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Ecological Considerations Relating To The Destruction Of Chemical Weapons

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ECOLOGICAL CONSIDERATIONS RELATING TO THE DESTRUCTION OF CHEMICAL WEAPONS

ALDO ZAMMIT BORDA

The Chemical Weapons Convention (CWC) not only establishes a global ban on the development of chemical weapons (CW), it also establishes an international obligation on possessor States to destroy their CW and production facilities. This is a central and mandatory obligation of the CWC, which aims at securing a world free of CW. In view of the risks posed by CW to human health and the environment, the obligation to destroy CW may be seen as directly connected to the right to a healthy environment. While the CWC seeks to set high standards for ensuring the safety of people and the protection of the environment, environmental standards are not routinely monitored by the Organisation for the Prohibition of Chemical Weapons as they fall within the responsibility of the possessor States. There are potential risks to humans and the environment from CW held in storage, old CW which have historically been disposed in the environment, and abandoned CW. There are also inherent risks in the CW destruction process. In this respect, the article underscores the need for public participation in order to develop safer and more holistic CW destruction programmes.

1. Introduction

The Chemical Weapons Convention (CWC) is an international, multilateral disarmament treaty which bans the development, production, stockpiling, transfer and use of chemical weapons (CW). All State Parties to the CWC are obligated to declare any CW-related activities, to secure and destroy any stockpiles of CW within the stipulated deadlines, as well as to inactivate and eliminate any CW production capacity within their jurisdiction.\(^1\)

The CWC is unique in that it lays down clear deadlines for the destruction of CW and CW production facilities. The Convention provides that:\(^2\)

A State Party shall start the destruction of Category 1 chemical weapons not later than two years after this Convention enters into force for it, and shall complete the destruction not later than 10 years after entry into force of this Convention.

The final deadline may be extended by a maximum of five years. The Organisation for the Prohibition of Chemical Weapons (OPCW), based in the Hague, verifies the irreversible destruction of declared CW stockpiles, as well as the elimination of all declared CW production facilities.

Membership of the CWC is approaching universality. At the time of writing, there were 188 State Parties to the CWC and two signatory States.\(^3\) This near-universal membership has promoted the Director-General of the OPCW, Rogelio Pfirter, to state:\(^4\)

It is quite clear that, today, the ban on chemical weapons is universal and it is mandatory for all states.

The CWC therefore not only establishes a global ban on the development, etc, of CW, it also establishes an international obligation on possessor States to destroy their CW and CW production facilities. This is a central and mandatory obligation of the CWC, which aims at securing a world free of CW.
In view of the risks posed by CW to human health and the environment, the obligation to destroy CW may be seen as directly connected to the right to a healthy environment, and the corollary obligations of governments to:

1. refrain from interfering directly or indirectly with the enjoyment of the right to a healthy environment;
2. prevent third parties such as corporations from interfering in any way with the enjoyment of the right to a healthy environment, and
3. adopt the necessary measures to achieve the full realisation of the right to a healthy environment.

This discussion is relevant to the Mediterranean region because two of the seven declared possessor States, Albania and Libya, lie within this region. Moreover, a number of others, including France, have declared old and/or abandoned chemical weapons in their territory, and historically, CW have been dumped in the Mediterranean Sea.

Where possible, the particular CW programmes of the Mediterranean States have been examined. However, on account of limited data available from this region, the article also draws on the programmes of other State Parties, in particular the experience of the two possessor States which have declared the largest arsenals, the U.S. and Russia.

The article firstly analysis the relevant provisions of the CWC, which places a strong emphasis on safeguarding human safety and the protection of the environment. It proceeds to examine the ecological impact of CW in storage, old CW disposed in the environment and abandoned CW, before focusing on the risks related to the CW destruction process and the various technologies which have been developed to minimise these risks. It concludes by underscoring the need for public participation in order to develop more holistic CW destruction programmes.

2. Relevant Provisions of the CWC

The Protection of human health and preservation of the environment is one of the primary obligations for all State Parties to the CWC. Under the provisions of the CWC, the transportation, sampling, storage and destruction of chemical weapons (the “CW destruction process”) is regulated by Article IV as well as Part IV (A) of the Verification Annex.

In particular, Article IV (10) states:

Each State Party, during transportation, sampling, storage and destruction of chemical weapons, shall assign the highest priority to ensuring the safety of people and to protecting the environment. Each State Party shall transport, sample, store and destroy chemical weapons in accordance with its national standards for safety and emissions.

Part IV (A) of the Verification Annex contains detailed and rigorous procedures for the destruction of CW and verification. As part of the detailed annual plans for
destruction which have to be submitted to the OPCW, paragraph 32 of the Annex provides that

“a possessor State Party must submit for each of its CW destruction facilities, the plant operations manuals, the safety and medical plans, the laboratory operations and quality assurance and control manuals, and the environmental permits that have been obtained.”

Article V (11) provides that State Parties are likewise required to “assign the highest priority to ensuring the safety of people and to protecting the environment” when destroying their CW production facilities. This Article goes on to provide that each State Party shall destroy CW production facilities in accordance with its national standards for safety and emissions. Paragraph 33(g) of Part V of the Verification Annex moreover requires that the detailed plans for destruction of each CW production facility shall contain, inter alia, the “security/safety measures to be observed during the destruction of the facility.”

Throughout the CWC, the obligation to ensure the safety of people and to protect the environment is cited in several other instances, including in Article VII (3)⁹; and in the Verification Annex, Part II (43)¹⁰; Part IV (A)(13)¹¹; and Part VI (7)¹².

According to these provisions, during CW transportation, sampling, storage, as well as destruction of CW and former production facilities, possessor States have to maintain high standards where the safety of the public and the protection of the environment are concerned¹³.

It should be underscored that, with the exception of certain prohibited methods of destruction - namely, dumping in any body of water, land burial or open-pit burning - each possessor State may select and apply the appropriate destruction method for its CW. While the OPCW recommends destruction technologies which minimise the risk of agent release during storage, transportation and disposal operations, as well as which reduce to a minimum the public health and environmental impact from process effluents¹⁴, the choice of destruction technology ultimately rests with possessor States, which normally have to take into account other competing considerations such as feasibility and cost.

Moreover, while possessor States are required to obtain the necessary national environmental permits for each CW destruction facility prior to the commencement of the facility’s operation, the OPCW will not aim to inspect and evaluate national standards or to monitor compliance with national standards. This remains the responsibility of possessor States. The OPCW inspections will be limited to verifying that such facilities are decommissioned and destroyed, or converted for peaceful purposes.

Therefore, while the CWC seeks to set high standards for ensuring the safety of people and the protection of the environment in the CW destruction process, these standards are not routinely monitored by the OPCW. They fall within the responsibility of possessor States and, given that there may be differences in the extent to which these States are committed to protecting the environment, there is the potential risk that the standards will not be enforced equally across the board.

As the OPCW website itself acknowledges:¹⁵
Standards vary considerably between individual State Parties and it is the responsibility of each State Party to consider the impact of the destruction process across the entire environmental spectrum - air, water, land, and subsequently apply the best environmental option.

The variation in these standards poses a significant risk, in light of the ecological issues associated with the storage and destruction process, which will be considered in the next sections.

3. Ecological impact of CW in storage and old and/or abandoned CW

In total, almost 70,000 metric tonnes of toxic agents in 8.6 million munitions and containers have been declared to the OPCW. The biggest arsenals that must be destroyed are in Russia and the U. S.\textsuperscript{16} Of this, just over 32,000 metric tonnes, or 46.1 percent of the world’s declared stockpile has been irreversibly and verifiably destroyed as of June 2009.\textsuperscript{17}

Table 1: Possessor States’ Declared and Remaining Category 1 Stockpile\textsuperscript{18}

<table>
<thead>
<tr>
<th>Country</th>
<th>Declared Stockpile in Metric Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania*</td>
<td>16</td>
</tr>
<tr>
<td>India*</td>
<td>1,055</td>
</tr>
<tr>
<td>Iraq</td>
<td>To be verified</td>
</tr>
<tr>
<td>Libya</td>
<td>23.6</td>
</tr>
<tr>
<td>Russia</td>
<td>40,000</td>
</tr>
<tr>
<td>A State Party*\textsuperscript{19}</td>
<td>605</td>
</tr>
<tr>
<td>United States</td>
<td>27,771</td>
</tr>
</tbody>
</table>

* Country has completed destruction of its entire stockpile.

The degradation and ageing of stockpiled chemical agents and munitions are a risk and a source of constant concern.\textsuperscript{20} The risk of leakage during storage increases each year\textsuperscript{21}. There are health and environmental risks inherently associated with the destruction and disposal of CW, starting with closing and sealing storage facilities, loading and unloading cargo containers, transport, filling of destruction equipment, controlling destruction processes and disposal of end-products, as well as on-site verification of all mentioned activities.\textsuperscript{22}

The destruction of CW stockpiles is a complex scientific, technological, and environmental issue. If an incorrect decision is made at any stage, the impact on human health and the environment may be unpredictable.\textsuperscript{23} In this respect, there is growing public concern regarding both the risk involved in a direct exposure, as well as the long term low-level exposure to agents, disposal, and degradation products.

Below is an overview of the potential risk activities predicted by the CWC: \textsuperscript{24}

- closing, sealing, visiting storage sites;
- checking declarations;
- any operations and on-site inspections at destruction/conversion of former production facilities;
• any handling and on-site inspections of acting small-scale production facilities;
• any handling and on-site inspections at CW destruction facilities, including all operations starting with loading cargo containers at storage sites, transport, filling of destruction equipment, controlling the destruction process, checking completeness of destruction, till the safe disposal of non-toxic waste, scrap metal etc.;
• on-site inspections on challenge;
• protection against and verification of alleged use of CW;
• any handling and on-site inspections at extremely dangerous operations connected with location, excavation, transport, demilitarisation and destruction of old and abandoned chemical weaponry and toxic armaments wastes.

In view of the above risks, it is not surprising that one of the main recommendations to emerge from the workshop on “Biotechnology Approaches to Chemical Weapon Destruction,” held at Saratov, Russia, in August 2000, was that all governmental, non-governmental, and social organisations should lend their support for activities directed to environmentally safe destruction of CW.

As mentioned above, possessor States are responsible for obtaining all necessary environmental permits for each CW destruction facility and the experience of the U.S. in obtaining such permits is instructive. As results from his Testimony before the Subcommittee on Environment, Energy, and Natural resources at the U.S. House of Representatives, the Director of Army Issues, National Security and International Affairs Division, Richard Davis, admitted that:

Despite the importance of public involvement in environmental permit decisions, the Army began incinerating munitions at the Johnston Island facility under a temporary authorization and initiated preliminary construction at the Anniston site under special authorization before soliciting public comment and scrutiny. The Army convinced regulatory officials that these authorizations were warranted to avoid further delays in completing congressionally mandated operational verification tests and to avoid possible loss of funding for construction of stateside facilities. The Army will likely not be able to continue to rely on similar actions to expedite program completion.

It is submitted that the same reasons which motivated the U.S. Army to rely on “temporary” or “special” authorisations in relation to their CW destruction process, in order to bypass environmental compliance obligations and public scrutiny, may have and may continue to motivate other possessor States with less rigid regulatory frameworks. Given that, as mentioned above, the OPCW does not evaluate national standards or monitor compliance with such standards, the fact that the CWC requires possessor States to obtain environmental permits for their CW destruction facilities does not in itself guarantee environmental protection.

Indeed, a high-ranking U.S. official acknowledged that, although safety and environmental protection were always important considerations for the U.S. Army, past decisions had placed undue emphasis on expeditious program completion.

Generally speaking, possessor States are committed to enhance medical and public health services in regions where CW stockpiles are located. For instance, in the US, where the Centers for Disease Control and Prevention (CDC) have oversight
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responsibility for CW destruction facilities, the CDC approached this task by identifying the key professional areas that would be necessary to address public health and safety concerns. These areas include medical science, engineering, chemistry, and statistics.

However, there have been instances of much less than full preparedness and ideal protection for local populations and onsite workers at CW destruction facilities. While, fortunately, no major accidents or injuries have yet been reported at operating destruction facility, in the absence of full preparedness, the consequences of such accidents occurring may be far-reaching. It is acknowledged, for instance, that when an emergency arises that is accompanied by spilling of considerable amounts of toxic agent, a cloud of contaminated air may spread over vast areas, affecting nearby communities.

In addition to CW stored in stockpiles, there are two specific categories of CW which pose particular challenges. The first category relates to old CW which were historically disposed of in an ecologically hazardous manner in the environment. The second category relates to abandoned CW.

The practice of disposing of CW by land burial, open-pit burning, explosion and sea dumping was common immediately after the First and Second World Wars, mainly to dispose of German and Japanese CW under Allied supervision. As mentioned above, this practice was prohibited by Part IV (A)(13) of the Verification Annex to the CWC.

In a Report for Congress on U.S. Disposal of Chemical Weapons in the Ocean, it is acknowledged that the U.S. Armed Forces disposed of CW in the ocean from the First World War through 1970. At the time, disposal in the ocean was deemed safer than disposal on land for two reasons. Firstly, methods for disposal on land were initially limited to burial, presenting a long-term risk if weapons leaked or were recovered. Secondly, it was thought that the vastness of ocean waters would dilute and absorb chemical agents that may leak from these weapons.

Estimating the cumulative quantity of CW dumped in the ocean and identifying all types of such weapons is not possible because of incomplete records. However, an Army report compiled in 2001 indicated that such disposal had been more common and widespread geographically than previously acknowledged. The U.S. Army catalogued 74 instances of disposal through 1970, including 32 instances off U.S. shores and 42 instances off foreign shores, including the Mediterranean Sea.

The degree of risk from weapons leaking chemical agents into the seawater depends on numerous factors. The extent to which an agent is diluted and the duration of exposure determine whether there is potential harm.

Exposure to chemical weapons can have numerous harmful effects on human beings. Depending on the particular chemical agent, these effects can include burns and sores on the skin, vomiting, respiratory dysfunction, mental impairment, damage to the immune systems, infertility, and death. Public health advocates have questioned whether possible exposure to such substances in seawater from leaking weapons may contribute to various symptoms experienced by coastal residents, swimmers, divers,
fishermen, and individuals who may have consumed contaminated fish or shellfish. Marine conservationists and environmental advocates have also raised questions about the possible effects of chemical weapons agents on the marine environment, including the possible contribution to declines in populations of certain fish and other marine life around areas where weapons were dumped at sea.\(^\text{34}\)

In addition to contamination of seawater, there have been concerns among the public that old CW could wash ashore, or that they could be retrieved accidentally during dredging operations or trawling fish along the seabed.

It should be underscored that the U.S. was not alone in disposing of old CW in this manner. The former Soviet Union, Germany, the U.K. and France all disposed of CW off the coast of Europe and Russia, in the Atlantic Ocean, North Sea, Baltic Sea and Mediterranean Sea.

In a comprehensive study compiled by the Imperial College London in 2005, it was concluded that the risks of human exposure were relatively small if weapons or persisting contamination on the seabed remained undisturbed.\(^\text{35}\) On the other hand, human disturbances, such as dredging, trawl fishing, or work on underwater pipelines, caused risks to rise significantly.

In shallower waters, such as the Baltic Sea, the study noted that the greatest risk was to fishermen who reported many instances of catching encrusted sulphur mustard in their nets when trawling the seabed. However, this risk decreased as the depth of the water increased.

While these risks are recognised, the question of how to respond is fraught with challenges. The primary obstacle is locating the weapons in the ocean, in the absence of coordinates for most of the disposal sites. There is also the possibility that ocean currents would have caused them to move. Moreover, in the event that the weapons are located, retrieving them from the seabed could be technically challenging and could introduce new risks during the retrieval and transport for onshore disposal.

Therefore, leaving located weapons in place and warning the public to avoid these areas may be a more feasible short-term solution, but does not tackle the longer-term risk of environmental contamination.

The second category of weapons which pose a particular safety risk and threat to the environment are abandoned CW. More than a dozen States have declared that such weapons have been found on their territory.\(^\text{36}\) It has been argued that, in general, abandoned CW pose a much greater hazard to civilians than military stockpiles of weapons stored in special bunkers under lock and key. Since the location of many abandoned CW is not known and civilians lack the understanding of their danger, they risk being accidentally exposed to these weapons.\(^\text{37}\)

Approximately 37,600 munitions have been declared as abandoned CW. Hundreds of World War I- and World War II-era shells containing CW are recovered annually from the European battlefields, mostly in Belgium and France. However, this dark legacy is not limited to Europe - such aged CW continue to affect other countries, such as China.\(^\text{38}\)
In the case of Japanese CW abandoned on Chinese territory, as the Second World War was drawing to an end, many such weapons contain a mixture of two blister agents, mustard and lewisite. On hot days, agents seeping from corroded shells evaporate, forming a toxic cloud that pollutes the air and poses a serious health hazard. Seepage from such weapons has contaminated the soil and entered the food chain. As a result, most land contaminated by abandoned CW has gone out of cultivation. Moreover, a significant amount of abandoned CW are buried near urban water supplies. If these munitions leak, they risk polluting the water with devastating consequences. 39

4. Destruction of CW

The discussion has so far focused on the environmental impact of CW in storage, old CW disposed in the environment and abandoned CW. This section will focus on the risks related to the actual destruction process and the various technologies which have been developed to minimise these risks.

Of the seven possessor States, Albania was the first nation to completely and verifiably destroy all of its CW. 40 The Albanian stockpile included mustard, lewisite, mustard/lewisite mixture, adamsite, and chloroacetophenone agents. The destruction of the Albanian stockpile was undertaken using a thermal treatment technology (incinerator). 41

In commending Albania’s achievement, the OPCW Director-General, Ambassador Rogelio Pfirter, welcomed Albania’s completion of this campaign, which had required the country to overcome considerable technical challenges associated with chemical disarmament. He also extended his appreciation to Greece, Italy, Switzerland and the U.S. for the support they had provided in Albania’s destruction effort. 42

The other Mediterranean country on the possessor list, Libya, submitted its initial declaration to the OPCW in March 2004. In addition to the 23.6 metric tonnes of mainly mustard gas and precursor chemicals, Libya also declared an inactivated CW production facility, as well as two CW storage facilities. Moreover, also in March 2004, the OPCW’s inspectors verified the irreversible destruction of Libya’s entire declared stockpile of unfilled munitions. 43

At the time of writing, Libya is at the stage of preparing its CW destruction facility and has pledged to fulfil its destruction obligations by 2011. 44 In this regard, it is noteworthy that Libya cancelled a bilateral agreement with the U.S., which provided for U.S. technical and financial assistance for Libya’s CW destruction process, on account of its dissatisfaction with the provisions on liability, financing, and facility ownership. 45 Neither the U.S., nor any other State Party has indicated that they see the breakdown of this agreement as a sign that Libya is stepping back from its CWC commitments. As of early October 2008, however, no new agreement for international funding of the Libyan CW destruction effort had been put in place. 46

Russia declared the world’s largest stockpile of CW stored at seven sites in western Russia. In 1993, the country took the decision to destroy CW at their storage locations because of public resistance to their transport. Most of the remaining stocks comprise
modern nerve agents (Sarin, Soman and VX) contained in munitions. In Russia, the main technology developed and used to destroy CW stockpiles is the neutralization of agents at low temperature. The generated reaction mass is then disposed of by incineration or bitumisation.

The stated major priorities of Russia’s CW destruction programme are to develop the social infrastructure in the areas surrounding the destruction facilities, ensure that the destruction process is conducted safely, protect and support recovery of the local environment, and make effective use of funding from all sources.

The U.S. declared the second largest CW stockpile, including blister and nerve agents, stored in a number of locations in continental U.S. and on Johnston Island in the Pacific. Some storage sites are located next to densely populated areas. The baseline destruction technology in the U.S. is incineration. However, following public concern about this destruction method, an alternative low-temperature, two-stage process, technology was developed and implemented in three large-scale U.S. CW destruction facilities.

The original U.S. law authorising the CW destruction programme specified that the destruction programme should provide for the maximum protection of the environment and the general public.

In line with the experience of Russia and the U.S. in the field of CW destruction, both approaches, i.e. incineration technology and low-temperature neutralization followed by reaction mass post-treatment, have been adopted and implemented by other possessor States to destroy their CW stockpiles.

Iraq was the most recent country to join the CWC regime as a possessor State in January 2009. It submitted its initial declaration on 12 March 2009, where Iraq declared two bunkers with filled and unfilled chemical weapons munitions, some precursors, as well as five former CW production facilities.

While there are inherent risks associated with normal destruction operations, it must be stated that, in most cases, these are substantially reduced by physical control safeguards within the destruction facilities.

Speaking with reference to the U.S. system, the environmental engineer, Harvey Rogers, stated that regardless of the destruction technology chosen, much of the front-end material-handling system will have similar safeguards. That is, items are put in containers, then monitored for leaks before handling, after moving and offloading to the disposal plant. Once in the plant, airflow is zoned through a cascade airflow system from clean to successively more-likely-to-be-contaminated areas, and ultimately to a carbon filtration system. In areas where leakage or release is reasonably possible or likely, there is continuous monitoring with associated alarms. These monitors are capable of detecting agent concentration levels below those that would be acceptable as an occupational exposure. These safeguards ultimately serve to make the CW destruction process safer.

While the deadlines for destruction referred to in the Introduction were meant to provide a fixed timeframe within which to rid the world of CW, it currently appears
highly unlikely that Russia and the U.S. will be able to meet them. Destruction programmes in each country have been affected by delays caused by a variety of political, technical, financial and legal factors. Construction of major destruction facilities in Russia and the U.S. in some cases has only just started or is still behind schedule. Aside from the legally- and politically-charged question of what action, if any, would be appropriate if these countries breach their destruction timelines under the CWC, the longer CW stockpiles will remain in existence, the longer the threat to the population and the environment will persist.

5. Conclusion

Greater awareness of the CW destruction process has generated growing concern among the public about potential risks to human health, safety, and the environment. This relates both to the risk involved in a direct exposure, as well as the long term low-level exposure to agents, disposal, and degradation products.

It has therefore become critical to set aside the traditional secrecy associated with CW and to provide the public, especially nearby communities, with reliable, transparent, trustworthy, and independent information. These communities must be given the opportunity to participate, at some level, in the decision-making process which directly affects their environment. They must feel that their interests are being served and equally that they are safe.

While public participation may lengthen the CW destruction process, it may serve to make this process safer in the long-term. For instance, the experience of the U.S. has shown that increased public awareness and concern about the CW destruction process led the Army in that country to take steps to minimize the potential environmental risks and to develop alternative, safer technologies. The Army also took steps to monitor and control toxic emissions, including dioxins and furans, which have been linked to cancer and other long-term health problems.

As Paul Walker, the Legacy Program Director of Global Green USA, noted:

While everyone is committed to eliminating the threat of chemical warfare, terrorist attacks and stockpile leaks and accidents in a timely and efficient way, this takes place best through extensive public outreach, transparency and involvement activities. Building consensus usually takes time up front, but saves much difficulty later on in the process.

Public participation is important, moreover, to develop a more holistic CW destruction process which to some extent also serves to improve the quality of life of nearby communities. This is what happened, for instance, at the Gorny CW destruction facility in Russia where a component of the EU Tacis Programme was used to help local authorities perform ecological control and outreach. As part of the project, a set of new, comfortable houses were constructed and the water-supply system was upgraded, thereby improving the water quality in the area.

1 OPCW, Albania was the First Country to Destroy All Its Chemical Weapons, www.opcw.org [Accessed: 03/08/2009].
2 PART IV (A)(17) of the Verification Annex. The CWC classifies CW into 3 categories, with Category 1 weapons being the more dangerous weapons which have little or no peaceful application.
OPCW (2009), OPCW Member States, opcw.org [Accessed: 03/08/2009]. The OPCW regularly undertakes Workshops to promote CWC universality in the Mediterranean Basin and Middle East Region. The most recent Workshop was held in Istanbul on 16 and 17 April 2009. Malta hosted three such Workshops, two in Malta (1999 and 2004) and one in Gozo (1996).


The other possessor States are: India, Iraq, Russia, A State Party (generally acknowledged to be South Korea), and the United States.

Providing for national implementing measures.

Providing for the observation of safety regulations in the conduct of inspections.

Prohibiting chemical weapons destruction through dumping in any body of water, land burial or open-pit burning, which are banned for ecological reasons.

Providing for activities not prohibited under the Convention.

Effluent streams resulting from all destruction technologies, whether gaseous, liquid or solid, can vary considerably in composition and quantity, depending on the destruction technology and disposal strategy used. The OPCW recommends that before being discharged into the environment, recycled, used commercially or as landfill, effluent streams will have to be treated to ensure that any remaining trace contaminants, organic or inorganic, are at acceptable levels, in compliance with national standards for release. See OPCW, Environmental Concerns and Provisions, op. cit.

Ibid.


This State Party has requested anonymity, but is widely accepted to be South Korea.

OPCW, Environmental Concerns and Provisions, op. cit.


J. Matousek (2006), Health and environmental risks associated with the destruction of chemical weapons, NATO Security through Science Series, pp75-83.


Based on Matousek, op. cit., p76.


Observations of the Assistant Secretary of the U.S. Army (Installations, Logistics, and Environment), quoted in R. Davis, op. cit.

Gottschall, Carl, ed. (1997), An interview with Harvey Rogers, in Safe Disposal of Chemical Weapons, Chemical Health and Safety, pp. 38-41. Describing the preparedness measures taken by the CDC, Rogers mentions: “We have an in-house physician who reviews medical preparedness capabilities of workers at demilitarization facilities, as well as local medical response capabilities in communities near stockpile sites. I am the in-house engineer who works on this project. I review plans and physical facilities for safeguards provisions. And procedures designed to prevent agent release or contain agent in a way that protects workers and the public from exposure to agents. We also have an in-house chemist who reviews agent-monitoring techniques and related quality assurance activities to ensure that any agent release will be detected and quantified both rapidly and accurately. Our in-house statistician works closely with the chemist to review and interpret [Quality
Assurance] data. In addition to our in-house resources, we can and do convene expert panels to help us with issues needing highly specialized review...”


29 Ibid.


The CWC defined “Old Chemical Weapons” as: “(a) Chemical weapons which were produced before 1925; or (b) Chemical weapons produced in the period between 1925 and 1946 that have deteriorated to such extent that they can no longer be used as chemical weapons.” And “Abandoned Chemical Weapons” is defined as “Chemical weapons, including old chemical weapons, abandoned by a State after 1 January 1925 on the territory of another State without the consent of the latter.”

31 Matousek, op. cit., p 77.


34 Imperial College London (2005), Munitions Dumped at Sea: A Literature Review, quoted in D. Bearden, op. cit., p10.


38 H. Deng and P. Evans, op. cit., p105.

39 OPCW, Albania the First Country to Destroy All Its Chemical Weapons, op. cit.

40 OPCW, Albania the First Country to Destroy All Its Chemical Weapons, op. cit.


42 NTI Research Library (2008), Libya Chemical Overview, www.nti.org, [Accessed: 03/08/2009]. This article provides a good overview of the motivating factors for which Libya may have developed a CW capability in the first place.


44 NTI Research Library (2008), op. cit.


49 OPCW, Destruction Technologies, op. cit.


51 OPCW, Destruction Technologies, op. cit.

52 C. Schneidmiller (2009), India Completes Chemical Weapons Disposal; Iraq Declares Stockpile, op. cit.

53 See Gottschall, Carl, ed. (1997), An interview with Harvey Rogers, op. cit.

54 CW destruction is undoubtedly a costly enterprise. Though it is hard to provide precise figures, in the case of the U.S., the total cost for destroying the entire U.S. CW arsenal was estimated between US$24 and US$35 billion. See Statement of the U.S. Assistant Secretary of State for Arms Control, Stephen Rademaker, quoted in K. Boyd (2002), Albania Has Chemical Arms; CWC Review
In the case of Libya, figures are available from when the U.S. was considering aiding the country with its CW destruction. At the time, the director of the Defense Threat Reduction Agency (DTRA) held that, based on initial estimates, U.S. assistance for destroying CW in Libya could cost more than US$100 million. Any destruction project in Libya would be fairly expensive because the weapons and materials were stored in a remote location in the desert, about 600 kilometres from Tripoli. Therefore, transporting the weapons would almost certainly be necessary, not least due to the high temperatures at their current location and lack of access to water, which is an essential element in any CW destruction process. See M. Nguyen (2006), Libya Chemical Weapons Destruction Costly, Arms Control Today, www.armscontrol.org [Accessed: 03/08/2009].

58 One approach to addressing this dilemma is the “management and oversight” approach, as suggested by P. Walker, op. cit.
59 OPCW, Environmental Concerns and Provisions, op. cit.
60 A. Fedorov, op. cit.
61 OPCW, Destruction Technologies, op. cit.
63 P. Walker, op.cit.