Identifying the Risks for Fire/EMS Crews at Indoor Marijuana Grow Operations

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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, quotations marks so indicate, and that the appropriate credit is given where I have used the language, ideas, expressions or writings of another.

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Abstract

The problem was that indoor marijuana grow operations pose safety risks to fire and EMS crews when operating at these facilities. The purpose of this study was to identify the safety risks associated, and determine best practices for fire and EMS crews while operating at these facilities. An evaluative method of research was used to gather data to support hypothesized findings of hazards that have already been encountered by other fire and EMS crews and to answer these questions:

1. What are the most common components to indoor marijuana grow operations?
2. What are the risks to fire and EMS crews at these facilities?
3. What are the best practices for safety during calls for service at such facilities for fire and EMS crews?

This research was conducted by examining current methods of construction of both legal and "make shift" indoor farms from documented drawings and schematics produced and available to the public. Fire marshals were also interviewed who have been directly involved with inspecting or investigating these types of operations pre-and-post incident. Articles and reports from past incidents were examined to determine if and what types of injuries and illness were sustained by the fire and EMS crews who responded. The findings of this study support that indoor marijuana grow operations are comprised of inherently hazardous components posing significant safety risks to fire and EMS crews. The ability of these crews to understand, recognize and anticipate these risks will result in a reduction of injury and illness. This study recommends adequate training for the crews to include a comprehensive understanding of what might be encountered when working in and around indoor marijuana grow operations.

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Identifying the Risks for Fire/EMS Crews at Indoor Marijuana Grow Operations

On January 1 2014, The State of Washington instituted Initiative-502(*New law emerges,* 2011, p. 5) a law legalizing the growth, sale and distribution of marijuana. This legal determinant is regulated and controlled by the Washington State Liquor Control Board. The problem is that indoor marijuana growing operations pose significant risks to responding fire and EMS crews and the state has now begun issuing permits to grow within Whatcom County, part of which is protected by North Whatcom Fire and Rescue, (NWFR). Firefighters are called for service to help mitigate various types of incidents at and around these facilities. The purpose of this study was to identify the risks to the crews and determine the best practices for safety when working at the scene both from the perspective of fire related incidents and EMS type alarms.

The questions answered through this research were:

1. What are the most common components to indoor marijuana grow operations?
2. What are the risks to fire and EMS crews at these facilities?
3. What are the best practices for safety during calls for service at such facilities for fire and EMS crews?

An evaluative method of research was used during this project to form conclusions designed to assist responding crews with the knowledge and understanding of what they may encounter as they serve the public at these types of structures. Because of the legalization of marijuana in Washington and other states, new grow operations are emerging as an acceptable means of commerce for the individual business owner/entrepreneur. Websites and other materials are readily available offering “how to” descriptions and details of how to build and be profitable as an indoor cultivator.

Certain unique components make up these grow operations that can pose as serious threats to the safety of first responders. This study identified many of these methods of

construction. Because growing marijuana indoors requires a heat source, ventilation, chemicals and possibly the need for security, fire and EMS teams that work at these facilities and are exposed to both short and long-term health risks that can affect their safety.

To support findings and conclusions to this research, past incidents from other agencies were analyzed and the data gathered was used to suggest better methods of safety for the crews. Fire marshals' comments and experiences at these types of operations were also utilized to assist in determining best practices.

Background and Significance

Historically, marijuana has been labeled as an illegal substance. One of its main compounds is THC, (tetrahydrocannabinol) and it gives the user a heightened mood or a euphoric effect. It has been used both recreationally and for medicinal purposes for centuries throughout the world and until lately in The State of Washington, it has been illegal to possess, grow or use.

Most recently, since the legalization of marijuana in Washington State has become a reality, permits for growing the plants indoors are being issued. As these facilities become more prevalent in the state and locally within Whatcom County, the relevance to provide information to fire and EMS crews regarding components and hazards of such places has become necessary for their safety. Crews from other jurisdictions who have responded to incidents relating to grow operations have encountered unique safety issues and have suffered injuries because of them ("Firefighter Injured," 2011, p. 1).

Fire and EMS operations at grow houses will become more common due to the number of facilities being built. This research provides important details to assist responding crews to make better decisions while at these buildings which will reduce the frequency and severity of injury and illness as a result of the hazards found there. It will provide a suggested “best practice” concept that will be beneficial to other responders and agencies as well.

This study relates to the United States Fire Administrations’goals by way of reducing risk at a local level through prevention and mitigation, and presenting quality and meaningful information to fire service personnel who may respond to indoor marijuana grow operations. It is in line with the objectives and curriculum of Executive Analysis of Community Risk Reduction through The National Fire Academy Executive Fire Officer Program because it

identifies safety issues in the community and will form a broader spectrum of knowledge for those involved. This project will have a positive effect on the communities near these places and will help reduce potential risks and health related issues.

Literature Review

Marijuana, like any other plant, needs basic elements to grow. Light, heat, nutrients, water and a medium of sorts are required to stimulate life. Growers of this plant seek certain desirable results from their efforts and go to great lengths to achieve these effects. They are striving to produce a product that has the right amount of flavor, scent, freshness, effectiveness and marketability. They also seek to find the fastest way to get their plants to grow. Essentially, growing marijuana indoors can be done either in soil, in a water system known as hydroponics or in air-type system known as aeroponics. Each has their own unique methods of production and requires certain elements that must be present to create the desired yield.

As growers set up an operation, they must choose a location that is suitable for the sustainability of the operation and is located in such a manner that doesn't attract the attention of unwanted eyes. It must also be accessible to adequate electricity, water and drainage, security and maneuverability. It is suggested that indoor gardens be located in areas such as closets, basements or attics (Grow Weed Easy, n.d., p. 1). The grower must decide how large of a space they will need to be effective in their endeavors and will be within their budget. Once a location is determined, the method of growing is decided and construction of the facility takes place.

Growing in soil

Growing in soil is the most economical technique. This process to develop a growth environment begins with a container of sorts, usually a pot that nurseries use to grow small trees or shrubs in. These containers are placed in the room determined to be the location of the

operation. After a location has been determined, a choice of soil must be made. Many different types of soil can be used. Some cultivators and botanists have determined that marijuana grows best in soil similar to that used for the production of tomatoes (Growing Marijuana Indoors, n.d., p. 1). Chemicals and nutrients are needed to sustain and enhance the growth of the plants. Marijuana grows very well in soil that contains nitrogen, phosphorus and potassium. Several pre-mixed commercial type soils are available (Marijuana Grow Guide, n.d., p. 1). Growers may also store these chemicals separately in and around the facility in marked or un-marked containers. Chemicals are available in dry- powder mixtures or in liquid form.

Hydroponics

Hydroponics is the term used to describe the method of growing in water. Marijuana cultivators choose this method over soil because of its faster yield of product and bigger buds from the plant. The components include: containers to hold the water, a light source equal to soil production, fertilizers which are water soluble, air pumps or drip systems and an adequate electrical supply.

Essentially there are two types of hydroponic systems, active and passive (Grow Marijuana, 2014, p. 1). A passive system suspends the plants in containers in a medium above the water source. A wick which drops down from the container is in contact with the water below, drawing the nutrients up to the plant. The water below is stagnant and does not need a pump to circulate.

An active- type process is more complex and hazardous to operate. The plants are also in a medium and container, but moving water from a pump filled with fertilizers to sustain and enhance the growth of the plant. Both require the use of water sources, chemicals, a light source and large amounts of electricity suitable for sustaining pumps, lights and fans.

Aeroponics

This method of growing marijuana has become more common because of its fast yield benefits. (Growing Marijuana. com, n.d., p. 1). It is a sprayed or blown on nutrient source to the root system of the plant. The plant is suspended surrounded by a medium and in a growing chamber like tubes or cradles. Pumps spray a water and chemical mixture into the air allowing the plant to absorb the substance. The components for this system are somewhat similar to the others needing a light source, ventilation, movable fresh water, chemicals and large amounts of electricity. However, the mediums used for this production can range from Rockwool to Vermiculite, from which exposure can cause harm. (*Mineral wool fiber*, 2011, p. 1).

Lighting/heat

Light sources used to enhance photosynthesis range from the simple and most economical fluorescent fixtures to metal halide and high pressure sodium bulbs. Fluorescent fixtures being the least expensive are also the least desirable for growers. They do work well in the early stages of growth but don't produce large mature plants. Fire danger is somewhat lower because of the reduced heat generated from these lights and they don't draw large amounts of amperage to operate.

Light emitting diodes (LEDs) are becoming more popular for a light source. This type of lighting has been shown to generate a better spectrum of light waves which in turn enhance the growth of the plant. The drawbacks for growers are the increased cost and shorter lifespan of the bulbs. Fire danger is increased somewhat because of the required electricity and load on the circuits.

Metal halide and high-pressure sodium fixtures are the most expensive and give the highest yield from the plants. During normal operation they give off a "blue light" which is said

to have negative health effects to humans (Leone, 2014, p. 1). These lights require circuitry adequate to handle high-amperage loads. Like the fluorescent type, these bulbs contain mercury but come with other inherent dangers. These bulbs are made of glass, are filled with inert gasses and operate under high heat and pressure. Constant cycling on and off or direct impingement of water creates weak points within the glass causing it to potentially fail. When it does fail, the glass breaks, sending chards of hot glass into the air which can affect the surrounding environment exposing combustibles to fire danger. Overheating and inadequate wiring and planning has been found to be common and been the cause of many fires and related injuries (Brahe, 2013, p. 1).

High pressure sodium bulbs are also considered for growing plants and fall into the HID, (high intensity discharge) family of lighting. These fixtures emit a broad spectrum of light waves and when new are relatively cost effective to operate. They do, however, contain many of the same properties as previously noted in the metal halide bulbs most importantly mercury and at higher pressures from heated gasses. These bulbs do operate at high heat ranges and are intrinsically safe until ruptured sending the same types of hazards airborne. They can be powered by circuitry ranging from 110v to 480v supplies.

Mercury, a common heavy metal used in most light sources, has been shown to be a toxic substance affecting the human body causing kidney failure and brain damage. It also has long-term effects on the environment as it is washed into the water supply. A small amount of mercury can contaminate a large amount of water (Ackendorf, 2014, p. 1). Fluorescent fixtures generally require an 110v circuit for power and draw low amounts of amperage making them more cost effective.

The chemicals held within the bulbs for them to work include a substance known as gallium arsenide. This chemical is comprised of gallium and arsenic to form a compound. An energy source is run through its substrate which in turn causes an illumination. Like the other light and heat sources listed, it too is safe during normal uses but will release these toxins upon failure of the bulb. Required power can be from 110v to 220v.

Chemicals/compounds

Nutrients are essential in all methods of growing marijuana. As in any other farming approach, cultivators of this plant rely on many different types of chemicals that have been found to be the most beneficial for their particular operation and outcome.

There are numerous fertilizers on the market promising to create tremendous yields and all attempt to stimulate the bud (flower) production of the plant. These products may contain chemicals including; potassium sulfate, monopotassium phosphate, whey protein hydrolsate, ascorbic acid, citric acid, phosphorus, nitrogen, magnesium, calcium and others. Each of these compounds has certain qualities that are necessary for desired size and THC percentages in the plant. Experienced growers will use commercially produced products and concoct their own unique blend of chemicals they have determined to be best for their crop. New growers will also use premixed fertilizers and potentially experiment with mixtures and cocktails of sorts said to be the recipe that works.

Potassium (K) is a metal that is a natural substance found in nature. In correct dosages, it is considered a needed nutrient for healthy plants and animals. The use in grow operations include adding this substance to the plant in high quantities/percentages to stimulate growth of the plant. It can be stored in bags, buckets or other containers in both powder and liquid forms.

When potassium is exposed to flame or reaches its flash point, it can react quite violently and is known to be an oxidizer (WebWISER, n.d., p. 1). It also has inhalation hazards known to cause breathing difficulty and have long-term health effects on the human body.

Another fertilizer commonly used for stimulating the growth of marijuana plants is phosphorus (P). It too has chemical properties that pose severe risks when exposed to heat and flame. This substance, when burning, reacts with water and emits toxic and corrosive fumes.

Nitrogen, symbol (N), is a gas that is all around us in the air we breathe. Its concentration naturally is approximately 78 percent. When used for production and growth of plants, it generally comes in the form of a dry powder in bags or buckets. It is added to the water or soil at certain stages of growth to enhance the qualities of the plant. Nitrogen found naturally in the air poses no risk to humans and is in fact necessary to sustain life. However, when mixed in dry form with other substances, it might produce inhalation hazards when burning or simply from the dust introduced into the air.

Water for growing marijuana can be sourced from a typical residential service to a commercially supplied system. Fresh water into the process is vital to the health of the plant and used in quantities commensurate with the size of operation. The “waste” water is expelled from the premises by different means. Misuse and discarding of contaminated water has been shown to effect the environment (*Marijuana Threatens Water Quality*, n.d., p. 1-3).

Hash oil is a derivative of cannabis that is extracted from the plant and used in various ways. The user of such product can experience a higher percentage of THC in the oil than is in the raw plant. It has been used medicinally in many states and in Washington. Unfortunately, Washington’s new law fails to clearly define the regulations regarding manufacturing and use of hash oil. Since the oil must be extracted from the plant, methods of “cooking it out” are used

and one common way is to use flammable chemicals and butane as a heat source. Many injuries, fatalities and property losses have been experienced because of amateur attempts to gain the product (Young, 2014, p. 1).

First responders to indoor growing operations may encounter several other hidden risks including mold spores and weakened structures from significant moisture. The fire and EMS crews will be entering these facilities for various reasons, not all will include fire involvement. The air inside may include high levels of carbon dioxide, toxic mold and airborne chemicals known to have both short and long-term effects on the human body. “One Colorado law enforcement officer was hospitalized in critical condition because of his work inside a marijuana grow house”. (Tatum, 2012, p. 1).

The way indoor grow operations are constructed and built into structures can have significant impact on crews when they are working at or around these buildings. As previously stated, growers often times will find a suitable location within an existing building to create an environment for growing. Often times these can be in hard to get to places and creatively built and may or may not adhere to local building codes or ordinances. Some have been found to be built in bedrooms, closets or garages which most likely have no fire walls between them leading to rapid fire growth and spread ("Indoor Hazards," 2011, p. 2).

Mitch Nolze, a Whatcom County Fire Inspector, is involved in the pre-planning and construction inspections of indoor marijuana grow operations and has seen extreme hazards within the buildings that fire and EMS crews could encounter. He reports obstacles such as; false doors (constructed to discourage intruders), numerous trip hazards, high-intensity heat lights and Co2 (carbon dioxide) generators in the operation used to stimulate the growth of the plants, (Appendix A). The Co2 generators, he says, use either propane or butane for power

which when burned, and give off Co (carbon monoxide) a deadly invisible and odorless gas. The generators pump Co2 into the grow rooms, and, as a result, reduce the oxygen concentration in the air. He also reports seeing fertilizing chemicals, poorly-constructed ceiling components used to confine the grow areas and poorly-ventilated cubicles that contain the plants.

"Best practices" can have a wide range of definitions depending on the context in which it is used. Many fire departments are using this phrase for identifying business practices, personnel management, fiscal responsibilities and operational responses into the public for service. For the sake of this research, the *best practice* terminology will be specifically used to identify what the crews should do to reduce their risk while at indoor marijuana grow operations.

Since the cultivation and farming of pot has become legalized in some U.S. states, many fire and EMS crews are beginning to recognize hazards and are protecting themselves accordingly. However, these facilities have become even more prevalent in our communities, exposing the responders to even greater risks.

In New York State, a best practice document has been written that identifies many areas of operation for firefighters and EMS workers. It identifies training guidelines and recommendations for responders while they are involved in emergency operations both from a defensive and offensive position (Stevens, n.d., p. 1).

Pre-incident planning involves not only recognition of structures and occupancies but determining what the potential hazards are within these buildings. Performing area familiarization, engine company inspections and site plan review have been used as a tool to assist crews and broaden their knowledge of what to expect at these types of structures.

In 1997, The State of Minnesota published documentation which outlines their definition of best practices for safety within their communities (Legislative Audit Commission, 1997, p. 1).

This report was compiled by a group of authors who determined what types of fire departments were in their state, (career, volunteer or combination), what types of services they provide, how they are financed and what the goals and objectives are for the collection of departments. A best practice model was then formed to help determine what safety methods would involve the agencies in the most appropriate way.

In California, a document which outlines considerations and operational guidelines for responders to indoor marijuana grow operations, has been authored and is in place today. Firescope.org has identified in this writing a need for all responders to have a situational awareness and significant training on how best to work at these places. “Initial response personnel need to maintain a high level of situational awareness and possess the skills necessary for incident stabilization”. (*Marijuana Cultivation Incidents*, n.d., p. 1)

The reviewed literature in this section provided significant identification of what the common components of marijuana cultivation operations are, what the potential risks to fire and EMS crews may be and what other agencies have identified as best practices for safety during responses to indoor marijuana grow operations.

Common components recognized were:

1. Growing methods: hydroponics, in soil and aeroponics
2. Necessary elements: light/heat source, chemicals/fertilizers, and medium
3. Energy source: circuitry
4. Changed or creative layout of building: walls, in basements, bedrooms, or attics
5. Waste water
6. Possible security measures in place: booby traps

The potential risks acknowledged in this review were:

1. Compounds, chemicals and other hazards emitted from burst or open lighting fixtures and bulbs that include: mercury, arsenic and hot shards of glass
2. Un-supported or overloaded circuitry
3. Chemicals used for fertilizer such as; potassium, phosphorus and nitrogen
4. Molds that are airborne within a high moisture/ high humidity environments
5. Unknown building construction methods

The review of "best practice" literature was used to study other agency's approaches to working around these risks. Some departments have responded to several incidents involving grow operations and have developed procedures for their crews to help keep them safe.

The key response guidelines found were:

1. Know your jurisdiction/response area
2. Be able to identify grow operations from a distance if possible
3. Listen to dispatch indications, ask questions
4. Perform pre-incident planning and training evolutions
5. Approach cautiously
6. Use appropriate PPE, (personal protective equipment)

Procedures

Growing plants indoors requires necessary components to create an atmosphere that will keep a plant alive. The aspiration of a marijuana cultivator is unique in that their goals are not to just keep the plant alive but to make it grow quickly, have high levels of THC and give off a desirable aroma when smoked. All of these outcomes require a stimulant of sorts that enhance the plant's natural maturing patterns. These artificial bombardments are widely used and readily

available through many online sources, printed publications and the local nurseries or home improvement stores.

Components in which firefighters and EMS crews may come in contact with at indoor marijuana growing facilities were studied and examined by gathering information from online documents that outlined the methods in which these operations were fabricated. Three distinctly different methods of cultivation were identified; in soil, in water (hydroponics) and in air (aeroponincs) (Grow Weed Easy, n.d., p. 1). The ways in which marijuana is grown are somewhat different but some commonalities were identified in studying drawings and descriptions available on the web. Some of the resources found appeared to be well prepared and reliable and others were a one-page sketchy illustration with poor grammar and spelling errors.

The research material gathered from these sites identified in detail how to affectively produce marijuana by using one or all of these methods and the construction thereof. The documents provided written narratives that gave conclusions and recommendations to the novice grower as well as the experienced producer. Many online sources provided drawings and diagrams depicting their ideas or claimed methods of how to be successful (Growing Marijuana Indoors, n.d., p. 1).

As this project matured, it became apparent that scientific data was less identified and opinions of the authors who posted these methods of construction and cultivation became more the norm. Each description and site may vary one from the other and offer suggestions or ideas on how to make it work for the user. Similarities were found from source to source but there were always variables as well.

To assist in gathering data for this project, an interview was developed to collect information from fire marshals who are or have been directly involved in the inspection and approval process of the grow operations. The interview questions were designed to assemble information on what they have seen for construction methods and what components make up the growing facilities. (Appendix A). The Fire Marshal's Office in Whatcom County is directly involved in inspecting the overall construction and testing of fire suppression systems, determining the proper use of fire resistive materials, fuel loading, entrances and exits, electrical circuitry and final approval of the occupancy. These personal interviews with the fire marshals were vital in helping to identify what some of the target hazards are. Within the jurisdiction of The Whatcom County Fire Districts, there are more grow operations in the process of being permitted and constructed.

By studying news articles depicting experiences other fire departments have had while working at emergency incidents at grow ops, the research gained depth from real-life happenings. These stories gave details about what fire crews found inside the structures that created safety issues for the teams and in some circumstances were the cause of injuries ("Firefighter Injured," 2011, p. 1).

Risks to fire and EMS crews at indoor cultivation buildings were studied from online sources as well. Breaking down the components more specifically helped to identify both short and potential long-term health effects. The project studied individual aspects to the methods of growing such as various light options, several key chemicals and their compounds used for fertilization and the byproducts of these if impinged upon by fire. It also established that there are numerous airborne hazards like mold inherent to high humidity environments and those molds that grow on the leaves of the marijuana (Tatum, 2012, p. 2).

The Center for Disease Control (CDC) was another resource used to assist this project in solidifying the evidence that hazards do exist at marijuana grow houses. Although the information gathered there was useful and informative, it does not specifically address grow operations but simply gives information of the properties of the elements growers use in their farming activities. The CDC's website has reliable information about health affects to the human body as they relate to the elements that may be found at grow operations such as Rock Wool (*Mineral wool fiber*, 2011, p. 1). The information provided by this website was disseminated to fit this research in helping to identify the hazards of the chemicals and compounds that were found to make up the fertilizers, heavy metals used in the lighting and heat sources and some mediums used in the processes.

"Best practices" for safety for fire and EMS crews at growing operations were considered by examining documents available at various online sites. Some agencies have been using this for years in their standard operating procedures or policies. Other non-emergency or private companies use a "best practice model" as it relates to customer service, budgeting or other aspects of their business development or procedures. This study looked at what other fire departments have identified as "best practices" or at least their structure of a matrix or development of ideas on how to operate. A statewide best practice model was reviewed that was written in the State of Minnesota for what they have determined as best practices (Legislative Audit Commission, 1997, p. 1).

Another key finding was a document authored in New York (Stevens, n.d., p. 1-3) that has developed training guidelines for firefighters and is in use today. By exploring these types of works, this project was able to develop best practice concepts and create applicable methods of

safe operations at known marijuana growing facilities or at minimum, identify an operation and approaching cautiously.

Limitations to this study were identified when comparing one publication to another and realizing the documents that were available may not have been based on scientific results or practices. Most of the sites that related to lighting, methods of growing and fertilizers were involved in the sale of such components most claiming to have the keys to success. The research found numerous opinions and some facts as to what works and what doesn't which may have been simply an attempt to market a product. Although most of these sources were more of an advertisement than a news source, many similarities were found and studied. Common fundamentals did arise and were broken down to create a group of known hazards that most likely will be encountered by emergency crews. The interviews with the fire marshals did help to validate the conclusions of even the most rudimentary writings found on the web.

The fact that marijuana growth, sale and distribution just recently have become legal and in only two states, the information available online is somewhat limited and could be considered unreliable. This study's strength came from more reliable sources and experiences of past incidents of the fire agencies who have seen these types of facilities first hand and the individuals who are involved in the inspection and permitting processes.

Results

Identifying the components of indoor marijuana grow operations was the first step in this study. By way of internet based publications and personal interviews, results were formulated to provide information to fire and EMS crews that would allow them to understand and identify what hazards exist at such facilities.

The methods in which marijuana can be cultivated are somewhat common amongst growers and were identified in three basic mediums: air, water and soil. Although the mediums are unique, the plant itself still requires the same basic needs for survivability and sustained growth. The growers use a light source to stimulate photosynthesis, chemicals for fertilization and water.

This study found that the way in which these components were constructed will vary. Depending on the building, the funding available, the desired outcome and the way in which the owner wants to protect the product from intruders, the components and the approaches of configuration may change. The conclusions identified that larger facilities were better funded and rely on a hydroponic method of cultivation and farming. Growing in soil has been shown to be the medium of choice for those whose facilities are much smaller in scale and have limited funding available. This medium and process is not widely used by major growers because of the slower speed in which the plant grows. Because aeroponics is somewhat new in the industry and un-substantiated, it was identified in this research as a less common way in which marijuana is grown in the commercial setting.

A very large legal grow operation in Whatcom County is currently under construction and beginning to be inspected by The Whatcom County Fire Marshal's office. Their office has found that a good portion of the building has been modified to fit the needs of the project that will provide the operational requirements necessary for production but not meeting fire codes. Some of these modifications include; false doors and walls, weak suspended ceiling members, non-fire resistive sheets of plastic or visqueen for room separation and many potential trip hazards due to wiring and structural supports. They also report finding inadequate water

supplies to fire suppression systems and overloaded circuitry which feed the lamps and lighting sources.

Requirements of cannabis production pose substantial risks to fire and EMS crews who will be called for service at these buildings. One component found to be the most destructive to the health and wellbeing of the responders relates to the lighting sources of the operation. Since marijuana requires grow lights and heat for stimulation, certain types of lights and fixtures have been proven to provide the desired light waves needed for rapid growth of the plant. With this comes the need for large amounts of electricity and circuitry to these fixtures. The interviews with the inspectors and fire marshals delineate the fact that the ways in which the power supplies and wiring have been constructed are often times inadequate and dangerously overloaded. They have also found that some fixtures are foreign made, not approved for use in The United States, and not labeled and proven safe by Underwriters' Laboratories.

Many chemicals are used for the stimulation of growth which may come in powder, granule or liquid forms. They can be stored in buckets, barrels or bags depending on their usages and will be found in various places throughout the facility. The chemicals most identified were potassium, phosphorus and nitrogen. These substances have their own inherent risks depending on the concentration and form in which they are used and stored. Potassium and phosphorus are known to be oxidizers when the flash point of the product is reached. Both can be water reactive as well. They can have long term health effects on the human body, mostly in the respiratory system. Nitrogen, a common substance in the growth of any plant, can be harmful when inhaled in dust form. Most growers rely on some form of nitrogen in their process and the product may be found in liquid or dry powder formulas.

Mercury was found to be a common heavy-metal compound used inside most light bulbs by studying the way in which the bulbs are constructed. Sources found in publication outlined how these bulbs and fixtures operate scientifically. Mercury is a substance known to cause cancer and birth defects in human beings and animals. Encapsulated inside a bulb itself it poses no health risks, however, when these bulbs break, the mercury is released into the air and will be attached to the shards of glass which made up the casement of the bulb. Metal halide, fluorescent and high pressure sodium fixtures all contain this hazardous material.

For-profit cultivators of marijuana rely on the quality of their plants for smoking, but hash-oil can also be extracted from the plant which is used in edible products. This oil contains THC and when added to food-grade items like candy and other consumables, the user will experience a similar euphoric effect like the one felt when smoking pot.

The process to draw this oil from the plant is comprised of a heating method and involves a compressed gas like propane or butane for the heat source. The facility owners may have this operation somewhere within the building. The dangers in the extraction method include the potential for explosion of the oil itself and the volatility of the compressed gasses. These hazards can pose extreme dangers to responders while working around such activities and precautions must be taken to minimize exposures.

Fire and EMS crews respond to grow operations for various reasons, not always for fire. This study revealed another hazard that may be present at these occupancies, mold. Growing large quantities of plants indoors creates a high humidity environment. On marijuana leaves, mold can grow during the process that becomes airborne and circulates within the structure. This mold can be inhaled by humans and has been known to have sort and long-term health effects. The cultivators attempt to keep the environments circulated and well ventilated to reduce the

production of these molds but some may exist and are difficult to identify. The structure of the building itself may also retain moisture which creates a suitable atmosphere for fungus and mold to thrive.

Disseminating information from printed sources online and the interviews with fire marshals, other peripheral hazards appeared possible. The use of carbon dioxide generators is becoming a method of plant stimulation. These machines produce Co2 and pump this gas into the air in and around the production to enhance the growth of the marijuana. Although carbon dioxide is found in the atmosphere naturally, within a closed structure it can displace the oxygen content in the air. Breathable air contains 21 percent oxygen which is suitable for life to exist. When the percentage of O2 falls below approximately 17 percent, the human brain ceases to function and damage to the brain will occur.

A best practice approach for responders was studied in this project to help recognize the importance of keeping crews safe while working in and around indoor marijuana grow operations. This methodology has been utilized by many in the corporate arena to outline ways in which their organizations would benefit in several aspects of their businesses.

For the sake of this research, some of these models of efficiency or best practice models were studied and applied to assist in determining a safe way to approach;

1. Methods or components of grow operations
2. Potential hazards common to these facilities

Best practice procedures are a way to format and formulate approaches to issues that have a need to be addressed. The fire service will often times use this tactic to write policy, procedure or standard operating guidelines to determine what the needs of the incident are or what safe and effective methods must be used.

Fire and EMS crews generally will respond to fires or medical calls in much the same way not changing their methods or working habits based solely on occupancy type. The fire crews may enter in an offensive or interior attack mode not realizing the potential problems that may be encountered because of the type of operation. The data gathered helped to acknowledge that these indoor farms contain many obvious as well as hidden obstacles that are hazardous if not deadly to those crews working inside. Best practice for the responders were categorized in areas of communication, training, hazardous material recognition, pre-event planning and post incident analysis.

Since the introduction of legalized marijuana in Washington State and Colorado is very new, not many in-depth studies exist. The fire service is relying on their current operational guidelines for response or reacting to the given circumstances of the incidents. Most of the best practice documentation or literature found was not specific to that of indoor marijuana grow operations but general guidelines for fire ground procedures. Limited resources are available to study that relate to the air quality inside these buildings and how responders can be effected both long and short term. The research did, however, reveal the potential individual hazardous airborne particles and that there is a need to protect the respiratory systems of the crews while in these atmospheres. It also recognized the fuel loading, creative construction methods and the need for security which may lead to inadequate means of ingress and egress.

The original hypothesis of this project was that most commercial occupancies adhere to strict safety rules, regulations and fire codes. Since this business is now legal, it was the original thought of the study that these facilities operated within said boundaries. However, the past experiences of other agencies and inspections of such properties have shown that permitted grow

operations most likely contain many hazards for fire and EMS crews and don't necessarily operate within modern fire and building codes.

Discussion

This research originally began with the thought that because of the newly formulated state regulations for growing marijuana, the ones being awarded the permits in Washington would adhere closely to the guidelines, codes and recommendations set forth. The original hypothesis of what may be risks to fire and EMS crews has been realized as definite risks and a deeper understanding of what is being found in existing facilities in both Washington and Colorado has become apparent.

Although the study began somewhat naive to the reality of the processes, it did realize that the laws are new and only in two states out of 50. Historically when drastic changes in society occur, stumbling blocks emerge as situations present themselves. The growers may be new to the industry never to have been a farmer before or may have constructed a smaller operation at some point. Now being legal in some respects, the new businesses are positioning themselves for profit and stature within the community.

In appendix F, Mr. Mark Rudolph of the Denver Fire Department commented on their conclusions about the marijuana industry. Denver Fire has determined that by embracing the fact that these facilities will continue to exist within their boundaries, good working relationships help tremendously to gain the owner's trust. If the fire departments are too stringent and unwilling to work with the people, they tend to hide different facets of their processes posing unknown or hidden risks. They have begun to create solutions to problems instead of just a violation.

The results of this research revealed what some of the potential hazards are to fire and EMS crews. The study began by identifying the components of the operations in several known formats, water, air and soil looking at both long-and-short-term effects which may be encountered in these facilities including mercury (Ackendorf, 2014, p. 1) Mercury is found in most of the lighting elements used for growing. Fertilizers, lighting and waste water are common elements to all cultivation methods and can pose both long-and-short-term health effects to humans.

The documentation provided online by companies who sell equipment for growing differed somewhat between outlets. Each wrote suggestions and guidelines for cultivation (Grow Weed Easy, n.d., p. 1) and varied depending on what product they were marketing. The conclusions drawn from these types of sources revealed that each was based on their own individual past experiences and not necessarily scientific data and findings. Many "gimmicks" seemed to appear and the sites and writings within the pages came with numerous grammatical and spelling errors diminishing the sites' credibility. Although the components of how to grow marijuana was somewhat common amongst the sellers, there were inconsistencies and limitations to the information provided.

Although websites were evaluated and used as part of this research, the most beneficial information came from the interviews with the fire departments and officials who have been in direct contact with business owners and responded to an emergency at a grow operation. From the interview with Mitch Nolze, Fire Inspector Whatcom County, the study began to gain depth in understanding into the reality of what is happening with Whatcom County. Appendix A revealed that there are ten permitted grow operations within NWFR's response area to date and most are in various stages of construction. The interview determined that many smaller grow

houses are also beginning to arise since the new law in January 2014. Like other interviews gathered, the comments on issues that are surfacing from the larger permitted facilities are common. Overloaded circuitry and the storage of hazardous chemicals remain consistent from state to state and grower to grower.

The Washington State Fire Marshal (Appendix B), provided answers to questions that were very beneficial to the results and findings of this project. The short and simple answers are telling of the newness of the law and the little we truly know about the potential hazards firefighters and EMS crews may come in contact with. Many other departments in Colorado have had some experience with this industry but are still learning as time progresses.

In appendix C, Fire Marshal Henry Hollander has identified that the larger commercial and permitted businesses have three distinct phases to the process: growing, processing and sales. He helped clarify that each part of the process has unique hazards that must be understood. Although these aspects to the sale and distribution of marijuana exits, the study only can help to identify what the components are and suggest what a safe approach may be.

The interpretation of this study is that many new and innovative methods of marijuana production exist. For decades, this plant has been grown in homes, fields and other structures by individuals wanting the product for their own consumption or to sell on the open market. It takes certain elements to sustain and enhance the health and growth of the plant and individuals and companies have developed chemical derivatives, methods of cultivation and lighting sources they claim to work the best. The research into what the potential hazards are came with limitations.

The questions that were to be answered through this project were written to help reduce the risks fire and EMS crews may encounter while working at indoor marijuana grow operations.

The available data to support the study was limited in the fact that growing marijuana has historically been illegal and sources of information in written from were unreliable and somewhat vague. Data gathered from past experiences of fire officials however did support the original thought that there are significant aspects to said facilities that pose substantial hazards to those who respond to grow operations on both fire and non-fire related incidents. The interviews did begin to reveal some commonalties even from one state to another but the differences in the state laws and regulations did become an issue in the findings.

The outcome of this project is significant in that it can be used as a training tool for responding agencies. This research and its findings may be used for implementation of department operating procedures and approach techniques. A quantifiable amount of data was collected from several sources that can assist emergency and non-emergency companies in developing a better understanding of what comprises a typical marijuana grow production, the reason this plant is grown and the illegal components potentially involved. The aftermath or waste products were studied and realized as a long-term environmental impact agent if not properly filtered and disposed of (*Marijuana Threatens Water Quality*, n.d., p. 1).

In Whatcom County, the results of this project will be implemented through the training officers and the operations divisions respectively. These two groups will develop training and operational algorithms designed to assist the crews on how to best approach a facility that may be growing, processing or storing marijuana. A discussion at the fire-chief level will also take place to enlighten and enhance their ability to provide knowledge to the elected officials that make up both the city councils and fire commissioner boards in the county's jurisdiction. Joint training exercises will be spawned from this project in an attempt to enhance multi-agency cooperation and safety procedures across boundary lines. Finally, this documentation will be

shared with the local fire and law enforcement dispatchers, local receiving hospital, hazardous materials response teams and county law enforcement agencies for use as informational data and further research.

Recommendations

This study determined that the best practice procedures for working at marijuana grow operations for fire and EMS crews are as follows:

1. Know where the grow operations are within the jurisdictional boundaries of which are protected by the fire and EMS crews.
2. Conduct pre-fire planning procedures to assist in identifying the type of grow operation including its components, building construction, suppression systems, floor plan, and ways of ingress and egress and fire loads.
3. Give good size-up reports and utilize good communications regarding any known occupants, the condition of the building, fire involvement, needed resources and maintain quality fire ground command and control structures.
4. Give clear and concise direction to subordinates during incidents.
5. Secure the utilities prior to entering the structure during fire type responses understanding that there is a potential for undetermined pirated power, maintain adequate staffing like back-up and rapid intervention teams, and preserve a known method of accountability for the crew members.
6. Always wear full PPE (personal protective equipment) including an SCBA during overhaul procedures and continually monitor air quality and O2 content.

7. Take adequate precautions during routine EMS calls for service considering the use of paper filter masks or respirators to include the use of an SCBA (self-contained breathing apparatus).
8. Take necessary precautions to reduce contamination during and after exposure to patients taken from these facilities.
9. Conduct vigorous training events that include the identification of known addresses of grow operations, study the effects of the hazards contained thereof and drill on how to identify obscurities of buildings not yet recognized.
10. Be involved with the local fire marshal's office when new occupancies apply for permitting and begin construction of the operation.
11. Conduct quality post incident analysis that can identify found hazards, operational issues, near misses and successes realized during the incident.
12. Develop good working relationships with the building owners and operators gaining their trust, understanding their processes, work hours, number of employees and continue a strong line of communication.

The continuation of study into this topic and experiences responding to grow operations will aid in the safety of workers. Fire and EMS crews must be an integral part of these types of entities and build cohesive working relationships with the business owners understanding that it is a very new and unique industry within our communities. Fire and EMS agencies can be proactive in their approach by staying in contact with building officials and fire marshals knowing where and when such occupancies are present. Not posing a threat to the owners during contact but allow them to operate safely and within the codes and laws. Fire and EMS crews must employ a healthy respect of what may be within the walls of the operation and take

extra precaution on approach, entering, fighting fire, overhaul operations and routine EMS incidents within the building.

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Appendix A

Interview with Whatcom County Fire Marshal's Office

Mitch Nolze Fire Inspector

10/09/2014

1. Are you experiencing a greater number of indoor marijuana grow operations in Whatcom County since the passing of Initiative 502 on January 1 2014, the legalization of marijuana in Washington State?

   Answer: *Yes. There are currently 10 permitted indoor marijuana grow operations in Whatcom County in various stages of construction. We have also seen the usual unpermitted or makeshift small operations in garages and homes but it is hard to determine whether this number has increased or decreased since January 1 2014. The largest permitted grow operation thus far in the county is approximately 24,000 square feet. The owners have invested nearly $100,000 in electricity upgrades to sufficiently handle the power consumption and loads that will be required to support all of the electrical equipment.*

2. Is The Fire Marshal's Office involved in the permitting, approval and pre-start up inspection processes of new indoor marijuana grow operations?

   Answer: *Yes, all of the above. We have been fully involved with the approval of the suppression systems, materials of construction and exits and entrances. Since these facilities are commercial and permitted, we do have some control when it comes to these critical infrastructures. Even though the businesses are known by the state and permitted, the builders and owners are still trying to use un authorized materials of construction that don't meet the fire and building codes. Some of the materials we are finding are*

walls constructed of plastic, non-UL Listed foreign lighting fixtures, and strands of wires not in approved enclosures and conduit.

3. What have you seen within these facilities that you would consider hazards for fire and EMS crews?

   Answer: *High-voltage circuits, false walls and doors (for security reasons) fall and trip hazards, stored chemicals, butane and propane cylinders. Also foreign-made fixtures that do not meet the UL approvals and listings.*

4. Have you been made aware of firefighter or EMS crew injuries as a result of them working in a grow operation?

   Answer: *Yes, well not an injury but more of a close call. The first fire recorded in Washington in a permitted grow operation in Maple Falls Washington occurred in August 2014. The firefighters were inside the structure and became disoriented due to complex floor plans and small, poorly-built cubicles within the structure. No injuries were reported.*

5. In your opinion, what should fire and EMS crews be mostly aware of when at these buildings?

   Answer: *False exits and entries which may result in being trapped. Electrical issues like exposure to live wires and high heat from fixtures. Use extreme caution while in overhaul operations. There is an increasing use of carbon dioxide generators within these grow houses used to enhance production of the plants. Due to large amounts of Co2 in the atmosphere, it reduces the oxygen content in the air. These generators are powered by propane or butane which emits carbon monoxide.*

Appendix B

Interview with the Washington State Fire Marshal

Chuck Duffy

10/28/2014

1. Are you experiencing a greater number of indoor marijuana grow operations in Washington State since the passing of Initiative 502 on January 1 2014?

   Answer: The State Fire Marshal's Office no longer has the NFIRS program and I cannot accurately answer this question.

2. Is The Fire Marshal's Office involved in the permitting, approval and pre-start up inspection processes of new indoor marijuana grow operations?

   Answer: No

3. What have you seen within these facilities that you would consider hazards for fire and EMS crews?

   Answer: Not observed

4. Have you been made aware of firefighter or EMS crew injuries as a result of them working in a grow operation?

   Answer: No data on this issue.

5. The ultimate goal is to keep our firefighters and EMS crews safe while working at these facilities.

   Taking a "best practice" approach, what do feel is the number one hazard crews need to be aware of?

   Answer: No comment

Appendix C

Interview with the NWFR/City of Blaine Fire Marshal

Henry Hollander

10/15/2014

1. Are you experiencing a greater number of indoor marijuana grow operations in Whatcom County since the passing of Initiative 502 on January 1 2014, the legalization of marijuana in Washington State?

   Answer: Yes. Since the legalization of marijuana in Washington, Whatcom County has been involved in 12 new permitted grow operations and have found several smaller illegal farms.

2. Is The Fire Marshal's Office involved in the permitting, approval and pre-start up inspection processes of new indoor marijuana grow operations?

   Answer: Yes. Since I am the Fire Marshal for the City of Blaine, I am directly involved in the inspection process and approval of the fire codes for these facilities.

3. What have you seen within these facilities that you would consider hazards for fire and EMS crews?

   Answer: I have seen very creative construction methods to grow their plants like plastic tent structures within the buildings. I have also learned that there are three distinct phases to the larger operations which are; growing, processing and selling, each having their own unique dangers. During the grow phase, they use a significant amount of electricity for heating and lights. The processing stage is when the oils are extracted and propane or butane may be used for this procedure. The selling phase has its own hazards simply because of the large fuel loads it creates.

4. Have you been made aware of firefighter or EMS crew injuries as a result of them working in a grow operation?

   Answer: None yet.

5. In your opinion, what should fire and EMS crews be mostly aware of when at these buildings?

   Answer: I believe that the processing phase of these operations will be our biggest hazard because of the potential of hash-oil explosions and the compressed gasses being used.

Appendix D

Interview with the Aurora Fire Department

Siegfried Klein Captain Fire and Explosive Investigator

10/29/2014

1. Are you experiencing a greater number of indoor marijuana grow operations in your jurisdiction since the legalization of marijuana in Colorado?

   Answer: Yes

2. Is The Fire Marshal's Office involved in the permitting, approval and pre-start up inspection processes of new indoor marijuana grow operations?

   Answer: Not yet. Colorado is a "home rule" state meaning that each jurisdiction has the authority to enforce codes and write ordinances.

3. What have you seen within these facilities that you would consider hazards for fire and EMS crews?

   Answer: There are many. We have seen quite a few hash-oil explosions and pirated 220v lines into the operations. These power sources bypass the meter making it very dangerous to responders. Although the power company will turn off the main source of energy to the structures, the pirated power is often times very difficult to find. Also, we have observed that inside a grow operation the CO2 levels are somewhat elevated, making the environment unsafe to breathe.

4. Have you been made aware of firefighter or EMS crew injuries as a result of them working in a grow operation?

   Answer: Not yet. We train around origin and cause assisting our crews to identify hazards. On the same lines of this question, other interesting outcomes may arise. If a

grow operation is indeed on fire, the crews working in the smoke may be exposed to the chemical that is inside the marijuana, THC. This chemical will permeate through the bunker gear of a firefighter and absorbed into their skin. We have considered the possibility of our drivers becoming intoxicated from the substance putting them and their crew at risk. The state recognizes a maximum of 5 nanograms in the bloodstream as an offense. This also becomes an employment issue.

5. In your opinion, what should fire and EMS crews be mostly aware of when at these buildings?

   Answer: I believe that pirated electricity into the building is one of our greatest risks. I have also seen a large amount of chemicals that we may be exposed to like potassium chloride, sulfur and ammonium nitrate.

Appendix E

Interview with the City of Littleton Fire Department

Jay Ruoff Division Chief of Operations

10/28/2014

1. Are you experiencing a greater number of indoor marijuana grow operations in your jurisdiction since the legalization of marijuana in Colorado?

   Answer: No. Mostly illegal operations still in existence.

2. Is The Fire Marshal's Office involved in the permitting, approval and pre-start up inspection processes of new indoor marijuana grow operations?

   Answer: No. Not required by the City of Littleton.

3. What have you seen within these facilities that you would consider hazards for fire and EMS crews?

   Answer: High levels of CO2 within the buildings and poor or unfamiliar building construction.

4. Have you been made aware of firefighter or EMS crew injuries as a result of them working in a grow operation?

   Answer: Not yet but near misses in illegal grow ops because of the fuel loads and makeshift walls made of OSB.

5. In your opinion, what should fire and EMS crews be mostly aware of when at these buildings?

   Answer: Unfamiliar construction methods.

Appendix F

Interview with the City of Denver Fire Department

Mark Rudolph Technician

10/24/2014

1. Have you seen a greater number of indoor grow operations since the legalization of marijuana in Colorado?

   Answer: Yes. There has been a significant increase of grow operations within our jurisdiction. It is hard to determine the actual amount since many of them are illegal and hidden from sight.

2. Is The Denver Fire Department involved in the permitting, plan review and inspecting processes of these facilities?

   Answer: Yes. Denver Fire has developed a team of specialist and is made up of five Fire Protection Engineers. The philosophy of the department is to work with the growers and develop good relationships, building their trust and embracing the fact that marijuana is legal and a quirky business.

3. What have you identified as hazards for fire and EMS crews at these facilities?

   Answer: Since the value of these crops is so high, many unique security measures have been taken by the owners in an attempt to protect their property like unmarked exits, false doors and barricaded windows which may delay ingress and egress. Also, another potential hazard is the unusual layout of the inside structures. Growers will build OSB (oriented strand board) walls and partitions covered with plastic to provide smaller individual grow rooms which could be confusing and easy for fire crews to become disoriented during firefighting activities. We have found that many illegal growers have

"pirated" 220v sources to their facilities. This is energy that bypasses the meter to the building. Our crews may be exposed to high voltage within the structure even after the main power source and meter have been disabled by the power company. In one instance, the owner of the grow operation removed the fuses and replaced them with copper pipe. This overheated the circuitry.

4. Has The Denver Fire Department experienced any firefighter injuries at these facilities since marijuana's legalization?

   Answer: No, none yet.

5. What is the single greatest hazard to fire and EMS crews at these facilities?

   Answer: There are many hazards, most very similar to other types we may encounter in other buildings, just intensified. Our goal as a fire agency is to work closely with these businesses providing solutions to problems so that the owners don't feel the need to hide their processes. By doing this, it gives us a peace of mind that after we inspect a business such as this, the operators won't feel the need to change things when we are not looking. We have developed a twice per year inspection process to help with code enforcement and safety.