National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

DIGEST 15 - FEBRUARY 1970

These **Digests** are issued in the interest of providing an early awareness of the research results emanating from projects in the NCHRP. By making these results known as they are developed and prior to publication of the project report in the regular NCHRP series, it is hoped that the potential users of the research findings will be encouraged toward their early implementation in operating practices. Persons wanting to pursue the project subject matter in greater depth may obtain, on a loan basis, an uncorrected draft copy of the agency's report by request to the NCHRP Program Director, Highway Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418

Highway Fog

An NCHRP staff digest of the essential findings from the final report on NCHRP Project 5-6, "Highway Fog" by Warren C. Kocmond and Kenneth Perchonok Cornell Aeronautical Laboratory, Buffalo, New York

Superseded by NCHRP 95

THE PROBLEM AND ITS SOLUTION

Highway deaths caused by foggy roadway conditions are a never-ending national problem. The horrors of these accidents often make front-page headlines. The problem is vividly demonstrated in the following newspaper report of the infamous Joliet Fog Accident:

> Fog Kills 5 on Interstate 55
>
> In the early morning dark hours of August 12, 1967, on Interstate Highway I-55, near Joliet, Ill., in a dense fog, a related series of collisions involving eleven vehicles occurred. Following the third collision, fire from leaking flammables destroyed six vehicles and caused five fatalities by burning.
>
> Investigation of this accident was begun by the Illinois State Police following notification at 5:42 a.m. When the first State trooper arrived on the scene, six vehicles were in flames. Fire-fighting equipment arrived 15 minutes following the accident, and the first of eight ambulances arrived 20 minutes after the accident. All eight ambulances were delayed in getting to the scene because of the fog. Thereafter, the coroner arrived and supervised the removal of the bodies. The State blocked the northbound lanes to all traffic for 5-1/2 hours.

Although the highway fog problem is well known, the feasibility of the many proposed solutions is not common knowledge. This research provides valuable information that will enable engineers to more adequately cope with the problem of fog on highways.

This informational report stands alone in its contribution because it provides the practicing engineer with a brief "state-of-the-knowledge" report on highway fog. The information and research results are defined explicitly enough to permit highway departments to initiate independent studies. The research report is easily understood and does not require translation into the working language of practicing engineers.

FINDINGS

Effect of Fog on Accidents

An extensive search of the literature indicates that the relationship between foggy weather and highway accident rate is unclear and, perhaps, surprising. At present it is not known whether the net effect

of foggy weather is to increase, or to decrease, the likelihood of highway accidents. Nevertheless, a convincing Australian study indicates that if the non-fog accident rate had occurred during the 29 foggy days of the year of the study, there would have been an expected increase of about 15 casualty accidents.

Effect of Fog on Traffic

It has been determined that drivers do not slow down very much in dense fog. The likelihood of overdriving and not being able to avoid a collision with a stopped lead vehicle reached almost 70 percent for the dense fog condition. Vehicle speeds decreased only about 5 mph during dense fog.

Fog Abatement

As part of the research, an examination was made of warm and cold fog modification concepts to determine whether, and to what extent, abatement systems could be used to alleviate the highway fog problem. The accompanying table summarizes the numerous methods that were reviewed.

The review of all known fog abatement methods shows that no magic solution to the highway fog problem is available, nor does it appear that any potential solution is being overlooked by the state highway departments. Recent fog seeding techniques using carefully sized hygroscopic nuclei have been shown to produce improved visibility in dense, warm fog over airports.

APPLICATIONS

The over-all application of this research lies in its value as a new source of information for highway engineers. More specific applications are as follows:

1. The technique of seeding warm fog with hygroscopic nuclei has been demonstrated and could be applied to abate fog in isolated valley areas. Use of helicopters for fog abatement also appears feasible. In this scheme, helicopters would either mix the saturated air with the drier air aloft or disseminate hygroscopic particles to abate fog over a target area (e.g., the area surrounding an accident). This procedure could be instrumental in preventing chain-reaction accidents from occurring and in assisting in the safe clean-up of vehicles already involved in an accident.

2. Seeding of cold fog with ice-nucleating agents to promote visibility improvement is an operational reality and cold fog abatement is technically feasible. (Most highway fog in the United States is not of the cold fog variety.)

3. Automobile rear lighting systems can be improved to increase the distance at which vehicles can be seen during foggy weather. Multifilament taillights can be used to achieve greater luminous intensity during periods of fog.

4. Use of forest stands and vegetation barriers to block movement of shallow fog from higher elevations to low-lying surrounding areas appears to be applicable to some highway fog situations.

5. Visibility in fog can be increased through use of roadway lighting systems designed to reduce the scattering of light. This can be accomplished through use of overhead roadway lighting systems having a narrow beam spread or by use of roadway lighting placed at very low levels along the roadway.

6. Roadway guidance through fog can be enhanced through use of systems employing illuminated delineators. The high intrinsic contrast and one-way light transmission losses involved with this type of system make the concept appealing for highway applications in fog.

7. The design of roadway control systems to alert drivers to the presence of dense fog conditions seems practical. An operational system would involve installation of visibility monitors along sections of roadway experiencing frequent fog and a signaling system several miles away to provide a warning of the hazardous fog conditions lying ahead of the motorist.

SUGGESTED FOG ABATEMENT CONCEPTS

COLD FOG ABATEMENT METHODS

1) Dry ice	3) Propane	5) Other ice-nucleating agents
2) Silver iodide	4) Infrared heat	6) Open-flame burners

WARM FOG ABATEMENT METHODS

Thermal	Chemical	Electrical	Mechanical
Open-flame burners Electrically generated heat Burning of coal Solar energy	Modification of drop-size distribution by seeding with hygroscopic nuclei Fog desiccation Polyelectrolytes Ammonium nitrate Condensation nuclei deactivation Surfactants Chemical monolayers	Droplet charging Charged particles and sprays	Natural vegetation to suppress fog movement Droplet removal by forests Fog broom Fans to cause mixing of clear air with fog Sweep out with falling particles Sonic agglomeration