Radioactive Waste Impacts Mitigated by the Arctic Military Environmental Cooperation Program: lessons in international cooperation

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Abstract

Climate change will have drastic effects on the Arctic environment, opening new opportunities for Arctic access regarding shipping, fishing, tourism, and offshore resources. As the importance of the Arctic grows, conflict among interested nation states and subsequent security concerns are likely to arise. Diplomacy on an international scale will be needed to resolve the Arctic's transboundary issues and international cooperation will be necessary to ensure the protection of the Arctic ecosystem and the sustainable and responsible development of Arctic resources. Strategies and frameworks for cooperation should be developed now to reduce or prevent potential international discord.

In 1996, the sustainability and security challenges posed by Russia's defense-related nuclear waste in the Arctic defied unilateral solution and the Arctic Military Environmental Cooperation (AMEC) was established. AMEC's goal was not only to mitigate the impact of radioactive waste on the fragile Arctic environment, but also to foster interaction and confidence between the militaries of the AMEC member states. This research examines the transboundary issues, significance, and environmental impacts of radioactive waste on the Arctic, as well as, the organization and initiation of projects to address these issues under AMEC. By analyzing AMEC's efforts, successes, and failures to date, lessons in international cooperation can be derived and the major barriers to successful cooperation can be characterized. A system involving increased international cooperation based on the lessons of AMEC is required if the sustainability and security of the Arctic is to be maintained.

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration except where specifically indicated in the text

The total length of this document, including all references and appendices is less than 15,000 words

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1 Introduction

Climate change will have drastic effects on the Arctic environment, increasing the ambient air temperature, melting glaciers and sea ice, and contributing to permafrost thaw. The environmental state change in the region will open new opportunities for Arctic access regarding shipping, fishing, tourism, and offshore resources. As the importance of the Arctic grows, conflict among interested nation states and subsequent security concerns are likely to arise. Diplomacy on an international scale will be needed to resolve the Arctic's transboundary issues.

In 1996, the Arctic Military Environmental Cooperation (AMEC) Program was created to deal with the impacts and transboundary issues of radioactive waste in the Arctic. This research will seek to determine the extent of the radioactive waste problem in the Arctic, how that problem was addressed by AMEC, and what lessons can be learned from AMEC's actions. By developing criteria to define the success and non-success of projects under AMEC, lessons in international cooperation can be derived. AMEC's role in addressing and mitigating the radioactive waste problem provides guidance for strengthening future international cooperation in maintaining the sustainability and security of the Arctic.

1.1 History

After the collapse of the Soviet Union, the secrecy surrounding the Soviet's military actions and subsequent contamination of the Arctic environment crumbled. In 1993, the Yablokov report released by the Russian government exposed the Soviet's practice of dumping radioactive waste (RW) in the Arctic seas over a period exceeding three decades (Yablokov *et al.*, 1993). Combined with the additional knowledge of the insufficient and poorly maintained capacity for the storage and transportation of spent nuclear fuel (SNF) and RW on Russia's Kola Peninsula, international concern began to surface regarding the handling and storage of the RW and SNF from the 116 Russian decommissioned nuclear submarines located in the Arctic (GAO, 2004). Without the proper infrastructure ashore or afloat to dismantle the submarines and process their RW and SNF, many of the submarines were falling into poor condition without proper personnel supervision or preventive maintenance (Rudolph *et al.*, 2003).

Though the U.S. established the Cooperative Threat Reduction Program (CTR) in 1991 to help fund Russia's dismantlement efforts, the program was concerned mainly with the goal of thwarting the military and nuclear proliferation threats associated with Russia's SNF and did not adequately address the related environmental threats (GAO, 2004). Due to the extreme cold and harsh conditions, the Arctic is more susceptible to environmental contaminants and slower to recover from physical destruction than other regions (AMAP, 2002). The Arctic's air, water, and ice combine to transport contaminants over vast distances to, from, and within the Arctic. Thus, the Arctic serves as a contaminant storage reservoir and/or sink (AMAP, 1997).

As the environmental conscience of the CTR program, AMEC was formed in 1996. Most of AMEC's work focused on Northwest Russia and its Kola Peninsula. At the time of AMEC's founding, a considerable amount of SNF was either damaged or stored in an unstable condition in on-shore or floating storage facilities exposed to corrosion and the Arctic's severe climate. Without proper management, the SNF was at risk of releasing enough radioactivity to damage the sensitive Arctic environment as well as endangering global environmental and physical security. Through AMEC, the Russian Federation cooperated with the U.S., Norway, and eventually the U.K., to enhance its RW and SNF transport infrastructure and reprocessing facilities by adding temporary storage capacity and improving the health, safety, and physical security requirements of existing infrastructure (Dyer *et al.*, 2003).

1.2 Russia's Northern Fleet

In 1996, at the time of AMEC's founding, the Kola Peninsula and Severodvinsk had "the highest concentration of nuclear reactors, active and derelict, in the world" (Nilsen *et al.*, 1996). With 220 nuclear reactors numbering 115 on active submarines, 101 on inactive submarines, and 4 on military surface ships, the Russian Northern Fleet accounted for 18% of the world's total nuclear reactors. With between 67 and 84 nuclear submarines in operation, Russia's Northern Fleet made up approximately 2/3 of Russia's submarine fleet (Ibid.). The Soviet's fast paced buildup during the Cold War (Table 1) left little time to develop a plan for handling the subsequent large amounts of decommissioned submarines and nuclear waste. With the retirement of 200 submarines after the fall of the Iron Curtain, Russia's capacity for the storage and handling of SNF and RW proved inadequate (Rudolph *et al.*, 2003).

Table 1. Nuclear-powered vessels built in the Soviet Union/Russia between 1958 and 1995 (Nilsen *et al.*, 1996 and Bøhmer *et al.*, 2001)

Project	NATO Class	Number built	Reactors	Number Operational in Northern Fleet	
				1996	2001
1st generation					
627 A	November	13	2 (PWR)*	0	0
658	Hotel	8	2 (PWR)	0	0
659	Echo I	5	2 (PWR)	0	0
675	Echo II	29	2 (PWR)	0	0
2nd generation					
667 A	Yankee	34	2 (PWR)	1	1
667 B-BDRM	Delta I-II-III-IV	43	2 (PWR)	18	10
670	Charlie I-II	17	1 (PWR)	3	0
671 /RT/RTM	Victor I-II-III	48	2 (PWR)	18	8
3rd generation					
941	Typhoon	6	2 (PWR)	6	3
949 /A/	Oscar I-II	12	2 (PWR)	9	5
945	Sierra	4	1 (PWR)	6	3
971	Akula	12	1 (PWR)	6	6
LMR					
645	ZhMT	1	2 (LMR)*	0	0
705	Alfa	7	1 (LMR)	1	0
Prototype					
661	Papa	1	2 (PWR)	0	0
685	Mike	1	1 (PWR)	0	0
Mini submarines					
10831	10831	1	1 (PWR)	1	unknown
1851	X-ray	1	1 (PWR)	1	unknown
1910	Uniform	3	1 (PWR)	3	unknown
Surface Vessels					
1144	Kirov	4	2 (PWR)	2	1
1941	Ural	1	2 (PWR)	0	0

*LMR - Liquid Metal Cooled Reactor, PWR - Pressurized Water Reactor

The Northern Fleet's nuclear-powered vessels operated from five naval bases on the Kola Peninsula: Zapadnaya Litsa, Vidyaevo, Gadzhievo, Severomorsk and Gremikha. Several facilities on the Kola Peninsula also had storage for spent fuel assemblies, solid radioactive waste (SRW), and liquid radioactive waste (LRW) as shown in Figure 1.

Located outside the Kola Peninsula, the Severodvinsk shipyard also contained large amounts of RW as shown in Figure 2 (Nilsen *et al.*, 1996).

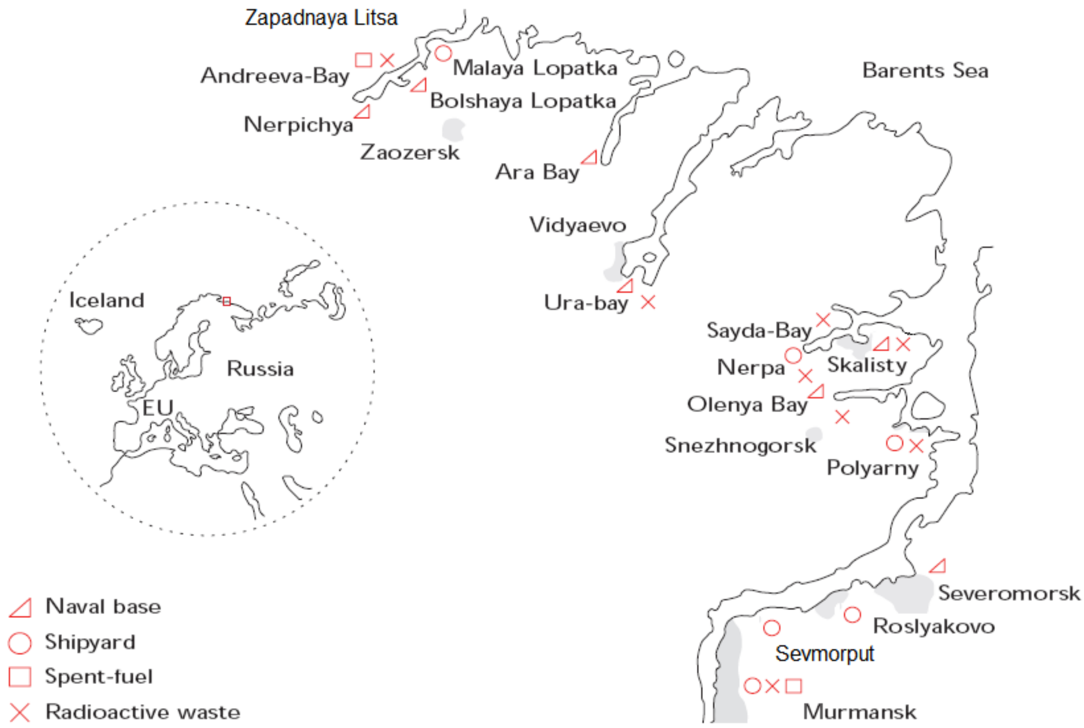

Figure 1. Northern Fleet locations in the Northwest Kola Peninsula (Modified from: Bøhmer *et al.*, 2001)

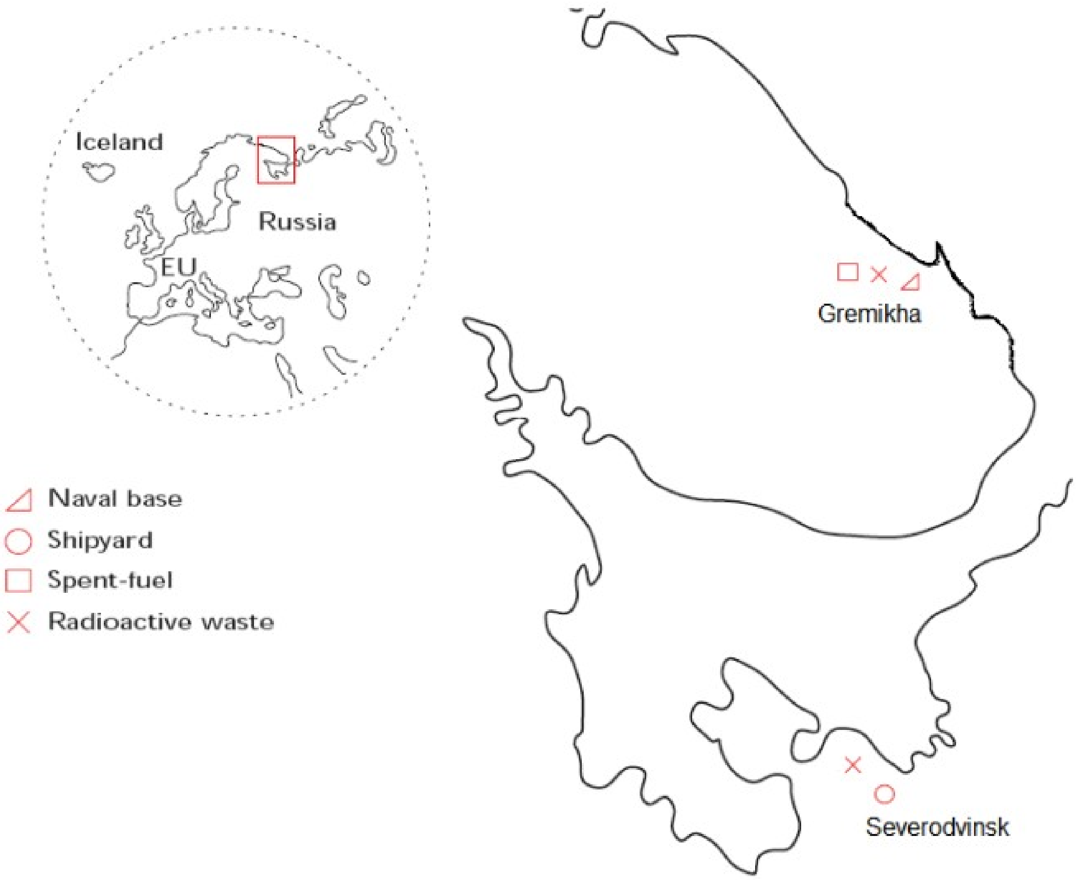

Figure 2. Northern Fleet locations in the Southeast Kola Peninsula (Modified from: Bøhmer *et al.*, 2001)

As seen, Northern fleet submarines were laid up in a vast number of locations on the peninsula. The lack of a central storage and handling facility hampered the decommissioning and dismantlement process. As an increasing number of the Russian Northern Fleet's nuclear submarines were decommissioned, the chance of an accident involving a laid-up submarine or radioactive leakage from a rundown storage site also increased. In addition, the Arctic Monitoring and Assessment Programme's 2002 Report, *Radioactivity in the Arctic*, outlined the issues relating to the presence and effects of radioactive contaminants in the Arctic. From an environmental and economic standpoint, it was imperative to dismantle the decommissioned submarines and safely store and secure their SNF and RW as quickly as possible (Bøhmer *et al.*, 2001). The many potential sources of radioactive contamination in the Russian Arctic are summarized in Table 2.

Table 2. Potential sources of radioactive contamination in the Russia Arctic – 1996 (Nilsen *et al.*, 1996)

Location	Type of Facility	Amount
Zapadnaya Litsa	Naval Bases	26 operational nuclear submarines 1 inactive nuclear submarine with nuclear fuel 1 inactive nuclear submarine 23,260 spent fuel assemblies 2,000 m^3 LRW 6,000 m^3 SRW
Vidyaevo (Ura Bay)	Naval Bases	4 operational nuclear submarines 1 Nurka class reactor 14 inactive nuclear submarines with nuclear fuel At least 3 m^3 LRW Unknown amount of SRW
Gadzhievo (Skalisty)	Naval Bases	Unknown number of nuclear submarines 200 m^3 LRW 2,037 m^3 SRW Occasional service ship containing nuclear fuel Occasional service ship with LRW
Sayda Bay	Storage Facility	12 submarine hulls with reactor
Severomorsk	Naval Bases	2 nuclear powered battle cruisers
Gremikha	Naval Bases	Some operational nuclear submarines 15 inactive nuclear submarines with fuel 300 m^3 SRW 2,000 m^3 LRW 795 spent fuel assemblies 9 reactor cores from submarines with LMR
Nerpa	Shipyard	2 submarines in process of being decommissioned Periodical service ships containing SNF Periodical service ships with LRW 200 m^3 SRW 170 m^3 LRW
Shkval (Polyarny)	Shipyard	1 submarine in for maintenance 1 service ship with SNF 1 service ship with LRW 7 inactive nuclear submarines with fuel Storage facility for SRW 150 m^3 LRW
Sevmorput	Shipyard	1 inactive nuclear submarine with SNF 1 inactive nuclear submarine – defueled Occasional service ship with LRW Storage for SRW
Severodvinsk	Shipyard	12,539 m^3 SRW 3,000 m^3 LRW 4 nuclear submarines in for maintenance 12 inactive nuclear submarines with nuclear fuel 4 reactor compartments from decommissioned submarines

In the 1990's, many of Russia's nuclear submarines were reaching the end of their operational life or were in need of maintenance or upgrading which could not be funded by Russia's defense budget. In addition, after the disintegration of the Soviet Union in 1991, several disarmament agreements, including the START I and START II treaties, were formed between the U.S. and Russia. With a peak of 196 nuclear submarines in operation in 1989, 109 in 1996, and 80 predicted for 2003, inadequate funding, infrastructure, training, and safety precautions existed to properly decommission Russia's nuclear fleet (Nilsen *et al.*, 1996). Highly publicized Russian submarine accidents, such as the sinking of the Kursk in 2000 and K-159 in 2003, made the inadequacies even more apparent. The state of Russia's Northern Fleet in 1996 can be viewed in Table 3. The location and increasing number of the Northern Fleet's decommissioned submarines in 2001 as compared to 1996 can be seen in Table 4 and Table 5.

Table 3. State of Russia's Northern Fleet in 1996. (Nilsen *et al.*, 1996)

Project	In Service	Inactive	Dismantled	Sunk
627A	0	9	0	1
658	0	6	0	0
675	0	11	0	0
667A	1	22	5	1
667B	2	7	0	0
667BD	4	0	0	0
667BDR	5	0	0	0
667BDRM	7	0	0	0
670M	3	3	0	0
671	0	13	1	0
671RT	2	5	0	0
671RTM	16	0	0	0
941	6	0	0	0
949	2	0	0	0
949A	7	0	0	0
945	6	0	0	0
971	6	0	0	0
705	1	6	2	0
661	0	1	0	0
685	0	0	0	1
1144	2	0	0	0

Table 4. Known locations of 70 of the Russian Northern Fleet's 88 decommissioned submarines in 1996 (Nilsen *et al.*, 1996)

	Project																	
	627A		658		659		661		667A		667B		670		671		705	
Location	w	o	w	o	w	o	w	o	w	o	w	o	w	o	w	o	w	o
Z. Litsa																	1	1
Ara					5	0							1	0				
Ura					6	0							1	0				
Sayda	0	1	0	2	0	2			1	2							0	1
Olenya			1	0	1	0					1	0	0	1	0	1		
Shkval	3	0	1	0	1	0									3	0		
Sevmorput			1	0														
Gremikha	4	0	1	0											8	0		
Severodvinsk							1	0	10	5							1	2

*w=with fuel
*o=without fuel

Table 5. Locations of the Russian Northern Fleet’s decommissioned submarines in 2001. (Bøhmer *et al.*, 2001)

	Project															
	627A	658	675	667A	667B	667BD	667BDR	670	671	671RT	671RTM	941	949	945	971	705
Location																
Z. Litsa											8					3
Ara														4		
Ura			11													
Sayda	1	2	3	11	7	4		1	1							4
Olenya		1														
Shkval	3	1								3						
Sevmorput		1	1													
Gremikha	4	1							9	3						
Severodvinsk				7	2							2	2			
Skalisty				3			2	5							6	
Nerpa										1						
Unknown									2			1				
Total	8	6	15	21	9	4	2	6	12	7	8	3	2	4	6	7
with fuel	6	3	12	10	2	0	0	5	11	4	8	3	2	4	6	3
without fuel	2	3	2	0	0	0	0	0	0	3	0	0	0	0	0	0
dismantled	0		1	11	7	4	2	1	1	0	0	0	0	0	0	4

1.3 AMEC Background

In the late 1980s, an evolving political climate combined with the acknowledgement that environmental problems have a cross-border nature, allowed for the initial stages of bilateral cooperation regarding nuclear safety between Russia and Norway. Norway's main efforts focused on the collection and analysis of data, but it soon became apparent existing Russian infrastructure was not allowing for the proper handling and storage of the RW and SNF arising from the dismantling of decommissioned submarines. Due to the large quantities of RW and SNF in Northwest Russia, the cross-border nature of its environmental problems, and the high cost of mitigating the impacts, Russia alone could not provide the solution. Therefore, international involvement was necessary (Nyman, 2002).

Norway's subsequent campaign for international cooperation arose mainly from the pollution of their prime fishing grounds. With fish making up 7% of Norway's total exports, it was important to ensure that the fish not only remained uncontaminated, but also that a potential threat of contamination was not perceived by buyers (Ibid.). By involving other governments and international organizations, Norway's hope was to provide "an integrated international approach" to solving Russia's nuclear problems and related environmental issues (Rudolph *et al.*, 2001). In March 1995, Norway took the initiative and arranged a series of meetings with the U.S. and Russia's defense ministries regarding the Arctic's defense-related environmental problems. Jørgen Kosmo, then Norwegian defense minister, suggested the formation of a cooperation involving the three countries' militaries because several of the Arctic's main environmental problems were linked to the military, but also because the military as an institution has the means to address such problems (Sawhill *et al.*, 2001).

As a result of that discussion, on September 26th 1996, the "Declaration among the Department of Defense of the United States of America, the Royal Ministry of Defence of the Kingdom of Norway, and the Ministry of Defence of the Russian Federation, on Arctic Military Environmental Cooperation" was signed in Bergen, Norway (Perry *et al.*, 1996). The Declaration established AMEC as a forum for tripartite communication and joint activity. The Declaration stated several reasons for the creation of AMEC including: "the need to ensure the conservation and sustainable use of the

Arctic environment" and that cooperation between military organizations could provide "a valuable contribution to the established framework for international environmental cooperation in the Arctic" (Ibid.).

The Declaration went on to lay out a framework for cooperation and contracts between the member states. The Declaration stated the cooperation was allowed to carry out discussions, studies, evaluations, reviews, and clean-up efforts regarding contamination from military activities in the Arctic, its prevention methods, and environmental impact. The Declaration defined cooperation in terms of ad-hoc meetings; workshops; seminars and conferences; exchanges of delegations; exchange of information on environmental monitoring and remediation plans and efforts; contamination surveys; and research and technology exchange. Each country was expected to "pay its own costs for participation in AMEC activities" through direct financing or the supply of equipment and materials (Ibid.).

Though the Declaration did not mention specific radioactive contamination projects, the program's focus from the start was clear. At the signing ceremony, then U.S. Secretary of Defense William Perry stated, "We will work to handle and store radioactive materials safely, to dispose of toxic materials properly, and to exchange information on risk assessments and clean-up technologies and methods" (USIS, 1996). Likewise, Norway stated that this cooperation would be "carried out through joint projects" to clean up radioactive and non-radioactive pollution (Royal, 1996).

Thus, AMEC became a joint undertaking between the U.S., Norway, and Russia. Under AMEC, the member countries cooperated through dialogue and joint technical projects to reduce the adverse effects of military operations on the Arctic environment, specifically regarding the SNF and RW from Russia's nuclear submarines. From the beginning, AMEC's goal was to not only mitigate the impact of military operations on the fragile Arctic environment, but also to foster interaction and confidence between the militaries of the AMEC member states (FFI, 2009). For the U.S., the founding of AMEC meant an opportunity to have access to some Russian sites for the first time (Kaiser, 1996).

1.4 AMEC Organization

AMEC's practical coordination was carried out by the Ministries of Defense in each country which were responsible for overseeing the Declaration and making any amendments to it (DOD, 1998). In the U.S., the Department of Defense (DOD) worked with the U.S. Navy. In Norway, the Ministry of Defence coordinated with the Defence Research Establishment (FFI) and, in Russia, the Ministry of Defence's Ecological Security Directorate worked with the Russian Navy (Rudolph, 2006). The Principals of the member states held the highest authority and were ultimately responsible for ensuring the Declaration's objectives were accomplished by overseeing project development, acquiring funding to implement agreed activities, and observing projects during the execution phase to ensure project milestones were being realized within budget constraints. In addition, the Principals approved and terminated annexes to the Declaration, as well as approved the involvement of other states in AMEC activities (DOD, 1998). For the U.S., the AMEC Principal was a member of the DOD, but also involved were Project Officers from the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Department of State (Rudolph, 2006). The DOD, DOE, and EPA all provided funding to AMEC for the U.S. For Norway, funding was provided through Norway's Plan of Action for Nuclear Safety to the Ministry of Defense. For Russia, funding was provided through the Ministry of Defense and the Ministry of Atomic Energy (Minatom) (Rudolph *et al.*, 2001).

From each country, a senior representative was appointed to serve as Co-chair and leader of the national Steering Group, helping coordinate program implementation and supervising all AMEC projects. The Co-chair had the authority to select people to join the Steering Group, including members of other national military institutions. The Steering Group was made up of the Co-chair and up to three special advisors. Receiving administrative, technical, and financial support from their respective national program offices and support and advice from ad hoc interagency advisory groups, the Steering Group's responsibilities included: identifying and prioritizing work requirements; providing project task management; managing logistics and other program support; overseeing national security aspects of AMEC projects; preparing and reviewing project proposals; and providing quality assurance and control oversight (DOD, 1998).

Reporting to the national Co-chair, the Project Officers had daily responsibility and leadership over the planning, implementation, and practical work for each project. The country with primary responsibility for the project designated a lead project officer, who then worked with project officers from the other two countries. When additional expertise would be needed, Technical Experts were recruited either internally, from other Government institutions, or from private companies (Ibid.). Figure 3 shows a visual representation of AMEC's organizational structure.

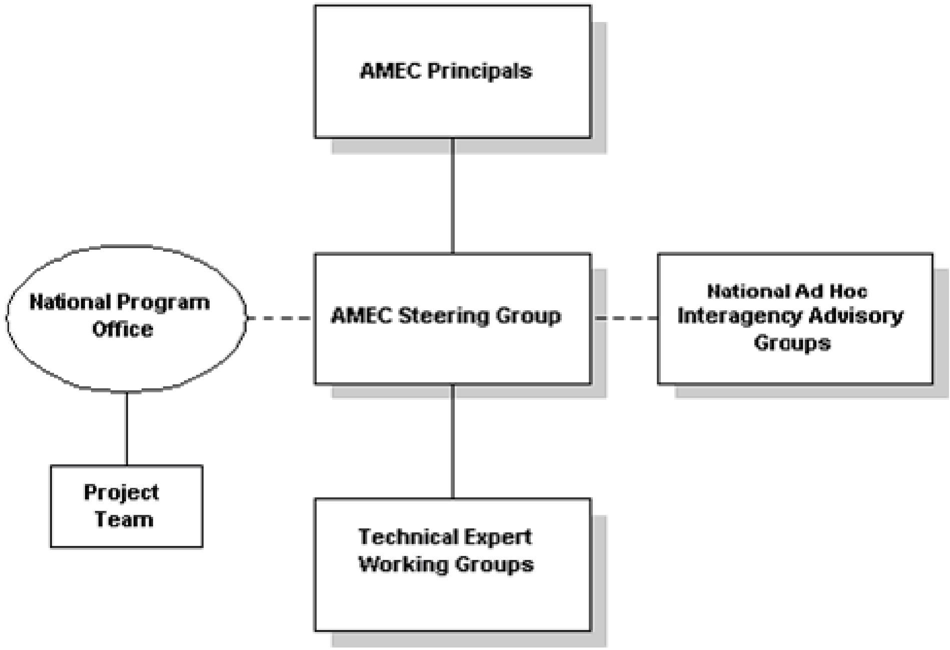

Figure 3. AMEC Organizational Structure (DOD, 1998)

2 Materials and Methods

The research aims of this project were:

- To determine the impacts of radioactive waste due to Russia's Northern Fleet on the Arctic environment

- To understand the reasons for the formation of an international cooperation such as AMEC

- To evaluate the accomplishments of AMEC
- To understand what sustainability and security mean for the Arctic

However, the overarching research question was:

- What makes international cooperation successful? And therefore, what lessons can we learn from the operation of AMEC which can then be applied to other international cooperation programs to make them more successful?

In order to measure whether international cooperation under AMEC was successful or not, certain criteria were developed to define success and non-success. Once a project was determined to be successful or unsuccessful, the project was analyzed to determine if a lesson on what to do or what not to do in a situation involving international cooperation could be derived.

A successful project was one that:

- 1. Encouraged member states to continue their funding or increase their funding of AMEC

- 2. Involved increased cooperation among member states, either through a meeting of AMEC officials, technology demonstration, or joint exercise

- 3. Increased the decommissioning and dismantlement pace of Russian nuclear submarines

- 4. Decreased or mitigated the environmental impact of nuclear waste on the Arctic environment

- 5. Encouraged member states to continue their involvement in existing projects or promote new projects

An unsuccessful project was one that:

- 1. Gave reason for member states to decrease their funding of future AMEC projects

- 2. Spawned hostility or disagreements which led to decreased cooperation and trust among member states

- 3. Failed to increase the decommissioning and dismantlement pace of Russian nuclear submarines

- 4. Failed to decrease or mitigated the environmental impact of nuclear waste on the Arctic environment

- 5. Encouraged member states to discontinue their involvement in existing projects or avoid involvement in new projects

To determine the research aims, a critical review and analysis of several different forms of documentation was conducted to include:

- Government websites
- Reports from international organizations and forums, such as the Bellona Foundation and Arctic Monitoring and Assessment Programme
- Conference proceedings authored by AMEC officials and researchers
- Government agency reports
- News articles
- Journal articles

3 Results

3.1 Projects

AMEC's original projects addressed five different radioactive and two nonradioactive waste program areas: SNF management, liquid waste treatment, SRW processing, radiation monitoring, and personnel safety, remediation technologies, and clean ship technologies (Rudolph *et al.*, 2001). However, SNF management occupied AMEC's top priority (Rudolph, 2006). SNF represents only 5% of the RW volume from a single nuclear submarine, but 99% of the radioactivity. In Northwest Russia, it was estimated in 2003 that 50% of the area's radiation potential emanated from the SNF of the over 50 decommissioned submarines which were waiting to be dismantled (Rudolph *et al.*, 2003). AMEC's budget allowed for technology demonstrations and the development of prototypes which could then be further developed and implemented using other funds (Rudolph *et al.*, 2001). The importance of the management of SNF can be identified through the initiation of AMEC's five original projects: dual-purpose transport and storage cask; cask trans-shipment facility; cask de-watering and fuel drying system; centralized radio-ecological monitoring system for the cask trans-shipment facility and SNF handling, transfer and auxiliary equipment technologies (Rudolph, 2006). A list of these and all other AMEC projects can be found in Table 6.

Table 6. Projects initiated under AMEC

Project	Project Description (Year initiated/Year completed)
Naval SNF management	
1.1	Design and construct interim storage and transportation container (1997/2003) (Petrushenko, 2002)
1.1–1	Design and construct temporary storage pad for SNF cask (2000/2003) (Rudolph, 2006)
1.1-2	Develop technology for cask dewatering and fuel drying (2002/Terminated) (Rudolph, 2006)
Naval LRW treatment	
1.2	Design and construct mobile LRW processing facility (1997/Suspended) (GAO, 2004)
SRW volume reduction	
1.3–1	Assess technology for waste volume reduction (1999/2003) (Griffith, 2003)
1.3–2	Manufacture a mobile pre-treatment facility (1999/2003) (Griffith, 2003)
1.3–3	Manufacture a decontamination unit for metal wastes (1999/Terminated) (Bøhmer *et al.*, 2001)
SRW storage	
1.4–1	Assess surface coating technologies (1998/1999) (Rudolph *et al.*, 2001)
1.4–2	Manufacture steel radioactive waste containers (1998/2001) (Petrushenko, 2002)
1.4–3	Manufacture concrete radioactive waste containers (1998/2002) (Petrushenko, 2002)
Radiation monitoring, and personnel and environmental safety	
1.5	Equipment transfer, training and exchange of monitoring strategies, PICASSO (1999/2003) (Endregard *et al.*, 2003)
1.5–1	Radiation control at facilities (1997/2002) (Pomerville, 2003)
Problems of non-radioactive waste and spills	
2.1	Technologies for the remediation of hazardous waste sites on Arctic military bases (1997/-) (Rudolph et al., 2001)
2.2	Review and implementation of "clean ship" technologies (1997/-) (Rudolph et al., 2001)
2nd Generation projects	
3.1	Radioactive waste management facility (1997/2004) (Bellona, 2004)
3.2	Identify technologies for improving the buoyancy of decommissioned nuclear submarines (2003/2008) (DECC, 2008)
3.3-1	Develop and manufacture equipment for the safe transport of decommissioned nuclear submarines (2003/2008) (DECC, 2008)
3.3-2	Safe transport of a decommissioned Russian nuclear submarine (2003/2006) (Digges, Sept. 2006)
3.4-1	Reduce the hazardous wastes generated during submarine dismantlement (2004/2006) (DTI, 2006)
3.4-2	Dismantlement of a general purpose Russian nuclear submarine using AMEC-developed technologies (2004/2006) (DTI, 2005)

3.5	Address environmental protection issues at Arctic military bases through environmental management (2004/-) (GAO, 2004)
3.6	Propose solutions for the management and disposal of used submarine storage batteries (2004/Terminated) (GAO, 2004)
3.7	Plan and stage an emergency preparedness exercise involving an accident with SNF (2004/-) (GAO, 2004)
3.8	Develop and implement a project management framework to help improve the effectiveness and risk avoidance of project management (2006/2006) (DTI, 2006)
3.9	Provide training and research opportunities to the Russian Navy in preparation for the salvage of K-159 (2006/-) (DTI, 2006)
3.10	Develop guidance document for the international marine transportation and salvage community on how to safely transport decommissioned nuclear submarines (2008/2008) (DECC, 2008)
3.11	Survey and environmental analysis of the K-159 (2007/2007) (BERR, 2007)
3.12	Collect, store, treat, and recycle 300 mercury-containing lamps (2007/2008) (UNEP, 2009)
3.13	Evaluate options and develop mobile effluent plant for managing LRW containing oils (2008/-) (DECC, 2008)
3.14	Bi-annual workshops on topics of mutual concern (2008/-) (DECC, 2008)
3.15	Assess methodologies and develop protocols for the survey and recovery of sunken radiological hazardous objects (2008/-) (DECC, 2008)
3.16	Create and define a new AMEC Information Support Strategy (2008/-) (DECC, 2008)

Project 1.1

Initiated by the Norwegian FFI, the Russian Minatom, and the U.S. EPA, AMEC Project 1.1 developed a prototype cask for the storage and transport of SNF. The first prototype cask's design and fabrication was completed by September 1999, design verification and drop testing by August 1999, and cold testing by June 2000 (Dyer *et al.*, 2003). The only previously available cask was intended only for transport and need required a cask that could be used for transport as well as long term storage of up to fifty years (Rudolph, 2006).

Managed by the EPA's Office of International Programs, the development of the cask was funded by two thirds Russian funding and one third U.S. funding (Norway's pledged funding was never received) (Kudrik, 1999). Beginning in 2000, the serial production of 48 casks was funded by the Russian government and cost 80% less than the previous single-purpose transport cask (Rudolph, 2006). With an additional 25-60 casks produced by CTR, the casks are currently being used for the storage and transport of SNF from dismantled Russian Ballistic Nuclear Submarines by the U.S. and dismantled General-Purpose nuclear submarines by Russia (Dyer *et al.*, 2003 and GAO, 2004).

Project 1.1-1

Project 1.1-1 developed a transshipment pad for the temporary storage of SNF casks removed from service ships and awaiting rail shipment at Atomflot. Being unable to store the casks temporarily meant the arrival of the railcars for transport had to be scheduled in sync with the arrival of the ship carrying the spent fuel from a decommissioned submarine. With a 50-year service life, the facility's reinforced concrete foundation plate can store up to nineteen casks and was designed with existing handling equipment in mind. By providing temporary storage for casks, the de-fueling time for nuclear submarines was reduced from 3 months to 3 weeks (Rudolph, 2006).

Project 1.1-2

Funded by the U.S., the cask de-watering and fuel drying Project 1.1-2 sought to design and construct a system for SNF casks which would eliminate their residual water while conditioning their fuel, thus, extending the cask's service life. Containing up to 3.2 liters of water after being sealed, casks stored for extended periods were at increased risk of corrosion and hydrolytic gas production (Rudolph, 2006). When the construction of a sizeable facility for dehydration at Mayak was announced by CTR in 2003, the AMEC project was cancelled after having completed a Conceptual Plan (approved in August 2002) and a Technical and Economic Feasibility Study (Dyer *et al.*, 2003). Though designs for the Mayak dehydration facility were completed, construction never began due to the cancelled funding (Rudolph, 2006).

Project 1.2

Project 1.2 was undertaken to treat the stored LRW byproduct of nuclear submarine dismantlement (FFI, 2009). With accumulated LRW totaling around 6400 m^3, a per year generation of 1300 m^3 was predicted. At the time, LRW was stored at many remote sites where transportation to a central treatment facility was difficult. The best solution for treating the waste was found to be a mobile treatment facility (MTF) which could be transported to the different sites. The facility was designed to fit inside a standard 20-foot naval container and weigh no more than 15 tons to facilitate easy transport. Additional features were added to the MTF's design when a facility for winter operations was needed at Polyarny. To operate in temperatures below zero degrees centigrade, the units and connecting pipelines were to be provided with insulation and heating (Ibid.). However, the project was suspended after CTR withdrew funding and liability protection because they felt adequate facilities for LRW treatment already existed at submarine dismantlement sites (GAO, 2004).

Project 1.3

On account of the high cost, a phased project was used to develop a Mobile Pre-treatment Facility (MPF) for SRW in Project 1.3 (Rudolph *et al.*, 2001). The MPF for SRW would be required to be mobile to permit its use at various Russian sites, capable of operating in the harsh Arctic climate, able to process large waste volumes (500 m^3 per year) at appropriate specifications, and operationally flexible to process SRW of varying composition. Jointly funded by the U.S. and Norway, construction of six of the eight modules was completed by the end of 2001, with construction of the entire facility finished by the middle of 2002. The implementation of the facility then involved training, certification, testing, and start-up (Griffith *et al.*, 2002). In September 2002, a demonstration test was held at Zvezdochka Shipyard. The MPF was then disassembled and transported to Polyarninsky Shipyard in the spring of 2003. At Polyarninsky, the MPF was reassembled and underwent equipment, systems, cold and hot testing (Griffith *et al.*, 2003).

To aid the work of the MPF, Project 1.3 also involved a pilot demonstration of the cutting and shearing equipment which would be deployed inside the MPF. While attending the Waste Management '99 Conference and Exhibition, Russian AMEC representatives were able to inspect the metal cutting tool product line of Mega-Tech Services and determine no such equipment was available in Russia, but the use of the portable and easy-to-use equipment could significantly contribute to Russia's SRW pretreatment and volume reduction operations. Two small portable cutting tools and a spreader tool were chosen for initial deployment, with the assumption that once Russian workers gained experience with the tools, additional tools may be added in the future. The equipment would be used to sort and reduce the size and volume of metallic wastes.

By integrating the hydraulic cutting tools with the capability of operating in, next to, or some distance away from the MPF, optimum operability was attained. The tools were modified to operate in the cold temperatures of the Arctic should they needed to be deployed outside the MPF (Griffith *et al.*, 2001).

Project 1.4

With almost six thousand tons of SRW being produced by the Russian Navy each year, another phased project was used to limit the spread of contamination in the Arctic environment by addressing the Russian Navy's deficiency in temporary storage for SRW. A year long test of a coating material used to seal surfaces and assist decontamination was completed in Project 1.4-1. Results found the coating material to be suitable for the Arctic environment and that one decontamination cycle could remove contamination without harming the coating (Rudolph *et al.*, 2001). In June 1999, AMEC "announced a world-wide tender for the production of reusable containers for transport and storage of low-level SRW," which would be designed to meet International Atomic Energy Agency (IAEA) and Russian standards (Petrushenko *et al.*, 2002).

Steel and concrete RW containers were manufactured and procured in Projects 1.4-2 and 1.4-3, respectively (Rudolph *et al.*, 2001). The design specifications for the manufacture of long-term (up to 300 years), single-use concrete containers in Project 1.4-3 were completed and approved, with production scheduled to be completed in late 2002 (Sawhill *et al.*, 2001). The manufacture of reusable steel containers in Project 1.4-2 was carried out at the Russian Shipyard Zvyozdochka (Petrushenko *et al.*, 2002).

Cylindrically shaped with a wall thickness of 6 mm, the PST1A-6 (or УКТ 1A-6 in Russian) containers could store seven standard 200-liter (55-gallon) drums, be stacked up to six high in storage facilities, and were designed to be transported by truck, rail, barge, ship, or aircraft. With the container's design licensed in September 1998, design work began in October 1999 and the first 100 containers were presented by AMEC officials at Zvezdochka shipyard on May 10, 1999 (Griffith *et al.*, 2003 and Korolev, 2000). The first 100 PST1A-6 containers were delivered to the Russian Navy's Northern Fleet in October 2000, with another 300 to be delivered in November 2001. Before putting the containers into production, Zvyozdochka performed a series of tests: water exposure, stacking, dropping, puncture, and air tightness. Able to withstand extreme temperature and air pressure variations, the containers were more durable and stronger than most of the low-level waste containers in the U.S (Petrushenko *et al.*, 2002).

Project 1.5

In project 1.5, an automated radiation monitoring system, PICASSO, was designed for operation at Atomflot and put into operation on the 25th September 2003. Due to the high density of nuclear activities at Atomflot where SNF is prepared and temporarily stored for rail transport and liquid and SRW is received, processed, and temporarily stored, enhanced technical means of measuring and controlling radiation exposure was needed to protect personnel, neighboring communities, and the environment (FFI, 2009).

The PICASSO Environmental Monitoring System is an automated "centralized radiological surveillance system" which provides real-time information regarding the actual radiation activity of the site (Rudolph, 2006). The data presentation and visualization software was originally used to monitor radiation parameters at Norway's research reactor in Halden where a demonstration of its application was given to Russian Naval officers in September 1998. After a trilateral decision to initiate the project, PICASSO was approved in February 1999 (Endregard *et al.*, 2002). With the system designed to easily incorporate more sensors at a later date if they should be needed, a total of 14 radiation sensors were installed around Atomflot's SNF cask storage pad and LRW treatment facility (Endregard *et al.*, 2003).

The project was jointly funded by the U.S., Norway, and Russia. Through a contract with Brookhaven National Laboratory, U.S. funding was provided to FFI (FFI, 2009). Signed in February 2002, a contract between FFI and ICC Nuclide (a Russian contractual partner) covered the project's installation (Endregard *et al.*, 2002). Russian funding allowed the software to be adapted for use at naval bases and modified to the Russian language by Russian programmers and technical experts at the Russian Institute for Nuclear Safety (FFI, 2009).

On August 14th, 2000, a practice demonstration of the PICASSO system was held in Moscow and attended by AMEC principals, senior officials from the Russian and

Norwegian Ministries of Defence and the U.S. DOD, and the press (Ibid.). The finalized designs for the project's installation at Atomflot were reviewed at a meeting in Halden in May 2002. In November 2002, the Norwegian-Russian contract for the technical aspects and installation of the design was completed. On October 11th 2002, the installation contracts were signed. Following its September 2003 installation, the PICASSO system underwent a six-month trial operation period (Endregard *et al.*, 2003).

Project 1.5-1

To improve the safety of personnel, the local population, and the environment when handling and storing RW and SNF from decommissioned submarines, project 1.5-1 provided new radiation safety equipment to Polyarny Shipyard in the form of dosimeters for measuring and controlling radiation doses (FFI, 2009). After the project's approval in October 1997, Norway and Russia co-funded the purchase and installation of Russian-made thermo luminescence dosimeters, which were installed in 2002. The U.S. provided 107 self-reading DD-100 electronic dosimeters along with batteries and a computer for storage and processing of the dosimeter readings (Pomerville *et al.*, 2003). However, the employment of the U.S.-supplied dosimeters was delayed due to their not meeting Russian technical specifications, but the DOD was notified in July 2004 by a Russian representative to AMEC that the dosimeters were being utilized (GAO, 2004).

Project 2.1 and 2.2

Project 2.1 centered on choosing the best remediation technologies for the Arctic environment to aid in the clean-up of defense-related hazardous material spills, such as leakage from lead acid batteries and oil spills (Mærli, 2002). Technologies for the gathering and processing of non-radioactive ship waste were examined in Project 2.2. First, the existing waste problems, "clean ship" technologies, and approaches to waste processing aboard Russian naval vessels were assessed and evaluated. The project found Russian Northern Fleet ships discharge 250,000 gallons daily of wastewater. "Clean ship" technology was demonstrated in Project 2.2-1 through the experimental evaluation of an oily wastewater treatment system on board a Russian naval ship (Rudolph *et al.*, 2001).

Project 3.1

As a combination of AMEC Projects 1.3, 1.4, and 1.5, an "integrated radioactive waste management complex" (abbreviated PPP RAO from the Russian language) was provided to Polyarny Shipyard (Endregard *et al.*, 2003). Having dismantled one first generation nuclear submarine, the shipyard found all of its available storage for SRW to be full and began placing the waste in metal containers outside the pre-designated storage site, increasing the potential for environmental damage. With seven nuclear submarines awaiting defueling and dismantlement, AMEC decided to help (Griffith *et al.*, 2002). The PPP RAO integrated several AMEC projects to provide Polyarny Shipyard with a MPF for SRW, the PICASSO system for radiation monitoring, a MTF for LRW, and a Waste Storage Facility (Griffith *et al.*, 2003). The development, design, and installation of the projects were under separate U.S. and Norwegian contracts with the Russia contractor ICC Nuclide (FFI, 2009). The completed PPP RAO opened on February 26, 2004 (Bellona, 2004).

Project 3.2

Due to several reported pierside sinkings and losses in buoyancy of decommissioned submarines awaiting dismantlement, AMEC initiated its improving the buoyancy of decommissioned nuclear submarines project. To keep 17 decommissioned submarines from sinking, their ballast tanks were injected with polystyrene. In 2003, the project proposed infrastructure for the removal, reprocessing, and re-injection of Polystyrene. Having joined AMEC in June 2003, the U.K. took a project lead for the first time. Due to technical difficulties, a variety of methods for the removal of the Polystyrene had to be investigated (Rudolph, 2006). The implementation of the project was funded by the U.K. and used a Russian contractor (DTI, 2005). By 2006, a conceptual design, budget, and schedule were developed for a polystyrene filling plant and designs were underway for a polystyrene removal plant. In December 2006, designs for a polystyrene recycling plant were completed and procurement and installation was scheduled for summer 2007 (DTI, 2006). In 2007, equipment for the extraction of polystyrene was delivered and tested (BERR, 2007). In 2008, equipment for the recycling of extracted polystyrene into concrete construction blocks was provided in a refurbished building at Nerpa Shipyard (DECC, 2008).

Project 3.3

In August 2003, the Russian nuclear submarine K-159 sunk while it was being towed to its dismantlement location, claiming the lives of 9 sailors (Bellona-Jan1106). Initiated in response, the definition phase of the safe transport of decommissioned nuclear submarines project evaluated 28 different options for the safe transport of nuclear submarines to dismantlement sites and named 4 viable options (Rudolph, 2006). The U.K. took project lead and provided funding for the project (DTI, 2005). Under AMEC, Russia's Nerpa Shipbuilding and Repair yard built and tested four support pontoons capable of holding 200 tons each and balancing a damaged submarine in challenging weather and wave conditions. With separate funding from the Global Partnership Programme, testing of the pontoons was completed in October 2008 with the successful transportation of submarine 291 from Polyarny Shipyard to Nerpa Shipyard (DECC, 2008).

The second implementation phase of the project involved the safe transport of K-60, a Russian November class submarine, from the Russian naval base of Gremikha to Polyarny Shipyard for dismantlement. Though discussions within AMEC hinted that Norway sought to pull out after the completion of the project, Norway took technical lead on the project. Norway would fund the submarine's transportation which would employ a heavy lift vessel at a cost of $3 million, while Norway and the U.S. would equally contribute to the submarine's subsequent dismantlement estimated at $5 million (Digges, Jan. 2006). In September 2006, the transportation of the sub was successfully completed five days ahead of schedule (Digges, Sept. 2006).

Project 3.4

Funded jointly by the U.K. and Norway, the submarine dismantlement project would apply new techniques to reduce the amount of hazardous waste produced during the dismantlement of a nuclear submarine (DTI, 2005). The U.K. took the project lead, investigating alternative cutting techniques for submarine dismantlement which would improve operational safety and reduce environmental impact. The review of alternative techniques was completed in November 2006 and information gained was used by the Global Partnership project in the dismantlement of submarine 291 (DTI, 2006). Second, a dismantlement demonstration would take place at Polyarny Shipyard (Rudolph, 2006). Set to begin during 2006, the project would demonstrate technologies developed under AMEC's buoyancy, transportation, and waste management projects (DTI, 2005).

Project 3.11

In June 2007, AMEC undertook and completed a project involving a survey and environmental analysis of the sunken K-159 submarine. The evaluation involved an inspection at a depth of 238 meters of the hull and surrounding underwater environment to determine if the 800 kilograms of SNF inside the sub represented an environmental threat (Ponomareva, 2008). During the operation, cable and pipe debris were cleared to help prepare the submarine for salvaging in the future (BERR, 2007). In addition, AMEC found that there was no radioactivity leaking from the wreck and no technical barriers to the future recovery of the K-159 (Ponomareva, 2008).

3.2 Project Lessons

The success or non-success of the outcomes of each of AMEC's projects can be determined according to the five research criteria. Table 7 provides a summary of each project's performance with respect to the criteria. The table is qualitative. Others may disagree as to whether a project was a success or non-success according to the criteria. However, Table 7 provides a starting point for evaluating the lessons in international cooperation provided by AMEC.

Table 7. Evaluation of AMEC Projects based on research criteria

Project	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
1.1	+	–	+	+	+
1.1-1	+	+	+	+	+
1.1-2	–	+	N/A	N/A	–
1.2	–	+	N/A	N/A	–
1.3-1	+	+	+	+	+
1.3-2	+	+	+	+	+
1.3-3	–	+	N/A	N/A	–
1.4-1	+	+	–	+	+
1.4-2	+	+	+	+	+
1.4-3	+	+	+	+	+
1.5	+	+	–	+	+
1.5-1	+	+	–	+	+
2.1	+	+	–	+	+
2.2	+	+	–	+	+
3.1	+	+	+	+	+
3.2	+	+	–	+	+
3.3-1	+	+	+	+	+
3.3-2	+	+	+	+	+
3.4-1	+	+	–	+	+
3.4-2	+	+	–	+	+
3.5	+	+	–	+	+
3.6	–	+	N/A	N/A	–
3.7	+	+	–	+	+
3.8	+	+	+	+	+
3.9	+	+	–	+	+
3.10	+	+	+	+	+
3.11	+	+	–	+	+
3.12	+	+	–	+	+
3.13	+	+	+	+	+
3.14	+	+	N/A	N/A	+
3.15	+	+	+	+	+
3.16	+	+	N/A	N/A	+
+ = successful – = unsuccessful					

4 Discussion and Conclusions

4.1 Security vs. Sustainability

Though AMEC was formed to ensure the "sustainable use of the Arctic environment," the program's involvement with its member countries' militaries and radiological issues often put the program in a security context (Perry *et al.*, 1996). As the program aged and world's political situation changed, nonproliferation, threat reduction, and counter-terrorism became important goals of the program. Even the U.S. DOD listed the primary goal of AMEC not as sustainability, but as "to advance U.S. national security interests" (DOD, 1999). So what was the primary purpose of the AMEC program, sustainability or security?

The answer involves a close examination of the definition of the two terms. Though sustainability and sustainable development have several definitions, the most recognizable definition has to be the Brundtland definition. "Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (U.N., 1987). Likewise, Mitchell *et al.* described the sustainability concept as involving the four principals of futurity, equity, public participation, and the environment (Mitchell *et al.*, 1995). Porritt introduced the concept that sustainability is dependent on the maintenance of five capitals: natural, human, social, manufactured, and financial (Porritt, 2005). As described above, the many definitions of sustainability often incorporate three common components: the environment, society, and the economy. Giddings et al described the interaction of these three components with a visual representation shown in Figure 4.

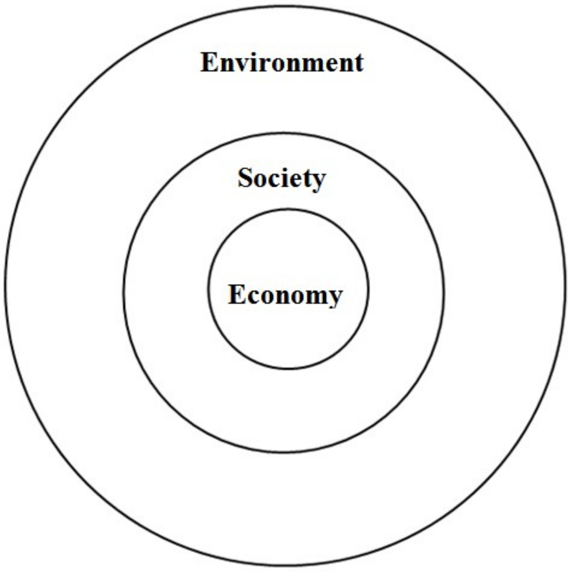

Figure 4. The three components of sustainability (Giddings *et al.*, 2002)

Like sustainability, the term security also has several definitions. Though the traditional idea of security was defined in purely military terms, its definition has expanded in recent decades. Mathews defines the broadening definition of national security as including environmental, demographic, and resource issues (Mathews, 1989). Ullman described threats to national security as events which: “(1) threatens drastically and over relatively a brief span of time to degrade the quality of life for the inhabitants of a state, or (2) threatens significantly to narrow the range of policy choices available to the government of a state or to private, nongovernmental entities (persons, groups, corporations) within the state” (Ullman, 1983). Like Mathews, Ullman’s definition includes environmental threats (environmental deterioration), demographic threats (wars, rebellions, terrorist attacks, and urban conflict), as well as resource threats (raw material shortage, boycotts, and blockades) (Ibid.). Similar to Porritt’s five capitals of sustainability, Buzan introduced the five sectors of security: military, political, societal, economical, and ecological (Buzan, 1991). The new understanding of security as a complex function of interrelated factors led to Westing’s suggestion that security is defined as both the prevention of armed conflict and the fulfillment of basic human needs and amenities, both of which are satisfied by environmental, economic and social factors (Westing, 1989).

Østreng combined the definitions of Matthews, Ullman, Buzan, and Westing to define the expanded definition of security as “extended” or “comprehensive security.” Østreng’s definition expands upon, in his view, the traditional interpretation of security in military and economic terms to include the environmental and demographic aspects of security (Østreng, 1999). As shown in Figure 2, Østreng’s visual representation of the interaction of the components of comprehensive security is not unlike Giddings’ sustainability definition in Figure 5.

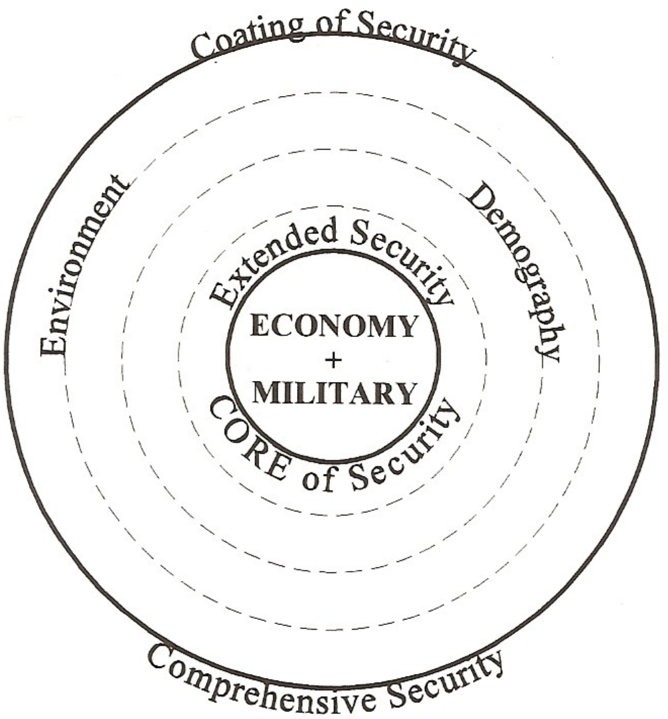

Figure 5. The three components of security (Østreng, 1999)

In response to the growing security concerns in the Arctic, on October 1, 1987, Mikhail Gorbachev, Secretary General of the Communist Party of the Soviet Union, delivered his famous “Pole of Peace” speech. The speech not only called for “a radical lowering of the confrontation level in the area,” but proposed to “let the northern part of the globe…become a zone of peace,” and “let the North Pole be a pole of peace” (NPA, 1987). Gorbachev’s comprehensive security concept for the Arctic included both military and non-military issues. The military security of the region could be maintained through the proposal of the establishment of a nuclear free zone and the restriction of military activities, while the civil (political) security of the region could be maintained through five non-military issues: joint utilization of natural resources, instituting a joint energy program for the northern region, cooperation on environmental protection and a joint environmental plan for the region, establishment of an international forum for scientific research, and the opening of the Northern Sea Route for international shipping (Ibid.).

At a public inquiry discussing Arctic issues following Gorbachev's speech, Audrey E. Granovsky, counselor for the Department of Arms Limitation and Disarmament in the Ministry of Foreign Affairs of the U.S.S.R., reiterated Gorbachev's view that "real security cannot be achieved by military means" (Granovsky, 1989). Granovsky described national security as a comprehensive and complex matter based on two principals. First, national security is an integral part of the security of others such that "no country can be more secure than others" (Ibid.). Second, security is achieved through international cooperation in solving common problems of a transboundary nature – "ecological, economic, social, humanitarian, etcetera." (Ibid.).

According to Gorbachev, the increased interdependence and complexity among states had created a need to develop a "comprehensive system of international security" based on a "mechanism capable of discussing common problems in a responsible way and at a representative level" (Gorbachev, 1987). Under this context, Gorbachev's view of comprehensive security extended beyond military matters to include economic, environmental, and social factors. With the added aspects to define security beyond pure military terms, the strategy for achieving security changed from one of opposition to cooperation. With this understanding, international cooperation became an integral and necessary measure to strengthen international security. In dealing with the security challenges posed by Russia's defense-related nuclear waste, international cooperation through programs such as AMEC became especially relevant and the only viable strategy to address the potential transboundary effects and associated challenges which defied unilateral solution.

As determined by the above discussion, having to choose the primary purpose of AMEC as either sustainability or security is unnecessary. In today's political climate and spheres of international cooperation, the goals of sustainability and security are both achieved through interactions in three common sectors: the environment, society, and the economy. With this new understanding, it is no coincidence that Ullman's 'alternate' conceptions of national security as involving limiting population growth, enhancing environmental quality, eradicating world hunger, and protecting human rights match up with the issues identified by the Johannesburg Declaration on Sustainable Development: natural resource depletion; environmental degradation; chronic hunger and malnutrition; intolerance and incitement to racial, ethnic, religious and other hatreds; and gender quality (Ullman, 1983 and World Summit, 2002). Nor is it a coincidence that Franklin Griffith's list of the different kinds of security (civil, collective, common, comprehensive, cooperative, cultural, demographic, ecological, economic, energy, food, global, human, military, national, personal, political, regional, shared, subregional, and environmental) lists terms which are used just as often in sustainability contexts (Griffiths, 1999).

Mathews explains the relationship of the three aspects of security and sustainability as "economic decline leads to frustration, resentment, domestic unrest or even civil war. Human suffering and turmoil make countries ripe for authoritarian government or external subversion. Environmental refugees spread the disruption across national borders." (Mathews, 1989) In simplified terms, security requires stability. However, stability can only be achieved through sustainability (the achievement of a steady state condition). Thus, sustainability can not exist without security and nor can security exist without sustainability. The inherently complex problems involving many independent, but interconnected variables in the realms of sustainability and security need to be embraced holistically with a systems approach and broad range of considerations. As apparent in Gorbachev's speech, the Arctic is no longer an isolated region and has long since been integrated into the national policies of the northernmost states and is now becoming an international policy dilemma. A system involving increased international cooperation based on the lessons of AMEC is required to maintain the security/sustainability of the Arctic.

4.2 Lessons in International Cooperation

By analyzing AMEC's efforts, successes, and failures to date, lessons in international cooperation can be derived and the major barriers to successful cooperation can be characterized.

4.2.1 Allow everyone to participate

In the field of international cooperation, it is extremely important to identify and engage all relevant parties in providing assistance. Too often key players are excluded and participating governments do not have the expertise needed. More specifically, because the Arctic is an international space, future cooperation and governance in the region should be expanded to include all nation states, not just Arctic rim states. When the success of AMEC led to increasing interest by other nations, the program remained open to outside assistance (Rudolph, 2006). With both Canada and Japan expressing interest in specific projects, an agreement by AMEC's member countries, referred to as "AMEC Plus," allowed other nations to contribute resources or technical expertise at the project level (Rudolph, 2003). If an interested nation wished to participate at a more formal level, they could be included in the AMEC Declaration, as the U.K. was in 2003 (Rudolph, 2006).

An additional AMEC project involved the scheduling and execution of a table top emergency exercise requiring the staging of a SNF accident in the Murmansk region for late 2004. The project was the first opportunity the DOE had to simulate a Russian nuclear submarine accident involving SNF. The exercise involved many participants including: the Russian Navy, emergency responders from several Russian organizations (Federal Agency on Atomic Energy, Ministry of Defense, and the Institute for Nuclear Safety), nuclear emergency management personnel from neighboring countries, and the International Atomic Energy Agency (GAO, 2004).

4.2.2 Develop adequate provisions for third party involvement

Once program goals have been identified, an effort should be made to discover where the program's relevant capabilities lie. Then, legal and other frameworks must be adjusted to make engaging these capabilities possible. Provisions are needed to give third parties—whether private businesses or non-governmental organizations the protections available under bilateral or multilateral agreements. These parties can bring both expertise and funding to bear in ways that may not be open to government actors.

One of AMEC's major challenges was Russian certification procedures. The responsibility for naval RW shifted from the Navy to Minatom in 1998. For awhile, there was confusion regarding which regulatory body, the Russian Nuclear Regulatory (GAN) or Minatom or both, was required to certify and license AMEC projects. The confusion contributed to the delay of certification and implementation of Projects 1.1 and 1.4 (Rudolph *et al.*, 2001). As of June 20th, 2000, the Russian government approved a decree that denied GAN the right to license "military application of nuclear energy" projects, thus, giving the responsibility for regulatory functions to Minatom. This arrangement would prevent independent insight into AMEC projects by allowing Minatom and the Defense Ministry to license itself or each other (Kudrik, 2000).

In Project 1.1-1, jurisdictional disputes between MOD GAN, the military regulatory authority, and Gosatomnadzor (GAN), the Russian civilian regulatory authority, concerning the different roles and responsibilities regarding the use of military and civilian equipment in the transport and handling of SNF, as well as, difficulties determining and acquiring all necessary Russian clearances and licenses for the pad's operation, delayed completion of the project by almost two years. As of 2006, the pad was still not in full production due to delays in receiving final documentation (Rudolph, 2006). Managed by the EPA at a total cost of $2.9 million to the U.S., the project was completed too late to aid CTR's dismantlement of ballistic missile submarines at Atomflot and instead will be used to store SNF from general purpose nuclear submarines (GAO, 2004).

However, before the responsibility had been sorted out in April 2000, licensing of the SNF casks in Project 1.1 was refused by GAN, who claimed Minatom and the Defence Ministry had conspired in fraud. Deputy Chairman of GAN, Aleksandr Dmitriev, called the casks unsafe, stating there was doubt whether "the casks under serial production can pass the same tests as the prototype" (Nilsen, 2000). GAN stated that without their certification use of the casks would be illegal. Yet, at a meeting of AMEC officials in Moscow in March 2000, the situation was discussed and the U.S. AMEC Program Director was told certification and funding would be given by Minatom in disregard of the GAN's objections. The Ministry of Foreign Affairs was tasked with adjudicating the dispute. In regard to nuclear liability, having proper certification of the casks was important to the U.S. to avoid economic responsibility for any potential accidents or damage involving equipment they helped produce or finance (Ibid.).

4.2.3 Use science to promote peace

The use of science as a tool of cooperation can not be underestimated and scientists have a valuable role to play in promoting international peace. International cooperation in science policy may be one of our most effective soft powers. Science and technology expertise is increasingly required for policy decisions regarding economic, environmental, and human security. Science is also inherently a collaborative field where interaction among individuals or states often leads to a sense of shared understanding. Any cooperation can build upon the already well established communication networks between international scientists. Scientific relationships have helped inform multilateral discussions, connect countries, present new opportunities, and provided access to the best researchers. Science is by is very nature an unbiased field, which if connected to policy and diplomacy, can help to overcome national interest.

AMEC's cooperation allowed a common understanding regarding the capabilities and limitations of Russia's nuclear waste management technology to be developed. When projects were selected and results were evaluated, AMEC exercised sound scientific principles and peer review. From the beginning, expert technical advice was obtained through the establishment of an international group of technical experts to consider ideas and develop an agenda for technical cooperation. By doing so, technical glitches in projects were kept to a minimum.

Though a goal of AMEC was to build nuclear waste management capacity in Russia, the sharing of knowledge by AMEC countries during the process helped improve the safety and efficiency of nuclear waste management in all countries involved and encouraged cooperation in outside fields. Through international technical and scientific knowledge sharing AMEC was able to create more advanced projects. For example, Project 1.5 combined the Norwegian software developed by Norway's Institute for Energy Technology (IFE) with Russian manufactured radiation sensors (terrestrial and underwater gamma detectors), smart controllers, and radio-modems for off-site transmission of data to ensure safer operation of a Russian naval base through early warning for accidents and radiation exposure monitoring allowing immediate preventative and emergency actions to be taken (Endregard *et al.*, 2003).

4.2.4 Insulate program goals from political goals

A high importance should be placed on keeping a clear separation between the cooperation's goals and outside political forces. The likely conflicting political goals of member nations can distract attention from the larger security/sustainability problems, as well as, endanger cooperation. However, at the same time, the cooperation's framework must allow for continued domestic political support in all of the states involved. If domestic governments stop making the program a top priority, officials may assume the goals of the cooperation are not important. Cooperations supported by strong international political agreements, especially those related to international treaties, have withstood the test of time. By maintaining strong and active political support of the domestic governments of the involved states, programmatic drift can be avoided and gains can be sustained. By maintaining long-term sustainability/security as the primary goal, distractions from or distortions of shared goals can be avoided.

The main reason for the U.S. linking AMEC with CTR in 1998 was the belief that AMEC would help speed up the decommissioning of nuclear submarines by providing much needed nuclear waste disposal capacity. Though CTR did provide much needed legal protection for AMEC, the linkage shows how the U.S.'s political interests in disarmament and non-proliferation outweighed its desire to provide environmental aid to Russia (Nyman, 2002). This linkage often weakened and led to questioning of U.S. involvement in AMEC. In September 2004, the U.S. Government Accountability Office released a report to the Congressional Committees entitled, "U.S. Participation in the Arctic Military Environmental Cooperation Program Needs Better Justification." The report evaluated AMEC's eight projects and found only one project (Project 1.1) aided the CTR program's goals of dismantling Russian ballistic missile nuclear submarines.

Many of the projects were implemented in locations where Russia subsequently decided to no longer dismantle ballistic submarines. Though AMEC's contribution to CTR was called into question, the report stated other benefits of the program. Almost all of the projects can be employed in the dismantlement of Russia's general purpose nuclear submarines and the program advances U.S. foreign policy interests and strengthens military-to-military cooperation with Norway and Russia (GAO, 2004).

On February 7th, 2007, the "observer" role of Norway was threatened when Ingerd Kroken, a Norweigian Ministry of Defense official and former AMEC project Co-chair, was not allowed to enter Russia and declared persona non grata by Moscow (Digges, Feb. 2007). Kroken was on her way to meetings in Moscow to discuss AMEC's successes and failures, as well as, an outstanding Norwegian grant of $10 million promised to AMEC (Digges, Apr. 2007). Having visited Russia more than 50 times, Kroken's travel documents were in order. The Russian Ministry of Foreign Affairs claimed border officials had turned Kroken away because they were not expecting her visit. Analysts and political experts hypothesized Kroken's non-entry may have been related to recent strained relations between Norway and Russia involving fishing, oil, and human rights issues (Digges, Feb. 2007). The situation became even more heated when Norway's press released an unsubstantiated report that Kroken was suspected of espionage involving the collection of Russian military information regarding nuclear submarine capabilities and trespassing on secret military territory (Digges, Apr. 2007).

Often during the sharing of scientific information, disputes arise regarding proper interpretation and use of the information. To combat misunderstandings, hard, clear, irrefutable scientific terms should be used in all state to state cooperation. By doing so, AMEC officials were able dismiss the accusations of the press and, by February 2008, relations between the four AMEC countries seemed to have returned to normal. Norway and the United Kingdom announced they would team up for the first time since the dissolution of AMEC to fund a project under the Global Threat Reduction Plan. The plan would involve the $7.6 million dismantlement of a Russian nuclear submarine (Digges, Feb. 2008).

4.2.5 Build capacity

When it comes to international cooperation, capacity building does not have to involve physical objects, though AMEC often did. When several countries are involved, capacity can be built through the improvement of communication networks, financial networks, administrative networks, technical programs, research programs, or infrastructure. Often times, the process used and the relationships established and knowledge shared during the process for building capacity will be more important than the product. By reinforcing Russia's nuclear waste management infrastructure, Russia can now better effectively direct and regulate its own nuclear waste program. The international cooperation under AMEC increased the country's capacity for nuclear waste management by improving Russian infrastructure through four basic steps.

First, the program encouraged scientific dialogue and technical training. As part of the demonstration phase of Project 1.3, Mega Tech Services representatives held a safety, maintenance, and operation equipment training course at RTP Atomflot for eight Polyarninsky shipyard representatives, including the Chief Engineer (Griffith *et al.*, 2003). In Project 1.5, Norway's funding contributed to the development of a prototype and software training for Russian Naval officers and programmers at IFE. In later stages of the same project involving the provision of dosimeters to improve radiation safety at Russian naval facilities, the U.S. and Norway held operation and maintenance training courses for Russian Naval radiation experts. In addition, procedures and regulations regarding the operation of the dosimetric system were developed and implemented (FFI, 2009).

The second step in capacity building for AMEC was collaborative research, analysis, and concept development. In March 1999, an AMEC Project Officer meeting was held in conjunction with Waste Management '99 Conference in Tucson, Arizona to discuss implementation options for Project 1.3 and allow Russian Ministry of Defence (MOD) and technical representatives to speak with and observe the products of U.S. technology developers (Griffith *et al.*, 2001). A mobile facility made up of eight modules was found to meet the required technology and design specifications (Griffith *et al.*, 2002). A Norwegian and Russian team named Storvik & Zvezdochka developed the design for the MPF, which included optional features requested by the Russian Navy

(Griffith *et al.*, 2002). Discussions during a trilateral Project Officers meeting held in Moscow in May 2000 further refined the scope of the MPF (Griffith *et al.*, 2001). For a project to receive design approval in Russia a Russian Statement of Work document called a Technicheskoye Zadaniye (TZ) must be approved. The TZ for the MPF was developed with input from the U.S., Norway, and Russia and final approval was achieved in fall of 2001 (Griffith *et al.*, 2002). According to an AMEC program manager, Project 1.3 allowed Russian representatives to observe western business practices and improved techniques for contract management (GAO, 2004).

The third step was technical collaboration and experimentation. In Project 1.1-1, the storage pad's design, physical protection, material accounting, and control were reviewed and finalized by a joint Norwegian, U.S. and Russian team (Dyer *et al.*, 2003). The testing of equipment in Project 1.3 was carried out by the U.S. Army Corps of Engineers at their Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH where the tests were videotaped and incorporated into a final report to be reviewed by the Russian Navy (Griffith *et al.*, 2001). During Project 3.11, the U.K. provided an operating platform (NATO Research Vessel Alliance), a remotely operated vehicle, and funding for radiation survey equipment from the Kurchatov Institute (BERR, 2007).

The fourth and final step was accomplished through implementation and operation. The capacity building will be even more effective if through the process new knowledge or technology can be produced, which was often the case in AMEC. The full-scale production of the containers produced through Project 1.4 could contribute to not only improving the storage and transportation of SRW in Russia, but also in others countries. The containers developed were the first and only low-level SRW transportation containers in Russia fully certified to meet Russian GOST requirements, which are equivalent to IAEA and U.S. standards for Type A containers. With all 400 containers shipped to Polyarninsky Shipyard in 2003, the containers can now aid in safely and securely storing approximately 1,000 cubic meters of Russia's SRW, assisting the creation of a self-sustaining waste management infrastructure in Russia (Petrushenko *et al.*, 2002).

4.2.6 Back with real funding

Though obtaining a commitment from nation states to cooperate on an international level is difficult, obtaining funding for the projects the cooperation then carries out is far harder. All parties must agree that the problem is important enough to put their money where their mouth is. After the signing of the Declaration, the three countries pledged 2 million dollars to fund six pilot projects over a three year period (Kaiser, 1996). For specific AMEC projects, written mutual financial agreements would be signed (Perry *et al.,* 1996). The funding then must be sufficient enough to accomplish the project's goals. Though AMEC operated on a relatively small budget of 4-5 million dollars per year, the budget allowed for technology demonstrations and the development of prototypes which then could be further developed and implemented using other funds (Rudolph *et al.*, 2001). The funding should be regulated with an appropriate funding mechanism in which funding is project dependent rather than time dependent. Too often funding is pulled because a project takes longer than expected, even though a late project completion would be better than no project at all. Instead, allocate funding based on project milestones where funding commitments are linked to project organization and clear goals.

While several countries may provide funding for a single project, the state that owns a commitment to completing the project is the most likely to provide necessary funds and continue funding it over an extended period of time. To ensure state ownership, AMEC involved all member nations in early discussions regarding each project and designated one country as project lead for each project. After joining AMEC in 2003, the U.K.'s funding increased rapidly as they took project lead for the first time over the buoyancy of decommissioned submarines and safe transport projects (DTI, 2005)

From fiscal year 1997 to when the U.S. left AMEC in 2006, the U.S.'s overall contribution to the program decreased. As the projects the U.S. was funding neared completion and other AMEC member states increased their contributions, U.S. assistance began to decline. As Figure 6 shows, U.S. contributions peaked near $6 milllion in fiscal year 2001 as large scale projects such as the SNF container and storage pad were being put into implementation. After fiscal year 2001, U.S. funding declined until only $1.42

million was allocated by the DOD in 2006 (DOS, 2009 and NTI, 2004). Soon after 2001, AMEC program officials began to realize the U.S. was carrying a large share of the burden of funding AMEC and it was endangering the program. An announcement was made for future plans for the member countries to share equally in project costs. However, by then it was too late. In 2004, the U.S. AMEC officials had promised a maximum of $3 million annually for fiscal year 2006 to 2011 (GAO, 2004)

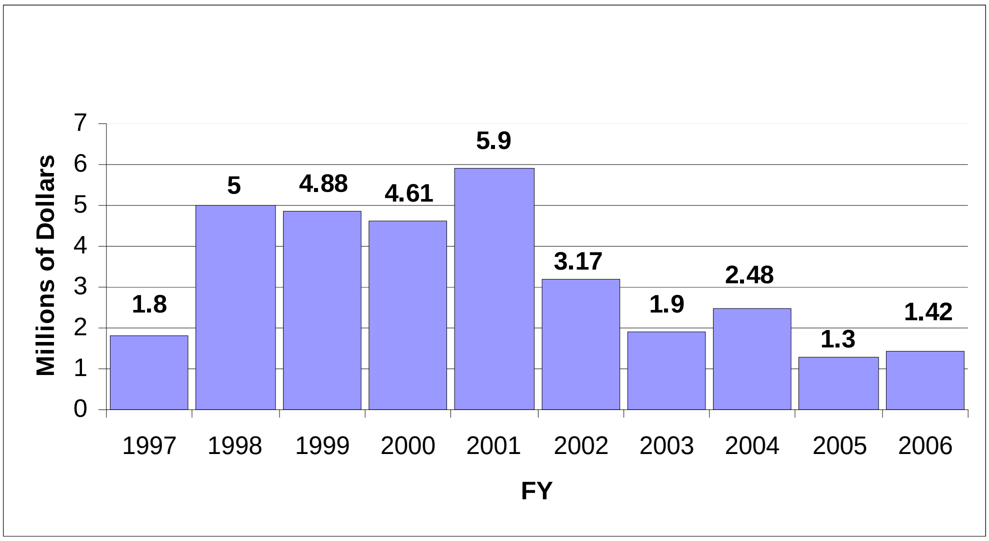

Figure 6. U.S. Contributions to AMEC, FY 1997-2006 (DOS, 2009 and NTI, 2004)

Though US funding was declining after 2001, other countries, most notably the U.K., stepped in to take the U.S.'s place. By providing a large amount of funding and asserting their power within the program, the U.K. slowly began to alienate the U.S. and Norway, which eventually led o their decision to leave the program in 2006. The U.K.'s contributions to AMEC were included within the country's funding of projects in NW Russia under the Global Threat Reduction Program (GTRP). The U.K.'s contributions to NW Russia under the GTRP from 2002 to 2008 totaled approximately $86 million. A yearly breakdown of the funding is provided in Figure 7. As can be seen in the figure, the U.K.'s funding increased from $0.64 million in 2003 to $16.52 in 2004 due in large part to the U.K.'s entry into AMEC (DECC, 2008).

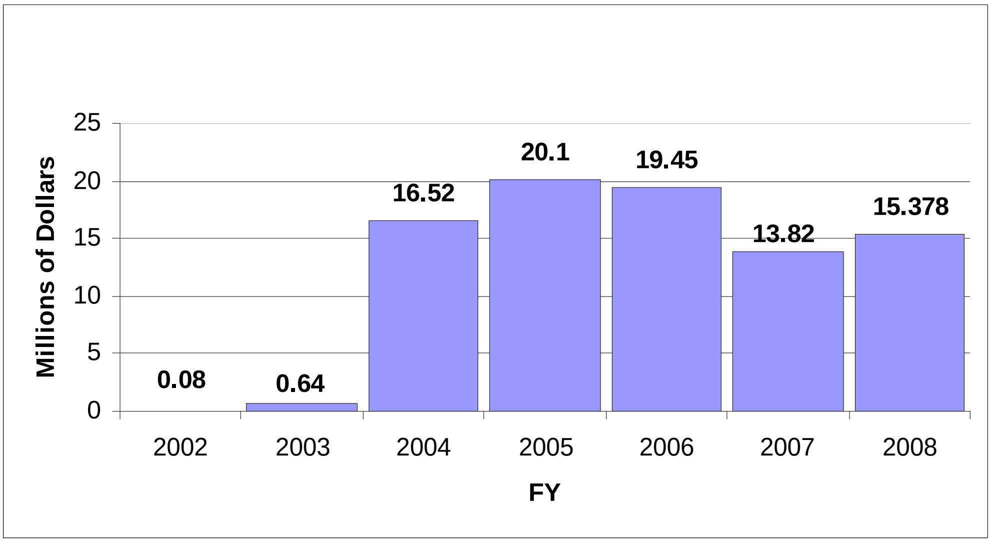

Figure 7. U.K. Contributions to NW Russia under the GTRP, FY 2002-2008 (DECC, 2008)

By 2002, approximately $41.5 million in funding had been provided to AMEC since its inception. The U.S. contributed over half with a total contribution of $25 million, while Norway contributed $10 million and Russia $6.5 million. Figure 8 depicts a percentage breakdown of these contributions (Digges, 2002).

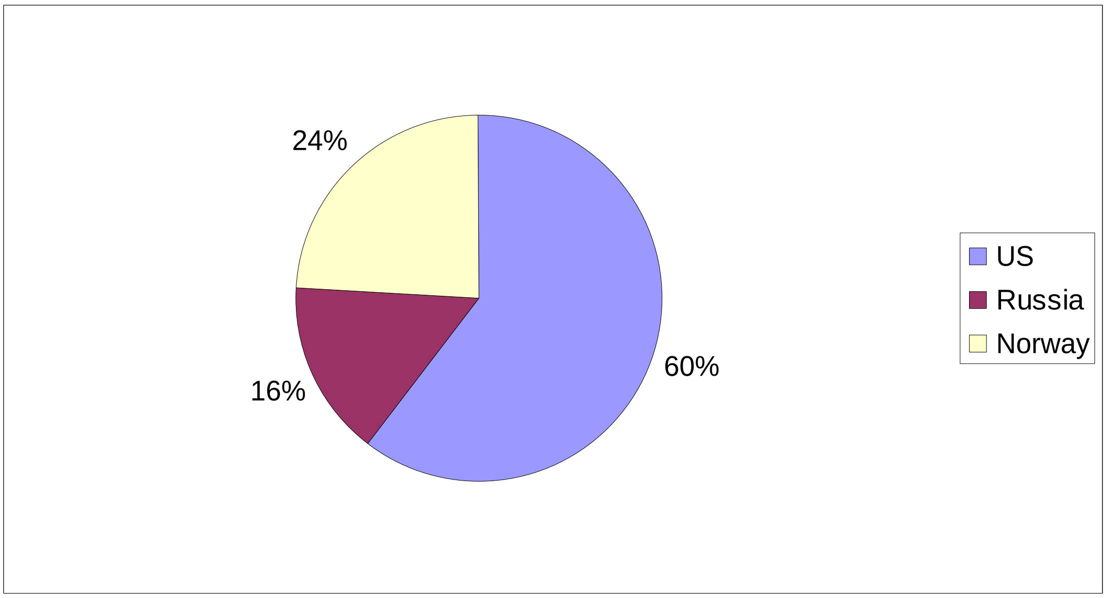

Figure 8. AMEC Member Countries Contributions, FY 1997-2002 (Digges, 2002)

By April 2004, approximately $56 million had been contributed to AMEC by its member countries. The U.S. had provided the most funding of any member at around $31 million. Of that $31 million, the DOD contributed the majority at $28 million, while the DOE and EPA provided around $2.6 million and $200,000, respectively. As Figure 9 shows, the other member states contributed as well with Russia contributing about $13 million, Norway contributing $12 million, Russia contributing $13 million, and the U.K. had contributing $100,000 since its recent joining of AMEC. The U.K.'s contribution was not depicted on Figure 9 because it was less than 1% (GAO, 2004).

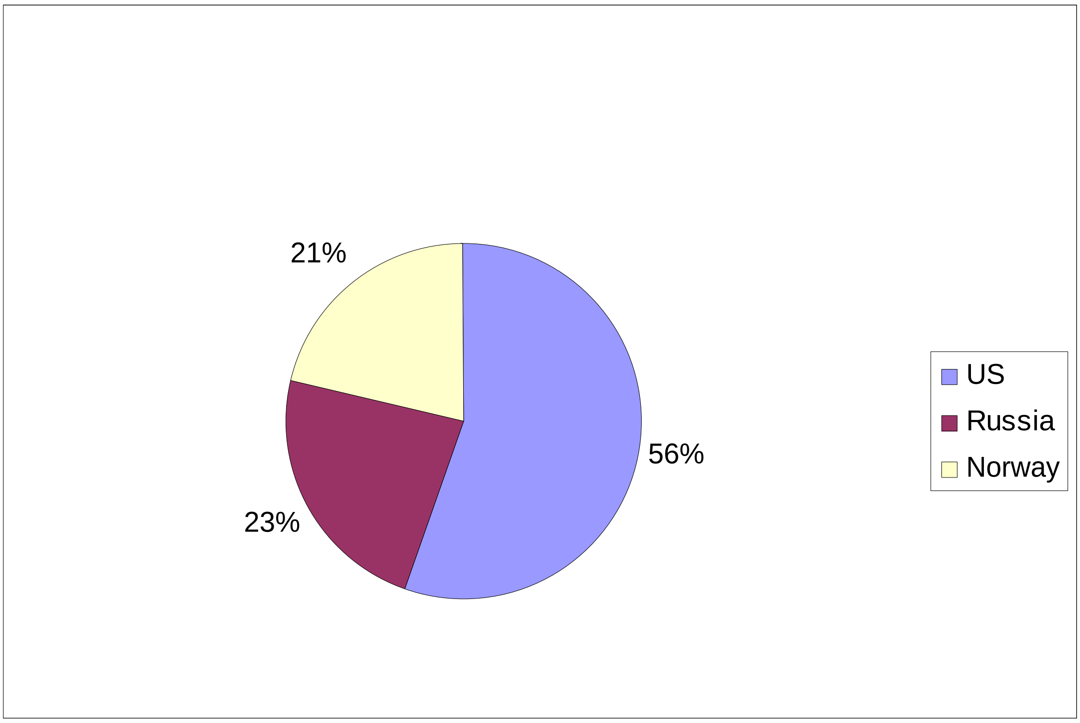

Figure 9. AMEC Member Countries Contributions, FY 1997- April 2004 (GAO, 2004)

Between fiscal years 2003 to 2007, over $17.5 million was contributed to AMEC. The U.S. contributed $7.1 million to AMEC (DOS, 2009 and NTI, 2004). During the same period, the U.K. contributed £3.64 million which using a historic exchange rate of 1.83 is equivalent to $6.64 million (G8, 2008). Likewise, Norway contributed €3.2 million which using a historic exchange rate of 1.25 is equivalent to $4 million (G8, 2007). Data on Russian contributions to AMEC during the same period were unavailable.

Figure 10 provides a percentage breakdown of these amounts. As can be seen in the figure, the U.K.'s contributions almost equaled those of the U.S. In comparison to Figure 9, the U.S. percentage of contributions had decreased while Norway's stayed about the same and U.K.'s increased from 0% to 37%.

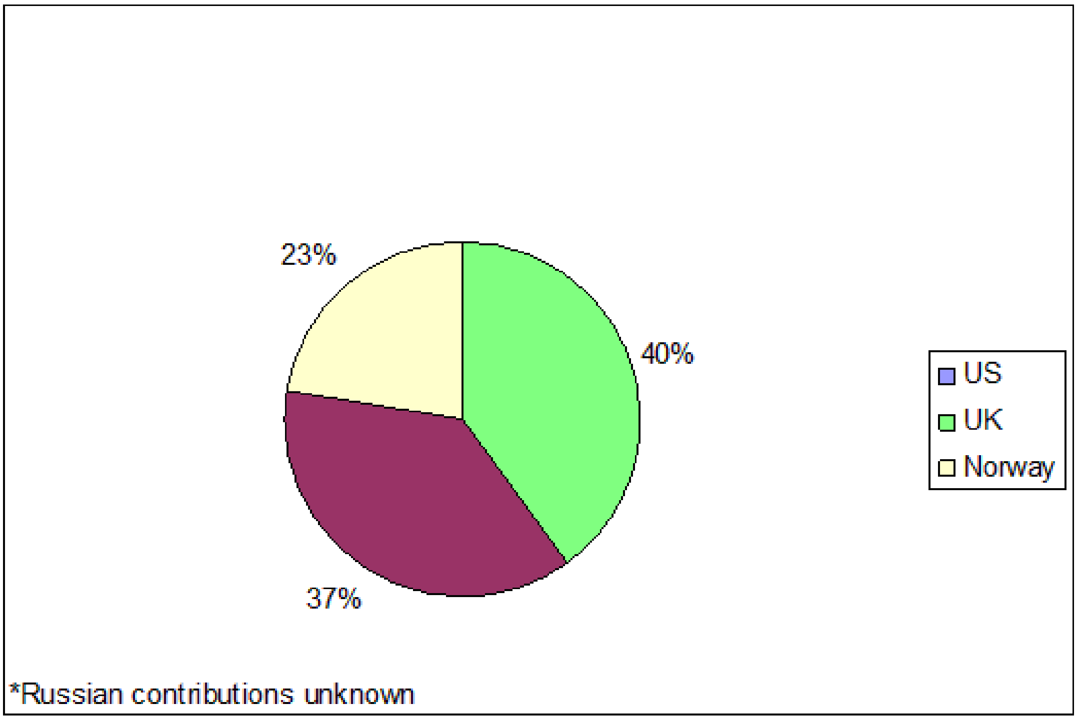

Figure 10. AMEC Member Countries Contributions, FY 2003- April 2007 (DOS, 2009; G8, 2007; G8, 2008)

4.2.7 Develop a clear legal framework

In international cooperation, a common legal agreement is necessary to standardize the terms and conditions of implementation, especially when projects are involved. The inability to develop an umbrella legal agreement for AMEC's projects was particularly problematic. AMEC suffered repeated delays due to its lack of an overarching legal framework. Despite ongoing negotiations, a legal framework for the program was never established (Rudoplh, 2006).

A trilateral legal agreement was proposed in 1999, but was not put into practice due to liability, access, tax, and status of personnel issues (Rudolph *et al.*, 2001).

Nonetheless, U.S. AMEC officials continued to work among the AMEC member countries to achieve a liability agreement until 2002 when the State Department, seeking to obtain a broader liability protection agreement with Russia for several U.S. programs, suspended AMEC's negotiations (GAO, 2004). Instead, the necessary legal coverage for projects was provided through bi-lateral legal agreements, which negatively impacted costs and schedules (Rudolph, 2006). The lack of liability protection not only hindered member state's participation in AMEC, but also meant any contractor and their employees could be held financially responsible for accidents involving AMEC projects during or after construction (GAO, 2004).

The U.S.'s interaction with Russia fell under the CTR Agreement, while the Norway – Russia Framework Agreement was used by Norway (Rudolph *et al.*, 2001). Formed in 1991 by the U.S. Congress to aid the Soviet Union in arms reductions, the CTR Program was linked to AMEC by U.S. authorities in 1998. With the goal of scrapping 30 Russian ballistic missile submarines by 2001, the CTR Program provided AMEC with much needed funding and indemnification from liability (Honneland *et al.*, 2002). Under the CTR, the U.S. could only contribute financially to projects directly associated with Ballistic Submarine dismantlement, which did not include liquid waste (Project 1.2) or nonradioactive waste (Project 2.1 and 2.2) projects. In addition, Congressional mandate prohibited the U.S. from being involved in remediation activities in Russia. Norway had to take the lead and fund AMEC's liquid and nonradioactive waste projects while the U.S. found and obtained the required legal coverage to participate (Rudolph *et al.*, 2001). In AMEC Projects 3.2 and 3.3, the U.S., protected by the United Kingdom's bilateral agreement with Russia, provided funding for both project's preliminary planning, but had to withdraw funding from later stages of the projects due to liability concerns (GAO, 2004). In 2002, the U.S. State Department had suggested the U.S. pull out of the cooperation due to the lack of an umbrella agreement on tax and liability issues, even after several years of negotiations. Without U.S. involvement in AMEC, Norway stated they would leave the cooperation as well (Nilsen, 2002). Norway did not establish a liability agreement with Russia until May 1998, which severely limited Norway's initial contributions to AMEC (GAO, 2004). The Norway –

Russia Framework Agreement allowed Norway to participate financially in projects involving SNF and liquid and solid waste.

4.2.8 Incorporate transparency and accountability

In order to have successful cooperation on an international scale, it is vital to incorporate transparency and accountability in to every engagement and seek to improve the accountability and reporting practices throughout the lifetime of that cooperation. With adequate transparency and accountability, a project appears more flexible and less adversarial. Access must be given to all donor countries prior to, during, and after project implementation, and with regard to openness in financial transactions. Transparency can help each side understand the other's (non-offensive) nuclear intentions, through knowledge of each side's processes and capabilities.

An important challenge for AMEC was the lack of full financial transparency by the Russian contractor Nuklid, employed by Minatom. Highly controversial in Russia and Norway, Nuklid's involvement with Norway led to slow to develop projects and many bureaucratic obstacles which often put project plans in jeopardy. Prevented from viewing the accounting for projects, Norweigian officials were concerned by Nuklid's unwillingness to use tenders when signing contracts. When combined with the licensing dispute, the situation brought to the attention of Western donors the importance of insisting on financial transparency, effective use of funds, and independent civilian agency review of nuclear projects (Kudrik, 2000).

4.2.9 Beware of setting bad precedents

Every international cooperation program sets a precedent for future programs and program participants. As more states become involved in international cooperation, they will certainly analyze past programs and continue to observe new developments. When shortcuts are taken to satisfy immediate aims rather than taking the more time intensive paths required for a more sustainable future, poor examples are often set. AMEC set a bad precedent regarding its trilateral legal agreement when Norway and the U.S. issued ultimatums to Russia regarding the need for an agreement, but then allowed work to continue on existing projects after the ultimatum's deadline had passed. The precedent not only set a bad example for future international legal agreements, but it also hindered the effectiveness of AMEC's projects. The lack of an umbrella agreement was also a significant contributor to the U.S. and Norway's decisions to leave AMEC in 2006. Such behavior not only endangered AMEC, but could have also made it more challenging for other programs to insist on multilateral legal agreements in the future.

AMEC set another bad precedent when Project 1.1 began serial production of its SNF casks before obtaining the proper licensing and certification (Nilsen, 2000). In regards to the bigger picture, it is very important not to run programs before regulations are codified or plans are approved. Not only did it lead to disputes in AMEC's case, but it can also lead to unsafe practices. However, AMEC set many good precedents as well by being very careful about the decisions made in the running of each and every program, setting careful objectives, making and fulfilling clear commitments, and being mindful of sustaining the main goals from the beginning of the planning of projects to their completion and implementation.

4.2.10 Expand upon successes

The sign of a successful cooperation is being able to expand upon ones successes. AMEC was able to take advantage of its small achievements and turn them into something more. For example, in Project 1.5, the installation of PICASSO at Atomflot went so well that it was also later installed at Polyarny Shipyard as part of an "integrated radioactive waste management complex" combining several AMEC projects (Endregard *et al.*, 2003). Completed in 2008, AMEC produced a "guidance document" for the international marine transportation and salvage community on how to safely transport decommissioned nuclear submarines based on their experience and lessons learned. Set to finish by late 2009, AMEC's "Radioactivity in the Marine Environment" project aims to create internationally recognized protocols, which will be used to educate the international salvage community on how best to handle radioactive contamination at sea (DECC, 2008).

In November 1998, AMEC's successes led Russia to request a Pacific Military Environmental Cooperation (PMEC) based on AMEC and leveraging its successes and lessons learned to address defense-related environmental problems in Russia's Far East

(GAO, 2004). With 50% of Russia decommissioned submarines located in the Western Pacific and presenting potential cross-border contamination problems, support grew among the current member countries to expand the program's geographical area to Russia's Far East (Rudolph, 2003). However, a new and separate administrative structure needed to be established so as not to dilute AMEC's current resources and funding (Rudolph, 2006). Seventeen technical cooperation projects were proposed for PMEC (GAO, 2004). Projects would address the same radioactive and nonradioactive program areas of AMEC and would begin as a bilateral cooperation between Russia and the U.S. with intentions of involving other nations with an interest in the region such as Japan, Korea, China, and others (Rudolph *et al.*, 2001). In 1999, the U.S. DOD promised 8 million dollars in funding for PMEC for fiscal years 2001-2004 (Rudolph, 2003). In 2002, AMEC requested the Defense Appropriations Bill set aside $25-30 million for fiscal years 2003-2008 to fund PMEC (Digges, 2002). However, after review by the DOD of the condition of the Russian submarines in the Pacific, their associated environmental impact, and Japan's announcement that they had no plans to join the U.S. in a "technology development program," the necessity for a Pacific program waned (GAO, 2004). As of September 2004, Congress had yet to approve the funding and, instead, most of the proposed projects are being undertaken through the G-8 Global Partnership (Ibid.).

4.2.11 Bring leaders together as often as possible

Communication and mutual understanding are intrinsic to successful international cooperation. Success is often dependent on strong personal relationships which can take years to develop. By maintaining a consistency of personnel, AMEC was able to build strong relationships. AMEC also proved that military to military cooperation could work on an international stage for peaceful purposes. The military to military cooperation promoted by AMEC not only allowed military personnel from the U.S., Norway, and U.K. access to Russian naval facilities that had previously been off limits, but in doing so, enable AMEC to better understand the environmental conditions and which technologies are most needed to aid in dismantling efforts. The culture of trust which developed between the respective militaries was found to be one that could not be easily supplanted by civilian contract work, as found by the U.K.

To aid in the formation of trust, confidence, and mutual understanding between AMEC's member states respective militaries, AMEC brought the leaders from the different nation states together to the same location at least once annually for the AMEC Principals Meeting. However, the location was varied among the member states so as to create an equal playing field. By maintaining a consistency and standardnization of communication, the task of bringing military or civilian leaders together becomes easier, as does maintaining commitment from the highest levels on all sides. Table 8 lists the date, location, and purpose of each meeting of AMEC officials for which records could be found. According to the data, though the cooperation began in 1996, regular meetings were not held until 1999. As projects began nearing completion around 2001 and the future of the program came into question, the frequency of meetings increased. By increasing communication and sharing their respective views, the military leaders of AMEC were able to extend AMEC operation beyond the original deadline of 2002.

Table 8. Meetings of AMEC officials

Date (Source)	Location	Purpose
March 1999 (Griffith *et al.*, 2001)	Tucson, Arizona	AMEC Project Officer meeting held in conjunction with Waste Management '99 Conference in to discuss implementation options for Project 1.3 and allow Russian Ministry of Defence (MOD) and technical representatives to speak with and observe the products of US technology developers
September 20-23, 1999 (Rudolph *et al.*, 2001)	Edinburgh, Scotland	4th International Conference on Environmental Radioactivity in the Arctic
October 1999 (Kudrik, 1999)	Izhora plant near St. Petersburg	Prototype cask was presented to the press at a meeting of AMEC officials
May 2000 (Griffith *et al.*, 2001)	Moscow	Trilateral Project Officers meeting – refined scope of MPF SRW being developed in Project 1.3
August 14th 2000 (FFI, 2009)	Moscow	Practice demonstration of the PICASSO system attended by AMEC principals, senior officials from the Russian and Norwegian Ministries of Defence and the U.S. Department of Defense, and the press
August 14th 2000 (FFI, 2009)	Moscow	Practice demonstration of the PICASSO system attended by AMEC principals, senior officials from the Russian and Norwegian Ministries of Defence and the U.S. Department of Defense, and the press
April 26-27, 2001 (Engle, 2001)	Norfolk, Virginia	AMEC Principals meeting
August 20th, 2001 (Forsvarsdepartementet, 2001)	Svanhovd Ecological Center in Kirkenes	AMEC Steering Group meeting
April 15th-19th, 2002 (News, 2002)	Bodo, Norway	AMEC Principals meeting
June 26-27th, 2003 (DOD, 2003)	Old Royal Navy College in Greenwich, U.K.	AMEC Principals meeting
November 24, 2003 (MOD, 2003)	Moscow	Meeting of Norwegian and Russian Defence Ministers
April 28-30th, 2004 (Kroken, 2004)	Longyearbyen, Svalbard	AMEC Principals meeting
November 2005 (Bellona, 2007)	Devonport, Plymouth, UK	AMEC Principals meeting
October 2006 (DTI, 2006)	Polyarny Shipyard 10 in Murmansk	AMEC Principals meeting
September 2007 (Bellona, 2007)	Devonport, Plymouth, U.K	AMEC Principals meeting
June 2008 (Digges, June 2008)	Zvedochka	AMEC officials meeting

4.2.12 Be Flexible

The successful decade long cooperation between AMEC's founding members was highly dependent on the program's ability to adjust to a new political situation. After September 11, 2001, AMEC was still needed, its goals just needed to be expanded and redirected. The terrorist attack on the world trade center indentified new risks and threats. No longer were decommissioned nuclear submarines just an environmental risk. They became a terrorist target for the "diversion and theft of fissile and highly radioactive materials" (Rudolph, 2006). As terrorist targets, the chance of cross-border contamination from an accident involving substantial amounts of neglected and unprotected RW and SNF increased. In June 2002, "The Global Partnership Against the Spread of Weapons and Material of Mass Destruction" by the G8 countries provided $20 billion in funding over a ten year period to address counter-terrorism, nonproliferation, disarmament, and nuclear safety issues. The "Global Partnership" identified nuclear submarine dismantlement in the former Soviet Union as a top concern and priority (Ibid.).

In response to September 11th and the "Global Partnership," AMEC developed a new Strategic Program Plan that reaffirmed the objectives of the AMEC Declaration and took into account the emerging global threats and risks presented by decommissioned Russian nuclear submarines (Ibid.). In May 2004, a draft of the strategic plan was developed (GAO, 2004). In addition to collaborative research and technology demonstration regarding the environment, the new plan encouraged cooperation in environmental security, non-proliferation, and threat reduction. Focus was placed on four specific areas of cooperation: "nuclear security issues in support of the G8 Global Partnership priorities; nuclear submarine dismantlement and issues associated with decommissioned military nuclear-powered vessels; management of hazardous waste generated as a result of military activities; environmental sustainability, safety and security." With nuclear security, submarine dismantlement, and hazardous waste management occupying the program's top priority up to 2010, significant advances were planned to be made in technology, infrastructure, and the nuclear submarine dismantlement program to improve the security of Russia's RW and SNF (Rudolph, 2006). Since the plan included improving the security of Russian nuclear submarine bases and SNF, the U.S.'s policy of not providing security-related assistance to active Russian military sites that may hold nuclear weapons was called into question (GAO, 2004). Between 2010 and 2015, AMEC was to focus on the safety, security, and environmental sustainability of defense-related activities in the Arctic (Rudolph, 2006).

In June 2008, Russia and the U.K.'s involvement in AMEC reached a new milestone with the announcement that Russia was offering to dismantle 11 of the U.K.'s decommissioned nuclear submarines at Zvedochka Shipyard. Before this time, all of AMEC's projects dealt with nuclear waste and submarine dismantlement problems originating in Russia. Earlier in the month, AMEC officials met in Zvedochka to discuss the project. The project represented the first time Russia has reciprocated any of the aid it has received through AMEC. Though Russia's main contribution to the project would be the experience of Zvedochka engineers, Russia even offered to fund part of the dismantlement costs. Funding by Russia would represent a major policy advance for AMEC, making Russia a full-fledged participant in the cooperation rather than just a beneficiary. If it reaches fruition, the project would involve the transport of 11 submarines from the U.K. to Russia, their subsequent dismantlement, and the transport of their hermetically sealed reactor compartments back to the U.K (Digges, June 2008).

4.2.13 Avoid fixing problems that do not exist

At the June 2003 meeting of AMEC Principals, the U.K. was formally inducted into AMEC on June 27th during a signing ceremony aboard the Russian warship Neustrashimiy ("Fearless") anchored in the Thames River (DOD, 2003). According to the then British Secretary of State for Trade and Industry, Patricia Hewitt, though the U.K's reasons for joining AMEC focused on achieving military-to-military cooperation, environmental, and proliferation benefits of helping Russia to safely dismantle nuclear submarines and store their SNF, AMEC also provided "future business opportunities for U.K. companies with nuclear cleanup experience" (Digges, 2003). According to Alan Heyes, chief of the U.K.'s Department of Trade and Industry (DTI), the U.K. joined AMEC in 2003 to strengthen the U.K.'s military contact with Russia. Referring to AMEC as an "excellent program," he also said the U.K. "joined because of…G-8 Global Partnership commitments" (Bellona, 2006).

After it joined AMEC, the U.K. proposed new procedures which were accepted on a trial basis by the other member states (Ibid.). However, the U.S. and Norway felt the new procedures were lacking in flexibility. Then, at a meeting of the AMEC principles in Plymouth in November 2005, the U.K. presented a paper entitled "AMEC — Napoleonic Bureaucracy or Effective Collaborative Delivery Programme?" The paper criticized the U.S. and Norway for hold-ups, inefficiency, and safety issues within the AMEC program and presented a "series of recommendations." Feeling the U.K. was ignoring AMEC's successful track record and proven approach, the U.S. and Norway were surprised and slightly angered by what they considered an attempt by the U.K to assert control over AMEC. In addition, the paper continued to support the U.K.'s controversial employment of a private contractor, RWE NUKEM, as an AMEC project manager, a post held by a government representative in the other three countries. The U.S. and Norwegian officials considered the U.K.'s insistence on using commercial contractors a breach of AMEC's military to military philosophy that threatened to alienate Russian military officials whose delicate trust took years to develop (Bellona, 2007). Following the meeting, the U.S. and Norway both announced potential plans to leave the cooperation. In response to the wavering commitments of Norway and the U.S., the U.K. announced in January 2006 that if the two countries were to leave the cooperation, the U.K. would complete any unfinished projects and consider welcoming Canada and Sweden into AMEC. When asked their opinion about the potential change in AMEC partner countries, Russian officials said they would express no concern as long as funding continued to arrive (Bellona, 2006).

Coinciding with AMEC's 10-year anniversary, AMEC's principals met at Polyarny Shipyard in Murmansk in October 2006 (DTI, 2006). At the meeting, the future role of the U.S. and Norway in AMEC was discussed. The outcome was the official removal of the U.S. and Norway as participatory members of AMEC and both countries relegation to "observer" status. Leaving civilian agencies to overtake their responsibilities, the U.S. and Norway referred to the program as complete and "a success" (Digges, Oct. 2006). By fostering trust and permitting access to otherwise restricted locations, the "strong and time-tested military to military relationship" of AMEC allowed for large strides to be made in multi-lateral nuclear disarmament (Ibid.).

As “observers,” the two countries would be allowed to attend AMEC principal meetings and express their opinions, but they would no longer financially sponsor projects or have any binding input. The change left AMEC as a bilateral cooperation between Russia and the U.K (Ibid.).

4.3 Conclusion

This research examined the transboundary issues, significance, and environmental impacts of radioactive waste on the Arctic, as well as, the organization and initiation of projects to address these issues under AMEC. By analyzing AMEC’s efforts, successes, and failures to date, lessons in international cooperation can be learned and the major barriers to successful cooperation can be characterized. The establishment of the Arctic as an international space by the Law of the Sea Convention opens the opportunity for international cooperation in the region. Thus, the dynamic in the Arctic must change from one of national focus to international focus. Any discussions must incorporate the new concepts of security and sustainability which address the transboundary issues of the environment, society, and the economy.

International cooperation will be necessary to ensure the sustainable and responsible development of Arctic resources and protection of the Arctic ecosystem. Future decisions in the region will be the product of the relationships which are built today. Strategies and frameworks for cooperation based on common interests should be developed now to reduce or prevent potential international discord. These relationships will be needed to convey common views on the global implications of Arctic events. A system involving increased international cooperation based on the lessons of AMEC is required if the sustainability and security of the Arctic is to be maintained.

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