

AVIATION OCCURRENCE REPORT

IN-FLIGHT LOSS OF CONTROL

**SUPERMARINE AIRCRAFT INC.
PZL M18A DROMADER
LITTLE MUSKRAT LAKE, ONTARIO
11 AUGUST 1994**

REPORT NUMBER A94C0160

MANDATE OF THE TSB

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, the TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

INDEPENDENCE

To enable the public to have confidence in the transportation accident investigation process, it is essential that the investigating agency be, and be seen to be, independent and free from any conflicts of interest when it investigates accidents, identifies safety deficiencies, and makes safety recommendations. Independence is a key feature of the TSB. The Board reports to Parliament through the President of the Queen's Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations.



The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Occurrence Report

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Synopsis

The pilot of the agricultural spray aircraft was circling a sector of forest in preparation for the spraying of herbicide. The aircraft was subsequently observed in a spin as it descended vertically and struck the ground. Shortly thereafter, a post-crash fire engulfed the aircraft. The pilot and lone occupant was fatally injured and the aircraft was destroyed.

The Board determined that the aircraft stalled and entered a spin at too low an altitude to permit recovery. Contributing to the occurrence was the reduction of the aircraft's handling characteristics and flight envelope that resulted from the operation of the aircraft at a higher weight than allowed by the manufacturer's type approval, as authorized by a special exemption program for agricultural operators.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

The pilot took off at 0951 eastern daylight saving time (EDT)¹, with a 2,040-litre load of herbicide and full fuel on board, for his fourth local aerial application flight of the day. The aircraft flew for approximately 10 minutes while en route to the application area where other company pilots were already operating. Upon arriving in the working area shortly after 1000 EDT, the pilot had a short radio conversation with another pilot working in the area. The conversation was routine in nature and there was no indication of any problem. At the time of the radio conversation, the aircraft was observed circling over the assigned sector at approximately 400 feet² above ground. A few moments later, a radio call of distress was heard while the aircraft was observed in a spin as it descended vertically into the ground.

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- 1 All times are EDT (Coordinated Universal Time [UTC] minus four hours) unless otherwise stated.
 - 2 Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.
 - 3 See Glossary for all abbreviations and acronyms.

The other pilots immediately radioed for help and did a low flypast over the crashed aircraft but were unable to land to provide further assistance. Moments later, a fire ignited and by the time ground personnel arrived, the fire had progressed to the extent that they were unable to provide rescue assistance.

The crash occurred during the hours of daylight at latitude 49°13'N and longitude 089°01'W and an elevation of 1,150 feet above mean sea level (asl)³.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	1	-	-	1
Serious	-	-	-	-
Minor/None	-	-	-	-
Total	1	-	-	1

1.3 Damage to Aircraft

The aircraft was destroyed by impact with the ground and by the subsequent post-crash fire.

1.4 Other Damage

The aircraft was loaded with 2,040 litres of glyphosphate herbicide, which was spilled in the area of the crash when the chemical tank ruptured during the collision with the ground.

1.5 Personnel Information

	Pilot
Age	25
Pilot Licence	Commercial
Medical Expiry Date	01 May 1995
Total Flying Hours	1,645
Hours on Type	35 (est)
Hours Last 90 Days	130
Hours on Type Last 90 Days	35 (est)
Hours on Duty Prior to Occurrence	3
Hours off Duty Prior to Work Period	12

1.5.1 Pilot Experience

The pilot commenced flight training in 1988 and, during the course of completing a college program in aviation and flight technology, acquired his commercial pilot licence and multi-engine endorsement in February of 1990. The

multi-engine endorsement included a blanket type rating for all aircraft with a maximum operating weight of up to 12,500 pounds (lb). An instrument flight rating followed in April 1990. The pilot began flying for the operator in May of 1990 and continued summer employment with the company while attending university.

Available records indicate that, prior to commencing operations with the occurrence aircraft, the pilot had accumulated approximately 1,230 hours flying experience in Cessna 150/152 and 172 aircraft, and about 350 hours of flight time in the Cessna 188 and Grumman G164A agricultural aircraft. On 06 July 1994, after a ground briefing regarding operation of the single-seat PZL-M18A company estimated that the pilot had accumulated 35 hours on the Dromader at the time of the occurrence.

1.5.2 Pilot Training

There are no regulatory requirements for either aircraft type specific training or agricultural flight operations training, nor is there a formal flight training course available for agricultural pilots in Canada. Agricultural operators in Canada operate as a commercial air service and are issued an operating certificate that designates them as a specialty air service. This designation exempts them from the requirement of having a Transport Canada approved company operations manual which normally contains the training and currency requirements for pilots. The operator was not required to have and did not have a formal training program. After the occurrence pilot obtained a commercial pilot licence and started working for the operator, training was provided by the operator. There was no documentation available to indicate any training that may have been accomplished. The pilot was certified and qualified for the flight in accordance with existing regulations.

1.6 Aircraft Information

Manufacturer	PZL-Mielec, Poland
Type and Model	Aeroplane
Year of Manufacture	1985
Serial Number	1Z015-12
Certificate of Airworthiness (Flight Permit)	Special - Restricted (with C of A weight exemption)
Total Airframe Time	1,955 hr (est)
Engine Type (number of)	Reciprocating (1)
Propeller/Rotor Type (number of)	Constant Speed (1)
Maximum Allowable Take-off Weight	12,500 lb (with C of A weight exemption)
Recommended Fuel Type(s)	Minimum 91 Octane Avgas
Fuel Type Used	100 Low Lead Avgas

1.6.1 Aircraft General

The PZL-M18 Dromader is a special-purpose, medium-load carrying capacity, agricultural airplane powered by a 967-horsepower piston radial engine. It is a Dromader aircraft, the pilot carried out a 0.9-hour local flight. Although there were no records available to indicate the pilot's flying times after 06 July 1994, the single-seat, low-wing, cantilever, all-metal airplane with fixed main and tail landing gear. A 2,500-litre capacity chemical

hopper is located in front of the cockpit. The aircraft can be configured for aerial application of liquid or dry chemicals, or for forest fire fighting. The M18A Dromader differs from the M18 in that a rearward-facing mechanic's seat is added behind the pilot's seat and the aircraft battery is relocated to the forward part of the fuselage. Canadian regulations prohibit the carriage of personnel in the mechanic's seat.

The aircraft was one of two that were purchased by the company in July 1994 and imported from the United States. The aircraft was manufactured in Poland and had been exported from East Germany prior to being certified and registered in the United States. An Export Certificate of Airworthiness was issued by the United States Federal Aviation Administration (FAA) on 15 July 1994. After the aircraft arrived in Canada, Transport Canada personnel inspected the aircraft, and they approved the aircraft for operation on 28 July 1994. Records indicate that the aircraft was certified and equipped in accordance with existing regulations and procedures.

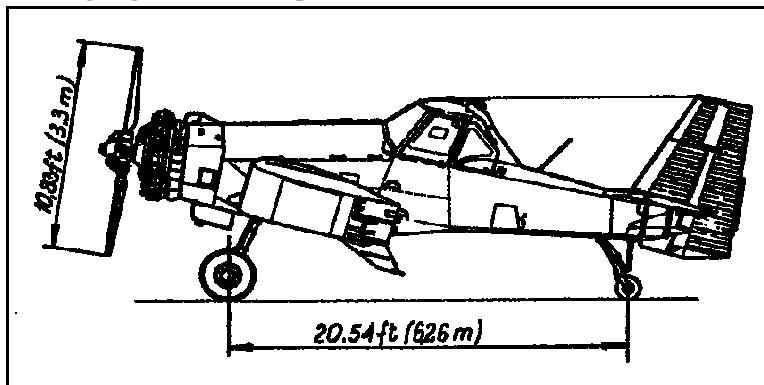


Figure 1 - PZL-M18A

1.6.2 Aircraft Operation

The operator has been operating Dromader aircraft since 1990. Company personnel indicated that they were expanding their use of Dromaders because the aircraft offered superior payload capability in comparison with other agricultural aircraft. The operator was under contract to a forest products company to conduct spraying operations in the area; the occurrence happened during the first day of operation on that contract. The occurrence aircraft was one of four Dromaders that the

operator had working at the contract site. Personnel at the site did not indicate that there were any problems regarding the operation of the Dromader aircraft.

During aerial application operations on forested areas, herbicide is sprayed at treetop level over the assigned areas by subsequent, contiguous runs. At the end of a run, the pilot normally manoeuvres the aircraft into a climbing turn in preparation for the next run adjacent to the one just completed. Depending on the situation and the location of the runs, the climbing turns may involve more abrupt manoeuvring to

better position the aircraft or to avoid collision with the terrain or other obstacles.

At the time of the occurrence, the aircraft was configured with wing-mounted spray booms for the application of liquid chemicals, and was being operated at a weight of approximately 12,115 lb with a centre of gravity (C of G) at 27.19 inches aft of datum.

1.7 Meteorological Information

The weather conditions in the area consisted of generally clear skies with a light southwesterly surface flow. The area was dominated by a ridge of high pressure and there may have been some early morning fog patches; however, by the time of the occurrence, the fog would have dissipated. There was no other significant weather in the area.

Other pilots operating in the area at the time of the occurrence reported that they experienced no restriction to visibility, light winds, and little or no turbulence.

1.8 Aids to Navigation

There were no electronic aids to navigation available at the airfield. All flights were conducted using maps and visual orientation. Because accuracy of spray application is critical, the pilots carried and used detailed aerial photos for navigation as well as for identification and orientation of spray areas.

1.9 Aerodrome Information

The airfield that was used for the spray operation is privately owned and is not listed in the *Canada Flight Supplement* (CFS). The compacted gravel airstrip is approximately 3,500 feet long and 75 feet wide.

1.10 Flight Recorders

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was either required by regulation.

1.11 Wreckage and Impact Information

The aircraft crashed approximately 185 feet to the east of a logging road on sloping terrain and came to rest on a heading of 040 degrees magnetic. Immediately adjacent to and surrounding the site were several large birch trees about 50 to 60 feet high, which remained untouched during the impact sequence. The collision with the ground created a uniform crater measuring approximately 12 feet across and 3 1/2 feet deep. The aircraft came to rest on the left forward edge of the crater.

The engine was torn from its mounts and three of the four propeller blades were extensively damaged by ground contact and broken off at the hub. The right wing tip was forward of its normal orientation, and the left wing was angled towards the rear of the aircraft in relation to its normal position. Both wings and the fuselage were extensively damaged by fire. All flight controls were checked and accounted for. The aircraft and systems were examined to the degree possible, and no evidence of a malfunction was found.

1.12 Medical Information

An autopsy, toxicological testing, and medical records revealed no evidence that incapacitation or other physiological factors affected the pilot's performance.

1.13 Fire

There was no evidence of an in-flight fire; however, a post-crash fire ensued.

1.14 Survival Aspects

The emergency locator transmitter (ELT) activated when the aircraft struck the ground and continued to operate until it was disabled by the post-crash fire. Search and Rescue resources began to respond; however, while they were still en route to the area, the response

was cancelled when communication was established with ground personnel who were already responding to the occurrence.

A clasped seat-belt buckle, including the shoulder strap attachments, was found at the site; the fabric sections of the belts were missing and presumed destroyed by fire. The accident was non-survivable because of the magnitude of the deceleration forces.

1.15 Maximum Take-Off Weight Exemption

Air Regulations subsections 210(1) and 218(a) require operation of an aircraft within the maximum permissible weight provision of the Certificate of Airworthiness. The operator, however, had been authorized by Transport Canada to operate the aircraft at a higher weight. The request for this exemption from the Air Regulations was prompted by events some years prior, when a competition for an aerial application contract in Canada was awarded to an American operator. A Canadian company that was unsuccessful in the contract bid subsequently asserted that the contract winner had submitted a bid with an aircraft type that would have to be operated in accordance with the less restrictive US weight allowances to carry the loads needed to accomplish the contract. As a result, the Canadian Aerial Applicators Association (CAAA) began an initiative, on behalf of Canadian agricultural aircraft operators, to obtain an exemption from Transport Canada that would allow operators to carry loads in excess of those allowed by the aircraft manufacturer's type approval.

In response to the CAAA initiative, Transport Canada, in concert with the CAAA, instituted guidelines and procedures for an operator to conduct a flight test evaluation of aircraft for which exemptions were being sought. An Airworthiness Notice was published by Transport Canada to inform the aviation industry of the availability of the Air Regulation exemption program.

The occurrence operator was sponsored by the CAAA and carried out the initial aircraft flight

evaluations of the Dromader in March 1993. The results of the operator's evaluation were then incorporated into an Operating Manual Supplement (OMS), also sponsored by the CAAA, which was submitted to Transport Canada with the application for exemption.

An exemption from the Air Regulations requires that the application for each specific aircraft be processed by Transport Canada. Transport Canada granted a weight exemption for the aircraft which was used in the original evaluation. Similar exemptions for other operators of the same aircraft type are obtained through written request without a flight evaluation. The exemptions are granted on the basis of the original flight evaluation.

1.15.1 CAAA Operating Manual Supplement

Once granted the exemption, aircraft may be operated at the higher weight limits specified in the CAAA OMS. Although Transport Canada issues the exemption from the Air Regulations, Transport Canada's evaluation guidelines stipulate that the CAAA OMS is not approved by Transport Canada.

The CAAA OMS states that "the information contained in this supplement amplifies or supersedes that contained in the basic aircraft operating manual. For items not addressed in this manual refer to the basic operating manual." The OMS stipulates that it has not been approved by Transport Canada and notes that, in accepting the document, the operator acknowledges that the maximum safe operating weights may be less than those indicated in the OMS and will vary according to temperature, altitude, terrain, aircraft condition, aircraft configuration, pilot skill, and type of operation. The OMS does not contain any documentation to quantify how these factors affect aircraft performance at the higher weights.

1.15.2 Aircraft Evaluation Guidelines

The guidelines published by Transport Canada for the flight evaluation and development of the OMS indicate that the proposed maximum take-off weight should not exceed either 1.25 times the maximum take-off weight in the

normal category, or the maximum take-off weight determined by the aircraft manufacturer's analysis to be structurally acceptable. The Transport Canada guidelines also require an assessment of the aircraft's tendency to stall, dive, or roll, and the determination of minimum operating and maximum level flight speeds--there must be a minimum of 30 knots (34 mph) between these speeds. Additionally, maximum hopper loads and C of G limits are to be specified. The guidelines caution that the C of G limits "previously approved are not to be expanded for, or as a result of this evaluation." The determination of pilot experience or training requirements is not required by the guidelines.

1.15.3 Evaluation Results

The evaluation pilot's report of the flight evaluation of the Dromader at 12,500 lb described the aircraft as handling very well. The minimum operating speed was determined to be 100 mph indicated airspeed (IAS), and the maximum operating speed was established as 139 mph IAS. The maximum hopper load was set at 5,300 lb and the allowable C of G range was specified as 25.9 to 27.9 inches.

4 See Appendix A for a comparison of the various weight and balance envelopes authorized, and Appendix B for the limitations and references for the PZL-M18/A Dromader aircraft.

1.16 Aircraft Operating Limitations⁴

1.16.1 Maximum Weight Limits

The Canadian Aircraft Type Approval (ATA) No. A-132 indicates that the maximum take-off and landing weight for the PZL-M18 and M18A is 9,260 lb. The ATA indicates in Note 3 that the aircraft may also be operated in an "Overload Version" at a maximum weight of 10,340 lb in accordance with Supplement No. 1 of the approved Aircraft Flight Manual (AFM).

The Transport Canada Restricted Special Certificate of Airworthiness (C of A) indicates that the aircraft was registered with a maximum take-off weight of 10,340 lb.

On 05 August 1994, the operator received temporary authorization from Transport Canada to operate all of their Dromader aircraft at up to a maximum take-off weight of 12,500 lb as identified in an Operating Manual Supplement (OMS) provided by the CAAA. Permanent authorization was issued to the operator on 18 October 1994.

1.16.2 Centre of Gravity Limits

The ATA refers to the approved AFM for specification of C of G limitations. The C of G limits are displayed in a chart contained in the limitations section of the AFM. The limits vary as a function of total weight and show an allowable range from 20.7 to 25.2 inches aft of the reference datum (leading edge of the wing) for operation at the minimum flying weight of 6,160 lb. The limits transition to a range of 24.3 to 27.9 inches aft of datum, for operation at the maximum weight of 9,260 lb.

C of G charts for "overload" operation at 10,340 lb are provided in AFM Supplement No. 1 for the M18 and in Supplement No. 8 for the M18A. The charts show that at 10,340 lb, the C of G limits are reduced to a range of 25.2 to 27.9 inches aft of the reference datum. The OMS provided by the CAAA lists the C of G allowable range as 25.9 to 27.9 inches for operations at 12,500 lb maximum take-off weight; however, the OMS does not contain performance charts to permit the calculation of the C of G variation at other weights and load distributions.

1.16.3 Aircraft Stall Speeds

The aircraft was not equipped with the optional stall warning system that is available from the aircraft manufacturer, nor is there a regulatory requirement for it to be so equipped.

Aircraft stall speeds vary with weight and bank angle. The AFM does not provide stall speed calculation charts for aircraft operating as heavy

as 12,115 pounds. The CAAA OMS lists a minimum operating speed of 100 mph IAS for operation up to 12,500 lb; however, there is no reference chart available for determination of stall speeds at various weights, bank angles, and configurations.

The following table shows the power-off stall speeds calculated by the TSB Engineering Branch Laboratory for the aircraft in level flight, as configured at the time of the occurrence.

Stall Speed Chart PZL-M18A - Level Flight, Power off, 0° Flap, Spray Configuration.			
Bank Angle (°)	Load Factor (g)	Stall Speed (mph IAS) @ 9,260 lb	Stall Speed (mph IAS) @ 12,500 lb
0	1.0	82	94
15	1.04	83	96
30	1.15	88	99
45	1.41	96	110
60	2.1	114	131

1.16.4 Aircraft Manoeuvring Limitations

The limitations section of the AFM states that intentional aerobatic manoeuvres, including entry into spins, are prohibited, and that the maximum allowable bank angle in a turn is 60 degrees. Maximum load factors are stipulated as +3.4 g and -1.4 g for operations at 9,260 lb with flaps retracted, and are reduced to +3.0 g and -1.2 g when the operating weight is increased to 10,340 lb. The AFM also restricts the maximum flying speed with spraying equipment installed to 120 mph IAS.

The OMS for operation up to 12,500 lb states that, except for manoeuvres required in aerial application operations, intentional spins, stalls, aerobatics, or abrupt manoeuvres are prohibited. Maximum allowable bank angle and load factors are not specified in the OMS. Although the OMS did not specify limitation differences with different aircraft configurations, examination of one of the operator's other Dromader aircraft revealed a

cockpit placard indicating the 120 mph IAS speed restriction in the agricultural spray configuration.

1.17 Overload Operations at 11,700 lb for Fire-Fighting

In a fire-fighting configuration, the Dromader aircraft can operate at a maximum take-off weight of 11,700 lb. Supplement No. 16 of the approved AFM outlines the aircraft manufacturer's criteria for operation of the aircraft in this fire-fighting overload version. However, Supplement No. 16 states that operation of the aircraft at a weight of 11,700 lb is not permitted in an agricultural configuration.

Supplement No. 16 specifies that, when operating in a fire-fighting configuration with a take-off weight of up to 11,700 lb, the maximum airspeed limitations are 120 mph IAS in cruise or operational flight, and a minimum of 103 mph IAS. The maximum bank angle is restricted to 15 degrees and load factors are reduced to +2.8 g and -1.1 g with flaps retracted. The maximum hopper load is listed as 4,850 lb and the C of G chart indicates an allowable range of 26.3 to 27.9 inches at 11,700 lb. Also specified is the requirement to fit the hopper with a partition eight to ten inches from the rear of the hopper, dividing it into two compartments. The forward compartment is designated for the fire-fighting agent and the rearward compartment accommodates containers of air displacing 78 U.S. gallons. Placement of the air containers is intended to limit rearward C of G travel.

The "Level Flight" section notes that, at 11,700 lb, the aircraft demonstrates dynamic longitudinal instability with a free control stick after about 20 seconds or two cycles, and describes the aircraft's tendency either to stall or to exceed the maximum flight speed. The "Fire Fighting" section cites that, during flight at the weight of 11,700 lb, the minimum speed while manoeuvring should be 106 mph IAS because a reduction in elevator control forces may occur. Supplement No. 16 also indicates that flying the aircraft below 106 mph requires the increased attention of the pilot.

In addition, Supplement No. 16 includes a section outlining the manufacturer's recommendations regarding pilot qualifications for operation of the aircraft at the higher weight of 11,700 lb. The manufacturer maintains that, to operate the aircraft at the higher weight, pilots must have 2,000 hours total flight time and 1,000 hours of agricultural and fire-fighting operational experience, including 200 hours of operational experience on the Dromader. The manufacturer also requires that instructor-pilots granting other pilots authorization to conduct missions in this configuration undergo training under the supervision of instructor-test-pilots at the manufacturer's facility.

1.18 Aircraft Spin Characteristics

The emergency procedures section of the AFM recommends a recovery procedure for an inadvertent spin, which involves the selection of maximum power, full rudder deflection opposite to the direction of the spin, and a control stick position forward of neutral. When the rotation stops, the rudder is to be returned to neutral, the power reduced to idle, and a smooth recovery from the ensuing dive is to be carried out.

A "NOTE" is incorporated in the spin recovery procedure stating that reducing power before the aircraft has gone one-quarter turn and before the nose pitches down may result in an uncontrollable spin.

2.0 *Analysis*

2.1 *Weather and Environment*

Other pilots flying in the area at the time of the occurrence indicated that they experienced light winds and little or no turbulence. There was no other significant weather in the area. Because it was the pilot's fourth trip of the day, he was familiar with the area of operation, the mission to be carried out, and the in-flight conditions. It is not likely that weather adversely affected the flight.

2.2 *Aircraft Malfunction*

Records indicate that the aircraft was certified and equipped in accordance with existing regulations and procedures. The aircraft and wreckage were examined to the degree possible, and no evidence of a malfunction was found. It is unlikely that a mechanical failure of an aircraft component or system affected the occurrence.

2.3 *Personnel Factors*

Records indicate that the pilot was certified and qualified for the flight in accordance with existing regulations. Based on the autopsy and toxicological information, and medical records, there was no evidence that incapacitation or physiological factors affected the pilot's performance. The pilot had several years experience in aerial application operations; however, he had only gained about 35 hours flying experience on the Dromader aircraft.

2.4 *Aircraft Handling and Performance*

While the operator's flight evaluation of the aircraft at 12,500 lb did not indicate adverse handling characteristics, the approved aircraft flight manual indicates that, for operations at 11,700 lb in a fire-fighting configuration, hopper loading must be modified to control

rearward C of G travel and that dynamic longitudinal instability may be experienced.

The weight of the aircraft was approximately 12,115 lb, compared to the 11,700 lb fire-fighting configuration; the effect of the additional 415 lb and the agricultural spray configuration could not be quantified. However, a comparison of the aircraft characteristics and limitations in the basic flight manual and those specified in the approved supplement to the flight manual for operations to 11,700 lb indicates that there is a proportional deterioration of the handling characteristics with increased weight. In particular, the flight manual warns about the reduction in the aircraft's dynamic longitudinal stability, and the increased minimum manoeuvring speed because of a reduction in elevator control forces, and states that flying the aircraft below 106 mph requires the increased attention of the pilot. The deterioration of the flying characteristics of the aircraft demonstrates that operation at heavy weights is significantly more challenging and explains the flight manual's minimum pilot experience requirement of 200 hours on type for operations to 11,700 lb.

The stall speed chart (see Section 1.16.3) shows the increase in the aircraft's stall speed, in level flight, with both weight and bank angle. The increase in stall speed reduces the flight speed envelope within which the aircraft may be operated.

The high operating weight at the time of the occurrence would have significantly reduced the flight envelope of the aircraft, increased the likelihood of a stall, and adversely affected the aircraft's handling characteristics by decreasing the aircraft's dynamic stability and by increasing the stall speed.

2.5 *Overload Operations*

There are a number of inconsistencies between the AFM and the OMS published for operations up to 12,500 lb (see Appendix B).

The C of G range, load factor limits, and some of the airspeeds specified in the OMS conflict with the more restrictive AFM limits for operations at a lower weight. The OMS also does not indicate any limitation or performance changes with various aircraft configurations, such as the agricultural spray configuration. The warnings and manufacturer recommendations contained in the flight manual regarding operation at 11,700 lb, and the prohibition from operating in the agricultural configuration at more than 10,340 lb were not reflected in the OMS for operation at 12,500 lb, nor was the 120 mph maximum operating speed with the agricultural spray booms. Despite these inconsistencies, Transport Canada issued an exemption from Air Regulations subsection 210(1) and paragraph 218(a) permitting operation of the aircraft at a higher weight than allowed by the manufacturer's type approval.

2.6 *Accident Sequence*

Without direct evidence of the actual events that occurred in the cockpit of the aircraft immediately prior to it entering the spin, it is not possible to conclusively determine why the aircraft stalled and spun. However, the high operating weight adversely affected the aircraft's handling characteristics by decreasing the aircraft's dynamic stability and increasing the stall speed in level flight, thereby increasing the likelihood of a stall. The pilot's relatively low level of experience on the aircraft type may have affected his ability to recognize the specific cues indicative of an impending stall condition and react in sufficient time to maintain aircraft control. As a result, it is likely that the pilot, while manoeuvring the aircraft overhead his assigned sector, did not recognize the cues of an impending stall and inadvertently allowed the aircraft to stall and enter a spin. Once the aircraft had departed controlled flight, there was insufficient altitude for the pilot to regain control of the aircraft prior to impact.

3.0 *Conclusions*

3.1 *Findings*

1. It is unlikely that weather adversely affected the flight.
2. Records indicate that the aircraft was certified and equipped in accordance with existing regulations and procedures.
3. The aircraft and systems were examined to the degree possible, and no evidence of a malfunction was found. It is unlikely that a mechanical failure of an aircraft component or system affected the occurrence.
4. There was no evidence of an in-flight fire; however, a post-crash fire ensued.
5. The pilot was certified and qualified for the flight in accordance with existing regulations.
6. Based on the autopsy, toxicology information, and medical records, there was no evidence that incapacitation or physiological factors affected the pilot's performance.
7. The pilot had several years experience in aerial application operations; however, he had only gained about 35 hours flying experience on the Dromader aircraft.
8. The weight and balance of the aircraft adversely affected the aircraft's handling characteristics by decreasing the aircraft's dynamic stability and by increasing the stall speeds.
9. It is possible that the pilot did not recognize an impending stall and allowed the aircraft to stall and enter a spin.

10. The aircraft stalled and entered a spin at too low an altitude to permit recovery.

11. Despite the inconsistencies between the OMS that was published for operations up to 12,500 lb and the more restrictive AFM limits for operations at lower weights, Transport Canada issued an exemption from Air Regulations subsection 210(1) and paragraph 218(a) permitting operation of the aircraft at a higher weight than allowed by the manufacturer's type approval.

3.2 *Causes*

The aircraft stalled and entered a spin at too low an altitude to permit recovery. Contributing to the occurrence was the reduction of the aircraft's handling characteristics and flight envelope that resulted from the operation of the aircraft at a higher weight than allowed by the manufacturer's type approval, as authorized by a special exemption program for agricultural operators.

4.0 *Safety Action*

4.1 *Action Taken*

4.1.1 *Maximum Take-off Weight Exemptions*

On 23 June 1995, the TSB forwarded an Aviation Safety Advisory Letter to Transport Canada. The letter suggests that Transport Canada may wish to reassess the exemptions granted under the weight exemption program, and to review the overall adequacy of the program.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson John W. Stants, and members Zita Brunet and Hugh MacNeil, authorized the release of this report on 17 July 1995.

*Appendix A - Comparison of PZL-M18A Weight & Balance
Envelopes*

Appendix B - Comparison Table of PZL-M18(A) Limitations

Item	Type Approval (A132 Issue 3)	Approved Flight Manual (AFM) Normal Category	AFM Supplmt 1 Overload Version (TA A132-Note 3)	AFM Supplmt 16 Fire Fighting Overload Version	12,500 Exemption Supplement
Max Take-off Weight	9,260 lb	9,260 lb	10,340 lb	11,700 lb	12,500 lb
Max Landing Weight	9,260 lb	9,260 lb	9,260 lb	9,260 lb	9,260 lb
Maximum Hopper weight	3,300 lb	3,300 lb	4180 lb (atomizing version limited to max 166 US gal fuel)	4850 lb w/air containers displacing 78 US gal in rear of hopper to limit rearwd C of G travel.	5,300 lb
C of G	see AFM Supplmt 8	@ 9,260 lb 24.3" fwd 27.9" aft	@ 10,340 lb 25.2" fwd 27.9" aft	@ 11,700 lb 26.3" fwd 27.9" aft	25.9" fwd 27.9" aft
Vmax	w/Ag equip instal'd 104 K (120 mph)	w/Ag equip instal'd 120 mph (104 K) IAS	120 mph (max green arc)	120 mph (operational flight)	139 mph
Vmin	as per AFM	84 mph (min green arc)	84 mph (min green arc)	103 mph (operational flight) 106 mph while manoeuvring	100 mph
Load Factors	flaps 0 +3.4 to -1.4G flaps 15 +2.0 to -0.0G	flaps 0 +3.4 to -1.4G flaps 15 +2.0 to -0.0G	flaps 0 +3.0 to -1.2G	flaps 0 +2.8 to -1.1G	None Specified /Unchanged
Maximum Bank Angle	as per AFM	60 degrees	60 degrees	15 degrees	None Specified /Unchanged
Approval Basis	FAR 23, E&I Manual Pt2 Ch 1 Sec 1.4.9-16	TC TA A-132, (FAR23)	auth by TC, amend AFM, placard A/C	operation @ 11,700 lb not permitted for agricultural operations	One time test flight by representative operator and TC authorization
Other Restrictions	as per AFM	Intentional aerobatic manoeuvres including entry into spins is prohibited	1) Intentional aerobatic manoeuvres including entry into spins is prohibited 2) min approach speed for lndgs above 9,260 lb - 96.3 mph (A/C log entry req'd for each lndg above 9,260 lb)	1) min approach speed for lndgs above 9,260 lb - 106 mph (A/C log entry req'd for each lndg above 9,260 lb) 2) pilot must have 2,000 hrs TT, 1,000 hrs operational, 200 hrs on type, be authorized for 11,700 ops; instructors authorizing pilots must undergo factory training 3) N.B. aircraft shows negative dynamic stability with free stick after 20 sec and 2 cycles	1) except for Ag Ops no intentional aerobatics or abrupt manoeuvres 2) no flight over built up areas or near commercial pax flights

Appendix C - List of Supporting Reports

The following TSB Engineering Branch Laboratory Report was completed:

LP 181/94 - Aircraft Performance Analysis PZL-M18A Dromader, C-GHVZ.

This report is available upon request from the Transportation Safety Board of Canada.

Appendix D - Glossary

AFM	aircraft flight manual
asl	above sea level
ATA	aircraft type approval
CAAA	Canadian Aerial Applicators Association
CFS	Canada Flight Supplement
C of A	Certificate of Airworthiness
C of G	centre of gravity
CVR	cockpit voice recorder
EDT	eastern daylight saving time
ELT	emergency locator transmitter
est	estimated
FAA	Federal Aviation Administration
FDR	flight data recorder
fpm	feet per minute
g	G load factor
hr	hour(s)
IAS	indicated airspeed
in. Hg	inches of mercury
lb	pound(s)
mph	miles per hour
nm	nautical miles
OMS	Operating Manual Supplement
TC	Transport Canada
TSB	Transportation Safety Board of Canada
US	United States
UTC	Coordinated Universal Time
Z	Zulu time
'	minute(s)
"	second(s)
°	degree(s)
°M	degrees of the magnetic compass
°T	degrees true

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