

**Worker Injured During
Fireworks Explosion
Date of Incident: 99 06 30
Type of Incident: Fatal**

SUMMARY

On 99 06 30 somewhere between 13:30 and 15:30 a worker engaged in destroying firework explosive waste materials, by a method called waste burning, was fatally injured when the material ignited and exploded.

The worker was employed by and performing a work activity routine for a firework factory located in West Central Alberta. The worker was working alone and in the process of burning an abnormal (excessive) amount of explosive waste material, outside of the fireworks factory compound. The explosive waste materials, accumulated over several weeks, were contained in a number of 5 gallon (19L) pails and transported to the incident location by pick-up truck. The worker had already burned off two pails of the explosive waste when he proceeded to pour out the contents of the third pail, into a pile, on the ground. An ignition source was introduced (most likely from a previous burn) and ignited the explosive waste material on the ground and in the pail. The material proceeded to burn very rapidly. The explosive waste material had enough energy and pressure to instantaneously cause the pail and contents to explode. The explosion inflicted fatal injuries on the worker.

The incident was investigated on 99 06 30 by an Alberta Human Resources & Employment, Occupational Health and Safety Officer. National Resources Canada - Explosive Regulatory Division and Alberta Infrastructure - Dangerous Goods Control Branch were also called and conducted concurrent investigations into the incident.

After analyzing the findings of the investigation, the Occupational Health and Safety Officer concluded that the cause of the incident was an uncontrolled explosion of explosive waste material brought on by an ignition source. This uncontrolled explosion was a direct result of a system failure that includes:

- Inadequate training,
- No supervision,
- Inadequate site specific work procedures.

The employer's activities following the incident included:

- Had a competent worker acquire a valid permit to handle, prepare or fire any explosive material in the Province of Alberta,
- Developed Safe Work Procedures for burning explosive waste material,
- Plans set in motion to relocate the fireworks factory compound to South Central Alberta,
- Plans for an external health & safety audit on the "new" factory compound.

Human Resources & Employment will conduct consultations with federal, municipal and industry stakeholders on permitting, education and inspections. The employer will be submitting a copy of the external health and safety audit to Human Resources & Employment for review.

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Section 1.0 FILE NUMBER

1.1 373899

Section 2.0 DATE AND TIME OF INCIDENT

2.1 99 06 30, Somewhere between 13:30 & 15:30

Section 3.0 DATE AND TIME OF INVESTIGATION

3.1 99 06 30, 22:00

Section 4.0 NAME OF INVESTIGATOR(S) (INTERNAL)

4.1 LYNES, Monty
Occupational Health and Safety Officer

Section 5.0 INCIDENT REPORTED BY

5.1 Royal Canadian Mounted Police (RCMP)
Drayton Valley Detachment

Section 6.0 DATE AND TIME INCIDENT WAS REPORTED

6.1 99 06 30, 18:40

Section 7.0 NAME & ADDRESS OF PRINCIPAL STAKEHOLDER(S)

7.1 **Owner(s)**

7.1.1 U.F.X. Enterprises Inc.
1210, 606 - 4th Street S.W.
Calgary, AB T2P 1T1

7.2 **Prime Contractor**

7.2.1 N/A

7.3 **Employer**

7.3.1 Mystical Fireworks Inc.
Box 7196
Drayton Valley, AB T7A 1S4

7.3.2 Factory Compound is located at LSD NW ¼ 34-49-8-W5M
(8 Km West on Secondary Highway 622 from Highway 22)

Section 8.0 DESCRIPTION OF PRINCIPAL OWNER(S) OR EMPLOYER(S)

8.1 The employer employed 15 workers to handle, prepare and fire explosive material for the purpose of manufacturing Class 7 - Division 2 - Subdivision 1 & 2 explosive products (aka: pyrotechnics industry). Pyrotechnics is the art of manufacturing or setting off fireworks

8.2 The owner, a pyrotechnics managing company, acquired controlling interest in the employer's operation on 99 01 29. The owner's interest in the employer's operations was managed through a panel of directors.

Section 9.0 LOCATION OF INCIDENT

9.1 NE of Drayton Valley at LSD - SE ¼ of 25-49-7-W5M
(8 Km East on Township Road 494 next to the North Saskatchewan River)

Section 10.0 EQUIPMENT AND MATERIAL INVOLVED

10.1 Definitions

10.1.1 As defined in Canada's Explosive Act, a Class 7 explosive is a firework. It is broken into two divisions. Division 1 of Class 7 is the firework compositions and Division 2 of Class 7 is the manufactured product. Division 2 of Class 7 is broken down further into five subdivision rated from low to high hazards.

Subdivision 1 of Division 2 fireworks comprises low hazard fireworks generally used for recreation, such as fireworks showers, fountains, golden rain, lawn lights, pin wheels, Roman candles, volcanoes, sparklers, Christmas crackers and caps for toy guns.

Subdivision 2 of Division 2 fireworks comprises high hazard fireworks generally used for recreation, such as rockets, serpents, shells, bombshells, tourbillons, maroons, large wheels, bouquets, barrages, bombardos, waterfalls, fountains, batteries, illumination, set pieces, pigeons and firecrackers.

- 10.1.2 “Explosive” means any chemical compound or mechanical mixture which by fire, friction, impact, percussion, or detonation may cause a sudden release of gases of such pressure as to be capable of producing destructive effects in adjacent objects, or of destroying life and limb.
- 10.1.3 Low Order Explosion - an exothermic reaction in which the reaction front advances at subsonic speeds [<350 metres per second (m/s), or approximately the speed of sound],
- High Order Explosion - an exothermic reaction in which the reaction front advances at above supersonic speed [>350 m/s]
- 10.1.4 A pyrotechnic mixture contains: An oxygen donor (oxidizer), one or more fuels that burn with the released oxygen when the oxidizer is heated, and other chemicals that serve as binders and create colour, spark, or other visual or audible effects.
- 10.1.5 Information gathered from the material safety data sheets located at the work site suggested the following compounds (fuels, oxidizers & others) could possibly be present:

Chemical names for the solid compounds:

- Aluminium Powders
- Antimony Sulfide
- Atomized Aluminium Powders
- Barium Nitrate
- Black Powder (Gun Powder)
- Boric Acid
- Calcium Carbonate
- Charcoal
- Acetone
- Chlorinated Rubber
- Copper Oxide (Black)
- Dextrin
- Ferrotitanium
- Magnesium/Aluminium Alloy Powder
- Potassium Dichromate
- Potassium Nitrate
- Potassium Perchlorate
- Denatured Ethyl Alcohol
- Saran Resin
- Silica
- Sodium Bicarbonate
- Strontium Carbonate
- Sodium Salicylate
- Sulphur
- Titanium Sponge Granules or Powder
- Yacca Gum
- Lac Clear 35 (paint)

- 10.2 The investigating officer entered on to the secured incident scene through a mixed stand wooded area on a dirt road that curved east to north. The road led into a fairly sandy beach with the North Saskatchewan River situated on the right (east) and a wooded/grassy area to the west. The sandy area was then surrounded by some more mixed stand timber 75m directly north of the entrance. In short, the sandy area was quite secluded.
- 10.3 Approximately 35m from where the groomed dirt road ended was the employer's red 1998 Ford F-150, parked facing south.
- 10.4 Inside the vehicle was a set of keys, a number of finished firework products, papers, a torch, etc.
- 10.5 In the pick-up truck box, were four white, plastic, five gallon (19L) pails. Two were empty, one full and one half-full. The contents of the full and half-full pails consisted of unspecified mixtures of explosive materials (a pyrotechnic mixture) used in the manufacturing of firework products. (See Attachment A-1)
- 10.5.1 There was another pail, a fifth pail, that was involved in the explosion (See 10.7).
- 10.6 On the open tailgate were a pair of fuse cutters and a spool of grey, slow burn ignitor cord, also known as fuse, used to ignite the "burn" piles. The fuse had a distance verification incorporated on the casing; dark markings every .3m continuously throughout the fuse.
- 10.7 Approximately 20m north, behind the truck, was a blackened area believed to be the "blast/explosion" site. (See Attachment A-2)
- 10.7.1 There were some other blackened sites in the sand that represented prior burn areas. Conditions of the burn sites suggest they were a result of burns from days prior to the day of the incident (they appeared to be lighter in colour). (See Attachment A-2)
- 10.8 From the blast location, plastic shrapnel from the exploded pail was observed to be strewn in numerous locations in every direction. Parts of the pail were observed directly on the blast site (a fragment from the bottom of the pail), and also away from the actual blast site at approximately 5m between the truck and the blast site, approximately 20m at the river's edge, and approximately 50m in the west wooded area. (See Attachment A-3)

- 10.8.1 There appeared to be various components of a finished firework product scattered in various locations around the blast site. Some of the products included:
- Machs or Signals: Used in the explosive effect of a firework
 - Whistles: Used to give a firework a whistling effect.
 - Plastic End Caps: Used to keep the chemicals inside the firework.
 - Paper Products: Used as casings for the explosive mixtures.
- 10.9 The severity of the explosion was also demonstrated by the worker's destroyed prescription eyewear found approximately 8.5m west of the blast site, and a blue baseball cap in two pieces (the brim portion found approximately 11.5m west of the blast and the cap portion found approximately 14m northwest of the blast area). (See Attachments A-4, A-5 and A-6)
- 10.10 Between the truck and the blast site, approximately 3m away, was a rake the worker would have used to rake and cool down ashes. It was not damaged from the explosion.
- 10.10.1 It could not be determined if the worker used the rake to mix and cool down the ashes at the actual "explosion/blast site" after each burn was finished or he used the rake to mix and cool the ashes of previous burn locations at the river site.
- 10.11 Close to the blast location, less than 1m away, was some spent fuse wire used for one of the explosive waste burns and an intact pail lid directly east of the spent fuse wire.
- 10.12 Immediately to the southwest of the blast site, 1m away, was an imprint of a person in the sand. The imprint was believed to be left from the worker when the explosion occurred. (See Attachment A-7)
- 10.13 Directly, southwest of this imprint, approximately .5m away, was a box of wooden matches scattered about. The matches were believed to be used to light a fuse. (See Attachment A-8)
- 10.14 Refer to Sketch in Attachment B.
- 10.15 At the time of the incident, weather conditions were inconclusive. Environment Canada's Monthly Meteorological Summary establishes mean temperature at 13C, relative humidity ranging from 46% to 85% and no rain or thunder showers. Local weather forecast for that day were projected to be periods of rain, with the chance of thunder showers, and temperatures ranging from lows of 7°C to highs of 16°C. The employer's daily log indicated periods of thunder showers were present that day.

10.16 At the time of the investigation the ambient air conditions were approximately 11°C under partly cloudy skies. The sun was setting and dusk was approaching.

Section 11.0 NAMES OF OTHER INVESTIGATORS (EXTERNAL)

11.1 RCMP - Drayton Valley Detachment

11.2 Natural Resources Canada - Explosives Regulatory Division

11.3 Alberta Infrastructure - Dangerous Goods Control Branch

11.4 U.F.X. Enterprises Inc.

Section 12.0 NARRATIVE DESCRIPTION OF INCIDENT

12.1 Background information leading up the day of the incident.

12.1.1 Early February 99, the employer and workers moved the original “burn site” from inside the factory compound to a small field outside the compound’s gates. The original burn site, inside the factory compound, was determined to be a hazard to the factory compound and workers. The decision to move the burn site outside the factory compound gates was made collectively by the supervisors and workers.

12.1.2 Mid February 99, neighbours complained to the Municipal District (MD) of Brazeau about excessive noise and smoke with the burn site located outside the factory compound gates. These types of complaints were lodged against the employer in the past; even when the burn site was located inside the factory compound gates.

12.1.3 On 99 04 26, the employer’s application for an amendment to the operating permit, the new burn location outside the factory compound, was denied by the MD of Brazeau.

12.1.4 Late April 99 or early May 99 the burn site located outside the factory compound gates flooded. The high water table made access to the burn pit impossible.

12.1.5 The burning of explosive waste material stopped on a daily basis and started to accumulate. Explosive waste burning procedures were then scheduled to be done on a weekly basis.

12.1.6 Approximately one week after the burn pit flooded, in mid May 99, the first of several activities involving the burning of waste began at the river site (See Attachment B- Sketch). This site was also used as a testing site for finished firework

products on a regular basis in the past. These activities were done without the proper permits from the MD.

- 12.2 On 99 06 30, at approximately 07:00, the worker started his shift at the fireworks factory. Total number of workers on shift the day of the incident was 15.
- 12.2.1 The worker was employed in the capacity of a foreman. He discussed the proposed work activities and strategies for the day with the manager and then commenced his planned duties (work activities for the day included foreman duties, manufacturing of testers & slurry machs, evaluating the testers and destruction of explosive waste).
- 12.2.2 Description of his other duties:
Testers- Producing various types of fireworks for the purpose of testing the quality of the effects on the finished products.
Slurry Machs- Applying a coating, which consists of powder and water (or acetone), uniformly around a Mach. The coating enhances ignition and/or the chemical mixture of the firework.
- 12.2.3 It was indicated that the worker's work environment and attitude were not anything out of the ordinary and appeared to be quite good.
- 12.3 Sometime after the morning coffee break the worker aided in the unloading of a chemical truck that arrived on site. The worker returned to production duties after this was completed.
- 12.4 At approximately 12:00 the worker stopped for a half an hour lunch break (lunch was scheduled from 12:00 to 12:30). The worker then returned to work duties after lunch.
- 12.5 At approximately 13:30 the worker gathered up the firework testers and five pails of explosive waste material (The waste material was accumulated over, approximately, the previous 4 weeks). The worker loaded the products into the employer's pick-up truck.
- 12.5.1 Contents of the waste material consisted of various levels and proportions of fuels and oxidizers, machs, slurries, end caps, and other waste debris (See 10.4.3). (See Attachments A-9 and A-10)
- 12.5.2 The exact proportions of the explosive material and contents of the pail involved in the incident could not be verified.
- 12.5.3 At some point the worker removed his fire retardant protective coveralls or cotton apron (both "protective" clothing were readily available). The protective clothing was regularly subjected to explosive waste material build up and not worn during the explosive waste burn procedures.

- 12.6 Prior to leaving the factory compound, the worker notified his manager as to what work procedures he would be commencing over the next couple of hours. This work activity involved burning the accumulated explosive waste material and testing some of the firework products manufactured that day.
- 12.7 At approximately 13:30, the worker left the factory compound and travelled nineteen kilometres to the river site to conduct his work duties (See Attachment B- Sketch).
- 12.7.1 The worker conducted this work activity alone at the river site. (It was common practice for the worker to conduct this task alone.)
- 12.8 The worker arrived at the river site to perform his work obligations.
- 12.9 It appeared the worker set up to conduct the explosive waste burning procedures first.
- 12.9.1 It was observed that the worker did not do any testing as the manufactured firework products were still present in the cab of the truck.
- 12.10 The following is a summary of the activities performed by the worker to burn the explosive waste material brought to the river site:
 - 12.10.1 The worker removed the first pail of waste from the back of the pick up truck.
 - 12.10.2 The worker then removed the lid from the pail and poured out an undetermined amount of waste into a pile on the sand.
 - 12.10.2.1 The quantity of the waste pile would have ranged from one half to a full five gallon pail of explosive waste material.
 - 12.10.2.2 Site conditions suggest that all burn piles were done on the same spot, or on different spots within a few metres of each other in a pre-determined rotation. It was most likely that the worker used the same spot for each burn and the other burn piles would represent burns from the previous weeks. (See 10.6.1 and Attachment A-2)
 - 12.10.3 Site evidence indicated that the worker used fuse to ignite the explosive waste material for, at the very least, the first explosive waste burn pile (observed a spent fuse near the blast location).
 - 12.10.3.1 The site procedure required the worker to: cut a length of the fuse with fuse cutters over of 6.1m, insert one end of the fuse into the explosive waste pile, stretch and straighten the fuse away from the burn area, and, at a safe distance, light the free end of the fuse with a wooden match.
 - 12.10.4 The fuse would have burnt down towards the pile and ignited the constituents of the

explosive waste pile.

- 12.10.4.1 Estimated burn time of the fuse is approximately 33 sec/m (10 sec/ft).
- 12.10.4.2 All firework compositions are energetic materials and tend to burn or deflagrate (low order explosion) rather than detonate (high order explosion). It involves rapid combustion and if confined may explode/detonate.
- 12.10.5 The worker then waited for an undetermined amount of time before approaching the burnt waste pile.
- 12.10.5.1 It is undetermined if the worker waited in the cab of the truck and/or at a safe distance away from the burn pile outside of the truck.
- 12.10.6 The worker had a rake available at the site in conformance with the site procedures. It was inconclusive as whether the rake was used, to help cool the ashes, on the burn piles or not.
- 12.10.6.1 No water was used to cool the ashes.
- 12.10.7 It is uncertain if the worker used the ashes from the previous burn to ignite the contents of the next burn or followed the steps outlined from item 12.10.3 to 12.10.6 (using the fuse).
- 12.10.8 The worker proceeded to follow the same previous steps for the second pail.
- 12.10.9 At some point the empty pails were returned to the back of the pick up truck.
- 12.10.9.1 The worker could have done this step after each pail was emptied of its contents or as one step after both pails were burned of their contents.
- 12.10 The employee grabbed the third pail from the back of the pick up truck to continue with the explosive waste burning activities.
- 12.11 The employee removed the lid and commenced to place an abnormal (excessive) amount of explosive waste into a pile.
- 12.12 Soon after, the explosion occurred. (See item 13.1.1)
- 12.12.1 As a result of the explosion, the worker was knocked back, leaving an imprint in the sand.

- 12.13 At some point after the explosion the worker got up and struggled to get assistance/help.
- 12.13.1 It appeared the worker travelled to the pick up truck and attempted to access the unlocked cab. After some failed attempts to enter the truck, the worker travelled 850m up the road where he later collapsed. (See Attachment A-11)
- 12.14 At approximately 15:30 the RCMP received a call from a member of the public that a body was found approximately seven kilometres east on township road 494.
- 12.15 RCMP and Ambulance arrived on the scene. The worker was pronounced dead at the scene and removed from the location.
- 12.16 At approximately 17:30 the worker's manager was notified that a workplace fatality had occurred.

Section 13.0 CONCLUSIONS

- 13.1 The cause of the incident was an uncontrolled explosion of explosive waste material brought on by an ignition source (See 13.1.1). The uncontrolled explosion was a direct result of a system failure that included inadequate worker training (See 13.1.2), no supervision (See 13.1.3) and inadequate site specific safe work procedures (See 13.1.4).
- 13.1.1 Ignition source causing the uncontrolled explosion -
Even though there is several possible ignition sources and no witnesses were present at the time of the explosion, a most likely theory can be determined. Based on site conditions and information gathered at the time of the investigation, the most probable source of ignition would be the remnants of hot ashes from a previous burn pile. When the worker began to pour out the explosive waste material from the third pail, directly on the ashes of the last burn pile, the hot ashes ignited the explosive mixture (which appeared to be the practised explosive waste disposal procedure - See 13.1.4.1.3). The interaction and combination of an ignition source, abnormal (excessive) quantity of explosive waste material and the containment of the material in the 5 gallon pail caused the fatal explosion.
- 13.1.2 Inadequate Training
The employer had not ensured that a competent worker was performing the burning of chemical waste (explosive waste material). The employer had no formal system to evaluate and/or verify a worker's competency level in explosive material destruction (waste burning) or safe transportation of an explosive product.
- 13.1.2.1 It was reasonable to expect the employer to recognize the hazards associated with the destruction of explosive materials and provide the appropriate level of worker

instruction as outlined in Section 14 of the General Safety Regulation. The employer appeared to make some attempts in controlling hazards at the work site through Factory Rules and a job procedure for Burning of Chemical Waste but fell short in providing a site specific training/education/orientation program to address the dynamics behind all explosive hazards. Adequate training in explosive material handling would have enabled the worker to assess the hazards surrounding the “new” burn location and to implement the appropriate control measures.

- 13.1.2.2 The employer did not meet their responsibilities to ensure the worker possessed a valid permit to handle, prepare or fire any explosive material as outlined in Section 12(1) of the Explosives Safety Regulations. The worker, or any other worker working at the factory compound the day of the incident, did not have a valid permit issued by and required by Alberta Human Resources & Employment - Workplace Health and Safety. The permit would acknowledge and/or verify the experience, qualifications and competencies of a worker prior to any explosive material being handled, prepared, detonated or destroyed. In addition to the provincial permitting requirements, National Resources Canada - Explosive Regulatory Division (NRC) requires worker certification if in any of the following ways a worker: purchases, stores, uses, supervises or transports pyrotechnic special effects. The employer did not ensure workers were provided training and certification appropriate to the tasks as outlined by NRC.
- 13.1.2.3 The employer did not provide any training on: safe movement of explosive materials (pails were unsecured in the back of an open box pick up truck), placards required on transport vehicle (no clearly marked signs or other identification marks were present when the vehicle was carrying more than 22.5 kg [total material transported was contained in five 5 gallon pails]), pre-transport vehicle inspections (no daily inspections done on the transport vehicle) and incompatible materials not to be transported during transportation of explosives (a non-approved, ferrous rake was present in the back of the pick up truck). It was reasonable to expect the employer to recognize the hazards associated with the transportation of explosive materials and provide the appropriate level of worker instruction as outlined in Section 14 of the General Safety Regulation and Section 44 of the Explosive Regulation.
- 13.1.3 No Supervision at the Time of the Incident
The employer did not fulfill their responsibilities to ensure direct, authorized supervision was provided to the worker during the destruction of explosive waste material as prescribed in Section 11 (b) of the Explosives Safety Regulations. The employer did not maintain or employ workers who possessed a valid permit to handle, prepare and fire an explosive at the work site.
- 13.1.3.1 The employer did not provide and could not verify the worker received adequate instruction on the hazards associated with the destroying of explosive material and therefore responsible to provide direct supervision from a competent worker as

prescribed in Section 14 of the General Safety Regulation. The employer did have competent staff to deal with the hazards associated with explosive materials but none were permanently based at the work site and were only readily available for direct supervision periodically.

13.1.4 Inadequate Site Specific Safe Work Procedures

The employer failed to provide adequate direction and instruction to the worker, as outlined in Section 14 of the General Safety Regulation. The safe work procedure, Chemical Waste Burn Procedures, did not reflect the change in the burn site location, increased quantities of explosive waste material, conflicted with standard practices and appeared not to be enforced or followed by workers (See 13.1.4.1). It was reasonable to expect the employer to recognize that a number of deficiencies were present with the safe work procedures (destruction of explosive material waste) and to follow through with the appropriate adjustments.

13.1.4.1 The following sections, 13.1.4.1.1 to 13.1.4.1.3, are a summary of observed deficiencies with the Chemical Waste Burn Procedures:

13.1.4.1.1 The worker was engaged in a work activity outside his routine duties (the burning of explosive waste was part of job description; but the task had ceased to be carried out on a regular basis and progressed to a periodic, more complex role). Several new hazards surfaced from the re-location of the burn area - new location for waste burning, transportation of explosive waste, larger quantities of explosive waste, emergency response plan did not apply outside the factory compound and isolation from the other workers (National Resources Canada recommends that burning explosive waste material always be done in tandem and never alone). The employer did not evaluate the new sets of hazards, through a hazard analysis, and implement the required appropriate controls. The worker did not receive any additional direction, controls or amendments on the burning procedures for outside the factory compound.

13.1.4.1.2 The larger quantities and “un-soaked” (See 13.1.4.1.3, second bullet) explosive waste material resulted in the increased risk of severe explosions. Not burning on a regular, daily basis lead to an excess waste accumulation.

13.1.4.1.3 Several pieces of information were either ignored or incorporated into one common waste burning practice/procedure. They had an explosive waste burning practice that conflicted with established safe guidelines; contrary to the requirement described in Section 112 of the Explosives Safety Regulations. The conflicting information sources included: the site specific written procedures, the procedures outlined in the National Resource Canada’s factory permit, National Resource Canada’s pamphlet- “Storage, Possession, Transportation, Destruction and Sale”, National Resource Canada’s manual- “Display Fireworks-Edition #1” and the method the worker was

shown. This confusion or absence of steps lead to several dangerous habits and aided in the procedure the worker was engaged in at the time of the explosion (See items 12.10 to 12.10.10.1).

- The site specific procedures stated the maximum explosive material to be burned is half a five gallon pail compared to where the National Resource Canada's factory permit outlines no more than 100g of Star waste, 10g of Whistle waste and 10g of Flash waste (for a total of 120g) to be burned at one time (a restriction on waste burning quantities self-imposed by the employer),
- National Resource Canada's manual states the destruction of firework products shall be soaked in fuel oil or water for at least 12 hours before burning (reduces possibility of violent explosions). This method is now currently employed by the employer but not at the time of the incident,
- The worker was instructed/taught to burn explosive waste material by throwing small bags (approximately 120g each) continually on to a burn pile (therefore fuses were not needed for all the burn material; used only for the first burn). The method is prohibited by National Resources Canada. Alberta Explosives Safety Regulations, Section 54, also prohibits putting explosives near an open heating unit or any other substance likely to cause an explosion or fire.
- The site specific procedures itemized matches to be used. The use of matches is inherently dangerous and is not recommended. National Resource Canada's pamphlet states no matches are to be used.
- The site specific procedures identified water as an additional cooling method to the raking. No water was used while engaged in burning procedures. It was observed that explosive material can remain hot and flare up after a long period of time (it was witnessed by the employer and NRC to be as long as 42 minutes after a burn).
- The site specific procedures identify fire protective clothing to be worn during waste burning. The protective clothing that was worn by the worker during production and throughout the day became saturated with the waste material. It became common practice for the worker to remove the protective clothing because of the hazards associated with excess waste residue/powder when burning. Not wearing fire retardant clothing increases the chance of static electricity build up.

Section 14.0 FOLLOW-UP/ACTION TAKEN**14.1 Industry****14.1.1 Owner/Employer**

14.1.1.1 On 99 07 12, the employer designate applied for a permit to handle, prepare and fire an explosive in the Province of Alberta.

14.1.1.2 On 99 07 12, the employer applied to National Resources Canada - Explosive Regulatory Division for removal of the factory licence suspension. The employer requested that the suspension be lifted so stored explosive waste material could be made into a finished firework product.

14.1.1.3 On 99 07 19, the employer commenced all work activities at the factory compound. An internal review and assessment to re-locate the factory to Rockyford, Alberta was initiated. New procedures, in accordance with NRC's published guidelines, were implemented and equipment made available for explosive waste burning. This included qualified/certified designated person, location, electric match, soaking waste material in fuel oil for 12 hours before burning commences, smaller quantities, decreased time in between burns, etc.

14.1.1.4 On 99 07 26, the employer's representative (the blasting designate) resigned and a director from the owner stepped in to manage the work site and the transition to re-locate. The owner continued to commit to the new site specific safe work procedure.

14.1.1.5 On 99 07 26, the owner's designate applied for a permit to handle, prepare and fire an explosive in the Province of Alberta.

14.1.1.6 On 99 09 01 the owner commenced the activities to move the firework manufacturing compound to Rockyford, Alberta.

14.1.2 National Resources Canada - Explosive Regulatory Division

14.1.2.1 On 99 07 03, the investigation commenced.

14.1.2.2 On 99 07 05, the factory licence was suspended.

14.1.2.3 On 99 07 12, the suspended factory licence was reinstated so stored explosive material could be made into a finished product. No new firework compositions could be made.

14.1.3 Alberta Infrastructure - Dangerous Goods Control Branch

14.1.3.1 On 99 07 06, the investigation commenced.

14.1.3.2 The Ministry is in the process of evaluating the investigation into possible contraventions within their legislation. Specifically relating to three regulations- Section 4.1, No Documentation; Section 5.1, No Labels; Section 9.1, No Training.

14.2 **Human Resources & Employment**

14.2.1 On 99 07 01, a Client Contact Report complete with Stop Work Orders and Orders to comply were left with the employer.

14.2.2 On 99 07 02, the investigating officer met with an employer representative to pick up the material/contents gathered as evidence at the time of site investigation.

14.2.3 On 99 07 03, the investigating officer along with a preliminary investigator from National Resources Canada-Explosive Regulatory Division met with the employer to review site conditions and the employer's obligations under the provincial and federal guidelines. Stop Work Orders remain in place.

14.2.4 On 99 07 06, the investigating officer along with a technical advisor for National Resources Canada-Explosive Regulatory Division and an inspector from Alberta Infrastructure-Dangerous Goods Control Branch met with representatives of the owner and employer. Further review and discussions on obligations pursued.

14.2.5 On 99 07 12, the investigating officer along with National Resources Canada - Explosive Regulatory Division met with the owner and the employer. Discussions and guidance were given to prepare for a safe start up for the work site. Stop Work Orders were tentatively lifted based on receipt and notification of a valid permit to handle, prepare and fire an explosive in the Province of Alberta received from Human Resources & Employment-Workplace Health & Safety (WH&S)

14.2.5.1 On 99 07 19, a valid permit to handle, prepare and fire an explosive in the Province of Alberta was issued by WH&S to the employer's designate. The valid permit satisfied conditions of the Stop Work Order and permission to commence work activities was given.

14.2.6 On 99 07 29, a follow up work site inspection was performed. Direction and guidance on health and safety systems and audits were given. An order to re-apply for a valid permit to handle, prepare and fire an explosive in the Province of Alberta was issued to the owner's designate (application sent that day).

14.2.7 On 99 08 12 a valid permit to handle, prepare and fire an explosive in the Province of Alberta was issued to the owner's designate (99 07 29 Order satisfied)

14.3 **Additional Measures**

- 14.3.1 Alberta Human Resources & Employment - Workplace Health & Safety shall conduct a work site inspection on the “new” factory compound once it is in production. Further guidance and direction will be given to the employer on the legislation & regulations and information provided on the Partnerships Program - Certificate of Recognition. A health and safety audit will be a benchmark to cultivate a safer work environment for workers working at the pyrotechnics work site.
- 14.3.2 There needs to be an increased awareness in the Province of Alberta on the safe use and destruction of explosives in pyrotechnic products. The size of the pyrotechnics industry can be measured through the number of firework shows at special events and in the rising movie industry across the province. The work activities involved in the pyrotechnics industry involves both high and low explosive materials (i.e.: detonating cord is being used more often for special effects). It appears that information on training and permits, needed to safely handle, use and destroy explosive materials, needs to be passed on to various levels of pyrotechnic stakeholders (including fire departments, cities, event coordinators, movie producers, etc..). A system or method to verify permits, worker competencies and safe work procedures must be in place prior to any pyrotechnics effect show commencing. A Bulletin will be developed and distributed to all stakeholders in the industry (example: target audience would comprise of municipalities, special event coordinators, theatrical companies) explaining the requirements for explosive waste destruction and permits.
- 14.3.3 The use of pyrotechnics is regulated by various government agencies. Information on the specific requirements to handle, prepare and fire an explosive in the Province of Alberta requires coordination between the National Resource Canada - Explosive Regulatory Division, Municipal Affairs- Technical & Safety Services (i.e.: Fire Code), Human Resources & Employment - Workplace Health & Safety and Industry Stakeholders. Recommendations include better coordination among agencies (including definitions), better definitions on the roles of different agencies and to remove duplication in regulations to minimize confusion of stakeholders.
- 14.3.4 20 days after the incident, a transport truck loaded with “left-over” fireworks from the Calgary Stampede was involved in an explosion in Calgary, Alberta. The material was slated for re-sale and/or destruction. The explosion is still under investigation by National Resources Canada, Alberta Infrastructure and Human Resources & Employment - Workplace Health & Safety.

Section 15.0 INJURY SEVERITY

- 15.1 Fatal

Section 16.0 SIGNATURES

(original signed) _____
M. Lynes, Investigator **Date**

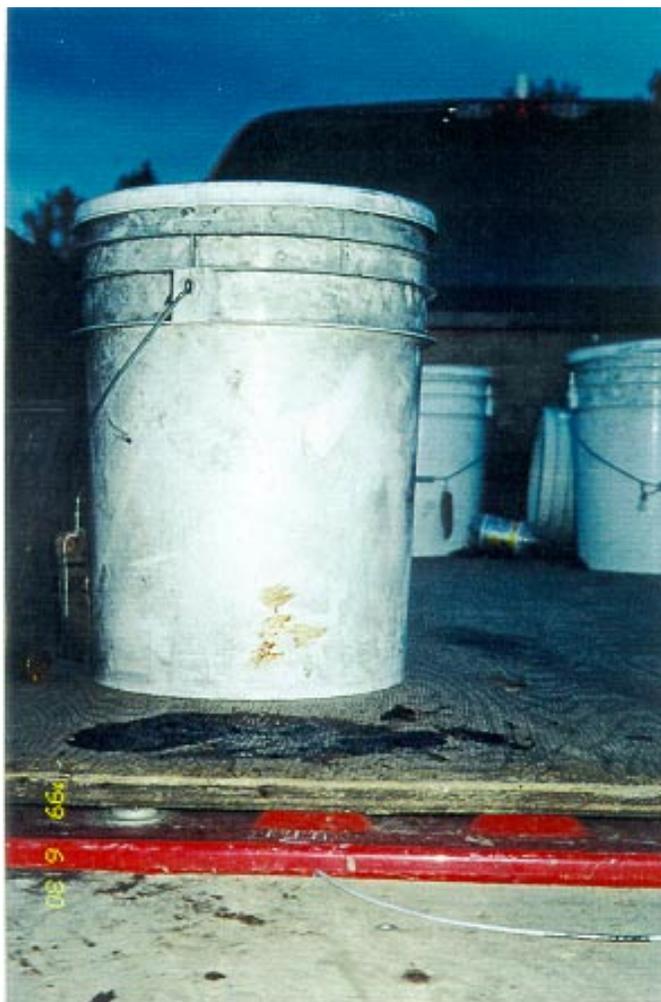
(original signed) _____
G. Wagner, Reviewer **Date**

(original signed) _____
Y. Lau, Reviewer **Date**

(original signed) _____
E. Reitsma, Manager, North **Date**

Section 17.0 ATTACHMENTS

Attachment "A" Photographs
Attachment "B" Sketch



Photograph #1

View of the contents inside the worker's company truck. The Pictured four white plastic pails contained the explosive waste materials. Two were empty (emptied during the prior burns) and two still contained explosive waste material.



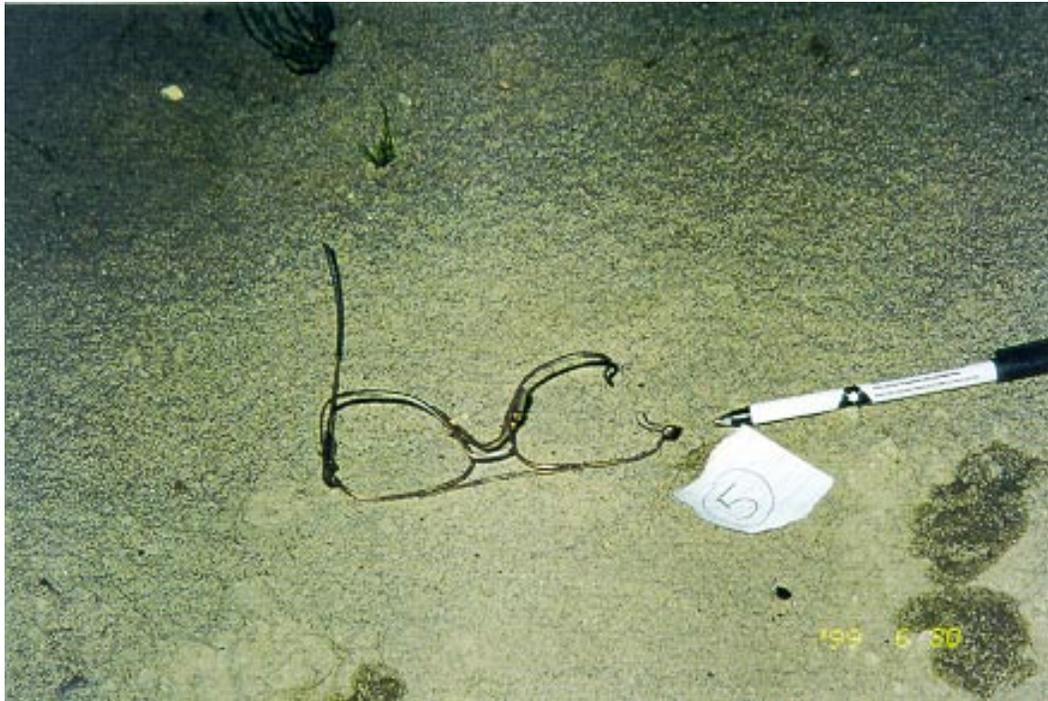
Photograph #2

View of where the explosion occurred. The red arrow [centre, right] points to a darker burn site. The spot where the explosion occurred. The green arrow [centre, left] points to a number of lighter burn sites believed to be a result of past burns.



Photograph #3

An example picture of a piece of the five gallon plastic pail that was involved in the explosion.



Photograph #4

The worker's prescription glasses the worker wore at the time of the explosion. The destruction of the glasses was a result of the explosion. (See Sketch – Attachment "B")



Photograph #5

The worker's brim portion of his blue baseball cap. The baseball cap was torn into two pieces as a result of the explosion. (See Sketch – Attachment "B").



Picture #6

The worker's cap portion of his blue baseball cap. The baseball cap was torn in two as a result of the explosion. (See Sketch – Attachment "B").
Note: inside the cap is firework component called a mach.



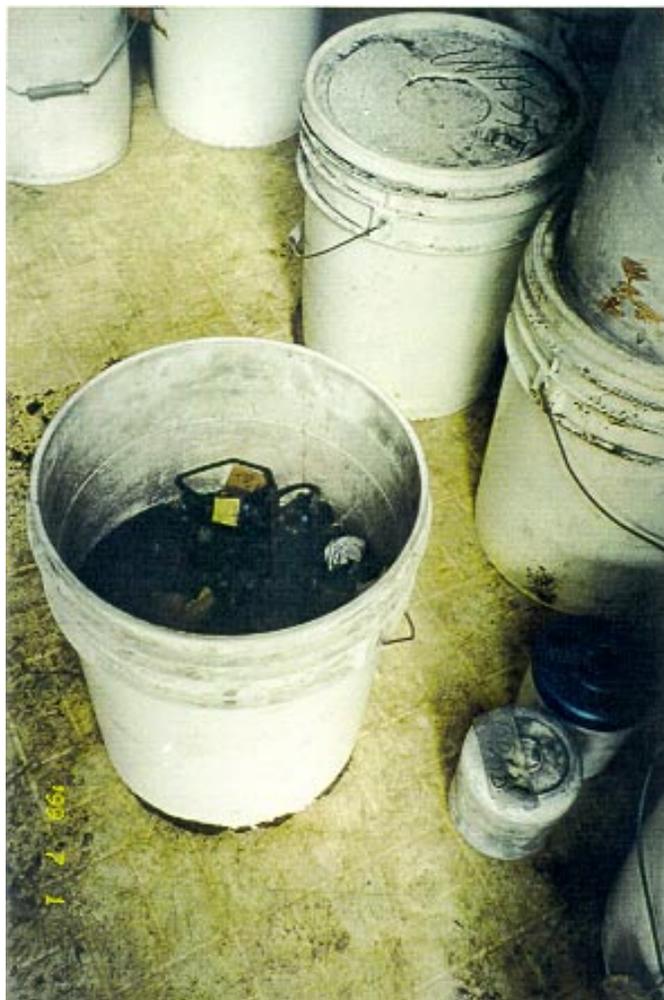
Photograph #7

The blue arrow (centre) points to the imprint in the sand left by the worker after the explosion occurred.



Photograph #8

Wooden matches the worker would have used to ignite the fuse.
As a result of the explosion, the matches were scattered outside and
around their container.



Photograph #9

An example of the various explosive waste materials contained in one of the two containers at the incident scene.

Note: compare A-9 to A-10



Photograph #10

An example of the various explosive waste materials contained in one of the two containers at the incident scene.

Note: compare A-10 to A-9

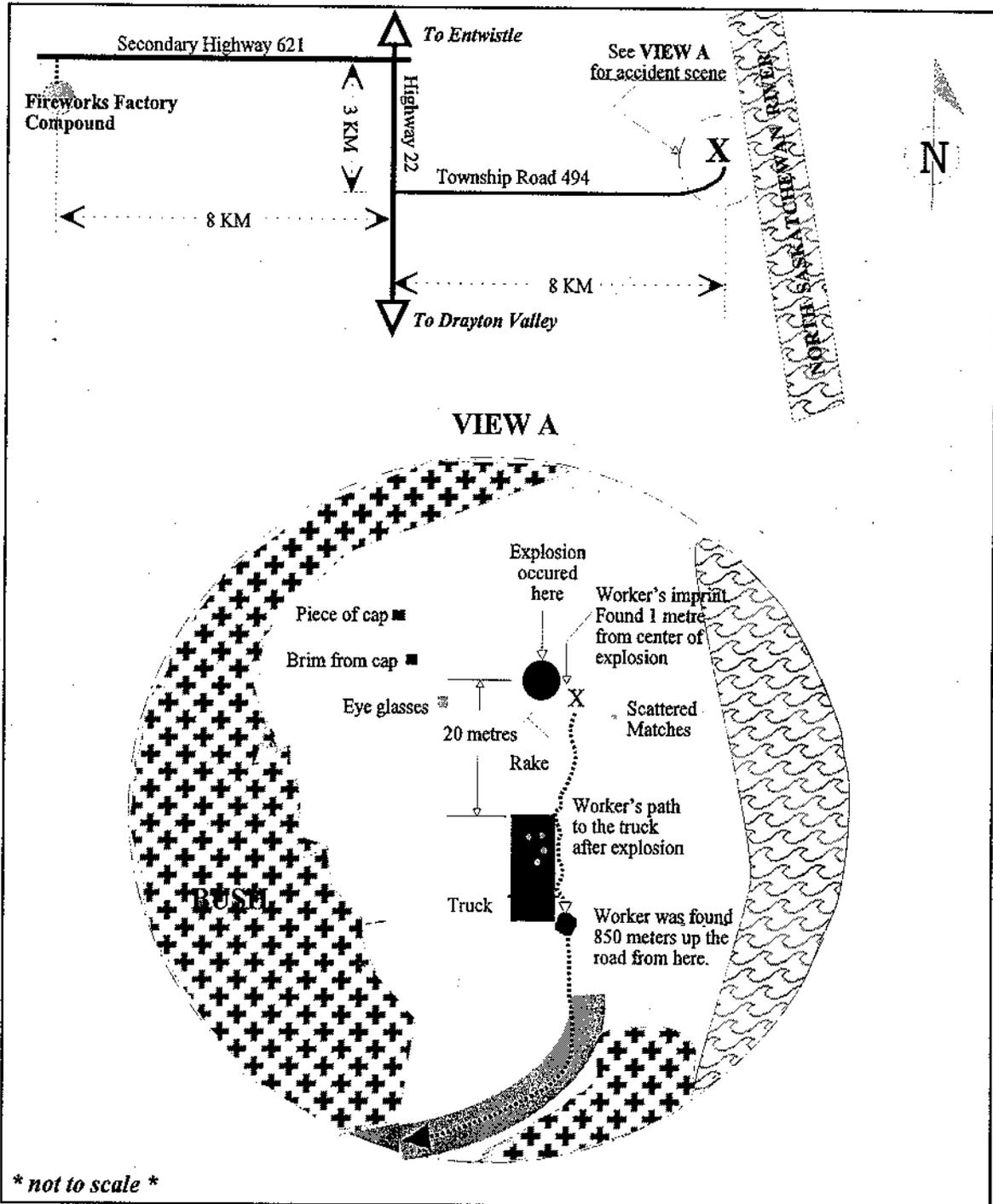


Photograph #11

The employer's pick up truck still parked at the scene of the incident.
The vehicle was used to transport the material to the incident scene.

Note: obvious signs of the worker's attempts to access the cab of the truck.

ATTACHMENT "B"



Drawn by M. Lynes
99 07 05