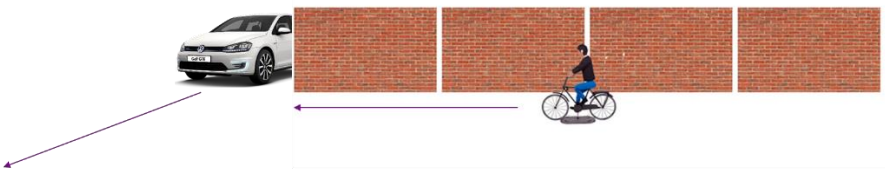
Report

Description:	MD-Wall and Real-Wall Radar Cross-Section Analysis
Test venue:	Upper Heyford, Oxfordshire
Date of test:	7th May 2019

1. General background

Following an updated test protocol, and several general enquiries for an obstruction wall 8.8 m wide x 2 m high appropriate for use in the AEB VRU NCAP protocol we decided to press ahead and make a design that fulfilled this need. The principal design idea is below.



This document reports the results of the build and radar reflectivity tests carried out to ensure that the design of this product meets the radar reflectivity brief received from the various engineers' requirements.

2. Test brief

Late 2017/Early 2018, MD received a number of requests for an 'Obstruction wall' 8.8 m W x 2 m H for use as defined in the Euro NCAP test protocol "euro-ncap-aeb-vru-test-protocol-v201 – August 2017", This document has since been updated a couple of times, but the original request for an obstruction wall design stays relevant but differs by engineers from different companies and regional locations.

One source asked for a design that would replicate the radar reflectivity of a van being used as an obstruction wall - this would mean a radar signature of a very high value. Another asked for a wall to act as though nothing was there, but that the radar should not be able to see anything behind or emerging from behind it.

Eventually we decided to compromise in an obstruction wall design that would simulate as close as possible a real wall but attempt to incorporate a method by which we could accommodate the difference of opinion between the engineer's requests.

3. The construction and test

The design chosen consists of four 2 m H x 2.2 m W x 20 cm thick walls made from a density graded foam. We estimated a particular density that would behave closest to that of a real wall. Once the selection was made, we would be able to adjust using different materials to either suppress or enhance the radar reflectivity.

We chose our usual Thatcham AEB test area at Upper Heyford, Oxfordshire, UK as a test location. This is an ideal location for us being away from other obstructions and obstacles but taking place in the same environment that AEB VRU tests are conducted every week.

It was felt that the best way to conduct a comparison was to construct a real 2 m x 2.2 m wall on a precise known location, taking radar reflectivity measurements, then tearing it down and replacing with one of our newly constructed 2 m x 2.2 m soft walls in exactly the same location and repeating the same tests.

Image shows both MD-Wall and Real wall. The real wall was the exact location of the test, MD-Wall moved to this location.

During testing, reflective foil would be added at two thirds the height of each of the full 2 m walls to compare the differences.

Looking at the results we would be able to determine a need to increase or decrease reflectivity to complete the final product.

Tests conducted as follows:

1. Real v Soft
    a. The comparison between a real wall without reflective film, and the MD-Wall with Just high-density foam and digital image of a brick wall on the front wall without reflective film,

2. Real v Soft + Reflective film
    a. The comparison between a real wall **with** reflective film, and the MD-Wall with Just high-density foam and digital image of a brick wall on the front wall with reflective film,

3. Real v Soft + Pedestrian behind
    a. The comparison between a real wall without reflective film with a pedestrian behind, and the MD-Wall with Just high-density foam and digital image of a brick wall on the front wall without reflective film with a pedestrian behind.

4. Real v Soft + Reflective film + Pedestrian behind
    a. The comparison between a real wall **with** reflective film with a pedestrian behind, and the MD-Wall with Just high-density foam and digital image of a brick wall on the front wall with reflective film with a pedestrian behind,

5. Further tests to see the difference when the pedestrian emerges from behind:
    a. Real wall
    b. MD-Wall

6. Analyse results and draw conclusions

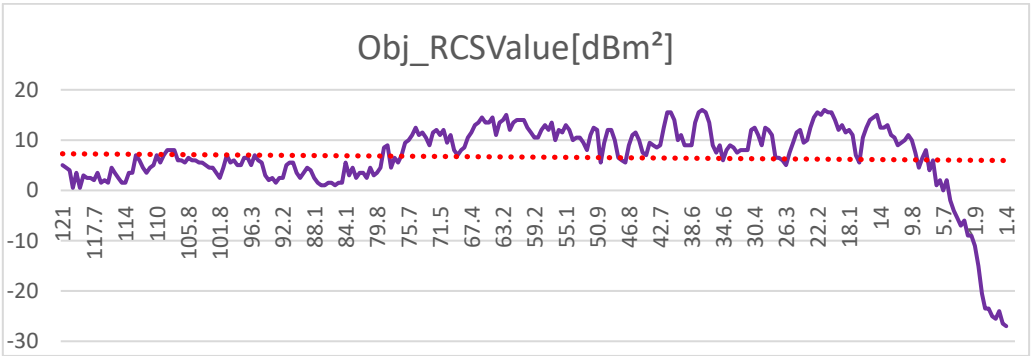
7. Following the conclusions, adjust the lining of the foam using either radar absorbent material to suppress the signature or add reflective film to increase and retest.

4. Results

The test results are shown in the same order as above.

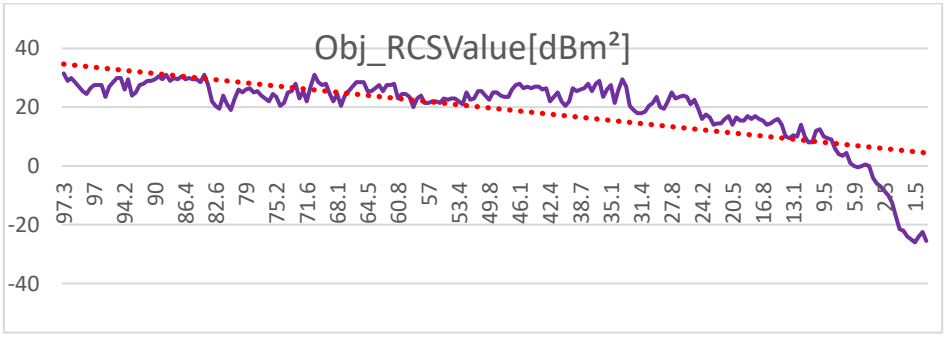
4.1. Test 1 - Real wall v MD-Wall

Real-block wall



RCS average linear approach: 6.61 dBm2
RCS average 30 sec static at 30 m: 9.36 dBm2

MD-Wall

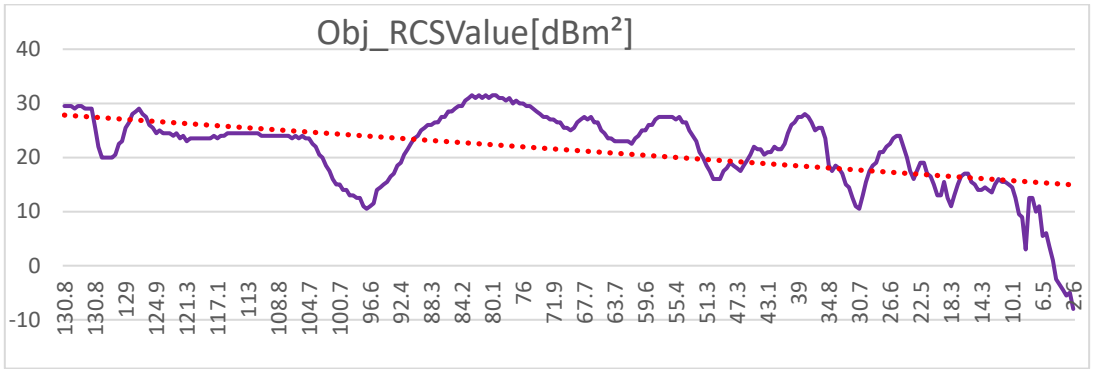


RCS average linear approach: 19.63 dBm2
RCS average 30 sec static at 30 m: 13.21 dBm2

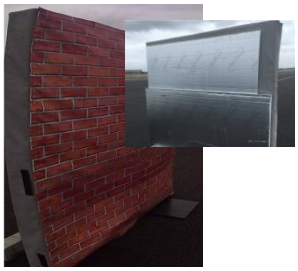
Comments: It is noted that the foam wall by default already has a much greater radar signature than the equivalent sized wall made of real brick blocks.

4.2. Test 2 - Real wall v MD-Wall + Reflective Film

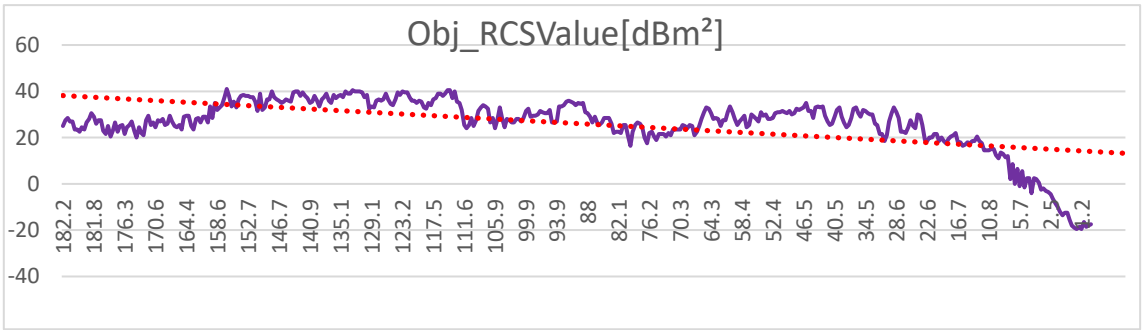
Real wall with foil lining



RCS average linear approach: 19.63 dBm2
RCS average 30 sec static at 30 m: 17.31 dBm2



MD-Wall with foil lining

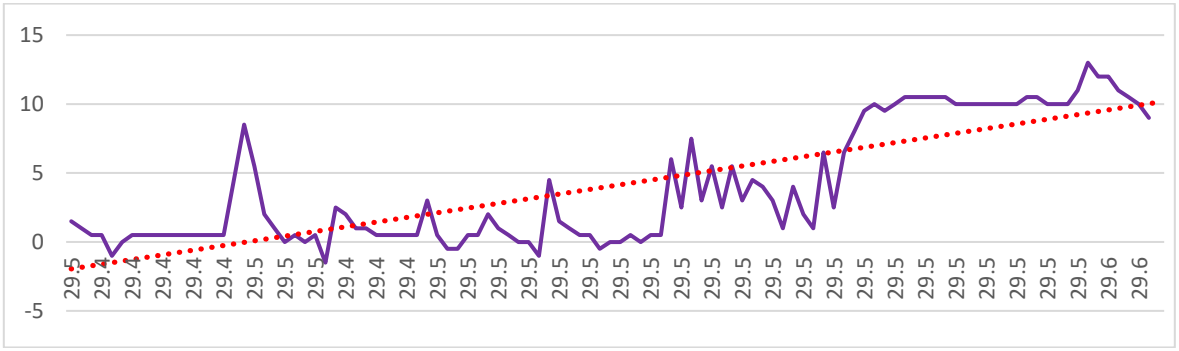


RCS average linear approach: 26.09 dBm2
RCS average 30 sec static at 30 m: 23.19 dBm2

Comments: Adding foil significantly increases the signature of both walls. It does make more of a difference to the Real wall bringing it to approximately the same value as the MD-Wall **without** a foil lining.

4.3. Test 3 - Real v Soft + Pedestrian behind

Real wall with pedestrian completely behind during test

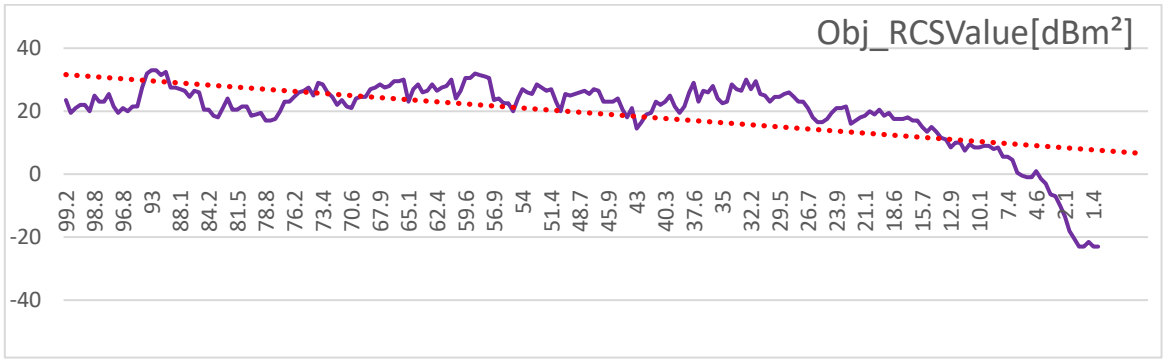


Linear approach tests invalid

RCS average 30 sec static at 30 m: 4.04 dBm2 –

(it is noted that the average is 9.83 dBm2 two thirds into dataset and levels out)

MD-wall with pedestrian completely behind during test

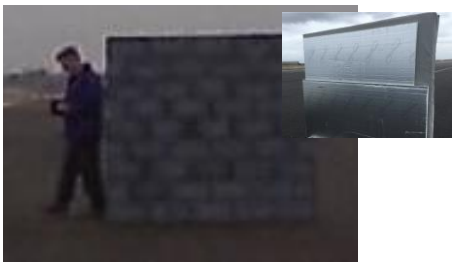


RCS average linear approach: 19.64 dBm2

RCS average 30 sec static at 30 m: 20.58 dBm2

Comments: The linear test result was invalid on the real wall run. But the static test reads much lower than expected value – it appears to jump back up to an expected value two thirds into the data set. This test is therefore invalid, but we can conclude that the real wall. Is 'most likely' higher by approximately 3 dBm2 with a pedestrian behind when compared to a wall without pedestrian. The MD-Wall appears to block the pedestrian from view as the value is approximately the same with or without the pedestrian. This is good news as it successfully obscures the pedestrian!

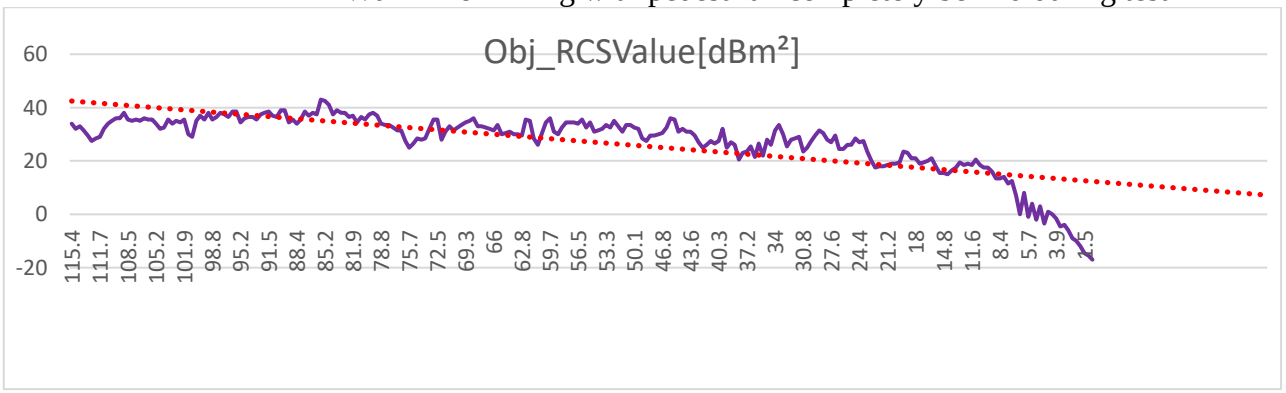
4.4. Test 4 - Real v Soft + Reflective film + Pedestrian behind



Real wall + Foil lining with pedestrian completely behind during test

Test not done – top layer of brick collapsed before it could be tested with a pedestrian.

MD-Wall + Foil lining with pedestrian completely behind during test



RCS average linear approach: 27.43 dBm2
RCS average 30 sec static at 40 m: 28.03 dBm2
(The 30 m static run was invalid)

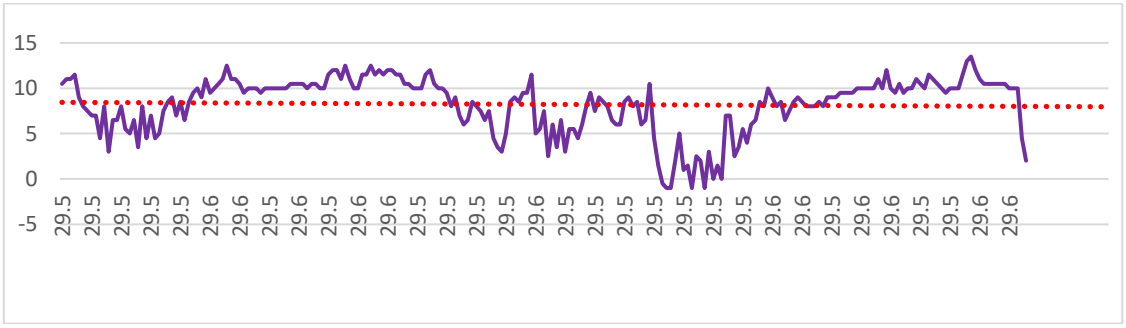
Comments: The linear test result was invalid on the real wall run. The RCS value of real wall is doubled when compared to test 3 without foil. But is the same as the real wall without pedestrian or foil behind based on test one. The latter comparison suggests the pedestrian makes no difference if we consider that real wall data in test 3 is likely to be invalid.

The MD-Wall behaves consistently once again and shows higher value consistent with test 2 and no variance with a pedestrian behind. Again, very good news!

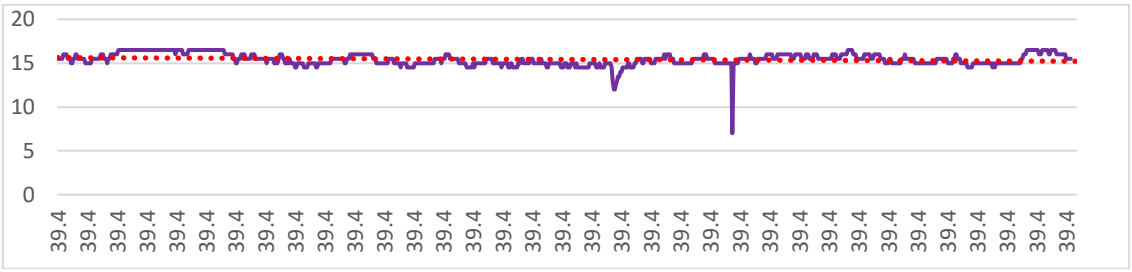
4.5. Test 5 – Pedestrian emerging

4.5.1. Real wall v Soft Wall – pedestrian walks out halfway through a 60 second data set

Real Wall – walkout at 30 seconds



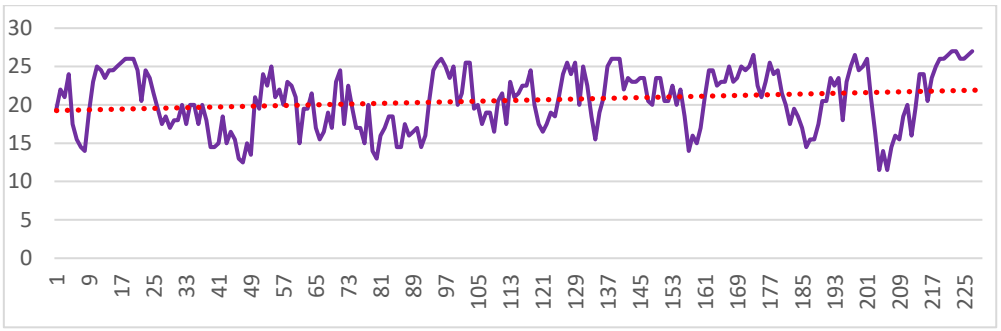
RCS average 60 sec static at 30 m: 8.23 dBm2



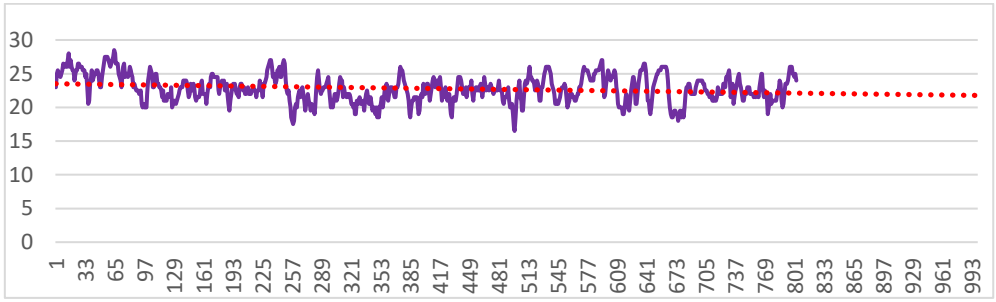
RCS average 60 sec static at 40 m: 15.43 dBm2

Comments: Some evidence of unspecific data change following the pedestrian emerging at 30 s into the data set. There are two blips of data change following the pedestrian emergence but little else. The Pedestrian walking away clearly has an effect which is to be expected, but nothing at all while behind.

MD-Wall – walkout at 30 seconds



RCS average 60 sec static at 30 m: 20.58 dBm2



RCS average 60 sec static at 50 m: 22.81 dBm2

Comments: No evidence of change in either. Would have expected some blip in the data as before but no change here.

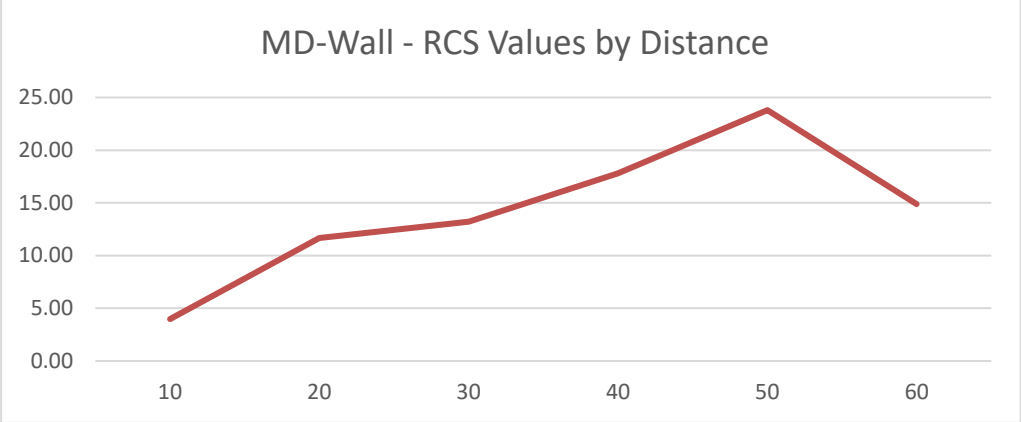
5. Analyse test results

Results tabled below.

	RCS Value - dbm2						
	Linear Approach	Static (meters)					
	0-100 - 5 mph	10	20	30	40	50	60
MD-Wall	19.63	3.98	11.67	13.21	17.80	23.80	14.88
Real Wall	6.61	2.50	15.49	9.36	12.50	10.07	5.28
MD-Wall + Foil Lining	26.09	0.68	18.5	23.19	25.45	22.56	27.65
Real Wall + Foil Lining	19.63	15.13	15.38	17.31	22.50	26.50	23.60
MD-Wall + Pedestrian	19.64	8.83	19.17	20.58	22.67	22.81	26.83
Real Wall + Pedestrian		7.04	4.00	4.04	16.17	1.50	-0.84
MD-Wall + Foil Lining + Pedestrian	27.43	-0.01	18.79	3.33	28.03	31.15	29.54
Real Wall + Foil Lining + Pedestrian							
MD-Wall + Pedestrian walkout				20.58		22.81	
Real Wall + Pedestrian walkout				8.23	15.43		

The light blue areas are data taken from the Linear tests at the appropriate distance to fill in the static blanks to complete an estimation where data is missing. Grey areas are either invalid results or no data taken.

Graph below shows a plot of the MD-Wall total RCS averaged data plotted by distance.



6. Conclusion

The brief was to design a wall of a similar radar signature of a real wall.

In tests the MD-Wall has proven to have a much greater radar signature than an equivalent block sized wall made of real brick blocks without any additional lining or materials.

Adding aluminium foil significantly increases the signature of both walls. It makes more of a difference to the real wall bringing it up to approximately the same value as the MD-Wall **without** a foil lining. A real wall typically has a foil lining in UK construction processes, so we believe the MD-Wall **without** a foil lining or any other radar enhancing, or defusing qualities is approximately the same as a UK brick wall.

In further tests the MD-Wall also appears to block a pedestrian located behind and hidden from visual view. This is validated by the RCS data where the value is approximately the same with or without the pedestrian in more than one test.

Further tests completed to see what would happen if a pedestrian emerges in the middle of a radar cross-section static test. Here, there is some evidence of an unspecific data change following the pedestrian emerging at 30s into the data set. Two blips of data change following the pedestrian emergence but little else. The

Pedestrian walking away clearly has an effect which is to be expected, but nothing at all while behind – this further validates the theory that nothing can be seen by radar behind either the foam wall or real wall.

This is very good news as it proves the MD-Wall successfully obscures a pedestrian located behind for the tests where this necessity is relevant to the test.

These results are to be followed up by further tests on our foam sidewalk/pavement and traffic island kits.

Update 200207*: Customer trials have since confirmed that the MD-Wall product is effective when put up against a real wall. Further evaluation tests in real world scenarios are ongoing to collect more data.*

For more information please contact info@moshondata.com

7. Acknowledgments:

- Thatcham UK for their support and use of their airfield area at Upper Heyford
- Continental for the supply of the Radar test equipment

/Moshon Data