Home Office

# CAST - Project DISPERSE

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| *Document Name* | Project DISPERSE Trial Results for German Water Cannon May 2014 & CAST Response to SACMILL Recommendations |
| *File Name* | 140606 WaWe9 - Comments against SACMILL recommendations v.3.0 Redacted |
| *Author* | CAST Redacted |
| *Project* | 157 – Project DISPERSE |
| *Version* | 3.0 Redacted |

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## Contents

# 1.

# 1. Executive Summary

At the request of the Home Office, CAST has produced this document providing additional information on how the recommendations from SACMILL's interim statement[1] will be addressed.

To achieve this, CAST has conducted limited testing and information gathering on the three WaWe9 water cannon (WC) that the Metropolitan Police Service (MPS) are considering purchasing from the German Police. Further assessments will need to be conducted if the vehicles are purchased once they are modified and the results of these will be provided to SACMILL for their final statement.

The recent work done in Germany indicates that adjustments are possible which will ensure that the vehicles can address the SACMILL recommendations if they are purchased.

The testing conducted demonstrated the following key points:-

- If the pump pressure on the WaWe9 vehicles tested is limited to a maximum of 16 Bar, the measured average pressures and average forces are lower, or similar to, the average pressures and average forces of the PSNI Somati WC. Limitation of the water pressure to 16 Bar can be achieved by modification to the commander's control console and the installation of a mechanical limiter on the throttle of the pump engine. See section 3.1.
- It is possible to limit the angle of the water jets on the WaWe9 to ensure that it is not possible to engage a person closer than the PSNI Somati WC. See section 3.3.
- The rear water jet can be removed and the outlet from the pump engine can be blanked off at that point. See section 3.6.
- Video cameras can be installed to the vehicle for both the forward facing water jets and to give the commander forward and rearward facing evidential cameras. See section 3.2.
- If the vehicles are purchased by the MPS, they will be modified by the MPS to bring them into line with vehicle licensing requirements in the UK. This work needs to be completed before final testing is conducted by CAST due to the bespoke nature of their construction and the possibility that the modifications will alter their characteristics.

The final testing reports will be submitted to SACMILL for information to assist with the preparation of their final statement.

**CAST has not identified any features on the WaWe9 cannon that are likely to preclude them from meeting the SACMILL recommendations.**

[1] SACMILL - 2013_11_18 Final Interim Statement WaWe 9

## 2. Purpose and Context of the Trial

The purpose of this document is to summarise CAST responses to the SACMILL recommendations from their interim statement and to comment on whether they are likely to be met.

In forming an opinion on the WaWe9 water cannon system and producing an interim statement on the medical implications for use, SACMILL considered the following:

- A review of the medical implications of use of water cannon.
- Preliminary technical data on the WaWe9 vehicles.
- Guidance and training documents relating to UK use of water cannon.

Part of the CAST response to the technical recommendations in the interim statement includes data from a short trial conducted on the three WaWe9 water cannons in Germany that the MPS are intending to purchase. This trial is only preliminary and does not constitute full final testing which will need to be conducted when the vehicles have been purchased by the MPS and planned modifications have been completed.

The testing was conducted using a pressure sensing mat with the following specification:-

- Model – <redacted>
- Active Area 20” x 20” (50.8cm x 50.8cm)
- Resolution 1.25” (3.175cm)
- Sensor array 16 x 16 = 256 individual sensing elements
- Custom calibration 1-80psi. (0.1 – 5.5 bar)
- Sampling rate 480Hz (min)

This pressure mat was mounted on a rigid framework with a mass >1000kg to ensure rigidity. From this pressure mat, the following data was obtained:-

- Peak pressure recorded on an individual element[2]
- Average pressure recorded over the contacted area of the pressure mat
- Peak force recorded on an individual element
- Average force recorded over the contacted area of the pressure mat
- Contact area

Figure 1 below shows an image of the WaWe9 vehicles that were tested.

[2] The pressure mat consists of an array of 256 individual elements in a 16 x 16 grid


*Figure 1 WaWe9 Water Cannon*

The two forward facing water jets on each of the three water cannons were tested. Data was recorded for 20 seconds for each water jet and this was repeated three times. Testing was limited due to time constraints around access to the vehicles. More extensive testing will be conducted during the full testing of the vehicles.

The full trial plan is in Appendix A and a screen shot showing the data capture is in Appendix B.

<redacted>

# 3. SACMILL Recommendations to be Addressed

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## 3.1 Recommendation Paragraph 18

"The peak forces and pressures developed by the WaWe 9 primary water cannon jets should be measured over a range of target engagement distances and at various pump pressure settings. These should be compared with equivalent measurements made on the in-service Somati RCV 9000 water cannon jets. The force and pressure measurements should be obtained using a range of appropriate force plate sizes. SACMILL has reviewed a draft outline proposal for the force and pressure testing of the WaWe 9 water cannon jets and looks forward to reviewing the final detailed technical plan when this becomes available."

### *3.1.1 CAST Response*

Full testing of the WaWe9 cannot be undertaken until all the modifications required or proposed by the MPS are completed. The testing undertaken in Germany was designed to gain a greater understanding of the current vehicle to address the interim SACMILL statement queries prior to full testing being conducted.

Preliminary testing has been undertaken to determine if it is possible to limit the pump pressure of the WaWe9 such that the average force and average pressure (<redacted>)are similar to, but not more than, those measured during the testing conducted on the PSNI Somati WC[3]. The WaWe9 has control switches on the commander's console to enable the selection of 4, 8, 12, 16 or 20 Bar[4] pump pressure.

The test results are tabulated and graphed in Appendix C.

**From the indicative test results, it has been determined that by limiting the maximum pump pressure selectable by the commander to 16 Bar, the results for the average pressures and average forces are less than, or similar to, the PSNI Somati WC. This can be achieved by removal of the 20 Bar selection switch from the commander's console and the installation of a mechanical limiter to the throttle of the pump engine.**

The measured average forces and pressures will be fully reassessed in final testing after all the modifications to the WaWe9 have been completed. The final detailed technical plan will be submitted to SACMILL for review in advance of this testing. The results from the full testing will be presented to SACMILL ahead of their final statement.

***Note:*** The pressure mat used for the testing the WaWe9 in Germany was different to the pressure mat used for the initial testing of the PSNI Somati WC. The sampling rate has been increased from 25 frames per second to 500 frames per second. The calibration range remained the same. This increase in sampling rate has resulted in more accurate data being captured. Testing is going to be repeated on the PSNI Somati WC to gather additional baseline data using the higher rate pressure mat.

<redacted>

[4] Bar is a measurement of pressure - 1bar is equivalent to 100kPa

The average force and average pressure for the WaWe9 was similar to, or lower than, the PSNI Somati. However, the WaWe9 had some higher measured peak forces and peak pressures which are believed to be a result of the change in mat. CAST will be confirming that these pressure peaks are the same as, or lower than, the PSNI Somati WC by additional testing using the new pressure mat.

## 3.2 Recommendation Paragraph 19

"Any substantive differences in performance between the Somati and WaWe 9 water cannon systems should be addressed by a combination of modifications to the WaWe 9 vehicles and implementation of appropriate training, tactics, techniques and procedures."

### *3.2.1 CAST Response*

The table below details the specific differences that have been identified to date and the associated comments on how they will be addressed.

| Number | Difference | CAST Comment |
|---|---|---|
| 1 | The selected pump pressures on the WaWe9 are selectable to 20 Bar compared to 15 Bar on the PSNI Somati RCV9000. | From the testing conducted it has been determined that by limiting the pump pressure on the WaWe9 to 16 bar the contact forces and pressures are less than, or similar to, the PSNI Somati WC. See section 3.1. |
| 2 | The closest forward contact distance on the WaWe9 is less than the PSNI Somati RCV9000 (<redacted>) | The minimum angle that the water jets can be set to will be limited on the WaWe9 <redacted> See section 3.3 (<redacted>) |
| 3 | The WaWe9 does not have a capability to operate in diffused mode. | The Germans have an operational tactic which creates this effect. However, the Water Cannon Project Board has determined that as the WaWe9 does not have this function, the tactic will not be employed, and is therefore not included in any training, in respect of use of water cannon on the mainland. |
| 4 | The water jets do not have their own cameras. | It is planned that a camera system is to be installed once the vehicles are in the UK. MPS to action. |
| 5 | The cannoneers' chairs rotate with the water jets on the WaWe9, but not on the PSNI Somati RCV 9000. | This is of potential benefit as the cannoneers are always pointing in the same direction as the water jets that they are controlling. Will need to be considered if this affects the training of the operators – action for MPS/College of Policing and CC David Shaw. |
| 6 | The control of the water jets <redacted> | <redacted> |

| Number | Difference | CAST Comment |
|---|---|---|
| 7 | All the labelling is in German on the WaWe9. | All the labelling will need changing to English. MPS to action. |
| 8 | The WaWe9 has a rear water jet. | This is being removed and the controls disabled. See section 3.6. |
| 9 | <redacted> | <redacted> |
| 10 | Run flat tyres on the WaWe9 are currently fitted and allow 30km travelling distance at maximum speed of 30 km / hr. | Currently unknown what is on the PSNI Somati WC, (CAST to follow up). |

*Table 1 – Specific Differences noted between the PSNI Somati RCV9000 and the WaWe9*

Further differences may become apparent once the modified cannons have been assessed against the full test protocol. These will be addressed before the full test reports are presented to SACMILL, for their final statement.

In addition to the identified differences, the vehicles would also be subjected to a series of modifications by the MPS before final testing is conducted. These modifications will make the WaWe9 comparable to the PSNI Somati WC and bring the vehicles in line with UK road legislation. These are identified below in table 2.

| No. | Proposed Modification | CAST Comment |
|---|---|---|
| 1 | The vehicle will undergo a goods vehicle type MOT test prior to UK registration which will check compliance for items such as;<br>1. Exterior lighting i.e. dip to left etc, marker lights conforming to UK lighting regulations etc<br>2. Brake efficiency to achieve a minimum of 50% for the service brake (foot brake), 25% for the secondary brake (emergency system) and 12% for the parking brake (hand brake).<br>3. Vehicle tyres<br>4. Vehicle emissions i.e. Euro 4<br>5. Tachograph reading in MPH as main scale<br>6. UK type number plates - | Cannot comment on this as it is outside of CAST's technical scope. |

| No. | Proposed Modification | CAST Comment |
|---|---|---|
| | currently non age specific<br>7. Spray suppression mud flaps<br>8. In cab height indicator. | |
| 2 | Compliance to NICEIC regulations together with an electrical installation certificate for 230 volts - involve changing mains plugs to EN60309 standard and external cables. | Cannot comment on this as it is outside of CAST's technical scope. However these changes are essential to ensure that the tank heater will operate when the vehicle is stored. |
| 3 | Installation of UK specification blue lights and siren. | Cannot comment on this as it is outside of CAST's technical scope. |
| 4 | Fit reversing warning system and reversing camera with night time override. | This will be evaluated as part of the final testing. |
| 5 | Fit blind spot camera system including side cameras and reversing camera with display for driver. | This will be evaluated as part of the final testing. |
| 6 | Fit ruggedized IP rated fixed focal length camera system to water jets including individual view screens for each cannoneer, front mounted rotate pan and tilt variable zoom camera with controller at the commander's seat position and rear wide angled camera, all cameras to be viewable (if selected) from the commander's seat. All video feeds to be recorded, solid state hard drive spec to be finalised. | This will be evaluated as part of the final testing. In addition CAST will review the technical specification once available prior to installation. |
| 7 | Installation of up rated public address system – specification to be finalised but will be equivalent to as a minimum the <redacted> | This will be evaluated as part of the final testing. In addition CAST will review the technical specification once available prior to installation. |
| 8 | Spray vehicle - colour to be advised. | Cannot comment on this as it is outside of CAST's technical scope. |

| No. | Proposed Modification | CAST Comment |
|---|---|---|
| 9 | Fit half Battenberg livery.<br>Fit orange chevron livery on rear of vehicle.<br>Fit aerial identification marker to roof.<br>MPS markings; Police, tyre pressures etc. | Cannot comment on this as it is outside of CAST's technical scope. |
| 10 | Change all German labels to read English. | This will be evaluated as part of the final testing. |
| 11 | Supply UK type hydrant adapter and key. | This will be evaluated as part of the final testing. |
| 12 | Install mechanical throttle limiter to pump engine to ensure that pump pressure cannot exceed 16 Bar. | This will be evaluated as part of the final testing. In addition CAST will review the technical specification prior to installation. |
| 13 | Removal of 20 Bar pressure switch, additives mixture controls, rear water jet control from commander's control console and blanking of these. | This will be evaluated as part of the final testing. |
| 14 | Removal of rear water jet and blanking of water outlet from pump engine to prevent use. | This will be evaluated as part of the final testing. After reviewing the WaWe9 this is achievable. This information will be passed to the MPS for action. |
| 15 | Modify the lower angle for the two forward facing water jets. | This will be evaluated as part of the final testing. On inspection of the WaWe9 this is achieved by adjustment of a micro switch and is achievable without significant effort. This information will be passed to the MPS for action. See section 3.3. |
| 16 | Modification to exhaust system in compliance with emission regulations (London Low emission zone). | Cannot comment on this as it is outside of CAST's technical scope. However these changes must be completed before any further testing is conducted on the vehicles. |

| No. | Proposed Modification | CAST Comment |
|---|---|---|
| 17 | Installation of a 'black box' recorder to record the pressure selected by the commander and also the pressures selected by the cannoneers. | It could be feasible to install a recording system to record the pressure selected by the commander (direct link from the digital pressure gauge on the commander's control console). In addition it should be possible to record the pressure selected by the cannoneers on separate channels. This would provide an audit of pressure selected. By time/date linking this to the video recording from the water jet cameras and the commander's cameras, this would give an audit trial for pressure used and duration of spray. This cannot be designed and assessed until the vehicles are in the possession of the MPS. |

*Table 2 – Proposed modifications by MPS to WaWe9*

## 3.3 Recommendation Paragraph 20

"The water jets produced by the WaWe 9 are capable of engaging people at considerably closer distances (and potentially with greater force) than those produced by the Somati RCV 9000. Since close proximity to the jets is likely to increase the risk and severity of injury, it is recommended that the implications of this design difference are thoroughly characterised and understood."

### *3.3.1 CAST Response*

This has already been identified as a significant difference between the PSNI Somati and WaWe9s and can be addressed as follows.

It has been determined that the angle of the WaWe9 water jets are controlled via an electric motor with limit switches for the upper and lower angles. Currently when the water jets are in their lowest operating position, the downward angle is approximately <redacted>. This will be adjusted by movement of the lower limit switch to set a maximum downward angle of approximately <redacted>, as shown in figure 2.

*Figure 2 - <redacted>*

These changes will be made once the vehicle is in the UK and will be confirmed as part of the final testing.

## 3.4 Recommendation Paragraph 21

"Some general characteristics of the WaWe9 vehicle itself should be established and compared to the Somati model. These include: determining the areas of restricted visibility from the cab, the turning circle, stopping distance of the vehicles in dry and wet conditions, and the effectiveness of any physical countermeasures designed to impede the ability of protesters to climb onto the vehicles."

### *3.4.1 CAST Response*

In conjunction with the substantive differences already noted (see section 3.1, table 1) and also the planned modifications (see section 3.1, table 2), some general characteristics of the WaWe9 were noted during the visit in response to this recommendation.

The further information and observations gathered are outlined below:-

- The area around the front of the cab (driver's and commander's view) is covered by 4 blind spot mirrors, which enables the driver and commander to see directly in front of, and down the sides of, the vehicle. The front windscreen has three wiper blades attached to motors at the bottom of the screen, at rest these wipers sit vertically.
- The "A" pillar at each side of the screen causes a certain amount of obstruction of vision to both the driver and commander when seated, however, with slight movement of the head it is possible to see round this for the driver and the commander has the ability to move further if required.
- The turning circle of the vehicle according to the original vehicle specifications is 18.4m. A quick test was conducted whilst in Germany using one of the water cannons and the turning circle was approximately 21m. The vehicle specification of the turning circle is probably calculated from the vehicle's dimensions; in addition, the speed at which the turn was conducted may affect the measured value that CAST obtained.
- The stopping distances of the vehicles in varying conditions were not assessed. However, as part of the vehicle licensing requirements the effectiveness of the brakes will be tested.
- <redacted>

Responses to this recommendation will need to be reassessed during the final testing, following the planned modifications by the MPS.

## 3.5 Recommendation Paragraph 22

"The public address system of the WaWe 9 should be of comparable efficiency to, or better than, that of the Somati RCV 9000. This system is used to warn of the imminent use of water cannon and hence provides an opportunity for people to disperse voluntarily."

### *3.5.1 CAST Response*

The existing PA system on the WaWe9 is currently in use by the Germans and links into their radio systems. The quality and audibility of this system has not been formally tested, but a simple listening test suggests the intelligibility appears to be good.

**However, it is recommended that this system be replaced with a system of similar specification to the system installed on the <redacted> and this system will then be assessed.**

## 3.6 Recommendation Paragraph 23

"The peak forces and pressures developed by the WaWe 9 rear-mounted water cannon jet should be measured to provide an indication of the effects of this facility (which is absent from the Somati RCV 9000) and its operational role should be clarified."

**NOTE**: It is CAST's understanding that the Water Cannon Project Board has decided to remove use of the rear water jet completely, in line with current operational guidelines.

### *3.6.1 CAST Response*

**On investigation of the WaWe9 and in discussion with the German mechanics, it has been determined that it is feasible to remove the rear water jet, blank off the outlet from the pump engine and remove the control system from the commander's console.**

## 3.7 Recommendation Paragraph 29

"Consideration should be given to the ergonomics of the operating area, the working conditions of the crew and to the risk of injuring police officers standing close to the device when it is operated."

### *3.7.1 CAST Response*

Certain aspects of this recommendation will be addressed via training, guidelines for use and risk assessments undertaken by the police and the College of Policing.

However, the UK team conducted a visual assessment whilst in Germany and their observations are noted below:-

- The driver's seat has range of motion to improve comfort of driving position and is air sprung. The seat has a standard 3 point seat belt.
- The commander seat has range of motion and is air sprung. In addition it has arm rests on both sides. The seat has a standard 3 point seat belt
- The loggist's seat sits slightly higher than the driver and commander seats and has slightly limited leg room, although when tried this was not seen as an issue. This seat has a body harness style seat belt.
- The cannoneers' seats have a full range of motion to aid comfort and have integrated 3 point seat belts. In addition, they have arm rests on both sides. All seats have adjustable head rests.
- There are air blowers for hot and cold air around the cab, which are controlled from the driver's seat.
- There is an air conditioning unit at the rear of the cab. However, the effectiveness of this unit is unknown.
- <redacted>
- There is internal lighting – one light at the front of the cab and one on each side of the cab. There is a map reading light by the commander seat.
- The windows are opened manually.
- The noise level in the crew cab whilst the vehicle/pump engines are operating was acceptable. However, this will be evaluated fully in the final testing.
- There is a windscreen washer fluid container inside the cab.

- The cannoneers' control panels adjust for height and tilt. Their chairs rotate with the water jet that they are controlling. <redacted>
- There is a rear view window for each cannoneer but the view is only straight ahead across the roof of the vehicle.

It is planned that the vehicles will be modified with the inclusion of view screens for the commander, the driver and the cannoneers. This should reduce the risk of injuring police officers standing close to the device when it is operated, by increasing the crew's visibility of them.

The planned modifications may alter the internal layout of the vehicle, so the layout and usability of the vehicle will need to be reassessed during the final testing.

# 4. Appendix A - Trial Protocol

# Trial Plan

**<redacted>**

**Purpose**

Evaluation of the output forces generated by the water jets from the WaWe9 water cannon (WC) in comparison to the forces from the PSNI Somati WC currently in use in Northern Ireland.

Gathering of additional information to support MPS' and CAST's responses to recommendations from the SACMILL Interim Statement 18th November 2013.

**Test Equipment**

- Home Office water cannon test rig
- <redacted> pressure Mat system
    - Covered by 3 layers of plastic sheet
- Laptop computer
- Tape Measure
- Stop watch
- Video/stills camera

**Test Plan**

Each individual water cannon will be tested. Both forward facing water jets for each cannon will be tested using the following protocol:

Test protocol – forward facing water jets

1. Place the water cannon test rig, with the <redacted> pressure mat mounted on the 400mm load plate, <redacted> from the front of the water cannon (central point on the front bumper)
2. Set the commanders pressure to 16 Bar and the cannoneer percentage to 100%
3. Target the centre of the pressure mat
4. Start the pressure mat system in preview mode
5. Start the water, when the computer operator identifies the water is hitting the central area of the pressure mat, start recording the data for 20 seconds
6. Signal the cannoneer to stop the water
7. Review the data against the data from the PSNI Somati WC for:
    a. Maximum pressure (kPa)
    b. Maximum average pressure (kPa)
    c. Maximum estimated contact area
    d. Maximum estimated force (N)

8. **If** the results are higher, adjust water pump engine revs to find the value at which the data captured is the same as, or is very similar to, that of the maximum output pressure of the PSNI Somati WC <redacted>
9. Record this value and repeat the process for three sets of data
10. Evidence the position at which the throttle has to be set.
11. **If** the results are lower than that of the PSNI Somati WC, repeat step 2 to 6 with the commanders pressure set to 20 Bar and the cannoneer set to 100%
12. Review the data against the data from the PSNI Somati WC for:
    a. Maximum pressure (kPa)
    b. Maximum average pressure (kPa)
    c. Maximum estimated contact area
    d. Maximum estimated force (N)

**AS REQUIRED**

13. **If** the results are lower, repeat test to get three sets of data
14. **If** the results are higher, adjust water pump engine revs to find value at which the data captured is the same as (or very similar to that) of the PSNI Somati WC.
15. Record this value and evidence the position at which the throttle has to be set.

Additional Actions to be carried out (1 vehicle only)

1. Check for obvious differences between the WaWe9 and the PSNI Somati WC (recommendations 19 & 21)
2. Determine angle for water jets to ensure contact distance <redacted> (recommendation 20)
3. Investigate restriction of view from Cab and note (recommendation 21)
4. Ability to disconnect rear water jet and disable any controls (recommendation 23)
5. Investigate feasibility of ‘black box’
6. PA system (recommendation 22)
7. Visual inspection of ergonomics of cab (recommendation 29)
8. Measure turning circle (if time permits) (recommendation 21)

# 5. Appendix B - Pressure Mat Screen Shot

The following is a typical screen shot of the pressure mat showing the individual elements and a visualisation of the pressure being applied to the mat by the water jet.

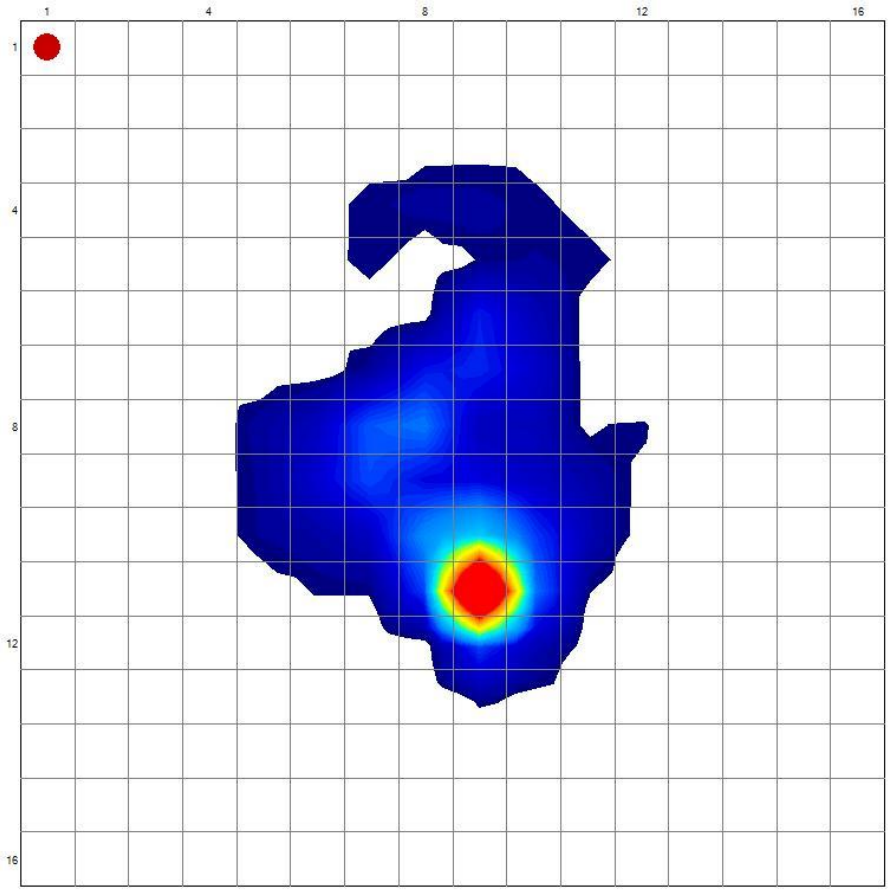



*Figure 3 – A typical screen shot from the pressure mat*

# 6. Appendix C – Test Results

The two forward facing water jets on each of the three water cannons were tested. Data was recorded for 20 seconds for each water jet and this was repeated three times.

Left hand side (LHS) and right hand side (RHS) are denoted as viewed from the driver's perspective.

Peak = highest recorded reading during the 20 seconds in any element of the array (within the contact area)

Average = mean of average pressures applied to the pressure mat in a single frame over a 20 second period.

| Vehicle 1 <redacted> | **16 bar 100% RHS test 1** | **16 bar 100% RHS test 2** | **16 bar 100% RHS test 3** | **16 bar 100% LHS test 1** | **16 bar 100% LHS test 2** | **16 bar 100% LHS test 3** |
|---|---|---|---|---|---|---|
| **Average Pressure (kPa)** | 27.1 | Error in data recording | 24.9 | 12.3 | 14.7 | 14.0 |
| **Peak Pressure (kPa)** | 877.5 | Error in data recording | 878.6 | 880.3 | 210.4 | 691.1 |
| **Average contact area (cm^2)** | 453.5 | Error in data recording | 309.3 | 519.1 | 743.8 | 604.0 |
| **Peak Force (N)** | 2631.2 | Error in data recording | 2172.0 | 2053.7 | 1851.2 | 1818.2 |
| **Average force (N)** | 1212.0 | Error in data recording | 757.9 | 673.2 | 1096.4 | 859.40 |

*Table 3 – Results from WaWe9 WC vehicle 1 registration <redacted>*

| Vehicle 2 <redacted> | **16 bar 100% RHS test 1** | **16 bar 100% RHS test 2** | **16 bar 100% RHS test 3** | **16 bar 100% LHS test 1** | **16 bar 100% LHS test 2** | **16 bar 100% LHS test 3** |
|---|---|---|---|---|---|---|
| **Average Pressure (kPa)** | 12.8 | 13.8 | 23.7 | 20.1 | 22.6 | 21.1 |
| **Peak Pressure (kPa)** | 765.1 | 882.5 | 877.4 | 696.8 | 877.1 | 878.5 |
| **Average contact area (cm^2)** | 1560.8 | 1712.3 | 459.3 | 582.8 | 515.3 | 474.8 |
| **Peak Force (N)** | 3259.2 | 3719.6 | 2509.3 | 2136.7 | 2368.4 | 2200.3 |
| **Average force (N)** | 1993.9 | 2353.7 | 1084.1 | 1172.3 | 1157.2 | 999.4 |

*Table 4 – Results from WaWe9 WC vehicle 2 registration <redacted>*

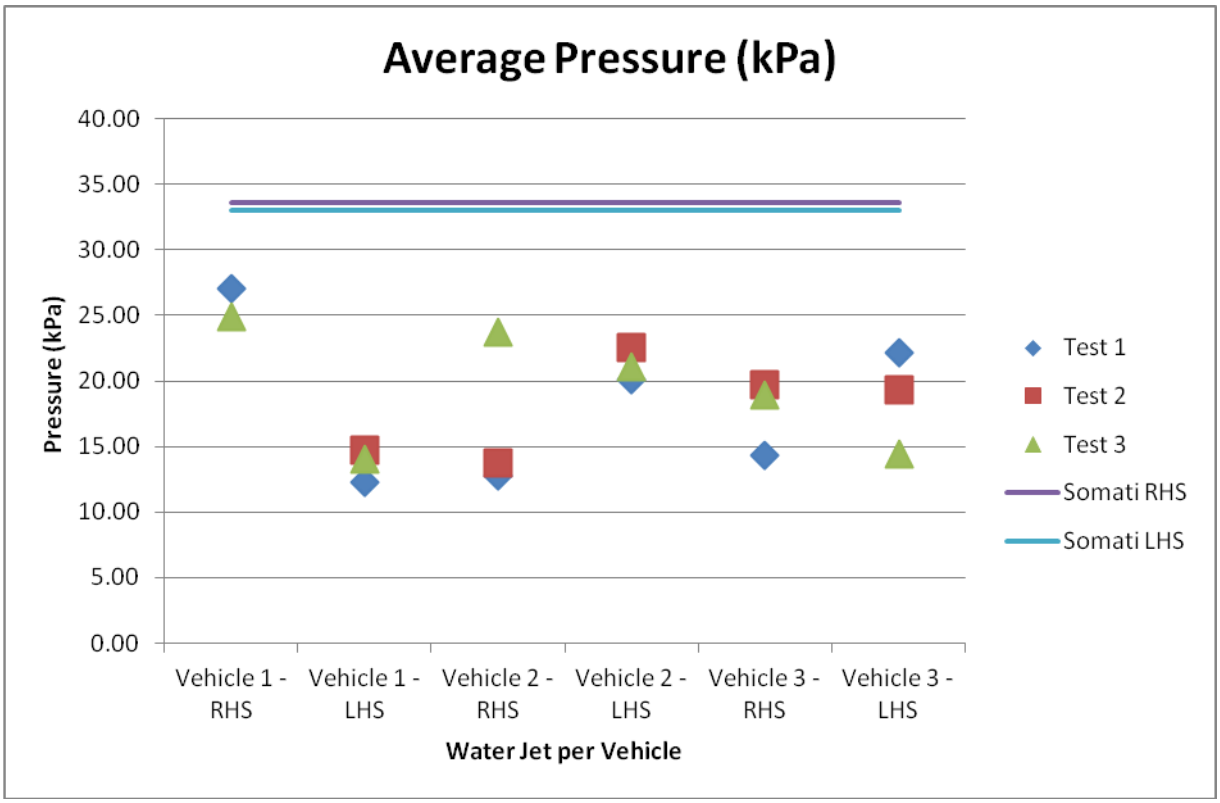
| Vehicle 3 <redacted> | **16 bar 100% RHS test 1** | **16 bar 100% RHS test 2** | **16 bar 100% RHS test 3** | **16 bar 100% LHS test 1** | **16 bar 100% LHS test 2** | **16 bar 100% LHS test 3** |
|---|---|---|---|---|---|---|
| **Average Pressure (kPa)** | 14.3 | 19.7 | 18.9 | 22.1 | 19.3 | 14.5 |
| **Peak Pressure (kPa)** | 882.5 | 564.2 | 658.9 | 879.5 | 877.8 | 252.1 |
| **Average contact area (cm^2)** | 1626.4 | 522.5 | 374.6 | 462.3 | 326.0 | 348.9 |
| **Peak Force (N)** | 3388.2 | 1946.4 | 1566.6 | 2193.2 | 1778.1 | 1165.8 |
| **Average force (N)** | 2328.2 | 1025.8 | 701.8 | 1015.1 | 641.3 | 504.5 |

*Table 5 – Results from WaWe9 WC vehicle 3 registration <redacted>*

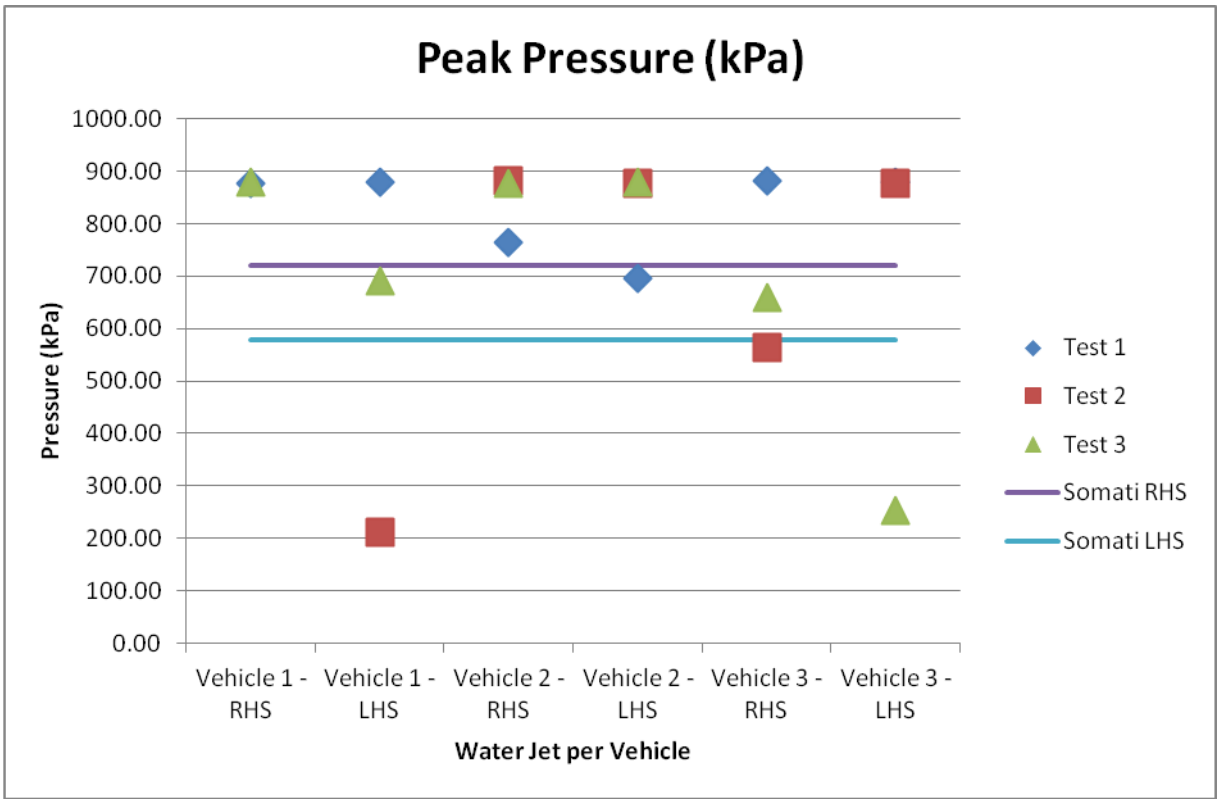
| PSNI Somati | **PSNI Somati RHS 15Bar 100%** | **PSNI Somati LHS 15Bar 100%** |
|---|---|---|
| **Average Pressure (kPa)** | 33.6 | 33.0 |
| **Peak Pressure (kPa)** | 719.4 | 577.5 |
| **Average contact area (cm^2)** | 344.1 | 537.3 |
| **Peak Force (N)** | 1947.3 | 2047.9 |
| **Average force (N)** | 1163.3 | 1769.8 |

*Table 6 – Results from PSNI Somati WC*[5]

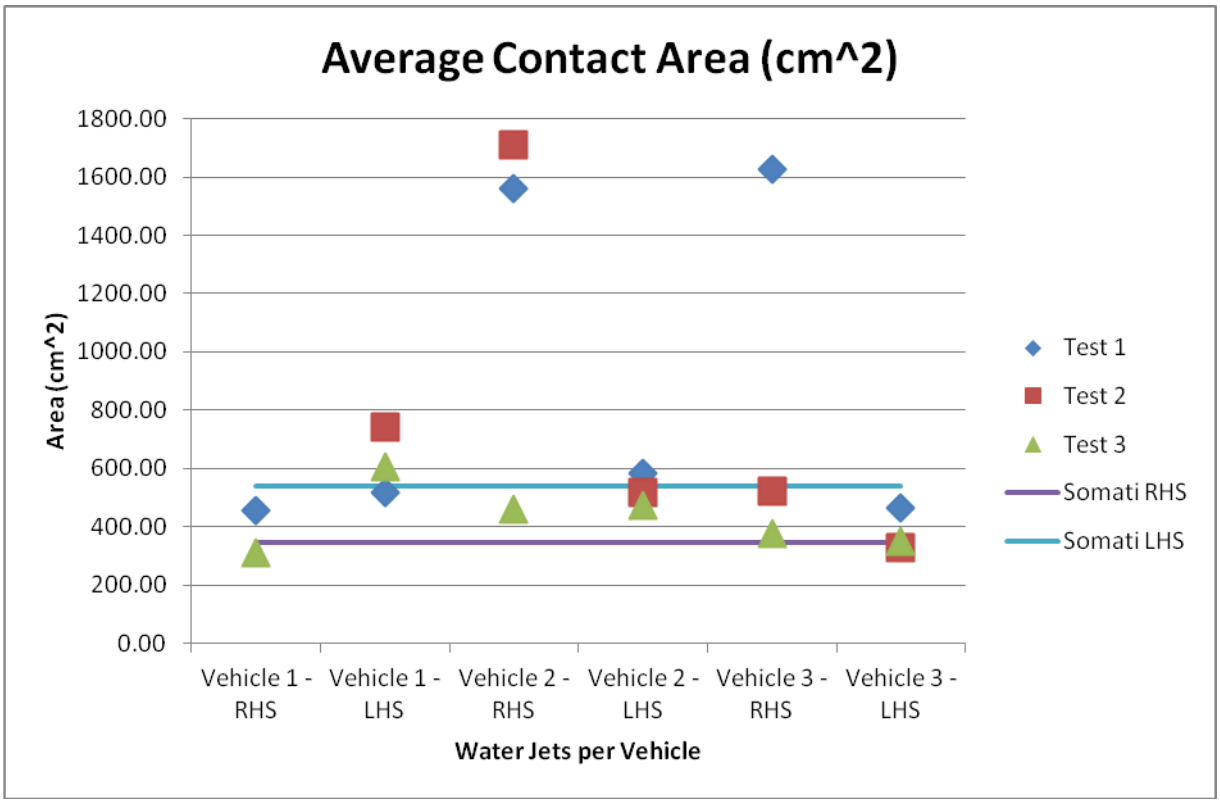
[5] Testing was conducted using a sampling rate of 25 frames per second WaWe9 was conducted using a sampling rate of 500 frames per second




*Graph 1 - Average measured target pressure comparison for WaWe9 and PSNI Somati*

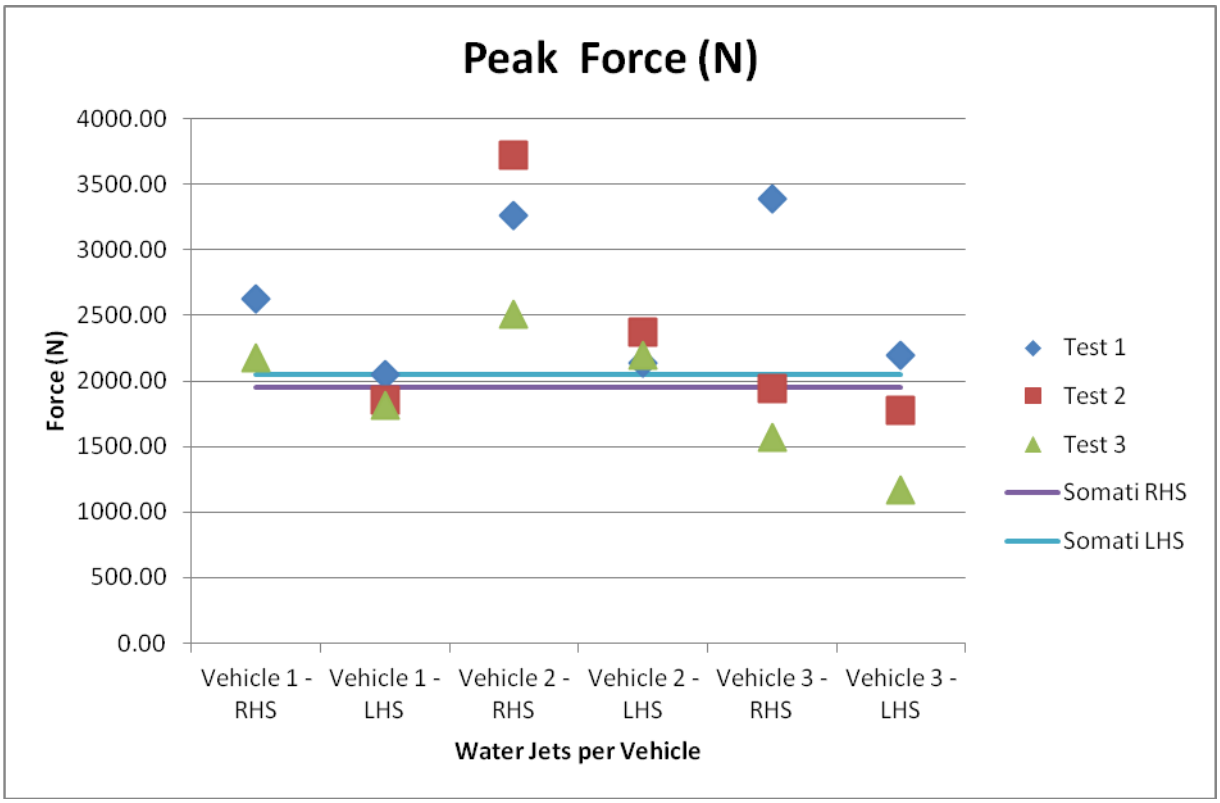



*Graph 2 - Peak target pressure comparison for WaWe9 and PSNI Somati*

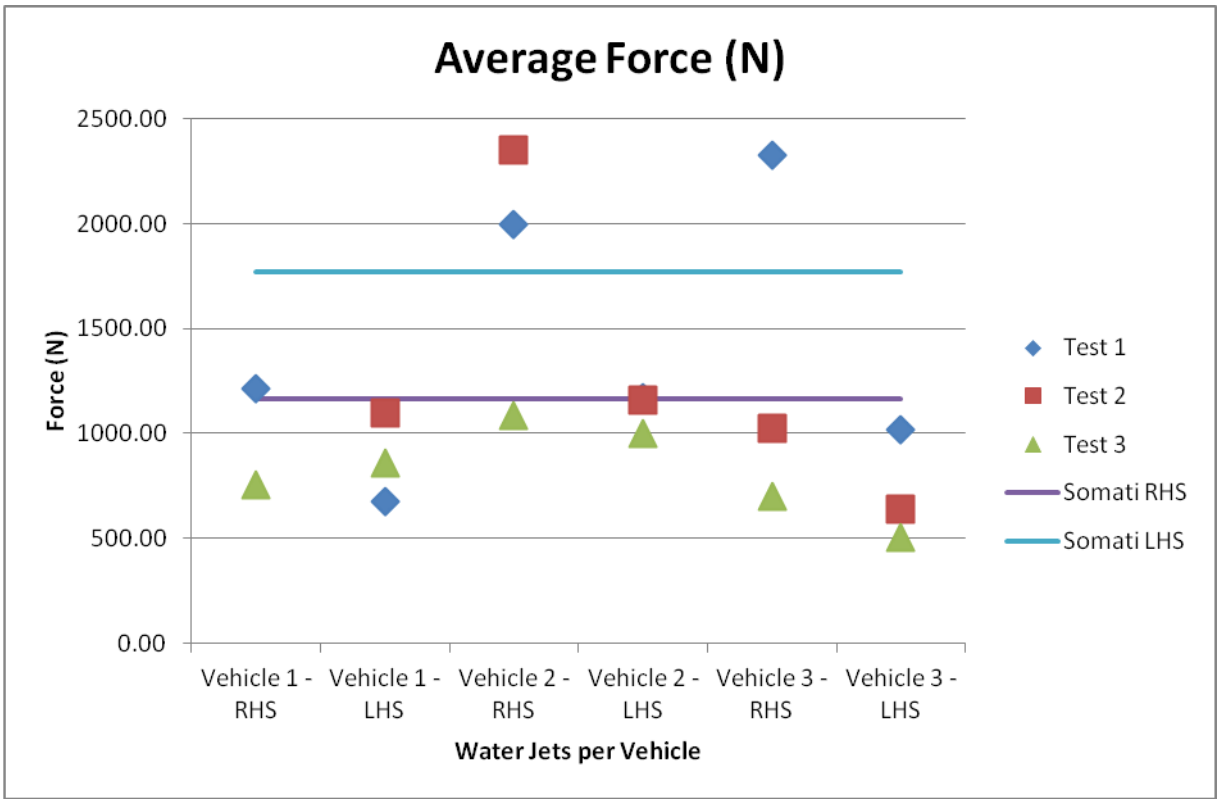



*Graph 3 - Average contact area comparison for WaWe9 and PSNI Somati*

**NOTE:** The three high outlying results are believed to be erroneous results due to water building up on the pressure mat. Modification will be made which will ensure that future testing does not have this effect. The same outlying results can be seen in the average force and peak force.




*Graph 4 - Peak measured target force comparison for WaWe9 and PSNI Somati*




*Graph 5 - Average measured target force comparison for WaWe9 and PSNI Somati*