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Our reference 2012-Efectis-R9103.162(E)[Rev.1]  
Project number 2015221

Bleiswijk (NL), 16<sup>th</sup> March 2015

## Expert judgement on fire resistance - maximum dimensions Metacon RGS rolling shutter

Dear Mr. Asscheman,

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. The construction has been tested for fire resistance. The tests are described in Efectis NL report 2012-Efectis-R0282.

The tested dimensions of the rolling shutter were 2650 x 2425 x 60 mm (width x height x thickness). In the direct field of application in the test report an extension of the tested dimensions is already allowed. The height may be increased by 30% and the width by 10% (for EI<sub>1</sub> 120 and EI<sub>2</sub> 120 classifications). 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 2012-Efectis-R0282;
- standards EN 1634-1 :2008, EN 15269-10 :2011;
- Knowledge and experience of Efectis Nederland BV.

### Efectis NL test report 2012-Efectis-R0282

This report gives the results of two fire tests performed on rolling shutters of type Metacon RGS. 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.

The fire tests were performed on the 29th of February and the 1st of March 2012, according to the European standard EN 1634-1:2008. The results can be summarised as follows:

Rolling shutter mounted on the fire side

- Integrity (E) 133 minutes
- Thermal insulation ( $I_1$  and  $I_2$ ) 135 minutes
- Heat radiation (W) 135 minutes

Rolling shutter mounted on the non-fire side

- Integrity (E) 180 minutes
- Thermal insulation ( $I_1$  and  $I_2$ ) 175 minutes
- Heat radiation (W) 180 minutes

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



*Photo 1*

### Expert judgement

You have asked what the maximum dimensions of the rolling shutter can be 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 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 construction. The rolling shutter construction has to remain fulfilling the classifications EI<sub>1</sub> 120 as well as EI<sub>2</sub> 120. For the supports, the EXAP standard EN 15269-10:2011 cannot be followed because the supports consist of UNP sections instead of end plates. Therefore, the supports are evaluated based on knowledge of Efectis Nederland.

### B.3 Barrel calculations

Barrel outside diameter ( $D_B$ ) =	323,9 mm
Lath length ( $L_L$ ) =	2850 mm
Height of shutter aperture ( $h_{AS}$ ) =	2425 mm
Weight per unit area of lath ( $\rho_L$ ) =	36,22 kg/m <sup>2</sup>
→ Curtain weight ( $W_L$ ) =	311 kg
Weight of barrel ( $W_B$ ) =	91 kg
→ Barrel assembly weight ( $W_{BA}$ ) =	3939 N
Barrel wall thickness ( $t_B$ ) =	4,0 mm
→ Barrel moment of inertia ( $I_B$ ) =	52072761 mm <sup>4</sup>
→ Barrel section modulus ( $Z_B$ ) =	321536 mm <sup>3</sup>
Barrel length ( $L_B$ ) =	2976 mm
→ Barrel stress ( $\sigma_B$ ) =	4,56 N/mm <sup>2</sup>
Barrel deformation factor ( $E_B$ ) =	7,1 10 <sup>3</sup> N/mm <sup>2</sup> , taken from EN 1993-1-2 for 1040 degC (= furnace temperature after 120 minutes heat exposure)
→ Free deflection of barrel ( $d_B$ ) =	3,66 mm

This means a maximum deformation of 3.66 mm in relation to a length of the barrel of 2976 mm. This corresponds to a deformation of 1/813 of the length of the barrel. 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 deformation is set at 1/500 of the barrel length.

If the maximum deformation of 1/500 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 - 4,5 - 5,0 - 5,6 - 6,3 - 7,1 - 8,0 - 8,8 - 10,0 - 12,5 mm. Second you will increase the diameter of the barrel; within the possible diameters of 323,9 - 355,6 - 406,4 mm.

<u>Example</u>	Lath length ( $L_L$ ) =	10000 mm
	Height of shutter aperture ( $h_{AS}$ ) =	10000 mm
	→ Curtain weight ( $W_L$ ) =	3266 kg
	Barrel outside diameter ( $D_B$ ) =	323,9 mm
	Barrel wall thickness ( $t_B$ ) =	12,5 mm
	→ Weight of barrel ( $W_B$ ) =	440 kg
	→ Barrel assembly weight ( $W_{BA}$ ) =	37060 N
	Barrel length ( $L_B$ ) =	10250 mm
	→ Free deflection of barrel ( $d_B$ ) =	19 mm

This means a maximum deflection of 19 mm in relation to a barrel length of 10250 mm, or a deformation of 1/539 of the barrel length. This is acceptable based on the criterion of a maximum deflection of 1/500 maximum of the barrel length.

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

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

clear opening dimensions [mm]	Weight of the rolling shutter [kg]	Barrel diameter [mm]	wall thickness of the barrel [mm]
3 000 x 3 000	326	323,9	4,0
4 000 x 4 000	579	323,9	4,0
5 000 x 5 000	906	323,9	4,0
6 000 x 6 000	1304	323,9	4,0
7 000 x 7 000	1775	323,9	4,0
8 000 x 8 000	2318	323,9	5,0
9 000 x 9 000	2934	323,9	8,0
10 000 x 10 000	3622	323,9	12,5
10 000 x 10 000	3622	406,4	6,3
5 000 x 15 000	2716	323,9	4,0
15 000 x 5 000	2716	610,0	6,3

For the present calculation the maximum dimensions of the rolling shutter are set to 10 x 10 and 5 x 15 m. The EXAP standard EN 15269-10:2011 does not mention maximum dimensions.

#### B.4 Barrel support bracket calculations

Based on article B.4 of the standard barrel support brackets are necessary if the barrel deforms too much in a fire situation. An excessive deformation of the barrel can lead to an opening at the top of the construction because the top lath deforms beyond the labyrinth, or the barrel deforms below the top lintel of the supporting construction.

The criterion that the barrel should not deform more than 1/500 of the barrel length fits within your design of the labyrinth closure of the top lath and the overlap on the wall. Due to this relatively small deformation the integrity of the top closure will stay intact and according to B.4 no "barrel support brackets" are necessary.

#### B.5 Axle calculations

Axle diameter ( $D_A$ ) =	40 mm
→ Axle section modulus ( $Z_A$ ) =	6280 mm <sup>3</sup>
Motor weight ( $W_{AL}$ ) =	26 kg
Axle length ( $L_A$ ) =	30 mm (determining till support)
Lath length ( $L_L$ ) =	4000 mm

Height of shutter aperture ( $h_{AS}$ ) =	4000 mm
→ Barrel assembly weight ( $W_{BA}$ ) =	6926 N
→ Axle bending stress ( $\sigma_{A1}$ ) =	18 N/mm <sup>2</sup>
→ Axle shear stress ( $\sigma_{A2}$ ) =	3 N/mm <sup>2</sup>

This values exceed the allowed stresses because according to EN 1993-1-2 it is specified that 3% of the strength of the steel at room temperature will remain at a temperature of 1040 °C (this is taken as the temperature in the furnace after 120 minutes of heating). This means 3% of 355 N/mm<sup>2</sup> = 10.7 N/mm<sup>2</sup>.

You indicated that because of larger dimensions or weights the axle diameter will be chosen from the range 30 - 40 - 50 - 60 - 80 - 100 mm. The diameter will be chosen so that the combined stress will stay below 10,7 N/mm<sup>2</sup>.

## 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 axel on both sides of the barrel. This method is based on a different construction then the one that is use in the Metacon RGS rolling shutter. This means that for this part the EXAP standard EN 15269-10 cannot be used.

To be able to assess the tested construction the tested end plats and supports have been dimensioned. see figure 1.

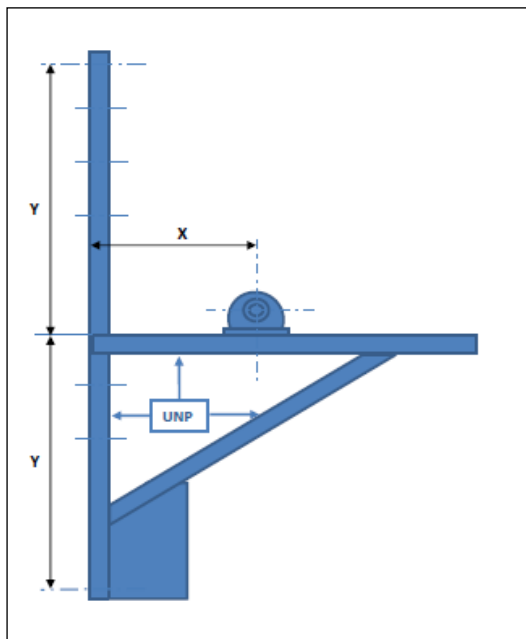


Figure 1 - End plates and supports

During the fire test the supports consisted of UNP80 profiles. These profiles functioned adequately for more than 120 minutes of heating. This is also caused because in the fire situation the laths of the rolling shutter rest on the floor. This means that the end plates and supports only have to support the full weight at room temperature. In case of fire most of the weight rests on the floor and is not supported by the end plates or the supports.

Based on the successful test an estimate has been made of the necessary dimensions of the supports at larger dimensions of the rolling shutter. The results are given in tables 2 and 3.

H	END OF EXAP														
	UNP 100	UNP 120	UNP 140	UNP 160	UNP 180	UNP 200									
	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b	a/b
15	710/70	1280/110	1840/150	2400/200	2970/350										
14	670/70	1190/110	1720/150	2240/200	2770/350	3300/380									
13	620/70	1110/110	1600/150	2090/200	2580/330	3070/380	3560/470								
12	570/70	1030/110	1480/150	1930/180	2390/330	2840/380	3300/470	3750/520							
11	530/70	950/100	1360/150	1780/180	2190/330	2610/380	3020/430	3440/520	3850/630						
10	480/60	860/100	1240/150	1620/180	2000/330	2380/380	3020/430	3140/520	3520/630	3900/880					
9	430/60	780/100	1110/150	1460/180	1800/330	2140/380	2480/430	2820/480	3160/630	3500/800	3840/1070				
8	390/50	690/100	990/130	1290/180	1600/220	1900/380	2200/430	2500/480	2800/630	3110/800	3410/920	3710/1140			
7	340/50	610/90	880/130	1150/180	1420/220	1690/250	1960/430	2230/480	2500/630	2770/800	3040/920	3310/1140	3580/1210		
6	300/50	530/90	760/130	990/160	1220/220	1450/250	1680/280	1910/480	2140/530	2370/800	2600/920	2830/1140	3060/1210	3290/1290	
5	250/50	440/90	630/130	820/160	1020/200	1210/250	1400/280	1600/310	1790/510	1980/800	2170/920	2360/980	2550/1210	2750/1290	2940/1470
4	200/50	360/80	520/120	680/160	840/200	1000/230	1160/280	1320/310	1480/510	1640/780	1800/920	1960/980	2120/1210	2280/1290	2440/1360
3	150/40	280/80	400/120	520/150	640/190	760/230	880/260	1000/290	1120/340	1240/560	1360/710	1480/750	1600/980	1720/1100	1840/1360
2	100/40	190/80	270/100	350/140	440/180	520/210	600/260	680/290	770/320	850/350	930/640	1010/750	1090/980	1180/1100	1260/1360
1	60/40	110/70	160/100	210/140	260/170	310/200	360/240	410/270	460/300	510/340	560/640	610/680	660/720	710/840	760/920

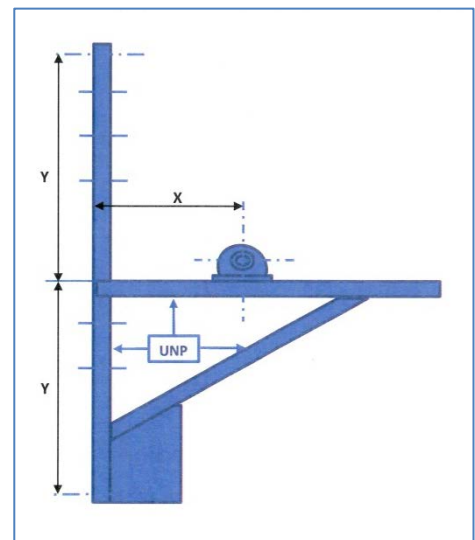
Table 2

H	END OF EXAP														
	M 16	M 20	M 22	M 24											
	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y	x/y
15	750/1100	750/1100	750/1100	750/1100	750/1100										
14	750/1100	750/1100	750/1100	750/1100	750/1100	750/1100									
13	750/1100	750/1100	750/1100	750/1100	750/1100	750/1100	750/1100								
12	675/1000	675/1000	675/1000	675/1000	675/1000	675/1000	675/1000	750/1200							
11	675/1000	675/1000	675/1000	675/1000	675/1000	675/1000	675/1000	750/1200	750/1200						
10	675/1000	675/1000	675/1000	675/1000	675/1000	675/1000	675/1000	750/1200	750/1200	750/1200					
9	625/875	625/875	625/875	625/875	625/875	625/875	625/875	750/1100	750/1100	750/1100	750/1100				
8	575/750	575/750	575/750	575/750	575/750	575/750	575/750	700/1000	700/1000	750/1100	750/1100				
7	525/650	525/650	525/650	525/650	525/650	525/650	525/650	525/650	525/650	700/1000	700/1000	700/1000	700/1000		
6	525/650	525/650	525/650	525/650	525/650	525/650	525/650	525/650	525/650	700/1000	700/1000	700/1000	700/1000	700/1000	
5	450/575	450/575	450/575	450/575	450/575	450/575	450/575	450/575	450/575	700/1000	700/1000	700/1000	700/1000	700/1000	700/1000
4	425/500	425/500	425/500	425/500	425/500	425/500	425/500	425/500	425/500	700/1000	700/1000	700/1000	700/1000	700/1000	700/1000
3	375/500	375/500	375/500	375/500	375/500	375/500	375/500	375/500	375/500	375/500	475/600	475/600	475/600	475/600	475/600
2	375/425	375/425	375/425	375/425	375/425	375/425	375/425	375/425	375/425	375/425	425/500	425/500	425/500	425/500	425/500
1	325/325	325/325	325/325	325/325	325/325	325/325	325/325	325/325	325/325	325/325	375/500	375/500	375/500	375/500	375/500

Table 3

- H = the clear opening in meters
- B = the clear width in meters
- a = the weight of the rolling shutter in kg
- b = the weight of the barrel axis in kg
- x = the distance from the vertical to the centre of the barrel
- y = the distance from the horizontal to the lower or upper mounting hole
- UNP = a hot rolled U-profile from which the support is constructed

Remark: In a different mounting situation the dimensions can differ.



These tables are no part of the EXAP standard EN 15269-10:2011 but are based on the test result and extrapolation of this for larger dimensions of the rolling shutter. Larger dimensions lead to larger loads on the end plates and the supports. Based on the actual weights heavier UNP profiles with larger load bearing capacity have been chosen.

### B.7 Curtain 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. Also the dimensions of all intumescent materials will be increased pro ratio of the enlarged width. If the rolling shutter is less wide than tested then the side guides will be constructed as tested. The tested situation is given in figure 2.

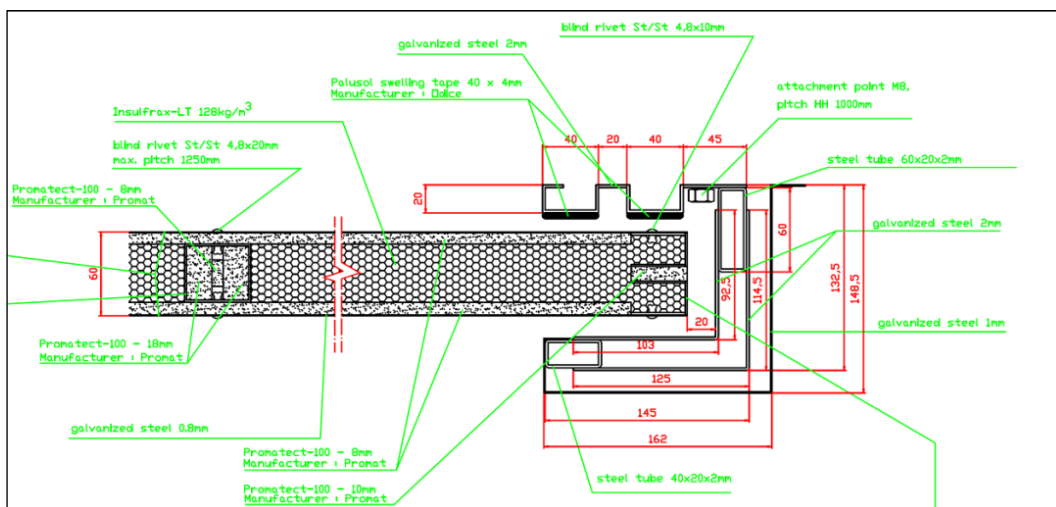


Figure 2 - Tested side guide

### B.8 Fire performance of fixings

In test report 2012-Efectis-R0282 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 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.

### Conclusion

All parts of the construction besides the end plates and supports have been evaluated using the EXAP standard EN 15269-10.

A classification document based on the EXAP standard EN 15269-10:2011 cannot be given because the end plates and supports are not constructed in a way that allows the use of article B.6 of the standard. Because of that specific expert judgement has been given in this document. This expert judgement is based on the knowledge and experience of Efectis NL.

Based on this approach it can be concluded that the rolling shutter construction type Metacon RGS, as tested and described in Efectis NL test report 2012-Efectis-R0282, will have an estimated fire resistance of 120 minutes based on the EI(1) 120 criteria.

The construction may be enlarged under the following conditions:

- Dimensioning of the barrel dimensions according to Table 1 in B.3
- The axel dimensions at the end plates will be dimensioned so that the remaining steel strength will be at least 3% of the strength at room temperature
- The end plates and supports have to be dimensioned according to tables 1 and 2 in B.6.
- Modification of the side guides according to B.7
- Mounting of the rolling shutter construction following the guide lines form B.8

Best regards,



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