Evaluation of fire bombing aircraft

A new standard for evaluating fire bombing aircraft shows that even with its high-cost the CL-215 can be more cost effective.

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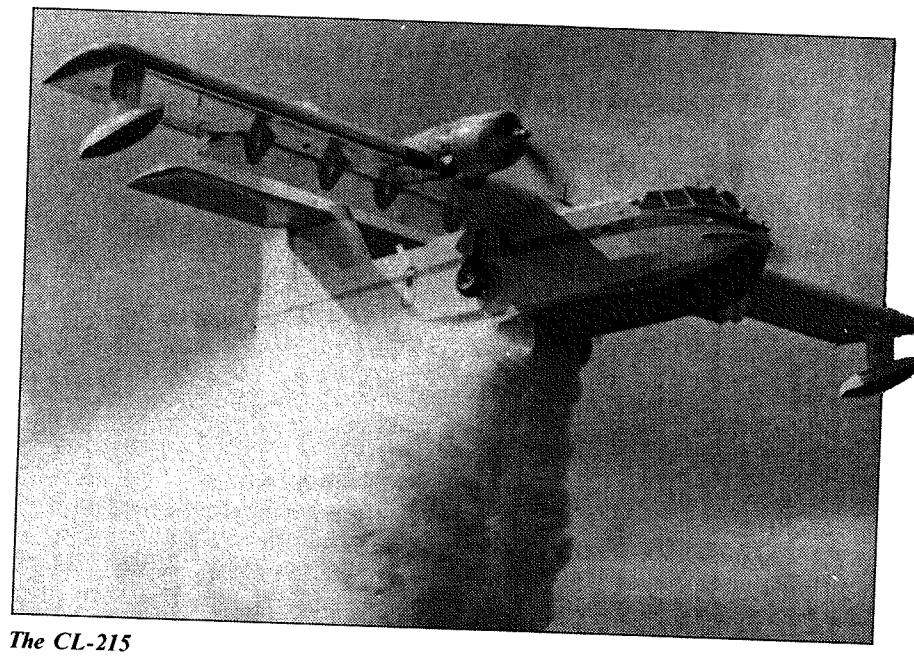
A new standard for evaluating fire bombing aircraft is proposed which shows that, even when the high capital cost of a new CL-215 aircraft is included, the CL-215 is more cost effective than depreciated aircraft where water availability allows this skimmer plane to place at least four drops per hour on a forest fire.



The CL-215

INTRODUCTION

Many studies of air tankers have considered the CL-215 water bomber a most effective fire fighting aircraft; however, these same studies also conclude that the high capital cost of a new aircraft in comparison to depreciated aircraft make the CL-215 less cost effective. Largely for this reason, the aircraft has not had as much success in North America (20 sold in Canada, none in the U.S.) as it has in Europe (50 sold in 5 countries). Limited acceptance in the North American market, particularly in Canada, has reduced the ability of the manufacturer to produce the CL-215 aircraft in a way which would capture full economies of scale, resulting in a low profitability program with a history of price escalation greater than inflation. These factors have placed further production of the aircraft in serious doubt, at a time when most of the present fire bombing fleets are between thirty and forty years of age and when the Canadian Council of Resource and Enivronment Ministers has identified the need for more fire bombers to cope with fire situations comparable to recent fire seasons.

If the CL-215 can be demonstrated to be more cost effective than alternative aircraft, cancellation of further production will increase future costs of woodland protection. Present evaluation methods make thirty year old aircraft, designed for other purposes and converted to drop expensive chemical retardant, appear more cost effective than the only modern aircraft ever designed specifically for fire bombing. If we set aside the question of how much longer thirty and forty-year-old aircraft can be expected to continue flying, how is scooping free water from lakes near fires more expensive than hauling chemicals from often distant airports? Before governments allow cancellation of the only modern scooper aircraft, surely another look at evaluation is in order.

ROLE OF FIRE BOMBING IN FOREST FIRE SUPPRESSION

One of the best ways to ensure prompt initial attack and early containment of a forest fire is to use fire bombers to drop water or chemical fire retardant. In either case, the primary purpose of air attack is to retard the progress of the fire and hold it until ground crews can move in and are able to complete the suppression job. In some cases, depending on the fuel type and rate of fire spread, fire bombing may extinguish a fire. However, this is not the general rule nor is it the prime objective of air attack operations. Fire bombers may also be used on large 'campaign' fires in support of ground forces – to attack the most inaccessible or intense parts of the fire, to drown spot fires outside the perimeter of the main fire, and to establish or reinforce control lines.

There are two basic types of fire bombing aircraft: air tankers and water skimmer aircraft. The choice of fire bombing aircraft is generally dictated by the availability of water. In the Precambrian Shield regions of Canada, where much of the productive Boreal Forest is located, water is readily available from many lakes. Many of these lakes are often situated close to a fire. In these areas, water skimmer aircraft such as the CANSO and the CL-215 are ideally suited for fire bombing. They can remain at the fire and deliver large volumes of water with minimal turnaround time between drops, since they do not have to reload at a permanent base. Also, there is no need for elaborate and expensive base facilities, although some permanent bases are required

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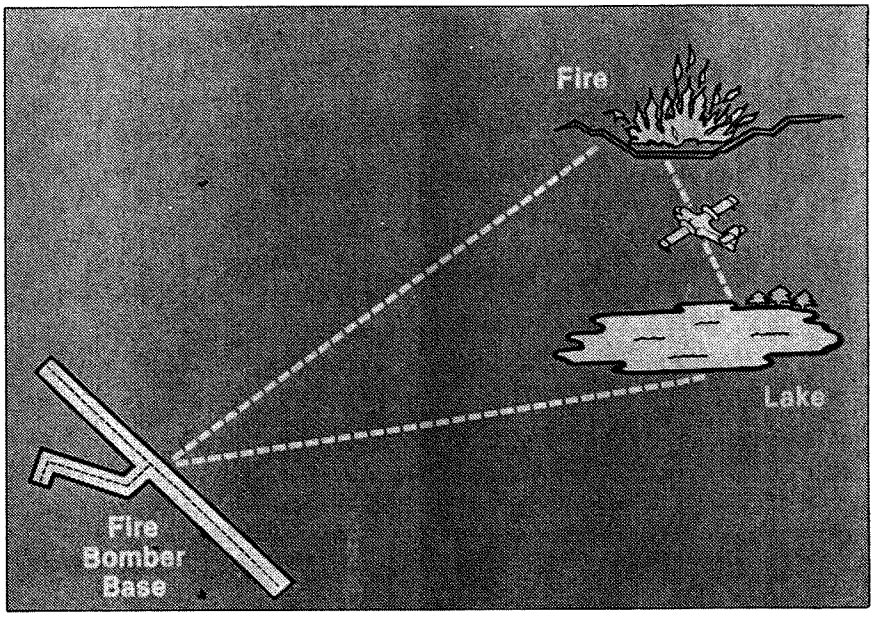


for aircraft maintenance and fueling as well as facilities for crew standby. Conversely, in areas where there are fewer lakes, land based retardant air tankers are practical. They are used mainly in the western provinces and in New Brunswick.

The long term retardant that is used in land based air tankers may vary from equivalent to appreciably greater effectiveness when compared with water placed on the edge of the fire. Effectiveness is governed by both fuel and fire conditions. The use of combustion inhibiting retardant compensates in part for the longer turnaround time between drops that results from the need to return to base for reloading. Also, in this type of operation, the usual practice is to dispatch several aircraft to complete the suppression activity in one strike. If necessary, successive strikes are made. And, as with water bombing, follow-up action with ground forces is necessary.

WATER AVAILABILITY IN CANADA

The division of the country into water skimmer zones and retardant zones is well accepted by the forest protection community, and protection agencies have developed effective suppression systems resulting from this basic choice. Fire suppression attack concepts, numbers of aircraft required, and make or buy decisions are all influenced by the choice of aircraft type. Each of these decisions results in a fire suppression system which is strongly defended by advocates of the basic choice of aircraft as the one most appropriate for their province. Division of the country into water skimmer or retardant zones has become a way of avoiding controversy – the basis for an either/or choice. However, the choice is not this simple. To choose in an either/or way ignores that, while it is true that the productivity of a skimmer aircraft is related to water availability, the availability of water varies greatly even within the retardant zones.

In an attempt to better define the size of these two zones, an independent consultant, Aviation Planning Services, was commissioned by Supply and Services, the Canadian Forestry Service and Canadair to study "Potential Savings by Utilization of the CL-215 Water Bomber in Western Canada". About 900 case reports for those fires on which land based air tankers had been active were obtained and, by indicating the fire location on a map, the distance to the nearest useable body of water was determined. The criterion for a useable body of water was taken as a minimum straight length of 3.2 kilometers even though the CL-215 can reload by scooping in only 1.2 kilometers. The additional two kilometers is only required for landing and take-off where a lake could be used as a base. In short, the consultant was asked to determine whether the use of skimmer aircraft on fires presently fought with land based retardant bombers would be practical. One of the findings was that a large percentage of fires occurred near water sources, and were started by people who tend to camp and picnic near water. The results confirmed other studies done by A.J. Simard, formerly of the Canadian Forestry Service, and United Aircraft Corporation that, while water availability is reduced in some parts of the "retardant zones", there are large areas remaining where water skimmers are practical.

The consultant's study concluded that the major retardant using provinces could save about 93 million dollars over the next 20 years by substituting CL-215's for the presently used land based aircraft. This figure is constant 1982 dollars, and results solely from the substitution of water for retardant and the greater fuel efficiencies of the CL-215.

OTHER FACTORS IN THE CHOICE OF AIRCRAFT TYPE

Clearly, other factors are also important in the selection of aircraft type: the make or buy decision, how the high capital cost of new aircraft is to be treated in the evaluations, assessment of aircraft productivity, and purchasing practices. In past considerations, these factors coalesced into a pattern which was biased against the CL-215 as the only modern water skimmer.

Most provinces which use retardant aircraft also contract for fire bombing services. Since it is easier to get into this business through purchasing depreciated aircraft, all contracts for fire bombers service in Canada and the U.S. call for depreciated aircraft. The purchasing decision for this fire bombing service is based on a combination of a basing charge and cost per flying hour. This is the normal way a purchasing department would evaluate the use of a utility aircraft, modified by a standby or availability charge.

Fire bombing aircraft are utilized very few hours per year (about 100 hours in a normal season). In this method of evaluation, the higher charge for insurance of a new aircraft rather than a depreciated one is sufficient to make new aircraft uncompetitive. A further addition to the hourly flying charge that makes them uncompetitive is the interest on capital borrowed to purchase new aircraft. Not surprisingly then, pri-

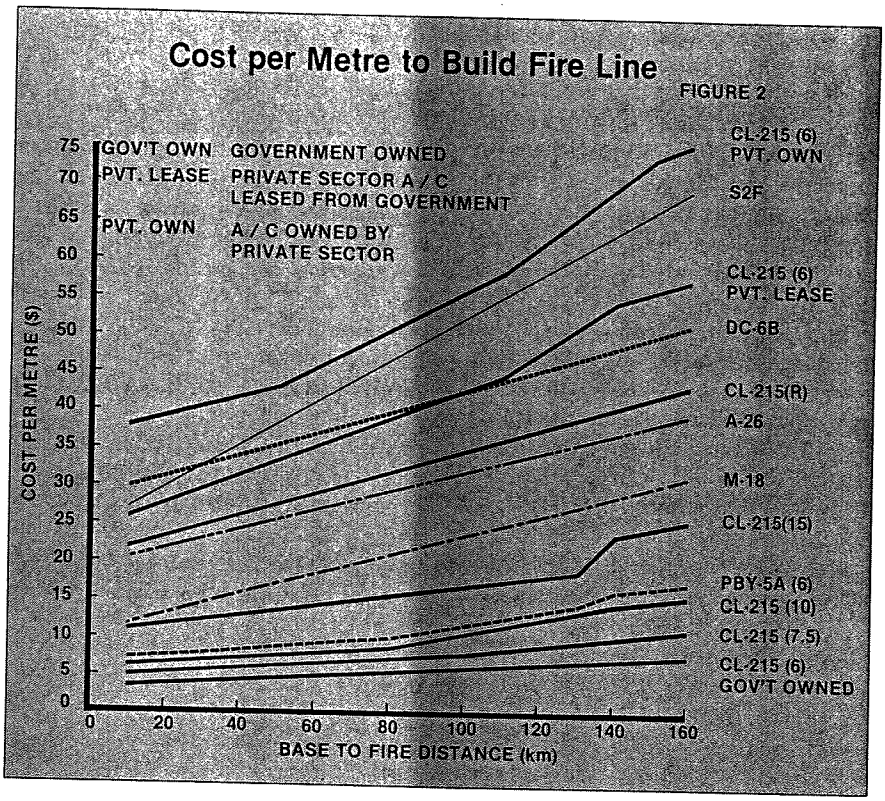
vate operators think their business is a depreciated aircraft business.

With the exception of the CANSO, only land based aircraft are available from the depreciated aircraft market, and therefore, retardant air tankers predominate in the United States and much of Canada. The productivity of land based aircraft converted to air tankers is judged on the basis of combination of speed, tank design and capacity. Generally, the larger the tank capacity and faster the aircraft the better, but this has to be tempered by the number and length of runways where the aircraft can be based.

Evaluating fire bombing aircraft in a manner appropriate to utility aircraft, only makes sense if in fact they are utility aircraft. This is to say, fire bombing aircraft would also perform other roles and functions which increase their total number of hours flown, and thus reduce the per hour flying charge by spreading fixed costs. This has been offered as a reason why contracting out made sense, as it was thought private operators have the incentive to increase aircraft utilization to increase their return on capital invested. However, an examination of the fire bombing service industry reveals that all aircraft used in fire bombing are used exclusively for this purpose. Most of the alternative uses to which these aircraft could be put occur during the fire season, or can be performed more efficiently by helicopters or other more modern aircraft. The fact of the matter is that fire bombing aircraft are dedicated to being flying fire trucks and nothing else. Therefore any new standard of evaluation should be one which considers the productivity of fire bombers as flying fire trucks rather than as air tankers hauling fire suppressant from point to point as a utility air freighter. The new standard for evaluation should compare air tankers and water scoopers by accounting for their productivity and by relating capital and operating cost to this productivity.

A NEW METHOD EVALUATION

The Canadian Forestry Service was able to provide the co-authors of this paper to assist in the development of another approach to evaluation. The request for assistance by the CCREM Task Force on Cooperative Supply of Fire Bombing Aircraft provided the opportunity to integrate CFS research into a comprehensive method of evaluation.



We developed the following simple scenario consisting of an airport base, a fire and a lake. The distance between base and fire was then varied from 10 km to 160 km maximum, on the assumption that a random distribution of fires could occur within 160 km radius serviced by the base. This range is a reasonable limit of effective productivity for land based aircraft.

The lake to fire distance was assumed to be one of four distances (7.0, 10.0, 16.0, and 28.0 km) somewhat representative of differing average water availability in different parts of Canada. That is, we assumed there would be a suitable lake within these attack radii, such that the CL-215 could scoop water and put a new load on the fire every 6, 7.5, 10 or 15 minutes respectively. The CL-215 was also assumed to have taken off from the same airport as the land based aircraft, not the nearby lake. Although our maximum productivity rate of a six minute cycle (ten drops per hour) is the average obtained in Quebec, it should be remembered in many cases fires occur very near water allowing for even greater productivity. For example a CL-215 in Yugoslavia recently set a new record for the number of drops on a fire in a single day. The Yugoslav pilots managed to average a new load on a large fire every 3 minutes over eleven hours of flying time. The aircraft dumped 225 drops or approximately 1300 tons of water on a burning strip of forest 7km long and 2km wide near a coastal tourist resort.

This record was achieved on what we call a "campaign fire", and is the sort of fire that quick initial attack is designed to prevent. The sustained action capability of a water scooper wins hands down in this type of situation, so our scenario assumed that after 95 minutes, the fire should either be contained and the fire bombers called off, or be declared a campaign fire justifiying extended suppression effort.

Within this assumed situation, we then calculated the number of drops various types of planes could make within 95 minutes, flying over the various attack distances and using actual flight speeds, tank capacities and drop patterns as established by tests. Drop patterns for retardant bombers were limited to that portion which put a continuous strip of .1 cm coverage on the ground; while skimmer aircraft drop patterns were limited to that portion resulting in a .25

cm water coverage. These relative amounts were considered sufficient to produce effective fire lines when placed on the edge of the fire in a fire environment of low to moderate fire intensity. Fires detected and attacked when small, can be contained by fire bombing, but when they reach rapid rates of spread and very high intensities only weather can contain them, hence escape fires result. The assumed method of air attack consisted of placing the loads half on and half off the fires' edge (direct attack). In effect, this means that skimmer aircraft would be required to put two and one half times the depth of coverage on the fire for every unit of retardant placed by a land based aircraft.

Actual operating costs were obtained so that the cost per litre of water or retardant delivered and the cost per metre of fire line constructed could then be calculated. These are the cost effectiveness standards we deemed to be most appropriate for evaluation of fire bombing aircraft.

By using this method of evaluation, forest protection personnel can use the airport locations and actual topographic data of their respective protection areas to calculate which aircraft would be most cost effective for that particular region. Instead of an either water or retardant choice, this method allows for productivity calculations based on varying water availability, and varying base to fire distance.

As distances from base to fire are, on average, greater than fire to lake distances, the greater productivity of the water scooper quickly becomes apparent even when greater coverage levels required that more water than retardant be hauled to the fire.

Assuming a random distribution of fires and interpreting substitution opportunities as integer values (you cannot fly part of an airplane to a fire) a scale of productivity comparison for any aircraft can be produced. Earlier arguments advocated that tank capacity could serve as a proxy for productivity. Using the new scale, at 6 and 7.5 minutes per cycle, the CL-215 can be shown to be twice as productive as a DC-6B, which has double the tank capacity, rather than half as productive as was previously believed on the basis of tank capacity.

Figure I converts the productivity into cost effectiveness by showing cost per meter of fire line constructed at various distances.

The costs have been derived from last year's contracts for fire bombing services and from actual operating costs of the Quebec government. The lowest costs are for the CL-215 are the Quebec government's actual operating costs. As with any government purchase, the capital cost is simply absorbed, so this picture is a bit unfair when compared to the prices paid to obtain other aircraft types from private operators. The private lease option was developed by adding the cost of financing a CL-215 from a large chartered bank to the 6 minute productivity curve. The government agency would own the aircraft in 8 years, after which time the cost would drop to about the lower rate which covers only operations costs. This private lease option still does not represent the financial terms that a private operator would be able to obtain, nor an allowance for profit. The privately owned option assumes a 15 percent profit on financing and operations and that the operator would own the aircraft after five years. These figures demonstrate that even after including financing costs, the costs of fire line construction are still competitive.

All of these figures are based on 100 days basing charges and 100 hours flying time per season. The difference between a utility aircraft approach to evaluation and a productivity approach becomes evident in the treatment of the initial capital cost. This method compensates for the higher charge resulting from financing costs associated with a new aircraft by factoring in the increased productivity of the CL-215 rather than simply loading it against the per hour flying charge. In this method, the total financing charge could be written off in either 500 or 800 hours of flying time (hardly time enough for the first engine overhaul) at prices not greatly different than those presently being paid for depreciated aircraft. In addition to this arguement on the basis of productivity, it should also be acknowledged that the economics of flying fire trucks are indeed different from the economics of operating flying dump trucks. The former are emergency vehicles that should be justified on the basis of escape fires prevented while the latter are routine service vehicles.

These results should encourage a re-evaluation of the CL-215 by provincial forest protection agencies. However, one should not conclude that land based air tankers are uncompetitive or that there is no role for retardant air tankers. Because of the rapid spread of fire in some fuel types, there is a role for retardants. This method merely provides a method of calculating air attack costs on the basis of productivity factors. More work needs to be done to factor this method of evaluation into provincial decisions about fleet compositions, numbers of aircraft required and basing of these aircraft in those woodland zones to be protected.

In closing, it is important to point out two other important facts about the CL-215:

– It is a good retardant aircraft as well as a water skimmer; and the fact that it does both roles well gives it flexibility in fire fighting that no land based aircraft has.

– Secondly, it should also be pointed out that since the CL-215 is the only large twin engined amphibious aircraft in production, it is also being sold for use in maritime patrol and utility transport.

CONCLUSIONS

1. Cost per metre of fire line constructed offers an improved method of evaluation of fire bombing aircraft.
2. When fire bombing aircraft are evaluated on this basis, using actual contract prices, the CL-215 is competitive even with allowance for financing charges.
3. Provincial govnerments should re-evaluate use of the CL-215 water skimmer when considering future requirements for air attack to protect our woodlands.
4. To carry this method of evaluation into forest protection decisions, there is a need for additional study to consider location and allocation alternatives for fire bombers, optimal fleet configurations and number, resource values-at-risk, the high investments for renewal of our future forests, and interagency cooperation to ensure the best possible levels of protection of Canada's dwindling forest resources.

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