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THESIS

EVALUATION OF MODERN NAVIES' DAMAGE CONTROL AND FIREFIGHTING TRAINING USING SIMULATOR PLATFORMS

by

Georgios Varelas

September 2011

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Modern navies have faced new roles and challenges during the last decade. From purely defensive responsibilities, modern navies have now taken on such multiple challenges in the worldwide theater, as peace keeping missions, humanitarian assistance, anti-piracy support, disaster assistance and others, both military and sociological in scope. Furthermore, the increasing complexity of these missions mandates a strong, constant operational readiness and a high level of performance in the full spectrum of a ship's activities. In order for these missions to be accomplished successfully, survivability is the foremost concern, and the cornerstone of survivability is damage control. Permanent, continuous and high-level damage control and firefighting training for all crewmembers of a navy ship is paramount. Hopefully, this training can be achieved safely, efficiently and economically by using simulation and training simulator platforms, which have dominated the training field in the last few decades. After participating in "damage control" and "firefighting" courses, investigating the main training system components, and administering surveys to instructors and students regarding subjective ratings and opinions about the training system, we found that the U.S. Navy Damage Control & Firefighting Training at San Diego location is very effective, valuable, and beneficial to ships crews and the U.S. Navy.

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EVALUATION OF MODERN NAVIES' DAMAGE CONTROL AND FIREFIGHTING TRAINING USING SIMULATOR PLATFORMS

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requirements for the degree of

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Modern navies have faced new roles and challenges during the last decade. From purely defensive responsibilities, modern navies have now taken on such multiple challenges in the worldwide theater, as peace keeping missions, humanitarian assistance, anti-piracy support, disaster assistance and others, both military and sociological in scope. Furthermore, the increasing complexity of these missions mandates a strong, constant operational readiness and a high level of performance in the full spectrum of a ship's activities. In order for these missions to be accomplished successfully, survivability is the foremost concern, and the cornerstone of survivability is damage control. Permanent, continuous and high-level damage control and firefighting training for all crewmembers of a navy ship is paramount. Hopefully, this training can be achieved safely, efficiently and economically by using simulation and training simulator platforms, which have dominated the training field in the last few decades. After participating in "damage control" and "firefighting" courses, investigating the main training system components, and administering surveys to instructors and students regarding subjective ratings and opinions about the training system, we found that the U.S. Navy Damage Control & Firefighting Training at San Diego location, is very effective, valuable, and beneficial to ships crews and the U.S. Navy.

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ACKNOWLEDGMENTS

First, I would like to thank my country Greece and my service, the Hellenic Navy, which gave me the opportunity to participate as a student in the Naval Postgraduate School in the Master's Degree program. I would like also to thank the U.S. government which accepted and hosted me in NPS for these studies.

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I. INTRODUCTION

A. BACKGROUND

Navies have always played a vital role in their countries in both peacetime and wartime. Perceiving this fact, nations use their Navies as an essential tool in implementing their military strategy. The basic responsibility and task of the Navy is to defend and preserve the integrity and interests of the home country by protecting physical borders and ensuring independence. Without doubt, war ships are the principal tool of the Navy in defending against any potential enemy and in applying the aforementioned strategy.

Especially during the last decade, the global population has faced changes in many aspects of their life such as demands in political, social, economic, cultural, and diplomatic activities. Navies also are affected by those alterations; consequently, they have faced new roles and challenges. Not only are military challenges served by the Navy today; Navies are also considered the representative of peace, the protector of the economy and the champion of social aims. Peacekeeping missions, humanitarian assistance, anti-terrorist operations, anti-piracy support, physical disaster assistance and many actions, both military and sociological in scope, are the focus of the Navy in recent years. No one could argue that these missions are not complex and difficult to be accomplished effectively. What is certain is that Navy ships must have a constant operational readiness and a high level of performance in the full spectrum of their activities. In order for these tasks to be accomplished successfully both during wartime and peacetime, survivability and integrity of Navy ships are paramount. The cornerstone of both is damage control, especially firefighting.

It is obvious that permanent, continuous and high-level damage control and firefighting training for all crewmembers of a navy ship is essential. Training is absolutely critical with respect to damage control and firefighting. While the main task of naval ships during periods of war is to be involved in military operations, in peace time this task is to focus on training, maintenance and administration. Today modern Navies maintain a continuous and uninterrupted operational rhythm: ships and crewmembers spend most of the time in deployments, inevitably resulting in decreasing time for training (Betts, 2008). Such issues could severely affect the readiness and performance of ships and crewmembers with dangerous results in case of real combat operations. This training can be achieved safely, efficiently, economically and in minimum time by using simulation and simulator training platforms (Jones, 2008). Simulators have dominated the training field for some time. Using simulators, efficient, safe and economical training can be achieved. This benefit becomes more significant when one recognizes that military budgets limit available time for training due to the plethora of deployments.

B. MOTIVATION

In July 2001, the author was trained as a Damage Control Assistant in the facilities of the U.S. Navy Surface Warfare Officers School Command (SWOS) in Newport, Rhode Island. For almost two months, he received professional and high quality training, theoretical and practical, simulated in all aspects of damage control, especially firefighting. Furthermore, as the Hellenic Navy purchased and installed a modern fire simulator almost four years prior in the facilities of its Damage Control School, the author felt the call for and the need to contribute in some way to his service by utilizing his education obtained in SWOS and the Naval Postgraduate School (NPS) and transferring that knowledge and his experience. Thus, evaluating the U.S. damage control and firefighting training programs using simulator platforms and transferring that training to the Hellenic Damage Control School, where an equivalent firefighting simulator exists, he considered this a very important and beneficial contribution to the Hellenic Navy. Furthermore, the ultimate goal of this thesis was to create a general “training evaluation model” which could be applied not only in damage control and firefighting programs but also in any training program with similar characteristics.

C. PROBLEM STATEMENT AND RESEARCH OBJECTIVES

This thesis focuses on the following objectives:

1. Primary Objective

- Evaluate the damage control and firefighting training provided by the U.S. Navy in the Center for Naval Engineering Learning Site in San Diego, using simulator platforms, as they are currently used at the San Diego location

2. Secondary Objectives

- Identify whether this training meets its goals and objectives
- Identify whether trainees and the U.S. Navy benefit from this training

D. METHODOLOGY

1. Field Observation and Researcher's Training Participation

The researcher visited the Center for Naval Engineering, Learning Site in San Diego, and participated as a student in the "Shipboard Damage Control Trainer" and "Shipboard Firefighting" training courses that took place from June13-17, 2011. The purpose of the visit was to observe and take an active part, in ongoing team training during simulated damage control and firefighting exercises/drills. Thus, the researcher was able to gain insight into damage control and firefighting training programs using simulator platforms.

2. Training System Components Examination

The main training system components of the "Damage Control" and "Shipboard Firefighting" courses were examined as follows:

- Training syllabus/learning objectives
- Description of curricula/training scenarios
- Instructor qualification standards
- Selection, training, certification, and evaluation of qualified instructors

- Training system resources
- Training plan and schedule management
- Simulation utilization log and other management data
- Training evaluation criteria and performance measurement methods
- Training performance data

3. Survey Administration - Data Collection

After the completion of each course, the researcher administered a survey (questionnaires) to both instructors and students regarding their attitudes and opinions about the training provided and received, respectively.

E. CHAPTER OUTLINE

The outline of the remaining chapters is as follows:

II. Literature Review
  - A. Introduction
  - B. Survivability, Damage Control, and Fire Fundamentals
  - C. Historical Background, Past Incidents, and Lessons Learned
  - D. Conclusions
  - E. Training in the U.S Navy
  - F. Simulation and Training

III. Firefighting Training Program Analyses
  - A. U.S Navy's Firefighting Training
  - B. Firefighting Training In Foreign Navies and the Civilian Sector

IV. Problem Statement, Research Objectives, and Methodology
  - A. Problem Statement and Research Objectives
  - B. Methodology
    - 1. Field Observation and Researcher's Training Participation
    - 2. Training System Components Examination
    - 3. Survey Administration - Data Collection

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II. LITERATURE REVIEW

A. INTRODUCTION

Undoubtedly, people are living in an era of changes. Dramatic and intensive alterations in all dimensions of life such as, social, economic, cultural, and military, are occurring. Navies and Navy ships are analogous to living organisms in a society, and consequently they must be concerned with this new reality. While during war time the Navy's goal is to preserve the nation's interests by fighting, in times of peace, different kinds of missions are required. There is also no doubt, that in the future Navy ships will be called upon to accomplish new and possibly unknown challenges. Therefore, it is obvious that a ship's ability to perform these multifaceted missions will depend upon the efficiency of its damage control organization, which ensures its integrity and survivability. But how does one define the terms "survivability" and "damage control?" Why are they so important for Navy ships?

B. SURVIVABILITY, DAMAGE CONTROL AND FIRE FUNDAMENTALS

At this point, the author considers it is essential to provide the readers with general information about survivability, damage control and fire basics that underlie the shipboard damage control training requirements. The presentation of these damage control fundamentals will help to fully understand the goals and objectives of this research. The following information is typical of the facts, concepts and other knowledge requirements that are normally taught in the classroom prior to undertaking simulation training exercises in firefighting.

"Survivability" is defined as the capacity of a ship to absorb damage and maintain mission integrity (Department of the Navy, Office of the Chief of Naval Operations, 2004).

"Damage control" in naval usage, according to the Military Dictionary (http://www.military-dictionary.org/DAMAGE_CONTROL), constitutes the measures necessary aboard a ship to:

- Contain, preserve and re-establish watertight integrity, stability, maneuverability, combat systems and offensive power
- Control list and trim
- Effect rapid repairs of materiel
- Limit the spread of and provide adequate protection from fire
- Limit the spread of, remove the contamination by, and provide adequate protection from chemical, biological, and radiological agents
- Provide care of wounded personnel

Just as combat systems dominate the battle space outside the ship, the goal of damage control is to dominate casualties inside the ship (Naval Sea Systems Command, Naval Ship's Technical Manual (NSTM, Ch079V2R2), 2000). The basic objectives of shipboard damage control, as described in NAVEDTRA 14057 (2003), are "to take all practical preliminary measures to prevent damage, to minimize and localize damage as it occurs, and to accomplish emergency repairs as quickly as possible to restore equipment in operation, and care for injured personnel." These damage control objectives are the same either in peace time or in war. Although the procedures used for damage control change over time in order to enhance performance, the basic concept and problem are constant. Damage control, especially fire fighting, is a basic pillar of a ship's survivability. Firefighting and damage control have been important to the U.S. Navy since the age of sailing. This concept remained vitally important, since naval ships contained large quantities of fuel, oil, weapons, ammunition, aircraft, helicopters, and many other hazardous and flammable materials (Stewart, 2004). This concept remains vital today since modern naval ships contain large quantities of fuel, oil, weapons, ammunition, aircraft, helicopters, and many other hazardous and flammable materials. The basic pillars of "survivability" are shown in the Figure 1 following:

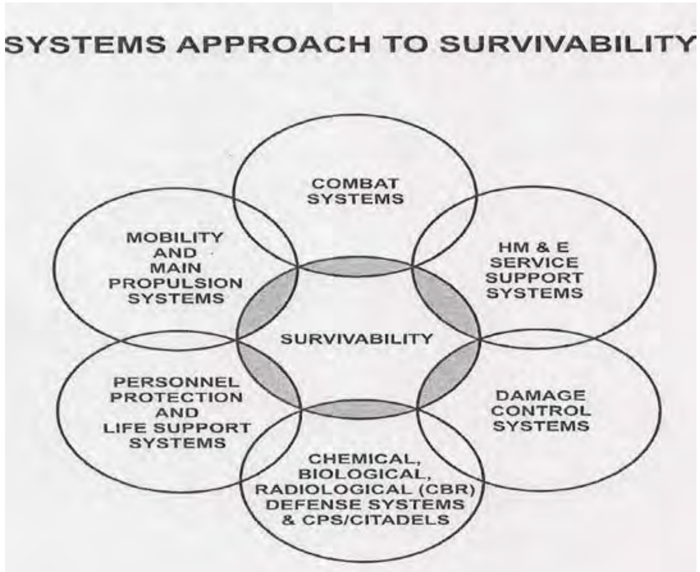

Figure 1. Systems Approach to Survivability (From NTTP 3-20.31 Surface Ship Survivability, 2004)

1. Fire Concern

Fires account for more deaths in the United States than all natural disasters combined. Between 1992 and 2001, an average of 4,266 people died and 24,913 were injured per year due to fires, not including the 9/11 tragedy (Wilson, Steingart, Russel, Reynolds, Mellers, Redfern, Lim, Watts, Patton, Baker, & Wright, 2005). Each year in the U.S., fires kill about 4,000 civilians and 100 firefighters (among the approximately 1.1 million firefighters) in the line of duty (National Center for Health Statistics (NCHS), 2011). Firefighting is a dangerous profession that calls for quick decisions in high stress environments, constant reassessment of dynamic situations, and close coordination within teams (Jiang, Chen, Hong, Wang, Takayama, & Landay, 2004). Fire is so elemental and fundamental to life on this earth that it is a source of wonder that man has not learned to master its destructive force (Clark, 1991).

2. Fire Prevention

The following information is extracted from the Naval Ship's Technical Manual Ch555V1R12 Surface Ship Firefighting and on the Naval Education and Training (NAVEDTRA 14057, 2003).

Fire prevention and firefighting have proven essential to survival of a ship in peace-time, and combat efforts must be made continually to reduce the damage resulting from fire (NTTP 3-20.31 Surface Ship Survivability, 2004).

> Many ships have been lost by fire. Fleet loss experience indicates that fire has caused more damage than groundings, collisions, or flooding. Experience also indicates that steel ships can become floating furnaces, fed by the combustible material carried on board. Some ships have become blazing infernos that had to be abandoned and later sunk by their own forces because fires grew out of control and prevented the effective application of damage control procedures.(Naval Ship's Technical Manual Ch555V1R12, 2006)

Consequently, fire is a constant danger aboard a ship, so preventive measures are required to minimize the possibility of the occurrence of fire. When a fire appears, actions for extinguishing it must be taken immediately. The initial few minutes of a fire are critical for the survival of a ship.

3. Chemistry of Fire

Fire or combustion is defined as "a rapid, persistent chemical reaction that releases energy (heat and light) and is accompanied by flame, especially the exothermic oxidation (chemical reaction between oxygen and the burning materials) of a combustible substance" (Farlex, 2011).

a. Start of a Fire

Every material is presented in one of three states: solid, liquid or gas. The atoms and molecules of solid materials are strongly connected together, while in liquid materials they are packed loosely. The molecules of vapor materials are not connected and are free to move. Therefore, if the molecules in vapors are surrounded by oxygen molecules, fire starts; that is the reason why only vapors can burn.

b. Combustion

Combustion is the rapid oxidation of millions of vapor molecules. This process generates energy in the form of heat and light.

c. Radiation Heat

The heat produced by the combustion reaction is emitted radially in all directions, and a portion of it radiates in the seat of the fire and revitalizes the fire.

4. Requirements for Combustion

a. Fire Triangle

The generation of a fire requires three components: the combustible material or fuel, oxygen and high temperature or heat. Those components form the “fire triangle”, which can be seen in Figure 2.

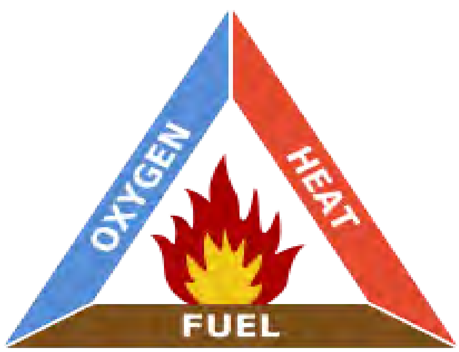

Figure 2. Requirements for Combustion (From Gustavb, 2006)

If any side of the triangle does not exist, a fire cannot be started. Thus, a fire is controlled and extinguished if at least one side of the triangle is removed. The goal of extinguishing a fire is to eliminate the heat, oxygen, or fuel. The combustible materials can be solid (e.g., wood, paper, cloth), liquid (e.g., oil, gasoline, paint), electrical equipment (e.g., wires, motors), or metals. For a hot enough fuel source to be burned, an ignition source must be present. The flash point is the lowest temperature at which a material produce vapors ready to burn in the presence of an ignition source or flame. The fire point is the temperature at which a fuel continues to burn after its ignition. The fire point is higher than the flash point. Auto ignition refers to the lowest temperature when a material can be burned without any ignition source or flame. The oxygen component is meant as the oxygen level of the air. Usually, concentrations of fifteen percent and higher in oxygen are enough to maintain the chemical reaction of fire.

b. Fire Tetrahedron

Another precondition required for a fire to exist is an uninterrupted chemical chain reaction that transforms the fire triangle to a fire tetrahedron.

5. Fire Products

As previously mentioned, fire is a chemical reaction that generates flames, heat, smoke, and gases. Those gases are mostly toxic and dangerous, reducing the available amount of oxygen for breathing. Smoke is the visible product of a fire and very dangerous since it reduces visibility and carries poisonous gases that can be fatal for firefighters when inhaled. Therefore, fire is a major and direct threat to a crewmember's life. Proper dress and protective gear should be present during a fire incident in order for personnel to be protected from the flames, heat, smoke, and gases.

6. Fire Classifications

Fires are distinguished according to the characteristics of the fuel sources. Each type of fire requires different extinguishing agents and special techniques.

a. Class ALPHA (A)

Fires in which the combustible materials are solid, such as clothes, wood, or papers, are classified as Class A fires. The main extinguishing agent is water.

b. Class BRAVO (B)

Fires in which the combustible materials are flammable liquids such as oil, gasoline, kerosene, or paints, are classified as Class B fires. Usually, halon, the dry chemical Purple-K-Powder (PKP) or aqueous film forming foam (AFFF) are used to extinguish these kinds of fires.

c. Class CHARLIE (C)

Fires in which the combustible materials are relative to electric equipment are classified as Class C fires. Although PKP can be used, carbon dioxide (CO2) and halon are suggested since they do not destroy the electrical circuits and leave no residue.

d. Class DELTA (D)

Fires in which the combustible materials are metals, such as magnesium or titanium, are classified as Class D fires. Water in large quantities is usually applied to extinguish these fires. These fire classifications are summarized in the Table 1 below:

FIRE CLASSIFICATION	**EXAMPLES OF TYPES OF MATERIAL**	**TYPE OF EXTINGUISHER**
ALPHA	Solids : Paper, wood, mattress, cloths	Water
BRAVO	Liquids: oil, paints, diesel oil, gasoline, kerosene	AFFF, halon, PKP, CO2, water fog
CHARLIE	Electric: wires, motors	CO2, halon PKP can be used as last option
DELTA	Metals	Discard from ship, water in large amounts, sand

Table 1. Fire Classifications

7. Fire Spread

A fire must be dealt with quickly and efficiently in order to be isolated in the space where it started. Otherwise, it spreads rapidly to other areas and creates new fires, releasing significant amounts of heat and becoming uncontrollable.

8. Fire Stages

Growth stage is the phase where the average space temperature is low and the fire is localized in its source. The rollover stage is when gases are burning and there is flame formation across the overhead of the space. The flashover stage is the short period of time when fire transits from the grown stage to the fully developed stage and the temperatures reached are almost 1100° F (600°C). The fully developed fire stage occurs when all combustible materials have reached their ignition temperature and are burning. Finally, the decay stage is the period when the fire has consumed all the available fuel and decays until it is completely extinguished.

9. Fire Extinguishment

A fire can be extinguished if any side of the fire triangle is isolated. Thereby, fuel can be removed by discarding it overboard, oxygen by decreasing its level in the air to under fifteen percent, and heat by the method of cooling. Breaking the combustion chain reaction is also an effective method to extinguish a fire.

10. Firefighting Agents

Many firefighting agents are available depending mainly on the type of fire one has to deal with. In this way, water, aqueous film forming foam (AFFF), carbon dioxide (CO2), potassium bicarbonate (PKP), and halon are the basic agents against fire aboard ships.

C. HISTORICAL BACKGROUND, PAST INCIDENTS AND LESSONS LEARNED

In this section, the author describes some representative incidents/mishaps in the U.S. Navy in order to reveal and illustrate the importance and significance of damage control and firefighting. In civilian life, surely, the catalogue of disasters and casualties due to fires worldwide is longer and more significant, but this research is focused on naval firefighting.

1. Pearl Harbor, WWII

The following information is based on the Department of Defense, 50th Anniversary of World War II Commemorative Committee document titled: *Pearl Harbor, 50th Anniversary Commemorative Chronicle, "A Grateful Nation Remembers" 1941-1991*.

On December 7, 1941, Japan attacked the U.S. Navy's infrastructures in Pearl Harbor, Hawaii, with six carriers and 353 aircraft, completely surprising U.S. forces. At that time, more than ninety ships were anchored in Pearl Harbor. The Japanese aircraft attacked the stationed ships using bombs and torpedoes. The USS West Virginia (BB-48) sank quickly. The USS Oklahoma (BB-37) turned turtle and sank. The USS Arizona (BB-39) was mortally wounded by an armor piercing bomb that ignited the ship's forward ammunition magazine. The resulting explosion and fire killed 1,177 crewmen, the greatest loss of life on any ship that day and about half the total number of Americans killed. Many other ships suffered major damage.

The aftermath of that attack for the U.S. forces was that 2,403 men were killed, 1,178 military personnel and civilians wounded, twenty-one ships of the U.S. Pacific Fleet sunk or damaged, 188 aircraft destroyed, and 159 damaged. This attack was so devastating for the U.S. with so many casualties because the multiple damages caused by the bombings could not be handled and controlled. After this incident, which shocked the American people, the U.S. entered World War II.

Figures 3, and 4 of that epoch illustrate fires resulting from the attack on Pearl Harbor.

Figure 3. USS Arizona Burning at Pearl Harbor on December 7, 1941 (From Official U.S. Navy Photograph, 1941)

Figure 4. Burning Ships after the Attack on Pearl Harbor (From Official U.S. Navy Photograph, 1941)

2. USS Forrestal (CVA-59) Incident

The following information is based on the Master Thesis of Henry P. Stewart, USN, 2004.

On July 29, 1967, one of the most severe catastrophes in recent naval history happened aboard the USS Forrestal (CVA 59), one of the U.S Navy's most modern aircraft carriers, which was operating in waters off the coast of Vietnam. The USS Forrestal was the first U.S. aircraft carrier specifically designed to operate jet aircraft and was the first carrier the U.S. built after World War II.

The ship had a crew of around 5,500 men and was assigned to bomb targets in North Vietnam with its aircraft. Each aircraft carried a full load of bombs, rockets, and ammunition, and it had full fuel tanks. Also, during preparations for flight, many crewmembers were working on the flight deck.

The USS Forrestal was underway preparing for a new strike and several aircraft started their engines. Suddenly and without any warning, a missile was fired accidentally due to an electrical power surge during the switch from external power to internal power by an F-4 Phantom aircraft located on the flight deck. The missile hit a crewmember, struck another aircraft passing through it without exploding to the opposite side of the flight deck, and finally directed to the sea. Then, a significant amount of jet fuel spilled from the broken aircraft's fuel tank and ignited from the hot parts of the missile remaining on the deck, causing a quick ignition of fire. The burning fuel from the aircraft spilled and transferred to another aircraft stationed on the flight deck, and consequently all these aircraft started to burn, spreading the fire rapidly.

After that, General Quarters was announced and all crewmembers fully manned all dedicated positions in the ship's damage control organization. All the necessary measures were taken to set the ship's proper material condition and prevent smoke and fire from spreading throughout the ship, but the fire continued to spread quickly. The high heat of the fire caused two bombs to explode on the flight deck a few minutes later, severely damaging the ship and killing several sailors on the flight deck. In total, nine bombs exploded on the flight deck, creating large holes in the flight deck and causing burning fuel to traverse into the interior of the ship, including the living quarters directly underneath the flight deck and the hangar deck below. The broken fuel tanks of some other aircraft continuously fed the fire.

After firefighting spread below the flight deck for over twenty-four hours, the crewmembers of the USS Forrestal finally succeeded in extinguishing all fires. The casualties of this incident were significant and the results tragic. A total of 134 sailors were killed in the fire, and 161 were injured. Furthermore, over twenty aircraft were destroyed. This incident terminated the ship's operations in the area. Also, the repairs cost nearly $72 million (not including damage to aircraft) and took almost two years to be completed.

Immediately after this disaster, a *Manual of the Judge Advocate General Investigation* was ordered. The findings relative to firefighting training were the following: (Department of the Navy, 1967)

- The normal damage control refresher – training period (REFTRA) was shortened from six weeks to four weeks for the USS Forrestal prior to her deployment
- Thirty-seven percent of the ship's damage control personnel who attended refresher training transferred prior to Forrestal's deployment
- At the time of the fire, fifty-seven percent of the ship's crewmembers had attended firefighting school in the previous three years. The remaining forty-three percent had not attended firefighting school in that time period
- Several fundamental training deficiencies and weaknesses in the crew's firefighting performance were identified as obstructing firefighting efforts. Numerous personnel on the flight deck were unfamiliar with firefighting procedures and equipment, and were unable to effectively contribute to the firefighting efforts
- Flight deck firefighting training drills were inadequate
- The majority of the recommendations were focused on improving damage control and firefighting training
- Personnel involved with aircraft should receive increased firefighting and damage control training
- All personnel assigned to aircraft carriers (including air wing personnel) should achieve basic qualifications in damage control and firefighting before embarking on their ships
- The U.S. Navy should develop realistic exercises based on fires of the magnitude experienced on the USS Forrestal, simulating the hazards of live weapons and the loss of key personnel and equipment
- Emphasis on damage control training for officers and enlisted personnel prior to reporting to their first ships should be given, and the capacity of the fleet damage control training schools should be expanded
- The investigation provides strong evidence that many sailors died needlessly on the USS Forrestal because of poor training

Figures 5, and 6 below, demonstrate the severity of Forrestal fire.

Figure 5. Fire Spreading on the USS Forrestal (From PH2 Mason, USN, 1967)

Figure 6. Firefighting on Board the USS Forrestal (From Official U.S. Navy Photograph, 1967)

3. USS Enterprise (CVAN-65) Incident

Approximately eighteen months after the fire mishap on the USS Forrestal, another severe naval fire accident occurred aboard the USS Enterprise (CVAN-65) on January 14, 1969. Similar to the USS Forrestal's previously described fire, a MK-32 Zuni rocket loaded on a parked F-4 Phantom on the flight deck of the USS Enterprise exploded after being accidentally ignited. The result of this incident was twenty-seven lives lost and 344 people injured. "The damage to the ship was estimated to be just below $11 million and the cost of replacing the fifteen destroyed aircraft and associated aviation equipment was estimated to be approximately $ 45.5 million" (Bardshar, 1969). Figures 7 and 8 below show the Enterprise fire.

The above investigation, which followed just after the accident, revealed that "although serious firefighting equipment deficiencies existed, solid damage control organization, training, and execution minimized casualties and limited the fire's spread and resulting damage" (Stewart, 2004). When the USS Enterprise's fire happened, almost the ninety-six percent of the ship's crew had attended firefighting school in contrast to the fifty percent of the USS Forrestal's crew who had been trained in firefighting when Forrestal's fire occurred.

Figure 7. Fire on Board the USS Enterprise (From USN, 1969)

Figure 8. Firefighting Efforts aboard the USS Enterprise (From Leonhardt, 1969)

4. USS Stark (FFG-31) Incident

The USS Stark was deployed in the Persian Gulf in 1987. On May 17, 1987, an Iraqi Mirage F-1 aircraft was heading into the Persian Gulf along the Saudi Arabian coast. This aircraft was detected by an Airborne Warning and Control System (AWACS) plane operating in the air over Saudi Arabia. The frigate USS Stark, which was operating in the Persian Gulf, also detected the Mirage at a distance of 200 miles. Since Iraq and Iran were at war, their aircraft routinely flew over the Gulf. For that reason, the USS Stark was not particularly alarmed. Furthermore, that day some Iraqi aircraft had fired missiles into a Cypriot tanker, disabling the ship, but no attack on an American vessel had occurred.

Following the required procedure, the USS Stark sent two radio messages requesting identification of the unknown Mirage without receiving any response. Suddenly, the Mirage aircraft changed its direction and launched two Exocet air-to-surface missiles under unknown circumstances. Unfortunately, for some reason, neither the AWACS plane nor the sophisticated monitoring system of the USS Stark detected those missiles.

The result was that both missiles hit the American vessel. The first one hit the ship on its port side, opening a ten-by-fifteen-foot hole in the hull before ripping through the crew's quarters but failing to detonate, leaving in its path flaming rocket fuel burning at 3,500 °F. The second missile hit almost at the same point, left a three-by-four-meter hole, and exploded in the crew quarters. The fire burned for almost a day, incinerating the crew's quarters, the radar room, and the combat information center.

In the aftermath of that tragic incident, one-quarter of the crew was incapacitated. Twenty-nine crewmembers were killed immediately, eight more died later, and twenty-one were injured. The ship was repaired at a cost of $142 million. (Manning, 2001)

Figures 9, 10, and 11 below, demonstrate the magnitude of the damage in the USS Stark

Figure 9. The USS Stark Listing to Port One Day after she was hit by Two-Exocet Missiles (From Navy Command, 1987)

Figure 10. The USS Stark on fire (From Navy Command, 1987)

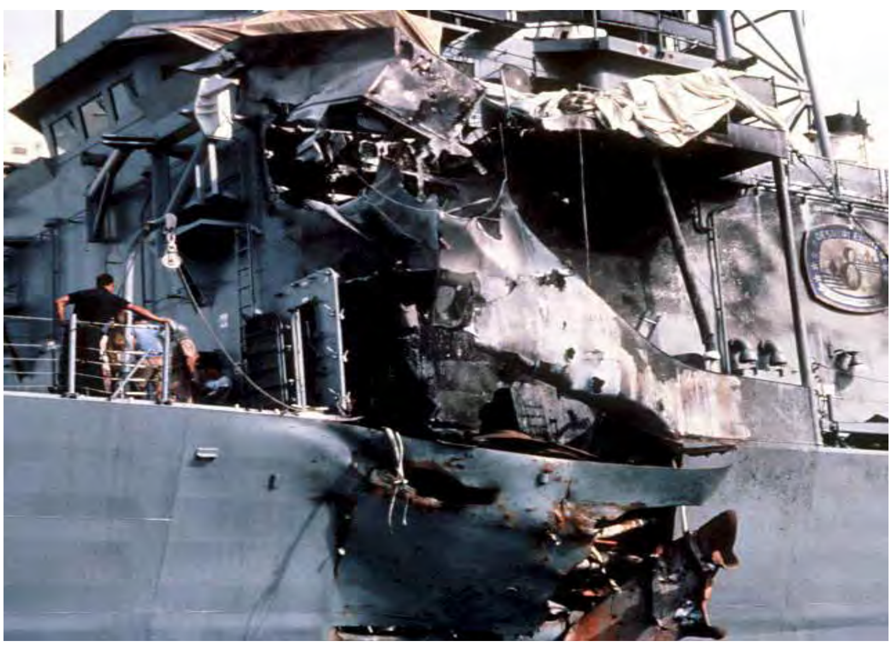

Figure 11. A View of the External Damage to the Stark's Port Side (From Navy Command, 1987)

5. USS Cole (DDG-67) Incident

The terrorist bomb attack on the destroyer Cole on October 12, 2000, was a watershed moment in modern navy history. It was also a wake-up call on the need for better force protection, damage control training, intelligence sharing, shipboard equipment and mass-casualty response (McMichael, 2010).

On October 12, 2000, the destroyer USS Cole was in Aden harbor for a routine fuel stop. While refueling, a small vessel containing explosives approached the port side of the ship and crushed against the hull. An explosion occurred, creating a forty-by-forty-foot hole in the ship's port side as shown in Figure 12 below. The explosion hit the ship's galley while crewmembers were taking their lunch. Significant flooding occurred and it took many hours to control the damage.

Seventeen sailors were killed and thirty-nine were injured in the blast. Timely and effective damage control skills learned by the crew prevented the ship from sinking.This attack was the deadliest against a U.S. Naval vessel since the Iraqi attack on the USS Stark (FFG-31) on May 17, 1987.

Figure 12. USS Cole After the Attack (From USN, 2000)

D. CONCLUSIONS

The above mentioned incidents are only some representative examples from a plethora of disasters that happened over time because of uncontrolled damages and fires. They are strong proof that damage control and firefighting are diachronically critical and vital, primarily for human life safety and, secondly, for material preservation and readiness. Moreover, they provide strong evidence that the basic concept of damage control and firefighting remains constant as there is continuous improvement in the technology and evolution of sophisticated firefighting systems.

In conclusion, damage control and firefighting must be encountered with major attention and importance. Consequently, a permanent, continuous and advanced damage control and firefighting training program is imperative and should be provided both to military and civilian personnel involved with firefighting generally.

E. TRAINING IN THE U.S NAVY

The following information in this section is extracted from the Standard Organization and Regulations of the U.S Navy, OPNAVINST 3120.32C, 1994.

1. Importance of Training

The training of personnel to operate and maintain their equipment/systems is a prime factor affecting the operational readiness, combat effectiveness, and performance of the command. The U.S. Navy training can be characterized as follows:

- In-rate, shore-based maintenance training
- In-rate, operator-basic training usually accomplished ashore
- Individual watch station qualification completed in the fleet unit
- Systems training for operators/teams and total integrated-systems training (e.g., damage control, combat systems). While subsystem basic training is normally provided ashore, proficiency training should be accomplished in the fleet unit
- General military training (GMT) conducted both ashore and in fleet units.

- Ship-wide training accomplished through drills, such as general quarters and exercises. This training incorporates the skills achieved in the above categories and hones the unit's overall combat effectiveness

2. Three Basic Features of an Effective Unit Training Program

- Compatibility in which the training program works within the organization's framework and schedule
- Evaluation and instruction: the training program requires instruction of personnel and evaluation of their individual progress and ability to function efficiently and safely as a team. Effective training is accomplished only when learning occurs. The surest way for learning to occur is through high-quality instruction. Evaluation of learning must rely on standardization (e.g., authorized technical manuals and references)
- Analysis and improvement: the analysis of training effectiveness includes observing the performance of groups and individuals, comparing results with standard criteria, and recognizing deficiencies and methods for improvement

3. Requirements for Effective Training

- Dynamic instruction: the instructor's preparation and presentation must be professional and reflect a thorough knowledge of the subject, tailored to the knowledge level of the trainee
- Positive leadership: persons in authority must show an active interest in the training program, which includes attendance and active participation in training sessions
- Personal interest: trainers responsible for the training program should set realistic goals and monitor an individual's rate of progress
- Quality control: training should be reinforced by questioning individuals on items that they are credited with knowing or requiring a demonstration of skills they have attained
- Technical support: supervisors must ensure that manuals, technical publications, operating procedures, safety precautions, and other references required for training are available and current
- Regular schedule: instruction must be scheduled and held regularly

4. Damage Control and Firefighting Training in the U.S. Navy

Damage control and firefighting are a crucial part of the U.S. Navy's training. There is nothing more dangerous than a fire at sea. In the Navy, every crewmember is a firefighter and should be trained continuously and effectively. Generally, damage control and firefighting training consist of three phases (http://www.navy.com):

a. Basic Training

> Basic damage control training is taught to recruits during the basic Seamanship phase of recruit training. As a part of basic seamanship instruction, recruits receive five days of classroom and hands-on training in shipboard firefighting. They also receive instruction on combating shipboard flooding, damage control communications and nuclear, biological and chemical attack survival. Upon successful completion of the training, sailors possess the basic skills necessary to become effective members of damage control parties when assigned to the fleet.

b. Continuing Education

> All sailors assigned to ships in the fleet receive continuing education in damage control by attending an on-site Damage Control Academy soon after assignment to a ship. As one example, the academy that is conducted by damage control trainers aboard the USS Wasp is five days of classroom and hands-on instruction in areas that include basic firefighting skills and how to put on and wear a self-contained breathing apparatus (SCBA). The training is mandatory for all newly assigned commissioned officers and enlisted sailors and satisfies the requirements for basic damage control qualification.

c. Specialized Training

> Shipboard damage control training is conducted by specialists trained in the U.S. Navy occupational field, Damage Controlman. Sailors holding the specialty provide formal classroom and practical training to other sailors at training centers and training groups. Having the benefit of advanced training in damage control, these specialists serve as advisers to commanders on how to integrate and organize damage control functions. Senior enlisted personnel holding the specialty perform managerial, safety and support services in the areas of damage control, firefighting and chemical, biological and nuclear defense.

F. SIMULATION AND TRAINING

Simulations have dominated the training field in the last few decades**.**

> Decreasing military budgets, reduced training infrastructure, and increasing complexity of weapon systems and missions mandate the exploitation of innovative advanced training technologies. In recent years, training developers have recognized the potential of virtual reality, often called virtual environments, as a flexible and effective training medium. (Hays, 1997)

Simulation plays a key role and has been used for many years for educational purposes in the training of civilian and military personnel. When it is expensive or simply too dangerous for the trainees to use real equipment in the real world, simulation provides an alternate and effective solution for training. Jones (2008) states that simulations provide the U.S. Navy with the opportunity to safely, effectively, efficiently, and economically train sailors at all levels in most aspects of their profession, starting with individual skills as the fundamental building blocks and then assembling progressively larger teams. High fidelity simulators allow the crews to experiment with new tactics and techniques, or in new environments. In addition, he states that the Navy has invested heavily in providing the correct level of simulation fidelity for each application. Simulation brings many advantages to the training community (Jones, 2008):

- Transforms the learning process from a passive to an active experience
- Provides a method to verify that each team member is able to perform his/her role before integrating with the team
- Provides an opportunity for students to demonstrate mastery of skills, thus increasing the students' confidence in their ability
- Provides immediate feedback to the instructor, allowing the instructor to accelerate or decelerate depending on the students' comprehension
- Provides an opportunity for students to experiment beyond the scenarios presented in the curriculum

Training simulations consist of three categories:

- *Live* simulation – a simulation involving real people operating real systems

- *Virtual* simulation – a simulation involving real people operating simulated systems (e.g., Figure 14)
- *Constructive* simulation – a simulation involving simulated people operating simulated systems

Regarding firefighting training, it can be easily understood that the use of a “live” simulation to train real personnel with the application of real fires in real environments is expensive and very dangerous both for the trainee’s and for the preservation of materials/infrastructures, since a real fire is always a major risk. For these reasons, modern navies and civilian factors utilize “virtual” simulations (firefighting trainers-platforms) or “constructive” (computer-based, non-real time) simulations to train their personnel.

In this way, many simulator platforms/trainers have been developed and used in various training centers in the U.S. and worldwide. Furthermore, another very popular training tool for firefighting is “serious games.” For instance, in the Recruit Training Command (RTC), Great Lakes, Illinois, U.S. Navy recruits are using video computer games as a training tool to prepare them to navigate around a ship, stop compartment flooding and fight fires. The game is called Virtual Environments for Ship and Shore Experiential Learning (VESSEL). It is an immersive, game-based training environment that teaches damage control skills, shipboard communication, and shipboard navigation to U.S. Navy recruits without the costs and risks associated with live training. A sample of this application is shown in the Figure 13 below:

Figure 13. Ship Interior Presented by the VESSEL Game (From Raytheon BBN Technologies, 2011)

Figure 14. U.S Firefighting Trainer, an Example of a “Virtual” Simulation

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III. FIREFIGHTING TRAINING PROGRAM ANALYSES

In this section, the author presents training programs currently used either by modern navies or by the civilian sector. The purpose is to compare and contrast those programs, and to find commonalities and differences that could be used as a tool to evaluate the U.S. damage control and firefighting training program. Moreover, useful information could be extracted that could improve and enhance the various training programs.

A. U.S. NAVY'S DAMAGE CONTROL AND FIREFIGHTING TRAINING

According to the Department of the Navy, Commander Naval Surface Forces (COMNAVSURFORINST 3502.1B) (2007), and the Catalog of Navy Training Courses (CANTRAC) (2011), the U.S. Navy firefighting training courses consist of the following:

- **Firefighting Courses:** general shipboard firefighting required by all hands afloat, prior to assignment and every six years
- **Aircraft Firefighting Course:** required by flight deck teams and General Quarters teams near the flight deck and hangar deck, prior to assignment, prior to deployment and every three years
- **Helicopter Firefighting Team Training:** required for all helicopter firefighting teams, every twenty-four months and whenever a forty percent or greater turnover has occurred
- **Shipboard Firefighting Team Training:** required for damage control repair teams and in- port emergency teams, every twenty-four months, and whenever a forty percent or greater turnover has occurred
- **Advanced Shipboard Firefighting:** required for On-scene leaders and all personnel assigned to MHC51/MCM class ships

In this section, the author briefly describes the courses offered by the Center for Naval Engineering Learning Site in San Diego, focusing on damage control and firefighting courses and considering them as representative training systems of the U.S. Navy in that area. The Center for Naval Engineering Learning Site in San Diego, provides the following schools/courses with their corresponding duration and enrollment numbers:

- **General Shipboard Firefighting –** 1 day with 48 students
- **Advanced Shipboard Firefighting-** 4 days with 48 students
- **Aviation Firefighting** - 1 day with 60 students
- **Aviation Firefighting Team Evaluation** - 1 day with 24 students
- **Shipboard Aviation Firefighting** - 1 day with 60 students
- **General Shipboard Firefighting with Self-Contained Breathing Apparatus (SCBA) -** 1 day with 48 students
- **Shipboard Damage Control Trainer –** 1 day with 48 students

Officers and enlisted personnel in all pay-grades participate in all of the courses mentioned above. Each year, the Center for Naval Engineering Learning Site in San Diego, offers 245 schools in total and approximately 1,500 students are trained in all courses. The normal schedule of the courses changes dramatically and becomes more intensive in case of any hot episode, conflict or war.

1. General Shipboard Firefighting Course (J-495-0412)

a. Objective of the Course

According to Catalog of Navy Training Courses (CANTRAC) (2011), and the Department of the Navy (2007) Course Master Schedule Binder, the objective of this course is to provide instruction and evaluation to officers and enlisted personnel in team-oriented firefighting tactics and procedures. Students receive training in high-temperature, high-intensity, and multi-space fires. Graduates will possess the necessary skill sets to allow immediate integration into shipboard repair parties.

b. Prerequisites

All participants in this course must be physically qualified to handle fire hoses, to wear full firefighting gear and to work with various damage control equipment in hot, humid and stressful environments. Students should be medically screened by their parent command no earlier than ninety-six hours prior to arrival at firefighting school.

Medical screening shall be completed according to the existing regulations. This is to ensure individuals are medically qualified to safely participate in the course.

c. Safety Risks and Hazardous Material

This course is characterized as moderate/high risk. Special emphasis is placed on strict compliance with published safety precautions and personnel awareness of potential hazards during live firefighting with instructors and students. Strict adherence to approved standard operating procedures and a pre-mishap plan is mandatory. Each individual is responsible for knowing, understanding, and observing all applicable safety precautions.

d. Course Schedule

This course is repeated each year for every crewmember, or when transferring from ship to ship, or whenever a Navy ship formally requests it to maintain proficiency.

2. Advanced Shipboard Firefighting Course (J-495-0419)

The course is offered twelve times per year with forty-eight students attending each session.

a. Objective of the Course

According to the Catalog of Navy Training Courses (CANTRAC) (2011), and the Department of the Navy (2007) Course Master Schedule Binder, the purpose of this course is to provide supervisory fire-party personnel with training in advanced firefighting techniques and effective management of on-scene personnel in a shipboard environment. Another objective of the course is to provide practical experience with various damage control and firefighting equipment. This course provides classroom instruction in advanced firefighting procedures and hands-on practical training and experience as a repair locker leader, on-scene leader, investigator, team leader, nozzleman, hoseman, plugman, and plotter. Students are required to combat different classes of fires under varied scenarios using different methods and equipment.

b. Prerequisites

Participants should have graduated first from the General Shipboard Firefighting Course (J-495-0412). They also must have at least six months of obligated service remaining and must have had previous live fire training. Students must be physically qualified to handle charged fire hoses, wear full firefighting gear including the SCBA, and work with various damage control equipment in hot, humid and stressful environments. Students must be medically screened by their parent command no earlier than ninety-six hours prior to arrival to the fire house according to the existing regulations. This is to ensure individuals are medically qualified to safely participate in the course.

c. Safety Risks and Hazardous Material

This course is characterized as moderate/high risk. Special emphasis is placed on strict compliance with published safety precautions and personnel awareness of potential hazards during live firefighting with instructors and students. Strict adherence to approved standard operating procedures and a pre-mishap plan is mandatory. Each individual is responsible for knowing, understanding, and observing all applicable safety precautions.

d. Course Schedule

This course satisfies the six-year live firefighting requirement (Catalog of Navy Training Courses (CANTRAC), 2011), but it can be repeated as often as required or whenever a ship requests it to maintain proficiency.

3. Aviation Firefighting

The objective of this course is to exercise an experienced and organized helicopter firefighting team assigned to such ships as a Landing Platform Dock (LPD) and smaller.

4. Aviation Firefighting Team Evaluation

The objective of this course is to evaluate an experienced and organized helicopter firefighting team assigned to such ships as an LPD and smaller.

5. Shipboard Aviation Firefighting

The objective of this course is to provide instruction to officers and enlisted personnel assigned to aviation-designated ships (LPD/Landing Helicopter Assault (LHA) and larger) to include all air-capable ships (Frigates (FFG), Destroyers (DDG), and equivalent) in aircraft firefighting.

6. General Shipboard Firefighting with SCBA

The objective of this course is to provide instruction to AIRFOR, Coast Guard Officers and enlisted personnel in firefighting equipment and procedures, and to prepare them for qualification as members of a Shipboard Damage Control Organization.

B. FIREFIGHTING TRAINING IN FOREIGN NAVIES AND THE CIVILIAN SECTOR

In this part, the author considers it is essential to present some other firefighting training programs used by modern Navies and civilian fire departments, so as to obtain a global idea of firefighting training.

1. Hellenic Navy’s Firefighting Training

Damage control and firefighting play a very important role in the Hellenic Navy, too. Since 1951, when the Hellenic Damage Control School was established, it has provided continuous training to ship crewmembers and to Navy personnel. Following needs for increased and more effective training, almost four years ago the Hellenic Navy purchased and installed a modern firefighting simulator in the facilities of its Damage Control School in order to train crews and profit from the advantages of simulation technology.

Although the damage control facilities and the Hellenic Navy, respectively, are significantly smaller than the U.S. Navy, a reference to the firefighting training plan currently used in the Hellenic Damage Control School would be useful to make. The following information is based on Hellenic's Navy, Naval Education Administration, Damage Control Training Regulations (2007).

The Hellenic Damage Control School provides the following schools:

- Damage control 1: Shipboard firefighting for ship's fire parties personnel–3 days, at least 10 students, and at most 15
- Damage control 2: Shipboard firefighting for new crewmembers aboard ships and students of Naval Academies–2 days, at least 10 students, and at most 20
- Damage control 3: Firefighting for ashore service personnel–3 days, at least 10 students, and at most 20
- Damage control 4: Firefighting for Hellenic Navy's ashore fire stations–5 days, at least 10 students, and at most 20
- Damage control 5: Firefighting for fire and smoke simulator trainers–20 days, at least 8 students, and at most 12
- Damage control 6: Ship's fire parties firefighting team evaluation–1 day, at most 20 students
- Damage control 7:Basic firefighting apparatus use and maintenance–2 days, at least ten students, and at most twenty

a. Selection and Training of Qualified Instructors

The instructors / trainers of the Hellenic Damage Control School are selected after successfully completing the "Damage Control 5" course in the same facilities. The duration of that training is twenty days.

b. Objective of the "Damage Control 5" Course

The objective of this course is to provide candidate instructors the required knowledge, both theoretical and practical, to utilize all the equipment of the Damage Control School in order to succeed as trainers.

c. Prerequisites

- The participants should have mastered basic damage control knowledge and have been members of ship fire repair parties for at least four years
- Instructor's age should not exceed thirty-five years
- Participants should meet medical requirements that confirm their proper physical health

d. Training Syllabus with Specific Learning Objectives

The training provided is given in two parts: the theoretical part, which is developed in thirty-nine class-lecture hours using multimedia; and the practical part, which is six usage-demonstration hours of employing portable firefighting equipment and fire hoses in specific, dedicated and fully equipped areas (demo area and hose range). In the practical part, 95 hours of training scenarios in the fire simulator platform take place.

e. Description of Curricula/Training Scenarios

The curriculum is equivalent to the Shipboard Firefighting Course for ship's fire parties personnel described in the next section (Damage Control 1), but more advanced, intense, and covering significantly more material in firefighting than the Damage Control 1 Course. The instruction mode and evaluation methods are also similar.

2. Shipboard Firefighting Course for Ship's Fire Parties Personnel (Damage Control 1)

In this section, the author analyzes the Shipboard Firefighting Course, taking into consideration that it is the most representative and an equivalent course to the "Advanced Shipboard Firefighting Course" in the Center for Naval Engineering Learning Site in San Diego. It is similar since it is addressed to a ship's fire repair party's personnel mainly responsible for firefighting and damage control aboard ships.

a. Objective of the Course

The objective of this course is to improve the efficiency of the fire repair party's personnel aboard Navy ships using portable firefighting equipment, personnel protective equipment, re-entry techniques in spaces on fire, and firefighting tactics/procedures, as well as utilizing and profiting mainly from the fire simulator platform training capabilities.

b. Prerequisites

- The participants should have at least six months previous service in Navy ships, of which at least three months should be as members of fire repair parties
- Participation priority is given to ship crewmembers who have not participated in the same course in the last three years
- Participants should meet the medical requirements that confirm their proper physical health to uninterruptedly participate in the course
- The number of participants is limited to fifteen and in no case at course outset should enrollment be less than ten. In addition, if during the training session the number of participants is reduced to less than five, the course is interrupted and the remaining students are allowed to participate in the next scheduled course.

c. Safety Precautions

Personnel **s**afety is the primary concern during firefighting training. Therefore, the training in the Hellenic Damage Control School is designed in such a way so as to minimize the likelihood of dangers and accidents, especially during the practical phase of training in the fire simulator. For this reason, students first receive a safety precaution presentation, familiarization with portable firefighting equipment, and personnel protective equipment. Secondly, practical training in scalable difficulty is provided. The objective of the briefing and debriefing done before and after the training scenarios, with available time for questions, is to maximize each student's safety and correctly execute and assimilate the scenarios.

All firefighting equipment is periodically checked by the school trainers based on the operating manuals before its use, and in case of any malfunction it is replaced immediately. Finally, during practical training in the fire simulator, students may ask for training to stop (training time-out) for emergency reasons.

d. Curriculum Development Method

(1) Training Syllabus with Specific Learning Objectives. The training provided is given in two parts:

- First is the theoretical part, which is developed in four class-lecture hours using multimedia, and in three usage-demonstration hours using portable firefighting equipment and fire hoses in specifically dedicated and fully equipped areas (demo area and hose range). Table 2 illustrates analytically the theoretical phase of the course:

	Syllabus	**Lecture Hours**	**Training Manuals**	**Multimedia Infrastructure**	**Remarks**
Lecture 1	**1. Students' reception-briefing** 1.1 Students responsibilities 1.2 Safety precautions during training	0.5	1. Fire simulator operational manual 2. Fire simulator ground plan 3. Damage Control School training scenarios manual	Power-Point projection	
	2. Training scenarios 2.1 Fire simulator capabilities 2.2 Training scenarios description	0.5		Power-Point projection	
Lecture 2	**1. Personnel protective equipment** 1.1 Fire suit, helmet, boots, gloves 1.2 Breathing device by Interspiro	1	1. Firefighter protective clothing user instruction, safety and training guide 2. Interspiro operating instructions	Power-Point projection	

	2. Portable firefighting equipment	1	Ship Firefighting BR 4007		
Lecture 3	**1. Portable firefighting equipment use demonstration** 1.1 Fire extinguisher use and refill	1	Ship Firefighting BR 4007	Demo area and hose range, fully-equipped areas	In those areas, training is provided without use of breathing apparatus. Students are prepared for the scenario execution in the fire simulator, familiarizing with all the equipment they will use.
	2. Fire hose use demonstration 2.1 Fire hose operation and use 2.2 Re-entry techniques demonstration in space on fire 2.3 Fire extinguishers, fire hoses, nozzles, foam system demonstration	2	Ship Firefighting BR 4007	Demo area and hose range, fully-equipped areas	
	3. Fire physiology 3.1 Fire spread in closed space 3.2 Backdraft and flashover definitions	1		Power-Point projection	

Table 2. Theoretical Course Description

- Second is the practical part, which is developed in fourteen hours of training scenarios in the fire simulator platform as shown in Table 3:

	Syllabus	Lecture Hours	Training Manuals	Multimedia Infrastructure	Remarks
Session 1	**1. Interspiro Breathing Device** 1.1 Operation and use	2	1. Interspiro operating instructions	Fire simulator	
	2. Horizontal re-entry in space on fire 2.1 Fire simulator capabilities 2.2 Training scenarios description	5	1. Ship Firefighting BR 4007 2. Damage Control School training scenarios manual	Fire simulator	
	3. Vertical re-entry in space on fire 3.1 Initial scenario execution-remarks-corrections- scenario re-execution 3.2 Students' general debriefing- completion of training evaluation questionnaires	7		Fire simulator	

Table 3. Simulator Training Description

(2) Documents Developed and Produced in Support of This Course

- Fire simulator operational manual
- Fire simulator ground plan
- Damage Control School training scenario manual

- Firefighter protective clothing user instruction, safety and training guides
- Interspiro breathing device operating instructions
- Ship Firefighting BR 4007

(3) Description of Curricula/Training Scenarios

- Student reception-briefing
- Student responsibilities
- Safety precautions during training
- Fire simulator capabilities
- Training scenarios description
- Personnel protective equipment: Fire suit, helmet, boots, gloves, Interspiro breathing device demonstration
- Fire hose operation and use
- Re-entry techniques demonstration in space on fire
- Fire extinguishers, fire hoses, nozzles, foam system demonstration
- Fire spread in closed space
- Definition of backdraft and flashover term

(4) The Primary Mode of Instruction. The primary mode of instruction is group-based, consisting of field exercises. The trainees demonstrate subject mastery by successfully applying knowledge and skills to practical exercises.

e. Evaluation

Students are evaluated individually on the second and third days of the course in parallel with their participation in training scenarios in the fire simulator. They are graded in the total of duty watch responsibilities by rotating during the re-executions of the training scenarios, and based on pre-existing student evaluation sheets. Grades are delivered on a scale of “A” for excellent, “B” for very good, “C” for good, “D” for fair and “E” for fail. The total of the two separate grades each student receives are then averaged.

If a student fails, he or she may retake the course in the future, but only once. A second failure will result in permanent rejection without having the right to participate in the same course in the future. This evaluation concept is applied to all courses of the Hellenic Damage Control School.

3. United Kingdom Royal Navy's Firefighting Training

An equivalent of, the U.S. Navy "Advanced Shipboard Firefighting Course", is the Phoenix CBRNBC (Chemical, Biological, Radiological, Nuclear and Damage Control) School, the UK's Damage Control School for the Royal Navy.

> All Royal Navy personnel, independent of specialization or seniority, receive firefighting training before joining their ships. The courses are theoretical and practical instruction lasts from between two days to one week, depending on whether they are basic, intermediate or advanced courses. Classroom teaching includes a wide variety of firefighting themes such as equipment, personal protection, breathing apparatuses, fire containment and duty-watch responsibilities.
>
> In the practical instruction part, "Fire in the Engine Room" training is provided using eight highly sophisticated firefighting training units (FFTUs). These units are three floored, propane-gas-fueled fire simulators providing the instructors complete control, through a control room, of the fire and environmental conditions faced by students. The areas in those units are exact replicas of what exists in Navy ships, such as the machinery control room, engine room, galley and passageways. "The FFTUs, owned by Flagship Firefighting Training Ltd, were opened in January 2001 and provide world-class facilities for the students to learn and practice fire-fighting techniques. (Crown, 2009)

Figure 15. Fire in the Engine Room in the Phoenix CBRNBC School (From Crown, 2009)

4. U.S. Navy's Damage Control and Firefighting Training Program versus Hellenic's Navy Firefighting Training

In this part, the author considers that it would be beneficial to make a comparison between the two pre-described and similar damage control/firefighting programs, the "Shipboard Firefighting Course for Ship's Fire Parties Personnel (Damage Control 1)" in the Hellenic Damage Control School, and the U.S. "Advanced Shipboard Firefighting" in the Center for Naval Engineering Learning Site in San Diego. This information is illustrated in the following Table 4 below:

Course Description	**Advanced Shipboard Firefighting Course (J-495-0419)**	**Shipboard Firefighting Course for Ship's Fire Parties Personnel (Damage Control 1)**
Navy	U.S. Navy	Hellenic Navy
Participants	Officers and enlisted personnel in all pay-grades. Up to 48 students.	Ships' fire parties personnel, at least 10 students, and at most 15.
Duration	4 days	3 days

Qualified Instructors	Instructor’s duty is designated to a maximum of thirty-six months. They should have graduated from the same course (four days) as a student prior teaching.	Graduates from the “Damage Control 5” course (twenty days) in the Hellenic Damage Control School.
Curriculum Development Method	Theoretical phase, which is developed in two class-lecture hours using multimedia classrooms. Practical phase that is delivered in twenty-two hours of training scenarios in the simulator platforms.	Theoretical part, which is developed in four class-lecture hours using multimedia, and in three usage-demonstration hours using portable firefighting equipment and fire hoses in specifically dedicated and fully equipped areas (demo area and hose range). Practical part, which is developed in fourteen hours of training scenarios in the fire simulator platform.
Mode of Instruction	The primary mode of instruction is group-based, and consists of field exercises. The trainees demonstrate subject mastery by successfully applying knowledge and skills to practical exercises.	The primary mode of instruction is group-based, consisting of field exercises. The trainees demonstrate subject mastery by successfully applying knowledge and skills to practical exercises.
Course Objective	To provide supervisory fire-party personnel with training in advanced firefighting techniques and effective management of on-scene personnel in a shipboard environment. Furthermore, to	To improve the efficiency of the fire repair party’s personnel aboard Navy ships using portable firefighting equipment, personnel

	provide practical experience with various damage control and firefighting equipment.	protective equipment, re-entry techniques in spaces on fire, and firefighting tactics/procedures, as well as utilizing and profiting mainly from the fire simulator platform training capabilities.
Prerequisites	Participants should have graduated first from the General Shipboard Firefighting Course (J-495-0412). They also must have at least six months of obligated service remaining and must have had previous live fire training. Students must be medically screened/qualified to safely participate in the course.	Participants should have at least six months previous service in Navy ships, of which at least three months should be as members of fire repair parties. Participation priority is given to ship crewmembers who have not participated in the same course in the last three years. Also, participants should meet the medical requirements that confirm their proper physical health to uninterruptedly participate in the course.
Course Schedule	Satisfies the six-year live firefighting requirement but it can be repeated as often as required or whenever a ship requests it to maintain proficiency.	Every three years or when required to maintain proficiency.
Evaluation	The course is "pass" or "fail." Students do not have written exams or oral response tests. Shipboard damage control and firefighting courses are evaluated with individual skills and as a team by instructors with the method of observation.	Students are evaluated individually in parallel with their participation in training scenarios in the fire simulator. They are graded in the total of duty watch responsibilities by

		rotating during the re-executions of the training scenarios, and based on pre-existing student evaluation sheets. Grades are delivered on a scale of "A" for excellent, "B" for very good, "C" for good, "D" for fair and "E" for fail. The total of the two separate grades each student receives are then averaged.

Table 4. U.S. and Hellenic Navies' Damage Control/Firefighting Program Comparison

5. Civilian Firefighting, U.S. Fire Administration – National Fire Academy in Emmitsburg, Maryland.

At this point, the author chooses to describe the basics of the National Fire Academy's Training Plan as it is the basis and the starting point of civilian firefighting in the U.S.

The mission of the National Fire Academy is to "provide national leadership to foster a solid foundation for the fire and emergency services stakeholders in prevention, preparedness, and response" (U.S. Fire Administration, National Fire Academy, 2010). The National Fire Academy conducts specialized training courses and advanced management programs of national impact. Thus, a plethora of curricula is provided, ranging from six to ten days. The most representative are the following:

- Executive Development
- Management Science
- Emergency Medical Services
- Incident Management
- Planning and Information Management

- Hazardous Material
- Fire Prevention
- Training Programs
- Volunteer Incentive Program
- Distance Learning Courses
- Train-the-Trainer Program

The National Fire Academy takes advantage of technology and also offers online training in order to deliver more instruction opportunities to students. “Interactive courses are available at no charge to the general public as well as to the fire service” (U.S. Fire Administration, National Fire Academy, 2010).

a. Mandatory Prerequisite for all National Academy Courses

For alignment purposes, it is required that all National Fire Academy candidates complete assigned training courses online before arriving at the Academy. Physical requirements must be met for successful acceptance. Furthermore, students should be familiar with Microsoft Word, Excel and PowerPoint since many classes use these tools.

b. Evaluation

According to the U.S. Fire Administration, the National Fire Academy has established a complete evaluation program to define the degree of student satisfaction in coordination with the training experience gained and as well as measure how this training influences a student’s performance on the job. At the end of each training session, students are administered an end-of-course evaluation to rate their satisfaction concerning that session.

National Fire Academy courses are also evaluated by students and their supervisors via the Academy’s Long Term Evaluation Program. Four to six months after students have returned to their jobs, the Academy invites students and supervisors to complete an online evaluation process. In this way, the Academy can identify what parts of the training have been transferred to the student's job and, finally, if any difference in the reduction of fires or human casualties due to fire-related hazards occurred.

c. *Simulation in Firefighting Training*

Most of the courses combine classroom instruction and a hands-on learning approach in the Academy's Fire Protection Systems Laboratories, which are different kinds of simulators. Some of the simulators at the Academy's facilities are the following:

- Ranch House
- Townhouse
- Mansion
- Casper Hall Dorm
- Strip Mall Hostage
- Nursing Home
- Urban Interface Fire

Figure 16. National Fire Academy's Simulation Laboratory (From U.S. Fire Administration, 2011)

Figure 17. Exercise Controllers Running a Simulation in the Laboratory (From U.S. Fire Administration, 2011)

> The Simulation Laboratory is designed to expand the knowledge, skills, and abilities of students in the Incident Management Curriculum by reinforcing lessons learned in the classroom through a series of practical simulation exercises.
>
> The laboratory is designed to provide students with "real-world" training using a variety of emergency situations, including incidents such as dwelling fires, commercial and large structure fires, catastrophic disasters and major emergency events, such as hazardous material releases and mass casualty incidents. (U.S. Fire Administration, National Fire Academy, 2010)

IV. PROBLEM STATEMENT, RESEARCH OBJECTIVES, METHODOLOGY

A. PROBLEM STATEMENT AND RESEARCH OBJECTIVES

This thesis focuses on the following objectives:

Primary Objective:

- Evaluate the damage control and firefighting training programs provided at the Center for Naval Engineering Learning Site in San Diego, using simulator platforms, as they are currently used at that San Diego location

Secondary Objectives:

- Identify whether this training meets its goals and objectives
- Identify whether trainees and the U.S. Navy benefit from this training

B. METHODOLOGY

In order to evaluate the damage control and firefighting programs, the author applied the systematic training design, development and operational evaluation methods. Specifically, the methodology consists of the following three pillars:

- "Field observation" and the author's personal active participation in the "Shipboard Damage Control Trainer" and "Shipboard Firefighting" courses as a student
- Examination of the training system components (syllabus, learning objectives, instructor qualification standards and instructor training, training system resources, training evaluation criteria, performance measurement methods, and trainee's simulation performance scores)
- Survey administration by obtaining instructor and student subjective ratings and opinions about the training system

1. Field Observation and Researcher's Training Participation

The author employed the method of "Field Observation" in this study. In this manner, he visited the Center for Naval Engineering, Learning Site, San Diego, and participated as a student in the "Shipboard Damage Control Trainer" and "Shipboard

Firefighting" training courses which took place from June 13-17, 2011. The purpose of the visit was to observe and take part actively in ongoing team training during simulated damage control and firefighting exercises/drills. Thus, the author was able to gain insight into damage control and firefighting training programs using simulator platforms.

The primary mode of instruction is group-based, and consists of field exercises. The trainees demonstrate subject mastery by successfully applying knowledge and skills to practical exercises. Thus, each course consists of two phases: the theoretical phase, which is developed in classrooms, and the practical phase that is delivered in simulator platforms. The training provided at those facilities is practical rather than theoretical, since only a small amount of time is spent on classrooms; in contrast, all the remaining time was focused on executing training scenarios and drills in simulators. The cycle of instruction is conducted as follows:

a. Theoretical Phase

The theoretical phase is delivered in classrooms using audiovisual material with PowerPoint projections and to present the basic damage control and firefighting equipment and their use. Analytically, the theoretical instruction covers the following:

- A refresher to students and crews of the basic training they had already received in their basic training and on their ships
- Students' preparation for the practical phase in simulators by demonstrating all the required damage control and firefighting equipment and their handling
- Information regarding policies, operational procedures and techniques during the upcoming training scenarios
- Presentation of the safety precautions and restrictions during the real drills on simulators

b. Simulator Platform Briefing

All participants are given a safety briefing and receive instructions regarding the simulation exercises, including assignment of team member roles, responsibilities, task performance requirements and expectations for the damage control and firefighting exercises. Especially for familiarizing purposes, instructors guide students into the simulator compartments before the start of the practical phase in order to demonstrate to them all the spaces of the simulator. All the scenarios and methods of correct execution are explained analytically as well.

Finally, emphasis is given to all students regarding the “training time-out” procedure, which is the emergency stoppage of the drills and shutdown of the simulator in case of an emergency and can be applied by pushing the emergency stop buttons located inside and outside each compartment of the simulator.

c. Simulator Platforms - Trainers

In the facilities of the Center for Naval Engineering Learning Site in San Diego, there are five simulator platforms -one for damage control and four for firefighting training.

First, the damage control simulator or “wet trainer” shown in the Figure 18 below is a two-story concrete structure including holes in bulkheads, ruptured pipelines, and almost all situations that can cause flooding aboard a ship. Students are exposed to water leaks from pressurized ruptured fire–main pipelines within those confined spaces, which simulate various ship compartments.

Figure 18. Damage Control - “Wet Trainer” Simulator

Second, there are four live fire simulators-trainers. Two of the four simulators address Class A, B, and C fires. The first one—the "Basic Firefighting Trainer"—is a single-story concrete structure with four individual compartments. The second one and the most representative of this training facility—the "Advanced Firefighting Trainer" displayed in the Figure 19—is a three-story concrete structure that houses berthing facilities, engine rooms, storage compartments and electrical and engine room mock-up spaces. In this simulator, the application of the practical phase and live fire training of the "basic" and "advanced" firefighting courses occurs. The third fire simulator is an open concrete structure for hose handling training to familiarize students with pressurized hoses ("wild hoses").

Figure 19. Firefighting Simulator -"Advanced Firefighting Trainer"

Finally, the fourth simulator, displayed in the Figure 20, is a flight deck simulator with an aircraft mock-up on deck, simulating crash and helicopter fire scenarios.

Figure 20. Flight Deck Simulator, San Diego

All live fire simulator platforms use propane as the fuel source, and each structure is controlled by a master computer and operated by instructors to achieve the desired training.

d. Practical Phase – Simulator Platform Exercises

The training drills in both the "Wet Trainer" simulator (Figure 22) and firefighting simulator (Figure 23) are conducted in accordance with specific pre-existing scenarios that are created and monitored at a simulator control station. Each simulator has an "observation deck" that allows the observation of trainees performing simulated tasks under realistic environmental conditions (pressurized water leaks and propane-generated fires). Instructors supervise and closely monitor all training events and are responsible for observing safety, training event sequences, and participant performance during the simulation exercises as presented in the Figure 21. The operating computer system currently used is Windows 2000.

Figure 21. Firefighting Simulator Control Station

Figure 22. Damage Control-Wet Trainer Simulator

Figure 23. Firefighting Simulator Platform

e. Simulator Debriefing

After the completion of the training scenarios, instructors methodically review the execution of the drills step-by-step and, trainees' task performance, and then present to students both positive and negative feedback for improvement.

2. Training System Components Investigation

In the following section the author describes analytically the main training system components of the "Shipboard Firefighting" course.

a. Training Syllabus/Learning Objectives

All the U.S. Navy training courses are thoroughly described in the Catalog of Navy Training Courses (CANTRAC) (2011), with their category, type, security, center, purpose, scope, and prerequisites.

Furthermore, the Department of the Navy (2007) Course Master Schedule Binder, is the basic guidebook that illustrates the elements of all training courses provided in the Center for Naval Engineering Learning Site in San Diego.

Specifically, it describes analytically:

- The Course Training Task List (CTTL) with the mission statement of each course, the duties/tasks, and the corresponding bibliography.
- The Curriculum Outline of Instruction (J-495-0419A) with the training units/terminal objectives, and the lesson topics with the enabling objectives and the analogous bibliography.
- The Learning Objectives (J-495-0419A) of the courses in details and the relative references.

b. Description of Curricula/Training Scenarios

The training scenarios are described in the Department of the Navy (2007) Course Master Schedule Binder, J-495-0419A, Curriculum Outline of Instruction, from Unit 11:1.0 to Unit 14.2:8.6.

Generally, the course includes the following subjects:

- Self-contained breathing apparatus (SCBA)
- Chemistry of fire
- Portable extinguishers
- Personal protective clothing (PPC)
- Damage control communications
- Fire party duties and responsibilities
- Firefighting procedures
- Wild hose recovery
- Portable exothermic cutting unit (PECU)
- De-smoking equipment and accessories
- P-100 emergency pump and accessories
- Machinery space fire doctrine
- Special hazard fires
- Mass conflagration procedures
- Repair locker equipment
- Trainer (simulator platform) familiarization

c. *Instructor Qualification Standards. Selection, Training, Certification, and Evaluation of Qualified Instructors*

The Center for Naval Engineering Learning Site in San Diego has seventeen qualified instructors, ten civilian contractors and seven military instructors. The instructor's duty is designated to a maximum of thirty-six months (Military Personnel Manual (MILPERSMAN) 1306-953, 2009).

The instructors are selected, trained, screened, certified, and evaluated according to the procedures described in the Naval Education and Training Command (NAVEDTRA 135C) (2010).

As stated by this document, the instructor is the front line representative of the training organization and is a critical element in the training process. To ensure that quality instructors are assigned to a training activity, standardization in the following key areas shall be maintained:

- Selection process for instructors
- Training of instructors
- Screening of instructors assigned to high-risk training
- Certification/evaluation of instructors

In some cases, contract instructors are required to provide instructional services.

The following information is extracted from the Naval Education and Training Command (NAVEDTRA 135C) (2010).

> (1) Instructor Selection Policy. First, candidate instructors should be meet the screening criteria listed in the Military Personnel Manual (MILPERSMAN) 1306-953 (2009), to determine the member's suitability for such duty. These requirements include the following:
>
> - Physically, psychologically, and temperamentally suited for instructor duty.
> - Knowledge and expertise in the subject area assigned to teach.
> - Good communication skills or the potential to develop them.
> - Maturity.

- Emotional stability and the ability to maintain self-control under all circumstances. If there is any doubt as to this attribute, psychological screening will be conducted.
- Adherence to Health and Physical Readiness Program Standards as defined in OPTAVINST 6110.1 (series).
- Positive role model.
- People oriented.
- Desire to teach.

(2) Instructor Training Policy. Personnel assigned instructor duty will complete training for their job assignment. If quota availability does not coincide with availability of qualified personnel, prospective gains will be assigned without instructor training to avoid billet gaping. Priority of assignment to instructor school will be given to members ordered to instructor duty who will not have an instructor school in the immediate geographic area of their ultimate duty station. Problems obtaining quotas will be coordinated with NETC. If the instructor arrives without the formal training, the instructor must complete it prior to qualification

(3) Screening of Instructors Assigned to High-Risk Training. Instructors assigned to high-risk courses will undertake a screening process according to OPNAVINST 5100.23 (series).

(4) Instructor Certification/Evaluation Policy. Certification is a process that prepares the instructor to conduct training without the direct supervision of a certified course instructor. Certification normally begins after the completion of formal training and upon arrival at the training command for duty. The certification/evaluation plan for instructors consists of the following eight phases:

- Command Indoctrination. COs are required to ensure that command indoctrination is provided for incoming instructors. The indoctrination is designed to provide information to the instructor on chain of command, command policies on instructor awards programs, and activities. Safety training will be included in all command indoctrinations.

- Course Indoctrination. COs are required to ensure that course indoctrination is provided to all incoming instructors. Course indoctrination includes indoctrination to safety policies and programs unique to certifying instructors for that course. It is designed for instructor trainees, introducing them to course policies and general duties they will be expected to perform. This training is normally provided by the individual course and may be completed in conjunction with command indoctrination.

- Attend the Course as a Student (High-Risk only). Prospective instructors of high-risk segments of the course they are to be certified to teach as a STUDENT, prior to practice teaching, unless a waiver has been granted by the CO based on prior training and experience.

- Core Unique Instructor Training (CUIT) (High-Risk only). CUIT is designed to prepare the instructor to teach in a high-risk course. The content of this training will vary from course to course, but it must include all items of high-risk, which require special attention. Familiarization with basic tenants of high-risk training and safety will include mitigation, protocol, and policy. For Core Unique Training, the items must apply universally to all sites where the course is taught. NETCINST 5100.1 (series) provides amplifying guidance on high-risk training and shall be applied

- Instructor Preparation and Practice Teaching. Prior to practice teaching, all prospective instructors will review the curriculum materials, observe classes in session, and personalize instructor guides. The time required to complete Instructor Preparation will vary based on the previous experience of the instructor and the frequency of which the training is provided. However, every effort shall be made to keep this time to a minimum

- Two Satisfactory Evaluations. During the instructor's Practice Teaching period, evaluations will be conducted to provide feedback to the instructor. This feedback will include an assessment of understanding of the subject matter, as well as proper use of instructional techniques. The prospective instructor must receive satisfactory evaluations on a minimum of two separate presentations while Practice Teaching.

One evaluation will be used to evaluate the instructor's knowledge of the subject matter. This evaluation verifies the instructor has the necessary technical qualifications to teach the material without direct supervision. An instructor evaluator knowledgeable in the subject matter will conduct this type of evaluation. The second evaluation will be used to evaluate the instructor's technique as taught in the formal instructor-training course.

- Certification. After phases one through six are satisfactorily completed, the instructor is recommended for certification. The designated certifying authority for the command will officially certify the instructor and ensure documentation is entered into the instructor's training record.

- Certification to Teach New Material. The course supervisor must have a process in place to ensure technical competency of the certified instructor prior to assigning new material for the instructor to teach. This may require a process similar to certification, or portions of it, depending on the type of material to be taught and the experience of the instructor. Course supervisors are responsible for ensuring that instructors are properly prepared and the training documented prior to their assignment to teach new material.

All these phases of instructor certification / evaluation are illustrated in the following Figure 24:

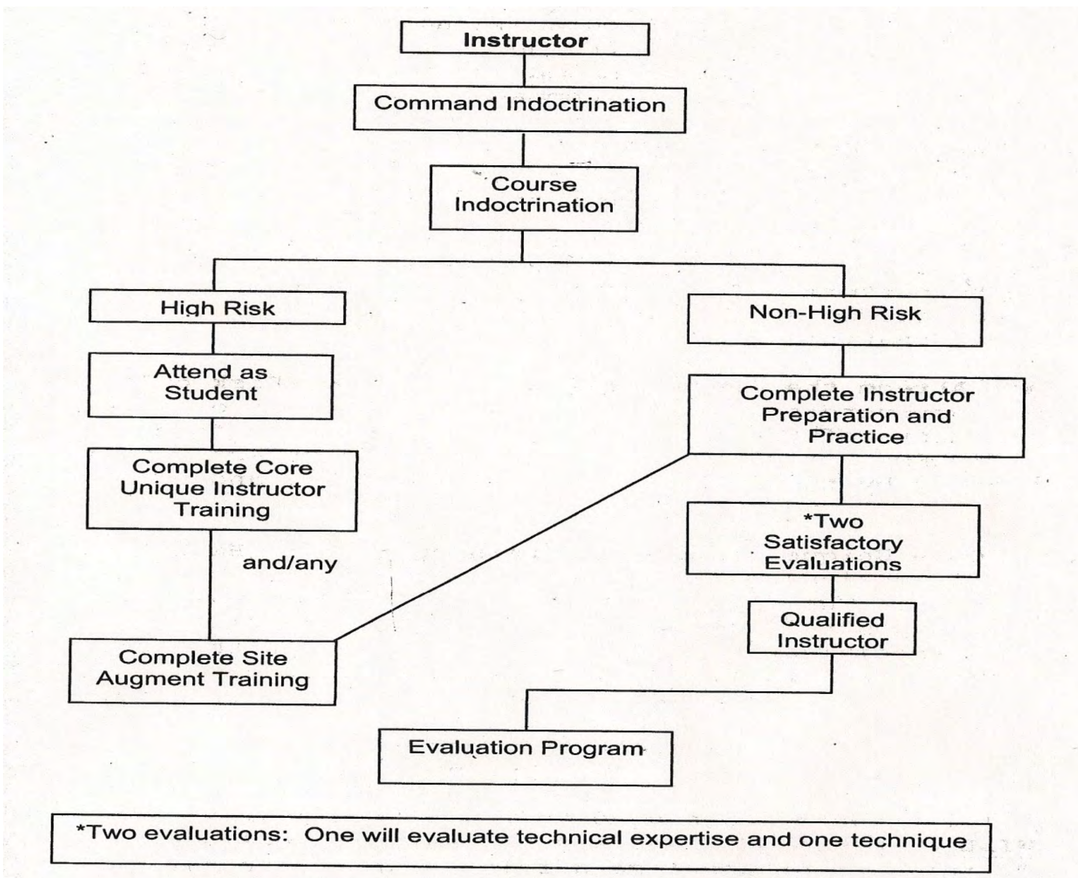

Figure 24. Instructor Certification/Evaluation Flow Chart (From NAVEDTRA 135C, 2010)

d. Training System Resources

For a training program to be effective it must include certain resources in place at the time of execution (after implementation of the training system). Such resources include laboratory and classroom spaces, training devices, test equipment, tools training support equipment, and support materials like syllabi and training guides. Additionally, qualified instructors, training system managers, and a training budget are also required.

The visit to the Center for Naval Engineering Learning Site in San Diego by the author resulted in the following considerations concerning the training system resources of their facilities:

- The general condition of the spaces, including heating, cooling, ventilation, and other environmental factors in the classrooms/labs, is satisfactory
- The availability of training devices, test equipment, damage control and firefighting gear/tools is adequate
- The general condition of training devices, test equipment, damage control and firefighting gear/tools, is satisfactory. In addition, equipment is stored properly. The training material is verified, functional, safe, updated and in proper working condition ready to be used just as onboard a ship
- There are enough qualified instructors to successfully instruct the training programs
- The course syllabi are current, accurate and reflect what is being taught in the courses. They also include training objectives and guidelines for determining training (learning) results

e. Training Plan and Schedule Management

The Department of the Navy (2007) Course Master Schedule Binder, defines the training plan and the schedule management of each course and, describes the schedule day by day, the type of topic (class or lab), the topic titles, the length period, and the number/ratio of students.

f. Simulation Utilization Log and Other Management Data

Statistical data are kept in the San Diego facilities regarding the following:

- Fire simulator consumables (propane, smoke generator agent, AFFF, PKP, CO2)
- Other consumables such as CO2 fire extinguishers, PKP fire extinguishers, AFFF fire extinguishers and SCBAs
- Classes taught per month and the number of students participating in each class, cumulative classes per year, and cumulative students taught per year

g. Training Evaluation Criteria and Performance Measurement Methods

All the courses are "pass" or "fail." Students do not have written exams or oral response tests. Shipboard damage control and firefighting courses are evaluated with individual skills and as a team by instructors with the method of observation.

A student can actually fail in the following conditions:

- Injuries or medical reasons
- Failure to show up for class
- Failure to participate in the class/lab
- Missing ten percent or more of the course

h. Training Performance Data

Data concerning trainees' success or failure and student critique forms are kept for feedback.

3. Survey Administration - Data Collection

At the end of each course, the author administered a survey both to instructors and students to examine their attitudes and opinions about the training provided and received, respectively.

a. Participant Population and Recruitment

The participants of the research were twelve instructors and 38 students of the “Shipboard Damage Control Trainer” and “Shipboard Firefighting” courses that took place in the facilities of the U.S. Navy Center for Naval Engineering Learning Site, in San Diego.

The recruitment took place in this location by the author’s personal and verbal contact before the start of each training session. The student investigator informed the candidates that participation was voluntary, not required by their supervisor, and part of his NPS thesis research.

A consent form was given to each participant prior to the beginning of the survey to confirm voluntary participation and inform about the scope and the potential benefits of the study. Furthermore, participants were informed about the duration of the survey and that they were free to skip any questions or stop participating in the survey anytime without any penalty. Also, the students were told that the questionnaires were anonymous and the results of the survey would be used responsibly and protected against release to unauthorized persons, and they would –only be used for the purpose of this thesis. The procedures used in this research were approved by the NPS Institutional Review Board (IRB).

b. Survey Administration (with Rating Items and Open-ended Items)

The author administered a written survey questionnaire to instructors and students of the Center for Naval Engineering Learning Site in San Diego, regarding their reaction and opinion engendered by the damage control and firefighting training they provided and received, respectively.

In this way, the author administered two sets of questionnaires that are illustrated in Appendices A and B. The questions of the survey were constructed in such a way to reflect the specific learning objectives of the courses and damage control doctrinal standards as taught by the instructors. Thus, twenty questions with rating items and open-ended items were developed for students and nine questions for instructors correspondingly.

V. RESULTS

A. DATA ANALYSIS

The purpose of the survey was to investigate the opinions and measure the level of satisfaction of both instructors and students regarding the "Shipboard Damage Control Trainer" and "Shipboard Firefighting" training courses. There were 38 students and twelve instructors of that participated in the survey; thus, 50 questionnaire forms were received in total.

B. STUDENT AND INSTRUCTOR OPINION FORM QUESTIONNAIRE RESPONSES

The inspiration for the following analysis is Zaharee's, (2003) *Training Program Review: Theater Battle Management Core Systems (TBMCS) Training Program Evaluation.* Furthermore, tables' presentations are based on the Master Thesis of Ray, (2010).

In this section, the author presents the responses given by students and instructors in the survey concerning their opinion/attitude of the training courses.

1. Student Opinion Forms

a. Rating Questions

Tables 5 through 20 illustrate the responses to the course opinion survey questions:

The plan of instruction/training syllabus was current and accurate		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	26.3%	10
Strongly Agree	71%	27
answered question		**38**
skipped question		**0**
NA		**1**

Table 5. Question 1 Results

An average of 71% of the students strongly agreed that the plan of instruction/training syllabus was current and accurate while 26.3% of the students agreed. With a cumulative total of 97.3% of students who strongly agreed or agreed, the results of Question 1 reveal that the vast majority of students perceived the plan of instruction/training syllabus was current and accurate

The plan of instruction/training syllabus reflects what is being taught in the course		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	21%	8
Strongly Agree	76.3%	29
answered question		**38**
skipped question		**0**
NA		**1**

Table 6. Question 2 Results

An average of 76.3% of the students strongly agreed that the plan of instruction/training syllabus reflects what is being taught in the course while 21% of the students agreed. With a cumulative total of 97.3% of students who strongly agreed or agreed, the results of Question 2 reveal that the majority of students perceived the plan of instruction/training syllabus reflects what is being taught in the course.

The goals/objectives of the training were clearly defined		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	0.8%	1
Agree	21%	8
Strongly Agree	76.3%	29
answered question		**38**
skipped question		**1**

Table 7. Question 3 Results

An average of 76.3% of the students strongly agreed that the goals/objectives of the training were clearly defined while 21 % of the students agreed. With a cumulative total of 97.3% of students who strongly agreed or agreed, the results of Question 3 reveal that the majority of students perceived the goals/objectives of the training were clearly defined.

The training material/student guides were sufficient to support the course		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	5.2%	2
Agree	28.9%	11
Strongly Agree	63.1%	24
answered question		**38**
skipped question		**0**
NA		**1**

Table 8. Question 4 Results

An average of 63.1% of the students strongly agreed that the training material/student guides were sufficient to support the course while 28.9% of the students agreed. An average of 5.2% of the students responded neutral to the question. With a cumulative total of 92% of students who strongly agreed or agreed versus a cumulative total of 5.2% of students who were neutral, the results of Question 4 reveal that the majority of students perceived the training material/student guides were sufficient to support the course.

The duration of the course was sufficient to adequately cover the training material/objectives of the course		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	7.8%	3
Agree	15.7%	6
Strongly Agree	47.3%	18
answered question		**38**
skipped question		**0**
NA		**11**

Table 9. Question 5 Results

An average of 47.3% of the students strongly agreed that the duration of the course was sufficient to adequately cover the training material/objectives of the course while 15.7% of the students agreed. An average of 7.8% of the students responded neutral to the question. Also, an average of 28.9% answered not available/do not know. With a cumulative total of 63% of students who strongly agreed or agreed versus a cumulative total of 36.7% of students who responded neutral or do not know the results of Question 5 reveal that the majority of students perceived the duration of the course was sufficient to adequately cover the training material/objectives of the course.

The course was very well organized		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	21%	8
Strongly Agree	78.9%	30
answered question		**38**
skipped question		**0**

Table 10. Question 6 Results

An average of 78.9% of the students strongly agreed that the course was very well organized while 21% of the students agreed. With a cumulative total of 99.9% of students who strongly agreed or agreed, the results of Question 6 reveal that the majority of students perceived the course was very well organized.

The lectures were very helpful		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	7.8%	3
Agree	21%	8
Strongly Agree	65.7%	25
answered question		**38**
skipped question		**0**
NA		**2**

Table 11. Question 7 Results

An average of 65.7% of the students strongly agreed that the lectures were very helpful while 21% of the students agreed. An average of 7.8% of the students responded neutral to the question. With a cumulative total of 86.7% of students who strongly agreed or agreed versus a cumulative total of 7.8% of students who were neutral the results of Question 7 reveal that the majority of students perceived the lectures were very helpful.

The scenarios in the fire simulator were realistic		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree	2.6%	1
Neutral		
Agree	13.1%	5
Strongly Agree	84.2%	32
answered question		**38**
skipped question		**0**
NA		

Table 12. Question 8 Results

An average of 84.2% of the students strongly agreed that the scenarios in the fire simulator were realistic while 13.1% of the students agreed. An average of 2.6% of the students disagreed that the scenarios in the fire simulator were realistic. With a cumulative total of 97.3% of students who strongly agreed or agreed versus a cumulative total of 2.6% of students who disagreed, the results of Question 8 reveal that the majority of students perceived the scenarios in the fire simulator were realistic.

The practical session in the fire simulator was very helpful		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	15.7%	6
Strongly Agree	81.5%	31
answered question		**38**
skipped question		**0**
NA		**1**

Table 13. Question 9 Results

An average of 81.5% of the students strongly agreed that the practical session in the fire simulator was very helpful while 15.7% of the students agreed. With a cumulative total of 97.2% of students who strongly agreed or agreed, the results of Question 9 reveal that the majority of students perceived the practical session in the fire simulator was very helpful.

The instructors were knowledgeable about the topic		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	7.8%	3
Strongly Agree	81.5%	31
answered question		**38**
skipped question		**4**

Table 14. Question 10 Results

An average of 81.5% of the students strongly agreed that the instructors were knowledgeable about the topic while 7.8% of the students agreed. With a cumulative total of 89.3% of students who strongly agreed or agreed, the results of Question 10 reveal that the majority of students perceived the instructors were knowledgeable about the topic.

The instructors were properly prepared for the course		
Strongly Disagree		
Disagree		
Neutral		
Agree	7.8%	3
Strongly Agree	81.5%	31
answered question		**38**
skipped question		**4**

Table 15. Question 11 Results

An average of 81.5% of the students strongly agreed that the instructors were properly prepared for the course while 7.8% of the students agreed. With a cumulative total of 89.3% of students who strongly agreed or agreed, the results of Question 11 reveal that the majority of students perceived the instructors were properly prepared for the course.

The goals / objectives of the training have been met		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	26.3%	10
Strongly Agree	63.1%	24
answered question		**38**
skipped question		**4**

Table 16. Question 12 Results

An average of 63.1% of the students strongly agreed that the goals/objectives of the training were met while 26.3% of the students agreed. With a cumulative total of 89.4% of students who strongly agreed or agreed, the results of

Question 12 reveal that the majority of students perceived the goals/objectives of the training were met.

I was satisfied with the overall training received		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	18.4%	7
Strongly Agree	71%	27
answered question		**38**
skipped question		**4**

Table 17. Question 13 Results

An average of 71% of the students strongly agreed that they were satisfied with the overall training received while 18.4% of the students agreed. With a cumulative total of 89.4% of students who strongly agreed or agreed, the results of Question 13 reveal that the majority of students perceived they were satisfied with the overall training received.

Training received will increase my confidence in my ability to effectively fight a fire aboard my ship		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	15.7%	6
Strongly Agree	73.6%	28
answered question		**38**
skipped question		**4**

Table 18. Question 14 Results

An average of 73.6% of the students strongly agreed that training they received will increase their confidence in their ability to effectively fight a fire aboard their ship while 15.7% of the students agreed. With a cumulative total of 89.3% of students who strongly agreed or agreed, the results of Question 14 reveal that the majority of students perceived training they received will increase their confidence in their ability to effectively fight a fire aboard their ship.

The level of instruction was of high quality		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral		
Agree	18.4%	7
Strongly Agree	71%	27
answered question		**38**
skipped question		**4**

Table 19. Question 15 Results

An average of 71% of the students strongly agreed that the level of instruction was of high quality while 18.4% of the students agreed. With a cumulative total of 89.4% of students who strongly agreed or agreed, the results of Question 15 reveal that the majority of students perceived the level of instruction was of high quality.

Overall, I would rate the quality of the received firefighting training received		
Answer Options	**Response Percent**	**Response Count**
Fair		
About Average		
Excellent	10.5%	4
Outstanding	78.9%	30
answered question		**38**
skipped question		**4**

Table 20. Question 16 Results

An average of 78.9% of the students answered that the overall quality of the received firefighting training, was outstanding while 10.5% of the students thought it was excellent. With a cumulative total of 89.4% of students who answered outstanding or excellent, the results of Question 16 reveal that the majority of students perceived the overall quality of the received firefighting training was high.

b. Open-ended Questions

The open-ended questions of the survey allowed students to provide comments and suggestions that they believed would improve the performance of the firefighting training received. The responses to the open-ended questions are shown below:

(1) Question 17: The most valuable part of the training

- The practical phase in simulators with live fire and realistic damage control scenarios
- Real sense of heat and temperature
- The demonstration and the walk through the simulator compartments before the start of the actual scenarios
- Learning changes since last time course was taken
- Proper hose use techniques
- Learning to use the various firefighting equipment
- Realistic firefighting
- Safety procedures

(2) Question 18: The least valuable part of the training

- The waiting time between the execution of scenarios
- The PowerPoint presentation of the firefighting courses

(3) Question 19: Changes or additions if unlimited funds and resources exist

- Send all hands to participate in the courses
- Longer course durations especially for the one-day courses
- More training time in simulators; Longer, more, and stronger scenarios

- More exposure to various fires; allow students to use/experience fighting fires with CO_2, PKP, AFFF
- More equipment
- A real Navy ship as the simulator platform

(4) Question 20: Additional comments/explanations or recommendations that could improve the quality of the firefighting training

- More training time in simulators
- Longer courses
- Use of all damage control and firefighting equipment

2. Instructor Opinion Forms

a. Rating Questions

Tables 20 through 24 illustrate the instructor's responses to course satisfaction survey questions:

Attending the training was a good use of student's time		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	8.3%	1
Agree	8.3%	1
Strongly Agree	83.3%	10
answered question		**12**
skipped question		**0**

Table 21. Question 1 Results

An average of 83.3% of the instructors strongly agreed that attending the training was a good use of a student's time while 8.3% of the instructors agreed. An average of 8.3% of the instructors responded neutral to the question. With a cumulative total of 91.6% of instructors who strongly agreed or agreed versus a cumulative total of

8.3% of instructors who were neutral, the results of Question 1 reveal that the majority of instructors perceived attending the training was a good use of a student's time.

The level of instruction was of high quality		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	8.3%	1
Agree	8.3%	1
Strongly Agree	83.3%	10
answered question		**12**
skipped question		**0**

Table 22. Question 2 Results

An average of 83.3% of the instructors strongly agreed that the level of instruction was of high quality while 8.3% of the instructors agreed. An average of 8.3% of the instructors responded neutral to the question. With a cumulative total of 91.6% of instructors who strongly agreed or agreed versus a cumulative total of 8.3% of instructors who were neutral, the results of Question 2 reveal that the majority of instructors perceived the level of instruction was of high quality.

Training environment was of high quality		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	8.3%	1
Agree	16.6%	2
Strongly Agree	75.0%	9
answered question		**12**
skipped question		**0**

Table 23. Question 3 Results

An average of 75% of the instructors strongly agreed that the training environment was of high quality while 16.6% of the instructors agreed. An average of 8.3% of the instructors responded neutral to the question. With a cumulative total of 91.6% of instructors who strongly agreed or agreed versus a cumulative total of 8.6% of instructors who were neutral, the results of Question 3 reveal that the majority of instructors perceived the training environment was of high quality.

The scenarios in the fire simulator were realistic		
Answer Options	**Response Percent**	**Response Count**
Strongly Disagree		
Disagree		
Neutral	8.3%	1
Agree	16.6%	2
Strongly Agree	66.6%	8
answered question		**12**
skipped question		**1**
NA		**1**

Table 24. Question 4 Results

An average of 66.6% of the instructors strongly agreed that the scenarios in the fire simulator were realistic while 16.6% of the instructors agreed. An average of 8.3% of the instructors responded neutral to the question and 8.3% of the instructors answered not available/do not know. With a cumulative total of 83.3% of instructors who strongly agreed or agreed versus a cumulative total of 16.7% of instructors who were neutral or answered not available/do not know, the results of Question 4 reveal that the majority of instructors perceived the scenarios in the fire simulator were realistic.

Overall, I would rate the quality of the firefighting training provided		
Answer Options	**Response Percent**	**Response Count**
Fair		
About Average		
Excellent	16.6%	2
Outstanding	83.3%	10
answered question		12
skipped question		0

Table 25. Question 5 Results

An average of 83.3% of the instructors answered that the overall quality of the provided firefighting training was outstanding while 16.6% of the instructors thought it was excellent. With a cumulative total of 100% of instructors who answered outstanding or excellent versus no instructors who thought the training was about average or fair, the results of Question 5 reveal that all instructors perceived the overall quality of the provided firefighting training was excellent or outstanding.

b. Open-ended Questions

The open-ended questions of the survey allowed instructors to provide comments and suggestions that they believed would improve the performance of the firefighting training received by students. The responses to the open-ended questions are shown below:

(1) Question 6: The most valuable part of the training

- The hands-on live fire training on the simulators

(2) Question 7: The least valuable part of the training

- None

(3) Question 8: Changes or additions if unlimited funds and resources exist

- Brand new gear and equipment
- Longer course durations

(4) Question 9: Additional comments/explanations or recommendations that could improve the quality of the firefighting training

- None

VI. DISCUSSION, SUMMARY FINDINGS, RECOMMENDATIONS, AND FUTURE RESEARCH

A. DISCUSSION

After the analysis, processing, and integration of the three methodology phases, the author extracted the following conclusions related to the damage control and firefighting training provided at the U.S. Navy Center for Naval Engineering Learning Site in San Diego:

- The visit to the training facilities was a worthwhile experience for the author since he had the opportunity to observe and participate in all phases of training; he was also able to gain much insight into how some damage control and firefighting training courses, using simulators, were conducted
- Every stage and phase of training is standardized and based on predefined training manuals/guides
- Simulator platforms-trainers are effective, operational, and provide realistic and high-quality training
- The training syllabi and learning objectives of various courses are current, accurate, and reflect the actual and realistic needs of modern Navies' damage control and firefighting functions
- The training scenarios in simulators are realistic and reveal the real requirements of firefighting aboard Navy ships
- Instructors follow a standard procedure in order to be selected, trained, evaluated, certified, and qualified
- The training system resources are adequate and sufficient to provide advanced high-level training
- The training plan and schedule management are accurately predefined in the training manuals in the school
- Simulation utilization logs and management statistical data regarding simulator consumptions, material, students' pipeline, and training courses are thoroughly kept in the training facilities
- Students' opinion forms-critiques concerning safety, instructor/courses evaluations are collected and maintained for further analysis
- During this study, instructors' and students' subjective ratings and opinions about the damage control and firefighting training courses were

absolutely positive. The majority of personnel involved in the training thought that the overall quality of the firefighting and damage control training was excellent or outstanding.

B. SUMMARY FINDINGS

After participating in several damage control and firefighting courses, investigating the main training system components, and administering surveys to instructors and students regarding their attitude and opinion about the training system, the author was led to the following considerations:

- The damage control and firefighting training currently provided at the Center for Naval Engineering Learning Site in San Diego is very effective, valuable, professionally delivered, and of very high quality
- The training meets its goals and objectives
- The training is certainly beneficial for trainees and consequently for the U.S. Navy
- This training program/plan can be utilized as a "Training Evaluation Model" and "Training Doctrine" for any program with similar characteristics

C. RECOMMENDATIONS

Considering that damage control and firefighting training courses need to be permanently updated, effective and maintained at a high quality, the author proposes some recommendations/considerations that can potentially lead to training enhancements and improvements:

- Continuous and uninterrupted propane supply should be available when required to ensure the smooth operation and continuous availability of fire simulators and consequently the training courses
- A periodic maintenance plan for simulators should be implemented to ensure that they are operational and ready to constantly serve the training purposes
- The training equipment as well as damage control and firefighting gear/apparatus used for training should have equivalent and analogous inspection standards as those in Navy ships

- The Phase Replacement Plan for the training equipment and gear needs to be automatically executed in order to ensure uninterrupted and high quality training
- If funds are available, new gear acquisition could be considered to replace older equipment
- If resources permit, reinforcement with newly qualified instructors would be beneficial
- New technologies, material, equipment or gear could be firstly provided to the training facilities and afterwards to Navy ships.
- After the completion of each course, students should be given the training material/student guides taught in class in the form of a CD or DVD as a reference to revise and recur when needed
- A close cooperation between the U.S. Navy and the U.S. Fire Administration/civilian firefighting in terms of exchanging experiences, lessons learned, training methods, or use of new technologies in firefighting, would be beneficial
- Like the firefighting training in the civilian National Fire Academy, the crewmembers/candidates of a Navy ship should complete some damage control/firefighting training courses online before arriving at the firefighting training centers

D. FUTURE RESEARCH

Considering the damage control and firefighting training provided in the Center for Naval Engineering Learning Site in San Diego as a training evaluation model and training doctrine, an analogous evaluation of the Hellenic's damage control and firefighting training program could be applied.

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APPENDIX A. STUDENT OPINION FORM QUESTIONNAIRE

STUDENT OPINION FORM FOR NPS THESIS STUDY[1]

Please enter your participant number. (Your participant number is the last 4 digits of your home or cell telephone number):

We are interested in your assessment of the firefighting training received during the "Advanced Shipboard Firefighting" course and would like to ask you to complete the following form. For each statement, please check if you agree or disagree using a rating scale from "1" to "5". A rating of "1" indicates that you strongly disagree with the statement and a rating of "5" indicates that you strongly agree and "3" is the level where you neither agree nor disagree (neutral). Also, a "N/A" (Not Applicable) choice is available if you feel unqualified or unable to answer any particular question. Please answer all questions.

CATEGORIES		**Check your response using the following scale:** 1- Strongly Disagree 2- Disagree 3- Neutral 4- Agree 5- Strongly Agree				
Instruction		1	2	3	4	5
1.	The plan of instruction / training Syllabus was current and accurate N/A	⬭				
2.	The plan of instruction / training Syllabus reflect what is being taught in the course N/A	⬭				
3.	The goals / objectives of the training were clearly defined N/A	⬭				
4.	The training material / student guides were sufficient to support the course N/A	⬭				
5.	The duration of the course (4 days) was sufficient to cover adequately the training material / objectives of the course N/A	⬭				
6.	The course was very well organized N/A	⬭				
7.	The lectures were very helpful N/A	⬭				
8.	The scenarios in the fire simulator were realistic N/A	⬭				

[1] This questionnaire is used to assess students' opinions following the "Advanced Shipboard Firefighting Training" course. The questions are based on: *DoD Handbook Instructional Systems Development/Systems Approach to Training and Education (MIL-HDBK-29612-2A, 31 August 2001), and NPS Student Opinion Form (SOF).*

9.	The practical session in the fire simulator was very helpful N/A	⬭				
	Instructors					
10.	The instructors were knowledgeable about the topic N/A	⬭				
11.	The instructors were properly prepared for the course N/A	⬭				
	General Satisfaction					
12.	The goals / objectives of the training have been met N/A	⬭				
13.	I was satisfied from the overall training received N/A	⬭				
14.	Training received will increase my confidence in my ability to effectively fight a fire aboard my ship N/A	⬭				
15.	The level of instruction was of high quality N/A	⬭				

Please use the following scale for the next item based upon your experience with other training classes:		**Check your response:** 1- Fair 2- About Average 3- Excellent 4- Outstanding			
		1	2	3	4
16.	Overall, I would rate the quality of the received firefighting training received N/A	⬭			

Open-ended questions

17. What was the most valuable part of the training for you?

18. What was the least valuable part of the training for you?

19. If unlimited funds and resources exist, what changes or additions would you suggest?

20. Please provide any additional comments / explanations or recommendations that could improve the quality of the firefighting training

APPENDIX B. INSTRUCTOR OPINION FORM QUESTIONNAIRE

INSTRUCTOR OPINION FORM FOR NPS THESIS STUDY[2]

Please enter your participant number. (Your participant number is the last 4 digits of your home or cell telephone number):

We are interested in your assessment of the training provided during the "Advanced Shipboard Firefighting" course and would like to ask you to complete the form. For each statement, please check if you agree or disagree using a rating scale from "1" to "5". A rating of "1" indicates that you strongly disagree with the statement and a rating of "5" indicates that you strongly agree and "3" is the level where you neither agree nor disagree (neutral). Also, a "NA" (Not Applicable) choice is available if you feel unqualified or unable to answer any particular question. Please answer all questions.

<u>Check your response using the following scale:</u>

1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree.

		1	2	3	4	5
1.	Attending the training was a good use of student's time N/A ◯					
2.	The level of instruction was of high quality N/A ◯					
3.	Training environment was of high quality N/A ◯					
4.	The scenarios in the fire simulator were realistic N/A ◯					

Please use the following scale for the next item based upon your experience with other training classes:		**<u>Check your response:</u>** 1- Fair 2- About Average 3- Excellent 4- Outstanding			
		1	2	3	4
5.	Overall, I would rate the quality of the firefighting training provided N/A ◯				

2 This questionnaire is used to assess instructors' opinions following the "Advanced Shipboard Firefighting Training" course. The questions are based on: *DoD Handbook Instructional Systems Development/Systems Approach to Training and Education (MIL-HDBK-29612-2A, 31 August 2001), and NPS Student Opinion Form (SOF).*

Open-ended questions

6. What was the most valuable part of the training for you?

7. What was the least valuable part of the training for you?

8. If unlimited funds and resources exist, what changes or additions would you suggest?

9. Please provide any additional comments / explanations or recommendations that could improve the quality of the firefighting training

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