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Improvised incendiary devices risk assessment, threats, vulnerabilities and consequences

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IMPROVISED INCENDIARY DEVICES: RISK ASSESSMENT, THREATS, VULNERABILITIES AND CONSEQUENCES

by

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September 2006

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The current trend in terrorist tactics is the use of simple, inexpensive and conventional weapons. One such weapon is improvised incendiary devices (IIDs). The homeland security community has underestimated the magnitude of the threat. Policy makers must recognize the potential for terrorist cells to use IIDs to create terror and fear in the public. IIDs have the potential to create devastating fires resulting in mass casualties.

In addition to evaluating the risk of an IID attack and determining the state of preparedness of first responders, this thesis includes a proposal for the creation of two new national planning scenarios, urban and wildland conflagrations or firestorms. Recommendations will include incendiary protocols in the weapon of mass destruction matrix as represented by "I" in CBIRNE. This organizational change can be applied to the homeland security strategies, lexicons and documents of Federal, State, and local governments and the private sector to address the IID threat.

This thesis is intended to serve as a catalyst for the Department of Homeland Security to set policy that will decrease vulnerabilities and consequences of this lesser-known threat.

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IMPROVISED INCENDIARY DEVICES: RISK ASSESSMENT, THREATS, VULNERABILITIES AND CONSEQUENCES

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SEPTEMBER 11, 2001
343
NEVER FORGET

EXECUTIVE SUMMARY

Terrorists choose their targets and weapons based on weaknesses in preparedness and defense. Presently, the homeland security community does not recognize the magnitude of the threat improvised incendiary devices (IIDs) pose as a terrorist weapon, and the community is prepared neither to prevent nor respond to this simple and ubiquitous threat. Most of the research on improvised devices has overlooked IIDs and their lethality. Despite historical evidence to suggest the continued and increased use of fire as a weapon, most research on terrorist weapons has focused primarily on chemical, biological, radiological, nuclear and explosives (CBRNE), ignoring fire's devastating potential.

Fire is a simple, inexpensive, and easily employed weapon, and will be used as a terrorist weapon in the future. It is essential that the homeland security community recognize that terrorists worldwide will deploy cells using IIDs to create panic and disruption. Extreme events like firestorms or conflagrations will overwhelm first responders and fire suppression systems as they destroy large areas of cities, towns, and wildland-urban interface (WUI).

The United States' hazardous materials cargo offers the same opportunity that airliners provided on 9/11: the chance to transform hazardous materials vehicles into mobile weapons of war. Thousands of trips are made each day by gasoline tankers, many of which hold as much fuel as a Boeing 757. The September 11, 2001 attacks on the World Trade Center proved that terrorists can create fires larger than our buildings are designed to withstand. A performance study of buildings at the WTC site by a team of civil, structural, and fire protection engineers concluded it was the fire, rather than the impact from the planes, that ultimately caused the collapse of the WTC towers.

The physiological and psychological consequences of fire and an IID attack are severe. A large-scale IID attack would quickly overwhelm medical facilities with burn victims due to the limited number of beds at burn center hospitals throughout the country.

The idea of dying by fire is abhorrent, triggering intense fear. Incendiary attacks are psychologically repellant as well as physically traumatic, making this technique appealing to terrorists.

This thesis will examine the threats, vulnerabilities and consequences of IID attacks, and determine the state of preparedness of first responders. It will generate two new proposed national planning scenarios: Planning scenarios #16 IID - Urban Conflagration/Firestorm and #17 IID - Wildland and Wildland-Urban Interface (WUI) Conflagration/Firestorm. Recommendations will be made to include incendiaries in the WMD matrix as represented by "I" in CBIRNE. This conceptual and organizational change can be applied to the homeland security strategies, lexicons and documents by the federal, state, and local government and the private sector to address the IID threat.

I. INTRODUCTION

Fire knows no human boundaries. It does not recognize wealth or poverty, property or political lines. It does not distinguish between abandoned structures or places we consider valuable. It does not stop to consider the economic, social, or aesthetic value of something. It will burn whatever is in its path, as it has always done, and always will. Fire is nondiscriminatory, and thus can affect any of us.[1]

Terrorists have used fire in the past and are acutely aware of its potential as a weapon. The homeland security community, on the other hand, does not fully recognize fire as a threat. The Department of Homeland Security (DHS) and other members of the larger homeland security community are overlooking the obvious terrorist weapon – FIRE. While tremendous emphasis is placed on non-conventional weapons like chemical, biological and radiological agents, simple and inexpensive improvised incendiary devices (IIDs) can be used to meet the terrorist's objectives.

These objectives are clear: create mass anxiety and fear, and generate a sense of helplessness in a free society. A successful terrorist attack erodes the public's sense of security and exposes weaknesses in those responsible for protecting us. Fire is the ideal weapon to accomplish these objectives. There are hundreds of ways IIDs and fire could be used as a terrorist weapon, but the simple scenarios below indicate some of the potential chaos and gravity of IID attacks.

While families in an apartment building sleep, a glass container of gasoline is thrown at the base of the staircase and ignited. The fire races up the stairs, trapping and killing innocent men, women, and children. The tactic is employed simultaneously a few houses away. These attacks are repeated every night in different neighborhoods for a week. People throughout the city are petrified.

Members of a terrorist cell rent an apartment in midtown Manhattan, and begin to stockpile insect repellant, acetone and assorted other solvents a little at a time in the apartment. They cut holes in the sheetrock and expose the steel structural members,

[1] National Interagency Fire Center, "The I-Zone: A Human Dimension of Wildland Fire," http://www.nifc.gov/preved/comm_guide/wildfire/fire_9.html, [accessed July 17, 2006].

scraping off the fireproofing. In the middle of the night, they open up the gas valves on the stove, spread the flammables, set a timer and leave the apartment.[2] *One member of the group is in the basement sabotaging the fire suppression system.*

An 8,000-gallon gasoline truck is hijacked, driven into the lobby of a high-rise multiple dwelling and ignited. Thousands of people are trapped above the fire and rescuers are unable to reach them. The victims begin jumping from the upper floors to escape the flames. The fires are burning out of control and the structural steel columns supporting the building are showing signs of failure. As the fire extends to the upper floors of the building, the Incident Commander orders all first responders to evacuate the building.

In a neighborhood of the North Bronx, blocks and blocks of Queen Anne wood-frame dwellings line the streets. On a windy night when firefighters are busy extinguishing fires on the opposite side of the city, members of a terrorist cell simultaneously ignite an entire block of homes. These fires burn so intensely that other homes nearby burst into flames from the radiant heat and flying brands. In a short period of time, fires are raging throughout the neighborhood, developing into a conflagration and engulfing the entire North Bronx.

A drought is taking place in the Northeast and the reservoirs are low. The conifers in the Pine Barrens of New Jersey are extremely dry. Using timed incendiary devices, members of a terrorist cell ignite scores of wildfires in close proximity of each other near the perimeter of the Pine Barrens and adjacent local communities. The fires grow and merge into one extremely large fire developing into a firestorm, threatening the nearby communities.

The outcome of each of these scenarios is easy to predict. Any one of them could accomplish the terrorist's objectives, but imagine if they occurred at the same time - al Qaeda's modus operandi.

[2] Vincent Doherty, FDNY HazMat Specialist, email correspondence with the author July 8, 2006.

A. PROBLEM STATEMENT

Terrorists choose their targets and weapons based on weaknesses in our preparedness and defense. They continue to use conventional weapons, especially improvised explosive devices (IEDs) as their weapon of choice.[3] Unlike IEDs, improvised incendiary devices (IIDs) use low explosives that do not produce shattering shock or massive pressure waves. They do, however, produce fires that can cause significantly more damage than a comparable amount of explosives. IIDs can range from a crudely-designed, homemade incendiary device to more advanced devices using commercial or military incendiaries. The majority of these weapons are easily manufactured, inexpensive, readily available and simple to use. With respect to intent, capability and sophistication, IIDs in the hands of terrorist groups are also clearly distinguishable from simple arson.

Properly placed IIDs can create fires that have the potential to develop into a firestorm or conflagration. These fire phenomena will overwhelm first responders and fire suppression systems, destroying large areas of cities, towns, and wildland-urban interface (WUI) – an area where private homes or community infrastructure abut or are intermixed with trees and other vegetation.[4] Extinguishment will be impossible; they will continue to burn and expand until all fuel is exhausted.

The 9/11 Commission Report cites a lack of imagination as one of the failures of the intelligence community. Prior to 9/11, the intelligence community failed to recognize the significance of the al Qaeda threat.[5] Bin Laden employed IIDs – human-guided missiles in the form of commercial airliners – to ignite tremendous fires and destroy the Twin Towers. Excerpts from a videotape of bin Laden after the 9/11 attacks suggest that his intention was to use fire to destroy the Twin Towers:

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[3] Office of the Dean of Research, Naval Postgraduate School, "Improvised Explosive Devices (IEDs), an NPS Research Update," November 1, 2005, http://www.nps.edu/Research/documents/IEDupdate.pdf. [accessed July 11, 2006].

[4] Front Range Fuel Treatment Partnership Roundtable, "Living with Fire: Protecting Communities and Restoring Forests," http://www.wilderness.org/Library/Documents/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=14899, [accessed August 9, 2006].

[5] 9/11 Commission, *National Commission on Terrorist Attacks upon the United States (9/11 Commission Report)* (New York & London: W.W. Norton & Company, 2004), 339.

> We calculated in advance the number of casualties from the enemy, who would be killed based on the position of the tower. We calculated that the floors that would be hit would be three or four floors. I was the most optimistic of them all (inaudible) due to my experience in this field, I was thinking that the fire from the gas in the plane would melt the iron structure of the building and collapse the area where the plane hit and all the floors above it only. This is all that we had hoped for.[6]

It is clear that the IIDs used at the World Trade Center (WTC) in 2001 were WMDs and were emphatically more effective than the IEDs used in the 1993 terrorist attack on the WTC. Many people, including homeland security professionals, mistakenly equate IIDs with IEDs, but IIDs are distinct entities and it is essential they be recognized as a separate category of weapon.

It is vital that the public (the greatest stakeholders in an IID attack), as well as future homeland security leaders, understand the threat posed by IIDs. These devices weaponize fire and cause more catastrophic loss of life and destruction than the more famous WMDs. Most literature on terrorist weapons has focused primarily on chemical, biological, radiological, nuclear and explosives (CBRNE) and ignored the devastating potential of fire.

Vincent Brannigan, a fire service expert in the field of building collapse, points out that a terrorist arson attack is analogous to but in some ways more serious than an attack using explosives.[7] Both fires and explosives can cause the progressive collapse of a structure. Fire, however, can spread well beyond the outer limits of an explosion and weaken structural members remote from the original site. On September 11, 2001 the World Trade Center towers collapsed because of the fires, igniting all the surrounding buildings and destroying the entire sixteen-acre complex.

The attacks proved that terrorists can create fires larger than our buildings are designed to withstand. In a National Institute of Standards and Technology (NIST) study, it was determined that despite the impact of the two aircraft striking the towers at high speed and damaging the principal structural components, the towers would have

[6] CNN.com, "Excerpt from bin Laden tape," December 13, 2001, http://archives.cnn.com/2001/US/12/13/ret.bin.laden.quotes/index.html, [accessed August 1, 2006].

[7] Vincent Brannigan, "How Do We Regulate the Risk of Terrorism?" *Fire Chief Magazine*, August 1, 2002, http://firechief.com/mag/firefighting_regulate_risk_terorism/index.html, [accessed November 1, 2005].

remained standing were it not for the dislodged fireproofing and the subsequent multiple floor fires.[8] The tremendous fires generated from the fuel of the two airliners (two large IIDs) crashing into the WTC towers ignited combustible materials on a number of floors; the resulting fire weakened the structural members, causing the progressive floor-by-floor collapse of both 110-story office buildings.

A region or city attacked by terrorists employing IIDs would generate more burn victims that any burn center has the surge capacity, burn victim beds, or other resources to handle. Most hospitals can treat the initial burn casualties, but would rapidly become taxed as more victims arrived. Once burn victims are stabilized, they require special care available only at burn centers. At a congressional briefing with the House Committee on Homeland Security on mass burn casualties, Cham E. Dallas, Professor of Toxicology and Director of the CDC Center for Mass Destruction Defense at the University of Georgia, cautioned members of the committee that burn injuries have emerged as a prime worry in his center's latest studies.[9] The point here is that this threat affects every discipline and agency in homeland security, particularly the medical and public health communities.

Fires can be set anywhere and any time. Presently, the homeland security community does not recognize the magnitude of the threat from arson and IIDs as a terrorist weapon, and is thus unprepared for the prevention of or response to this simple and ubiquitous threat:

- Many DHS training programs, exercise activities, and grant funds focus on weapons of mass destruction rather than all-hazards and fire.
- The hazardous materials trucking industry has a tremendous availability of incendiary materials and is highly vulnerable to exploitation by terrorists groups. Little has been accomplished by Homeland Security to harden this vulnerability.
- Funding for academic studies on firestorms and conflagrations is limited.
- There are an insufficient number of burn care centers in the U.S.; a catastrophic fire will quickly overwhelm these medical facilities.

[8] National Institute of Standards and Technology (NIST), "Final Report of the National Construction Safety Team on the Collapses of the World Trade Center Towers, Executive Summary," xliii, http://wtc.nist.gov/pubs/NCSTAR1ExecutiveSummary.pdf, [accessed August 2, 2006].

[9] Cham E. Dallas, "U.S. Congressional Briefing with the House Committee on Homeland Security," *NY Post*, November 10, 2005, http://nypost.com, [accessed December 18, 2005].

- Incendiary devices are listed in Title 18 of the U.S. Code, but incendiaries are grouped as a subset of explosives and not identified in CBRNE.
- The National Planning Scenario includes five catastrophes that could result in massive fires, but fire is mentioned only cursorily in these scenarios.

Unless DHS acknowledges and acts on the threat posed by IIDs, the entire homeland security community will remain unprepared to prevent or respond to an attack.

The goal of this thesis is three-fold. First, it will introduce and define the concept of IIDs and argue that the U.S. is not fully prepared for a terrorist attack employing them. The nation's fire departments are able to handle a great many incidents; if properly staffed and outfitted, they would be able to handle a great many more. Second, it will make the argument that IIDs should be included in the WMD matrix, which would then change from CBRNE to CBIRNE. Third, it will generate two new proposed national planning scenarios: #16 IID - Urban Conflagration/Firestorm and #17 IID - Wildland and WUI Conflagration/Firestorm. Through these recommendations it will contribute to the preparedness of the United States as identified in the *National Preparedness Goal* to prevent, protect against, respond to, and recover from terrorist attacks, major disasters, and other emergencies of national significance.

B. LITERATURE REVIEW

There is a limited amount of research on IIDs as a terrorist tactic, since the term itself is new – distinct from but not unrelated to arson and explosives. The second-tier research and literature on arson, fire, and explosives are therefore useful as a starting point and a frame of reference. The sub-literatures that support the current discussion and that will be addressed in this section are documents on the use of fire and incendiary devices by nation-states in war; sources on contemporary terrorist groups using arson and IIDs; descriptions of hazardous materials transported by the trucking industry as alternative weapon or surrogate bombs; information on the effects of fire on the structural components of structures and buildings; and the psychological and medical consequences affecting victims of an incendiary attack. Other sources include government documents guiding the development of the national planning scenarios, as well as the many policy and strategy reports, documents and directives for homeland security.

Fire and incendiary devices, the oldest known weapons, have long been used as a tactic or weapon in warfare. In a study of the history of incendiary devices, the Global Security Institute traced the use of incendiaries in battle back to biblical times.[10] Another source describing the ancient predecessor of napalm, known as Greek Fire, describes how Greek Fire clung to everything it touched, ignited any organic material spontaneously, and was unable to be extinguished with water. This ancient IID was especially deadly in naval combat, and has been cited as a prime reason for the long survival of the Byzantine Empire.[11]

Fire and incendiary weapons continued to govern the battlefield for hundreds of years. When the American Civil War started in 1861 the use of Greek Fire was threatened but never used. Flame and incendiary weapons have been used in almost every war.[12] The Germans first employed flamethrowers during World War I against the French at Malencourt, and by 1916, Britain and France had utilized flamethrowers as well.

During World War II, the U.S. Secretary of War directed the development of flamethrowers for the U.S. military after the Germans made use of flamethrowers in Poland, Belgium, and France.[13] In addition to flamethrowers, both Britain and the United States conducted research on incendiary bombs. Lynn Eden, in *The Whole World on Fire*, examines the policies of both Britain and the U.S. in deploying incendiary bombs. Both countries sought an understanding of the physical processes involved in the spread of fire throughout a city and the ability to assess fire damage.[14] Fire experts involved in

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[10] Global Security Institute, "Incendiary Weapons: History," http://www.globalsecurity.org/military/systems/munitions/incendiary-history.htm, [accessed December 12, 2005].

[11] Encyclopedia Britannica, "Greek Fire," *Encyclopedia Britannica Premium Service*, http://www.britannica.com/eb/article-9037919, [accessed 16 September 2005].

[12] Global Security Institute, "Incendiary Weapons: History," http://www.globalsecurity.org/military/systems/munitions/incendiary-history.htm, [accessed December 12, 2005].

[13] Ibid.

[14] Lynn Eden, *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation* (Ithaca & London: Cornell U. P., 2004), 67.

assessing and predicting damage from incendiary weapons determined "area" damage by fire, rather than "precision" damage by blast; this was seen as a more effective way to degrade enemy capabilities and morale.[15]

The U.S. bombing policy during World War II was concerned with precision bombing and the resulting blast damage. Eden points out that the area bombing strategy with incendiary bombs was more deeply embedded in British doctrine than American. Sir Charles Portal, British commander-in-chief of the Bomber Command, supported the strategy of dropping a large quantity of incendiaries followed by a sustained attack with high explosives to drive the firefighters underground, burst the water mains and let the flames get a good hold. Instead of trying to blow up each building with high explosives, the aim was to start simultaneous conflagrations in the center of a targeted town such that the ensuing fires would consume the whole town, including major target systems such as oil refineries, aircraft production, aluminum plants, ports and shipping, communications, naval targets, and transport.[16] Today, just as during World War II, U.S. policy makers and homeland security experts are focused on explosives in the form of IEDs and are ignoring the threat of IIDs and fire in a terrorist attack.

The U.S. military today uses incendiary weapons to attack strongholds in Iraq. Mark Sappenfield, in an article published in the *Christian Science Monitor*, reviews evidence that the U.S. used incendiary weapons in the Iraqi city of Fallujah in 2004 during Operation Iraqi Freedom. According to Sappenfield, white phosphorous rounds were used by gunners against insurgents during the battle of Fallujah to set enemy positions on fire.[17] Though our own military uses incendiary weapons, the homeland security community still ignores the threat they pose in the hands of terrorists.

The use of fire and incendiary weapons by enemy states engaged in formal battle is fairly well-known and documented, but fire and incendiary devices have also been used asymmetrically. The Ku Klux Klan (KKK) has used fire for over a hundred years to

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[15] Lynn Eden, *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation* (Ithaca & London: Cornell U. P., 2004), 67.

[16] Ibid., 68.

[17] Mark Sappenfield, "Arms Controversy in Iraq," *Christian Science Monitor*, November 18, 2005, http://www.csmonitor.com/205/1118/p03s01-usmi.html, [accessed November 20, 2005].

spread terror in the African-American population across the country. Fires and fire-bombings in churches across the U.S. can be classified as incendiary terrorism. The Animal Liberation Front (ALF) and Earth Liberation Front (ELF) are two domestic extremist groups that consistently use arson as a terrorist weapon.

IID attacks by Islamic terrorists and others intent on causing the death and destruction of innocent civilians could be readily accomplished, for example via the hazardous materials trucking industry, where the availability of incendiary material is well known. The trucking industry, a major component of the U.S. transportation sector, receives much less funding both in raw dollars and proportionate to other transportation industries. Saul B. Wilen of International Horizons Unlimited points out the airline industry uses billions for security while the trucking industry receives about $500,000 per year. This money is used to train drivers on how to detect and report suspicious activities that might have terrorist or national security implications under the Driver Awareness Education Program.[18] There are over 800,000 hazardous material shipments per day; many involve materials that could be used for terrorist attacks of staggering potential for deaths, injuries, property damage, and business disruption.[19]

Some elected officials, such as U.S Senator Charles Schumer (D-NY), are aware of the risk to the trucking industry. In May of 2004, Senator Schumer persuaded the U.S. Transportation Security Administration to adopt a comprehensive anti-terrorist truck-bomb plan. The plan requires background checks for every truck driver carrying hazardous materials including gasoline. Schumer argued the federal government needs to build on this and require background checks of all truck drivers, tracking devices in every truck, a database to monitor hazardous materials traveling by road, and federal funds to

[18] Saul B. Wilen, "Countering Terrorism Threats: Trucking Industry and Multi-Modal Distribution Network Vulnerabilities," International Horizons Unlimited, Ltd, February 10, 2003, http://www.intlhorizons.com/article-trucking.htm, [accessed December 30, 2005].

[19] Federal Motor Carrier Safety Administration, *Hazardous Materials Safety and Security Technology Field Operational Test, Volume 1: Evaluation Final Report Executive Summary*, http://www.fmcsa.dot.gov/safety-security/hazmat/fot/eval-rpt-summary-part5.htm, [accessed August 2, 2006].

pay overtime to New York City Police Department (NYPD) and Port Authority police now checking trucks entering New York City (NYC).[20]

As elected officials work to develop legislation to protect against IIDs, first responders must develop awareness and knowledge of the threat. Robert Burke, in *Counter-Terrorism for Emergency Responders*, describes the many types of simple and inexpensive incendiary devices. An incendiary device requires only an ignition source, a flammable or combustible fuel, and some type of housing or container. Some of the components used to assemble a device can include flares, motor fuels such as gasoline or diesel, electric light bulbs, electrical appliances and components, fireworks, reactive chemicals, propane and butane cylinders and plastic pipes, bottles, and cans.[21]

Because of the ease of obtaining and creating improvised incendiary devices, terrorists can use fire as a low-cost weapon of terror. According to Michael J. Karter of the National Fire Protection Association, U.S. fire departments in 2005 responded to an estimated 31,500 intentionally set structure fires that caused $664 million in property loss and 315 deaths.[22] The National Center for the Analysis of Violent Crime (NCAVC) conducted a study on motive classifications for arson. The study identified vandalism, excitement, revenge, crime concealment, profit and terrorism as motivations for arson.[23] Deliberately set fires motivated by spite and revenge are directed at people and can therefore be considered weapons. These fires are set specifically to inflict personal and emotional harm.

The idea of death by fire triggers intense fear in most people. Indeed, part of their appeal to terrorists is that incendiary attacks are psychologically repellent. Research on natural and human-caused disasters strongly suggests that the psychological reactions

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[20] Charles Schumer, "Anti-Terror Bomb Plan," Schumer Website, Press release, http://schumer.senate.gov/SchumerWebsite/pressroom/pressreleases/2004/PR02660.Trucksec053004.pf.html, [November 20, 2005].

[21] Robert Burke, *Counter-Terrorism for Emergency Responders* (Boca Raton, Fla.: Lewis Publishers, 2000), 168.

[22] Michael J. Karter, "Fire Loss in the U.S. during 2005," National Fire Protection Association, Fire Analysis and Research Division, Quincy, Massachusetts, July 2006, iii, http://www.nfpa.org/assets/files/PDG/OS.fireloss.pdf, [assessed August 4, 2006].

[23] American Re-Insurance Company, *A Guide to Arson Investigation: Motive, Means and Opportunity* (Corporate Communications and Advertising, Department of American Re-Insurance Company, 1996, 9, http://www.amre.com/content/rl/arson.pdf, [accessed August 15, 2006].

following human-caused disasters such as terrorism are more intense and prolonged than those following natural disasters. In addition to the physical destruction resulting from an incendiary attack, this fear and psychological trauma is a central part of the terrorist's goals.

The literature offers solid research on both domestic and international groups who have used IIDs as a terrorist weapon as well as the medical and psychological effects of fire as a weapon. Historical accounts show that fire has always been a favored weapon in military operations. Evidence suggests that the trucking industries and other transportation sectors will most likely be targeted by terrorists using IIDs.

C. METHOD

In addition to evaluating the threat of an IID attack against mandated national preparedness strategies and the target capabilities lists to determine the state of preparedness of first responders, this thesis will propose two new national planning scenarios. Planning scenario #16 addresses conflagrations or firestorms from IIDs in an urban setting, while scenario #17 addresses conflagrations or firestorms from IIDs in a wildland and WUI environment. These scenarios will complement existing national planning scenarios to contribute to the preparedness of the United States from a terrorist attack. Recommendations will be made to include incendiary weapons in the WMD matrix as represented by "I" in CBIRNE as an organizational change in the federal, state, local and private sector to address the IID threat through the Homeland Security Strategies, lexicons and documents.

This thesis uses the protection program strategy for reducing risk of critical infrastructure and key resources (CI/KR) from the *National Infrastructure Protection Plan* (NIPP). The risk can be measured or calculated by analyzing the threat, vulnerability and consequences of IIDs. Integrated risk-reduction activities for IIDs can then be accomplished by employing protective programs that address the threat, vulnerability and consequence for each element of risk.

- Threat – protective programs to reduce threat by lessening vulnerability and lowering consequences making targets less attractive to terrorist groups.
- Vulnerability – protective programs to reduce vulnerability by decreasing susceptibility to destruction, or exploitation of weaknesses in a system.

- Consequences – protective programs must reduce damage of a successful attack or natural hazard with redundant system design, back-up systems and alternative sources for raw materials.

D. CHAPTER OVERVIEW

Chapter II discusses in greater detail the concept and definition of IIDs, as well as our vulnerability to them; it does so through the lens of the "predictable surprise" theoretical framework. It documents the use of arson in riots, protests, for revenge and profit, as well as by domestic terrorist groups. This chapter also identifies the danger of terrorist groups using the hazardous materials trucking industry as a source of ready-made IIDs. Finally, it will address the most common types and properties of incendiary materials.

Chapter III examines the consequences of an IID attack; investigates the potential for the development of firestorms or conflagrations in both an urban setting and wildland environment; and explores the human factor of this weapon by appraising the physiological and psychological consequences of fire and an IID attack.

Chapter IV suggests two policy changes: to modify the CBRNE matrix to include incendiaries, and to include two new scenarios in the National Planning Scenarios, and recommends a strategy to implement these changes.

Chapter V concludes with the importance of the homeland security community recognizing the threat of IIDs by taking necessary steps in all four areas of the *National Preparedness Goal*: prevention; protection; response; and recovery.

II. IID THREAT AND VULNERABILITY

This chapter examines the threats posed by and vulnerabilities to terrorism employing IIDs and weaponized fire. It will demonstrate how arson, a simple and common tactic among domestic terrorists and criminals, can be advanced by extremist terrorist groups intent on producing mass casualties and destruction to create intense fear and anxiety in the public. IIDs were used in the World Trade Center attack on September 11, 2001 and are readily available in the hazardous materials trucking industry. The wildland and WUI, with its latent energy, are waiting to burst into flames from a terrorist's improvised incendiary device. While the disparate sections of this chapter are not necessarily new information, taken together as an integrated threat they constitute the quintessential "predictable surprise:" the theoretical lens through which this material will be viewed.

A. PREDICTABLE SURPRISE

"Predictable surprise" is a term developed by Bazerman and Watkins of the Harvard Business School. Predictable surprises are events or disasters that catch leaders off-guard even though the latter had all the information necessary to anticipate them.[24] The 9/11 attack, the Enron collapse, and Hurricane Katrina all had warning signs, but leaders and organizations either did not recognize the signs or failed to act on them. Many catastrophes are predictable, including IID terrorist attacks. Bazerman and Watkins propose six distinguishing traits of a predictable surprise, each of which was discernible in their example of the September 11 tragedy:

- Leaders know a problem exists and that it will not solve itself. The administrations of George H. W. Bush, Bill Clinton, and George W. Bush all knew that aviation security was deficient. These leaders were aware of a growing threat, yet failed to mobilize and respond accordingly.
- The problem is getting worse over time. Report after report told U.S. leaders that the nation's aviation security system was worsening by the day, while al Qaeda's powers to take advantage of this weakness increased.
- There is a perception that fixes are costly and the benefits of those fixes are delayed. New security to reduce the likelihood and magnitude of an

[24] Max H. Bazerman and Michael D. Watkins, *Predictable Surprises: The Disasters You Should Have Seen Coming and How to Prevent Them* (Boston, Massachusetts: Harvard Business School Press, 2004), 4.

attack would have imposed high direct costs on both the federal government and the airline industry, and leaders and citizens would have seen no immediate or tangible return on their investment of time and money.

- There is no call for action to prevent a predictable surprise. Because the U.S. public could not envision the predictable surprise of commercial aircraft being used as a missile, aviation security remained a low priority for politicians.
- The natural human tendency is to maintain the status quo. When a system still functions and there is no crisis to catalyze action, people will continue doing things the way they always have.
- The final characteristic of predictable surprises is that a small vocal minority (special interest groups) benefits from inaction and maintaining the status quo, and are thus motivated to subvert the actions of leaders for their own personal gain. The airline industry fought hard to block reform and manipulated governmental decisions through lobbying and campaign donations.[25]

It is likely incendiary terrorism could become the next predictable surprise for the Department of Homeland Security (DHS). The use of fire as a terrorist weapon has all the characteristics of a predictable surprise but it is still not a priority for many homeland security experts and disciplines. If awareness is raised, policy makers and the homeland security community will take the necessary steps for preparedness and apply the *National Preparedness Goals* of prevention, protection, response, and recovery to IIDs.

Lynn Eden, associate director for research at Stanford University, emphasizes that organizations will define problems and identify solutions based on organizational interest.[26] She suggests that organizational interest is a social construct that brings attention and resources to solve one problem, but may not recognize others.[27] In *The Whole World on Fire*, she focuses on organizational shortfalls of the U.S. government during World War II to determine how and why the government failed to predict nuclear fire damage as it drew up plans to fight strategic nuclear war.

Besides the failure of imagination, the *9/11 Commission Report* reveals three additional failures: policy, capability, and management, all the result of organizational

[25] Bazerman and Watkins, *Predictable Surprises,* 5-7.

[26] Eden, *Whole World on Fire*, 48.

[27] Ibid, 50.

shortfalls.[28] DHS was established to overcome these limitations, but IIDs and fires are still not recognized as a threat. When the strategic plans were developed for nuclear war during the Cold War era, the U.S. failed to predict nuclear fire damage; DHS fails similarly to recognize the threat of IIDs. One explanation for this failure could be that there are still organizational shortfalls in DHS – inherent in DHS are organizational biases and favoritism toward law enforcement agencies, which in turn seem to focus exclusively on the CBRNE threat.[29]

Eden gives examples of these organizational shortfalls. She questions how organizations build knowledge when they have little or no experience from which to learn. For example, Thomas Andrews of Harland & Wolff, the shipbuilders of the R.M.S. *Titanic,* did not understand just how brittle the steel plates used in its construction were until it struck an iceberg. In another instance, the builders of the World Trade Center designed the towers to withstand the impact of a Boeing 707, the largest airliner of the early 1960s, but not to withstand the fire that would be produced by the many thousands of gallons of jet fuel burning inside the building as a result.[30] This phenomenon may be happening now in DHS. A great deal of effort is directed toward the CBRNE threat, but IIDs and fire continue to be ignored.

B. FIRE, IIDS, AND TERRORISM

1. Arson

Fire has long been and will continue to be used as a criminal tool. Under modern statutes, the definition of arson includes the crime of a malicious act of burning a dwelling or other structure such as bridges, vehicles and private property, where the fire causes actual damage of the property.[31] In general, the public views arson as a crime of fraud affecting insurance companies, though local street gangs and criminal organizations also use arson to control or terrorize their victims and force compliance or silence.

Arson was used extensively in New York City during the 1960s and 70s, when many neighborhoods in Brooklyn and the Bronx were burned down by landlords wishing

[28] 9/11 Commission, *9/11 Commission Report,* 339.

[29] Joseph Pfeifer, "Dirty Fires: Radiological Incendiary Devices," *With New York Firefighters (WNYF)* 2 (2006): 13.

[30] Eden, *Whole World on Fire*, 5.

[31] Arson Definition, http://en.wikipedia.org/wiki/Arson, [accessed 11 April 2006].

to collect insurance money for their dilapidated, vacant buildings. After the fire, social services would relocate displaced families into hotels and newer apartments managed by the city. Once people saw their friends and neighbors move into better housing an arson epidemic sparked in the city, as did a string of riots: incendiary devices were utilized to burn automobiles and buildings alike.

Arson can also be "extremist"-motivated, committed to further a social, political, or religious cause. The targeted property usually corresponds in some way to the offender's belief system: laboratories, slaughterhouses, fur stores, abortion clinics, and religious institutions.[32] Arson has also historically been used extensively by domestic terrorists groups like the Animal Liberation Front (ALF) and Earth Liberation Front (ELF). These groups are primarily concerned with attacking symbols of capitalism and exploitation: businesses they perceive to be engaged in animal abuse, habitat destruction, or environmental atrocities. In a joint special assessment on arson tactics, DHS confirmed that arson is the preferred method of attack for ALF and ELF, and that IIDs used in ALF and ELF attacks have unique signatures that tie the groups to these crimes.[33] John E. Lewis, deputy assistant director of the FBI, in testimony to the U.S. Senate Committee on Judiciary stated that ALF and ELF extremists consistently use improvised incendiary devices equipped with crude but effective timing mechanisms to commit their acts of terrorism.[34]

Propaganda found on the ALF websites, in particular the manual *Arson Around with Auntie A.L.F: Your Guide for Putting Heat on Animal Abusers Everywhere*, explains the advantages of using incendiary devices. The manual points out that a high-quality incendiary device can be improvised more easily than explosives and the required

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[32] Sarah Kilpatrick, *International Encyclopedia of Justice Studies*, http://www.iejs.com/Law/Criminal_Law/arson.htm, [assessed September 30, 2005].

[33] DHS, ATF, and FBI, *Joint Special Assessment: Arson-Related Tactics, Techniques, and Procedures of the Animal Liberation Front and Earth Liberation Front*, U/FOUO (Washington, D.C.: U.S. Department of Homeland Security, Sept 2005), 2.

[34] John E. Lewis, Deputy Asst Director, FBI, "Testimony to U.S. Senate Committee on the Judiciary," May 18, 2004, http://judiciary.senate.gov/testimony.cfm?id=1196&wit_id=3460, [accessed November 7, 2005].

materials more easily obtained. It also provides basic rules of safety, tools and techniques, and instructions on preparing and igniting many different types of incendiary devices.[35]

ALF and ELF activists have carried out numerous multimillion-dollar arson attacks:

- Veterinary Medicine Research Building at the University of California-Davis in April 1987, which resulted in an estimated $3.5 million in damages.
- In August 1992, ALF extremists raided the campus of Michigan State University and set fire to an office, destroying files containing thirty-two years' worth of toxicology and nutrition research.
- ALF also claimed responsibility for the July 1997 arson of a horse-rendering plant in Redmond, Oregon, which resulted in over $1 million in damage to the physical plant and imposed significant secondary costs resulting from the loss of revenue normally generated by the site.
- In May 1998, ALF claimed responsibility for an attack on a processing plant owned by Florida Veal Processors, Inc., in Wimauma, Florida which caused about $500,000 in damage.[36]

Despite having caused millions of dollars of damage and economic loss, ALF's goal - unlike other terrorist groups - is not to kill or terrorize the public.

Pyro-terrorism, a term devised by Lt. Col. Robert Baird of the U.S. Marine Corps, differentiates "simple" arson from terrorism. Using the FBI definition of terrorism, Baird substitutes "the unlawful use of force and violence" with "the use of incendiary attacks" to intimidate or coerce a government, the civilian population, or any segment thereof, to advance political or social objectives.[37] Pyro-terrorism possesses all the elements of terrorism: targeting of noncombatants; political motivation; violence with

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[35] ALF/ELF, *Arson Around with Auntie A.L.F: Your Guide for Putting the Heat on Animal Abusers Everywhere*, http://www.thedisease.net/arcana/explosives/Arson_Around.pdf, [accessed August 3, 2006].

[36] U.S. Department of Justice, Federal Bureau of Investigation, FBI Publication #0308, "Terrorism 2000-2001," 35, http://www.fbi.gov/publications/terror/terror2000_2001.htm#page35, [accessed 6 January 2006].

[37] Robert A. Baird, "Pyro-Terrorism: The Threat of Arson-Induced Forest Fires as a Future Terrorist Weapon of Mass Destruction," *Studies in Conflict & Terrorism* 29 (2006): 415.

a psychological impact; and organized perpetrators. Baird points out that it is indeed the political and psychological effect that differentiates Pyro-terrorism from arson.[38]

Incendiary devices are easily improvised and are inexpensive to produce. The materials to construct an IID are readily available from any hardware or grocery store, and are unlikely to invite suspicion from store employees. There are many advantages to using IIDs as terrorist weapons: they require little training to prepare and use. Overall, flammable materials are not as volatile as explosives; a person using these materials therefore does not require the same level of knowledge and experience as someone handling explosives. Properly used and strategically placed, firebombs have the potential to kill more people and cause greater property damage than a similarly-sized explosive device. Arson also provides a greater opportunity for evidence to be destroyed in the fire, and presents excellent opportunities for terrorists to draw attention to their cause.

The mission of fire departments across the country is to protect the life and property of citizens from the ravages of fire. These front-line battles in "the war that never ends" have taken their toll on both firefighters and civilians. The addition of a terrorism component and the use of IIDs will undoubtedly take an even greater toll. Many of the buildings in NYC and across the nation were built more than a hundred years ago. A building, like a person, has a life span of seventy-five to hundred years; beyond this age a structure becomes badly deteriorated as wood shrinks and rots, mortar loses its adhesive qualities, and steel rusts and weakens.[39] Unless these buildings are rehabilitated or renovated, a fire will rapidly destroy the already-weakened structural elements of the building and cause swift collapse. Lightweight building materials used in new construction throughout the nation also increase the possibility of early collapse during a fire. These factors, in conjunction with the possibility of IID use, place at higher risk the citizens living and working in these buildings along with the firefighters who respond to protect them.

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[38] Robert A. Baird, "Pyro-Terrorism: The Threat of Arson-Induced Forest Fires as a Future Terrorist Weapon of Mass Destruction," *Studies in Conflict & Terrorism* 29 (2006): 415.

[39] Vincent Dunn, *Collapse of Burning Buildings: A Guide to Fireground Safety* (New York: PennWell Publishing, 1988), 2.

2. Hazardous Material Trucking Industry

After the 9/11 terrorist attacks, intelligence agencies warned that the U.S.'s vast fleet of trucks, particularly those hauling loads of explosive fuel or toxic chemicals, would be ideal terrorist weapons. To date, little has been done to address this threat. Many companies are now developing or adopting satellite navigation and location technologies that rely on the Department of Defense's GPS (Global Positioning System) satellites in order to track shipments. The Automatic Vehicle Location (AVL) system is a popular satellite system used by the trucking industry, though there are a number of union concerns and privacy issues associated with it.[40]

Terrorists have frequently used vehicles to transport explosives in order to destroy a target. They are acutely aware that tanker trucks full of flammable and combustible fuel constitute convenient weapons or surrogate bombs. These tanker trucks can be used against specific targets, even turning hazardous industrial factories or plants into chemical weapons. Saul Wilen, in "Countering Terrorist Threats," cites numerous attacks internationally involving trucks that caused massive devastation and death.[41] This shift in terrorist behavior signals a new tactic and must heighten awareness among security specialists to the increased risk potential for the trucking industry.

This nation's hazardous cargo offers the same opportunity that airliners provided on 9/11: the chance to transform hazardous materials vehicles into mobile weapons of war. Thousands of trips are made each day by gasoline tankers, many of which hold as much fuel as a Boeing 757. The establishment of the Transportation Security Administration (TSA) ensured stricter security controls on the aviation industry, but the increased security of the airline industry has shifted the vulnerability to the trucking industry. America's trucks now bear an even greater risk than before 9/11.[42]

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[40] Daniel R. Sovocol, "GPS: Charting New Terrain – Legal Issues Related to GPS-Based Navigation and Location Systems," Construction Weblinks, April 1999, http://www.constructionweblinks.com/Resources/Industry_Reports_Newsletters/April1999/april_1999.html, [accessed August 2, 2006].

[41] Sovocol, "GPS: Charting New Terrain."

[42] Dr. Saul B. Wilen, "Countering Terrorism Threats: Trucking Industry and Multi-Modal Distribution Network Vulnerabilities," International Horizons Unlimited, Ltd, February 10, 2003, http://www.intlhorizons.com/article-trucking.htm, [accessed December 30, 2005].

3. World Trade Center IID Attack

After the September 11, 2001 IID attacks on the World Trade Center (WTC), the Federal Emergency Management Agency (FEMA) and the Structural Engineering Institute of the American Society of Civil Engineers (SEI/ASCE) deployed a team of civil, structural, and fire protection engineers to study building performance at the WTC site. This Building Performance Study (BPS) team made the following observations and findings:

> The large quantity of jet fuel carried by each aircraft ignited upon impact into each building. A significant portion of this fuel was consumed immediately in the ensuing fireballs. The remaining fuel is believed either to have flowed down through the buildings or to have burned off within a few minutes of the aircraft impact. The heat produced by this burning jet fuel does not by itself appear to have been sufficient to initiate the structural collapses. However, as the burning jet fuel spread across several floors of the building, it ignited much of the buildings' contents, causing simultaneous fires across several floors of both buildings. The heat output from these fires is estimated to have been comparable to the power produced by a large commercial power generating station. Over a period of many minutes, this heat induced additional stresses into the damaged structural frames while simultaneously softening and weakening these frames. This additional loading and the resulting damage were sufficient to induce the collapse of both structures.[43]

The FEMA study concludes it was the fire that ultimately caused the collapse of the WTC towers.

Baird makes an insightful observation in modeling future terrorist behavior. He contends that future pyro-terrorist attacks will lean toward unrestrained violence for maximum psychological impact and challenge the conventional definitions of "attack" and "weapon," which cause destruction by releasing a catalyst in the target to release stored energy in a destructive way.[44] The attack on the World Trade Center did just that. Instead of planting conventional explosives as in 1993, on 9/11 al Qaeda used jet fuel as a catalyst to create fires. The latent energy stored in the combustible components of the Twin Towers was released by the chemical action of fire. It was the World Trade

[43] FEMA, "World Trade Center Building Performance Study," Executive Summary, 2, http://www.fema.gov/library/wtcstudy.shtm, [accessed 30 October 2005].

[44] Baird, "Pyro-Terrorism," 418.

Center's own destructive energy that led to the towers destroying themselves.[45] The enormous fire that developed weakened the steel support structure at its critical vulnerability, causing the WTC Towers to collapse under their own weight.

4. Wildland and Wildland-Urban Interface (WUI)

Generally, wildland fires, especially in the Western United States, burn in areas of low or nonexistent human habitation, with minimal impacts on social or economic systems. The advent of wildland-urban interface poses a greater threat to human populations (growing especially in the west) and infrastructure. The frequency and magnitude of wildfires has increased because of significant fuel buildups and extreme drought to the extent that wildfires now cause significant damage and disruption.

Wildland fires are an increasing natural hazard in most regions of the United States, posing a threat to life and property particularly where native ecosystems meet developed areas.[46] Wildland fires are also a natural process and often beneficial to ecosystem balance; their suppression is now recognized as having created a greater fire hazard as live and dead vegetation accumulates in areas where natural fires would have burned and removed these hazards.[47] Thus, when fire is unnaturally suppressed in a fire-dependent ecosystem, the native species that need fire die out and ground litter becomes excessive, creating an extreme fire hazard. When fire finally strikes, the results are even more destructive than otherwise would have been the case.

As recently as July 2006, *Newsday* reported that Assem Hammoud, arrested in Lebanon for plotting to bomb New York's PATH trains, had also considered setting a huge fire in the forests of California.[48] In June of 2004 the FBI warned of a possible al Qaeda plot to set wildland fires in Colorado, Montana, Utah, and Wyoming.[49] Terrorist groups can easily ignite immense wildland fires that would have a significant impact on the nation's social and economic disposition.

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[45] Baird, "Pyro-Terrorism," 418.

[46] United States Geological Survey (USGS), "Wildfire Hazards-A National Threat," Fact Sheet 2006-3015, February 2006, http://pubs.usgs.gov/fs/2006/3015/2006-3015.pdf, [accessed July 14, 2006].

[47] United States Geological Survey (USGS), "USGS Wildland Fire Research," Fact Sheet 125-98, October 1998, http://pubs.usgs.gov/fs/1998/125-98/1998-125-98.pdf, [accessed June 30, 2006].

[48] Mohamad Bazzi, "Terror Suspects Plotted Against Brooklyn Bridge, Other Landmarks, Officials Say," *Newsday*, July 9, 2006.

[49] Baird, "Pyro-Terrorism," 417.

C. INCENDIARY DEVICES

As the name implies, the principal purpose of all incendiary devices is to start fires; depending on their action on detonation, they are classified as either scatter type or intensive type.[50] Upon bursting, the scatter-type bomb disperses its incendiary contents over a wide area with the intention of starting a number of simultaneous fires among easily ignitable materials. In contrast, an intensive-type bomb burns fiercely in one concentrated mass at the point where it detonates.

There are scores of flammable chemicals and materials that can be used to manufacture IIDs. An ideal incendiary weapon, as defined by scientists and engineers during World War II, should have the following characteristics: burn persistently for an appreciable length of time with a very high temperature; burn vigorously and not be easily extinguished; be able to distribute itself over a fairly large area; and be safe to handle. Incendiary devices require a detonator or igniter to assure positive ignition, should be stable enough not to ignite by shock or bullets, and they should not deteriorate in storage.[51]

The chief commercial and military incendiary agents used to manufacture incendiary devices are thermite (TH), magnesium (MG), white phosphorus (WP), combustible hydrocarbons, and napalm (MK 77).[52] Their basic properties and usage combinations are:

- Metal incendiaries burn metal. Magnesium is the most common pure metal incendiary agent; it has the advantage of a very high burning temperature.
- Pyrotechnic incendiary agents incorporate an oxidizing agent to ensure initial combustion independent of air supply. Thermite is a mixture of ferric oxide and aluminum that generates high temperatures sufficient to melt iron or steel.
- Oil-based incendiary agents burn liquid fuel. Napalm petroleum thickened with rubber is a very effective fire starter.

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[50] With New York Firefighters (WNYF), "Defense School, Lessons Learned from the Battle of Britain applied to New York's Emergency Preparations," *WNYF* l3 (1941): 5.

[51] John W. Mountcastle, *Flame On!* (Pennsylvania: White Mane Books, 1999), x.

[52] Army Field Manual, "Incendiary Agents," FM 8-285/NAVMED P-5041/AFJMAN 44-149/FMFM 11-11, http://www.globalsecurity.org/wmd/library/policy/army/fm/80285/ch9pdf. [accessed July 28, 2006]. Federation of American Scientists, FAS, "MK77 750lb: Napalm," http://www.fas.org/man/dod-101/sys/dumb/mk77.htm, [accessed July 28, 2006].

- Oil-and-metal incendiaries use oil incendiaries for spreading effect and the metal incendiaries are added to increase heat. Pyrogels consist of thickened gasoline and metal incendiary and have extremely high temperatures.
- Pyrophoric incendiary weapons are capable of igniting spontaneously in the air without an ignition device. White Phosphorus forms a dense, white cloud of smoke and has a relatively low combustion point.
- Inorganic substances that ignite in water: Sodium is a very reactive substance – common as a compound but never found free in nature – that spontaneously ignites when it contacts water. It is sometimes used as an additive to napalm.[53]

Other than WP, these weapons require only a small amount of explosive material to ignite. Upon ignition, a raging fire develops and burns at such extreme temperatures that it could destroy most buildings.

Step-by-step instructions on how to manufacture IIDs and the ignition devices are available on the internet. All the materials can be purchased at a local hardware store or gas station. The simplest incendiaries are flammable and combustible fuels like gasoline and diesel fuel, but include others:

- Home-Made Napalm – Shaved or chipped bar soap with a liquid hydrocarbon fuel (gasoline, fuel oil, diesel oil, kerosene, turpentine, benzene or toluene), mixed together in a double boiler.
- Paraffin-Sawdust Incendiary – Sawdust and melted paraffin mixed and poured into a waxed paper carton. This mixture is almost as effective as napalm.
- Sawdust, Moth Flakes, and Oil Incendiary – Sawdust, moth flakes (naphthalene), fuel oil (kerosene or diesel oil). Mixed in equal parts and stirred until the mixture is the consistency of mush; stored in any container that will retain the oil fumes.
- Incendiary Brick – Composed of potassium chlorate, sulphur, sugar, iron filings and wax. When properly made, it looks like an ordinary building brick and can be easily transported without detection.
- Thermate Incendiary – Similar to commercial thermite, except it also contains an oxidizer, making it easier to ignite. Composed of aluminum or magnesium filings plus potassium nitrate, sodium nitrate, barium nitrate,

[53] Stockholm International Peace Research Institute (SIPRP), *Incendiary Weapons* (Cambridge, Massachusetts: MIT Press, 1975), 88-103.

> potassium dichromate, sodium dichromate, or potassium permanganate. Thermate made from magnesium is easier to ignite.[54]

These simple, homemade incendiary devices demonstrate the vulnerability of the U.S. to IIDs; that the recipe for manufacturing them is available on the internet makes the threat particularly acute.

[54] ALF/ELF, "Arson Around with Auntie A.L.F," http://www.thedisease.net/arcana/explosives/Arson_Around.pdf, [accessed August 3, 2006].

III. THE CONSEQUENCES OF AN IID ATTACK

This chapter will demonstrate the possible consequences of an IID terrorist attack. Specifically, it will discuss the destructive fires that can develop in a wildland setting as well as in an urban environment. Large area fires, firestorms and conflagrations will be defined and differentiated, along with their mechanisms of ignition and fire behavior. An overview will be provided of the devastating effects that IIDs and their consequent fires have on the public, critical infrastructure, key resources, and first responders. Finally, we will address the terrorist's ultimate goal: the catastrophic consequences – both physical and psychological – of these horrifying fires.

A. FIRESTORMS AND CONFLAGRATIONS

All catastrophic fires, whether urban or wildland, involve large burning areas with abundant and continuous fuel sources. Most of the literature on large fires classifies these types of fires as firestorms or conflagrations; the two modes have distinct characteristics and important consequences with regard to the damage produced.[55]

The transition of a large fire into a conflagration results from the interaction of a single fire, its fuel, and the surrounding air mass.[56] A conflagration can be driven by high winds and spawn localized fire whirls.[57] Conversely, a firestorm begins with the simultaneous ignition of many fires in a particular area that burn as autonomous entities.[58] Firestorms are characterized by an inrushing fire wind of hurricane force, producing a rotating rising column of highly heated gases. The resulting fire is a synergistic phenomenon of extreme burning that responds to its own internal energy dynamics. A firestorm may be an extreme event but is a likely possibility if many fires are simultaneous ignited in a highly combustible area.

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[55] R.D. Small and H.L. Brode, *Physics of Large Urban Fires*, PSR Report 1010 (Santa Monica, CA: Pacific-Sierra Research Corporation, March 1980), 16.

[56] Stephen J. Pyne, *Fire in America: A Cultural History of Wildland and Rural Fire* (Princeton, New Jersey: Princeton University Press, 1982), 24.

[57] James G. Quintiere, "Canadian Mass Fire Experiment," *Journal of Fire Protection Engineering* 5, no. 2 (1993): 68.

[58] Pyne, *Fire in America*, 24.

The properties of firestorms and their relation to area ignition were first recognized as a result of the firebombings of World War II. This fire phenomenon has been intensively researched in view of the fact that in the event of nuclear war, firestorms would dominate the landscape. During World War II, firestorms were created by British and American conventional incendiary weapons and by U.S. atomic bombs. The consequent firestorms from these weapons destroyed a number of cities, most notably Hamburg and Dresden, Tokyo, Hiroshima, and Nagasaki.[59]

Theodore A. Postol, a renowned physicist and nuclear engineer from the Massachusetts Institute of Technology (MIT), describes firestorms as:

> Numerous near-simultaneous ignitions that cause a significant heating of air, which rises and pumps large masses of cooler air out and down. This cooler air is then drawn at high speeds into the fire zone at ground level. Mass Fires (firestorms) thus generate significant winds that spread the fire violently inward... The vacuum created by buoyantly rising air follows from the basic physics of combustion and fluid flow. As the area of the fire increases, so does the volume of rising air over the fire zone, causing even more air to be sucked in from the periphery of the fire at increasingly higher speeds. [60]

Firestorms exhibit traits not observed in such smaller-scale fires as those in isolated buildings, most wildland fires, and conflagrations burning on a front. In firestorms an atmospheric disturbance takes place that results in a recirculation of air flow into the flaming area.[61] This causes inward-rushing hurricane force winds to develop on the perimeter of the fire, drawing the cooler air into the fire area. Firestorms are predominantly stationary, are independent of atmospheric wind conditions, and spread by themselves rather than by wind.

In contrast, conflagrations are large, uncontrolled fires that may be started by a single ignition or a few ignitions and spread along a front. Conflagrations, unlike firestorms, continue to respond to the fire environment and the weather. The great urban fires in London, Chicago, and San Francisco are considered conflagrations.[62]

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[59] Eden, *Whole World on Fire*, 28.

[60] Ibid, 156, 27.

[61] Small and Brode, "Physics of Large Urban Fires," executive summary.

[62] Ibid, 159.

Conflagrations have extreme energy releases and are stopped only by dramatic changes in the fire environment, including different or depleted fuels or the onset of rain. These large fires may release the energy equivalent of a Hiroshima-type atomic bomb exploding every five to fifteen minutes.[63] The advancement and destructive features of the conflagration can be much greater than those of a firestorm; the conflagration fire continues to spread until there is no longer combustible material to burn and the fire runs out of fuel. In a firestorm, the area of fire spread is less significant and nearly uniform in all directions around its perimeter.[64] The inward-rushing air in a firestorm is the decisive factor in limiting the spread of fire beyond the initial ignited area. Firestorms, though, will cause almost total destruction within the burning area.

In the past, conflagration and firestorm disasters have occurred in urban, wildland and wildland-urban interface (WUI) settings from natural and military measures. In the future, terrorist groups using asymmetric methods and employing IIDs have the ability to create these large, destructive fires. Both conflagrations and firestorms are terrifying and extremely lethal.

The potentially destructive forces inherent in conventional facilities and nuclear power plants provide a strong foundation for terrorist groups to create fires aimed at these critical nodes of our infrastructure. Fire damage would trigger uncontrolled and wide-scale destructive events. The extreme temperatures produced by conflagrations or firestorms could affect the structural components of a nuclear power plant, resulting in a leak of radioactive material. Such an event would take a tremendous toll on human and other resources. Local, state and federal assets would be severely depleted in the mitigation of the fires and from released hazardous materials. The key resources from power plants and production facilities would be interrupted and could create a nationwide power shortage.

In the past decade, especially in the western part of the United States, large and severe wildland fires have occurred regularly. In cities throughout the country, large fires are a perpetual threat. Currently, firefighters cannot meet the challenge of a large-scale

[63] Pyne, *Fire in America*, 24.

[64] Eden, *Whole World on Fire*, 91.

urban or wildland fire of the magnitude of a conflagration or firestorm. Neither equipment nor training nor manpower is adequate to cope with such an event.[65]

1. Wildland / Wildland-Urban Interface Fires

Wildland and wildland-urban interface fires have a significant impact on the social and economic systems of city, county, and state. The immediate consequences are easy to anticipate:

- Forest destruction and destruction of homes and businesses
- Fire suppression costs. Since 2000, federal costs have averaged more than $1 billion annually[66]
- Erosion
- Landslides
- Introduction of invasive species
- The destruction of numerous critical infrastructures and key resources:
    - Entire Communities
    - Telecommunications towers
    - Gas transmission lines
    - Electrical substations and power lines
    - Nuclear power plants
    - Domestic livestock
    - Timber resources
    - Road and Rail systems
    - Pollution of watersheds and reservoirs.

Long-term impacts include:

- Reduced property values and property tax revenues
- Lost sales tax and business revenues from reduced tourism
- Health problems and the ensuing medical expenses from smoke and other toxic gases
- Lost productivity by those evacuated and by firefighters performing suppression activities

[65] Small and Brode, "Physics of Large Urban Fires," 42.

[66] Robert A. Robinson, "Wildland Fire Suppression – Better Guidance Needed to Clarify Sharing of Costs between Federal and Nonfederal Entities," GAO Testimony Before the Subcommittee on Public Lands and Forest, Committee on Energy and Natural Resources, U.S. Senate, June 21, 2006, http://www.gao.gov/new.items/d06896t.pdf, [August 6, 2006].

- Poor water quality from watersheds and reservoirs resulting in increased water treatment costs.

Non-market costs include aesthetic and habitat damage, reduced or lost recreation use, and reduced access to the area.

The post-fire effects of wildland fires pose a double hazard. First, the fire burns away all vegetation, causing rains following the fire on a mountain slope to trigger landslides of mud, rock and other debris. The organic material in the soil may also burn away or become transformed into water-repellent substances that prevent water soil infiltration. Even normal rainfall can result in substantial erosion or flooding from a burned area.[67] Second, water supplies are affected by fire. The loss of ground-surface cover such as needles and small branches and the chemical transformation of burned soils make watersheds more susceptible to erosion from rainstorms since the kinetic energy from each raindrop causes a continuous process of erosion during a rainfall event. Furthermore, floating burned debris in reservoirs causes deterioration of water quality.[68]

Fire studies reveal a decline of cyclical wildland fires during the past century due to timber harvesting, agriculture, roads, fire suppression, and lack of deliberate controlled burning as was practiced in the past. All these factors increase the vulnerability to a terrorist attack employing IIDs. Terrorist groups have the ability to create large fires in wildland and wildland-urban interface environments. Much of the U.S. is already susceptible to wildland fires, particularly during summer drought periods that occur with ever-greater frequency in the western U.S. (Appendix A contains a map showing locations that experienced wildland fires greater than 250 acres, from 1980 to 2003.) Once terrorist groups begin using IIDs as a weapon, the consequences of these fires will increase exponentially.

With little planning, terrorist groups can create large fires in wildland and WUI conducive to fire extension or containing critical infrastructure. Large fires ignited in the path of critical infrastructures like nuclear power plants or near key resources such as reservoirs will create a greater hazard than the fire itself. In the 2000 fire season, two

[67] United States Geological Survey (USGS), "USGS Wildland Fire Research," USGS Fact Sheet 125-98, October 1998 http://pubs.usgs.gov/fs/1998/125-98/1998-125-98.pdf, [accessed June 30, 2006].

[68] Ibid.

nuclear power facilities were threatened by wildland fires in less than two months. First, in mid-May, the Cerro Grande fire severely threatened the Los Alamos National Laboratory in New Mexico. Then in June, another fast-moving range fire swept through the Hanford Nuclear Site in Washington.[69] Luckily, because of the wind direction none of the buildings housing radioactive or chemical materials was burned. On the other hand, under more favorable meteorological conditions a terrorist group could ignite a wildland fire in the path of these facilities. Damage from the extreme heat of these fires could cause a release of radioactive material into the environment.

Erosion on reservoirs and ecosystems after a wildland fire can be enormously destructive. As much as 100 times more erosion can occur after fires, causing damaging floods and choking freshwater ecosystems and hydroelectric power generators with sediment and debris.[70] The increased sediment in the reservoirs alters the smell and taste of the water, making more frequent charcoal flushing necessary. An increase in sediments like clay and silt in streams and reservoirs can significantly alter natural ecosystems by killing fish and vegetation. Flooding and debris slides on steep mountain slopes are dangerous consequences of wildland fires: fire changes the chemistry of soil, making it more water repellant.[71] In burned areas, the chance of flooding increases with erosion because there is no vegetation to protect the soil and slow the overland flow of water from hill slopes to streams.

The Earth Resources Observation and Science (EROS) Data Center of the U.S. Geological Survey (USGS) produces bi-weekly "Greenness Maps" for the forty-eight contiguous states and Alaska. These satellite maps provide comprehensive growing season profiles for forests, rangelands, grasslands, and agricultural areas, and are used by land managers to plan for fire suppression and schedule prescribed burns.[72] The USFS

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[69] Keith Easthouse, "Nuclear complex: Too close for comfort," *Bulletin of the Atomic Scientists* 56, no. 5 (September/October 2000), 10, http://www.thebulletin.org/article.php?art_ofn=so00easthouse, [accessed August 7, 2006].

[70] Colorado University Researcher, "Wildfire Erosion Effects Will Show up in Reservoirs, Ecosystems," July 15, 2002, 1, http://www.colorado.edu/news/releases/2002/330.html, [accessed August 8, 2006].

[71] Ibid., 2.

[72] United States Geological Survey (USGS), "USGS Wildland Fire Research," USGS Fact Sheet 125-98, October 1998, http://pubs.usgs.gov/fs/1998/125-98/1998-125-98.pdf, [accessed June 30, 2006].

uses Greenness Maps to generate national maps of selected fire-weather and fire-danger components of its Wildland Fire Assessment System.[73] Additionally, the Fire Potential Index (FPI) characterizes relative fire potential in these same areas. This information is easily accessible on the internet; terrorist groups can use it to their advantage to employ IIDs to create destructive wildland fires that could extend into WUI, rural, suburban and eventually into urban areas.

Terrorists can initiate fires and modify fire behavior by deliberately altering wildland fuels and creating unique ignition patterns. This may magnify burning intensities of fires that can develop into firestorms when natural conditions might not have allowed for the transition.[74] Approximately 50,000 fires occur each year, ranging from large area brush fires to extensive wildland fires.[75] As terrorist groups begin igniting multiple fires throughout our forests, resources would be severely depleted. There are seven Regional Geographic Area Coordination Centers (GACC) directing only seventeen National Type I Incident Management Teams (IMTs).[76] These Type I IMTs manage the mitigation of wildland fires throughout the country. Multiple wildland and WUI fires would quickly overwhelm IMTs.

2. Urban Fires

During World War II, urban firestorms destroyed many cities in Germany and Japan. The firestorm created in Hamburg, Germany, was reported to have produced hurricane force winds and air temperatures over 400^0 F. Within three to six hours more than five square miles of the city were completely burned and approximately 60,000-70,000 people died as a result of the firestorms.[77]

Other than wartime firestorms, natural disasters have produced conflagrations in a number of urban environments. Some of the most notable city fires include the Great Fire

[73] United States Geological Survey (USGS), "USGS Wildland Fire Research," USGS Fact Sheet 125-98, October 1998, http://pubs.usgs.gov/fs/1998/125-98/1998-125-98.pdf, [accessed June 30, 2006].

[74] Pyne, *Fire in America*, 28.

[75] National Fire News, Daily Statistics, 2, http://www.nifc.gov/fireinfo/nfn.html, [accessed August 7, 2006].

[76] "National Type I Interagency Incident Management Teams and Regional GACCs," http://www.wildlandfire.com/docs/IIMT.htm, [accessed August 8, 2006].

[77] Theodore A. Postol, *Possible Fatalities from Superfires Following Nuclear Attacks in or near Urban Areas*, National Academy of Sciences Institute of Medicine (Washington, D.C.: National Academy Press, 1986), 52-53.

of London in 1666, the Chicago Fire in 1871, the San Francisco earthquake and fire in 1906, and the Tokyo and Yokohama earthquake and fire in 1923. These large urban fires are fraught with dangers and complications.

After an IID attack, when numerous fires are burning simultaneously throughout a city, firefighting resources would quickly become taxed and limited. Limited resources and the combination of intense radiant and convection heat energy generated by these large fires would prevent firefighting forces from getting close enough to extinguish them. The fires would likely expand and ignite adjoining structures. As additional structures became involved, conflagrations or even firestorms could develop and engulf an entire section of a city in flames.

Buildings are designed and constructed according to Building and Fire Codes to confine and control a fire, to allow building occupants time to evacuate, to allow fire department personnel time to access and gain control over the fire, and to accommodate expected fire loads of the building. Large, expanding fires can countermand the design and construction features in these buildings. Structural fires have three identifiable stages: growth stage, fully developed stage, and decay stage. The second and third stages of fire growth are when a building's structural framework is often affected and when most burning building collapses occur.[78]

Vertical development in crowded cities poses unique dangers during fires. High-rise buildings are common in cities throughout the country, containing thousands of occupants, many on the upper floors who are beyond the reach of fire department ladders. A modern high-rise building's primary component is a central core containing the building's services and facilities such as power and water lines, elevators, air supply and return shafts, enclosed stairs and restrooms. The core is connected to columns in the exterior walls of the building by steel girders; this eliminates the need for intermediate columns and provides an unobstructed floor space.[79] These modern, lightweight, high-rise buildings are less fire resistant than the previous generation of high-rise construction. They have an open-floor design with a potential for larger fires, more and superior

[78] Vincent Dunn, *Collapse of Burning Buildings* (New York: PenWell Publicaton, 1988), 264.

[79] John. T. O'Hagan, *High Rise/Fire and Life Safety* (New York: Dun-Donnelley Publishing, 1977), 23.

insulation that retains heat, and complex building systems in the core. The combination of factors increases the fire hazards of high-rise buildings.

The World Trade Center collapse is a poignant example of how fire can cause modern high-rise buildings to crumble. The impact of the planes destroyed the sprinkler system and knocked off the fireproofing material on the structural steel. The lightweight truss beams supporting the concrete floor had very little inherent fire resistance, and as a result heated up rapidly and failed. A progressive mechanical collapse of all floors destroyed the building and killed most of the occupants. The National Institute of Standards and Technology (NIST) Building Performance Study of the World Trade Center Towers concluded that it was the fire rather than the impact of the planes that ultimately caused the collapse of the WTC Towers.[80]

In contrast to this, when a ten-ton B-25 U.S. Army aircraft crashed into the Empire State Building on July 28, 1945, the building withstood both the crash and the ensuing fire. The Empire State Building was built of heavyweight construction, with all structural elements protected by brick and concrete. The plane crashed into the seventy-eighth and seventy-ninth floors, spewing 800 gallons of gasoline that ignited and spread fire throughout a number of floors. The fire was extinguished within thirty-five minutes of the arrival of the fire department: this is a tribute not only to the FDNY's efficiency, but also to the construction and design of the building.[81]

High-rise buildings require substantial resources to control a fire because occupants on the upper floors are easily trapped as high heat and smoke in the stairwells render the exits impassable. Sabotaged fire suppression systems will prevent firefighters from extinguishing the fires and reaching the trapped occupants. Multiple, simultaneous high-rise fires would rapidly deplete municipal fire department resources; without sufficient resources, high-rise buildings burn until all fuel is exhausted or until the building collapses.

Modern-day cities contain more plastics and hydrocarbon fuels than ever before. Once ignited, these fuels burn extremely hot and produce more dense black smoke than a

[80] FEMA, "World Trade Center Building Performance Study," Executive Summary, 2, http://www.fema.gov/library/wtcstudy.shtm, [accessed 30 October 2005].

[81] O'Hagan, *High Rise/Fire and Life Safety*, 21.

wood-based fire load. As a precursor to an IID attack in a city, a terrorist group could easily sabotage as many fire protection systems as possible. With fire protection systems inoperable the simultaneous ignition of multiple IIDs in strategic locations would trigger large, expanding fires and potentially create the same type of firestorms that Germany and Japan experienced during World War II.

B. PHYSIOLOGICAL AND PSYCHOLOGICAL CONSEQUENCES OF FIRE

The physiological and psychological consequences of fire are significant. Fire gases contain many toxins that can incapacitate a victim within minutes and the extremely high temperatures can cause severe skin and respiratory burns. A person subjected to the trauma of fire not only experiences physiological breakdown, but also is vulnerable to the development of psychological disorders.

1. Physiological Effects of Fire

A fire environment contains many hazards detrimental to the human body, including high ambient room temperatures, heat transfer to the body, smoke and toxic gases, and oxygen depletion.[82] The body's response to thermal injury is complex: burns severely affect a number of interrelated physiological systems, including the cardiovascular, pulmonary, renal, gastrointestinal, and immune systems.[83] The burn damages the epidermis and creates an ideal environment for the growth of bacteria and infection. This, in conjunction with the suppression of the body's immune system, is the reason infection is one of the leading causes of death in burn victims.[84] Pain, both continuous background pain and the acute pain from therapeutic procedures, places additional stress on the body functions struggling for homeostasis. On the whole, burns are the most painful and physiologically damaging injuries a person can sustain. The human body is highly susceptible to burn injuries and has very little defense against them.

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[82] Flannery Associates, "Human Behavior and Fire," in *Introduction to Fire Science* (New York: CUNY John Jay College, January 2001), http://web.jjay.cuny.edu/~tflan/documents/101docs/FIS101OccupancyTypesandExits.pdf [accessed June 19, 2006].

[83] Baris Cakir and Berrak C. Yegen, "Perspectives in Medical Sciences: Systemic Responses to Burn Injury," *Turkish Journal of Medical Science* 34 (May 2004): 215.

[84] Ibid.

Following a large-scale IID attack, hospitals would quickly become inundated with countless burn victims. The American Burn Association maintains a list of burn care facilities throughout the United States. Nationally, there are only 125 hospitals that operate burn care facilities, with a total of 1,817 burn beds.[85] These numbers can be misleading: many facilities are typically already at capacity, substantially reducing the number of available burn beds. On average, most burn care hospitals have six to twelve burn beds; the largest, the William Randolph Hearst Burn Center in New York City, has forty. If a serious IID attack were to occur in the New York metropolitan area the maximum number of burn patients who could be treated at one time would be 133.[86] This includes utilizing the burn beds from burn care facilities in New York, New Jersey and Connecticut, and assuming that all burn beds are available at the time of the event, which is highly unlikely. The graph below depicts the number burn care facilities and beds regionally. Appendix B illustrates the five U.S. regions used in the graph.

[85] American Burn Association, *Burn Care Facilities in the United States*, http://www.ameriburn.org/pub/Publications.htm, [accessed June 21, 2006].

[86] Ibid.

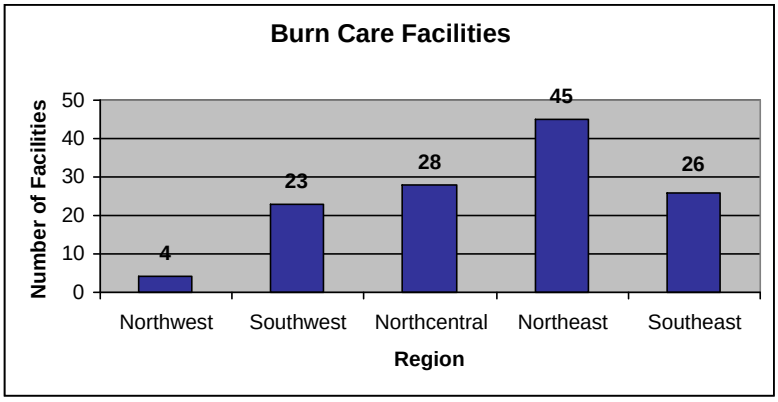

Figure 1. Burn Care Facilities

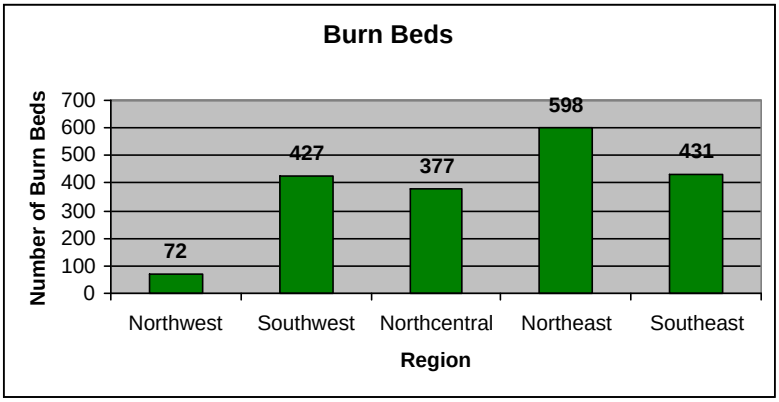

Figure 2. Number of burn beds by region

2. Psychological Effects of Fire

Fire can have serious mental health consequences for its survivors. At large and growing fires, people do not have adequate time or warning to take protective measures, and the opportunity to escape is limited. Many people trapped by fire experience a sense of extreme fear, panic and a vivid confrontation with death.[87] Acute stress-related symptoms, recurring flashbacks, nightmares and waves of fear often emerge shortly after a fire is contained. This is the period when some develop chronic psychological disorders, including post-traumatic stress disorder (PTSD).[88]

[87] American Burn Association, *Burn Care Facilities in the United States*, http://www.ameriburn.org/pub/Publications.htm, [accessed June 21, 2006].

[88] Ibid, 349.

The fires that followed the 1906 San Francisco Earthquake are widely considered America's worst urban disaster and one of the world's greatest urban conflagrations.[89] These fires burned for three days and generated fire fronts with such intense radiant heat and toxic gases that many people died from asphyxiation and the inhalation of toxic gases even before the fire reached them. In a study conducted at the University of California at Berkeley thirteen years after the fire, students who were children at the time were asked to describe their feelings during the quake and subsequent fires. Some of the students said they were paralyzed with an indescribable fear at seeing the fire. Another student living outside the city feared the fire would sweep all through California. Many students stated that for years and years they had recurring memories of the devastation caused by the fires. There are hundreds of other stories illustrating the fear the earthquake and fire instilled in the people of San Francisco; the accounts clearly demonstrate the long-lasting psychological effects of this disaster.[90] Even though the diagnosis of PTSD was not available in the early 1900s, we may presume many suffered from this disorder.

People trapped by fire will take extreme measures to escape the flames. A fire in Peshtigo, Wisconsin that occurred on the same day as the Great Chicago fire in 1871 was the deadliest conflagration in U.S. history. There is an account of a man who slit the throats of all his children in order to spare them death by this horrifying fire.[91] It is estimated that between 1,200 and 2,500 people perished in the Peshtigo fire. The Triangle Factory fire, which occurred in a sweatshop in New York City in 1911, is another example of the level of fear fire can inflict and the extreme measures people take to escape. This fire began on the eighth floor of a ten-story "fireproof" building. Within minutes, those on the ninth floor were trapped by smoke and flames coming up the stairwell. Realizing there was no other way to avoid the flames, some of the women broke out windows and jumped, while others pried open elevator doors and tumbled down the elevator shaft. Those remaining died as the smoke and fire overpowered them.

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[89] Philip L. Fradkin, *The Great Earthquake and Firestorms of 1906: How San Francisco Nearly Destroyed Itself* (Berkeley and Los Angeles, California: University of California Press, 2005), 3.

[90] Philip L. Fradkin, *The Great Earthquake and Firestorms of 1906: How San Francisco Nearly Destroyed Itself* (Berkeley and Los Angeles, California: University of California Press, 2005), 3.

[91] Stephanie Hemphill, "Peshtigo: A Tornado of Fire Revisited," Minnesota Public Radio, November 27, 2002, http://new.minnesota.publicradio.org/features/200211/27_hemphills_peshigofire/ [accessed June 4, 2006].

A total of 146 people were killed in the Triangle Factory fire, fifty-four of them as a result of jumping or falling.[92] Many bystanders, policemen and firemen that day were horrified as young women leaped to their deaths to escape the flames.

The fires that developed as a result of the terrorist attacks on the World Trade Center on 9/11 trapped hundreds of innocent people on the upper floors of the towers. The fear and horror experienced by those trapped in the North Tower were evident as they broke windows for air in order to breathe. Faced with insufferable heat, smoke, and fire, along with no hope for relief, an estimated 200 people either jumped or fell trying to escape.[93] Most witnesses say those jumping appeared to make a conscious choice to die by falling; the fear of dying by fire was so great that ultimately they were choosing not whether to die but how. Figure 3 is a powerful illustration of the helplessness and fear being trapped by fire can create: it graphically depicts the desperation these people were subjected to. Many of the people in this photograph either fell or jumped to their death.

Figure 3. Trapped Occupants in the World Trade Center
(AP Photo/Amy Sancetta)

[92] Cornell University ILR School, "The Triangle Factory Fire," March 25, 1911, http://www.ilr.cornell.edu/trianglefire/, [accessed June 11, 2006].

[93] USA Today, "Desperation forced a horrific decision," *USATODAY.com*, Sept 9, 2002, http://www.usatoday.com/news/sept11/2002-09-02-jumperx.htm, [accessed June 1, 2006].

Although IIDs have the potential to create conflagrations and firestorms, these large fires are not necessary to create fear and panic in the public. All fires can be deadly, especially those that occur in crowded theaters or nightclubs – transient occupancies assembling large numbers of people, many of whom are unaware of the layout or the location of exits. The After-Action Report of the Rhode Island Station nightclub fire in February 2003 powerfully describes what the victims of this fire must have experienced:

> It is difficult to conceive of a more terrifying and helpless situation than imminent death by fire without hope of escape – the smoky darkness, the toxic fumes and superheated air, the uncontrollable advance of all-consuming flames, and the press of the bodies of other terrified, screaming persons. [94]

Tragic fires in nightclubs and theaters have occurred many times in the past hundred years. In 1903, the Iroquois Theater fire in Chicago, the deadliest nightclub fire in U.S. history, claimed the lives of 602 people. The Rhythm nightclub fire killed 209 people in Mississippi in 1940, and the 1942 Cocoanut Grove fire in Boston killed 492 people. These fires were accidents, but a simple IID containing only three-quarters of a gallon of gasoline killed eighty-seven people at the Happyland Social Club in New York City on March 25, 1990.[95]

All forms of terrorism create fear, but the fear of burning to death is horrifying to all people. This fear is amplified by the randomness of an attack, the fact that people have no control over the situation and that no one knows where the next attack will occur. The use of weaponized fire by terrorist groups can only intensify this fear and anxiety. Terrorists do not need to use chemical, biological, radiological, nuclear or explosive (CBRNE) weapons to inflict mass casualties or cause extensive damage to critical infrastructure and key resources. IIDs can be used to serve the terrorist purpose by creating fires that generate fear and anxiety in communities throughout the country.

Research on natural and human-caused disasters strongly suggests that the psychological reactions following human-caused disasters such as terrorism are more

[94] The Titan Corporation, "Rhode Island: The Station Club Fire After-Action Report," Rhode Island Governor Donald L. Carcieri Website, http://www.governor.ri.gov/other/stationfirereport.php, [accessed June 7, 2006].

[95] Richard W. Bukowski and Robert C. Spetzler, "Analysis of the Happyland Social Club Fire with Hazard I," *Fire and Arson Investigator* 42, no. 3 (March 1992): 36.

intense and more prolonged than psychological reactions following natural disasters. In a study on mental health consequences, Diane Myers of the Clara Barton Center for Domestic Preparedness proposes that in order to understand, prevent, and respond to terrorist events, we must understand the critical importance of their psychological impact.[96] Myers lists certain characteristics of a terrorist event that magnify the psychological effect, including a lack of warning, lack of familiarity, an abrupt change in reality, serious threat to personal safety, the scope of destruction, exposure to gruesome and grotesque situations, the intentional human casualties, and the degree of uncertainty.[97] A major attack with an IID incorporates all these elements; the fear and destruction resulting from a conflagration initiated by an incendiary attack will guarantee the terrorist's goals to create fear and uncertainty in society are achieved.

America's HealthTogether (AHT), a national health and health-care policy organization surveyed health care professionals around the country to investigate the science of disaster mental health. The results of the survey made it clear that the mental health needs of Americans have increased post-9/11 (especially in the New York and Washington, D.C. areas).[98] In the 2003 survey, seventy-eight percent of health care providers reported that patients have been displaying terrorism-related emotional distress since 9/11.[99] As illustrated in the graph below, events like 9/11 engender severe and persistent psychological and physical effects.[100]

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[96] Diane Myers, "Weapons of Mass Destruction and Terrorism: Mental Health Consequences and Implications for Planning and Training," *Weapons of Mass Destruction/Terrorism Orientation Pilot Program* (Pine Bluff Arkansas: Clara Barton Center for Domestic Preparedness, August 15, 2001), http://www.icisf.org/articles/Acrobat%20Documents/TerrorismIncident/WMDMyers.html, [accessed 1 November 2005].

[97] Ibid.

[98] Hahrie Han et al, America's HealthTogether, "Facing Fear Together, Blueprint Report," May 2003, http://www.healthtogether.org/healthtogether/facingFear/bluePrint.html. 16, [accessed 28 January 2006].

[99] Ibid.

[100] U.S. Department of Health and Human Services, Office of Behavioral & Social Science Research, "Assessing the Effects of the Attacks on America," October 15, 2002, http://obssr.od.nih.gov/activities/911/attack.htm. [accessed 28 January 2006]

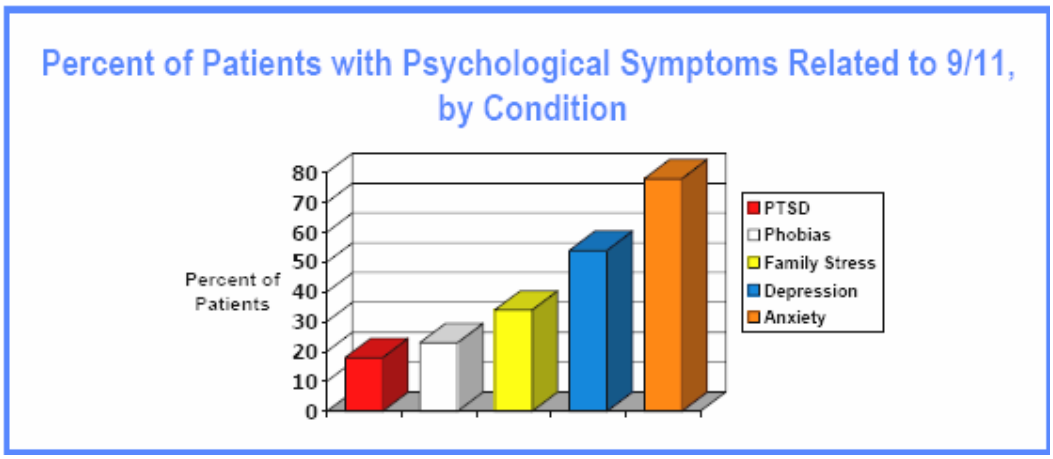

Figure 4. Percent of patients with psychological symptoms related to 9/11

Unlike a natural disaster that victimizes a specific locality or region, a terrorist attack targets an entire society. The public is aware that everyone in the United States and abroad is a potential target for future attacks. It is the awareness of the persistent threat that distinguishes terrorism from natural disasters. The psychological strategy of terrorism is to ensure that no matter what defensive actions are taken, the next act of terror seems inevitable, likely to occur sooner rather than later, and threatens each and every individual.[101]

The psychological consequences of an IID attack killing hundreds or thousands of people and injuring many more with severe burns would be devastating. Survivors of physically disfiguring trauma, like burn injuries, experience a series of assaults on the mind and body that present extraordinary challenges to human resilience. In fact, twenty years ago it was generally accepted in the United States that persons with massive burns could not survive, or if they did, would be so unhappy they would want to die.[102] Survivors of burn injuries not only experience a terrifying psychological event from the fire, but also have to endure physical injuries that leave their bodies forever changed and disfigured. The physical changes in the victim's body are a constant reminder of the fear, sadness and pain they have endured. But the agonizingly painful treatment of these burns

[101] James N. Breckenridge and Philip G. Zimbardo, "The Strategy of Terrorism and the Psychology of Mass-Mediated Fear" (Lecture, Naval Postgraduate School, Monterey California, Spring 2006).

[102] Patricia Blakeney and Daniel Creson, "Psychological and Physical Trauma: Treating the Whole Person," *Journal of Mine Action*, James Madison University, Issue 6.3 (December 2002).

can also be just as traumatic. Besides the burns and treatment, the reactions of others to their changed physical condition present survivors with the additional trauma of feeling rejected, isolated, worthless and humiliated.

Finally, an IID attack will have a substantial economic impact. The cost for burn care, long-term hospitalization and mental health care is extremely high; burns are one of the most expensive catastrophic injuries to treat. A burn of 30% of total body area can cost as much as $200,000 in initial hospitalization costs and physician fees.[103] For many, long-term care and rehabilitation usually follows the initial burn treatment. One year in a nursing home can average more than $50,000.[104] Generally, long-term care is not covered by health insurance – most people who need the care pay for it out of their own pockets. The addition of mental health care will increase the costs even more. If hundreds or thousands of people were injured in an IID attack, the costs would be astronomical, both to the affected individuals and their families, to insurance companies and health care providers and facilities, and to the government.

[103] Burn Survivor Resource Center, "Medical Care Guide, Burn Statistics," 2, http://www.burnsurvivor.com/burn_statistics.html, [accessed August 8, 2006].

[104] General Services Administration, "Guide to Long Term Care (LTC) Insurance," http://www.pueblo.gsa.gov/cic_text/health/ltc/guide.htm#cost, [accessed August 8, 2006].

IV. POLICY CHANGES

A. OVERALL STRATEGY

The homeland security community's intense concentration on the threat posed by IEDs has caused it to overlook the use of IIDs as potentially devastating terrorist weapons. Such a preparedness oversight has created the kind of weakness that terrorists prey on. To reduce the threat of, and our vulnerability to, an IID attack the homeland security community and the public must be educated on the dangers posed by weaponized fire and turn their attention to preparing for and defending against IIDs.

1. Purpose

The purpose of this strategy is to create a greater awareness of the terrorist threat posed by IIDs and the United States' vulnerability to the probable consequences so steps may be taken to ensure preparedness at all levels. The obvious destructive force of fire and its potential use as a terrorist weapon with the capability for mass casualties and destruction necessitates the classification of fire as a weapon of mass destruction. The U.S. Homeland Security community and first responders are not prepared for the tactical use of IIDs by terrorists. For one thing, the use of incendiary devices may not be immediately evident to the initial fire units responding. The key to identifying an IID attack is situational awareness; indications of an advanced fire on arrival, multiple ignition sources, and nearby fires will serve as signs of a possible IID attack.

Providing awareness of the threat and vulnerability to, and also preparing for the consequences of conflagrations or firestorms will help to achieve the National Preparedness Goal. The homeland security community needs to be well-informed in order to recognize the threat, prioritize it among other threats, take actions to prevent an attack using IIDs, and prepare a response to their use. This greater awareness will assist first responders in preparing their response operations and will assist law enforcement in preventing an IID incident by recognizing the possibility of flammable liquids and other materials as a possible terrorist threat.

2. Vision

The vision for this strategy is a national homeland security community that recognizes and is prepared for IID-Conflagration/Firestorm terrorist incidents, as

evidenced by full inclusion of the IID threat into the National Preparedness Goal. IIDs should be included with other weapons of mass destruction (chemical, biological, radiological, nuclear and explosives) and incorporated into the National Planning Scenarios.

3. Focus

Realizing the vision of preparedness for an IID-Conflagration/Firestorm incident requires a strong focus on three points:

- Renewing research for the modeling of urban firestorms. Updated and expanded research would help local fire departments and all first responders prepare for their response to a conflagration or firestorm.
- Classifying IIDs as weapons of mass destruction. DHS should change the threat classifications of the existing weapons of mass destruction matrix from CBRNE to CBIRNE. This change would then include fire and incendiary devices/weapons (IIDs) as an individual component of WMD. By including IIDs in the CBIRNE matrix, policy makers would thus ensure IIDs are recognized as a significant and unique threat to homeland security and defense.
- Creating two new National Planning Scenarios: #16 IID – Urban Conflagration/Firestorm and #17 IID - Wildland-WUI Conflagration/Firestorm. Like the other scenarios, these fire scenarios will provide the foundation for identifying the capabilities across all mission areas and the target levels of those capabilities needed for effective prevention of, response to, and recovery from an IID attack and a conflagration or firestorm.

4. Coordination and Effort

In order for the homeland security community to change the status quo of the CBRNE threat and include IIDs in the matrix as a potential weapon of mass destruction it must overcome four organizational hurdles: cognitive recognition, limited resources, motivation and politics.[105]

The first challenge is cognitive recognition. The most important stakeholders are citizens who will be innocent victims of an IID attack. In view of that, a change must be created in the public's perception of the threat posed by IIDs. Most people are unaware of the potential danger lying in wait from an IID attack. Horrific deaths and the extensive property damage from accidental fires are in the public's consciousness; a terrorist attack

[105] W. Chan Kim and Renee Mauborgne, *Blue Ocean Strategy* (Cambridge, Massachusetts: Harvard Business School Publication Corp., 2005), 147-148.

using weaponized fire is still unfathomable. By raising awareness of the potential dangers, citizens of this nation can rally their community leaders to work with local, state and federal officials, insurance companies, and private-sector stakeholders to respond to the threat.

The second challenge is one of limited resources: the homeland security community must know that extensive additional resources like the equipment necessary for chemical, biological or radiological hazards will not be necessary in order to prepare for an IID attack. Stockpiling fire-suppressing foam, dry chemical and dry powder (used for the extinguishment of combustible metals) is all that may be necessary to enhance our response capabilities. Conducting additional research and incorporating the ensuing knowledge in training programs, coupled with increased situational awareness, will help in achieving the National Preparedness Goal of providing an all-hazards approach to terrorism preparedness. Like the existing National Planning scenarios, new plans for both Urban and Wildland-WUI IIDs and firestorms and conflagrations will help prepare the nation to prevent, protect, respond and recover from all fires, whether from a terrorist attack or natural disaster.

Another challenge is motivation. Stakeholders at all levels must be motivated to acknowledge the IID threat. In order to achieve this level of motivation stakeholders with key influence in the homeland security community (e.g. DHS, FBI, and DOD) must ensure that all stakeholders are cognizant of the threat from weaponized fire. Making the actions or inactions of these key players transparent to the public and the entire homeland security community greatly raises the stakes of inaction in the event of an IID attack.

The final challenge is political. A critical component of overcoming any political resistance is to secure the combined endorsement of the U.S. Fire Administration (USFA), the National Fire Academy (NFA), and the International Association of Firefighters (IAFF). Another decisive action is to employ the media to assist in deterring possible detractors like the Department of Justice (DOJ) and law enforcement agencies who do not understand the consequences of fire. The media has the power to demonstrate to the public the consequences of ignoring IIDs and the potential of fire as a WMD.

To overcome resistance, this strategy will require buy-in from all stakeholders. Preparedness and response begins with local resources; it is therefore essential that the recognition of the IID threat be initiated on a local level, and more specifically that first responders – firefighters, emergency medical service providers, and fire marshals – push hardest to resolve this preparedness issue. As an entity within DHS, the U.S. Fire Administration is well-positioned to take a lead role in bringing the IID threat to the attention of other members of the homeland security community. The International Association of Firefighters (IAFF) and the National Fire Academy (NFA), as well as unions representing firefighters, fire officers, and emergency medical service personnel, who represent and train the nation's first responders, are also important stakeholders. Coordinating efforts with these organizations will be imperative to successfully raising the level of national awareness to the threat of IIDs.

5. Goals, Objectives, and Implementation Steps

The goal of this strategy is to achieve a greater awareness and preparedness within the homeland security community of the terrorist threat posed by IIDs, conflagrations and firestorms. This can be accomplished through the publication of the present research, which proposes a new WMD matrix classification – CBIRNE – to include incendiary devices, and two new planning scenarios for wildland and urban conflagrations and firestorms.

To increase preparedness, the National Fire Academy as well as local fire academies can develop response plans for conflagrations and firestorms. These new response plans can be incorporated into training curricula and exercises can be conducted to test the plans and the competency of local, state and federal agencies on their implementation. In addition, specialized equipment to manage fires from flammable gases, liquids, and solids must be procured and maintained. The U.S. Fire Administration should require these endeavors to ensure preparedness.

6. Evaluation Plan

An evaluation plan is necessary to ensure the success of this strategy. Monitoring the progress of the outcomes, compiling key management information, and tracking

trends are all important aspects of the evaluation plan. Ongoing performance evaluations will need to continue on a semi-annual basis to determine if the strategy is successful and if the performance targets are being met.

B. PROPOSAL TO CHANGE CBRNE TO CBIRNE AND INCLUDE INCENDIARY DEVICES AND FIRE AS A WEAPON OF MASS DESTRUCTION

The acronym CBRN stands for Chemical, Biological, Radiological and Nuclear weapons, and is synonymous, along with its predecessors ABC (atomic, biological, and chemical agents, used in the Cold War Era)[106] and NBC (nuclear, bacteriological and chemical agents, utilized by NATO Forces)[107] with WMD (Weapons of Mass Destruction). The United States civil defense extended CBRN to include conventional explosives, so it is now known as CBRNE. Although the definition of a WMD under U.S. law, Title 18 U.S.C. Section 2332a, includes incendiaries, the acronym CBRNE does not. Weapons of mass destruction are characterized as chemical, biological, radiological, nuclear, and explosive (CBRNE), and defined as:[108]

- Any destructive device as listed in Section 921 of U.S. Code 18 to include: explosives, incendiaries, poison gases, bombs, grenades, or rockets [109]
- Poison gas
- Any weapon involving a disease organism
- Any weapon that is designed to release radiation at a level dangerous to human life.

In 1996, the Nunn-Lugar-Domenici program established the first homeland security training programs to prepare U.S. cities to respond to terrorist attacks.[110] FEMA/USFA/NFA accordingly produced *Emergency Response to Terrorism* – the first terrorism training for first responders. This self-study guide listed five categories of

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[106] Wikipedia, "NBC Weapon," http://en.wikipedia.org/wiki/ABC_weapons, [accessed July 25, 2006].

[107] NATO-North Atlantic Treaty Organization, "SFOR Shows its NBC Means," http://www.nato.int/sfor/indexinf/107/s107p12a/t01022112a.htm, [accessed July 25, 2006].

[108] LII/Legal Information Institute, U.S. Code Collection, Title 18 > Part I > Chapter 113B > Section 2332a, http://www4.law.cornell.edu/uscode/html/uscode18/usc_sec_18_00002332---a000-html, [accessed July 19, 2006].

[109] Onecle, "Crimes and Criminal Procedure – 18 U.S.C. Section 921," http://law.onecle.com/uscode/18/921.html, [accessed July 19, 2006].

[110] Nuclear Threat Initiative (NTI), "The Nunn-Lugar Vision, 1992-2002," http://www.nti.org/e_research/nunn-lugar_history.pdf, [accessed June 13, 2006].

terrorist incidents first responders might encounter: biological, nuclear, incendiary, chemical, and explosive.[111] The acronym B-NICE was chosen as a simple way to remember the five incident types. It never caught on, however, and the CBRNE acronym developed by the Department of Defense and Domestic Preparedness programs was adopted. The incendiary segment was either left off or combined with explosives and quickly forgotten.

Incendiary devices are listed in the definition of weapons of mass destruction in Title 18 of U.S. Code Section 921, but are grouped with explosives. Given that the lethality and destructiveness of IIDs are so great, incendiary devices should again be separated from explosives and identified independently. Changing the CBRNE acronym to CBIRNE to include incendiaries allows the homeland security community, and all other agencies and disciplines of government, to recognize their significance.

C. NATIONAL PLANNING SCENARIOS

The goal of the *National Strategy for Homeland Security* is to provide a comprehensive plan to enhance protection and reduce vulnerability to terrorist attacks.[112] The *National Preparedness Goal,* mandated by Homeland Security Presidential Directive-8 (HSPD-8), can be achieved by using the *National Planning Scenarios*, *Universal Task List* and the *Target Capabilities List.* This common approach for national preparedness is based on the four homeland security missions - prevention, protection, response, and recovery.

Together these capabilities-based planning tools establish measurable readiness that balances risk with resources across the nation:

- The *National Planning Scenarios* – illustrate the potential threat and magnitude of terrorist attacks, major disasters, and other emergencies.
- *The Universal Task List* (UTL) – provides the tasks to identify the resources required to prevent, respond to, and recover from attacks, disasters and emergencies.

[111] FEMA/USFA/NFA, "Emergency Response to Terrorism Self-Study," http://www.usfa.dhs.gov/downloads/pdf/publications/ertss.pdf, [accessed July 11, 2006]

[112] National Strategy for Homeland Security Washington, D.C: Office of Homeland Security, Superintendent of Documents, U.S. Government Printing Office, July 2002), abstract.

- The *Target Capabilities List* (TCL) – provides the capabilities and outcomes used to identify measurable readiness target.[113]

Figure 1 illustrates how the National Preparedness Goal, Homeland Security Presidential Directives, NIMS, the NRP and NIPP are all integrated to support the National Strategy for Homeland Security.[114]

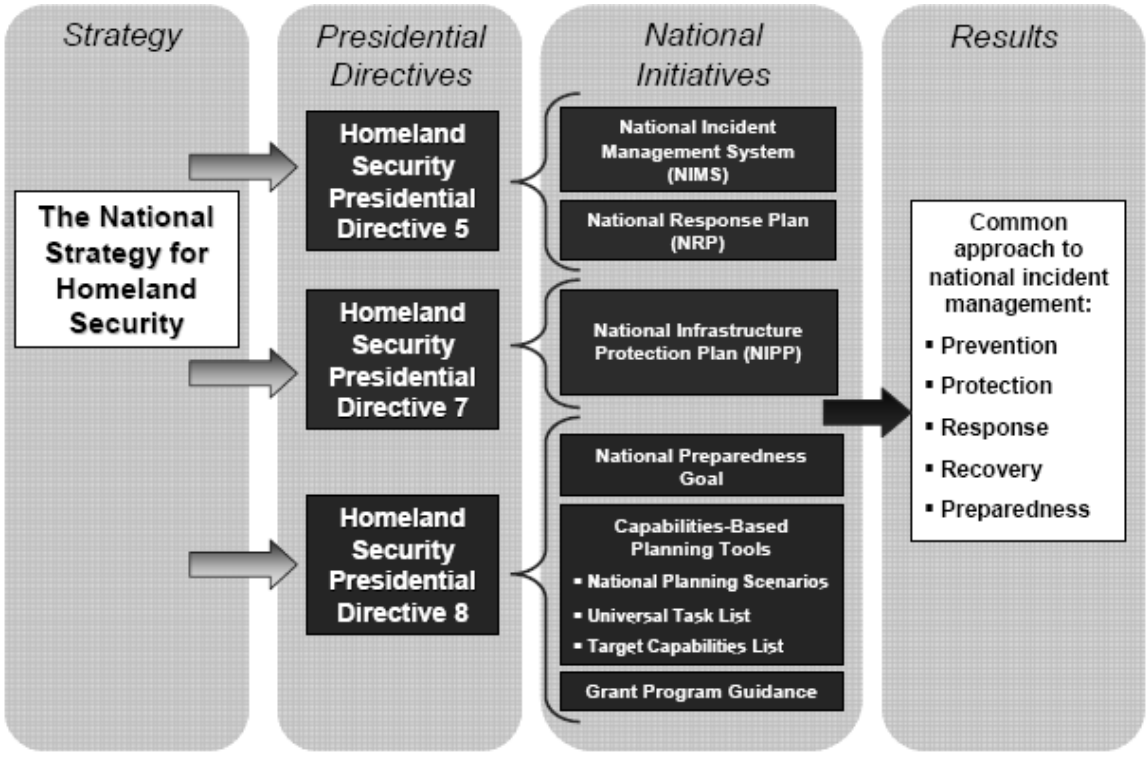

Figure 5. The National Strategy for Homeland Security

The *National Planning Scenarios* are the first step in the capabilities-based planning process. Fifteen scenarios were developed to provide an illustration of the potential threats to national, state, and local homeland security preparedness. These *National Planning Scenarios* are designed as a reference for all levels of government to identify the scope, magnitude, and complexity of potential major events.[115]

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[113] U.S. Department of Homeland Security, *National Preparedness Goal* (final draft), (Washington, D.C.: Department of Homeland Security, December 2005), 6.

[114] U.S. Department of Homeland Security, *National Preparedness Goal* (final draft), (Washington, D.C.: Department of Homeland Security, December 2005), 2.

[115] U.S. Department of Homeland Security, *National Planning Scenarios: Executive Summaries*, (Washington, D.C.: Department of Homeland Security, April 2005), ii.

Scenarios were developed for natural disasters as well as for weapons of mass destruction in the CBRNE matrix. But two scenarios are conspicuously absent: IID/Urban Conflagration/Firestorm and IID/Wildland-WUI Conflagration/Firestorm attack. These scenarios are essential to fully implement HSPD-8 on national preparedness, and to help achieve the *National Preparedness Goal*.

Five of the fifteen scenarios (nuclear detonation, industrial chemical attack, chlorine tank explosion, earthquake, and IED) could cause massive and uncontrollable fires far worse than any of the multiple hazards described for each scenario. In these scenarios, fire is mentioned only cursorily, most likely because of limited fire service representation in their development. The planners developing the scenarios either did not contemplate the consequences of fire, or dismissed it as an everyday occurrence easily dispatched by the fire department.

The Improvised Nuclear Device (IND) attack depicted in Scenario 1 contains only two sentences addressing fire: "A nuclear detonation will also produce a great deal of thermal (heat) energy that will cause burns to exposed skin (and eyes)," and "It is likely that the blast and subsequent fires will destroy all buildings in the immediate area of detonation."[116] The latter sentence combines blast and fire damage, which leads the reader to believe the blast damage is responsible for most of the destruction.

National Planning Scenario 6: Chemical Attack – Toxic Industrial Chemicals acknowledges major fires from petroleum refineries and cargo ships as a significant consequence of the attack. However, firefighting is mentioned superficially as just one of the eight actions necessary for hazard mitigation. The firefighting procedures necessary to mitigate this incident would be extensive and complicated: special equipment, along with substantial quantities of fire suppressing foam, would be required to control the flammable liquid and spill fires of this magnitude.

The Chlorine Tank Explosion described in Scenario 8, although not flammable, would react violently with other chemicals to create fires that produce deadly products of combustion. Emergency Response Guidebook (ERG2004) Guide #24 states that although

[116] U.S. Department of Homeland Security, *National Planning Scenarios: Executive Summaries* (Washington, D.C.: Department of Homeland Security, April 2005), 1-3.

chlorine does not burn, it is a strong oxidizer and will react vigorously or explosively with many materials (including fuels) and support combustion.[117] The toxic effects of the release are a major concern of hazardous material. Unless there is a major source of ignition present and the chlorine is confined to allow the concentration to remain in the flammable range, the fire hazard becomes the primary hazard. Many terrorist groups have chemists in their organization and are cognizant of this dual hazard. Under the right conditions, a chlorine tank explosion can cause both fire and a toxic chemical release. Yet the chlorine tank explosion scenario fails to address this dual hazard.

Earthquakes have the potential to cause massive fires, yet the Natural Disaster Scenario 9 conspicuously ignores the potential for a firestorm, even though the initial earthquake causes only about two percent of the damage.[118] The scenario addresses service disruptions from the rupture of underground fuel, oil and natural gas lines but fails to mention the risks from fire. Fires igniting after an earthquake have the potential to develop into firestorms due to compromised water systems and availability of firefighting units to respond. Even according to the scenario there is a limited capacity to battle fires and search for trapped victims in collapsed buildings; assistance may have to come from outside cities with mutual aid agreements. This is a prime example of the need for fire suppression planning.

The improvised explosive devices (IEDs) scenario focuses on blast damage from the IED; the scenario groups the fire hazard with six other primary hazards: toxic smoke, un-detonated explosives, unstable structures, electrical hazards, and low visibility. In this scenario, like the others, the fire service is assumed to be performing its core competency and is taken for granted.

The objective of the National Planning Scenarios is for all levels of government to identify the potential scope, magnitude, and complexity of major events. This thesis includes a proposal to develop two new proposed National Planning Scenarios: #16 IID/Urban Conflagration/Firestorm and #17 IID/Wildland-WUI Conflagration/Firestorm.

[117] North American Hazardous Materials Emergency Guidebook, "ERG 2004, Guide #24 – Chlorine." (Washington, D.C.: U.S. Department of Transportation, Research and Special Programs Administration, n.d).

[118] Dennis Smith, *San Francisco is Burning: The Untold Story of the 1906 Earthquake and Fires* (New York: Viking, 2005), 269.

Scenario #16 is proposed initially for use by the fire service in an urban setting and Scenario #17, if approved by the National Wildfire Coordinating Group (NWCG), could serve as a guide for fire departments within wildland and WUI environments. Both scenarios, or some variation thereof, should be adopted by the U.S. Fire Administration, the National Fire Academy, the National Interagency Fire Center (NIFC) and ultimately DHS to supplement the fifteen National Planning Scenarios in current use.

1. Planning Scenario # 16: IID - Urban Conflagration/Firestorm

Executive Summary

Casualties	1,500 fatalities, 25,000 hospitalizations
Infrastructure Damage	Total, within a 1-mile radius
Evacuations / Displaced Persons	50,000 assisted and self-evacuations
Contamination	Products of Combustion
Economic Impact	Billions
Potential for Multiple Events	Yes
Recovery Timeline	Years

Table 1. Executive Summary of Urban Conflagration/Firestorm

a. Scenario General Description:

A spring snowstorm was descending upon New York City in late March. Snow was falling heavily, reducing visibility to about 100 feet. The weather was perfect, Mohammad thought, as he slowly loosened the gas-line coupling in the basement of the huge apartment complex; he was planting his homemade igniter (potassium chlorate and sugar – directions courtesy of "Arson Around with Auntie ALF"). Almost two years in the planning, New York City would awaken to a fiery chaos. Two cells had placed twenty-five IIDs on points of the compass across the New York metropolitan area. The first few would go off in the warehouse district as a diversion; these would be followed an hour later with a half-dozen high-rise apartment explosions in the upper floors, which would clog traffic and create chaos. His cell phone beeped as he climbed into the back seat of the car that quickly disappeared down the alley. A smile came across his face as he glanced at his watch: 6:00 A.M. In the distance the faint sounds of sirens drifted through the air; the first fire was already at a five-alarm.

In this scenario, agents of the Universal Adversary (UA) use improvised incendiary devices (IIDs) to ignite four separate fires in proximity of each other but strategically placed throughout different sectors of metropolitan area. Unlike simple arson, these IIDs are weapons designed to create a large area fire with the potential to develop into a conflagration or firestorm. The UA-utilized incendiary weapons are composed of a combination of materials such as gasoline, high temperature accelerants, napalm, thermite, or white phosphorus. These are simultaneously ignited with initial explosives strategically placed in high-rise commercial and residential buildings, industrial complexes of buildings with heavy timber and mill construction, and residential homes of brick and joist or wood-frame construction. Thirty minutes later, as a subway train transverses an under-river tunnel, two incendiary fires ignite: one on the train and the other in the under-river tunnel.

b. Planning Considerations

(1) Geographical Considerations/Description –

The incident is designed for an urban environment; casualty estimates would be reduced in less populous cities. The primary urban location for this scenario would be a large city like New York, Chicago, or Detroit, with a mixed occupancy of commercial and residential buildings and probably an underground transportation system.

(2) Timeline/Event Dynamics –

The response timeline begins with the identification of the fires and the response of the fire department. Initial firefighting procedures will be conducted by the first arriving fire units to protect life and property by performing rescues and by locating, confining and extinguishing the fires. An accurate and complete size-up will be conducted to determine if an offensive or defensive strategy will be employed.

The simultaneous events throughout the city will require the normal response to alarms to be adjusted to a reduced response mode, decreasing the number of units responding to each fire. The Incident Commander will implement the Incident Command System to manage the incident, in full compliance with the guidelines set forth by the U.S. Department of Homeland Security (DHS) and the National Incident Management System (NIMS).

(3) Mission Areas Activated –

Prevention/Deterrence: IIDs are inexpensive, readily available and tactically simple to use. The ability to prevent and deter an IID attack would be challenging.

Infrastructure Protection: The pre-event planning stage could be used to ensure proper security measures are in place and fire protection systems are in proper working order.

Preparedness: Firefighters and EMS are properly trained to perform their assigned missions to National Fire Academy standards. Mutual aid agreements must be in place and exercised.

Emergency Assessment/Diagnosis: The initial size-up at these incidents could indicate arson or an IID attack and the potential for a firestorm. Proper notifications to higher command must be transmitted immediately. The potential exists for the entire city to be destroyed by fire.

Emergency Management/Response: Immediate action requires search and rescue, fire containment, additional resources, air reconnaissance, the implementation of ICS, and the activation of an Incident Management Team.

Hazard Mitigation: Contain and extinguish the fire through various extinguishing methods compatible with the fire and occupancy: large-caliber water streams, foam, dry chemical or dry powder.

Evacuation/Shelter: The potential for a firestorm and building collapse requires evacuation of the population within the surrounding area. The use of law enforcement is necessary to assist in evacuation and traffic control.

Victim Care: Injuries will include burns, smoke inhalation, respiratory distress and trauma. EMS will triage and track patients on scene and provide transportation to appropriate hospitals. A determination must be made that medical facilities will not be exposed to an expanding firestorm.

Investigation/Apprehension: Investigation during the mitigation phase by fire marshals and law enforcement will not be possible due to radiant heat and collapse potential of structures. Coordination of federal, state, and local investigative resources will be necessary following the extinguishment of the fire.

Recovery/Remediation: Firestorms and conflagrations have the ability to completely destroy an entire city. Essential services will be non-existent. Thousands of people will need to be relocated. Long-term medical care will be required for both physiological and psychological injuries. Recovery will require clean-up and rebuilding, which will take years and cost billions of dollars.

c. Key Implications

Terrorist groups employing IIDs simultaneously ignite fires in separate, strategically-located sectors throughout New York City. Fires ignited on the lower floors of high-rise buildings with sabotaged fire protections systems trap people above the fire with no chance of escape or rescue. As most resources are battling the high-rise fires, additional fires burn out of control in different sectors of the city. As these individual fires burn and intensify over the city, the fires unite and develop into a conflagration consuming entire neighborhoods, critical infrastructure and key resources.

The simultaneously-ignited fires contribute to the volume of heated and buoyantly rising air from each fire zone. As the fires feed upon themselves and as smaller fires converge, cool air is sucked into the vacuum left by the expelled hot air. Winds or updrafts of over 100 miles per hour are generated. Cyclonic winds carry flames, fireballs, hot embers, billows of smoke, and large objects aloft. Volatile gases generated by the intense heat explode in the air, causing flames to spread in outward surges. The temperature in a firestorm can exceed 1,000 degrees Celsius, which will melt glass and metal and burn ordinary fireproof materials. The consequence of a firestorm is total devastation within the affected area.

There will be thousands of civilian and emergency personnel casualties due to burns and exposure to toxic gases. Hospitals will be destroyed and the limited number of burn care centers nationwide will be inadequate to treat the thousands of burn victims.

The firestorms or conflagrations will destroy critical infrastructure, both physical and cyber-based, including but not limited to telecommunications, energy, banking and finance, transportation, water systems and emergency services, essential to the continuity of the government (COG) and economy of the United States.

2. Planning Scenario #17: IID - Wildland-WUI Conflagration/Firestorm

An important factor contributing to the destructiveness of wildland fire is that structural firefighters are trained and equipped differently from wildland firefighters. Urban firefighters rely on the water systems provided in urban settings, and count on catching the fire in its early stages. Often, neither of these situations exists in WUI. Wildland firefighters have no ready water supply except what they transport to the site. They also anticipate larger fires, and are thus trained to fight the fire from its perimeter, clearing fuel to prevent spread. Complications often arise with WUI fires, and the IID terrorist component amplifies these problems.

Executive Summary

Casualties	< 500
Infrastructure Damage	100,000 to 500,000 acres
Evacuations / Displaced Persons	10,000-20,000
Contamination	Products of Combustion, Watersheds
Economic Impact	Billions
Potential for Multiple Events	Yes
Recovery Timeline	Decades

Table 2. Executive Summary of Wildland-WUI Conflagration/Firestorm

a. Scenario General Description

In the early morning hours, the L.A. County Terrorism Early Warning Group (TEW) received reports of the multiple fires burning out of control in New York City. Just before dawn, TEW received additional reports of a massive wildland fire burning out of control and moving toward a residential development in L.A. County. Shortly thereafter, a message was broadcast on a foreign news network, stating: "The American infidels will all die in hell fire; there will be no escape from the flames — the wrath of Allah will sweep down upon you as the desert wind, consuming your miserable lives and razing your dwelling places. You will be unable to flee Allah's deadly breath. Allahu Akbar! (God is great.)"

In this scenario, agents of the Universal Adversary (UA) use improvised incendiary devices (IIDs) to ignite hundreds of individual fires within close proximity to each other, but strategically placed throughout different segments of a Wildland and WUI. The incendiary weapons are composed of materials such as gasoline, high temperature accelerants, napalm, thermite, white phosphorus or something as simple as a road flare. IIDs are ignited from the ground and the air in areas where the forest is most vulnerable to rapid ignition and fire growth, taking advantage of the topographical conditions to rapidly extend the fire. The UA also mimics the Japanese Balloon Bombs of World War II, in which Japan launched thousands of balloons carrying incendiary devices across the Pacific Ocean, some landing as far east as Michigan.[119] These balloons are released at night to avoid detection; flying at low altitudes they crash into the forest igniting thousands of fires. Under ideal fire conditions of drought, high winds, and excessive ground fuel, these IID weapons are designed to create a multitude of large fires that will travel unimpeded for miles, burning areas of forest, homes and critical infrastructure. Many of these fires coalesce into a large area fire, generating tremendous heat and developing into a massive fire. As they continue to grow and merge with other large fires a conflagration arises, and if sufficient heat is built up, there is also a strong possibility of a firestorm developing.

[119] United States Air Force Museum, "Japanese Balloon Bombs," http://www.wpafb.af.mil/museum/history/wwii/jbb.htm, [accessed July 17, 2006].

b. Planning Considerations:

(1) Geographical Considerations/Description –

The incident is designed for a Wildland and WUI; casualty estimates would increase as unimpeded fires extend into suburban and urban environments. California was probably the first state to experience this phenomenon, and has endured several devastating fires. One extreme example of a WUI fire occurred in October 1991, when wildland fire broke out in urban Oakland Park. It spread throughout an intermix area, and ignited much of the adjacent urban area. Twenty-five people were trapped and killed, and more than 3,000 homes were destroyed. The Rodeo-Chediski Fire in Arizona in the summer of 2002 destroyed 426 structures and burned 462,000 acres.[120] The primary wildland and WUI locations can be anywhere in the U.S., but the north- and southwest are the most susceptible.

(2) Timeline/Event Dynamics –

The response timeline begins with the identification of the fires and the response of the local fire departments. The kind and number of resources responding to initial attack varies depending upon the fire danger, fuel type, and the values to be protected. Initial firefighting procedures will be conducted by the first group fire units to protect life and property. Early evacuation of homes and towns is of primary importance. Firefighter and public safety is the first priority at wildland fires; thus, requests for mutual aid and assistance from an Incident Management Team are called for without delay. The simultaneous fires throughout the area will necessitate a limited or non-response to those fires with low life-hazard or critical infrastructure potential. All personnel will follow the procedures in the *Fireline Handbook* published by National Wildfire Coordinating Group.[121]

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[120] Science & Policy Brief, "Summary of Rodeo-Chediski Fire, Arizona: June 18-July 7, 2002," *The Wilderness Society, Ecology and Economics Research Department* no. 8 (March 2003), http://www.wilderness.org/Library/Documents/upload/Summary-of-the-Rodeo-Chediski-Fire-AZ-PDF.pdf#search=%22Rodeo-Chediski%20Fire%20in%20Arizona%20%22, [accessed August 23, 2006].

[121] Incident Operations Standards Working Team, *National* Wildfire *Coordinating Group, NWCG Handbook 3* (Boise ID: National Interagency Fire Center, March 2004), http://www.nwcg.gov/pms/pubs/large.html#FirelineHandbook, [accessed August 15, 2006].

(3) Mission Areas Activated –

Prevention/Deterrence: IIDs are inexpensive, readily available and tactically simple to use. The ability to prevent and deter an IID attack would be challenging.

Infrastructure Protection: The pre-event planning stage could be used to ensure prescribed burns are conducted in vulnerable areas and that firewise practices are in place. Prevention measures include creating a defensible space around all structures, using fire-resistant construction, and developing an emergency access and disaster plan in the event of a wildfire.

Preparedness: Prescribed burning by the National Forestry Service removes fuel from the path of a future fire from an IID attack and can protect specific buildings, cultural resources, critical natural resources, and habitats. Ensure sufficient resources are available and equipment caches ordered to set up for necessary activation and deployment. Conduct year-round training for all wildland firefighting and IMT positions.

Emergency Assessment/Diagnosis: The initial size-up at these incidents could indicate arson or an IID attack and the potential for a massive fire. Conduct aerial reconnaissance to determine the number of fires and their perimeters. Proper notifications to higher command must be transmitted immediately. The potential exists for the wildland fire to involve wildland-urban interface, suburban and urban surroundings.

Emergency Management/Response: The Incident Command System is employed. Ensure the command and general staff positions are filled and necessary resources are available. Prepare for an extended attack once the complexity levels exceed initial attack capabilities.

Hazard Mitigation: Use aircraft to drop fire retardant and water. Line crews and bulldozers are used to establish fire lines. Task forces and strike teams are employed to extinguish fires, and protect structures. Residents are evacuated from their homes when necessary.

Evacuation/Shelter: There will be little or no warning during the acute stage of the fire. Many homes in the wildland-urban interface will be quickly

engulfed by the large area fires and generate many fatalities. Shelter-in-place is not an option; evacuation is mandatory. However, access and egress routes are limited; many residents will be trapped. Helicopter evacuation may be necessary.

Victim Care: Injuries will include burns, smoke inhalation, respiratory distress and trauma. Pre-hospital medical will be limited. Medical facilities will be a distance away, delaying transportation of victims to the appropriate medical facilities.

Investigation/Apprehension: Investigation during the mitigation phase by fire marshals and law enforcement will not be possible until the fire burns itself out. Coordination of federal, state, and local investigative resources will be necessary following the extinguishment of the fire.

Recovery/Remediation: Firestorms and conflagrations have the ability to completely destroy a large section of forest as well as nearby towns and cities. Essential services will be non-existent. Thousands of people will need to be relocated. Long-term medical care will be required for both physiological and psychological injuries. Recovery will require clean-up and rebuilding that will take decades and cost billions of dollars.

c. Key Implications

Terrorist groups employing the many forms of IIDs available to ignite hundreds of simultaneous and strategically-located fires throughout wildland and wildland-urban interfaces will devastate the area and the environment. As these individual fires burn and intensify throughout the forest, the fires could join together to create an extremely large area fire. Depending on the atmospheric conditions and winds, this fire could develop into an advancing line fire miles long. Also, the volume of heated and rising air from each fire zone could increase to significant levels and develop into firestorms. In this scenario fire classification is irrelevant, since both types of fires have the potential to consume large sections of the forest and extend into suburban and urban areas, causing total destruction throughout their path.

Critical infrastructures and key resources will be destroyed by the fire. The destruction of telecommunication towers will severely affect vital first responder communications. Whole towns and cities will lose power when the electrical substations

and power lines burn. The after-effects of the fire will pollute reservoirs and watersheds, leaving communities without fresh water. In addition, the smoke plume generated from these fires will create a myriad of problems such as respiratory problems. The smoke will also interfere with air traffic and vehicles traveling on nearby roads. Many other critical infrastructures and key resources will be affected, including continuity of government and the country's economy.

As Secretary of Homeland Security Michael Chertoff states in the revised *Target Capabilities List*, in order to meet the twenty-first-century challenges facing this nation,

> …we must understand performance requirements for a major event at the task level and build and maintain the capabilities required to perform those tasks. Preparedness for major events assumes a coordinated and shared response that involves all levels of government, the private sector, non-government organizations, and citizens.[122]

The two scenarios above can help to ensure preparedness in the event of a conflagration or firestorm no matter the source or cause.

[122] U.S. Department of Homeland Security, *Target Capabilities List: A Companion to the National Preparedness Goal* (draft), August 2006, iii.

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V. CONCLUSION

The goal of the *National Strategy for Homeland Security* is to provide a comprehensive plan to enhance protection against and reduce vulnerability to terrorist attacks. The nation must anticipate terrorist groups employing weaponized fire as an asymmetric weapon. Reducing the risk of IIDs and weaponized fire used by terrorist groups can be accomplished in a number of ways. The first step is to recognize IIDs as a threat and gain an awareness of our vulnerabilities to and the consequences of such an attack. Changing the WMD matrix from CBRNE to CBIRNE to include incendiary devices will promote this awareness at all levels.

Capabilities-based planning tools like the *National Planning Scenarios*, *Universal Task List* and the *Target Capabilities List* aid in our national preparedness. The addition of the proposed urban and wildland/WUI planning scenarios for conflagrations or firestorms can further prepare us for an IID attack and aid in achieving the four homeland security missions: prevention, protection, response, and recovery.

Threat reduction can also be achieved by applying protective measures to decrease our vulnerability and lower the consequences of an IID attack. Building code changes can be made to improve building and occupancy safety, including increased resistance to building collapse; redundancy of fire protections systems; improved egress for occupants; and improved access for first responders. The U.S. Forest Service can reduce wildland fire risk through forest treatment projects that will restore ecological structures and protect human life, property, critical infrastructure, and key resources. Residents of WUI can help to protect their homes and nearby structures from wildland fires by following firewise practices.[123]

Emergency responders' ability to respond to weaponized fire and extreme fire events (like conflagrations or firestorms) depends on three fundamentals:

- Capability – unique skills that emergency responders perform.

[123] Front Range Fuel Treatment Partnership Roundtable, "Living with Fire: Protecting Communities and Restoring Forests," http://www.wilderness.org/Library/Documents/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=14899, [accessed August 9, 2006].

- Capacity – how many resources or trained personnel are available.
- Proficiency – how well emergency responders perform each task.[124]

The capability of emergency responders can be increased through specialized training and proper equipment, including the appropriate extinguishing medium necessary for the many flammable and combustible solids, liquids, and gases. The knowledge and training required for this equipment is paramount to achieving this capability. In order to maximize emergency responders' capacity to respond and mitigate disasters like conflagrations or firestorms, each agency must insure a proper recall system is in place, as well as sufficient mutual aid agreements with other cities. Proficiency is dependent on proper response plans, scenarios and well-implemented exercises.

Response to an extreme terrorist event or natural disaster resulting in a conflagration or firestorm will initially be managed by local first responders. It is important that all emergency responders and agencies operate together under a unified command of the Incident Command System. The synergetic results of each agency working together within their core competency will enhance the control and mitigation of the disaster. While the fire service is conducting fire suppression, pre-hospital emergency care, and search and rescue, law enforcement can be simultaneously performing evacuation, site security, force protection and investigation. Force protection is particularly important; all first responders are susceptible to attack while performing their duties. Although local emergency responders and medical facilities will be overwhelmed due to the magnitude of the event, a cohesive local response will allow for a smooth and unencumbered transition as state and federal resources arrive to augment the local response.

Terrorists select their tactics based on a number of factors: the risks to their group, impact on the target, media exposure, and the effect of recruitment.[125] IIDs present a minimal risk to a terrorist group, are easy to acquire, safe to handle and employ, and difficult to detect. The destructiveness of fire guarantees impact on a target will be

[124] Joseph Pfeifer, "Command Resiliency: An Adaptive Response Strategy for Complex Incidents," Naval Postgraduate School Thesis, 7, https://www.hsdl.org/homesec/docs/theses/05Sep_Pfeifer.pdf, [accessed August 11, 2006].

[125] Rollie Lal and Brian A. Jackson, "Change and Continuity in Terrorism Revisited: Terrorist Tactics, 1980-2005," The MIPT Terrorism Annual 2006, 23, http://www.tkb.org/documents/Downloads/2006-MIPT-Terrorism-Annual.pdf, [accessed August 18, 2006].

substantial. The sensationalism of fires will act as an effective recruitment vehicle; indeed, the extensive media exposure in itself makes IIDs an attractive weapon for terrorist groups. Currently, IEDs and bombings have been the most effective means for terrorist groups to carry out their mission. Nonetheless, the various targets and tactics used by groups will most likely shift as our counter-terrorism measures improve. Terrorist groups will likely adjust their strategies and tactics to employ IIDs as their weapon of choice.

The use of fire as a terrorist weapon has all the characteristics of a predictable surprise. Bazerman and Watkins offer four suggestions on how organizations can avoid being predictably surprised:

- Scan the environment and collect sufficient information regarding all significant threats.
- Integrate and analyze information from multiple sources within the organization to produce insights that can be acted upon.
- Respond in a timely manner and observe the results.
- In the aftermath, reflect on what happened and incorporate lessons-learned to avoid repetition of past mistakes.[126]

DHS and the entire homeland security community can prevent weaponized fire from becoming the next predictable surprise by following these four steps: 1) Become aware of the threat and collect intelligence on IIDs; 2) Take action on the credibility of this threat by including "I" in WMD matrix CBIRNE and produce planning scenarios for all levels of government to use as a reference and as a training tool; 3) Immediately begin to take necessary measures to reduce the risk by lowering our vulnerability and the consequences of an attack; and 4) If an attack does occur, be prepared to mitigate and incorporate lessons learned to prevent another attack.

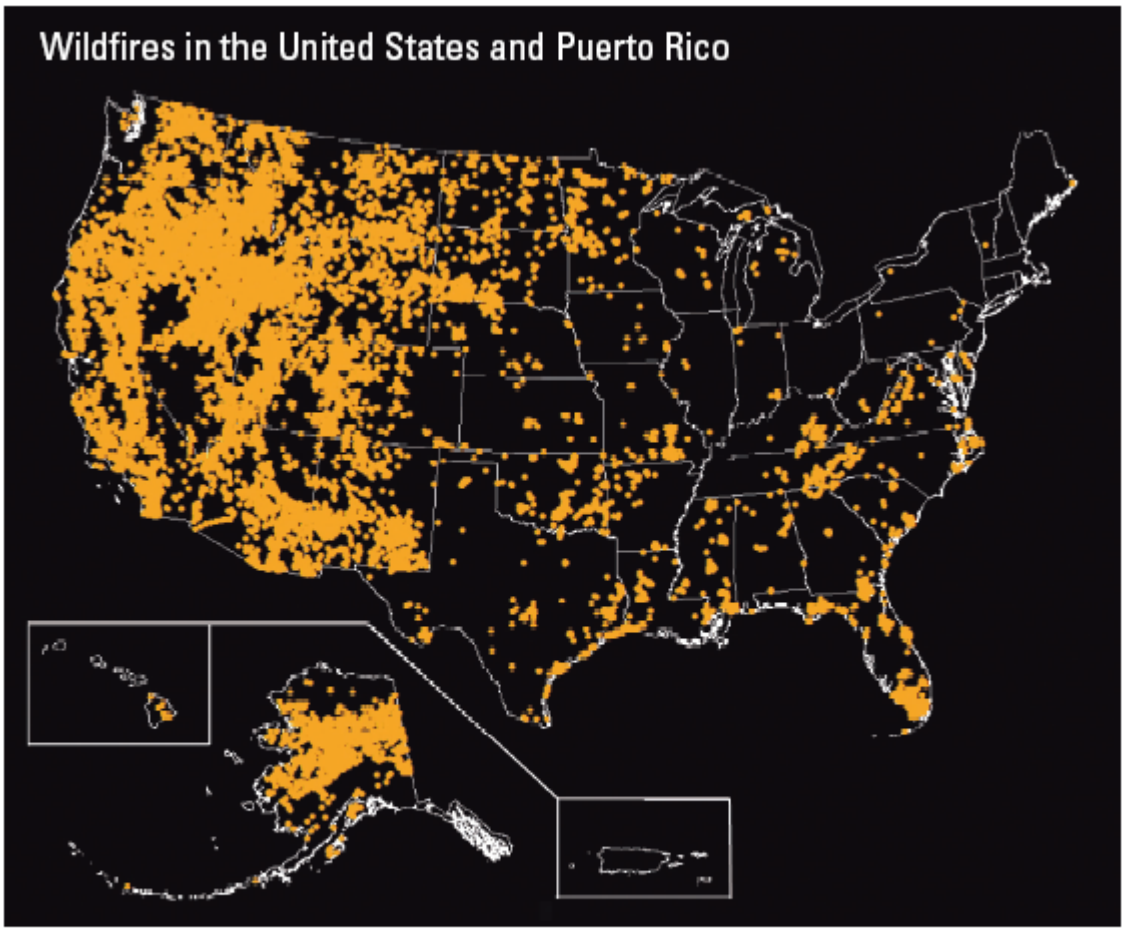
Unfortunately, the homeland security community has yet to recognize the enormity of the threat, vulnerability and consequence from IIDs as a terrorist weapon. As a result, the U.S. is unprepared for the prevention of or response to IIDs. Unless this threat is acknowledged by entire homeland security community as significant, and action

[126] Bazerman and Watkins, *Predictable Surprises,* 97.

is immediately taken on this threat, the U.S. will not be properly prepared to prevent or respond to an IID attack when it occurs. This thesis is intended to act as a catalyst for such acknowledgement and action.

APPENDIX A

WILDFIRES IN THE UNITED STATES AND PUERTO RICO



This map shows locations that experienced wildfires greater than 250 acres, from 1980 to 2003. Map not to scale. Sources: Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Indian Affairs, National Park Service, and the USGS National Atlas

http://pubs.usgs.gov/fs/2006/3015/2006-3015.pdf

[accessed June 25, 2006]

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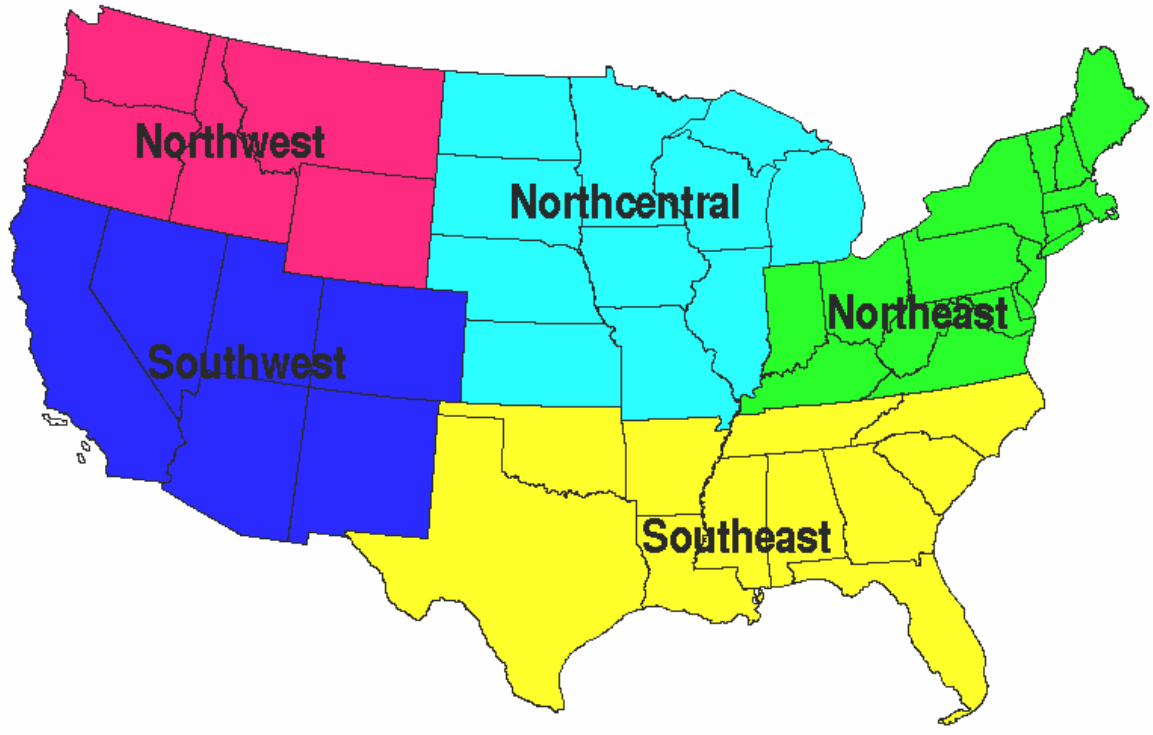
APPENDIX B

REGIONS OF THE UNITED STATES



Regions of the United States
Source: http://www.3.baylor.edu/cagsr/ndbp/images/regions.gif

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