Biomedical assessment of vehicle mounted water cannon

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Dstl/TR08627 V2.0
28 April, 2004

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Executive Summary

The Northern Ireland Office and the Home Office have requested an independent opinion on the medical implications of the use of vehicle mounted water cannon in public-order incidents. The DSAC sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL) has been requested to provide this opinion. On behalf of DOMILL, Dstl Biomedical Sciences has undertaken a programme consisting of the review of the published information from a wide range of sources on the reported incidence world-wide of injuries from jets of water from water cannon, and tested two different designs of water cannon to assess the medical implications of their use. The types of water cannon tested have been the Mol CY NV MSB18 (owned by the Belgian Federal Police, but loaned to the Police Service of Northern Ireland – PSNI) and the Somati RCV 9000 (purchased by the PSNI). This is believed to be the first assessment programme of its kind, despite extensive use of water cannon by police and other agencies in many other countries. The results of the review and testing were then compared against the operational guidance to determine the medical implications of the water cannon use.

There were no fatalities reported in the literature that were directly attributable to the impact of the jet in public order situations. The overall reported frequency of serious injury was very low.

The first four Somati RCV 9000 Water Cannon were tested by Dstl in February 2004 and the comparison of the results from these tests with earlier tests on the Mol vehicles was published in Version 1.0 of this report. This earlier report resulted in the production of a medical statement by DOMILL. Version 2.0 of this report covers the results in Version 1.0, with the addition of results from the testing of the fifth and sixth production vehicles. Both the Somati and the Mol water cannon showed similar injury causing potential, although this risk can be mitigated by appropriate training. No amendments to the existing medical statement are recommended, however, review of the training should still be undertaken. Any changes to the equipment, policy or guidance should result in review of the applicability of the medical statement. It is not believed that the Somati RCV 9000 vehicle mounted water cannon will result in serious or life threatening injuries when used within ACPO Guidance.

Table of Contents

List of figures

List of tables

1 Introduction

1.1 Recommendations 69 and 70 of The Report of the Independent Commission on Policing for Northern Ireland [1] state:

'We recommend that an immediate and substantial investment be made in a research programme to find an acceptable, effective and less potentially lethal alternative to the PBR' (Plastic Baton Round).

and

'We also recommend that the police be equipped with a broader range of public order equipment than the RUC currently possess, so that a commander has a number of options at his or her disposal which might reduce reliance on, or defer resort to, the PBR.'

1.2 A Steering Group has been formed to address these recommendations and the alternative approaches to the management of conflict. Work has been carried out under the auspices of this Steering Group to recommend public order equipment that may address the issues raised in Reference 1, and the following technologies have been selected as worthy of further investigation [2]:

a. *Medium and Long Range Devices (kinetic energy rounds and discriminating chemical delivery devices/rounds)*

b. *Water cannon*

c. *Tasers*

d. *Laser/Light Devices*

e. *Noise Generating Devices*

1.3 As part of the possible introduction of these technologies into service to support conflict management strategies, it is necessary to define suitable equipment and produce guidance to the users that underpins their operation. The use of these devices is to be examined within the bounds of the Strategic Audit Framework [2] to ensure that the use of the equipment will comply with all of the necessary legal, ethical and societal requirements and expectations. The framework includes a review of the medical implications of the equipment to enable policy makers and users to undertake risk assessments of operational use and make judgements of proportionality to the threat.

1.4 The review process may include an assessment of the use of the equipment with other operators, the use of comparable equipment or the review of medical issues/reported injuries associated with similar equipment or technologies. The medical review will also consider any injury mitigation within the guidance for users, such that the overall hazards and risks may be considered. This allows a medical statement to be produced that will

advise on the risk if the equipment is used within defined operational guidance and policy.

1.5 This report covers the technical steps that have been taken in drawing together the information for submission to the DSAC[1] Sub-committee on Medical Implications of Less Lethal Weapons (DOMILL) for the use of the Somati RCV 9000 vehicle mounted water cannon. This vehicle was recently purchased by the Police Service of Northern Ireland as a replacement for the Mol CY NV MSB18 (loaned from the Belgian Federal Police). The Somati water cannon is a new design with no history of operational use. The independent medical statement is an essential aspect of the decision by Ministers to authorise deployment of water cannon in Northern Ireland and Great Britain as part of a conflict management strategy.

[1] DSAC – Defence Scientific Advisory Council

2 Process

2.1 Initial statement

2.1.1 In early 2002, DOMILL was requested to produce an interim statement on the medical implications of use of the Mol CY NV MSB18 water cannon. This statement was part of the evidence provided to Ministers to enable deployment in Northern Ireland during the Summer of 2002. The statement was based upon an expedient review of the literature (dictated by timescales) and the extant Guidance to the PSNI on the use of water cannon [3]. Little evidence was available in the technical literature on the direct effects of water cannon, so the search of the technical journals was expanded to include industrial processes that included human contact with high pressure water jets (usually accidents), medical reports of hydraulic injuries, children's toys, surgical equipment, meat processing equipment and crowd control devices produced within other programmes. The review also included newspaper, magazine and Internet reports relating to the use of water cannon. The review was conducted by Dstl Biomedical Sciences on behalf of DOMILL.

2.1.2 The principal conclusions of the review were:

- There were no reported fatalities arising directly from the impact of the water jet from diverse water cannon in appropriate operational use.
- There were very few reports of injuries that could be classified as life threatening, that could be directly attributable to water cannon.
- The PSNI, Belgian and German Police had not reported any instances of serious or life-threatening injuries that could be attributed to the Mol MSB or German Ziegler water cannon either during operational use or training.
- There was ambiguity regarding the reporting of injuries from public order incidents where the injuries may have been caused by other equipment, such as batons, kinetic energy projectiles or irritants, and not directly from water cannon.
- The behaviour and structure of a water jet is complex and it is not possible to calculate the effective dynamic loading on the human body; direct measurement of the forces from a jet is required.
- The PSNI Guidance should reinforce that there is an enhanced risk of injury under certain circumstances.

2.1.3 This review was presented to DOMILL and an interim medical statement was produced [4 and reproduced in Appendix A]. The statement was issued into the public domain and presented to Parliament [5]. The statement recommended that the following factors should be determined to an approved technical plan:

a. measurement of the gross fluid output of both the Mol CY NV MSB 18 water cannon, and the new water cannon proposed to be procured by the PSNI;

b. definition of the biologically effective loading within the jets;
c. measurement of the contact velocity and acceleration of the head with a rigid object such as a wall or the ground;
d. measurement of the initial linear and rotational acceleration of the head/neck assembly following direct or sweeping interaction of the jet with the head, and with the torso;
e. the distribution of representative debris accelerated by the cannon directed to the ground, and the possibility of specific injuries such as ocular trauma;
f. the risk of primary injury to the torso and head assessed using computer or physical models.

2.2 Activities since interim medical statement

2.2.1 Following the interim medical statement, a business case was formalised for the purchase of six vehicle mounted water cannon for the Police Service of Northern Ireland. A competitive tender process was undertaken that assessed two vehicle types; the successful bidder was Somati based in Belgium, with their submission of the RCV 9000 vehicle. This is a new vehicle design (Somati are experienced fire tender and crash vehicle manufacturers).

2.2.2 One of the constraints on the purchase of vehicles would be a medical assessment against a set of operators' guidelines/instructions and policy. This medical assessment required testing to assess the aspects raised in Section 2.1.3 of this report. These tests were also undertaken on the vehicles on loan to the PSNI, since they had a known pedigree of use and could be used as a baseline. These loaned vehicles were the Mol CY NV MSB18 (or Mol MSB18, for short).

2.2.3 Testing of the Mol MSB18 water cannon was undertaken by Dstl in October 2002 at Sprucefield in Northern Ireland and the results are reported in Reference 6. This work showed that it was possible to produce serious injury as a result of direct impact of the jet, however this risk could be mitigated by training and appropriate guidance to users.

2.2.4 The testing on the Mol MSB18s used:

- a specifically designed force plate rig to determine the loading/pressure profile of the water jet and the potential injury risk;
- a Hybrid III automotive impact dummy to assess the injury potential from the jet;
- a thoracic injury rig to assess the possibility of non-penetrating (internal) organ injury (the Dstl Behind Armour Blunt Trauma rig), and
- representative debris to assess the potential hazards of blunt or penetrating trauma, particularly to the eye.

In particular, the thoracic rig was used to assess whether any thoracic displacement pattern of injuries could be predicted and the gravel was used to determine whether debris could be lifted off the ground and projected with sufficient residual energy to cause injury.

2.2.5 Similarly, as the Somati RCV 9000 Vehicles 001 and 002 completed production, they were tested to broadly the same technical plan as the Mol MSB18. These tests took place in early September 2003 and were led by Dstl staff. The only differences between the two evaluations were:

- the Dstl Behind Armour Blunt Trauma rig was not used for the Somati vehicle, because it failed to show any potential for injury in the trials on the Mol MSB18 that would not be found using the Hybrid III dummy,
- gravel picked up in the jet from the break-up of the surface of the test area was assessed in the Somati trials, rather than introducing a specified gravel – the practice with the Mol.
- the control system for the water delivery system was examined in greater detail for the Somati vehicle because direct access was obtained to the designers and manufacturers.

2.2.6 A report on Dstl's testing of Somati Vehicles 001 and 002[2] was produced [7]. This made similar conclusions to the Mol trials report [6], that it was possible to produce serious injury if used inappropriately. However, additional recommendations were also stated regarding the calibration of sensors, the sensitivity of the control system and the necessity to test the equipment after a period of use.

2.2.7 The experimental data and a further review of published information was used as the basis for a second DOMILL statement that specifically addressed the Somati RCV 9000 vehicle.

2.2.8 Subsequent to the initial testing, further acceptance trials by the PSNI identified problems with the two Somati vehicles, notably:

- The failure of the design to meet the specification on the operation of the water jets whilst driving.
- Failure of a rigid coupling between the pump and monitors.
- Water hammer in the pump.

These problems were rectified by Somati and the vehicles were returned to PSNI, but it was decided by Dstl and DOMILL that these vehicles would require re-testing since the modifications involved changes to the water delivery system. The second medical statement was suspended and not issued to Ministers. In late February 2004, Vehicles 003 and 004 were delivered to PSNI, so the opportunity was taken to re-test Vehicles 001 and 002 at the same time as the initial testing of Vehicles 003 and 004. These tests were undertaken on 24th and 25th February 2004 and are reported in Reference 8.

2.2.9 In order to determine whether any additional information was available relevant to the assessment of injury from water cannon, the original review of the medical literature was also updated and re-issued [9], to take account of any new information and experience.

[2] The remaining four vehicles were still in production.

Amendment of this document between Issue 1.0 and 2.0 is discussed in more detail in this report (Section 4).

2.2.10 The Guidance for the use of water cannon has now changed to have applicability across the UK and is under the auspices of ACPO [10 and reproduced in Appendix B]. These new vehicles have been assessed to the ACPO document, rather than the previous RUC (PSNI) Instructions.

2.2.11 This initial programme of assessment and review of the available literature resulted in the production of a medical statement that covered the use of the Somati RCV 9000 water cannon vehicles 001-004 by the Police Service of Northern Ireland within ACPO Guidance. This medical statement was placed in the House of Commons Library on 16 March 2004 [11]. This is also reproduced in Appendix C.

2.2.12 Vehicles 005 and 006 were delivered to the Police Service of Northern Ireland in late April 2004 to apply the finishing details and acceptance testing. Dstl took the opportunity on 27th April 2004 to test these vehicles at the public order training facility at PSNI Sprucefield. These tests were carried out against the Trial Plan used for testing the other four vehicles [8] and have been reported in full in Reference 12.

2.2.13 A more detailed comparison of the Somati and Mol vehicles is given in Section 3 of this report.

3 Comparison of the Mol MSB 18 and Somati RCV 9000 water cannon

3.1 General

3.1.1 The initial tests carried out on the two vehicle designs in 2002 and 2003 were very similar. Both used a Hybrid III crash test dummy and both used a specifically designed force plate measurement rig[3]. The first series of tests (on the Mol MSB 18) also used the Dstl Behind Armour Blunt Trauma (BABT) rig and specially selected gravel.

3.1.2 Overall, both vehicles produced similar results on the Hybrid III dummy. Injury Assessment Reference Values[4] (IARVs) were, on the whole, not exceeded during the water jet impact (the applicability of these may be questioned during long impact), but high loads were witnessed, giving an indication of a risk of producing serious injury (it is not necessary for IARVs to be exceeded to cause injury – they are purely guidelines). IARVs were exceeded during impact of the dummy with the floor or wall, indicating that there is a risk of tertiary impact injury from being thrown by these water jets. These IARVs predicted a risk of head, neck and thoracic injury, which may arguably be mitigated if the person had a brace response (not present in the dummy), although this response may not be relevant in the case of an impact with a wall or object where the reaction time may not be sufficient to provide protection. Cases where the reaction time is slowed due to alcohol or drugs may also make someone susceptible to head impact injury (from tertiary impact).

3.1.3 The testing of Somati Vehicles 001-004 in February 2004, and Vehicles 005 and 006 in April 2004 only used the Force Plate Rig. It was believed that this was the only test that would be sensitive enough to discriminate between the different vehicles and identify any significant changes in the output. There is scatter in the results from the force plate rig, primarily due to the accuracy of aiming and sweeping the jet.

3.1.4 During all tests, the force plate rig showed that at close ranges (less than approximately 25m for the Somati and less than approximately 18m for the Mol) and full pump pressure (15 bar for the Somati; 21 bar for the Mol), the water jet had sufficient energy to produce a local pressure in excess of 1 bar (over a round area of 25mm diameter) (see Figures 1-3 – solid circles). This may cause eye or ear injury. This is similar to the results witnessed during the initial tests on Vehicles 001 and 002 in September 2003 (see Figure 4).

[3] The force plate rig had five different diameter plates (25mm, 50mm, 100mm, 200mm and 400mm). The 25mm plate was designed to represent the presented area of the orbit and the 400mm diameter was designed to represent the biacromial breadth of a 50th percentile male. Other sizes were selected to double the diameter with increasing size.
[4] IARVs are suggested guidelines for assessing injury potential for measurements made with Hybrid III type automotive crash test dummies.

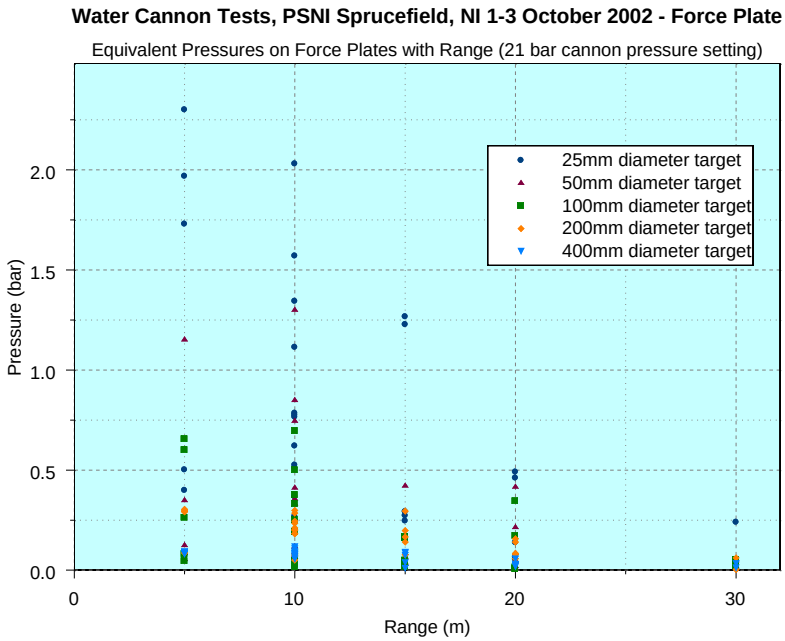

Figure 1: Equivalent pressure against range for Mol MSB18

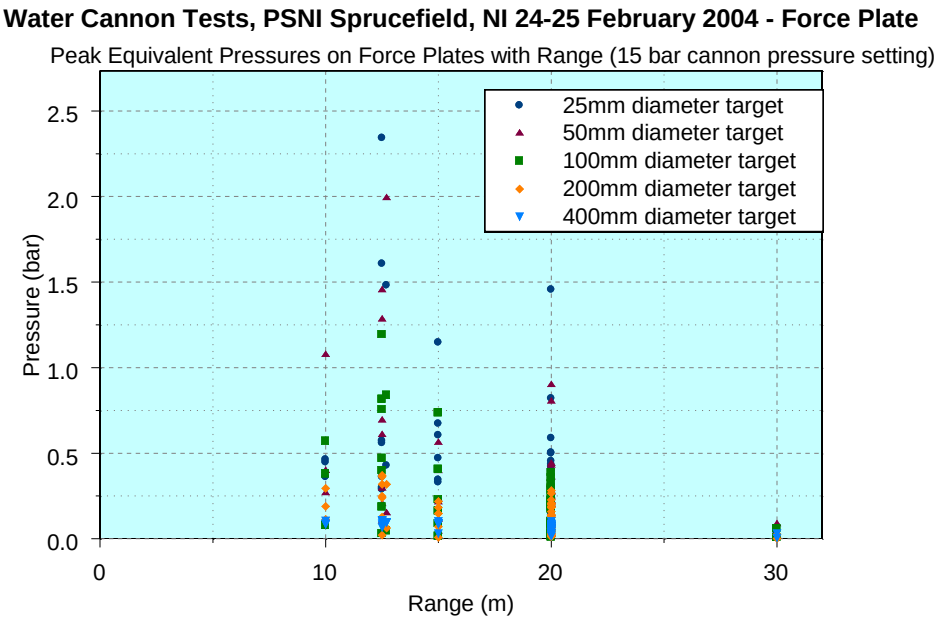

Figure 2: Equivalent pressure against range for Somati RCV 9000 Vehicles 001-004 (Feb 04 Tests)

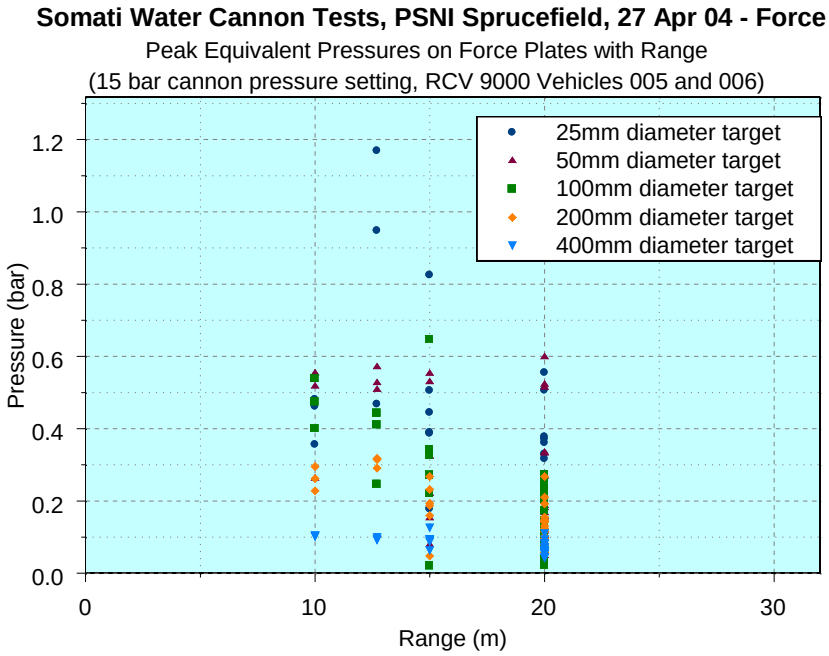

Figure 3: Equivalent pressure against range for Somati RCV 9000 Vehicles 005 and 006 (April 04 Tests)

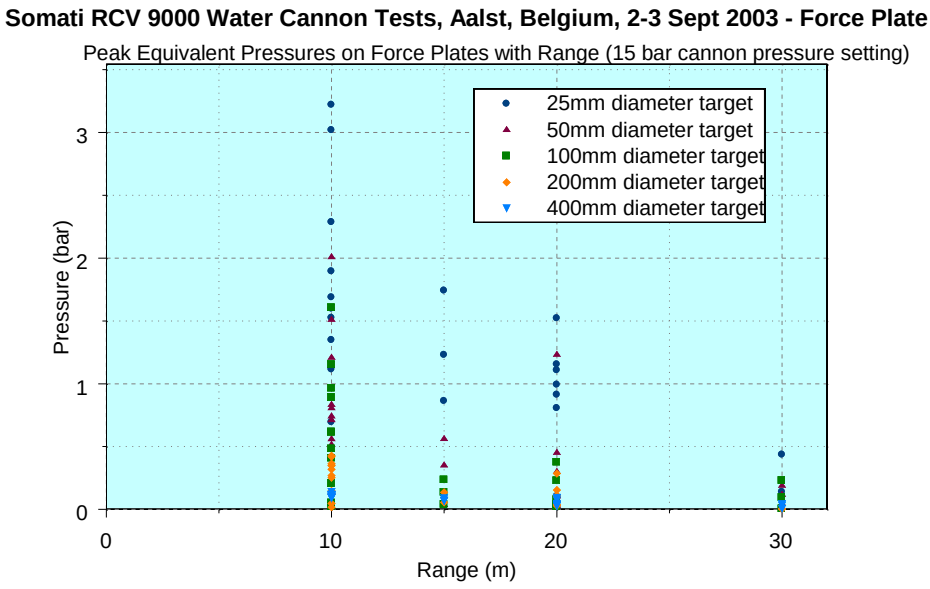

Figure 4: Equivalent pressure against range for Somati RCV 9000 Vehicles 001 and 002 – initial tests (Sept 03)

3.1.5 The force plate tests also showed that the two vehicle designs could produce sufficient force to start to elicit a knock-down of a person and that this would occur before the local pressure exceeded 1 bar (greater than 30m for each vehicle) – see Figures 5-7. This is in agreement with the initial tests carried out on Vehicles 001 and 002 in September 2003 (see Figure 8). Therefore, the results indicate that someone who is subjected to the jet at increasing pressure would be knocked over before eye or ear damage occurs. The rapid introduction of the jet onto a person's head/neck may however mean that the possibility of inducing eye or ear injury exists. This highlights the need to introduce the water jet away from the target's vulnerable area of the head and neck.

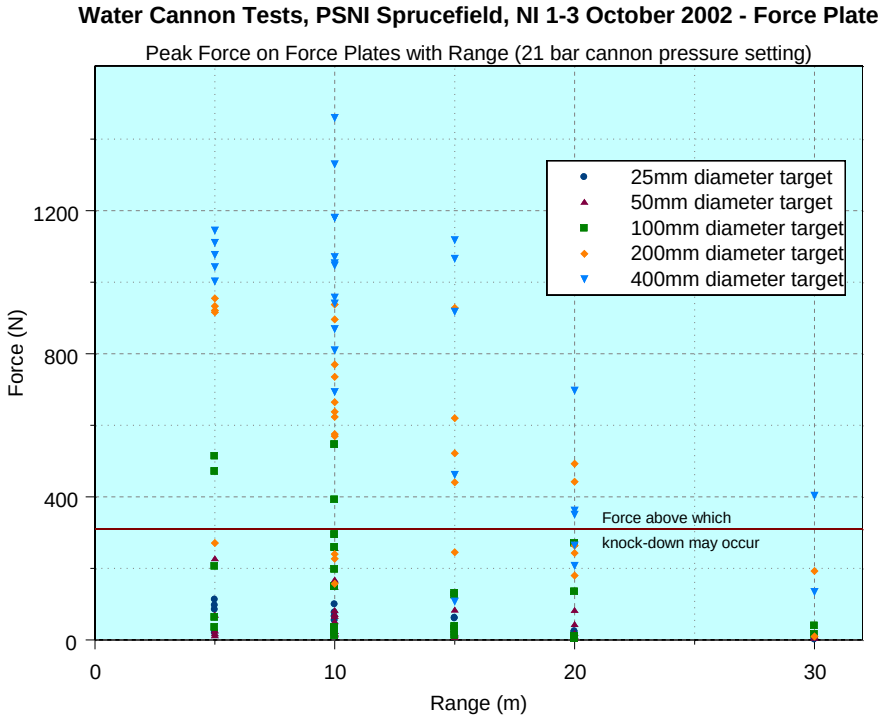

Figure 5: Force against range for Mol MSB 18

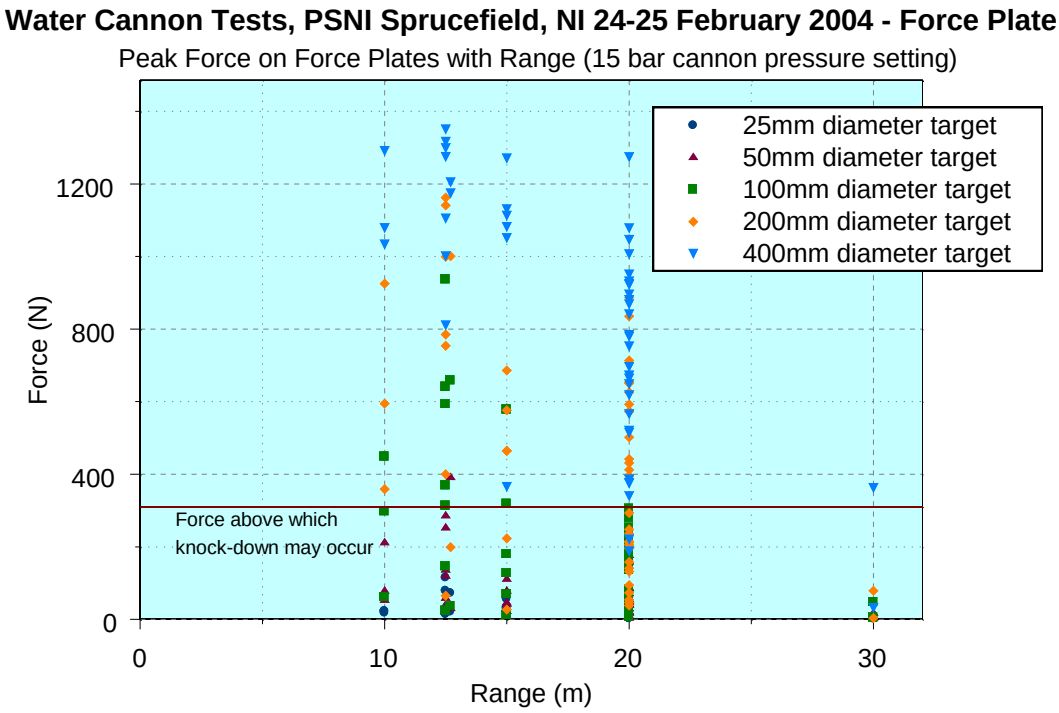

Figure 6: Force against range for Somati RCV 9000 Vehicles 001-004 (Feb 04)

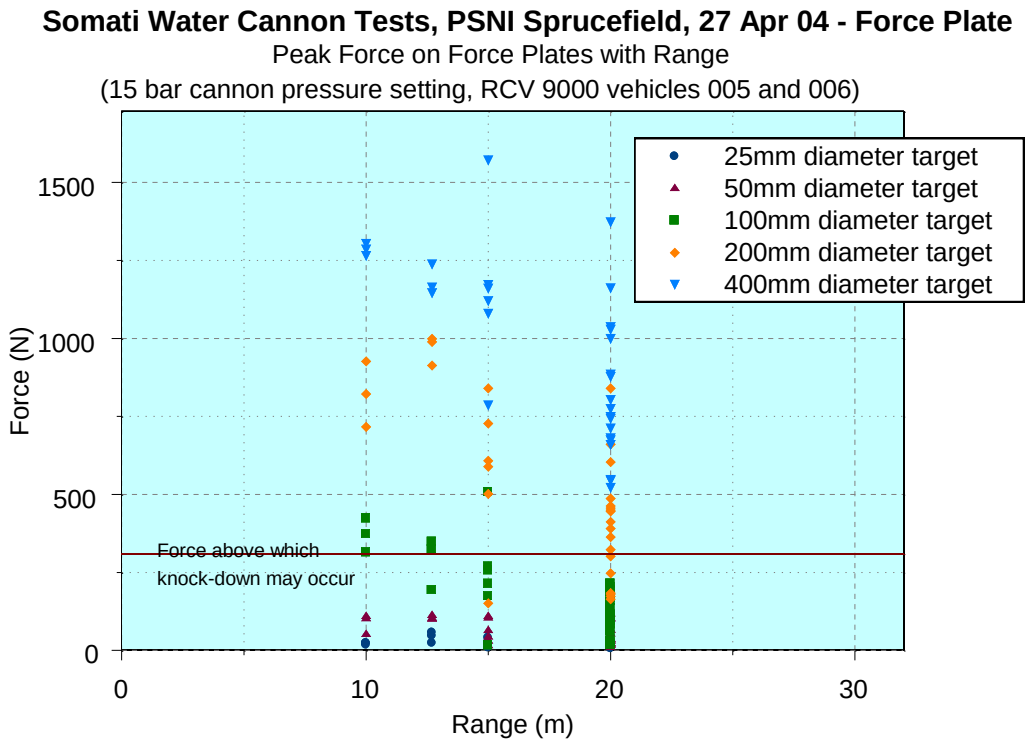

Figure 7: Force against range for Somati RCV 9000 Vehciles 005 and 006 (April 04)

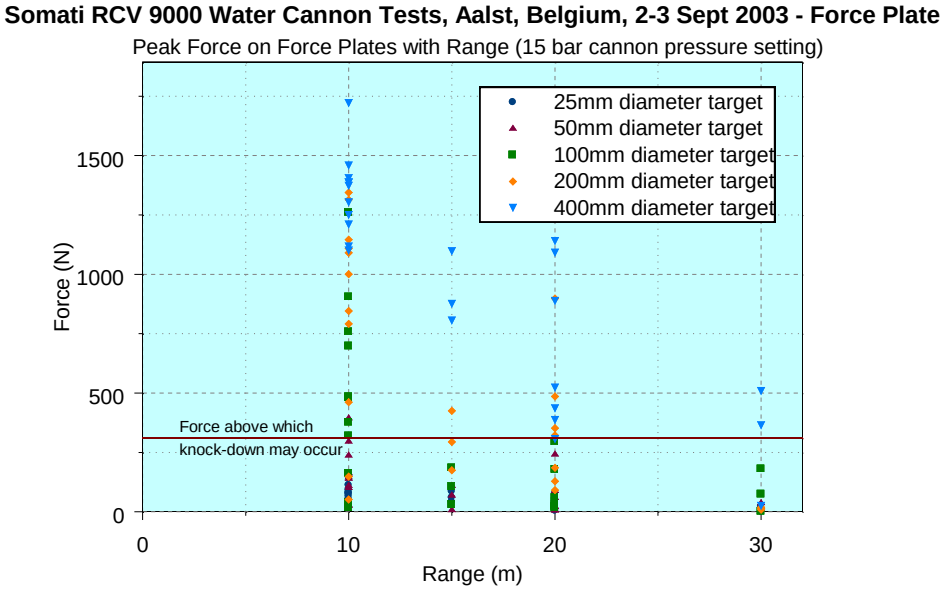

Figure 8: Force against range for Somati RCV 9000 Vehicles 001 and 002 – initial tests (Sept 03)

3.1.6 Comparison of the force incident on the force plate rig and its variation with range (Figures 4-6) also indicated that the Somati vehicle was more powerful. Statistical analysis of this showed that some data did not demonstrate a statistical significance in the difference in a limited number of the results[5]. Since there is no range estimation device on the vehicle, it will be advisable for the guidance to ensure that water jet is introduced in the least injurious manner initially (such as a spray) but this may be constrained by the threat and tactical necessity – discussed in the ACPO Guidance [see Appendix B].

3.1.7 With both vehicle designs against the force plate, no difference was observed between operating with full and low tanks, nor in the force produced by individual vehicles of each type (but insufficient data for rigorous statistical tests). The 'feel' of the control levers was different between vehicles, which may in turn provide different levels of system accuracy (see Section 3.2).

3.1.8 With forces of the order of 1.5kN produced by the water jet, it is possible that weak structures such as a wall may be toppled.

[5] *t*-test carried out to compare the means and standard deviations of comparable sets of data. Statistical significance $p>0.05$ that the results came from the same set of data in 17 out of 20 paired results. Mean of Somati tests was greater than mean of Mol tests in 13 out of 20 paired comparisons (5 targets at each of 10, 15, 20 and 30m). The Somati vehicle during the earlier tests was different to the Mol vehicle – statistical significance in 5 out of 15 paired results (4 out of 5 at 10m (n=23), 0 out of 5 at 15m and 1 out of 5 at 20m (n=12); mean of Somati tests was greater than mean of the Mol tests in 18 out of 20 paired comparisons).

3.1.9 Comparison of the individual vehicles failed to demonstrate that there was any difference between the performance of the water delivery systems with vehicle serial number. This is shown in Figure 9 where the forces produced at 20 m from each vehicle are presented.

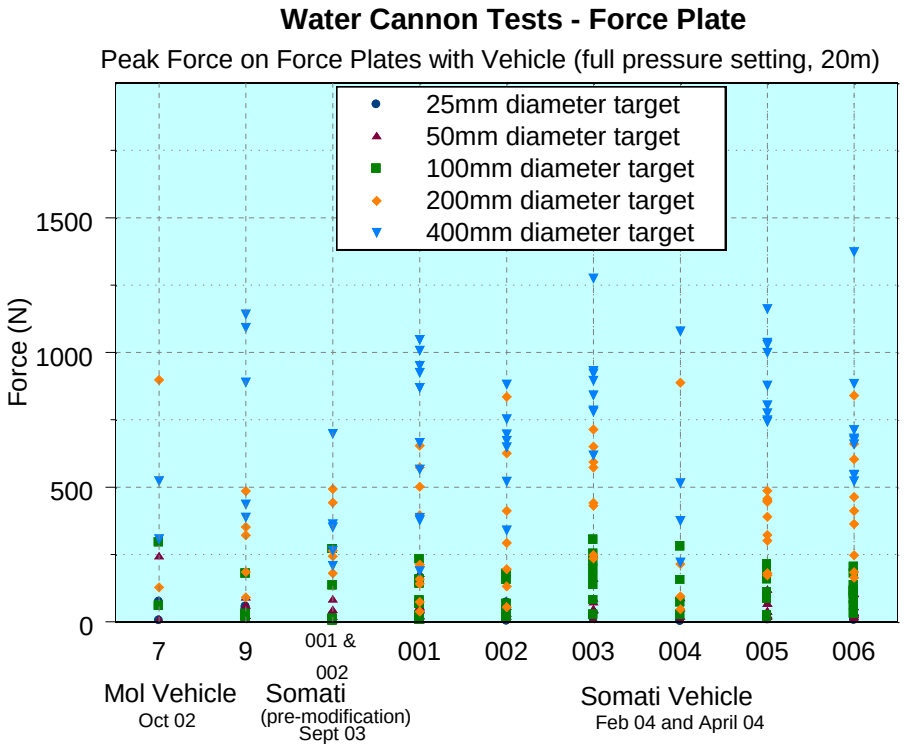

Figure 9: Comparison of water force with individual vehicle

3.1.10 Examination of the individual tests (and reported in References 6, 7, 8 and 12) showed that the forces produced were not affected by the monitor (left or right), pressure selection location (operator or vehicle commander) or the level of water in the tank.

3.2 Vehicle construction

3.2.1 The construction and specification of the vehicles (Mol or Somati) is similar in many respects (for example the physical size, tank size and appearance), however, the Somati vehicle has many refinements requested by PSNI in the light of experience of operating the Mol. In particular, the Somati has:

- Pressure step-down that can be selected by the cannon operators if the feel they require a less powerful jet.
- A sophisticated vehicle control system for the cannon commander, to control water pressure and indicate water level. This includes pressure transducers for the water delivery system with a feedback loop to control the drive speed of the pump.

- A suite of cameras and recording systems to record the events.
- Better visibility and crew comfort compared to the Mol.

3.2.2 The control lever (joystick) for the Mol water jet was a differential system whereby movement of the joystick would move the monitor relevant to the current position (i.e. a movement left would move the monitor left irrespective of where it was facing originally). To stop the monitor moving, the control lever is returned to a null position. The control lever for the Somati has an absolute position control, whereby the monitor actually points in the direction of the control stick. When the cannon control unit is not powered, it is possible to move the control stick without moving the monitor. This may result in cases where the operator is unaware (except through the view from the monitor camera) of the direction in which the monitor is pointing. When the monitor control is switched on, the monitor will align itself with the joystick position. This effect should be addressed in the training, and evidence of this should be sought.

3.2.3 It was also noted during the testing of the vehicles that individual control levers had their own 'feel'. In particular, one of the levers would stick during its traverse. An investigation of its cause was underway during the tests, but it demonstrates the need for familiarity with the vehicles. Again, this could be mitigated through training and competency of operators.

4 Update of 'Medical Implication of the Use of Vehicle Mounted Water Cannon' [3]

4.1 General

4.1.1 The updated review of Issue 1.0 [3] focussed on two areas:

- Review of new reports on injury
- Review of the recently drafted 'ACPO Guidance on the Deployment and Use of Water Cannon' [see Appendix B], (as a replacement for the 'RUC (Police Service of Northern Ireland) Instructions: Police use of water cannon').

These are both covered in more detail in Sections 4.2 and 4.3. This review culminated in the production of Issue 2.0 of the review document (Reference 9 – currently at draft 1A, awaiting confirmation of the ACPO Guidance).

4.1.2 The original review (Issue 1.0) had identified that there was a risk of injury from:

a. Running, tripping or falling when trying to evade water cannon.

b. Being pushed onto hard or sharp objects and windows by the force of the jets (Tertiary Impact).

c. Being knocked off walls or other high positions.

d. Secondary missiles being propelled from the ground (stones, gravel or street furniture).

e. The vehicle striking someone on foot.

f. Impact or fragmentation risk from optical or protective (specific or improvised) equipment.

These risks may be enhanced for children or other vulnerable people.

4.2 Review on new reports of injury

4.2.1 A review of technical papers failed to produce new information on the performance of water cannon. A review on the Internet was undertaken to examine news stories that implicated water cannon in trauma. For most of the reports that were found to mention the presence of water cannon and that there were injuries, the injury was always associated with a combination of the use of batons (and sticks), kinetic energy projectiles, irritants or live ammunition.

4.2.2 One uncorroborated case of a fatality from the use of a water cannon has been reported [13], but the exact circumstances of this incident have not been made available. In this

case, a prison warden in Japan allegedly tortured and killed an inmate with a water cannon blast whilst the inmate was tightly restrained in leather handcuffs. This report in turn states that these handcuffs have been '*criticized as a possible violation of the U.N. convention against torture – are wrapped tightly around an inmate's waist, with one hand strapped to the front and the other to the back.'* With respect to the fatality, the report states:
'A warden at Nagoya Prision was arrested last month for allegedly torturing and killing an inmate two years ago with a water cannon blast while the inmate was tightly restrained in leather handcuffs.'

4.2.3 No further information could be obtained about this incident, but this demonstrates that fatal injuries are possible under certain circumstances, but operation under these circumstances would be outside the guidance and policy for the use of water cannon within the UK, since the water cannon use must be appropriate, proportional and authorised [10, Appendix B, paras B.3.8d and B.6.2].

4.3 Review of ACPO guidelines

4.3.1 In order to assess the constraints on operators that may be applied, a review was also undertaken on the Draft 'ACPO Guidance on the Deployment and Use of Water Cannon' [10 see Appendix B]. This was compared to the original instructions used by the PSNI that were reviewed for the interim DOMILL statement. This original review highlighted issues relating to safety that required clarification. These concerns were then relayed to the PSNI branch responsible for the production of the guidance.

4.3.2 These concerns related to:

- The training and certification of officers;
- The use of the water cannon against specific individuals;
- The mode of the introduction of the water jet to individuals;
- The operation (command and control) of the vehicle.

4.3.3 These issues are shown in Table 1, and compared to how they are now addressed in the new ACPO guidelines [10 and Appendix B].

4.3.4 The principal issue still outstanding is that related to the training of operators, the syllabus that will be used and how this will include aspects such as the medical issues and control of the monitor. DOMILL enquired on the nature and the scope of the briefing given to water cannon commanders, operators and drivers on the medical implications of deployment and use during a visit by DOMILL members in January 2004. They were briefed on the water cannon operation, deployment and training. It is an aim that DOMILL will review the written and presentational material that underpins the training.

4.3.5 Dstl is aware that ACPO regularly reviews the Guidance and will incorporate the Guidance into the forthcoming Tactics Manual. It is important that ACPO appreciate

that the validity of the Medical Statement is reliant upon the Guidance and any changes to the Guidance should be reviewed by DOMILL to determine whether there are any medical implications.

5 Discussion

5.1 Relevance of the medical statement [Reference 11]

5.1.1 The Formal Medical Statement (Reference 11) was produced after review of the Interim Medical Statement [4], the production of the updated review of the literature [9] and review of the process.

5.1.2 The updated literature review of the medical implications of vehicle mounted water cannon did not highlight any information from the open literature that questioned the validity of the Interim Medical Statement, or the process that was undertaken. The recent reports of injuries have all followed similar lines to those previously reported and the only recent uncorroborated report in the literature relating to a fatality appears to be due to inappropriate use of a water jet.

5.1.3 The testing of the Mol and Somati vehicles 001 to 004 allowed clarification of the nature and the cause of the injuries, including:

a. Running, tripping or falling when trying to evade water cannon.
b. Being pushed onto hard or sharp objects and windows by the force of the jets (Tertiary Impact).
c. Being knocked off walls or other high positions.
d. Secondary missiles being propelled from the ground (stones, gravel or street furniture).
e. As with the use of any vehicle in areas where there are large crowds of people, there is a danger of the vehicle colliding with an individual. Water cannon will only be used after sufficient warning has been given.
f. Care should be exercised if children or other vulnerable persons are amongst the crowd subjected to the use of water cannon.
g. Impact or fragmentation risk from optical or protective (specific or improvised) equipment.
h. Damage to masonry / windows caused by force of water jet.
i. Jets striking the head, even peripherally.

Some of these were not explicit in the original literature review.

5.1.4 The initial testing of the water cannon also highlighted issues relating the guidance/training/maintenance that need to be considered. These include:

a. The approval and certified competency of the vehicle operators.
b. The sensitivity of the water monitors control lever and how this will affect accuracy.
c. The isolation of the water monitor control lever from the monitor position and how this could mean that the operator is initially unaware of the direction of the monitor.
d. The difference in the control lever ‘feel’ between vehicles of the same design and whether this will controlled through adequate training.
e. The calibration of the vehicle sensors.

f. The maintenance programme and how modifications to the water delivery system (no matter how apparently trivial) may affect the vehicle output.

5.2 Vehicle construction/comparison

5.2.1 The Somati vehicles that have been tested were evidently initial production vehicles and Vehicle 001 was repeatedly described as 'a prototype'. The development work that was undertaken during the manufacture and design iterations that took place were continuous up until the first four vehicles were accepted by PSNI. It is therefore a concern that future Somati RCV 9000 vehicles may not be identical to the six purchased by the PSNI. This has implications on the validity of a medical statement if it referred specifically to a model of vehicle (rather than serial numbers).

5.2.2 The current Medical Statement specifically refers to the tests on the original four vehicles and recommends tests on the remaining two vehicles before operational deployment and use. This recommendation has been carried out with the series of tests reported in Reference 12 and compared in this document. Any modification of the Medical Statement should reflect these tests and again specifically limit the statement to the six vehicles purchased by PSNI and operated under ACPO Guidance.

5.3 Injury causing potential

5.3.1 The Guidance specifically refers to the use of the water cannon as needing to be 'authorised' and 'appropriate', as well as giving the caveat that any application of force carries with it a risk of injury. The water cannon themselves are described as providing a graduated response that provides a '*flexible application of force ranging from use of the water cannon in spray or diffused mode to deter or discourage unlawful protestors from remaining in an area, to forceful water jets that can physically push people to disperse them'* [para B.1.10]. The key issue relates to how well this Guidance is translated into effective training, and how well it is applied by the users.

5.3.2 The Guidance is not prescriptive on the methods of the application of force, because the application under a particular circumstance will depend upon the individual incident. Earlier versions of the Guidance gave reference so *'that jets are directed from the ground up towards the lower part of the body'*. This reference has now been removed and replaced by the less explicit list of potential risks [paras B.3.4 and B.3.5] and the declaration of the responsibility of the Crew Commander to *'determine the appropriate mode of use (diffused or directed jets)'* [para B.9.2].

5.3.3 This ACPO Guidance has been reviewed by DOMILL and it is recognised within the statement (paragraph 23) that adherence to the Guidance is unlikely to result in serious or life threatening injuries.

5.4 Training

5.4.1 No direct visibility has been given to the training that will be provided to staff in the use of water cannon. It is hoped that the syllabus for any training courses is reviewed by

DOMILL when it becomes available to ensure that the medical aspects are fully covered and that the competence of the operators is effectively measured.

6 Conclusions

6.1 The recommendations in the Interim Medical Statement from DOMILL have been carried out and the testing of vehicles 005 and 006 have been conducted as recommended in the current medical statement.

6.2 No new injuries or fatalities have been reported that are directly attributable to the appropriate use of water cannon.

6.3 No new injury mechanisms have been identified from the physical testing of the Mol MSB18 or the Somati RCV 9000 water cannon due to the water jet impacting the body.

6.4 It is possible to produce ocular injuries from the direct impact of the water-jet on the head, but the current guidance advises against aiming the water jet directly at the head. Training should also ensure that this is avoided.

6.5 It is possible to produce head and neck injury from being thrown by the force of a water jet (from a tertiary impact).

6.6 It is possible to produce ocular injuries through the energising of debris. It is possible that sufficient force may be produced by the jet to topple weak structures.

6.7 The tests of the different vehicle designs against the force plate indicated that the Somati RCV 9000 is a more powerful vehicle with respect to range from the jet nozzle, however there was little statistical proof of this.

6.8 There was no difference in the force produced by the water jet with individual vehicle (of the six tested), the level of the fill of the water tank, the monitor used or the location of the selection of the water pressure.

6.9 Issues exist with the control levers for the water-jet, but these are mitigated by the Guidance and training should specifically address these issues.

6.10 The training of officers has not been developed. This should be reviewed at the first opportunity.

6.11 The vehicle design may change with future purchases. The medical statement should specifically refer to vehicles bought under the current contract.

6.12 The electronic control system for the water delivery system should be calibrated as part of the routine maintenance schedule.

6.13 Any modifications to the ACPO Guidance on the Deployment and Use of Water Cannon, including the incorporation of the Guidance into Tactics or Training Manuals should be reviewed by DOMILL to determine whether there are any implications on the validity of the Medical Statement. ACPO should also be aware that validity of the Medical Statement is dependant upon the wording of the Guidance.

6.14 Overall, it is concluded that the use of the Somati RCV9000 Vehicle Mounted Water Cannon within the ACPO Guidelines is unlikely to result in serious or life threatening injuries. The current medical statement is valid in its reference to the production of injuries, however it may be desirable to update the text to reflect the testing of Vehicles 005 and 006.

7 Recommendations

7.1 The implementation of the Guidance relies on its mitigation and implementation through appropriate crew training. It is recommended that the training syllabus for staff is reviewed by DOMILL.

7.2 DOMILL should review the medical statement based upon this report, taking into account the literature review, technical tests, and the Guidance provided by ACPO.

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13. http://www.corrections.com/internetwork/internews.html, The Corrections Connection International Network - News Briefs, 12/05/03, 11.13

14. Fax D1(2) Operational Planning (PSNI HQ Brooklyn) to <redacted> (Dstl CBS) – 9th Jan 2002, RUC Instructions Police Use of Water Cannon (dated 2 July 1999, 13:02)

15. Fax D1(2) Operational Planning (PSNI HQ Brooklyn) to <redacted> (Dstl ISS) – 28th Jan 2002, Response to request for information

9 Tables

Issue	Comments on RUC (PSNI) Instructions [14]	Relevance to ACPO draft Guidelines (Appendix B) [10]
How were officers selected?	Selected from Public Order Instructors or Tactical advisors [15]	Explicit in ACPO guidelines on requirements for officers (Para B.13.1)
What was the training syllabus and the experience of trainers?	Staff were trained by the Belgian Gendarmerie [15]	Trained by Belgian Gendarmerie, but a specific training course to be developed by PSNI
Level of approval and control over the production and control of the guidance	Local (PSNI) level of control	Now an ACPO document to be produced for national use and review, with force specific information added as required (e.g. for training, etc)
Reasons for deployment of the vehicle	Based upon a risk assessment [15]	Now explicit in the document to provide a graduated response after an appropriate threat and risk assessment (para B.3.7). Only authorised if their use '*is appropriate in order to achieve lawful objectives*' (Para B.6.2).
Guidance on the mode of the spray/jet	Personal judgement	Several references to a graduated response (Paras B.1.5, B.1.9, B1.10, B3.8), particularly a single reference to a '*flexible application of force ranging from use of the water cannon in spray or diffused mode to deter or discourage unlawful protestors from remaining in an area, to forceful water jets that can physically push people to disperse them'* (Para B.1.10)
Use of vehicle by untrained crews	Concern was raised that untrained crews may be able to use the vehicle under certain circumstance and they need to understand the medical implications	Now explicitly states in the ACPO document that '*Water Cannon may only be operated by officers who are currently trained in their use'* (Para B.2.1) and *'Water Cannon Operators must be appropriately trained and qualified'* (Para B.11.1). Selected staff must also be

		public order trained (Para B.13.1)
Use of a water cannon against a particular individual	Concern was raised over targeting a single person (either isolated or in a crowd)	If deemed necessary and '*is appropriate in order to achieve lawful objectives*' (Para B.6.2). It is also highlighted that the possibility of hitting one person in a crowd is unlikely and several people may be affected (Para B.3.8e). Additional risks have been highlighted for the effects of the jet putting someone into danger (such as pushing them in front of a moving vehicle – parap B.3.5) and the increased risk of injury from two jets (para B.3.4a)
Mode of introduction of water jet	Guidance was required to explain the mode of introduction	Requirement that the force is proportionate (para B.3.8d), and references to a graduated response (Paras B.1.5, B.1.9, B1.10, B3.8), but no reference to method of introducing the jet to the body. Explicit reference to the responsibility of Crew Commander to selection of pressure and selection of mode of water (diffuse spray or jet) – para B.9.2.
Concern on debris being swept into protestors	No reference to risk of debris	Explicit concern that debris may be projected at people (Para B.3.4.e and B.3.5)
Possibility of impact (tertiary injury)	No reference of risk of impact injury from being thrown	Now explicit (Para B.3.4.c)
Control system accuracy	No reference to accuracy of the control system	Explicit that people must be trained. (Para B.11.1)
Communication system	No mention of communication systems that need to be used	Some requirements placed on communications for cannon commanders (Para B.10.4). New vehicle design has good radio and communications between exterior and interior through vehicle mounted system.
Fail-safe system	No mention in system design of any fail safe mechanism	Current vehicle design has emergency shut-off for water jets and the power take off

		from the engine has a power cut-off. Water distribution system has an electronic control system (although there is no mention of calibration)
Movement in crowds	No mention for the safety of people when the vehicle is moving	Mention of care required when moving vehicle and need for sufficient warning (Para B.3.1)

Table 1: Comparison of RUC Instructions for the use of Water Cannon [10] and ACPO Water Cannon Guidelines [9]

APPENDIX A Interim statement on the medical implications of the use of vehicle-mounted water cannon in a public-order role

Background

1. The role of the DSAC[6] Sub-Committee on the Medical Implications of Less Lethal Weapons (DOMILL) is to provide the Secretary of State for Northern Ireland with:

a. Advice on the medical implications of generic classes of less-lethal (LL) weapon systems (which includes biophysical, biomechanical, pathological and clinical aspects);

b. Independent statements on the medical implications of use of specific LL systems, when used according to the formal guidance provided to users;

c. Advice on the risk of injury from identified LL systems striking specific areas of the body, in a format that would assist users in making tactical decisions, and developing guidance to users to minimise the risk of injury.

2. This advice is in support of the UK Government's requirements arising from:

a. Recommendations 69 and 70 of the Patten Report into policing in Northern Ireland[7]: (i) a research programme to find an acceptable, effective and less potentially lethal alternative to the Baton Round, (ii) provision of a broader range of public-order equipment to the police;

b. The desire of the Association of Chief Police Officers (ACPO) to have a wider range of options in conflict management scenarios, including those most commonly associated with self-defence and restraint, and the Police use of firearms.

In summer 2000, the Secretary of State for Northern Ireland set up a UK-wide inter-departmental Steering Group to co-ordinate a programme to address both requirements.

3. The second report of the Steering Group has described the various classes of LL weapon systems being evaluated to address the requirements[8]. The report categorises the technologies according to the requirement for research and evaluation. Within Category A (devices which may be subject to research and evaluation immediately) are vehicle-mounted and portable water cannon.

4. DOMILL was invited to provide a statement on the medical implications of the use of vehicle-mounted water cannon in public-order role, by October 2002. At a meeting of the Steering Group on 20 December 2001, DOMILL was requested to provide an interim statement by February

[6] Defence Scientific Advisory Council.
[7] Report of the Independent Commission on Policing in Northern Ireland; September 1999.
[8] Patten Report Recommendations 60 and 70 relating to Public-Order Equipment – A research programme into alternative policing approaches towards the management of conflict. Second report of the Steering Group; November 2001.

2002; at a subsequent meeting of the Steering Group in January 2002, this was extended to March 2002. The interim statement was required to facilitate the consideration of future water cannon use and in particular, the proposal for purchase of water cannon for use by the Police Service of Northern Ireland (PSNI). This document is the interim DOMILL statement.

Technical approach

5. In view of the short time-scales necessary to inform the procurement process, the Steering Group was advised by DOMILL that the statement could only be considered expedient. It would encompass a review of published medical and technical data, and of official reports on operational use of water cannon by UK and some European police forces. The statement would not be able to address detailed technical assessments of water cannon output, or experiments using physical or computer models of human injury. These tests would be undertaken subsequently on the water cannon identified for purchase.

6. The review of the literature and the assessment of the reported technical performance of specific water cannon were undertaken on behalf of DOMILL by the Defence Science and Technology Laboratory (Dstl). Over 500 references and web-sites were reviewed. The documents and web-sites addressed the use of water cannon and injuries attributed to that use, the physics of water jets, and injuries reported from the impact of water in other scenarios, such as water sports. Dstl reviewed the technical specification of some of the water cannon used recently in Northern Ireland, Belgium and Germany, and the specification of the water cannon to be purchased for future use in Northern Ireland.

Conclusions

7. On the basis of the review of a diverse body of literature – little of which had direct, substantiated relevance to the medical consequences of the operational use of water cannon or its use in training – the following conclusions are offered.

8. **Deaths:** There was no evidence in the peer-reviewed journals, press, police or fringe literature reviewed that any person has been killed by the direct or indirect effects of the impact of a jet from a water cannon in operational use. This conclusion encompasses injuries directly from the jet impact (primary injury), penetrating or blunt impact injuries form debris and street furniture accelerated by the jet (secondary injury) and the impact of the accelerated human body against solid objects or the ground (tertiary injury).

9. **Life-threatening injuries:** In the world-wide literature, there was an extremely low incidence of injuries that could be classed as life-threatening attributable to, or actually caused by water cannon jets. The Belgian and German police authorities, and the Police Service of Northern Ireland (PSNI) have no reports of serious or life-threatening injuries to the public that could be attributed to the jet of the Belgian Mol CY NV MSB 18 or the German Ziegler water cannon. It should be recognised however that the use of force of any nature carries a risk of injury.

10. In public-order incidents in which water cannon may be deployed, it may be difficult to differentiate injuries arising directly from its use, or from other potential sources of trauma such as batons, kinetic energy projectiles, assaults or irritants. This clouded the review of all sources of

published information on the use of water cannon, and will have implications for assigning injuries arising from future deployments and use, in the subsequent audit.

11. **Water jet dynamics:** The behaviour of free water jets is complex. Although the bulk properties of a jet of water can be calculated (mass flow rate; average jet velocity), it is extremely unlikely that the effective loading on the body could be calculated from first principles. The distribution of energy in the jet (and thus risk of injury) can be altered by ostensibly minor changes in pump/nozzle characteristics, with little overt effect on bulk output. This has three consequences:

a. The effective loads on the body must be determined experimentally;

b. All evaluations must be undertaken on operational equipment, not prototypes or rigs;

c. More than one example of each specific water cannon should be evaluated.

12. **Future vehicle-mounted water cannon:** It is currently unlikely that a water cannon built to the proposed specification of the PSNI would result in a notable change in probability or severity of injury (compared to that from existing water cannon) if used according to the extant PSNI guidance to users. This should not inhibit a review of the extant guidance to reduce the risk of injury from the currently deployed and future water cannon. In the light of the known complexity and variability of water jets, it is essential that the injury potential of the water cannon be verified experimentally.

Recommendations

13. **Guidance to users and training:** The impact of a high-pressure water jet from a water cannon is a high momentum event and may therefore lead to the displacement of the body. In certain scenarios (such as people close to solid obstacles), the potential for an increased risk of injury exists. Future guidance and training should reflect the risks arising from the displacement of people and objects.

14. **Future assessment:** DOMILL has been requested to deliver a final statement on the medical implications of the use of water cannon by October 2002. A formal technical plan for the experimental work to support the statement must await confirmation of the availability for testing of existing and future water cannon equipment. At this stage, it is envisaged that the scope of the programme my encompass:

a. Measurement of the gross fluid output of both the Mol CY NV MSB 18 water cannon, and the new water cannon proposed to be procured by the PSNI;

b. Definition of the biologically effective loading within the jets;

c. Measurement of the contact velocity and acceleration of the head with a rigid object such as a wall or the ground;

d. Measurement of the initial linear and rotational acceleration of the head/neck assembly following direct or sweeping interaction of the jet with the head, and with the torso;

e. The distribution of representative debris accelerated by the cannon directed to the ground, and the probability of specific injuries such as ocular trauma;

f. The risk of primary injury to the torso and head assessed using computer or physical models.

APPENDIX B ACPO Guidance on the Deployment and Use of Water Cannon (repeated text from ref 10)

B-1 Introduction

B-1.1 The purpose of these guidelines is to facilitate an understanding, and to provide practical guidance concerning the deployment and use of vehicle mounted water cannon.

B-1.2 The guidelines have been audited to ensure the content is in compliance with the provisions of the Human Rights Act 1998 and the provisions of the United Nations Basic Principles on Use of Force and Firearms by Law Enforcement Officials and the UN Code of Conduct for Law Enforcement Officials. Account has also been taken of the Police Service of Northern Ireland Code of Ethics.

B-1.3 Managing conflict and responding to violence are core police functions. Police response is underpinned by Human Rights and in particular the obligation under Article 2 of the European Convention on Human Rights, to uphold the right to life.

B-1.4 Article 2 of the UN Basic Principles on the use of Force and Firearms states that:

'Governments and law enforcement agencies should develop a range of means as broad as possible and equip law enforcement officials with various types of weapons and ammunition that would allow for a differentiated use of force and firearms.'

B-1.5 Vehicle mounted Water Cannons can be used in a variety of modes and therefore provide the police service with an additional, flexible and graduated means of responding to situations where use of force is considered necessary to disperse individuals or persons causing violence. As well as the physical presence of the water cannon providing a deterrent The modes of operation are:

a. Spray or Diffused Mode.

b. Short bursts of water jets.

c. Continuous water jets.

B-1.6 The design and use of the vehicle mounted water cannon system are subject to strict criteria. Only water cannon that have undergone a full technical evaluation and consideration of the medical implications of its operation may be used within in the United Kingdom. The 'RCV9000 Vehicle Mounted Water Cannon' is currently approved for use within the UK.

B-1.7 The deployment and use of water cannon will be informed by reference to the ACPO Conflict Management Model. The availability or deployment of the Water Cannon should not however be considered as a replacement for other less lethal weapons but rather as a further tactical option. Whilst primarily designed as an option for dealing

with unlawful protest and disorder water cannon may provide a tactical and less lethal response in other situations where a use of force is required.

B-1.8 The deployment and use of water cannon is required to be documented as soon as practicable thus providing an audit trail of decision making in respect of command and operational decisions.

B-1.9 Water cannon are one tactical option within a range of tactics and equipment that are available to the police service when responding to unlawful protest, disorder and threats of violence. They provide a graduated, flexible and proportionate police response and may reduce the need to resort to other less lethal weapons or other uses of force. Police, in carrying out their duty, shall as far as possible, apply non-violent means before resorting to the use of force. Force may be used only if other means remain ineffective or without any promise of achieving the intended result. In dealing with assemblies that are unlawful but non-violent the use of force should be avoided, or where that it is not practicable, such force shall be restricted to the minimum extent necessary.

(Sourced from United Nations' Basic Principles on the Use of Force and Firearms by Law Enforcement Officials - Principle 4)

B-1.10 A unique characteristic of water cannon is the ability to graduate the delivery of water from a diffused spray to a directed jet and at varying pressures. Thus water cannon provide a graduated and flexible application of force ranging from use of the water cannon in spray or diffused mode to deter or discourage unlawful protestors from remaining in an area, to forceful water jets that can physically push people to disperse them. This represents a use of force option that may be considered appropriate in a variety of situations falling short of serious disorder and riots where its use may prevent the escalation of violence.

B-1.11 Water cannon are intended to complement the existing range of tactical options and equipment. Size, weight and manoeuvrability may place constraints on their use. Therefore, whilst water cannon may be an appropriate option in many circumstances, the topography of the area and ground conditions may negate their use and other appropriate tactical options should be considered.

B-1.12 Nothing in these guidelines should be construed so as to constrain the police service in its fundamental responsibility to save life, protect property and maintain the peace. Police officers shall at all times fulfil the duty imposed upon them by law, by serving the community and by protecting all persons against illegal acts, consistent with the high degree of responsibility required by their profession.

B-2 Outline Description of the RCV9000 Vehicle Mounted Water Cannon

B-2.1 The RCV9000 water cannon vehicle consists of a six wheel drive chassis on which is mounted a superstructure consisting of a crew cabin; a pump compartment and a water tank. Water Cannon may only be operated by officers who are currently trained in their use.

B-2.2 Within the cab there is a comprehensive set of controls and recording equipment to capture data from sensors monitoring water pressure, date and time of use. Each vehicle has two water cannons mounted on the roof of the cab.

B-2.3 The vehicles are each equipped with a public address system, distinctive audible sirens and blue flashing lights. A high intensity light bar is fitted to the front of the cab above the windscreen.

B-2.4 Due to their size and weight water cannon should normally be deployed at least in pairs to provide mutual support and immediate recovery capability in the event of a mechanical failure.

B-3 Considerations for Deployment and Use of Water Cannon

B-3.1 As with the use of any vehicle in areas where there is large crowds of people there is a risk that the moving vehicle could result in a collision and injure individuals. The provision and of use the public address system, distinctive audible sirens and blue flashing lights system will provide a means to warn persons present of impending use.

B-3.2 The ability to discharge jets of water in differing modes and at varying pressures is a unique characteristic of water cannon representing a use of force option that may be considered appropriate in a wide range of situations.

B-3.3 Water cannon can provide an effective means by which persons using violence towards the police or others involved in the destruction of property, or who are engaged in unlawful assemblies, protests or demonstrations, can be kept at a distance, contained or dispersed. In dealing with assemblies that are unlawful but non-violent the use of force should be avoided, or where that it is not practicable, such force shall be restricted to the minimum extent necessary. (*Sourced from the UN Basic principles on the Use of Force and Firearms by Law Enforcement Officials – Principle 13*)

B-3.4 Water cannon are intended to be a less lethal use of force option. The method of delivery and use is intended to avoid causing serious or permanent injury. However as with any use of force there is the potential for unintended or unforeseen injuries being caused. In respect of water cannon the following potentials for injury have been identified.

a. Direct injury from water jet. In particular the application of two jets on individuals (E.G. both jets from one vehicle or one jet from two vehicles) will increase the risk to subjects.

b. Running, tripping or falling when trying to evade water cannon.

c. Being pushed onto hard or sharp objects and windows by the force of the jets (Tertiary Impact).

d. Being knocked off walls or other high positions.

e. Secondary missiles being propelled from the ground or dislodged from buildings of other structures.

B-3.5 Training will address these considerations and other potential risks from :-

- Jets directed at the ground in front of crouching/sitting persons where there may be debris on the ground;
- Jets striking the head, even peripherally;
- Jets striking, even peripherally, persons using optical equipment or with the equipment (cameras etc) directly;
- Persons adjacent to obstacles such as walls, barricades and vehicles, or lying on the ground where the pressure of water may cause them to fall against such objects;
- Persons on top of structures who may be toppled by the jet;
- Persons who may be thrown into the path of moving vehicles by the jet:
- Children, the elderly or small adults being struck by the jet.

B-3.6 Water cannon should be supported by other public order tactical options and equipment and should not ordinarily be deployed as a standalone option.

B-3.7 Water Cannon will only be deployed following appropriate threat and risk assessments, however in certain situations where there is limited time for detailed planning, commanders may have to undertake real time dynamic threat and risk assessments**.** Specific tactical objectives will be drawn up by the Silver Commander and agreed with the Gold Commander to be implemented by the relevant Bronze Commander(s).

B-3.8 Given the flexibility in use of the water cannon it is impossible to provide a definitive list of situations or precise criteria for their deployment and use but the following principles should taken into consideration:

a. The physical presence of water cannon can act as a deterrent to those intent on disobeying lawful and reasonable police directions or using violence, however their presence may also inflame a situation and the decision to move water cannon forward and into view must rest with Bronze and Silver Commanders at the time.

b. The public address system, high intensity lights, flashing blue lights and distinctive sirens can all be used to provide warnings and alert a crowd of the presence of water cannon and police intentions.

c. Water cannon may be considered as an alternative tactical option to police officers physically engaging with unlawful protests and violent persons in situations that would otherwise require the intervention of officers at close quarters, thus placing police and others at potentially greater risk.

d. The modes of use (diffused or directed jets of varying duration) and level of water pressure used on any given occasions must be necessary and proportionate to situation being encountered.

e. Use of the water cannon is likely to result in more that one person being affected and the use of the water cannon may have a direct or indirect effect on the whole crowd hence the importance of providing warnings as outlined at paragraph 7 of these guidelines.

B-4 Useful Definitions

B-4.1 In the course of reading these guidelines the following definitions will be of assistance:

Deployment – Water cannon is deployed when it has been made available for operational purposes.

Authority to Deploy - the authorisation by an officer of Assistant Chief Constable/Commander rank to make water cannon and trained personnel available for operational purposes.

Use – Water cannon is deemed to have been used when it has been discharged at any person in pursuit of police operations.

Authority to Use – The authorisation given by the Silver Commander (Inspecting and Superintending ranks) to discharge water cannon, in accordance with the principles set out in these instructions. The authority to use water cannon is not an order to discharge it. It is a decision that is made, based upon all of the information available, that water cannon may be a necessary and proportionate response to public protest or disorder.

Assistant Chief Constable/ Commander - an officer of substantive ACC or Commander rank or an officer of Superintending rank who is specifically designated to perform the role of ACC/Commander in the absence of the relevant ACC/Commander**.**

B-5 The law relating to the use of force

The law relating to the use of force is set out in this section and must be complied with.

B-5.1 The deployment of water cannon does not, of itself, constitute a use of force. It is only when water cannon are used to discharge water against persons that the considerations contained in this section become relevant.

The law is contained within …

Section 3 Criminal Law Act 1967 and Section 3 Criminal Law Act (Northern Ireland) 1967

B-5.2 ‘A person may use such force as is reasonable in the circumstances in the prevention of crime, or in the effecting or assisting in the lawful arrest of offenders or suspected offenders or of persons unlawfully at large’

Section 117 Police and Criminal Evidence Act 1984 and Article 88 Police and Criminal Evidence (Northern Ireland) Order 1989

B-5.3 'Where any provision of this Act or Order

a. confers any power on a constable; and

b. does not provide that the power may only be exercised with the consent of some other person other than a police officer, the officer may use reasonable force, if necessary, in the exercise of the power.'

Common Law

B-5.4 The Common Law has always recognised the right of self-defence.

European Convention on Human Rights (ECHR)

B-5.5 When making a determination as to whether the level of force used was lawful in any particular instance the courts will take cognisance of the Articles under the ECHR.

B-5.6 Whilst water cannon are intended to be a less lethal use of force option it is recognised that the use of any force may have unintentional lethal consequences and, as such, Article 2 of the ECHR is of particular relevance.

B-5.7 Article 2 – Right to life

Everyone's right to life shall be protected by law. No one shall be deprived of his life intentionally save in the execution of a sentence of a court following his conviction of a crime for which this penalty is provided by law.

Deprivation of life shall not be regarded as inflicted in contravention of the Article when it results from the use of force which is no more than absolutely necessary:

I. in defence of any person from unlawful violence;

II. in order to effect a lawful arrest or to prevent the escape of a person lawfully detained;

III. in action lawfully taken for the purpose of quelling a riot or insurrection.

B-5.8 The European Court has held that 'in keeping with the importance of this provision [the right to life] in a democratic society the court must, in making its assessment, subject deprivation of life to the most careful scrutiny …taking into consideration not only the actions of the agents of the State who actually administer the force but also all the surrounding circumstances including such matters as the planning and control of the actions under examination'. (McCann v United Kingdom (1995) 21 EHRR 97 at paragraph 150).

B-5.9 The test of absolute necessity found in Article 2 of the ECHR relating to the obligation to protect life provides a stricter test of proportionality than is required in

other areas of the Convention. It is also a stricter test than is provided by the concept of reasonable force within s 3 Criminal Law Act 1967, s 117 of Police and Criminal Evidence Act 1984, the equivalent Northern Ireland legislation and the Common Law. Even where the use of force may be seen as being reasonable it may not be absolutely necessary.

B-5.10 Water cannon can be used in a variety of modes and its use in any given circumstances must be based on the principals of proportionality.

B-5.11 The justification for the mode (spray or jet), the pressure and duration of use will always be dependant on each situation and based on the principles of legality, necessity and proportionality. For example directed jets may be a necessary and proportionate level of force against a violent and riotous crowd who have refused to disperse and their dispersal is necessary for the maintenance of the peace and the prevention of disorder. However if dispersing an unlawful but non-violent assembly, in the first instance a diffused spray may be appropriate followed by lower pressure jets proportionate to the amount of resistance offered by the crowd. A record is maintained on the pressure of the jets on each occasion they are used.

B-5.12 When that force is used it should be reported at the time, or as soon as practicable thereafter, by the Crew Commander to the Water Cannon Commander and to the Silver Commander. It is not intended that each short burst of water need to be reported, however a report(s) should be made when a particular phase of use has ended. It is impossible to set strict guidance in this respect and must be left with the discretion of the Crew Commander who has a duty to report the use of force.

B-6 Authorisation for the Deployment and Use of Water Cannon

Deployment of Water Cannon

B-6.1 Chief Constables\Commissioners may delegate the authority for the deployment of water cannon to an officer of Assistant Chief Constable\Commander rank. The authority to deploy water cannon should be limited by time and geographical boundaries. These may be for as long and cover as wide an area as necessary for the purpose of the operation(s) for which they are being deployed.

B-6.2 The deployment and use of water cannon in situations of unlawful public protest and disorder should only be considered where it is believed that their use (in conjunction with other methods of policing disorder) is appropriate in order to achieve lawful objectives.

B-6.3 A Tactical Adviser, who is specifically trained in the characteristics and use of water cannon, will be consulted prior to any deployment. The Tactical Adviser must be consulted on the deployment and use of water cannon in the planning phase and during the operation.

B-6.4 **Pre-Planned Deployments** - for pre-planned operations, the Gold Commander in consultation with the Silver Commander must make an assessment of the threat to public order and the need to deploy water cannon. Where the Gold Commander is not an Assistant Chief Constable/Commander, a written request for the deployment

of water cannon, based upon this assessment, will be made to the relevant Assistant Chief Constable/Commander by the Gold Commander.

B-6.5 Water cannon vehicles will be deployed under the overall command of the Water Cannon Commander. The Water Cannon Commander will liase with the appropriate Bronze Commander to ensure co-ordination in achieving tactical objectives.

B-6.6 The relevant Gold and Silver Commanders will keep authority to deploy water cannon under constant review.

Use of Water Cannon

B-6.7 Once authority to deploy water cannon has been granted the authority to use water cannon is vested in the Silver Commander (Inspecting and Superintending ranks).

B-6.8 The Silver Commander will keep authority to use water cannon under constant review through liaison with the relevant Bronze Commander(s) and Water Cannon Commander.

B-6.9 Water Cannon can be used in the following ways:-

a. Stationary

b. As part of a forward moving police line.

When being used as part of a moving formation care must be taken to avoid striking any person with the vehicle.

B-7 Warnings

B-7.1 The use of the public address system, high intensity lights, flashing blue lights and distinctive sirens can all be used to provide warnings and alert a crowd of the presence of water cannon and police intentions. RCV9000 water cannon vehicles are equipped with a powerful public address system and distinctive audible sirens that can be used to give audible warnings. Blue flashing lights mounted on the front and on the roof will provide a visual warning of their presence.

B-7.2 Water Cannon Crew Commanders should ensure that sufficient warning is issued to the crowd before water cannon and/or any other use of force option is deployed. The warning(s) should make it clear to the crowd that unless they disperse, a specified use of force tactical option will be used. The officer delivering the warning will keep a record of the time of the warning(s) and the words used. The following words should be used:

"Attention, attention this is a police message. Unless you disperse immediately, water cannon (or other option(s)) will be used"

B-7.3 Warnings should be repeated, as frequently and as often as is necessary to ensure that all of those engaged in the unlawful activity and bystanders have heard the

warning(s) and have had an opportunity to disperse. The police objective should be to ensure those who choose to remain are left in no doubt of the police intentions.

B-8 Command

B-8.1 In order to ensure appropriate operational command over the use of water cannon, the following procedures are to be implemented. These procedures are intended to enhance command and increase accountability whilst maintaining the ability to evidence the need to use water cannon.

B-8.2 Policy and command decisions in respect of the deployment and use of water cannon should be subject to continuous critical review during the lifetime of any incident or operation. The officer in overall command of the incident (Gold Commander) should ensure formal review and documentation of the requirement for water cannon as the disorder enters each new phase.

B-8.3 All command decisions in respect of the authority to deploy and use water cannon (or not, as the case may be) should be fully documented. The relevant Bronze Commander will be responsible for documenting the assessment of the situation and rationale pertaining to the decision to request the authorisation to use water cannon. In addition each Crew Commander will, in respect of the vehicle under their command, ensure that a record is maintained of the use of water cannon and that reports are completed as soon as practicable after each use.

B-8.4 In the event of spontaneous outbreaks of public disorder water cannon may, or may not be readily available. In any event the officer in charge of the scene of disorder should ensure the introduction of formalised command and control structures (Gold-Silver-Bronze) with the minimum delay and if water cannon are available they must be duly authorised for deployment and use. However, nothing in these instructions should be so construed so as to prevent an immediate and effective police response or the use of water cannon where their use is justified on the grounds of necessity and proportionality where decisive intervention is likely to bring about an early resolution of a potentially violent situation.

B-9 Role of Crew Commanders

B-9.1 Crew Commanders are responsible for the safety of the entire crew and that of the vehicle. A Crew Commander has overall command of their respective vehicle.

B-9.2 Crew Commanders will set a water pressure for any period of use that is a proportionate response to the unlawful protest or disorder being encountered. They will also determine the appropriate mode of use (diffused or directed jets). Whilst this will be the overall water pressure individual water cannon operators have the ability to reduce the pressure in their respective cannons by 5 or 10 bar or can close their cannon if appropriate.

B-9.3 Once a decision has been made to use water cannon the Crew Commanders will be responsible for directing and commanding their respective water cannon vehicle whenever their use has been authorised. The Crew Commander must also issue

orders to cease the use of water cannon when the tactical objective has been achieved or when ordered to do so by the Water Cannon Commander.

B-9.4 A Crew Commander (nominated by the Water Cannon Commander) will cause a warning(s) to be given to the crowd using the on-board public address system when available. Details of date, time, method and wording of the warning(s) should be recorded by the person issuing the warning.

B-9.5 Crew Commanders will ensure records are kept in respect of the use of water cannon, including records of date, time place of authorisation and use.

B-9.6 Crew Commanders will be responsible for ensuring that water cannon crews wear protective clothing and equipment appropriate to the level of threat pertaining to the circumstances.

B-9.7 The Crew Commander is responsible for the filling of the water cannon with water. To this end he will ensure correct procedures are followed at all times.

B-10 Role of Water Cannon Commanders

B-10.1 When two or more water cannon vehicles are deployed the senior Crew Commander will act as the overall Water Cannon Commander unless an additional officer has been specifically appointed. When authority for the use of water cannon has been given, the Water Cannon Commander will brief and instruct the Crew Commanders and crews as to the tactical objective(s) determined by the Bronze Commander for the sector in which the vehicles are then operating (Territorial Bronze). A record of authorisations, times etc. must be made at the time or as soon as possible thereafter (by the Water Cannon Commander, Crew Commanders and the relevant Bronze Commander) for evidential purposes.

B-10.2 The Water Cannon Commander is the person in charge of the water cannon vehicles deployed and his or her status in terms of the command structure is that they are in charge of a resource in a similar fashion to that of a PSU / TSG Inspector. The Water Cannon Commander's role is therefore subordinate to the relevant Bronze Commander as shown in Appendix 'A'.

B-10.3 The Water Cannon Commander is responsible for the overall safety of the water cannons, any escort and support vehicles and their crews.

B-10.4 Water Cannon Commanders / Crew Commanders are trained to provide Tactical Advice to Gold, Silver and Bronze Commanders. If an additional Water Cannon Commander has been appointed he or she can operate from within the vehicle or in close proximity outside the vehicle, providing communications can be maintained by the use of radio / intercom.

B-11 Water Cannon Operators

B-11.1 Water Cannon Operators control the use of the jets and must be appropriately trained and qualified.

B-11.2 In undertaking this role the operators must take account of the considerations set out in paragraphs 3.1 to 3.8 of this guidance.

B-12 Water Cannon Drivers

B-12.1 Drivers must be trained in driving water cannon and hold appropriate driving licences and internal police service qualifications for this category of vehicle.

B-12.2 Drivers have a great responsibility for the safety of the crew and the public when moving to and from deployments and during operational use and must therefore drive in a safe, responsible manner appropriate to road conditions, crowd conditions and general traffic legislation.

B-13 Selection of Personnel

B-13.1 Water Cannon Commanders and crews are selected on the basis of the following criteria.

a. Length of service and relevant experience

b. Attitudes and approach to work

c. Motivation and interests

d. Temperament, maturity and personality

e. Relationships with colleagues and supervisors (teamwork)

f. Personal Skills and competencies

g. They are Public Order trained

h. Only those officers who are capable of displaying a mature and professional approach to public order policing should be selected.

B-14 Medical Considerations

B-14.1 Police officers will ensure that assistance and medical aid, where possible, are secured for any injured or affected person(s) that they are aware of at the earliest possible opportunity.

B-14.2 The relatives and close friends of the injured or affected person should be notified at the earliest possible opportunity

B-14.3 Where it is known that death or injury has been caused by the use of water canon, the police officer becoming aware will report the matter promptly to his or her supervisor.

(*Sourced from United Nations' Basic Principles on the Use of Force and Firearms by Law Enforcement Officials, Article 5 and Article 6*.)

B-15 Records

B-15.1 Water cannon vehicles are equipped with electronic means of recoding data including date and time of use, the pressure set at any specific time by the Crew Commander, the pressure and flow rates used by the individual cannon operators and the duration of each use and the temperature of water in the water tank. The Crew Commander, who is in charge of a specific vehicle and is responsible for all technical aspects, will ensure the recording equipment is tested prior to deployment. If it is not working and cannot be repaired in time before necessary deployment the Crew Commander will ensure these records are recorded manually. The water Cannon Commander will ensure that records are maintained for all vehicles under his or her command.

B-15.2 Water cannon vehicles are equipped with video cameras mounted beside each cannon, behind the front windscreen and on a telescopic mast mounted to the rear of the cab. An additional two cameras are mounted at the rear of the body as a safety aid for the driver before reversing.

B-15.3 Whilst the images from cameras will be recorded during operational deployment water cannon are not intended for primary use as an evidence-gathering platform. The cannon mounted cameras are primarily intended to be an aiming aid for the cannon operators before the cannons are used. When in use the spray from the water jets generally obscures the image that these cameras can capture.

B-15.4 The combination of the various cameras means the crew has 360^0 vision around the vehicle, primarily for road safety purposes and the safety of the crew and others deployed in the vicinity. Images from this camera will also be recorded and when water cannons are in use the mast mounted camera should be forward facing to capture images from above the water jets, although these images may also be obscured by spray depending on prevailing conditions.

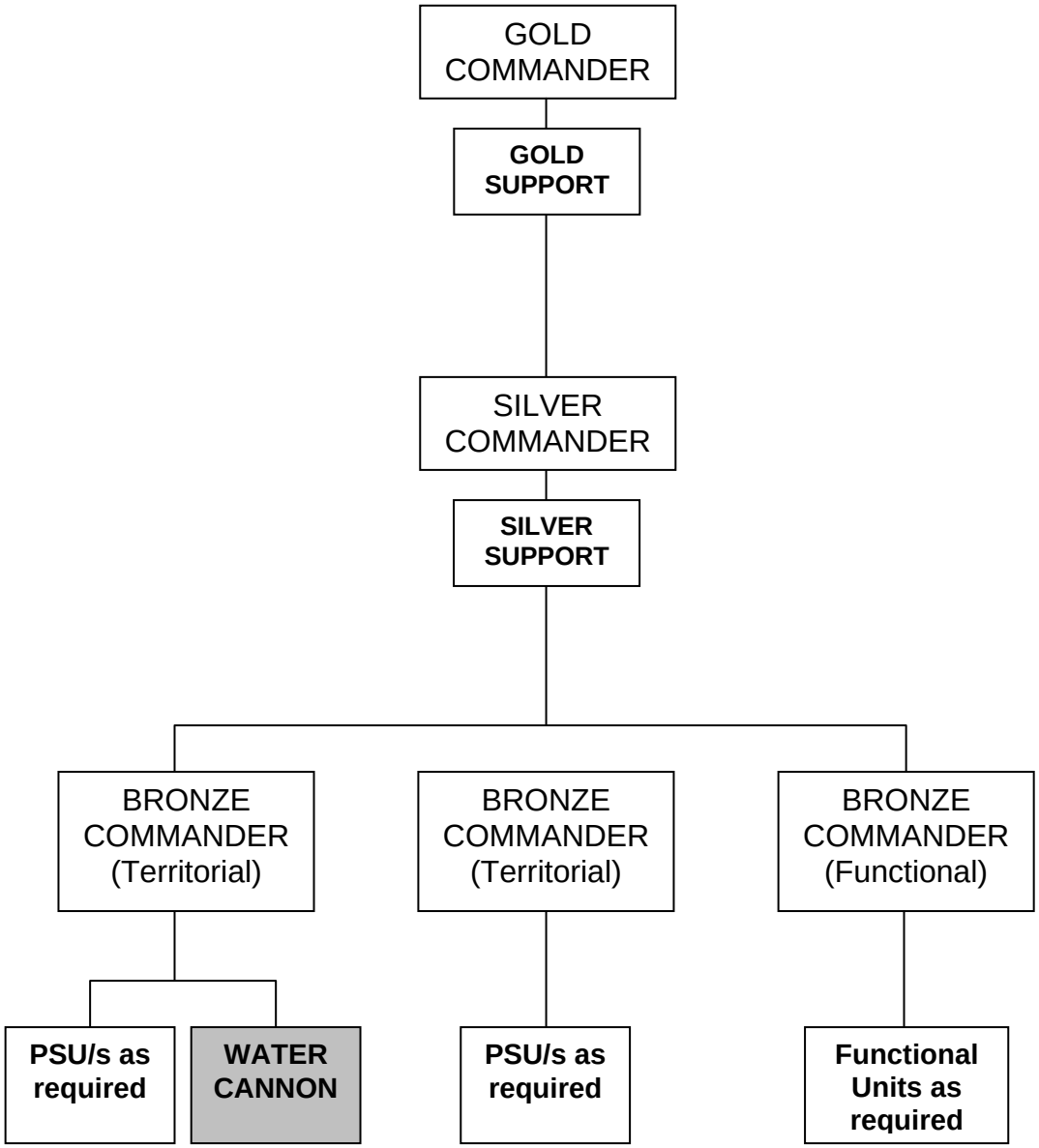
B-15.5 During the deployment the Crew Commander should at the time, or as soon as possible thereafter, make contemporaneous notes concerning deployment and use of water cannon. At the end of the deployment the overall Water Cannon Commander will submit a report to the officer in charge of the operation through normal channels which may be used as necessary for local debriefing purposes or to assist in any form of investigation.

B-15.6 The Crew Commander will ensure data and images recorded during operational deployment are downloaded from the data recorder, logged and stored in accordance with existing force instructions and practice in respect of the storage of electronic data for evidential purposes.

B-15.7 All equipment required for the recording of data and images must be tested frequently and any faults reported for prompt attention and repair. If during operational use the Crew Commander becomes aware of any defects in this

equipment they must make a contemporaneous note of this and take all reasonable steps to record events by other means including contemporaneous notes.

APPENDIX 'A' COMMAND STRUCTURE



APPENDIX C DSAC Medical Statement

DSAC Sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL)

Statement on the medical implications of the use of the
Somati RCV9000 Vehicle Mounted Water Cannon

Introduction

1. This statement addresses the use of the Somati RCV9000 Vehicle Mounted Water Cannon as a less-lethal option for dealing with unlawful protest, disorder and threats of violence in the United Kingdom. The statement supercedes an interim statement that considered the medical implication of use in Northern Ireland of the Mol CY NV MSB 18 water cannon[9]; the interim statement was placed in the Library of the House of Commons in July 2002.

Background

2. The role of the DSAC[10] Sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL) is to provide the Secretary of State for the Home Department and the Secretary of State for Northern Ireland with:

    a. Advice on the medical implications of generic classes of less lethal (LL) weapon systems (which includes biophysical, pathological and clinical aspects);

    b. Independent statements on the medical implications of use of specific LL systems, when used according to the formal guidance provided to users;

    c. Advice on the risk of injury from identified LL systems striking specific areas of the body, in a format that would assist users in making tactical decisions, and developing guidance to users to minimise the risk of injury.

3. This advice is in support of the UK Government's requirements arising from:

    a. Recommendations 69 and 70 of the Patten report into policing in Northern Ireland[11]: (i) a research programme to find an acceptable, effective and less potentially lethal alternative to the Baton Round, (ii) provision of a broader range of public-order equipment to the police;

    b. The desire of the Association of Chief Police Officers (ACPO) to have a wider range of options in conflict management scenarios, including those most commonly associated with self-defence and restraint, maintenance of public order, and the police use of firearms.

    In Summer 2000, the Secretary of State for Northern Ireland set up a UK-wide inter-departmental Steering Group to co-ordinate a programme to address both requirements.

[9] DSAC Sub-committee on the Medical Implications of Less Lethal Weapons (DOMILL). Interim statement on the medical implications of the use of vehicle-mounted water cannon in a public-order role. DSTL/CBS/BTP/DOC/592/1.0 dated 13 May 02.
[10] Defence Scientific Advisory Council.
[11] Report of the Independent Commission on Policing in Northern Ireland; September 1999.

4. The second report of the Steering Group described the various classes of LL weapon systems being evaluated to address the requirements[12]. The report categorised the technologies according to the requirement for research and evaluation. Within Category A (devices which may be subject to research and evaluation immediately) were vehicle-mounted and portable water cannon. The third report of the Steering Group[13] concluded that portable water cannon did not merit further study, and were unsuitable for use as a less-lethal option in a public-order role. The Steering Group took forward the assessment of commercially available vehicle-mounted water cannon.

5. DOMILL was invited to provide, by March 2002, the interim statement on the medical implications of the use of water cannon in a public-order role. Prior to and during this period, the Police Service of Northern Ireland (PSNI) were deploying the Mol CY NV MSB 18 water cannon. These cannon had been borrowed from the Belgian police authorities. The interim statement was required to facilitate the consideration of future water cannon use and in particular, the proposal for purchase of water cannon for use by the PSNI.

6. On 18 July 2002, the Northern Ireland Office Minister of State announced that the PSNI - following discussions with the Northern Ireland Policing Board and the Association of Chief Police Officers (ACPO) - would shortly place an order for six new vehicle-mounted water cannon. Upon the announcement, a PSNI, ACPO and Home Office project team took forward the procurement, and following an objective review of the specifications of water cannon from two manufacturers that had responded to a technical requirement, a contract was negotiated with Somati of Belgium to supply six water cannon – the Somati RCV9000 Vehicle Mounted Water Cannon. The first two of these vehicles were accepted by the PSNI in August 2003, subject to a medical statement by DOMILL. ACPO produced guidance on the deployment and use of the water cannon in the UK[14]. The water cannon are a new design, and there is no history of operational use.

7. DOMILL was requested to produce a statement on the medical implications of the use of the Somati RCV9000 within the ACPO Guidance. The Defence Science and Technology Laboratory (Dstl) developed and implemented a technical strategy to gather experimental data to underpin DOMILL's statement. The strategy was based on the recommendations presented in para. 14 of the interim DOMILL statement[9]. Dstl undertook tests on the Mol CY NV MSB 18 water cannon in October 2002, and on the first two Somati RCV9000 vehicles in Belgium in early September 2003.

8. A DOMILL statement was prepared in October 2003. However, familiarisation trials undertaken by PSNI identified technical problems in the first two vehicles that required modifications by the manufacturers. DOMILL withheld its statement until additional tests could be undertaken by Dstl to ensure that the modifications had not increased the injury potential of the systems. The additional tests on the first and second vehicles took place in February 2004; the water jet outputs of the third and fourth vehicles were also determined at the same time. This statement encompasses these data.

Technical approach

[12] Patten Report Recommendation 69 and 70 Relating to Public-Order Equipment – A research programme into alternative policing approaches towards the management of conflict. Second Report of the Steering Group; November 2001.

[13] Patten Report Recommendation 69 and 70 Relating to Public-Order Equipment – A research programme into alternative policing approaches towards the management of conflict. Third Report of the Steering Group; December 2002.

[14] Association of Chief Police Officers. Guidance on the Deployment and Use of Water Cannon.

9. The approach was two-fold: a comprehensive review of the literature pertinent to water jets, and a comparison of the water jet output and its effect on responding structures selected to predict the principal hazards. The potential injuries from a jet of water are defined thus:

- Primary injuries are those caused directly by the energy of a water jet impacting the human body (including rotational injuries to the head and neck).

- Secondary injuries are those caused by the impact on the human body of street furniture or other debris, energised by the water jet.

- Tertiary injuries are caused by impact of the body with other items, as a result of the initial event, such as being thrown against a wall or falling.

10. For the literature review, over 500 references and web-sites were reviewed. The documents and web-sites addressed the use of water cannon, and injuries attributed to that use, the physics of water jets, and injuries reported from the impact of water in other scenarios, such as water sports. Dstl reviewed the technical specifications of some of the water cannon used recently in Northern Ireland, Belgium and Germany, and the nominal specification of the Somati water cannon to be purchased. Dstl updated the review to gather any new information published between the interim DOMILL statement (May 2002) and February 2004.

11. The technical assessment comprised the following activities on the Mol and Somati water cannon:

c. Measurement of the gross fluid output;

d. Definition of the biologically effective loading within the jets;

e. Measurement of the contact velocity and acceleration of the head with a rigid object such as a wall or the ground;

f. Measurement of the initial linear and rotational acceleration of the head/neck assembly following direct or sweeping interaction of the jet with the head, and with the torso;

g. The distribution of representative debris accelerated by the cannon directed to the ground, and the risk of specific injuries such as ocular trauma;

h. The risk of primary injury to the torso and head assessed using physical models.

12. Vehicle-mounted water cannon are less accurate than those LL options that are designed to strike specified individuals. However, they can be used in a variety of modes that reduce the energy transferred to the body by the water: spray or diffused output; short bursts of water jets; continuous water jets. The technical assessment used continuous water jets; uses of lower forces, such as spray output, were considered to be less hazardous. Specifically designed force plates of five different diameters were used to measure the force and the pressure (force per unit area) from the jets. Hybrid III automotive dummies and other injury assessment models were exposed to the jets to assess the hazard. The force and pressure from the jets, and the responses of the injury assessment models were determined at a number of ranges, and cannon output pressure settings. The tests in February 2004 to check the output of the first two vehicles after the modifications, and the tests on the third and

fourth vehicles, only employed force plates. The ACPO Guidance was reviewed to assess how the risks were to be controlled in operational use.

Conclusions

Literature review

13. On the basis of the review of a diverse body of literature - little of which had direct, substantiated relevance to the medical consequences of the operational use of water cannon or its use in training - the following conclusions are offered.

14. **Deaths:** There was no evidence in the peer-reviewed journals, press, police or fringe literature reviewed that any person has been killed by the direct or indirect effects of the impact of a jet from a water cannon in appropriate operational use. This conclusion encompasses injuries directly from the jet impact (primary injury), penetrating or blunt impact injuries from debris and street furniture accelerated by the jet (secondary injury) and the impact of the accelerated human body against solid objects or the ground (tertiary injury).

15. **Life-threatening injuries:** In the world-wide literature, there was an extremely low incidence of injuries that could be classed as life-threatening attributable to, or actually caused by water cannon jets. The Belgian and German police authorities, and the PSNI have no reports of serious or life-threatening injuries to the public that could be attributed to the jet of the Belgian Mol CY NV MSB 18 or the German Ziegler water cannon. It should be recognised however that the use of force of any nature carries a risk of injury.

16. In public order incidents in which water cannon may be deployed, it may be difficult to differentiate injuries arising directly from the use of water cannon, as opposed to those caused by other LL weapons such as batons, kinetic energy projectiles, physical assaults or chemical irritants, in cases where such approaches are also used. This clouded the review of all sources of published information on the use of water cannon, and will have implications for assigning injuries arising from future deployments and use, in the subsequent audit.

Technical assessment

17. **Water jet dynamics:** The measured forces and pressures were very variable; this was principally a consequence of the natural structure of water jets, and the difficulties in directing water jets to small experimental targets. Overall, the forces and pressures from the Somati water cannon at maximum pressure were greater than those of the Mol at the same range, although this was not reflected in the variable response of the principal injury model deployed. There was no significant difference between the water output of the four examples of the Somati water cannon.

18. The pressures measured by the force plates were predicted to be sufficient to displace personnel at medium range. At short range, the predicted pressures to the ocular area exceeded a threshold developed from the medical review, and could result in ocular injury.

19. **Response of the injury models:** Unsurprisingly, the responses of the models were also variable. Jets from both types of water cannon directed to the head/neck area could result in high forces that directly accelerate the head/neck assembly. Using a Hybrid III dummy restrained at the torso, the accelerations, forces and moments indicated that according to criteria developed for automotive impact, serious injuries would not be expected, although there was undoubtedly a risk of injury.

20. An unrestrained Hybrid III dummy was accelerated and displaced by the jet, and struck either the ground, or a barrier placed 2 m behind the dummy. The peak accelerations to the head upon the secondary impact were high, and in some cases exceeded the automotive thresholds for serious injury. The high accelerations were observed with the Mol and Somati water cannon. The loads in the neck were also high, and were close to but did not exceed the automotive criteria for serious injury. The loads indicated that there was a risk of injury ("moderate" as defined by the Abbreviated Injury Scale). The Hybrid III dummy does not model the controlled fall of a human; in practice, it is likely that in a human, forces on the head and neck would be less.

21. There was no evidence from the models deployed that there was a significant risk of direct thoracic injury from the jets, arising from body wall deflection. However, in a few of the instances when the dummy was displaced by the jet, high accelerations to the rear of the thorax were observed, as a result of impact with hard surfaces.

22. The application of the water jets to the ground resulted in the acceleration of small pieces of debris to a height that resulted in the risk of non-penetrating impact to standing and seated personnel. The principal risk was impact to the eye.

Overall assessment

23. The hazards identified in the trials have been reviewed in the context of the ACPO Guidance, and the information acquired from the literature survey. It is concluded that the use of the Somati RCV9000 Vehicle Mounted Water Cannon within the ACPO Guidance is unlikely to result in serious or life threatening injuries.

Recommendations

24. Any modifications to the vehicles relevant to the jet output or use of the jets, or any changes to the ACPO Guidance, should be reported promptly to DOMILL.

25. The output of the jets from the two remaining Somati vehicles should be determined prior to operational deployment and use.

26. The maintenance schedule and routine review of the suitability for service of the vehicles should include a check of the calibration of the water pressure sensors in conjunction with the control system.

27. The training syllabus for Water Cannon Commanders, Operators and Drivers should be reviewed by DOMILL to ensure that the medical risks of the use of the system (declared in the ACPO Guidance) are clear and understandable.

28. DOMILL should be advised immediately of any injuries specifically attributable to the operational use of the water cannon, or in training.

29. DOMILL request a joint report from ACPO, the Home Office and the Northern Ireland Office on the operational performance of the Somati water cannon, and the frequency and type of injuries directly or indirectly attributed to the water cannon. It is requested that this report is provided within one year of the formal acceptance of the first four Somati water cannon by PSNI.

Chairman, DSAC Sub-committee on the Medical Implications of Less Lethal Weapons
3rd March 2004

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