Fire Management Branch
Department of Conservation & Environment

PROJECT MAFFS/HERCULES THE MODULAR AIRBORNE FIRE FIGHTING SYSTEM IN VICTORIA

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INTRODUCTION

This report documents the Forests Commission Victoria's (FCV) use of a Modular Airborne Fire Fighting System (MAFFS) installed in a RAAF C-130 Hercules aircraft for firebombing during the 1981/82 fire season. The MAFFS is capable of discharging 11 250 litres of retardant in either a single drop or up to three separate drops. A more complete description of the system is attached as Appendix 1.

In 1967 the FCV introduced a system of firebombing based upon the ready availability of small agricultural aircraft which, depending on type, are capable of delivering 400-1500 litres of fire retardant. The concept of using small aircraft requiring little or no modification was designed to provide a first attack capability for small remote fires which ground forces were unable to reach quickly. The system has been successfully used in this role over the intervening years and, increasingly, in a support role for crews establishing control lines on difficult sections of larger fires.

During the 1980/81 fire season, which was particularly severe in East Gippsland, the FCV reconsidered the possibility of using larger aircraft, and in late 1980 the Commonwealth Government was asked to provide a RAAF Hercules for an operational evaluation of the MAFFS in Victoria. At the same time, because of the production lead time of 14 months and high purchase cost, the FCV made arrangements to obtain a MAFFS on loan from the United States Forest Service (USFS). Protracted negotiations with the Commonwealth led to the evaluation being deferred until 1981/82. However, once it was known that the evaluation would proceed considerable time was spent during 1981 training RAAF and FCV crews in the US on the use of MAFFS, establishing retardant mixing and loading bases at three airfields from which the Hercules could operate, and on further training of RAAF and FCV crews in Victoria.

After arriving in Australia in late December 1981, the MAFFS was installed in a Hercules operated by the 36th Tactical Air Squadron, RAAF from Richmond, NSW. It was ready for operational use on 12 January 1982 and subsequently brought to Victoria on three occasions and used in operations on four fires.

BASE SELECTION

The airfields chosen for operations were at Hamilton, Mangalore and the RAAF Base, East Sale. Apart from being suitable for Hercules aircraft each site had the basic facilities which made it feasible to operate retardant mixing and loading bases.

The airfields are within 30 minutes travelling time of the FCV District headquarters at Heywood, Broadford and Yarram respectively, and therefore crews selected to operate the bases could be on site quickly. The locations of the three bases allowed good coverage of the forested area of the State (see Figure 1) with the majority of area being within 45 minutes flying time of at least one of the bases.

BASE ESTALBISHMENT

The FCV's existing retardant mixing facilities were inadequate to cope with the capacity of the MAFFS, and new mixing and loading facilities had to be constructed at each site. The design criteria were to be able to supply 6 aircraft loads per day and attain a maximum supply rate of one load per hour.

Batch mixers of 3 600 litre capacity were constructed for Hamilton and Mangalore and a 560 litre/min. eductor mixer was used at East Sale. To provide an immediate supply of mixed retardant, and a buffer against high usage rates, two pre-fabricated storage tanks of 22 500 litre capacity were erected at each base. One tank held mixed retardant and the second water. The loading facilities were designed to fill the MAFFS in approximately 15-20 minutes.

The MAFFS has to be charged with compressed air to discharge the retardant and a special compressor for this purpose was loaned by the USFS. To service the three bases it was mounted on a truck based at Powelltown. To help cover any time difference between the arrival of the aircraft and the compressor, or a compressor breakdown, bottled air sufficient for two full charges was supplied at each base, and the MAFFS could also be charged with air before leaving Richmond.

The crew for each base comprised a manager plus three men to mix and load retardant.

Figure 2 shows the base design at Mangalore. Similar designs were used at Hamilton and East Sale.

COMMUNICATIONS

To ensure efficient operations, particularly while the Hercules was in the fire area and being directed over the drop zone, communication links between the FCV Command Aircraft, the Hercules and FCV ground stations had to be established. These links were created by the installation in both the Hercules and Command Aircraft of radios with FCV frequencies, and the availability of an aeronautical frequency which allowed direct communication between aircraft without interference from, or to, other FCV transmissions. Each base was also equipped with radio on FCV frequencies.

TRAINING

In May 1981 three FCV personnel and a RAAF Hercules of the 36th Tactical Air Squadron, with the nucleus of two crews, attended a MAFFS training program at the Boise Interagency Fire Centre, Idaho, USA. This training and familiarisation period involved flying exercises with the MAFFS.

In September the FCV assisted with further theoretical training of RAAF crews in the use of MAFFS and FCV fire protection responsibilities and procedures. When the MAFFS arrived in Australia RAAF crews gained additional flying training in NSW and from 6-11 January 1982 full operational trials were conducted from each of the Victorian bases. These trials provided the opportunity to establish and test communications and operational procedures between the Hercules and the FCV Command Aircraft, train FCV base crews in mixing and loading retardant and conduct additional flying training in forested areas. At the end of this period four RAAF crews were trained to standards set by the USFS and Air National Guard.

During the spring of 1981 FCV field staff likely to come into contact with MAFFS operations were briefed on the capabilities of the system.

FIGURE 1 : OPERATIONAL RANGES FROM MAFFS BASES

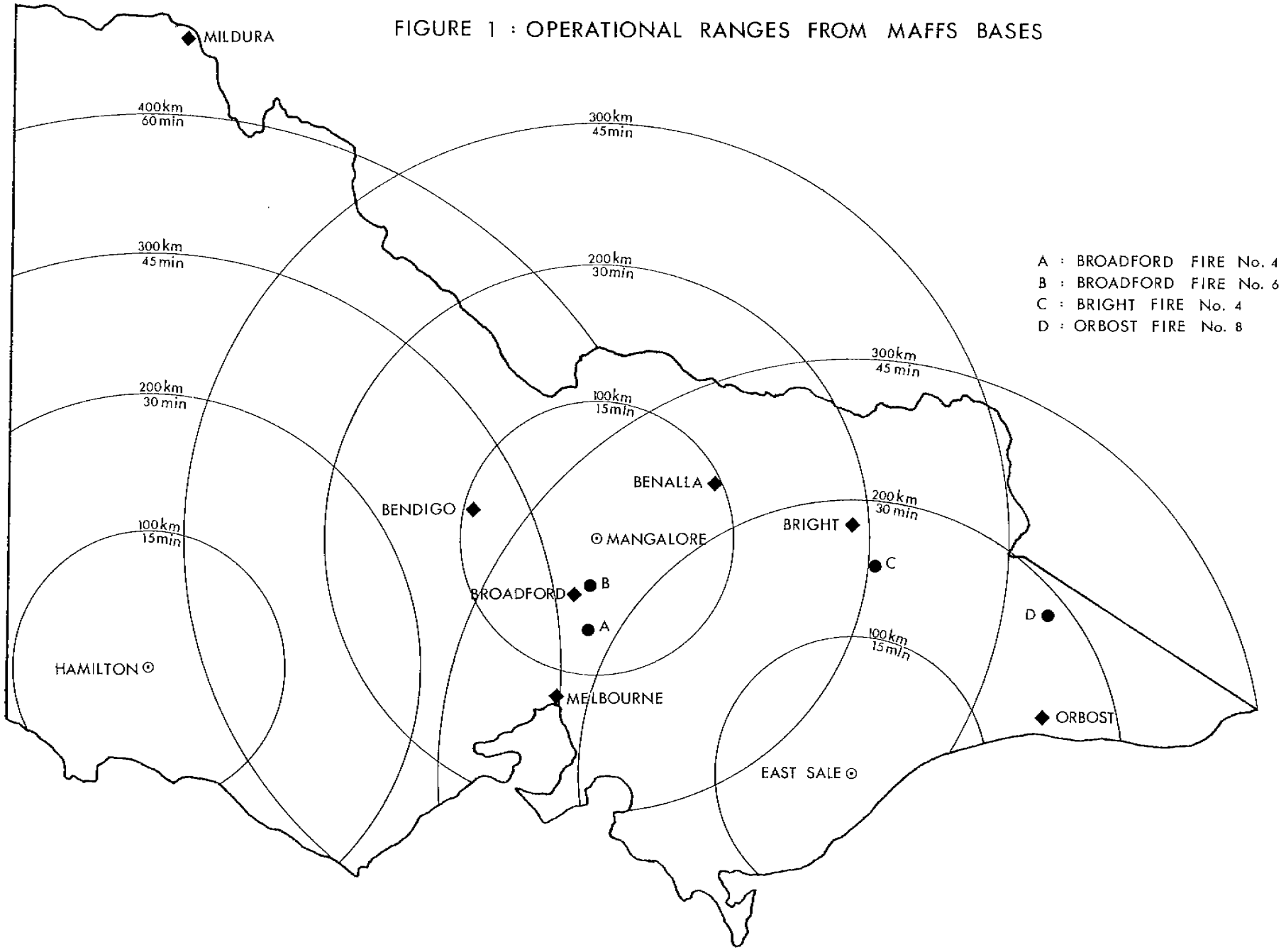
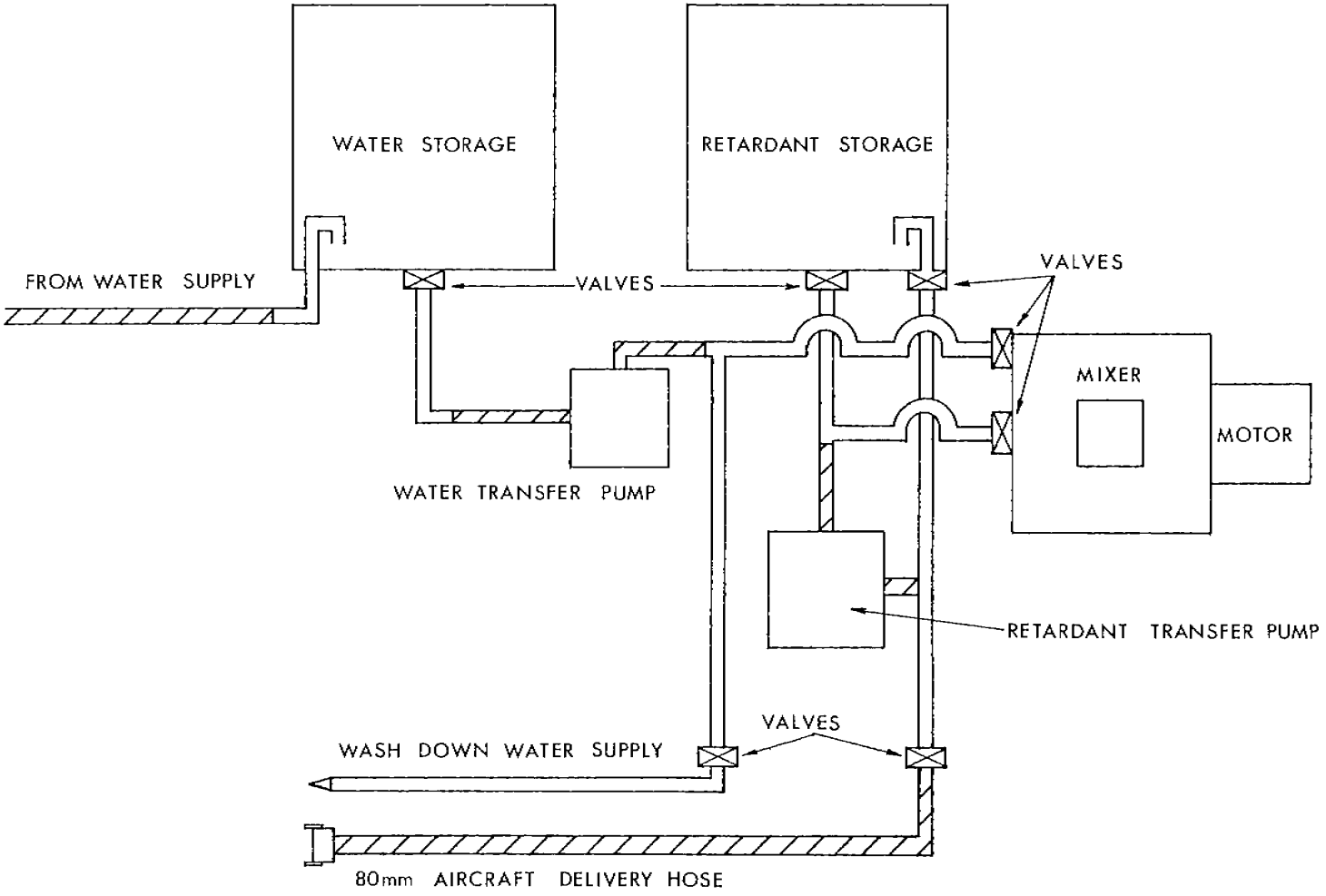


FIGURE 2 : RETARDANT MIXING BASE — MANGALORE



RETARDANTS

The long-term fire retardants used by the FCV since the introduction of firebombing to Victoria have been various formulations of Phoschek, a gum-thickened dry powder retardant supplied by Monsanto, Australia Pty Ltd. These formulations passed stringent standards laid down by the USFS and have proved to have satisfactory retarding capability, storage life and mixing and handling properties. One hundred tonnes of Phoschek XB, with monoammonium phosphate (MAP) as the active ingredient, were ordered for MAFFS operations and delivered in November 1981.

Unsubstantiated claims that the corrosion inhibitor used in Phoschek XB was a health hazard forced the FCV to purchase a new retardant. The retardant, Amgard AII, was manufactured in Melbourne by Albright and Wilson Pty Ltd and based upon diammonium phosphate (DAP). The cost was initially $1.65/kg and later $1.50/kg compared with $1.08/kg for Phoschek XB.

At the recommended mixing ratios the first retardant batches were too viscous to handle. The mixing ratio had therefore to be amended to provide a slurry of acceptable viscosity even though the consequent drop in DAP concentration would reduce retarding effectiveness.

There were problems in obtaining supplies of Amgard AII which were largely due to the company's inexperience in fire retardant manufacture and delays in the supply and production of various constituents.

OPERATIONAL PROCEDURES

Although the MAFFS can be fitted into a Hercules without modification in approximately two hours, the unit was permanently installed prior to the commencement of fire operations. The aircraft remained based at Richmond but to accommodate different levels of fire danger, and the existing fire situation, three states of readiness were agreed to between the RAAF and FCV as follows:-

STATUS 1: Up to two hours from call-out to take-off to a nominated base.
STATUS 2: Up to one hour from call-out to take-off to a nominated base.
STATUS 3: Hercules positioned at a nominated base in Victoria by 1000 hours.

The flying time from Richmond to any of the Victorian bases is approximately 1.5 hours. This, together with the time taken to load retardant, meant that the MAFFS could be ready for operations within approximately four hours from call-out for Status 1 and three hours for Status 2.

Decisions on the type and location of retardant drops were made by personnel in the FCV Command Aircraft or, where possible, in conjunction with personnel on the fireline. Final positioning of the Hercules in the drop zone was achieved by the Command Aircraft demonstrating or describing the line to be flown and again, where possible, through further direction from personnel near the drop zone. In some instances the final positioning of the Hercules required a number of passes when terrain or smoke, combined with the low flying height of approximately 50 m above canopy, made it difficult to pick up the precise line. The accuracy achieved in most drops was very good.

OPERATIONAL EFFECTIVENESS

The MAFFS was used operationally on four fires, the locations of which are shown in Figure 2.

1 Broadford Fire No 4 - 4/2/1982

This fire burnt 20 hectares of logging slash in the Mt Disappointment Forest and a very small area of eucalypt regrowth in a spot fire 300 m to the north.

One retardant load flown from Mangalore and split into two drops was used. The first drop was designed to reinforce control line established on the eastern edge of the slash area while the second drop was on the western edge of the spot fire. Although both were reasonably accurate neither had an impact on fire control because the mild fire activity at the time was readily controlled by ground forces.

2 Broadford Fire No 6 - 8/2/1982

This fire burnt into the Tallarook Forest after originating in private property. The initial spread under conditions of extreme fire danger was very rapid. Using the Mangalore base five retardant loads were dropped on the first day in an effort to check various edges of the fire while on the second day, after the fire spread had been checked, five loads were used to reinforce established lines on both the eastern and western flanks to assist the control of backburning operations.

The effect of one of the drops on the first day was able to be closely observed. Sufficient retardant reached the ground to slow and, in many places, stop a flank fire that had flame heights of 1-1.5 m. Despite this there is no evidence that the drops on the first day contributed significantly to fire control, and the benefits of providing added depth on control lines for backburning, as on the second day, are impossible to quantify.

3 Orbost Fire No 8 - 14/2/1982

This fire was caused by lightning and first reported late on 12/2/1982. It was located near the Snowy River to the east of Gelantipy and eventually burnt 80 hectares. It burnt in generally steep terrain with slopes mostly between 10° and 30° but exceeding 50° on the western edge.

Access to the fire was difficult and the MAFFS was used from East Sale to assist crews that had reached the fire on foot. Small agricultural aircraft operating from Benambra were already being used on difficult sections of the fire perimeter. Two MAFFS loads were dropped with the first on the eastern edge and the second, split into two drops, on the southern edge. The fire behaviour was generally mild with flame heights of 0.5-1.5 m, but areas of more intense fire behaviour did occur. Personnel on the fire considered that the two drops, together with the work of the smaller aircraft, contributed significantly to fire control.

4 Bright Fire No 4 - 14/2/1982

This fire was caused by lightning and located in alpine ash forest close to Harrietville. Because it was anticipated ground crews would be delayed in reaching the fire, one load of retardant from East Sale was used and, split into three drops, it effectively surrounded the fire. A crew reached the area at about the same time as the first drop and, because of the mild fire behaviour, experienced little difficulty in achieving control and the retardant barriers were therefore largely untested.

Although there were few opportunities to directly observe the effect of retardant lines on fire spread, observations at Broadford 6 and Orbost 8 indicated sufficient retardant was reaching ground level to slow or stop the spread of mild fires. Increased effectiveness could be expected in the future as problems with the retardant, which were described earlier, are overcome. A full load was estimated to be capable of establishing a retardant line with an effective length of 350-400 m and width of 30-50 m.

The Hercules proved capable of operation in a very wide range of topographical conditions. Particularly on the last three fires the aircraft was required to drop retardant on fires in steep terrain, and it generally did so accurately provided the aircrew received adequate guidance from FCV personnel.

LINE CONSTRUCTION RATE

On the basis of data taken from the operations described earlier, the following equation can be used to help indicate the turn around time that could be expected during future operations using the same mixing and loading facilities.

$$T = 0.3D + 45$$

where T = turn round time (minutes

D = distance of fire from base (kilometres)

The equation is based upon:-

1 An average flying speed of 400 km/hr. This is 150 km/hr less than the cruising speed of the Hercules but it allows for all phases of flight from engine start to engine stop.

2 A constant value of 45 minutes made up of:-

(i) 30 minutes taken on the ground, between engine stop and engine start, to load the MAFFS;

(ii) 15 minutes over the fire area identifying the target, practising the line and conducting the drop.

After the turn round time has been calculated the rate of line construction can be determined by assuming an effective length of 400 m is constructed with each full load.

The range of times which made up the 30 minutes loading average was very narrow and suggests little room for improved efficiency in this area of operations. However, the 15 minutes on average spent over the fire came from a wide range of values. Part of this variation was due to the nature of the operation where, for example, considerably more time was required to accurately position the Hercules for drops on the second day of Broadford Fire No 6. However, there is no doubt that every effort should be made to reduce the time spent in the fire area to a minimum, and this requires early and accurate identification of the drop zone.

COSTS

Final FCV expenditure, exclusive of RAAF costs, was approximately $450 000. The RAAF have not yet provided an estimated cost for Hercules operations concerned with the MAFFS. Major items of expenditure were base construction (approx. $63 000); transport of the MAFFS to and from Australia (approx. $169 000); purchase and delivery of retardant (approx. $82 000); hire of Command Aircraft ($26 000) and staffing and servicing of bases (approx. $83 000).

CONCLUSION

The operational use of MAFFS in Victoria during 1981/82 was limited by the mild fire season and, because it was used on only four fires, it has not been possible to make an evaluation of cost effectiveness. However, it was demonstrated that the FCV structure could handle firebombing operations involving large aircraft, and that a Hercules crewed by RAAF personnel could fly effective firebombing operations under Victorian conditions.

The experience exposed the limited capability of the established system to fulfil a first attack role. Significant delays between call-out and arrival over the fire area mean that substantial changes would be required if MAFFS was to be used effectively for first attack. The system did however demonstrate a capacity for constructing fireline which could be valuable during the phases of secondary attack on large fires.

System Specification

Capacity
Modular in 500 gallon (1893 liter) increments, dependent upon aircraft.

Power Supply
Air — individual reservoirs on each module.

Pumping Rate
Up to 40,000 gallons (151,416 liters) per minute.

Pumping Characteristics
Constant flow rate at any discharge setting. Volume and pressure evenly maintained by automatic regulators.

Installation
Completely integrated system.
- Emplaced as cargo
- No aircraft modification
- No special tools
- Initial installation less than two hours

Ground Deposition in Unbroken Lines
With thickened thixotropic retardants and 3000 gallon (11,356 liter) system.
- At C-130 Hercules drop speed of 140 knots (259 kilometers per hour)
- Altitudes effective 100 to 500 feet (30 to 152 meters)
- Line widths of 40 to 200 feet (13 to 61 meters)
- Line length to 2000 feet (610 meters)
- Concentrations of 1 to 4 gallons (3.8 to 15 liters) per 100 ft^2 (9.3 m^2)

Resupply Time
Ground supply dependent — 10 minute turnaround with standard supply system to 3000 gallon capacity (11,356 liters).

Weights

• Tank module including pallet and controls	1400 lbs (635 kg)
• Control module pallet and controls	1650 lbs (750 kg)
• Dissemination module, pallet and controls	1800 lbs (816 kg)
• Power cable	100 lbs (45 kg)
Total weight of empty system	10,550 lbs (4795 kg)

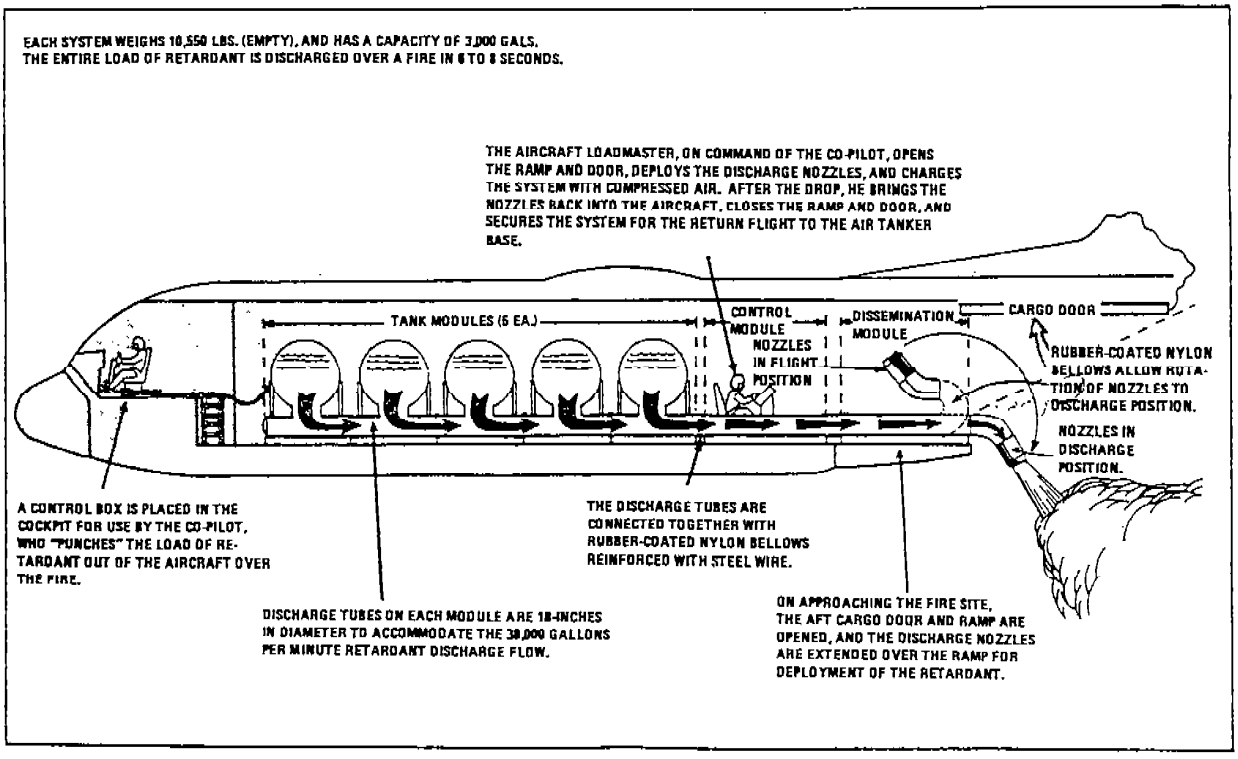
Standard safety features installed for a pressurized system.

System design standardized for production as required for military C-130 Lockheed Hercules aircraft models C-130A, C-130B and C-130E. Loading by U.S. Air Force 463L pallet system.

Variations to customize for other aircraft are available.

Price quotations furnished upon request.

Materials and specifications subject to change without notice or obligation.



MAFFS System Installed in C-130 Aircraft. The System is Self-contained and Requires No Aircraft Modifications.