SAFEX Webinar #4: Transportation of Explosives
19 October 2022: Session 2

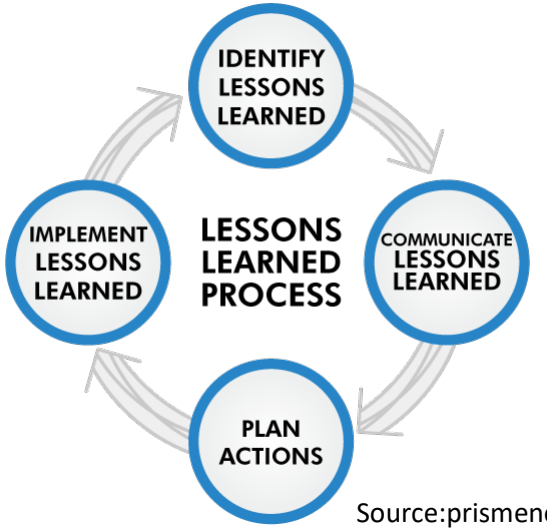
SAFEX International

Program

1. **Ammonium Nitrate Vehicle Explosion Investigation**
   Noel Hsu – ORICA

2. **Mobile Explosives Manufacturing Unit (MEMU) – smoke incident**
   Stéphan Ruhlmann - EPC

3. **Emulsion Truck Fire**
   Christo Peltz - AECI



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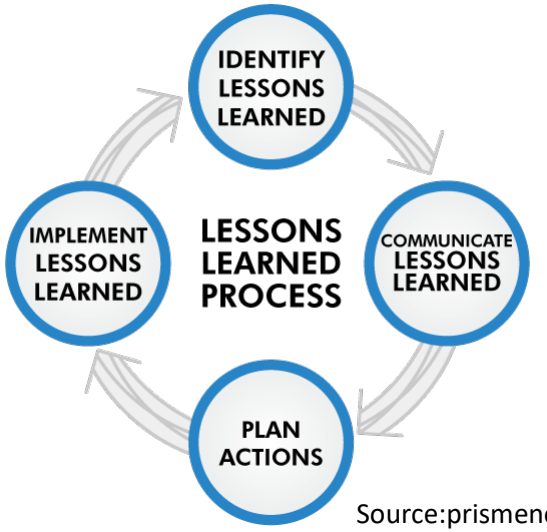
Questions and Answers

Please type questions into the Chat



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SAFEX WEBINAR 4
OCTOBER 19 2022

AN TRANSPORT INVESTIGATION BY DEPT OF NATURAL RESOURCES AND MINES QLD

ORICA

NOËL HSU

Acknowledgements: Thanks to the Dept of Natural Resources and Mines, Queensland for making the simulation and investigation available to the public.

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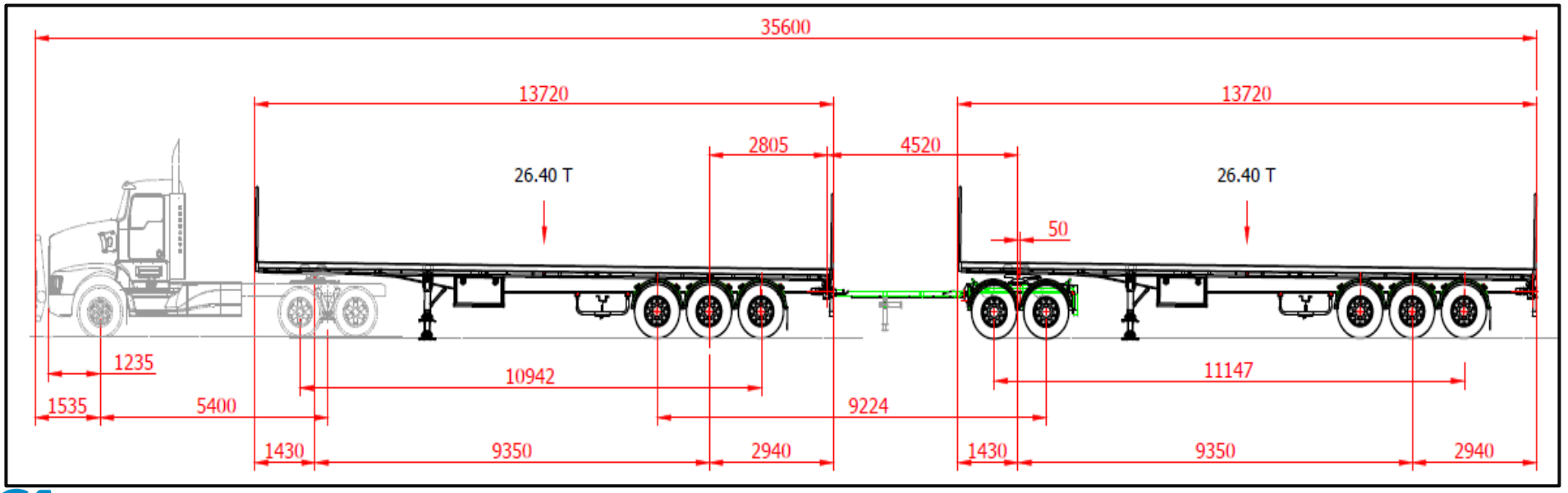
Scope of investigation

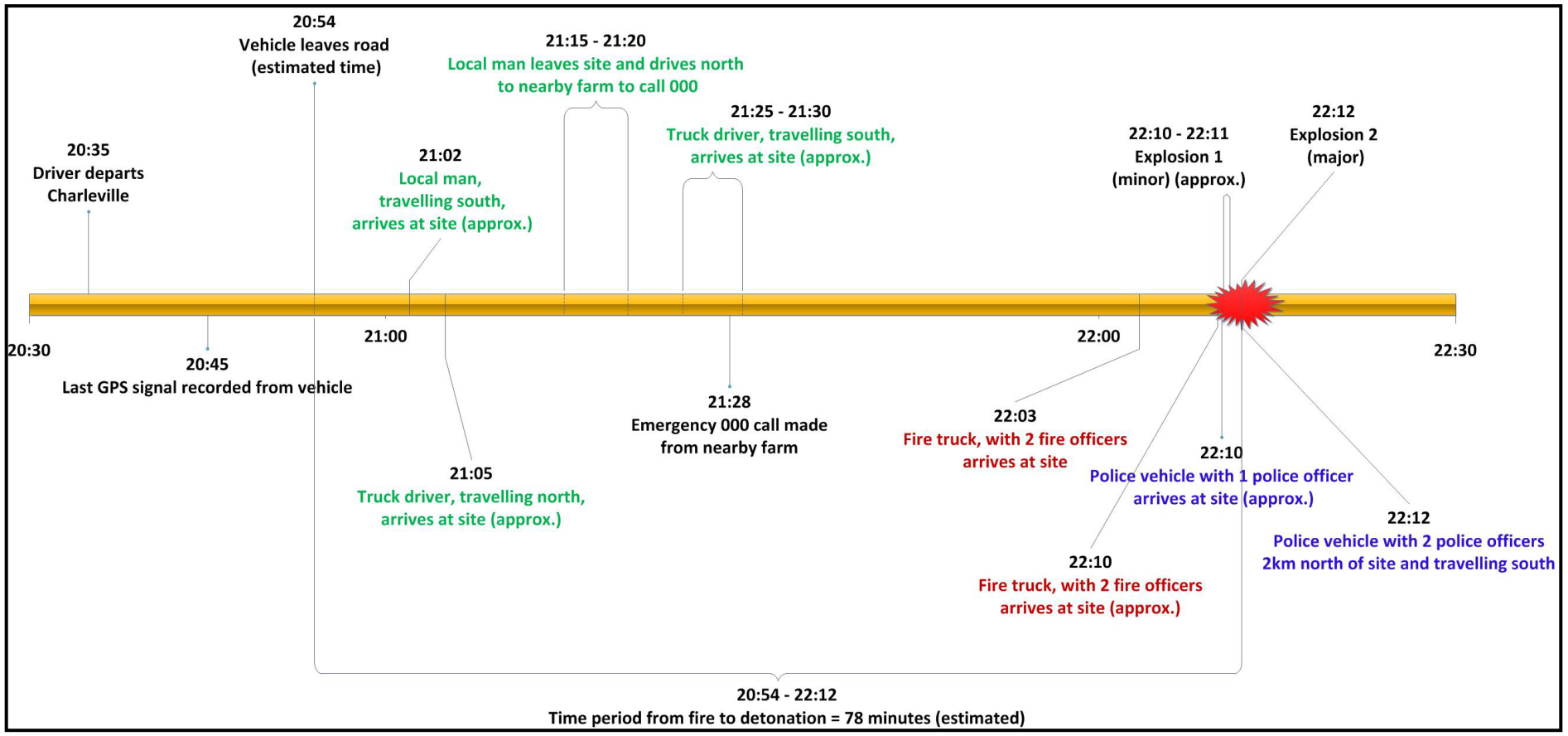
- Investigate the nature and cause of the fire and explosion
- Police investigated traffic crash

Pre-incident details

- Type 1 road train consisting of prime mover and two trailers connected by a converter dolly
- Carrying 52.8 t ammonium nitrate in IBCs
- Driver was approx. 13 hours into trip at time of incident; 30 minutes from rest stop for the night



Incident Timeline



Incident date - 5 September 2014

Incident details

- Exact time fire started unknown; likely result of crash
- No phone signal at site; 30 minutes to contact emergency services
- Fire burned for about 1 hour 20 minutes
- Two explosions about 1-2 minutes apart
- Explosion measured 2.1 on Richter Scale at the site
- Estimated to be equivalent to 10 to 15 t TNT
- Blast injuries to eight people, some serious
- Driver 35% burns, crash and blast injuries

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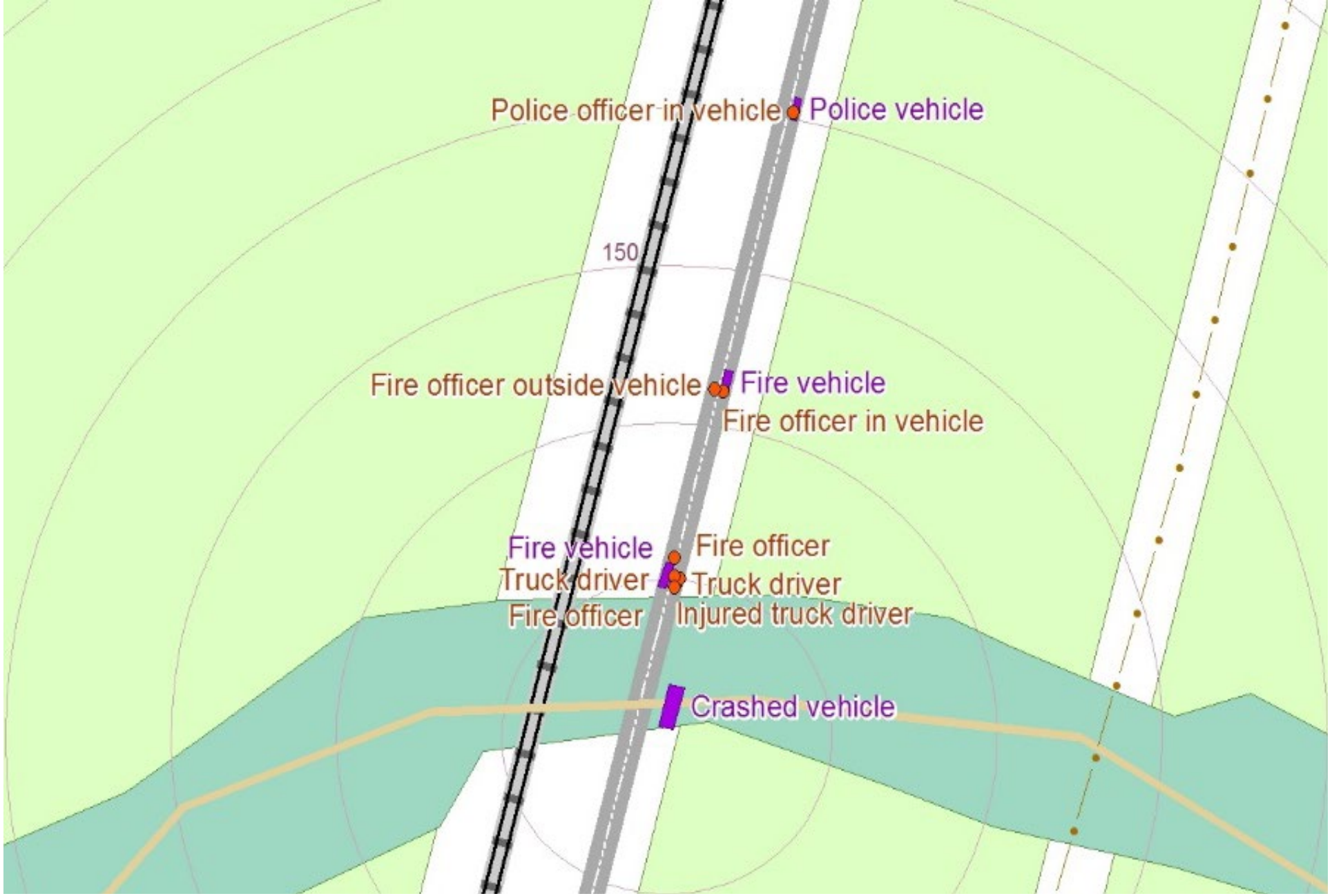
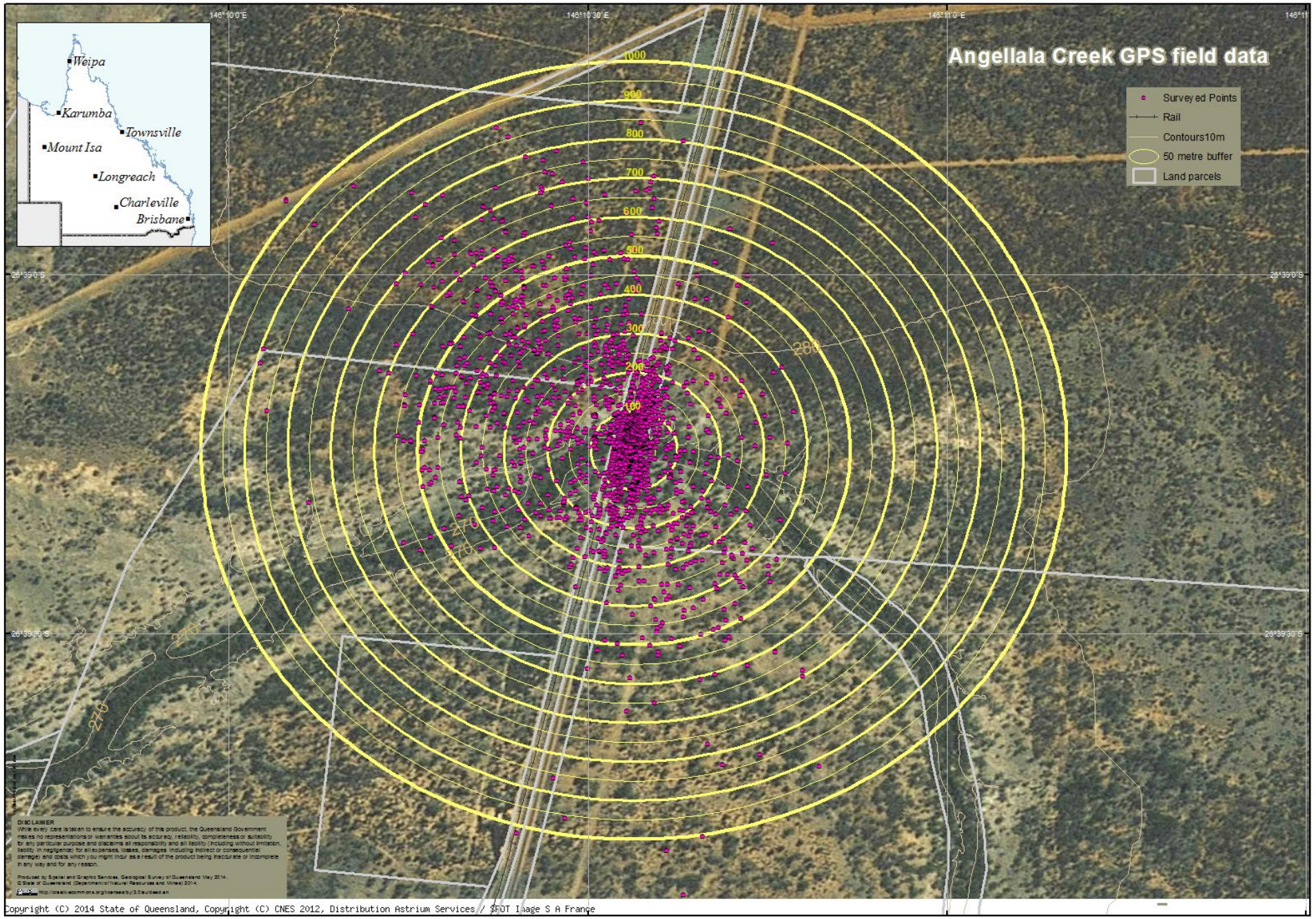

Police officer in vehicle
Police vehicle
150
Fire officer outside vehicle
Fire vehicle
Fire officer in vehicle
Fire vehicle
Truck driver
Fire officer
Fire officer
Truck driver
Injured truck driver
Crashed vehicle

Explosives Inspectorate response

- Initially provided advice to police and emergency services
- Site handed to EI 2 days after incident
- Assistance from QPS, QFES, SES, TMR and DNRM Charleville
- 8 Explosives Inspectors on site for up to two weeks (half of Qld EIs)
- Collected and documented over 2,500 pieces of debris
- Interviewed witnesses and other parties


Angellala Creek GPS field data
Surveyed Points
Rail
Contours10m
50 metre buffer
Land parcels
Weipa
Karumba
Townsville
Mount Isa
Longreach
Charleville
Brisbane
1000
900
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200
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280
270
260
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Investigation process

- Investigation focussed on:
  - Mechanical
  - Metallurgical
  - Electrical
  - Chemical
  - AN transition to explosion
  - Blast effects

Chemical analysis

- Collected number of residues from site
  – Solid prill to recrystallised and contaminated AN
- Collected samples from same batch to:
  – confirm AN within specification
  – compare to site samples

Key Findings of investigation

- The ammonium nitrate was within specification and classified as UN1942
- The vehicle involved in the accident was mechanically sound and regularly maintained
- The vehicle contained a large amount of combustible material
- The crash led to a spill of fuel across the site
- Some ammonium nitrate was contaminated with diesel fuel and metals
- An arc event has occurred on the starter motor circuit

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Analysis of findings

- Further work needs to look at controls that:
  - Prevent a fire
  - Reduce the intensity of a fire
  - Isolate the ammonium nitrate from a fire
- Using a layers of protection analysis (LOPA) approach

Conclusions – Cause of fire

- The cause of fire could not be determined.
- Based on analysis the following probable scenarios are proposed:
  - Spilt fuel from the crash contacted hot engine exhaust and ignited
  - Electrical arc from crash and leaking fuel

Conclusions – Cause of first explosion

- The cause of the first explosion could not be determined.
- The analysis of evidence gave the following possible scenarios:
  - A pressurised piece of equipment (e.g. tyre or air tank) has ruptured from the fire
  - A thermal explosion from heating and decomposition of ammonium nitrate
  - Molten aluminium has mixed with water or molten ammonium nitrate causing a violent reaction

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Conclusions – Cause of second explosion

- The cause of the second explosion could not be determined.
- Explosion was estimated to be between 10 – 15 tonnes of TNT.
- The second explosion caused significant destruction to nearby infrastructure and vehicles and blast injuries to people nearby.

Recommendations - design

- Develop appropriate design criteria for vehicles transporting AN that includes safety design features to prevent, reduce and isolate a fire.

- A steel vertical and horizontal fire-screen be fitted to flat deck trailers transporting AN.

- Reduce the quantity of combustible material on a vehicle, particularly in proximity to ignition sources.

Recommendations – incident response

- Increase the fire extinguisher capacity and provide additional water/foam on vehicles transporting AN.

- Review the appropriate hazard information on vehicles, including documentation and vehicle marking, and systems to alert external parties to an incident involving AN.

Recommendations – incident response

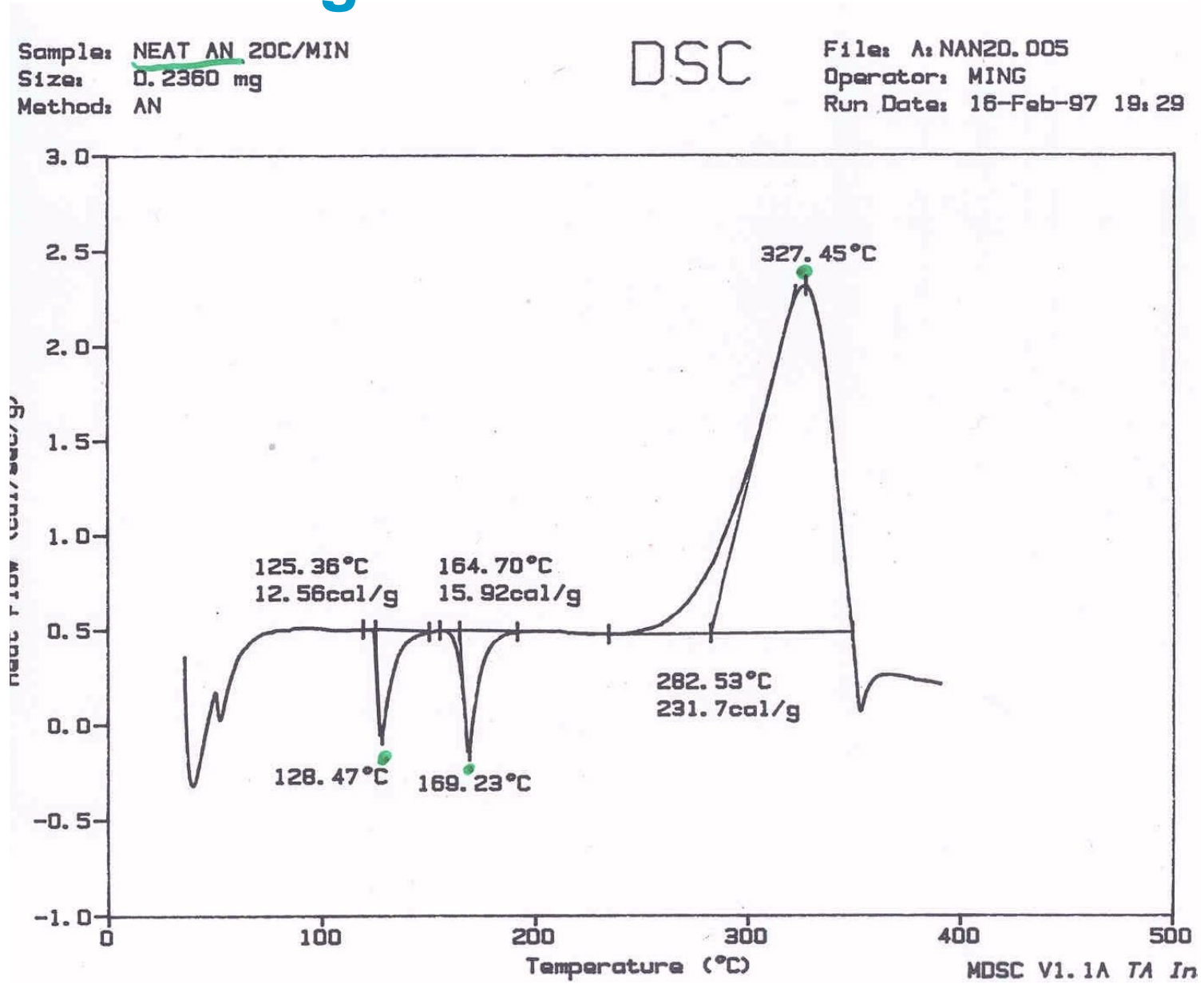
- Communicate AN transport routes to emergency services and remote communities for pre-planning of emergency response.

- Update the initial emergency response guide to reflect the appropriate initial response and evacuation response to an AN fire.

Recommendations - research

- Conduct further research into the causes of initiation of an AN explosion in a transport incident, particularly the interaction of molten metals with molten AN in large loads.
- Informal Working Group to Competent Authority Panel (CAP)
- IMESAFER – APT Research

Thermogram of Ammonium Nitrate



J.C. Oxley et al. / Thermochimica Acta 384 (2002) 23–45

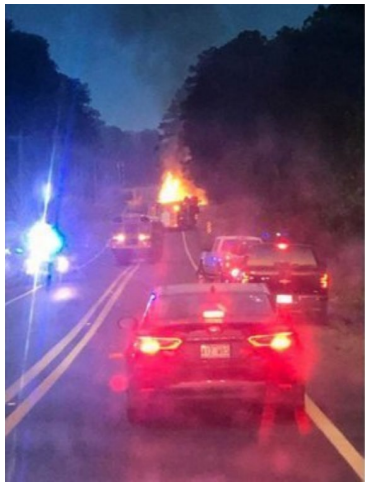
Sensitivity of AN Melt

"At temperatures greater than 240°C liquid phase ammonium nitrate can be initiated by electric blasting caps, and at 260°C it can be initiated to a state of detonation by a #6 cap, the smallest electric blasting cap made in this country, and, in fact, no longer in use. This puts liquid phase ammonium nitrate at 260°C on the same level of shock sensitivity as nitroglycerine based dynamites."

The Detonation Properties of Liquid Phase Ammonium Nitrate
Author(s): A King; A Bauer; R Heater; July 6, 1978

Camden, Arkansas, March 27, 2019

Fire initiated in tire (from faulty brake). Call made to emergency services at ~06:40. They were told what the truck was carrying.



Fire fighters started evacuating people in surrounding area.

Driver headed back to truck.

Mass explosion at 07:03 (from seismograph)

… As the building became more involved [in the fire] the roof collapsed and an explosion occurred.

Firefighter Fatality Investigation, State Fire Marshal's Office

Is the vehicle in good working order?

Is an **Emergency Response Plan** in Place?

Is it up to date?

Have the personnel/responders been trained?

Thank you

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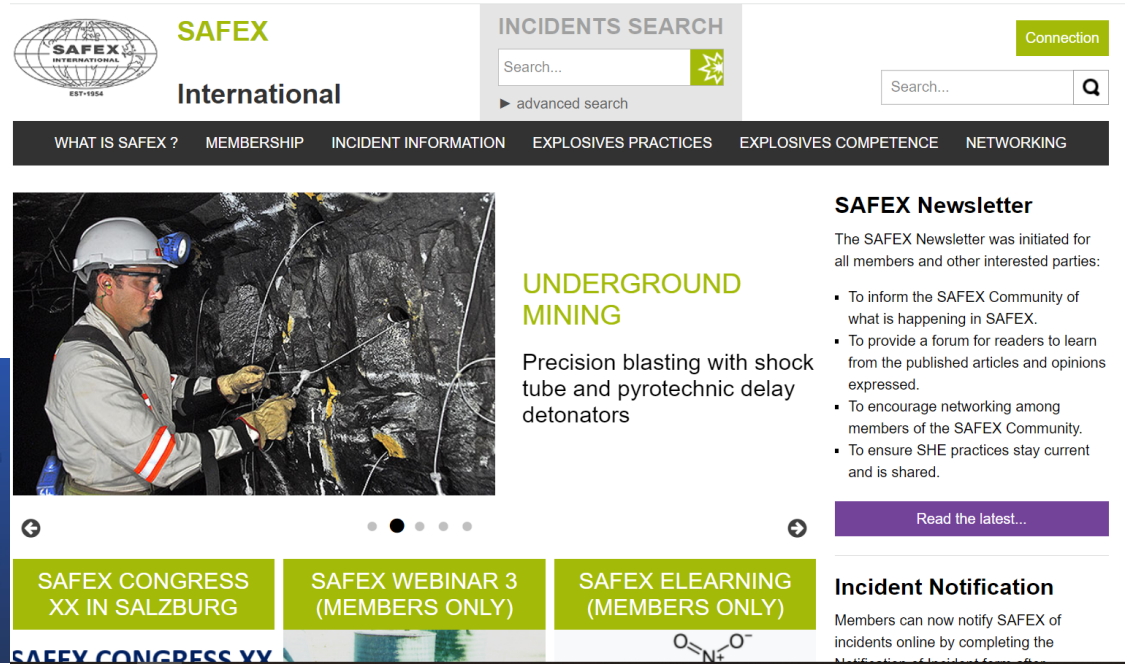

Website:
https://www.safex-international.org/

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