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RECOMMENDATION FOR THE EVALUATION OF FIRE PERFORMANCE AND APPROVAL OF LARGE FIRE DOORS

1 The Maritime Safety Committee, at its eighty-sixth session (27 May to 5 June 2009), having considered the proposal by the Sub-Committee on Fire Protection, at its fifty-third session, approved the Recommendation for the evaluation of fire performance and approval of large fire doors, as set out in the annex.

2 Member Governments are invited to apply the annexed Recommendation when approving large fire doors and to bring them to the attention of all parties concerned.

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ANNEX

RECOMMENDATION FOR THE EVALUATION OF FIRE PERFORMANCE AND APPROVAL OF LARGE FIRE DOORS

1 Methods of evaluation and testing

For doors larger than those which can be accommodated in the standard specimen size (e.g., 2,440 mm wide and 2,500 mm high), as specified in part 3 of the FTP Code:

.1 if such doors can be accommodated into a larger test furnace, it is recommended to conduct a test with the full size specimen of the door; or

.2 it is recommended to use the following method for evaluation of the fire performance of the door and approval of the door.

2 Doors of marginally larger dimensions

2.1 A fire door of marginally larger dimensions than a fire-tested fire door may be individually assessed and accepted for a specific project with the same classification, provided all of the following is met:

.1 dimensions (width, height) are not more than 15% above those of the tested door;

.2 the surface area of the door is not more than 10% above that of the tested door;

.3 the door design does not deviate in any other aspect from the one tested; and

.4 the tested door has successfully satisfied both insulation and integrity criteria for the following times, as appropriate:

"B-0"	0 min insulation	36 min integrity
"B-15"	18 min insulation	36 min integrity
"A-0"	0 min insulation	68 min integrity
"A-15"	18 min insulation	68 min integrity
"A-30"	36 min insulation	68 min integrity
"A-60"	68 min insulation	68 min integrity.

2.2 If the door to be approved is larger than stated above and complies with the size requirements stated under section 3 below, the test should also include additional instrumentation as specified in paragraph 3.4.2 below, or equivalent arrangement.

3 Doors larger than those in section 1 above, but not exceeding 50% in surface area

3.1 An engineering assessment can be used to extrapolate the fire test results of a door having a larger geometry than the tested door.

3.2 Such an assessment should be used for verification only if the dimensions of the actual door are greater than the maximum permitted by the furnace (considering a furnace with an aperture of 2,440 mm width x 2,500 mm height) and the door involved has already been tested, with such dimensions, with satisfactory results in accordance with section 1 above, and the actual door does not exceed 50% in surface area.

3.3 The methodology used to extrapolate the fire tests results should consider the following three steps:

.1 standard fire test of the "specimen" to obtain reference temperature and structural displacements. Such a "specimen" may be either:

.1.1 a door already certified through the fire test which is identical in design to the door to be analysed (fire test to include additional instrumentation as per paragraph 3.4.2, or equivalent arrangement); or

.1.2 a specially-built specimen where the finite element method is to be performed to extrapolate the results of a specimen of an actual door having a size exceeding the maximum size allowed by the furnace of the testing laboratory; the specimen should be a mock-up of the actual door, but having a size that fits in the furnace;

.2 finite element analysis in paragraph 3.6, of the "specimen" to calibrate the thermal and mechanical boundary conditions of the FEM model, which are adjusted until the numerical and experimental temperature and displacement distribution compare satisfactorily; and

.3 finite element analysis in paragraph 3.5, of the actual door carried out using the model calibrated as per paragraph 3.7, assuming that the differences in the geometry and dimensions between the actual door and the specimen door do not significantly influence the results.

3.4 ***Data to be submitted***

3.4.1 In order for the analysis to be carried out, the following information should be submitted:

.1 detailed drawings of the door, the door frame and the closure and locking devices including the indications of clearances and interferences;

.2 test report of the prototype used to extrapolate the results.

In this respect, additional instrumentation should consist of two sets of three 1.6 mm diameter thermocouples fitted through the thickness of the leaf, at depths of 1/3 t, 1/2 t, 2/3 t. Such sets should be fitted, on the upper part of the door, within a circle of 100 mm in diameter whose centre is 150 mm aside of the surface thermocouples fitted in the centre of the top quarters;

.3 mechanical characteristics of all materials used for the construction of the door and its insulation:

.3.1 Young's module;

.3.2 yield strength; and

.3.3 density; and

.4 thermal properties:

.4.1 thermal expansion coefficient;

.4.2 thermal conductivity; and

.4.3 specific heat.

3.4.2 Since all these properties are temperature dependent, it is necessary that the required data be given as a function of the temperature range foreseen for the fire tests. Where it is not possible to obtain experimental data, an engineering evaluation should be submitted with the supporting considerations for the proposed curves of variation of mechanical and thermal characteristics as a function of the temperature in the considered range.

3.5 *Method of analysis*

The comparison of the fire resistance of doors having larger geometry should be considered in two steps:

.1 evaluation of the heat transmission through the specimen thickness and of the temperature on the unexposed specimen surface; and

.2 evaluation of the strength characteristics and of the displacements of the structural members of the specimen.

3.6 *Heat transmission analysis*

3.6.1 By carrying out finite element calculations, the histories over time of the heat transmission within the structural assembly are computed and the temperature is compared with the temperature experienced by the assembly represented in the standard fire test.

3.6.2 Based on suitable data for the temperature-dependent variables, an iterative procedure is used for the evaluation of thermal-mechanic properties.

3.6.3 The thermal boundary conditions of convecting and radiative type are:

$$q_c = h_c (T_s - T_\infty)$$

and

$$q_r = \sigma\varepsilon(T_s^4 - T_\infty^4)$$

where:

q_c and q_r	:	Convective and radiative heat flux, respectively
h_c	:	Convective heat transfer coefficient
σ	:	Stefan-Boltzmann constant
ε	:	Emissivity coefficient
T_s	:	Surface temperature
T_∞	:	Furnace or ambient temperature.

3.6.4 The two equations can be included in an equivalent boundary condition:

$$q = H_{eq} (\sigma, \varepsilon, T_s, T_\infty) (T_s - T_\infty)$$

where:

the equivalent coefficient H_{eq} depends on the unknown surface temperature. However, it can be calculated as part of the finite element analysis using an emissivity coefficient appropriately calibrated with the fire test results.

3.6.5 The equivalent heat transfer coefficient can be assumed to be constant on the single exposed surface, as the furnace assembly built in accordance with the FTP Code gives uniformity of the temperature and heat flux within the furnace.

3.6.6 Alternatively, the temperature distribution measured on the specimen of the standard fire test can be directly applied on the finite element structural model taking into account the same time histories.

3.7 *Structural analysis*

3.7.1 Using the results of the heat transmission analysis and information on temperature-dependent material properties, the thermal stresses and deformations on the geometry are evaluated. When modelling the structural assembly, attention should be paid to using a sufficient number of elements to account for the non-uniform temperature distribution within the member and to catch the non-linear temperature-dependent behaviour.

3.7.2 Once the model is prepared, the analysis should be carried out stepwise. For each element, the incremental strain or deformation caused by a temperature increase is calculated and a new stress level is obtained based on the stress-strain relationship applicable for that particular temperature increase.

3.7.3 The mechanical boundary conditions should be congruent in order to represent the real interaction of the door with the external frame for the overall length of the test.

4 Larger doors exceeding 50% in surface area

4.1 For larger doors exceeding 50% in surface area, a full analysis based on SOLAS regulation II-2/17 should be performed to assess the safety of the vessel.

4.2 The approach should be based on the results of the fire test of the door having the maximum dimensions permitted by the furnace (considering a furnace with an aperture of 2,440 mm width x 2,500 mm height) according to the procedure described under section 3.

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