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CRTI 02-0043TA – Accelerated Consequences Management Capabilities. Summary Report of Project Aims and Achievements.

J.G. Purdon, M.D.G. Mayer, and A.F. Burczyk

Defence R&D Canada

Technical Report
DRDC Suffield TR 2006-162
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This study pertains to formulations covered under one or more of the following:

Purdon, J. Garfield, Burczyk, Andrew F.H., and Chenier, Claude L., *Broad Spectrum Decontamination Formulation and Method of Use,* CA Patent No.2300698, awarded 7 October 2000; US Patent No. 06525237, 25 Feb. 2003; European Patent No. 1,154,820 B1, granted 25 Sept 2002, covering AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LI, LU, MC, NL, PT, SE; Israeli Patent Application No. 144,978, filed 19 August, 2001; Singapore Patent Application No.200105018-6 filed 15 Feb and 200104 94903, filed 25 Feb 2000; Australian Patent Application No.25302/00, filed 20 Feb. 2000.

Bureaux, John G., Cowan, George R., Cundasawmy, N. Edward, and Purdon, J. Garfield, *Decontamination and Dispersal Suppressing Foam Formulation*, CA Patent Application No. 2299259, awarded 26 Aug 2000; US Patent No. 6,405,626, granted 18 June 2002; PCT Patent Application No. 00906112.8-2111, filed 26 Feb 2000 covering AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LI, LU, MC, NL, PT, SE; Australian Patent Application No. 25302/00 and 27898/00, filed 20 Feb 2000; Singapore Patent Application No.2001104949.3, filed 15 Feb 2000; Eur. Patent Application No. 00906112.8, filed 25 Feb 2000; Israeli Patent Application No. 145033, filed 25 Feb 2000; Italian Patent Application, Aug 2003; Finnish Patent Application, Aug 2003.

Bureaux, John G., Cowan, George R., Cundasawmy, N. Edward and Purdon, J. Garfield, *Foam Formulations,* CA Patent Application No. 2298971, granted 19 Aug 2000;US Patent Application No. 09/507,081 filed 18 Feb and 60/120,874, filed 19 Feb. 2000; PCT Patent Application No. CA00/00160, filed 18 Feb 2000; Aus. Patent Application No. 26545/00, filed 18 Feb 2000; Israeli Patent Application No. 144961, filed 19 Aug 2001; Singapore Patent Application No. 2001104948-5, filed 18 Feb 2000; Eur. Patent Application No. 00904769.7, filed 18 Feb 2000; Italian Patent Application EP 00904769.4, filed Aug 2003; Finnish Patent Application No. EP 1155281, filed Aug 2003; Swedish Patent Application No. 00904769.7/1155281, filed Sept 2003; Swiss National Phase-Eur. Patent Application No. EP 1155281, filed Sept 2003.

Abstract

An overview and summary of a recently-completed project, funded by the Canadian government's CBRN Research and Technology Initiative (CRTI), to accelerate development of the Universal Containment System (UCS) is presented. This project, led by DRDC Suffield, involved the Licensee for the CASCAD® family of decontaminants/blast suppressants, Allen-Vanguard Corporation (AVC) and Environment Canada who reviewed environmental impact determinations.

UCS is a containment/mitigation/decontamination system for CBRW agents consisting of a lightweight, tent-like enclosure filled with an aqueous-based foam formulation. One of the CASCAD® family of aqueous-based decontaminating/explosive mitigation formulations known as Surface Decontaminating Foam (SDF) has been developed to address CBR threats in the civilian arena and is a central aspect of this project. Foam phase SDF was demonstrated to be effective against neat mustard gas (HD) and the nerve agent, GD, in decontaminating five non-porous civilian substrates and to have utility in containing CW vapour from several of the seven contaminated porous surfaces studied. The effectiveness of liquid SDF was determined against two V, four G and HD CW agents as well as anthrax and T-2 mycotoxin and the decontaminant:agent ratios required for >99% effectiveness in one hour were determined by periodic reaction mixture analyses; all CW agents save T-2 were shown to be satisfactorily detoxified. SDF and CASCAD® were also demonstrated to be effective against the BW agent, anthrax, in the liquid phase.

In aquatic toxicity and ready biodegradability environmental studies, the toxicity of the CASCAD® family is related to the concentration of the surfactant in the decontaminant and in soil environmental studies, the concentrations of both the active ingredient and the surfactant affected the toxicity.

On the basis of physico-chemical characterization of surfactant concentrate, recommendations were made to lower the gelling point of the concentrate while other improvements to increase component solubility, increase transportation safety of the ingredients and to extend the pot life of the active ingredient after mixing were realized. New dispersal equipment was designed and fabricated. Both the modified formulation and equipment were tested and proved effective in a live-agent and IED Field Trial held at DRDC Suffield.

Although this marks the close of the official project, further studies of the modified formulation's CW effectiveness and pot-life are planned under a Technology Development Fund.

Résumé

On présente ici un aperçu et sommaire d'un projet récemment complété et financé par l'Initiative de recherche et de technologie CBRN du gouvernement canadien (IRTC) pour accélérer la mise au point du Système de confinement universel (SCU). Ce projet, dirigé par RDDC Suffield, implique le porteur de licence de la famille des décontaminants et déflecteurs de souffle CASCAD®, Allen-Vanguard Corporation (AVC) et Environnement Canada qui a étudié les décisions relatives à l'impact environnemental.

SCU est un système de confinement, de réduction et décontamination des agents de guerre CBR consistant en une installation légère, de style tente, remplie d'une formulation de mousse de décontamination à base de solution aqueuse. L'une des formulations de décontamination et de réduction des explosions à base de solution aqueuse appartenant à la famille CASCAD®, connue sous le nom de Mousse de décontamination de surface (MDS), a été mise au point pour en réponse au problème des menaces CBR dans un environnement civil et représente l'aspect principal de ce projet. On a démontré que la phase en mousse de décontamination était efficace contre le gaz moutarde pur (HD) et l'agent neurotoxique GD, pour décontaminer cinq substrats civils non poreux et qu'elle était utile pour contenir les vapeurs d'agents de guerre chimiques provenant de plusieurs des sept surfaces poreuses contaminées qui étaient examinées. On a déterminé l'efficacité de la MDS liquide contre des agents de guerre chimiques (CW) dont deux V, quatre G et HD ainsi que contre le charbon bactéridien et la toxine T-2. Les rapports requis entre l'agent et le décontaminant pour une efficacité supérieure à 99 % et une durée d'une heure ont été déterminés par des analyses périodiques de mélanges réactifs; on a démontré que tous les agents CW, sauf le T-2, ont été détoxifiés de manière satisfaisante. On a aussi démontré que la MDS et CASCAD® en phase liquide étaient efficaces contre les agents de guerre biologiques et le charbon bactéridien.

Selon les études environnementales de toxicité aquatique et de biodégradabilité immédiate, la toxicité de la famille CASCAD® est liée à la concentration de surfactant dans le décontaminant et selon les études environnementales de sols, les concentrations de la matière active ainsi que celles de surfactant affectaient la toxicité.

En se basant sur la caractérisation physico chimique de concentré de surfactant, on a recommandé de baisser le point de gellification du concentré pendant qu'on réalisait d'autres améliorations pour augmenter la solubilité des composants, augmenter la sécurité du transport des matières et étendre le délai d'utilisation de la matière active après le mélange. On a conçu et fabriqué un nouveau matériel de dispersion. On a testé la formulation modifiée ainsi que le matériel et les deux ont été prouvés efficaces, à RDDC Suffield, durant un essai sur le terrain EEI avec agent vivant.

Ceci conclut le projet officiel mais, grâce à une Fond de développement technologique, on prévoit d'étudier plus profondément l'efficacité des formulations modifiées d'armes chimiques et leur délai d'utilisation.

Executive Summary

Purdon, J.G., Mayer, M.D.G. and Burczyk, A.F. CRTI 02-0043TA - Accelerated Consequences Management Capabilities. Summary Report of Project Aims and Achievements. DRDC Suffield TR 2006-162. DRDC Suffield.

Introduction: Current military decontaminating solutions such as C1, C8 and Super Tropical Bleach (STB) are all capable of decontaminating CB agents but suffer from serious disadvantages such as flammability, corrosivity, toxicity of ingredients, etc. There has been an on-going military requirement for a rapid-acting decontaminant for Nuclear Chemical Biological Warfare (NCBW) agents deposited on the surfaces of vehicles, personal weapons and equipment. The Canadian federal police force, the Royal Canadian Mounted Police (RCMP), also require a capability for responding to terrorist situations which might involve explosive dispersal devices containing CBW materials. CASCAD® is an aqueous foam decontaminant developed by DRDC Suffield for decontamination of military equipment and facilities and contents that have been contaminated with CBW agents which has been patented and licensed to Allen-Vanguard Corporation (AVC) who market the application hardware and formulation products under the name of Universal Containment System (UCS), previously known as BlastGuard. UCS is a containment/ mitigation/decontamination system for Chemical Biological Radiological Nuclear Warfare (CBRNW) agents consisting of a lightweight, tent-like enclosure filled with one of two aqueous-based foam formulations depending on whether the presence of CBW agents or radioactive material is suspected and decontaminating capabilities are required or only explosive device mitigation is needed. These foams mitigate the effect of explosive devices and contain the effects of device disruption as well as devices to release NBCW agents through explosive dissemination. One of this family of aqueous-based decontaminating/explosive mitigation formulations, known as Surface Decontaminating Foam (SDF), has been developed as a formulation to be employed against CBR threats in the civilian arena and is a central aspect of this project.

In this Report, an overview and summary of the achievements in a recently completed project, funded by the Canadian government's CBRN Research and Technology Initiative (CRTI) to accelerate development of the UCS, specifically SDF, is described as well as future plans to extend the study are presented. This project, led by DRDC Suffield, involved the Licensee for the CASCAD® family of decontaminants/blast suppressants, AVC, and Environment Canada who reviewed environmental impact determinations.

Results: This project was comprised of five tasks; a brief summary of the results of each segment is presented. In decontamination studies in which CW agent vapour desorbing following decontamination of contaminated coupons was quantified, SDF in foam phase was demonstrated to be effective against neat mustard gas (HD) and the nerve agent, GD, in decontaminating five non-porous civilian substrates and to have utility in containing CW vapour from several of the seven contaminated porous surfaces studied. The effectiveness of liquid-phase SDF was determined against two V, four G and HD CW agents and T-2 mycotoxin as well as the BW agent, anthrax. The decontaminant:CW agent ratios required for >99% effectiveness in one hour were determined by periodic reaction mixture analyses; all CW agents save T-2 were shown to be satisfactorily detoxified. SDF and CASCAD® were also demonstrated to be effective against anthrax in the liquid phase determined by reduction of Colony Forming Units following contact with the formulation.

In standard five-element aquatic and ready biodegradability environmental studies, the toxicity of the CASCAD® family of formulations was observed to be related to the concentration of surfactant in the decontaminant whereas in standard four-element soil environmental studies, the concentration of both the active ingredient and the surfactant affected the toxicity.

The surfactant concentrate was characterised and reasons for its high gelling temperature (~10°C)were identified leading to an additive which lowered the gelling point by 10C°.   Other improvements were discovered to increase the component solubility and the transportation safety of the ingredients, to extend the storage life of the concentrates and to extend the pot life of the active ingredient after mixing. It was demonstrated that the surfactant concentrate additive does not appear to have altered either the decontamination effectiveness or blast mitigation capabilities.

Three new pieces of equipment (dual-tank dolly, dual-tank Backpack and large scale trailer) for the dispensing of the SDF and other CASCAD® formulations utilising an improved procedure for combining the concentrates were also developed. Prototypes of the first two units for dispensing the improved formulations were successsfully demonstrated in a live agent/IED Field Trial at Suffield.

Significance: As a result of this project, a new improved capability for First Responders to decontaminate CBW agents has been developed. The SDF formulation has been demonstrated to be an effective decontaminant to address the threats potentially posed to First Responders and homeland security against a variety of CW and BW agents including anthrax. Improvements to the formulation have extended its temperature range of use and the storage stability of its concentrates. The environmental impact of use of the CASCAD® family of decontaminants have been determined. Improved procedures in the preparation of the formulation have increased its pot-life and effectiveness and new equipment has been designed and fabricated for its dissemination. A guide book for First Responders has been develped to assist in addressing NBCW threats. This new equipment and the guide book will provide the First Responder with an enhanced capability when faced by CBW agents.

Future Plans: Although this marks the close of the official project, further studies of the modified formulation's CW effectiveness and pot-life are planned under a Technology Development Fund.

Sommaire

Purdon, J.G., Mayer, M.D.G. and Burczyk, A.F. CRTI 02-0043TA - Accelerated Consequences Management Capabilities. Summary Report of Project Aims and Achievements. DRDC Suffield TR 2006-162. RDDC Suffield.

Introduction: Les solutions militaires actuelles de décontamination telles que C1, C2 et le chlorure de chaux sont toutes capables de décontaminer les agents CB mais possèdent de graves inconvénients tels que l'inflammabilité, la corrosivité, la toxicité des matières, etc. Il existe un besoin militaire permanent de décontaminant à action rapide contre les agents de guerre nucléaires, chimiques et biologiques (NCBW) qui se déposent sur la surface des véhicules, des armes individuelles et du matériel. La force de police fédérale canadienne, la Gendarmerie royale du Canada (GRC) requiert aussi des moyens pour répondre aux situations terroristes pouvant comporter des engins de dispersion contenant des matériaux CBW. CASCAD® est une mousse de décontamination aqueuse mise au point par RDDC Suffield pour décontaminer le matériel militaire et les installations et leurs contenus contaminés par des agents CBW; cette mousse a été brevetée et agréée pour Allen-Vanguard Corporation (AVC) qui commercialise des produits de formulation sous le nom de Systèmes de confinement universels (SCU), autrefois connus sous le nom de BlastGuard. SCU est un système de confinement, de réduction et décontamination des agents de guerre chimiques, biologiques, radiologiques et nucléaires (CBRNW), consistant en une installation légère, de style tente, remplie de deux formulations de mousse de décontamination à base de solution aqueuse, selon que l'on suspecte la présence d'agents de guerre CB ou de matériel radioactif et qu'on requiert des capacités de décontamination ou bien qu'on ait seulement besoin d'atténuer des engins explosifs. Ces mousses atténuent l'effet des engins explosifs et contiennent les effets de disruption d'engins ainsi que les engins qui relâchent des agents de guerre NBC au moyen de dissémination par explosifs. L'une des familles de ces formulations à base de solution aqueuse de décontamination et de réduction d'explosifs, aussi connue sous le nom de Mousse de décontamination de surface (MDS), a été mise au point pour être employée contre les menaces CBR dans une environnement civil et représente l'aspect principal de ce projet.

Dans ce rapport, on décrit un aperçu et un sommaire des résultats d'un projet récemment complété et financé par l'Initiative de recherche et de technologie CBRN du gouvernement canadien (IRTC) pour accélérer la mise au point du SCU, dont plus spécifiquement la MDS et on présente aussi les perspectives d'avenir visant à étendre la portée de cette étude. Ce projet, dirigé par RDDC Suffield, implique le porteur de licence de la famille des décontaminants et déflecteurs de souffles CASCAD®, AVC et Environnement Canada qui a étudié les décisions relatives à l'impact environnemental.

Résultats: Ce projet comprenait cinq volets et un bref sommaire des résultats de chaque segment est présenté. Les études de décontamination ont quantifié les vapeurs d'agent de guerre chimique se désorbant après la décontamination de coupons contaminés; on a démontré que la MSD en phase mousseuse était efficace contre le gaz moutarde pur (HD) et l'agent neurotoxique GD, pour décontaminer cinq substrats civils non poreux et était utile pour contenir les vapeurs d'armes chimiques provenant de plusieurs des sept surfaces poreuses contaminées qui étaient étudiées. L'efficacité de la MDS en phase liquide a été déterminée contre des armes chimiques dont deux V, quatre G et HD et la toxine T-2 ainsi que le charbon bactéridien qui est un agent biologique. Les rapports requis entre l'agent et le décontaminant pour une efficacité supérieure à 99 % et une durée d'une heure ont été déterminés par des analyses périodiques de mélanges réactifs; on a démontré que tous les agents CW, sauf le T-2, ont été détoxifiés de manière satisfaisante. On a aussi démontré que la MDS et CASCAD® contre les agents de guerre biologiques et le charbon bactéridien étaient efficaces dans la phase liquide déterminée par la réduction d'unités formant des colonies après avoir été en contact avec la formulation.

Selon les études environnementales standards des cinq éléments aquatiques et de biodégradabilité immédiate, on a observé que la toxicité de la famille de formulations CASCAD® est liée à la concentration de surfactant dans le décontaminant alors que selon les études environnementales standard des quatre éléments de sols, la concentration de la matière active ainsi que celle du surfactant affectaient la toxicité.

Le concentré de surfactant a été caractérisé et on a identifié les raisons de sa haute température de gellification (~10EC) ce qui a abouti à un additif qui baissait le point de gellification de 10CE. On a découvert que d'autres améliorations augmentaient la solubilité des composants, la sécurité du transport des matières et étendaient la durée limite de stockage et le délai d'utilisation de la matière active après le mélange. On a démontré que l'additif de concentré de surfactant ne semble pas avoir altéré ni l'efficacité de la décontamination ni les capacités d'atténuation de l'explosion.

On a aussi mis au point trois nouveaux éléments du matériel (chariot à deux réservoirs, sac à dos à deux réservoirs et remorque à grande capacité) pour administrer la MDS et les autres formulations CASCAD® en utilisant une méthode améliorée pour combiner les concentrés. On a réussi la démonstration des prototypes de deux premières unités dispensant les formulations améliorées à Suffield durant un essai EEI sur le terrain avec agent vivant.

Portée des résultats: Le résultat de ce projet consiste en la mise au point d'une nouvelle capacité améliorée au service des Premiers intervenants qui décontaminent les agents de guerre CB. On a démontré que la formulation MDS est un décontaminant efficace contre les menaces potentielles que représente une variété d'agents de guerre chimiques et biologiques dont le charbon bactéridien contre les Premiers intervenants et la sécurité intérieure. Les améliorations apportées à la formulation ont augmenté l'amplitude de la température d'usage et la stabilité d'entreposage de ses concentrés. On a déterminé l'impact environnemental produit par la famille des décontaminants CASCAD®. L'amélioration des méthodes de préparation de la formulation ont augmenté le délai d'utilisation et l'efficacité du nouveau matériel conçu et fabriqué pour sa dissémination. On a développé un manuel pour les Premiers intervenants pour mieux aborder le problème des menaces des agents NBC. Ce nouveau matériel et le manuel procureront aux Premiers intervenants une capacité améliorée quand ils devront faire face aux agents de guerre CB.

Perspectives d'avenir: Ceci conclut le projet officiel mais, grâce à une Fond de développement technologique, on prévoit d'étudier plus profondément l'efficacité des formulations modifiées d'armes chimiques et leur délai d'utilisation.

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Acknowledgements

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Introduction

This is a summary overview of the studies undertaken under CRTI project 02-0043TA to accelerate the development of a blast mitigation/decontamination system for Chemical, Biological, Radiation, Nuclear, Explosive (CBRNE) agents/devices for use by First Responders.

Background

Current military decontaminating solutions such as C1, C8 and Super Tropical Bleach (STB) are all capable of decontaminating CB agents, but suffer from serious disadvantages such as flammability, corrosivity, toxicity of ingredients, etc. There has been an on-going military requirement for a rapid-acting decontaminant for Nuclear Chemical Biological Warfare (NCBW) agents deposited on the surfaces of vehicles, personal weapons and equipment [1, 2]. In Canada, the development of a new decontaminant was initially undertaken during the first Gulf War (Operation FRICTION - 1991) in response to this requirement. Subsequently, DRDC Suffield was tasked to develop a broad-spectrum aqueous decontaminant which was to be less corrosive than most other current formulations, reasonably stable after preparation of solution or concentrate, effective at dissolving thickened agents, more environmentally friendly than compounds such as bleach, and compatible with other military equipment [3]. The resulting decontaminant is known as the Canadian Aqueous System for Chemical/Biological Agent Decontamination or CASCAD® which addresses the major areas of concern and is formulated from readily available chemicals [4-8].

The Canadian federal police force, the Royal Canadian Mounted Police (RCMP), also require a capability for responding to terrorist situations which might involve explosive dispersal devices or disruption of devices that contain CBW materials. The RCMP, in collaboration with industry (George Cowan Enterprises, Ottawa and Irwin Aerospace, Fort Erie, ON), developed an aqueous-based blast-suppressant foam (Dispersal Suppressant Foam - DSF) and foaming dispenser system [9, 10] with superior performance which has been successfully demonstrated repeatedly in CA/UK/US collaborative field trials [11-13]. As part of a collaborative effort between DRDC Suffield and the RCMP, DRDC Suffield was tasked to incorporate some components of the CASCAD® formulation into the foam formulation for use against CBW agent-containing dispersal devices without significantly altering its effectiveness for containing and mitigating explosive devices resulting in DDSF or decontaminating dispersal suppressant foam [14]. In addition to the CASCAD® and DDSF, a formulation which is intermediate in decontaminating effectiveness between these two formulations was developed for use by the RCMP and other agencies in situations when release of CB agent has already taken place prior to their arrival. This Surface Decontaminating Foam (SDF), when applied to the walls, ceiling, floor and contents of a contaminated room, reduces/eliminates the CW vapour hazard and the liquid CB-agent contact and vapour hazards are mitigated. This family of decontaminants/blast suppressants has been patented and licensed to Allen-Vanguard Corporation (AVC, formerly Vanguard Response Systems Inc., previously known as NBC Team Ltd. which was originally a division of Irvin Aerospace (Canada) Ltd.) of Ottawa and Stoney Creek, ON, who market the application hardware and formulation products under the name of Universal Containment System (UCS). UCS is a containment/mitigation/decontamination system used to absorb and contain blast and bomb/device fragments, to neutralise CB threats and to remove radiological particles from surfaces and was previously known as BlastGuard. A number of assessments of the effectiveness of CASCAD® and its related formulations have been carried out both in the field and in the laboratory [15-24]. It has been demonstrated to be effective against G-, VX and HD CW agents as well as the biological agent, anthrax and the associated anthrax simulant, BG spores [25-27].

Current Project

This report will summarise a project to enhance the CBW agent decontamination capability for First Responders. The project, which operated from Aug 2003 until May 2006, was funded by the federal government's CBRN Research and Technology Initiative program (CRTI, project 02-0043TA). The amended Charter for this project is presented in Annex A. The purpose of the project was to accelerate development of the the UCS to provide First Responders with a fieldable system for CBRNW decontamination. There were three partners in the project – DRDC Suffield (federal department project lead), the industrial partner, AVC, and Environment Canada (EC).

The Universal Containment System (UCS)

AVC, exclusive licensee for the aqueous decontaminant family developed at DRDC Suffield (CASCAD®), market UCS to CBRN response teams to contain, mitigate, or decontaminate:

1. packages and devices suspected of containing CBRN agents;
2. enclosed areas contaminated by a CBW agent,
3. specific targets of a CBRN attack.

The UCS consists of a lightweight, tent-like enclosure of specialized fabric layers which is filled with an aqueous foam formulation. It is used to absorb blast and fragments, neutralize CB substances and contain radiological particles and/or remove them from surfaces. The foam consists of an active ingredient for decontamination, a surfactant for foam generation and agent solubilisation, a mixture of buffers to control the formulation activity, a cosolvent for thickener/agent solubilisation and water. As indicated above, it is available in four strengths:

1. DSF (Dispersal Suppressant Foam – 0% active ingredient intended solely for blast mitigation);
2. DDSF (Decontaminating Dispersal Suppressant Foam – lowest level of active ingredient intended for blast mitigation against Improvised Explosive Devices (IEDs) containing agents);
3. SDF (Surface Decontaminating Foam – medium level of active ingredient, intended for use primarily by the First Responder community for facilities decontamination);
4. CASCAD® (Canadian Aqueous System for Chemical/Biological Agent Decontamination – full strength active ingredient, developed primarily for military use)

Aims of the Project

More research on the UCS was required in order to address several important issues in its performance in CBRNW situations for First Responders including environmental impacts, operating temperature range, performance against a wider spectrum of agents on a variety of surfaces and extension of the decontamination technology to assess its long term effect and examine remediation measures. Since First Responders are the primary focus for CRTI projects such as this, studies were centalised on examination of SDF more than the other variants in the CASCAD® family of products.

The amended charter is attached as Annex A. The original Charter called for commencement of operations 1st August, 2003, to operate for two years but, due to delays in finalising a contract to the industrial partner, changes to the overall funding permitted to the partner and delays in equipment delivery, the Charter was amended to extend the contractual and laboratory functions until March, 2006, with no change in funding and the project was itself extended to May, 2006, without CRTI funding to allow for completion of Reports.

The project (see Charter in Annex A.) was comprised of five different tasks:

1. Task 1. Determine the quantitative decontamination effectiveness of UCS foam when applied to various surfaces contaminated with traditional CW agents simulating emergency procedures. (Performed by DRDC Suffield with on-site support from AVC);

2. Task 2. Determination of the liquid-phase rates, stoichiometries and products of reaction of UCS formulation with a wide range of CW agents and related compounds; Determine the UCS effectiveness in detoxifying the BW agent, anthrax. (Performed by DRDC Suffield with on-site support from AVC and O'Dell Engineering, licensee for the Reactive Skin Decontaminant Lotion or RSDL®);

3. Task 3. Assessment/quantification of the environmental impact of UCS usage to determine the need for any post-treatment or effluent containment. (Led by AVC);

4. Task 4. Modification of the UCS surfactant to enhance the performance of the foam components for operation over a wider climatic range, more suitable to the Canadian winter, and testing in a Field Trial. (Shared elements by AVC and DRDC Suffield);

5. Task 5. Investigation of extension of the UCS for remediation measures. (AVC).

In this report, a summary of the achievments and progress on each of these tasks is presented along with an overview of the financial and administrative aspects of the project. Details of the experimental approaches, results and conclusions in each of the studies are published in separate Reports and presented in various Symposia and meetings and are listed in the Bibliography (designated as CXX in the subset of References).

Personnel/Contractors

DRDC Suffield

Dr. Kent Harding - Chief Scientist and Project Champion.
Dr. J.G. Purdon - Project Manager and Scientific lead on Task 2.
Dr. A. Burczyk - Scientific lead on Task 1.
M.D.G. Mayer - Deputy Project Manager for DRDC scientific activities and overall status reporting.
Dr. B. Kournikakis - Assessment of BW decontamination effectiveness under Task 2.
L. Negrych - Assessment of BW decontamination effectiveness under Task 2.
R. Hilsen - Assessment of BW decontamination effectiveness under Task 2.
L. Ripley - Financial matters and Administrative support.
D. Cooper - Financial matters and Administrative support.
Counter Terrorism and Technology Center - Field Trial under Task 4.
M.W.J. Ceh - Characterisation of explosive mitigation under Task 4.

L. McDowall - Visiting Scientist from DSTO, Melbourne, AS, located on-site at DRDC Suffield for limited Task 1 activities.
G. Hunter, Greenley Associates, under contract to DRDC Suffield - Financial matters.

Allen-Vanguard Corporation

C. Corbin - Chief Technology Officer.
L. Cochrane - Deputy Project Manager for Allen-Vanguard activities (Tasks 3-5).
M. Lukacs - Chemist located on-site at DRDC Suffield for Task 2 activities.
M. Beugeling - Chemical technologist located on-site at DRDC Suffield for Task 1 and 2 activities.
J. Rakics - O'Dell Engineering Chemist located on-site at DRDC Suffield for Task 2 activities under contract to AVC.
Stantec Consulting Ltd. - under contract to AVC for studies under Task 3.
McMaster University - under contract to AVC for studies under Task 4.
Farrington, Lockwood Co. Ltd. - under contract to AVC for studies under Task 4.

Environment Canada

Dr. M. Fingas - review of environmental impact studies under Task 3.

CRTI

Dr. C. Boulet - Director
N. Yanofsky - Portfolio Manager - Chemistry

RCMP

Insp. J. Bureaux - advisory role for explosive mitigation (Task 4).

Financial Overview/Acquisitions

Financials

As indicated in the Amended Charter (Annex A.), the following was the predicted expenditures for the project. The total of CRTI funds to be expended during this Project was $1,961,762 and was administered by DRDC Suffield. The quarterly breakout of the budget is given in the amended Charter in Appendix A. Table 2 provides an overview of the actual funding details over the life of the project.

Acquisitions

DRDC Suffield

The following major equipment was acquired in order to perform the tasking:

1. Upgrade to existing Agilent 1100 Liquid Chromatograph-Mass Spectrometer (LC-MS) from version A to D including a third source, Atmospheric Pressure Photometric Ionisation for Task 2.

2. An Agilent 1100 LC system with Diode-Array Detector and Capillary and Binary pumps for use with existing Flame Photometric Detector for Task 2.

Table 1. *Amended Charter Budget for CRTI 02-0043TA*

Project Phase	Fiscal Year	Amount (in $FY)
Definition (CRTI Funds)	2003/04	0
Execution (CRTI Funds)	2003/04	448624
	2004/05	921766
	2005/06	591372
Project Phase	**Fiscal Year**	**Amount (in $FY)**
Definition (In-kind Funds)	2003/04	12316
Execution (In-kind Funds)	2003/04	236674
	2004/05	761450
	2005/06	713340
Participant	**Fiscal Year**	**Amount (in $FY)**
DRDC Suffield	2003/04	273624
	2004/05	271940
	2005/06	166170
Vanguard Response Systems Inc.	2003/04	175000
	2004/05	649826
	2005/06	25202

3. A Varian 3800 Gas Chromatograph with Pulsed Flame Photometric/Flame Ionisation detectors, sorbent collection/injection system and liquid autosamplers for Task 1.

4. Two Combi-pal systems for preparation/injection of agent standards and decontamination samples for use with existing 3800 GC systems for Task 1.

5. A Nicolet Fourier Transform Infrared Spectrophotometer in Task 2.

6. A water purifier to supply LC-grade eluent for use in Tasks 1 and 2.

7. Camcorder to record agent spreading for use in Task 1.

8. Digital camera used to record agent spreading for use in Task 1.

9. A high-precision five-place balance for agent weighing in Task 2.

10. Chilled mirror Dewpoint Hygrometer used to measure relative humidity of air flos in Task 1.

10. On-line gas flow meters for detector fuel gas measurements in Task 1.

11. Controlled humidity source of sample air for Task 1.

Allen-Vanguard Corporation

1. Design and fabrication of improved Backpack, Air-Dolly and Mid-Scale (30 gal) Decontaminant application systems

2. Fume hood to contain toxic chemical vapours.

Table 2. *Overview of Financial Activties for CRTI 02-0043TA*

CRTI Project Nur	**02-0043TA**	**Accelerated Consequences Management Capabilities**															
Lead Departmen	**18**	**DRDC Suffield**															
Project Manager	**Dr. J.G. Purdon (403)544-4106**																
Project Champio	**Dr. Kent Harding (403) 544-4627**																
Portfolio Manage	**Norm Yanofsky (613) 998-6417**																
Project Finance (	**Louise Ripley (403) 544-4955**																
Partner Name	**Funding source**	**FISCAL YEAR 2003/2004**				**FISCAL YEAR 2004/2005**				**FISCAL YEAR 2005/2006**				**PROJECT**			
		Charter	**Receiv'd**	**Actual**	**Diff**	**Charter**	**Receiv'd**	**Actual**	**Diff**	**Charter**	**Receiv'd**	**Actual**	**Diff**	**Charter**	**Receiv'd**	**Actual**	**Diff**
DRDC-Suffield	CRTI - Funds	273,624	273,624	273,785	-161	271,940	271,940	262,131	9,809	166,170	175,979	176,053	-74	711,734	711,660	711,969	-309
AVC	CRTI - Funds	175,000	175,000	175,000	0	649,826	649,826	630,407	19,419	425,201	444,620	444,547	74	1,250,027	1,249,446	1,249,954	-508
Total CRTI contribution		**448,624**	**448,624**	**448,785**	**-161**	**921,766**	**921,766**	**892,538**	**29,228**	**591,371**	**620,599**	**620,799**	**0**	**1,961,761**	**1,961,761**	**1,962,122**	**-361**
DRDC-Suffield	In-Kind	218,768		218,768	0	402,807		412,186	-9,379	420,000		302,940	117,060	1,041,575		933,894	107,681
AVC	In-Kind	17,905		17,905	0	358,643		270,174	88,469	293,340		190,549	102,791	669,888		478,628	191,260
Total In-kind contribution		**236,673**		**236,673**	**0**	**761,450**		**682,360**	**79,090**	**713,340**		**493,489**	**219,851**	**1,711,463**		**1,412,522**	**298,941**
GRAND TOTAL (CRTI & In-kind)		**921,970**		**922,131**	**-161**	**2,444,666**		**2,257,258**	**187,408**	**2,018,051**		**1,607,777**	**410,274**	**5,384,687**		**4,787,165**	**597,522**

Summary of Achievements

DRDC Suffield

Tasks 1 and 2 were undertaken in the laboratories at DRDC Suffield and are described in this section. Aspects of Task 4 (Field Trial, modification to formulation preparation methodology) will be described later.

Experimental details

Vapour Desorption Experiments (Task 1)

In these experiments, the decontaminant in the foam phase was tested against agent applied onto various surfaces such as would be encountered in a typical office environment.

Surfaces to be Studied

A total of twelve surfaces were studied - seven porous surfaces (alkyd wall paint on drywall, latex wall paint on drywall, varnished wood, ceiling tile, carpet, concrete and asphalt) and five non-porous surfaces (Chemical Agent Resistant Coating (CARC) on steel, alkyd paint on steel, window glass, anodized aluminum and vinyl floor tile). Each test surface was prepared as a 25 cm^2 (5 cm X 5 cm)coupon for use in a specially-designed sample desorption cell and apparatus. Concrete and asphalt samples were cast using plastic containers and were not cut down to 25-cm^2 areas. Substrates such as varnished wood and drywall were sealed at the exposed edges using an epoxy sealer to prevent spreading agent from creeping around the edge and penetrating the sample in areas to which foam would not be applied. Fresh substrates were used in each desorption experiment.

Chemicals Tested

Both mustard (dichlorodiethyl sulphide or HD) and the nerve agent, GD (isopropyl methylphosphonofluoridate), were applied to test surfaces. HD experiments were conducted initially on each substrate and the results of these experiments were used to assess the safety (and benefit gained) of further experiments using GD. For instance, GD was not tested on ceiling tile or carpet, due to safety concerns as well as personnel and time constraints. In these experiments, the neat liquid agent was dyed with the oil-soluble dye "Williams Red[1]" to visualise agent spread on the surfaces and as an indicator of agent destruction by the decontaminant. Wherever possible, the agent spread was calculated from pictures taken during the experiments. The mass of dye dissolved in the agent was too small to accurately measure. The decontaminant used in these experiments was freshly prepared SDF (with medium strength active ingredient) in the foam phase.

Testing Procedures

Ten µL of agent containing William's Red dye was applied to the sample coupon to be studied. Agent spread and challenged area were recorded by digital photography initially and every five minutes thereafter over an absorption period of 30 minutes. These pictures, in many cases, illustrated

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1 Due to the undocumented nature of this colloquial name, studies were carried out at DRDC Suffield and by Farrington, Lockwood Co. Ltd. which led to the modern identity of this dye as "Sudan IV" [C23].

the areas of exposure and surface changes that affected decontamination. At this time, the surface was decontaminated using either isopropanol (control experiment) or with SDF.

The decontaminant was tested using two application procedures. In the scrubbing method, the decontaminant foam generated from 150 mL of liquid SDF[2] was applied to the surface mounted in a horizontal position, the surface was scrubbed for one minute with a pastry brush, then left to sit for 30 minutes. The surface was then tilted up and rinsed with 500 mL of distilled water before being placed in the desorption cell. In the non-scrubbing method, the SDF was applied as above, left to sit on the horizontally-mounted surface for 31 minutes before rinsing with 500 mL of distilled water and placement in the desorption cell.

In the control experiments, the agent was applied and photographed over a 30-minute period, then the coupon was rinsed with ten mL of isopropanol applied from a syringe with a 26-gauge needle. The stream of solvent was used to rinse the agent off the surface and to remove any adherent contaminated materials. The sample was allowed to air dry before being placed in the desorption cell.

Test coupons were mounted in a TTCP EAG-30-developed standard desorption test cell [29] with an air-sweep to a GC equipped with absorbent collection tubes, Pulsed Flame Photometric (PFPD) and Flame Ionization (FID) detectors. In samples which eluted quantities of agent that would have overloaded the apparatus, a sweep-splitting mechanism was used [30]. The desorption cell was maintained at 30°C and the sweep air was at 30°C at 50% relative humidity. The air sweep was started and repetitive GC analysis continued for at least 24 hours.

Results

Non-Porous Surfaces

The results will be described in detail in separate reports [C7-C10]. A summary of the HD test results is given in Table 3 and the GD results are summarized in Table 4. In both tables, the "% Desorbed at 24 Hours" represents the accumulated recovered agent as a percentage of the amount of agent initially applied leading to "% Desorbed in 24 Hrs".

In the case of HD, there was essentially no residual agent desorbing from the control or decontaminated non-porous substrates at the 24-hour mark, except for the vinyl floor tile which proved to be partially dissolved by the agents used. Similar results were observed for the non-porous substrates and GD. These results indicate that there was very little adsorption into these surfaces and that most of the agent was removed either with the water rinse or through the use of the decontaminant.

For vinyl floor tile, 26% of the initial HD applied eventually desorbed from the control sample, indicating some of the agent absorbed into the vinyl, and desorbed over time. In comparison, 33% of the amount of HD applied to the unscrubbed decontaminated surface desorbed, but less then one percent desorbed from the decontaminated scrubbed vinyl floor sample. The results with GD showed the control sample with 21% desorbing at 24 hours, compared to 14 % for the decontaminated non-scrubbed sample and two percent for the decontaminated scrubbed sample.

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2 Prepared using a Waring lab blender equipped with a custom stirrer designed and fabricated by the Quality Engineering and Test Establishment, DND, Hull, PQ [28].

Porous Surfaces

For HD applied to alkyd-painted wallboard, carpeting, ceiling tile, concrete and varnished wood, application of SDF with/without scrubbing clearly decreased the quantities of residual agent desorbing relative to that observed in the respective controls, whereas results for asphalt and latex wall board were less consistent. Similarly for GD, application of SDF to contaminated surfaces of alkyd wall board, concrete and varnished wood demonstrated decreased desorption of residual agent relative to controls, whereas, again, results for asphalt and latex wall board were less convincing and consistent. From the results of both agents on non-porous substrates, it is clear that the processes are extremely complicated and reflect the composite nature of all of the samples studied. Further details and conclusions are to be found in the individual reports.

***Table 3.** Residual HD Desorbing After Foam Application on Porous and Non-porous Materials*

Type	Substrate	Control/Decon	Scrub	% Desorbed at 24 hrs	% Decontamination at 24 hrs
Non-porous	Anodized Aluminum[1]	Control		0.01	100
	Anodized Aluminum	Decon	No Scrub	0.00	100
	Canadian Alkyd Paint	Control		0.73	99.3
	Canadian Alkyd Paint	Decon	No Scrub	0.24	99.8
	Canadian Alkyd Paint	Decon	Scrub	0.28	99.7
	CARC	Control		0.00	100
	CARC	Decon	No Scrub	0.00	100
	Glass	Control		0.00	100
	Glass	Decon	No Scrub	0.00	100
	Vinyl Floor Tile	Control		25.5	74.5
	Vinyl Floor Tile	Decon	No Scrub	33.2	66.8
	Vinyl Floor Tile	Decon	Scrub	0.14	100
Porous	Alkyd Wall Board	Control		2.99	97
	Alkyd Wall Board	Decon	Scrub	0.52	99.5
	Alkyd Wall Board[2]	Decon	No Scrub	0.44	99.6
	Asphalt	Control		15.7	84.3
	Asphalt	Decon	No Scrub	22.6	77.4
	Asphalt	Decon	Scrub	0.91	99.1
	Carpet	Control		47.3	52.7
	Carpet	Decon	No Scrub	9.57	90.4
	Ceiling Tile	Decon	No Scrub	17	83
	Concrete	Control		37.2	63
	Concrete	Decon	No Scrub	2.95	97.1
	Concrete	Decon	Scrub	2.36	97.6
	Latex Wall Board	Control		29.8	70.3
	Latex Wall Board	Decon	No Scrub	50.2	50
	Latex Wall Board	Decon	Scrub	1.26	98.7
	Varnished Wood	Control		4.80	95.2
	Varnished Wood	Decon	No Scrub	1.36	98.6
	Varnished Wood	Decon	Scrub	3.14	96.9

[1] 54 hours [2] 20 hours

Conclusions

SDF is effective in decontaminating the non-porous substrates, especially when used with the scrubbing procedure.

The non-porous samples results were complicated by the composite nature of the various materials tested. For example, the latex wallboard contained latex paint, cardboard and gypsum, and all three components would interact with the agent and the decontaminant. Some of the more complicated substrates, including the ceiling tile and the carpet proved difficult, if not impossible, to decontaminate without destroying the substrate. As such, it is likely more economical to remove and incinerate these contaminated surfaces rather than try to decontaminate them.

The dye added to the agent was a very useful tool for determining the spread and flow behaviour of the agents, both on the surface and penetrating through the samples.

Table 4. *Residual GD Desorbing After Foam Application on Porous and Non-porous Materials*

Type	Substrate	Control /Decon	Scrub	% Desorbed at 24 hours	% Decontamination at 24 hours
Non-porous	Anodized Aluminum[1]	Control		0	100
	Anodized Aluminum	Decon	No Scrub	0	100
	Canadian Alkyd Paint	Control		0.03	100
	Canadian Alkyd Paint	Decon	No Scrub	0.01	100
	Canadian Alkyd Paint	Decon	Scrub	0.01	100
	CARC	Control		0.00	100
	CARC	Decon	No Scrub	0.00	100
	Glass	Control		0.00	100
	Glass	Decon	No Scrub	0.00	100
	Vinyl Floor Tile	Control		21.2	78.8
	Vinyl Floor Tile	Decon	No Scrub	14.5	85.5
	Vinyl Floor Tile	Decon	Scrub	1.65	98.4
Porous	Alkyd Wall Board	Control		4.65	95.4
	Alkyd Wall Board	Decon	No Scrub	0.20	99.8
	Alkyd Wall Board	Decon	Scrub	0.70	99.3
	Asphalt	Control		4.99	95
	Asphalt	Decon	No Scrub	5.91	94.1
	Asphalt	Decon	Scrub	0.82	99
	Concrete[2]	Control		0.01	100
	Concrete[3]	Control		0.00	100
	Concrete[2]	Decon	Scrub	0.03	100
	Latex Wall Board	Control		15.2	84.8
	Latex Wall Board	Decon	No Scrub	21.9	78.1
	Latex Wall Board	Decon	Scrub	0.36	99.6
	Varnished Wood	Control		4.07	95.9
	Varnished Wood	Decon	No Scrub	2.78	97.2
	Varnished Wood	Decon	Scrub	2.87	97.1

[1] 10.6 hours; [2] 2 hours, split flow; [3] Immediately, direct flow

Liquid Phase Studies (Task 2)

<u>CW Agents</u>

In these experiments, the reaction between SDF and various agents were studied in the liquid phase in order to estimate the rate of reaction, the stoichiometry and the reaction products formed. A separate part of this task involved the decontamination of the BW agent, anthrax, and is described later.

Agents Studied

The agents studied included HD, four G-agents (GA, GB, GF and GD), two V-agents (VX and R33) and T-2 mycotoxin. Originally (Annex A.), the intent was that Lewisite (L) and KCN would also be investigated for decontamination effectiveness. L presented significant difficulties in achieving consistent results via GC analysis of standard solutions but, based on these efforts, a way forward to address assessment of decontamination effectiveness against L in the future was identified and will be reported as a Technical Note. Subsequent loss of personnel and the time expended with development of reliable L analysis prevented completion of the L and KCN assessments.

Testing Procedure

For the agents studied, the SDF formulation was prepared as a liquid and transferred to a 2-mL temperature-controlled reaction vessel equipped with a pH probe. The agent was added with a calibrated pipette and the mixture stirred; the pH of the solution was recorded throughout the experiment. Aliquots were taken from the reaction mixture at timed intervals for analysis.

This investigation was carried out to verify the effectiveness of SDF against these agents and to estimate the minimum quantities of SDF liquid to achieve complete decontamination. A modified formulation of SDF (developed under Task 4) was also briefly tested against R33 and GD to determine if any changes to effectiveness due to the modification may have occurred. The intent of the modification was to lower the temperature at which the GCE-2000 concentrate forms a gel and, in turn, widen the range of conditions in which SDF can be used; the modification was not expected to have any impact on the effectiveness of SDF.

Separation of the reaction components was achieved on a capillary liquid chromatography (LC) column with detection/quantitation by an LC-FPD (Flame Photometric Detector)/Diode Array (DAD) and quantitation/product characterization by LC-Mass Spectrometric Detector (MSD). HD samples were quenched (hydrogen peroxide/isopropanol) and centrifuged prior to analysis whereas G- and V- agent samples were injected without active quenching. VX type samples were centrifuged prior to analysis due to the formation of a precipitate when the SDF was added.

Results

In total, over 25 individual experiments were undertaken and are detailed in four recent publications [C3-C6]. A summary of the results is given in Table 5. It should be noted that, due to the limited number of experiments that could be completed in the time available, the minimum volumetric ratio of liquid decontaminant-to-agent will, in fact, be less than that stated. For example, the lower limit for 99% effectiveness for Fluoride-contining G-agents was approximately 90:1 but 100:1 is stated due to the limited number of observations to ensure effective decontamination. The observed decrease in pH for the reaction solution of SDF-GA was significantly greater than that for the other G-agents indicative of a different overall mechanism of reaction.

Table 5. *Summary of Results for Liquid Phase Studies*

Agent	# of Expt.	Decon Used	Decon Ratio*	Reaction	Comments
HD	6	SDF	30:1	Oxidation	Precipitate with quench
VX	11	SDF	40:1	Oxidation	precipitate
R-33	5	SDF	40:1	Oxidation	precipitate
	2	Modified SDF	40:1	Oxidation	precipitate
GA	12	SDF	300:1	Hydrolysis	
GB	8	SDF	100:1	Hydrolysis	
GD	11	SDF	100:1	Hydrolysis	
	2	Modified SDF	100:1	Hydrolysis	
GF	8	SDF	100:1	Hydrolysis	
T-2 Mycotoxin	3	SDF	>>5000:1	Hydrolysis	

*Minimum volumetric ratio of decontaminant to agent to achieve 99% decontamination effectiveness within 60 minutes

Conclusions

SDF worked well to decontaminate the V-agents, the G-agents and HD but it was not effective against T-2 mycotoxin. An unexpectedly high ratio of decontaminant to agent was required for the agent GA, most likely as a result of the chemical structure of that agent (P-CN and P-N bonds) as compared to the other G-agents (P-F and P-CH_3 bonds).

The formulation modified in accordance with the recommendations of studies described below under Task 4, appeared to work as well as the unmodified original version in the liquid phase in the two experiments performed suggesting that no degradation in decontamination performance appears to have occurred due to the modification.

BW Agent

Initially, three biological agents were to be tested against the UCS formulation - yersinia pestis, vaccina, and anthrax. However, due to time restraints and immunisation/safety issues, only anthrax could be tested. The details of the study are reported in separate documents [C1, C11].

Materials Tested

The BW agent tested was *Bacillus anthracis* Ames strain, originally obtained from USAMRID, Ft. Detrick, MD, USA. The agent concentration was 1.37 x10^8 cfu/mL. Two freshly prepared decontaminant formulations, SDF and CASCAD®, were tested in the liquid phase, as well as SDF aged for 30-minutes.

Test Procedures

Aliquots (500 µL) of the decontaminant solution were dispensed into three 10-mL tubes. Bacteria stock (100 µL) was added immediately to each of the three tubes and swirled gently to mix. After a 30-minute contact time, each bacteria/decontaminant solution was diluted with five mL of sterile PBS (phosphate buffered saline) and centrifuged at 4750 x G to pelletize the bacteria. Each bacterial pellet was then resuspended in 500 µL of sterile PBS and the samples (200 µL) were each spread onto a Blood Agar Plate and the plates incubated overnight at 35°C. The plates were examined for bacterial growth following the incubation.

Controls were processed as described above with different control solutions substituting for the decontaminants –

1. In control solution “A”, bacterial dilutions were prepared with PBS.
2. Control solution “B” bacterial dilutions were prepared with a control version of SDF without the active decontaminant.
3. Control solution “C” bacterial dilutions were prepared with a control version of CASCAD™ without the active decontaminant.
4. Control solution “D” was tap water.

Spore concentrations were determined by preparing 10-fold serial dilutions and plating 100-µL aliquots onto 5% Sheep Blood agar plates in triplicate, incubating the plates overnight at 35º C and visually counting the number of bacterial colonies.

Results

The control solutions exhibited no decontamination effect, as expected, although the spore concentrations in PBS and water (Controls A and D) were somewhat lower than the SDF and CASCAD® controls (B and C). This difference may be due to the presence of surfactants in Controls B and C which could break up spore aggregates in solution leading to increased spore counts.

Both SDF and CASCAD® were found to be equally effective as sporicides, killing 100% of the anthrax spores in the test system described indicating a reduction efficiency in excess of 10^7. Since all decontaminated samples had plate counts of zero, it was not possible to determine how far in excess of 10^7 the reduction efficacy could extend to. As well, there was no observed loss of decontamination efficacy in SDF following a 30-minute waiting period before use. Whether the aging had an impact on effectiveness can, therefore, not be determined until tests involving higher initial levels of spores at which failure can be detected are carried out.

Earlier studies of the effectiveness of CASCAD® formulations against anthrax have been carried out. In Reference 25, anthrax cultures were placed on metal plates and allowed to dry overnight. CASCAD® or a control foam was applied to the plates, allowed to sit for 30 minutes and flushed off with sterile PBS. Decontamination effectiveness was measured at 99.99% translating into a 4-5 log reduction. Again, higher challenges would have better defined the effectiveness of CASCAD® but it is noted that the plating of spores onto the plates to dry before contact with the decontaminant is a more stringent and realistic procedure to simulate actual decontamination situations. In addition, this approach employed CASCAD® in its intended form - that of a foam not as a liquid. A similar approach was followed by Sattar [31] under an independent initiative by AVC in which the spore cultures were applied in a soil load to better simulate field conditions but which employed CASCAD® in the liquid phase. A 30-minute contact time at 20°C demonstrated an effectiveness of over a 6-log reduction even with the soil loading [31].

Conclusions

Both SDF and CASCAD® are effective in killing 100% of the anthrax spores, with a reduction efficiency of greater than 10^7. The aged SDF solution was as effective as the freshly-prepared solution at this challenge level.

Allen-Vanguard

Allen-Vanguard commissioned studies of the environmental impact of various formulations of foam in the UCS family (Task 3) as well as methods to reduce the gelling point of the surfactant (Task 4). The bulk of the effort was contracted out and a summary of the results follows. As a result of these subcontracts, modifications were made to the formulations, preparation methods and delivery systems.

Environmental Impact (Task 3)

AVC subcontracted Stantec Consulting in Guelph, ON to study:

a. Aquatic toxicities (rainbow trout, *Daphnia magna*, fathead minnow, *Ceriodaphnia dubia*, and *Selenastrum capricornutum*) and ready degradability testing

b. Soil toxicity (acute screening and chronic toxicity) of the UCS components.

The results were reported in three Contract Reports [C18-C20].

Aquatic Toxicity Testing

Tests Undertaken

The tests undertaken by Stantec Consulting included:

1. 96-hour acute lethality test with rainbow trout (ECS 1/RM/9)
2. 48-acute lethality test using *Daphnia magna* (ECS 1/RM/11)
3. 7-day survival and growth tests using fathead minnows (EPS 1/RM/22)
4. 7-day survival and growth test using *Ceriodaphnia dubia* (EPS 1/RM/21)
5. 72-hour growth inhibition test using *Selenastrum capricornutum* (EPS 1/RM/25)
6. "Closed bottle test" for ready biodegradability (OECD Method 301D "Closed Bottle Test)

The results were reviewed by Environment Canada (the second federal partner in the project).

Components Tested

A training formulation, DSF, diluted DDSF, SDF, Backpack and diluted CASCAD® formulations were tested for aquatic toxicity; three of the formulations without the active ingredient were also tested for ready biodegradability using the OECD Method 301D "Closed Bottle Test".

Results

The least toxic formulations were found to be the training solution (no active ingredient) and DSF (dispersive suppressant foam with no active ingredient). The most toxic solution was concluded to be the Backpack formulation, which contained the highest concentration of the surfactant. Overall, the results correlated to the concentration of surfactant in the formulations [C18].

Soil Toxicity Testing

These toxicity assessments involved evaluating the potential adverse effects to both terrestrial and aquatic receptors in soils. Two reports were issued, the first a range-finding test for both acute and chronic toxicity [C19] and the second, an in-depth examination of the formulations to identify potential toxicities associated with prolonged exposure to lower substrate concentrations [C20].

Test Subjects and Conditions

The test subjects were: northern wheatgrass or *Elymus lanceolatus* and lettuce or *Lactuca sativa*, the compost or red wiggler earthworm (*Eisenia andrei*) and the springtail (Collembola – *Onychiurus folsomi*) as a representative of a soil anthropod.

For the definitive tests in the plants, measurements included seedling emergence, shoot and root length and shoot and root dry and wet phytomasses over 14 (lettuce) and 21 (wheatgrass) days. For the earthworm, the chronic reproduction parameters were adult survival at day 35 and mean number and wet and dry masses of progeny, while for the springtail, adult survival, adult fecundity and the mean number of progeny after 35 days were recorded.

pH and conductivity measurements were recorded at the beginning and end of each test and soil moisture determinations were recorded for the invertebrate tests.

Components Tested

The DSF, DDSF and CASCAD® formulations were tested in the soil toxicity studies.

Results

For both plant species, CASCAD® and DDSF were found to be more toxic than DSF. Similar ordering was observed in the chronic reproduction toxicities for the earthworm and springtail. Overall, CASCAD® had the most severe effects, DDSF had fewer effects and DSF had the least impact on the species studied. These results are not unexpected, since the concentrations of active ingredient and surfactant are:

CASCAD® > DDSF > DSF

Formulation Optimisation (Task 4)

AVC subcontracted McMaster University to examine the UCS surfactant concentrate with an objective to propose approaches to reduce the gelling temperature for storage and field use [C21]. Another subcontract was let to Farrington-Lockwood Company Ltd (FLCL) to examine and develop methodology for assessment of shelf- and pot-life and characterisation of prepared formulations [C16, C17, C22].

Gelling Temperatures (McMaster University)

Strategies

During the study, it was discovered that the surfactant GCE-2000 is, in fact, a microemulsion which changed the original direction of the planned effort. Avenues to address the objective of lowering the gelling point of the concentrate then included disruption of the arrangement of organized surfactant-water structures by the addition of various additives. Mixtures of GCE-2000 with candidate additives were studied using Differential Scanning Calorimetry to reveal thermal effects accompanying the gelling process to better understand the mechanisms.

Additives Tested

Several classes of additives were tested, such as

1. Soluble Polymers
2. Soluble Block copolymers
3. Selected sodium salts
4. Amphiphilic additives or linkers

Results

It was found that the amphiphilic additives or linkers had the greatest beneficial effects on decreasing the maximum rate of solidification. Results for various combinations of additives were provided and recommendations made as to preferred mixtures of additives to achieve maximal decrease in the gelling points [C21].

Shelf Life Studies (FLCL)

Objectives

The objectives of this subcontract were four-fold –

1. To collect background data on the properties of the UCS components and its individual ingredients
2. to design a suitable shelf-life test plan,
3. to select suitable stability-indicating test methods
4. to investigate the behaviour of UCS components subjected to various accelerated aging conditions.

Results

A test plan was developed in which samples of UCS components and individual ingredients were subjected to a matrix of severe environment conditions to accelerate degradation and then tested with the selected methods to determine if the tests could distinguish between "aged" and "not aged" samples.

In addition, tests on the individual ingredients led to recommendations for adapting alternate forms of the active ingredient and some of the buffering components and a change in the distribution of concentrate components resulted in increased storage life and increased transportation safety of the concentrates and increased solubility of the active ingredient.

It was observed that the surfactant is very resistant to degradation based on determination of physical changes in the product and the foam's appearance and drain rates which were not significantly different between test and control samples. Information on stabilities of the formulation at various steps during component dissolution and its preparation was documented.

Recommendations

In view of the stability of the surfactant, it was concluded that range-finding tests on GCE-2000, the surfactant concentrate, would not identify conditions that accelerate degradation or lead to new methods that could detect degraded product. Thus, the stability of GCE-2000 should be tested for acceptability using Allen-Vanguard's existing standard Backpack test protocols [C16, C17].

Recommendations were also provided for changes to the preparation procedure for the formulation similar to those used in earlier field trials during the development of the CASCAD® family [C22] which would lead to significant increases in pot-life for the prepared formulations.

Formulation and Equipment Changes (Task 4)

As a result of the subcontracts to McMaster and FLCL, the chemical forms of active ingredient and buffer components, the composition of the individual concentrates, the formulation preparation method and the delivery equipment for UCS were modified.

Formulation Modifications

The new formulation now utilizes a different chemical form of the active ingredient which enhances the solubility of the active ingredient and increases its transportation safety. This change did not affect the stability or shelf life of the final product. Alternate forms of the buffer chemicals were identufied leading to increased storage stability of the solid concentrate. The new formulation also incorporates the modified surfactant concentrate, which serves to lower the gelling point of the surfactant concentrate mixture.

Preparation Method

The concentrate constituents and their preparation methods have been changed in order to separate the active ingredient from the other dry ingredients until generation of the foam and contact with the intended surface. This serves to increase the pot-life of the formulation considerably even though the overall final composition remains essentially unchanged.

Equipment Modifications

There are three delivery systems for UCS in the field - a pallet/trailer system (approx. 360 L), a dolly system (approx. 130 L) and a Backpack (portable self-contained unit designed for emergency spot decontamination on hardware or structural surfaces, approx. 12.5 L). The designs of both the dolly system and the backpack have been modified to include dual tanks in order to incorporate the change in the method of preparation and prototypes manufactured. A design of the larger pallet system has also been completed. With the modified equipment, the active ingredient is kept separate from the other ingredients until the foam is required, thus extending the pot-life of the decontaminant by several hours [C24].

Testing of the Formulation and Equipment Modifications

All of the liquid phase tests were completed using the original version of the active ingredient and the modified preparation method. The formulation based on using the modified surfactant was also tested briefly in the liquid phase laboratory study with both a V-agent and a G-agent and found to be as effective as the original formulation (see Table 4). The foam phase experiments used only the original formulation and the recommended laboratory preparation method [28]. The modified dual tank dolly and Backpack, along with the modified formulation (improved surfactant), were tested in the Field Trial described below.

Field Trials (Task 4)

The Field Trials were held outdoors at DRDC Suffield from Aug. 29 to Sept. 2, 2005 at the Chemical Training Site. A total of 23 DRDC, seven AVC and one EC personnel were involved over the five days. DRDC Suffield provided trial support, explosives, explosive dissemination equipment, experimental expertise and personnel for the trials. AVC provided the modified UCS equipment and formulations and personnel to operate them, while EC sent a chemist to observe the trials.

One aim of the trial was to verify the continued effectiveness of the blast suppression and explosive dissemination mitigation capabilities of an improved UCS based on the modified foam formulation, a redesigned foam application system, an improved method of formulation preparation, and the original tent containment equipment (which is used to mitigate the destructive effects of blasts from explosive devices and agent-filled explosive dissemination devices) [C2]. The second aim of the trial was to demonstrate the efficacy of the modified foam formulation and preparation procedure in decontaminating agent-contaminated panels of various civilian surfaces as a field application of some surfaces studied under Task 1.

There were four parts to the trial –

1. Blast Suppression using modified DSF in a 4-panel tent (no active ingredient)
2. Blast Suppression using modified DDSF in a 6-panel tent (low level of active ingredient)
3. Blast Suppression using modified DDSF in a 4-panel tent incorporating explosively-disseminated mustard (low level of active ingredient)
4. Decontamination of civilian surfaces contaminated with HD using modified SDF (medium level of active ingredient)

Blast Suppression Using Modified DSF in a 4-panel Tent

The aim of this trial was to test the blast suppression capabilities of the modified DSF formulation (containing modified surfactant concentrate but no active ingredient for decontamination) as well as to trial the new dual-tank dolly system. This was accomplished by detonating an explosive charge (1/4 lb of C4) inside a 4-panel containment tent (1557 L capacity) filled with DSF foam.

Materials and Procedures Used

The materials used in trial included –

1. 4-panel containment tent
2. Modified DSF foam formulation
3. Modified air dolly system
4. Metal containment tray for the tent and explosive
5. 113.4g C4 explosive (1/4 lb)
6. Support/container for the explosive
7. Hand-held radios
8. Stopped-frame video recording equipment
9. Still camera equipment
10. Portable meteorology station
11. Pressure monitoring equipment
12. Medical personnel and equipment

The meteorological information was collected to determine the prevailing wind direction. The support/ container for the explosive device was placed in the containment tray and the unarmed explosive was located on the support with the arming leads secured off the layout in the upwind direction. The containment tent was then manually placed over the explosive device. The fast speed and normal video equipment was set up and the normal video recording commenced. Explosive pressure-monitoring detectors and data logging equipment were also set up. Still photos were taken as required.

The UCS foam dispensing equipment (the new dual-tank dolly system) was assembled and the formulation installed. This equipment was moved to the site of the containment tent and the foam sprayed into the tent through the top opening. The tent was filled to capacity to ensure that the explosive device was fully covered. The layout was cleared of equipment and all personnel were moved upwind of the layout. The explosive device was armed and functioned (fast speed photography was used to bracket the detonation) using the normal countdown procedure.

After the event, the layout was surveyed, photographs taken, and the monitoring equipment removed for processing.

Data Collection and Analysis

In this trial, normal and high speed videos, photos and over-pressure information were recorded. The pressure data was collected through an array of sensors placed at regular intervals outside the tent and was used to analyze the blast mitigation effect of the modified UCS by comparing it to that observed in open air. This data collection and analysis will be documented in a separate report [C12].

Results

The new dual-tank system worked satisfactorily to fill the tent with foam. The tent was lifted approximately 45 cm into the air when the explosion was triggered then settled down again. There was little or no apparent damage to the 4-panel tent as a result of the explosive detonation indicating that the foam structure was adequate to contain the explosive force. The foam reduced the blast over pressure by 18.89 kPa or 88.7% at a 3m standoff compared to a similar open-air free field shot [C12].

Conclusions

The modified air-dolly equipment worked well with the modified formulation to produce the foam. The foam adequately contained the explosive charge indicating that the modified surfactant did not impair the foam bubble formation.

Blast Suppression Using Modified DDSF in a 6-panel Tent

This trial was designed to verify the effectiveness of the modified DDSF formulation (containing a low level of the active ingredient for decontamination) for containing an explosion in a 6-panel tent (3880 L capacity). The effectiveness of the new dual-tank dolly system in filling the tent with the modified DDSF formulation was also observed.

Materials and Procedures Used

The materials used were similar to that reported above with the following exceptions –

1. 6-panel containment tent
2. Modified DDSF foam formulation
3. 226.8g C4 explosive (1/2 lb)

The procedures used were as described above.

Data Collection and Analysis

As in the previous trial, normal and high speed videos, photos and over-pressure information were recorded. This data collection and analysis will be documented in the same report [C12].

Results

The new dual-tank system worked satisfactorily to fill this larger tent with foam. The tent appeared to be lifted about 30 cm off the ground after the explosion then settled down onto the ground. There was no apparent damage to the 6-panel tent as a result of the explosive detonation indicating that the foam structure was adequate to contain the explosive force. There was twice as much explosive used in this trial as in the 4-panel tent described above, however, the capacity of the 6-panel tent is 2.5 times that of the 4-panel tent. Pressure data was lost from this trial due to instrumental problems [C12].

Conclusions

The new dual-tank dolly system worked well with the modified DDSF formulation to fill the tent with foam. The foam was adequate to contain the explosive force of ½ lb of C4 with no apparent damage to the tent. This indicates that the modifications made to the formulation did not adversely affect the bubble structure of the foam, either with (DDSF) or without (DSF) inclusion of the active ingredient.

Blast Suppression/Agent Decontamination of an Explosive CW-Containing Dissemination Device Using Modified DDSF in a 4-panel Tent

This trial was designed to verify the blast suppression capabilities as well as the vapour/liquid suppression and agent decontamination capabilities of the modified DDSF formulation. A 4-panel tent was used along with munitions-grade mustard in an explosive dissemination device. This was a potentially much more hazardous trial and the materials and procedures used reflected that.

Materials and Procedures Used

The materials used were similar to that described above with the following exceptions –

1. Primacord (explosive)
2. 150 mL Munitions-grade mustard in a Nalgene bottle
3. Gallows support for the agent bottle
4. Four Chemical Agent Detection System (CADS II) stations equipped with eight Chemical Agent Monitors (CAMs) set to monitor for HD vapour
5. Four hand-held CAMs
6. 24 one-way CW agent jump cards to detect liquid agent contamination
7. RSDL® (Reactive Skin Decontaminant Lotion)
8. Individual Protective Equipment (IPE) including masks, gloves and undergarments
9. Bleach and boot trays for decontamination
10. Mask fit test chamber
11. CW agent transportation castle

Meteorological information was collected to determine the prevailing wind direction. The dispersal device containing the mustard was placed on its gallows in the containment tray with the arming leads secured off the layout in the upwind direction. (The device was not armed until the agent layout preparation was completed and all personnel cleared from the layout). The containment tent was then manually placed over the gallows and dispersive device. Full IPE was required for approaching the trial layout at any time.

The fast speed and normal video equipment was set up and the normal video recording commenced; still photos were taken as required. The CADS II stations were set up and the data monitoring units connected and initiated. The UCS dispensing equipment (the new dual-tank dolly system) was assembled and the formulation installed. This equipment was moved to the site of the containment tent and the foam sprayed into the tent through the top opening. The tent was filled to capacity to ensure the gallows and dispersive device was fully covered. The layout was cleared of equipment and all personnel were moved upwind of the layout. The explosive device was armed and functioned (the fast speed video was used to bracket the detonation) using the normal countdown procedure.

After the event, the layout was surveyed with portable CAMs, jump cards were monitored and photographed and the monitoring equipment removed for processing. All personnel involved underwent standard decontamination procedures and removal of IPE. The tent was left in the containment tray overnight. The next morning the tent was checked with portable CAMs for residual mustard response.

Data Collection and Analysis

As in the previous trial, normal speed videos and photos were recorded. In addition, agent vapour was monitored through the use of four CADS II stations and hand-held CAMs. Evidence of any liquid agent splattering after the explosive dissemination was recorded by the use of one-way detector paper jump cards placed around the tent. These results are detailed in a report on the CW aspects of the trial [C13]. Pressure transducers were not used during this trial.

Results

There was not enough explosive employed in this trial to create a pressure pulse trace, hence pressure monitoring equipment was not used. The surfaces tent barely moved on detonation of the Primacord and a small amount of smoke or steam exited from top of the tent. There was no downwind response to HD from the CADS II stations throughout the trial. There was no evidence of any liquid droplets on any of the jump cards, although three of the cards were splashed with the DDSF foam from the tent during the explosion causing changes in colour on those cards. There was one reading of four bars on a handheld CAM 30 minutes after the blast when the tent overcover was removed. There were no readings on the portable CAMs when the tent was opened; this was checked four times.

The tent was left on the containment tray overnight and checked with a hand-held CAM the next morning. At this point, the foam had collapsed and only liquid remained. There was a CAM reading of four bars; some HD had remained in the lower corners of the 4-panel tent and was insufficiently decontaminated in the actual trial. There was some question as to whether this was a result of an air pocket in the corner of the tent (particular to the 4-panel tent design as opposed to the 6- or 8-panel tents) where the foam did not reach upon filling or due to HD soaking into the rust on the floor of the containment tray. (The tents have openings in the bottom to facilitate their placement over the devices so formulation would drain directly onto the tray surface). Some tearing of the tent nylon was observed. This is a result of the manner in which the tent is made; the ballistic inner layers swell, but the nylon does not and therefore must tear.

Conclusions

The foam from the modified DDSF formulation easily contained the blast and there was neither vapour nor liquid mustard detected outside of the tent during the detonation. One CAM registered a response when the tent overcover was removed but there was no indication of residual mustard vapour at the top of the foam when the tent was opened. Mustard vapour was detected the following day in the corners of tent after the foam structure had collapsed. This may be the result of the design of the 4-panel tent and the resulting inability of the foam to completely fill in the corner areas or to HD soaking into rust on the containment tray. As a result of this trial, a clear 4-panel tent was fabricated by AVC for training visualisation and redesign purposes.

Decontamination of Civilian Surfaces Contaminated with HD Using Modified SDF

In this part of the field trial, one-foot square sections of four different civilian surfaces similar to the materials used in Task 1 were attached to a metal support frame, dosed with distilled HD (dyed red for visibility), then covered with the modified SDF foam formulation. The foam was applied using the new dual-tank Backpack. Effectiveness of decontamination was monitored through the use of hand-held CAMs and three CADS II stations positioned around the perimeter of the layout. The four surfaces tested were vinyl floor tile, ceiling tile (white PVC side exposed), ceiling tile (yellow fibreglass side exposed) and carpeting.

Materials Used

The materials used in this trial included –

1. Metal containment tray for the layout
2. Metal frame support for the samples on which a stiff white polybutylene terephthalate (PBT) backing was mounted
3. clips to hold the samples to the frame
4. 30 cm^2 (one foot square) samples of the four surfaces
5. Eight vials of HD, approximately two g each, dyed red with William's Red dye
6. Modified SDF foam formulation
7. New dual-tank Backpack equipment
8. Garden sprayer and tap water for rinsing
9. Three Chemical Agent Detection System (CADS II) stations equipped with six Chemical Agent monitors (CAMs) set to monitor HD vapour
10. Two hand-held CAMs
11. Hand-held radios for communication
12. Video recording equipment
13. Still camera equipment
14. Portable meteorology station
15. Waste jar for used mustard containers
16. KOH/methanol to decontaminate used mustard and transfer vials
17. RSDL® (Reactive Skin Decontaminant Lotion)
18. Individual Protective Equipment (IPE) including masks, gloves and undergarments
19. Bleach and boot trays for decontamination
20. Mask fit test chamber
21. CW agent transportation castle

The support stand was set up inside the metal containment tray and the four samples were attached to the support via large clips. The CADS II stations were positioned outside the containment tray along three sides downwind of and beside the sample frame. One video camera was set up about seven meters from the containment tray on a tripod. The other video recorder was used to monitor the output of the CADS II stations due to inadequate automatic digital transfer and storage capabilities on the particular Central Computing Unit supplied with the CADS II system. Still photographs were taken throughout the trial.

The formulation concentrates were prepared by AVC personnel and transported to the layout. The agent was also transported to the trial site. One vial (two mL) of dyed HD was applied to each surface by pouring it directly from the vial. The hand-held CAMs were used to monitor any agent vapour desorbing or evaporating from the surfaces.

The foam decontaminant was applied to the panels using the Backpack system. The panels were decontaminated one at a time in the same order that the agent had been applied. After approximately 30 minutes (no scrubbiing), the foam was rinsed off the panels using water from a garden sprayer. The panels were then photographed and checked again with both CAMs and TIMS detectors. The undersides of the panels were also checked with the detectors and, later, SDF was reapplied to the panels to effect further decontamination. Following this, the ceiling panels were separated from their backings, more decontaminant was applied then rinsed off. Further examination using both types of monitors followed.

After the trial was over, the excess agent and the empty agent vials were decontaminated using KOH/methanol. All personnel working inside the containment tray decontaminated their boots in a tray containing bleach. The four test panels were also decontaminated in the bleach tray. Personnel then proceeded to the decontamination line for cleanup and removal of the IPE.

Data Collection and Analysis

Data was collected through video equipment, still photographs, and manual recording of the portable detector readings given over radio communication. The output of the CADS II stations was recorded via video recorder. This was later analyzed manually and the results tabulated in an Excel spreadsheet.

Results

The results are given in a separate report [C14] and summarized in Table 6.

Table 6. *CAM Results from the Panel Testing Trial*

Sample	Vinyl Floor Tile	Ceiling Tile white side exposed	Ceiling Tile yellow side exposed	Carpet
Observations after Agent Application	Some agent ran off the tile and down the PBT sheet	Agent absorbed into white PVC, some into yellow fiberglass underneath	Agent absorbed in a small area, soaked into the white PVC skin underneath	Agent absorbed into carpet all the way through to the back
Initial CAM Response	8 bars	8 bars	8 bars	8 bars
CAM Response after foam applied	0 bars	0 bars	0 bars	0 bars
Observations after foam applied	3 bars after 22 minutes		red dye drained from ceiling tile after foam	
CAM Response after rinse applied	3 bars	0 bars	0 bars	0 bars
Observations after rinsing	red dye drained from floor tile when rinsed	red dye drained from ceiling tile when rinsed	no dye drainage when rinsed	very little red dye drained from carpet when rinsed
CAM Response to Red Streaks	0 bars	0 bars	0 bars	n/a
Further CAM Response	3 bars	3 bars for underside of white PVC, 2 bars from fiberglass	2 bars from white PVC underside	0 bars

When the agent was applied to the various surfaces, substantial amounts ran off the vinyl tile, was adsorbed into a large area on the ceiling tile (white side exposed), was adsorbed into a very small area on the ceiling tile (yellow side exposed) and was adsorbed into a small area of the carpeting. The initial response of the CAM after application of the agent on all four surfaces was eight bars (full scale). This decreased to zero after the decontaminant foam was applied. One of the surfaces (ceiling tile with yellow backing exposed) displayed red streaks below the coupon as some of the agent/dye ran off the surface. On examination 22 minutes after application of the foam, a further CAM response of three bars was observed on the vinyl floor tile. At this point, the foam had begun to dry out in the heat of the day and agent adsorbed into the vinyl tile had begun to desorb again. None of the other surfaces gave a CAM response at this time. All four surfaces were then rinsed with water. Again, the only surface displaying a CAM reading was the vinyl floor tile. There was no CAM response to the red streaks below the various surfaces. This may be due to the fact that the streaks were caused by the dye only without any agent, or perhaps the agent/dye was adsorbed into the PBT material such that no CAM response was possible although this would be less likely to result in a nil response.

When the undersides of the various surfaces were checked with a CAM, a response was detected on both ceiling tile surfaces but not on the carpet sample. There was evidence of red dye on the under layers of all three samples. There was also a streak of red dye at the lower edge of the underside of the floor tile where the agent/dye had pooled after running down the front of the sample.

Conclusions

The foam successfully suppressed the vapour from the agent while it was wet on all four surfaces. Once the foam on the vinyl floor tile dried, agent began to desorb, and continued even after the water rinse. This result is similar to that observed in the laboratory study on vapour desorption using the non-scrubbing procedure on vinyl floor tile (see above - Task 1). The ceiling tile material readily soaked up liquid desontaminant and broke apart and the PVC surface delaminated from the backing on handling.

The ceiling tile with the white PVC surface facing was decontaminated on the surface, but the under layers of fibreglass were not and displayed a positive CAM response. The ceiling tile with the yellow fibreglass (under layer) exposed appeared to be decontaminated but, again, the agent had soaked down through the layers and the underside had a CAM reading after decontamination. These results are in agreement with the foam desorption experiments on ceiling tile performed in the laboratory (see above).

The carpet had a red stain on the back side but there was no CAM response anywhere on the sample after decontamination. The non-scrubbing experiment in the laboratory using a similar carpet sample resulted in 30% desorption of the original amount of agent over 24 hours.

The new dual-tank Backpack worked well in dispensing the foam, and the modified formulation worked at least as well as the original formulation. SDF was successful in suppressing the vapour hazard of HD on all of the samples tested.

Investigation of Extension of the UCS for Remediation Measures (Task 5)

Based on the achievements realised from Tasks 1-4, AVC have designed a self-contained prototype mobile palletized system for UCS application to address mass or wide-area decontamination and remediation. In contrast to the smaller systems which are designed for access to interior enclosures or small areas, this equipment is capable of continuous operation compared to the batch approach of the smaller units. As such, this application equipment is well suited for addressing large areas such as large building interiors, vehicles, terrain, asphalt, concrete and infrastructure. In addition, evaluation of the data generated in the above tasks has been condensed onto a booklet to provide First Responders with an overview of response procedures, blast mitigation and containment options, equipment/formulation options ranging from small scale to large scale decontamination and a database on overall performance of optimized formulation against agents on a variety of surfaces which is now available for First Responders [24].

Final Conclusions from the Project

Overall the project was clearly a success. There have been significant advances in understanding the behaviour of the UCS system and equally significant technological advances and improvements to the UCS formulation and equipment. In particular, SDF foam was shown to be effective in decontaminating five non-porous civilian substrates and to have utility in containing the vapour from contaminated porous surfaces and destroying residual liquid agents on surfaces.

The minimum volumetric decontaminant:agent ratios in the liquid phase for SDF to completely decontaminate seven CW agents in 60 minutes were determined and SDF was demonstrated to be effective against anthrax in the liquid phase.

In the aquatic environmental studies, the toxicity was related to the concentration of surfactant in the solution with the training solution being the least toxic while in the soil environmental studies, the concentration of both the active ingredient and the surfactant affected the toxicity. Numerical values for the toxicities of UCS-related formulations have been determined and, in concert with local environmental policies, decisions can be made as to the need for any post-use mitigation based on quantities used, areas covered and dilutions involved due to rinsing, etc.

Recommendations were made to modify the formulation, the composition of its concentrates and the procedure for its preparation - to lower the gelling point; to increase its aqueous solubilisation and the transportation safety of its ingredients; to extend the storage life of the solid concentrate; and to extend the pot life of the active ingredient after mixing. New pieces of dispersal equipment (dual-tank pallet system, dual-tank dolly and dual-tank Backpack) were designed and fabricated and allow for large, intermediate and small scale decontamination in the field. Both the modified formulation and the equipment were tested and proved to be effective in a Field Trial held at DRDC Suffield involving blast suppression, CW-vapour suppression and mitigation/decontamination of explosively-disseminated CW agent.

The significance of this project to the First Responder Community is considerable. Modification of the formulation composition, changes to the constituent concentrates and the method for preparation and equipment of UCS will increase its usefulness and safety; users will have a better knowledge of the amount of decontaminant required for complete effectiveness in specific situations; and recommendations have been made for use of the product on a variety of indoor surfaces. In addition, the Field Trials have demonstrated the blast mitigation and agent decontaminating ability of the foam under explosive situations.

Finally, the results of studies undertaken in this project have been presented at a number of fora, symposia, Annual Meetings, etc. A list is provided in the Reference Section [C25-37].

Future Plans for Follow-on Studies

Additional Reports

There are several Reports to be finalised and issued in addition to those already described. The results of the desorption experiments (Task 1) will be modelled with previously-developed empirical mathematical models [15,16] to gain a better understanding of the agent-material interaction (absorption vs adsorption) which could lead to further improvements to the formulation. The LC-MS files recorded in Task 2 will be further examined for expected products and for other new eluting components to characterise the behaviour of these products under the various conditions (ratios) employed. It was already demonstrated that there was no MS evidence of a build up of the toxic hydrolysis product of VX (EA 2192) in agreement with the observations for reaction of CASCAD® with VX [24]. In addition, the improved methodology for detection and quantitation of HD using LC-MS will be reported [C25]. A literature review of the toxicity of these products will also be finalised [C15].

Additional Studies

Under CRTI 04-0019RD, three Field Trials are planned for August 2006 in which three modular rooms fabricated from various civilian materials will be separately subjected to CW and BW simulants and R contamination, then decontaminated using established methods of decontamination. For the chemical Trial, modified SDF, prepared by the improved mixing procedure, will be applied using the modified Backpack equipment.

Since Tasks 1-4 were performed simultaneously, improvements/modifications to the formuation developed in Task 4 could not be instituted in Tasks 1and 2 until late in their undertaking. As a result, only a few experiments employed the modified SDF (GD and VX). On the basis of these few observations, it would not appear that any degradation in performance resulted from the addition of a component to lower the gelling point of the surfactant concentrate. This is to be expected since the amounts added are low and the concentrate is further diluted substantially in preparing the final mixed formulation. In addition, the chemical nature of this additive would suggest minimal change to, if not a slight improvement in, performance against G agents. In any case, it is highly desireable that confirmatory experiments be conducted to verify that the minimum ratios of liquid decontaminant:agent recorded are maintined, if not decreased when the modified formulation based on all of the improvements is employed, at least for the G-agents and VX. In light of the observations in the Field Trial, the strong indication is that the SDF modified by the surfactant additive is equally effective against HD and, based on the fact that VX and HD are oxidized rather than hydrolysed, it is highly probable that V-agents will be similarly addressed by the improved formulation.

In addition to the agent assessments, a brief investigation of the pot-life of the modified formulation is planned in which pH and active ingredient concentrations will be measured and modelled. This study will be completed as part of the CRTI project with costs being inkind from AVC whereas the agent assessments will be performed under auspices of a Technical Development Fund from the royalties generated by sales of CASCAD®-related material.

Another area of study which is desirable to pursue is that of effectiveness against higher levels of anthrax. Since the current studies demonstrated complete decontamination of the challenge employed for all formulations with active ingredient, there is a need to determine what the maximum challenge which can be addressed by these formulations is, i.e., what maximum log reduction that can be achieved.

Finally, but very importantly, there are plans to examine the effectiveness of SDF and related formulations against selected Toxic Industrial Chemicals (TICs) which is now a priority in military and civilian circles since TICs are more likely to confront First Responders in larger quantities than even the CBRW agents.

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Annex A. Amended Charter for CRTI Project 02-0043TA

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ANNEX A TO CRTI MOU
PROJECT CHARTER

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PROJECT CHARTER For CRTI - 02 - 0043TA
Accelerated Consequences Management Capabilities
TO THE

MEMORANDUM OF UNDERSTANDING

CONCERNING

THE CHEMICAL, BIOLOGICAL, RADIOLOGICAL OR NUCLEAR RESEARCH AND TECHNOLOGY INITIATIVE (CRTI)

DATED August 19, 2004

DISTRIBUTION LIST

Action - Internal	Action - External
Dr. Kent Harding Dr. J. Garfield Purdon Dr. Andrew Burczyk Ms. Michele Mayer Mr. Geoff Hunter	Mr. Chris Corbin – Vanguard Response Systems Inc. Ms. Laura Cochrane – Vanguard Response Systems Inc. Dr. Merv Fingas – Environment Canada

Information - Internal	Information - External
Dr. Jacques Lavigne Ms. Dawn Cooper	Phil O’Dell – O’Dell Engineering Ltd Norm Yanofsky - CRTI Sgt John Bureaux - RCMP

RECORD OF AMENDMENTS

Amendment No.	Amendment Date	Entered By	Date
1	Aug. 19, 2004	Michele Mayer	

DOCUMENT OVERVIEW

1. BACKGROUND

Effective decontaminants are required to limit contamination, to reduce vapour hazards and to decontaminate contaminated areas, especially critical infrastructure. As the 2001 anthrax letter incidents in the US have shown, the time, effort and cost of effectively decontaminating buildings is enormous ($23,000,000 US for the Hart Senate Office Building). This proposal offers an effective and potentially environmentally friendly decontaminant that would greatly reduce the time, effort and cost required to remediate CB decontaminated structures. The product will be of great benefit to both the First Responder community and the military user.

This project will study the decontamination effectiveness of the Universal Containment System in the foam phase when applied to surfaces contaminated with an agent. Seven porous and five nonporous surfaces will be tested with CW agents (HD and GD) using both scrubbing and non-scrubbing procedures. The results are vital to guide First Responder's responses to a crisis (can the surface be decontaminated or does it have to be removed?) and to identifying the appropriate training and equipment.

Further research in this project will expand the current database of rates and stoichiometries of reactions of the Universal Containment System formulations with selected CW and BW agents in the liquid phase. As well, reaction intermediates and stable end products will be examined for identification and quantitation. Knowledge of the reaction intermediates and end product information will be invaluable in criminal investigations into the illegal use of agents and for forensic investigations.

A literature search and laboratory toxicity testing will determine the likely impact of the Universal Containment System formulations on the environment. All of this information is critical for First Responders in a crisis (is the residue hazardous, must it be contained, can it be allowed to run off?), as well as in the long-term consequences (when is it safe to enter the contaminated area, will it remain safe?).

Novel means of dispensing the formulations, such as aerosolisation, will also be investigated, and all research results will then be incorporated into a final product, to be tested and evaluated by end users. These enhancements will allow the product to be used in a broader range of CBRN events, not currently easily addressed.

2. INTRODUCTION

2.1 This Project Charter hereby establishes the project CRTI-02-0043TA Accelerated Consequences Management Capabilities as a Project in accordance with the Chemical, Radiological, and Nuclear Research and Technology Initiative (CRTI) Memorandum of Understanding (MOU).

2.2 This Project Charter is subsidiary to the CRTI MOU.

2.3 CRTI Funds can only be transferred to the Lead Participant, if they are a signatory to the MOU, and a satisfactorily completed Project Charter has been filed with the CRTI Secretariat.

3. SCOPE

The objective of this project is to accelerate the development of the Universal Containment System, a world leading containment/mitigation/decontamination system for chemical/ biological/radiological warfare (CBRW) agents. The lead federal agency is DRDC Suffield and the major industrial partner is Vanguard Response Systems Inc. (formerly known as NBC Team Ltd.). Environment Canada is the second federal partner and the RCMP are also participating in this project.

More research on the Universal Containment System is required in order to address several important issues in its performance in CBRW situations including; environmental impact, operating temperature range, stability testing, performance against a wider spectrum of agents on a variety of surfaces, extension of the decontamination technology to assess its long term effect and to examine remediation measures. The researched information will then be applied to the design of a product that can be used in further CBRN scenarios (e.g. aerosol/fogging technology and equipment sizing).

3.1 Included Work

The research will be completed in five tasks, with each task addressing a specific area of need.

Task 1. To determine the decontamination effectiveness of Decontaminant Dispersal Suppressant Foam (DDSF) and related formulations when applied in the foam phase to a series of surfaces contaminated with representative traditional CW agents simulating emergency procedures. This will be accomplished by either analyzing vapour concentrations of selected CW agents which desorb into a flowing air sweep above a surface which has been contaminated and subsequently decontaminated with decontaminant foam formulations using a NATO-approved standard vapour desorption cell or, alternatively, by a liquid extraction test followed by GC analysis. The surfaces tested will be representative of materials used in an office environment. Seven porous surfaces (alkyd wall paint on dry wall, latex wall paint on drywall, varnished wood, ceiling tile, carpet, concrete and asphalt) and five nonporous surfaces (Chemical Agent Resistant Coating (CARC) paint on steel, alkyd paint on steel, window glass, anodized aluminium and vinyl tile) will be examined for desorption profiles with two CW agents – HD (CAS 505-60-2) and GD (CAS 96-64-0) using both a scrubbing and a non-scrubbing procedure to simulate different field decontamination techniques. This laboratory work will be undertaken at DRDC Suffield.

Task 2. To determine the stirred-reaction liquid-phase rates and stoichiometries of reaction and, if applicable, the identity and composition of reaction products and any toxic intermediates of DDSF and related formulations in reaction with a series of traditional and potential CW agents (including KCN (CAS 151-50-8), HD, L (CAS 541-25-3), GA (CAS 77-81-6), GB (CAS 107-44-8), GD, GF (CAS 329-99-7), VX (CAS 50782-69-9), R33 (CAS 159939-87-4), and T-2 mycotoxin (CAS 21259-20-1)) using LC-MSD, HPLC-FP/UV-VIS Detection, UV-VIS Diode-Array and/or Stopped Flow Spectrophotometry, and NMR and/or FTIR Spectrometry analyses procedures. There will also be a determination of the effectiveness of the Foam system in detoxifying selected BW agents/simulants (including yersinia pestis, vaccinia and anthrax) by analysis for colony-forming-units (CFUs) or residual agent at predetermined contact times. Task 2 will be performed at DRDC Suffield.

Task 3. To conduct testing to quantify the environmental impact of the use of Universal Containment System to determine the need for post-treatment or effluent containment. Testing will include both aquatic toxicity and soil toxicity tests, and will be undertaken by commercial laboratories. The results will be reviewed in consultation with Environment Canada and initiated by Vanguard Response Systems Inc.

Task 4. To enhance the performance of the foam components in order to operate over a wider climatic range, more suitable to the Canadian winter environment. This work will be conducted in liaison with Vanguard Response Systems, who will contract and collaborate with McMaster University and Farrington Lockwood Company Ltd. Modifications to the formulation will be evaluated by field trials conducted by the RCMP and assisted by DRDC Suffield.

Task 5. Investigate extending evaluation of the system for remediation measures. Vanguard Response Systems Inc. will evaluate the data resulting from Tasks 1, 2, 3 and 4 in order to optimize the Universal Containment System equipment. This may allow for the capability for mass or wide area decontamination and remediation. A database of the available information on the performance against agents on a variety of surfaces will be developed and made available to end-users.

3.2 Project Risk Analysis and Risk Management Plan

This section outlines the primary risks in the project, and categorizes each risk according to its probability of occurrence and severity of impact on the project should the risk occur:
• Probability of occurrence is rated first for each risk, using a scale of High, Medium, and Low.
• Severity of Impact on the project success is rated second for each risk, using a scale of High, Medium or Low.

The overall project risk level has been determined through a review of the risk ratings across all of the primary risks identified to date. Each project risk has been stated in the sub-sections below, followed by an indication of risk severity (S) and then risk probability (P). If a mitigation method has been established, the risk mitigation measure is described in italics in parentheses after the risk statement.

3.2.1 Overall

The overall project risk has been assessed as Low.

3.2.1.1 Project Management

The project management risks on the project include:

1. Loss of lead federal partner (DRDC Suffield) – P low, S high, *none*
2. Loss of lead industrial partner (Vanguard Response Systems Inc.) – P low, S high, *none*
3. Loss of second federal partner (EC) – P low, S low, *identify alternative partner*
4. Loss of Project Manager (Dr. J. G. Purdon) – P low, S medium, *identify alternative PM*

3.2.1.2 Research Personnel

The research personnel risks on the project include:

1. Loss of key research personnel – P medium, S medium, *identify alternative personnel*
2. Loss of other research personnel – P medium, S medium, *identify/recruit alternative personnel*
3. Reassignment of personnel due to priority changes – P medium, S high, *none*

3.2.2 Contracts and Contractors

The risks due to contracts and contractors on the project include:

1. Loss of Commercial labs – P low, S low, *identify alternative source*
2. Loss of McMaster University – P low, S low, *identify alternative source*
3. Loss of Farrington Lockwood – P low, S medium, *identify alternative source*
4. Delays in the contracting process through PWGSC – P high, S medium, *none*
5. Capping the amount of the Vanguard Contract - P high, S medium, *reconfigure the budget.*

3.2.3 Technical

The technical risks on the project include:

1. delays due to equipment problems – P high, S low, *some leeway has been built into the project schedule*
2. need to repeat experiments due to flawed data - P medium, S low, *some leeway has been built into the project schedule*
3. delays in receiving equipment or supplies - P medium, S low, *some of the tasks may have to be rescheduled*
4. building maintenance problems - P high, S medium, *some of the tasks may have to be rescheduled*

5. power outages - P high, S low, *some leeway has been built into the project schedule*

6. Inoperable new equipment - P medium, S medium, *the scope of the project may be limited*

3.2.4 Natural Events

The risks due to natural events on the project include:

1. base closure due to poor weather conditions - P medium, S low, *some leeway has been built into the project schedule*

3.2.5 Cost

The cost risks on the project include:

1. increased equipment costs - P medium, S low, *order the equipment as soon as possible; all large pieces of equipment have either been purchased or ordered already*

2. increased contract prices - P medium, S low, *major contract is in place; place other contracts as soon as possible*

4. need to repeat experiments due to flawed data - P medium, S low, *some leeway has been built into the project schedule*

3.2.6 Schedule

The schedule risks on the project include:

1. Delays due to experimental difficulties - P high, S medium, *some leeway has been built into the project schedule*

2. Delays due to DRDC Suffield building maintenance - P high, S medium, *some leeway has been built into the project schedule*

3. delays in receiving equipment or supplies - P medium, S medium, *some of the tasks may have to be rescheduled*

4. delays in starting the contracts - P medium, S medium, *proceed with contract negotiations as soon as possible*

5. Inoperable new equipment - P medium, S medium, *the scope of the project may be limited*

3.2.7 Programmatic and Organization

The programmatic and organization risks on the project include:

1. Communication problems between the partners due to geographical locations of both parties - P medium, S medium, *implement a good communication plan*

2. Poor communication between DRDC Suffield support elements and the researchers - P medium, S medium, *establish procedures and protocols for entry into the lab area*

3. Changes to lab assignment and space in containment area - P high, S medium, *management understanding that project must be completed before changes are implemented*

4. Delays in project closeout due to DRP approval of final research reports - P low, S medium, *expedite the DRP approval process*.

3.3 Assumptions

The following points are assumed-

3.3.1 Project Starting Date

The starting date for the project will be Aug.1, 2003.

3.3.2 Contract Starting Date

The starting date for the contract with Vanguard Response Systems Inc. will be Aug. 1, 2003.

3.3.3 Project Funding

Funds for the project will be made available on Aug. 1, 2003.

3.3.4 Experimental Methodology

The experimental procedures used previously on similar equipment will be usable in this project without lengthy delays to modify the techniques

3.4 Constraints

The following constraints are known at this time-

3.4.1 Start of Project

The Project will start on time only if the industrial Contract is in place by Aug. 1, 2003. If there is a delay in the implementation of the Contract, there will be a similar delay in the start of parts of the Project, a consequent delay throughout the Project and a delayed end to the Project. *(Note for Amendment: The Contract was not finalized until Feb. 27, 2004 despite initiation in August 2003)*

3.4.2 Length of Project

The Project is scheduled for two years and eight months (ending March 31, 2006). This time is contingent upon the dedicated use of the scheduled laboratories, equipment and personnel and other resources at DRDC Suffield and Vanguard Response Systems Inc. for the Project during this time. *(Note for Amendment: extension to March 31, 2006 required due to late start of and changes to the Contract and technical difficulties)*

3.4.3 Sole Source Contracting

The contract to Vanguard Response Systems Inc. will be mandated as sole source contracting due to the fact that they are the lead industrial partner for the Project, that the project was competitively selected, and that they are the exclusive licensee for Universal Containment technology.

3.4.4 Equipment Delivery

The start of the Project is dependant upon the delivery of the laboratory equipment by the start of the Project – Aug. 1, 2003. Major pieces of equipment were purchased but some items remain to be acquired. Difficulties in sourcing by PWGSC have delayed purchases.

3.4.5 Equipment

The timing and scope of the project is constrained by the prompt delivery of an FTIR identified for use in the project at DRDC Suffield as well as by the continued acceptable performance of the Varian 3800 GC purchased for the project in July 2003.

3.4.6 Experimental Methodology

The scope of the project is constrained by the length of time necessary to develop new experimental methodology for agent use, if the previously used methods are incompatible with the new equipment.

3.5 Related Projects

3.5.1 Product Development Funds

Related projects include the Product Development Fund (PDF) for the Reactive Skin Decontaminant Lotion (RSDL®) and the planned PDF for CASCAD® (Canadian Aqueous System for Chemical/Biological Agent Decontamination) and subsequent work carried out under these PDFs at DRDC Suffield.

3.5.2 DRDC Suffield Projects

Development of new decontaminants such as the sensitive equipment decontaminant, which is part of DRDC Suffield Project 16QD35, will be carried out simultaneously with this project.

3.5.3 CRTI Projects

There is one other CRTI project related to this project – CRTI 02-0067RD Restoration of Facilities and Area after CBRN Attack (Environment Canada lead partner)

3.5.4 Other Projects

There is one external project associated with this project and the RSDL PDF. It will be conducted by Lawrence Livermore National Laboratories and is entitled Low Cost Personal Decontamination System (LLNL-DHS).

3.6 Project Termination

3.6.1 The Secretariat Director, in consultation with the Project Champion, will make recommendations regarding the termination of a project to the Steering Committee, whose decision will be final.

3.6.2 Conditions that may lead to termination could include:

Deliverables / Milestones not met.

Forecast inability to deliver (i.e. key personnel have left the department or project).

Failure of a contractor to meet obligations.

Change in CRTI investment priorities.

3.7 Level of Classification

3.7.1 No Classified Information

No Classified Information or Material will be exchanged under this Project Charter. Information classified as Commercial Confidential has already been exchanged under the licence agreement for the Universal Containment System (see section 7.1) and will continue to be exchanged during the course of this project.

3.8 Duration and Withdrawal

3.8.1 This Project Charter will remain in effect for a minimum period of two years and eight months (ending March 31, 2006), notwithstanding mutual consent of the participant(s) and approved by the CRTI Steering Committee.

4. RESOURCES

The following resources are required to meet the objectives of the project.

4.1 Budget

4.1.1 Total of the funds to be expended during this Project is $1,961,762, and will be administered by DRDC Suffield. The quarterly breakout of the budget is given in Appendix A.

Project Phase	Fiscal Year	Amount (in $FY)
Definition (CRTI Funds)	2003/04	0
Execution (CRTI Funds)	2003/04	448,624
	2004/05	921,766
	2005/06	591,372

Project Phase	Fiscal Year	Amount (in $FY)
Definition (In-kind Funds)	2003/04	12,316
Execution (In-kind Funds)	2003/04	236,674
	2004/05	761,450
	2005/06	713,340

4.1.2 Distribution of CRTI Funds by Partner.

Participant	Fiscal Year	Amount (in $FY)
DRDC Suffield	2003/04	273,624
	2004/05	271,940
	2005/06	166,170
Vanguard Response Systems Inc.	2003/04	175,000
	2004/05	649,826
	2005/06	425,202

4.2 Schedule

A further breakdown of the work can be found in the Work Breakdown Structure in Appendix C.

Milestone	Event	Completion Date
1	Project Approval-in-principle	April 22, 2003
2	Project Approval	July 22, 2003

3	Project Implementation Begins	July, 2003
4	RFP Release	Aug. 29, 2003
5	Contract Award	Feb. 27, 2003
6	Project start	Aug. 1, 2003
7	Environmental Review Report	Nov. 2, 2004
8	GCE Gelling report	Mar. 21, 2005
9	Biological Effectiveness Testing and Report	Mar. 31, 2005
10	Non-scrubbing profiles completed	May 27, 2005
11	Scrubbing profiles completed	Dec. 13, 2005
12	Field Trial Report	Dec. 31, 2005
13	Stoichiometries/product identification completed	Jan. 18, 2006
14	Literature Search (end products) completed	Jan. 25, 2006
15	Effectiveness /products on CW agents completed	Jan. 31, 2006
16	Equipment prototype and Technical Report	Feb. 27, 2006
17	Issue Final Reports on Laboratory work	Mar. 27, 2006
18	Final reporting and Project Closeout	May 29, 2006

4.3 Personnel

	FY 2003/04	FY 2004/05	FY 2005/06
DRDC Suffield (Full Time Employees, direct costs only without overhead)	32,979	81,995	80,000
Vanguard Response Systems Inc. (Full Time Employees)	132,201	576,328	476,405

4.4 Facilities

4.4.1 DRDC Suffield

4.4.1a. Chemical Containment

Rooms 423 and 428 in the chemical containment area will be required for use in this project for the entire duration of the project.

4.4.1b. Biological Containment

The BL-3 laboratory will be required for a period of three weeks during the second year of the project (Aug. 1, 2004 to July 31, 2005).

4.4.1c. Other Laboratory Space

The laboratory space in Rooms 324 and 427 will be required at various times throughout the duration of the project. Use of facilities in Rooms 326 and 132 may be required at various times throughout the duration of the project.

4.4.1d. Office Space

Office space and equipment (including furniture, computers, software, etc.) in Rooms 410, 410B and 404 will be required for this project for the whole duration of the project, while office space in Rooms 413 and 308 will be required at various times during the project.

4.4.1e. Specialized Equipment

The dedicated use of two Gas Chromatographs (along with the associated equipment and resources for the experiments) will be required for the duration of the project, as well as the equipment purchased especially for the project with CRTI funds. The LC-MSD, UV-VIS Diode-Array and/or Stopped Flow Spectrophotometers, NMR and/or FTIR Spectrometer (along with the associated equipment and resources for the experiments) will be required periodically throughout the duration of the project.

4.4.1f. Field Trial Resources

All the resources required for field trials will be required for a period of three weeks in the second year of the project (April to Oct. 2005).

5. ORGANIZATIONAL STRUCTURE AND RELATIONSHIPS

5.1 Project Review Committee

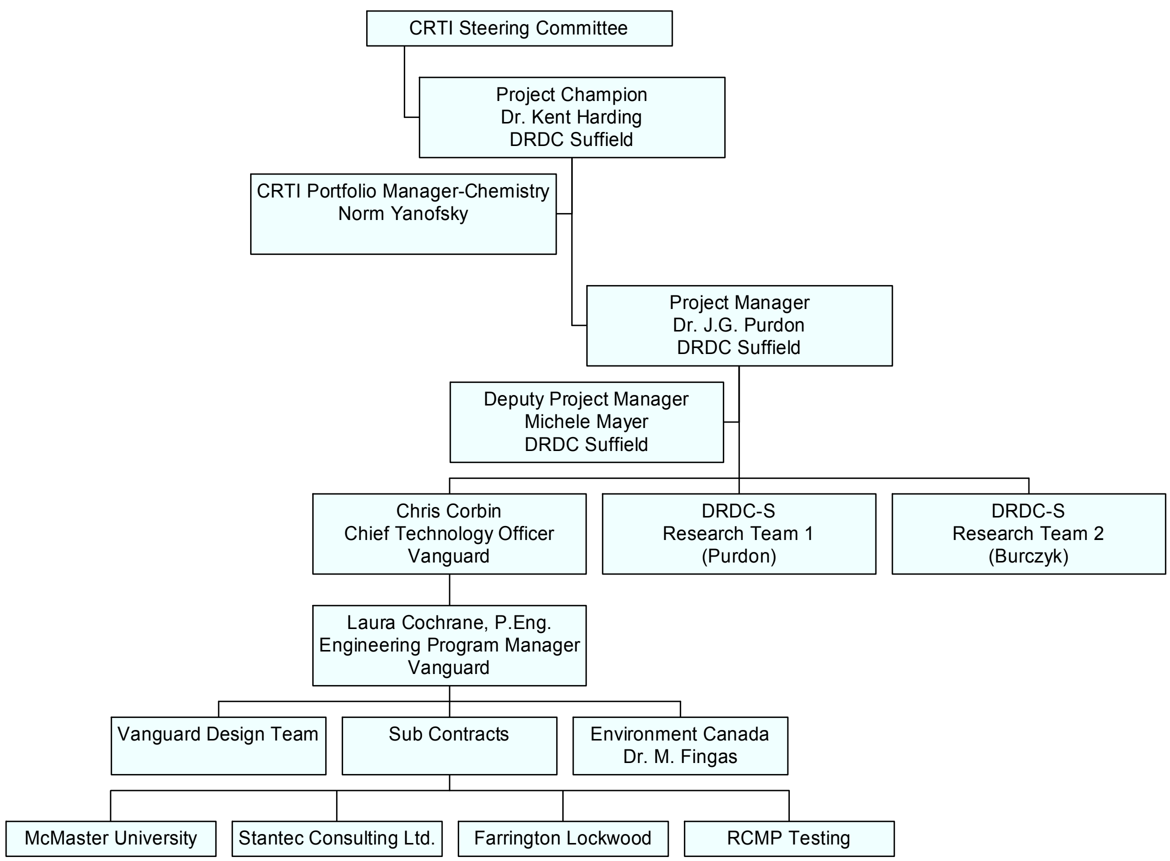
The PRC will convene annually and will review project progress in accordance with project performance criteria specified in the CRTI Project Implementation Plan.

The PRC for the project consists of:

Name	Title	Phone Number	Fax Number
Project Champion (Chair)			
Dr. Kent Harding (DRDC Suffield)	Chief Scientist	(403) 544-4627	(403) 544-3388
Core Members			
Dr. J. Garfield Purdon (DRDC Suffield)	Project Manager and Team Leader	(403) 544-4106	(403) 544-3388
Chris Corbin (Vanguard Response Systems Inc.)	Chief Technology Officer	(905) 643-8801	(905) 643-8824
Dr. Merv Fingas (Environment Canada)	Chief, Emergencies Science and Technology Division	(613) 990-7297	(613) 991-9485

Associate Members			
Norm Yanofsky (CRTI)	Portfolio Manager-Chemistry	(613) 998-6417	(613) 995-0002
Michele Mayer (DRDC Suffield)	Deputy PM	(403) 544-4966	(403) 544-3388
Laura Cochrane (Vanguard Response Systems Inc.)	Engineering Program Manager	(905) 643-8801	(905) 643-8824
Dr. Andrew Burczyk (DRDC Suffield)	Team leader	(403) 544-4788	(403) 544-3388
Sgt. John Bureaux (RCMP)	Explosives Disposal and Technology Section	(613) 993-7880	(613) 993-9917
Procurement Lead Lorna Hoey (PWGSC)	Contracting Services	(780) 497-3588	(780) 497-3510

5.2 Project Organization



5.3 Project Organization Responsibilities

The responsibilities for each of the key positions are described in Appendix B. The key members of the Project Organization are as follows:

Position	Name	Title	Phone Number
Project Role			
Project Champion	Dr. Kent Harding	Chief Scientist	(403) 544-4627
Project Manager	Dr. J. Garfield Purdon	Senior Defence Scientist	(403) 544-4106
Vanguard Response Systems Inc (Industrial Partner)	Chris Corbin	Chief Technology Officer	(905) 643-8801
Environment Canada (Second Federal Partner)	Dr. Merv Fingas	Chief, Emergencies Science and Technology Division	(613) 990-7297
Advisory Role			
	RCMP Sgt. John Bureaux	Explosives Disposal and Technology Section	(613) 993-7880

5.4 Project Interfaces

5.4.1 Reactive Skin Decontaminant Lotion (RSDL®) Product Development Fund (PDF)

The point of contact for the RSDL® PDF is
Phil O'Dell
President
O'Dell Engineering Ltd.
6615 Concession 1, R.R. #2
Puslinch, Ontario
N0B 2J0
Phone (519) 740-8620

5.4.2 CASCAD® intended Product Development Fund (PDF)

The point of contact for the CASCAD® intended PDF is
Chris Corbin
Chief Technology Officer
Vanguard Response Systems Inc.
921 Barton Street, PO Box 11040, Stoney Creek, ON
L8E 5P9
Phone (905) 643-8801

5.4.3 DRDC Suffield Project 16QD35

The points of contact for the DRDC Suffield Project 16QD35 are
Dr. Jaques Lavigne
Phone (403) 544-4672 and
Dr. J. Garfield Purdon
Phone (403) 544-4106
Defence R&D Canada – Suffield
P.O. Box 4000 Staion Main
Medicine Hat, AB
T1A 8K6

5.4.4 CRTI Project 02-0067RD

Dr. Merv Fingas
Chief, Emergencies Science and Technology Division
Environmental Protection Service
Environment Canada
335 River Road
Environmental Technology Center
Ottawa, ON
K1A 0H3
Phone (613) 990-7297

5.4.5 Lawrence Livermore Project

Dr. J. Garfield Purdon
Defence R&D Canada – Suffield
P.O. Box 4000 Staion Main
Medicine Hat, AB
T1A 8K6
Phone (403) 544-4106

6. CONTRACTUAL ARRANGEMENTS

6.1 Contract with Vanguard Response Systems Inc.

A sole source contract with the lead industrial partner (Vanguard Response Systems Inc) for Tasks 3, 4 and 5 of the Project will be administered by PWGSC, Edmonton region.

7. SPECIAL PROVISIONS

7.1 Intellectual Property Management Plan

Canada has developed the world-class Universal Containment System mitigation and decontamination products, providing leading edge counter CBRN capability to military and First Responders. A licence agreement is currently in effect between the Crown and Vanguard Response Systems Inc. for the development, manufacture, marketing and distribution of the Universal Containment System. The Crown owns the background intellectual property and all conditions pertaining to any improvements and collaborations are contained in the licence agreement.

All project partners will respect the interest of collaborators with regards to the divulgence or use of third-party information, or any previous commitments/licensing of background Intellectual Property. Non-disclosure agreements will be used where appropriate.

The Crown will retain all Intellectual Property arising from this Project. Recognising that access to operational communities is the primary goal, all reasonable efforts will be made to further commercialize the Intellectual Property generated by this project.

7.2 Disclosure and Use of Information

All freely shared information generated by the project partners during the course of the project will be disseminated among the project partners via various media (including email, htp server, fax, mail, telephone, teleconference).

Information that is sensitive should be labelled "Commercial in Confidence". The terms "Confidential" or "Secret" should not be used as these terms have distinct meanings under the Official Secrets Act for DND.

All commercially sensitive information related to this project including designs, schedules, fabrication methodologies, test plans, and performance results are considered Protected Business Information and may not be disclosed to any external source, nor internal government departments that are not specifically working on the project. Documents containing such information will be marked "Commercial in Confidence"

Project charters, project reports and other accompanying documentation to CRTI will be archived by the CRTI Secretariat.

Partners must get approval to release any information (press releases, conferences etc.) from the Project Manager. CRTI must be acknowledged on all presented information.

Participants in CRTI projects will provide copies of any reports, articles or publications to the Secretariat for its review for possible security considerations 30 days prior to any release, distribution or planned publication. The CRTI recognizes the balance between freedom to publish, and control in terms of protecting national security and will advise participants accordingly. Organizations such as universities have broad authorities in terms of distribution and dissemination of results. All publications should acknowledge the funding and support of CRTI.

CRTI reserves the right to disclose and/or use information for projects for which it provides funding when requested by the appropriate authorities.

7.3 Other

This project requires that the laboratory personnel from or contracted by Vanguard Response Systems be allowed access to and use of research facilities at DRDC Suffield and to work with CW agents when necessary. Field personnel from the contractor or collaborator (e.g. RCMP) will also require access to DRDC Suffield training facilities and the use of CW agents as required.

8. EFFECTIVE DATE AND SIGNATURE

This Project Charter will enter into effect on the date of the last signature

Dr. Cam Boulet — Date
Director
CBRN Research and Technology Division

Dr. Kent Harding — Date
Chief Scientist
DRDC Suffield

Dr. J.Garfield Purdon — Date
Project Manager
DRDC Suffield

Chris Corbin — Date
Chief Technology Officer
Vanguard Response Systems Inc.

Dr. Merv Fingas — Date
Chief, Emergencies Science and Technology Division
Environment Canada

Appendix A – Quarterly Breakdown of Budget

CRTI - 02 - 0043TA
Accelerated Consequences Management Capabilities

Cost Element	2003/04			2004/05				2005/06				Total
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Total Project												
Pro Labour	5,463	9,780	20,254	18,458	81,291	84,649	86,328	53,584	68,697	64,499	55,263	548,267
Tech Labour	25,540	40,864	63,279	51,845	112,654	124,255	98,842	107,308	108,226	56,054	42,774	831,641
Project Managemt	3,044	3,044	14,030	16,153	62,617	54,781	92,466	53,792	31,401	33,640	25,804	390,773
Equipment	247,724	2,000	3,687	54,042	104,600	16,002	17,706	124,668	4,500	6,500	4,000	585,430
Lab O/M	6,256	6,256	6,256	8,333	9,000	9,000	9,000	11,250	9,000	9,000	9,352	92,702
Overhead	7,649	13,693	24,829	25,327	28,000	33,466	28,000	28,000	28,000	31,500	28,000	276,463
Travel	0	0	1,488	6,445	13,300	8,500	17,300	35,300	12,800	9,800	10,000	114,932
Contracts	0	0	40,544	90,189	80,544	12,500	21,603	14,000	0	0	0	259,380
Other	18,111	40,839	80,669	35,019	57,000	57,000	57,000	57,000	57,000	57,000	57,000	573,638
Total	313,787	116,476	255,035	305,811	549,006	400,153	428,246	484,902	319,624	267,994	232,193	3,673,226
In-kind	33,316	67,741	135,617	113,667	204,002	219,083	224,698	224,934	178,750	166,020	143,636	1,711,464
CRTI Funds	280,471	48,735	119,418	192,144	345,004	181,070	203,548	259,968	140,874	101,973	88,556	1,961,762
DRDC-Suffield												
Pro Labour	5,463	9,780	17,735	18,091	20,000	20,000	20,000	20,000	20,000	20,000	20,000	191,070
Tech Labour						3,904						3,904
Project Managemt	3,044	3,044	3,044	4,818	10,000	10,000	10,000	11,250	11,250	11,250	11,250	88,951
Equipment	245,724			52,524	90,000			31,068				419,316
Lab O/M	6,256	6,256	6,256	8,333	9,000	9,000	9,000	11,250	9,000	9,000	9,352	92,702
Overhead	7,649	13,693	24,829	25,327	28,000	33,466	28,000	28,000	28,000	28,000	28,000	272,963
Travel	0	0	0	6,445	5,000	5,000	5,000	12,500	10,000	5,000	10,000	58,945
Contracts				37,821				14,000				51,821
Other	18,111	40,839	80,669	35,019	57,000	57,000	57,000	57,000	57,000	57,000	57,000	573,638
Total	286,247	73,612	132,533	188,377	219,000	138,370	129,000	185,068	135,250	130,250	135,602	1,753,309
In-kind	31,223	64,312	123,233	78,437	105,000	114,370	105,000	105,000	105,000	105,000	105,000	1,041,575
CRTI Funds	255,024	9,300	9,300	109,940	114,000	24,000	24,000	80,068	30,250	25,250	30,602	711,734
Vanguard												
Pro Labour	0	0	2,519	367	61,291	64,649	66,328	33,584	48,697	44,499	35,263	357,197
Tech Labour	25,540	40,864	63,279	51,845	112,654	120,351	98,842	107,308	108,226	56,054	42,774	827,737
Project Managemt	0	0	10,985	11,335	52,617	44,781	82,466	42,542	20,151	22,390	14,554	301,822
Material	2,000	2,000	3,687	1,518	14,600	16,002	17,706	93,600	4,500	6,500	4,000	166,114
Lab O/M	0	0	0	0	0	0	0	0	0	0	0	0
Overhead	0	0	0	0	0	0	0	0	0	3,500	0	3,500
Travel	0	0	1,488	0	8,300	3,500	12,300	22,800	2,800	4,800	0	55,988
Contracts	0	0	40,544	52,368	80,544	12,500	21,603	0	0	0	0	207,559
Other	0	0	0	0	0	0	0	0	0	0	0	0
Total	27,540	42,864	122,502	117,434	330,006	261,783	299,246	299,834	184,374	137,744	96,591	1,919,917
In-kind	2,093	3,429	12,383	35,230	99,002	104,713	119,698	119,934	73,750	61,020	38,636	669,889
CRTI Funds	25,447	39,435	110,118	82,204	231,004	157,070	179,548	179,900	110,624	76,723	57,954	1,250,028

APPENDIX B. PROJECT ORGANIZATION RESPONSIBILITIES

The responsibilities for each of the key positions are described here.

A.1 Project Review Committee

Responsible For:

a. providing oversight of the project;

b. advising the Project Champion on the management of the project from planning through to implementation;

c. considering and recommending options presented by the project team;

d. providing approval of changes to project objectives;

e. providing approval of changes to project schedule;

f. providing approval of changes to project cash profile;

g. resolving differences between project team members;

h. recommending changes in the project's CRTI allocation to the Steering Committee for approval;

i. ensuring that contingency funds are used for activities within the scope of the project and are expended only as a result of "unforecast events" beyond the project staff's control which make it impossible to get the deliverables for the originally estimated price;

j. monitoring and reviewing project progress, including issues of finance, personnel, and contracting;

k. reviewing project approval documentation, i.e., the Synopsis Sheet, Project Charter, and Technology Demonstration Project Implementation Plan;

l. ensuring that projects linked to the CRTI-02-0043TA project are aware of Accelerated Consequences Management Capabilities progress, findings and recommendations;

m. providing guidance in the development of the Transition Plan;

n. ensuring that the project team complies with the policies and procedures imposed by higher authority;

o. addressing other exceptional circumstances that cannot be resolved by the Project Team; and

p. establishing a cohesive CRTI position for any forum involving other government departments.

A.2 Project Champion

The Project Champion will be accountable to the CRTI Steering Committee. The project's lead participant will typically appoint this person. The Project Champion will typically be a science manager at the Director General or Director level.

Responsible For:

a. ensuring the project meets its objectives within schedule and budget;

b. chairing the Project Review Committee and overseeing the execution of the project;

c. ensuring conflicts between project participants are resolved in cognizance of a project's objectives and constraints;

d. controlling the expenditure of contingency funds and ensuring that such expenditure is consistent with the approved scope of the project and is reviewed by the SRB;

e. ensuring that progress is made towards the approved objectives according to plan, and that corrective action is taken whenever necessary;

f. ensuring that an appropriate degree of authority is delegated to the Project Manager consistent with good management practices and in keeping with Departmental Policy;

g. ensuring that the Project Manager plans, organizes and co-ordinates all of the assigned activities in accordance with approved Departmental direction and established functional organization procedures;

h. ensuring compliance with appropriate management practices, consistent with the methods and procedures for the management of projects in DRDC Suffield; and

i. ensuring the early and continued participation of any third party whose mission or interest may affect or be affected by a project.

A.3 Portfolio Manager

The CRTI will appoint the Portfolio Manager to each project.

Responsible For:

a. assisting the Project Manager in the preparation and obtaining approval of project approval documentation, i.e. , the synopsis sheet, Project Charter, etc.;

b. identifying the stakeholder participation consistent with program expectations;

c. in consultation with the Project Manager, resolving conflicts between aspects of the requirements;

d. reviewing the implementation documentation and participating in meetings to ensure the objectives of the project are met;

e. advising the Project Review Committee of any significant developments, which may affect the project in meeting its objectives and on what corrective action has been or should be taken.

f. establishing or validating the scientific and technological objectives of the project; and

g. ensuring, where applicable, that the system design meets the project objectives.

A4. Project Manager

The Project Manager will be appointed by the project's lead participant.

Responsible For:

a. assisting the Portfolio Manager in the generation of project approval documentation;

b. managing and administering the activities of the project team;

c. coordinating all requests for implementation support from DRDC Suffield functional organisations;

d. coordinating functional organisation inputs and preparing required implementation documentation;

e. in consultation with the Portfolio Manager, resolving conflicts between aspects of the requirement by assigning priorities;

f. ensuring problems and differences are resolved at the lowest possible level;

g. advising the Project Champion and Project Review Committee of any significant developments which may affect the project in meeting its objectives and identifying what corrective actions have been taken or should be taken; and

h. ensuring that all approved project objectives are met, within the assigned resources.

A5. Deputy Project Manager

A Deputy Project Manager may be assigned to the team if the Project Manager responsibilities are too great for one person or who may have other significant matrix or project duties. A Deputy Project Manager may also be assigned to project resources if the geographical dispersion of the project team is such that a Deputy Project Manager presence is required permanently at a site other than that where the Project Manager is located. The Deputy Project Manager is responsible to the Project Manager and will derive his/her responsibilities and authority from the Project Manager. The Deputy Project Manager may be a DRDC Suffield employee or a contracted individual.

A6. Procurement Lead

The Procurement Lead will prepare the requisitions associated with the procurement of equipment and services.

Responsible For:

a. preparing cost estimates for decision documents;

b. providing input to all relevant project documentation;

c. advising the PM on financial, procurement and supply regulations;

d. preparing procurement requisitions and instruments as directed by the PM;

e. preparing and maintaining project cost, budget and expenditure information;

f. acting as the principal point of contact between DRDC Suffield and other government departments to obtain concurrence and, where necessary, support and assistance on procurement, contractual and financial matters;

g. preparing and staffing documentation required to obtain a Record of Decision from the Interdepartmental Procurement Review Committee;

h. recommending the procurement strategy and obtaining the necessary approvals; and

i. advising and assisting, as necessary, to find ways of meeting objectives within policy constraints or attempting to have the constraints lifted, ensuring that policies are followed.

A7. Project Team

The Project Manager will lead the Project Team. It shall include the Portfolio Manager and representatives from each stakeholder involved in the project.

Responsible For:

a. carrying out all aspects of the project activities; and

b. reporting projects issues promptly, as required, to the Project Manager.

A8. Operational Research Member

An operational Research (OR) representative may be identified dependent on the CRTI project requirements.

APPENDIX C. WORK BREAKDOWN STRUCTURE

Task #	Task Name	Duration	Start Date	Finish Date
1	**CRTI - 02-0043TA Accelerated Consequences Management Capabilites**	**645d**	**8/1/2003**	**3/31/2006**
131	Project Management	645d	8/1/2003	3/31/2006
152	Complete Project definition	0d	8/1/2003	8/1/2003
134	Manage project	645d	8/1/2003	3/31/2006
135	Establish Team	0d	8/1/2003	8/1/2003
136	Manage Communication	0d	8/1/2003	8/1/2003
137	Manage Risk	0d	8/1/2003	8/1/2003
138	Monitor and Control Project	645d	8/1/2003	3/31/2006
153	Create Monthly Progress Reports	645d	8/1/2003	3/31/2006
154	Create Quarterly Progress Reports	645d	8/1/2003	3/31/2006
155	Conduct Annual Project Review	645d	8/1/2003	3/31/2006
2	**Task 1 Decon effectiveness**	**582d**	**8/1/2003**	**12/21/2005**
3	Startup	141d	8/1/2003	3/5/2004
181	delay	20w	8/1/2003	1/7/2004
4	Familiarization	2w	1/8/2004	1/21/2004
5	Calibrations	5.2w	1/29/2004	3/5/2004
93	Preparations	143d	8/11/2003	3/16/2004
7	Panel Prep	0.4w	3/15/2004	3/16/2004
8	Prep of agents	2w	8/11/2003	8/22/2003
94	Generation of Prewash Profiles	81.35d	3/31/2004	7/28/2004
10	porous	8w	3/31/2004	5/28/2004
11	hard	1.87w	6/14/2004	6/25/2004
12	clean-up	2.4w	7/12/2004	7/28/2004
13	Generation of Non-scrubbing profiles	126d	8/19/2004	3/3/2005
14	Agent Desorption - porous	12w	8/19/2004	11/16/2004
15	Agent Desorption - hard	5.6w	12/7/2004	1/28/2005
16	Clean-up	3.6w	2/4/2005	3/3/2005
17	Generation of Scrubbing profiles	114d	3/24/2005	9/8/2005
18	Agent Desorption - porous	9.6w	3/24/2005	6/3/2005
19	Agent Desorption - hard	5.6w	6/24/2005	8/5/2005
20	Clean-up	3.6w	8/12/2005	9/8/2005
21	Application of Models	40.65d	8/19/2005	10/18/2005
22	Desorption	1.44w	8/19/2005	8/30/2005
23	Decon	4.69w	9/14/2005	10/18/2005
24	Reports	6w	11/9/2005	12/21/2005
25	**Task 2 Determination of Rates/Stoichiometries**	**597d**	**8/1/2003**	**1/23/2006**
26	Development of List	0.5w	8/6/2003	8/8/2003
27	Procurement of Agents/Media	15.5d	8/27/2003	9/18/2003
28	Chemical	1w	8/27/2003	9/4/2003
29	Biological	0.6w	9/16/2003	9/18/2003
30	Startup	496d	8/1/2003	8/18/2005
182	delay	159d	8/1/2003	3/31/2004
31	Familiarization/Installation	3w	4/8/2004	4/30/2004
32	Calibrations - HD	2w	5/3/2004	5/14/2004
33	Calibrations - GA	3w	6/22/2004	7/13/2004

34	Calibrations - GB	1w	8/19/2004	8/25/2004
35	Calibrations - GD	1w	9/27/2004	10/1/2004
36	Calibrations - GF	1w	11/1/2004	11/5/2004
37	Calibrations - VX	1w	2/16/2005	2/23/2005
38	Calibrations - R33	4w	3/9/2005	4/5/2005
39	Calibrations - T2	0.6w	8/16/2005	8/18/2005
189	Acquisition of FTIR	329d	7/2/2004	11/4/2005
190	Acquisition and installation of FTIR	1w	7/2/2004	7/8/2004
192	Familiarization/training	4w	7/9/2004	8/6/2004
191	Method Development for FTIR	2w	8/9/2004	8/20/2004
40	Calibrations - KCN	1w	9/20/2005	9/26/2005
41	Calibrations - L	4w	10/7/2005	11/4/2005
42	Effectiveness/Products on CW Agents	393d	5/25/2004	1/9/2006
43	HD	4w	5/25/2004	6/21/2004
44	GA	4w	7/21/2004	8/18/2004
45	GB	3.2w	9/2/2004	9/24/2004
46	GD	2.8w	10/12/2004	10/29/2004
47	GF	11.2w	11/16/2004	2/15/2005
48	VX	0.8w	3/3/2005	3/8/2005
49	R33	16.8w	4/13/2005	8/15/2005
50	T2	3.2w	8/26/2005	9/19/2005
51	KCN	0.6w	10/4/2005	10/6/2005
52	L	6.4w	11/15/2005	1/9/2006
53	Biological effectiveness	285d	8/1/2003	10/1/2004
183	delay	54w	8/1/2003	9/10/2004
54	yersina	1w	9/13/2004	9/17/2004
55	vaccinia	1w	9/20/2004	9/24/2004
56	anthrax	1w	9/27/2004	10/1/2004
57	Stoichiometry products	361.5d	5/25/2004	11/15/2005
58	HD	2.4w	5/25/2004	6/9/2004
59	GA	0.1w	7/21/2004	7/21/2004
60	GB	0.1w	9/2/2004	9/2/2004
61	GD	0.1w	10/12/2004	10/12/2004
62	GF	0.1w	11/16/2004	11/16/2004
63	VX	3.2w	3/3/2005	3/24/2005
64	R33	3.2w	4/13/2005	5/6/2005
65	T2	1.6w	8/26/2005	9/7/2005
66	KCN	0.1w	10/4/2005	10/4/2005
67	L	0.1w	11/15/2005	11/15/2005
68	Literature search - end products	351.5d	6/10/2004	11/17/2005
69	HD	0.4w	6/10/2004	6/11/2004
70	GA	0.2w	7/21/2004	7/22/2004
71	GB	0.1w	9/2/2004	9/2/2004
72	GD	0.1w	10/12/2004	10/12/2004
73	GF	0.1w	11/16/2004	11/16/2004
74	VX	0.8w	3/25/2005	3/30/2005
75	R33	0.8w	5/9/2005	5/12/2005
76	T2	0.8w	9/8/2005	9/13/2005
77	KCN	0.2w	10/4/2005	10/5/2005
78	L	0.4w	11/15/2005	11/17/2005

79	Generation of Reports	383d	6/22/2004	1/23/2006
80	HD	2w	6/22/2004	7/6/2004
81	GA	1.5w	8/19/2004	8/30/2004
82	GB	1.5w	9/27/2004	10/6/2004
83	GD	1.5w	11/1/2004	11/10/2004
84	GF	1.5w	2/16/2005	2/28/2005
85	VX	8w	3/31/2005	5/30/2005
86	R33	6w	8/16/2005	9/27/2005
87	T2	4w	9/28/2005	10/26/2005
88	KCN	2w	10/27/2005	11/9/2005
89	L	2w	1/10/2006	1/23/2006
188	delay	8w	10/4/2004	11/30/2004
90	yersina	0.4w	12/1/2004	12/2/2004
91	vaccinia	0.4w	12/3/2004	12/6/2004
92	anthrax	0.4w	12/7/2004	12/8/2004
98	**Task 3 Environmental Review**	**171d**	**2/27/2004**	**11/2/2004**
156	Task Management	171d	2/27/2004	11/2/2004
185	delay	5w	2/27/2004	4/1/2004
99	Aquatic Toxicity Testing	109d	4/2/2004	9/9/2004
106	Soil Toxicity Testing	86d	4/2/2004	8/6/2004
110	Environment Canada Review	30d	9/10/2004	10/22/2004
111	Reporting and Documentation	146d	4/2/2004	11/2/2004
95	**Task 4 Optimization of GCE 2000**	**373d**	**9/2/2003**	**3/21/2005**
157	Program Management	230d	9/2/2003	8/12/2004
186	Delay	6.8w	2/27/2004	4/16/2004
96	McMaster University Program	81d	4/19/2004	8/12/2004
123	Review and Evaluation of University Findings	90d	8/13/2004	12/21/2004
158	Equipment Material Compatibility	20d	1/5/2005	2/1/2005
160	Testing of "new" chemical blend	12d	1/5/2005	1/20/2005
159	Review Manuals and Procedures	15d	2/2/2005	2/23/2005
161	Process Control and Production Review	10d	2/2/2005	2/15/2005
97	Reporting and Documentation	23d	2/16/2005	3/21/2005
112	**Task 5 Blast Guard Equipment**	**486d**	**2/27/2004**	**2/27/2006**
187	Delay	5w	2/27/2004	4/1/2004
168	Literature Search	60d	4/2/2004	6/29/2004
167	Complete Design Objectives and System	41d	6/30/2004	8/27/2004
166	Prototype System/Engineering Design	90d	8/30/2004	1/19/2005
165	Equipment Build	90d	1/20/2005	5/31/2005
164	Test System for Function	30d	6/1/2005	7/13/2005
163	Revise Design - Second Prototype	25d	7/14/2005	8/18/2005
177	Qualify Prototype in Live Agent Environment	30d	8/19/2005	9/30/2005
176	Complete Production Plans and Estimates	30d	10/3/2005	11/15/2005
175	Complete Market Commercialization	30d	11/16/2005	1/6/2006
174	Produce Tech Manuals and Procedures	30d	1/9/2006	2/17/2006
173	Database	39d	1/3/2006	2/27/2006
139	**Close Project**	**43d**	**2/28/2006**	**4/27/2006**
142	Transfer all documentation to federal sponsor	10d	2/28/2006	3/13/2006
143	Completion of Project Closeout Report	43d	2/28/2006	4/27/2006

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An overview and summary of a recently-completed project, funded by the Canadian government's CBRN Research and Technology Initiative (CRTI), to accelerate development of the Universal Containment System (UCS) is presented. This project, led by DRDC Suffield, involved the Licensee for the CASCAD® family of decontaminants/blast suppressants, Allen-Vanguard Corporation (AVC) and Environment Canada who reviewed environmental impact determinations.

UCS is a containment/mitigation/decontamination system for CBRW agents consisting of a lightweight, tent-like enclosure filled with an aqueous-based foam formulation. One of the CASCAD® family of aqueous-based decontaminating/explosive mitigation formulations known as Surface Decontaminating Foam (SDF) has been developed to address CBR threats in the civilian arena and is a central aspect of this project. Foam phase SDF was demonstrated to be effective against neat mustard gas (HD) and the nerve agent, GD, in decontaminating five non-porous civilian substrates and to have utility in containing CW vapour from several of the seven contaminated porous surfaces studied. The effectiveness of liquid SDF was determined against two V, four G and HD CW agents as well as anthrax and T-2 mycotoxin and the decontaminant:agent ratios required for >99% effectiveness in one hour were determined by periodic reaction mixture analyses; all CW agents save T-2 were shown to be satisfactorily detoxified. SDF and CASCAD® were also demonstrated to be effective against the BW agent, anthrax, in the liquid phase.

In aquatic toxicity and ready biodegradability environmental studies, the toxicity of the CASCAD® family is related to the concentration of the surfactant in the decontaminant and in soil environmental studies, the concentrations of both the active ingredient and the surfactant affected the toxicity.

On the basis of physico-chemical characterization of surfactant concentrate, recommendations were made to lower the gelling point of the concentrate while other improvements to increase component solubility, increase transportation safety of the ingredients and to extend the pot life of the active ingredient after mixing were realized. New dispersal equipment was designed and fabricated. Both the modified formulation and equipment were tested and proved effective in a live-agent and IED Field Trial held at DRDC Suffield.

Although this marks the close of the official project, further studies of the modified formulation's CW effectiveness and pot-life are planned under a Technology Development Fund.

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