A Plan for Structural Collapse Rescue

Training Facility Development

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions or writings of others.

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Abstract

Many disasters including hurricanes and tornadoes have taken place in the state of Mississippi that resulted in victims trapped in collapsed structures. Mississippi firefighters and rescuers are called to help these people who become victims of structural collapse. The problem was the Mississippi State Fire Academy does not have a training facility for structural collapse rescue and without a place to train, Mississippi rescuers are not able certify or maintain skills in structural collapse rescue. The purpose of this research was to identify the resources required to construct a structural collapse rescue training facility that will facilitate certification courses and skills maintenance. Descriptive research including document analysis and interviews with other training providers were used to answer the following research questions: a) what training facilities are required to meet the requirements for the structural collapse rescue job performance requirements outlined in NFPA 1006? b) what training facilities are required to meet the requirements for the FEMA Structural Collapse Technician course curriculum? c) What types of facilities and props do other training providers use for structural collapse rescue training? and d) what are possible alternatives for building a new structural collapse training facility?

The research identified 13 prop-related techniques used to construct and facilitate a structural collapse rescue training program. Innumerable materials for props and facilities were also identified using documents and interviews. It was recommended that agencies seeking to provide similar courses of instruction use the collected results of this study. Agencies should also contact others that provide collapse rescue training and visit their facilities to learn how instructors and students interact with various props.

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Introduction

Urban search and rescue or US&R requires training in structural collapse rescue. Structural collapse rescue is the use of advanced techniques to locate, extricate, and stabilize victims within collapsed structures or other confined spaces. After large disasters, structures are likely to collapse, presenting significant risks to both rescuers and the occupants. The ability to carry out these types of rescue operations requires technical training in many areas of specialization. Structural collapse rescue, as a unique and standalone multidiscipline, is not a new concept. A paradigm shift occurred in the 1980's when more citizens came to expect timely, professional, and effective, rescue responses from local fire departments, state, and federal governments. As rescue professionals reacted to more terrorism and natural disasters during this time period, coupled with the growing technical proficiency of these responders, the all-hazards approach to rescue came to be known as Urban Search and Rescue (US&R) (Collins, 2004).

Presently, in the event of a manmade or natural disaster, a coordinated response of technical rescue will be initiated from local, state, and federal levels. Once these specialized US&R teams are activated, they will deploy to the disaster and conduct around the clock rescue operations until they are relieved or demobilized. These rescue operations will include the physical and technical search of damaged or collapsed structures, emergency medical care for patients and trapped victims, the assessment and shut-off of building and commercial utilities, evaluation of structures needed for immediate occupancy to support the response, stabilizing damaged structures, and the removal of victims from the hazardous environment (Cooper, 2005). A wide range of knowledge, skill, and ability are needed to implement these response and mitigation efforts. In most cases, years of training are required for the various responders to collapse events to be adequately prepared to face the challenges of such wide spread disasters.

The Mississippi State Fire Academy (MSFA) is the primary training provider for firefighters and rescuers in the state of Mississippi. Structural collapse rescue training and facilities are necessary to maintain capable state US&R and regional rescue teams for response to large-scale disasters. The problem is the Mississippi State Fire Academy does not have a training facility for structural collapse rescue and without a place to train, Mississippi students are not able certify or maintain skills in structural collapse rescue.

The purpose of this research is to identify the resources required to construct a structural collapse rescue training facility that will facilitate certification courses and skills maintenance. The research will be used as an outline to plan and facilitate the planning and construction of a structural collapse rescue training facility on the campus of the Mississippi State Fire Academy. An academic and pragmatic approach will help ensure resources and facilities are built to high standards with the most progressive rescue philosophies available. This research will utilize the descriptive research method. Analysis of documents such as the National Fire Protection Association (NFPA) 1006 Standard for Technical Rescuer Professional Qualifications, the Federal Emergency Management Agency (FEMA) Structural Collapse Technician Course manual, documents, photos, and case studies will be used to develop strategic and tactical plans for the construction of a structural collapse rescue training facility. Further descriptive research techniques such as focus groups and structured interviews will be used to evaluate what comparable training providers are utilizing for structural collapse rescue training facilities. The following research questions will be used: a) what training facilities are required to meet the requirements for the structural collapse rescue job performance requirements outlined in NFPA 1006? b) what training facilities are required to meet the requirements for the FEMA Structural Collapse Technician course curriculum? c) What types of facilities and props do other training providers use for structural collapse rescue training? and d) what are possible alternatives for building a new structural collapse training facility?

Background and Significance

Urban search and rescue teams and operations are conducted and administered on many levels, including municipal fire departments, state offices of homeland security, and Federal Emergency Management Association (FEMA) within the Department of Homeland Security (DHS). The funding for these teams comes from various entities. Teams are most often staffed on a volunteer basis by career firefighters. When a disaster takes place, they are mobilized and these highly trained individuals deploy with extensive resources to satisfy the needs of the mission. The NFPA and FEMA outline training criteria and resource typing for the various rescue disciplines within Urban Search and Rescue, which will be referred to as US&R for this research. These disciplines include but are not limited to emergency medicine, hazardous materials response, rope rescue, confined space rescue, water rescue, trench and excavation rescue, vehicle and heavy machinery rescue, and structural collapse rescue. With funding and support from the local, state, or federal levels, teams and individual members train and acquire many skill sets on a continuum over their careers. Training is likely to come from within a members' respective fire department as part of their professional development, or from outside agencies in order to satisfy the training requirements of the response team.

On August 29, 2005 Hurricane Katrina made landfall in Mississippi, the last of three landfalls. It was the third most powerful storm ever to make landfall in the United States. Along the entire Gulf coast, the storm overwhelmed first responders, municipal assets, and all other local resources. A 27-foot storm surge washed up to six miles inland. The surge washed over Interstate 10 for several miles and swept away several major bridges and infrastructure (Knabb, Rhome & Brown, 2005). The storm left 238 people dead in Mississippi and 67 people missing. Over 80,000 homes were flattened or destroyed on the coast. Katrina remains the costliest storm in the history of the United States (Knabb et al., 2005).

Expectations are reasonable that disaster-affected areas become overwhelmed when they bear the direct impact of earthquakes, terrorist attacks, floods, and hurricanes like Katrina. In Mississippi, smaller municipalities were virtually decimated, as were their local governments and emergency services (Collins, 2006). For this reason, it has become national practice that rescue personnel from less affected or unaffected areas often conduct rescue operations above and beyond the daily needs of local public safety. Fire departments and law-enforcement personnel typically respond from other jurisdictions to augment the services in the affected areas. In the case of a hurricane or major storm, search and rescue personnel with equipment travel from other parts of the affected states, neighboring states, and in some cases the entire country, in order to render aid to the affected. Emergency mutual aid compacts (EMAC)s, between state governments, make fire and rescue response from other states possible. In the aftermath of a disaster, police and fire must cope with their own primary responsibilities. Additionally, extra situations created by the incident such as special operations, rescues, and logistics must also be addressed. This creates a huge strain on all emergency services. A large concrete structure, that is structurally compromised and partially collapsed, would require an entire US&R task force to shore and perform search and rescue operations. Most fire departments in Mississippi cannot provide fire suppression and emergency medical services while shoring and conducting technical search and rescue operations.

In the aftermath of Hurricane Katrina, rescue, response, and recovery were handled very well on the Mississippi Gulf Coast. Absent from the Mississippi response was a cohesive, organized, and trained state-sponsored search and rescue element. The August 29, 2005 Presidential Disaster Declaration dispatched 11 Federal Emergency Management Agency Urban Search and Rescue Task Force Teams to Mississippi. Additionally, state urban search and rescue teams were deployed from Florida, Alabama, and other states. Mississippi created three urban search and rescue strike teams in the hours following the storm (Collins, 2006).

Need

In 2005, Hurricane Katrina demonstrated a need for state-based search and rescue teams, capable of a prolonged regional deployment, in Mississippi. The ability to respond to a declared disaster area is made possible by the emergency mutual aid compacts (National Emergency Management Association, 2005). States should maintain a certain level of self-sufficiency where search and rescue is concerned. Furthermore, as a good neighbor, Mississippi needs to train and prepare to reciprocate rescue aid to states such as

Alabama and Florida when they become afflicted by disaster. Mississippi state urban search and rescue teams should serve local needs and the needs of bordering states as US&R first responders. Disasters such as hurricanes, cyclones, earthquakes, tornadoes, floods, dam failures, hazardous materials releases, and terrorist attacks are inevitable. A state is obligated to act accordingly in the best interest of its citizens and neighbors. The burden and duty falls upon the state to provide citizens with a large-scale all hazards approach response contingent. The *all-hazards* response model can be found in the Federal and state models of current US&R teams.

In the years since hurricane Katrina, US&R and its structural collapse rescue technician (SCRT) training is in its developmental stages and as a consequence, the certification and refresher training lacks a central location and deliverable format. State leadership, leadership of the Mississippi State Fire Academy, and responders have expressed a clear need and desire to develop a facility for the training of responders who have and will face these types of disasters again. In the time since 2005, contracted trainers from out of state have trained students in the discipline of structural collapse rescue technician. These courses have often taken place at mocked-up, improvised, and temporary locations. The contract courses were delivered at a considerable expense to fire departments and the Mississippi Office of Homeland Security.

The Mississippi State Fire Academy, referred to as MSFA in this document, provides training in firefighter certification, firefighter professional development, rescue, and hazardous materials. Most pundits believe the obvious solution is to integrate vertically and horizontally into the structural collapse rescue technician discipline. In order for this to take place, a facility to accommodate the training must be constructed.

To achieve a high level of service delivery, such a facility should not be built to a minimum standard, but rather excel and push the limits of public funding, innovation, and imagination.

As with many organizations, the greatest asset to the Mississippi US&R task force teams will be the highly trained human capital. The level of training and the appropriate skill sets of these members will help to ensure that members are prepared for the harsh and dangerous conditions that exist when natural or man-made disasters take place. Correct training, outlined by the NFPA and FEMA, will also allow the US&R responders from Mississippi to be on par with US&R members from other teams and states that maintain training to the nationally accepted standards. For these reasons, there is a need invest in the training and certification of each of the responders that may participate in the role of technical rescuer in a disaster. There are no less than eight separate disciplines of US&R response and rescue that require certification training. In most cases, structural SCRT is the all-encompassing apex area of training. When a team member is not proficient in each these eight disciplines, or especially SCRT, then responders and citizens may face dire consequences.

When a candidate is proficient in all the disciplines culminating in SCRT, then state and local leadership will have greater confidence in the abilities of those members to carry out their assigned technical rescue tasks. Furthermore, when these eight areas of training or criteria are validated, then individuals can assert the nationally recognized title of rescue specialist, currently in use by other agencies. This position, along with technical search specialists, medical specialists, and hazardous materials specialists are the workhorse positions on a US&R Task Force. Even though these positions have different specialties, many are cross-trained as rescue specialists in order to operate safely in the same hazardous environments as the other rescue specialists. The rescue specialists' skill sets act as a building block for the other specialist positions. This sequence of training, that culminates in the SCRT course, has direct implications on the ability of responders to safely and effectively respond to emergent threats and all-hazards disasters.

Executive Development Linkage

It is the intent of this research project to discover the most progressive and dynamic options available for the construction of a structural collapse rescue training facility. The process of this project follows the Five Stages of Innovation and Creativity found in the *Executive Development Student Manual*. The first step is realizing the problem or the opportunity that our organization faces. This is addressed by establishing the need for providing a training facility for structural collapse rescue. The second step, gathering information, takes place within the review of literature and some of the methodology during the descriptive research process. The third and fourth steps respectively are incubation and insight(U. S. Fire Administration, 2010a). These steps are both part of the literature review and methodology, but also take place for the duration of the project. These stages are continual until a finished product is available to the customers of the Mississippi State Fire Academy. The fifth and final stage of evaluation and implementation is the point where a decision takes place and the action is performed. This will take form in the construction and early provisions for a structural collapse rescue training facility.

A second and equally important benefit of this research is the improvement in service quality. Improving the service delivery of this training institution is necessary to meet the growing needs of the customers. The Executive Development course manual emphasizes the importance of creating a constancy of purpose and adopting new philosophies(U. S. Fire Administration, 2010a). The need for this facility and research are highlighted by the disasters in the last twenty years.

USFA Linkage

This research project is central to four of the five strategic goals supported by the U.S. Fire Administration. Four of those goals are: a) reduction of risk as the local level, b) the improvement of local planning and preparedness, c) to improve the fire services capability to respond to and recover from all hazards, and d) to improve the professional status of emergency services(U. S. Fire Administration, 2010b). Training in rescue constitutes the foremost goal of public safety organizations, which is life safety. Hurricane Katrina and similar wide-area disasters have demonstrated the need for all-hazard responders at the local level. Training Mississippi emergency responders in SCRT breaks the cycle of reliance on outside resources for rescue at the local level. Structural collapse rescue is a discipline that touches and encompasses many other disciplines in rescue and hazardous materials response. This discipline and the training therein, is a perfect example of all-hazards training and response. This area of training does not stop at certification, but rather should be treated as a career-long skills acquisition process. This is why this discipline and research improve the professional capability and perception of emergency responders. Training in a needed area that is considered low-frequency and high-risk, is central to the goals of the U.S. Fire Administration in innumerable ways.

Literature Review

Rescue History

It is important to frame the rescue challenges faced by the rescuers in the State of Mississippi in a historical context. First, one should examine the greater community of technical rescue in both a national and international sense. The last century has seen the practice of technical rescue develop from rough experimentation into a respected profession with many sub-disciplines. Secondly, it is important to realize the extent technical rescue has changed in the eyes of Mississippi rescuers during the 21st century. Like the rest of the world, Mississippi took major lessons from the September 11 terrorist attacks as well as Hurricane Katrina.

In the *Fire Chief's Handbook*, Larry Collins(2003) describes the earliest acknowledgment of technical rescue as a unique discipline and profession. Collins describes how the Fire Department of New York (FDNY) was the first department to implement a dedicated company of firefighters tasked with performing specialized rescue and the rescue of other firefighters in distress. The FDNY established this rescue company in 1915. The company was staffed with a captain, a lieutenant, and up to eight firefighters. The FDNY would hold its place on the cutting edge of specialized rescue from that point forward. The Boston Fire Department followed suit in 1917. In 1929, the Chicago Fire Department placed three heavy rescue companies into service. Theses pioneering agencies are credited with what is widely thought to be the first of two rescue revolutions in the 20th century(Collins, 2003).

Collins (2003) goes on to describe the second rescue revolution in the 20th century. This revolution was largely technology and training driven and saw rescue services handling situations that would have once been viewed as non-survivable. Collins uses the example of advances in vehicle extrication technology that enabled rescuers to deliver a patient to higher levels of care in faster time. It was during the 1980's that citizens came to expect fire departments to handle rescue situations in a professional and timely manner. Collins goes on to describe that citizens have come to expect that fire departments can handle most any emergency problem(2003).

In *Managing Fire and Rescue Services*, Page (2002) offers insights into some of the volunteer based rescue services development and public expectations of rescue. Page notes that the first volunteer rescue organization was founded in 1928. The Roanoke Lifesaving Crew in Virginia gained much attention and popularity. It inspired numerous volunteer rescue organizations in the Eastern and Southern United States. In the years following World War II, thousands of volunteer rescue organizations were created that responded to emergencies in mountain rescue, high-angle rescue, water rescue, wilderness search and rescue, and cave rescue.

Several events transpired to gradually push greater responsibility and public expectation for rescue to be performed by fire service professionals. As vehicle engineering improved, passenger vehicles became heavier and faster. This resulted in more collisions with greater complexities. When responding police would face motor vehicle crash victims entrapped in tangled metal, their natural tendency was to call the fire department. Fire departments began to play a greater role in the technical extrication of these victims(Page, 2002).

Another singular event that would indelibly impact the would-be rescue community took place in San Marino, CA in 1949. This was a time where technology was leading to the widespread proliferation of media and the early days of commercial broadcasting. In San Marino, a child named Kathy Fiscus fell into abandoned water well and became trapped. This was one of the first live on-scene events to reach a large television audience. The local emergency services were both ill-equipped and ill-trained to deal with such a rescue. Many ideas and efforts failed resulting in cave-ins and changing tactics. The broadcast went on for 27.5 hours with a largely captivated audience. The event culminated in Kathy being removed from the well and pronounced dead, after over a day of failed efforts. This event tugged at the emotions of those watching and galvanized the expectations from the public of timely and professional rescue by dedicated emergency services. Over the second half of the 20th century the world has come to expect a response my trained and equipped rescuers to a wide array of emergencies. In the United States and Canada, it is the fire service that responds to rescue most frequently(Page, 2002).

In the *Fire Chief's Handbook*, Larry Collins summarizes the public expectation of rescue services with this statement:

> First, it is the public that determines the scope of fire department responsibilities. Every time a citizen dials 9-1-1 the public is defining the mission of the fire department. And it is an indisputable fact that the public expects the fire department to conduct effective, professional, and timely rescue operations, as well as handling other emergencies like hazardous materials releases, emergency medical emergencies, floods, earthquakes, terrorists attacks, and other life and death situations(2003, p. 554).

He goes on to note that the ever-expanding populations moving into more disaster prone areas will result in increasing frequency for need of rescue services. The aging cities, infrastructure, and industrialization also compound the frequency of people becoming trapped in accidents and disasters (Collins, 2003).

A benefit to this need for specialized rescue within the fire services is a better firefighter. Collins (2003) notes that one cannot separate the function of rescue from the mission of the fire service. The result, however, can be a better-trained and equipped firefighter. This makes for a more well-rounded responder that excels in the face of problem-solving situations.

Mississippi Rescue History

Mississippi faced its own rescue revolution in 2005 in the wake of Hurricane Katrina. On August 29, 2005 Hurricane Katrina made landfall on the Mississippi and Louisiana state line. The storm brought with it a tidal surge that in some areas was as high as 30 feet. The surge washed inland up to 6 miles and 10 to 12 miles along coastal estuaries and waterways. As a result, over 80,000 structures were destroyed and many were collapsed. Two-hundred-thirty-eight people were killed and another 67 people were missing and presumed dead. Katrina was the most costly hurricane to ever make landfall on the United States and was the second deadliest to date (Collins, 2006).

The National Weather Service advised Gulf Coast Emergency Managers and department heads that Hurricane Katrina would be a catastrophic storm with a severe loss of life and property. DHS and FEMA recognized the potential for a major disaster as a Category 5 storm approached the coast and began emergency preparations. Highly trained and well-equipped teams of rescuers were pre-staged in safer areas away from the coast(Harper, 2006). Teams were staged in places such as the Naval Air Station in

Meridian, MS, Camp McCain in Grenada, MS, and Camp Shelby in Hattiesburg, MS. Many of these teams were FEMA sponsored US&R Task Forces.

Hurricane Katrina affected the Mississippi gulf coast differently than New Orleans. The storm impacted structures and infrastructure, but not was not as costly in terms of the loss of life and stranded citizens. Where US&R was concerned, structural collapse of large heavy-construction buildings was not the primary concern. The problem was the thousands of collapsed light-framed structures spread over hundreds of square miles. There piles of one-story high wood-framed house debris for many miles (Godfrey, 2006). In essence, shredded 2x4 lumber and building materials as tall as the houses themselves. It is highly unlikely in an event of such devastation that survivors would be found within the once-flooded debris pile. It is nearly impossible to search every pile within a reasonable rescue time frame. Instead, there is a long process of accountability and reconnaissance in which rescue personnel must account for people that are safe and for those still missing. Rescuers can contact homeowners and neighbors in order to put together the missing pieces (Godfrey,2006).

The need for all-hazards approach in the urban search and rescue response to the State of Mississippi was very well illustrated during Hurricane Katrina. Over 80,000 structures were flattened or destroyed. Many boats and barges were washed inland and slammed into other structures. This type of devastation caused propane and natural gas leaks all over the Gulf Coast, resulting in hazardous flammable atmospheres. A mile long cargo train was lifted and overturned in a residential and hotel area. Many rail cars were compromised, resulting in the release of all manner of hazardous materials. Some of the heavy-construction structures were racked and damaged from floating casino barges surging and colliding into structures (Collins, 2006).

Larry Collins(2006) describes many of the adversities rescuers faced in his Fire Engineering article *Urban Search and Rescue Operations in Mississippi.* There were water hazards, hazardous materials releases and structural collapses that called for skills in rope rescue, confined space rescue, and extrication from collapsed structural members. These scenarios potentially draw from all of the skill areas outlined in the rescue specialist’s job description. In order to satisfy this need and augment responders in Mississippi, FEMA allocated 11 US&R Task Forces to the Gulf Coast operation. Initially searches were conducted over very broad areas, but as more intelligence was gathered and 911 call records were analyzed, searches grew more targeted.

The initial FEMA activation took place on Friday, August 26, 2005. At this point, several FEMA US&R Task Forces would prepare for deployment and move to forward operating bases. Texas Task Force 1, Tennessee Task Force 1, and Missouri Task Force 1 all reported to Shreveport, LA. On Saturday, August 27, Indiana Task Force 1 and Ohio Task Force 1 pre-deployed to the Naval Air Station in Meridian, MS. Other task forces would be deployed and staged in areas close to the coast, but in relative safety from the effects of the storm. Hurricane Katrina would make the last of three landfalls on Monday, August 29, 2005 (Harper, 2006).

The land operations were arduous with difficult travel and access. Many places had one way in and out. Some of these roads, such as MS Hwy 49, were designated for emergency use only. Travel was only made possible on Interstate 10 and Highway 90, with the use of chain saws and four-wheel drive vehicles. Given that transportation in an area with this type of devastation was a unique challenge; four-wheel drive vehicles and all-terrain-vehicles were essential to gain access to many areas(Godfrey, 2006). Virginia Task Force 2 (VA TF-1) traveled from the emergency operations center in Harrison County to explore the hardest hit, west branch, in Hancock and Pearl River Counties. The storm surge in this most-affected area had risen over 30 ft. It washed over Interstate 10, which runs inland several miles from the coast. A 3000-gallon propane tank from an airport washed up and came to rest on the Interstate. Mud from the rivers and swamps was pulled back towards the coast and deposited several feet deep on roadways and in neighborhoods. Late at night, as the task forces convoyed to Waveland, there were no signs of life and the landscape was void of light. In Waveland, three miles inland, homes were destroyed and much debris was clearly deposited 30 ft. up in the trees. The nearest functioning hospital to Waveland was over 25 miles away. This was true wilderness. It was at this location that VA TF-2 would establish their encampment and base of operations (Collins, 2006).

To the responding teams, the area seemed to lack any signs of local government. The emergency operations center in Bay St. Louis had been flooded and destroyed. Most fire and police vehicles were also destroyed. The destruction along the entire 26-mile coastline was comparable to the 2004 Sumatra Tsunami (Harper, 2006). There was still work to be done. When the sun would rise the following day, the teams would survey unimaginable damage. Many people were still missing and trapped. Searching was difficult due to thick mud and swamps. Temperatures were over 100 degrees and there was nearly 100% humidity. Snakes and alligators were also an ongoing problem for responders. The hazards were exacerbated by the lack of nearby medical facilities (Collins, 2006).

Searches were prioritized, by singling out the most affected and most densely populated areas. Eventually seven FEMA Task Forces would join the search efforts in Hancock County. This would constitute nearly 500 FEMA US&R personnel. Every building that was collapsed was searched and marked as having been searched with orange spray paint. Due to the distance from the Gulfport emergency operations center (EOC) and US&R base of operations (BoO) it was more practical to establish a satellite BoO. This helped save time and energy among the rescuers as well as fuel –which was in critically short supply in Mississippi and along its Gulf Coast. The destruction in Hancock County was so prolific, that the US&R leadership in the field decided that it warranted its own Incident Command System (ICS) designation as an incident itself. They would virtually operate as their own unified incident command system under the overall command system in Gulfport. This required establishing incident priorities specific to Hancock County and using an independent incident action plan (IAP) (Collins, 2006).

Collins(2006) recalled how the large number of rescuers based in Hankcock County, allowed continuous search operations and expedient rescues when trapped survivors were located. Grid searches were conducted town-by-town, block-by-block, and house-by-house. Teams would search debris piles, vehicles, and larger commercial buildings. When searches were complete, teams would mark a structure with the familiar US&R x-marking with the team identifiers and date searched. Emergency 911 calls and excerpts from phone calls were used to compile a written list for more targeted searches.

These investigative techniques would be the most definitive way that missing individuals could be accounted for. Many of these calls were recorded conversations of victims claiming to be trapped in their attics with water continuing to rise. Often calls indicated drowning was imminent. As the storm was passing over, the dispatchers were forced to tell the callers that the fire department and emergency services would be unable to respond. In many of the locations where calls originated, the houses would be washed away and victims might be found in nearby debris piles. There were a number of instances where the victims were never found.

The first patient found in the East Branch of the operations was an elderly female that was found lying in her driveway complaining of hip pain. US&R teams from Indiana Task Force 1(IN TF-1) packaged and evacuated her to a hospital. While conducting search operations at 09:30 on Wednesday, August 31, IN TF-1 found the first live victim in a partially collapsed apartment complex. Many of the survivors that IN TF-1 encountered were able to provide valuable information on which neighbors stayed and which ones evacuated (Harper, 2006). The condition of those that remained were typically dead, or alive and ambulatory. After the first 48 hours, there were few survivors that were trapped or injured in a way that they could not help themselves. Unfortunately, much of the Mississippi Gulf Coast urban search and rescue operation was an accounting of the victims that did not survive the storm. This mission was important for the welfare of those remaining, so that they were not alone –without a public safety response; and that they could have closure in the loss of their loved ones.

Need for Specialized Training

The state of Mississippi has approximately 3300 career firefighters and over 16,000 volunteer firefighters according to State Fire Coordinator Larry Barr (personal communication, April 13, 2012). SCRT is the apex discipline within the US&R community and the leadership of Mississippi has chosen to pursue the necessary training in order to field teams of effective rescuers. Through legislative mandate, the MSFA is responsible for the training of all of the firefighters in the state. It is a logical progression to take on this SCRT training task.

In the *Fire Chief's Handbook*, Collins(2003) explains that intelligent and realistic rescue training is one of the determining factors that enable rescuers to locate and extricate without causing additional harm to the victims and the rescuers. He goes on to explain that good training is the best tools rescuers have to contend with a lack of experience. This training should not be confined to classroom and books, as there is no substitute for realistic, manipulative, rescue training.

David Purchase emphasizes the need to train with quality educational props in the *Chief Fire Officer's Desk Reference*(2006). He continues to explain that students learn very well through hands-on instruction and will have greater retention than information provided in lecture format only. Author Tom Pendley reinforces this concept in the same text(2006). Pendley refers to technical rescue as a special operations category of response that fall into the high-risk and low frequency category. Both authors summarize that the risk and benefit of operating in these special operations environments is great. Due to the low frequency of occurrences, training is where much of a rescuer's experience is drawn. Good training that involves manipulative skills will be of greater benefit and yield a better rate of retention.

Pendley also explains the further benefits of a training facility for students across the entire state(2006). A technical rescue program that is regional should also have access to a training facility that is regional. Rather than one department shouldering the burden of such a facility, resources are pooled into a facility that can reach many more. Larry Barr states there are 119 career and combination fire departments in Mississippi(personal communication, April 13, 2012). These departments would all have access to the kind of regional training facility that Pendley advocates.

A second benefit that Pendley(2006) describes is the ability to provide on-going continual education at a training facility. In as little as six months, if unpracticed, students' skills begin to greatly diminish. A training center helps allow for recurrency training where the course may have been first held. Ready and regional access to a facility with an adequate training prop is invaluable.

In *Managing Fire and Rescue Services,* Forsman(2002) echoes this practice. He explains that special operations training is one of the areas that is most expensive to develop and deliver to firefighters. The cost draining areas that he outlines are technical rescue, HAZMAT, weapons of mass destruction, and advanced emergency medicine. In these cases, he too characterizes them as high-risk and low-frequency events that require a specialized approach. Often personnel will have to be sent to remote locations for training, which results in ballooning travel and coverage costs. This increase in cost causes the authority having jurisdiction to plan accordingly. To this end, a regional training facility for SCRT can help mitigate such costs incurred by out of state travel(Forsman, 2002).

The text *Technical Rescue Operations* offers many lessons on why training in special operations is necessary, studies in the rescue field, and why fire departments can deliver this service(Collins 2004). Firefighters are the first line of defense in most civilized nations when a wide range of disasters occurs. In the public's perspective, fire services are the most cost-effective and capable providers of special operations, including SCRT. A large part of this expectation is due to the proliferation of fire stations in the community. Firefighters are often the first on the scene when citizens call 911. The public expects fire services to deal with these emergencies in a professional manner. Today the rescue arena extends into both the urban and wilderness setting. When planning for rescue-related disasters, Collins explains there are steps to be made. If the resources that will respond are lacking, then they need to be built up. This process what is taking place in Mississippi. To build them up will require equipment, rescue planning, personnel, and very importantly, training(Collins, 2004).

Collins offers much insight on the technical rescue training, contending that few topics are more essential to safe rescue operations than an intelligent regimen of training, continuing education, and exercises(2004). Furthermore it is paramount that the training be realistic to augment abilities in recognition-primed decision-making. Progressive training systems can be offered as simulations that force the rescuer to make decisions at a greater level than initial certification training. Repetitive practice of these high-risk operations helps prepare virtual slide shows in the minds of rescuers and scene commanders. These individuals will use images of past experiences and training to make life and death decisions in the chaos of en emergency scene. This is what Collins goes on to refer to as “recognition-primed decision”(RPD) making(2004).

Collins did not coin this term. RPD takes place when high-pressure stakeholders instinctively refer to previous images of events while in the course of dynamic and dangerous operations. This belief is largely haled from military studies that show operators make continual size-ups of the situation and compare them with situations from the past. This instantaneous comparison of actual conditions with the mental prototypes is what the ARMY labels as RPD. It is because of this decision model, Collins argues, that rescuers can benefit from realistic training and simulation. “Realistic training is a proven path to safer and more effective rescue operations”(Collins, 2004, p. 170). He also likened the RPD theory to the philosophy of one of the great technical rescuers of the 20th century, Ray Downey of the FDNY. Downey believed if the mind was programmed with the right information, then it will be able to rapidly “scroll” through the options and choose the best possible solution and outcome for the problem. In essence, Downey was a big advocate that the most important tool a rescuer has is under his helmet. Training is one of the best and most readily available avenues to program the rescuer’s computer. Downey believed this included good training, physical experiences, accurate data, all through actual circumstances or realistic training(Collins, 2004).

Need for Training Academy

In 2004, Brian Martin Crandell published a study in which he examined the learning actions of firefighters in Montana. Crandell discusses the different needs of firefighter learning by framing it in the context of the dangers that they face. The firefighters on an emergency scene are under stress, working within compressed time frames, and the consequences of their decisions are often severe. In order to be successful and employ the best practices in such a profession, continual training and learning should take place. It is argued that experience alone cannot be relied upon as a learning tool. Knowledge, skills, and abilities must be continuously learned, refined, and honed to operate safely and deliver aggressive service(Crandell, 2004).

The problem in Crandell's study is that "the learning sources used by firefighters recognized as using best practices are not identified nor, necessarily, are they well understood."(Crandell, 2004, p. 10). The questions he sought to answer included where competent firefighters, identified as using best practices, first receive information regarding effective methods and innovations. Also of interest was what sources did the firefighters using best practices use to obtain information about effective methods and innovations. The study makes it readily apparent that firefighters must know a great deal about complex and emerging hazards. Because of this, they are engaged in a career-long learning process. Training and practice take a major role in helping firefighters learning to deliver services. It is a direct means of preparing a safe and competent workforce(Crandell, 2004).

Crandell's study identified nineteen individuals that a focus group identified as using best practices across the fire service in Montana. They came from career and volunteer backgrounds with a wide range of rank. The participants indicated their learning preferences using a Rating of Learning Sources Instrument. They indicated that learning took place as a conscious decision from sources of their choosing. The learning source most frequently used by participants was the state fire academy, the fire academy's learning resource center, and networking with other firefighters including fire academy instructors. The study revealed that the statewide training academy was greatly instrumental in the education of the firefighters using best practices. The participants revealed that the learning process is multi-modal, but many of the modalities center around the state fire academy and the services they delivered(Crandell, 2004).

Learning Styles of Emergency Services Responders

Klingensmith published an educational study on the learning actions of emergency responders in 2006. She too, acknowledges that an effective emergency response hinges on a vast body of knowledge enabling responders to make decisions ranging from hazmat to medical triage. This knowledge is acquired through education and training. The problem that Klingensmith identifies is that there are no studies to verify the assumption that emergency service responders learn primarily through kinesthetic activity(2006).

A validated instrument known as the VARK preferences learning styles inventory was used to assess 100 emergency responders enrolled at a training academy. Half of the respondents were recruit level and half of the respondents were officer level. The VARK acronym stands for visual, aural, read/write, and kinesthetic. Visual includes charts, graphs, flow charts, symbols, and hierarchies used to represent or summarize material. Aural includes information that is heard such as lectures and networking. Reading and writing is information displayed in words. Kinesthetic learning includes the use of experience and practice. The VARK instrument has evolved to include a fifth category, which is multi-modal(Klingensmith, 2006).

The results of the study can be examined in both broad and specific contexts. The greater majority of emergency responders indicated that kinesthetic learning was the preferred modality. A strong secondary preference was multi-modal learning styles. The more specific subgroups of the study displayed some variations. Younger cadets and responders with less formal education strongly preferred kinesthetic learning. Officers with over 15 years experience and more formal education preferred multi-modal methods of learning. In summary, with the exception of those emergency responders that were advanced in their careers and education, the vast majority prefers learning that is kinesthetic in nature. That is to say, emergency responders prefer learning that involves experience, practice, and simulations(Klingensmith, 2006).

NFPA Standards

The National Fire Protection Organization(NFPA) is an international consensus standards-making body that has been in existence since 1895. The American National Standards Institute (ANSI) accredits the NFPA, and its documents carry the ANSI standard. The standards published by the NFPA have a wide application in code enforcement, prevention, education, fire suppression, and safety. There are more than 300 NFPA codes that are updated every three to five years. The consensus standard process includes over 6,100 volunteers on over 220 technical committees. The background of these volunteers consists of fire service, manufacturers, government, professional associations, insurance, architects, and engineers(Forsman, 2002).

Technical committees accept and make proposals for changes to various standards. Submissions for changes are open to the public. When a submission passes the committee by a two-thirds majority, it is then posted for public comment. Following a sixty-day period for public review. Proposals are again subjected to a strong-majority vote and then passed by NFPA members during one of two annual meetings. The document then moves to the standards council for adoption(Forsman, 2002).

NFPA 1402.

NFPA 1402 Guide to Building Fire Service Training Centers is a consensus standard that addresses all types of venues for fire service training. The vast majority of this document focuses on fireground training activities. Chapter 13, however, briefly addresses the components necessary for the facilitation of collapse rescue and urban search and rescue training. The chapter outlines four primary training functions or props. They are a) a basic concrete cutting prop, b) a basic support and balancing prop, c) a partially collapsed building prop, and d) a rubble pile that simulates a complete building collapse prop(National Fire Protection Association, 2012). The document(2012) goes on to explain that the props should be constructed with safety and stability in mind when students are bracing and supporting various components.

NFPA 1006.

The origin of *NFPA 1006 Standard for Technical Rescuer Professional Qualifications* dates back to 1994 when the NFPA standards council received a request for such a committee. Editions for NFPA 1006 were released in 2000, 2003, and 2008. The purpose of the document is to outline specific minimum job performance requirements for fire service individuals acting as rescuers in an emergency response. The document acts as a skill checklist for technical rescue disciplines including rope rescue, confined space rescue, trench rescue, structural collapse rescue, vehicle and machinery rescue, water rescue, wilderness rescue, and subterranean rescue(National Fire Protection Association, 2008). Chapter 9, on structural collapse, contains a total of twenty-nine job performance requirements pertaining to structural collapse rescue technician level two.

Within NFPA 1006, Chapter 9 is divided into levels one and two. Level one focuses on job performance knowledge, skills, and abilities concerned with search and rescue in light frame collapsed structures. Light frame construction, in the context of NFPA 1006, are structures that are framed with wood or other lightweight materials. Level two knowledge, skills, and abilities are concerned with operations in collapses structures of heavy construction. Heavy construction utilizes masonry, steel, and concrete. This includes precast concrete, tilt slab construction, steel frame, unreinforced masonry, and other related heavy construction configurations and materials(National Fire Protection Association, 2008).

The job performance requirements (JPRs) in this chapter can be divided into five general areas. These are a) administrative and management, b) search and rescue, c) shoring and stabilization, d) lifting and moving, and e) breaching breaking, and cutting. These five categories appear in the level one-light frame construction part of the chapter and the level two heavy-frame construction part of the chapter. For the purpose of organization and continuity, these areas will be examined individually across levels one and two.

Administrative.

Each level contains five administrative JPRs that involve managing the scene and resources. These administrative functions constitute ten of the twenty-nine JPRs within the chapter. Each level requires members to 9.1.2) & 9.2.1) conduct a size up, 9.1.2) & 9.2.2) ascertain victim locations and search areas, 9.1.3) & 9.2.3) develop an incident action plan, 9.1.4) & 9.2.4) implement a collapse rescue incident action plan, and 9.1.7) & 9.2.7) implement collapse support operations at a rescue incident. These areas rarely constitute learning new skills in the psycho-motor areas, but instead focus on management and support activities(National Fire Protection Association, 2008).

Search and Rescue.

There are three JPRs in each chapter that relate specifically to search and rescue in collapsed structures. Sections 9.1.5) & 9.2.5) focus on performing the search function in collapsed structures. The skills outlined include applying search techniques, using search marking systems, and the selection and use of victim location devices. Knowledge in technological search devices, collapse patterns, and marking systems is also required.

Sections 9.1.8) & 9.2.8) outline the ability to release a victim from entrapment by the components of the collapses structure. Both levels require students to be proficient with the tools and personal protective equipment required to breach, break, pry, shore, lift, or otherwise move the structural component that is entangling or entrapping the patient. This JPR includes considerations for patient care, crush syndrome, and on-going risk benefit analysis for various rescue plans.

Sections 9.1.9) & 9.2.8) are JPRs that take the next step, which is the removal of a victim from a collapse incident. In both levels pre-hospital care, patient packaging, basic life support techniques, and adequate selection and use of personal protective equipment is required to allow for the safe removal of a victim. These JPRs also require responders to monitor and treat for signs and symptoms of crush syndrome as needed.

Shoring and Stabilization.

Chapter 9 of NFPA 1006 contains five JPRs for shoring and stabilization. There are two JPRs in level one and three in level two. There is also explanatory material in Annex A Chapter 9 of NFPA 1006 that outlines specific shoring and cribbing knowledge areas. Sections 9.1.6) & 9.2.6) require individuals to stabilize collapsed structures of light and heavy construction respectively. The goal of both JPRs is to capture the load and minimize any movement while performing shoring operations. Members are also required to calculate the expected loads of various construction materials. The main component of these JPRs are to safely use the tools to construct shores to support various collapse patterns and loads. The explanatory material goes on to emphasize the basic ability to construct vertical shores and basic Raker shores.

Sections 9.1.13) & 9.2.13) require the ability to utilize cribbing systems in support of collapsed structures. This involves the calculation of expected loads and knowledge of different cribbing methods. The explanatory material in Annex A outlines five systems with which rescuers should have knowledge and proficiency: two-piece layer crosstie, three-piece layer cross tie, platform crosstie, triangle crosstie, and the modified crosstie.

The fifth JPR in shoring and stabilization pertains to only level two- heavy construction. Section 9.2.14) is the ability to stabilize a collapsed structure of heavy construction. This environment has considerable risks and thus rescuers must add provisions to mitigate those risks. This JPR outlines the deployment of rapid intervention crews, identification of hazard and safe zones, shore exceeding calculated loads, accountability systems used, atmospheric monitoring is performed, and personal protective equipment is mastered. The explanatory material dictates an ability to shore windows, doors, walls, and roofs of heavy construction materials. It also requires proficiency and knowledge in Ellis clamp systems, Ellis screw jacks, pneumatic shores, mechanical shores, laced post shoring systems, horizontal shores, and cross-tied Raker shores.

Lifting and Moving.

Each level of chapter 9 has two reflective components pertaining to lifting and moving. Sections 9.1.10) & 9.2.10) require participants to lift a heavy load as a member of a team. Control of the load must be maintained and appropriate shoring systems must be implemented to reduce uncontrolled movement. Knowledge of expected load, gravity, and balance, must be acquired. Explanatory material in Annex A elaborates that tools to lift include prybars, jacks, airbags, and other leverage. Recognized cribbing systems should be used to ensure movement is controlled throughout the lift.

Sections 9.1.11) & 9.2.11) describe the knowledge skills and abilities (KSAs) required to move a heavy load so that rescuers can gain access. Principles of leverage, inclined planes, balance, friction, weight, and equipment limitations must be learned. Annex A explains the load should be moved at least 20 ft. using pipes as rollers. Control of this movement is established using various rigging systems. These two JPRs require thorough knowledge and ability to stabilize the load.

Level two of chapter 9 contains one additional JPR for lifting and moving. Section 9.2.16) calls for participants to be able to coordinate the use of heavy equipment on a collapse rescue scene. NFPA 1006 describes heavy equipment as construction equipment such as backhoes, trac hoes, grade-alls, and cranes. This JPR calls upon rescuers to apply heavy equipment rigging techniques, personal protective equipment(PPE), safety protocols, communication, and hand signals to operators.

Breaching, Breaking, and Cutting.

Sections 9.1.12) & and 9.2.12) both describe the KSAs for breaching light frame and heavy construction components respectively. Both levels require rescuers to be able to breach, break, or cut an opening that supports the objectives of the rescue operation. These components can range from wood and gypsum board to steel, concrete, and plastics. Thorough knowledge of the tools and PPE to perform these operations is imperative. The participant must also understand the strengths and weaknesses of the material to be breached, as well as the limitations of the tools they use. Stabilization and control of the cut-away components must also be a top consideration.

Section 9.2.15) in level two has one additional area of emphasis in breaching, breaking, and cutting. This section denotes the KSAs required for cutting through structural steel. Considerations within this JPR include protections for the rescuers and the victim, provisions for fire control, and efficient cutting. Stabilization of cut-away objects and other hazards must also be controlled and mitigated.

FEMA Structural Collapse Technician Curriculum and Manual

FEMA has been utilizing a curriculum for structural collapse rescue technician for many years. The curriculum includes lesson plans, handouts, powerpoints, materials lists, and recommended facilities list. The course was designed to be delivered, in one delivery, to all of the rescue specialists on a given task force. The course can accommodate 81 students. There are 72 positions for recue specialists on a FEMA Type I US&R Task Force. The course's development committee and contributors consist of over 25 individuals from all sorts of professional backgrounds including rescue, instruction, engineering, and administration. Agencies that have contributed to the material include Montgomery County Division of Fire and Rescue Services, Spec. Rescue International, Memphis Fire Department, Virginia Beach Fire Department, Paratech, and several more (FEMA National US&R Response System, 2007).

The material in the FEMA SCT course is exhaustive and specific. The course is formatted for delivery over eight ten-hour days. The first day is dedicated to lecture and classroom sessions. Some time on the first day is allotted for tool-lab stations that focus on tool familiarization. Days two through seven consist of rotations that expose the students to practical applications of job performance requirements (JPRs) within three areas. The eighth and final day consists of a large group exercise utilizing the whole class(FEMA National US&R Response System, 2007).

The three areas include shoring, breaching-breaking-burning, and lifting-rigging. These reflect the areas outlined within chapter 9 of NFPA 1006, with the exception of the search and rescue and administrative requirements. The content, however, within each of these sub-disciplines in the FEMA SCT course is much more specific. One example is the requirement for the student in the FEMA course to be evaluated on the construction of over 20 various shoring systems(FEMA SCT). The NFPA 1006 standard simply states that stabilization of a heavy-construction structure is a JPR(NFPA, 2008).

FEMA’s course material outlines the required tools, time, materials, props, spaces, and breaching mediums required to achieve instruction and certification for 81 persons. This document serves as an excellent map for the facilities and resources required to facilitate SCRT training and certification. The site prop and raw materials requirements for the area of breaching, breaking, and burning are outlined in table 1. The facility requirements for shoring and testing shoring for the FEMA SCT course are outlined in table 2(FEMA National US&R Response System, 2007).

The FEMA SCT manual also outlines the personal protective equipment required for the students to participate in the tool labs and activities. Another benefit of the FEMA manual is a listing of the tools and raw materials requirements necessary to construct and erect the shores, as well as perform breaches, breaks, and burns. This list includes an extensive amount of lumber and also the hardware required for construction. For the area of breaching, breaking and burning; the list includes the necessary drills, bits, demolition hammers, blades and other necessary equipment(2007).

The JPR area of lifting and rigging does not include any site or prop-specific requirements in the FEMA SCT manual. The tool and raw material requirements to fulfill this tool lab overlap the other areas of supplies required in the FEMA curriculum. Some of these items include large slabs, pinch-point pry bars, 6”x6”x16’ timbers, life safety rope, carabiners, pulleys, crane straps, and chains for example. A great majority of the logistical requirements for the FEMA SCT curriculum fall within the areas of shoring and breaching, breaking, and burning.

The FEMA US&R Structural Collapse Technician Course is an excellent tool and outline for the requirements to teach and certify students in the discipline of structural collapse rescue technician. Where NFPA 1006 is more of an outline, the FEMA curriculum fills in much of the gaps with specific techniques to accomplish the JPRs listed in the NFPA document. The overall focus of the FEMA curriculum is the tools, raw materials, and techniques required to learn the fundamental JPRs. Much of this is in the form of tool familiarization and tool manipulation. Other than the physical space required to perform various shoring operations and confined space breaching, there are few specifics in this document on what structures or props truly augment the facilitation of structural collapse rescue training delivery.

Summary

The propensity for the fire service has been growing for nearly one hundred years since the FDNY placed the first rescue companies in service. Other major cities followed and several national events kept pushing technical rescue into the national spotlight. Kathy Fiscus fell in an abandoned well and succumbed to her injuries while an entire nation watched the ordeal. The public has come to expect ever-higher levels of service from fire service organizations. Collins reminds us that the role of the fire department is defined every time a citizen dials 9-11.

The devastation in Mississippi that resulted from hurricane Katrina in 2005, served as a wake-up call for emergency services within the state. Katrina killed hundreds of Mississippians and destroyed tens of thousands of homes and structures. Local resources were so overwhelmed that outside elements were called in to perform urban search and rescue on the coast. Eleven FEMA US&R teams were utilized on the ground in Mississippi. In the years that followed, state leadership initiated the creation of state US&R teams to fill the void and render rescue services to the citizens within Mississippi in the case of future similar disasters. These teams would be staffed with some of the 3300 career firefighters across the state.

Authors Collins, Pendley, and Forsman, weigh in on the special training needs of the technical rescuer. These emergencies are considered high-risk and low frequency.

They fall into the category of special operations. Aggressive and realistic training is required to yield the desired level of service delivery. Collins points out that experience and training will yield a better “database” for recognition-primed decision-making (RPD). Chief Downey echoes this concept with his desire to continually program the computer underneath the helmet.

Two dissertations published by Crandell and Klingensmith help illustrate where and how the best learning takes place within the emergency services. Crandell’s study tells us that firefighters using best practices, generally obtain their knowledge from a state fire academy and its resources. Klingensmith’s study using the VARK learning styles model indicates that most line firefighters prefer that learning be delivered and obtained through kinesthetic experience. Hands-on training and simulation are the most preferred methods.

NFPA 1402 Guide to Building Fire Service Training Centers, provides insight on four different prop components that should be considered when building a collapse rescue training facility. These components include a shoring prop, concrete cutting prop, and two kinds of collapsed building props. The information in this document is also reflected in NFPA 1006 and the FEMA Structural Collapse Technician Course.

The NFPA 1006 Standard for Technical Rescuer Professional Qualifications 2008 edition is a document that outlines specific job performance requirements, in many disciplines, for the individual rescuer. This guide shows the minimum requirements for one to function as a SCRT level 2. There are twenty-nine requirements in this document that directly pertain to structural collapse rescue training. The 1006 standard contains both an outline of JPRs and explanatory material in the appendices. The information in this document will be analyzed and used to answer the first research question.

The FEMA Structural Collapse Technician manual and curriculum was developed in collaboration by many professionals within fire and rescue services. There have been revisions and improvements to the curriculum since its inception. Much information can be gathered from the curriculum to offer guidance in structural collapse rescue training. The curriculum manual contains materials lists, schedules, tool lists, and course information. This document has the benefit of specificity, where the 1006 standard has the luxury of generality. The information in this document will be used to answer the second research question. Careful study of this document illuminates many types of the training facilities and props that are required to teach structural collapse rescue technician.

The rescue community as a whole is a vital asset to the public. Mississippi has particular need in structural collapse, which was indentified during hurricane Katrina. Education in technical rescue requires discipline, practice, funding, and a whole host of specialized provisions. Firefighters tend to learn best practices from training academies, and prefer to learn using kinesthetic approaches. There are courses and consensus standards available that outline the types of knowledge, skills, and abilities that are required to be a SCRT and function on a state or regional US&R team. This information can be used to make thoughtful and informed steps toward the development of a structural collapse rescue training facility.

Procedures

This study will primarily utilize descriptive research to answer four research questions. The methods to answer the questions are outlined in this section. Some methods will require the review of course manuals and documents while others will require structured interviews with other training providers.

a) What training facilities are required to meet the structural collapse rescue job performance requirements outlined in NFPA 1006? This question will be answered using descriptive research. In the literature review, the Structural Collapse Rescue chapter in NFPA 1006 will be examined to determine a minimum requirement for training facilitation. Emphasis will be placed on cost effectiveness and multi-use dimensions of the facility in reference to what is required in the NFPA 1006 Standard. Pertinent information and material will be consolidated and organized into lists and tables.

b) What training facilities are required to meet the requirements for the FEMA Structural Collapse Technician course curriculum? This question will be answered using descriptive research. The FEMA Structural Collapse Technician course curriculum and manual will be examined to determine what "best practices" are being employed. Interviews with other training providers will also be used to establish the kinds of fixed facilities and props that are typically utilized. Emphasis will be placed on cost effectiveness and high-priority instructional areas for the SCRT discipline. Some of the research in this area will require descriptive research and analysis of photographs of props and facilities. Some information about the FEMA SCT course can be obtained through the interviews with similar training providers.

c) What types of facilities and props do other training providers use for structural collapse rescue training? This question will be answered using descriptive research. Interviews with other training providers will be the cornerstone of this research question. Surveys with broad questions will be sent to program managers and coordinators of other structural collapse rescue programs. Documents such as photographs, plans, drawings, and schematics will also be researched and solicited.

d) What are possible alternatives for building a new structural collapse training facility? This question will be answered using descriptive research, by utilizing both the surveys and interviews of similar training providers. The data and research collected in questions 1 and 2, will also be used deduce alternative on-sites, training options, props, and venues for structural collapse rescue training.

Surveys

During the week of June 18, 2012 the survey in Appendix A was emailed to five program managers at separate agencies. These agencies included: Texas Engineering Extension Service at Texas A&M University(TEEX), Safety Solutions Incorporated(SSI) out of Ocala FL, the Illinois Fire Service Institute(IFSI), Fire Service Training of Oklahoma State University(OSU), and the Alabama Fire College(AFC). They were also mailed to seven trainers that participate as FEMA Instructors. None of the surveys were returned and no research was produced from surveys.

The author believed the five agencies and handful of instructors represented an adequate sample of known public funded providers of structural collapse rescue training in the central and southeastern U.S. A benefit of soliciting more agencies may have a higher survey return.

Interviews

Interviews were conducted by first seeking out program managers and coordinators for: Texas Engineering Extension Service at Texas A&M University, Safety Solutions Incorporated out of Ocala FL, the Illinois Fire Service Institute, Fire Service Training of Oklahoma State University, and the Alabama Fire College. These agencies, and their staff, were contacted by telephone during June of 2012. The contact person would then be interviewed by phone using the survey questionnaire for a structured interview.

Representatives from TEEX could not be contacted. The contact person for Safety Solutions Inc. answered emails, but was too busy for the survey or phone conversations. Positive contact was made with representatives from IFSI, OSU, and AFC. These led to productive interviews on several occasions and shed a great deal of insight on questions within the survey instrument. The interviews with these three agencies had overarching benefits for all the research questions in this document.

Jason Louthan is the coordinator of rescue programs with Oklahoma State University's Fire Service Training program. He developed their structural collapse program by contacting other similar training providers and learning from their experiences. He was interviewed twice; once on June 19, 2012, and once on June 26, 2012. Both interviews proved productive and answered all questions from the survey form and research questions three and four. Jason referred the author to Michael McCastland with the Illinois Fire Service Institute. He stated McCastland was instrumental in helping OSU launch their programs.

Marty McElroy is the structural collapse program specialist with the Alabama Fire College. He oversees classes, props, and curriculum at their campus in Tuscaloosa. He was interviewed on June 25, 2012, and provided insight in all of the areas within the survey and research questions three and four.

Michael McCastland is structural collapse program manager with the Illinois Fire Service Institute. He oversees the structural collapse rescue programs, but also developed the facility and prop currently used. He took many of his lessons from TEEX. He was interviewed twice on June 19 and 26, 2012. The depth of experience at site and prop development helped answer several of the survey questions, as well as research questions three and four.

Limitations

This research will be limited in a number of ways. The information gathered from other training providers is not exhaustive or comprehensive, but instead a sampling of trainers teaching similar courses of instruction in structural collapse rescue. Information gathered and interpreted from documents, such as NFPA 1006 and the FEMA Structural Collapse Rescue Technician Course, will be subject to interpretations and biases of the author relative to his understanding of the subject matter. Finally, some information, such as operating costs and teaching philosophies utilized by other providers, may not reflect current trends or practices. This may be due to changing economic climate, commodities, and the rapid evolution of practices and technology in technical rescue disciplines.

Results

What training facilities are required to meet the structural collapse rescue job performance requirements outlined in NFPA 1006?

Chapter 9 of NFPA 1006 was analyzed in depth in the literature review of this study. Much information was gleaned from the document and outlined in the literature review. This standard is broad and generalized. This is especially true in the area of props and facilities. There is more to be gained out of this document in the areas of tools, specific mediums to be shored and breached, and functions to be performed. The document focus is JPRs.

The overall chapter divides the JPRs into light frame construction and heavy construction. This changes the material supported by shoring and medium for breaching from primarily wood to primarily concrete and steel. The document is open as to how these are accomplished, but steel-reinforced concrete and wood construction must be breached and penetrated.

The chapter dictates that individuals perform search and rescue in a collapsed structure. A training prop that simulates a collapsed structure is necessary. This also allows for the shoring required in the document. The search and rescue portion also calls for a victim to be released from entrapment. This can be simulated by using manikins in the partially collapsed structure; and assorted heavy members with which to impinge the victim.

The shoring requirements in chapter 9 require shoring in heavy and light construction. Annex A offers more explanatory material as to the types of shores and shoring required. These include “dead” or vertical shores, raker shores, and various cribbing methods. A unique component or prop specifically outlined in the annex includes the use of Ellis clamps, Ellis jacks, and Ellis screw jacks. These are proprietary shoring tools that US&R teams have adopted from construction. Other tools specifically outlined in this area are mechanical and pneumatic shores. The ability to perform shoring in windows and doors is also listed as a supplement in annex A under heavy construction.

The breaching and cutting section of the document mandates the ability to cut through light-frame construction components and heavy-construction components. In addition, level 2 requires the ability to cut through structural steel. This ability to cut through steel in training becomes a requirement. Steel and tools, such as I-beams and torches, would be a necessary teaching station.

As in the other areas, lifting and moving requirements repeat themselves across levels 1 and 2 for light and heavy respectively. There are two specific areas that require special provisions. Annex A explains the need to move a heavy object, while maintaining control-using pipes as rollers. The object should be moved a distance of 20 ft. Additionally in level 2, students must become familiar with methods to work with "heavy equipment." The chapter details heavy equipment to include cranes, excavators, and trac hoes. Students must learn the basic rigging and signaling to work with these pieces of equipment and their operators. This constitutes a significant prop-related provision.

What training facilities are required to meet the requirements for the FEMA Structural Collapse Technician course curriculum?

Parts of the FEMA SCT curriculum materials include train-the-trainer components. Within this area and other parts of the document are very specific space and material requirements for the facilitation of an 81-student class. These items are listed in different parts of the curriculum and its documents. Some of the listed items include many tools for different SCT functions and raw lumber requirements for the construction of shores and other activities. The tool and lumber components were decidedly outside the scope of this study. The concrete components and other prop features for facilitation are outlined in Table 1. These are items that can be used for breaching, incorporated into a debris pile, used for metal cutting, and class facilitation.

Table 1
Props and mediums required for breaching, breaking, cutting, and burning in the FEMA SCT curriculum

JPR Area:	**Breaching / Breaking / Burning**
Number of Units	
56	**Concrete Slabs 6'x6'x6" w/ #3 Rebar**
69	**Concrete Slabs 4'x4'x3" w/ #3 Rebar**
8	**Concrete Slabs 4'x4'x4"**
3	**Concrete Pipe 36" Diameter**
4	**Concrete Pipe 8'x 48" Diameter**
3	**Double T 30' in Length**
14	**Steel Plates 1/4" Thickness (4'x8')**
14	**Steel I-Beams(Scrap) Various**
1	**Trench Box**
4	**Q-Decking 10'x2'x20 Gauge**
4	**Automobiles**
8	**Miscellaneous Appliances**
1	**Fork Lift for moving concrete**

A second benefit of the FEMA SCT curriculum is the estimation of space requirements needed for teaching and evaluating the shoring part of the course. These requirements are presumably a result of the squad and station rotation concept employed by the curriculum. The spaces required for the various shores are outlined in Table 2.

Table 2
Space and height requirements for shoring in the FEMA SCT curriculum

JPR Area:	**Shoring**	
Number of Spaces	**Shore Type**	**Requirements**
1	**Laced Post**	**Area 20'x20' Height 8'-10'.**
1	**Sloped Floor**	**Area 20'x20' with level floor & sloped ceiling section of 16'x16' with a pitch of 3/12 that starts at 2' high and terminates 6' high.**
1	**Window Shore**	**Area 30'x30' with 3 windows 3'-4' wide, one square and one racked. Third window is 6' wide.**
1	**Door Shore**	**Area 30'x30' with 3 doors 3'-4' wide, one square and one racked. Third door is 6' wide.**
1	**Vertical Shore**	**Area 20'x20' with stable floor and full ceiling with height 8'-10'**
1	**Horizontal Shore**	**Two walls 8' high and 8' long. 4'-6' width between walls required**
1	**Double Raker**	**Area of 20'x20' with stable and level wall at least 20' high and 16' long. Area has both hard surface and section of earth.**
1	**Raker Anchor and Bracing**	**Area of 20'x20' with stable and level wall at least 10' high and 16' long. Area has both hard surface and section of earth.**
1	**Split Sole Raker**	**Area of 20'x20' with stable and level wall at least 10' high and 16' long. Area has both hard surface and section of earth.**
1	**Solid Sole Raker**	**Area of 20'x20' with stable and level wall at least 10' high and 16' long. Area has both hard surface and section of earth.**
1	**Testing Station**	**Area of 30'x30' with stable floor and level ceiling with height of 8'-10'. Another section with a slope ceiling of 3/12 pitch, 8'x8' minimum. Wall section 10' high and 16' long containing hard surface and section of earth. Wall section with several openings- two which must be racked, 8'x16' minimum.**

Table 2 outlines 11 areas and the features that should be unique to these props to facilitate shoring. For some shores, a door or open room is all that is required. There are other shores, however, with more site-specific requirements such as a sloped roof or floor with a specific pitch. Some of the raker family of shores not only require an exterior wall of specific dimensions, but also a similar wall with a dirt or otherwise loose base. These requirements give the course facilitators an idea of what spaces and prop features are specifically required for the shoring parts of the FEMA SCT Curriculum. One can also look at Table 2 and discern where some areas can be used for the same shores in order to prevent a duplication of props or facilities.

What types of facilities and props do other training providers use for structural collapse rescue training?

Other training providers proved extremely beneficial in their contributions towards props and techniques. Items and raw materials used for props and course facilitation are outlined in Table 3. This table contains unique items that an agency seeking to create SCRT course may wish to seek out and obtain for their facility. Table 3 also contains a brief description of the item's benefit and purpose.

Interviews with other training providers also yielded 13 specific ideas for construction and facilitation of a SCRT training facility. These ideas came from first hand knowledge through trial-and-error by the respondents. These ideas are outlined in Table 4a and 4b. These items vary in benefit from cost savings for facility construction to cost savings for materials used. There are also benefits in the realism and the challenges presented to the students during the SCRT training deliver. Interviews also yielded valuable administrative lessons and ideas that proved to be outside the scope of this study. Summaries of the interviews, their application to the questionnaire instrument, and the other benefits can be read in Appendices E, F, and G.

Table 3

Raw materials for prop / facility construction and course facilitation

JPR Area	Item / Raw Material	Application
Search, Rescue, Breaching	36" Diameter Concrete Pipe	Searching and breaching pathways / Debris pile / Instructor access
Breaching	"Jersey" Concrete highway barriers	Breaching / Debris pile construction
Search, Rescue, Breaching	"Double-T" Concrete spans	Breaching / Debris pile construction
Lifting & Stabilization	Concrete bridge spans	Debris pile construction / Lifting off of vehicles
Shoring, S&R, Breaching	Large metal shipping containers	All shore types / Breaching / Search and Rescue
Lifting & Stabilization	Angle-iron	Protect concrete block edges from prying and leverage
Breaching	Rectangle concrete vaults	Area for students to perform three breach types in many materials and substrates.
Shoring, S&R, Breaching	Small house / cottage / structure	Create partially collapsed structure. Perform all skill areas in light-frame construction
Search, Rescue, Breaching	Variety of pallets	Breaching of light material / Use in debris pile construction
Lifting & Stabilization, S&R, Breaching	Vehicles	Prop for breaching / Search / Lifting and moving heavy concrete as result of bridge or garage collapse
Lifting & Moving	Crane	Crane allows heavy props and objects to be reset. Students use signals and learn heavy equipment rigging and moving

A further benefit of this research yielded photographs from Alabama Fire College, and direction towards web-based photographs from the Illinois Fire Service Institute. The photographs in Appendices B, C, and D, show many of the discussed benefits and techniques outlined in Tables 3 and 4. The adjustable raker shore prop can be seen in the bottom left corner of the flyer in appendix B and figure C2. The bridge spans used to impinge vehicles can be seen in the middle of the page, on the right side of the flyer in appendix B. The application of shipping containers is photographed in D1, D2, D3, and D4. The vaults, poured specifically to facilitate tool lab breaching stations, are shown in D5, D6, and D7. An example of an adjustable ceiling can be seen in figures D9 and D10. An example of the iron used in the forming of the slabs for lifting and moving is seen in figures D11 and D12.

Table 4a
Unique methods training providers to enhance props, facilities, and course deliveries

JPR Area	Skill	Technique & Benefit
Search & Rescue	Search, rescue, & breaching in collapsed structure	Use a smaller, cleaner, pile with pipe pathways and interchangeable concrete breaching panels.
Search & Rescue	Search, rescue, & breaching in collapsed structure	Light construction pile uses vertical 4x4", 6x6", and telephone poles to support unintended collapse of material.
Search & Rescue	Search, rescue, & breaching in collapsed structure	Heavy construction pile utilizes "instructor tunnels" for setting victims, student access, egress, and maintenance.
Search & Rescue	Search, rescue, & breaching in collapsed structure	Use pallets in the pile as vertical cover. This allows broken material to fall through adding to the realism of the collapse.
Shoring	Vertical shores & sloped floor shores	Use hanging ceiling on a hinge and winch system to lower height each rotation, thus saving on lumber and material.
Shoring	Vertical shores & sloped floor shores	Use hanging ceiling on pulley and prusik system to lower height each rotation, thus saving on lumber and material
Shoring	Vertical shores & sloped floor shores	Reduce the height of existing structures by raising the floor. Pallets and panels can be used to accomplish the raise.
Shoring	Door & window shores	Use shims and wedges in squared windows and doors to give them a "racked" effect. Increase shim size and can reuse lumber through rotations.

Table 4b

Unique methods training providers to enhance props, facilities, and course deliveries.

JPR Area	Skill	Technique & Benefit
Shoring	Raker shores	Create exterior wall that is hinged / adjustable. Rakers can be erected at multiple degrees and "out-of square" thus enhancing problem solving and realism.
Breaching, Breaking, Cutting, Burning	Interior horizontal breach	Five 36" concrete culverts are placed in series with a gap between each. This allows for insertion of wall panels of ordinary construction materials: studs, gypsum, garbage, and anything challenging.
Breaching, Breaking, Cutting, Burning	Exterior breach, interior breach, overhead breach	Construct / pour concrete vaults with open ends, side, and top. After performing an exterior horizontal breach in the side, replace panel with wood- giving emergency access during other breaches.
Lifting, Moving, Stabilization	Heavy slabs / slab obstacle course	Pour custom form slabs and blocks with angle-iron on all edges and corners. This prevents chipping and cracking when leverage is applied.
Lifting, Moving, Stabilization	Roadway / garage collapse	Simulate long and heavy bridge span or parking garage member on passenger vehicle. Lift and stabilize.

What are possible alternatives for building a new structural collapse training facility?

This question was posed to all of the interview participants and those that received the questionnaire instrument. The responses varied widely. Most conversations turned towards what providers used in the initial stages of their program development before other provisions were in place.

Alabama Fire College reported that they were unable to use many existing facilities or components. They used some pipe and concrete components that were already at their facility. Ultimately they built their facility and brought in the majority of the prop components that would meet their format and requirements. They built their props specifically for the vision they had for their program.

Oklahoma State University's Fire Service Training program used "all" of their existing facilities for their early SCRT course facilitation. They used their burn buildings, drill towers, skills buildings, and more. They performed shoring in nearly any available doors or windows. These facilities accommodated their needs while they made efforts towards a dedicated SCRT training facility and props.

When the Illinois Fire Service Institute launched their program, they also used some of the facilities already on their campus. They used two different burn buildings to perform shoring and search operations. They also shared tools and equipment from their other rescue programs. Presently, the facility, props, and tools are dedicated exclusively for their SCRT program.

Discussion

In keeping with most academic research, the research questions answered in this study generate many more questions and possible avenues of study. The first two research questions were answered comprehensively using document analysis and compiling findings in tables. There is not much more that can be done with these two questions. The author was satisfied with the descriptive research process and findings in NFPA 1006 and the FEMA SCT curriculum.

Questions 3 and 4 could be entirely repeated and the research process could utilize different respondents. This could yield more results and valuable information concerning the construction of a SCRT facility and props. The information used to answer these questions proved valuable and seems to be in line with the current literature in the collapse rescue field. Nearly every research question is answered with information that directly parallels the prop components required in *NFPA 1402 Guide to Building Fire Service Training Centers*(2012). Many parts of the research focus on shoring props, concrete cutting props, partially collapsed props, and totally collapsed props. This is also true of the original research interviews with other training providers.

Interviews with other trainers also show that their programs draw heavily from the FEMA SCT and NFPA 1006 documents. All of the trainers interviewed used the JPRs in both documents as the outline for their programs. *NFPA 1006* is more broad and generalized(2008). The FEMA SCT curriculum offers much more specific JPRs in the areas of shoring and cutting(2007). OSU, IFSI, and AFC use these detailed JPRs and have props and facilities to accommodate them.

The tables displaying the results of the research offer very specific materials and facility additions that can benefit a burgeoning SCRT training program. During the course of the interviews, however, other information was extrapolated that could also be found in modern literature. The biggest and most daunting reality faced by the researcher is the tremendous expense incurred by this line of training. This is concurrent with Forsman's discussions in *Managing Fire and Rescue Services*(2002). The great majority of advice gained in research carries with it a significant cost to facilitate. This expense adds to the quality and reality of training. Pendley (2006) and Collins (2004) both place great emphasis on the need for realistic and hands-on training high-risk and low-frequency operations such as structural collapse. Discussions with other training providers indicate that they adhere to the same philosophies and approach.

It happened that the interview respondents were not only similar training providers, but were also state-based training organizations. They are well-known and respected trainers that provide regional training for their respective states and others. This is in keeping with benefits outlined by Crandell's study of learning methods and preferences(2004). Each of the interview respondents operates their programs in a similar method. There is usually one day of lecture and the rest of the time focuses on the hands-on interaction with props. This seems consistent with Klingesmith's study that found emergency responders prefer the kinesthetic method of learning(2006). The fact that more emphasis is focused on kinesthetic learning in the SCRT realm means that more attention and efforts should be placed on the props and facilities.

It is worth noting that Alabama Fire College follows the FEMA curriculum as it stands. OSU and IFSI, however, have a unique approach to their courses. They use FEMA's outline and JPRs to gain their course content. Their delivery format follows chapter 9 in NFPA 1006(2008). They teach a 50-hour program for level 1 and a 50-hour program for level 2. They both cover most of the shoring in level 1 and focus more on metal cutting, lifting and moving, and debris pile operations in level 2. This format has the benefits of an additional 20 hours of instruction and allows skills to be separated. More fire trainers have an obligation to NFPA consensus standards than to a FEMA curriculum. This approach utilizes the additional content of the FEMA course much of the format of NFPA 1006 chapter 9.

Interpretation of the Results

The results of the study read like a shopping list. It is easy for a reader to surmise that the best approach is to acquire one of everything in tables 1-4 and more. The reality is that it seems the NFPA 1006 document actually instructs much more on what format can be used to deliver training on structural collapse and what general contents are required. The FEMA curriculum outlines great detail in specific JPRs, site needs, facilities, tools, and raw materials. This part of the study provides the richest list of program needs. The NFPA document is a skeleton with some additional explanation in the appendix. The FEMA curriculum provides both an outline, content, and necessary materials.

The similar training providers have been teaching SCRT for some time. They have used both these documents and are familiar with their lists, benefits, and shortfalls. The benefit of the original research within this project, is the methods of making the material in NFPA 1006 and the FEMA curriculum work for the training agency. Through interviews, tricks-of-the-trade and cost saving methods were learned. Creative and inexpensive methods to challenge students and conserve resources were also obtained. Methods to enhance student and instructor safety were learned and taken into consideration.

The majority of the respondents admitted when they first began their programs, they were resigned to use buildings already on their campuses. In the early stages of their deliveries, much improvisation and compromise was needed to teach structural collapse. The respondents learned their lessons from other training providers and site visits to others' facilities.

Organizational Implications

The purpose of this research was to identify some of the resources required to construct a structural collapse rescue training facility that is able to facilitate certification courses and skills maintenance. There are tremendous implications this research provides for the MSFA structural collapse program development. The most obvious are the lists of materials and prop requirements. The leadership of the MSFA must wade through the material in the results section of this document and decide what has priority and what is attainable. Anyone in the same position would face the same questions. The results of this research are not all *required* elements to develop a program, but many are highly *desired* ones. Once one discovers what other trainers are doing out there, they must then figure out what they can do and choose to adopt. The problem faced by the author is that from a facility standpoint, there is a gap in the literature outlining what others have done to build similar training facilities. This research has sought to narrow that gap.

The MSFA must decide where to focus facility development efforts with the given funding. The focus can be in areas pertaining to shoring, breaching, and lifting. The totally collapsed and partially collapsed structures should also be considered. An organization must decide where to focus their efforts. The partially collapsed and totally collapsed structures are the venues that require the most materials and financial consideration. If facilities to host shoring labs already exist, then the MSFA may focus on the debris pile. These are the decisions that should evolve from the results findings in this document. It would be incumbent for organizations to perform an honest and creative self-assessment of their facilities. When initiating a SCRT program, an organization can take full advantage of elements already in place and focus their efforts on areas that most enhance and improve instructional delivery.

Recommendations

This research project was tremendously helpful for the author and his organization. This benefit leads one to urge the MSFA and others, pursuing similar program development, to stand on the shoulders of those that have been in the same position. Take as much advice and guidance from other strong programs with solid reputations. Using this research is an excellent tool to learn about structural collapse programs from an office or a computer; though there is no substitute for site visits and enrolling in courses of instruction under other training providers. An organization's staff may have fundamental training in a discipline, but there is much to be gained from participating in additional training from the point-of-view of the person imminently delivering the same course of instruction. This participation would allow instructors to see how students and staff interact with and operate various props. This gives realism and first hand knowledge of tricky elements like adjustable floors, ceilings, and walls. Interview participants pleaded for the author to come see their site, or go see one site or another. There is no substitute for the kinesthetic ability to interact with the materials described in the results section.

If the readers found themselves in the early phases of developing a training facility for structural collapse rescue certification and refresher training the following pursuits are recommended. The MSFA and readers should check to see if facilities required to facilitate shoring already exist at the desired location. One would want to check through the items in Table 2 to identify if the spaces required exist or need to be constructed. The spaces may be cheaply constructed using raw materials, such as shipping containers that are configured into stacked structures.

The MSFA and interested parties should obtain as much raw material resources as possible. Structural collapse training seems to turn concrete and steel “trash” into busted, broken, rubble trash. There are a lot of disposable commodities involved. Potential trainers should seek out and solicit as much of the materials in Table 1 and Table 3 as possible. The material in Table 1 is supposed to accommodate 81 students. The material in Table 3 is less consumable in nature and much of it can be used to construct props at the fixed facility. The concrete elements in this table can be used for destroying while breaching or they can be used as permanent structures within the collapse pile.

The 13 elements in Table 4a and 4b all add to the safety, cost saving, and interactive nature of SCRT props and facilities. These are all elements the author recommends for his organization and others. The elements seem to be well thought out ideas that others have learned through first-hand knowledge. The four tables listed in the results section of this document support the JPRs and objectives in chapter 9 of NFPA 1006. When participants obtain the elements in the tables, such as heavy slabs to roll on pipes and structural steel, then the prop and facility requirements to satisfy the needs of NFPA 1006 are also attained.

Training providers that currently have access to heat buildings and drill towers have an easily adaptable venue to teach shoring and perform searches. This was confirmed with the interviews with other providers. This is one of the most cost-effective ways to avoid new construction and utilize existing elements. This includes windows, doors, and exterior walls.

Future training providers approaching this issue should make plans and preparations years in advance. There is great benefit to not only contacting, but also visiting institutions such as IFSI, OSU, AFC, TEEX, and many others. Agencies may have to make some concessions in the early stages of their facility development in order to allocate more efforts to needed areas and facilities. The ideas and materials list gathered in this document are a valuable resource for prop and facility development. Revisiting the first two research questions will yield consistent results. Questions three and four can be as divergent and different as the responding training provider is creative.

Recommendations for Further Research

When problem exists where an agency needs a facility, the most thorough and comprehensive research possible should take place. Future researchers in this area may want to consider researching and developing a more exhaustive and comprehensive list of facility and prop features for structural collapse rescue training. Different training institutions should be used. A significant limitation of time for this research precluded the visit of other training providers. Visits to other trainers will be made before MSFA SCRT programs are prepared for delivery. Props and facilities will be studied more in-depth with program delivery in mind.

Future researchers would also do well to collect and examine the programs and curriculums of other training providers teaching a similar course of training. There are likely trainers that have ideas that take a greater departure from the FEMA and NFPA 1006 paradigms. These curriculums can be studied and mined for information as to facility elements and raw materials.

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Appendix A
Survey Sent to Training Providers

Institution________________

1. What types of facilities and props do other training providers use for structural collapse rescue training?

Most curriculums include the following elements listed below. What props or facilities enhance your ability to teach and deliver quality instruction in each area? Examples, diagrams, photos, and links are appreciated.

Search / Rescue within a collapsed / partially collapsed structure:

Shoring

Breaching, Breaking, Cutting, Burning

Lifting, Moving, & Stabilization

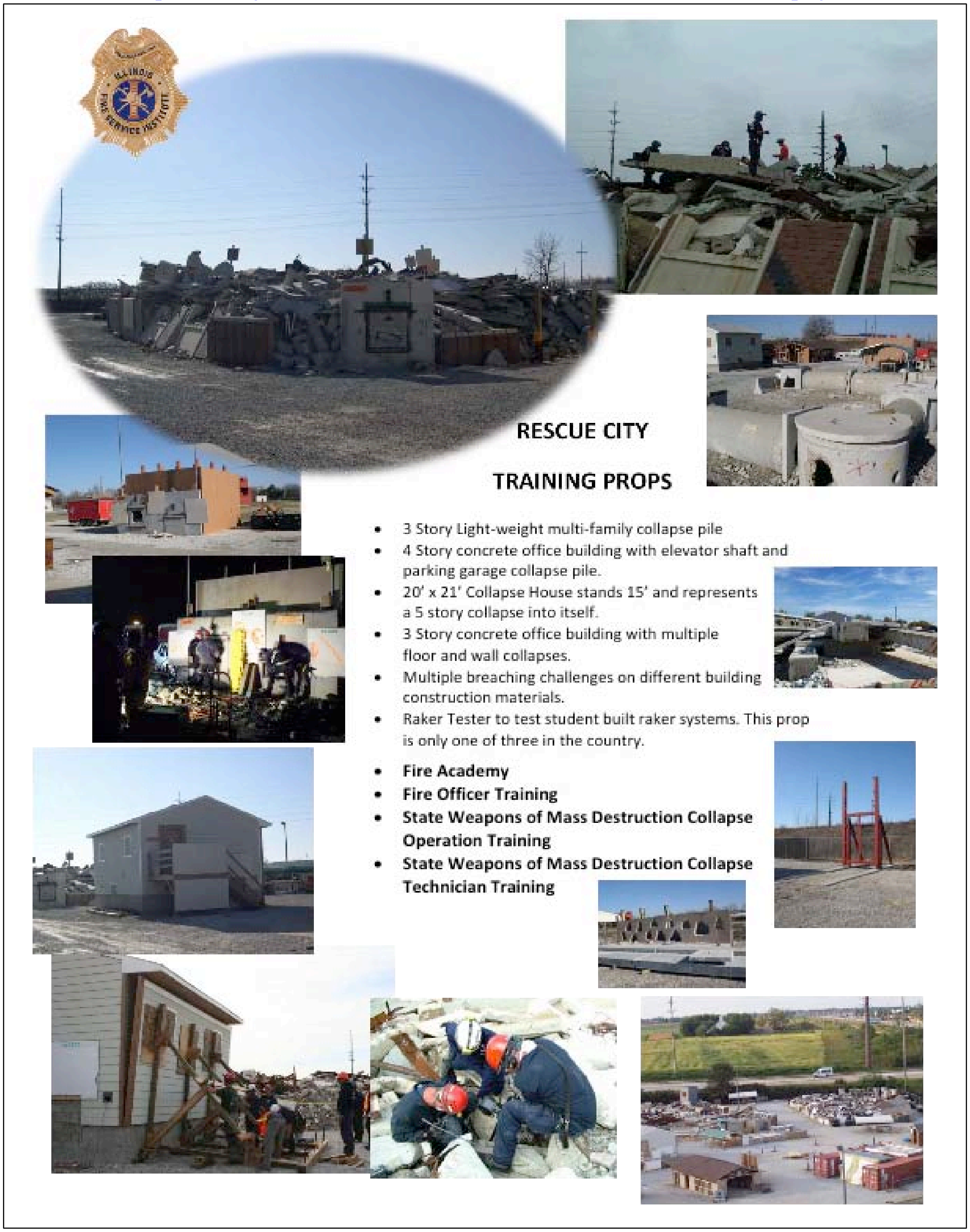
2. What are possible alternatives for building a new structural collapse training facility?
Did you agency find unique or creative avenues to utilize existing structures / props at your institution for SCRT training? i.e. Confined space props, unused buildings, training towers, tanks, shipping containers, other? Examples, diagrams, photos, and links are appreciated.

Additional Comments and Feedback

Appendix B

Illinois Fire Service Institute Rescue City Training Props Flyer

http://www.fsi.illinois.edu/documents/Facilities%20Overview.pdf



Appendix C

Illinois Fire Service Institute Rescue City Photographs

http://www.fsi.illinois.edu/content/information/facilities/rescue_city.cfm

Figure C1

15' "Multi-story" simulated collapsed office building. Breaching and shoring.

Figure C2

Two and a half story wood framed structure for shoring and void exploitation.

Figure C3

Large concrete and steel collapse pile with tunnels, cars, breaches, and crane operations.

Figure C4

Large concrete and steel collapse pile with tunnels, cars, breaches, and crane operations.

Appendix D
Alabama Fire College Structural Collapse Prop Photographs
Emailed courtesy of Marty McElroy, Structural Collapse Program Specialist

Figure D1
Collapse debris pile(foreground) Shipping containers for shoring and breaching.

Figure D2

Prop for performing and overhead breach through concrete.

Figure D3

Bracket on shipping container for performing horizontal breach through concrete.

Figure D4

Shipping containers used for horizontal shores and horizontal breach.

Figure D5

Fabricated concrete vaults for breaching panel placement. Exterior-horizontal breach. Interior breach. Overhead breach.

Figure D6

Close-up of angle-iron brackets used for the breaching vaults.

Figure D7

Interior view of the breaching vaults.

Figure D8

Prop for horizontal breach and vertical breach.

Figure D9

Interior of building constructed with a "floating ceiling." Sloped floor and roof shores.

Figure D10

Example of shoring in room with adjustable "floating ceiling"

Figure D11

Examples of large lifting and moving blocks. Angle-iron protects the corners.

Figure D12

Concrete panels with protected edges. Used for lifting and moving and weight calculation.

Appendix E
Interview Notes and Survey Answers with Alabama Fire College

Institution __**Alabama Fire College**__

Contact:

First contacted AFC Program Director Curtis Poe at 9:21am June 26, 2012.
He referred me to subject matter expert Marty McElroy.
Emailed and called Marty McElroy at 9:40 am June 26, 2012 and left voice mail to return call.

Returned previous phone call. Phone Interview on 6/25/12 at 3:15pm CST.

Marty McElroy, Structural Collapse Program Specialist

Conversation Summary:
The way our program runs is we divide the class into three squads. We typically enroll 24 students, but will allow up to 30. The three squads have 8-10 students. The first day we bring in an engineer to lecture on shoring systems. The students are in the classroom all day. Days two through seven are divided into three separate two-day rotations. The three rotations are shoring, lifting and moving, and breaching/cutting. Day one of each rotation starts with a 4-hour lecture. The students then move outside for the 1.5 days to perform the manipulative / psychomotor components.

The last day consists of a scenario-based skills exam. The students draw from three stations. Their squads will have to move and object out of their way. Perform two shores, two breaches, and rescue a patient. This sufficiently tests each squad on their skills. Some squads will perform different types of shores or breaches than others. In this manner, the skills are kept at random.

We make sure to have a FEMA Instructor at every course deliver. They come to us from different geographical areas and Task Forces. We like students to get a variety in this regard.

Our programs are dual IFSAC and ProBoard Accredited.

1. What types of facilities and props do other training providers use for structural collapse rescue training?

Most curriculums include the following elements listed below. What props or facilities enhance your ability to teach and deliver quality instruction in each area? Examples, diagrams, photos, and links are appreciated.

Search / Rescue within a collapsed / partially collapsed structure:

I have different opinions about the rubble pile. Some say bigger is better. It involves heavy upkeep. Pile maintenance is an issue. Weeds, trees, spiders, and snakes all present *a significant problem with debris piles in my experience. There is no need to be big or extravagant. Our final scenario, being four-hour scenario, limits the time we actually spend in the pile performing search and other tasks. Our rubble pile primarily consists of pipe pathways and breaching components. We can drop panels for interior cuts within the pile. There is also the option to replace concrete panels with wood.*

Shoring:

A real benefit for shoring is a cinder-blocked concrete structure. Within that structure we have a hanging ceiling that uses hinges and cable winches. We were surprised in how much expense and overhead goes into a course. This prop offers a cost-saving benefit. Squads rotate through stations performing the same shores in 8-10 person teams. Early in the week, the ceiling starts at full height. With each new squad, the ceiling is lowered. This enables us to use the same lumber multiple times. Each squad still has the benefit of making the cuts and fully constructing the shore.

We also have a less expensive and less sophisticated version of this within one of our connex / shipping containers. That system uses rope, pulleys, and prussic cord to lower the ceiling in the same fashion. This could allow you to use some of your facilities already on site.

There are five containers on site. We use the inside of at least three of the containers. Another benefit of the containers is that we have cut doors and windows that are "racked" or out-of-square and must be shored. These warped entryways do not compromise any stability for the containers.

Breaching, Breaking, Cutting, Burning:

We found the thickness of concrete breaching panels is big deal. Our panels are 3.5"-5.5" thick. with19 feet of rebar and forms. We make our panels on site from scratch. Each class we use approximately 10-11 yards of concrete to pour panels. This yields us 39 panels. We use 36 concrete panes for tool lab stations. This can include the exterior horizontal breach, vertical breach, step cut, interior breach, and overhead breach. We will also use 3 for the final scenario or skills test. Sometimes we use wooden panels. This allows students to familiarize themselves with tools such as the reciprocating saw. We will probably switch from wooden panels to pallets to save on cost. We can obtain pallets for $1. As I stated, we pour our own panels. How far out you pour the panels affects wear and tear on saws.(time prior to course) Step cuts and thickness of it will also bring much to bare on the longevity of the tools and blades. Our first panels were not thick enough. We changed the size and dimensions to get the right cut to properly demonstrate a step-cut. The green concrete proved to thin and gave way.

Green concrete protects the tools. Too green a concrete is too brittle and will cheat the students with an easy breach. There are significant limitations for the saw. Max for *circular 4.5-5". Thicker panels would require chain type saw. The switch from a circular saw blade a chainsaw chain is to switch from $60 circular to $400 for round the chain.*

We also constructed and poured specific vaults for the course. These gave the ability to use one station to serve as a tool skills lab and perform an exterior breach, interior breach, then overhead breach. We start with the fundamentals from the exterior. Once this breach is performed, we can place a wooden panel where the concrete panel previously sat. This allows fast access to the students for the instructors while students are performing interior and overhead breaches.

Lifting, Moving, & Stabilization:

We poured our own panels and blocks for lifting and moving. We framed them up and welded angle iron together for all the corners. The angle-iron protects the blocks from chipping and busting when students apply leverage to them for their initial purchase points. The set concrete blocks allow for students to perform calculations of weights or raw materials and equipment limitations. Our cubes are nearly 5' cubed. The flat blocks we use for card shuffle-type lifting and moving maneuvers. We have a crane on site that we use for the teaching crane operations, slinging, and resetting prop components. There are some concrete pillars we use for gantry maneuver portion of lifting and moving.

2. What are possible alternatives for building a new structural collapse training facility?
Did you agency find unique or creative avenues to utilize existing structures / props at your institution for SCRT training? i.e. Confined space props, unused buildings, training towers, tanks, shipping containers, other? Examples, diagrams, photos, and links are appreciated.

There were not many things that were previously on site for out structural collapse rescue program. There were some concrete pipes and components that we were able to use for lifting. We built the building with a movable ceiling and brought in the shipping containers. We looked at many options and other providers. We feel like we built the prop specifically to cater to our format and the way we have chosen to deliver the program.

Additional Comments and Feedback

Appendix F
Interview Notes and Survey Answers with Illinois Fire Service Institute

Institution_ Illinois Fire Service Institute _

Contact:

Referred to Mike McCastland by Jason Louthan, with Oklahoma State University Fire Service Training

Telephone Interview 6/19/12 10:30am CST

Michael MaCastland, Program Manager: Structural Collapse Program

Conversation Summary:

We looked at things we like and saw on deployments and trainings. In the process we visited Oklahoma City, California, New York, LSU, and Texas A&M.

In the 11 years since we built the prop, we must have changed it at least 100 times. . . It's something that is constantly evolving as a result of our experiences and lessons.

We have two piles. One is light-weight construction and the other is heavy. When we first conceived the light pile, it was approximately 40'x25'. Today it has grown to 200'x70'or 80'? We grew the pile to support canine training, team validation, and operational readiness exercises that go on for days continuously. The light piles uses sunken telephone poles, 6"x6"s, and 8"x8"s to act as vertical supports for much of the material.

In our heavy pile we used lots of jersey barriers. There are channels that consist of concrete double-Ts. A unique feature of the piles are instructor tunnels. Instructors maintain separate access using tunnels such as large vertical culverts and 36" concrete pipe. This allows victims to be reset and access to students. It can also provide escape zones for students. Many times students "believe" they are in a collapsed area, when in reality they are in a protected "vault" or safe passage.

Institution_ Illinois Fire Service Institute_

Phone Interview Follow-up 6/26/12 11:01am CST

Michael MaCastland, Program Manager: Structural Collapse Program

Our 15' collapse house is a wood-framed structure. We framed it up as an actual house. Even though it is only 15' tall, it contains 2.5 stories of collapsed floors within the structure. The house sits on a slab foundation. This allows for exercises in multiple types of collapse common in lightweight structures. We have pancake collapses, lean-to collapses, v-pattern collapses, and sloped floor slash ceiling collapses. As we have seen students perform differently we have changed the house multiple times. We probably changed the inside of the collapse house over 25 times.

We do use adjustable ceilings for some parts of our shore. Instead of lowing the whole ceiling however, we start higher and set braces at lower levels so the students can use the same equipment.

Our concrete collapse building was adopted from Texas A&M(TEEX). This structure represents a 3-story collapsed office building. We used A&M's plans and adopted certain aspects to tailor specifically to our needs. The prop components within this structure are mostly sloped-floor shoring and variation of concrete breaching. We (IFSI) sent our whole staff to A&M. The guys from OSU did that as well.

It is very difficult to communicate through phone and email how the props and components actually work. The best thing to do is go to the facilities, walk through, take pictures, and see it.

When we first launched our program, we used some pre-existing facilities for the class. We used two different burn building to perform shoring and search operations. We shared tools and equipment from out other rescue programs. Today the facility, props, and tools are standalone for structural collapse rescue programs.

For Lifting and moving we use many of the same teaching methods that other providers use. We have removed the gantry-lift from our programs because we feel it is replicated in some of our other programs. Our students move heavy blocks through the standard O-course. One unique and important area in our lifting and moving came from the Minnesota bridge collapse and the California earthquakes. This move involves lifting a sizable bridge beam or span off of a crushed vehicle. Our typical program utilizes three stations for concrete lifting and one station for the O-course.

We deliver our programs separately in two 50-hour formats. We choose to do all of our shoring in the operations level (level 1). The technician level(level) is a 50-hour class, but it focuses more on the breaching and cutting heavy concrete and steal. We basically took the JPRs and KSAs from the FEMA SCT curriculum and run it in the 1670 and 1006 format. That is to say, there is delineation between the levels that corresponds with light construction and heavy construction.

It's important that you send your lead guys to a class so that they can learn or re-learn the material from the perspective of future instructional delivery.

Institution_ Illinois Fire Service Institute__

Interview answers to survey questionnaire:

1. What types of facilities and props do other training providers use for structural collapse rescue training?

Most curriculums include the following elements listed below. What props or facilities enhance your ability to teach and deliver quality instruction in each area? Examples, diagrams, photos, and links are appreciated.

Search / Rescue within a collapsed / partially collapsed structure:

We have two piles. One is lightweight construction and the other is heavy. When we first conceived the light pile, it was approximately 40'x25'. Today it has grown to 200'x70'or 80'? We grew the pile to support canine training, team validation, and operational readiness exercises that go on for days continuously. The light piles use sunken telephone poles, 6"x6"s, and 8"x8"s to act as vertical supports for much of the material.

In our heavy pile we used lots of jersey barriers. There are channels that consist of concrete double-Ts. A unique feature of the piles are instructor tunnels. Instructors maintain separate access using tunnels such as large vertical culverts and 36" concrete pipe. This allows victims to be reset and access to students. It can also provide escape zones for students. Many times students "believe" they are in a collapsed area, when in reality they are in a protected "vault" or safe passage.

Shoring:

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Breaching, Breaking, Cutting, Burning:

Lifting, Moving, & Stabilization:

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2. What are possible alternatives for building a new structural collapse training facility?
Did you agency find unique or creative avenues to utilize existing structures / props at your institution for SCRT training? i.e. Confined space props, unused buildings, training towers, tanks, shipping containers, other? Examples, diagrams, photos, and links are appreciated.

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Additional Comments and Feedback

Appendix G
Interview Notes and Survey Answers with Oklahoma State University

Institution _Oklahoma State University Fire Service Training

Contact:

Telephone Interview: 6/19/12, 10:00am CST

Jason Louthan, Coordinator of Rescue Programs

Conversation Summary:

The way we have divided our programs is different than others that are delivering the normal FEMA 80 hour program. We run a 50-hour Operations Level (level 1) program and a 50-hour Technician (level 2) program.

The reason we chose to do this is that there are two rescue teams in our state (Oklahoma). One team performs at the operations level. The other team operates at the Technician level. This format allows customers to choose one or both levels.

Concepts of Crane Operations can be achieved through boom truck. A heavy-duty crane is not required to facilitate a program.

On day one of the Operations class, we spend 8 hours in the classroom doing lecture. Another 2 hours are spent in rotations completing tool familiarization. This includes showing tools, operations, and maintenance. Techniques like how to use a speed square and start a chain saw are also learned.

Day 2 consists of shoring. There are 4 stations set up in the morning and 4 stations in the afternoon. Students perform a complete rotation each half day.

On Day 3, in the morning there are three shoring stations. Then in the afternoon the students perform breaching. The reason Day 3 has 3 shoring stations in the morning is that the sloped floor shore requires more time. The afternoon consists of breaching stations and a lifting and moving station.

The breaching station consists of 5 separate 36" culverts in series. A wall for breaching is placed in between each culvert. The walls are constructed of ordinary material such as studs and sheet rock. We fill the voids with anything we can to challenge the students. This includes mattresses, plastics, wires, and more. This station is run as a competition between two squads. We have found that there is a need to place emphasis on blade and battery conservation. The students get two batteries and when they are out, they are out.

At the same time groups are performing at a lifting station rotation. There objective is to lift large slabs vertically 3' so that cribbing may be installed. Lifting is entirely vertical in the Operations class. They uses pry bars, hi-lift jacks, air bags, wooden beams, and an array of tools.

The 4th day consists of skills exams. The students move in squads from shore to shore. If they complete the shore correctly, they move on. If they mess up, then they tear it down and build it again. The teams start at 8 am, pick there lunch hour, and go until they are "finished." Sometimes we are there until 9pm at night.

The Operations level class contains all the shoring JPRs. The Technician level class focuses more on breaching, breaking, and burning through heavy construction. There is an emphasis on hot work and operations within the debris pile.

In order to construct the debris pile we laid out the tunnels first. It was initially on dirt. This was bad because is dulled the equipment. We came back and poured concrete pads for the pile. The verticals for safety consist of wood members such as 4"x4"s and bigger. Many of the walls and coverings are made of pallets. We found this desirable because debris falls through, creating a more realistic working environment. You don't want clean tunnels. Our pile simulates a tornado hitting three single family residential structures. That is what we prepare for in Oklahoma. In the near future a house is being moved next to the debris pile and then "racked" into the pile. Students will enter and shore the "racked" house to gain access to the pile.

In the technician course (level 2), for lifting and moving, there are three heavy slabs labeled A, B, & C stacked in that order. There is a perimeter extending approximately 5' from the stack. Students must lift and move all the slabs from within the perimeter and then move them back to the stack. The slabs must be stacked in reverse order- C, B, & A.

I recommend calling Michael McClastand with IFSI. He helped me out.

Institution_ Oklahoma State University Fire Service Training

Phone Interview Follow-up 6/26/12 1:31pm CST

Jason Louthan, Coordinator of Rescue Programs

As I stated in our last conversation, on the fourth day we use a scenario based skills exam to check off students on their various skills acquisition. On the fifth and last day of the operations level class we spend more time in the debris pile. Students use tunneling systems underneath all of the collapsed debris. They are forced to build shores with limited access and room to move around. It also puts the students performing rescues and patient packaging in tight spaces.

We did start out pouring our own panels. That had mixed results and success. The company Hilti,that manufactures many of the tools we use is located nearby. They pour their own slabs and panels in order to test equipment. Many times they will drill a panel once or twice and then they are through using it. We simply pick up the panel from them and transport them to our site.

Hilti and other manufacturers are a great resource. There are all kinds of companies have mis-pours on their concrete forms and will donate them if you come pick them up.

As for cutting, you are always going to run into problems with slabs that are either too green or too seasoned. We have found what tends to be a bigger issue with blade and saw maintenance is operator error. Inexperienced users will often run a chainsaw bar or saw blade out of alignment and either warp them or burn them up.

As a method to save on lumber we raise the floor rather than lower the ceiling. We did this when we started in our drill tower. We will come behind a team and put down wooden pallets on the floor that will give the shoring teams a shorter length to work with. This allows them to get multiple uses out of the lumber.

A technique we use to simulate racked windows and doors is simply to initially place shims in the window or doorway. When another group rotates to the station we will replace the shims with larger ones or wedges. A carpenter can help you form walls that contain racked doors and windows. These can be constructed out of 4'x4' panels that allow them to be transported and then bolted together.

We used all of our existing facilities when we first began our structural collapse program. We used the burn buildings, drill towers, skills building, and others. We also used any and all available doorframes and windows.

One thing that we felt was necessary in order to give the students realistic training was to make a wall for the raker shores. We built a 12'x16' out of 4"x4" studs and plywood sheeting. The wall is leaning outward to that students are not able to shore a perfect 90-degree angle. What helps even more is if the wall is not only leaning, but out-of square.

This makes it so that when they measure, the shore must be installed exactly in that spot. It will not fit anywhere else. Another challenge is to consider that the ground slopes away from most wood-framed structures so that water will run away.

One last piece of advice is to make sure your instructors stay on task. You will have to reign them in so they do not try to deliver three hours of information in a 45-minute time slot. Try to stick to the schedule you decide.

Institution_ Oklahoma State University Fire Service Training

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