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INITIAL ATTACK ON FIRES IN THE SOUTH-EAST PLANTATIONS

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INITIAL ATTACK ON FIRES IN THE SOUTH-EAST PLANTATIONS

INTRODUCTION

When significant areas of pine plantations are burnt by wild-fire, quite severe direct financial losses can result and considerable consequential forest management difficulties can arise. Accordingly, it is usual that fire suppression systems are developed with the aim of keeping burnt areas to a minimum.

The essential basis of the initial attack system for the suppression of fires in the radiata pine plantations of the Woods and Forests Department in the South-east of South Australia, described herein, has this as its main aim.

Successful initial attack on fires in severe fire weather is largely a problem of logistics. The system described involves the assembly of fire suppression crews, the provision of adequate total fire-crew working time so that fire perimeter can be suppressed at a greater rate than it is being formed by the spreading fire, and provision of water supply and line construction facilities which are matched to the available fire-crew working times.

Because of the great variability of the key factors in fire suppression, it is not practicable to encompass the individual characteristics of all fire situations in such a system. However, a sufficient range of situations can be defined well enough to provide a basis for planning appropriate initial action, and the generalised data tabulated here is aimed at this.

INITIAL ATTACK CRITERIA

For the purposes of this presentation, successful initial attack is taken as suppression of fire in pine plantations within 1 - 1½ hours in severe fire weather conditions. If suppression has not been achieved in this time, areas burnt by then commonly exceed 100 acres in continuous plantations, and the initial attack can be said to have failed.

This note, then, considers criteria for achieving successful initial attack.

Successful initial attack must involve both extinguishing fire perimeter and ensuring that this extinguished fire edge is held secure by subsequent fuel separation. Experience to date in South Australia indicates that fire perimeter can be knocked down effectively in pine forest fuels in severe fire weather if 10 - 20 litres of water is applied per metre of perimeter. (10 000 - 20 000 litres per kilometre).

Successful initial attack therefore requires :-

(1) Provision of enough 'fire-crew working time' to apply water where needed within the defined 1 - 1½ hour period

(2) Provision of water supplies adequate to ensure that all available fire-crew working time is used effectively

and (3) Provision of sufficient men and equipment to consolidate and make secure the fire-line so produced, by separation of burnt from unburnt fuels.

The criterion of fire spread adopted is the rate of increase of fire perimeter for various degrees of fire danger. Three levels are considered, viz. fire danger indices (McArthur 1966) of 60 (in the Extreme range), 40 (Very High) and 20 (High). The values for perimeter spread adopted for these indices are those for eucalypt fuels at 25 tonnes per hectare. Wild-fire evidence indicates that the rate of spread of radiata pine plantation fires is of the same order. The values adopted are shown graphically in Figure I and tabulated below.

TABLE I

Perimeter spread of fires

Time after start (mins)	20, High	40, Very High	60, Extreme
	kilometres of perimeter		
15	0.10-0.20	0.50-0.70	0.90-1.10
30	0.30-0.50	1.15-1.55	2.00-2.40
45	0.60-1.00	1.90-2.40	3.20-3.80
60	1.00-1.45	2.70-3.30	4.40-5.20
75	1.50-2.10	3.60-4.40	5.80-6.80
90	2.00-2.80	4.60-5.60	7.30-8.50

AVAILABLE TOTAL EFFECTIVE FIRE-CREW WORKING TIME

It is general practice in the South-east that fire-crews comprise at least 5 men for each major fire truck. The number of these crews which stand-by varies with the predicted fire danger for the day and crews are despatched automatically to nominated zones immediately a fire is reported. Fire trucks are equipped with heavy duty pumps, 400 metres of delivery hose, and are capable of nozzle deliveries of 90 - 150 litres per minute at 350 - 550 Kpa nozzle pressure.

Fire-crews assemble more rapidly in some parts of the forest area than in others because of varying proximities to stand-by locations, access considerations, etc. Three basic 'Assembly Grades' are nominated below, I. being fastest and therefore providing the greatest 'total fire crew working time', and III. being the slowest.

TABLE II

Average numbers of fire-crews and fire-crew working times available for each assembly grade

Minutes after Automatic Despatch	Assembly Grade	Fire Danger					
		High		Very High		Extreme	
		crews	mins.	crews	mins.	crews	mins.
15	III	1 or 2	2	1 or 2	2	2	5
	II	1 or 2	5	2 or 3	5	2 or 3	10
	I	2 or 3	15	2 or 3	15	2 or 3	20
30	III	2 or 3	20	2 or 3	25	3	30
	II	3 or 4	35	4 or 5	45	5 or 6	50
	I	3 or 4	60	5 or 6	70	5 or 6	75
45	III	3 or 4	65	4	70	4	85
	II	3 or 4	90	5 or 6	115	6 or 7	120
	I	4	110	6	150	7 or 8	160
60	III	3 or 4	120	5 or 6	150	6	160
	II	3 or 4	145	5 or 6	195	7 or 8	215
	I	4	170	6	240	8	265

The effectiveness of each working-minute in terms of unit length of fire perimeter extinguished, will vary in relation to :-

(a) the efficiency, determination and leadership of fire-crews,

(b) the actual number of fire-crews each contributing to the total number of working minutes available. (Two crews working together can probably suppress more line than one crew working for twice the time),

(c) the quantity and distribution of the fuels, and

(d) the availability of sufficient and uninterrupted water supplies.

Provided that the available working times nominated in Table II are used effectively, and provided also that 20 metres of fire perimeter per working-minute can be knocked down, then initial attack can often succeed (vide Figure I and Table II).

TABLE III

Total perimeter knock-down times
if perimeter is extinguished
at 20 metres per minute

Assembly Grading	Fire Danger		
	High	Very High	Extreme
I	5 - 12 min.	20 - 33 min.	45 - 60 min.
II	5 - 20 min.	31 - 47 min.	62 - 78 min.
III	20 - 37 min.	55 - 64 min.	85 - ? min.

In the Extreme situation, it will be noted that small increases in the rate of fire spread, and/or reductions in the rate of flame suppression, mean large increases in the time for total perimeter knock-down. For assembly grades II and III, failure of the initial attack is thus very likely.

THE PROVISION OF ADEQUATE WATER SUPPLIES

On the assumption that successful initial attack requires the application on the fire edge of 200 - 400 litres per 20 metres per working-minute, available water supplies need to be matched to the total available fire-crew working time for each automatic despatch zone. Table IV shows water volume needs for each assembly grade.

TABLE IV

Water volume (litres) needed to meet requirements of available fire-crew working times for each Assembly Grade (at 200 - 400 litres/20 metres/minute)

Minutes after Automatic Despatch	Assembly Grade	Fire Danger		
		High Litres	Very High Litres	Extreme Litres
15	III	400-800	400-800	1000-2000
	II	1000-2000	1000-2000	2000-4000
	I	3000-6000	3000-6000	4000-8000
30	III	4000-8000	5000-10000	6000-12000
	II	7000-14000	9000-18000	10000-20000
	I	12000-24000	14000-28000	15000-30000
45	III	13000-26000	14000-28000	17000-34000
	II	18000-36000	23000-46000	24000-48000
	I	22000-44000	30000-60000	32000-64000
60	III	24000-48000	30000-60000	32000-64000
	II	29000-58000	39000-78000	43000-86000
	I	34000-68000	48000-96000	53000-106000

Water availability for each automatic despatch zone can be compared with the needs indicated in Table IV. The ability to supply these water requirements may vary from zone to zone, and administrative decisions are needed when it is necessary to give preference to one zone over another. Figure II shows supply needs against supply capability for two representative zones in the South-east.

PROVISION FOR LINE CONSTRUCTION

After knock-down by water, the essential physical separation of burnt and unburnt fuels may be achieved by :-

(a) men with hand tools (rakes, chainsaws, etc.),

(b) men with flail trenchers and ancillary hand tools,

(c) bulldozers or other mechanical equipment.

Ideally the assembly of men and/or equipment, putting them to work, and their rate of line production, should be such that a fire-line to mineral earth can be established no more than 10 minutes after initial knock-down of flames by water.

If initial attack is to be successful within the times indicated in Table II, then the distances for which a mineral earth fire-line which must be constructed are as shown in Table V.

TABLE V

Length of fire-line needed to consolidate successful initial attack by water

Assembly Grading	Fire Danger		
	High	Very High	Extreme
I	0.05 - 0.10 km	0.9 - 1.7 km	3.2 - 5.2 km
II	0.05 - 0.10 km	1.4 - 2.5 km	4.6 - 7.2 km
III	0.20 - 0.70 km	2.4 - 3.5 km	6.7 - ? km

(a) Men with handtools

It is general practice to have handtools available with every fire truck, so that men not required for pumping and handling fire hose can be made available for line construction using rakhoes.

The rate of fire-line construction by raking crews varies with the quantity and nature of the ground fuels. In light fuels a 6-man crew can

readily achieve 1 000 - 1 400 metres/hour for the first hour with some decrease in production for longer work periods. In moderate-heavy thinning slash a 6-man crew operations at 500 - 1 000 metres/hour initially.

If line construction commences 15 minutes after the commencement of the knock-down of perimeter flames by water, from 4 to 6 6-man crews may be needed to complete line construction in a reasonable time.

(b) Men with flail trenchers plus handtools

In light litter and moderate slash, a crew of 4 comprising 2 flail trenchers and 2 assistants can construct 1 500 - 2 500 metres of fire-line per hour provided that one man clears away heavy slash ahead and another tidies up behind.

(c) Bulldozers

Light tracked bulldozers fitted with a hydraulic angle-tilt blade working through thinned stands can operate at 800 - 1 600 metres per hour in heavy slash and 1 200 - 1 800 metres per hour in medium slash. Fitted with a special V-blade, similar machines can operate at 2 000 - 3 200 metres per hour.

In practice a combination of rakhoes, flail trenchers and bulldozers are used. The key requirement is to be able to have enough men and machines available to be able to establish from 5 - 10 kilometres of mineral earth fire-line within say 2 hours. The lower the availability of manpower, the greater the need for mechanical equipment.

The time taken to float bulldozers from their stand-by locations varies considerably between the various automatic despatch zones and can range from 15 to 60 minutes, so allowance must be made for this.

CONCLUSION

Successful initial attack, then, requires that the suppression forces available to each automatic despatch zone meet an acceptable assembly standard for that zone and, further, that the availability and disposition of manpower, equipment, and mobile water supplies are such that the total available fire-crew working time can be used effectively.

The 'assembly grade' for any automatic despatch zone is the essential determining factor. It is an administrative matter to decide whether the assembly grade for each particular automatic despatch zone is satisfactory. Assembly grades may be changed by varying either the number of fire-crews on stand-by, or their stand-by locations, or both.

Any variation in assembly grade requires concomitant changes in the arrangements necessary to ensure that the initial attack force has the necessary facilities to operate with maximum effectiveness.

FIGURE II

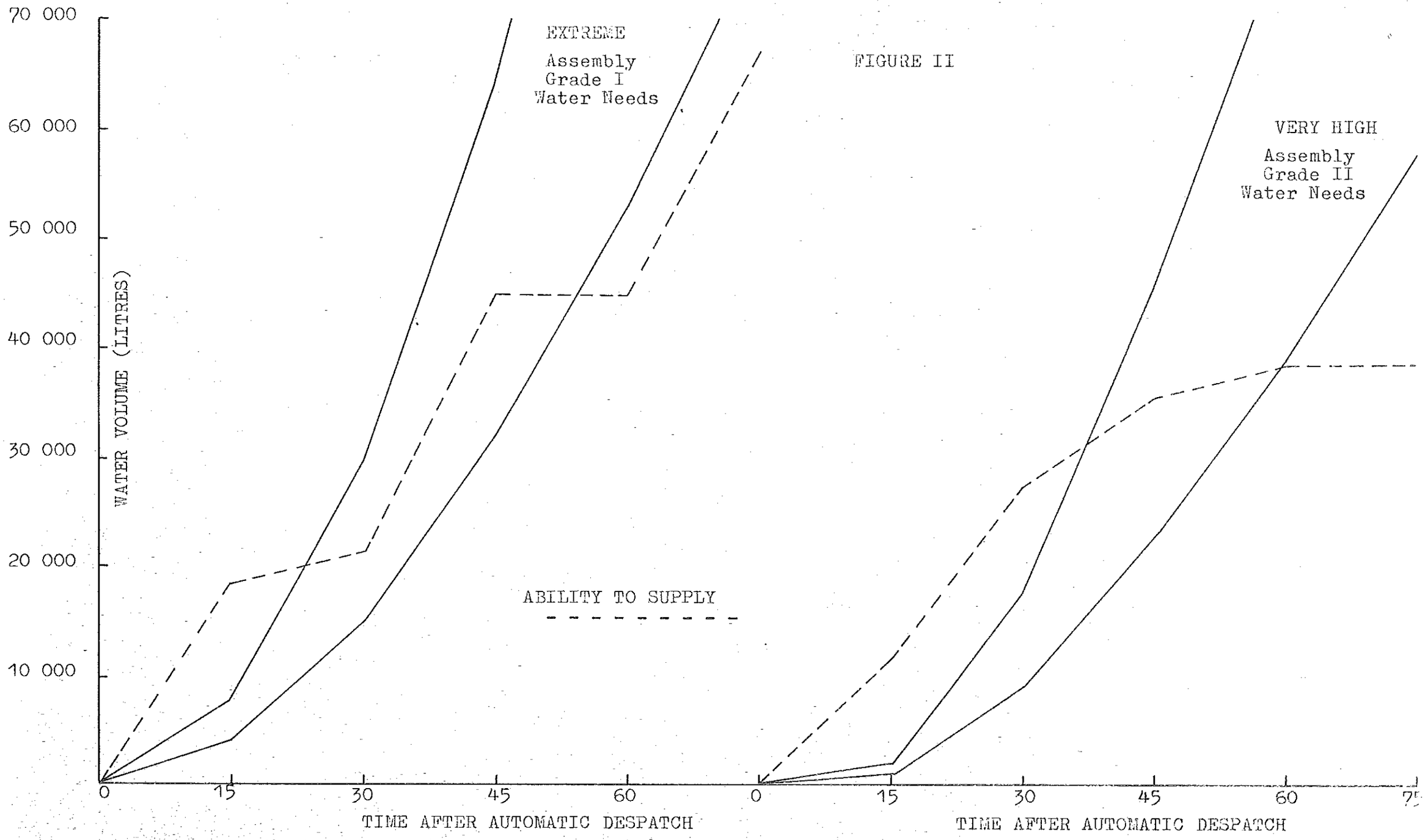
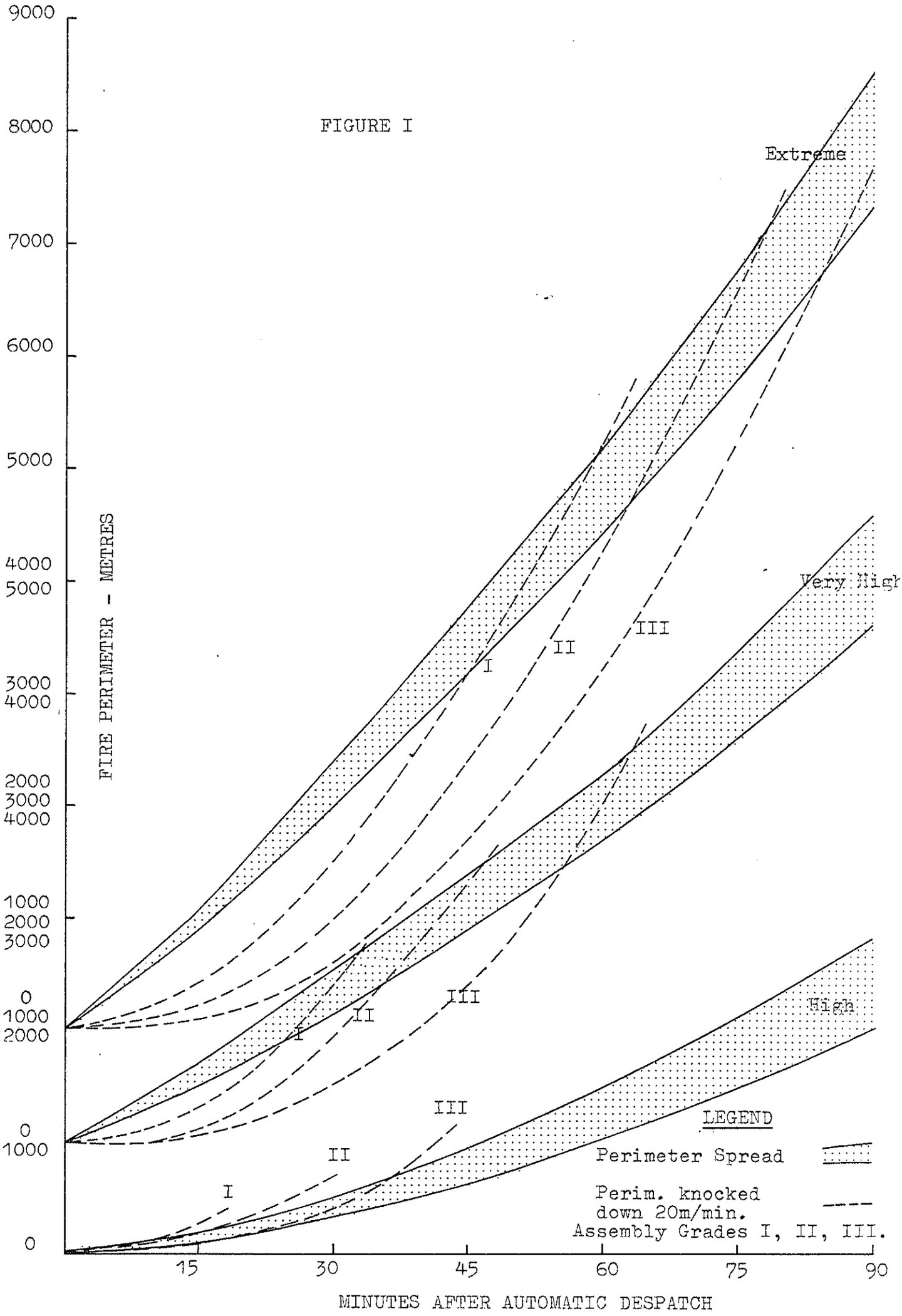

70 000
60 000
50 000
40 000
30 000
20 000
10 000
WATER VOLUME (LITRES)
EXTREME
Assembly
Grade I
Water Needs
ABILITY TO SUPPLY
0
15
30
45
60
TIME AFTER AUTOMATIC DESPATCH
VERY HIGH
Assembly
Grade II
Water Needs
0
15
30
45
60
TIME AFTER AUTOMATIC DESPATCH

FIGURE I


9000
8000
7000
6000
5000
4000
5000
3000
4000
2000
3000
4000
1000
2000
3000
0
1000
2000
0
1000
0
FIRE PERIMETER - METRES
Extreme
Very High
High
I
II
III
I
II
III
I
II
III
LEGEND
Perimeter Spread
Perim. knocked down 20m/min.
Assembly Grades I, II, III.
15
30
45
60
75
90
MINUTES AFTER AUTOMATIC DESPATCH