NOTES AND CORRESPONDENCE

Note on the Use of Liquefied Propane for Fog Dispersal at the Medford-Jackson Airport, Oregon

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1. Introduction

In his report to the First National Conference on Weather Modification, Beckwith (1968) briefly discussed the propane fog dispersal program conducted during the winter of 1967–1968 at the Medford-Jackson Airport. This program, financed by United and West Coast Airlines, was conducted under a contract between the City of Medford and Aerojet General Corporation, Sacramento, Calif. The Environmental Sciences Division of Aerojet General was responsible for the design and operation of the fog dispersal system.

Beckwith's report covered a period of about three weeks from the initiation of the dispersal program at Medford on 24 December 1967 to 11 January 1968. It is the purpose of this Note to present a summary of the results of the full seasonal operation, which extended from 24 December 1967 to 8 February 1968. During that period, 25 fogs within a temperature range of 21–34°F were treated with propane.

2. Theory

When liquefied propane is released into the atmosphere it vaporizes at a temperature of -42°C , causing glaciation of any available fog droplets. Mechanical turbulence induced by the release pressure and the thermally induced turbulence caused by the release of latent heat of fusion contribute to the diffusion of the small ice crystals throughout the fog and their growth by the usual vapor transfer process.

It is also possible for a propane hydrate or clathrate to be formed by the inclusion of gas molecules in the ice crystal. Such crystals have a melting, or dissociation, point between 1.0 and 5.96°C , depending upon the number of molecules of propane included in the clathrate. Recognition of the potentials of clathrates has been slow since they were first named less than 20 years

ago. Hagan (1962) presents what may be the most comprehensive review of clathrate properties in the existing literature and briefly refers to their possible use in meteorology.

3. Procedures

The dispersal system used at Medford was essentially the same as that described by Hicks (1967 a,b) which was very similar to that used at Orly Field, France, where the first successful dispersal of fog with liquefied propane was achieved (Serpalay, 1960). The liquefied propane is valved from a tank through a metal tube extending several feet above the tank with an expansion orifice at the top. At Medford, one 500-gallon tank was located at the approach end of the instrumented runway and another was towed on a trailer by a $\frac{3}{4}$ -ton truck and used as a roving dispenser to provide any adjustment of operational procedures which might be dictated by wind shifts during a fog period. During the last several dispersal operations, near the end of the fog season, a second fixed tank was located some distance upwind from the instrumented runway. Operation of this third dispenser was undertaken to reduce fill-in of fog on the runway when the roving tank was at the far end of the field. At Medford only one runway is instrumented and all commercial flights land and take off in the same direction.

Radio communication between the operator of the roving tank and the control tower made it possible to direct the driver to critical fog areas and provided for safe operations when the roving tank was used on the main runway. Depending on plane schedules, fog dispersal treatments might be continued for as long as 4 hr or they might be conducted in discontinuous operations of an hour or two during extensive fog periods of 2–3 days. Achievement of an operational minimum of 0.5-mi horizontal visibility and 200-ft ceiling as observed

and reported by FAA was considered to represent successful fog dispersal.

4. Results of dispersal operations

A summary of the propane dispersal operations by temperature groups is presented in the following table.

	Surface temperature		
	Group 1 (21- 31F)	Group 2 (32- 34F)	Both (21- 34F)
No. of fogs treated	18	7	25
No. of cases where operational minima were achieved	12	3	15
Per cent success	67	43	60

In only two instances was there a natural burn-off of fog near the end of the treatment period and in both cases clearing over the airport occurred an hour or more before clearing was observed in the adjacent residential areas. In 13 of the 15 treatments which were classified as successful there was a return of fog when propane treatment was discontinued. In almost all fog incidents, the official transmissometer record clearly indicates the start and end of propane dispersal operations. In 8 of the 10 fog dispersal events in which operational minima were not achieved the transmissometer record shows improvement in horizontal visibility from 500 to several thousand feet during the seeding operation. Abrupt changes in the transmissometer trace were definitely associated with the start and end of propane treatment. Although only 3 of the 7 treatments in Group 2, with fog temperature between 32 and 34F, were classified as successful, in 6 of these 7 tests the transmissometer record showed an increase of from 1000 ft to over 3000 ft in horizontal visibility during the propane treatment period.

Snow fall-out occurred during all propane treatments and at times was very heavy. Attendants often had to clear paths from the terminal to gates for passengers following a successful dispersal operation. Fall-out was usually limited to a radius of about 2 mi from the airport.

The successful dispersal of fogs in the 32-34F temperature range is not unique to this operation. Hicks (1966) reported one successful fog modification with propane with a surface temperature of 32F and one at 35.2F during a series of 6 fog dispersal tests at Hanover and Lebanon, N. H. Serpolay (1960) states that some propane dispersal operations at Orly Field were successful with temperatures only a few tenths of a degree

below freezing. Hicks attributes the success in New Hampshire to either low temperature aloft, without citing substantiating data, or to clathrate formation.

This warm fog dispersal capability of propane has particular applicability to the airports in the far west where, for instance, 54% of Medford's supercooled fogs, 72% of Portland's and 77% of Seattle's are between 30F and 32F, a temperature range in which dry ice is generally ineffective (Beckwith and Harrison, 1964).

5. Summary

During the 1967-1968 winter 25 fogs were treated with liquefied propane at the Medford, Ore., Airport. Surface temperatures of the treated fogs varied from 21-34F. Operational minima of 0.5-mi horizontal visibility and 200-ft ceiling were attained in 15 of the 25 treatments. Of the 10 treatments classified as unsuccessful because of failure to achieve the operational minima, sufficient modification occurred in 8 cases to improve horizontal visibility, as measured by the transmissometer, from 500 to several thousand feet. Three of seven fogs in the 32-34F range were successfully treated as evidenced by achievement of operational minima.

Although the natural variability in ceiling and horizontal visibility during the winter fog period at the Medford Airport has not been evaluated, the fact that the transmissometer trace showed a return of the fog and reduction in visibility within a few minutes of cessation of the propane treatment in all but two fog events, substantiates the effectiveness of liquefied propane as a fog dispersal agent.

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