Position Paper:

Intermodal Shipping Container Fire Safety

The 2011 Line of Duty Death of Enderby Volunteer Fire Captain Daniel Botkin was a wake-up call for the fire service on the fire hazards of shipping containers used as temporary or permanent buildings. In this incident, it has been determined that an exposure fire to the shipping container and the presence of small volumes of flammable liquids resulted in an internal low speed explosion that ejected the container doors. One of these doors subsequently struck the Fire Captain Botkin.

In Saanich in April 2013 a leaking barbecue tank stored in a shipping container exploded and destroyed the shipping container. In this incident, the parts of the container landed 274m [300 yards] away and the walls were flattened. Luckily, no one was seriously injured in this incident.

In order to prevent injuries to the public and the fire service we must:

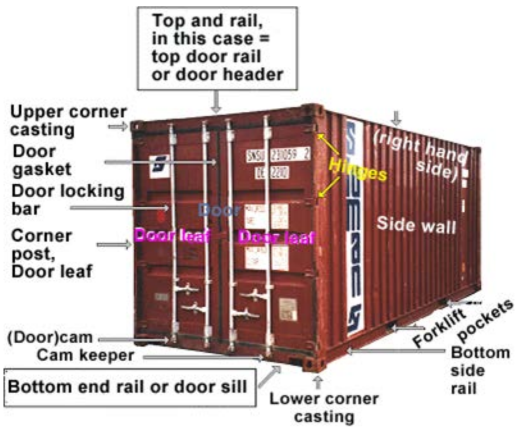
- communicate the fire safety hazards of shipping containers,
- regulate the use of shipping containers as temporary buildings and structures,
- regulate the materials stored in shipping containers,
- provide guidelines on how shipping containers can be modified to be safer and,
- provide procedures can be used by the fire service to deal with the shipping container building fire incidents.

This position paper provides the information and recommendations on how to improve the fire safety of shipping containers.

BACKGROUND

There are over 16 million shipping containers being used to transport goods and materials on ships, trains and trucks. Millions of these containers become surplus every year and are repurposed as buildings or structures.

These surplus containers are made of steel construction and range in size from 1.5m to 16m [5 to 53 feet long]. The containers are 2.4m [8 feet wide], 2.6m [8.5 feet high] with steel doors at one end. Some of the shipping containers have small vents on the ends at the top for air pressure



equalization due to changes in the ambient air temperature (±20 to 30ºC). These vents are a series of three rows of three 3.2mm to 6.4mm [1/8" to 1/4"] holes thru the steel wall and covered by a metal or plastic outer cover. Containers have 2, 4 or 6 sets of the equalization vents depending on the size of the container.

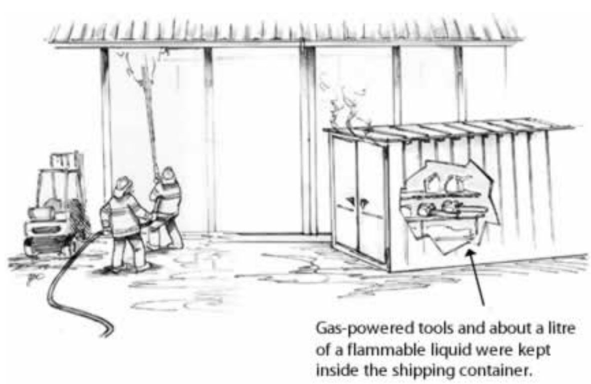
Typical containers are designed to be stacked 6 to 9 containers high and to hold weights of 32205kg [71,000 pounds]. The side walls are designed to withstand shifting loads up to 60% of the permitted load and the end wall and doors are designed to withstand 40% of the permitted load. As a result these containers are able to allow the internal pressures to build to the point that they fail catastrophically.

The features of the shipping containers that make them secure from theft and structural sound, also make them a fire safety hazard until they are regulated, weakened and approached with caution during a fire incident.

ENDERBY LODD INCIDENT SUMMARY

At 3:51on December 29, 2011, a fire at a log construction facility in Enderby BC was reported to 911.

At 04:01 the first fire truck arrived on site, and 15 firefighters (including Deputy Fire Chief & 4 Fire Captains) along with two pumpers and a rescue truck. The fire had apparently started in a modular trailer and spread to the large production building where log structures were assembled. The fire in the production building exposed a (2.4m [8 foot] wide, 2.6m [8.5 foot] high and 12m [40 foot] long) shipping container under a roofed addition to the production building and approx. 2 metres [6.6 feet]from the building. At several times during the fire there was smoke showing from the equalization vents and from overheating door gaskets and water was directed onto the container or its area.



A shipping container that held small amounts of flammable liquids was exposed to extreme heat when the building next to it caught fire. The evidence indicates that the flammable liquids vaporized and exploded, blowing off the container's doors.

At about 5:05 a Fire Captain climbed onto the top of the container to attack the fire in the production building. While the Captain was on the top of the container it was not hot. The Incident Commander was concerned about the possible failure of the production building structure and pulled the firefighters away from the structure including the shipping container. The operation went into the mop-up stage.

At 05:15 the shipping container exploded and;

- one side of the shipping container along the roof line tore along the length
- the roof along the production building was bent upward
- the sides and end were bent outward
- both of the 113 kg [250 pound] metal doors were blown off

One of the doors struck Fire Captain Botkin and landed 41 metres [135ft.] southwest of the container and the second door was found 54 metres [177ft.] northwest of the container. Fire Captain Botkin died at the site.

The various investigation reports indicate that the explosion was caused by 1/2 litre to 1.5 litres of gasoline/oil from two chainsaws and 1/2 litre of methyl hydrate. Witnesses advised that the fire impinged unto the shipping container for 45 to 55 minutes before the explosion. One of the Fire Captains was on top of the roof of the shipping container 10 minutes before the explosion, directing a hose line at the production building fire. At that time the Fire Captain did not find the top of the container steel to be warm.

ANALYSIS

The WorksafeBC and the Office of the Fire Commissioner reports identified the specific fuels that could have been involved in the Enderby incident, but they had difficulty identifying the ignition scenario. An NFPA advisor helped form the conclusion that a "low volume detonation" occurred.

Research

Some information is available on the ISO construction standards for shipping containers when used for their original purpose of transporting goods and materials. These standards have been changing to consider the containers operating conditions. The older container had fewer air compensating vents compared to the newer containers, also the range of sizes of shipping containers have increased. The only document that could be found on the fire testing of shipping containers is a 1977 US Coast Guard report on the "Fire Performance of Intermodal Shipping Containers". In this testing they looked at the consequences on fires in the containers and exposure fires impacting the shipping containers. The internal testing involved wood crib fire inside the container that vitrified or consumed the internal oxygen before all of the wood could be consumed. The air compensating vents did not have any impact on the results of the testing. The second exposure tests involved 65m^2 JP5 spill fires exposing single and stacked containers. These tests indicated that the internal temperatures reached 230^{o}C in 4 to 9 minutes. The conclusion was that there was a potential for "ignition or charring" of Class A materials within 5 minutes.

Fuels

The general conclusion was that 500 millilitres of Methyl Hydrate (methanol) or approx one litre of gasoline or the combination of the two were the fuels involved. The following tables give some information on the characteristics of the methanol & gasoline, and propane and hydrogen for comparison:

Table 1 Characteristics of common fuels

Properties	Hydrogen	Propane	Methanol	Gasoline
Flammability limits				
LEL (%)	4.1	2.2	6	1.4
UEL (%)	74	9.5	36.5	7.6
Stoichiometric air/fuel ratio (weight)	34.3	15.7	6.45	14.7
Min. Ignition Energy	0.017	0.03	0.14	0.2
Auto-Ignition Temperature (°C)	400	450	385 to 464	232 to 280
Vapour Density	0.067	1.5	1.1	3 to 4
Burning Velocity (cm/s)	312		56	40
Gross combustion energy			17.9 MJ/litre	34.8 MJ/litre

Some of the key information from this table is that when heated the methanol vapours could rise and the gasoline vapours will still stay low, the autoignition temperature (AIT) of the methanol is significantly higher than the gasoline, the flammability ranges are close and the combustion energy of the gasoline is significantly greater than the methanol.

The temperature at the ceiling of the shipping container will also be higher than at the floor, this will result in lower minimum ignition energy. For example the minimum ignition energy (MIE) for ethanol at 25°C is 0.40 mJ, but at 100°C the MIE is 0.21mJ. Also, if there is an increase in pressure within the container the AIT will decrease.

Ignition Sources

The most difficult element to determine is the ignition source. While there was information that the production building side of the shipping container was exposed to direct flame impingement that could have heated the steel to above the ignition temperature of the fuels, one of the fire captains were on top of the shipping container 10 minutes before the rupture indicated that the roof was not hot. The reports key temperature indicator is there were two chainsaws hung on the production building side wall of the shipping container and that the plastic gas tanks had melted. The chainsaw manufacturer advised WorksafeBC that the melting temperature of the chainsaw plastic was approx. 200ᵒC. This would indicate the spilling or boiling off gasoline was exposed to at least 200ᵒC and the AIT of gasoline is 232ᵒC. The US Coast Guard exposure tests indicated that the container ceiling and 2m temperature were approx. 360ᵒC within 6 minutes of the start of the test fire. The witnesses indicated that there had been flame impingement on the side of the container for 45 to 55 minutes. Using the fire testing as a baseline, it could be concluded that the temperature in the area where the chainsaws were located (and losing gasoline) could have been at least 200ᵒC or considerably higher. It could then be theorized that this area of the interior of the container was heated by radiation, conduction and convection to above the autoignition temperature of the gasoline and possibly the methanol.

Container Characteristics

The US Coast Guard fire tests provide some background on the characteristics of shipping container fires; they do not give any critical information on the strength and venting of the performance. Based on published wall loading information, a conservative estimate of the wall strength was done and these calculations determined that the yield strength of the walls would be 7.0 kPa (1.0 psi) and the bursting strength of 8.4 kPa (1.22psi). This is lower than the rough estimate but it is useful to determine the area of the explosion relief panels.

The air compensating vents are designed to deal with climatic temperature changes without causing damage to the container. If the vents were not installed then small changes in temperature could dramatically increase the internal container pressure. Using the Ideal Gas law and assuming that the container was not vented, the following increases in pressures could occur:

Temperature above Ambient	Resulting pressure increase
20ᵒC	7.1 kPa (1.03 psi)
40ᵒC	15.2 kPa (2.2 psi)
60ᵒC	22.3 kPa (3.2 psi)
100ᵒC	37.5 kPa (5.4 psi)

These vents will not bleed off sufficient pressure fast enough during a fire because the vents only amount to 0.0079% of the wall and roof area of a typical shipping container.

Venting Scenarios

In order to prevent a shipping container rupture similar to the Enderby incident, with similar fuels, calculations were done in accordance with NFPA 68-2012. The following table indicates the required area of the explosion venting for the various fuels for standard 12m long containers:

Fuel	Fuel volume causing the Explosion	Maximum unvented pressure (Pmax)	Area of Explosion vent	Percentage of the explosion vent area versus the area of the walls, doors and the roof
Methanol	0.5 litre (0.4 kg)	750 kPa (109 psi)	26 m^2	36.4 %
Gasoline	1.0 litre (0.72 kg)	780 kPa (113 psi)	25.9 m^2	36.3 %
Propane (for comparison purposes)	(1.0 kg)	790 kPa (115 psi)	32.5 m^2	46 %

These vent areas are only for comparison because the key calculation factor of container strength is only a rough calculation.

The key conclusion is that even very small unregulated volumes of flammable liquids or combustible gases in shipping containers can possibly create a low energy explosion and the rupture of a shipping container.

HAZARD AWARENESS & REGULATIONS

Shipping containers are recognized as a safety concern when they are used to ship various goods and materials including Dangerous Goods on the roads, rail and ships. When they are used as buildings or structures we do not associate them as being a fire safety hazard. The Enderby incident and the Saanich incident are two examples of the fire safety hazard they can create. Examples can be found where shipping containers are being used for:

- the storage of fireworks,
- the storage of flammable gases and liquids at construction sites,
- as first aid buildings at construction sites (with supplies of antiseptic alcohol or oxygen bottles),
- uses as construction offices,
- uses by hobbyist for the recharge of hunting ammunition,
- uses as electrical rooms or electrical vaults at construction sites (with the accompanying arc blast risk),
- The applications are only limited by the user's imagination.

The key reasons that shipping containers are used as temporary or permanent structures is that they are cheap to purchase, do not need assembly, are weather resistant, structurally strong, are a sealed container and they are secure from theft. Also, these containers are not looked upon as buildings or structures therefore skirt the building and fire approval requirements. A number of jurisdictions have put in place planning or building bylaws and provincial bulletins to regulate the use of these containers. The following are some of the jurisdictions that have regulations in place:

Canada

- Township of Laurentian Valley, ON
  - Shipping containers used to store flammable and/or hazardous materials shall be properly ventilated and placarded to identify the materials stored in the structure,
  - Install fire extinguishers in accordance Ontario Fire Code,
  - Provide a maintained road capable of withstanding the weight of firefighting equipment to within 45m of the container.
- Vermillion, Alta
  - Bylaw #6-2010 Land Use Bylaw,
  - Based on other Alta LUBs,
  - Defined as a structure = accessory building,
  - No dangerous or hazardous materials or containers,
  - No connected services,
  - Permit requires compliance with Alberta Building & Fire Codes,
  - Restricted to specific zoning.
- City of Burnaby
  - Shipping containers are defined as permanent buildings,
  - They must comply with BCBC and the design and field review must be done by an architect or professional engineer.

USA

- Riverside CA
  - Accessory building,
  - Building permit required,
  - 1 container per acre to max of 2,
  - No windows, plumbing, electrical and mechanical improvements allowed.
- Bellflower, CA - Planning Department requires:
  - Storage of materials approved by LABD & LAFD,
  - Only one for 15,000 sq. ft.,
  - Compliance with ordinance 853.

- County of Los Angeles, CA
  - A miscellaneous permit must be obtained with approvals from the fire dept. etc.,
    - No flammable or combustible liquids or hazardous materials can be stored.
- Sonoma County, CA
  - Different requirements for temporary and permanent used for storage,
  - Permit required,
  - For permanent non-storage sprinkler protection required.
- City of Santa Rosa, CA
  - Temporary storage use requires a temporary use permit,
  - Permanent storage use requires a building permit, fire sprinklers and a hazardous materials management plan for hazmat use.
- New York State
  - Defined as storage buildings and must meet new York State Uniform fire prevention and Building code,
  - Building permit not required but a fire safety inspection and a certificate of occupancy required,
  - Install exit doors and install a ventilation louver on one side.
- Airway Heights, WA
  - Prohibition of shipping container as accessory buildings, storage buildings except where done under permit.

International

- Te Tari Kaupapa Whare, NZ
  - Determination analysis that shipping containers are buildings
- Dept. of building and housing, NZ
  - Shipping containers are defined as buildings.
- Cooma-Monaro Shire, New South Wales, AU
  - shipping containers considered as buildings
  - exemptions for construction sites and farms.

In order to regulate the fire safety of shipping containers the following steps should be put into place as follows:

1. Have the National Building code recognize that the temporary and permanent use of shipping containers are regulated buildings or structures when not used for the transport of goods and materials.
2. Have the National Fire code recognize the fire safety hazards of small volumes of dangerous goods stored in shipping containers by modifying Section 3.3 Outdoor Storage 3.3.1.1. Application 3.3.1.1. 2) c) "Intermodal shipping containers, except when containing dangerous goods" to clarify the shipping container fire and explosions hazards.
3. Have the BC Standards Branch issue a bulletin or advisory to:
    a. Define shipping containers as buildings under the BC Building Code (similar to the March 2010 Shipping Container Advisory from the Government of Saskatchewan) and,
    b. Change the BC Fire Code to recognize the fire and explosion hazards caused by the storage of very small volumes of dangerous goods in shipping containers and the possible mitigation.
4. Have Local Governments adopt bylaws to regulate the use of shipping containers as buildings within their jurisdiction. In Appendix A is a sample of a shipping container fire safety bylaw.

MITIGATION/PREVENTION

The key components of the mitigation strategies for shipping container fire safety are to:

1. **Regulate**

   As noted above it is key to regulate what shipping containers are used for, what contents can be safely stored in the shipping containers, and are there any possible fire exposures that the shipping containers are exposed to or that they may create to critical structures or site access points.

2. **Weaken**

   Weaken the shipping containers to prevent high pressures from building up in the containers that exceed the rupture strength of the containers. The current standard shipping containers are very strongly constructed to withstand cargo loading and forces from being stacked, twisted and dropped on ships, trucks and trains. These containers are also built strong to prevent theft on the contents. The containers can be weakened by installing explosion relief panels that may have to exceed 25% of the wall surface, replacing the end doors with light weight walls, installing conventional doors and windows in the sides. The degree to which the container has to be weakened is dependent on the use of the container. If dangerous goods are to be stored in the containers then specially designed relief panels will have to be determined by a professional Engineer. Small top and bottom vents can be used to provide some low level weakening of the containers and provide ventilation of the container.

3. **Venting**

   The lack of indications of what is happening in the shipping container was one of the key issues with the Enderby incident. The fire fighters were not fully aware that the interior of the shipping container was increasing. The provision of the top and bottom level openings at opposite ends of the container may have shown smoke pushing from the container and that there were hazardous conditions building in the container. This information may have allowed them to change their tactics.

4. **Incident safety**

   Fire departments should consider having standard operating procedures in place that cover the incident size-up, hot & exclusion zones and fire attack planning. Appendix B provides the framework for a typical Shipping Container Standard Operating Procedure.

CONCLUSIONS

In order to prevent injuries to the public and the fire service, we must work at:

- communicating the fire safety hazards of shipping container,
- put in place national, provincial and local government regulations of the use of shipping containers as temporary buildings and structures,
- regulating the materials stored in shipping containers,
- providing information on how shipping containers can be modified to be safer and
- provide operating procedures that can be used by the fire service to deal with the shipping container fires safely.

Our conference motion of container fire safety, our position paper, shipping container bylaw template and standard operating procedure template are the first steps in improving shipping container related fire safety for the public and the fire service.

REFERENCES

1. Fire Investigation Report Incident 2011-12-29-01 Office of the Fire Commissioner
2. Incident Investigation Report NI 2011116120216 WorkSafeBC
3. WorkSafeBC Hazard Alert Firefighter killed n explosion involving flammable liquids
4. Fire Performance of Intermodal Shipping Containers US Coast Guard Report CG-D-62-77
5. Using Physical and Chemical Properties to Manage Flammable Liquid Hazards by Roberts & Roberts
6. Information Bulletin July 2012 Emergency Management BC/Office of the Fire Commissioner
7. Sources of Ignition - Flammability Characteristics of Chemicals and Products (James Bond)
8. NFPA 68 Standard on Explosion Protection by Deflagration Venting
9. BC Hydro - Shipping Container Explosion Venting Calculations by J. McBryde

Shipping Containers

Minimum Standards for the use
Shipping containers as storage buildings

Issue.

Shipping containers are designed for overseas storage and shipping of material, equipment and hazardous material. These containers are normally poorly vented and are therefore able to build internal pressure. The containers easily behave like a closed vessel.

In January 2013 a BC fire fighter was killed as a result of the catastrophic failure of shipping container exposed to an external fire. This container contained some minor amounts of flammable liquids (less than 2 litres was involved) and, as designed, had very little venting since the doors were closed and latched. The adjacent fire heated the container and contents which resulted in a buildup of flammable vapours and pressure inside the container. Ultimately, the shipping container ruptured tearing one of the top seams of the container and blowing out the latched and locked doors. One of the doors struck a fire fighter standing about 10 m away and the fire fighter sustained fatal injuries.

In <input name of local government> shipping containers located within/on properties subject to fire inspections will be inspected for compliance. Shipping Containers used for storage of any flammable or combustible liquids, or combustible materials and other long term uses, will be considered as permanent buildings and therefore must meet the requirements of the BC Building and Fire Codes as well as <input name of local government> Bylaws.

<ins>Code Compliance.</ins> The container must meet, or exceed as indicated, all relevant requirements of BC Safety Codes such as, but not limited to:

- Division B – Part 3 & Division B – Part 4 of the BC Fire Code will apply in all cases
- There will be no electrical service to the container unless it <ins>exceeds</ins> all requirements of the BC Building, Fire and Electrical Codes for explosive/moist/wet environments. It must be fully explosion proof and tested regularly to ensure compliance.
- The Dangerous Goods storage shall be restricted to materials that are declared at the permit stages. Any changes to the types of dangerous goods must be approved by the <input local fire services name>.
- No smoking shall be allowed in shipping containers.
- Where flammable liquids and combustible liquids are stored in the container combustible construction shall be removed, provisions for spill containment installed

and the container shall be grounded. The dispensing of flammable liquids and the storage of open containers shall be prohibited in the shipping container.

- Compressed gases shall not be stored in the shipping containers. Limited amounts of aerosols shall be stored in the shipping containers and only when stored in metal cabinets.
- Shipping containers shall not be installed under power lines.

Location. The container must be positioned such that:

- There is a minimum separation of 1.5-3m between any non-combustible structure and the container to allow for firefighting access to the exposed structures.
- The shipping container must be located at least 6m from exits, windows or unprotected openings in the exposed building
- Greater separation distances will be required based upon exposure to any combustible materials or structure
- The container doors are positioned such that they face away from any other structure
- The container doors must be positioned such that they face away from any means of road access to the container for fire personnel
- No combustible materials may be placed near the container

Identification. The container must be identified such that:

- UN Placards for all stored Dangerous goods must be visible on the two container sides most visible to emergency responders
- The name of the company/person responsible for the storage and an emergency telephone contact number must be marked on the container in lettering visible from 10m
- The container and contents must be identified in the Fire Safety Plan

Safety Features to be added. The container must have the following safety features in place prior to any use for storage:

- One ventilation opening must be added within 150 mm of the floor in the container door primarily used for opening
- One ventilation opening must be added within 150 mm from the top of the container on the opposite end from the doors for cross ventilation
- The high ventilation opening cannot be directly venting toward a structure
- Neither ventilation opening can be obstructed by stored materials at any time and must be kept clean of internal and external debris
- The additional ventilation openings must be constructed based upon the following minimums:

- Two – 0.3 m X 0.3 m openings for containers 6m or less
- Two – 0.5 m X 0.5 m openings for containers over 6m
- Both openings will be covered by open grate wire mesh with greater than 50% free area
- Higher opening will also have a wind vent device, designed to generate a venturi effect during low wind speeds

- Where heavier than air flammable and combustible liquids are stored in the container a ventilation opening at low level should also be installed at the opposite end from the doors.
- Where 1A flammable liquids in quantities greater than 4 litres are stored in the shipping container then provisions shall be made to comply with the requirements for withstanding an internal explosion as per the BC Fire Code, BC Building Code and NFPA 68.
- Alternate engineered solutions for ventilation and explosion protection will be considered.

NOTE: ***Standard existing environmental vents normally built into shipping containers ARE NOT ACCEPTABLE as ventilation openings for land-based storage applications. These were designed for air movement based upon atmospheric weather changes only and do not provide adequate air flow***

Reference documents:

BC Hydro Fire Marshal's Fire Safety Bulletin on Shipping Container Fire Safety- 2013

WorksafeBC Incident Investigation Report #2011 – 1476

Office of the Fire Commissioner of BC – Firefighter Fatality Scene Photographs: Enderby, BC Dec. 2011

Pitt Meadows Fire & Rescue Service Draft Shipping Container Fire Safety Standard.

THE HAZARD

The photo below shows the failure of the shipping container due to explosion in Enderby, BC – December 2011. This explosion fatally injured a firefighter standing 10m away as he was hit by a flying

The photo below shows the folding of one the doors as it blew out of the latches and flew over 10m

PART OF **THE**

SOLUTION

Required lower ventilation opening in container door

Suggested upper ventilation opening and wind vent

Photographs courtesy of BC Hydro Fire Marshal's Office

APPENDIX B

Shipping Containers Fires

Purpose: To provide tactical safety procedures for fire department response to a fire involving intermodal shipping containers.

Scope: Fire Department Personnel & other Emergency Personnel

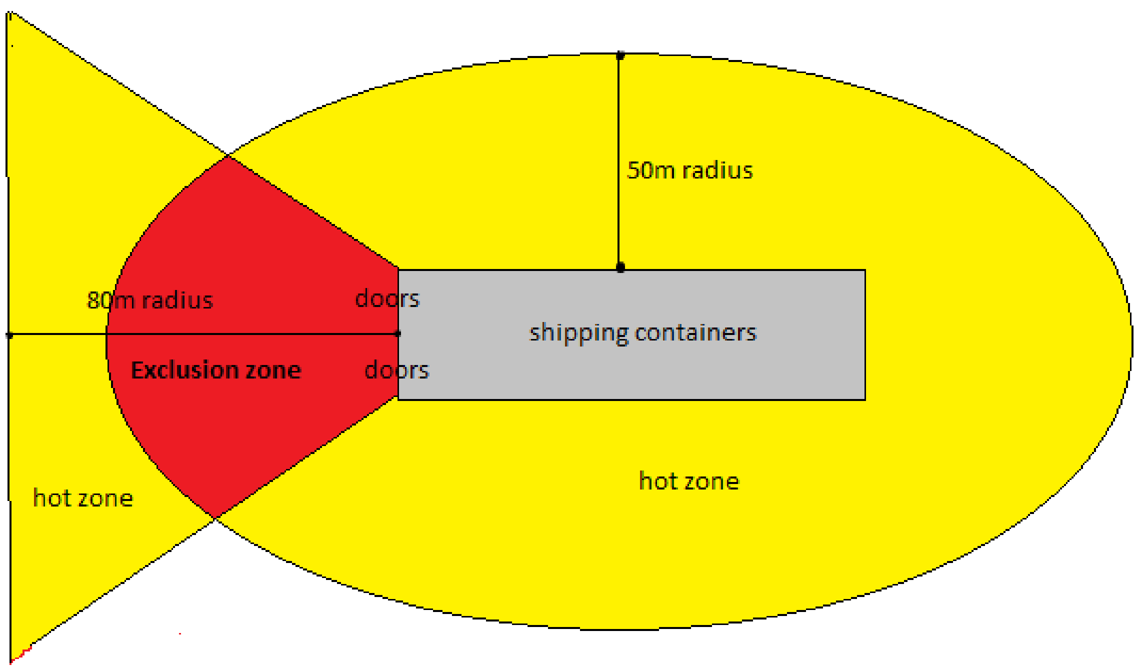
General Information:

The current uses of shipping containers as buildings and structures has become wide spread, but these uses and applications have not always been regulated from the fire safety perspective. These containers can create significant fire hazards to fire responders when there are fires adjacent to them or inside them. The 2011 Enderby fire fighter LODD is an example of the fire exposure fire & explosion hazard created by the containers, and Saanich propane storage related container explosion is another indication of the pressure build-up explosion that can occur. These shipping containers are commonly being used as permanent, long term and temporary buildings and structures at farm sites, construction sites, industrial sites, commercial sites and residential sites. Their uses are only limited by the imagination of the end users. Some of the examples of uses that are common are offices, first aid buildings, electrical rooms, storage buildings for all sorts of the hazardous & non-hazardous materials, shops for the various uses including an example where they were used to store and reload ammunition. Some local governments have tried to control the use of application of the these containers but there is little control over their sales and installation, therefore fire department responders must recognize the possible hazards that they can creates and take appropriate tactical safety precautions during a response to a location where they are located.

Shipping containers are designed to be very durable and very secure. They are designed to be stacked one on top of each other on container ships or to withstand being dropped, hit or subject to the pitching, rolling or vibration of a ship. One of the major advantages of shipping containers is that they are very secure which also becomes an issue when they are involved in a fire. The structural strength, secure nature of the doors and lack of venting make the containers a quasi-pressure vessel, therefore they can build up high pressure before they explode. As a result when they explode or rupture the containers can blow out the doors and tear apart. The Enderby LODD has been theorized to be caused by as little as 1/2 to 1 1/2 litres of gasoline and approx. 1/2 a litre of Methyl hydrate. This small volume of hazardous material caused the container doors to be torn off the hinges and container to be torn along one of the top steel seams. Shipping containers exposed to external fires or internal fires can result in a rupture or explosion caused by non-regulated volume of flammable liquids can create safety issues to first responders.

Procedures:

1. Upon arriving at a site with one or more shipping containers, the first incoming company should try to determine whether the incident has been initiated by a fire in the shipping container or whether a fire will expose the shipping container.
2. If the shipping container is exposed or involved in the incident the company officer should maintain a 50m foot radius hot zone around the container and for a radius of 80m radius quadrant in front of the doors with limits of 45⁰ from the corners of the containers.
3. If the container has been blown the roof off, the doors out or has ruptured then hot zone can be reduced at the discretion of the senior officer.
4. A priority should be put on suppressing any fires that are adjacent or against the shipping container while trying to keep out of the hot zone.
5. If the container must be approached in the hot zone consider approaching the container at 45⁰ to the corners of the end opposite the doors.
6. To lessen the risk unmanned oscillating ground monitor should be used.



7. Careful observations should be made of the involved container to determine the interior conditions of the container.
8. There may be UN placards or information in the prefire plan.
9. Information on the container contents maybe available from the property owner of representative. Binoculars should be used to see if there is any of the following indications of internal heating within the container:
   - smoke from the heating gaskets
   - smoke from the small atmospheric vents at the corners of the container
   - smoke from any larger vents that have been added to the container
   - indications of heat on the top or sides of the container such as scorching or burn marks in the paint

- Any warping or bulging of the container.
- These observations may indicate that there is a buildup of hot gases, flammable vapours that may lead to an explosive rupture.

10. Spray of water can be discharged onto the metal exterior to determine if there are any hot spots and their location.

The senior officer should then determine a fire attack plan based on any exposure fires, heating within the container and the criticality of the container risk within the fire ground. An aggressive attack may involve the insertion of a piercing lance thru the container wall or thru any large size vents that have been added. A less aggressive attack would be cool the roof and sides of the container down with manned or unmanned hose line, until the container steel is no longer boiling off the water, then access to the interior of the container

References:

- WorksafeBC Hazard Alert "Firefighter killed in explosion involving flammable liquids" 2012-04
- Emergency ManagementBC Information Bulletin July 2012
- Office of the Fire Commissioner Fire Investigation Report 2011-12-29-01
- BC Hydro "Shipping Container Fire Safety Bulletin"
- Developing Effective Standard Operating Procedures FEMA FA-197

About the author: Don Delcourt Eng.L. is Fire Marshal for BC Hydro, and is the Industrial Sector Director for the FCABC where he leads FCABC industrial members in championing fire safety issues. Don can be reached at don.delcourt@bchydro.com.