Fire Technology Transfer Note

Number - 5 December 1994

Wildfire Behaviour Case Study of the 1986 Awarua Wetlands Fire[1]

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One might be quick to suspect that there is very little relationship between wetlands and wildland fires, yet many terrestrial plant communities in these ecosystems are exceedingly flammable inspite of the fact that they may be associated with mild fire climates. A case in point is a human-caused wildfire that occurred in wetlands associated with the Awarua Plains (elevation 1-9 MSL) some 17 km southeast of Invercargill on the South Island of New Zealand during the spring of 1986 (Fig. 1). The "Awarua Fire" originated from a vehicle striking and knocking down a transformer pole at 1:22 p.m. NZDT on Tuesday, October 28, 1986. The damaged power lines initially ignited the gorse (*Ulex europaeus*) scrub along the roadside. In the next two hours or so, the fire advanced some 7 km under the influence of gale force westerlies from the point of origin before its progress (Fig. 2) was halted by a combination of fuel type discontinuities and various natural and man-made barriers coupled with effective suppression action. Complete containment was achieved by noon the next day but the fire was not declared officially out until four days later. The final area burnt amounted to 1360 ha with a total perimeter length of 21.7 km. No lives were lost or structures destroyed (although 12 houses and other buildings were threatened) but the head of the fire came perilously close (to within 1.8 km) to an area containing rare and endangered flora (i.e., cushion bog or *Donatia* spp.); vegetation very quickly reclothed the fire area, albeit with some changes in relative abundance of individual species. The wetland vegetation provides habitat for the endangered fernbird (*Bowdleria punctata*). The other potential value-at-risk were the power lines leading to the nearby Comalco NZ aluminium smelter plant; a disruption in the power supply would have caused a financial calamity.

The major run of the fire took place under moderately cool ambient temperatures (12-13ºC), relatively high humidities (76-82% RH) and nearly overcast skies, but exceedingly strong surface winds (43-50 km/h) (Table 1) occurred as a result of an anticyclone to the west of New Zealand and an intense low pressure system southeast of the country (Fig. 3). The 1 p.m. NZDT upper air sounding at Invercargill revealed a region of drier air above 1600 m MSL (Fig. 4) and a "jet point" or wind maximum at 2200 m MSL (Fig. 5), although the shape and angle of the fire's smoke/convection column or plume typified that of a classic wind-driven conflagration.

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[1] This Fire Technology Transfer Note (FTTN) is based largely on a poster paper entitled "Wildfire Behaviour in a New Zealand Wetland: A Case Study" as presented at the 19th Tall Timbers Fire Ecology Conference - *FIRE IN WETLANDS: A MANAGEMENT PERSPECTIVE* that was held from 3-6 November 1993 in Tallahassee, Florida. The text of this FTTN constitutes the abstract for the poster paper that will appear in the conference proceedings to be published early in 1995 by the Tall Timbers Research Station, Tallahassee, Florida. The capable assistance of L.G. Fogarty of the New Zealand Forest Research Institute in the preparation of this wildfire behaviour case study is gratefully acknowledged.

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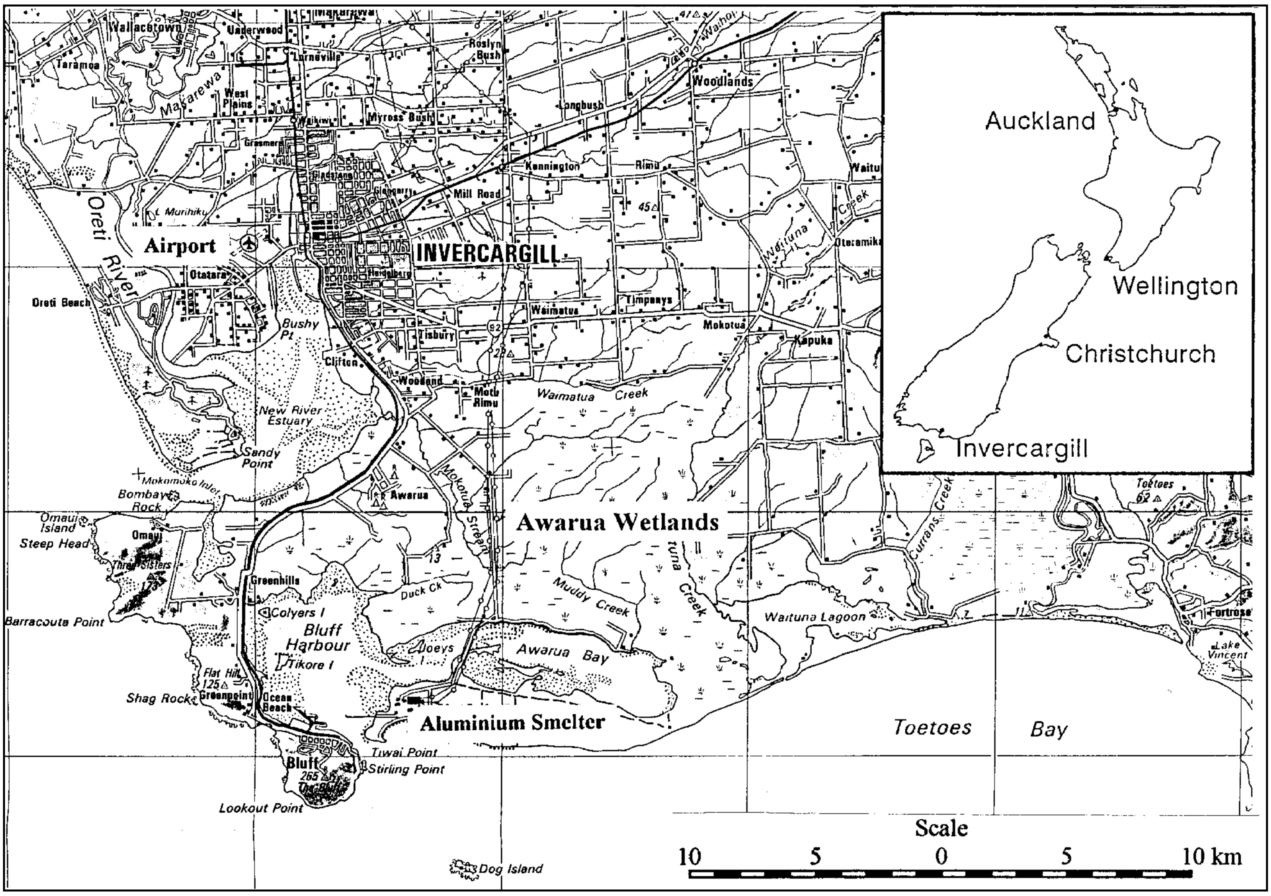

Figure 1. Geographical setting of the 1986 Awarua Fire.

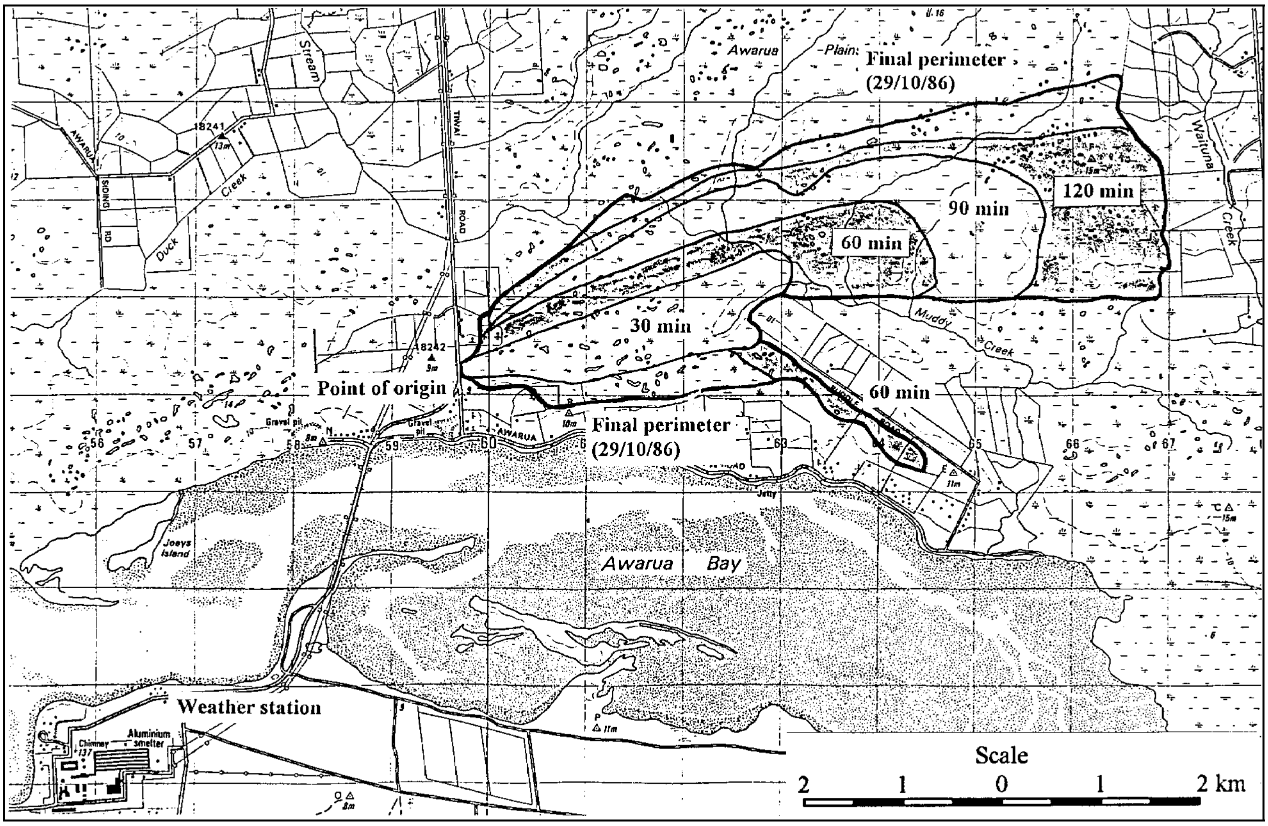

Figure 2. Fire progress map for the 1986 Awarua Fire.

Table 1. Hourly weather observations recorded at the Invercargill Airport (temperature and relative humidity) and Comalco NZ Aluminium Smelter Plant (wind speed, wind direction and rainfall amount) meteorological stations associated with the major run of the Awarua Fire on 28 October 1986.

Local Time (NZDT)	**Dry-bulb Temperature (°C)**	**Relative Humidity (%)**	**10-m Open Wind**		**Rain (mm)**
			Speed (km/h)	**Direction (°)**	
1300	12	75	46.3	260	-
1400	12	81	50.0	260	-
1500	12	74	42.6	260	-
1600	13	76	51.9	260	-
1700	13	80	55.6	260	-
1800	13	67	46.3	260	-
1900	12	69	53.7	260	-
2000	11	73	57.4	260	-
2100	10	85	48.2	260	0.1
2200	10	82	50.0	260	-
2300	11	81	57.4	270	-
0000	10	82	53.7	270	0.1

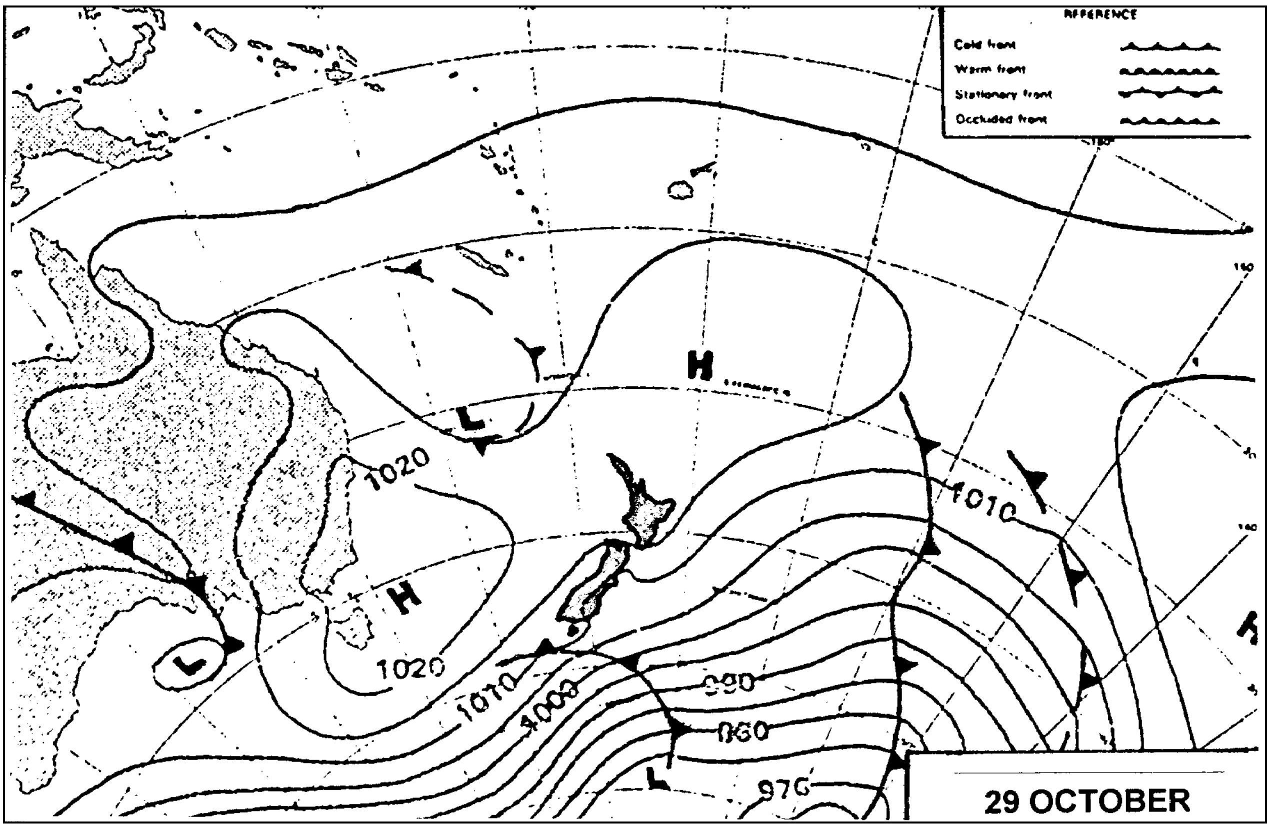

Figure 3. Surface weather map for 1.00 a.m. NZDT, 29 October 1986.

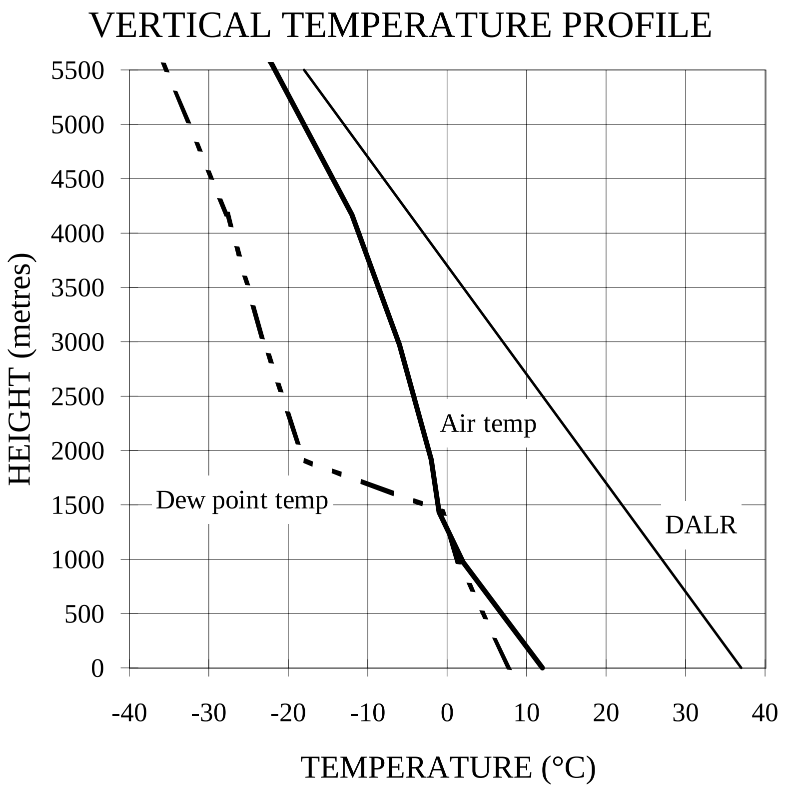

Figure 4. Vertical temperature profile above Invercargill Airport at 1.00 p.m. NZDT, 28 October 1986 (DALR = Dry Adiabatic Lapse Rate).

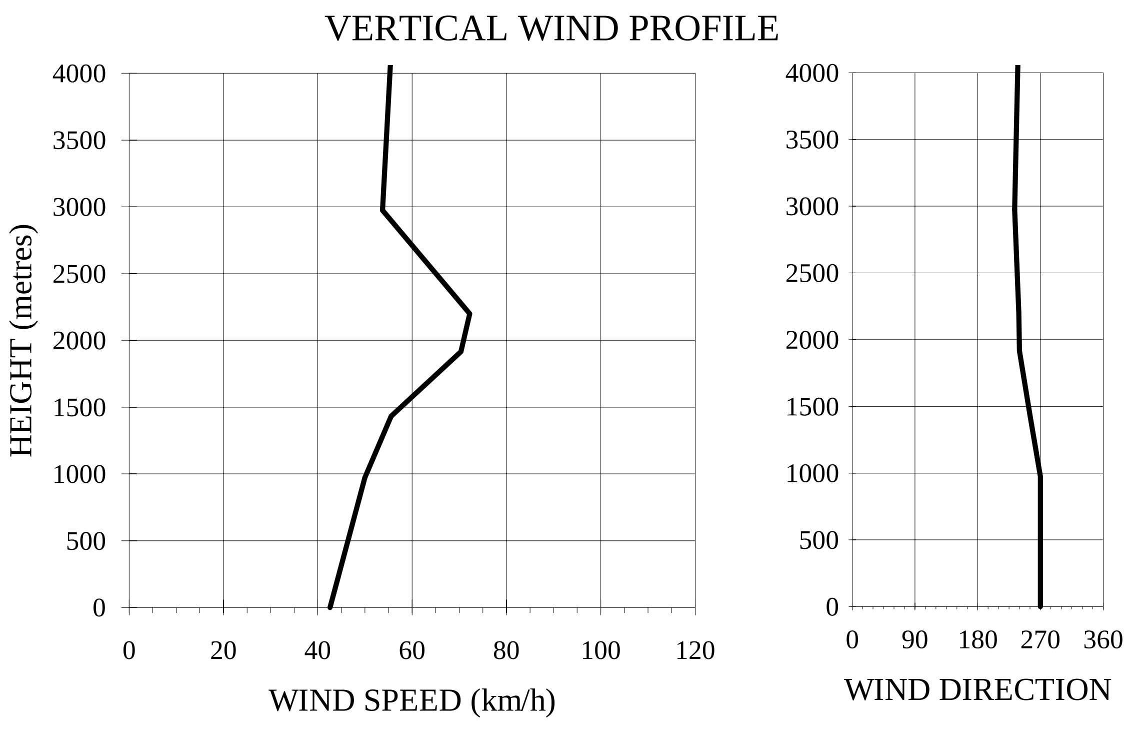

Figure 5. Vertical wind profile above Invercargill Airport at 1.00 p.m. NZDT, 28 October 1986.

During the previous week, maximum air temperatures averaged under 16ºC. A total of 15.5 mm of rain fell on October 20-22 and smaller amounts totalling 1.1 mm occurred in the following days, including a 24-hour accumulation of 0.2 mm recorded at 9 a.m. on the day of the fire's major run. The values of the Fire Weather Index (FWI) System (which was originally developed in Canada, but has been used in New Zealand since 1980) fuel moisture codes and fire behaviour indexes were as follows: Fine Fuel Moisture Code (FFMC) - 83.2, Duff Moisture Code (DMC) - 10, Drought Code (DC) - 71, Initial Spread Index (ISI) - 17.1, Buildup Index (BUI) - 15, and the FWI itself - 19. According to the classification scheme used by the former New Zealand Forest Service at the time, these conditions would only be rated as a *HIGH* fire danger class inspite of the fact that head fire intensities undoubtedly exceeded 10 000 kW/m as evident by the flames which reportedly reached heights averaging around 5-8 m. It's speculated that the strength and persistence of the surface winds which averaged 38 km/h during the 72 hours following the wildfire's major run contributed to the duration of smouldering combustion by subsurface fires that would otherwise have naturally extinguished themselves due to the moist ground fuels.

The main fuel types in the area consisted of stunted manuka (*Leptospermum scoparium*), red tussock (*Chionochloa rubra*), bracken fern (*Pteridium esculentum*), wire rush (*Empodisma minus*), *Dracophyllum* species, flaxes (*Phormium* spp.) and associated grasses; 95% of the available fuels would be considered as fine fuels (~10 t/ha). Interestingly enough, the predicted head fire rate of spread for the uncut grass fuel type (O-1b) in the newly released Canadian Forest Fire Behaviour Prediction System, assuming 100% degree of curing, was 3865 m/h which is remarkably close to the observed value of 3750 m/h. Furthermore, the burning conditions would have been classed as *EXTREME* fire danger (Fig. 6) based on the criteria for grasslands recently implemented in the country as a result of research undertaken by the Canadian Forest Service and New Zealand Forest Research Institute[4].

[4] Alexander, M.E. 1994. Proposed revision of fire danger class criteria for forest and rural areas in New Zealand. National Rural Fire Authority, Wellington. Circular 1994/2. 73 pp.

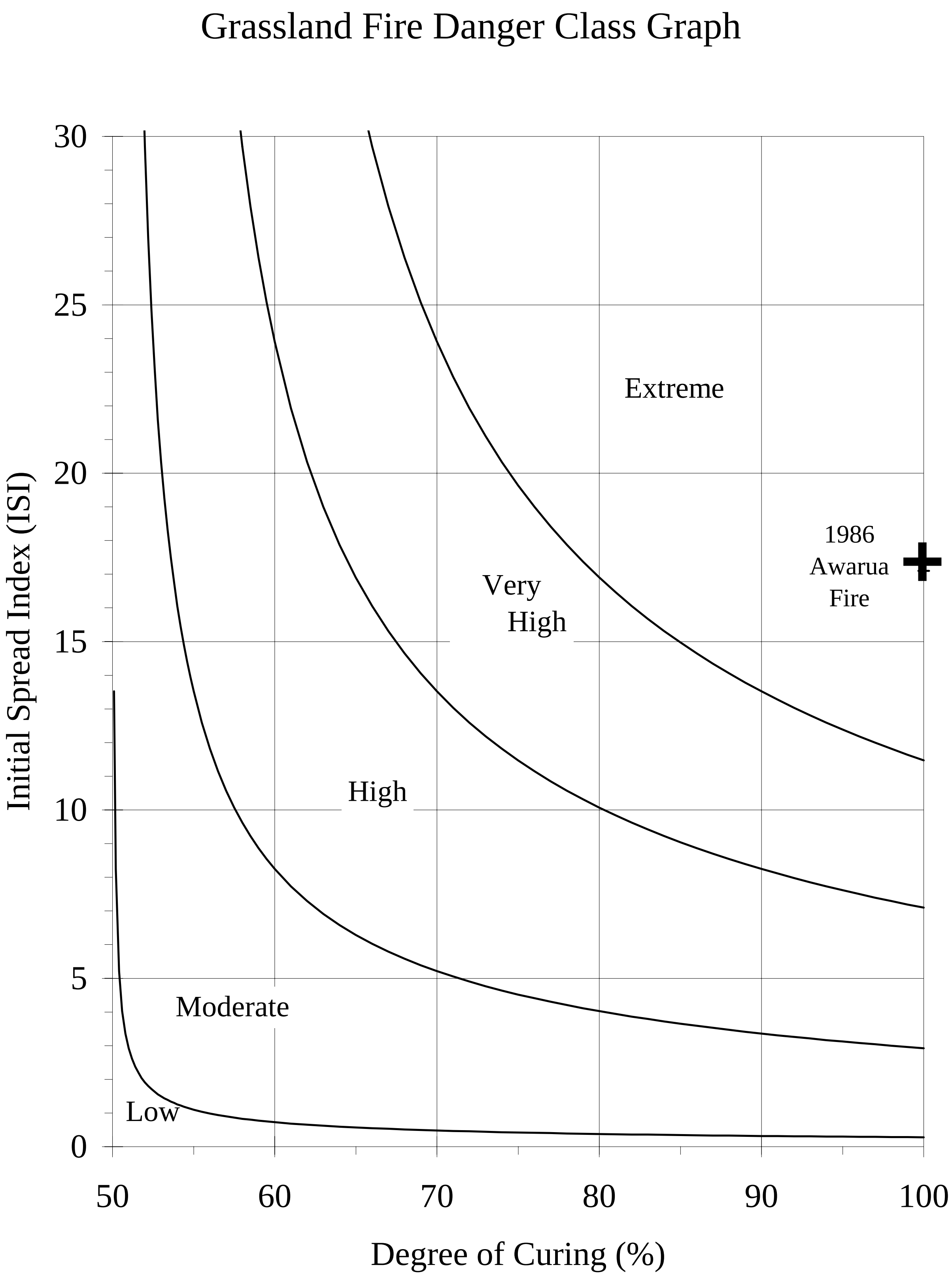

Figure 6. The grassland fire danger class criteria as described by Alexander (1994) applied to the major run of the 1986 Awarua Fire.