Classifying Environments

The new environmental categorisation systems for corrosive and fire protection coating systems

Information and guidance for the Construction Sector
This document has been prepared jointly by the BCF’s High Performance Coatings committee and Intumescent Coatings Group. Our thanks go to the following organisations and groups who also contributed and assisted in the preparation of this guidance document:

Association for Specialist Fire Protection (ASFP)

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Purpose

The purpose of this guidance document is to provide detailed information on the new corrosive and fire environment classification schemes and corresponding category systems introduced in the International Standard BS EN ISO 12944 (2017 revision) and the European Standard BS EN 16623 (published in 2015).

This document is provided for reference by anyone working within the European construction sector, including architects, specifiers, inspectors, painting contractors and applicators, coating manufacturers, and any other persons involved with the designation of a building’s environment and corresponding coating system requirements. It will especially aid those who are required to specify / select an appropriate protective coating, and/or an intumescent (reactive) fire protection coating for structural steel to meet the requirements of aggressive environments, such as polluted industrial areas or coastal locations.

Background

Up until now, the industrial heavy duty protective coatings sector has referred to BS EN ISO 12944:1998 ‘Paints and Varnishes – Corrosion protection of steel structures by protective coatings systems’ (which in turn relates to ISO 9223:2012) for the UK construction industry to classify the durability requirements of such coatings according to the ‘C1 – C5’ classification scheme, specifying their degree of resistance to corrosion in different environments. Additionally, ISO 20340:2009 has been used for offshore and related structures (the ‘C5M’ classification). The tendency has also been to apply this classification system to specify intumescent (reactive) fire protection coatings, although this has led to some confusion within the construction sector, as a durability or corrosive environment classification does not directly relate to the environmental resistance requirements of an intumescent coating.

Recent work by the relevant CEN and ISO standards committees for these product sectors has resulted in the revision of BS EN ISO 12944, as well as the publication of a new European standard for intumescent (reactive) fire protection coatings, BS EN 16623:2015 ‘Paints and Varnishes – Reactive coatings for fire protection of metallic substrates’. The C1 – C5 classification scheme has been revised, and a new scheme for specifying the durability of fire protection coatings has been introduced. As a result, the old C1 – C5M categorisation should be phased out and replaced with these new classification schemes.

This document sets out the details behind these two new classification schemes, and how these may be compared with the previous classification system, enabling organisations to reference the correct Standard and appropriate classification when specifying the requirements for a protective or intumescent coating. There is a summary table for each scheme listing the different categories to choose from, and examples of environments, with specific comments below each table.

The two Standards may be purchased from the BSI online shop – https://shop.bsigroup.com/Navigate-by/Standards/

Please contact the Regulatory Affairs Manager at the British Coatings Federation if you have any questions with regard to the information contained within this document, info@coatings.org.uk

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## Corrosion Protection of Steel Structures – BS EN ISO 12944:2017

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<th>Existing Categories + Corrosivity</th>
<th>New Categories</th>
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<th>Typical interior environment</th>
<th>Coating Industry commentary</th>
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<tr>
<td>C1</td>
<td>C1 Very Low</td>
<td>Not Applicable (there is no C1 exterior)</td>
<td>General heated buildings with clean, non-corrosive atmospheres</td>
<td>Corrosion potential very low / non-existent. Sufficient protection is required during transportation &amp; construction, when a more corrosive environment may be encountered.</td>
</tr>
<tr>
<td>C2</td>
<td>C2 Low</td>
<td>Low pollution (e.g. rural areas)</td>
<td>Unheated buildings where condensation may occur</td>
<td>Unlikely to be used for any external environments in the UK due to our climate and pollution levels</td>
</tr>
<tr>
<td>C3</td>
<td>C3 Medium</td>
<td>Moderate pollution (e.g. urban &amp; industrial areas, also low salinity coastal areas)</td>
<td>Production rooms with high humidity and some air pollution</td>
<td>Commonly used for UK non-aggressive external environments</td>
</tr>
<tr>
<td>C4</td>
<td>C4 High</td>
<td>High pollution (e.g. industrial areas, coastal areas with moderate salinity)</td>
<td>Mild corrosive environments, e.g. swimming pools &amp; chemical plants</td>
<td>Commonly used for UK aggressive external environments and most coastal environments</td>
</tr>
<tr>
<td>C5I Industrial</td>
<td>C5 Very High</td>
<td>High humidity and aggressive atmospheres due to industry, coastal areas with high salinity</td>
<td>Buildings / areas with almost permanent condensation and with high pollution</td>
<td>The most severe category for general use, when referring to industrial and coastal land environments.</td>
</tr>
<tr>
<td>C5M Marine</td>
<td>CX Extreme</td>
<td>Off-shore high salinity; extreme humidity &amp; aggressive industrial atmospheres (e.g. tropical)</td>
<td>Industrial areas with extreme humidity and aggressive atmospheres</td>
<td>Designed for specifying highly corrosive off-shore marine environments only. CX to be used for other extreme environments only when clearly agreed between manufacturer and specifier as a specific special (very) extreme case.</td>
</tr>
</tbody>
</table>
Specific Notes on BS EN ISO 12944:2017

- This Standard is currently being finalised through the ISO procedures, it is expected for all parts to be published in 2018.
- Part 2 of this Standard ‘Classification of Environments’ has now been approved and confirmed ready for publication, hence the above information is not subject to further changes through the current standardisation activities.
- This classification is enhanced by considering the ‘durability requirement’ for coatings falling within categories C2 – C5.
- There are four durability requirements for C2 – C5 (low, medium, high and very high).
- The results to testing for different coatings under part 6 of this Standard will determine their suitability for the environment in question and their appropriate durability performance e.g. specifiers could refer to a ‘C4 High durability’ product.
- Additional testing criteria have been introduced in part 6 (including cyclic testing) to support the justification for classifying the coatings available for selection.
- Offshore marine environments are specifically covered by part 9 of this Standard, which reproduces the current ISO 20340 testing criteria for coatings used for such environments.
- Part 2 also provides classification details for structures buried in water or soil, with the categories Im1 – Im3. Part 6 refers to appropriate testing that is required to satisfy the corrosion resistance requirements for these environments.
### Fire Protection provided by reactive (intumescent) coatings – BS EN 16623:2015

<table>
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<tr>
<th>New Durability Categories</th>
<th>Exposure Description</th>
<th>Typical Examples of Locations Similarity to C1-C5 classifications (BS EN ISO 12944:2017)</th>
<th>Coating Experts Commentary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X</strong></td>
<td>Intended for all conditions where intumescent may be recommended for use up to full outdoor exposure. (internal, external exposed and semi-exposed environments)</td>
<td>General industrial areas, exposed outdoor car parks, low-moderate salinity coastal environments, swimming pools Similar to C3 external &amp; C4 environments</td>
<td>The highest durability category in BS EN 16623 X aligns well with C3 external exposure description. Durability and lifetime of a coating system will relate to the degree of pollution (sulphur dioxide etc.) and salinity of the environment</td>
</tr>
<tr>
<td><strong>Y</strong></td>
<td>Intended for internal and semi-exposed external conditions (semi-exposed includes temperatures below 0°C, but no exposure to rain and limited or only casual exposure to UV)</td>
<td>Use under canopies / sheltered locations, internal locations which are constantly damp with some air pollution Similar to C2 external &amp; C3 internal environments</td>
<td>UV exposure levels are important in determining whether category X or Y should be used as UV light can affect the performance of intumescent coatings. Y to be used for all internal and semi-exposed external environments that may freeze</td>
</tr>
<tr>
<td><strong>Z1</strong></td>
<td>Intended for internal conditions only, with high humidity (greater or = 85%) (excluding temperatures below 0°C)</td>
<td>Unheated warehouses, sports halls, plant rooms, roof voids Similar to C2 internal environments</td>
<td>Z1 aligns well with C2 internal exposure description. Occasional damp or wet conditions, where condensation may occur</td>
</tr>
<tr>
<td><strong>Z2</strong></td>
<td>Intended for internal conditions only, with humidity conditions &lt; 85% (e.g. humidity class 5 in EN ISO 13788) (excluding temperatures below 0°C)</td>
<td>Inside offices, schools, shops, hotels Similar to C1 environments</td>
<td>The lowest durability category in BS EN 16623 Z2 aligns well with C1 exposure description. Heated and air-conditioned buildings. No likelihood of damp atmospheres / condensation</td>
</tr>
<tr>
<td><strong>W/Y</strong></td>
<td>Temporary full external for a maximum of 6 months then semi-exposed external environments</td>
<td></td>
<td>These categories cover the factory-preparation of intumescent-coated structural steel beams and components that are subsequently delivered to a building site and then will remain exposed to the weather during the construction process, up to a maximum of 6 months.</td>
</tr>
<tr>
<td><strong>W/Z1</strong></td>
<td>Temporary full external for a maximum of 6 months then internal environments with high humidity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>W/Z2</strong></td>
<td>Temporary full external for a maximum of 6 months then internal controlled environments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Specific Notes on BS EN 16623:2015

- This Standard was first published in 2015 and is currently under review. It is expected to form the basis for a future harmonised standard (hEN) for intumescent (reactive) fire protection coatings for metallic substrates.

- Reactive fire protection coatings are more susceptible to damage from exposure to moisture and UV light than steel is, hence the need for a separate durability classification system not directly related to BS EN ISO 12944:2017 / ISO 9223.

- This X-Z2 classification system was originally devised as part of the European Technical Assessment (ETA) system for intumescent coatings, and is included in ETAG 018-2.

- Durability of a reactive coating system is determined by testing in accordance with Annex C of BS EN 16623:2015, after exposure to the appropriate conditions as detailed in Annex B of this Standard.

- Note that a coating tested and confirmed to meet a certain BS EN 16623 category does not guarantee that this coating would necessarily meet the corresponding C1 – C4 categories mentioned in the table.

- If durability performance for C5 or CX environments is required then please seek specific advice from the intumescent coating manufacturers. Coatings recommended for such extreme environments would need to be tested to BS EN ISO 12944:2017 parts 6 & 9, in conjunction with a comparative fire test such as within the Norsok M 501 scheme.

- Similarly use of intumescents in C4 internal and external mild corrosive environments (e.g. chemical plants) should be done under detailed guidance and support from the intumescent coating manufacturer, to ensure sufficient chemical resistance properties.

- Use of intumescents in C3 special internal environments where there may be biological or chemical pollution (e.g. food processing plants, breweries, laundries) should also be carefully considered and specified after consulting with the intumescent coating manufacturer.
• Care should be taken in terms of ease of access, inspection and maintenance recommendations when considering and specifying expected lifetime for a coated structure.

• It should be noted that the BS EN ISO 12944:2017 categories are often quoted with a “high” level of durability, which equates to a lifetime of 20 years, or more. The BS EN 16623:2015 durability criteria are indicative of a 10-year lifetime. However, in practice, the real working life of a system may be considerably longer or shorter than this period, dependent upon a number of factors, including the exact environmental conditions, design, execution of work, use and maintenance of the structure.

• It is not unknown for specifiers to require both a Corrosion Protection classification and a Reactive Fire Protection system classification. If the two specifications are matched up, then adopting a protective coating system in accordance with a C1-C5 classification, in conjunction with a reactive coating, will probably exceed the requirements of the BS EN 16623 test. However, under certain conditions, increasing the anti-corrosion system underneath the reactive coating can actually be to the detriment of the fire resistance performance. Therefore, meeting both a corrosion control requirement and a fire resistance requirement according to each specific Standard mentioned above should be tested and fully confirmed before specifying.