FOREST HEALTH:
Fire Behavior Considerations[1]

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This presentation will provide a overview (for the non-specialist) of relevant fire behavior terms and concepts, existing tools for predicting fire behavior at the stand level (with particular emphasis on the development and propensity for crown fire activity), and finally, to offer some suggestions for future direction. The limitations of present day fire behavior models and systems are highlighted.

Most of the references that either support this presentation or are mentioned/referred to in the presentation are provided here. Items available from the Canadian Forest Service Online Bookstore (http://bookstore.cfs.nrcan.gc.ca/default.htm) are denoted by a "(*)" at the end of the citation.

The seven scenarios presented in the graph near the end of the PowerPoint presentation (i.e., image 40, fifth from the end) are described in the **Annex** of this document.

Postscript

I agonized over the fact that the conference organizers asked me to limit my remarks to fire behavior at the stand level. I had wanted to touch on some issues regarding fire behavior at the landscape level. In this regard, the following passage comes from Alexander (1998, p. 6):

> *Logic would dictate that the chance(s) of a high-intensity crown fire occurrence would gradually increase as the size of the total plantation estate increases. The value of a dispersed pattern of relatively small to moderately sized plantations, especially in fire-prone environments exhibiting very high ignition risk coupled with an adverse fire climate, was demonstrated during the 1983 Ash Wednesday Fires in the southeastern portion of South Australia and Victoria … State-owned plantations in the region managed by the Woods and Forests Department amount to approximately 80 000 ha and are comprised of a few large, more or less contiguous blocks of land. On February 16, 1983, some 21 000 ha of*

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exotic pine plantations were burnt over in South Australia alone[2]*, most very severely, by eight fires that covered a gross area of around 120 000 ha. In contrast, private forest industry in the region, with a comparable estate of around 70 000 ha, but comprised of many smaller parcels scattered across the region more as a result of circumstances rather than by any strategic design, suffered only minor (40 ha) wildfire losses …*

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[2]Keeves, A.; Douglas, D.R. 1983. Forest fires in South Australia on 16 February 1983 and consequent future forest management aims. Australian Forestry 46: 148-162.

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Short Biographical Sketch

Dr. Marty Alexander is a Senior Fire Behavior Research Officer, Canadian Forest Service (CFS), Northern Forestry Centre, Edmonton, Alberta. He has been employed by the CFS since 1976. His research interests are wildland fire behavior and forest/grassland fire danger rating, including the practical and scientific application of such knowledge to fire/fuel management and other disciplines. Marty was one of the architects of the Canadian Forest Fire Behavior Prediction System and also served as one of the co-coordinators of the International Crown Fire Modelling Experiment in the Northwest Territories from 1995-2001. He has been heavily involved in fire behavior training on a national and international basis.

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Annex[3]

Fire behavior models are quite commonly used to judge the impacts or effectiveness of fuel treatments on potential fire behavior in the U.S. both from a research standpoint (e.g., Fule et al. 2001) and in training (Johnson 2005). It's important to recognize that different models (and how the inputs are handled) can produce widely varying results The graph shown on image 40 of the PowerPoint presentation was based on a fuel and stand characteristics for a lodgepole pine stand near Whitecourt, Alberta (Dam 2000), the treated (i.e., precommercial thinning) portion of which had been undertaken by Millar Western Forest Products Ltd. The analysis of potential fire behavior in treated/untreated areas of the stand was examined based on the 97^{th} percentile fire weather and fire danger conditions for the area. Seven distinct scenarios were examined:

- **Scenario 1:** Application of the Rothermel (1972) surface fire spread model considering changes in fuelbed structure induced by the silvicultural treatment and assuming identical fuel moisture and within stand wind speed.

- **Scenario 2:** Same as **Scenario 1** but modeling changes in fuel moisture of fine fuels by application of Rothermel et al. (1986) model (i.e., fine fuel moisture content in the treated portion of the stand was predicted to be 0.5% lower than in untreated portion.

- **Scenario 3:** Same as **Scenario 1**, but considering the fuel moisture differences as sampled by Dam (2000) in the study site (i.e., fuel moistures in the litter of the treated portion of the stand were consistently lower, averaging 2.6% in needles and 2.0% for small twigs);

- **Scenario 4:** Wind speed threshold for crowning based on the Cruz et al. (2004) model and considering the same fuel moisture as for **Scenario 1**.

- **Scenario 5:** same as **Scenario 4** but with fuel moisture as for **Scenario 3**.

[3]Adapted from: Cruz, M.G.; Alexander, M.E. 2005. Implication for evaluation of fuel treatments effectiveness in reducing potential fire behavior: A case study in a lodgepole pine stand. Unpubublished.

- **Scenario 6:** Wind speed threshold for active crowning as per NEXUS (Scott and Reinhardt 2001) but using the Cruz et al. (2004) model.

- **Scenario 7: Scenario 6** but with fuel moisture as for **Scenario 3**.

The graph below shows the relative increases in surface fire intensity (**Scenarios 1-3**) and crowning potential (**Scenarios 4-7**). For **Scenarios 1-3**, the relative variation in fire potential is with respect to the predicted surface fire intensity of the untreated plot. For **Scenarios 4-7,** the relative variation in fire potential is with respect to the wind speed threshold for crowning in the treated plot.