已查證 8.4.3 所指定之措施。

應隨機檢查螺釘式及螺栓式連接之密封性的正確性。

11.5 內建式組件之合併

內建式組件之安裝及識別，應依據組裝品製造廠商說明書。

11.6 內部電氣電路及連接

應隨機檢查連接(尤其是螺釘式及螺栓式)之密封性的正確性。

應依據組裝品製造廠商說明書檢查導體。

11.7 外部導體用之端子

端子之數量、型式及識別，應依據組裝品製造廠商說明書。

11.8 Mechanical operation

The effectiveness of mechanical actuating elements, interlocks and locks including those associated with removable parts shall be checked.

11.9 Dielectric properties

A power-frequency withstand test shall be performed on all circuits in accordance with 10.9.1 and 10.9.2 but for a duration of 1 s.

11.8 機械操作

應檢查機械制動元件、互鎖及鎖(包括與可動零件有關連者)之有效性。

11.9 電介質特性

商頻耐受試驗應依 10.9.1 及 10.9.2 在所有電路上進行，但持續時間為 1 s。