CABLE GLAND STANDARDS

Cable glands are mechanical fittings that form part of the electrical installation material. The purpose of a cable gland is to seal the cable and retain it in the electrical equipment that it is attached to. It should maintain the ingress protection rating of the enclosures, keeping out dust and moisture but it should also prevent the cable from being pulled out of the equipment and from being twisted whilst connected to equipment. If it is intended for use with armoured cable, the cable gland also provides an earth continuity function.

By David O'Brien, CMP Products Pty Ltd

When selecting cables glands, is there a standard that needs to be considered to which the cable gland conforms? Here are just a few of the features that ought to be considered.

Ingress Protection rating:
Will the product perform in service as on the day of the original ingress protection test?

Material:
What grade of material is the cable gland made from? Taking a material strength, electrical conductance, and corrosion resistance point of view, metallic cable glands could be produced in brass (with or without nickel plating), aluminium or stainless steel, but what material grade has been used in the manufacture of the cable gland?

Cable pull out resistance:
What forces will the cable gland withstand in terms of cable pull out and cable twisting?

Impact Strength/Resistance:
What is the impact strength? Is the cable gland design and construction robust enough to withstand heavy duty service and survive the rigours of the installation throughout the on-going operations for the life of the electrical plant?

Electrical rating:
What tests have been conducted to determine the suitability of cable glands and any associated earth tags under short circuit fault conditions? What are the ratings?

Electromagnetic Interference:
What performance enhancement can the cable glands provide when connected to screened cables. What 3rd party EMC performance tests have been conducted? What noise reduction potential can they offer in relation to the EMC of the installation?

COMPLIANCE WITH STANDARDS

For industrial electrical installations the need for compliance with standards is vital in order to ensure such things as OH&S in the workplace, security and safety of earthing systems, functional safety, longevity of performance and continuity of supply for mission critical plant and equipment. The same criterion which is applied to the plethora of electrical equipment should also be considered as applicable to cable glands, in order for systems to be installed and operated reliably. In various countries, national cable gland standards may have existed that determine the construction and performance requirements for cable glands. How many times have you heard users or installation contractors saying that a product is no good if it doesn't meet "Australian standards"? Well it may surprise you to know that for industrial cable glands there are no Australian standards for manufacturers to comply with, which begs the question what, if any, standard do the various cable glands circulated in the Australian standard comply with?

NEED FOR A COMMON STANDARD

In some other overseas territories comprehensive cable gland standards have prevailed and this has enabled products to be designed, tested and manufactured to a defined set of requirements that can be compared, measured or audited at some point in time. During the formative years of the rapidly expanding power generation industry in the United Kingdom, the acute need for a common standard reference document that could address cable gland requirements was recognised, and from this GDCD 190 was created. This original void was later met by the British Standard BS 4121, when the industry had developed further and with more sophistication. Latterly in the 1970's BS 4121 was superseded by BS 6121 with the introduction of the metric system of measurement across Europe.

CONSTRUCTION REQUIREMENTS

In order to meet the full scope of the BS 6121, manufacturers are required to comply with specific construction requirements, one of which is the maximum cable diameter that a cable gland can accept, which in turn determines the minimum wall thickness at the point where the cable passes through the threaded section of a cable gland. This is demonstrated in Table 1 below.

BS 6121 also deals with other aspects of the cable glands that have an effect on the design, including such things as impact resistance, cable pull out resistance and electrical short circuit current carrying capacity under earth fault conditions.

DEGREES OF PERFORMANCE

Whilst BS 6121 was established as a construction standard, to which products could be designed and tested, and they simply either met or didn't meet the scope, more recent standards have been introduced which are performance based. One of these is the European Standard EN 50262, which was published in 1999, and offers manufacturers the opportunity of meeting its requirements by degrees of performance. What this means is that for each feature, for example Impact Resistance, there is a range of permitted levels that a manufacturer

TABLE 1: BORE SIZES REFERENCED IN BS 6121 PART 1 : 1989, TABLES 1 TO 6

Cable Gland Size	16	20S	20	25	32	40	50S	50	63S	63	75S	75
Entry Thread Size	M20 or M16	M20	M20	M25	M32	M40	–	M50	–	M63	–	M75
Bore Size	8.7	11.7	14.0	20.0	26.3	32.2	38.2	44.1	50.1	56.0	62.0	68.0
Permitted Tolerance	+ 0.3 mm	+ 0.3 mm	+ 0.3 mm	+ 0.3 mm	+ 0.5 mm	+ 0.5 mm	+ 0.5 mm	+ 0.5 mm	+ 0.5 mm	+ 0.5 mm	+ 0.5 mm	+ 0.5 mm
Maximum Bore Size	9.0	12.0	14.3	20.3	26.8	32.7	38.7	44.6	50.6	56.5	62.5	68.5

can aim for under test, and if its product design cannot demonstrate that a certain level is achievable, then a lower rating may be declared. In this fashion products are graded according to how robust they are in performing each function (See Table 4 for the range of Impact Resistance levels). It should be noted that whilst products that have been designed to comply with BS 6121 in its entirety will quite comfortably meet the higher requirements of EN 50262, it does not automatically follow that cable glands designed to EN 50262 would also be able to comply with the requirements of BS 6121.

PROFOUND IMPACT ON USERS

A new IEC standard for "Cable Glands for Electrical Installations", IEC 62444, was published in 2010 and in time this will be adopted in several countries across the world, including Australia. This new standard could have a profound impact on users and manufacturers, especially those who discover for the first time that the products they have previously used have not been tested to any current standards. IEC 62444 is similar to EN 50262 in that it is also a performance based standard, allowing manufacturers to produce cable glands of varying degrees of robustness some of which may be more suited to light industrial applications such as factory automation, whilst others may be more applicable to medium and heavy duty industrial electrical installations, such as power generation and distribution. What this should mean in the longer term is that comparisons between different cable gland products should be easier to make, that is providing that the manufacturers live up to their expectations, and duty, in declaring the important technical features that truly reflect the rating of their cable glands. Users should therefore also be aware that if they intend to select or specify cable gland products according to IEC 62444 they must also stipulate clearly what electrical and mechanical classification from IEC 62444 they require. Without such a clear definition the likelihood of the wrong product being obtained is unfortunately likely to prevail. IEC 62444 classifies cable glands according to Material, Mechanical properties, Electrical properties, Resistance to external influences, and Sealing system. This can be expanded upon as follows:-

Mechanical properties

- Cable retention test (*)
- Cable anchorage test for non-armoured cable (**)
- Cable anchorage test for armoured cable (**)
- Resistance to impact
- Seal performance

(*) This test intended to demonstrate cable pull out resistance.

(**) This test intended to show resistance to cable twisting

IEC 62444 – TABLE 2 – PULL FORCES FOR CABLE RETENTION AND CABLE ANCHORAGE

Cable diameter	Cable retention	Cable anchorage for non-armoured cable		Cable anchorage for armoured cable	
		Type A	Type B	Type C	Type D
mm	N	N	N	N	N
Up to 4	5	–	–	–	–
> 4 to 8	10	30	75	75	640
> 8 to 11	15	42	120	120	880
> 11 to 16	20	55	130	130	1280
> 16 to 23	25	70	140	140	1840
> 23 to 31	30	80	250	250	2480
> 31 to 43	45	90	350	350	3440
> 43 to 55	55	100	400	400	4400
>55	70	115	450	450	5600

IEC 62444 – TABLE 4 – IMPACT VALUES

Category	1	2	3	4	5	6	7	8
Energy J	0.2 ±10%	0.5 ±10%	1.0 ±10%	2.0 ±15%	4.0 ±5%	7.0 ±5%	10.0 ±5%	20.0 ±5%
Mass kg	0.2	0.2	0.2	0.2	1.0	1.0	1.0	2.0
Height m	0.10	0.25	0.5	1.0	0.4	0.7	1.0	1.0
NOTE: Mass and height may vary in degrees necessary to achieve the required energy.								

IEC 62444 – TABLE 5 – ELECTRICAL CURRENT VALUES

Cable Ø (mm)	Minimum kA rms		
	Category A	Category B	Category C
> 8 to 11	0.5	3.06	10.0
> 11 to 16	0.5	3.06	13.1
> 16 to 23	0.5	3.06	13.1
> 23 to 31	0.5	4.0	13.1
> 31 to 43	0.5	5.4	13.1
> 43 to 55	1.8	7.2	43.0
> 55 to 65	2.3	10.4	43.0
> 65	2.8	10.4	43.0
NOTE 1: Category A is the minimum requirement, which applies in cases where a cable armour, other than steel wire, is the limiting factor.			
NOTE 2: Category B is a medium requirement, which applies in cases where a steel wire armoured cable is used and the system includes a high sensitivity method of protection against fault currents.			
NOTE 3: Category C is the highest requirement, which applies in cases where a steel wire armoured cable is used and the system relies on a low sensitivity method of protection against fault currents.			

Electrical properties

- Equipotential bonding to electrical equipment
- Equipotential bonding to metallic layer(s) of cable
- Protective connection to earth
- Electrical current test

IEC 62444 – TABLE 3 – TORQUE VALUE FOR CABLE ANCHORAGE TWIST TEST

Cable diameter mm	Torque Nm
> 4 to 8	0.10
> 8 to 11	0.15
> 11 to 16	0.35
> 16 to 23	0.60
> 23 to 31	0.80
> 31 to 43	0.90
> 43 to 55	1.00
> 55	1.20

RESISTANCE TO EXTERNAL INFLUENCES

IEC 62444 requires that cable glands shall be protected against external influences in a variety of ways:

- Degree of protection in accordance with IEC 60529 (IP Code)
  - Requires a minimum of IP54
- Resistance to corrosion (***)
- Resistance to ultraviolet light (non-metallic cable glands)
- (***) Cable glands made of steel shall be subjected to a 96h minimum neutral salt spray test as defined in ISO 9227.
- (***) Cable glands made from non-metallic materials, stainless steel containing at least 13 % chromium, copper alloys containing at least 55 % copper (#), aluminium alloy & zinc alloy do not require testing.
- (#) Cable Glands produced from 385 Brass alloy to AS/NZS 1567 are not required to be subjected to corrosion resistance tests.

385 Brass Alloy to AS/NZS 1567 is equivalent to Brass Grade CuZn39Pb3 to EN 12164 and Architectural Bronze C38500 to ASTM B455-05.

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The alloy primarily consists of copper and zinc, the specification of which makes for reliable levels of corrosion resistance and excellent conductivity properties, ensuring high integrity earth continuity can be maintained. Reducing the copper component in the brass alloy may allow manufacturers to reduce their production costs, but this does not help the industry as durability will be compromised in the process. Usually the lower the copper content, the higher the zinc, or other, content, and the outcome is a weaker material that has a lower impact strength, and is more susceptible to corrosion, hence the requirement for salt spray testing in IEC 62444.

The breakdown of the 385 / CuZn39Pb3 Brass Grade can be demonstrated in Table 6. Strict compliance with this material grade would ensure better all round performance both mechanically and electrically for the desired life expectancy, not just the initial warranty period.

TABLE 6 – CuZn39Pb3

Cu	Al	Fe	Ni	Pb	Sn	Zn
57-59%	0.05% Max	0.3% Max	0.3% Max	2.5-3.5%	0.3%	Rem

REGARDED AS A LOW PRIORITY

Cable glands are so often regarded as a low priority consumable, without any great importance attached to them. However that is not a healthy situation to be in, and they should be considered a lot more carefully.

In some scenarios they are equally as important as the cable, and for example the lighting fixtures in an emergency lighting circuit. In a plant where the cables are buried in the ground and are protected with mechanical armour, or in a fire performance cable system where the survival of key parts of the electrical system are relied upon to sustain life, cable glands are effectively a safety critical element of the installation. Hopefully the arrival of the IEC 62444:2010 publication will help to restore some of the balance that has been lost over the years in undervaluing the importance of cable glands.

FAULT CURRENT RATINGS

Slip on Earth Tags, installed between the cable gland and equipment, provide an earth bond connection as required by BS6121:Part 5:1993 and may also comply with category "B" rating specified in EN 50262:1999 and IEC 62444:2010. Table 7 details fault current ratings relating to CMP Nickel Plated Brass Earth Tags determined under tests conducted by a third party testing and research station.

It can be noted that the short circuit fault current ratings for the earth tags shown in Table 7 have subsequently been adopted in several cable gland standards including IEC 62444.

TABLE 7

CMP Earth Tag Size	Short Circuit Ratings Symmetrical Fault Current (kA) for 1 second
20	3.06
25	4.0
32	5.4
40	7.2
50	10.4
63	10.4
75	10.4

EMC PERFORMANCE

EMI or RFI has been around for many years, but a greater focus has been placed upon Electromagnetic Compatibility (EMC) in recent years. Cable glands are neither capable of emitting electromagnetic interference nor being susceptible to it. However they may be used to contribute to the electromagnetic compatibility of installations. Several industry studies have been conducted as to the effect of cable terminations in systems that are required to provide a specified degree of EMC protection.

Customers often make requests for EMC cable glands or cable glands for an EMC cable, or a VSD cable, but the definition is usually vague or insufficiently clear. The problem is that there are a number of shielded cable construction types that may be deemed suitable for a given application. These may be utilising either flexible braid screens, aluminium foil screens, copper tape screens or even double steel or double brass tapes, all of which may deliver the high degrees of shielding performance required. Some cable glands may be designed to terminate some of these cables but not all of them, hence the need to be specific on product selections. Not only should the cable gland be compatible with the cable construction, but it should also be tested to prove that it is capable of delivering the required EMC performance that the cable is intended to provide.

CMP Products has carried out 3 Metre Class B Radiated Emission Measurement tests in accordance with EN 55022 to verify the performance of cable glands that are terminated on screened and armoured cables using a 360° termination of the metallic cable sheath. The typical results of these CNE measurement tests are shown below, with the noise reduction performance levels seen to be significantly improved in Figure 2 when the cable has been correctly terminated in the CMP cable gland. Figure 1 shows that when the cable has not been terminated in such cable gland, the noise levels recorded are far higher than the acceptable Class B noise floor shown.

CONCLUSION

In any modern electrical system design there will be a host of high tech and sophisticated equipment and cables that must comply with various standards and requirements. Why should this not reasonably be extended to the cable glands that are used to terminate and seal the cables, and maintain adequate earth continuity of the metallic elements, and / or the ingress protection of this equipment?

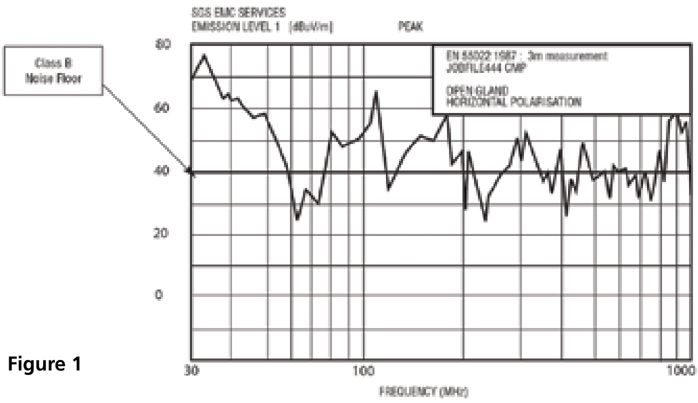

Figure 1

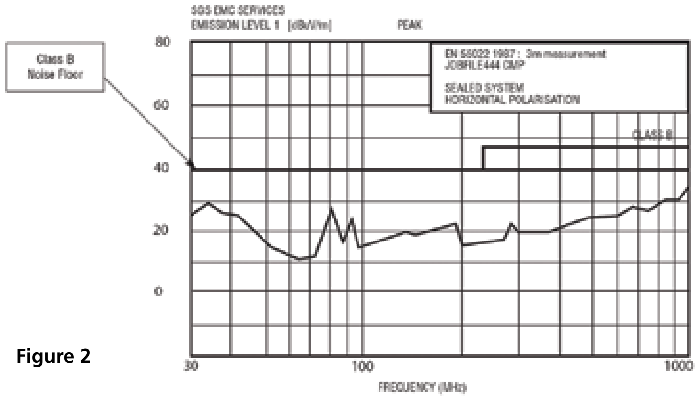

Figure 2