Advantage
NOT Restricted to FERIC Members and Partners Vol. 6 No. 9 April 2005

Contents

Use of a smoke generator and smoke plots to aid fire lookout personnel

Abstract

The Forest Engineering Research Institute of Canada (FERIC) and Alberta Sustainable Resource Development (SRD) researched new methods of producing smoke for use in the training and testing of Alberta's fire lookout personnel. Because Alberta's goal is to have fires detected before they exceed 0.1 ha, two test burns were also done to see if documenting smoke from 0.1 ha fires could help train lookouts.

Keywords

Fire management, Smoke, Smoke detection, Smoke production, Wildfires, Fog machines.

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Introduction

Alberta has an extensive system in place for detecting wildfires, including a network of over 130 lookout sites strategically placed throughout the forest protection area (SRD 2001). The lookout personnel undergo training when hired and are tested annually. Simulated wildfires must be used to test and train personnel. These mock wildfires have been produced in the past by igniting debris piles, material in burn barrels, and small patches of standing timber. However, these resources are not always available, and the forest industry is reluctant to allow any burning of standing timber. Therefore, Alberta Sustainable Resource Development (SRD) asked FERIC to research alternative means to produce smoke.

FERIC tested smoke grenades, airtight stoves, and burn pans as methods of generating smoke for an evaluation of video-based wildfire smoke detection systems (Schroeder 2004). However, it was obvious that none of these methods would generate a sufficient smoke column to mimic the smoke produced from a 0.1 ha wildfire. Also, some were not feasible due to environmental and safety concerns, e.g., burning petrochemicals in a burn pan raises environmental and safety issues. Based on this experience, FERIC decided to investigate mechanical means of generating smoke.

Because SRD's goal is to detect wildfires before they exceed 0.1 ha in size, a suitable smoke generator would have to produce enough smoke to simulate a 0.1 ha fire. However, observations of smoke generated from a fire of this size have not been documented. Therefore, FERIC in cooperation with Alberta SRD and the Northwest Territories government conducted two 0.1 ha test burns in the Northwest Territories and documented the smoke as seen from the ground and a lookout tower. This information was intended to help determine the amount of smoke needed to simulate a 0.1 ha fire under various conditions. As well, this information, which would provide documented characteristics of small fires as observed from a lookout tower and from the ground under various conditions such as fuel and weather, would be assessed for usefulness in training lookout personnel.

This report presents the results of the investigation into alternative methods to produce smoke, and documents observations made of the small test burns.

Objectives

The objectives of this study were to:

- Evaluate mechanical methods to simulate smoke produced from a small (0.1 ha) wildfire.
- Conduct 0.1 ha test burns and describe the attributes of resulting smoke columns.

Study methods

Evaluating smoke generators

A suitable smoke generator would have to meet the following criteria:

- Smoke volume should be equivalent to that of a 0.1 ha fire.
- Smoke column should be able to reach 50 m height in light winds.
- Column duration should be adjustable and last up to 20 minutes.
- Apparatus should be easily transportable (e.g., by helicopter) as many lookout sites have fly-in access only.
- Method should be safe for the operator and environment.

Figure 1. Testing the IGEBA TF 35 for smoke-generating capability.

Figure 2. Testing the Dyna-Fog 1200 for smoke-generating capability.

The results of an Internet search of smoke generator vendors indicated that special effects companies had good potential to supply a suitable machine. Commercial fog machines were considered suitable for the investigation even though they are intended as pesticide applicators, because the fog generated from these machines is visually similar to smoke. Bleeding Art Industries, a special effects company based in Calgary, Alta., expressed interest in FERIC's investigation and arranged demonstrations for the following:

- custom-built fog machine manufactured by Bleeding Art Industries
- TF 35 fog generator manufactured by IGEBA Geraetebau GmbH of Weitnau, Germany (Figure 1)
- Dyna-Fog 1200 manufactured by Curtis Dyna-Fog, Ltd. of Westfield, Indiana (Figure 2)

Fog machines can be compared by smoke fluid consumed, but the amount of fog generated is not easily quantified. Therefore, the generators were compared visually on the basis of the fog (smoke) produced. FERIC and Alberta SRD together evaluated the smoke generators.

Burning small test plots

FERIC, Alberta SRD, and the Northwest Territories government burned two 0.1 ha plots at the Community Protection Trials site near Fort Providence, N.W.T. on June 24, 2004. Sites that would produce a small amount of smoke were selected since the objective was to detect fires while they were small. The plots were located within mature pine stands with little understorey and feathermoss/lichen ground cover. Footage of the fires was recorded from the ground using handheld video cameras and from a tower-mounted video camera at the Caen lookout site located 16 km northeast of the fire.

An open air weather station was located on site to record meteorological data. One of the smoke generators was also on site, and

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ISSN 1493-3381

it was run simultaneously with the 0.1 ha burns.

Results and discussion

Evaluating smoke generators

The three evaluated units could be transported by pickup truck or light helicopter; however, because of its size and weight a forklift was needed to load the Dyna-Fog 1200 on to a truck.

The Bleeding Art custom unit and IGEBA TF 35 fogger did not generate a sufficient amount of smoke, and light winds kept the columns from rising to the required height. A 3 m chimney stack made of flexible plastic was also used to try to get the smoke above the forest canopy. This proved to be unsuccessful as the chimney was not rigid enough. A rigid chimney would work better, but would likely be awkward to transport. Two types of smoke fluid (glycol and mineral oil based) were tested and although the smoke colour varied slightly, there was no difference in performance.

The Dyna-Fog 1200 was tested at the Elbow ranger station and the smoke was spotted by a lookout at a 38 km distance. An experienced lookout stationed 10 km away indicated that the smoke was a realistic fire simulation (Figure 3). Visibility was very good on the day of these tests and winds were low (<15 kph).

The Dyna-Fog 1200 consumes considerably more smoke fluid than the other units tested (e.g., 450 L/h versus 42 L/h for the IGEBA TF 35) and therefore generates much more smoke. The heat exchanger used to propel the smoke is much hotter and generates a better vertical column. As well, the unit can burn a variety of smoke fluid types.

Smoke fluid consumption for the Dyna-Fog 1200 could be controlled to produce smoke columns of various sizes. The column easily exceeded 50 m in height, and the fogger could produce a column for over 20 minutes. The smoke fluids used were the same as those used in the pesticide and special effects industries and meet environmental and safety requirements.

Burning small test plots

Visibility was clear on the day of the test burns.

The ground fire spread slowly (<1 m/min) and generated a white smoke column. Eventually several pine trees candled, with mainly bark ignited (Figure 4). The tower operator detected the smoke before the fires reached 0.1 ha and before any trees candled. The smoke plumes also became visible on the camera before the detection criteria were surpassed (Figure 5). Candling trees produced a noticeable increase in smoke (Figure 6). It was not clear from records taken in the field whether the operator saw the smoke before it was visible on the camera. Better coordination between ground and tower camera operators and synchronized time stamps on the cameras would solve this problem.

Figure 3. Smoke generated by the Dyna-Fog 1200 at 10 km distance.

Figure 4. Ground fire during 0.1 ha test smoke.

Figure 5. Image showing influence of light reflection on image quality. There are two white columns of smoke within the circle – from the smoke generator (left) and the smoke plot (right). The angle between smoke and sun is optimal for detection, but results in poor images.

Figure 6. Smoke is from candling trees in a fireguard burn started in dried debris. Picture quality (e.g., blue sky) on the day was better than for the smoke plots. Black dot within the smoke plume is a helicopter.

The Dyna-Fog 1200 produced a similar column of smoke as the ground fire (Figure 5), but did not match the column when trees candled. Both columns were affected by wind gusts.

Sun angle was not measured but was in an optimal quadrat (SW of the Caen tower) for detecting smoke plumes (Buck 1938). This factor likely contributed to the early smoke detection; however, there was also reflection from the lake between the tower and smoke and that could have interfered with visibility. The lake reflection did influence the video quality and the tower operator was forced to zoom in so the lake was out of the picture.

Conclusions and implementation

Of the three units tested, the Dyna-Fog 1200 was the only one suitable for simulating a small wildfire as the other two units were unable to generate sufficient smoke. The Dyna-Fog 1200 is easily transported by a pickup truck (once loaded with a forklift) or by helicopter. A chimney attachment may be required for use on windy days to help the smoke clear the forest canopy.

The smoke plots generated useful fire behaviour data during the period between ignition and detection. Data collected from this study will be used for training fire lookout personnel, and may form part of a database that combines fire/smoke visual data and Canadian Forest Fire Behavior Prediction (FBP) System (Hirsch 1996) information. More smoke plots are planned for 2005 including possible use of a helicopter to capture smoke images from different ranges and angles to the sun relative to the Caen tower. In addition to helping lookout personnel, the data could help train helicopter-based initial attack crews that report fire characteristics as they arrive on scene. Making a rapid estimate of fire size is difficult and once the crew is on the ground, no time is available to measure the fire size.

Alberta SRD made arrangements to use the Dyna-Fog 1200, including a customized adaptor for helicopter transport, to test personnel at several lookout towers throughout the 2004 season. The machine saved resources as fire crews were not needed to burn brush piles and several towers could be tested in one day. Alberta SRD also used the Dyna-Fog 1200 to simulate wildfire smoke at a mock disaster exercise held in Kananaskis Provincial Park in September 2004. Smoke generators are also being used in Quebec to test air observers in detection aircraft, and Alberta SRD has plans to do the same in 2005.

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Acknowledgements

The author would like to thank Tim Klein and Gordon Graham of Alberta SRD for their assistance. Bleeding Art Industries of Calgary, Alta. provided the smoke generators, and the Northwest Territories government allowed FERIC to use its research plots. Project funding and logistic support were provided by Alberta SRD.