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TRI-LEVEL STUDY: MODIFICATION
Task 3: Validity Assessment of Police-Reported Accident Data

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16. Abstract

A special analysis was conducted as a part of a major accident causation study to assess the validity of police-reported traffic accident data.

Information theory and signal detection theory techniques were used to assess police data reliability by comparing it with MDAI and Level II (technicial level) data collected during the Tri-Level Study of Accident Causation. Results indicate the accident level variables reported by the police with least reliability were vertical road character, accident severity, and road surface composition. The most reliably reported data were those concerned with the accident location, date, and number of drivers, passengers, and vehicles. The informativeness of the police reports with respect to driver/vehicle characteristics was practically nil, with the exception of driver age, sex, and vehicle model for which the police were correct most of the time (but not errorless). It was also found that police reports provided very little information regarding the presence of different human conditions and states, vehicle defects and environmental/road deficiencies.

The sensitivity of police investigators to all accident causes was low; when causes were categorized into human direct, human indirect (conditions and states) vehicle, and environmental; police were more reliable with respect to human direct causes than to vehicle, environment and lastly, human indirect causes. In the assessment of alcohol presence and involvement a strong and significant difference in reliability existed between male and female drivers, with a lower reliability associated with females.

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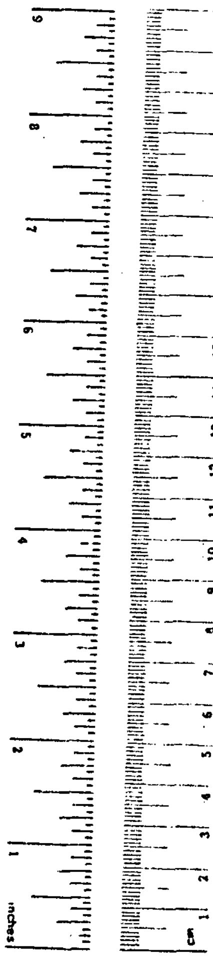
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

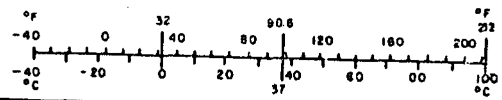
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



CONTRACT NO. DOT-HS-034-3-535

TRI-LEVEL STUDY; FINAL REPORT OF SPECIAL ANALYSIS/MODIFICATION TASK 3:

A VALIDITY ASSESSMENT OF POLICE-REPORTED ACCIDENT DATA

JUNE 30, 1977

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This analysis could not have been conducted in an efficient and economical manner were it not for the availability of the detailed in-depth case reports and supporting analysis files and programs developed under the Tri-Level Study of The Causes of Traffic Accidents. Accordingly, the contributions of the many individuals who have participated in the collection and analysis of data, and in the preparation of the individual case reports over a period of several years, are also gratefully acknowledged.

We also thank the City, County and State police agencies for their full cooperation with us in notifying us promptly of accidents, in making their accident reports available to us, and in responding to our various needs throughout the course of the accident investigation project.

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1.0 INTRODUCTION

Police accident reports are probably the most ubiquitous source for traffic accident data analysis. While the primary purpose of such reports is to provide both summary descriptive statistics on accidents and information that might later be used for litigation purposes, very often data from these reports are taken at face value for inferential analysis, most notably in the area of traffic safety improvement programs. Thus, many safety programs are evaluated on the basis of whether or not the program yields a reduction in accidents as reported by the police. In conducting such analyses, one must be aware that at least as far as rigorous scientific procedures are concerned, this approach is questionable. This is because in any scientific data gathering effort, the nature of the data collection process is often dependent on the objectives of the program. In the case of analyzing police data, however, the objectives of the researcher may be totally different from those of the policeman who is collecting the data at the scene. Thus, while police reports may be a useful source of information for the evaluation of various safety improvement programs, they are, as most researchers know, by no means the best possible source.

Various studies have demonstrated that even at the level of reporting accident frequencies, sources other than

police reports may be more complete. Driver self-reports typically reveal more accidents than police reports (McGuire, 1973)*. Accident reporting is also less complete the less severe the accident. A comparison of police records with hospital records in England showed 30% of injury-producing accidents were not reported to the police at all (Bull and Roberts, 1973). Similar results were obtained in Sweden (Thorson and Sande, 1969). Probable reasons for the incompleteness of police accident data is fear of litigation by the drivers, reluctance to get involved in bureaucratic red tape, as well as the reluctance of police officers to file accident reports for accidents involving low levels of property damage only.

The same factors probably operate to influence the accuracy of details of each accident once it is reported. Thus, when attempting to tease out factors such as location of accident, cause of accident, and driver characteristics, errors in the data source are likely to lead to inappropriate conclusions concerning appropriate improvement programs. Nonetheless, since police reports are so readily available, it is extremely important to gain a more in-depth knowledge about the accuracy of police reports for purposes of accident data analysis. If the true facts concerning each accident were known, then the police reports could be compared against them in order to assess the validity of police

* A possible exception is that of alcohol-related accidents, which drivers may be less likely to report voluntarily (McGuire, 1976).

reports for different accident-related data.

It would be desirable to have a validity criterion for accident evaluation that would be independent of human judgment. Short of this goal, however, the most we can strive for is the careful analysis of accidents that would involve the most sophisticated techniques of information-gathering available, combined with expert skills of the accident investigators. An approximation to this more realistic goal is provided by the in-depth accident analysis conducted by the Institute for Research in Public Safety (IRPS). The accident collection procedures involved in this data collection effort have been detailed elsewhere (Treat et al., 1977; Treat and Shinar, 1976). In that data collection effort, a relatively representative sample of 420 motor vehicle accidents were analyzed by multi-disciplinary teams and 2,258 accidents were analyzed by on-site technicians. The analysis involved both a detailed description of the driver-vehicular-environmental context within which the accident took place, as well as a human information processing model-based analysis of the causal factors involved in that accident. The present task is aimed at using this IRPS-obtained data as the criterion against which police reports will be evaluated.

1.1 The Problem of Validity

The assumption that the validity of the police-collected data can be tested by comparing it to that collected by IRPS'

multi-disciplinary teams needs a qualification, however. Accident investigation, by its nature, is a post hoc analysis of events (i.e., the accident has already occurred). An important part of the data base used for the evaluation depends on human judgment. This is not only judgment with respect to the existence or nonexistence of physical evidence. To illustrate, there is a judgment involved in measuring the length of the skid marks, the speed of the car prior to impact, the speed at impact, the condition of the brakes, etc. In evaluating all these factors, human judges are known to have consistent biases and deficiencies that affect their judgment. Thus, it has been demonstrated that in the context of accident cause analysis, hindsight is very different from foresight, or the ability to predict what would happen given those conditions that are presumed to exist (Fischhoff, 1974; Walster, 1966). Furthermore, the falability of memory, as demonstrated by eyewitness reports, has been documented both in actual cases of accidents as well as in well-controlled laboratory studies (Loftus and Palmer, 1974).

Two different approaches have evolved concerning the identification of accident causes. The first approach is to identify those attributes (either of the driver, vehicle, or environment) which are overinvolved in accidents. The second one is to clinically assess accidents, and, with

the aid of hindsight, identify those factors which could be described as causal. Both approaches have advantages and shortcomings. To identify overinvolvement, there is a need for an extensive data base; the variables identified as overinvolved do not necessarily indicate cause-and-effect relationships (e.g. sex); accurate exposure data is needed; and ultimately, the data base still has to be based on human judgment -- most often police. The alternative approach, that of clinical assessment, is a relatively expensive one and does not reflect the extent of the problem in terms of the overinvolvement of some factors relative to others in the total accident causation picture (because exposure is not measured). A solution to the dilemma presented by the two different approaches is to upgrade the quality of the data base and then evaluate the overinvolvement of various measurable and clinically-identified accident causation factors. If police accident records are to be used as the research data base, the first step in this process would be to evaluate the accuracy of their data relative to the strictest criterion realistically available, i.e., that of the accident description provided by a multi-disciplinary team, such as IRPS'.

1.2 Basic Assumption: The Validity of the IRPS-Collected Data

Like any post hoc accident investigation effort, the IRPS investigation is likely to be to some extent erroneous.

In the absence of an independent "true" criterion, the validity of the IRPS data is very difficult to assess. Nonetheless, a strong case can be made for the higher accuracy (and, therefore, validity) of IRPS-collected data over police-collected data for the following reasons:

1. The time delay between the occurrence of the accident and the initiation of the IRPS investigation was as short as that of the police, but the professional time spent in investigating each accident, by both the on-site and the in-depth teams, was much longer than that available to the police.

2. The IRPS teams consisted of professional accident investigators, each with his/her own area of expertise in either the vehicular, environmental, or human area. Accident analysis performed by IRPS was based on accurate measurements taken by the automotive engineer and environmental specialist, and extensive testing and interviews conducted by the human factors specialist.

3. IRPS reports were based on composite opinions of four or more experts, whereas police reports were often based on the opinions of a single investigating officer who did not have available to him/her any quality control or feedback mechanisms.

4. The IRPS investigators disassociated themselves from the legal system, and the information provided by the drivers was perceived by drivers as confidential.

This was especially helpful in providing cause-related data that might incriminate one or both of the drivers.

5. The IRPS data was subjected to quality control checks, both within the team, and by the project director, and NHTSA personnel, as well as by statistical consistency tests (Treat et al., 1977, Vol. I., Sections 7.0 and 8.0). Furthermore, in the case of causal assessment, multiple sources of evidence were considered in attributing causes.

For these reasons, it was considered best to evaluate the police data relative to IRPS (rather than vice-versa), and thus provide the best approximation of the accuracy of police-reported accident information.

1.3 Objectives

The objectives of this task were to: 1) Evaluate the accuracy of police-collected data relative to that collected by the in-depth team on the following accident data:

a. accident characteristics;

b. driver and vehicle characteristics;

c. attributed accident cause; and in particular

d. The presence and involvement of alcohol in the accident;

2) Evaluate interagency variability in accident assessment on the same variables.

3) Evaluate the effects of nighttime accidents vs. daytime accidents on cause assessment and involvement of alcohol.

4) Assess the effects of police agency, driver age and sex, light conditions (day versus night), and accident severity on the reliability of police assessments for presence and involvement of alcohol, using an on-site sample drawn during a period of 24-hour coverage.

2.0 METHOD

2.1 Technical Approach

In the present study, a random sample of 120 accidents, involving 219 drivers, was drawn from the 420 in-depth accidents. For each of these drivers and accidents, the police records were obtained, and a comparison between the police-reported data and IRPS-reported data was made. The coding forms including a copy of the Indiana Police Report used for the in-depth case reveiw are presented in Appendix A.

In addition, an on-site data base consisting of 1,317 accidents from phases IV and V of the tri-level causation study was analyzed to compare IRPS and police alcohol assessments. As with the in-depth data, each case was reviewed manually and the appropriate information recorded on the data collection forms presented in Appendix A.

2.2 Personnel: The Police Accident Investigators

While the purpose of the study is to provide an estimate of the reliability/validity of police data, the results cannot be generalized beyond the three agencies actually investigated; i.e., the municipal, county, and state

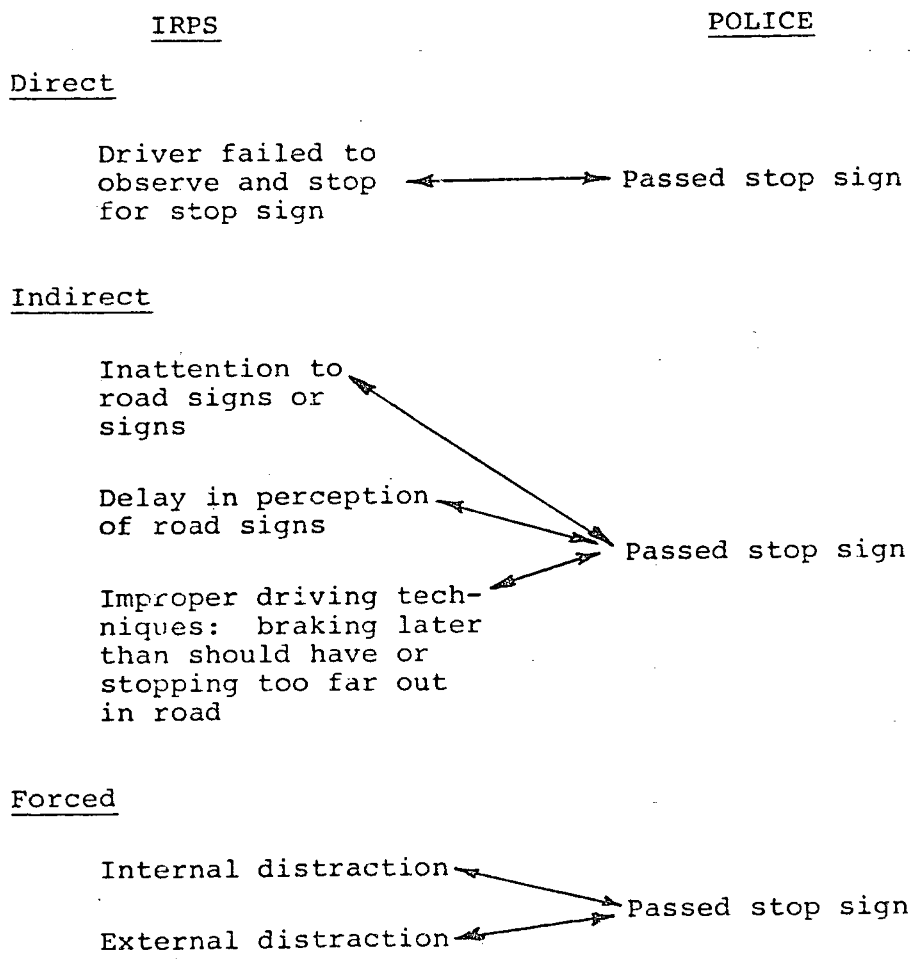
police operating in Monroe County. Generalizations to police data elsewhere are valid only to the extent that the accident investigation procedures and level of investigator skill are the same. The need to caution against such generalizations is underscored by the interagency differences found in the present study.

2.3 Mapping Procedure for Causation Data

Since IRPS data forms were designed with the specific objective of providing accident cause data as detailed as possible, the amount of information available for each case was much greater in the IRPS files than in the police files. This necessitated the derivation of mapping strategies from one file to the other. Because the police file was the one with the fewer categories, the mapping for most variables was from many IRPS categories to one police category (i.e., a homormorphic mapping). Illustrative mapping combinations for one police category are described in Figure 2-1. In a true homomorphic mapping, for each item in one set (IRPS) there is a corresponding one, and only one, item in the other set (police). This is apparent in Figure 2-1 for the "direct" mapping of the accident cause labeled as "Passed stop sign." In the reverse mapping (police items into the IRPS categories) this was not always the case, since on several occasions some categories could be mapped into more than one alternative IRPS category as illustrated in Figure 2-1. Furthermore, depending on the situation, a given IRPS category could be mapped into different police categories. This required a case-by case reanlysis of all the accidents

to ascertain the correct mapping from IRPS to police. A more detailed description of the mapping rules employed in this analysis is provided in Appendix B, along with the original categories in the IRPS and police files.

Figure 2-1: An example of IRPS-Police mapping of accident causes.



2.4 Alcohol Involvement

The prominence of alcohol in highway accidents merited a closer evaluation of the police agencies' accuracy in evaluating this variable. This is because the majority of empirical data on the involvement of alcohol in accidents is based on police reports.

In light of the small number of accidents in which alcohol was causally involved, the in-depth sample of accidents was considered insufficient for a proper evaluation of the police agencies' ability to detect alcohol involvement as a function of various other variables. Instead, all the on-site cases analyzed during phases IV and V of the "Tri-Level Study of Accident Causes" were used for this analysis. In some respects, for the particular evaluation of alcohol involvement, on-site data have some advantages over the in-depth data. These advantages are:

1. more cases investigated;
2. greater likelihood of detecting alcohol presence which the driver may admit on-site but may deny later (for fear of legal implications) when inter viewed by the in-depth investigator;
3. on-site investigations were conducted even without the drivers' complete cooperation, whereas in-depth cases depended on a much higher level of cooperation of all drivers (which was probably less likely when alcohol was involved).

Thus, in this analysis a total of 1,317 accidents were examined approximately one-seventh of which involved some level of alcohol presence.

2.5 Presence Versus Cause

A distinction was made between assessments of presence (e.g., an assessment that a driver is under the influence of alcohol) and assessments of cause (e.g., an assessment that the driver's being under the influence made a difference in whether or not the accident occured). While both assessments may involve large elements of judgement, the latter clearly requires an additional level of influence, with additional opportunity for error. This distinction between presence items and causal items is useful since it relates to two types of information, the first being purely associative information, the kind that could be associated or not associated with the accident involvement, while the latter are the kind that definitely could be described as "causes" of accidents. Furthermore, it allows tabulating the less judgemental presence information for associative comparisons, while still making the alternative "clinical assessment" information readily available.

3.0 ANALYTICAL APPROACH

Two different statistical procedures were used to evaluate the accuracy of the police-reported data. The first procedure involved the derivation of an information metric which provides a way of describing the proportion of information that the police can transmit on each one of those items, given the amount of uncertainty that exists beforehand. This metric is based on the information theory model of communications. The second technique involved

measuring the "sensitivity" and response bias of the police in terms of their ability to detect information, and it involved the use of decision theory statistics used in the mathematical procedure developed in signal detection theory (SDT).

The use of these rather uncommon statistics is due to the nature of the data involved. For most presence variables and all causal variables, the data were at the nominal scale level, and most often dichotomous. The advantages of the information transmission metric and the SCT statistics can best be illustrated with an actual examination of the data.

3.1 The Shortcomings of Some Standard Measures

Table 3-1 contains the two frequency matrices that served as the data base for evaluating the reliability of the police data on two accident causes: "fatigue" and "failure to yield right-of-way".

Note that failure to yield right-of-way was identified as a cause by IRPS approximately 16% of the time, while the police identified it as a cause approximately 19% of the time. In the second example, fatigue was identified as a cause twice (or 1% of the time), while the police identified it as a cause only one (or 0.5% of the time). Thus, a significant difference between the two causes is that the marginal distributions are extremely different. Accepting IRPS as reflecting the true state of events, it appears that

Table 3-1

A Comparison of the Various Measures of Association on Causal Assessment, and the Extent to Which They Are Affected by the Marginal Distributions

FAILURE TO YIELD RIGHT-OF-WAY

IRPS

POLICE		NO	YES	TOTAL
	NO	166 (80.2)	1 (.5)	167 (80.7)
	YES	8 (3.9)	32 (15.5)	40 (19.4)
	TOTAL	174 (84.1)	33 (15.9)	207 (100)

% Agreement: 95.7

Phi Coefficient: .85641

Contingency Coefficient: .65047

Uncertainty: .71225

FATIGUE

IRPS

POLICE		NO	YES	TOTAL
	NO	204 (98.6)	2 (1.0)	206 (99.6)
	YES	1 (.5)	0 (0)	1 (.5)
	TOTAL	205 (99.0)	2 (1.0)	207 (100)

% Agreement: 98.6

Phi Coefficient: .00688

Contingency Coefficient: .00688

Uncertainty: .00086

failure to yield right-of-way was an accident cause 16% of the time, whereas fatigue was an accident cause only 1% of the time. Now, to derive one commonly-used measure -- percent agreement between the IRPS investigators and the police -- we simply have to add the percent of times that both investigators either agreed that the cause was present or agreed that the cause was not present. In the case of failure to yield right-of-way, we obtain an agreement of approximately 96%, whereas in the case of fatigue, we obtain an agreement of approximately 99%. Thus, the high percent of agreement obtained for fatigue is mostly due to the fact that the police failed to cite this factor whether it existed or not. In fact, if the police were never to identify the factor of fatigue, we would still obtain the same 98.6% agreement! In general, in the total absence of any police citings, the lower the probability of occurence of a cause (or the more specific it is), the higher the expected percent agreement. Therefore, it can be easily concluded that percent agreement is not a very useful statistic in all cases, since the marginal probability of a cause being identified or not being identified is not the same for all causes.

Some traditional statistics, such as the Phi coefficient and the contingency coefficient, do account for the variation in marginal frequencies. Accordingly, in both cases, the Phi coefficient and contingency coefficient are higher for

the failure to yield right-of-way than for the fatigue factor. The major limitation of the Phi coefficient -- which is the deriviation of the Pearson r correlation for two-category variables -- is that it is applicable only to dichotomous variables and therefore is not applicable to variables with more than two categories. The contingency coeefficient, derived from the Chi-square distribution, is applicable to nominal variables of more than two categories. However, its upper limit depends on the number of categories, making comparisons across variables with a different number of categories difficult to interpret. Also, the contingency coefficient is inappropriate when some of the cell-values approach zero.

3.2 The Information Metric

The basic approach to this analysis assumes that some uncertainty exists with tespect to the occurence of accident-related variables, and that the purpose of the police investigation is to reduce such uncertainty. We further assume that the IRPS data reflect the true frequency of occurrence of various events, and then examine the degree to which knowledge of the police report reduces the uncertainty. Since the amount of pre-existing uncertainty depends on the priori probability of probability of occurence of the various events, we can adjust our measure to reflect the proportion of uncertainty reduction. The quantitative measure used for this purpose is the uncertainty coefficient (Uc), which is defined as $[U(Y) - U(Y|X)]/U(Y)$,

where U(Y) is the uncertainty associated with the in-depth citing by IRPS, and U(Y|X) is the uncertainty associated with guessing the IRPS assessment given information obtained by the police. The UC can vary from 0.0 (where the association is random) to 1.0, where the correlation between the two data sources is perfect. This measure is preferable to the contingency coefficient since the expected value for some of the cells is small or zero; the use of measures based on Chi-square distribution in these situations is therefore questionable. The advantage of the information metric over the Phi correlation is that the information metric can be used for any number of categories and is not limited to the case of the 2 x 2 matrix. Thus, of the four measures above, it is the only measure that can provide useful information, based on a single mathematical formula, for all the IRPS-Police comparisons.

For the dichotomous accident causes the Uc correlates highly with both Phi (r = .94) and the Signal Detection Theory statistic d' (r = .98) (discussed below) and so Phi will be included in the accident cause tables, to provide a better "feel" of the IRPS/Police correspondence for those familiar with the Pearson r correlations.

3.3 Signal Detection Theory (SDT) Statistics

A decision theory approach to evaluating the police assessment was used in which the IRPS assessment is taken to reflect the true state of the world. A methodology typically associated with Signal Detection Theory (SDT) was then used to determine the α and β error levels of the police, and indices based on these error rates were derived. The SDT approach will be briefly described below; a more extensive treatment of the SDT analytical approach and rationale is available in Green & Swets (1966).

According to SDT, when an event (signal) occurs in the outside world, it gives rise to a change in the person exposed to it. Whether this change in the situation will be detected or not is, however, a function of two different phenomena: a) the extent to which the signal is stronger than the general "noise" in the system; and b) the bias or risk-taking level that the person has with respect to stating the signal is there when in fact it is not (α type error). Each of the above phenomena can be quantified, as will be illustrated below.

For the purpose of this illustration, let us examine the police performance in correctly identifying failure to yield right-of-way (FYRW). We can then depict the factor detection process, as shown in Figure 3-1. In this figure, the left curve is the frequency distribution (f) of the "strength

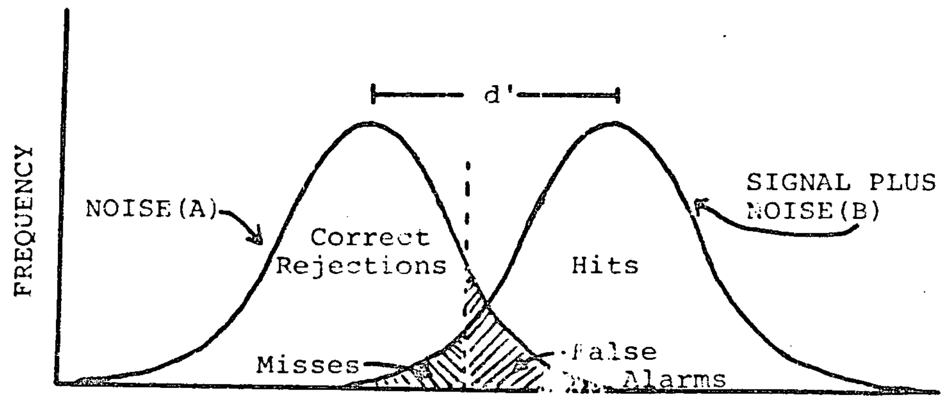


Figure 3-1. A signal detection theory (SDT) representation of the detection of causal factors. (See text for explanations.)

of evidence," or intensity of FYRW cues, when it is <u>not</u> a causal factor. The right curve is the frequency distribution of the same cues when FYRW <u>is</u> a causal factor. Typically, the two curves will overlap, and the investigator then is assumed to have (not necessarily consciously) a critical cue intensity (see Fig. 3-1) so that whenever the signal exceeds this intensity, he identifies FYRW as a causal factor; and whenever the signal intensity is less, he decides that the "signal" is not present, i.e., FYRW is not a factor. While the critical cue intensity itself will not determine the overall error rate, it does represent the bias the investigator has in terms of the relative proporation of times a factor is not cited when it is causal (misses), and the number of times a factor is cited when in fact it should not be cited (false alarms). The conditional probabilities of misses (factor not cited given signal plus noise) and false alarms (factor cited given noise only) can be derived from a frequency table and formulas such as those in Table 3-2. In the case of FYRW, P(Hit) = .97 and P(False Alarm) = .05. Note that for the area marked "misses" in Figure 3-1, P(Miss) = 1 - P(Hit).

Obviously, it would be most desirable to both maximize the hits and minimize the false alarms. Since -- short of increasing the investigator's sensitivity -- this cannot be done, an alternative objective is to maximize the quantity P(Hit) - β P(False Alarm), where β is a constant. A decision rule that maximizes this quantity is to cite the

TABLE 3-2

IRPS and Police Frequency Tabulations and Signal Detection Statistics Derivable From These Frequencies (Frequencies are for "Failure to Yield Right-of-Way")

POLICE \ IRPS	Yes	No	Total
Yes	$P_Y I_Y=32$ Hits	$P_Y I_N=8$ False Alarms	$P_Y=40$
No	$P_N I_Y=1$ Misses	$P_N I_N=166$ Correct Rejections	$P_N=167$
Total	$I_Y=33$	$I_N=174$	T=207

From this table we can then derive the following conditional probabilities:

$P(\text{Hit}) = P\ (P_Y | I_Y) = P(P_Y,\ I_Y)/P(I_Y) = P_Y I_Y/I_Y = .97$

$P(\text{False Alarm}) = P(P_Y | I_N) = P(P_Y, I_N)/P(I_N) = P_Y I_N/I_N = .05$

where I denotes IRPS

P denotes Police

Y denotes citing a factor

N denotes not citing a factor

presence of a factor (in this case FYRW) if and only if the likelihood ratio (LR) below is greater than β:

$$LR = \frac{f(\text{Hits})}{f(\text{False Alarms})} = \frac{f(\text{critical cue intensity}|\text{signal + noise})}{f(\text{critical cue intensity}|\text{noise})} > \beta$$

where f(Hits) is the value of the ordinate of curve B at the critical cue intensity, and f(False Alarms) is the value of the ordinate of curve A at the same point.

The LR is a statistic that enables us to evaluate the police performance in terms of both hits and false alarms. An ideal detector can optimize the criterion β so that β = 1 whenever the value of a hit and the cost of a false alarm are identical, or when the a priori probability of a signal is 0.5; β > 1 whenever the cost of a false alarm is greater than the value of a hit, or the probability of a signal is less than 0.5 β < 1 whenever the cost of a false alarm is less than the value of a hit, or the probability of a signal is more than 0.5. In the case of FYRW, β = .66. Thererore, in the case of FYRW, the police were hedging in favor of <u>false alarms</u> rather than misses.

The likelihood ratio should reflect the values and costs associated with hits and false alarms, and when these

can be quantified, a procedure to adjust LR is available (see Green and Swets, 1966, p. 21).

In the analysis of the police agencies' ability to detect causal factors, another variable is the distance between the "noise" and "signal plus noise" distribution (A and B in Figure 3-2). This distance, labeled d', denotes the discriminality of the signal, the "obviousness" of the factor (when it is present), or the discriminating capacity of the police independently of where the criterion β is. If we assume that both signal and noise are normally distributed and have equal variance, then from the P(Hit) and P(False Alarm) we can determine the distance of the critical cue intensity from the means of the two distributions and, hence, the distance between the two distribution means (in standard scores). The greater the d', the more detectable the factor is. In the case of FYRW, d' = 3.53. This means that if the police would give equal value to misses and false alarms -- shifting their criterion β to 1 -- then the probability of either error would be $P(Z \geq d'/2) = .04$, i.e., any reduction in the rate of misses would be costly in terms of the increase in false alarms, but in any case, assuming equal-variance distributions, the lowest error rate possible, given that level of d', is 4% of each of the error types (false alarms and misses). For convenience's sake, in the discussion below a factor will be considered as adequately dis-

criminable by the police whenever d' > 1.96, i.e., whenever the sum of P(misses) and P(false alarms) < .33%.

The use of conditional, rather than unconditional, probabilities is helpful in reducing effects caused by variations in the frequencies of occurence of the factor (in this case, variations in I_Y and I_N). Nonetheless, the small cell frequencies obtained for many of the factors make the stability of the SDT estimates questionable. In light of the great potential of this analysis, it is recommended that this analysis be expanded to a larger data set.

In interpreting the results obtained by the SDT procedures, care should be taken to separate the appropriateness of the statistical procedure from the appropriateness of the underlying signal detection theory. The above discussion was primarily addressed to the appropriateness and implications of the procedure rather than the psychological theory. Whether or not is appropriate to describe the detection of causal factors in terms of a "cue intensity" variable--and accordingly interpret β and d'--remains an open question. While the application is intuitively appealing, it has no precedence in accident causation research (though it has been applied to quality control; Fox, 1973). Given the potential promise of this analytical technique, it is recommended that experiments be designed to test its appropriateness.

4.0 RESULTS AND DISCUSSION

In the discussion that follows, accident variables, traffic unit variables, and accident causes will be dealt with separately. These three variable categories can be distinguished on the basis of the ease of getting at the information. Accident variables, for the most part, require no more than observation at the scene after the accident. On the other hand, traffic unit variables involve determination of both the driver and vehicle condition that precipitated the accident -- though these may not necessarily have been causally relevant. Finally, causal factors are those variables which are deemed to be responsible for the occurrence of the accident, the assumption being that had these events, behaviors, or conditions not existed, the accident would not have occurred.

In addition to comparing the validity of the police reporting relative to IRPS, the police interagency variability (state, county, and municipal) will also be discussed by comparing each one of them to IRPS, and against each other. More detailed analyses will evaluate the effects of light conditions on the police agencies' causal assessment capability, and the influence of various factors on the assessment of alcohol involvement.

The data base, on the basis of which the police data were evaluated, consisted of the two types of agreements and three types of disagreements with the IRPS conclusions. For each accident variable the total percent agreements was the sum of the times that the event or cause was cited

by both, and the sum of the times that it was cited by neither, i.e., the sum of correct identifications and correct rejections. Disagreements could arise from either commission or omission errors, or misidentifications. A commission error was cited whenever the police identified a variable when IRPS did not, while an omission error was cited whenever the police failed to identify a variable cited by IRPS. Misidentification was cited whenever the police identified a variable but misidentified its level (e.g., severity of accident), either due to an error in reasoning or coding.

4.1 Accident Variables

Nineteen variables that together provide a description of the scenario for each accident were identified for this analysis. The variable names and the agreements and disagreements on their occurrence are provided in Table 4-1. The variables included in this analysis are of such a nature that commission errors on the part of the police are impossible. Therefore, the only two kinds of disagreements possible for these analyses were misidentifications (noting the wrong answer for that variable) or omissions (simply failing to make an entry for that variable).

4.1.1 IRPS/Police Differences

It appears that the police are highly reliable in observing the correct location and date and may be considered to be sufficiently reliable in noting the day of week, number of drivers, passengers, and vehicles involved in each accident ($Uc \geq .88$).

Converging tragectories, which are important to crash data analysis, are also fairly well reported by the police (Uc = .80). Of the 14 misidentifications, 3 were because headons were misclassified as opposing oblique; 9 were because opposing oblique, right angle and acute oblique were not distinguished properly; 3 because rearend and acute oblique were confused and 1 because a rearend was misclassified as a collision while backing.

Police performance begins to deteriorate when they note the ambient road, light, and weather conditions (.70 < UC < .80). Here, most of the police errors are probably due to misunderstanding of the coding procedures and confusion between weather conditions and road conditions (for example, snow may be coded under both road condition and weather -- even if it was not snowing at the time of the accident).

Police accuracy is poorest in noting the vertical curvature (grade of the road (Uc = .17). This is an important variable since there is evidence suggesting that, at least in curves, vertical curvature may be related to accident propensity of a road section (Shinar, 1977). In this case, the lower accuracy of the police may be due either to confusion concerning accidents occurring at intersections or to poor judgment and measurement capabilities. Of the 38 misidentifications 14 were because accidents on level roads were mis-classified as being on grades*; 22 times the reverse occurred and 2 times accidents on grades were misclassified as occurring on hill-crests.

*IRPS classified a road as level whenever the vertical curvature was less than 2%.

Table 4-1 Agreements and Disagreements Between IRPS and Police Reports on Accident Variables
(N = 124 accidents)

Variable	Disagreements: Misidentifications n	Disagreements: Misidentifications %	Disagreements: Police Omissions* n	Disagreements: Police Omissions* %	Disagreements: Total n	Disagreements: Total %	Agreements N	Agreements %	Uncertainty Coefficient u
Month	1	0.8	0	0.0	1	0.8	123	99.2	.99
Day of Month	6	4.8	0	0.0	6	4.8	118	95.2	.97
Year	1	0.8	0	0.0	1	0.8	123	99.2	.98
Day of Week	6	4.8	2	1.6	8	6.5	116	93.5	.88
# of Traffic Units	2	1.6	0	0.0	2	1.6	122	98.4	.90
# of Passenger Units	3	2.4	0	0.0	3	2.4	121	97.6	.88
# of Trucks (GVW ≤ 8,000 lbs.)	1	0.8	0	0.0	1	0.8	123	99.2	.91
# of Motorcycles	0	0.0	0	0.0	0	0.0	124	100.0	1.00
# of Parked Units	1	0.8	0	0.0	1	0.8	123	99.2	.90
Accident Severity	38	30.6	0	0.0	38	30.6	86	69.4	.25
Converging Trajectories	14	11.3	0	0.0	14	11.3	110	88.7	.80
Speed Limit	28	22.6	21	16.9	49	39.5	75	60.5	.59
Horizontal Character	9	7.3	4	3.2	13	10.5	111	89.5	.68
Vertical Character	38	30.6	13	10.5	51	41.1	73	58.9	.17
Surface Composition	13	10.4	1	0.8	14	11.3	110	88.7	.37
Road Ambience	7	5.6	0	0.0	7	5.6	117	94.4	.71
Weather Ambience	7	5.6	1	0.8	8	6.5	116	93.5	.72
Light Ambience	6	4.8	1	0.8	7	5.6	117	94.4	.78
Location	1	0.8	0	0.0	1	0.8	123	99.2	N/A

* Police omissions are equivalent to missing values (no entry on police report), and are therefore not included in the computation of the uncertainty coefficients.

The second variable for which the police data are definitely inadequate is the accident severity (Uc = .25). Whereas the police report is typically filed immediately after the IRPS in-depth report is based on data collected both immediately following the accident, as well as on follow-up data collected up to a month after the accident. This allows the IRPS investigators to get more eliable information concerning the injuries to all drivers/passengers involved. Of the 38 misidentifications, all were because personal injury accidents were misclassified as property damage only. Obviously, the use of police data to code severity would therefore be extremely misleading in various cost-benefit analyses of safety improvement programs.

Other variables where police accuracy is low are surface composition (Uc = .37), speed limit (Uc = .59) and horizontal character of road (Uc = .68). For road surface composition, all the misclassifications were caused by confusing concrete and blacktop road surfaces. For speed limit, of the 28 misidentifications the police were within 10 mph of the actual speed limit 19 times and made mistakes outside that range 9 times. For horizontal character, the police misclassified straight and curved roads 9 times.

4.1.2 Interagency Differences

Comparisons among the agencies are useful in identifying those variables on which high interagency variability exists. The identification, coding, and reporting procedures used for these variables by each agency can then be

Table 4-2

Degree of Correspondence Between IRPS and Each of the Police Agencies on Accident Variables

Variable	All Agencies Combined		Uncertainty Coefficient		
	Uncertainty Coefficient	Rank	City (N=73)	County (N=36)	State (N=15)
Month	.99	2	.98	1.00	1.00
Day of Month	.97	4	.97	.98	1.00
Year	.98	3	1.00	.95	1.00
Day of Week	.88	8	.90	.92	.91
# of Traffic Units	.90	7	.89	.84	1.00
# of Passenger Cars	.88	9	.93	1.00	.60
# of Trucks	.91	5	1.00	.81	*
# of Motorcycles	1.00	1	1.00	1.00	*
# of Bicycles	*				
# of Pedestrians	*				
# of Trains	*				
# of Parked Vehicles	.90	6	.88	1.00	*
Accident Severity	.25	17	.22	.42	.33
Converging Trajectories	.80	10	.78	.89	1.00
Speed Limit	.59	15	.73	.49	.93
Horizontal Character	.68	14	.41	.44	.71
Vertical Character	.17	18	.14	.17	.37
Road Surface Composition	.37	16	.06	+	1.00
Road Ambience	.71	13	.77	.70	.65
Weather Ambience	.72	12	.80	.81	.55
Light Ambience	.78	11	.71	1.00	1.00

* None in sample.
\+ Not reported.

identified, and those procedures used by the most reliable agency can then be recommended for adoption by the other agencies. Thus, this comparison also provides a method for amelioration of the poorer accuracy of one or two of the three agencies.

To evaluate the reliability of the individual agencies, the uncertainty coefficient was calculated separately for each of the three agencies investigated -- the State Police, the County Police, the Municipal Police -- and the results are tabulated in Table 4-2.

Although no statistical tests were conducted to assess the significance of the interagency differences, it appears that the State Police provided the most accurate data, while the Municipal Police provided the least accurate data. Some of the more conspicuous differences involve the recording of the speed limit, the road surface composition, and the vertical curvature. The speed limit was correctly reported every time except once by the State Police, reported correctly 56 out of 61 times by the City Police, and only 6 out of 28 times by the county. Information concerning the vertical curvature is poor for all agencies, but is nonetheless twice as good for the State Police as for the Municipal Police. Finally, the most striking difference is in the notation of road surface composition, which was correctly identified by the State Police in all cases, while hardly ever identified correctly by the Municipal Police. The poor performance of the latter remains unexplained.

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Table 4-3 Agreements and Disagreements Between IRPS and Police Reports on Driver/Vehicle Variables

Variable	Disagreements: Misidentifications n	%	Police Commissions n	%	Police Omissions n	%	Total n	%	Agreements: Not Present n	%	Present n	%	Total n	%	Uncert. c/f u	Phi
Age	24	11.6	N/A	N/A	1*	0.5	25	12.1	N/A	N/A	N/A	N/A	182	87.9	.91	N/A
Sex	1	0.5	N/A	N/A	0	0.0	1	0.5	N/A	N/A	N/A	N/A	206	99.5	.96	.99
Model Year	11	5.3	N/A	N/A	20*	9.7	31	15.0	N/A	N/A	N/A	N/A	176	85.0	.91	N/A
Drinking - Degree of Impairment	6	2.9	5	2.4	6*	2.9	17	8.2	N/A	N/A	N/A	N/A	190	91.8	.32	N/A
Brakes Defective	N/A	N/A	0	0.0	90	43.5	90	43.5	113	54.6	4	1.9	117	56.5	.02	.15
Lights Defective	N/A	N/A	0	0.0	40	19.3	44	21.3	163	78.7	0	0	163	78.7	+	+
Steering Defective	N/A	N/A	0	0.0	76	36.7	76	36.7	131	63.3	0	0	131	63.3	+	+
Other Vehicle Defects	N/A	N/A	0	0.0	168	81.2	168	81.2	37	17.9	2	1.0	39	18.8	.00	.05
Attention Diverted	N/A	N/A	6	2.9	17	8.2	23	11.1	181	87.4	3	1.4	184	88.9	.03	.17
Drinking	N/A	N/A	3	1.4	7	3.4	10	4.8	195	94.2	2	1.0	197	95.2	.09	.28
Eyesight Defective	N/A	N/A	0	0.0	87	42.0	87	42.0	120	58.0	0	0	120	58.0	+	+
Hearing Defective	N/A	N/A	0	0.0	1	0.5	1	0.5	206	99.5	0	0	206	99.5	+	+
Illness	N/A	N/A	0	0.0	3	1.4	3	1.4	204	98.6	0	0	204	98.6	+	+
Fatigue	N/A	N/A	1	0.5	8	3.9	9	4.3	198	95.7	0	0	198	95.7	.00	.01
View Obstruction (Hill Crest)	N/A	N/A	2	1.0	5	2.4	7	3.4	197	95.2	3	1.4	200	96.6	.13	.46
View Obstruction (Embankment)	N/A	N/A	3	1.4	5	2.4	8	3.9	199	96.1	0	0	199	96.1	.00	.02
View Obstruction (Growth)	N/A	N/A	1	0.5	8	3.9	9	4.3	196	94.7	2	1.0	198	95.7	.11	.35
View Obstruction (Other)	N/A	N/A	7	3.4	15	7.2	22	10.6	176	85.0	9	4.3	185	89.4	.14	.40
Foreign Substance on Road	N/A	N/A	14	6.8	3	1.4	17	8.2	187	90.3	3	1.4	190	91.8	.14	.26
Shoulder Defective	N/A	N/A	1	0.5	9	4.3	10	4.8	194	93.7	3	1.4	197	95.2	.15	.42
Other Road Defects	N/A	N/A	0	0.0	17	8.2	17	8.2	189	91.3	1	0.5	190	91.8	.04	.23
Make of Vehicle	2	1.0	N/A	N/A	4*	1.9	6	2.9	N/A	N/A	N/A	N/A	201	97.1	N/A	N/A

* These omissions are equivalent to missing values (no entry on police report), and are therefore not included in the computation of the uncertainty coefficient.

+ No statistics computed, because of insufficient data.

4.2 Traffic Unit Variables

Traffic unit variables are those measures which reflect characteristics of each one of the participating drivers and vehicles. Thus, these characteristics must be specified separately for each one of the involved units. Twenty-two traffic unit variables were defined for the purpose of this analysis, and they are listed in Table 4-3, along with the agreement-disagreement analysis between the police and IRPS.

4.2.1 IRPS/Police Differences

In this analysis, we begin to see large discrepancies between the percent agreements and the uncertainty coefficient statistics for the presence of either a driver deficiency, a vehicle deficiency, or a road-related problem. The poor level of agreement is due, for the most part, to a tendency by the police not to cite these variables, i.e., to make omission errors. The fact that commission errors are rare suggests that conservativism/nonreporting on the part of the police is indeed their underlying characteristic. Note also that for all but the first four variables, misidentificiation does not apply. Thus, the police can either cite or not cite defective brakes, but there is no opportunity for them to misidentify defective brakes as something else.

In light of the results presented in Table 4-3, the use of police data for evaluating the frequency and type of vehicle defects in accidents is very questionable. For all the vehicle defect categories evaluated here, the uncertainty coefficients are practically zero, i.e., no

information is conveyed at all. Phrased in another way, the uncertainty is not reduced at all by the police reports. The situation is fairly similar with respect to driver mental characteristics, including the police report of whether a driver was drinking or not.

Finally, again with respect to road-related characteristics, the police report may be viewed as transmitting very little information. Whereas for vehicle and driver characteristics, the police tend to make omission errors significantly more than commission errors, in the case of road-related defects, the police are approximately just as likely to make a commission error as they are to make an omission error. As in the other two areas, the high percent agreement is mostly based on the lack of any detected deficiencies.

4.2.2 Interagency Differences

The comparisons among the three law enforcement agencies on the traffic unit variables are displayed in Table 4-4. Due to the smaller number of cases involved, data for some of these variables is not available for all of the agencies. Nonetheless, there are some interesting discrepancies in the accuracy of reporting among the three agencies. It appears that the correct detection of presence of alcohol while driving is much better for the county police than for the other two police agencies, though this is not true of the for the on-site data.*

*The accuracy of police reporting of alcohol involvement will be discussed separately below.
**Results obtained with the larger, on-site sample indicate the superiority of the State Police over the other two agencies for this factor (see Section 4.5.1).

Table 4-4

Degree of Correspondence Between IRPS and Each of the Police Agencies on Driver Variables

Variable	All Agencies Combined		Uncertainty Coefficient		
	Uncer-tainty Coeffi-cient	Missing Values	City (N=134)	County (N=52)	State (N=21)
Age	.91	1	.90	.98	.97
Sex	.96	0	1.00	.87	1.00
Model Year	.91	20	.93	.95	.90
Drinking - Degree of Impairment	.32	6	.00	.46	.01
Brakes Defective	.02	0	.03	.02	+
Lights Defective	+				
Steering Defective	+				
Other Vehicle Defects	.00	0	.00	.01	+
Attention Diverted	.03	0	.05	.08	.02
Drinking	.09	0	.00	.21	+
Eyesight Defective	+				
Hearing Defective	+				
Illness	+				
Fatigued	.00	0	+	.01	+
View Obstruction (Hill Crest)	.13	0	+	.03	1.00
View Obstruction (Embankment)	.00	0	+	.01	.03
View Obstruction (Growth)	.11	0	.15	+	+
View Obstruction (Other)	.14	0	.14	.26	+
Foreign Substance on Road	.14	0	.14	.20	+
Shoulder Defective	.15	0	+	.09	.71
Other Road Defects	.04	0	.10	+	+
Make of Vehicle	N/A				

+ None in sample.

On the other hand, the identification of the view obstructions (hill crest) and road conditions (shoulder defects) is better when performed by the State Police. It is possible that criteria for identifying -- or perhaps just the attentiveness to -- hill crest view obstructions or road shoulder defects are better for the State Police than for the other two agencies. Comparisons of the procedures used by the different agencies could be used to develop a uniform and improved procedure.

4.3 Accident Causes

In many ways, the determination of an accident cause is the ultimate goal of an accident investigation. Nonetheless, as has been mentioned above, the definition of an accident cause is very different for the police investigator than for the IRPS investigator. Part of the policeman's role is to determine the most legally culpable driver in an accident. Thus, a priori, his orientation is to find some fault with one or both of the drivers. On the other hand, the IRPS investigators attempted to identify cause-and-effect relationships which led to the accident regardless of the legal culpability involved. Thus, discrepancies between the police and the IRPS investigations are as likely to be a result of: (1) differences in the focus of attention and the definition of the accident cause, and (2) the relative accuracy of the police investigations. Unfortunately, no statistical analysis can separate these two issues and determine the accuracy of the police on each, independent of the other. However, since the underlying issue here is

the validity of the police-reported data for highway safety research, analysis, and development programs, the results of the comparisons are still valid because they indicate the extent to which the police are accurate in reporting accident causes as defined by a research-oriented, MDAI team (IRPS).

Twenty-three different accident causes were identified by IRPS for the purpose of this analysis. These causes are listed in Table 45, along with the results of the agreement/disagreement analysis. Since errors of misidentification were not applicable here, they are not listed for this table. The causes are grouped into the vehicular, human direct, human indirect, and environmental causes as they had been originally grouped in the IRPS accident causation hierarchy of factors.

4.3.1 IRPS/Police Differences

The analyses of the agreements and disagreements between the IRPS evaluations and the police evaluations again indicate a very high value for the total percent agreements between IRPS and the police, but an extremely variable relationship based on the uncertainty coefficient and Phi correlation. As has been noted above, the more detailed the description of the cause is likely to be, the higher the percent of noncitings by the police. However, because of the large number of correct noncitings (correct rejections), there is a high the percent of total agreements between IRPS and the police. The uncertainty coefficient is therefore a more realistic measure of the accuracy of the

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Table 4-5 Agreements and Disagreements Between IRPS and Police Reports on Accident Causes

Variable	Disagreements						Agreements							
	Police Commissions		Police Omissions		Total		Cause Not Present		Cause Present		Total		Uncert. coeff. u	Phi
	n	%	n	%	n	%	n	%	n	%	n	%		
Vehicular Causes	2	1.0	9	4.3	11	5.3	191	92.3	5	2.4	196	94.7	.20	.48
Inadequate Brakes	2	1.0	3	1.4	5	2.4	198	95.7	4	1.9	202	97.6	.37	.60
Tire Problems	0	0.0	7	3.4	7	3.4	200	96.6	0	0	200	96.6	+	+
Other Vehicle Causes	1	0.5	1	0.5	2	1.0	205	99.0	0	0	205	99.0	.00	<.01
Direct Human Causes	4	1.9	33	15.9	37	17.9	73	35.3	97	46.9	170	82.1	.40	.67
Speed Too Fast	8	3.9	8	3.9	16	7.7	181	87.4	10	4.8	191	92.3	.26	.51
Failed to Yield Right-of-Way	8	3.9	1	0.5	9	4.3	166	80.2	32	15.5	198	95.7	.71	.86
Drove Left of Center	7	3.4	3	1.4	10	4.8	193	93.2	4	1.9	197	95.2	.26	.43
Improper Overtaking	6	2.9	2	1.0	8	3.9	193	93.2	6	2.9	199	96.1	.43	.59
Passed Stop Sign	1	0.5	1	0.5	2	1.0	201	97.1	4	1.9	205	99.0	.63	.80
Followed Too Closely	5	2.4	0	0.0	5	2.4	202	97.6	0	0	202	97.6	+	+
Made Improper Turn	1	0.5	2	1.0	3	1.4	200	96.6	4	1.9	204	98.6	.49	.72
Other Improper Driving	8	3.9	56	27.1	64	30.9	121	58.5	22	10.6	143	69.1	.07	.30
Indirect Human Causes	3	1.4	10	4.8	13	6.3	192	92.8	2	1.0	194	93.7	.06	.23
Had Been Drinking	2	1.0	1	0.5	3	1.4	202	97.6	2	1.0	204	98.6	.42	.57
Fatigue	1	0.5	2	1.0	3	1.4	204	98.6	0	0	204	98.6	.00	.01
Driver Inexperience	0	0.0	2	1.0	2	1.0	205	99.0	0	0	205	99.0	+	+
Other Indirect Human Causes	0	0.0	8	3.9	8	3.9	199	96.1	0	0	199	96.1	+	+
Environmental Causes	1	0.5	60	29.0	61	29.5	135	65.2	11	5.3	146	70.5	.07	.30
Slick Roads	2	1.0	12	5.8	14	6.8	189	91.3	4	1.9	193	93.2	.13	.36
View Obstructions	0	0.0	30	14.5	30	14.5	176	85.0	1	.5	177	85.5	.02	.17
Other Highway-Related Causes	0	0.0	17	8.2	17	8.2	189	91.3	1	.5	190	91.8	.04	.23
Ambience-Related Causes	1	0.5	12	5.8	13	6.3	190	91.8	4	1.9	194	93.7	.15	.43
All Causal Factors	52	14.7	168	47.5	220	62.1	---	---	---	---	134	37.9	.35	+

+ No statistics computed.

police reporting procedures than the percent agreement or disagreement. While the uncertainty coefficient can provide us with a single measure of the police's accuracy, the SDT statistics, presented in Table 4-6 are useful in interpreting the reduced accuracy. Recall that d' is a "pure" measure of the investigator's sensitivity, while the likelihood ratio reflects the degree of conservativism or reluctance to make false alarm errors. Since these two measures reflect two different human information processes, they are susceptible to improvement by different methods. Thus, knowledge of performance along these two measures can be used in the design, development and improvement of police investigating procedures. In evaluating the actual results, a note of caution is in order. Due to the extremely low a priori probabilities of some of the accident causes, and the relatively small sample of accidents studies, the cell probabilities on which these statistics are based may not be very stable. This is particularly true with respect to estimates of the likelihood ratio.

Looking at all the causal factors together, the SDT statistics support the notion that the police in fact are conservative in their attribution of causes since the probability of false alarms is extremely low for all causal factors, and as a result the likelihood ratio is extremely high. The true sensitivity of the police investigators is reflected in d' (1.83), which suggests that for all causes together the police are fairly insensitive. For those

Table 4-6

Signal Detection Analysis of Police Performance in Identifying Accident Causes

Causal Factor	P(Hit)	P(False Alarm)	LR	d'
Vehicular Causes	.36	.01	14.05	1.97
Inadequate Brakes	.57	.01	14.75	2.50
Tire Problems	---	---	---	---
Other Vehicle Causes	.08	.05	---	---
Direct Human Causes	.75	.05	3.08	2.32
Speed Too Fast	.56	.04	4.58	1.90
Failed to Yield Right-of-Way	.97	.05	.66	3.53
Drove Left of Center	.57	.04	4.56	1.93
Improper Overtaking	.75	.03	4.67	2.56
Passed Stop Sign	.80	.01	10.52	3.17
Followed Too Closely	---	---	---	----
Made Improper Turn	.67	.01	13.60	2.77
Other Improper Driving	.28	.06	2.83	.97
Indirect Human Causes	.17	.02	5.23	1.10
Had Been Drinking	.67	.01	13.60	2.77
Fatigue	.00	.01	---	---
Driver Inexperience	---	---	---	---
Other Indirect Human Causes	---	---	---	---
Environmental Causes	.16	.01	9.14	1.33
Slick Roads	.25	.01	11.94	1.65
View Obstructions	.03	.00	---	---
Other Highway-Related Causes	.06	.00	---	---
Grand Mean	.48	.03	5.86	1.83

factors for which no police citings at all were available, d' and the likelihood ratio could not be calculated, even though the uncertainty coefficient could be calculated.

A comparison between the different categories of causal factors --vehicular, human direct, human indirect, and environmental causes -- indicates that direct human causes are the ones that are best detected by the law enforcement agencies (d' is highest), while the human indirect and environmental causes are the ones that present the most difficulty (d' is lowest). Also, it appears that relatively speaking, the human direct cause category is the one area where the police are willing to commit a slightly higher rate of false alarms, probably due to the police orientation to search for culpability in terms of inappropriate driver behaviors. Indirect human causes are simply difficult to detect within the short amount of time available for the police, and environmental causes often require careful measurements by an accident reconstruction specialist -- something beyond the scope of the police capabilities, in terms of time, cost, and possibly, expertise.

In the domain of vehicular causes, the only cause that the police are marginally successful at detecting correctly is that of inadequate braking (Uc = 0.37, d' = 2.5). One way of possibly improving the police's detection rate would be to be less conservative, and risk increasing the false alarm rate. An increase of from 0.01 to 0.05 would probably greatly increase the probability of hits without

involving too great a "cost" in terms of permissible level of accuracy. It is most likely that the major limitation here is that of time -- the police simply do not have the time (or do not consider the spending of such time appropriate) to actually remove a wheel and examine the brakes. In fact, they usually do not even have the time to drive the car themselves.

Human direct causes are perhaps the best identified by the police. Of these, failure to yield right-of-way and failure to stop at a sign are the best identified (Uc = .71 and .63, respectively, and d' = 3.53 and 3.17, respectively). The level of false alarms that the police are willing to tolerate here is much greater than it is for vehicular or environmental causes and appears to be appropriate. Note that failure to stop at a stop sign is associated with both a high probability of hits and a low probability of false alarms, indicating high sensitivity to this cause. Direct human causes with respect to which the police's assessment can be considered unreliable are speeding, driving left of the center of the road, and any other improper driving behaviors. The problem with identification of speeding and driving left of center is not one of poor criterion (β), but actually one of the investigator's sensitivity to these factors. It may be that, given the stress that the police are under, it is impossible for them to actually determine whether a driver was speeding or driving left of the center line. Obviously, the driver himself/herself would be reluctant to volunteer this type of information. Transient

environmental evidence to this effect (tire markings on the pavement) are perhaps too time-consuming to be properly assessed by the police. Nonetheless, since both speeding and driving left of the center line are clear-cut violations of the law, it may be advantageous to try to improve the overall detection capability of the police (d') by providing them with short workshops that would give them additional cues to look for and some rules of thumb that they can use to calculate speed and paths prior to impact. Also, with respect to speeding, it is likely that the police use different criteria from those used by IRPS. This is because IRPS' evaluation of speeding was in essence "driving too fast for conditions," while the police definition is probably restricted to "above the speed limit."

The police assessment of "other improper driving" behaviors is practically useless, as indicated by both the uncertainty coefficient and d', which reflect chance-level performance. This is probably because more subtle human errors escape the police's notice (especially if they do not have a specific code for these behaviors on the form), which is suggested by the high rate of omission errors in this category (27%).

Of all the indirect human causes, only drinking can be evaluated since for the three other categories -- fatigue, driver inexperience, and other indirect human errors -- no correct identifications were made at all (a negative reflection

on police performance). The assessment of drinking may be considered adequate (Uc = .57 and d' = 2.77), especially since perhaps the only way to increase the number of correct identifications may be to shift the criterion to increase the percent of false alarms. Since this is a type of cause in which the police would want to be conservative in their estimate, it is likely that short of increasing pressure on the police to give alcohol tests prior to citing for driving while intoxicated, no improvement can be expected.

In the assessment of environmental causes the police performance is also not very reliable. For none of the factors cited does the police performance exceed the chance level. This shortcoming is particularly critical if police reports are to be used as data sources for highway improvement programs. As to the reason for the poor performance, the near zero false alarm rate for the three environmental causes is a clue suggesting that the police in fact simply disregard this category. This can become a bad habit relevant to any causal factor that is relatively rare.* For this reason, the formatting of police accident reports is extremely important since proper formatting can force the investigating police officer to scan all relevant

*This may be a particularly difficult problem to solve since it appears that subjective probabilities for (objectively) low probability events are often zero (Naatanan and Koskinen, 1975.)

alternatives. Slick roads as a causal factor may be an exception since it is checked at some frequency, as is indicated by the probability of a hit = 0.25.

4.3.2 Interagency Differences

Because of lack of data, differences among the three agencies on some of the causal factors could not be evaluated. The reduced causal factor list and the results of the comparisons among the agencies are presented in Table 4-7. As with the assessment of accident and driver characteristics, so with the assessment of accident causal factors, the State Police seems to be the most reliable, while the Municipal Police seems to be the least reliable.

With respect to specific factors, the differences among the agencies are significant on only four, three of which are in the domain of human direct causes. The accuracy of reporting failure to yield right-of-way is relatively high for all agencies, but significantly better for the State Police than for the Municipal Police, which in turn is significantly better than the County Police. In magnitude the differences are small, and an examination of the SDT statistics revealed that for all agencies, ρ (hit) $\geq$ .96, so the differences among the agencies are in the false alarm rates. The State Police had no false alarms at all, whereas the County Police had ρ (false alarm) = .06. Thus, even though the differences among the agencies are significant for practical purposes they are small, and the reliability of all three agencies is high. Differences of both practical

Available

Table 4-7 - Degree of Correspondence Between IRPS and Each of the Police Agencies in Identifying Accident Causes

Causal Factor	Uncertainty Coefficient (U)			Phi			
	(n=134) City	(n=53) County	(n=20) State	(n=134) City	(n=53) County	(n=20) State	Significance*
Vehicular Causes	.24	.18	+	.50	.48	---	
Inadequate Brakes	.32	.41	+	.57	.65	---	
Direct Human Causes	.43	.32	.45	.71	.59	.61	
Speed Too Fast	.21	.41	.03	.39	.68	.19	2/3,1
Failed to Yield Right-of-Way	.72	.66	1.00	.87	.73	1.00	2/3/1
Drove Left of Center	+	.22	.52	---	.50	.55	
Improper Overtaking	.47	.26	.65	.62	.48	.69	
Passed Stop Sign	.73	+	+	.89	---	---	
Made Improper Turn	.73	.00	+	.89	.02	---	2/3
Other Improper Driving	.07	.03	.17	.32	.20	.38	
Indirect Human Causes	+	.05	+	---	.22	---	
Had Been Drinking	+	.34	+	---	.55	---	
Fatigue	+	.00	+	---	.03	---	
Environmental Causes	.03	.14	.12	.19	.40	.41	
Slick Roads	.10	.05	.71	.34	.24	.79	1/2,3
View Obstructions	.03	+	+	.19	---	---	
Other Highway-Related Causes	+	+	.24	---	---	.55	
Ambience-Related Causes	.10	.15	.40	.34	.43	.69	

+ No statistics computed, due to insufficient data.
* Differences significant at $p \leq .05$ are specified by the initials of the two agencies separated by a slash. Tests of significance are based on Fisher's Z.

and statistical significance are obtained in the identification of speeding. Here, most of the difference among the agencies was in the P (hit) rather than in P (false alarms) and, given the relative constancy of false alarms, this was reflected in both differences in the likelihood ratio and the d'. The d' scores for the Municipal, County, and State Police were 1.88, 2.24, and 0.63, respectively; while the likelihood ratios for the three agencies were 16.67, 11.14, and 2.86 respectively. The significant differences were between the County Police and the State Police, and the County Police and the Municipal Police. The higher accuracy of the County Police is attributed to a higher hit rate (P (hits) = 0.78) relative to the Municipal and State Police (0.50 and 0.20). Perhaps the County Police uses criteria that are more similar to IRPS' or are somehow better able to evaluate precollision speeds. Whatever the reason, it is worth investigating since this knowledge could enable the other agencies to upgrade their evaluation significantly. The other significant interagency difference was obtained between the accuracy of the Municipal and County Police in their recording of improper turns. Here, the Municipal Police was much more accurate than the County Police (no data were available for the State Police). The difference was due to P (hit) = 0.0 for the County Police, compared to 0.8 for the Municipal Police! This cannot be interpreted as failure to note improper turn as a cause since it was erroneously recorded (false alarms) by the County Police 2% of the time versus 0% of the time by the Municipal Police.

Significant differences were also found to exist between State and Mjnicipal and State and County Police in the identification of slick roads as a causal factor. The State Police was significantly more reliable than the other two agencies in identifying this factor. The difference was again due to the P (hit) where the State Police had 1.00 compared to .17 for the County and .13 for the Municipal Police.

4.4 The Effects of Night vs Day Occurrence on Causal Factor Assessment Reliability

Much of the information gathering activities in which accident investigators are involved depend on the availability of visual cues (roadway characteristics, damage, skid marks, etc.). One would therefore suppose that the accuracy of assessing accident cause might be, at least for selected causal factors, poorer during the nighttime than during the daytime. Poorer performance may be expected only on the average, rather than for all accidents, since some accidents may occur in well-lit environments to which the investigator is visually adapted. However, some accidents are likely to occur on dark roads where even at full adaptation, visual acuity is poorer than it would be under normal daytime illumination.

The results of comparing the police performance to that of IRPS separately for the daytime and the nighttime accidents are presented in Table 4-8. Z tests of significance conducted on the Phi correlations reveal that of all the factors, only three were significantly different during the day than during the night, two of which were human causes.

Of the vehicular causes, the ability to identify inadequate brakes as an accident cause was much poorer at night than during the day. This result is not surprising since part of the evaluation of brake problems would depend on either the driver's report or the policeman's own check of the brakes based on visual cues (e.g., skidmarks, presence of brake fluid).

Table 4-8

Degree of Correspondence Between IRPS and Police in Identifying Accident Causes as a Function of Light Conditions

Causal Factor	Uncertainty Coefficient (U)		Phi		Signi-ficance
	(n=40) Night	(n=149) Day	(n=40) Night	(n=149) Day	
Vehicular Causes	.30	.29	.61	.53	NS
Inadequate Brakes	.24	.55	.47	.74	.02
Direct Human Causes	.38	.42	.66	.68	NS
Speed Too Fast	.27	.21	.54	.47	NS
Failed to Yield Right-of-Way	1.00	.75	1.00	.85	---
Drove Left of Center	.70	.21	.70	.41	.02
Improper Overtaking	+	.46	---	.59	---
Passed Stop Sign	+	.73	---	.89	---
Made Improper Turn	1.00	.42		.66	---
Other Improper Driving	.09	.05	.36	.27	NS
Indirect Human Causes	.01	.08	.04	.29	.16
Had Been Drinking	.01	.82	.03	.81	< .01
Fatigue	+	.00	---	.01	---
Environmental Causes	.14	.05	.38	.25	NS
Slick Roads	.18	.14	.47	.39	NS
View Obstructions	+	.03	---	.18	---
Other Highway-Related Causes	+	.07	---	.29	---
Ambience-Related Causes	.11	.17	.37	.46	NS

+ No statistics computed due to insufficient data.

Another possibility is that the loss of visual cues at night also prevents the driver from becoming aware that his brakes are not functioning as well as expected compared to the daytime, when visual cues provide the driver with more intense feedback on the adequacy of his brakes.

Based on this data, the ability to detect alcohol involvement at night is practically nonexistent. In fact, this analysis indicates that police are able to assess involvement of alcohol very well during the daytime ($\overline{Uc}$ = 0.82), but during the night their assessment is practically random.* Again, this is a surprising finding since one would expect that at nighttime the police would be more alert to alcohol as a potential causal factor. It is possible that drivers intoxicated during the daytime are in a different category in terms of their level of intoxication and the obviousness of the alcohol's effect on their driving. Whatever the reason, the extremely large difference between police performance during the daytime and nighttime merits close study. This finding could also be the result of the convenience sampling technique used to select the in-depth accidents where drivers who were properly assessed as alcohol involved by the police at night could have been systematically excluded from the sample. Because of the potential biases associated with the in-depth sample on this particular cause, an additional alcohol analysis was performed using the on-site data. This sample

*Here too there is a discrepancy between the results based on the in-depth data file and those based on the on-site. For alcohol involvement the on-site data is probably more appropriate to use (Section 4.5).

was selected during a 24-hour coverage period and is less biased because of noncooperation on the part of drivers (see Section 4.5).

The police are more accurate in their assessment of driving left of the center line and failure to yield right-of-way during the nighttime than during the daytime. Again, this result in contrary to the expectations since the assessment of both factors depends to a large extent on visual cues. It is possible that the police employ different procedures to assess these factors during the daytime and during the nighttime and that the procedures employed during the nighttime are either more similar to those employed by IRPS or are more accurate. Similarly, it is possible that during the nighttime the drivers are more likely to admit to these behaviors and justify them by claiming poor visibility.

4.5 Alcohol Presence and Involvement

For each accident analyzed, both the police and IRPS indicated whether alcohol was present and/or involved. Alcohol presence was indicated on a four-level scale of certainty ranging from "no alcohol detected" through "possible" and "probable" presence of alcohol, to "certain" presence of alcohol. Similar categories were used for the evaluation of the involvement of alcohol as a contributing causal factor. Thus, the comparison between IRPS and police was not based on a yes-no set of comparisons but rather on the correspondence in level of certainty in the attribution of alcohol presence and/or involvement.

4.5.1 The Detection of Alcohol Presence

In order to focus on the ability of the police to detect the presence and degree of involvement of alcohol in accidents, it was necessary to obtain a larger sample for the data base. This is because, when dealing with a representative sample of accidents (rather than concentrating on fatal accidents), the percent of accidents in which alcohol is involved is relatively small (Treat et al., 1977). Thus, for the purpose of the analyses in this section, the accidents investigated by the on-site IRPS team in Phases IV and V served as the data base. This yielded a sample of nearly 2,000 accident-involved drivers, sampled from a 24-hour period and less severely affected by non-respondent data.

To assess the ability of the police to detect the presence of alcohol as a function of other variables, Pearson r correlations and uncertainty coefficients were calculated between the police level of confidence and the level of confidence of the IRPS investigators.* For the purpose of this analysis the total data set was categorized according to the following variables (and levels within variables): the different police agencies; accident severity (personal injury versus property damage only); the number of vehicles involved (single versus multiple vehciles); the light conditions (night versus day); driver age (15-24, 25-54, 55+); and driver sex. The results are summarized in Table 4-9. In this table, the variables on which the comparisons were made are listed on the first three columns. The next two columns indicate the number of drivers involved in each one of the levels, and the next two columns contain the correlations between the alcohol presence confidence level of IRPS and the police. The next two columns indicate the Z score and the level of significance of the difference between the two correlations. The last two columns list the uncertainty coefficients, indicating the police's accuracy relative to IRPS.

*The use of confidence ratings in this analysis makes direct comparisons between the on-site and in-depth data somewhat difficult. Nonetheless, cross references between the results have been footnoted throughout this report.

Table 4-9 The Relationship Between IRPS and the Police Level of Confidence in the Detection of Alcohol Presence

	Levels		Sample Sizes		Correlations		Significance of Difference		Uncertainty Coefficients	
Variable	V1	V2	n1	n2	r1	r2	Z	p	U1	U2
Agency	City	County	1,271	320	.87	.84	1.54	NS	.53	.41
	City	State	1,271	174	.87	.92	3.53	.001	.53	.57
	County	State	320	174	.84	.92	4.05	.001	.41	.57
Injury	No	Yes	1,351	414	.84	.88	2.51	.01	.44	.51
# of Vehicles	Single	Multiple	279	1,486	.87	.82	2.70	.01	.45	.42
Light Condition	Night	Day	350	1,289	.87	.86	0.34	NS	.44	.53
Driver Age	(15-24)	(25-54)	874	680	.87	.81	4.04	.001	.48	.43
	(15-24)	(55 +)	874	162	.87	.88	0.46	NS	.48	.51
	(25-54)	(55 +)	680	162	.81	.88	2.80	.01	.43	.51
Driver Sex	Male	Female	1,170	584	.87	.71	8.68	.001	.48	.32

The results in Table 4-9 indicate that, on the whole, the correlations between the confidence of IRPS and police agencies were relatively high for all variables studied. The high correlation values, however, are somewhat spurious due to the large percent of agreements on the absence of alcohol. The correlations are therefore meaningful mostly for the purpose of comparing differences between levels within variables. A more conservative -- and valid -- measure of the extent of agreement between the police and IRPS is provided by the uncertainty coefficients, which are much lower than the Pearson correlations.

Comparisons among the three police agencies indicated that the state police level of confidence corresponded closely to that indicated by IRPS. The difference between the state and the other two agencies was statistically significant, whereas the difference between the municipal and county police was not. As before, using IRPS' judgements as the criterion, the State Police may be said to be more accurate in their assessments of alcohol presence than the other two agencies.* Furthermore, the detection of alcohol presence is better in the case of injury producing accidents, single-vehicle accidents, accidents involving drivers who are either under 25 or over 55 years old and accidents involving male drivers. Conversely, the ability of the police to detect alcohol is least reliable when the driver

*This finding is at odds with the results obtained with smaller in-depth sample (Section 4.2.2). In light of advantages of using the on-site data for this particular factor only, the on-site results may be more valid than the in-depth results.

is female, when the accident involves multiple vehicles or property damage only, and when the driver is between the ages of 25 and 54. It is interesting to note that whether the accident occured at night or during the daytime made no significant difference in the police ability to detect the presence of alcohol.*

Since all the comparisons are essentially pair-wise comparisons, interactions among the variables are unknown. Therefore, the data do not indicate which combination of agency-injury-number of vehicles-light condition-driver age-driver sex is either the most or the least reliably detected by the police. One interesting observation, though, is that of all the classifications, the one that yielded the least reliable police data involved the classification of driver sex, in which the police are found to be the least reliable in detecting alcohol in females. This may be due to the officer/driver sex interaction since it is accurate to assume that in the overwhelming majority of the cases, the investigating officer was a male. The influence of this "sexual" interaction has been noted in various psychological research contexts (Rosenthal, 1966).

4.5.2 The Identification of Alcohol Involvement as Causal Factor

The correspondence between IRPS and the police in the

*This result is not inconsistent with that obatined in Table 4-8, since the in-depth data in Table 4-8 refer to alcohol as a causal factor, while the present discussion is concerned with the detection of alcohol presence only.

detection of alcohol involvement (rather than presence) is summarized in Table 4-10, which is similar in format to Table 4-9. Comparisons between the uncertainty coefficients in the two tables indicate that the police are less reliable in assessing alcohol as a contributing causal factor than in merely detecting its presence. This result may be related to the legal system, which implies different consequences for the detection of alcohol presence versus the claim of alcohol as a contributing factor. This hypothesis is consistent with a separate analysis that indicated that the lower correspondence is due to a tendency of the police to understate their confidence in alcohol involvement rather than overstate their confidence. This tendency was true for all variables and levels analyzed, with the exception of the State Police, which tended to overstate their confidence of alcohol involvement rather than understate it. Whether in fact the police were not capable of better assessing the role of alcohol remains to be determined. It is just as likely that, given the present legal system, the police are simply reluctant to cite alcohol since it would result in an increased involvement on their part with each accident case cited (appearance in court, additional tests, etc.).

The test of significance conducted on the correlations indicated that the State and County Police were better than the City Police in detecting alcohol as a causal factor, and were not significantly different from each other. The only other significant differences were with respect to driver

Table 4-10 The Relationship Between IRPS' and the Police's Level of Confidence in the Assessment of Alcohol Involvement

Variable	Levels		Sample Sizes		Correlations		Significance of Difference		Uncertainty Coefficients	
	V^1	V^2	n^1	n^2	r^1	r^2	Z	p	U^1	U^2
Agency	City	County	1,380	372	.64	.75	3.64	.001	.32	.39
	City	State	1,380	184	.64	.75	2.64	.01	.32	.55
	County	State	372	184	.75	.75	0.05	NS	.39	.55
Injury	No	Yes	1.464	470	.67	.71	1.48	NS	.34	.37
# of Vehicles	Single	Multiple	316	1,620	.66	.64	0.59	NS	.27	.37
Light Condition	Night	Day	417	1,377	.67	.64	0.97	NS	.29	.35
Driver Age	(15-24)	(25-54)	930	726	.70	.67	1.45	NS	.40	.31
	(15-24)	(55 +)	930	172	.70	.82	3.27	.001	.40	.68
	(25-54)	(55 +)	726	172	.67	.82	4.04	.001	.31	.68
Driver Sex	Male	Female	1,277	619	.70	.58	4.23	.001	.36	.33

sex and age. The identification of alcohol as a causal factor was more reliable when the driver was either male or over 55 years old.

As with alcohol presence, no significant differences were obtained in the ability to identify alcohol involvement as a function of the light condition. This similar performance level (on detecting alcohol involvement) for night and daytime accidents contrasts sharply with the results obtained with the in-depth data (see Table 4-8), for which the police performance in identifying alcohol as a causal factor was indicated to be practically random for nighttime accidents. The most immediate explanation is that the in-depth sample contained a relatively small number of alcohol-involved accidents, and therefore the discrepancy between the two results may be due to sampling errors. This is particularly true for the nighttime in-depth sample since during Phases II and III (included in the in-depth but not on-site samples used in the present analysis) only accidents occuring between 11:30a.m. and 10:30p.m. were investigated. If this in fact is the reason, then analyses using the on-site data should be considered more reliable. An alternative explanation involves the inherent differences between the in-depth and the on-site level of investigation. Since the on-site investigation was conducted in the same vicinity and at the same time as the police investigation, it is much more reasonable to expect that the on-site investigators would obtain a similar impression of the driver behavior, and

often obtain a similar "confession" from the driver as the police. This would raise the uncertainty coefficients for both the nighttime and the daytime data, as in fact was the case. If this explanation is accepted, then the results obtained with the on-site data may or may not be more valid than those obtained with the in-depth data. In fact, if sampling biases are ruled out, then it is more likely that conclusions based on the in-depth analysis are more valid since in the in-depth interview the driver is typically more cooperative (in fact, the less cooperative drivers are not included in the in-depth sample). On the other hand, the nonrespondent data may have biased the in-depth results.

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Objectives and Methodology

In the present study, a random sample of 120 accidents involving 219 drivers was investigated by both multi-disciplinary accident investigation (MDAI) teams and by police. The MADI team investigating an accident consisted of an accident reconstruction specialist, an automotive engineer, and a psychologist. The representatives of the three relevant disciplines each investigated the accident from his/her own viewpoint and then together, through a formal process of accident analysis, formulated conclusions concerning the characteristics of the accident and the relevant causal factors (see Treat and Shinar, 1976, for MDAI methodology details). In the absence of an external criterion for accident description and cause, the MDAI report was assumed to reflect the true state of events, and the validity of the police data was then evaluated relative to the MDAI report. Comparisons were made on three types of accident variables: 1) accident descriptors, including date and time of accident, number of traffic units involved, converging tragectories of the vehicle(s), accident severity, roadway characteristics, ambience, weather, etc.; 2) driver/vehicle descriptors, including driver age, sex, presence of alcohol, presence of hearing and visual deficiencies, reports of fatigue, vehicle condition, vehicle make and year, etc.; and 3) accident causes, including vehicular factors (e.g., inadequate brakes and tires), human direct causes (e.g., speeding, failing

to yield right-of-way, driving left of center, passing a stop sign, making improper driving maneuvers, following too closely), human indirect causes (e.g., alcohol intoxication, fatigue, driver inexperience), and environmental causes (e. g., slick roads, view obstructions).

The nature of the data (nominal categories, unevenly distributed) precluded the use of standard parametric statistical procedures. Instead, measures derived from information theory and signal detection theory were used.

5.2 Conclusions

The police performance was evaluated on three types of data items: accident-descriptive data, such as location and time of accident; human, vehicular, and environmental deficiences present in the accident such as alcohol intoxication, bad brakes, and view obstructions; and the cause(s) of each accident.

More detailed analyses of this research investigated the variability among different police agencies (city, county, and state) and changes in reporting accuracy as a function of daytime versus nighttime accidents. Alcohol was singled out for further evaluations by evaluating the police accuracy in detecting the involvement of alcohol in an accident as a function of various other factors such as driver age, sex, nighttime versus daytime accidents, accident severity, etc.

In general the most valid police reported data were those concerned with accident descriptors and least reliable were driver/vehicle variables. The police's ability to

accurately attribute accident causes varied considerably across the different cases. There were also significant differences among the three police agencies evaluated. The main conclusions can be summarized as follows:

1. Among accident-descriptive data reported by the police, it was found that police data were adequately reliable for six of 19 variables assessed: location, date, day of week, and numbers of drivers, passengers, and vehicles in each accident. At the other extreme, the least reliable police data concerned vertical road character, accident severity, and road surface composition. Of the vertical road character errors, the biggest problem was misidentifying accidents which occurred on grades as occurring on level roads; out of 38 total misidentifications, this error occurred 22 times. In 14 additional cases accidents on level roads were misclassified as being on grades, while two times accidents on grades were misclassified as occuring on hillcrests. Accident severity is often underestimated by the police; in all of the 38 misidentifications, personal injury accidents were misclassified as involving property damage only. Under road surface composition, the 13 misidentification errors (10.4% of cases) all involved confusion of concrete and asphalt surfaces. Reliability was also inadequate for speed limit and horizontal character of roadway. The police improperly identified

the speed limit in 28 of the 124 accidents (22.6%), and failed to indicate the speed limit in another 21 accidents (16.9%). Of the 28 misidentifications, the police were within 10mph of the actual speed limit 19 times. For horizontal character, the police misclassified straight vs. curved roadway sections in nine accidents (7.3%).

2. The police reports analyzed provided very little information regarding the <u>presence</u> of different driver factors, and human conditions and states, and both vehicular and environmental/roadway factors and deficiencies. For example, the police misclassified driver age for 24 of the accident drivers (11.6%), and misclassified vehicle model year for 11 vehicles (5.3%), with model year not stated for an additional 20 vehicles (9.7%). For vehicle and driver characteristics, the police tended to make omission errors significantly more often than commission errors (i.e., the police often failed to provide any information on the report, rather than to identify a factor -- such as a defective brake component -- as being present when in fact it was not). However, in the case of road-related defects, the police were approximately just as likely to make omission as commission errors.

3. The sensitivity of police investigators to <u>accident causes</u> was also generally low. Police often failed to cite factors which in fact should have been cited,

although they rarely cited factors which were not in fact involved (i.e., the false alarm rate was low). In terms of the identification of the overall categories of causal factors, the police performed most reliably in detection of human direct causes followed by vehicular, environmental, and human indirect causes. In the area of human direct causes, police performance was relatively good in identifying "failure to yield" and "failure to stop at a stop sign," and was relatively poor with respect to "speeding," "left-of-center," and "other improper driving." For vehicle factors, the police were marginally successful in detecting the role of inadequate braking, but performed inadequately with respect to all other vehicle factors.

With respect to environmental factors, police performance did not exceed the chance level for any of the factors cited. A particular problem exists with respect to police identification of view obstructions -- the most frequent environmental cause identified by the tri-level study, and a factor which police record systems could perform an important service in correctly identifying. The police failed to implicate view obstructions as causes in 30 accidents (14.5%) in which the in-depth team indicated this factor should have been cited. Overall, the police correctly implicated view obstructions in only 3% of the accidents.

Among human indirect causes, police performance was adequate only for the "had been drinking" involvement assessment. This category was identified by the police in 67% of the cases in which the in-depth team indicated identification was appropriate, with improper identifications (false alarms) occuring in only 1% of the accidents.

4. Analyses of inter-agency differences in the reliability of the data, indicated a slight, but not consistent superiority of the State Police over the other two police agencies, the municipal police being poorest of the three. The greater accuracy of the State Police was most pronounced in the accident variables of road surface composition, vertical curvature, and posted speed limit; driver variables of view obstructions and defective road shoulders; and the accident causation variables of speeding, failure to yield right-of-way, and slick roads. Based on the on-site data, the State Police also appeared to be the most reliable of the three agencies in noting alcohol presence and involvement.

5. A separate analysis was performed on the assumption that light condition (day or night) might affect the reliability of certain causal factor assessments. It was found that the validity of brake system, driving "left-of-center," and drinking assessments all varied significantly on this basis. For inadequate brakes,

police accuracy was signficantly poorer at night. Similarly, based on the comparison of police and in-depth team data, the "had been drinking" (i.e., the causal involvement of alcohol) assessment was much poorer at night, although a similar result was not obtained with the larger and possibly less biased on-site sample when compared in a similar manner. For the "driving left-of-center" assessment, the police were less reliable for daytime accidents.

6. The final analysis focused on indications of presence and involvement of alcohol, using the more extensive on-site accident files from Phases IV and V, involving nearly 2,000 accident drivers. Based on this analysis, the reliability of the police-reported presence of alcohol was most strongly affected by driver sex, with lower reliability occurring for females (the police underreported the presence of alcohol for accident-involved females). The reliability of alcohol presence was also significantly poorer in multiple vehicle accidents, in which drivers were between 25 and 54 years of age and where there was no injury. Similarly, the police-reported involvement of alcohol varied significantly as a function of driver sex, the validity again being poorer for females then for males. As a function of driver age, validity was highest for drivers 55 years of age and over, and lowest for those 25 to 54.

5.3 Recommendations

The prevalent use of police records for various non-police needs such as research, policy making, and highway inprovements, provides a strong justification for improving the validity of police reported data -- or at the very least bringing the lack of validity to the awareness of the different data users. An important implication of the results obtained in the preceding analyses is the need to reevaluate police-reported data in the proposed National Accident Sampling System use of that data for accident statistics purposes.

Because it is very likely that police reports will remain a popular source for various traffic accident statistics in the forseeable future, some steps should be taken to monitor the quality of police-reported accident data and where possible improve its accuracy. Specifically, three recommendations are made:

1. The generally poor police performance indicated by this assessment provides a strong argument for improving the training and motivation of police officers in traffic accident reconstruction and investigation. Significantly, many of the errors were recorded for factors which clearly do not require high levels of expertise to correctly assess. For example, as important as driver age is to the use of a police record system for problem identification, the police improperly identified driver age in 11.6% of the accidents considered.

In other instances, data simply were not entered. For example, whereas vehicle model year was improperly stated in 5.3% of these accidents, it was simply not provided in 9.7%. In addition to better motivating police officers through informing them of the importance of accurate records (and then demonstrating this importance through actual use of these record files), in some instances -- such as vehicle model year -- it may indicate a problem in the availability of needed reference information. Perhaps vehicle model year should be more clearly indicated on the vehicle.

2. This assessment also demonstrates a need to periodically monitor and report the accuracy of police agencies. Such evaluation can be of benefit both in motivating law enforcement personnel, and through helpful feedback, in better informing them as to problem areas and errors they may be making. For example, the frequent misidentificaton of asphalt and concrete surfaces could reflect a procedural problem, such as the completion of police reports only upon return to the station, with large elements of guessing then taking place for certain items which are perceived as being of lesser importance. Where possible, such evaluations might be conducted either by supervisors within the agency itself, or by state personnel, to reduce the potential political impact and sensitivity of such assessments.

3. Some of the problems detected emphasize the need for improved design of accident report forms. For example, the extreme lack of sensitivity in recording the presence of environmental problems may reflect a habit of simply failing to consider such factors or failing to address this section of the reporting form, due to the relative infrequency with which environmental factors are clearly involved. A change in the structure of the recording form might ensure that such relatively rare items are properly considered. In addition, police agencies should also monitor the rate of missing information, and take corrective action when missing value rates exceed reasonable levels.

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APPENDIX A

Data Collection and Coding Forms

The forms used to collect and code the information from the in-depth sample of accidents is presented on pages A-2 to A-8. The form on page A-2 to A-5 was used to record the accident level data; page A-6 to record the traffic unit level data and pages A-7 and A-8 for the causation data.

The forms for the special on-site alcohol presence and involvement analysis are presented on pages A-[illegible] and A-11.

The Indiana Police report form is presented on pages A-12 and A-13.

ACCIDENT CAUSE
POLICE REPORT VALIDATION FORM

Phase and Array Number ___ ___ ___ (1 2 3)

Number of: Traffic Units ___ ___ (4 5)

On-Site, In-Depth Flag 2 (6)

On-Site Case Number ___ ___ ___ ___ (7 8 9 10)

Traffic Unit Number ___ ___ (11 12)

Card Number 0 1 (13 14)

Consecutive In-Depth Case Number ___ ___ ___ (15 16 17)

FROM THE INDIANA STATE POLICE FORM

Place a checkmark (✓) in the space indicated for each "FACTOR" that the police indicated to be "involved" for this traffic unit.

_____ (0) Not involved

✓ (1) Involved

FROM THE IN-DEPTH CASE SUMMARY

Place a number (1,2,3) in the column entitled "level" and the appropriate letters (CAU,S/I) in the column entitled "significance" for each "FACTOR" that the In-Depth team indicated to be "involved" for this traffic unit.

1 - Possible   CAU - Causal
2 - Probable   S/I - Severity Increasing
3 - Certain

Number	FACTOR	Police	Code	Level	Significance	Code
1.	Vehicular Causes		18			45 46
2.	Inadequate brakes	___	19	___	___	47 48
3.	Improper lights	___	20	___	___	49 50
4.	Tire problems*	___	21	___	___	51 52
5.	Steering problems*	___	22	___	___	53 54
6.	Suspension problems*	___	23	___	___	55 56
7.	Other vehicular causes*	___	24	___	___	57 58
8.	Direct Human Causes		25			59 60
9.	Speed too fast	___	26	___	___	61 62
10.	Failed to yield right-of-way	___	27	___	___	63 64
11.	Drove left of center	___	28	___	___	65 66
12.	Improper overtaking	___	29	___	___	67 68
13.	Passed stop sign	___	30	___	___	69 70
14.	Disregarded traffic signal	___	31	___	___	71 72
15.	Followed too closely	___	32	___	___	73 74

ACCIDENT CAUSE

POLICE REPORT VALIDATION FORM -- CONTINUED

Number	FACTOR	Police	Code	Level	Significance	Code
16.	Made improper turn	___	33	___	___	75 76
17.	Other improper driving	___	34	___	___	77 78
18.	Indirect Human Causes		35			79 80
19.	Had been drinking	___	36	___	___	CARD 02 — 15 16
20.	Fatigue*	___	37	___	___	17 18
21.	Driver inexperience*	___	38	___	___	19 20
22.	Other indirect human causes*	___	39	___	___	21 22
23.	Environmental Causes		40			23 24
24.	Slick roads*	___	41	___	___	25 26
25.	View obstructions*	___	42	___	___	27 28
26.	Other highway related causes*	___	43	___	___	29 30
27.	Ambience related causes*	___	44	___	___	31 32

Phase and Array Number ___ ___ ___ (1 2 3)

Number of: Factors cited ___ ___ (4 5)

On-Site, In-Depth Flag 2 (6)

On-Site Case Number ___ ___ ___ ___ (7 8 9 10)

Traffic Unit Number ___ ___ (11 12)

Factor Number See Below

Each time a factor was cited in the above array by either the Police, or IRPS, or both fill in one of the lines below. Complete only as many lines as there were unique factors cited. Under the column entitled "Police Factor" or the column entitled "IRPS Factor" code the hierarchy line number assigned to the factor being coded. Under the column entitled "IRPS Level" code the corresponding value from the "Level" column above. Repeat this coding procedure for only those factors indicated to be involved in the above array. If additional lines are required add them at the end.

Consecutive In-Depth Case Number ___ ___ ___ (15 16 17)

Cause Number	Police Factor	IRPS Level	IRPS Factor
0 1 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 2 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 3 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 4 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 5 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 6 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 7 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)
0 8 (13 14)	___ ___ (18 19)	___ (20)	___ ___ (21 22)

DRIVER/VEHICLE CHARACTERISTICS
POLICE REPORT VALIDATION FORM

Phase and Array Number ___ ___ ___ (1 2 3)

Number of: Traffic Units ___ ___ (4 5)

On-Site, In-Depth Flag 2 (6)

On-Site Case Number ___ ___ ___ ___ (7 8 9 10)

Traffic Unit Number ___ ___ (11 12)

Card Number 0 1 (13 14)

Consecutive In-Depth Case Number ___ ___ ___ (15 16 17)

FROM THE INDIANA STATE POLICE FORM

1. Driver age_______? ___ ___ (18 19)

2. Driver sex?

_____(1) Male

_____(2) Female ___ (20)

3. Model year of driver's vehicle:

_______? ___ ___ (21 22)

4. Condition of driver with respect to drinking?

_____(0) Not drinking

_____(1) Had been drinking - obviously drunk

_____(2) Had been drinking - ability impaired

_____(3) Had been drinking - ability not impaired

_____(4) Had been drinking - unknown if impaired ___ (23)

5. Factor "presence"?
[Indicate the presence (✓) or absence for each of the factors listed below]

_____(a) Brakes defective? ___ (24)

_____(b) Lights defective? ___ (25)

_____(c) Steering defective? ___ (26)

_____(d) Other vehicular defects? ___ (27)

_____(e) Attention diverted? ___ (28)

_____(f) Drinking? ___ (29)

_____(g) Eyesight defective? ___ (30)

_____(h) Hearing defective? ___ (31)

_____(i) Illness? ___ (32)

_____(j) Fatigued? ___ (33)

_____(k) Vision obscured by hillcrest? ___ (34)

_____(l) Vision obscured by embankments? ___ (35)

_____(m) Vision obscured by roadside structures and growth? ___ (36)

_____(n) Other vision obstructions? ___ (37)

_____(o) Foreign substance on road surface? ___ (38)

_____(p) Road shoulder defective? ___ (39)

_____(q) Other roadway deficiencies? ___ (40)

FROM A POLICE - IRPS COMBINATION

6. Make of driver's vehicle?

_____(0) Disagree

_____(1) Agree ___ (41)

DRIVER/VEHICLE CHARACTERISTICS

POLICE REPORT VALIDATION FORM -- CONTINUED

FROM THE IN-DEPTH CASE SUMMARY

7. Driver age_______? 42 43

8. Driver sex?

_____(1) Male

_____(2) Female 44

9. Model year of driver's vehicle:

________? 45 46

10. Condition of driver with respect to drinking?

_____(0) Not drinking

_____(1) Had been drinking - obviously drunk

_____(2) Had been drinking - ability impaired

_____(3) Had been drinking - ability not impaired

_____(4) Had been drinking - unknown if impaired 47

11. Factor "presence"?
[Indicate the presence (✓) or absence for each of the factors listed below]

_____(a) Brakes defective? 48

_____(b) Lights defective? 49

_____(c) Steering defective? 50

_____(d) Other vehicular defects? 51

_____(e) Attention diverted? 52

_____(f) Drinking? 53

_____(g) Eyesight defective? 54

_____(h) Hearing defective? 55

_____(i) Illness? 56

_____(j) Fatigued? 57

_____(k) Vision obscured by hillcrest? 58

_____(l) Vision obscured by embankments? 59

_____(m) Vision obscured by roadside structures and growth? 60

_____(n) Other vision obstructions? 61

_____(o) Foreign substance on road surface? 62

_____(p) Road shoulder defective? 63

_____(q) Other roadway deficiencies? 64

ACCIDENT CHARACTERISTICS
POLICE REPORT VALIDATION FORM

Phase and Array Number ___ ___ ___ (1 2 3)

Number of: B B (4 5)

On-Site, In-Depth Flag 2 (6)

On-Site Case Number ___ ___ ___ ___ (7 8 9 10)

Traffic Unit Number B B (11 12)

Card Number 0 1 (13 14)

Consecutive In-Depth Case Number ___ ___ ___ (15 16 17)

FROM THE INDIANA STATE POLICE FORM

1. Month of accident?

_____(01) January _____(07) July
_____(02) February _____(08) August
_____(03) March _____(09) September
_____(04) April _____(10) October
_____(05) May _____(11) November
_____(06) June _____(12) December
___ ___ (18 19)

2. Day of accident_______? ___ ___ (20 21)

3. Year of accident_______? ___ ___ (22 23)

4. Day of week of accident?

_____(1) Sunday _____(5) Thursday
_____(2) Monday _____(6) Friday
_____(3) Tuesday _____(7) Saturday
_____(4) Wednesday
___ (24)

5. Time of accident:

_______________ AM PM
circle
___ ___ ___ ___ (25 26 27 28)

6. Total number of traffic units involved_______? ___ (29)

7. Number of passenger cars_______? ___ (30)

8. Number of trucks_______? ___ (31)

9. Number of motorcycles_______? ___ (32)

10. Number of bicyclists_______? ___ (33)

11. Number of pedestrians_______? ___ (34)

12. Number of trains_______? ___ (35)

13. Number of parked vehicles_______? ___ (36)

14. Accident severity?

_____(1) Fatal
_____(2) Personal injury
_____(3) Property damage
___ (37)

15. Converging trajectory?

_____(01) Head-on
_____(02) Opposing oblique
_____(03) Right angle
_____(04) Acute oblique
_____(05) Rear-end
_____(06) Collision while backing
_____(07) Collision with pedestrian
_____(08) Collision with bicyclist
_____(09) Hit object on roadway
_____(10) Hit object off roadway
_____(11) Non-collision on roadway
_____(12) Non-collision off roadway
___ ___ (38 39)

16. Speed limit at accident location?

_____(01) 5 mph _____(08) 40 mph
_____(02) 10 mph _____(09) 45 mph
_____(03) 15 mph _____(10) 50 mph
_____(04) 20 mph _____(11) 55 mph
_____(05) 25 mph _____(12) 60 mph
_____(06) 30 mph _____(13) 65 mph
_____(07) 35 mph
___ ___ (40 41)

ACCIDENT CHARACTERISTICS

POLICE REPORT VALIDATION FORM -- CONTINUED

17. Horizontal character of road?

_____(1) Straight

_____(2) Curve 42

18. Vertical character of road?

_____(1) Level

_____(2) Grade

_____(3) Hillcrest 43

19. Road surface condition?

_____(1) Concrete

_____(2) Blacktop

_____(3) Sand/dirt

_____(4) Gravel 44

20. Road ambience condition?

_____(1) Dry

_____(2) Wet

_____(3) Snow/ice 45

21. Weather ambience condition?

_____(1) Clear

_____(2) Raining

_____(3) Snowing

_____(4) Fog 46

22. Light ambience condition?

_____(1) Dark

_____(2) Dawn

_____(3) Day

_____(4) Dusk 47

23. Police agency submitting form?

_____(1) City

_____(2) County

_____(3) State 48

FROM A POLICE - IRPS COMBINATION

24. Location of accident?

_____(0) Disagree

_____(1) Agree 49

FROM THE IN-DEPTH CASE SUMMARY

25. Month of accident?

_____(01) January _____(07) July

_____(02) February _____(08) August

_____(03) March _____(09) September

_____(04) April _____(10) October

_____(05) May _____(11) November

_____(06) June _____(12) December 50 51

26. Day of accident_______? 52 53

27. Year of accident_______? 54 55

28. Day of week of accident?

_____(1) Sunday _____(5) Thursday

_____(2) Monday _____(6) Friday

_____(3) Tuesday _____(7) Saturday

_____(4) Wednesday 56

29. Accident severity?

_____(1) Fatal

_____(2) Personal injury

_____(3) Property damage 57

30. Converging trajectory?

_____(01) Head-on

_____(02) Opposing oblique

_____(03) Right angle

_____(04) Acute oblique

_____(05) Rear-end

_____(06) Collision while backing

_____(07) Collision with pedestrian

_____(08) Collision with bicyclist

_____(09) Hit object on roadway

_____(10) Hit object off roadway

_____(11) Non-collision on roadway

_____(12) Non-collision off roadway

58 59

31. Light ambience condition?

_____(1) Dark

_____(2) Dawn

_____(3) Day

_____(4) Dusk

60

32. Weather ambience condition?

_____(1) Clear

_____(2) Raining

_____(3) Snowing

_____(4) Fog

61

33. Road ambience condition?

_____(1) Dry

_____(2) Wet

_____(3) Snow/ice

62

34. Road surface condition?

_____(1) Concrete

_____(2) Blacktop

_____(3) Sand/dirt

_____(4) Gravel

63

35. Horizontal character of road?

_____(1) Straight

_____(2) Curve

64

36. Vertical character of road?

_____(1) Level

_____(2) Grade

_____(3) Hillcrest

65

37. Speed limit at accident location?

_____(01) 5 mph

_____(02) 10 mph

_____(03) 15 mph

_____(04) 20 mph

_____(05) 25 mph

_____(06) 30 mph

_____(07) 35 mph

_____(08) 40 mph

_____(09) 45 mph

_____(10) 50 mph

_____(11) 55 mph

_____(12) 60 mph

_____(13) 65 mph

66 67

38. Legal basis for speed limit at accident location?

_____(1) Posted

_____(2) Statuatory

68

39. Total number of traffic units involved_______?

69

40. Number of passenger cars_______?

70

41. Number of trucks_______?

71

42. Number of motorcycles_______?

72

43. Number of bicyclists_______?

73

44. Number of pedestrians_______?

74

45. Number of trains_______?

75

46. Number of parked vehicles_______?

76

POLICE REPORT VALIDATION FORM -- CONTINUED

FROM OFFICIAL SOURCES

47. Light conditions at time of accident?

_____(1) Dark

_____(2) Dawn

_____(3) Day

_____(4) Dusk

77

48. Light conditions at time of accident?

_____(0) Preceeding sunrise or following sunset

_____(1) Between sunrise and sunset (inclusive)

78

PRESENCE OR INVOLVEMENT OF ALCOHOL
ALCOHOL PRESENCE ANALYSIS FORM

Phase and Array Number ___ . ___ (1 . 3)

Number of: Drivers per Accident ___ ___ (4 5)

On-Site, In-Depth Flag ___ (6)

On-Site Case Number ___ ___ ___ ___ (7 8 9 10)

Traffic Unit Number 0 1 (11 12)

Card Number 0 1 (13 14)

Consecutive In-Depth Case Number ___ ___ ___ (15 16 17)

FROM THE INDIANA STATE POLICE FORM

1. Police agency completing form?
   ____(1) City
   ____(2) County
   ____(3) State
   ___ (18)

2. Light conditions at time of accident?
   ____(1) Dark
   ____(2) Dawn
   ____(3) Day
   ____(4) Dusk
   ___ (19)

3. Was anyone injured in the accident?
   ____(0) No
   ____(1) Yes
   ___ (20)

Date of Accident (IRPS): ______/______/______ month day year

Location of Accident (IRPS): ____________________

____

Policy Agency Submitting Form (Police):

____

Time of Accident (Police): ____________ AM PM circle

NOTES: Complete this form for each accident. Additional forms will be provided to record driver variables.

FROM THE ON-SITE HUMAN FACTORS FORM

4. Number of driver operated vehicles in the accident?
   ____(1) One
   ____(2) Two or more
   ___ (21)

FROM OFFICIAL SOURCES

5. Light conditions at time of accident?
   ____(1) Dark
   ____(2) Dawn
   ____(3) Day
   ____(4) Dusk
   ___ (22)

6. Light conditions at time of accident?
   ____(0) Preceeding sunrise or following sunset
   ____(1) Between sunrise and sunset (inclusive)
   ___ (23)

PRESENCE OR INVOLVEMENT OF ALCOHOL

ALCOHOL PRESENCE ANALYSIS FORM -- TRAFFIC UNIT LEVEL DATA

On-Site Case Number ____

Traffic Unit Number __ __ (11 12)

COMPLETE THIS FORM FOR ALL DRIVEN TRAFFIC UNITS (NOT: Parked cars, Bicyclists, or Pedestrians)!

For the striking traffic unit (T.U. No. 1) complete this form without regard to the additional instructions given below. For all other driven traffic units follow the instructions given below!

INSTRUCTIONS for Traffic Units 02-09: Duplicate card columns 01 through 10! Punch the traffic unit number assigned by the IRPS on-site investigators to the driver's vehicle in card columns 11 and 12! Duplicate card columns 13 through 23!

FROM THE INDIANA STATE POLICE FORM

7. Driver age____? (24 25)

8. Driver sex?

____(1) Male

____(2) Female

(26)

9. Was driver offered a chemical test?

____(0) Not offered

____(1) Refused

____(2) Breath test given

____(3) Blood test given

____(4) Urine test given

(27)

10. Presence of alcohol?

____(0) Had not been drinking

____(1) Obviously drunk

____(2) Ability impaired

____(3) Ability not impaired

____(4) Unknown if impaired

(28)

FROM THE ON-SITE HUMAN FACTORS FORM

11. Driver age____? (29 30)

12. Driver sex?

____(1) Male

____(2) Female

(31)

13. Presence of alcohol?

____(0) No

____(1) Yes--definite or probable drunk

____(2) Yes--possible drunk

____(3) Yes--not drunk

(32)

FROM THE ON-SITE CONCLUSION FORM

14. On-Site assessment of alcohol as a cause?

____(0) No ____Causal--1st column

____(1) Possible ____Severity Increasing--2nd column

____(2) Probable

____(3) Certain

(33 34)

FROM THE IN-DEPTH CASE SUMMARY

15. Presence of alcohol? (for in-depth cases)

____(0) No

____(1) Yes

(35)

16. In-Depth assessment of alcohol as a cause? (for in-depth related cases)

____(0) No ____Causal--1st column

____(1) Possible ____Severity Increasing--2nd column

____(2) Probable

____(3) Certain

(36 37)

INDIANA STATE POLICE

17. Involvement of Alcohol?

____ (0) No

____ (1) Yes

(38)

POLICE REPORT

Mail Report To: **INDIANA STATE POLICE, INDIANAPOLIS, INDIANA 46204**

DO NOT WRITE IN THIS SPACE

(8) TYPE ______ (9) SOURCE ______ (10-11) ANALYSIS ______ (12-13-14-15) LOSS ______ (16) LOCATION ______ (2-3-4-5-6-7) ACCIDENT NO. ______

TIME

DATE OF ACCIDENT (17-18) ______ (19-20) ______ (21) ______ Month Day Year (22) DAY OF WEEK ______ TIME OF DAY ______ AM ______ PM (23-24)

LOCATION

PLACE WHERE ACCIDENT OCCURRED: (25-26) COUNTY ______ (27) (28-29) CITY OR TOWN ______

If accident occurred outside of city limits, indicate distance from nearest city or town limits, using two directions, if necessary. (30-31) TOWNSHIP ______

______ Occurred within corporate limits. ______ MILES NORTH, ______ MILES SOUTH, ______ MILES EAST, ______ MILES WEST OF,

______ Occurred outside corporate limits. LIMITS OF ______ City or Town

(32-33-34) ROAD ON WHICH ACCIDENT OCCURRED ______ Name of Street or No. of Highway (US or STATE). If no No., use name. (35-36) AT IT'S INTERSECTION WITH ______ (37-38-39-40) Name or Number of Intersecting Street or Highway.

IF NOT AT INTERSECTION ______ FEET (______ N ______ S ______ E ______ W) OF ______ Show nearest intersection, house number, or other identifying landmark.

DO NOT MARK IN BOXES

VEHICLES

VEHICLE NUMBER 1:	VEHICLE NUMBER 2:
(41) (42-43)	(41) (42-43)
YEAR ______ MAKE ______ TYPE ______ Sedan, Truck, Bus, etc. (44)	YEAR ______ MAKE ______ TYPE ______ Sedan, Truck, Bus, etc. (44)
LICENSE PLATE ______ Number State Year	LICENSE PLATE ______ Number State Year
DRIVER ______ (Print) Last Name First Middle	DRIVER ______ (Print) Last Name First Middle
ADDRESS ______ (Print) Street or R.F.D. (45-46) (47)	ADDRESS ______ (Print) Street or R.F.D. (45-46) (47)
______ City and State BIRTH DATE ______ AGE ______ SEX ______ (48)	______ City and State BIRTH DATE ______ AGE ______ SEX ______ (48)
DRIVER'S LICENSE ______ Number State Type (49)	DRIVER'S LICENSE ______ Number State Type (49)
OWNER ______ Last Name First Middle	OWNER ______ Last Name First Middle
ADDRESS ______ Street or R.F.D. City State	ADDRESS ______ Street or R.F.D. City State
PARTS OF VEHICLE DAMAGED ______	PARTS OF VEHICLE DAMAGED ______
ESTIMATE OF REPAIR $ ______	ESTIMATE OF REPAIR $ ______
VEHICLE REMOVED TO ______ BY ______	VEHICLE REMOVED TO ______ BY ______

Total Number of Vehicles Involved ______

INJURED

(53-54) (55)	(53-54) (55)
NAME ______ (Print) Last Name First Middle AGE ______ SEX ______	NAME ______ (Print) Last Name First Middle AGE ______ SEX ______
ADDRESS ______ (56) Street or R.F.D. City (57) State	ADDRESS ______ (56) Street or R.F.D. City (57) State
DRIVER ______ PASSENGER ______ IN VEHICLE NUMBER ______	DRIVER ______ PASSENGER ______ IN VEHICLE NUMBER ______
PEDESTRIAN ______ Other (EXPLAIN) ______	PEDESTRIAN ______ Other (EXPLAIN) ______
NATURE AND EXTENT OF INJURIES ______	NATURE AND EXTENT OF INJURIES ______
1. ______ Died as result of accident. 2. ______ Visible signs of injury, as bleeding wound, distorted limb or had to be carried away. 3. ______ Other visible injuries, as bruises, swelling, abrasions, limping, etc. 4. ______ No visible injuries, but complaint of pain or momentary unconsciousness.	1. ______ Died as result of accident. 2. ______ Visible signs of injury, as bleeding wound, distorted limb or had to be carried away. 3. ______ Other visible injuries, as bruises, swelling, abrasions, limping, etc. 4. ______ No visible injuries, but complaint of pain or momentary unconsciousness.

Total Number Killed (50) ______ Injured (51) ______ (52) ______ Mark Only One Type Apply (58)

DAMAGE TO OTHER PROPERTY ______ Name of Object (s) Owner's Name and Address Nature of Damages

______ ESTIMATE OF REPAIR $ ______

This form is approved by the Superintendent, Indiana State Police, pursuant to Burns Indiana Statutes 47-1918, Acts 1939, Ch. 48.

SR 302

POLICE REPORT

(59) CHEMICAL TEST (Check one)

Driver 1 2 Ped

0___ ___ ___ No test offered.
1___ ___ ___ Test offered but refused.
2___ ___ ___ Breath test given.
3___ ___ ___ Blood test given.
4___ ___ ___ Urine test given.

(60) ARREST—(Check one)

Driver 1 2

0___ ___ Not arrested.
1___ ___ Arrested for D. U. I.
2___ ___ Arrested for other violation

(61) SPEED LIMIT ___________ MPH

(62) SPEED BEFORE ACCIDENT

Veh 1 _______ MPH Veh 2 _______ MPH

(63) CONTRIBUTING CIRCUMSTANCES INDICATED.

Driver 1 2

1___ ___ Speed too fast.
2___ ___ Failed to yield right-of-way.
3___ ___ Drove left of center.
4___ ___ Improper overtaking.
5___ ___ Passed stop sign.
6___ ___ Disregarded traffic signal.
7___ ___ Followed too closely.
8___ ___ Made improper turn
9___ ___ Other improper driving.
10___ ___ Inadequate brakes.
11___ ___ Improper lights.
12___ ___ Had been drinking.

(64) VEHICLE DEFECTS

Driver 1 2

0___ ___ No defects.
1___ ___ Brakes defective.
2___ ___ Lights defective.
3___ ___ Defective steering
4___ ___ Puncture or blowout.
8___ ___ Other defects

(66) VISION OBSCURED

Driver 1 2

0___ ___ Not obscured.
1___ ___ By buildings.
2___ ___ By embankment.
3___ ___ By signboard
4___ ___ Trees, crops, etc.
5___ ___ By hillcrest.
8___ ___ _______________

(Specify other)

INDICATE ON THIS DIAGRAM WHAT HAPPENED — **DRAW DIAGRAM TO SCALE**

Indicate North by arrow

DESCRIBE WHAT HAPPENED:

Refer to vehicle by number: ____

____

____

____

WHAT DRIVERS WERE GOING TO DO BEFORE ACCIDENT:

(65)

Driver No. 1 was headed ___N ___S ___E ___W on _______________ (Name or number of street or highway.)

Driver No. 2 was headed ___N ___S ___E ___W on _______________ (Name or number of street or highway.)

(Check applicable items for each driver.)

Driver 1 2		Driver 1 2		Driver 1 2	
0___ ___	Passing.	2___ ___	Backing.	5___ ___	Start from parked position.
1___ ___	Turn right.	3___ ___	Slow or stop.	6___ ___	Avoiding veh., obj., ped.
1___ ___	Turn left.	4___ ___	Going straight ahead.	7___ ___	Skidded before applying brakes.
1___ ___	Make U turn	5___ ___	Start in traffic lane	8___ ___	Skidded after applying brakes.
				9___ ___	Parked

WHAT PEDESTRIAN WAS DOING BEFORE ACCIDENT

(67) Pedestrian was going ___N ___S ___E ___W ___along ___across or into _______________ Street or Highway

From _______________ to _______________

(N. E. corner to S. E. corner or from West side to East side, etc.)

(Check one)

0___ Not in roadway.
1___ Walking in roadway with traffic.
2___ Walking in roadway against traffic.
3___ Pushing or working on vehicle.
4___ Getting on or off vehicle.
5___ Standing in roadway
6___ Other working in roadway.
7___ Playing in roadway.
8___ Other _______________ (Specify actions)
11___ Crossing or entering not at intersection.
12___ Crossing or entering at intersection.

CONDITION OF DRIVERS AND PEDESTRIANS (Check one)

(03) (70)

Driver 1 2 Ped.

0___ ___ ___ Had NOT been drinking.
1___ ___ ___ Obviously drunk.
2___ ___ ___ Ability impaired.
3___ ___ ___ Ability not impaired.
4___ ___ ___ Unknown if impaired.

(64) (71)

11___ ___ ___ Apparently normal.
0___ ___ ___ Eyesight defective.
1___ ___ ___ Hearing defective.
2___ ___ ___ Other defects.
3___ ___ ___ Illness.
4___ ___ ___ Fatigued.
5___ ___ ___ Apparently asleep.
6___ ___ ___ Attention diverted.
7___ ___ ___ Advanced senility.
8___ ___ ___ Other handicaps.

(Specify other handicaps)

ROAD

(72) TRAFFIC CONTROL

Driver 1 2		Driver 1 2	
0___ ___	Police officer.	4___ ___	Other lane markings.
1___ ___	Automatic signal	5___ ___	Stop sign.
2___ ___	Yield right-of-way sign	6___ ___	Warning sign or signal
3___ ___	Center line marked.	7___ ___	No passing zone
		8___ ___	All others.

(73) CHARACTER (74) (Check two)

1___ Straight.
2___ Curve.
1___ Level.
2___ On grade.
3___ Hillcrest.

(75) SURFACE (Check one)

1___ Concrete.
2___ Black top.
3___ Sand or dirt.
4___ Gravel.
8___ _______ Other

(76) CONDITION (Check one)

1___ Dry.
2___ Wet.
3___ Snow/Ice
8___ _______ Other

(77) WEATHER (Check one)

1___ Clear.
2___ Raining.
3___ Snowing.
4___ Fog.
8___ _______ Other

(78) LIGHT (Check one)

1___ Daylight.
2___ Dark.
3___ Dawn or dusk.

(79) KIND OF LOCALITY (Check one to show that area adjacent to roadway for 300' was primarily.)

1___ School or playground.
2___ Industrial or business.
3___ Residential.
4___ Open country.

(69) ROAD DEFECTS

1___ Foreign material on surface.
2___ Loose sand, gravel, etc.
3___ Holes, ruts, dips, bumps, etc.
4___ Defective shoulders.
5___ Obstruction not lighted or signaled
6___ Standing water, landslide, etc.
7___ Obstructed by previous acc.
8___ All other defects

WITNESSES

Name _______________ Address _______________ Location _______________

Name _______________ Address _______________ Location _______________

POLICE ACTION

ARRESTS: Name _______________ Charge _______________

Name _______________ Charge _______________

INVESTIGATION: Time notified of accident _______ AM _______ PM Time of arrival at the scene _______ AM _______ PM

Where else was investigation made? _______________ Is investigation complete? _____ Yes _____ No

Were photographs taken? _____ Yes _____ No Driver report form furnished to _____ driver No. 1 _____ driver No. 2

SIGNATURE _______________ Dept./Div. _______________ Date of report _______________

ARS-2 Investigator's Report Rev. 68

APPENDIX B

Causal Factor Mapping

The greater detail of the IRPS causal scheme compared to that of the police resulted in a situation in which several IRPS factors had to be mapped to a single police factor (in order to exhaust all of the IRPS factors). The IRPS causal factor labels and their corresponding data item number are presented on pages B-3 through B-13.

Major IRPS categories were: (1) Human direct; (2) Human indirect; (3) Vehicular; and, (4) Environmental. Subcatagories of the latter three were readily matched with the police factors. This is because most of the more detailed IRPS factors were subsets of the broader police factors. Thus it was only necessary to exhaust the IRPS factors into the broader scope of a compatible police factor. However, it was more difficult to map the IRPS direct human factors into the corresponding police factors for several reasons. First, only a few factors could be mapped unequivocally from one scheme to the other. Second, many IRPS factors could be mapped to more than one police factor. Finally, a substantial number of IRPS human direct factors were not directly compatible with any of the police factors.

Therefore, the IRPS direct human factors were mapped into the comparable police factors on three different levels -- direct, indirect and forced. The IRPS factors which correspond to the direct level mapping were those which were unequivocally compatable with the police categories. The indirect level consisted of IRPS factors which could correspond to more than one of the more general police categories. And finally the forced factors were those which were not directly comparable to any of the police categories.

For each police category the direct, indirect and forced IRPS categories are listed on pages B-12 through B-13. An IRPS/Police agreement resulted during the coding when factors which mapped to each other were present. When indirect or forced factors were present, judgments based on the intent of both police and IRPS descriptions were made. In accidents where the police cited only one factor while IRPS cited several, those which mapped to the police factor constituted an agreement while those which did not resulted in omissions (Disagreements). Since many of the same IRPS factors were mapped to more than one police factor, multiple IRPS factors in accidents where the police cited fewer did not always result in omission on the part of the police. This occurred only if no possible connection could be made for the IRPS factors listed.

A second mapping was constructed as part of the analysis on Driver-Vehicle Characteristics. This required less detail and did not have the various levels (direct, etc.) of mapping associated with it. The mapping is presented on page B-14.

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
001	VEHICULAR FACTORS
002	Tires and Wheels
003	Inflation
004	underinflation
005	overinflation
006	improper pressure distribution
007	Inadequate tread depth
008	Blow-out/sudden failure
009	Mismatch of tire types and/or sizes
010	Wheel loss or failure
011	Other tire or wheel problems
012	Brake System
013	Gross failure (front and/or rear)
014	wheel cylinder failed
015	front and rear failure
016	front failure
017	rear failure
018	unspecified failure
019	brake line failed
020	front and rear failure
021	front failure
022	rear failure
023	unspecified failure
024	master cylinder problem
025	front and rear failure
026	unspecified failure
027	insufficient fluid level
028	front and rear failure
029	unspecified failure
030	adjustment mechanism loss or failure
031	front and rear failure
032	front failure
033	rear failure
034	unspecified failure
035	gross failure-other or unspecified reasons
036	front and rear failure
037	front failure
038	rear failure
039	unspecified failure
040	Delayed braking response-pumping required
041	required pumping due to improper adjustment
042	required pumping for other reasons
043	Imbalance (pulled left or right)
044	Brakes grabbed, locked prematurely, or were oversensitive
045	due to improper proportioning
046	grabbed or locked prematurely
047	Performance degraded for other reasons

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
048	<u>Steering System</u>
049	Excessive freeplay
050	Binding (undue effort required)
051	Freezing or locking
052	Other steering problems
053	<u>Suspension Problems</u>
054	Shock absorber problems
055	weak shock absorbers
056	missing, broken, or other shock absorber problems
057	Spring problems
058	missing broken, or defective springs
059	raised rear-end
060	spring imbalances (due to helper springs, etc.)
061	Other suspension problems
062	<u>Power Train and Exhaust</u>
063	Power loss
064	ran out of fuel
065	other problems
066	Exhaust system
067	carbon monoxide leaked into driver's compartment
068	other problems
069	<u>Communication Systems</u>
070	Vehicle lights and signals
071	headlamp problems
072	inoperable headlamps
073	misaimed headlamps
074	dirt-obscured headlamps
075	inoperable taillights
076	inoperable turn signals
077	inoperable stop lights
078	rear lights/signals obscured by dirt, road grime, etc.
079	other light problems
080	Vehicle-related vision obstructions
081	due to ice, snow, frost, water or condensation on windows
082	due to cracked or opaque windows (e.g., cardboard or decals on windows)
083	due to design or placement of windows
084	due to objects in or attached to vehicle
085	due to inoperable or deficient vision hardware
086	inoperable or misaimed windshield washer
087	inoperable or ineffective wiper

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
088	inoperable or inadequate defroster
089	absence or condition of mirrors
090	other problems
091	Auditory problems
092	inoperable or weak horn
093	excessive radio or tape player volume inside car
094	other problems
095	<u>Driver Seating and Controls</u>
096	Driver controls
097	steering wheel problems (e.g., spinner snagged clothing)
098	brake pedal problem (e.g., pedal broke off)
099	accelerator problem (e.g., stuck)
100	other problems
101	Driver anthropometric
102	seat loose or became detached
103	driver not positioned to adequately reach controls
104	driver not positioned to see adequately
105	other problems
106	<u>Body and Doors</u>
107	Door Came open
108	Hood came open
109	Other body and door problems
110	<u>Other Vehicle Problems</u>

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
111	HUMAN FACTORS
112	DIRECT HUMAN CAUSES
113	Critical Non-Performance
114	Blackout
115	Fell asleep/dozing
116	Non-Accident (e.g., suicide attempt)
117	Recognition Errors
118	Driver failed to observe and stop for stop sign
119	Delays in recognition (for which reasons were identified)
120	inattention
121	to traffic stopped or slowing ahead
122	to position of car on road
123	to road feature (such as oncoming curves, lane narrowings, etc.)
124	to road signs, signals providing driver information
125	to cross-flowing traffic
126	other
127	internal distraction
128	event in car (loud noise, yell, scream, etc.)
129	adjusting radio or tape player
130	adjusting windows
131	conversation
132	other
133	external distraction
134	other traffic
135	driver-selected outside activity (looking for house number, etc.)
136	activity of interest outside vehicle (fist fight, etc.)
137	sudden event outside vehicle (explosion, etc.)
138	other
139	improper lookout
140	pulling out from parking place
141	entering travel lane from intersecting street or alley
142	prior to changing lanes or passing
143	other
144	Delays in perception for other or unknown reasons
145	of traffic stopped or slowing ahead
146	of position of car on road

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
147	of road features (such as oncoming curves, lane narrowings, etc.)
148	of road signs or signals providing driver information
149	of cross-flowing traffic
150	other
151	Unaccounted for delays in comprehension or reaction
152	delayed comprehension
153	delayed reaction
154	Decision Errors
155	Misjudgment of distance, closure-rate, etc.
156	False assumption
157	assumed other driver was required to stop or yield at intersection
158	assumed other driver would stop or yield without assuming any requirement
159	assumed oncoming car would move left or right, out of way
160	assumed vehicle was going to turn and it did not
161	assumed no traffic was coming
162	other
163	Improper manuever
164	turned from wrong lane
165	drove in wrong lane but correct direction
166	drove in wrong direction of travel for lane
167	passed at improper location
168	other
169	Improper driving technique
170	cresting hills, driving in center of road
171	braking later than should have or at inappropriate location
172	stopping too far out in road or intersection
173	driving too close to center line or edge of road
174	slowed too rapidly
175	other
176	Driving technique was inadequately defensive
177	should have positioned car differently
178	should have adjusted speed
179	should not have taken other driver's adherence to traffic sign or signal for granted

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
180	other
181	Excessive speed
182	for road design regardless of condition or traffic
183	only in light of traffic, pedestrians, etc.
184	solely in light of weather conditions
185	due to combinations of above factors
186	other
187	Tailgating
188	Inadequate signal
189	failure to signal for turn
190	failure to use horn to warn other
191	other
192	Failure to turn on headlights
193	Excessive acceleration (loss of control)
194	Pedestrian ran into traffic
195	Improper evasive action
196	locked brakes-could not steer (but ineffective steer was attempted)
197	above does not apply, but driver could have avoided by steering and did not
198	driver could have accelerated out of danger, but did not
199	other
200	Other decision errors
201	<u>Performance Errors</u>
202	Overcompensation
203	Panic or freezing
204	Inadequate directional control
205	on curve-allowed car to enter opposing lane of travel
206	on straight-allowed car to enter opposing lane of travel
207	on straight or curve-allowed car to go off edge of road
208	on straight or curve-didn't go "left of center" or off road to right but did not stay in own lane of travel
209	other
210	Other performance errors
211	<u>Other Human Causal Factors</u>

Data Item Number	CAUSAL FACTOR LABELS (IRPS)
212	HUMAN CONDITIONS OR STATES
213	Physical/Physiological
214	Alcohol impairment
215	Other drug impairment
216	Fatigue
217	Physical handicap
218	Reduced vision
219	Chronic illness
220	Mental/Emotional
221	Emotional upset
222	Pressure from other drivers
223	"In hurry"
224	Mental deficiency
225	Experience/Exposure
226	Driver inexperience
227	Vehicle unfamiliarity
228	Road overfamiliarity
229	Road/area unfamiliarity

Data Item Number	CAUSAL FACTOR LABEL (IRPS)
230	ENVIRONMENTAL FACTORS
231	<u>Environmental Factor--Slick Roads</u>
232	Road wet
233	Road snow and/or ice covered
234	Gravel and/or sand on pavement
235	Road slick due to traffic polishing
236	Wet and traffic polished asphalt
237	Gravel road
238	Other problems
239	<u>Environmental Factors--Excluding "Slick Roads"</u>
240	Highway related
241	control hindrances
242	drop-off at pavement edge
243	excessive road crowns
244	improperly banked curves
245	soft shoulders
246	ditches, embankments, and other roadside features
247	unexpected wet or slick spots
248	other control hindrances
249	inadequate signs and signals
250	stop sign needed but not provided
251	stop sign present but not adequate
252	curve warning signs needed
253	curve sign present but not adequate
254	signal light poorly placed and/or not adequately visible
255	poor signal timing
256	center or lane lines not present or inadequate
257	edge lines not present or inadequate
258	other
259	view obstructions
260	hillcrests, dips, etc.
261	roadside embankments, escarpments, etc.
262	roadside structures and growth
263	stopped traffic
264	parked traffic
265	other view obstructions
266	design problems
267	accesses insufficiently limited or improperly placed
268	intersection design problems
269	road overly narrow, twisting, etc.

Data Item Number	CAUSAL FACTOR LABEL (IRPS)
270	trees and other objects too close to road
271	other design problems
272	maintenance problems
273	signals inoperative
274	traffic control sign missing
275	traffic control sign or signal obscured
276	other problems
277	Ambience related
278	special hazards
279	animal in road
280	object in road
281	non-contact vehicle caused problem
282	stopped vehicle in road
283	other
284	vision limitation
285	rain
286	snow
287	fog
288	darkness
289	glare from sun
290	glare from headlights
291	other
292	avoidance obstructions
293	parked or stopped traffic
294	trees and other fixed objects
295	other
296	rapid weather change
297	suddenly encountered fog
298	suddenly encountered slick roads
299	other
300	camouflage effect
301	motor vehicle blended in with background
302	other
303	environmental overload
304	other embience related factors

MAPPING OF IRPS TO POLICE FACTORS (Causation Analysis)

[DIRECT HUMAN FACTORS]

Police		IRPS Data Item Number
Speed too fast	direct:	181, 193
	indirect:	
	forced:	124
Failed to yield right-of-way	direct:	125,140, 141,149,157,158,160,161,172
	indirect:	148,155,171,124
	forced:	162, 194,127,133,143
Drove left of center	direct:	170,205,206
	indirect:	122,142,146,160,161,166,167,202,188
	forced:	123,124,147,148,162,127,133,143
Improper over-taking	direct:	142,167
	indirect:	155, 159,160,161,165,166,170,171,188
	forced:	124,148,162,208,121,145,143
Passed stop sign	direct:	118
	indirect:	124,148,171,172
	forced:	127,133
Disregarded traf-fic signal	direct:	124,148
	indirect:	157,158,171,172
	forced:	194,127,133,162
Followed too closely	direct:	187
	indirect:	
	forced:	
Made improper turn	direct:	164
	indirect:	122,124,146,148,161,166
	forced:	162,127,133
Other improper driving	direct:	
	indirect:	
	forced:	113,116,122,123,124,125,126,139,146, 147,148,149,150,155,158,160,161,162, 165,166,168,169,176,188,193,194,195, 200,202,203,204,210,211,192,127,133, 143,151,192,121

[INDIRECT HUMAN FACTORS]

Police	IRPS Data Item Number
Had been drinking	214
Fatigued; Apparently asleep *	216
(Eyesight defective; hearing defective; Other defects; Illness; Advanced senility) *	215,217,218,219,220, 227,228,229
Other handicaps *	226

[VEHICULAR FACTORS]

Police	IRPS Data Item Number
Inadequate brakes	012
Improper lights	070
Puncture or blowout *	008,011
Defective steering *	048
Other defects *	003,007,009,010,011, 062,080,091,095,106, 110

[ENVIRONMENTAL FACTORS]

Police	IRPS Data Item Number
(Slick road: wet, snow/ice, other; Foreign material on surface: loose sand, gravel, etc.) *	231,298
(Vision obscured by: buildings; embankment; signboard; trees, crops, etc. hillcrest; other) *	259,297,300
(Holes, ruts, dips, bumps, etc.; Defective shoulders; obstruction not lighted or signaled; standing water, landslide, etc.; obstructed by previous accident; All other defects) *	241,249,266,272,278, 284,292,299,303,304

* These factors must be discussed, implicitly or explicitly, in description section to be assessed as causally related.

MAPPING OF IRPS TO POLICE FACTORS
(DRIVER-VEHICLE CHARACTERISTICS)

[DIRECT HUMAN FACTORS]

Police	IRPS Data Item Number
Attention diverted	117

[INDIRECT HUMAN FACTORS]

Police	IRPS Data Item Number
(Obviously drunk; ability impaired; ability not impaired; unknown if impaired)	214
Eyesight defective	218
Hearing defective	217
Illness	219
Fatigued	216

[VEHICULAR FACTORS]

Police	IRPS Data Item Number
Brakes defective	012
Lights defective	070
Defective steering	048
(Puncture or blowout; other defects)	002,053,062,080,091,095,106,110

[RELATED ENVIRONMENTAL FACTORS]

Police	IRPS Data Item Number
Vision obscured by hillcrest	260
Vision obscured by embankment	261
(Vision obscured by buildings; signboards; trees, crops, etc.)	262
Vision obscured by other	263,264,265
(Foreign material on surface; loose sand or gravel)	234
Defective shoulders	242,245
All other defects	243,244,246,247,248