Scientific Fire Setting Report

Service de sécurité incendie de Laval

August 8, 2022

Table of Contents

ACKNOWLEDGEMENTS

The realization of this fire study was made possible thanks to the collaboration of the following people:

Instructional Design

Claude Lussier

Vincent Mercier

Jean-Sébastien Roch

Editor

Claude Lussier

Validation Committee

Richard Béliveau

Sébastien Daviau

Jean-François Ledoux

Alexis Proulx-Marchessault

Layout and Proofreading

Sonia Barrasso

Aline Major

English Translation

Sonia Barrasso

Foreword

This fire setting study made possible by the city of Laval's Fire Department (Service de sécurité incendie de Laval-SSIL), in collaboration with La Régie du Nord des Maskoutains, l'IPIQ (Institut de protection contre les incendies du Québec), as well as with the participation of Ottawa University, on May 8, 2021, at Saint-Barnabé-Sud, Québec, to prevent recognized cancers related to the firefighting and fire-inspectors' professions. PAH (polycyclic aromatic hydrocarbon) contaminants found in the air during and after a fire are often called "silent killers".

In 2016, the CNESST (Commission des normes, de l'équité, de la santé et de la sécurité du travail) recognized seven different cancers for firefighters and inspectors-investigators. In 2020, two other cancers were identified. This recognition of risk has led the SSIL to review its practices and habits to mitigate exposure of its employees to the various contaminants present during fires and other types of interventions. This acknowledgement of dangers also requires employers to establish a risk-based prevention program and implement monitoring measures.

In 2018, at 51 and a half years old, Firefighter Langis Villeneuve was diagnosed with cancer. He passed away of cancer related to the firefighting profession on November 3rd, 2020. He was 54 years old.

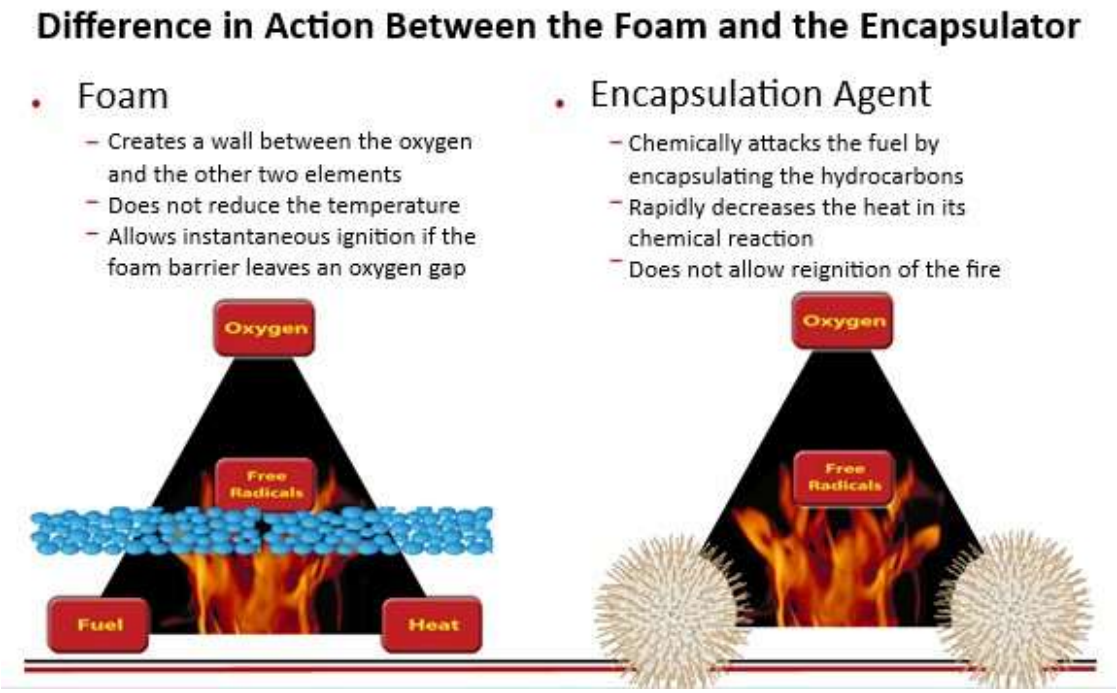
In autumn of 2020, the SSIL distributed a survey to find out how firefighters perceive the measures put in place to reduce exposure to carcinogens. The “PPE Maintenance Guide” (Personal Protective Equipment) Committee is now known as the “Cancer Prevention Committee”.

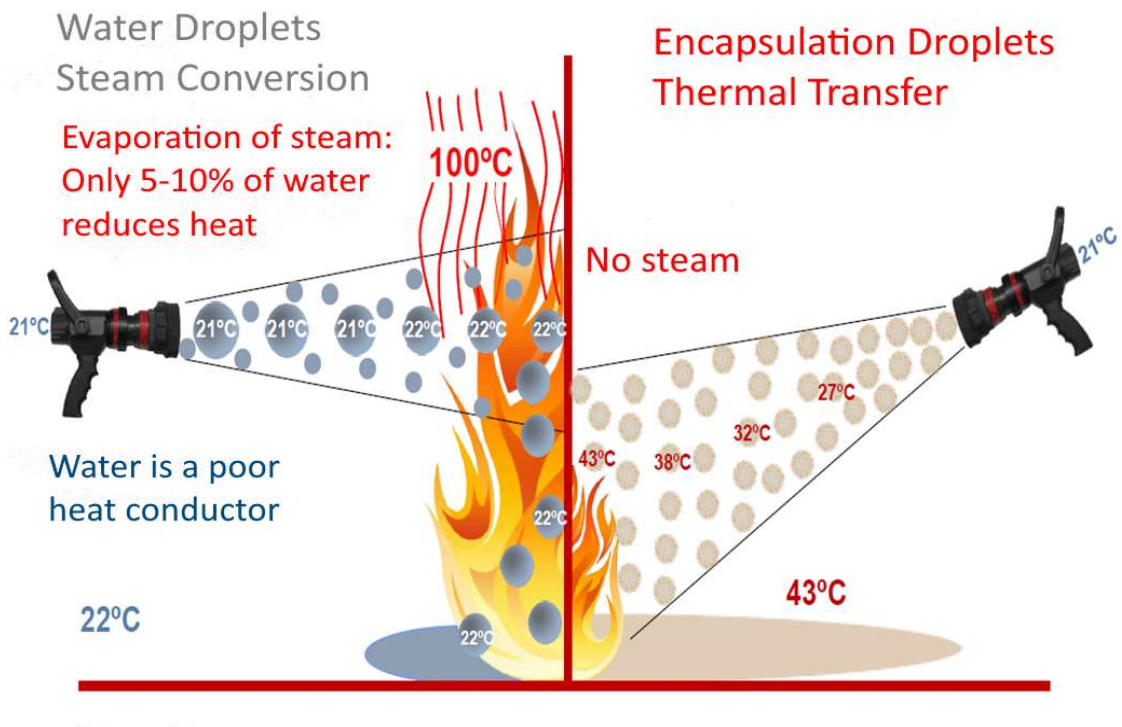
As such, the committee wanted to know more about the encapsulating agent (EA) and requested a presentation from the supplier of the product.

The committee is confident that the encapsulating agent reduces firefighter’s exposure to carcinogenic contaminants. Furthermore, its use is also effective for class B, C and D fires (see images below) while water should not be used on fires of these categories.

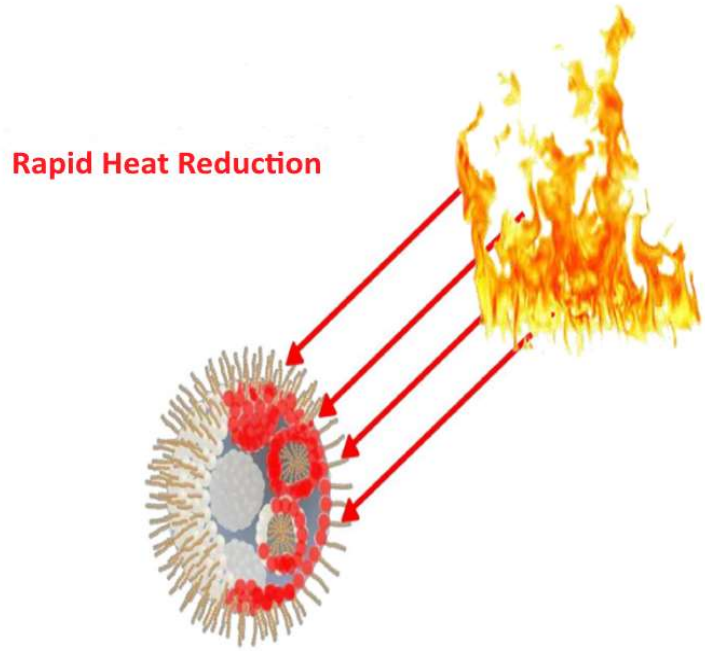
FIRE CLASSES

Classes	Name	Description
A	Solid or Dry Fires	Fires of materials (coal, wood, cotton, fabrics, papers, etc) with quick or slow combustion.
B	Liquid or Greasy Fires	Fires involving liquids or liquefiable solids (gasoline, oil, fuel, grease, etc).
C	Gas Fires	This class concerns gas or vapour fires, in particular pure or mixed hydrogen (town gas), propane, butane, etc.
D	Metal Fires	Metal fires (aluminium, magnesium, potassium, etc) for which special extinguishing means are required.





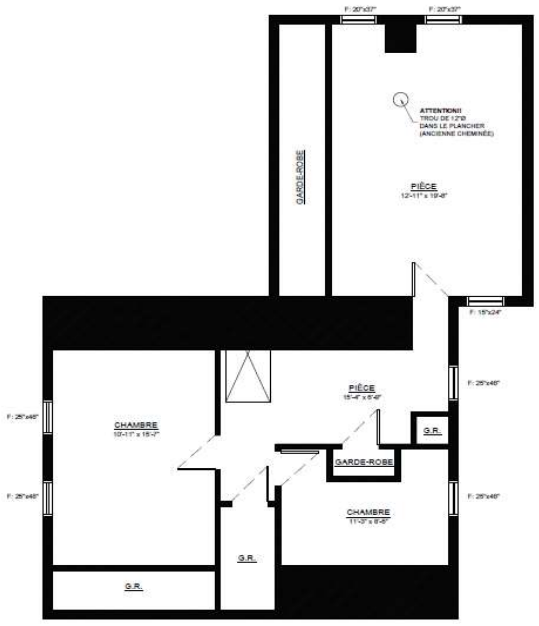
Wetting agents create even more steam than ordinary water.



The encapsulating agents create a thermal circuit, where heat is drawn into the inner part of the droplet.

We were able to pay the necessary fees to the University of Ottawa thanks to the following organizations:

- Ms Tonia Di Guglielmo, Executive Director of APSAM (Association paritaire pour la santé et la sécurité du travail – secteur « affaires municipales » / Joint Occupational Health and Safety Association – Municipal Affairs Sector),
- Mr. Simon-Pierre Savard-Tremblay, Federal Member of Parliament for the Saint-Hyacinthe-Bagot constituency,
- Messrs. Claude Lussier and Jean-Sébastien Roch, SSIL Operations Division Chiefs,
- Mr. Alain Jobin, Mayor of Saint-Barnabé-Sud,
- Mr. Richard Veilleux, Mayor of Saint-Hugues,
- Mr. Sébastien Daviau, Assistant Director of La Régie du Nord des Maskoutains.



PLAN DU 2e ÉTAGE

Objectives

Conduct comparative tests to validate the use of the encapsulating agent in a residential building:

The **primary objective** is to validate the use of the encapsulant in pre-flashover conditions during interior attacks to ensure the safety of firefighters.

The **second objective** is to determine if the use of the encapsulant mitigates the amount of smoke development, thus reducing firefighters' exposure during a fire scene.

The **third objective** is to compare the extinguishing rate for similar conditions.

The **fourth objective** is to compare the level of PAH (polycyclic aromatic hydrocarbons) exposure of firefighters during battle and extinguishing it with or without an encapsulating agent.

Expected Results

- Ensure that the use of the encapsulating agent is safe during indoor attacks.
- Improve extinguishing times.
- Reduce smoke production with more control and faster extinguishing.
- Reduce the amount of volatile PAH particles after extinguishing.
- Reduce the amount of water used during extinguishing.

Methodology

To have an accurate, fair, and exact research, a total of 6 identical buildings with the same heat load under similar environmental conditions would have been required.

We used a single building with an approximate reproduction of the same heat load for fires #1 and #2, followed by fires #3 and #4, and concluded with fires #5 and #6.

An analysis of protective hoods used by Laval firefighters during battles #1-2 and #3-4 were carried out. For every fire, a new hood and complete change of the helmet's interior was performed. The C/O SST ("Santé et Sécurité au Travail" / Occupational Safety and Health) handled and bagged the hoods

exposed to the fumes in accordance with the guidelines issued by Ottawa University.

During fire settings #1 to 4, the plan is to keep the team inside for the progression, cooling of fluids, curb and contain the fire for a period of 10 minutes. The attack team is directed to not immediately proceed to extinguish the fire, but to simulate within 5 minutes for an interior progression with primary search and location of the fire.

Maneuvers Performed

- Interior attack with progression in an environment limited by the oxidant, water attack, attack with encapsulation agent. Flashover condition in the compartment with propagation in the adjoining room.
- Interior attack in a compartment limited by the fuel. Flashover condition with propagation in the adjoining room by an attack with water, attack with the encapsulation agent.
- Transient attack, a water attack, and an attack with the encapsulation agent.

Contribution From SSIL

- A pumper with equipment and extra cylinders, as well as an additional TIC (Thermal Imaging Camera).
- RIC (Rapid Intervention Crew) rescue equipment.
- A pallet of encapsulating agent.
- 2 firefighter instructors, 2 C/O (battalion chiefs), 1 C/D (operations division chief), RIC firefighters.
- A CP (Command Post) table.
- Collaborate and communicate well with the different teams.


F10
F1


STIHL

Contribution From IPIQ (“Québec Institute for Fire Protection”)

Expertise for the application of the standard NFPA (National Fire Protection Association) 1403: Standard on Live Fire Training Evolutions when preparing the building:

- Interior preparation and closure of openings
- Supervise the application of the NFPA standard during fire-settings
- Deliver 5 specialized fire-setting instructors responsible for the following positions:
  - Communication/liaison and application of NFPA 1403
  - Sector 1
  - Attack Support Team
  - Propagation Team
  - Valves Control
- Issue 3 specialized thermal imaging instructors responsible for the following positions:
  - Coordinate the filming of both interior and exterior in collaboration with the fire-setting team
  - Capture the progression of the interior attack teams
  - Capture the progression of exterior teams
  - Install interior imaging equipment
- Supply a specialized RIC instructor:
  - Supervise and train the RIC team in real-life situations
- Thermal coupling equipment and ICT (Information and Communication Technology) for filming
- Vehicle 500 with combat equipment and PPE
- Vehicle 800 and trailer with pedagogical fire setting equipment

Contribution From La Régie du Nord des Maskoutains

- Provide a building and prepare for the fire setting and standard NFPA (remove siding)
- Supply the fuel required for all tests
- Ensure access to a second water source
- Produce the interior plan
- Produce the site plan
- Request permits (government, demolition)
- Provide a CP table
- Firefighter participation in testing
- Supply the mechanical shovel.

Fire Settings Schedule

The fire settings study took place on May 8, 2021:

Departure: QM (Quartermaster in Laval)		05h30
Arrival: 230, rang Saint-Amable in Saint-Barnabé-Sud		07h00
Presentation Meeting (SSIL-IPIQ–La Régie du Nord des Maskoutains)		07h15
Preparation:		07h30

- Equipment installation
- Fire settings preparation
- RIC preparation
- SST verification

Fire #1	(chamber 2 with water)	09h00
Post mortem	(10 minutes)	
Fire #2	(chamber 2 with EA)	09h45
Post mortem	(10 minutes)	
Fire #3	(chamber 1 with water)	10h30
Post mortem	(10 minutes)	
Fire #4	(chamber 1 with EA)	11h15
Post mortem	(10 minutes)	
Lunch	(45 minutes)	12h00
Fire #5	(transient attack with water)	12h45
Post mortem	(10 minutes)	
Fire #6	(transient attack with EA)	13h30
Post mortem final		14h00
Dismantling		14h40
Departure		15h00

TEST 1 (9h00)

Interior attack with progression in a smoke-filled environment limited by combustion. It's a water attack. The following are the team members that participated in this study:

C/O CP:	Vincent Mercier
OS/Communication/Liaison:	Richard Béliveau
C/O SST:	André Bouchard
Nozzle Operator:	Jean-François Ledoux
Logistics/Media C/D:	Claude Lussier and Sébastien Daviau

Intervention Team

SSIL Firefighter:	Alexis Proulx-Marchessault
La Régie du Nord des Maskoutains:	Jean-Sébastien Savaria
La Régie du Nord des Maskoutains:	Yan Inkel

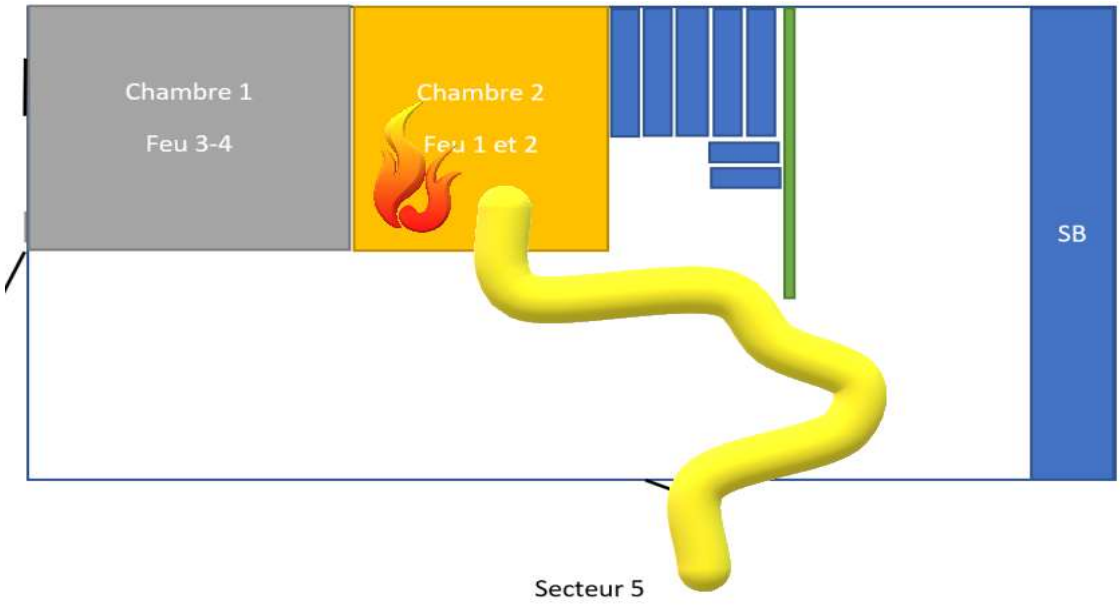
RIC IPIQ O/S: Régis Dion

SSIL: Médéric Gagnon
SSIL: Mathieu Meilleur
SSIL: Jean-Michel Gaudreault
SSIL: Jonathan Syms

IPIQ

Responsible for applying NFPA 1403 norm:	Richard Béliveau
Responsible for sector 1:	Robert Therrien
Responsible for attack support team:	Pierre-Luc Biello
Responsible for propagation team:	Olivier Lachance
Responsible for operating shut-off:	Régis Labelle

Fire setting preparation, distribution of tasks, presentation	**7h30**
Ignitions	**9h00**
Decontamination	**9h20**
Post mortem	**9h30**



Observations by the CP C/O Vincent Mercier

Fire setting at stipulated time, attack team is outside the building waiting for approval from sector 1 officer.

The conditions during the initial attack are the following:

- Gray smoke
- 50% density with medium velocity
- Neutral plane in upper third
- Bidirectional fluid convection movement through sector 5 door.

The intervention team goes on the attack.

Interior report confirms that there is smoke and heat with little visibility. Some short water applications are visible from the outside. Extinction is commanded by the sector officer. There is no propagation to the structure. Clearance and ventilation of residual smoke.

Observations by Nozzle Operator Alexis Proulx-Marchessault SSIL Firefighter

Prior to the first fire setting, we planned how we would proceed inside the building. We spent two minutes in the kitchen for research and explanations on thermal phenomena, as well as the neutral plane to La Régie du Nord des Maskoutains firefighters. Afterwards, we spent two minutes in the living room to perform a primary search and apply some water to treat the smoke. When we received the signal to intervene, we entered the first chamber (the kitchen). There was no heat, and the neutral plane was about 5 to 6 feet. I settled in, as planned, to proceed with an explanation of the neutral plane and flow path to my team, but my sector officer instructed me to proceed towards the fire, so I cut my time in the kitchen to head to the living room.

Upon entering the living room, I wanted, as intended, to proceed to primary research along the walls, but the neutral plane was still between 4 and 5 feet, thus useless. The sector officer instructed me to proceed to attack the fire source. I then opened the door to the room and noted the generalised blaze in the room. Tending to want to use my nozzle for the attack, but the positive pressure from the fire closed the door. When reopening the door, the sector officer ordered me to extinguish the fire. I then proceeded to and applied a

stream to the ceiling for a few seconds and then on the fire itself for about 15 seconds. The fire was brought under control, but there were still secondary fires and small reignitions. We remained in the room to complete the extinguishing of the secondary fires around the window frames and under the mattress to complete our scheduled exposure time.

TEST 2 (9h45)

Interior attack with progression in a smoky environment limited by the oxidant. It's an attack with the encapsulation agent. The following are the team members that participated to this study:

C/O CP:	Vincent Mercier
OS/Communication/Liaison:	Richard Béliveau
SST C/O:	André Bouchard
Nozzle Operator:	Jean-François Ledoux
Logistics/ Media C/D:	Claude Lussier and Sébastien Daviau

Intervention Team

SSIL Firefighter:	Alexis Proulx-Marchessault
La Régie du Nord des Maskoutains:	Yvon Roy
La Régie du Nord des Maskoutains:	Alex St-Pierre

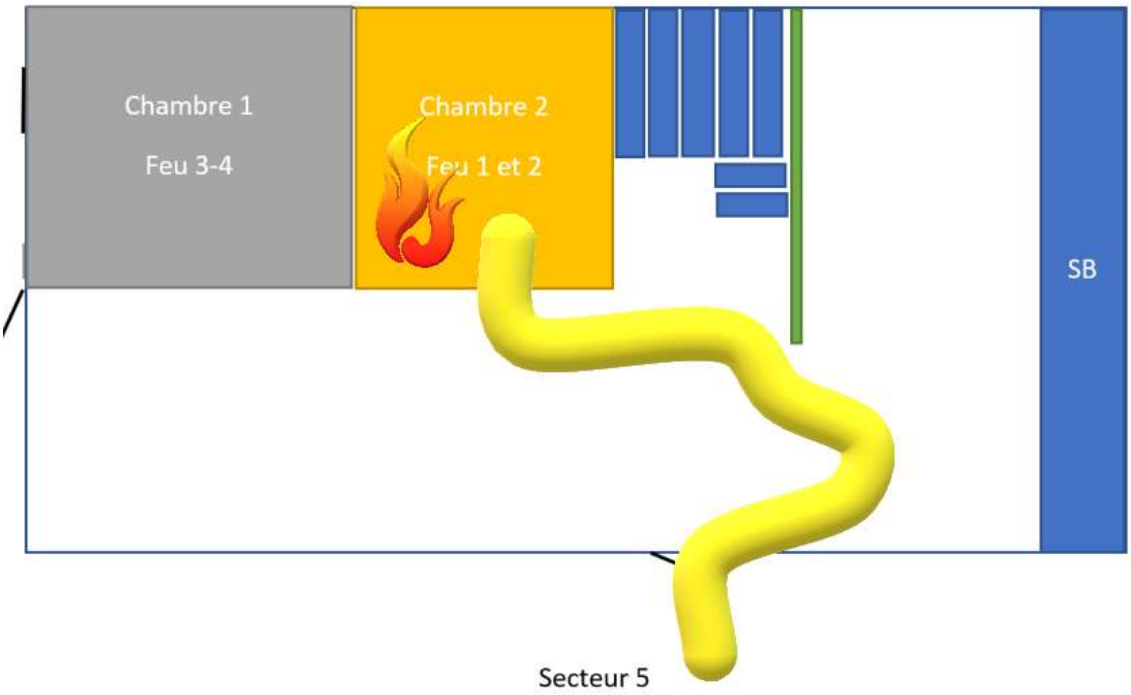
RIC IPIQ O/S: Régis Dion

SSIL: Médéric Gagnon
SSIL: Mathieu Meilleur
SSIL: Jean-Michel Gaudreault
SSIL: Jonathan Syms

IPIQ

Responsible for applying NFPA 1403 norm:	Richard Béliveau
Responsible for sector 1:	Robert Therrien
Responsible for attack support team:	Régis Labelle
Responsible for propagation team:	Pierre-Luc Biello
Responsible for operating shut-off:	Olivier Lachance

Fire setting	**9h45**
Decontamination	**10h05**
Post mortem	**10h15**



Observations by CP C/O Vincent Mercier

Fire set at scheduled time; attack team is outside the building awaiting approval from sector 1 officer.

The following are the conditions from the initial attack:

- Gray smoke
- 50% density with medium velocity
- Neutral plane in the upper third
- Bidirectional fluid convection movement through the door of sector 5.

The intervention team goes on the attack.

An interior report confirms that there is smoke and heat with little visibility. A few short water applications are visible from outside. The sector officer ordered the extinguishing, without any propagation to the structure. Clearing and ventilation of residual smoke. From sector 5, the smoke present when water is applied is 50% less. The fire is brought under control more quickly and there is a lot less smoke escaping through the door of sector 5 after it's put out.

Observations of Nozzle Operator Alexis Proulx-Marchessault SSIL Firefighter

The second fire setting was carried out as an exact copy of the first. The difference being that we used the encapsulation agent for this one. I noticed a remarkable difference. The heat in the chamber where the fire is burning faded much more quickly. We could stand up immediately following extinguishing without feeling any heat, even though we had to let the room go into flames, just like the first fire.

Another noticeable difference was in the amount of smoke in the room. During fire #1 I was communication with my team without seeing them after the extinguishing due to the residual smoke and water vapor, whereas in fire #2 I was communication with them by looking at them because visibility returned extremely quickly. Finally, the last difference I noticed was the lack of a secondary focus. However, I used the same extinguishing tactics as the first fire. During the second fire, there was neither re-ignition nor a secondary fire under the mattress or in the frames.

- Fire #2 under-ventilated with encapsulation agent:
    - Purge and fill to line: 0.3 gal (this data is a bit skewed because I also watered the siding in sector 3 during this time. My estimation is that between ½ and ⅔ of this figure was used for the cladding of sector 3).
    - Application and circumscribing: 0.25 gal (we count here also about 5 to 10 seconds that I used to soak the foam mattress post-circumscription upon request by the sector officer).

Comparison of Fires #1 and #2

Conclusion by Firefighter Alexis Proulx-Marchessault

Finally, personally, I found the experience conclusive. It has demonstrated the high efficiency of the encapsulating agent. It has proven to be effective not only in containing the fire more quickly, but also in increasing visibility by reducing the amount of smoke present and acting quickly to extinguish secondary fires by simply deflecting the primary attack.

Conclusion by C/O Vincent Mercier

Comparing fires #1 and #2, there is no doubt, from an external point of view, that fire #2 was brought under control more quickly. À la suite de l'extinction, la présence de fumée résiduelle était beaucoup moindre.

Comparative PAH Scientific Data of Fires 1 and 2 from Ottawa University

HAP (ng/cm^2)	Without EA Fire 1	With EA Fire 2
Naphthalene	0.181	0.052
Acenaphthylene	0.144	0.024
Acenaphthene	< L.D.	< L.D.
Fluorene	0.048	0.019
Dibenzothiophene	0.007	0.007
Phenanthrene	0.210	0.078
Anthracene	0.036	0.006
Fluoranthene	0.111	0.012
Pyrene	0.093	0.009
Retene	< L.D.	< L.D.
Benzo[*a*]anthracene	0.042	< L.D.
Chrysene	0.076	< L.D.
Benzo[*b*]fluoranthene	< L.D.	< L.D.
Benzo[*k*]fluoranthene	< L.D.	< L.D.
Benzo[*e*]pyrene	< L.D.	< L.D.
Benzo[*a*]pyrene	< L.D.	< L.D.
Indene[1,2,3-*cd*] pyrene	< L.D.	< L.D.
Dibenzo[*a,h*]anthracene	< L.D.	< L.D.
Benzo[*ghi*]pyralene	0.017	< L.D.
< L.D. = below the detection limit		

TEST 3 (10h30)

Interior attack with a ventilated compartment; attack with water. Team members who participated in this study include:

C/O CP:	Vincent Mercier
OS/Communication/liaison:	Richard Béliveau
SST C/O:	André Bouchard
Nozzle Operator:	Alexis Proulx-Marchessault
Logistics/ Media C/D:	Claude Lussier et Sébastien Daviau

Intervention Team

SSIL Firefighter:	Jean-François Ledoux
La Régie du Nord des Maskoutains:	Patrick Roy
La Régie du Nord des Maskoutains:	Gabriel Lapointe

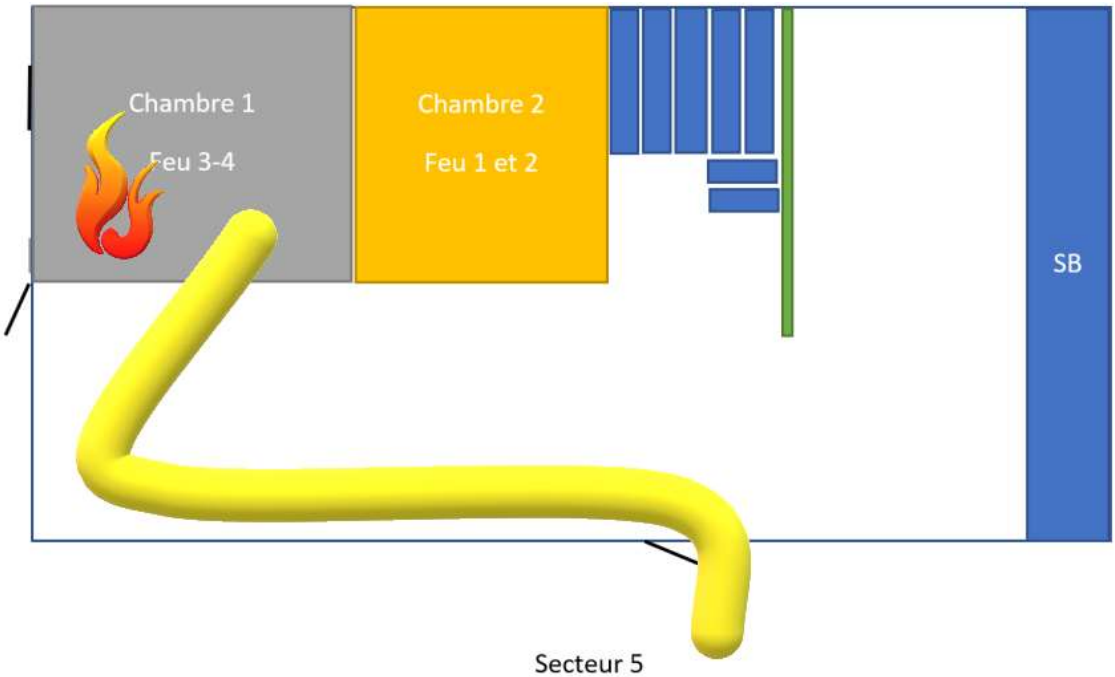
RIC IPIQ O/S: Régis Dion

SSIL: Médéric Gagnon
SSIL: Mathieu Meilleur
SSIL: Jean-Michel Gaudreault
SSIL: Jonathan Syms

IPIQ

Responsible for applying NFPA 1403 norm:	Richard Béliveau
Responsible for sector 1:	Robert Therrien
Responsible for attack support team:	Olivier Lachance
Responsible for propagation team:	Régis Labelle
Responsible for operating shut-off:	Pierre-Luc Biello

Fire setting	**10h30**
Decontamination	**10h40**
Post mortem	**10h50**



Secteur 5

Observations by CP C/O Vincent Mercier

Fire set at scheduled time the attack team is outside the building awaiting approval from the sector officer. The conditions through the main entrance for the initial attack are the following:

- Gray smoke
- 30% density with low velocity
- Top quarter neutral plane
- Bidirectional fluid convection movement through the door of sector 5.

The conditions through sector 2 window during the initial attack are as follows:

- Gray smoke
- 70% density with great velocity
- Absent neutral plane
- Unidirectional fluid convection movement through the sector 2 window.

The intervention team goes on the attack.

An indoor report confirms smoke and heat with little visibility. Several short applications of water can be seen from the outside. As soon as you enter the building, the conditions are in pre-flashover. Flames billowing out of sector 2 window. The fire spreads to the adjoining chamber. Extinguishing ordered by the sector officer, no propagation to the structure. Clearing and ventilation of residual smoke.

Observations of Nozzle Operator Jean-François Ledoux SSIL Firefighter

Interior attack in quadrant B with compartment ventilated by the window which represents a complete opening towards sector 2. Extinguishing with water only.

The nozzle was purged and checked before entering the building. During the interior progression, we have conditions for a generalized flashover with pyrolysis on the floor. The initial water application was done with a cylindrical jet by treating the surfaces from left to right of the compartment and then a direct application to the fire source.

There was a substantial amount of smoke generation at the source of the fire, and I had to reapply water on occasion.

TEST 4 (11h15)

Internal attack in a ventilated compartment; attack with encapsulating agent. The following are the team members that participated in this study:

C/O CP:	Vincent Mercier
OS/Communication/Liaison:	Richard Béliveau
SST C/O:	André Bouchard
Nozzle Operator:	Alexis Proulx-Marchessault
Logistics/ Media C/D:	Claude Lussier et Sébastien Daviau

Intervention Team

SSIL Firefighter:	Jean-François Ledoux
La Régie du Nord des Maskoutains:	Dany Beaulac
La Régie du Nord des Maskoutains:	Yves Guérette

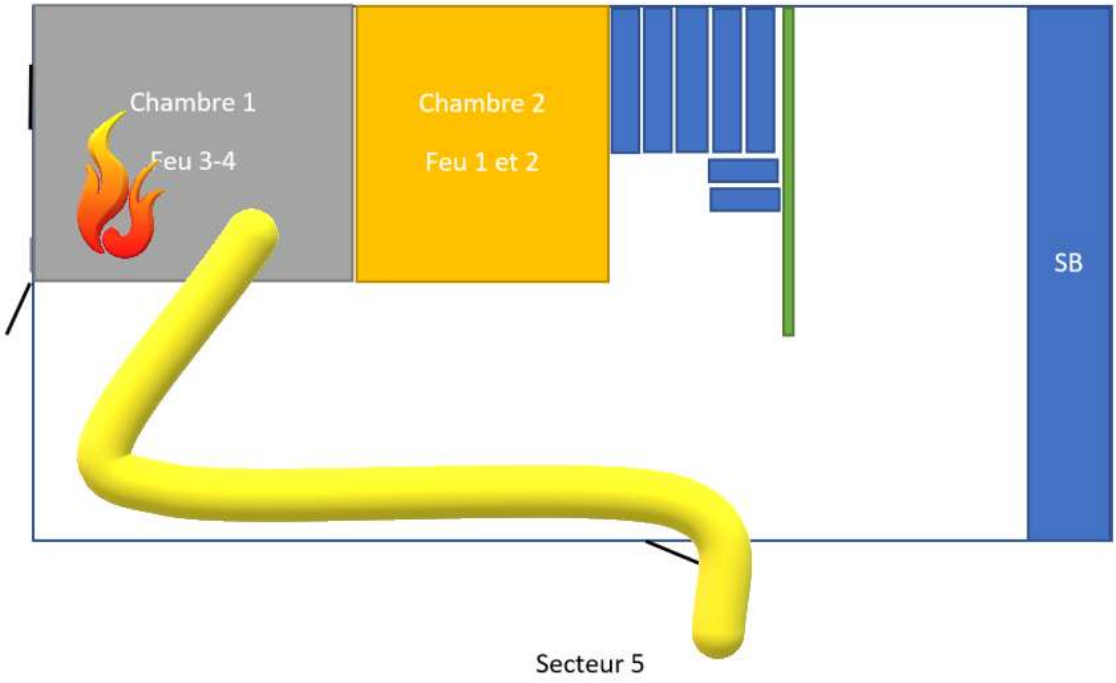
RIC IPIQ O/S: Régis Dion

SSIL: Médéric Gagnon
SSIL: Mathieu Meilleur
SSIL: Jean-Michel Gaudreault
SSIL: Jonathan Syms

IPIQ

Responsible for applying NFPA 1403 norm:	Richard Béliveau
Responsible for sector 1:	Robert Therrien
Responsible for attack support team:	Pierre-Luc Biello
Responsible for propagation team:	Olivier Lachance
Responsible for operating shut-off:	Régis Labelle

Fire set	**11h15**
Decontamination	**10h35**
Post mortem	**10h45**



Fire #4

Interior attack in B quadrant with the compartment ventilated by the window with a full opening to sector 2. Water spraying with encapsulation agent.

N.B.: The compound had already accumulated a lot of energy from the previous fire.

Observations by CP C/O Vincent Mercier

Fire set at the scheduled time; the intervention team in attack position is outside the building awaiting approval from the sector officer. The conditions through the main entrance door for the initial attack are the following:

- Gray smoke
- 30% density with little velocity
- Neutral plane in the upper plane
- Bidirectional fluid convection movement through the door of sector 5.

The conditions through the sector 2 window during the initial attack as follows:

- Gray smoke
- 70% density with avec considerable velocity
- Absent neutral plane
- Unidirectional fluid convection movement through the sector 2 window.

The intervention team goes on the attack.

The interior report confirms smoke, heat with little visibility. Several short water applications are noticeable from the outside. Upon entering the building, the interior conditions are pre-flashover. Lots of flames are escaping from the window of Area 2. The fire spreads into the adjoining compartment. Fire extinguished by the Sector Officer, no spread to the structure. Clearance and ventilation of residual smoke.

From the outside, the extinguishing was faster and there was much less smoke coming out of the door in Area 5.

Firefighter Jean-François Ledoux's Report

The jet was purged and checked before entering the building. Validation that the encapsulation agent was present before entry. Fast-evolving and growth of blaze in the compartment. We are in generalized flashover conditions in the room with flames approximately two feet to the floor. The water application was performed the same way with the encapsulation agent, but I used less water on the fire for the same control.

After the surface treatment was applied, the flames on the floor disappeared in a fraction of a second.

There was considerably less smoke at the source of the fire after the water application.

The fourth fire was ventilated with the encapsulation agent:

- Purge and fill the line: 0.04 gal (the line had not been purged of its encapsulation agent from fire #2).
- Application and circumscribing: 0.06 gal.

Comparisons of Fires #3 and #4

Firefighter Jean-François Ledoux's Conclusion on Fires 3 and 4

The use of the encapsulating agent in indoor extinguishing has a very good performance and the decrease in indoor smoke generation was striking in addition to the most important factor, the 2nd fire was much more violent.

CP C/O Vincent Mercier's Conclusion

Comparing fires #3 and #4, there is no doubt from an external point of view that fire #4 was brought under control more quickly. After the extinction, there was much less residual smoke.

Comparative PAH Scientific Data of Fires 3 and 4 from Ottawa University

(The Mayors of the RIPINM [The North Maskoutins Intermunicipal Board of Fire Protection] have seen the effectiveness at this point)

PAH (ng/cm^2)	Without EA Fire 3A	With EA Fire 4A
Naphthalene	0.103	0.084
Acenaphthylene	0.030	0.027
Acenaphthene	< D.L.	< D.L.
Fluorene	0.030	0.010
Dibenzothiophene	0.021	< D.L.
Phenanthrene	0.230	< D.L.
Anthracene	0.010	0.004
Fluoranthene	0.045	0.017
Pyrene	0.038	0.023
Retene	< D.L.	0.045
Benzo[*a*]anthracene	< D.L.	< D.L.
Chrysene	< D.L.	< D.L.
Benzo[*b*]fluoranthene	< D.L.	< D.L.
Benzo[*k*]fluoranthene	< D.L.	< D.L.
Benzo[*e*]pyrene	< D.L.	< D.L.
Benzo[*a*]pyrene	< D.L.	< D.L.
Indeno[1,2,3-*cd*]pyrene	< D.L.	< D.L.
Dibenzo[*a,h*]anthracene	< D.L.	< D.L.
Benzo[*ghi*]pyrene	< D.L.	< D.L.

TEST 5 (12h45)

Transient attack; water attack. The following are the team members who participated in this study:

CP C/O:	Vincent Mercier
OS/Communication/Liaison:	Richard Béliveau
SST C/O:	André Bouchard
Nozzle Operator:	Alexis Proulx-Marchessault
Logistics/ Media C/D:	Claude Lussier et Sébastien Daviau

Intervention Team

SSIL Firefighter:	Jean-François Ledoux
La Régie du Nord des Maskoutains:	Philippe Bonin
La Régie du Nord des Maskoutains:	Fred Moisan

RIC IPIQ O/S: Régis Dion

SSIL: Médéric Gagnon
SSIL: Mathieu Meilleur
SSIL: Jean-Michel Gaudreault
SSIL: Jonathan Syms

IPIQ

Responsible for applying the NFPA 1403:	Richard Béliveau
Responsible for sector 1:	Robert Therrien
Responsible for attack support team:	Régis Labelle
Responsible for propagation team:	Pierre-Luc Biello
Responsible for operating shut-off:	Olivier Lachance

Fire set	**12h45**
Post mortem	**13h05**

Fire #5:

Transient attack on 2nd floor through sector 3 in the left frame.

Conclusion by SSIL Firefighter Jean-François Ledoux for Fire #5

Purges jet, properly arranged with the cylindrical pattern selected and tested beforehand. I was instructed to let the staff of La Régie du Nord des Maskoutains operate the lance. Initial jet opening with a diffused pattern. After the correction for a replacement of the jet to a cylindrical patter, there was some movement to it, which may have altered its effectiveness. The spray stabilized afterwards, and the water application was effective. We stopped the water application when the flame went out and the smoke lost its velocity in the right window.

Observations by the CP C/O Vincent Mercier

My position as a sector 5 CP does not allow me to have a visual of sector 3 and to comment on the extinction.

TEST 6 (13h30)

Transient attack; attack with the encapsulating agent. The following are the team members that participated in this study:

PC C/O :	Vincent Mercier
OS/Communication/Liaison :	Richard Béliveau
SST C/O :	André Bouchard
Nozzle Operator:	Alexis Proulx-Marchessault
Logistics/ Media C/D:	Claude Lussier et Sébastien Daviau

Intervention Team

SSIL Firefighter:	Jean-François Ledoux
La Régie du Nord des Maskoutains:	Yves Guérette
La Régie du Nord des Maskoutains:	Patrick Gaudette

RIC IPIQ O/S: Régis Dion

SSIL: Médéric Gagnon
SSIL: Mathieu Meilleur
SSIL: Jean-Michel Gaudreault
SSIL: Jonathan Syms

IPIQ

Responsible for applying the NFPA 1403:	Richard Béliveau
Responsible for sector 1:	Robert Therrien
Responsible for attack support team:	Olivier Lachance
Responsible for propagation team:	Régis Labelle
Responsible for operating shut-off:	Pierre-Luc Biello

Fire setting	**13h30**
Post mortem	**13h50**

Fire #6:

Transient attack on the 2nd floor by sector 4.

Conclusion From Firefighter Jean-François Ledoux for Fire #6

N.B.: I could see an obstacle between the two windows. We were requested to place ourselves at an angle to the window for the water application.

Jet purged, properly arranged and the cylindrical pattern selected and tested beforehand. I was ordered to let the staff of La Régie du Nord des Maskoutains operate the nozzle.

Fire #6 transient with encapsulating agent:

- Purge and fill the line: 0.32g (the line had been purged of the encapsulating agent during fire #5 for use by the interior attack team).

- Application and circumscribing: 0.08 first use while waiting for the burnback, 0.38g the second use of post burnback, hence, total use of 0.46g in transient.

Observation by the CP C/O Vincent Mercier

My position as CP in sector 5 does not allow me to have a visual of sector 3 and comment on the extinction.

Conclusion

Primary objective is to validate the use of the encapsulating agent in preflashover conditions during interior attacks to ensure the safety of firefighters.

The fire setting has confirmed that the use of the encapsulating agent with water to a 1% concentration is safe and recommended. The interior conditions were rapidly improved during both fires with the encapsulating agent in comparison with the use of water only.

The second objective is to determine if the use of the encapsulating agent reduces the amount of smoke development and thereby reducing firefighters' exposure to it during firefighting.

Use of the encapsulating agent considerably reduced smoke development discernible to both internal and external participants.

The third objective is to compare the speed of extinction in similar conditions.

The firefighters assigned to circumscribe the fire have remarked a rapid extinction, as well as an absence of reigniting while using the encapsulating agent.

The fourth objective is to compare the level of firefighters' exposure to PAH during fire setting and extinctions with or without encapsulation agent.

Although the analysis of the conditions during the fire setting were not optimal, considering that we did not measure the amount of fuel accurately and we could not control the environmental conditions (wind level, humidity, and pressure), the following results have nonetheless demonstrated:

- An improved concentration of PAH 18 times out of 20
- An equal level 1 time out of 20
- A deterioration 1 time out of 20

Scientific Data of PAH Comparison of fires 1 to 4 from Ottawa University

PAH (ng/cm²)	Without EA Fire 1	With EA Fire 2	Without EA Fire 3	With EA Fire 4
Naphthalene	0.181	0.052	0.103	0.084
Acenaphthylene	0.144	0.024	0.030	0.027
Acenaphthene	< D.L.	< D.L.	< D.L.	< D.L.
Fluorene	0.048	0.019	0.030	0.010
Dibenzothiophene	0.007	0.007	0.021	< D.L.
Phenanthrene	0.210	0.078	0.230	< D.L.
Anthracene	0.036	0.006	0.010	0.004
Fluoranthene	0.111	0.012	0.045	0.017
Pyrene	0.093	0.009	0.038	0.023
Retene	< D.L.	< D.L.	< D.L.	0.045
Benzo[*a*]anthracene	0.042	< D.L.	< D.L.	< D.L.
Chrysene	0.076	< D.L.	< D.L.	< D.L.
Benzo[*b*]fluoranthene	< D.L.	< D.L.	< D.L.	< D.L.
Benzo[*k*]fluoranthene	< D.L.	< D.L.	< D.L.	< D.L.
Benzo[*e*]pyrene	< D.L.	< D.L.	< D.L.	< D.L.
Benzo[*a*]pyrene	< D.L.	< D.L.	< D.L.	< D.L.
Indene[1,2,3-*cd*] pyrene	< D.L.	< D.L.	< D.L.	< D.L.
Dibenzo[*a,h*]anthracene	< D.L.	< D.L.	< D.L.	< D.L.
Benzol[*ghi*]pyralene	0.017	< D.L.	< D.L.	< D.L.

These data are encouraging and suggest that the use of the encapsulating agent results in firefighters being exposed to a lower level of PAHs in the course of their duties. When risk cannot be eliminated at the source, the most effective corrective measure is to mitigate the elements at risk with risk. The use of the encapsulating agent is therefore at level 2 of CNESST prevention.

Expected Results:

- Ensure the use of the encapsulating agent is safe for indoor use:

  The use of 1% of the encapsulating agent is safe for indoor attacks.

- Improve extinction times:

  An improvement was noticeable by all the participants during all the fire settings.

- Reduce smoke production by increasing the speed of extinction:

  An improvement was noticeable by all participants during all the fire settings. Furthermore, reignition also slowed down considerably.

- Reduce the amount of polycyclic aromatic hydrocarbon particles after extinction:

  Encouraging and positive result. A scientific study of indoor fire settings with a building and controlled fuel is required to confirm the thesis.

- <u>Reduce the amount of water during extinction:</u>

  La Régie du Nord des Maskoutains

  Improved resource efficiency (reduction in the use of water to extinguish a fire). Cost reduction: we have water meters; we take water from the aqueduct which is billed to us and is treated.

  Reduction of tanker trips, thus limiting the number of tankers round trips (travel distance for distant water points).

  Keeps personnel on the scene, less risk of injury on the road, less stress for the firefighter, CP has its resources at the fire.

  Decreased response time (lower costs, fewer firefighters needed).

- <u>Does not affect the environment</u>:
  When we empty our pool on site, the remaining 5000 gallons are poured into the sewer or ditch.

ANNEX I

Firefighter Hoods 2021 – Sampling for Polycyclic Aromatic Hydrocarbons (PAHs)

Prepared by Dr. Jules M. Blais, Professor, Department of Biology, University of Ottawa

This report presents the results of PAH analysis for a study initiated and performed by Vincent Mercier under the agreement between the Service de sécurité incendie de la Ville de Laval (SSIL) and the University of Ottawa dated May 15, 2021. As stated in Appendix 1 of this Agreement, “A report consisting of PAH concentrations in samples will be provided to the Company. This work will consist of reporting results (PAHs on wipes) and does not include interpretation of results.”

Collection and transportation of firefighter hoods:

These collections were performed by Chief Vincent Mercier and colleagues with Service de sécurité incendie de Laval, under the supervision of Division Chief, Claude Lussier. The University of Ottawa was not involved in this aspect of the project.

Laboratory methods:

Alpha Wipes were moistened with 70% isopropanol. The hoods were then wiped to the left of the chin, using a 6x 5 cm template to ensure a consistent sampling area. Wipes were spiked with deuterated PAHs as recovery standards (Cambridge Isotope Laboratories Inc., Tewksbury, MA, USA) and extracted in 3:1 hexane acetone via sonication for 30 minutes, followed by evaporation under a gentle nitrogen stream. 5 mL water was added to cause separation of phases and the top organic solvent layer containing PAHs was removed. This was concentrated to 1 mL, spiked with p-terphenyl-d14 (Cambridge Isotope Laboratories Inc., Tewksbury, MA, USA) as an internal standard and then PAHs were quantified by gas chromatography (Agilent 7890B)-mass spectrometry (Agilent 5977B). Samples were method blank, and recovery corrected.

Brûler une maison pour la science | Journal de Montréal (« Burning Down a House for Science »):

https://www.journaldemontreal.com/2021/05/08/bruler-une-maison-pour-la-science-1

https://www.journaldemontreal.com/2021/05/08/bruler-une-maison-pour-la-science-1?utm_source=j5_app&utm_medium=social&utm_campaign=share_article

ANNEX II

Conclusion From La Régie du Nord des Maskoutains

Since its creation on January 1, 2017, La Régie du Nord des Maskoutains has made sure to be at the forefront of new techniques and products to fight fires.

It has been two years since we added skills training with IPIQ to our practice schedule. Through this partnership, we learned that SSIL was looking for a building to use for their scientific fire settings with the product. Our involvement in the fire settings was facilitated not only by our knowledge of the encapsulating agent that we have introduced into our service since January 26, 2021, but also by the fact that we have a house on our territory available to perform these scientific tests. The only request from La Régie du Nord des Maskoutains to SSIL and IPIQ was to participate in the scientific fire settings. We were excited to attend and contribute to this study, as we were already aware of the benefits of using the encapsulating product. The encapsulating agent was introduced in our department to replace class A and B foams. The goal is to simplify purchases by using a single product that has no expiration date and does not damage equipment because it has a neutral pH.

The use of this product has not required any changes to our products or procedures. The May 8, 2021, fire sessions confirmed our expectations of the beneficial effects of using the encapsulating agent, i.e., a reduction in the need for water, faster extinguishing of fires, as well as ease of implementation for our team. In conclusion, with all the benefits of this product, regardless of the different issues in our fire departments, we have all found our reason to use the encapsulating agent.

ANNEX III

Project – ENCAPSULATION AGENT TO PREVENT CANCER

Prepared by:
JEAN-SÉBASTIEN ROCH and CLAUDE LUSSIER
SSIL OPERATIONS DIVISION CHIEFS

2022-03-28

Purpose/Project Justifications

The use of the encapsulating agent significantly reduces the amount of water required to extinguish a fire. We can take the example of the construction debris fire at 140 Saulnier Street. After four days of intensive spraying, the use of the encapsulating agent significantly reduced the flames and smoke production within two hours. The effectiveness of this product in fighting three dimensional fires is particularly impressive. Its use from day one could have minimized the amount of water used, the production of smoke, the number of hours worked by firefighters, but above all, its use could have prevented the inhalation of carcinogenic fumes by our personnel.

Project Objectives/Benefits

A. Objective

- Reducing firefighters' exposure to carcinogenic fumes

This objective has been validated with:

- A six-month trial period
- Validation of usage costs for the use of the encapsulating agent

B. Benefits

- Reduce firefighters' probability of developing cancer
- Take all necessary measures to ensure the safety and protect the physical and mental health of its employees (article L. 4121-1 of the Labour Code)
- Stand out as an employer in the deployment of innovative measures to protect its employees.

Assumptions and Conditions

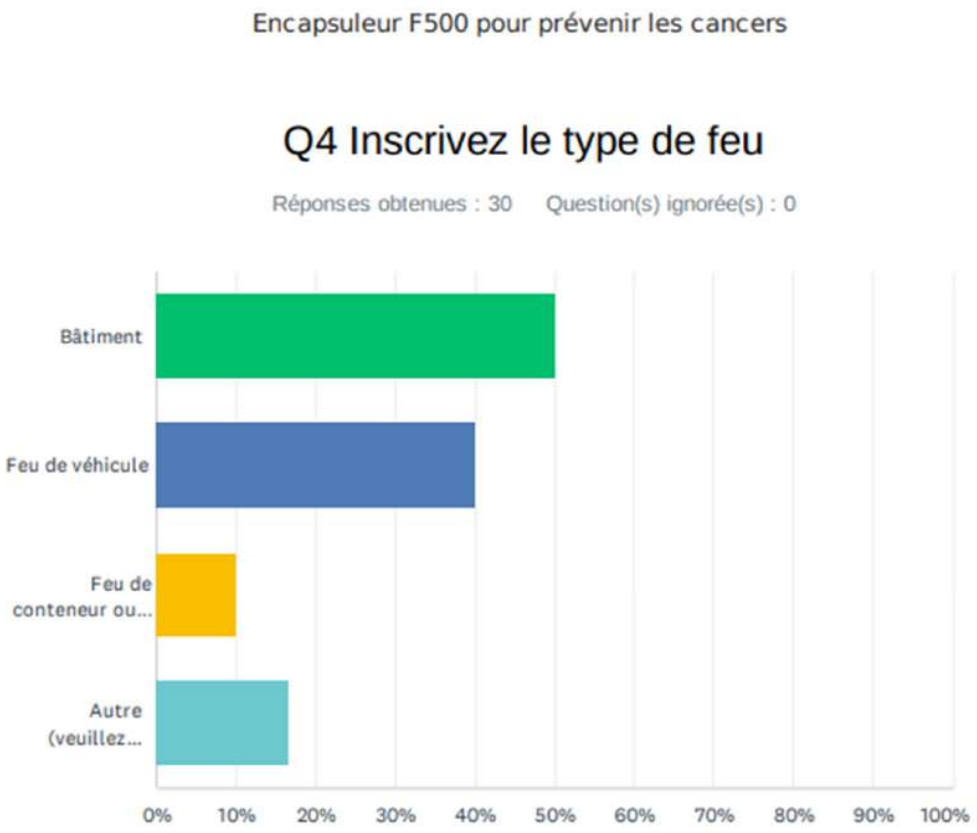
The following are the assumptions and conditions:

- Use of the encapsulation agent
  - Reduces firefighters' exposure to carcinogenic fumes
  - Reduces the amount of water required to extinguish a fire

- Reduces intervention time

Survey Results

Below are the results of the different survey questions:

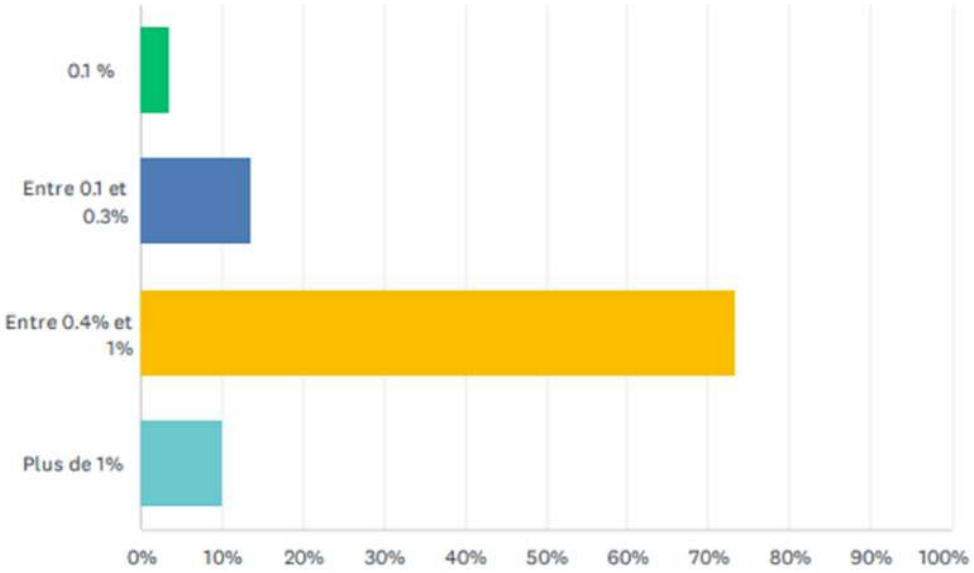


CHOIX DE RÉPONSES	RÉPONSES	
Bâtiment	50.00%	15
Feu de véhicule	40.00%	12
Feu de conteneur ou de déchet	10.00%	3
Autre (veuillez préciser)	16.67%	5
Nombre total de participants: 30		

Encapsuleur F500 pour prévenir les cancers

Q6 Quel pourcentage de F500 avez-vous utilisé?

Réponses obtenues : 30 Question(s) ignorée(s) : 0

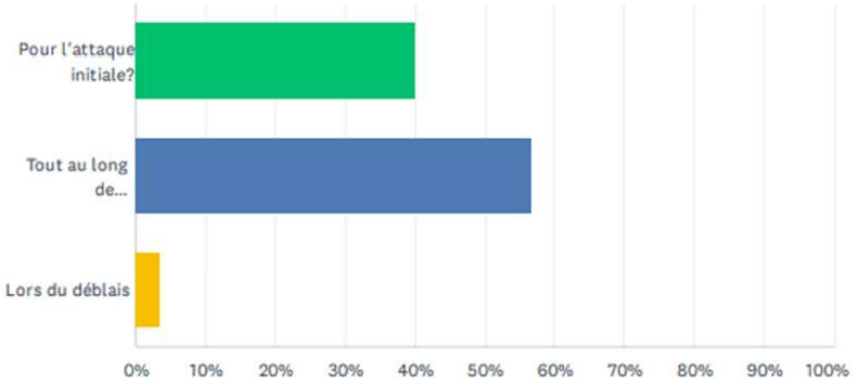


CHOIX DE RÉPONSES	RÉPONSES	
0.1 %	3.33%	1
Entre 0.1 et 0.3%	13.33%	4
Entre 0.4% et 1%	73.33%	22
Plus de 1%	10.00%	3
TOTAL		**30**

Encapsuleur F500 pour prévenir les cancers

Q8 L'application de l'encapsuleur a été fait à quel moment ?

Réponses obtenues : 30 Question(s) ignorée(s) : 0



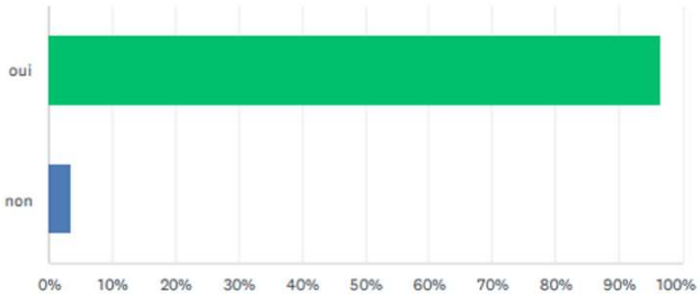
Statistiques du quiz			
Pourcentage de réponses correctes 100%	Score moyen 1.0/1.0 (100%)	Écart-type 0.00	Difficulté 1/1

CHOIX DE RÉPONSES	SCORE	RÉPONSES	
✓ Pour l'attaque initiale?	1/1	40.00%	12
✓ Tout au long de l'intervention?	1/1	56.67%	17
✓ Lors du déblais	1/1	3.33%	1
TOTAL			30

Encapsuleur F500 pour prévenir les cancers

Q9 Est-ce que vous considérez que l'utilisation de l'encapsuleur F500 a amélioré l'efficacité d'extinction?

Réponses obtenues : 30 Question(s) ignorée(s) : 0

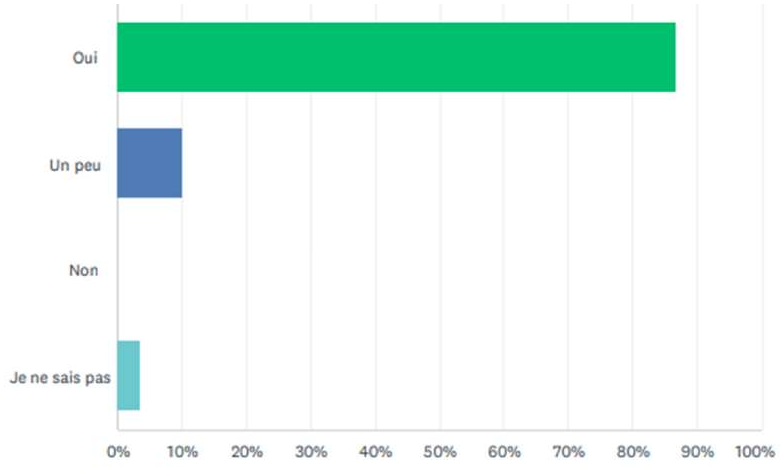


CHOIX DE RÉPONSES	RÉPONSES	
oui	96.67%	29
non	3.33%	1
TOTAL		30

Encapsuleur F500 pour prévenir les cancers

Q10 Est-ce que l'utilisation de l'encapsulateur F500 a réduit la quantité d'eau requise pour circonscrire l'incendie?

Réponses obtenues : 30 Question(s) ignorée(s) : 0

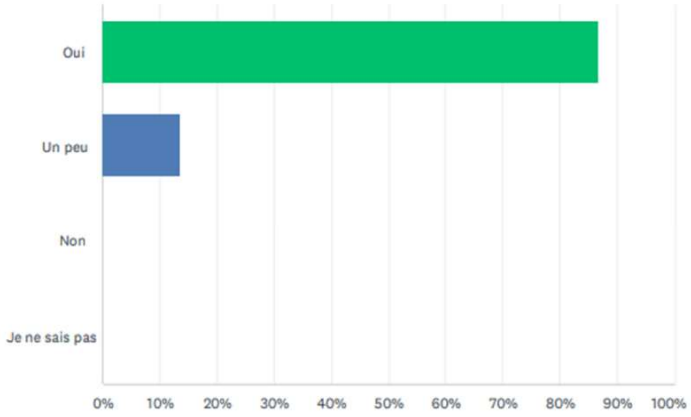


CHOIX DE RÉPONSES	RÉPONSES	
Oui	86.67%	26
Un peu	10.00%	3
Non	0.00%	0
Je ne sais pas	3.33%	1
TOTAL		30

Encapsuleur F500 pour prévenir les cancers

Q11 Est-ce que l'application de l'encapsuleur F500 a réduit la quantité de fumée noire?

Réponses obtenues : 30 Question(s) ignorée(s) : 0

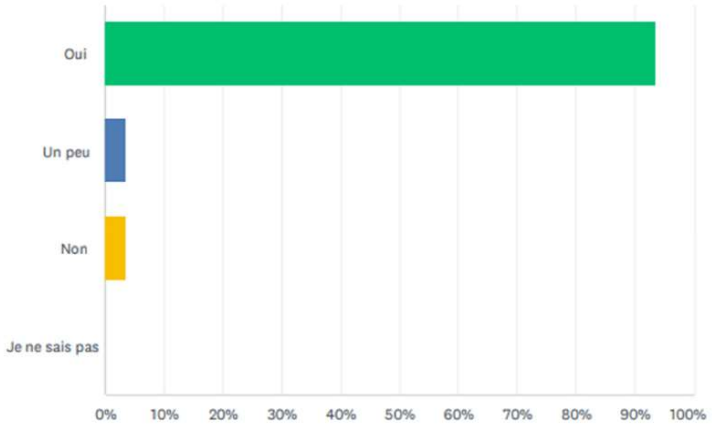


CHOIX DE RÉPONSES	RÉPONSES	
Oui	86.67%	26
Un peu	13.33%	4
Non	0.00%	0
Je ne sais pas	0.00%	0
TOTAL		30

Encapsuleur F500 pour prévenir les cancers

Q12 Est-ce que l'utilisation de l'encapsuleur F500 a permis de réduire le temps d'intervention et de remettre les unités en devoir plus rapidement?

Réponses obtenues : 30 Question(s) ignorée(s) : 0

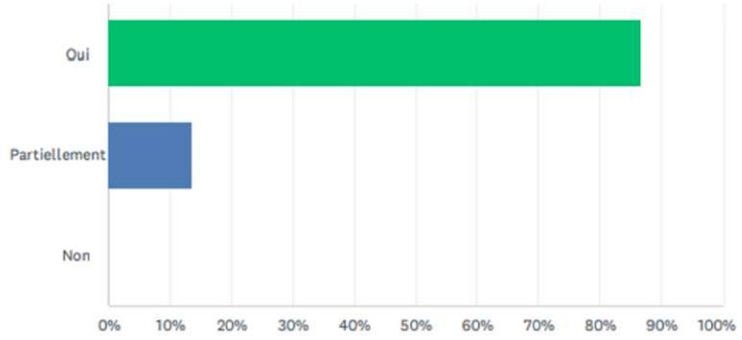


CHOIX DE RÉPONSES	RÉPONSES	
Oui	93.33%	28
Un peu	3.33%	1
Non	3.33%	1
Je ne sais pas	0.00%	0
TOTAL		30

Encapsuleur F500 pour prévenir les cancers

Q13 Est-ce que l'utilisation de l'encapsuleur F500 a réduit l'exposition des pompiers aux éléments cancérigènes?

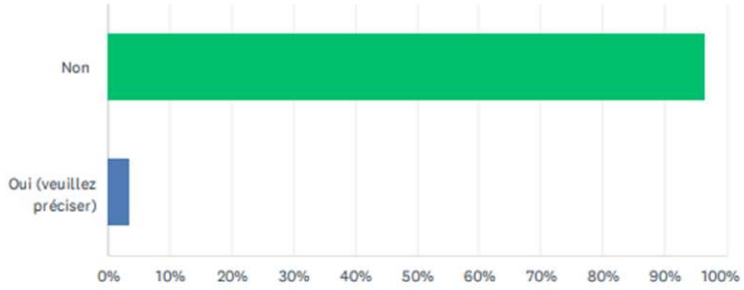
Réponses obtenues : 30 Question(s) ignorée(s) : 0



CHOIX DE RÉPONSES	RÉPONSES	
Oui	86.67%	26
Partiellement	13.33%	4
Non	0.00%	0
TOTAL		30

Q14 Est-ce que vous avez constatez des risques associés à l'utilisation de l'encapsuleur F500?

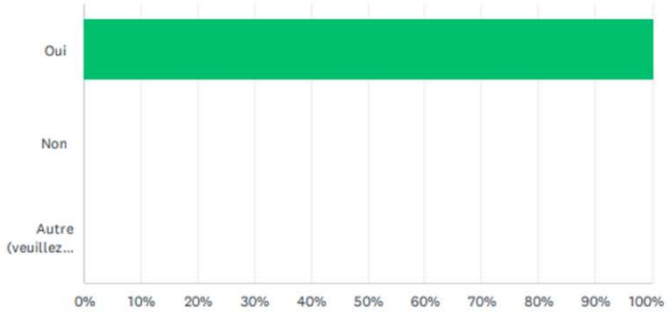
Réponses obtenues : 30 Question(s) ignorée(s) : 0



CHOIX DE RÉPONSES	RÉPONSES	
Non	96.67%	29
Oui (veuillez préciser)	3.33%	1
TOTAL		30

Q15 En conclusion, est-ce que vous recommandez l'utilisation de l'encapsuleur F500 pour prévenir les cancers chez les pompiers?

Réponses obtenues : 30 Question(s) ignorée(s) : 0



CHOIX DE RÉPONSES	RÉPONSES	
Oui	100.00%	30
Non	0.00%	0
Autre (veuillez préciser)	0.00%	0
TOTAL		30

Cost of Using the Encapsulation Agent to Fight All Fires

- The cost of testing for the six-month period requires 50 five-gallon containers for a total of approximately $12,350. The annual cost is therefore estimated at $25,000.
- The Chief of Technical Support Operations has assessed the annual consumption between March 22, 2021, and March 18, 2022, at 138 five-gallon containers. If we consider that the inventory of the 1605 was replaced by the encapsulation agent and that we added an inventory in the fire stations, we can say that the annual consumption is between 100 and 140 containers of five gallons, between $25,000 and $35,000.
- Since there is currently an annual budget of $48,323 for the use of foam, there is no need to request additional funds to implement this test.

Conclusion

Following the testing of the encapsulation agent, 100% of respondents recommend using this product to prevent cancer. The use of the encapsulating agent could significantly reduce the firefighter's exposure to carcinogenic fumes and thereby reduce the probability of developing cancer. The cost of implementing this procedure for the SSIL is between $25,000 and $35,000 per year.

The encapsulating agent is a product with the following qualities:

- Non-corrosive,
- Non-toxic,
- Does not contain any chemicals such as PFOS (perfluorooctane sulfonate) or PFOA (perfluorooctanoic acid),
- 100% biodegradable.

This product is listed as an oil spill surface cleaning agent on the official US government website EPA's (Environmental Protection Agency) NCP (National Contingency Plan).

Encapsulation Agent

Applications

Vehicle Fires

- Magnesium component without explosion
- Class B polarized or non-polarized fuel
- Lithium ion batteries
- Tires
- Ideal 3 dimensional lights

Transformer Fires

- Rapidly reduces the temperatures of metals
- Encapsulates and reduces the temperature of hot oils
- Can be used on transformers (345 KV), at a distance of 125 ft
- Stops the fire very quickly

Fuel Dust Fires

- Push-free application
- Optimal penetration
- Rapidly extinguished

Structural Fires

- Very quickly extinguished
- No possibility of reignition
- Speedy overhaul
- Less damage caused by water
- Easier to clean
- Less reignitions
- Reduces the temperature and protects the adjacent structures

As the encapsulating agent is fast acting and reduces the release of toxins, it is considered a cancer and environmental risk reduction tool.

Encapsulation Agent

Applications

Class D Fires

- No explosion in contact with water
- Cools very rapidly
- Excellent for metal fabricants that have to cool the metals
- Magnesium, titanium, etc.

Tire Fires

- Very fast to stop
- Reduces very rapidly the metals included in the tires
- Encapsulates the residual oil and reduces its temperature
- Reduces black smoke
- Reduces toxins
- Penetrates the entire tire pile

Fuel Fires

- Push-free applications
- Optimal penetration
- Fast extinguishing
- Can be used with the drill rod for deep hot spots
- Impairs the fire to reignite

Fuel Spills

- Quick to put out of danger
- Encapsulates fuel
- No absorbent required
- Less need for water; less run-off
- Less cleaning, if applicable
- No hazardous materials should be removed
- Less expensive

For these reasons we are moving forward with the use of the encapsulating agent to prevent cancer in Laval firefighters.