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Our reference 2014-Efectis-R0103.121/BGG/TNL  
Project number 2014103 / 121

Bleiswijk, 14 March 2014

## Expert judgement on fire resistance Maximum dimensions of Metacon RGS EW60 ECO rolling shutter

Dear Mr. Vergunst,

You have requested Efectis Nederland BV to give expert judgement, using where possible the EXAP standard EN 15269-10:2011, on the fire resistance of a rolling shutter construction developed by your firm. The rolling shutter is of type Metacon RGS EW60 ECO.

The construction has been tested for fire resistance. The test results are described in Efectis NL report 2013-Efectis-R0536a [Rev. 1] dd. February 2014. The tested dimensions of the rolling shutter were 3800 x 3300 mm (width x height). In the direct field of application in the test report an extension of the tested dimensions is not allowed.

Your question is what the maximum dimensions of the rolling shutter can be if the rules from the EXAP standard EN 15269-10:2011 are followed. This will be explained in this letter.

This expert judgement is based on:

- Efectis NL test report 2013-Efectis-R0536a [Rev. 1] dd. February 2014;
- standards EN 1634-1:2014, EN 15269-10:2011;
- Knowledge and experience of Efectis Nederland BV.

### **Efectis NL test report 2013-Efectis-R0536a [Rev. 1]**

This report gives the results of two fire tests which were performed on a rolling shutter of type Metacon RGS EW60 ECO. The rolling shutter construction had overall dimensions 3800 x 3300 mm (width x height).

The rolling shutter construction was identical in both tests and was of dimensions as mentioned above. The difference between the two fire tests was the side of the supporting construction on which the rolling shutter was mounted. One test was performed with the rolling shutter mounted on the fire side and the other one with the rolling shutter mounted on the non-fire side.

For the fire test, the rolling shutters were mounted to the face of a supporting construction consisting of 150 mm thick aerated concrete.

Alle rechten voorbehouden.

Dit document heeft de status van een Efectis Nederland-rapport.

Niets uit deze uitgave mag worden vermenigvuldigd en/of openbaar gemaakt zonder voorafgaande toestemming van Efectis Nederland. Het ter inzage geven van het Efectis-rapport aan direct belanghebbenden is toegestaan.

Indien dit rapport in opdracht werd opgesteld, wordt voor de rechten en verplichtingen van opdrachtgever en opdrachtnemer verwezen naar de Algemene Voorwaarden voor onderzoeksopdrachten aan TNO, dan wel de betreffende ter zake tussen de partijen gesloten overeenkomst.

The fire tests were performed on 28 and 29 January 2014, according to the European standard EN 1634-1:2014. The results can be summarised as follows:

### Rolling shutter mounted on the fire side

- Integrity (E) 133 minutes
- Heat radiation (W) 133 minutes

### Rolling shutter mounted on the non-fire side

- Integrity (E) 135 minutes
- Heat radiation (W) 135 minutes

See photo 1 for the test specimen, mounted on the fire side, before the fire test.



*Photo 1*

## 1. EXPERT JUDGEMENT

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You have asked what the maximum dimensions of the rolling shutter are if the extrapolation rules in the EXAP standard EN 15269-10:2011 are followed.

In the EXAP standard EN 15269-10:2011 rules are given in articles A.1.2 and A.1.4 for the extrapolation of the height and width of tested constructions. These articles give specific requirements for E, EI and EW applications and refer to Annex B for methods of calculation.

These methods of calculation will, as far as possible, be followed in this document. The calculations will be specific for the Metacon RGS EW60 ECO construction. The rolling shutter construction has to remain fulfilling the classifications EW 60.

### B.3 Barrel calculations

For the rolling shutter configuration as tested, the following calculation applies.

Barrel outside diameter ( $D_B$ ) =	133 mm
Lath length ( $L_L$ ) =	3 600 mm
Height of shutter aperture ( $h_{AS}$ ) =	2 810 mm
Weight per unit area of lath ( $\rho_L$ ) =	22.5 kg/m <sup>2</sup>
→ Shutter weight ( $W_L$ ) =	227 kg
Weight of barrel ( $W_B$ ) =	43 kg
→ Barrel assembly weight ( $W_{BA}$ ) =	2646 N
Barrel wall thickness ( $t_B$ ) =	3.0 mm
→ Barrel moment of inertia ( $I_B$ ) =	2 588 345 mm <sup>4</sup>
→ Barrel section modulus ( $Z_B$ ) =	38 922 mm <sup>3</sup>
Barrel length ( $L_B$ ) =	3476 mm
→ Barrel stress ( $\sigma_B$ ) =	29.5 N/mm <sup>2</sup>
Barrel deformation factor ( $E_B$ ) =	63 10 <sup>3</sup> N/mm <sup>2</sup> , taken from EN 1993-1-2 for 950 degC (= furnace temperature after 60 minutes heat exposure)
→ Free deflection of barrel ( $d_B$ ) =	8.87 mm

This means a maximum deformation of 8.87 mm in relation to a length of the barrel of 3476 mm. This corresponds to a deformation of 1/390 of the barrel length. This deformation can be accommodated in the labyrinth mounted on the wall and on the last lath. Also the overlap of the mounting frame of the rolling shutter has to be dimensioned for this. In the rest of this document the maximum allowable deformation is set at 1/500 of the barrel length (when ≤ 10 meters) and at 1/800 of the barrel length (when > 10 meters).

If the maximum deformation of the barrel length is exceeded you will use a heavier type of barrel. First you will increase the wall thickness of the barrel within the possible thicknesses of 4.0 - 6.3 mm, eventually combined with an increase in the diameter of the barrel; within the possible diameters of 168.3 - 219.1 - 323.9 mm.

A summary table of acceptable dimensions is given in Table 1.

Table 1 - Summary of barrel dimensions in relation to the dimensions

clear opening dimensions w x h [mm]	Weight of the rolling shutter [kg]	Barrel diameter [mm]	wall thickness of the barrel [mm]
3 000 x 3 000	203	159.0	3.0
4 000 x 4 000	360	159.0	3.0
5 000 x 5 000	563	168.3	4.0
6 000 x 6 000	810	219.1	4.0
7 000 x 7 000	1 103	323.9	4.0
8 000 x 8 000	1 440	323.9	4.0

10 000 x 8 000	1 800	355.6	4.0
8 000 x 10 000	1 800	323.9	4.0
12 000 x 7 000	1 890	508.0	4.0
7 000 x 12 000	1 890	323.9	4.0
15 000 x 6 000	2 025	610.0	4.0
6 000 x 15 000	2 025	323.9	4.0

For the present calculation the maximum dimensions of the rolling shutter are set to 15 x 6 meters. The EXAP standard EN 15269-10:2011 does not mention maximum dimensions.

### B.5 Axle calculations

Axle diameter (DA) =	30 mm
→ Axle section modulus (ZA) =	2 651 mm <sup>3</sup>
Motor weight (W <sub>AL</sub> ) =	6 kg
Axle length (L <sub>A</sub> ) =	20 mm (determining till support)
Lath length (L <sub>L</sub> ) =	4000 mm
Height of shutter aperture (h <sub>AS</sub> ) =	4000 mm
→ Barrel assembly weight (W <sub>BA</sub> ) =	936 N
→ Axle bending stress (σ <sub>A1</sub> ) =	8 N/mm <sup>2</sup>
→ Axle shear stress (σ <sub>A2</sub> ) =	1 N/mm <sup>2</sup>

This values is under the allowed stresses because according to EN 1993-1-2 it is specified that 10% of the strength of the steel at room temperature will remain at a temperature of 950 °C (this is taken as the temperature in the furnace after 60 minutes of heating). This means 10% of 355 N/mm<sup>2</sup> = 35.5 N/mm<sup>2</sup>.

In case of larger dimensions and weights, the axle diameter will be increased. The diameter will be chosen such that the combined stress will stay below 35.5 N/mm<sup>2</sup>. Efectis NL suggest to incorporate some safety margin, and thus advises to stay below 15 N/mm<sup>2</sup>. Results are presented in Table 2.

Table 2 - Summary of axle diameters

clear opening dimensions w x h [mm]	Weight of the rolling shutter [kg]	Axle diameter [mm]
3 000 x 3 000	203	30.0
4 000 x 4 000	360	40.0
5 000 x 5 000	563	50.0
6 000 x 6 000	810	60.0
7 000 x 7 000	1 103	60.0

8 000 x 8 000	1 440	80.0
10 000 x 8 000	1 800	100.0
8 000 x 10 000	1 800	80.0
12 000 x 7 000	1 890	100.0
7 000 x 12 000	1 890	80.0
15 000 x 6 000	2 025	100.0
6 000 x 15 000	2 025	80.0

### B.6 Endplate calculations

In annex B.6 a method of calculation is given for the dimensioning of the end plates that support the barrel axle on both sides of the barrel.

Endplate height ( $h_E$ ) =	350 mm
Fixing angle cross-sectional area ( $A_{FA}$ ) =	$350 \times 3 = 1050 \text{ mm}^2$
→ Weight of fixing angle ( $W_{EEL}$ ) =	288.5 N
Endplate width ( $w_E$ ) =	350 mm
Endplate thickness ( $t_E$ ) =	3 mm
Endplate cross-sectional area ( $A_E$ ) =	$1050 \text{ mm}^2$
Area correction factor ( $\phi$ ) =	1.0 [-]
Length correction factor ( $\varphi$ ) =	16.67 [-]
50% of barrel assembly weight ( $W_E$ ) =	468 N
Axle end bearing length ( $L_E$ ) =	10 mm
Load on end plate due to motor ( $W_M$ ) =	60 N
Effective motor shaft length ( $L_M$ ) =	300 mm
→ Endplate bending stress ( $\sigma_{EB}$ ) =	$2.4 \text{ N/mm}^2$
Endplate self-weight ( $W_{ESL}$ ) =	28,3 N
Eccentric loading ( $W_{EL}$ ) =	528 N
Total endplate load ( $W_T$ ) =	532 N
Number of bolts =	5
Cross-section of bolt (M10) =	$75 \text{ mm}^2$
→ Shear stress in bolts ( $\tau_{EFB}$ ) =	$1.4 \text{ N/mm}^2$
→ Tensile force on top bolt ( $F_{EFB}$ ) =	122.5 N
→ Tensile stress in top bolt ( $\sigma_{EFB}$ ) =	$1.6 \text{ N/mm}^2$

These values are under the allowed stresses because according to EN 1993-1-2 it is specified that 10% of the strength of the steel at room temperature will remain at a temperature of

950 °C (this is taken as the temperature in the furnace after 60 minutes of heating). This means 10% of 355 N/mm<sup>2</sup> = 35.5 N/mm<sup>2</sup>.

In case of larger dimensions and weights, the endplate cross-sections will be increased. The dimensions will be taken in the following steps : width and height 200 - 250 - 300 - 350 - 400 mm etc., and the thickness is chosen as 3 - 4 - 5 mm etc. Efectis NL suggest to incorporate some safety margin, and thus advises to stay below 15 N/mm<sup>2</sup>. Results are presented in Table 3.

**Table 3 - Summary of endplate dimensions**

clear opening dimensions w x h [mm]	Weight of the rolling shutter [kg]	Endplate height x width [mm]	Endplate thickness [mm]
3 000 x 3 000	203	350 x 350	3.0
4 000 x 4 000	360	400 x 400	3.0
5 000 x 5 000	563	450 x 450	3.0
6 000 x 6 000	810	500 x 500	4.0
7 000 x 7 000	1 103	600 x 600	6.0
8 000 x 8 000	1 440	600 x 600	8.0
10 000 x 8 000	1 800	650 x 650	10.0
8 000 x 10 000	1 800	650 x 650	8.0
12 000 x 7 000	1 890	700 x 700	12.0
7 000 x 12 000	1 890	700 x 700	10.0
15 000 x 6 000	2 025	750 x 750	12.0
6 000 x 15 000	2 025	750 x 750	10.0

### B.7 Shutter expansion allowance

If the width of the rolling shutter in practice is larger than in the test, then the depth in through which the laths fall in the side guides will be increased by 5 mm per extra meter of width. If the rolling shutter is less wide then tested then the side guides will be constructed as tested.

### B.8 Fire performance of fixings

In test report 2013-Efectis-R0536a [Rev. 1] it is proven that the tested fixing method (anchoring completely through the wall with anchor plates on the cold side) is a suitable method for a fire resistance of at least 120 minutes if the rolling shutter is mounted on an aerated concrete wall with a thickness of 150 mm. The rolling shutter may also be mounted

on heavier supporting constructions such as concrete as long as the fixing method stays the same as tested and the wall is at least 150 mm thick.

For other types of supporting constructions or fixing methods it has to be proven that they fulfil the requirements given in the EXAP standard EN 15269-10 in the articles J.1.1 t/m J.1.6. The rolling shutter may also be mounted on a steel supporting construction if the requirements of article J.2.1 of EN 15269-10:2011 are fulfilled.

## 2. CONCLUSION

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All parts of the construction have been evaluated using the EXAP standard EN 15269-10.

Based on this approach it is concluded that the rolling shutter construction type Metacon RGS EW60 ECO, as tested and described in Efectis NL test report 2013-Efectis-R0536a [Rev. 1], will have a fire resistance of 60 minutes based on the criteria *integrity* and *heat radiation* (EW 60).

The construction may be enlarged under the following conditions:

- Maximum dimensions are 15 x 6 meter (width x height or height x width)
- Dimensioning of the barrel dimensions according to Table 1 in B.3
- The axle dimensions at the end plates will be dimensioned on the basis that the remaining steel strength will be at least 5% of the strength at room temperature, see B.5 and B.6
- Modification of the side guides according to B.7
- Mounting of the rolling shutter construction following the guide lines from B.8

Yours sincerely,



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