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Log H-449

**NATIONAL TRANSPORTATION SAFETY BOARD**  
WASHINGTON, D.C.

ISSUED: November 12, 1985

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Forwarded to:

Honorable Diane K. Steed  
Administrator  
The National Highway Traffic  
Safety Administration  
400 7th Street, N.W.  
Washington, D. C. 20590

SAFETY RECOMMENDATION(S)

H-85-23 through -26

At about 4:30 p.m. on March 11, 1983, a 1982 Pontiac sedan was traveling eastbound on State Highway 22 near Hutchinson, Minnesota, when an oncoming car crossed the centerline and hit the Pontiac head-on. The Pontiac was occupied by a young couple and their 2-month-old daughter, who was seated in a convertible child safety seat in the left rear seat. The crash killed the child, the child's father, who was driving, and seriously injured the mother, seated in the right front seat. The adults' injuries were due largely to vehicle deformation, but the child's death could have been prevented had her child safety seat been installed properly. Not only was the 15-pound infant riding in a safety seat installed in a forward-facing instead of rear-facing position as specified by the manufacturer for infants under 17 pounds, but the vehicle seatbelt was routed incorrectly through the safety seat frame--the belt was too low. The combination of these two errors permitted the safety seat to tip forward during the impact and allowed the baby's head to be crushed by contact with the intruding sheet metal.

This case was one of 53 motor vehicle accidents involving infants and small children investigated by the National Transportation Safety Board during 1982-83 as part of a Safety Study on child passenger protection. 1/ Misuse of child restraints 2/ was widespread in the accidents investigated as part of that study: only 6 of the 34 child restraints involved in these accidents were being used properly. 3/ In many cases,

1/ National Transportation Safety Board, Safety Study, Child Passenger Protection Against Death, Disability, and Disfigurement in Motor Vehicle Accidents (NTSB/SS-83/01), September 7, 1983.

2/ The term "child restraint" as used in this letter refers to many forms of child restraint devices including infant, toddler, and convertible safety seats and booster seats.

3/ Forty-nine usage errors were detected in the 28 child restraints which were being misused. Multiple errors were common. Misuse conditions, in order of their frequency, were harness misuse (17), tether misuse (14), failure to anchor the child restraint with vehicle seatbelt correctly (12), and improper child safety seat inclination (6).

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misused restraints offered sufficient protection, given the accident circumstances, to minimize or prevent injuries to the child. In other cases, such as the accident just described, they did not. Misuse can seriously degrade or negate the protection potential of a child restraint. 4/ 5/ If the child safety seat in the example had been installed properly, the 2-month-old child probably would have survived the accident, with minor or no injuries.

In connection with the study, NTSB issued several Safety Recommendations aimed at combating misuse of child restraints, among them recommendations that States undertake programs to increase proper use of the restraints and evaluate these programs. Many States implemented specific programs to increase use and combat misuse of child restraints after the Board issued those recommendations.

Since then, use of child restraints has grown: of the child passengers younger than 5 years observed in a recent NHTSA survey of restraint use, 6/ 51.7 percent were riding in child restraints compared to 49.3 percent in 1984, 44.2 percent in 1983, and 15.2 percent in 1979. Furthermore, the enactment of child passenger protection legislation has contributed to a national decrease in child passenger fatalities. According to Federal fatal accident data, 532 child passengers younger than 5 years were killed in 1984 in motor vehicle accidents involving passenger cars, vans, and light trucks (the vehicles most likely to be covered by mandatory child restraint laws), compared to 598 in 1983 and 606 in 1982. The number of fatalities among older child passengers, typically not covered by the child passenger protection laws, did not show declines of this magnitude. (Indeed, the number of child passengers, ages 10 to 17, killed in motor vehicle accidents involving passenger cars, vans, and light trucks, increased in 1984 compared to 1983.)

4/ Researchers at the University of North Carolina Highway Safety Research Center (HSRC) analyzed a sample of North Carolina passenger car accidents involving child passengers younger than 4 years and found that misused child restraints in crashes of all severities reduced the chance of any injury by 26 percent and of severe head or fatal injury by 48 percent. Properly used child restraints, in contrast, reduced chance of injury by 59 percent and of a fatality by 81 percent. For more information, see HSRC report, "The Use of Telephone Interviews to Verify the Reliability of Police Accident Reports in Assessing the Effectiveness of Child Safety Seats," Final Report, May 1984.

5/ Estimates of the effectiveness of child restraint use vary widely, ranging from 40 to 91 percent for fatality reduction and 13 to 74 percent for injury reduction. Differences are probably due to sample size, quality of reported data, and type of injury analysis. Researchers also have been handicapped by lack of data since, until recently, so few children were restrained. For a comprehensive review of effectiveness studies, read C.J. Kahane, J. Kossar, and G.Y.H. Chi, "Evaluation of Effectiveness of Child Safety Seats in Actual Use," SAE Child Injury and Restraint Conference Proceedings (1983), 113-123. The authors of this study concluded that overall injury reduction for child restraints (properly and improperly used) appears to be about 25 to 30 percent and as high as 40 to 50 percent when the restraints are used properly. Fatality effectiveness may be 40 to 50 percent overall and 65 to 75 percent for restraints used properly.

6/ National Highway Traffic Safety Administration (NHTSA) 19-City Survey of Restraint Use, January-June 1985.

Misuse of child restraints, however, remains high. While use of child restraints in motor vehicles has increased steadily, misuse also has increased. In 1983, an observational survey of unoccupied forward-facing crashworthy child safety seats conducted in 12 States found that 75 percent had errors in seatbelt routing, tether use, or both. <sup>7/</sup> The most recent comprehensive survey of misuse, conducted by Goodell-Grivas in 10 U.S. cities during the winter of 1984, found that occupied booster seats and infant and toddler safety seats were misused about 65 percent of the time. <sup>8/</sup>

During the latter survey, Goodell-Grivas observed 1,006 children in child restraints in cars entering Hardee's Restaurants parking lots. Child restraint harness and shield use and installation were evaluated simultaneously, and adults in the cars were questioned about the reasons behind any misuse observed. While lack of understanding underlies some forms of misuse, interviewers found that child restraints are misused knowingly much of the time. Findings included:

- Toddler safety seats, infant safety seats, and booster seats were misused at a rate of 66, 59, and 62 percent, respectively.
- The most common error was failure to use a tether. Tethers were not used in 85 percent of the cases where they should have been. For the most part (80 percent of the time), parents were fully aware of the need for using a tether but considered it too much trouble to install.
- For the 734 toddler safety seats observed, harness or shield misuse consisted of 22 percent nonuse and 18 percent incorrect use. In over 95 percent of the misuse cases, parents were aware that the harness should be used and indicated that child resistance to being harnessed was the principal reason for this nonuse.
- Infant safety seats were facing the wrong direction 1/3 of the time and 71 percent of the parents knew the seat was positioned incorrectly. The most common reason given for this error was that they thought the child was old enough to use the seat facing forward.
- Vehicle seatbelts were routed improperly around the child restraint 28 percent of the time. Most parents (75 percent) were not aware of the error.

To explore in greater detail the nature of misuse and to search for ways to combat the problem and to increase the use of child restraints, the Safety Board held a Symposium on Child Passenger Safety in Washington, D.C., January 28, 1985. (A summary of the symposium with a transcript of the general sessions, workshop recommendations, and reference material for child passenger safety advocates will be published and sent to

<sup>7/</sup> Annemarie Shelness and Jean Jewett, "Observed Misuse of Child Restraints," SAE Child Injury and Restraint Conference Proceedings (1983), 207-215.

<sup>8/</sup> Michael J. Cynecki and Michael E. Goryl, "The Incidence and Factors Associated with Child Safety Seat Misuse," prepared by Goodell-Grivas, Inc., under contract to the NHTSA, U.S. Department of Transportation, December 1984.

all Governors and Governor's Highway Safety Representatives, among others.)<sup>9/</sup> The symposium included a number of group workshops that focused on various aspects of the misuse problem and explored ways to increase proper use. During these workshops, child passenger safety advocates discussed design changes, educational programs to combat misuse, enforcement issues, legislation, education and incentives to increase use, and baseline data collection. Since there are many programs to combat misuse and increase use, symposium participants examined the most promising approaches. However, workshop participants agreed that many times it was impossible to evaluate the effectiveness of programs because of inadequate, unreliable baseline data on rates of use and misuse.

This statement should not be construed as implying that States should forego implementation of programs to increase proper use until better data are available. Adequate data are available to suggest misuse is a serious problem and that use rates, while higher than prelegislation levels, are too low. Programs need to be implemented to address these problems. Data, however, are not adequate to evaluate the efficacy of these programs, nor to identify shortcomings that could be rectified.

Child restraint data are needed at all levels: national, State, and local. However, child restraint data are needed most at the State and local levels because it is at those levels where programs to increase use and combat misuse of child restraints will be implemented. Knowledge of the use and misuse rates existing in the State or county before a program is implemented is necessary before a program's success or failure can be measured, or program deficiencies remedied.

Child passenger safety advocates also need data to establish the efficacy of their programs when requesting funding or when lobbying for expanded State child passenger protection laws. The effectiveness of such laws must be demonstrated by a measured decline in number and severity of injuries to young child passengers of motor vehicles, as well as by a decline in fatalities.<sup>10/</sup> The extent of misuse of child restraints also must be known for proper interpretation of accident data; without this information, the benefits of child restraint use may be understated.

Two methods are in use to obtain data to evaluate the effectiveness of child passenger protection programs: observational surveys and analysis of accident-generated records, i.e., police accident reports and hospital injury records. All these data sources are needed to evaluate State and local programs to increase proper use of child restraints since each has inherent limitations and is insufficient by itself. Observational surveys alone are insufficient because they provide no information on injuries; because the nature of use and misuse information collected depends on the method of observation; and because the data collected on the surveyed population may not accurately depict use and misuse among the accident-involved population. Police accident reports alone are insufficient because they do not necessarily include all accidents in which children are injured or protected from injury, and because accident report data on use, nonuse, and misuse are not reliable. Hospital records alone are insufficient because they include no

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<sup>9/</sup> National Transportation Safety Board, Safety Study, "Summary of the NTSB Child Passenger Safety Symposium: Ways to Increase Use and Decrease Misuse of Child Restraints" (NTSB/SS-85/03), January 28, 1985.

<sup>10/</sup> Analysis of injury data is very important since the number of child passengers younger than 5 years fatally injured each year in a State is small and thus subject to considerable year-to-year differences.

information on children protected from injury in crashes and because hospital personnel must rely on second- or third-hand information on restraint use, nonuse, or misuse by the children admitted after a crash (assuming the hospital even attempts to collect and record such information). The inherent limitations of these major data sources are discussed in more detail below.

Two basic types of observational surveys have been used in the past to collect child restraint data: 1) a use survey conducted by observers stationed at the exits or entrances of selected shopping malls or roadside rest stops, and 2) an installation survey of unoccupied child restraints in cars in suburban shopping mall parking lots. A third type of survey, an observation of occupied child restraints to collect both use and installation data along with attitude information, is less common. The Hardee's Restaurants survey described earlier is an example of this type.

The extent of use and misuse information that can be collected by observing occupied child restraints at shopping mall exits or by observing unoccupied child restraints in mall parking lots is limited by the method of observation. For example, observers stationed at a traffic light at a shopping mall entrance have only a short time to look into the car while it is stopped to check child restraint use and installation. Thus, they may be able to record data on the use and installation of infant safety seats (correct or incorrect orientation, belt routing, harness use, etc.), but can collect only simple use/nonuse data for convertible or toddler safety seats. They cannot determine installation data for these seats---whether seatbelt routing is correct, tether attached properly, etc.--because of their inadequate vantage point and lack of time. In contrast, an installation survey conducted in parking lots can supply detailed information on installation, but cannot supply any information on proper use, such as harness use or misuse, since it is based on unoccupied cars. (Such a survey also cannot supply complete data on infant seat installation, since with many models the vehicle seatbelt, used to secure the infant seat, must be detached before the infant can be lifted out of the infant seat.)

A final, major limitation on use data collected through observational surveys is that use rates among the surveyed population may not be the same as the rates among the accident-involved population. Restraint use rates among adult occupants of passenger cars involved in crashes, for example, is much lower than restraint use rates observed for adult occupants as a whole. Restraint use rates also decrease as crash severity increases. For example, the University of Michigan Transportation Research Institute (UMTRI) time series analysis of restraint use among Michigan crash-involved occupants found that the child passenger protection law had its main effect in reducing moderate injuries to child passengers and less effect in reducing severe injuries and death, not because child restraints were less effective in severe crashes, but because restraint use among children involved in less severe crashes was higher than among those in severe crashes. 11/

Despite its shortcomings, the observational survey can be useful to States wishing to demonstrate how effective their programs in child restraints have been in reducing injuries and fatalities. Amendments to the Surface Transportation Assistance Act provide that in FY 1985, 1986, and 1987, each State must spend not less than 8 percent of its Highway Safety Program funds (23 U.S.C. 402) to develop and implement a comprehensive program to promote child restraint use. Each State program must meet several criteria to qualify for Federal funding assistance; program evaluation is one criterion.

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11/ Alexander C. Wagenaar, "Restraint Usage Among Crash-Involved Motor Vehicle Occupants," The University of Michigan Transportation Research Institute (UMTRI-84-2), February, 1984.

For example, a State child restraint program must show "positive results" to qualify for continued funding. Positive results are defined as "demonstrating that the program has been instrumental in reducing fatalities and injuries by the increased proper use of child restraints. As a minimum, the State must evaluate the program on the basis of fatal and injury reduction; or on the basis of the increased level of proper child restraint use. Preferably, both measures (fatal and injury reduction and increased proper use) should be used to make the best case for effectiveness of the program." 12/

According to draft guidelines issued to NHTSA Regional Administrators, an increase in proper use can be shown by data from use and installation surveys. The Safety Board believes observational surveys conducted along the line of NHTSA's Hardee's Restaurants survey will result in more valid data on proper use.

Like the observational surveys, such accident records as police-generated accident reports also have inherent limitations. First, the investigating officer who fills out the accident report often is not the first person on the scene of an accident. The child already may have been removed from the child restraint by the time the officer arrives, making it difficult to determine whether the restraint was used and used properly. The child restraint device itself may have been removed from the car, or the vehicle seatbelt may have been cut, making it difficult to determine whether the child restraint was correctly or incorrectly installed. Even if the restraint was not removed, many officers lack the training necessary to identify misuse errors other than the most obvious, i.e., the child restraint was unsecured by the vehicle seatbelt.

Further, it may not always be obvious that a child was injured in some cases (for example, in the event of a head injury to an infant), or the extent of a child's injuries may be difficult to determine. Given the urgency of transporting obviously injured occupants to the nearest hospital and reestablishing traffic flow, accurate reporting of injuries may be affected. Conflicting statements from parents, witnesses, and EMS personnel also can complicate the officer's task of determining whether the child restraint was used and used properly. 13/ 14/

Finally, police may not be called to the scene of all accidents, rendering police files incomplete.

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12/ NHTSA memorandum to Regional Administrators, October 29, 1984.

13/ The HSRC study of North Carolina accident records found that, in one-fourth of the cases analyzed, the police officer and the parent disagreed on whether a child restraint was used. By an overwhelming majority, the nature of the disagreement was that the police officer reported that the child was not restrained, while the parent said the child was. As pointed out by the report's authors, it is impossible to determine who is correct, although HSRC staff believe the parents interviewed generally were truthful. If the parent's report in all these disputed cases is correct, it would suggest that as many as 25 percent of police reports may have incorrectly categorized children as unrestrained. Any analysis based on the restraint status recorded in police records therefore would be inaccurate.

14/ Police bias also can complicate analysis. In the 1970-1977 Washington State accident file study of child restraint effectiveness, for example, some researchers believe the finding of 91 percent fatality reduction effectiveness was biased by police officers' tendency to assume that if a person was injured in a crash, he or she was unrestrained. For an analysis of reporting bias, see Yosef Hochberg, "Problems of Inference in Studies of Seatbelt Effectiveness," HSRC, December 1975.

The magnitude of the reporting problem is suggested by hospital-generated data. <sup>15/</sup> In particular, injuries incurred by children in motor vehicle accidents may be substantially undercounted in official injury data.

For instance, a probability sample of the records of 41 hospital emergency departments in Ohio found that only 55 percent of the records on people treated in these hospitals for injuries sustained in motor vehicle accidents could be matched with police accident records. Likelihood of a match increased with the age of the passenger: only 27 percent of the passengers younger than 16 had matched reports, compared to 54 percent of the older passengers. <sup>16/</sup> Thus, some child passenger injuries may not appear in official accident reports.

A study conducted in California as part of a multi-hospital monitoring of motor vehicle injuries to child passengers suggests one issue that contributes to the under-reporting of child injuries in the police record system. <sup>17/</sup> Child passengers are particularly vulnerable to injury in a type of accident that often goes unreported: the "noncrash event" which involves sudden acceleration, sudden stops, swerves, turns, or door openings, which can cause substantial injury to unrestrained small passengers as they are thrown against the vehicle interior or ejected. In the California study, it was found that accident reports were not filed in 80 percent of these cases, even though many of the cases involved serious injury. Failure to file has another ramification: loss of restraint data.

Specific improvements are needed in police reporting forms. Information about age, injury status, and restraint use for all child occupants of motor vehicles covered by the State's child passenger protection laws should be collected routinely in all towaway accidents, not just fatal or injury-producing accidents, as is now the case in some States. <sup>18/</sup> A section for recording this information should be a standard part of all police accident reports. Many States now record restraint use/nonuse only for injured occupants; the "success stories" of child restraint use thus do not become part of the official record.

Furthermore, use of a child safety seat should be a separate and distinct restraint use category, not included under a general "restraint" use or seatbelt use category. <sup>19/</sup> Information that should be recorded on the accident report includes type of

<sup>15/</sup> J.P. Bull and B.J. Roberts, "Road Accident Statistics - A Comparison of Police and Hospital Information," Accident Analysis and Prevention, 5:45-53, 1973.

<sup>16/</sup> Jerome I. Baranick and Daniel Fife, "Northeastern Ohio Trauma Study IV: Discrepancies in Vehicular Crash Injury Reporting," Upton, New York, Brookhaven National Laboratory, 1984.

<sup>17/</sup> Phyllis F. Agran and Debora E. Dunkle, "A Comparison of Reported and Unreported Noncrash Events," Accident Analysis and Prevention, Vol. 17, No. 1 (1985).

<sup>18/</sup> New York State, for example, does not require law enforcement officials to file reports on accidents other than those which result in injury or death. For a comprehensive discussion of traffic accident records in six States, see "An Evaluation of Traffic Accident Records Systems in Texas and other States," Lyndon B. Johnson School of Public Affairs, Policy Research Project Report, Number 65, 1984.

<sup>19/</sup> Michigan's police crash-report form was changed in January 1982 to include a separate category for child restraint in addition to existing seatbelt use codes. North Carolina includes a code for child restraint system under "belt use," as does the New York State Police form under "safety equipment used."

child restraint (infant, toddler, or convertible safety seat or booster seat, make and model); whether the restraint was used properly or improperly; and the nature of any misuse (was the required harness used, was seatbelt routing correct, was the infant seat properly installed in a rear-facing fashion, etc.).

It is especially important that misuse information be collected and made part of the standard form. In some accidents it has been claimed that a child restraint "failed," when further investigation showed that it was grossly misused. Further, as the Safety Board's investigations have revealed, even misused child restraint devices sometimes have protected their child occupants from death or serious injury. Regular collection of misuse information will provide a strengthened basis for warning against misuse and for arguing the benefits of child restraint use in many instances, despite misuse.

The collection of misuse information should include every form of misuse. Tether misuse has received considerable attention since it is the most common error. However, data on harness or shield misuse, improper seatbelt routing, and improper safety seat orientation may well prove more useful to researchers. Researchers also need to know how misuse modes interact with one another in an accident, since multiple errors are not uncommon.

Another reason for broadening the scope of misuse information beyond tether misuse (or nonuse) is that tether models will become less common as the market continues to shift to untethered child restraints. Furthermore, the consequences of a failure to attach a tether also will decline in the future. 20/

At present, researchers must rely on Federal accident data files--the Fatal Accident Reporting System (FARS) and National Accident Sampling System (NASS)--and on Federal survey programs to supply data on proper use of child restraints. However, these data files have their own limitations and need improvement.

Although both FARS and NASS utilize State accident records as a data source, only FARS provides child passenger accident data on a State-by-State basis. (Since the number of child passengers under 5 killed annually in motor vehicle accidents fortunately is so small, the significance of annual changes in fatalities of small child passengers within any single State is of questionable validity for the purpose of program evaluation.)

Further, FARS data do not permit the evaluation of the impact of misuse on these fatality statistics. FARS data forms are not designed to record proper or improper use of child restraints, or any misuse information, even if the information is available in the State accident records from which FARS data are derived. The FARS form records only whether a child restraint was being used. The Safety Board would like to see FARS analysts record misuse information on the FARS forms if available from State records.

20/ Child restraints are required currently to pass two tests under FMVSS 213: a 20-mph "misuse" test without the tether attached and a 30-mph test with the tether attached. NHTSA has published a Notice of Proposed Rulemaking in which it proposes to amend FMVSS 213 to require all newly manufactured child restraints to meet the 30-mph crash test when fastened only by a safety belt. For full text of the proposed rule, see Docket No. 74-09, Notice 17, Child Restraint Systems, 50 F.R. 27637, July 5, 1985.



NASS also will benefit from improved State data files, but this Federal data file can be improved independently in regard to child restraint data. Unlike the FARS data file, which is based solely on State accident files, NASS has its own accident investigation teams who collect detailed information on the accidents included in the NASS sample <sup>21/</sup>; this information may be supplemented with hospital and police records. The NASS investigators themselves could thus collect and record more data on child restraint device use and misuse in accidents.

Only limited misuse data are collected currently in NASS investigations. During a routine investigation, NASS investigators record if the child restraint in use at the time of the accident was being used "properly" or "improperly" or "unknown if used properly." If the restraint was a model designed with tether, they code whether the tether was properly or improperly installed. Thus, tether misuse is the only form of misuse that can be correlated with child passenger injury data in the NASS sample.

Although FARS and NASS are useful now as indicators of national trends, they could become useful program evaluation tools if the data collection system were improved to include more data on child restraint use and misuse. But this use also will require improved data collection at the State and local levels. For these reasons, the Safety Board encourages the collection at the Federal, State, and local levels if possible, of detailed accident data on all forms of child restraints.

The Safety Board has recommended to the Governors of the 50 States, 4 U.S. Territories, and the Mayor of the District of Columbia that they incorporate in State and local accident records information regarding use of restraints and injury for any or all child occupants (injured and uninjured) covered by the State child passenger protection law. Also, incorporate in accident report forms a category for child restraint use separate from any category for vehicle seatbelt use and record whether the child restraint was used properly or improperly, and the mode of misuse.

Therefore, the National Transportation Safety Board recommends that the National Highway Traffic Safety Administration:

Revise Fatal Accident Reporting System data forms to include the categories "child restraint--used properly" and "child restraint--used improperly," along with "child restraint--unknown if used properly."  
(Class II, Priority Action) (H-85-23)

Revise National Accident Sampling System data forms to record additional information on the type of misuse, specifically harness errors, vehicle seatbelt routing errors, improper positioning of the child restraint, as well as tether nonuse or misuse. (Class II, Priority Action)  
(H-85-24)

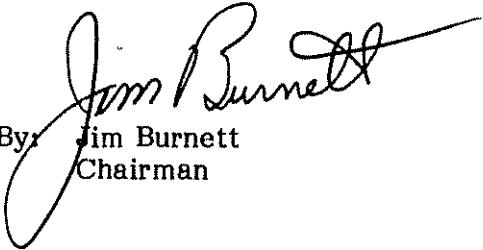
Encourage States to conduct workshops for local police precincts and State Police on child restraints and their proper use and installation.  
(Class II, Priority Action ) (H-85-25)

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<sup>21/</sup> NASS team accident investigators, located in 50 sites across the country, investigate a random sample of police-reported accidents. Results are then weighted to arrive at national estimates.

Conduct special training for National Accident Sampling System accident investigation teams on the types of child restraints in use, the ways they are misused, and field investigation techniques. (Class II, Priority Action) (H-85-26)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and BURSLEY, Member, concurred in these recommendations.

  
By: Jim Burnett  
Chairman