LAW and ORDER

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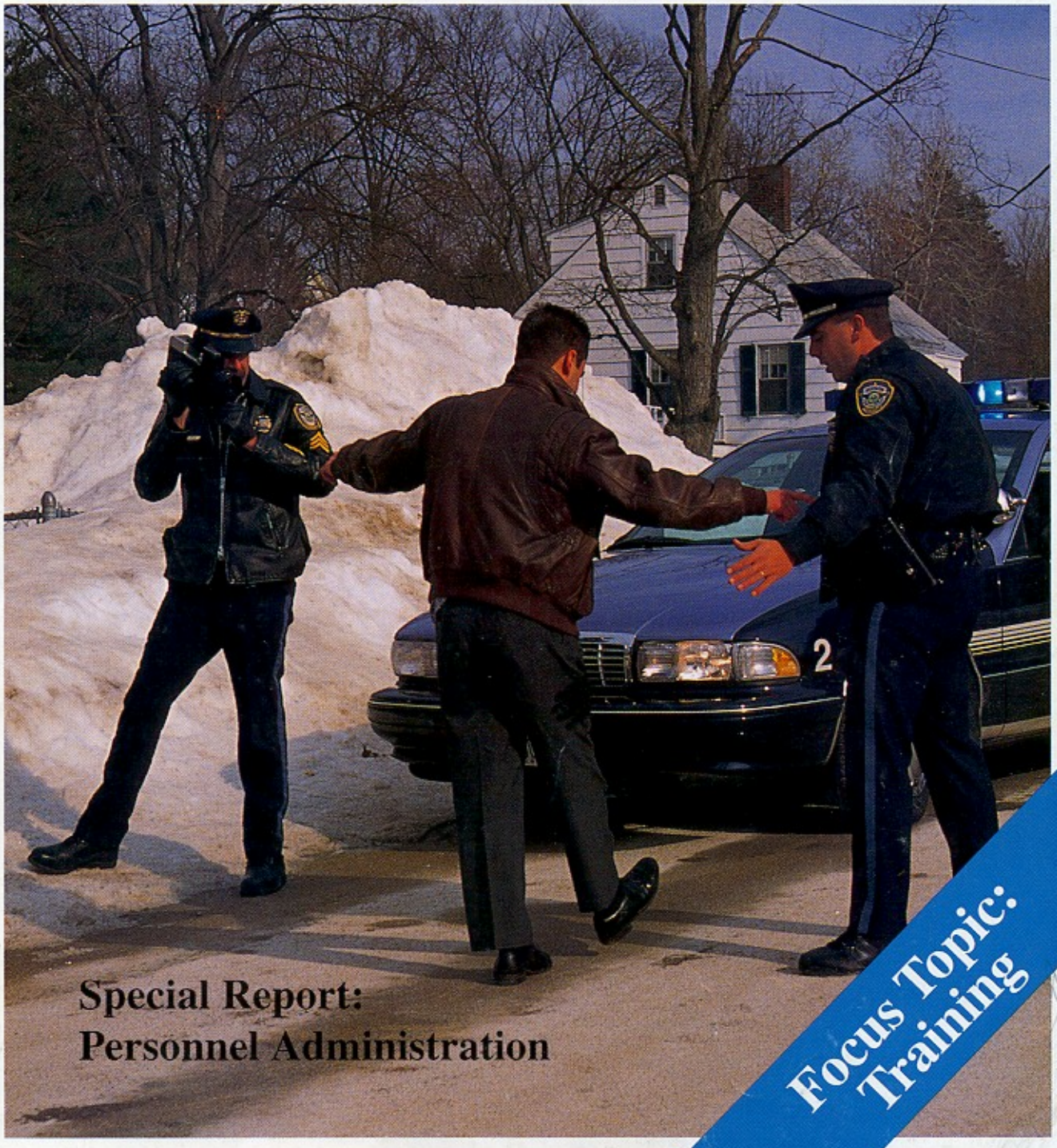

Special Report:
Personnel Administration

Focus Topic:
Training

Snowmobile Reconstruction, Part I

Applying Newton's Laws of Motion

BY RICHARD HERMANCE

Collisions involving cars, trucks, aircraft, and even snowmobiles, are generally governed by the laws of physics, most specifically, Newton's three laws of motion. Although all types of vehicles follow the laws of physics, the reconstruction of various types of vehicular collisions do have idiosyncrasies involving the way the vehicle interacts with the crash environment.

A familiarization with Newton's three laws of motion is necessary to understand snowmobile reconstruction, or any vehicle reconstruction. A confused crash investigator can fall back on his knowledge of the three laws of motion and raise questions at the scene with these laws serving as the common denominator.

Newton's First Law Of Motion: An object at rest or in uniform motion will remain at rest or in uniform motion until acted upon by an external force. In essence, a snowmobile sitting still will remain there unless an external force is applied.

External forces that may be applied are; forces between the track and the snow causing forward acceleration; forces from a moving vehicle which impacts with the snowmobile causing it to accelerate in a certain direction based on the orientation of impact; or possibly the effects of another vehicle pulling a snowmobile.

In the case of a moving snowmobile, the machine will continue to move at a constant rate of speed if no acceleration is applied from the throttle. Similarly, the snowmobile will move in a straight line unless there is some type of steering input or change in snow surface which will allow the force of gravity to change the direction of the vehicle laterally.

Deceleration in a snowmobile's motion are commonly caused by: braking; letting off the throttle; and results of linear impacts with either other moving vehicles or fixed objects.

Newton's Second Law Of Motion: Force is equal to mass times acceleration (F=MA). For this explanation, term weight (W) will be substituted for mass since the snowmobile crashes will not be subject to any significant changes in gravitational force. Force, in regard to snowmobiles, does define the extent of vehicle damage and in most cases define and set both the threshold and limiting factors as to injury mechanisms. Acceleration is defined as change in velocity. An increase would be termed acceleration and a decrease would be termed as negative acceleration or deceleration.

Considering this relationship, F=MA, from a common sense standpoint, the magnitude of force is not defined by the magnitude of velocity or speed in a crash, but by the magnitude of acceleration or deceleration. The important role that the velocity or speed plays in the force equation is simply that more speed allows the possibility of greater acceleration.

In essence, a snowmobile going 30 mph and crashing into a tree only has the potential for a speed change of slightly over 30 mph. Similarly, a snowmobile travelling on the same surface and striking the same tree at 60 mph, has the potential for a speed change of 60 mph. In either case, reconstruction and examination of the vehicle damage profile will be the big factor in evaluating what the Delta-V of either crash is, but in the 30 mph crash there is no possibility of having a 60 mph speed change by virtue of the snowmobile's motion before impact.

Also note that Delta-V is a vector quantity and does have a direction which is commonly referred to as PDOF (Principle Direction of Force). In any crash, the governing factors in the generation of the geometries of injuries, as well as the seriousness of injuries, are the crash Delta-V and PDOF.

Finally, crash Delta-V refers to the speed change in the few milliseconds of actual vehicle contact and crushing, not the entire speed change from when a vehicle makes contact until it comes to rest, as in some collisions. The impact speed and crash pulse Delta-V can be very far apart. For example, a snowmobile traveling at 30 mph and crashing into a solid barrier would have a Delta-V of approximately 30 mph. On the other hand, one travelling at 30 mph and crashing into a stationary snowmobile of similar weight would have a Delta-V of approximately 15 mph, although the impact speed was 30 mph.

Newton's Third Law Of Motion: For every action there is an equal and opposite reaction. This concept of action-reaction can be used to evaluate occupant motion as well as to evaluate forces when only the damage profile on one vehicle is available.

ENERGY DISSIPATION

Energy dissipation is important in reconstruction and is it necessary to understand and be able to utilize it. The general theory of analyzing the amount of energy dissipated in bringing a vehicle to a stop to determine initial speed is very common in reconstruction and certainly applies to snowmobile collisions.

It is a fact of physics that kinetic energy is equal to one half an object's mass multiplied by its velocity squared. Also, kinetic energy is equal to the product of an object's weight, the distance it moves, and the friction coeffi-

cient of the medium the object is moved over. If an investigator knows how far the snowmobile slid in coming to a stop and also knows the weight of the snowmobile and friction coefficient of the snow base that the snowmobile slid over, a reconstructionist can determine the magnitude of kinetic energy dissipated in bringing the snowmobile to a stop.

Inserting the magnitude of kinetic energy and the mass of the snowmobile as the two knowns in the equation—"kinetic energy is equal to one half mass times velocity squared"—algebraic manipulation will yield an equation for the velocity of the snowmobile in feet per second—"V subscript FPS equals square root of 2KE over M." The result of this equation, in feet per second is then multiplied by the conversion factor of .68 to give an original speed in units of mph.

Another method of evaluating energy dissipation is to analyze the amount of energy dissipated in crushing a vehicle to in turn solve for the speed required to cause that particular amount of damage. This is a common method of analyzing motor vehicle crashes, and the physics hold true in a snowmobile crash.

Snowmobile crash Delta-V can be evaluated using the reconstructionist's ability to relate the damage profile as seen on a particular machine to damage profiles on other machines. In snowmobile/car crashes, if the Delta-V of the car can be calculated from its crush profile, the Delta-V on the snowmobile can often be calculated from this information.

Returning to the theory of slide to stop for snowmobiles, distance, if measurable, will usually not be a point of discrepancy in any type of calculation based on slide to stop. However, there are no charts which indicate the deceleration factors involved with snowmobile skidding.

This writer conducted approximately 48 skid tests in 1992 with a 1990 Arctic Cat 440cc Prowler and a 1992 Arctic Cat 700cc Wildcat. The results showed that minor differences in deceleration rate were based on the two different snowmobiles but that higher deceleration factors where found in the 50 to 60 mph speed ranges as opposed to the 30 to 50 mph speed ranges. This increase is attributed to the fact that as the snowmobile is sliding, snow is piling up in front of the snowmobile track which increased resistance to forward motion.

The first 30 mph skid tests showed deceleration factors in the range of .5 to .6, the 40 miler per hour skid tests showed ranges from .6 to .75, the 50 mph skid tests showed ranges from .65 to .82 and the 60 mph skid tests showed ranges from .75 to .82. These tests were done on a surface consisting of a two foot snow base with approximately 6" of powder on top and a temperature of approximately 25 degrees Fahrenheit.

The snowmobiles were then moved to an area where higher speeds were possible. The second round of tests was done on a 1' packed snow base with three to six inches of loose wet snow on top since the temperature had risen to 36 degrees. Some 39 tests of the Prowler and Wildcat were then conducted. On this surface, the 30 mph skid tests showed deceleration factors in the range of .42 to .46, the 40 mph skid tests showed ranges of .59 to .63, the 50 mph skid tests showed ranges of .54 to .63, the 60 mph skid tests showed ranges of .65 to .67, and the 80 mph skid tests showed ranges of .69 to .71.

These deceleration factors were a little lower, attributed to the fact that the snow was very wet and loose without significant consistency. Twenty five of these tests were done with a 135 pound rider, and the final tests were done with a 300 pound rider from each speed. The average value of deceleration factor did not change significantly despite the increased rider weight.

To finish off, a series of roll-down decelerations were documented. A snowmobile was run up to a specific speed and the operator simply let off on the throttle, allowing the snowmobile to free roll to a stop. From 30 mph, deceleration factors ranged from .16 to .18. From 40 miles per hour, deceleration factors ranged from .24 to .25.

The above tests show consistent results, and there no tests deviated substantially from the general range of numbers documented under each condition. Again, the most noted results were that the maximum braking deceleration tests showed that on very wet snow, the deceleration factors were not as high and the effect of increase speed did not have as much of an effect as in the skid tests done on the more powdery and packable type of snow.

The weight of the rider did not appear to be a substantial factor, which was expected. In doing these types of calculations, the weight of the snowmobile/rider combination basically factors out.

Much more testing with regard to various other types of snowmobile characteristics will continue through the next three or four winter seasons. L&O

Richard Hermance, owner of Collision Research Ltd. in New York, is an accident reconstruction expert with a nationwide reputation.

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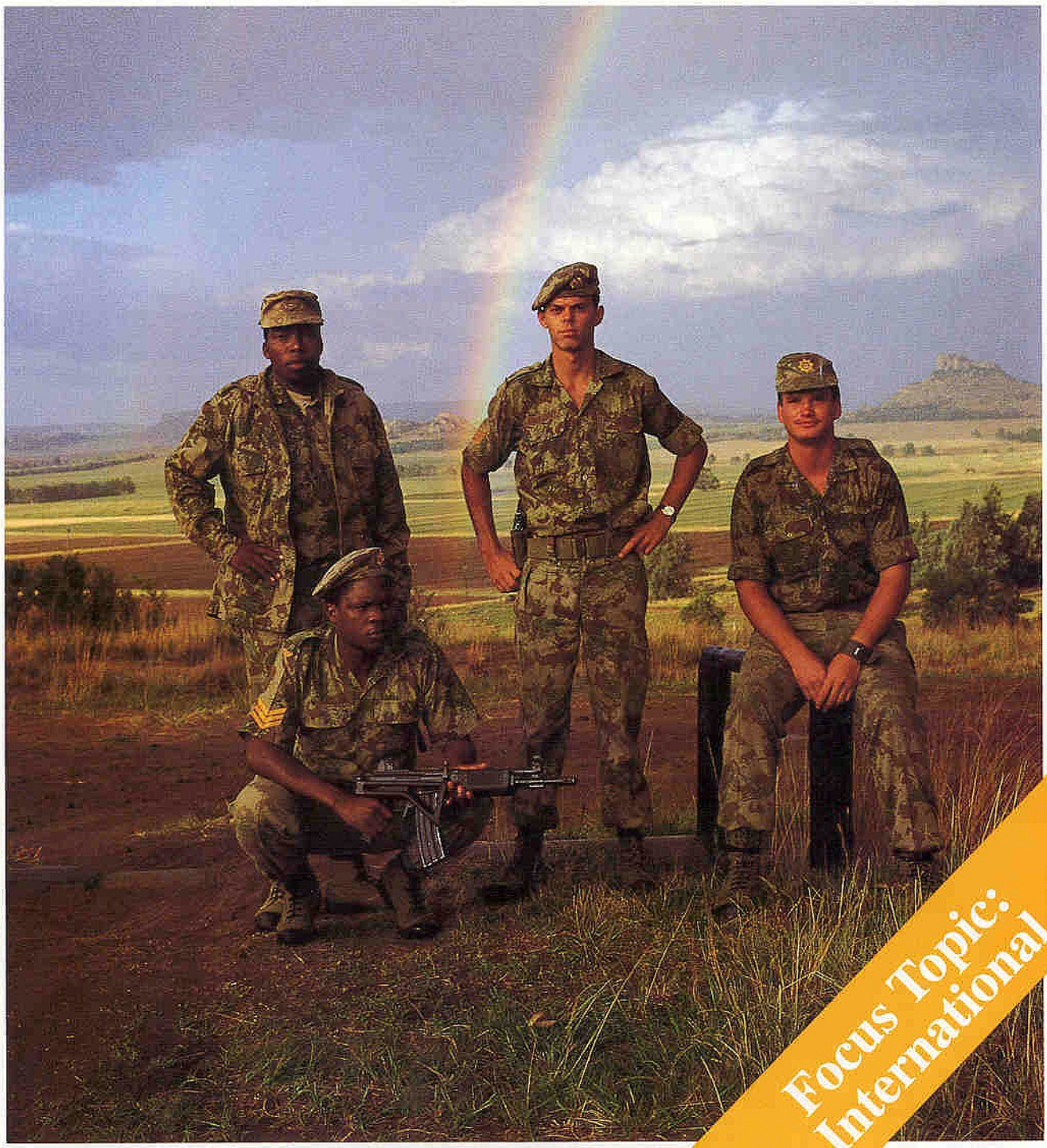

Focus Topic: International

Snowmobile Reconstruction, Part II

Getting the necessary evidence

BY RICHARD HERMANCE

Snowmobile crashes are occurring with greater frequency as the trails get more crowded. Injuries to persons and destruction of private property ranges from minor to very expensive and sometimes fatal. As a result, the cause of a snowmobile collision has to be determined and, at some point, liability has to be assigned.

The first step in this process is usually enforcement of various laws governing the use of snowmobiles and recreational vehicles. This portion of the process obviously starts with the responding law enforcement personnel in charge of making the initial investigation and assessment, as well as filing criminal charges if warranted based on a proper evidenciary foundation.

There are problems unique to snowmobile crash investigation. This is unfortunate for the law enforcement part of the snowmobile investigation, but also carries into the civil portion of liability apportionment. The following is a list of some of these topics with a brief explanation as to the limitations they put on the investigation, and some ideas on ways to cope with them.

1. The simple task of reporting the call and getting to the crash scene can be difficult; it could take hours or even days. There is nothing responding officers can do about this, they have to work as best as they can with what they have to work with.

2. At the crash site, there is usually a very limited amount of evidence available. Falling snow and changing weather conditions frequently obliterate physical evidence as to how the vehicles approached and departed from the scene. Track marks, ski marks, and dig marks in the snow or on pavement or ice surfaces might only be available for a few minutes after a collision occurs. Valuable evidence is also routinely destroyed by people trying to assist injured parties, and other snowmobiles travelling through the crash area.

Snowmobilers usually ride in groups, and many times friends will move machines. Sometimes they completely remove machines from the trail system to hinder police prosecution or to apportion liability and reconstruct the crash. Oftentimes, officers never get to see the machines and do not have any good scene evidence to work with, which makes the reconstruction and investigation of a snowmobile crash difficult or even impossible.

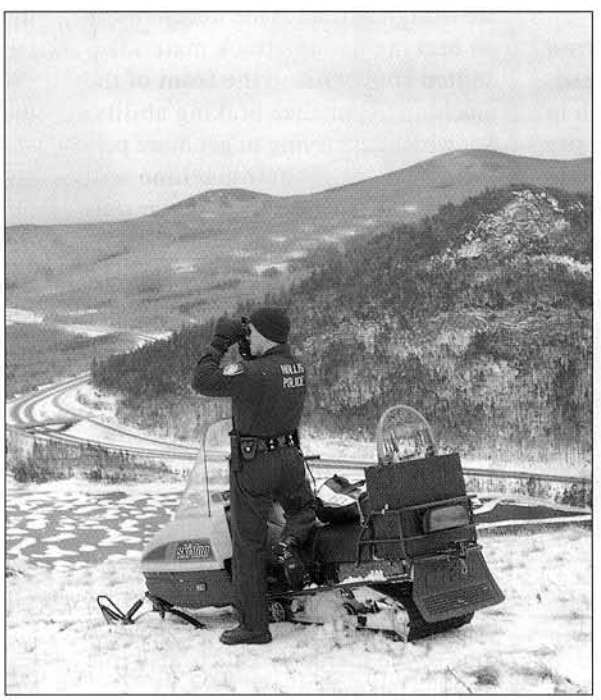

Photo by Leslie O'Shaughnessy

3. The areas in which snowmobile collisions occur usually do not have pedestrians and/or people in general positioned where they can see the crash. The only people near the scene when it happens are commonly the people riding the machines involved. Riders in front of the machine that crashes typically will not see the collision occur and, in many cases, riders behind the subject machine are too far back or are blinded by snowmobile spray to either see the crash or get a good view of it. In addition, those riding with friends seldom provide incriminating evidence against each other.

4. Measurement and documentation of the crash site can be a problem. In a situation where the officer responds and does have some reasonable physical evidence to work with, it is very difficult to properly measure and document a trail scene. This is compounded if the examination had to be performed at night, and you can not depend on the scene being preserved until daylight.

Conditions at a snowmobile crash site may consist of rain, snow, high winds, and other weather-related factors that make seeing, measuring, photographing, and documenting very difficult, and sometimes impossible. At night, the investigator usually has only other snowmobile headlights and flashlights to work with.

Some tips to remember are: use fiberglass measuring tapes that will not freeze and crack; carry writing pads in a weather-resistant enclosure; and a micro cassette recorder is a valuable replacement for pen and paper in recording scene information. The advantage of using a micro cassette recorder is that the officer does not have to attempt to write in the dark or in snow, rain, or sleet storms. Also, a

recorder eliminates balancing hands with flashlights, clip boards, pens, etc.. With a roll-a-tape and a micro cassette recorder, you can take very accurate and detailed measurements alone. A large wheel roll-a-tape works best in snow accumulations.

5. A couple of issues involving alcohol make investigating and enforcement of snowmobile-related violations difficult. The major problem in dealing with intoxicated snowmobile operators is the timing in getting the blood or breath tests taken. It may be hours before the officer even finds out who the snowmobile operator is, and by then the normal tests for blood alcohol content are not possible. Breath analyzers are not carried on snowmobiles, and results from portable devices are not sufficient for court evidence.

In making an alcohol-related arrest of a snowmobile operator, the investigator must be extremely thorough in his physical testing at the crash site and make every attempt to accurately reconstruct the collision. He must be able to prove exactly what caused the incident.

A major issue in hindering preventive measures in snowmobile-related crashes is that the snowmobile alcohol laws do not have as serious an effect on the snowmobile operator as would an alcohol-related arrest when driving a motor vehicle.

In some jurisdictions, snowmobile citations come under a section of state law other than Vehicle and Traffic Law, and there many be no assignment of points to an operator's driver's license. This is compounded by the fact that some jurisdictions do not have licensing parameters for snowmobile operators.

6. Officers responding to snowmobile crashes seldom have training in the handling of this type of collision. In fact, the officers may never have ridden a snowmobile. Investigating officers at car wreck at least have a basic understanding of various vehicle equipment and operations such as tire tread, air pressure, steering and acceleration controls, braking controls, etc. In the basic sense, most officers at a car crash know what to look for in terms of mechanical failure or negligence.

If the investigating officer at a snowmobile collision does not understand what a snowmobile track is, the effects of worn or no ski rods, or other parameters that relate to snowmobiles, it is almost impossible for him to do the job properly. In jurisdictions where snowmobiling is common, officers should at least have some basic training in the various differences between snowmobiles.

Investigators should be aware of certain things to document on a snowmobile, such as:

· Diameter of the wear rods on the front skis, and note if the machine is being operated without wear rods.

· Condition of the snowmobile track, and if it is reversed. Snowmobile tracks are designed to provide deceleration on braking and the track material is angled somewhat to the front of the machine to enhance braking ability. Snowmobilers trying to get more performance out of their machine will reverse the track so the angular portions of the track are pointing towards the rear, which gives the snowmobile more traction for acceleration at the expense of traction for braking.

· Odometer, as well as the trip odometer, should be noted.

· Oil and fuel levels should be noted.

· Head lamp should also be secured, as examination of the filament and chemical substances inside of the vacuum area of the glass encasement can lead to scientific proof as to whether or not the lamps were activated at the time of the incident. This is also true with the tail light.

· Physical damage should be noted and measured with some type of reference, even if the reference is somewhat primitive. This evidence will assist any reconstruction expert brought into the case later.

· Test the brake and throttle controls to see if they engage and release properly.

· Check the kill switch, as well as the status of any tether line to an alternate kill switch available on the machine.

· Many snowmobile crashes involve out-of-town operators on vacation. If physically able, these people are usually free to return home. Even where injuries occur, most victims are transported to hospitals closer to their residence within days of the accident. Locating and interviewing such witnesses is difficult and expensive. Officers might request local medical personnel to contact them prior to the release of snowmobile victims.

· At-scene priority for officers is to assist and aid injured persons as it may take a while for medical personnel to arrive. In such situations the investigation must wait, and as a result there is the possibility that witnesses will leave or that physical evidence will be destroyed. This is sometimes unavoidable but the officer's first duties are to aid the injured and prevent further crashes from occurring.

There is a lack of information and training materials available regarding the investigation of snowmobile crashes. This makes it difficult for officers to become educated with regard to the various idiosyncrasies of investigating a snowmobile accident but perhaps this article will be a catalyst for more being produced. L&O

An article on the basic concepts of snowmobile accident reconstruction was published in the March 1994 issue of LAW and ORDER, page 17.

Richard Hermance, owner of Collision Research Ltd. in New York, is an accident reconstruction expert with a nationwide reputation.

National Night Out 1994

The National Association of Town Watch (NATW) has announced that the 11th Annual National Night Out (NNO) will culminate on Tuesday, August 2nd. It is expected that over 27 million people in more than 8,700 communities will join forces this year during NNO to promote police-community partnerships, neighborhood unity and to build safer, more caring communities.

Any individual, agency or organization that is interested in participating and has not yet received a 1994 Registration Form should contact the NATW office: (610) 649-7055 or (800) NITE-OUT.