Conducted Energy Weapons

Gaps Analysis for Test Procedure (Version 1.1)

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Contract No: EN578-060502/053/ZT

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Defence R&D Canada – Centre for Security Science

September 2010

DRDC CSS 3781-2010-32BJ

Abstract

A Conducted Energy Weapons (CEW) Test Procedure (Version 1.1) was completed on 31 July, 2010 by an ad-hoc committee of independent subject matter experts. The primary focus of the paper was to provide a methodology to enable "organizations across Canada to test CEWs in a reliable, repeatable manner to determine whether they are operating within manufacturer's specifications." A number of areas require further discussion, development and/or research in order to enable the document to become expanded into a comprehensive CEW Test Protocol. This report examines those areas. The analysis is divided into three sections: Technical Details of Test Procedure, Other Test Protocol and Related Areas, and Medical Knowledge.

Résumé

Une procédure d'essai (version 1.1) d'armes à impulsions a été réalisée le 31 juillet 2010 par un comité spécial d'experts indépendants en la matière. L'objectif principal du document en cause était de présenter une méthodologie qui permettrait « aux organisations dans tout le Canada d'éprouver des armes à impulsions d'une manière fiable et reproductible, afin de déterminer si elles fonctionnent conformément aux spécifications du fabricant. » Plusieurs domaines nécessitent davantage de discussions, de développement et de recherche pour que le document puisse être élargi pour devenir un protocole global d'essai d'armes à impulsions. Le présent rapport présente l'examen de ces domaines. L'analyse est divisée en trois parties : les détails techniques de la procédure d'essai, le protocole d'essai et les domaines connexes et la connaissance médicale.

Executive summary

Conducted Energy Weapons: Gaps Analysis for Test Procedure (Version 1.1)

Laurin Garland; Donna Wood; DRDC CSS CR 2010-999; Defence R&D Canada – CSS.

Background: A Conducted Energy Weapons (CEW) Test Procedure (Version 1.1) was completed on 31 July, 2010 by an ad-hoc committee of independent subject matter experts. The primary focus of the paper was to provide a methodology to enable "organizations across Canada to test CEWs in a reliable, repeatable manner to determine whether they are operating within manufacturer's specifications." A number of areas require further discussion, development and/or research in order to enable the document to become expanded into a comprehensive CEW Test Protocol. This report examines those areas. The analysis is divided into three sections: Technical Details of Test Procedure, Other Test Protocol and Related Areas, and Medical Knowledge.

Results: The test procedure itself has a number of topics where more technical detail would be beneficial and some areas where significant research and/or discussion among subject matter experts will need to take place in order to define what additional information should be included in the procedure. Identified gaps include the following:

Calibration and Quality Assurance

Accuracy

Parameter Variability

Resistive Load

Spark Gap

Environmental Effects

Failure Modes

Frequency and Types of Tests

Data Format

Other CEWs and Electrical Discharge Weapons.

In addition, other factors not addressed in the test procedure which need to be included in a full test protocol are identified as follows:

Facilities and Personnel

Data Mining

Statement of Operational Requirement.

Finally, there is one medically related parameter which was specifically included in the CEW Test Procedure and so is discussed here. That is the consideration that ventricular fibrillation is a significant potential negative outcome of CEW usage on humans and that, as a result, limits on a measure such as monophasic charge should be included as a performance criterion related to risk of ventricular fibrillation.

Significance: While this document is not meant to direct how the identified gaps should be addressed or what research or development should be undertaken, familiarity with the test procedure development and a review of the state of knowledge for the gap areas identified leads the author to make suggestions for some areas where it appears a given way forward may be preferable.

Future plans: The results of this report will be used to inform a team of engineers and policy makers developing the detailed test plan to be undertaken by the CEWSI project team.

Sommaire

Conducted Energy Weapons: Gaps Analysis for Test Procedure (Version 1.1) (armes à impulsions : analyse des carences pour une procédure d'essai (version 1.1)

Laurin Garland; Donna Wood; DRDC CSS CR 2010-999; Recherche et développement pour la défense Canada – SLC.

Introduction : Une procédure d'essai (version 1.1) d'armes à impulsions a été réalisée le 31 juillet 2010 par un comité spécial d'experts indépendants en la matière. L'objectif principal du document en cause était de présenter une méthodologie qui permettrait « aux organisations dans tout le Canada d'éprouver des armes à impulsions d'une manière fiable et reproductible, afin de déterminer si elles fonctionnent conformément aux spécifications du fabricant. » Plusieurs domaines nécessitent davantage de discussions, de développement et de recherche pour que le document puisse être élargi pour devenir un protocole global d'essai d'armes à impulsions. Le présent rapport présente l'examen de ces domaines. L'analyse est divisée en trois parties : les détails techniques de la procédure d'essai, le protocole d'essai et les domaines connexes et la connaissance médicale.

Résultats : La procédure d'essai elle-même comporte plusieurs sujets sur lesquels il serait avantageux d'obtenir davantage de détails techniques, et quelques domaines dans lesquels une importante recherche et des discussions entre les experts en la matière devraient avoir lieu, afin de déterminer quels renseignements devraient être inclus dans la procédure. Les carences identifiées comprennent :

- L'étalonnage et l'assurance de la qualité
- L'exactitude
- La variabilité des paramètres
- La charge résistive
- L'écartement des électrodes
- Les impacts sur l'environnement
- Les modes de défaillance
- La fréquence et le type des essais
- Le format des données
- Les autres armes à impulsions et les armes à décharge électrique

En outre, le rapport indique les autres facteurs dont le protocole d'essai ne tient pas compte et qui devraient être inclus dans un protocole d'essai complet, notamment :

- Les installations et le personnel

- L'exploration des données
- L'énoncé des exigences opérationnelles

Enfin, il existe un paramètre d'ordre médical qui a été expressément inclus dans la procédure d'essai d'armes à impulsions et qui est donc présenté ici. Il s'agit de la possibilité que la fibrillation ventriculaire soit un effet négatif éventuel et important de l'utilisation des armes à impulsions sur des humains et que, par conséquent, il faudrait inclure des limites à une grandeur telle que la charge monophasique comme critère de performance touchant le risque de fibrillation ventriculaire.

Portée : Bien que ce document n'ait pas pour objectif d'ordonner comment les carences identifiées devraient être corrigées, ni quelle recherche ou développement devraient être entrepris, une connaissance de l'élaboration des procédures d'essai et un examen de l'état des connaissances dans les domaines des carences identifiées conduisent l'auteur à formuler des suggestions dans certains domaines lorsqu'il serait parfois préférable d'aller de l'avant.

Recherches futures : Les résultats de ce rapport seront utilisés pour informer une équipe d'ingénieurs et de décideurs du plan d'essai détaillé que devra entreprendre l'équipe de projet de l'ISAI.

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Acknowledgements

During the course of the CEW Test Procedure development, input was received from a number of participants, representing both academia and industry. As noted throughout this Gaps Analysis, there was considerable discussion on many points. In the interest of arriving at a consensus document in a reasonable time frame, certain areas of discussion among the authors were not able to be resolved prior to publication of the test procedure. These are reflected in many of the items detailed in Section 2 of this Gaps Analysis. Thus, although this report does not necessarily reflect their opinions, the contents were informed by the input of all the authors of the test procedure.

The authors of the test procedure were: Andy Adler (Carleton University), Dave Dawson (Carleton University), Ron Evans (Datrend Systems Inc), Laurin Garland (Vernac Ltd.), Mark Miller (Datrend Systems Inc.), and Ian Sinclair (MPB Technologies).

This work was supported under project 3781-2010-32BJ by Defence Research and Development Canada Centre for Security Science

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1 Introduction

1.1 Background

A Conducted Energy Weapons (CEW) Test Procedure (Version 1.1) was completed on 31 July, 2010 by an ad-hoc committee of independent subject matter experts. The report can be found online at the following URL:

http://curve.carleton.ca/papers/2010/CEW-Test-Procedure-2010-ver1.1.pdf

The ad-hoc committee was formed following the May 2010 CEW Workshop at Carleton University in order to address an urgent requirement expressed by many attendees who had an operational need to test CEWs either as users or as regulators. The primary focus of the paper was to provide a methodology to enable “organizations across Canada to test CEWs in a reliable, repeatable manner to determine whether they are operating within manufacturer’s specifications.” It was recognized specifically in the document, however, that “The authors give no warranty or representation of any kind whatsoever that the recommendations contained in this report are comprehensive.” A number of areas require further discussion, development and/or research in order to enable the document to become expanded into a comprehensive CEW Test Protocol. This report examines those areas.

1.2 Terminology

The terminology around test procedure and test protocol is often loosely interchanged. For clarity, we have adopted a nomenclature convention which uses test procedure (as per the referenced paper above) to describe a document which sets out the details of equipment and steps necessary for an experienced test laboratory to evaluate the technical properties of a product in relation to required performance specifications. Test protocol is used to describe a broader document which, in addition to the test procedure, lays out all of the other conditions necessary to ensure the collection and analysis of valid data. Thus, the test procedure becomes one part of the test protocol.

1.3 Scope

The focus of this report is primarily to provide guidance as to what areas of technical interest require further exploration, however, many of the identified gap areas touch on or are primarily policy oriented, as might be expected given our definition of test protocol. The success of a comprehensive test protocol will, of necessity, involve some policy components. As a result, such areas have been identified here. One example of this is the question of required frequency of testing. While technical knowledge will inform any decision in this area, it is ultimately a matter of policy for the user or regulator.

While this document is not meant to direct how the identified gaps should be addressed or what research or development should be undertaken, familiarity with the test procedure development and a review of the state of knowledge for the gap areas identified leads the author to make suggestions for some areas where it appears a given way forward may be preferable.

The analysis is divided into three areas: Technical Details of Test Procedure, Other Test Protocol and Related Areas, and Medical Knowledge. There is, of course, overlap among the various areas to some extent. Gaps have been classified by the primary area to which they relate.

2 Technical Details of Test Procedure

During the development of the CEW Test Procedure, there was a desire on the part of the ad-hoc committee to be as generic as possible, for example in the specification of test equipment, so that all labs might be able to utilize existing equipment as long as it operated within certain guidelines. Further, there was considerable discussion among the authors on certain points of detail and on whether or not certain technical issues should be included. As noted earlier, there was a time sensitivity on the part of a number of potential users of the test procedure. Indeed, that was one of the major reasons for constituting the ad-hoc committee. As a consequence of all of the above, some details were not specified and some technical areas were not included in order to enable the publication of a consensus document within a reasonable time frame. The test procedure itself, therefore, has a number of topics where more technical detail would be beneficial and some areas where research and/or discussion among subject matter experts will need to take place in order to define what should be included in the procedure.

Identified gaps include the following:

Calibration and Quality Assurance (QA)

- Details of calibration requirements
- Surrogate CEW (or CEWs) for equipment validation and QA
- Quality Control Data Set (or sets) for software validation and QA

Accuracy

- Overall data collection accuracy requirements
- Detailed specifications for individual pieces of equipment

Parameter Variability

- Allowable variance in maxima and minima for voltage, current, etc.

Resistive Load

- Detailed specifications and adequacy of values chosen

Spark Gap

- Definition of spent cartridge or equivalent

Environmental Effects

- Expected usage and requirement for environmental tests

Failure Modes

- Other specific methodologies to test for potential failure modes

Frequency and Types of Tests

- Spark test - required or not

- Daily (or shift level) test vs maintenance level
- Digital Power Module (DPM) replacement, software version effects

Data Format

- Standardization and definition

Other CEWs and Electrical Discharge Weapons

- Other CEWs which are not covered by the CEW Test Procedure
- New CEWs and Electrical Discharge Weapons under development.

Each of these areas is covered in more detail in the following sections of this report

2.1 Calibration and Quality Assurance

2.1.1 Yearly Calibration

Calibration of test equipment helps ensure the repeatability of measurement and its precision. The statement in the test procedure, under section 3.2 is as follows: "All test equipment must be calibrated yearly to national standards." More detailed guidance should be provided here. There are a number of recognized standard approaches to ensuring appropriate calibration of test equipment. One example is PALCAN Policy on Calibration and Measurement Traceability, CAN-P-1626, November 2009 published by the Standards Council of Canada. While it should not be the goal of the test procedure to overly encumber any test laboratory with costly procedures, equipment calibration is the foundation for measurement repeatability and precision and thus data validity. The test procedure would benefit from the inclusion of a recommended approach to ensuring appropriate calibration.

2.1.2 Surrogate CEW

Calibration of equipment is one of the keys to ensuring integrity of test data. This, however, addresses only part of the data capture event. Sampling rates, signal filtering and data storage processes also all have the potential to introduce false readings which would invalidate the test results. In order to ensure that the test set up is capturing and storing exactly what is required by the procedure and is not introducing any artefacts, we need a Surrogate CEW, which creates a representative, repeatable input pulse train, coupled with a set of raw data which represents what any test system should record when testing the Surrogate CEW . This type of calibrated input device is often colloquially referred to as the Gold Standard. This will enable test labs on a regular basis to verify the set up and operation of their probes, data acquisition systems or oscilloscopes, connectors and wiring, as well as data sampling and storage processes.

Such a Surrogate CEW will need to reproduce a repeatable pulse train with characteristics similar to those created by the types of CEWs liable to be tested. It may be necessary to create individual surrogates for each model/type of CEW in order to enable adequate conformance between surrogate and weapon. On the other hand, some research effort might indicate that a single surrogate would suffice. Consideration will need to be given to the effect of individual pulse shape on results and whether or not to introduce variability in parameters such as Pulse Repetition

Rate, Peak Voltage and so on (and to what level). Traceability of the measured output of such a surrogate back to national standards will also be a consideration.

A method for automatically comparing the lab test results with the known data set and identifying acceptable conformity will also need to be developed.

Finally, there is a matter of policy around whether such a surrogate should be centrally maintained with a requirement for test labs to send their equipment yearly for validation/calibration, or whether individual labs could create their own as long as it is traceable back to national standards. There are arguments on both sides of this issue.

2.1.3 Quality Control Data Set

As with the test data collection and storage process, the analysis also has the potential for introducing false results. As currently outlined in the test procedure, Carleton University has made a version of analysis software available, however, any test laboratory could develop and use its own version of data analysis software in order to calculate from the raw data the parameters required by the procedure in order to determine weapon performance. This allows for variances in the methodologies used during software development and thus possible differences in the calculated outputs.

To be able to verify the integrity of the outputs of any different data analysis programs, we need a Quality Control (QC) Data Set (or more than one) which is representative of the types of raw data which should be collected and stored. This would enable test labs to verify the function of their data analysis programs by feeding the QC Data Set(s) as input to the analysis and comparing the output with known expected values. As with the Surrogate CEW, there are questions as to the details of data and what levels of variability in raw data to include in such a data set.

Once again, it may be necessary to create individual data sets for each model/type of CEW in order to enable adequate conformance between QC data and weapon data. On the other hand, some research effort might indicate that a single QC Data Set would suffice.

Note that it may be desirable also to have both of the previous Quality Control approaches combined into one, so that a tester may simply test a Surrogate CEW using the test equipment, feed the output raw data through the analysis program and compare the final results to the required output of the QC data set. In some instances this may even be necessary, as a complete set of "test equipment" could also include firmware for the analysis of raw data and it would be inconvenient to try and separate the two for individual validation.

2.2 Accuracy

2.2.1 Measurement Accuracy

In addition to repeatability and precision, measurement accuracy is an important factor in the collection of valid data. The accuracy of a measurement system may be thought of as the degree to which measurement of a quantity approaches its true value. Each of the components of a measurement system has an inherent accuracy (or inaccuracy) and these combine to result in an overall measurement system accuracy. Some of the possible effects of using a measurement system with a low degree of accuracy include failing of test units which are actually operating within specification or the converse of accepting test units which are actually performing outside allowable tolerance. The specification of the required system accuracy has a significant effect on the validity of results as well as the cost of test equipment. Too low an accuracy results in the type of errors noted above. Too high an accuracy will result in excessive equipment costs.

As noted earlier, the approach taken with the test procedure was to be as generic as possible in order to allow various test laboratories to utilize existing equipment. As a consequence, no specific type of equipment was required. For example, the option was given to use either a voltage probe or a current probe for measurement of electrical characteristics. The overall accuracy of the final data measurement was specified under section 3.3 simply as “sufficient to achieve at least 1% maximum voltage sampling error as per good engineering practice”.

High voltage measurement is usually subject to fairly large inherent error, (2% or greater) whereas current measurement may be significantly more precise. To pick a representative example, the Tektronix P6015A high voltage attenuating probe of the type which would meet the specification in the test procedure, is reported by authors of the test procedure to have an inherent measurement error due to attenuation of +/-3% (although this number is not directly available from manufacturer’s literature). To use this to calculate current values, which are required for the calculation of charge, one must also factor in the error in load resistance which, while it may be small, still exists. (Note that the present CEW Test Procedure does not specify any tolerance on the resistive load values). On the other hand, a Pierson model 101 current probe which would again meet the specifications given in the test procedure has a sensitivity of +1/-0 %. Use of the voltage probe to measure voltage and then calculate a 3A peak current over a 500 Ω load (from a voltage measure of 1500 V) would result in an uncertainty of +/- 90 mA (plus whatever uncertainty is introduced by the resistor value tolerance) compared to a direct measurement of current which would give an uncertainty in measurement of +30/-0 mA. This difference in error of measurement of peak current has a similar influence on calculation of total or monophasic charge.

One problem which may result from the existing test procedure requirement is that a detailed analysis of individual laboratory test equipment systems may actually show that a lab is unable to meet the 1% specification, given the inherently less accurate nature of their high voltage measurement equipment.

One acceptable means of determining overall measurement system accuracy is the IEC/ISO 98-3:2008 Guide to the Expression of Uncertainty in Measurement (GUM) which is referred to in the Test Procedure appendices. Such an approach could be used to determine overall accuracy for the equipment system to be used. That in turn needs to be evaluated in light of an informed judgement as to what level of inaccuracy is acceptable to users of the CEWs under test. This may ultimately be further informed by the results of medical research which could shed some light on acceptable limits for CEW performance.

2.2.2 Component Specification

As with measurement accuracy, detailed specification of measurement system components was left flexible in order to accommodate various existing test equipments. For example, the CEW Test Procedure specifies connecting wires be "as large a gauge as practical in order to minimize impedance" and "Should be kept as short as possible".

Further, the input signal filtering was specified simply as "Anti-aliasing low pass filter (5 MHz) in accordance with good engineering practice" and the specification for measurement set up was given as "Adequate pre-trigger interval if pulse triggering is used".

All of these invoke good engineering practice, which is reasonable, however, they do allow for some variability from lab to lab and thus may affect the accuracy of data collected. It is likely that with a little further discussion among the authors, more specific detail could be provided across the entire test equipment list. This would further reduce the potential for variability in results from lab to lab without significantly restricting the ability of test laboratories to use existing equipment.

Further analysis of overall measurement system cumulative error and the required specification of both overall and individual system component accuracies and characteristics should be carried out.

2.3 Parameter Variability

Considerable discussion was held with respect to whether or not to add in requirements which would limit the allowable variability of measured parameters such as Peak Voltage, Peak Current, Total Charge, and so on. The manufacturer's specifications calculate allowable values for these parameters by taking the average value for the last eight pulses in the second test burst, however, there are no requirements which limit the variance of these parameters, for individual pulses within the burst, above or below the calculated average. The same holds true for Pulse Repetition Rate which is measured over the last second of the first test firing. Variability during that burst or the other test burst(s) is not considered. Additionally, there are parameters of importance such as Burst Length which are defined by the manufacturer in the literature but not specified as required to determine in tolerance performance. These are also subject to variability which might have an impact on weapon effects (for example a burst which exceeds the 5 sec. nominal value may deliver more charge).

There is substantial evidence from testing carried out to date that significant variability exists and there is concern that such variability could lead to unwanted applications of out of tolerance values even though the unit has been reported as being within manufacturer's specifications based on the averages. This is one of the reasons for the addition to the test procedure of a third test burst and for the requirement to collect and store all raw data over the three weapons firings. This will allow future analysis of large quantities of data to look at things such as variability of results within individual firings of the weapons.

It should be noted that because CEWs are designed to be Less Lethal Weapons, their operating parameters are often required to fall within a range of values bordered by a minimum and a maximum. Maximums are set with a view to limiting the potential for injury to the humans receiving the application of the weapon. Minimums are set to ensure effective operation of the device from the point of view of the user. Variability of the operating parameters outside either of these bounds may be cause for concern.

In the end, it was agreed not to impose such variability limits since there was no empirical evidence to support specific numbers (such as +/-5% or +/-10%). Work needs to be done in this area in order to define allowable variability.

This is an area with considerable overlap into medical effects. While data mining might provide more evidence as to existing variability, that is only half the problem. Further research will likely also be required to show what, if any, adverse effect such variability might have on humans or on weapon effectiveness.

2.4 Resistive Load

This is an area which has implications in medical knowledge gaps as well. Considerable discussion took place during the development of the CEW Test Procedure regarding this part of the test equipment. In order to maintain conformance with manufacturer's specifications, the TASER International specified test loads were used (500 Ohm for the M26 and 600 Ohm for the X26). The test procedure addresses this in Note 3 in part as follows:

> *"We consider the test loads recommended by TASER International… to be an adequate model of the impedance load of the body. These CEWs behave largely as a current source and have relatively little variation in charge with load…. Such variation may be accounted for by the safety factor."* (Adler, Dawson, Evans, Garland, Miller, & Sinclair, 2010)

Again, this is certainly a reasonable approach to cover the requirement of establishing a procedure for existing CEWs and maintaining conformance with manufacturer's specifications. If the CEWs do indeed behave largely as a current source, by providing a constant current (and thus charge) independent of the load, this may be a valid approach. The gap which could stand more investigation is why the human body need be represented by different resistive loads for different CEWs, and whether this is an accurate representation of reality. Whether or not a purely resistive load is a sufficient representation of the human body could also be considered. This problem may become more significant as different models of CEW reach the market and as different techniques for delivering charge are used.

It would be preferable to have a more definitive representation of the human body which would serve as a test load for every type and model of CEW regardless of its functional parameters – or a definitive rationale as to why this is not appropriate.

2.5 Spark Gap

The CEWs specifically included in the test procedure utilize internal spark gaps to control the establishment of charge levels. In addition, however, there is a spark gap created externally by the mating of the weapon with the replaceable cartridge. It is this specific spark gap which is covered here. As with other parameters, there was considerable discussion regarding this spark gap. In order to maintain conformance with manufacturer's specifications for testing, the use of a "spent cartridge" was required. Additionally, however, in order to allow for some innovation and standardization of test equipment, the procedure under Note 1 says:

> *"A mechanical/electrical system equivalent to a spent cartridge may be used. If so, it must include a housing designed to firmly hold the weapon and expose it to equivalent electrical connections and spark gap as would be seen with a spent cartridge."* (Adler, Dawson, Evans, Garland, Miller, & Sinclair, 2010)

It is clear that spark gap is an important aspect in the functioning of the two models of CEW currently covered by the test procedure, however, data on what that spark gap should be in order to represent a "typical" CEW during test is unknown, and the effect on CEW output of variability in that spark gap is also unclear.

The TI procedure does not specify a spark gap dimension, it simply suggests the use of a spent cartridge to interface to the TASER. This provides an inherent gap due to the construction of the weapon system (which is important for its discharge characteristics). According to data from two of the authors of the test procedure, measurements on a TASER X26 and some cartridges indicate this gap has significant inherent variability. There are actually 2 gaps in the TASER/cartridge interface, one at each electrode. The first variable is the distance the electrodes protrude above the surface of the plastic case of the weapon (measurements from 0.3 to 0.5mm). The second variable is the distance the cartridge terminals are recessed within the cartridge (6 measurements from 3 cartridges: 1.73, 1.76, 1.76, 1.76, 1.83, 1.98mm). The third variable is the seating of the cartridge in the TASER (the cartridge has some variability in position depending on how hard the cartridge is pushed in, due to some inherent tolerances to allow the catches to work consistently). This interface adds up to 0.5 mm to the gap. Note also that there are at least three versions of cartridge for the X26, so additional variability is possible. There have been some reports that testing with gaps varying from 0.3 to over 10.0 mm has had no substantial effect on the results, however a more definitive study should be carried out.

As an addendum to this, there is no definitive data regarding an appropriate usage life for the spent cartridge (or equivalent). Laboratory experience indicates that contact wear due to arcing should not be a problem, however, it might be advisable to collect data in this area from labs conducting regular tests so that additional specifications could be added to the test procedure. The existing procedure simply states as follows in Note 2:

> *"Repeated use of the spent cartridge will result in build up of deposits due to arcing. Inspect and clean the cartridge regularly."* (Adler, Dawson, Evans, Garland, Miller, & Sinclair, 2010)

2.6 Environmental Effects

It is not known to what extent environmental factors play a significant part in any variability in or deterioration of performance for existing CEWs. At present, the CEW Test Procedure does not include any tests for such environmental factors.

It is normal practice to test equipment for exposure to environmental effects based on expected usage scenarios. MIL-STD-810 is an often cited US military testing standard which provides test procedures for a wide range of environmental conditions. These tests might include exposure to, for example, shock and vibration, humidity, and temperature (both high and low). The Canadian usage environment would indicate that some consideration should be given to testing for the effects of exposure to cold as a minimum, since the TASER Certified Test Procedure for the X26, as an example, requires all testing be carried out at 25C +/- 5C, a temperature range which is not at all representative of Canadian usage conditions, and there is little information available on specification sheets regarding the expected range of environmental conditions for which the weapon is suited.

The brochure for the newer TASER X3 claims protection of the device from "environments such as high humidity, salt-fog, or even full submersion in water". If these are considered useful performance characteristics by the manufacturer, they should be included in the test procedure. Resistance to inadvertent discharge as a result of static electricity might also be a consideration worth testing, as this is claimed to be an improvement in performance characteristics for the X3.

2.7 Failure Modes

Out of tolerance performance incidence rates from 3 to 10% for in-service CEWs are being reported based on testing done to date using present test methodologies. The major out of tolerance parameter in these cases appears to be Pulse Repetition Rate. Little work has been done on whether or not there are specific failure modes for existing CEWs, however, there is some indication that such do exist. Digital Power Modules and related software/firmware version (for earlier versions) have been identified as an area of concern as has the gas discharge tube and associated LED which forms part of the in-service TASER systems.

Other areas of concern include the DPM display which shows battery status (Is it an accurate reflection of actual battery capacity?), and the data download available (Does it accurately represent weapon usage history? Is there any method to independently verify this accuracy?).

Investigation of the designs, and discussions with testers who have conducted thousands of tests on CEWs might establish the likely failure modes for these weapons. This would then allow the development or incorporation of test methods which would predict imminent failure by selectively looking at the components which are expected to fail.

Additionally, selective testing based on the potential failure modes highlighted during the previous design review and discussions might reveal actual failures of specific components.

Tests for such failure modes would, however, likely be design specific and the preferred approach for a standard test procedure applicable to all designs is to incorporate performance based testing.

In order to remain as performance oriented as possible, it may be appropriate to use environmental exposure tests as per the preceding section to expose any potential design specific problem areas.

2.8 Frequency and Types of Tests

Many users conduct "spark test" level testing before every shift where a weapon is issued. This involves simply pulling the trigger on the weapon without having a cartridge inserted. This causes current flow through an arc across the exposed terminals which normally seat into the cartridge. In addition, some testing organizations carry out such a spark test prior to conducting testing to a more detailed test procedure. The rationale for both of these is that the spark test "conditions" the weapon, likely by ensuring internal capacitors are fully charged, and thus prepares the weapon for proper use on any subsequent trigger pull. This is thought to be of particular benefit for those services where weapons are not issued regularly but only in response to a specific incident and thus may have spent some time on the shelf.

Such a spark test is not mandated by the manufacturer as a warranty required procedure, although it is believed to be recommended practice, and it is not required as part of the manufacturer specified test procedure. In addition, a concern of the ad-hoc committee was that if, through differing policy for a given police service or through breakdown in standard procedure on a given day, a weapon was released into service without such a spark test, it would need to function within specification on first trigger pull. Any weapon which could not do so should not be issued into service until it could do so (either through simple replacement of the batteries or DPM, or through repair). As a result, the authors of the CEW Test Procedure agreed that a spark test would not be included in the document.

As a result, the CEW Test Procedure states under Note 4 as follows:

> *"The full procedure with three weapon firings is meant to collect additional data for future data mining. This should be used for acceptance testing and regularly scheduled maintenance testing. For users wishing to conduct daily testing, only two firings are required in order to determine weapon compliance with manufacturer's specifications."* (Adler, Dawson, Evans, Garland, Miller, & Sinclair, 2010)

Following the release of the CEW Test Procedure there has been some discussion that daily or every shift testing using the two firings test procedure will add significant cost to operations though depletion of batteries or Digital Power Modules. It has been asserted by some users that a full two burst test will decrease battery life by approximately 1%. This is supported by testing carried out by some of the test procedure authors, which indicates a full three burst test will reduce battery capacity, as indicated on the weapon display, by around 2%. In order to assist in acceptance of the test procedure, particularly if its use may significantly increase operating costs, additional investigation should be carried out to look at the effectiveness of a simple spark test, primarily for daily use.

This needs to be coupled with an investigation of the required frequency of test using the two and three firing procedures mentioned in Note 4. Does the two firing procedure need to be carried out daily, or will a daily spark test coupled with something such as a weekly two firing test adequately indicate weapon suitability for duty? How often should the "regularly scheduled maintenance testing" be carried out? This, of course, is a matter of policy, but that policy should be informed by technical knowledge.

This also touches on another policy area of concern for users. In its Certified Test Procedure for the X26, TASER International notes as follows:" If the DPM/XDPM is less than 25% (as shown on the X26 CID when armed), replace the DPM/XDPM with a new DPM/XDPM." Various police services use different criteria for DPM replacement, ranging from 20% to 30%. The CEW Test Procedure developed by the ad-hoc committee does not include any such criterion, rather taking the view that the weapon system should be tested as supplied to the lab. This is covered under Note 6 in part as follows:

> *"Note that for some weapons, introduction of a new DPM may introduce new operating software, which will create an essentially new configuration for the weapon. This procedure should only be carried out if prior agreement on this policy has been established with the owner of the weapon and, in any event, a complete test series should be repeated on the new weapon/power system combination and reported as a separate test with a separate test report."* (Adler, Dawson, Evans, Garland, Miller, & Sinclair, 2010)

It may be that investigation of failure modes as per the previous section 2.7 will be able to inform policy in this area.

2.9 Data Format

In order to ensure data from all sources can be used in future data mining, particularly in an automated fashion, a convention for data format standardization should be established and included in the test procedure. A format has been provided for a hard copy report, however specifications for an electronic version should also be included. If data is to be collected in electronic form, from numerous test facilities across the country to be used in future data mining, there will need to be some convention as to what data is reported, in what order and in what specific format. As a very simple example, the appropriate Canadian format for date, according to ISO 8601, which was adopted by this country, is yyyy/mm/dd, however various alternatives obviously exist and are in use in various jurisdictions within the country. Without clear direction for all required data items, comparability of data from lab to lab will not be possible.

2.10 Other CEWs and Electrical Discharge Weapons

This is perhaps the most potentially challenging of the gaps identified. During the development of the test procedure, the approach taken was to craft a main body which was as generic as possible in terms of equipment and methodology so that it could be applied to CEWs other than the two TASER variants (M26 and X26) which were in service at the time. Specific appendices were added in order to accommodate the need for differing values of parameters such as load resistance and allowable values for performance measures such as Peak Voltage and Peak Current for the two devices.

Given the wide range of CEWs which are now either available on the market or which are under development for near term future release, this may not prove to be an approach which continues to be viable. In addition, there are weapons under development which use electrical discharge, but, which could not properly be referred to by the acronym CEW, as the energy is not "conducted". Further, there are similar weapons which are not hand held. How to contain the scope of a "CEW" Test Protocol as distinct from a much broader Less Lethal Weapons Test Protocol will be a challenge.

This section of the report gives an overview of some other CEWs and electrical discharge weapons which are currently available and some which will be available in the near term, in order to indicate the possible scope of the problem of creating a single test procedure which will be applicable to all.

2.10.1 Existing CEWs

At present we have detailed test procedure and test data analysis numbers for two models of CEW, the TASER M26 and X26. There are two other models of handheld TASER on the market, the X3 and the XREP, for which we have no detailed data. In addition, there are a number of Stinger Systems Inc S200 units in service. Stinger Systems has recently been acquired by Karbon Arms who now offer a "Multi Purpose Immobilization Device" to replace the S200.

As a minimum, appendices will need to be developed for each of these units if the test procedure is to be capable of addressing all hand held CEWs which may be introduced into service in Canada in the near future.

Modifications to the main body of the test procedure may well also need to be incorporated in order to address the different operating parameters of these devices. For example, the X3 is meant to use up to three separate cartridges at a time. This is clearly a different operating profile from the other two models and may affect the test procedure necessary to confirm operation within manufacturer's specifications. The XREP cartridges are self contained and fired from a shotgun and will, as a result, have kinetic energy (blunt trauma) effects that need to be tested in addition to the electrical parameters. Indeed, the advertising literature for this device highlights this additional feature.

Any future CEW products will also need to be considered as they present themselves on the market. The TASER M26 and X26 are not the end of the technical development in this area of technology.

To this point, the Test Procedure addresses only those products which are in use by Canadian police services at the present time. In addition to the TASER X3 and XREP and the Stinger and Karbon Arms hand held weapons previously mentioned, other related CEW weapons approaches are being offered for sale but have not yet been adopted by the Canadian police population. The TASER Shockwave, for example is a multiple unit ground based system used to simultaneously fire numerous cartridges at multiple targets for use in a crowd control, area denial scenario. The Karbon Arms Ice Shield is a crowd control personal shield with conductive strips built in to the forward face, which can deliver electrical pulses on contact with a subject or subjects. The

Karbon Arms Band-It is a universal sleeve which is placed either on a prisoner's leg or arm. Through a placement of electrodes on the subject's leg or arm, the Band-It delivers an incapacitating electric shock if the subject attempts to escape or attack. These impulses can be set to go off automatically on movement or manually with a wireless remote up to 175 feet away.

2.10.2 Weapons Under Development

Research and development is proceeding at present on Less Lethal Weapons that use Electro Muscular Incapacitation in a different but related manner in order to achieve subject submission.

As an example, the Joint Non-Lethal Weapons Program of the US Department of Defense is working on an approach using a nanosecond electrical pulse (nsEP) to, in the words of the program,

> *"…examine whether stimulation with ultra-short nanosecond electrical pulses can cause safe, controlled, temporary and reversible incapacitation of individuals. This counter-personnel capability will give warfighters a non-lethal option to deter, suppress or even temporarily disable suspicious individuals. It will provide an escalation-of-force option to minimize casualties and collateral damage across the range of military operations.*
>
> *Nanosecond electrical pulses generate extremely high peak powers but for only very short durations— tiny fractions of a second. Yet these durations are long enough to create reversible incapacitation effects in biological tissue. Also, nsEPs use very low average power. This is important because it means they could potentially be incorporated into small hand-held weapons.*
>
> *A single-shot, prolonged incapacitation from nanosecond pulses has the potential to support a medium-range, wireless electro-muscular incapacitation capability. A small, lightweight, pulse-creating device could then provide prolonged incapacitation with only a single discharge of the weapon. The project's ultimate goal is to provide reliable and repeatable nanosecond or short-pulse electrical waveform characteristics that produce long-duration incapacitating effects with minimal risk of injury."*

A potentially more short term entry into the market may be the Sticky Shocker, manufactured by L-3 Applied Technologies. The company web site states the following about the Sticky Shocker.

> *"L-3's Advanced Technologies Division (ATD) has a variety of nonlethal weapons in development for both military and law enforcement applications. One of those devices, dubbed Sticky Shocker® for its ability to both stick to a human target and electrically stun the person, is nearing completion of engineering development. This project is being sponsored by the Defense Advanced Research Projects Agency and the National Institute of Justice through the Joint Program Steering Group.*
>
> *The Sticky Shocker® idea evolved in response to the need for a nonlethal weapon bridging the gap between kinetic rounds (e.g., rubber bullets, beanbags, wooden batons) and devices designed for use at close-in range, such as electric stun devices with darts and pepper spray (effective only within 5 m) or stun guns (arms-length range). The Sticky Shocker® concept puts stun gun technology on a wireless self-contained projectile,*

allowing temporary incapacitation of a human target at safe, stand-off distance, using a widely accepted 40 mm or 37 mm projectile configuration and conventional launchers. The Sticky Shocker® can extend the range of electrical stun technology out to 10 m and potentially further. The projectile contains a battery pack and associated electronics that will impart a short burst of high-voltage pulses. Pulse amplitudes are near 50 kV with pulse widths of a few microseconds and repetition rate between 10 to 15 pulses per second. The pulse characteristics are similar to those of commercial stun guns. The pulses are not lethal but will disable a human target temporarily, with full recovery from impact within a few minutes."

Other developments of CEW related munitions call for the miniaturization of stun cartridges, which would enable them to fit into 5.56 mm ammunition. A different method of wireless stun weapon application is the "laser induced plasma" weapon, which uses "artificial lightning" effects to stun and incapacitate a target. Initial applications of such technology include the StunStrike and Portal Denial System which are currently maturing into operational systems.

The CEW Test Procedure has been developed to address a short term requirement to allow the performance of in service CEWs to be monitored. The Test Protocol will need to look forward to future scenarios and be made adaptable to them so that it continues to be relevant to new CEW and related technologies which may be used by police services across Canada.

3 Other Test Protocol and Related Areas

As noted in the Introduction, our nomenclature convention defines test protocol to include significantly more than the technical test procedure. What is required of a test facility in order to accept, handle and store such weapons? How can we ensure that data remains valid and is not corrupted during storage and transmission? Who should be considered qualified (both personnel and facilities) to conduct such testing and analysis? How and where should data be stored for future analysis and who will fund such a process? If such topics are to be answered in a CEW Test Protocol, the identified gap areas include the following:

Facilities and Personnel

- Weapons handling and security
- Data management and security
- Personnel and facilities qualifications

Data Mining

- Central storage requirements
- Validation of previously collected data

Statement of Operational Requirement.

With the exception of Data Management and Security, and Data Mining, these are largely policy issues, however, they are central to the ultimate success of a Test Protocol. Details which need to be considered for each of these areas are explored in the following sections of this report.

3.1 Facilities and Personnel

Facilities and Personnel issues include the following:

CEWs in Canada are defined under the Criminal Code as Prohibited Firearms. As a result, their transport, handling and storage need to be carried out in accordance with the appropriate sections of the Firearms Act. In addition, particularly for any test data which may be used in an investigation or trial, security, integrity and traceability of both the firearm and the resulting data are imperative.

The facilities must meet certain requirements for security in the handling of test data.

The qualifications of the personnel conducting the test must be capable of being subjected to critical scrutiny and must meet accepted norms.

It is understood that the logistics of testing CEWs from numerous police services in widely spread locations across a province might recommend the use of a mobile testing capability which can go to the test samples rather than having to ship or carry the prohibited firearms samples to a fixed central laboratory location. Nevertheless, security of the devices under test and the resulting data, validity and reproducibility of the results and traceability of both the weapons and the data are of paramount importance. As a consequence all of the following requirements should be applicable to any test "facility" whether fixed or mobile.

3.1.1 Weapons Handling and Security

Any person or business wishing to possess prohibited firearms must first be licensed to do so under the Firearms Act. Details regarding authorized possession and licences can be found in appropriate sections of the Firearms Act. The entire act may be found at the Department of Justice web site, at

http://laws.justice.gc.ca/eng/MainPage

As noted above, CEWs in Canada are Prohibited Firearms[1], therefore, their shipping, handling and storage are governed by appropriate sections of the Firearms Act. The two regulations which apply directly are the following:

SOR/98-209, Storage, Display, Transportation and Handling of Firearms by Individuals Regulations (effective 01 December 1998)

SOR/98-210, Storage, Display and Transportation of Firearms and Other Weapons by Businesses Regulations (effective 01 December 1998).

Note that SOR/98-209 states that the regulation does not apply to peace officers and some other specific classifications of person, acting in the course of their duties or for the purposes of their employment. As a result, if the CEWs are accompanied at all times while at the test facility by a serving police officer or other similarly authorized individual, the facilities requirements may be waived.

Detailed requirements providing for conformance with the above regulations need to be included in a CEW Test Protocol.

3.1.2 Data Management and Security

The goal here is to ensure the integrity of the data by reducing the risk that data is corrupted either during testing and data collection or post test. This will be particularly important where there are chain of evidence considerations, but will still be important if we are to use all cross country data gathered over a lengthy time span for later analysis and the development of future policy. Previous gaps discussed earlier address the issue for testing and data collection. This section addresses the handling of the data post test.

This will require protection of computers and their programs to ensure valid data storage and analysis, and possibly securely stored non-modifiable electronic media backup for any electronic data.

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[1] Note that this, in itself, is an issue requiring clarification. Considerable discussion exists as to whether CEWs as they currently are designed are or should be classified as Prohibited Firearms or rather as Prohibited Weapons. For this document we have assumed the classification as Prohibited Firearms is a correct interpretation of the law. Note, however, that detailed handling and storage requirements actually do not vary substantially for the two possible classifications.

Data management and security is a field where much expertise exists both within government and within industry, and normal best practices for both should be incorporated into the CEW Test Protocol.

Further, some analysis needs to be carried out on volume of data to be expected and, therefore, storage media capacity required. If we are to sample at 10 MHz or faster for each weapon firing continuously for a full 5 sec pulse train (three times per test) and store all raw data at 8 bit digitization rates for future analysis, data volume will build rapidly. Some compression of data may be achieved by eliminating all sampling data for times between individual pulses, either post test or by using pulse triggering during data collection, however, data volume related questions remain. Will we be practically able to store and transmit such volume? If so, what is the preferred approach? If not, what are our options? This impacts on the central data storage location as well. (Section 3.2.1)

3.1.3 Personnel and Facilities Qualifications

In order to ensure that testing is carried out by qualified personnel in facilities which practice appropriate Quality Assurance (QA) practices, provisions for both will need to be included in a CEW Test Protocol.

Various test personnel and facilities qualification processes, such as MIL-STD-410 Military Standard, Nondestructive Testing Personnel Qualification and Certification, NAS-410 Certification & Qualification of Nondestructive Test Personnel, and ISO 9001 exist both in the military and in industry. Many of these, however, can be costly and complex to implement, and might have a negative effect on the ability of CEW users across the country to find test laboratories willing to carry out the test procedure for a reasonable price. One possible more cost-effective approach to qualifying personnel and facilities is explored here.

Every Province and Territory in Canada has an Association of Professional Engineers with a legal mandate to license firms and individuals who offer engineering services and to set standards for and regulate engineering practice. In order to ensure that the test procedure is carried out by adequately qualified and trained personnel in a professional manner which will ensure validity and repeatability of results, the test protocol might require that every company carrying out such tests be licensed by the appropriate Professional Engineers Association as qualified to offer engineering services or that a duly registered Professional Engineer take responsibility for the conduct of the tests by signing off on the results or stamping the test results with his or her P. Eng. seal.

Whatever approach is used, the CEW Test Protocol will need to include a requirement for some level of QA certification for both personnel and facilities.

3.2 Data Mining

3.2.1 Central Data Storage Location

One of the goals of standardized CEW testing using the developed test procedure is to enable future data analysis to be done on large data sets accumulated from many tests over time. This should enable researchers to identify any meaningful trends in performance as a result of weapon ageing, design changes or other similar factors. In order for this to be achievable practically, we need a central location where all data can be stored and be made accessible to analysts. This will involve dedicated computer space and some level of personnel availability. It will also require specific protocols for acceptance and entry of new data, security of stored data, and accessibility of the data for analysis. Specifications for all of these processes and hardware will need to be developed, along with a budget for operation of such a centre.

Further, this will also likely require significant negotiation with the existing holders of the data, which is presently distributed among a number of jurisdictions across the country.

3.2.2 Validation of Previous Data

There are potential significant concerns with any data mining to be done using data collected prior to the finalization of a test protocol which has been agreed upon by all stakeholders. Since the data was collected prior to a nationally agreed upon test procedure/protocol, the following types of questions regarding the validity of the data could easily be asked by any reviewer of the results:

Were the test procedures and equipment used to collect the data adequate?

Were the personnel conducting the tests qualified to do so?

Was the data stored and transmitted in a manner which guaranteed its integrity?

Was the data comparable from source to source?

This series of questions becomes even more important if consideration is given to using data from other than Canadian sources (USA, UK) in order to expand the sample size.

Any of the factors which will eventually be incorporated into an agreed test protocol will need to be considered for the data collected to date to be used in data mining. The present test procedure may not differ substantially from what has been used previously to collect the body of existing data, however, before any data mining begins, we will need to show that the data sets previously collected are comparable to present sets. Prior to commencing data mining, we will need to create a set of Terms of Reference or similar document for this work. This will need to include some statement as to what data can be used and in what way, or a statement about how to validate any data before it is included in the data mining. If this is not done, the resulting analysis will not be scientifically rigorous and will be subject to considerable questioning after the fact. This is not to say the existing data is not valid, however, it needs to be shown clearly to be so.

3.3 Statement of Operational Requirement

Clearly, this is an area of policy and it is external to any CEW Test Protocol, however, it is noted here as it will have an impact on the Test Protocol to the extent that it may inform the document as to what performance parameters need to be examined during test, and how often. This may be particularly true for any new CEW which is offered in the marketplace and is being considered for use by police services in Canada. The test protocol will form part of any acceptance or approval process for new CEWs which might be implemented, and a Statement of Operational Requirement will be another key element in such a process. This is an element for which the involvement of operational personnel from police services in the development will be key.

4 Medical Knowledge

The possible serious negative medical effects on humans of receiving an application or applications of a CEW are yet to be fully agreed in detail. Considerable research has been done, however, considerably more will need to be accomplished before any definitive statements can be made. There is much contradictory evidence from the work done to date on humans and animals and by simulation or calculation. This report will not detail the complete body of medical research which should be attempted. That is the subject of another task within the CEW Strategic Initiative. There is one medically related parameter, however, which was specifically included in the CEW Test Procedure and so will be discussed here. That is the consideration that Ventricular Fibrillation (VF) is a potential negative outcome of CEW usage on humans and that, as a result, limits on a parameter such as Monophasic Charge should be used as an additional performance criterion.

There are a number of questions to be considered as a result, as follows:

Is VF really of concern in relation to CEW usage?

Is Monophasic Charge the best parameter to use to measure possible VF causation?

To what specification (and value) should the defined parameter be compared?

4.1 Ventricular Fibrillation

Much work has been done on both humans and animals to investigate the specific possibility that CEW discharges will cause Ventricular Fibrillation in humans, particularly in so-called vulnerable populations. There is some evidence that this medical outcome is a low percentage likelihood and, therefore, that it may not be not a significant concern. Clearly, attempting to answer this question is well beyond the scope of this report, however, the inclusion of a specific performance criterion related to VF in the test procedure makes it a priority for any medical research review. If VF is not the cause of deaths proximal to the use of CEWs, there may be no reason to include a performance measure based upon risk of VF.

During the May 2010 CEW Workshop at Carleton University, a presentation was made by Dr. W. Bosseau Murray, an anesthesiologist with Penn State University, which indicated strongly that, in his opinion, VF was not likely the mechanism for death proximal to the use of CEWs. That paper was not made available to Carleton for posting on the workshop web site, however, Dr. Murray and/or his presentation might be considered as worth including in the medical research review.

4.2 Parameter Measured

If VF is indeed found to be of significant concern, there is still some question as to what parameter of CEW output should be used to compare with VF related limits. The test procedure notes two possible parameters may be compared to the IEC 60479-2 based threshold:

Total Charge - the integral of the absolute value of the current waveform for the full pulse duration, and

Monophasic Charge - the maximum of the absolute values of A and B, where A = the integral of all positive current in a pulse, and B = the integral of all negative current in a pulse.

Total Charge was seen to be a more conservative measure, however, Monophasic Charge was justified based on specific physiological models such as Reilly et al[2]. There is a further caveat mentioned in Note 7 of the test procedure that the assumptions which lead to the use of Monophasic Charge as a VF related performance measure may not be applicable to CEWs other than the two specific models currently covered by the test procedure.

4.3 Specification Used

Further, there are questions as to what specification should be used as the comparator, or if any applicable specification exists.

The CEW Test Procedure addresses these points in Note 7 in part as follows:

> *"There is no specification which applies exactly to the waveforms of complex CEW discharges. In our opinion, the most relevant specification is that of IEC TS 60479 Part 2 (Section 11) which considers the "effects of unidirectional single impulse currents of short durations" (0.1 ms and above). This section of the specification defines curves based on the "probability of fibrillation risk for current flowing through the body from the left hand to both feet". .... To account for differences in body size and placement of stimulation electrodes, we recommend an additional safety factor of four be imposed…."* (Adler, Dawson, Evans, Garland, Miller, & Sinclair, 2010)

Clearly, the whole area of Medical Knowledge related to adverse effects of CEW discharges on humans could have significant impact on any test procedure if clear empirical knowledge were to be available which indicated a specific causative link between some measure of CEW performance and death proximal to the use of CEWs.

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[2] JP Reilly, AM Diamant and J Comeaux. Dosimetry considerations for electrical stun devices. Physics in Medicine and Biology, 54 (2009) 1319-1335. http://iopscience.iop.org/0031-9155/54/5/015

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.)

DRDC CSS

2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.)

UNCLASSIFIED

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

Conducted Energy Weapons: Gaps Analysis for Test Procedure (Version 1.1)

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Garland, L.A

5. DATE OF PUBLICATION (Month and year of publication of document.)

November 2010

6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.)

22

6b. NO. OF REFS (Total cited in document.)

0

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Letter Report

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)

Conducted Energy Weapons Strategic Initiative (CEWSI) (32bj)

9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)

EN578-060502/053/ZT

10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)

DRDC CSS 3781-2010-32BJ

10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

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A Conducted Energy Weapons (CEW) Test Procedure (Version 1.1) was completed on 31 July, 2010 by an ad-hoc committee of independent subject matter experts. The primary focus of the paper was to provide a methodology to enable "organizations across Canada to test CEWs in a reliable, repeatable manner to determine whether they are operating within manufacturer's specifications." A number of areas require further discussion, development and/or research in order to enable the document to become expanded into a comprehensive CEW Test Protocol. This report examines those areas. The analysis is divided into three sections: Technical Details of Test Procedure, Other Test Protocol and Related Areas, and Medical Knowledge.

Une procédure d'essai (version 1.1) d'armes à impulsions a été réalisée le 31 juillet 2010 par un comité spécial d'experts indépendants en la matière. L'objectif principal du document en cause était de présenter une méthodologie qui permettrait « aux organisations dans tout le Canada d'éprouver des armes à impulsions d'une manière fiable et reproductible, afin de déterminer si elles fonctionnent conformément aux spécifications du fabricant. » Plusieurs domaines nécessitent davantage de discussions, de développement et de recherche pour que le document puisse être élargi pour devenir un protocole global d'essai d'armes à impulsions. Le présent rapport présente l'examen de ces domaines. L'analyse est divisée en trois parties : les détails techniques de la procédure d'essai, le protocole d'essai et les domaines connexes et la connaissance médicale.

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Conducted Energy Weapons, Less Lethal Weapons, Non-Lethal Weapons, Gap Analysis, Test Procedure, Taser, Taser International