

CBRN Decontamination Industry Outlook

2007 - 2012

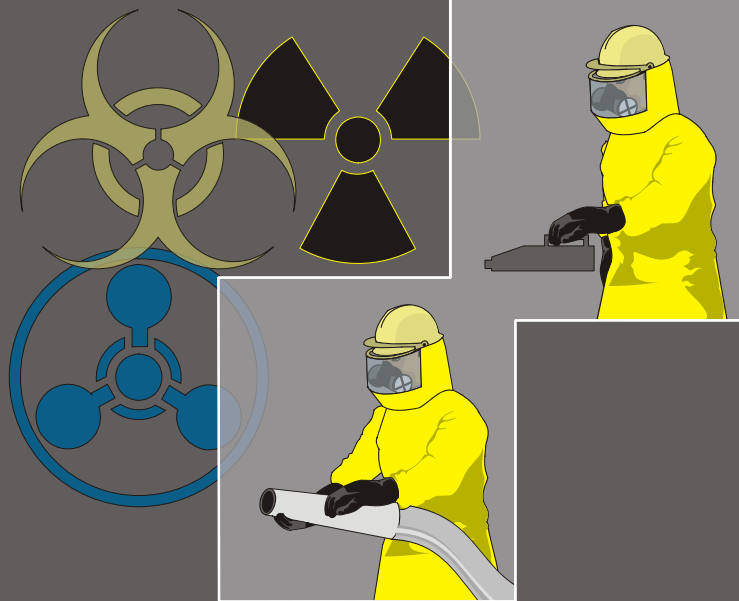


Table of Contents

1.	Scope.....	17
1.1.	Definition of Decontamination	17
1.2.	Scope of this Report	17
1.3.	Basic Assumptions.....	18
1.3.1.	General	18
1.3.2.	Why is Stockpiling Decontamination Solutions Needed?.....	18
1.3.3.	Possible Scenario Analysis	19
1.4.	Methodology	20
1.4.1.	Research Methods	20
1.4.2.	Report Structure	20
1.5.	Who is this Report for?	21
2.	Executive Summary	22
2.1.	Main Conclusions.....	22
2.2.	The Threat of CBRN Terrorism	23
2.3.	How Real is the Threat?	24
2.4.	Decontaminating After a CBRN Event	25
2.5.	Decontamination – the Industry	25
2.6.	Decontamination Market Forecast – 2007–2012	26
2.7.	Challenges for Next Generation Decontamination Technologies.....	26
3.	Decontamination – Industry Drivers	27
4.	Decontamination – Industry Inhibitors	28
5.	The Threat of CBRN Warfare	29
5.1.	The Threat of Biological Terror	29
5.1.1.	Use of Bio-Weapons – Historical Perspective	30
5.1.2.	Biological Terror – Bacterial Agents	32
5.1.3.	Biological Terror – Viral Agents.....	36
5.1.4.	Biological Terror – Rickettsiae Agents	41
5.1.5.	Biological Terror – Toxins.....	43
5.2.	The Threat of Nuclear Radiological Terror	45
5.2.1.	How Real is the Nuclear Threat?	45
5.2.2.	Nuclear Terror	47
5.2.3.	A Radiological Dispersal Device (RDD)	47
5.3.	The Threat of Chemical Terror.....	49
5.3.1.	Nerve Agents	49
5.3.2.	Blister Agents.....	51
6.	Decontamination – Technological and System Requirements.....	54
6.1.	Defining the Problem	54
6.2.	Stages of a Decontamination Process	56
6.2.1.	Contaminant Identification.....	57
6.2.2.	Sample Characterization.....	58
6.2.3.	Isolation of Contaminated Area	58

6.2.4.	Design of Decontamination Strategy	58
6.2.5.	Decontamination	60
6.2.6.	Clearance Sampling.....	60
6.3.	Performance Limitations	60
6.3.1.	Limit 1 – Time.....	60
6.3.2.	Limit 2 – How Clean is Clean	61
6.3.3.	Limit 3 – Lack of Accurate Contamination Simulations Scenarios.....	61
6.3.4.	Limit 4 – Cost	61
6.3.5.	Limit 5 – Environmentally Unfriendly Materials.....	61
6.3.6.	Limit 6 – Transport and Storage Limitations.....	61
6.3.7.	Limit 7 – Inability to Handle Radioactive Contamination.....	62
6.4.	Decontamination Core Technologies Overview	63
6.5.	Physics-Based Decontamination Core Technologies	64
6.5.1.	Sorbents.....	64
6.5.2.	Solvent-Wash.....	64
6.5.3.	High-Pressure Methods	65
6.5.4.	Thermal Methods	65
6.6.	Chemistry-based Decontamination Core Technologies	66
6.6.1.	Oxidizing Agents	66
6.6.2.	Strong Bases.....	67
6.6.3.	Surfactants	67
6.6.4.	Microemulsions	68
6.7.	Biology-Based Core Technologies.....	69
6.7.1.	Bacterial Decontamination Agents	69
6.7.2.	Enzymatic Systems.....	70
6.8.	Decontamination System Configurations	71
6.8.1.	Application 1 – People Decontamination Systems	71
6.8.2.	Application 2 – Equipment Decontamination Systems	74
6.8.3.	Application 3 – Building and Infrastructure Decontamination Systems.....	76
6.9.	New Technologies Drivers	79
6.10.	New Technologies Inhibitors.....	79
7.	Business Opportunities – 2007–2012	80
7.1.	Historical Perspective: A Market Waiting for Transition	80
7.1.1.	The Current and Future HLS Decontamination Strategy.....	81
7.1.2.	Factors Affecting Decontamination Systems Business Opportunities and Technologies – 2007– 2012	82
7.2.	Business Opportunities for Decontamination Systems	84
7.2.1.	Business Opportunity 1 – New Technologies to Counter Radiological Contamination.....	84
7.2.2.	Business Opportunity 2 – Non-Toxic/Environmentally Friendly Biological-Agents Decontamination Technology.....	85

7.2.3.	Business Opportunity 3 – Improving Contamination Simulation Capability.....	85
7.2.4.	Business Opportunity 4 – Improving Biological Sampling Accuracy	85
7.2.5.	Business Opportunity 5 – Decontamination Standards.....	85
7.2.6.	Business Opportunity 6 – Reducing Decontamination Time	86
7.2.7.	Business Opportunity 7 – Reducing Cost of Reagents / Decontamination Material	86
7.3.	Radiological Decontamination Technologies	87
7.3.1.	Business Opportunity 8 – Concrete-Eating Bacteria	87
7.3.2.	Business Opportunity 9 – Decontamination Foams	88
7.3.3.	Business Opportunity 10 – Nano-Particle Super-Absorbent Gels	88
7.3.4.	Business Opportunity 11 – Strippable coatings.....	88
7.3.5.	Business Opportunity 12 – Electro-Kinetic Concrete Cleaning.....	89
7.4.	Chemical-Biological Decontamination Technologies and Business Opportunities	90
7.4.1.	Business Opportunity 13 – Forced Hot Air Systems	90
7.4.2.	Business Opportunity 14 – Modified Vaporous Hydrogen Peroxide	90
7.4.3.	Business Opportunity 15 – Decon Green.....	91
7.4.4.	Business Opportunity 16 – Resistant/Reactive Coatings.....	91
7.4.5.	Business Opportunity 17 – Enzyme Decontamination	92
7.4.6.	Business Opportunity 18 – Ionic-Liquid-based Decontamination	92
7.4.7.	Business Opportunity 19 – Supercritical Carbon Dioxide Decontamination	92
7.4.8.	Business Opportunity 20 – Electrostatic Decontamination System	93
7.4.9.	Business Opportunity 21 – Atmospheric Plasma Decontamination	93
7.5.	Contamination Simulation Algorithms	94
7.5.1.	Business Opportunity 22 – Vulnerability of Building to CBRN Attack Algorithms	94
8.	Decontamination – U. S. Federal HLS R&D Programs and Funding Opportunities Forecast – 2007–2012	95
8.1.	Summary & Outlook.....	95
8.2.	Decontamination – U. S. Federal HLS R&D Funding Opportunities by Major Departments Forecast – 2007–2012.....	95
8.2.1.	EPA – Decontamination HLS R&D Budget Forecast – 2007–2012	98
8.2.2.	DOD – Decontamination HLS R&D Budget Forecast – 2007–2012	99

8.2.3.	DHS – Decontamination HLS R&D Budget Forecast – 2007–2012	100
8.2.4.	DOE – Decontamination HLS R&D Budget Forecast – 2007–2012	101
8.2.5.	TSWG – Decontamination HLS R&D Budget Forecast – 2007–2012	102
8.3.	Decontamination – U. S. Federal HLS R&D Funding Opportunities Forecast – 2007–2012	103
8.4.	Decontamination – U. S. Federal HLS Pharmaceuticals R&D Funding Opportunities Drivers – 2007–2012	108
8.5.	Decontamination – U. S. Federal HLS R&D Funding Opportunities Inhibitors – 2007–2012	108
8.6.	DHS – Decontamination HLS R&D Programs.....	109
8.6.1.	Response and Recovery	109
8.6.2.	Decontamination of Porous Surfaces After a Radiological Attack.....	109
8.6.3.	Expedient Mitigation of a Radiological Release	109
8.7.	DARPA (DOD) – Decontamination HLS R&D Programs	110
8.7.1.	Immune Buildings.....	110
8.7.2.	External Protection.....	111
8.8.	CBDP (DOD) – Decontamination HLS R&D Programs.....	112
8.8.1.	Project CB1 – Decontamination	112
8.8.2.	Project CB2 – Decontamination	112
8.8.3.	Project CB3 Biological Defense (ATD) – Decontamination	112
8.8.4.	Project DE4 Decontamination Systems (ACD&P).....	112
8.8.5.	Project DE5 Decontamination Systems (SDD).....	113
8.9.	ARMY (DOD) – Decontamination HLS R&D Programs	116
8.9.1.	Environmental Quality Technology.....	116
8.10.	DOE – Decontamination HLS R&D Programs	119
8.10.1.	Environmental Remediation Science Research	119
8.11.	EPA – Decontamination HLS R&D Programs.....	121
8.11.1.	Water Infrastructure Decontamination.....	121
8.11.2.	Threat and Consequence Assessment	121
8.11.3.	Nonstandard Methods.....	121
8.11.4.	Decontamination for Buildings, Large Structures, and Outdoor Areas.....	122
8.11.5.	Toxicity, Infectivity, and Mechanism of Action	122
8.12.	TSWG – Decontamination HLS R&D Programs	123
8.12.1.	Statistical Design Tool for Sampling Contaminated Buildings.....	123
8.12.2.	Decontamination	123
9.	Vendors	124
9.1.	Vendors and Products	124
10.	Patent Review	128
10.1.	Scope.....	128

10.2. Decontamination Technology Patents	129
11. Decontamination – Legal Issues	137
11.1. International / European Legislation/Agreements	137
11.1.1. The Nuclear Weapons Non-Proliferation Treaty (NPT) – 1970.....	137
11.1.2. The Biological and Toxin Weapons Convention (BTWC) – 1972	137
11.1.3. Convention for the Physical Protection of Nuclear Material – 1987	138
11.1.4. Chemicals Weapons Convention – 1992	138
11.2. U.S. Legislation.....	139
11.2.1. U.S. Code Title 50, Chapter 40 – Defense Against Weapons of Mass Destruction	139
11.2.2. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) – 1996	139
11.2.3. Emergency Supplemental Appropriations Act for Recovery from and Response to Terrorist Attacks on the United States – 2001	140
11.2.4. Public Health Security and Bioterrorism Preparedness and Response Act – 2002.....	140

List of Figures

1. Scope

Figure 1 - Modalities of Decontamination Systems	17
--	----

2. Executive Summary

Figure 2 - Closed area (e.g. building) decontamination boundaries.....	25
Figure 3 - Open area decontamination boundaries.....	25

5. The Threat of CBRN Warfare

Figure 4 - Categories of the Biothreat Divides	30
Figure 5 - The Spraying of Anthrax from Aum Shinrikyo's Headquarters June 1993.....	32
Figure 6 - Anthrax Spores and disease.....	33
Figure 7 - Cholera Bacteria.....	34
Figure 8 - Pneumonic plague – the disease.....	35
Figure 9 - Tularemia the disease	35
Figure 10 - Smallpox Virus and Disease.....	37
Figure 11 - Ebola virus – Electron Microscopy Image.....	39
Figure 12 - VEE – Venezuelan Equine Encephalitis Virus in The Olfactory Mucosa of a Mouse	40
Figure 13 - Q Fever.....	41
Figure 14 - Typhus Microbe – Electron Microscopy Image	42
Figure 15 - Castor Plant and Structure for the Ricin Toxin.....	43
Figure 16 - The Dinoflagellate Alexandrium Tamarense and Structure of Saxitoxin	44
Figure 17 - Reported Interceptions of Nuclear/Radiological Materials – 1993–2000.....	46
Figure 18 - A Simulation of the Impact of the Explosion of a 500 Curie Co60 Dirty Bomb in Downtown Manhattan.....	48
Figure 19 - Categories of the Chemical Divides.....	49

6. Decontamination – Technological and System Requirements

Figure 20 - Comparison in Weight of Pathogens Between BW Agents and CW Agents [mg].....	54
Figure 21 - Closed area (e.g. building) decontamination boundaries.....	55
Figure 22 - Open area decontamination boundaries.....	55
Figure 23 - Decontamination Corridor.....	56
Figure 24 - Basic Decontamination Process	57
Figure 25 - A Detailed Decontamination Process	59
Figure 26 - Decontamination Core Technologies Overview.....	63
Figure 27 - Skin Decontaminate Lotion, Anachemia Canada, Inc.....	72
Figure 28 - Decontamination Kit, Personal No. 2, Mark 1, Richmond Packaging (U.K.) Ltd.....	72
Figure 29 - Portaflex Decontamination Shower System, High Safety Showers USA	73
Figure 30 - K4-05 High Purity, Applied Surface Technologies, USE.....	75
Figure 31 - Decocontain 3000, Karcher, Germany.....	76

7. Business Opportunities – 2007–2012

Figure 32 - Factors Affecting Decontamination Business Opportunities and Technologies – 2007–2012..... 83
 Figure 33 - Schematic of the ISOTRON system 89

8. Decontamination – U. S. Federal HLS R&D Programs and Funding Opportunities Forecast – 2007–2012

Figure 34 - Decontamination – U. S. Federal HLS R&D Funding Forecast by Major Departments [\$M] – 2007–2012 97
 Figure 35 - Decontamination – U. S. Federal HLS R&D Funding Forecast by Major Departments Share [%] – 2005, 2008 & 2012 97
 Figure 36 - EPA – Decontamination HLS R&D Budget Forecast [\$M] – 2007–2012..... 98
 Figure 37 - DOD – Decontamination HLS R&D Budget Forecast [\$M] – 2007–2012..... 99
 Figure 38 - DHS – Decontamination HLS R&D Budget Forecast [\$M] – 2007–2012..... 100
 Figure 39 - DOE – Decontamination HLS R&D Budget Forecast [\$M] – 2007–2012..... 101
 Figure 40 - TSWG – Decontamination HLS R&D Budget Forecast [\$M] – 2007–2012..... 102
 Figure 41 - Decontamination – U. S. Federal HLS R&D Funding Opportunities Forecast by Sector [\$M] – 2007–2012..... 104
 Figure 42 - Decontamination – U. S. Federal HLS R&D Funding Opportunities Forecast Share by Sector [%] – 2005, 2008 & 2012..... 104
 Figure 43 - Decontamination – U. S. Federal HLS R&D Private Sector Funding Opportunities Forecast [\$M] – 2007–2012..... 105
 Figure 44 - Decontamination – U. S. Federal HLS R&D Academia Sector Funding Opportunities Forecast [\$M] – 2007–2012..... 106
 Figure 45 - Decontamination – U. S. Federal HLS R&D Government Sector Funding Opportunities Forecast [\$M] – 2007–2012..... 107
 Figure 46 - Project DE4 Decontamination Systems (ACD&P) – Program Funding [\$M] – 2004 – 2011 113
 Figure 47 - Project DE5 Decontamination Systems (SDD) – Program Funding [\$M] – 2004 – 2011 114

List of Tables

Table 1 - Physical and Chemical Properties of Common Nerve Agents	50
Table 2 - Physical and Chemical Properties of Common Blister Agents.....	52
Table 3 - Decontamination – U. S. Federal HLS R&D Funding Forecast by Major Departments [\$M] – 2007–2012	96
Table 4 - Decontamination – U. S. Federal HLS R&D Funding Forecast by Major Departments [%] – 2007–2012	96
Table 5 - Decontamination – U. S. Federal HLS R&D Funding Opportunities Forecast by Sector [\$M] – 2007–2012.....	103
Table 6 - Decontamination – U. S. Federal HLS R&D Funding Opportunities Forecast Share by Sector [%] – 2007–2012	103
Table 7 - U.S. Vendors	124
Table 8 - Canadian Vendors	126
Table 9 - EU Vendors	126