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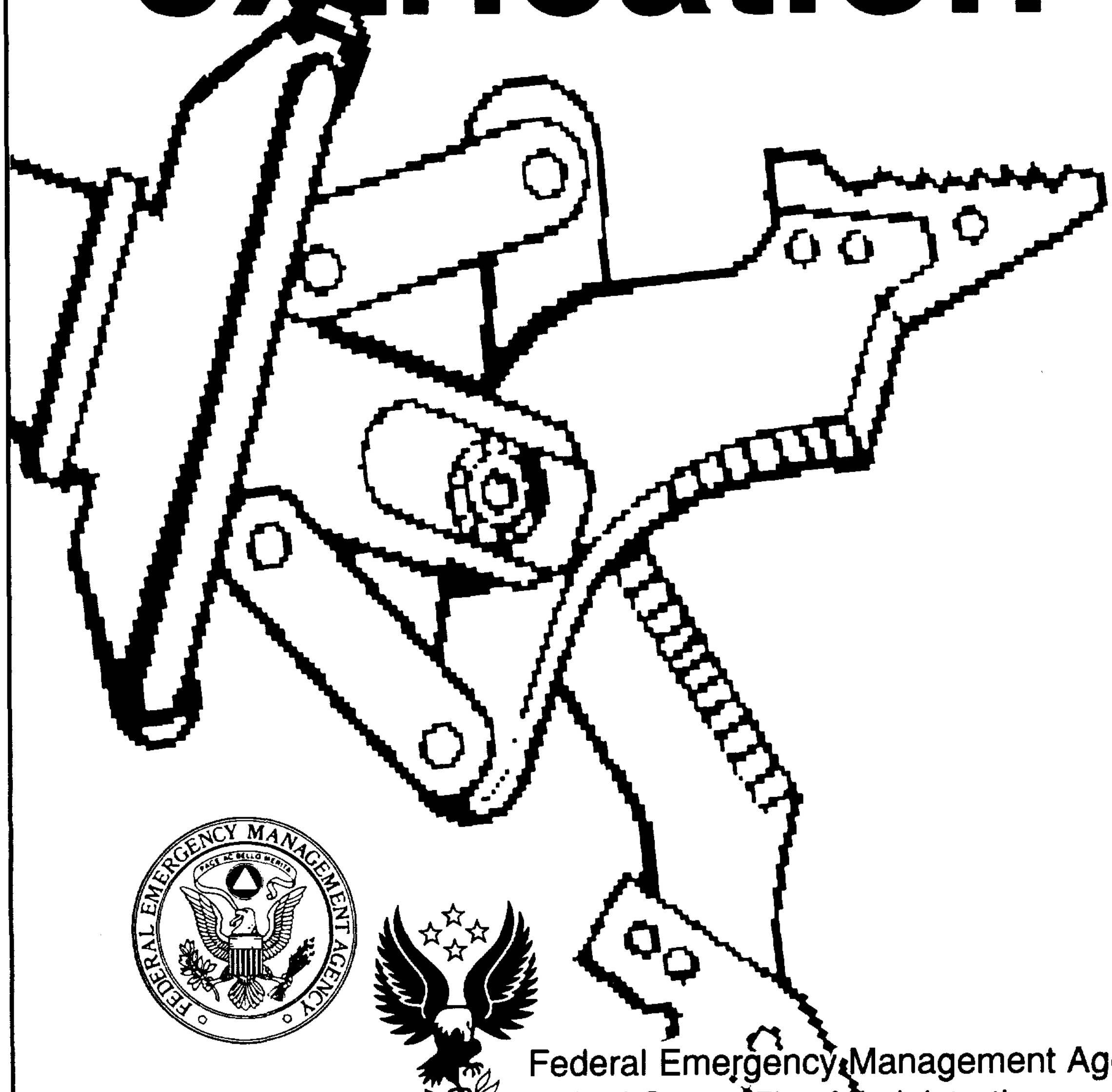
NEW technologies in vehicle extrication



Federal Emergency Management Agency
United States Fire Administration

NEW TECHNOLOGIES IN VEHICLE EXTRICATION EQUIPMENT

Federal Emergency Management Agency

United States Fire Administration

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1 Introduction and Summary

1.1 Overview

The main objective of this research project was to identify new technologies or enhancements that could increase the safety and efficiency of vehicle extrication equipment. A multifaceted approach was taken to reach this objective. Central to every aspect of the project, however, was the involvement of vehicle extrication equipment users. The end product of the project was to produce the *New Technologies in Vehicle Extrication Equipment Report* in a format that could be readily distributed to the Federal Emergency Management Agency (FEMA)/United States Fire Administration (USFA) audience. A general overview of the project is provided in this section and a graphic depiction of the tasks that were conducted can be seen in Figure 1-1.

The first phase of the project entailed the selection of the Quality Review Panel (QRP) members. The selection of the QRP members was based on their high level of expertise with vehicle extrication equipment. The purpose of the QRP was to evaluate and comment on the New Technologies in Vehicle Extrication Equipment Report. A more detailed discussion of the QRP's role in the project is presented in Section 1.2.

During the second phase of the project a telephone survey of vehicle extrication equipment manufacturers/suppliers was conducted in order to identify currently available equipment. A literature review also was conducted during this phase of the project. The search served to identify in-service equipment and focused on procedures and techniques involved with the use of vehicle extrication equipment.

The investigation was conducted during the third phase of the project. Two approaches were taken to evaluate the safety and effectiveness of currently used vehicle extrication equipment. The primary approach was to conduct a nationwide survey of vehicle extrication equipment users. The survey focused on the types of equipment or tools that are currently in use; provided a forum for evaluating aspects of the equipment, such as ease of operation, portability, satisfaction, and safety; and requested comments on areas for improvement and equipment modifications. The data were analyzed according to geographic location and population size in order to identify any differences that could exist due to the demands specific to a geographic region or requirements particular to community size.

The second approach taken in the investigation was to conduct in-field observations of vehicle extrication equipment training sessions. During the observations, information such as usage problems or potential safety hazards encountered, time taken to complete a procedure, tool portability, tool effectiveness, ease of operation, unique application of tools and tool modifications were assessed and recorded.

The data obtained from the survey and the in-field observations were used in the assessment of the extrication equipment interface with the vehicle design. The assessment focused on the interface

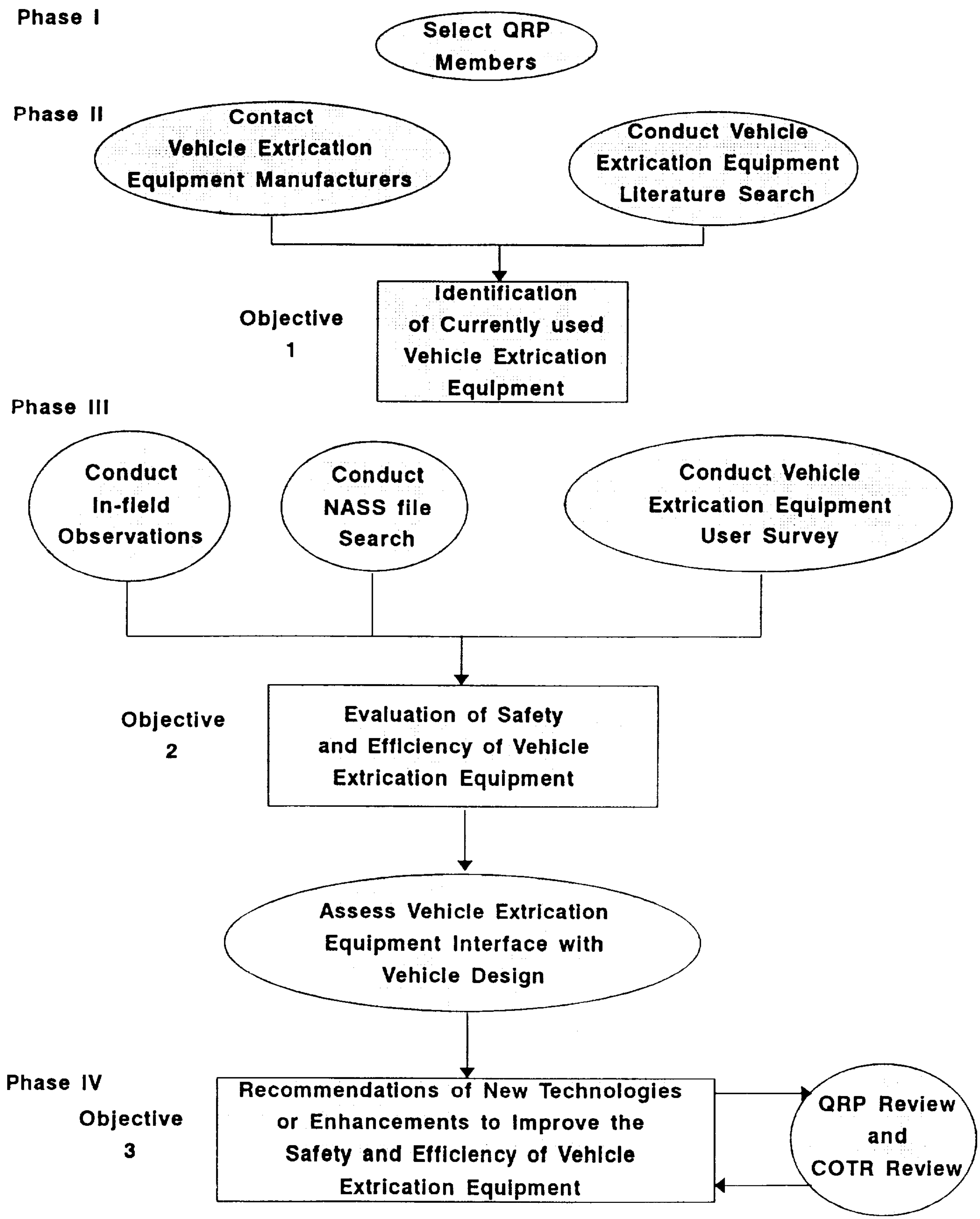


Figure 1-1 New Technologies in Vehicle Extrication Investigation

of extrication equipment with structural designs and construction materials of late model vehicles. The assessment included literature review on new vehicle composite structural materials and structural designs. Potential areas of concern that could affect the efficiency of extrication equipment or pose a safety problem were identified. The last phase of the project focused on the identification of new technologies or enhancements in vehicle extrication equipment that could serve to resolve the efficiency and safety problems identified through this project. The recommendations were based on the suggestions provided by survey participants, the QRP, the USFA Project Officer and contractor personnel.

1.2 Quality Review Panel (QRP)

Three vehicle extrication experts were selected to serve as members of the Quality Review Panel. Listed alphabetically the members were Lieutenant Thomas Carr, Jr., Assistant Chief Dwight Clark, and Director of Training and Education/Program Director Ronald Moore. Lieutenant Carr, from the Department of Fire Rescue Services in Montgomery County, Maryland, has 20 years of firefighting and rescue experience. He has written numerous articles for fire and rescue service journals. He also has served as a vehicle rescue instructor and developed vehicle extrication training programs, including video training programs on emergency medical services (EMS) and rescue topics. Lieutenant Carr has received many awards and honors attestin g to the high quality of' his contributions in the area of fire rescue. Assistant Chief Clark of San Angelo, Texas has more than 30 years of experience as a firefighter, more than 15 years of experience as a vehicle rescue instructor both on a national and international level, and has written articles for various fire/rescue magazines. Assistant Chief Clark was a founding member of the Transportation Emergency Rescue Committee (TERC) that is working to establish teaching guidelines for vehicle rescue. He also was the founder of "First Care," a San Angelo, Texas-based organization that provides emergency medical service (EMS) and rescue training, Director Moore is currently with the Fire and Emergency Television Network Westcott Communication in Carrollton, Texas. He has served as a Fire Protection Specialist with the New York State Fire Academy in Montour Falls, New York, **and** is the author of the training text *Vehicle Rescue and Extrication.* He founded RESQUE- I, *a* training consulting firm, which provides specialized vehicle rescue and extrication training programs. His reputation as a highly regarded vehicle rescue instructor has been acknowledged with the George D. Pose Instructor of the Year Award presented by the International Society of Fire Service Instructors.

We would like to thank these QRP Members for their expert review and valuable input to this document.

1.3 Report Organization

The New Technologies in Vehicle Extrication Equipment report is organized according to a modular format. It is intended to be used as a reference document, so that each section can be pulled out for various purposes. Each section is tabbed by topic for case of use. An overview of the report organization can be seen in Table I .3-I.

Table 1.3-1 Report Organization

Section	Topic	Organization	Purpose
2	• Vehicle Extrication Literature Review • Extrication Equipment Manufacturers' Survey	Alphabetic Alphabetic	Reference Reference
3	• In-field Observation of Vehicle Extrication Equipment Training Sessions	Site #	Evaluation
4	• Nationwide Vehicle Extrication Equipment Users' Survey	Survey format Tool type	Evaluation
5	• Assessment of Vehicle Design Interface with Extrication Equipment	Tool type	Reference Evaluation
6	• Recommendations for New Technologies/Enhancement of Vehicle Extrication Equipment	Tool type	Reference

2 Literature Review

2.1 Extrication Equipment Literature Database

The following section contains summaries of articles on vehicle extrication. The search was conducted through the contractor's Technical Information Center (TIC) and the National Emergency Training Center's Learning Resource Center (LRC). The articles are presented alphabetically by first author.

REFERENCE:

Alrutz, Walter Jr., "Vehicle Extrication" (Part I), FIRE ENGINEERING, November 1988, pp.46-50.

SUMMARY

Vehicle extrication is approached as a systematic process. The approach entails the following eleven steps:

1. Preparation
2. Response
3. Assessment
4. Hazard Control
5. Stabilization
6. Primary Access
7. Secondary Access
8. Disentanglement
9. Packaging and Removal
10. Cleanup
11. Evaluation

The first four of these eleven steps are presented in this article. The remainder of the steps are addressed in two consecutive articles. Each step includes issues to be considered as well as recommended tools and procedures.

1. PREPARATION- Preparation refers to both the good working order of equipment and the readiness of personnel. Equipment preparation requires selecting the most appropriate rescue vehicle for the task and properly maintaining and servicing the equipment. Personnel preparation refers to proper training and the selection of protective gear.

2. RESPONSE- Response means response to the scene. The scene must be immediately assessed for traffic control and potential hazards. Placement of the rescue vehicle is an important consideration as well.

3. ASSESSMENT- The first decision to be made is whether rescue is needed. If so, then it is necessary to locate all vehicles and victims. Once this is accomplished, it must be determined if rescue is possible or if more equipment and/or manpower is necessary.

4. HAZARD CONTROL- The primary hazard is fire potential. Two high-volume hoses should always be ready. If necessary, gas leaks should be plugged or diked. Flammable vehicular fluids and electrical systems which could supply a spark for ignition should be checked and remedied. Sharp metal and glass can also pose a danger and rescuers and victims should be protected. Downed power lines and bystanders are other potential hazards which must be considered.

REFERENCES

Alrutz, Walter Jr., "Vehicle Extrication" (Part II), FIRE ENGINEERING, December 1988, pp.62-70.

SUMMARY

Stabilization, Primary Access, and Secondary Access, steps 5, 6, and 7, in the systematic approach to vehicle extrication, are examined.

5. STABILIZATION- All vehicles must be stabilized for the safety of victims and rescuers. For victims this is especially important since any movement could worsen an injury. Even vehicles on all four wheels are not stable because it is capable of rolling or bouncing on the tires. Instructions on how to use cribbing to stabilize a vehicle in this position and on its roof and side are given. Other options, if cribbing is not available or adequate, are also given.

6. PRIMARY ACCESS- The objective of primary access is to provide medical personnel with a means to reach victims so they may administer emergency medical attention. The best means of primary access is simply opening one of the vehicle's doors. If the doors are jammed, do not pry them; go through the windows. A second option is to break a side window, preferably away from any victims, using tape to cover the window to avoid glass shattering in the vehicle. The rear window is not recommended because it is usually more difficult to control glass shattering due to the shape and size of the window. Finally, access can be achieved relatively easily through a hatch-back for this type car model.

7. SECONDARY ACCESS- The objective of secondary access is to create an opening from which to remove victims. This usually requires the opening or removal of doors. Several methods for removing doors and opening them beyond their normal range are given. Another less recommended option for secondary access is window removal, with the front windshield advised over the rear window. Options and directions for removing both mastic and rubber mounted windshields are discussed. Finally, two types of roof removal (half-roof and full-roof) are explained.

REFERENCE:

Alrutz, Walter Jr., "Vehicle Extrication" (Part III), FIRE ENGINEERING, January 1989, pp.28-34.

SUMMARY:

The final four steps in an eleven step vehicle extrication process are discussed. They include Disentanglement, Packaging and Removal, Cleanup, and Evaluation.

8. DISENTANGLEMENT- Disentanglement, the process of freeing victims who become entrapped, may require the movement or removal of certain vehicle parts. Seats can be moved or removed by using hydraulic spreaders or rams, jacks, come-a-longs, or even socket wrenches. Steering wheels can often be tilted, cut half off at the bottom, or fully removed for more working room. The dashboard may be cut out in sections using an air chisel or hacksaw, or it can be displaced using a hydraulic power tools or a come-a-long. Foot pedals causing entanglement can be moved using hydraulic power tools, chains or ropes, or may be unbolted if time permits.

9. PACKAGING AND REMOVAL- Packaging can include bandaging, splinting, spinal immobilization, and weather protection of the victim. Removal refers to the removal of the victim through the passage created during the Secondary Access stage. The same consideration must be given to fatal victims as living victims. Care must be taken not to disturb any evidence.

10. CLEANUP- Cleanup requires the collection and inventory of all tools used. Note should be made of any missing or broken tools. Cribbing used to stabilize a vehicle should be dismantled carefully. All equipment should be cleaned and made ready for their next use.

11. EVALUATION- Evaluation should be an objective critique of the extrication process that generates feedback and can serve as a learning experience. Positive and negative occurrences should be discussed and alternative methods should be examined. New rescuers should be questioned and give their response to the process.

REFERENCE:

Anderson, Brian G., "Rediscovering the Air Chisel", FIRE ENGINEERING, April 1990, pp.65-70.

SUMMARY:

The author creates a scenario in which a department's hydraulic tool fails during a vehicle extrication and an air chisel is used as a back-up, rediscovering its capabilities. Following the scenario, factors are considered for selecting the proper air chisel and bits. Proper operating and maintenance procedures are also discussed.

REFERENCE:

Burgess, James, "Basic Extrication Hand Tools", EMERGENCY, June 1983, pp.32-33.

SUMMARY:

This article explains how hand tools may be used in emergency vehicle extrication situations where powered tools are not available. Techniques are explained for opening a jammed door using a wrecking bar and pry bar, and removing a roof using two hack saws.

REFERENCE:

Carr, Tom, "Vehicle Rescue in the 90's: New Cars, New Challenges" (Part I), RESCUE, Vo1.3, No.6, November/December 1990, pp.38-43.

SUMMARY:

Carr recounts an extrication session performed by the Transportation Emergency Rescue Committee (TERC) of the International Association of Fire Chiefs conducted at General Motors Proving Grounds in Milford, Michigan. New crash tested vehicles were examined to determine how new vehicle design has altered the causes of entrapment and created new problems for extrication. For example, a victim in a newer model vehicle with an energy-absorbing steering column is more likely to be entrapped by the dashboard and firewall than by the steering column. In this situation a dash push is recommended rather than the traditionally used dash pull. The dash push requires the following steps:

1) Remove, flap, or cut "A" pillar at windshield area to allow the dashboard to move forward.

2) Make a shallow cut through the connector at the base of the "A" pillar at the rocker panel.

3) Place a ram low against the "B" pillar and high against the "A" pillar (against hinge).

4) Activate ram(s) to push the dashboard.

5) Place short, thick wedges at the base of the "A" pillar and rocker panel.

6) Remove ram(s).

Other new vehicle design changes and associated extrication techniques Carr discusses include unibody construction, air bags, and collision bars and striker bolts on doors.

REFERENCE:

Carr, Tom, "Vehicle Rescue in the 90's: New Challenges in Patient Care" (Part II), RESCUE, Vo1.4, No.2, March/April 1991, pp.46-60.

SUMMARY:

Carr discusses some challenges created by the new vehicle design, largely due to unibody construction, and provides new extrication techniques that address these design changes. The techniques were developed through work conducted by the Transportation Emergency Rescue Committee (TERC) at General Motors Proving Grounds in Milford, Michigan. New techniques are presented for the extrication of doors, roof, hatchback, windshield, and dashboard. For example, windshields are no longer set in rubber (1970's' or mastic (1980's), but are an integral part of the structure. This type of windshield should be removed along with the removal of the roof by cutting across the bottom of the windshield or left in place by cutting across the top of the windshield. When the windshield is removed with the roof, the unit should be removed toward the front or side of the vehicle and not be passed over the victim. If left in place, the exposed windshield glass should be covered to avoid posing a hazard to rescuers. The author also provides a broader view of the vehicle rescue process that includes the following six step approach:

1) Access
2) Stabilization
3) Doors
4) Roofs
5) Dashboards
6) Patient Removal

REFERENCE:

Clark, Dwight, "TERC Studies in New Vehicles", FIRE CHIEF, Vo1.35, No.11, November 1991, pp.57-60.

SUMMARY:

Clark provides an overview of an extrication training session of International Association of Fire Chiefs Transportation Emergency Rescue Committee (TERC) members at the General Motors (GM) Proving Ground in Milford, Michigan. New crash tested GM vehicles were examined for differences in structural design and composite materials as compared to older model vehicles. It was found that:

1. New car posts and roofs were similar to older models.

2. Sliding roofs in new cars were significantly heavier than a standard roof. Due to potential hazard if the roof fell on crash victims, total roof removal was recommended, rather than folding the roof.

3. New vehicle door design was observed to be very different, more complex and heavier than older models. A pipe has been used in place of side guard door beams and a wedge has replaced the Nader pin.

4. The increased use of plastics in vehicle bodies will produce toxic gases during a vehicle fire, thus mandating the use of self-contained breathing apparatus.

5. New vehicle front-wheel steering columns pose a potential hazard for drivers as they could break if not properly displaced.

6. Supplemental inflatable restraints (SIR) or airbags can be disarmed by disconnecting or severing a toggled, yellow cable located under the steering column. Although unlikely, the SIR can be activated by electrical current from other steering column wires.

REFERENCE:

Czajkowski, John D., and Kidd, J. Steven, "Vehicle Extrication Training: No Injuries Allowed", RESCUE, Vol.2, No.6, November/December 1989, pp.34-39.

SUMMARY:

The authors describe the steps that should be taken to make extrication training sites safer for fire and rescue personnel. They suggest that:

1. The ease of use of powered hydraulic tools can be misleading and cause users to lose regard for the potential for injury.

2. Training vehicles should be made safer through pre-training session inspection, neutralizing/removing fuel tanks, disconnecting electrical systems, checking storage areas for hazardous materials. Full protective gear should be worn when securing the vehicle for removal.

3. The training site should be level, clear of obstructions, well lit, supplied with fire extinguishing equipment, and vacated of spectators.

4. Safety considerations include: a) knowledge of equipment and appropriate application, b) maintenance of tools, c) the assignment of a safety officer to observe the training operation and stop activity if a potential hazard develops, d) a minimum of two instructors when simultaneous operations are conducted, and e) wearing full protective gear by all personnel in the operation area. Training should be avoided during extreme environmental conditions. Instructors should ensure that training participants use safe hand and body positions and that participants take rest periods during the drill.

5. The use of personnel as "victims" should be based on the following considerations: experience level of training participant, adequate protection of the victim during the use of extrication equipment, and level of control maintained throughout the training session.

REFERENCE:

Dick, Thorn, "Have A Bite: Taking Care of Your 'Jaws"', JEMS, September 1981, pp.28-30.

SUMMARY:

Three general reasons are given for hydraulic tool failure. These are motor malfunction, hose malfunction, and operator malfunction. Motor malfunction, the most common cause of tool failure, is usually the result of carburator problems. This can be attributed to dirt in the air filter or around the starting cord, or use of an incorrect spark plug. Hose malfunctions may be caused by poor cleaning and maintenance practices, improper storage, or use of lesser quality hydraulic fluid. Operator malfunction is limited to the control valve, the only operable part. It is designed for thumb pressure and excessive force should be avoided. Proper tool maintenance, cleaning, and usage will prevent most of these malfunctions.

REFERENCE:

Erven, Lawrence W., Chapter 5. Extrication from Crashed Motor Vehicles, EMERGENCY RESCUE, Macmillan Publishing Co., Inc. 1980, pp.82-104.

SUMMARY:

Vehicle extrication is viewed as five stages:

1) Gaining access to victims
2) Administering lifesaving emergency care
3) Disentanglement
4) Preparation for removal
5) Transportation

Each of these stages is expanded upon with particular attention paid to the stage of disentanglement. Disentanglement techniques included are: opening locked or jammed doors; removing the windshield; breaking other windows; entering through the roof, floor, and trunk; removing the roof; and moving and removing the seat, steering wheel, pedals, and other devices. In addition to these five stages, Evren discusses rescuer training, scene and accident assessment, determination of victim priority and the special circumstances posed by bus accidents.

REFERENCE:

Haase, Rick, "Training Notebook: Some Notes on Extrication", FIRE ENGINEERING, November 1988, pp.lO-13.

SUMMARY:

Haase presents his notes, a list of forty-three items, that can be applied to every vehicle extrication. The items are comprised of do's and don'ts, reminders, and safety tips. The list covers the full scope of procedures from pre-scene information gathering to final documentation and clean-up.

REFERENCE:

Hunt, Dexter W., "The Ins and Outs of Automobile Extrication, Part I ", EMERGENCY MEDICAL SERVICES, Vol.14, No.1, January/February 1985.

SUMMARY:

Part I of this article looks at the general procedures which apply to any vehicle extrication, regardless of the the type and extent of damage or the specific tools applied. All vehicle extrications call for considerations of traffic control, rescue vehicle placement, hazards survey, vehicle stabilization, rescuer safety, and most importantly, patient access and care.

REFERENCE

Hunt, Dexter W., "The Ins and Outs of Automobile Extrication, Part II", EMERGENCY MEDICAL SERVICES, Vol.14, No.2, March/April 1985.

SUMMARY

Part II of this article considers the requirements and various methods of extrication once patient access has been achieved. Extrication may require displacement or removal of a door, seat, steering wheel, windshield, dashboard, foot pedal, roof, or entire vehicle side. Various means and tools to accomplish these tasks are considered.

Immobilization of the patient before beginning extrication is a key point stressed throughout the article.

REFERENCE:

International Association of Fire Chiefs,"Air Restraint Bags: Answers for Extrication", IAFC on Scene, Vol.2, No.22, December, 1993.

SUMMARY:

The article presents information regarding the possibile hazards associated with air restraint bags. The following information is provided by the Transportation Emergency Rescue Committee of Fire Chiefs:

1) The presence of an air bag restraint is indicated by an extra large steering wheel hub.

2) Air bags can be deactivated by disconnecting the nef\gative side of the battery. Wait four to eight seconds to allow the capacitor back-up to decay.

3) About 80 grams of sodium azide is used to deploy an air bag. When the sodium azide burns nitrogen is released through vents on the steering column and a slightly alkaline, non-toxic powder will be present. The small amount of sodium azide used in air bags is not hazardous for vehicle occupants or rescue personnel.

4) In the case of a vehicle fire, water can be used whether or not the air bag is deployed. If the air bag is deployed, the sodium azide will have already burned and if the air bag has not deployed, the sodium azide will be contained within the system.

REFERENCE:

International Association of Fire Chiefs,"IAFC Committee Members Use General Motor's Proving Grounds to Sharpen Extrication Skills, Develop New Techniques", IAFC on Scene, Vol.4, No.13, July 1, 1993.

SUMMARY:

The article describes a vehicle extrication session conducted at General Motor's Proving Grounds. It includes rescue procedures for vehicle air bags:

Deployed Air Bag-

-- Wear gloves and safety glasses
-- Do not get air bag residue in your eyes or patient's eyes or wounds
-- Remove gloves/wash hands after handling deployed air bag
-- Follow normal rescue procedures

Undeployed Air Bag-

-- Disconnect/cut negative battery cables
-- Disconnect air bag connector at base of steering column. If it cannot be disconnected, wait ten min. after battery disconnect before handling air bag.
-- Do not cut steering column unless battery cables or air bag connector have been disconnected.
-- Do not cut or drill into the air bag module
-- If air bag module is ruptured, do not touch or ingest air bag chemicals
-- Follow normal rescue procedures

Fire in Air Bag Equipped Vehicles-

-- First follow normal rescue and fire extinguishing procedures

REFERENCE:

International Fire Service Training Association, Extrication Equipment (from Chapter 4), PRINCIPLES OF EXTRICATION (First Edition), Fire Protection Publications, Oklahoma State University, 1990.

SUMMARY:

This article looks at some of the more common vehicle extrication tools available and addresses uses, maintenance, safety precautions, and other features as they are applicable to each tool. Twelve types of tools are discussed within four general categories. They are as follows:

Hand tools:
- striking tools
- cutting tools
- non-hydraulic jacks

Hydraulic tools:
- powered-hydraulic
- manual-hydraulic

Pneumatic tools:
- chisels/hammers
- air bags

Other tools:
- power saws
- lifting/pulling tools
- oxyacetylene torches
- cribbing
- chains, ropes, and webbing

REFERENCE:

Kidd, J. Steven and Czajkowski, John D., Chapter 4 Tools and Equipment, VEHICLE EXTRICATION: A TRAINING MANUAL, PennWell Publishing Company, 1991.

SUMMARY:

This chapter teaches about the selection, safe use, and proper maintenance of vehicle extrication tools. General criteria for selecting tools is discussed. Some of these criteria include safety, multiple use potential, light-weight, ease of operation, effectiveness, and utility. Other considerations are space limitations, budget constraints, warranties, and servicing.

The remainder of the chapter looks at eighteen tools with respect to these criteria. The tools are as follows:

1. Air rescue bags
2. Air chisel
3. Axes
4. Chains
5. Come-along
6. Cribbing
7. Hacksaws
8. Jacks
9. Knives
10. Manual hydraulic rescue tool (includes porta-power, spreader and cutter)
11. Mechanic's tool box (includes 12 types of tools)
12. Operations work pack (includes 14 types of tools)
13. Pike poles
14. Pneumatic wrench
15. Powered hydraulic rescue tool (includes spreader, cutter and ram)
16. Pry bar
17. Reciprocating saw
18. Spring-loaded center punch

REFERENCE:

Metcalfe, Harry, "Air Bag Maintenance and Storage Procedures", FIRE ENGINEERING, Vo1.137, No.1, January 1984, pp.52-53.

SUMMARY:

Metcalfe discusses systematic air bag maintenance and safety checks to ensure equipment is in good working order. To perform a check, the equipment is assembled and tested. Ten steps are given for testing the air supply, pressure regulator, controller, supply hoses, and air bags. Proper storage and cleaning procedures, important factors in ensuring the safe operating condition of the equipment, are reviewed.

REFERENCE:

Moore, R. E., "More Extrication Hazards: Surviving the New Auto Technology", JEMS, Vol.11, No.7, 1986, pp.63-65.

SUMMARY:

Moore discusses several new technology advancements in passenger vehicles that affect EMS personnel. The following issues are presented:

1. The need for EMS and rescue personnel to record whether or not crash victims were using safety belts. This requirement is based on General Motors Corporation insurance certificate provided to new vehicle purchasers which awards a death benefit for belted GM occupant fatalities.

2. Anti-lacerative windshields, while reducing severity of lacerations suffered by occupants contacting the windshield, may become stiffer and more difficult to remove in cold climates. However, traditional removal techniques are still acceptable for this type of windshield.

3. The "electric" windshield, heater wires bonded front and rear windows, poses no problems for vehicle occupants or EMS/rescue personnel. Electrical charge to the windows is provided only when the engine is running. Further, a sensing resistor shuts off the current when the windshield cracks.

4. Increase in size and weight maximum regulations for tractor-trailor trucks have increased the risk of death for vehicle occupants relative to truck occupants.

5. Undeployed air bag systems present EMS/rescue personnel with a chemical hazard. Sodium azide, a Class C explosive propellant, is used in the activation of an airbag. EMS/rescue personnel need training in how to deactivate an airbag system.

REFERENCE:

Moore, Ronald E. (edited by Daniel B.C. Gardener), Chapter 9. Extrication, MANAGING FIREGROUND OPERATIONS: FIRE OFFICER SERIES (Book Three), International Society of Fire Service Instructors, 1991.

SUMMARY:

The Incident Command System (ICS) is presented as the best means of managing a vehicle extrication operation. The ICS establishes a hierarchy of command to ensure order and organization. A leader of the operation, the Incident Commander, is needed to organize the various agencies involved and make sure everyone understands the objective and fulfills their function in the system. The qualities and responsibilities of an effective commander are discussed. Proper procedures including rules of conduct and safety are reviewed in detail.

REFERENCE:

Moore, Ronald E., "Advances in Automobiles Alter the Vehicle Rescue", FIREHOUSE, Vol.17, No.4, April 1992, p.86-88.

SUMMARY:

Rescuers need to recognize the difference between the appearance and the reality of damage to a vehicle in an accident situation. Damage to modern cars cannot be judged in the same manner as older cars. With newer vehicles, rescuers need to learn the difference between "totaled" and "totally destroyed". Often modern cars will be considered "totaledlly, that is, not worth the cost of repairing. The vehicle, however, may not appear t'totally destroyed". For example, newer cars have crumple zones which are not repairable although damage to them may not appear severe. Rescuers should not hesitate to attack a car because it appears new and fixable. Preserving a vehicle should never be a concern of the rescuer.

REFERENCE:

Moore, Ronald E., "Extrication: A Method to the Madness", EMERGENCY, March 1991, pp.38-41.

SUMMARY:

A typical motor vehicle accident is viewed as a thirteen step process called the "Vehicle Rescue Life Cycle". The steps are:

1. Accident occurs:
   Patients golden hour begins
2. Notification and response
3. Response size up begins
4. Arrival
5. Command and control
6. Initial size up
   Sustained size up
7. Scene stabilization,
   safety and support
8. Initial access
   Sustained access
9. Patient care
10. Disentanglement
11. Extrication
12. Transportation
13. Termination

In an emergency, in order to quickly comprehend the extrication process, standard operating procedures (SOPs) should be followed. Four SOPs or phases are suggested which can be easily remembered in emergency circumstances by attaching key words to each. The phases are:

Phase 1 -- stabilization/access
Phase 2 -- roof
Phase 3 -- sidewalls
Phase 4 -- dash/firewalls

REFERENCE:

Moore, Ronald E., "Steering Column Extrication: The Preparation" (Part I), FIRE ENGINEERING, Vo1.141, No.1, January 1988, pp.32-36.

SUMMARY:

The technology of front-wheel-drive has produced new problems for steering column extrication, and demands new solutions. Front-wheel-drive vehicles have rack-and-pinion steering systems. The steering column consists of several sections connected end-to-end by joints. The lower part of the first section, located just inside the passenger compartment, may break at the joint when employing the conventional method of an "across the hood pull". The force exerted to move the top of the column away from the driver may cause the lower part to move inward, possibly further injuring or entrapping the driver. Moore refers to this as the "seesaw" effect. Procedures and considerations necessary for all steering column extrications are reviewed in the remainder of the article. Two susequent articles in this series are devoted to alternative methods of steering column extrication.

REFERENCE:

Moore, Ronald E., "Steering Column Extrication: Across the Front" (Part II), FIRE ENGINEERING, Vol.141, No.2, February 1988, pp.48-54.

SUMMARY:

Pulling across the hood is no longer the primary method for displacing the steering column. If this method is used, however, newer cars need to have the grille and hood supported. This can be accomplished using blocks, ladder cribbing, or a sliding box crib. Moore describes a "cradle wrap" technique which requires wrapping chain or strap around the lower portion of the column to protect the victim from the "seesaw" effect of the column (described in Part I of this series). He describes the technique using either chain or strap for pulling and recommends chain. The patient should be protected using a medical longboard or shortboard when pulling the column. The tools to be used depend upon the across the hood approach to be taken. The two across the hood approaches are pulling the column and lifting the column. A forward pull is described using a come-along and a vertical lift using both a hydraulic spreader and an air bag.

REFERENCE:

Moore, Ronald E., "Steering Column Extrication: Alternatives" (Part III), FIRE ENGINEERING, Vo1.141, No.3, March 1988, pp.43-56.

SUMMARY:

Moore describes three alternative methods of steering column extrication; two for moving the steering column and one for removing it. Working across the windshield to displace the column is the first technique and, according to Moore, it is the quickest, safest, and simplest method. However, there are several scenarios in which working across the windshield is not possible. Under these circumstances, the steering column can be moved by pushing from the side. An advantage of this method is that it avoids the "seesaw" effect described in Part I of this series. When pushing from the inside, a suitable anchor point is needed and a few options are mentioned. Lastly, the steering column can be removed. For each of the three approaches, Moore thoroughly explains the steps involved and tool options.

REFERENCE:

Moore, Ronald E., Chapter 6. Rescue Tools and Equipment, VEHICLE RESCUE AND EXTRICATION, Mosby Year Book.

SUMMARY:

In this chapter, Moore defines eight categories of extrication equipment. Tools in each category are discussed in terms of their function, operation, capacity, safety, efficiency, maintenance, troubleshooting diagnostics, and storage. This comprehensive chapter is intended to teach the reader how to categorize tools and define relationships among tools, and to understand the function of tools and their component parts. Safety considerations, preventive maintenance and diagnostic procedures associated with equipment operation are provided.

REFERENCE:

Moore, Ronald E., and Hicks, Lewis W., "New Frontiers in Extrication Techniques", RESCUE, Vol.1, 1988, pp.46-47.

SUMMARY:

This article focuses on extrication techniques appropriate for modern front-wheel-drive vehicles. In vehicles with light weight, energy absorbing front ends, dashboards are frequently displaced rearward into the occupant's compartment. Vehicles with split steering columns and rack-and-pinion steering control systems also require different extrication techniques. The techniques discussed are:

1. Hydraulic Ram -- strategic relief cuts are made near the "A" post, and then the ram is used to push the steering wheel and column or the dashboard forward.

2. Stacked Manually Powered Rams -- two manually powered rams are threaded together at their base ends in order to double travel distance.

Rams of a different rating can be connected with a stepdown fitting. However, the larger ram must be activated first to full plunger distance before activating the smaller ram. To operate the stacked rams, one ram is positioned low on the "B" post, with the other ram located against the post or dashboard structure.

REFERENCE:

New York State Department of State, Office of Fire Prevention and Control, ACCIDENT VICTIM EXTRICATION WORKBOOK, 1982.

SUMMARY:

The workbook provides a training course in vehicle extrication. Instruction includes new developments in vehicle design that present safety concerns for fire/rescue personnel. The developments and their associated safety concerns include:

1) Catalytic converters - excessive heat can ignite fuel vapors. If broken, can release toxic gases.

2) Energy-absorbing bumper system - compressed bumped may release unexpectedly or rupture off vehicle.

3) Auto front Suspension - excessive heat can cause strut cartridges to explode and blow hot oil out near the front fender.

4) Fuels (unleaded gasoline, gasohol, compressed gas fuels) - flammable, mechanical damage to cylinders/distribution system.

5) Air cushion restraints - exposure to toxic chemical (sodium azide) only if container leaks, not if air bag deploys.

6) Vans, light trucks, jeeps - higher occupant fatalities due to non-compliance with passenger car standards, e.g., braking distances, side-door strength, roof crush resistence, interior padding, etc.

7) Split rim truck wheels - explosion hazard if rim pieces separate.

8) Tractor-trailor combinations - Heavy cargo weight, hazard materials, runaways diesel engine.

9) Fuel evaporation central system - violent rupture and fireball can result from vapor pressure build-up in sealed tank.

10) Plastic fuel tanks - Upon exposure to ground fire plastic fuel tank melted and dumped its contents after 2-l/2 minutes.

11) Drive shafts - excessive heat can cause an explosion due to increased pressure in the drive shaft.

12) Infant and child safety restraints - remove child and child seat together, cut vehicle/tether belts if more efficient than unbuckling belts.

Among other training materials, the workbook provides a complete list of rescue tools and quantity recommended to complete a fire departments tool inventory.

REFERENCE:

Russo, Victor B., "Unusual Auto Extrication", FIRE COMMAND, Vo1.54, No.2, 1987, p.20.

SUMMARY:

Russo describes unusual techniques that were used to extricate a crash victim from a vehicle completely lodged under the porch of a house. The dash and steering column were lifted from above through a hole in the porch floor. Fourteen and eighteen ton air bags were placed on a roof ladder located across the hole. A nylon strap was wrapped around the steering wheel and back up through the hole and the air bags were slowly inflated to raise the steering column.

REFERENCE:

Swinney, Dick, "Extrication Techniques, Part I", EMERGENCY, May 1984, pp.28-31.

SUMMARY:

Vehicle extrication is discussed as being based on a philosophy that "Everything done in an autc extrication is based on the needs of the patient, not on the constraints caused by the vehicle." Implementation of this philosophy is accomplished by following four guidelines and a general set of rules. The four guidelines are based on the idea of 'stabilization' and called the "4S" approach. They are:

1. Stabilize Yourself
2. Stabilize the Scene
3. Stabilize the Vehicle
4. Stabilize the Patient

The general rules relate to scene and victim assessment, vehicle stabilization, extrication methods, tool options and protective gear.

REFERENCE:

Swinney, Dick, "Extrication Techniques, Part II", EMERGENCY, June 1984, pp.36-39.

SUMMARY:

A hypothetical situation is created by Swinney in which two vehicles collide, both requiring extrication. Extrication techniques discussed include: 1) the use of a porta-power system to open jammed doors, 2) the use of an air chisel or hydraulic cutter for roof removal, and 3) the use of a come-along, a "handyman"- type jack, and a hydraulic spreader, each in recognized methods of steering wheel removal.

REFERENCE:

Valcourt, Greg, "The ABCs of Vehicle Rescue", RESCUE, Vo1.6, No.3, 1993, pp.44-53.

SUMMARY:

Valcourt presents a structured approach (steps A-F) to vehicle extrication. The approach includes the following steps:

Pre-response steps: Ensure proper training of personnel to use appropriate equipment safely and effectively. Personnel should be trained to follow an Incident Command System (ICS) .

A -- Assess scene: Stage/position rescue vehicles at a safe distance (minimum 50 ft) from crash site without obstructing other vehicles. Approach scene with caution and conduct hazard assessment.

B -- Balance vehicles/Begin access: Safely position and secure vehicle. Select appropriate stabilization technique. Wearing sufficient protective clothing, begin access. Use forcible entry only when required for closed vehicles through windows, doors, or the vehicle body. Begin patient care.

C -- Cut roof: If required to access the victim, determine which type of "roof flapping" is appropriate, i.e., front-to-rear, rear-to-front, side-to-side, or complete removal.

D -- Do doors: (Steps C and D may be switched if necessary) Use hand or power tools to pry, cut, crush or remove bolts from door hinge. Remove door or bend it beyond its normal opening.

E -- Enlarge opening: Use hand or power tool to cut, pry, push or pull vehicle component (e.g., dashboard, floorboard, steering wheel/column, pedals, or body panels) beyond its normal position.

F -- Follow up: Use a flexible approach and re-examine procedures throughout the extrication process.

Post-response steps: After victim removal, secure the accident scene and safely return to the station. Ensure proper maintenance of rescue tools and perform critique of extrication operation.

REFERENCE:

Vigiano, John T., "...An Update", W.Y.N.F., No.2, 1984, pp.12-18.

SUMMARY:

Vigiano examines the components of the Hurst brand hydraulic tool based on personal experience with the New York City Fire Department. The components include the jaws, cutter, rams, power unit, hoses, hydraulic fluid, hand pump, chains and hooks. Characteristics such as tool weight, capacity, materials, and uses. A general procedure for vehicle extrication is set forth and the use of hydraulic tools in specific extrication scenarios is examined.

REFERENCE:

Vigiano, John T., "Training Notebook: Extrication Tool", FIRE ENGINEERING, Vol.141, No.12, December 1988, p.10.

SUMMARY:

The origin of what is sometimes called a kickplate is credited to the Seminole County Fire Department. The device was presented during a competition in 1983 which was to serve as a learning symposium for vehicle extrication. The devise is L-shaped with stop blocks welded at regular intervals and fits against the B-post and rocker panel for placement of a ram and distribution of its force.

REFERENCE:

Williams, Dan, "Buying Rescue Equipment: How to Extricate the Confusion", RESCUE, November/December 1990, pp.17-20.

SUMMARY:

When purchasing hydraulic equipment, a business-like approach should be used. There are six tasks the consumer should perform:

1. Investigate-- For example, the company should be questioned as to whether rescue equipment is their main business and for how long?

2. Expect training-- Find out if the company has qualified trainers and if they would be willing to give a refresher course.

3. Ask around-- Get opinions on various companies from other departments. Talk to experts in the field about the qualities to expect in a rescue tool.

4. Consider safety-- Important safety considerations are ease of operation, reliability, and adaptability. The tools and hydraulic fluids must be safe for the rescuers.

5. Insist on demonstration-- Have the dealer perform basic functions and insist that your personnel be allowed to try the equipment.

6. Conduct evaluations-- Evaluate equipment without salesmen present. Lastly, compare prices.

2.2 Extrication Equipment Manufacturers by Tool Category

In this section extrication equipment manufacturers are listed according to the six tool categories. The listing is not intended to be comprehensive, but rather to serve as a quick point of reference.

The search was conducted by contacting extrication equipment manufacturers and requesting copies of their equipment brochurea.

2.2.1 Hand Tools

TOOL CATEGORY:	Hand tools
TOOL DESCRIPTION:	Any relatively small tool whose operations is completely dependent upon the user.
TOOL EXAMPLES:	Basic mechanic's tools, bolt cutters, come-alongs.

TOOL MANUFACTURERS:

Fire Hooks Unlimited, Inc.
979 Saw Mill River Rd.
Yonkers, NY 10710
Tel: (914) 423-5632/ Fax: (914) 423-5633

Geris Enterprises — PRODUCT NAME: GAM

Guardian
215 E. Hancock St.
Lansdale, PA 19446
Tel: (215) 855-2000/Fax: (215)855-8525

Iowa American Firefighting Equipment Company, Inc.
Industrial Park P.O. Box 517 Osceola, IA 50213
Tel: (800) 342-IOWA

Paratech, Inc.
1O25 Lambrecht Rd.
Frankfort, IL 60423
Tel: (815) 469-3911

Porter-Ferguson. Inc. — PRODUCT NAME: Arsenal System
321 Newbury St.
Danvers, MA 01923
Tel: (508) 774-1629/Fax: (508) 777-1281

Ziamatic Corp.
IO West College Ave.
P.O. Box 337
Yardley, PA 19067-0587
Tel: (215) 493-3618/Fax: (215) 493-1401

2.2.2 Manually Powered Tools

TOOL CATEGORY:	Manually powered tools
TOOL DESCRIPTION:	Tools in this category serve to increase the level of incoming operator energy/power to a higher level of energy output. The power source, however, is still the human operator.
TOOL EXAMPLES:	Various ram-type tools, and portapower equipment jacks

TOOL MANUFACTURERS:

Lukas Rescue Team, Inc. P.O. Box 1277 Fredericksburg, VA 22402 Tel: (703) 891-6600/Fax: (703) 891-6609	PRODUCT NAME: Lukas
Nike Rescue Tools P.O. Box I 107 S-631 80 Eskilstuna, Sweden Tel: +4616227260/Fax: +4616139316	PRODUCT NAME: Nike
Paratech, Inc. 1025 Lambrecht Rd. Frankfort, IL 60423 Tel: (815) 469-391 I	
Porter-Ferguson. Inc. 321 Newbury St. Danvers, MA 01923 Tel: (508) 774-1629/Fax: (SOS) 777-1281	PRODUCT NAME: Arsenal System
Special Service and Supply, Inc. 9I7 East Cemetery Ave. Chenoa, IL 61726 Tel: (815) 945-5221	PRODUCT NAME: The Boss

2.2.3 Cutting Tools

TOOL CATEGORY:	Cutting tools
TOOL DESCRIPTION:	Tools that are self-powered and perform cutting/sawing operations. They require the operator to guide and direct, but not power, the tool.
TOOL EXAMPLES:	Reciprocating saws, abrasive saws (K12 type), and oxyacetylene torches.

TOOL MANUFACTURERS:

Broco, Inc.
2834 North Locust Ave.
Rialto, CA 92376
Tel: (800) 845-7259/Fax: (714) 356-1426

Milwaukee — PRODUCT NAME: Sawzall
13135 West Lisbon Rd.
Brookfield, WI 53005
Tel: (414) 78l-3600/Fax: (414) 781-3611

Paratech, Inc.
1025 Lambrecht Rd.
Frankfort, IL 60423
Tel: (815)469-3911

2.2.4 Pneumatic Tools

TOOL CATEGORY:	Pneumatic tools.
TOOL DESCRIPTION:	Various types of tools that are operated on compressed air pressure. This pressure can be delivered either from a portable cylinder/tank or directly from an air compressor.
TOOL EXAMPLES:	Chisels, airbags, airshores, etc.

TOOL MANUFACTURERS:

Hart International, Inc. 265 N. Main St. Ambler, PA 19002 Tel: (215) 643-3473/Fax: (215) 643-1349	PRODUCT NAME: Lampe-Lifter (Zumbro)
Hurst Emergency Products 700 Spring Mill Ave. Conshohocken, PA 19248 Tel: (215) 825-6300/Fax:(215) 825-6440	PRODUCT NAME: Hurst
Indianapolis Industrial Products, Inc. 1428 Sadlier Circle, East Drive Indianapolis, IN 46239 Tel: (800) 827-3755	PRODUCT NAME: Mat-Jack
Paratech, Inc. 1025 Lambrecht Rd. Frankfort, IL 60423 Tel: (815) 469-3911	
Safety Corporation of America 1005 International Drive Oakdale, PA 15071-9223 Tel: (412) 695-3100/Fax: (412) 695-3232	
Special Service and Supply, Inc. 917 East Cemetery Ave. Chenoa, IL 61726 Tel: (815) 945-5221	PRODUCT NAME: The Boss

2.2.5 Hydraulic Tools

TOOL CATEGORY:	Hydraulic tools.
TOOL DESCRIPTION:	This type of tool is self-powered and generates a force by conveying fluid through a pump system.
TOOL EXAMPLES:	Spreaders/pullers, cutters.

TOOL MANUFACTURERS:

Amkus, Inc.
4728 Yender Ave.
Lisle, IL 60532- 1653
Tel: (708) 515-1800/Fax: (708) 515-8866

PRODUCT NAME: Amkus

F.A. Brick Industries, Inc.
437 Ivyland Road
Hunter Industrial Park Warminster, PA 18974
Tel: (215) 443-5008/Fax: (215) 443-9916

PRODUCT NAME: Phoenix

Holmatro, Inc.
1110 Benfield Blvd.
Millersville, MA 21108
Tel: (410) 987-6633/Fax: (410) 987-1638

PRODUCT NAME: Magnum

Hurst Emergency Products
700 Spring Mill Ave.
Conshohocken, PA 19248
Tel: (215) 825-6300/Fax: (215) 825-6440

PRODUCT NAME: Jaws of Life

Iowa American Firefighting Equipment Company, Inc.
Industrial Park
P.O. Box 517 Osceola, IA 50213
Tel: (800) 342-IOWA

Jerome Fire Equipment
840 E. Summer Ave.
Indianapolis, IN 46227
Tel: (317) 788-4611

PRODUCT NAME: Kinman Tool

TOOL CATEGORY:	Hydraulic tools
TOOL MANUFACTURERS (continued):	
Lukas Rescue Team, Inc. P.O. Box 1277 Fredericksburg, VA 22402 Tel: (703) 891-6600/Fax: (703) 891-6609	PRODIJCT NAME: Lukas
Nike Rescue Tools P.O. Box 1107 S-631 80 Eskilstuna, Sweden Tel: +461622726O/Fax: +4616139316	PRODUCT NAME: Nike
Porter-Ferguson, Inc. 321 Newbury St. Dancers, MA 01923 Tel: (508) 774-1629/Fax: (508) 777-1281	PRODUCT NAME: Arsenal System

2.2.6 Miscellaneous Other Tools

TOOL CATEGORY:	Miscellaneous tools.
TOOL DESCRIPTION:	This category serves as a catchall for devices that are used in rescue operations but are not actually tools.
TOOL EXAMPLES:	Webbing, cribbing, rope, pike poles, etc.

TOOL MANUFACTURERS:

Broco, Inc.
2834 North Locust Ave.
Rialto, CA 92376
Tel: (800) 845-7259/Fax: (714) 356-1426

F.A. Brick Industries, Inc.
437 Ivyland Road
Hunter Industrial Park Warminster, PA 18974
Tel: (215) 443-5008/Fax: (215) 443-9916

Fire Hooks Unlimited, Inc.
979 Saw Mill River Rd.
Yonkers, NY 10710
Tel: (914) 423-5632/ Fax: (914) 423-5633

Guardian
215 E. Hancock St.
Lansdale, PA 19446
Tel: (215) 855-2000/Fax: (215) 855-8525

Hurst Emergency Products
700 Spring Mill Ave.
Conshohocken, PA 19248
Tel: (215) 825-63OO/Fax: (215) 825-6440

PRODUCT NAME: Hurst

Paratech, Inc.
1025 Lambrecht Rd.
Frankfort, IL 60423
Tel: (815) 469-3911

2.3 Extrication Equipment Manufacturers Database

The equipment manufacturers' summaries included in this section arc housed in a database and they provide information regarding the manufacturers' brochures. The are presented alphabetically.

Manufacturer/Supplier	Address/Phone	Equipment	Contents	Comments
Airshore International Corp.	16211 - 84th Ave. Surrey, British Columbia, Canada V4N 1B3 TEL: (604) 597-0947 FAX: (604) 597-2384	Pneumatic-shoring device	Features, dimensions, specifications, facsimile, price list	• Two types-standard and swivel • Price list effective April 1, 1992
Amkus, Inc.	4728 Yender Ave. Lisle, IL 60532-1653 TEL: (708) 515-1800 FAX: (708) 515-8866	Hydraulic-spreader/ cutter, spreader, cutter, ram, accessories (chain package)	Features, dimensions, specifications Two articles, maintenance manual	• Article topics are history of Amkus and rescue equipment, and how to evaluate rescue equipment • Several power supply options including hand or foot pump • Catalog published 1992
Eliminator Industries	7830 Byron Drive, Suite 5 Riveria Beach, FL 33404 TEL: (800) 452-7144 FAX: (407) 844-9211	Pneumatic-glass and metal cutter/knife and accessories	Uses, prices, user's guide, video cassette	• Two blade types • 1993 Catalog
F.M. Brick Industries, Inc.	437 Ivyland Rd. Hunter Industrial Park Warminister, PA 18974 TEL: (215) 443-5008 FAX: (215) 443-9916	Hydraulic-spreader/cutters, cutters, rams, accessories (belts and shackles)	Features, dimensions, specifications, video cassette	• Gas/diesel or air power units • No date of publication
Fire Hooks Unlimited, Inc.	979 Saw Mill River Rd. Yonkers, NY 10710 TEL: (914) 423-5632 FAX: (914) 423-5633	Hand-axes, bolt cutters, hacksaws, pry bars, wrenches Cutting-circular/abrasive saw Miscellaneous-rope and hooks	Features, specifications, prices	• Mainly pike poles • Catalog and prices effective March 1992
Geras Enterprises, Inc.	4621 Dewey Drive New Port Richey, FL 34652	Hand tool-glass/metal cutter	Features	
Guardian Firefighting Equipment	215 E. Hancock St. Lansdale, PA 19446 TEL: (215) 855-2000 FAX: (215) 855-8525	Hand-prybars Miscellaneous-pike poles, hooks	Uses, features, price list	• Tools available with various handle types and materials • No date of publication

Manufacturer/Supplier	Address/Phone	Equipment	Contents	Comments
Hilti, Inc.	5400 South 122nd East Ave. P.O. Box 21148 Tulsa, OK 74121 TEL: (800) 879-8000 FAX: (800) 879-7000	Pneumatic-chisel/hammer/ drill and bits	Features, dimensions, specifications	• Gasoline or electric-powered models • Kits available
Holmatro, Inc.	1110 Benfield Blvd. Millersille, MA 21108 TEL: (410) 987-6633 FAX: (410) 987-1638	Manually powered-hydraulic jack with hand pump, spreader, cutters, rams, accessories (chains) Pneumatic-air bags and mats	Features, dimensions, materials, specifications, video cassette	• Various high- and low-pressure air bags and mats • Several power supply options including hand pump
Hurst Emergency Products	700 Spring Mill Ave. Conshohocken, PA 19248 TEL: (215) 825-6300 FAX: (215) 825-6440 (Sales address)	Hydraulic-spreader/cutters, spreaders, cutters, rams, accessories (chain and shackles) Pneumatic-air bags	Features, dimensions, materials, specifications, price list, article	• Several power supply options including hand pump • Hydraulic-standard and "mighty-1ite" series • Air bags-high pressure, various sizes • Article topic is history of Hurst • Price lists effective January 1 and July 1, 1992 • Catalogs published April and June 1992
Indianapolis Industrial Products, Inc.	1428 Sadlier Circle, East Drive Indianapolis, IN 46239 TEL: (800) 827-3755	Pneumatic-air bags	Uses, features, materials, dimensions, specifications, price list	• Air bags-various sizes, high and low pressure • Price list effective May 1, 1992

Manufacturer/Supplier	Address/Phone	Equipment	Contents	Comments
Iowa American Firefighting Equipment	Industrial Park P.O. Box 517 Oscella, IA 50213 TEL: (800) 342-IOWA	Manually powered-forcible entry tool with two spreader attachments and hand pump Hand-seat belt cutter	Features, prices	• Two sizes (4” and 8”) • Mainly forcible entry tools • No date of publication
Kinman of Indianapolis	840 E. Summer Ave. Indianapolis, IN 46227 TEL: (317) 788-4611	Hydraulic-spreader/cutter, ram, accessories (chains and shackles)	Features, specifications, materials, price list	• Battery-powered, can be adapted for other power sources • Price list effective January 1, 1990
Lukas Rescue Team, Inc.	P.O. Box 1277 Fredricksburg, VA 22402 TEL: (703) 891-6600 FAX: (703) 891-6609	Hydraulic--cutters Manually powered-hydraulic spreader with built-in hand pump	Features, specifications	• Advertisement page • March 1992 issue of Fire Engineering
Milwaukee Electric Tool Corporation	13135 West Lisbon Rd. Brookfield, WI 53005 TEL: (414) 781-3600 FAX: (414) 781-3611	Cutting-reciprocating saws, circular saws, chain saws, and accessories	Uses, features, specifications, price book	
Nike Rescue Tools	P.O. Box 1107 S-631 80 Eskilstuna, Sweden TEL: +4616117260 FAX: +4616139316	Manually powered-hydraulic spreader, hydraulic cutter with built-in hand pumps Hydraulic tools-spreader, cutter, ram	Features, dimensions, specifications	• Electric-powered hydraulic pump or hand pump (available) • Catalog distributed December 1990

Manufacturer/Supplier	Address/Phone	Equipment	Contents	Comments
Paratech, Inc.	1025 Lambrecht Rd. P.O. Box G Frankfort, IL 60423-0705 TEL: (800) 435-9358 FAX: (815) 469-7748	Hand-axes, chisels, pry bars, saws, seat belt cutter Manually powered-ram-type tool (various attachments) Cutting-circular saws Pneumatic-air bags, air chisel Miscellaneous--chains, hooks	Features, specifications, price lists	• Air bags-high pressure, various sizes • price lists' dates range from March 1990 to March 1992
Partner Industrial Products	907 W. Irving Park Rd. Itasca, IL 60143	Cutting-circular saw, blades, and accessories	Features, specifications, price list	• Various models • Kits available from distributor only • Prices effective 5/l/92 (distributor prices)
Porter-Ferguson, Inc.	321 Newbury Street Danvcrs, MA 01923 TEL: (508) 774-1629 FAX: (508) 777-1281	Hand-bolt cutter Manually powered-spreaders, cutters, portapower, cutters with built-in hand pump, and accessories	Description, features, dimensions, specifications, price list, video cassette	• Air/hydraulic pumps including hand/foot pump • No date of publication
Rite Line Inc.	P.O. Box 226 Tolland, CT 06084-0226 TEL: (203) 228-0047 or (203) 871-7208	Hydraulic-spreader pads and parts	Uses	• Two sizes • No publication date
Special Service and Supply, Inc.	917 East Cemetery Avenue Chenoa, IL 61726 TEL: (815) 945-5221	Pneumatic-air chisel, spreader Manually powered-portapower systems	Uses, features, specifications	• Various kits available • No date of publication
Speedway Hydraulics, Inc.	2480 Calle Narisco Thousand Oaks, CA 91360 TEL: (805) 494-4556 FAX: (805) 379-9715	Hydraulic-utter	Uses, features, dimensions, materials, video cassette	• No date of publication

Manufacturer/Supplier	Address/Phone	Equipment	Contents	Comments
Vetter Systems, Inc.	PllP-ICM Bldg. 1005 International Drive Oakdale, PA 15071-9223 TEL: (412) 695-3100 FAX: (412) 695-3232	Pneumatic-air bags	Uses, features, dimensions, materials, specifications, price list	• Air bags-low, medium high pressure; various sizes • Brief history of Vetter products • Catalog published April 1992 • Price list effective March 15, 1992 • Address is for Vetter's North American distributor
Ziamatic Corporation	10 West College Ave. P.O. Box 337 Yardley, PA 19067-0587 TEL: (215) 493-3618 FAX: (215) 493-1401	Hand-axes, bolt cutters, cutters, pry bars	Features, dimensions	• Mainly firefighting tools • 1992 catalog
Zumro	6003 Cassowary Lane New Bern, NC 28560 TEL: (800) 932-6003 FAX: (919) 638-6853	Pneumatic-air bags	Materials, specifications, price list	• Air bags-high pressure, various sizes • Bulletins published July 1990 and May 1991 • Price list effective March 1, 1992

3 In-Field Observations of Vehicle Extrication Equipment Training Sessions

3.1 Overview

Just over 100 written requests were sent to fire service agencies asking to observe an extrication equipment drill or training course. The agencies were primarily in the western New York State area. Records were kept regarding the various agencies' responses to the letter and followup telephone calls were placed as needed.

Of the requests that were sent out, 1 agency declined and 15 other various agencies responded via telephone calls, expressing their interest in participating. Twelve in-field observations were scheduled as quickly as a response was received from a fire service agency. The participating agencies were comprised of three urban, five suburban, and four rural agencies. These agencies included three career agencies and nine volunteer agencies as shown in Table 3. 1-1,

Observations were attended by two contractor employees with extrication equipment experience as volunteer fire/rescue personnel. The comments and totals (in bracketed areas) that have been provided on the Observation form in Table 3.1-2, attempt to summarize the overall results of the 12 observations. Each site is discussed individually in the sections that follow. Each observation was videotaped and the Video Tape Observation Form was completed (See Table 3.1-3). The form was used by the observation team member to evaluate equipment safety and effectiveness. The vehicles that were extricated during the observation sessions are listed in Table 3.1-4.

Table 3.1-1 Participating Agencies for In-Field Observations

CLASSIFICATION MATRIX

Urban: 3 observations

Suburban: 5 observations

Rural: 4 observations

COMPOSITION MATRIX

Career: 3

Volunteer: 9

FIRE SERVICE AGENCY	CLASSIFICATION	COMPOSITION
Site #1	Rural	100% Volunteer
Site #2	Urban	100% Career
Site #3	Rural	100% Volunteer
Site #4	Suburban	100% Volunteer
Site #5	Suburban	100% Volunteer
Site #6	Urban	100% Career - recruits
Site #7	Rural	100% Volunteer
Site #8	Suburban	100% Volunteer
Site #9	Urban	100% Career - recruits
Site #10	Suburban/Rural	100% Volunteer
Site #11	Suburban	100% Volunteer
Site #12	Rural	100% Volunteer

Table 3.1-2 In-Field Observations

IN-FIELD EXTRICATION EQUIPMENT OBSERVATION FORM

DATE: N/A
OBSERVATION TEAM: N/A
FIRE/RESCUES SERVICE AGENCY: 1 - 12
COMMANDING OFFICER: N/A
LOCATION: Site 1 - 12 VEHICLE (S) TYPE (S): Various
VEHICLE DAMAGE: Minor to simulated roll-over
EXTRICATION EQUIPMENT USED: Various
NUMBER OF RESCUERS REQ'D. TO OPERATE THIS PIECE OF EQUIP.: Average is 1
START TIME OF PROCEDURE: N/A END TIME OF PROCEDURE:
1) DOES THIS APPEAR TO BE THE CORRECT TOOL FOR THE PROCEDURE‘? A (12) - YES - (in most cases, the correct tool was used) B ( ) - NO IF NO, EXPLAIN

2) DID THIS TOOL CAUSE ANY RESCUER INJURIES‘?

A ( )-YES
B(12)-NO

IF YES. EXPLAIN:

3) DID THIS TOOL CAUSE ANY ADDITIONAL, VICTIM INJURIES?

A ( ) - YES
B(12)-NO

IF YES, EXPLAIN:

4) TOOL’S EFFECTIVENESS FOR THIS APPLICATION:

A ( ) UNACCEPTABLE
B ( ) ACCEPTABLE. BUT COULD BE IMPROVED
C ( ) SATISFACTORY
D ( ) VERY SATISFACTORY

COMMENTS: Ranges from acceptable, but could be improved, to very satisfactory.

5) TOOL’S EASE OF OPERATION, (including setup. weight, fatigue factors, etc.):

A ( ) DIFFICULT
B ( ) SATISFACTORY, BUT COULD BE IMPROVED
C ( ) SATISFACTORY
D ( ) EXCELLENT

COMMENTS: Ranges from satisfactory, but could be improved, to excellent.

6) PHYSICAL STRENGTH, WEIGHT. OR HEIGHT REQUIREMENTS FOR PROPER TOOL USAGE?

A ( ) YES
B(12)NO

IF YES, EXPLAIN:

7) TOOL'S PORTABILITY:

A ( ) DIFFICULT
B ( ) SATISFACTORY, BUT COULD BE IMPROVED
C ( ) SATISFACTORY
D ( ) EXCELLENT

COMMENTS: Ranges from satisfactory, but could be improved, to excellent.

8) HOW EXTENSIVE A TRAINING PROGRAM IS REQUIRED TO OPERATE THIS PIECE OF EQUIPMENT? Ranges from very extensive to little training required.

A ( ) VERY EXTENSIVE - (with periodic refresher training)
B ( ) EXTENSIVE
C ( ) SOME TRAINING REQUIRED
D ( ) LITTLE TRAINING REQUIRED
E ( ) NO TRAINING REQUIRED

9) WAS THIS TOOL USED IN WAYS OTHER THAN WHAT IT WAS DESIGNED FOR'?

A ( ) YES
B (12) NO

IF YES, EXPLAIN:

10) HAVE ANY USER MODIFICATIONS BEEN MADE TO THIS TOOL'?

A ( ) YES
B (12) NO

IF YES, EXPLAIN:

11) ADDITIONAL COMMENTS: N/A

Table 3.1-3 Video Tape Observation Form

EXTRICATION EQUIPMENT FIELD OBSERVATION ANALYSIS FORM

DATE: N/A EVALUATOR (S): N/A

FIRE/RESCUE SERVICE AGENCY/SITE NUMBER: 1 - 12

VEHICLE TYPE: Various

VEHICLE DAMAGE: Minor to simulated roll-over

VEHICLE STABILIZATION:

A (9) ACCOMPLISHED PRIOR TO INITIATION OF " CUT-DOWN ” OPERATIONS
B (1) ACCOMPLISHED DURING OPERATIONS
C (1) PARTIALLY STABILIZED DURING OPERATIONS
D (1) NO STABILIZATION UNDERTAKEN - (vehicle does not have wheels)

COMMENTS:

EFFECTIVENESS OF STABILIZATION/ METHOD OR TECHNIQUE OF..

A (12) CRIBBING
B ( ) AIRSHORES
C (1) HIGH-LIFT JACK (S)
D ( ) ROPES/STRAPS/SLINGS
E ( ) CHAINS
F ( ) DEFLATION OF TIRES (IF INDICATED)
G ( ) OTHER:______________________________

QUALITY OF VEHICLE STABILIZATION:

H (11) SOLID
I (1) SLIGHTLY MOVEABLE
J ( ) POORLY STABILIZED

K (10) STABILIZATION CHECKED PRIOR TO INITIATION OF RESCUE WORK

EXTRICATION DEVICE TO BE EVALUATED: Various

EXTRICATION OPERATION (S) TO BE UNDERTAKEN: Various

NUMBER OF RESCUERS REQ'D. TO OPERATE THIS DEVICE: Average 1 person

PHYSICAL STRENGTH, WEIGHT, OR HEIGHT REQUIREMENTS FOR PROPER TOOL USAGE ?

A ( ) YES
B (12) NO

IF YES, EXPLAIN:

TOOL PORTABILITY:

A ( ) SMALL,COMPACT - EASILY CARRIED BY ONE RESCUER
B ( ) MODERATELY LARGE UNIT - CAN BE CARRIED BY ONE RESCUER
C ( ) LARGE UNIT - CANNOT BE CARRIED ANY DISTANCE ALONE
D ( ) LARGE, BULKY - REQUIRES TWO RESCUERS TO CARRY
E ( ) EXTREMELY CUMBERSOME TO CARRY - REQUIRES 2 + RESCUERS
F ( ) OTHER: ______________________

COMMENTS: Majority of tools/equipment are : small,compact to moderately large.

PORTABILITY OF THE POWER UNIT :

A ( ) HARD-MOUNTED / PTO DRIVEN UNIT
B ( ) OPERATES FROM TRUCK AIR SYSTEM
C ( ) SLING PACK / BACK PACK UNIT
D ( ) REMOTE, HAND CARRIED UNIT
E ( ) OTHER: ________________

COMMENTS: Majority of power units are hand carried, one sling pack was observed.

START TIME OF PROCEDURE:

ELAPSED TIME: N/A

END TIME OF PROCEDURE:

DOES THIS APPEAR TO BE THE CORRECT TOOL FOR THE PROCEDURE ?

A (12) - YES For most observations

B ( ) - NO IF NO, EXPLAIN

IS THERE SUBSTANTIAL POTENTIAL FOR RESCUER INJURIES ?

A ( ) - YES, IF YES EXPLAIN

B (12) - NO Not if use sensibly/properly

TOOL EFFECTIVENESS FOR THIS APPLICATION:

A ( ) VERY SATISFACTORY
B ( ) SATISFACTORY
C ( ) SOMEWHAT SATISFACTORY, BUT COULD BE IMPROVED
D ( ) UNSATISFACTORY
E ( ) INAPPROPRIATE DEVICE FOR THIS OPERATION

COMMENTS: Majority were satisfactory to very satisfactory.

TOOL EASE OF OPERATION:

A ( ) EXCELLENT
B ( ) SATISFACTORY
C ( ) SATISFACTORY, BUT COULD BE IMPROVED
D ( ) DIFFICULT

COMMENTS: Most were satisfactory

TOOL EFFICIENCY:

A ( ) EXCELLENT
B ( ) SATISFACTORY
C ( ) SATISFACTORY, BUT COULD BE IMPROVED
D ( ) POOR

COMMENTS: Ranges from: satisfactory, but could be improved to excellent.

TOOL EASE OF SET-UP/RIGGING TIME:

A ( ) EXCELLENT, EASILY SET-UP
B ( ) SATISFACTORY, SETS-UP MODERATELY EASILY
C ( ) SATISFACTORY, BUT COULD BE IMPROVED - REQUIRES TIME TO SET-UP
D ( ) SATISFACTORY, BUT COULD BE IMPROVED - REQUIRES EFFORT TO SET-UP
E ( ) DIFFICULT, REQUIRES TOO MUCH TIME AND/OR IS TOO LABOR INTENSIVE - TAXES MANPOWER

COMMENTS: Ranges from: satisfactory, sets-up moderately easily to excellent.

TRAINING REQUIRED FOR OPERATION OF THIS DEVICE:

A ( ) VERY EXTENSIVE - (with periodic refresher training)
B ( ) EXTENSIVE
C ( ) SOME TRAINING REQUIRED
D ( ) LITTLE TRAINING REQUIRED
E ( ) NO TRAINING REQUIRED

COMMENTS: Ranges from: little training required to very extensive.

UNIQUE OR UNUSUAL APPLICATIONS OF THIS DEVICE TO RESCUE OPERATIONS ?

A (1) YES
B (11) NO

IF YES, EXPLAIN: Use of windshield wiper arm and, radio whip antenna to remove side/rear glass.

HAVE ANY USER MODIFICATIONS BEEN MADE TO THIS TOOL ?

A ( ) YES
B (12) NO

IF YES, EXPLAIN:

ADDITIONAL COMMENTS: The use of the windshield wiper arm and/or the solid radio whip antenna were demostrated and discussed as a means of obtaining access to the passenger compartment of a vehicle utilizing equipment that is part of the vehicle. These procedures were intended for use in an “urgent-need” situation, they were not intended for an everyday “front line” approach to side or rear glass removal.

Table 3.1-4 Field Observations: Vehicle Types

Site #1	Dodge Regis 4 door Toyota Corolla 2 door
Site #2	‘81 Plymouth Reliant 4 door ‘80 Fort Fairmont S/W
Site #3	‘85 Chevrolet 30 van chassis Sturdibus mini school bus - wheelchair accessible
Site #4	Toyota Corola 2 door ‘85 Mercury Lynx 4 door
Site #5	‘79 Chrysler LeBaron 2 door
Site #6	‘84 Mazda GLC 4 door Chevrolet Citation
Site #7	‘81 Ford Escort Hatchback (3 door)
Site #8	‘81 Toyota Corolla SRS hatchback (3 door)
Site #9	Buick Regal 2 door Cadillac Sedan DeVille 4 door Chevrolet Caprice S/W Chevrolet Impala 4 door Ford Granada 4 door
Site #10	‘81 Dodge Omni 4 door
Site #11	‘65 Buick Le Sabre 4 door Datsun (Nissan) 2802
Site #12	‘78 Buick Skylark 2 door

3.2 In-Field Observation Sites

3.2.1 Site #1

Site #1 was a mutual-aid training drill involving rural volunteer agencies. The host fire company, that was soon to put in service a new Hurst 5000 combination tool, hoped to gain experience/familiarity with its equipment. This was, in part, to be accomplished by observing and working with the mutual-aid companies in this controlled situation. The mutual-aid neighbors came to this drill with their own hydraulic equipment-one Hurst 5000 combination (one-person) toot and one Hurst 32B (two-person) spreader.

Operations that were attempted with the Hurst 5000 combination were: left front door opening and removal from hinges; driver's seat push to rear of vehicle; A-pillar cut, vehicle lift. All operations were basically "typical" operations. All vehicles used were fully stabilized prior to initiation of operations. The operation undertaken with the Hurst 32B spreader was a typical over-the-hood steering column pull. The windshield was removed by a "hammer-type" windshield glass tool and a pneumatic chisel prior to the column putt.

It seemed that the tool operators were coming to grips with an important concept that should be applied to the use of any power tool. This is it is imperative to understand the limits of the toot, and not demand performance above and beyond those limits. It also is important to understand "your own limits" as the rescuer or rescuer tool operator.

Extrication times were recorded where and when possible. No excessively long times were observed. Several operations were delayed in progress for instructional purposes. Tool performance and safety were not a concern. No unsafe procedures were observed. However, an excessive amount of time was spent with the Hurst 5000 combination tool in an effort to **cut** through the base of the B-pillar (at or near the rocker panel) to facilitate removal. The H-pillar cut was initially attempted with the rear door open. but still attached at the hinges. During the operation. the door was removed at the hinges to provide clear access to the rear side of the B-pillar. Perhaps this was undertaken to assess the effectiveness/capabilities of the cutter aspect of this tool. No tool modifications were observed, nor had any modifications been performed on any type of tool used by these fire companies.

3.2.2 Site #2

Site #2 was an equipment familiarity refresher drill involving a large urban (metro) career agency. Specifically, this drill was led by one of this agency's two heavy rescue units, along with an engine company and a ladder company. The hydraulic equipment available for use at this drill was as follows: Hurst 5000 combination (one-person) tool; Hurst 30" ram; Hurst 32B (two-person) spreader; Holmatro spreader: and Holmatro cutter.

Various operations that were undertaken as well as the equipment used are as follows:

1) windshield removal using a flat-head axe and windshield glass saw
2) side and rear glass removal with a spring-loaded center punch
3) various door openings and removals with a Hurst 5000 combination tool and a Hurst 32B spreader
4) A and B pillar cuts (for roof roll) with a Hurst 5000 combination tool, Hurst cutter, and Holmatro cutter
5) dash roll with a Hurst 30" ram, used with rocker panel support bracket
6) C & D pillar cuts (station wagon) using a Milwaukee Super Sawzall

Extrication times were recorded where and when possible. All operations were completed efficiently with no excessively long times observed. However, several delays in various operations occurred for instructional purposes. Tool performance/efficiency and safety were not a problem and no unsafe procedures were observed. However, it should be noted that vehicle stabilization was not accomplished until completion of glass removal operations. The need for stabilization was discussed, but not attempted immediately. This may have been due to the extremely poor environmental conditions---very sloppy, muddy conditions.

No tool modifications were observed, nor had any modifications been performed on any type of tool used by this agency. However, this agency did fabricate two devices that arc used by the rescue company. These items arc:

1) a windshield saw, which resembles some of the commercially available models; and 2) a rum/rocker panel support bracket, which is also similar to commercial units. These items work in the same manner at the commercial units, only they were not as costly to obtain.

3.2.3 Site #3

Site #3 was a bus rescue drill using a wheelchair bus (based on a one-ton dual wheel ram chassis). It was conducted by a rural volunteer agency. The drill scenario was intended to simulate a roll-over accident where the vehicle had barrel-rolled and was once again upright, on its wheels, with substantial roof deformation (see Figure 1) and unopenable doors. ("Damage" was created by using a bent-end loader to deform roof.)

Some of the equipment available for use at this drill was as follows: Amkus spreaders, cutters, rams and pneumatic chisels. Several different methods of completing a specific task were attempted and some were more efficient than others. The pneumatic chisel malfunctioned and could not be repaired on site. Therefore, there was a delay while a replacement chisel was obtained. Tool performance/efficiency was a concern regarding the pneumatic chisel and a standard hacksaw. All other tools or implements performed very welt. Some operations were started with either the pneumatic chisel or the hacksaw and completed with the Amkus cutters due to increased speed and case of operation of the hydraulic tool.

Stabilization of the vehicle was achieved prior to the start of any rescue work. Also, the stabilization was checked several times during the operation. The intent of the operation was to allow the roof to be "rolled up" from right to left (see Figure 9). Thus, all structural members on the right side were removed (cut) prior to the "roil." The roll-up was started with the come-along, and, once free of all hindrances. the roll was competed by moving the engine (to which the come-along was anchored) away from the left side of the bus.

No modifications were observed, nor had any modification been performed on any type of tool used by this agency. Extrication times were recorded where and when possible. Ail operations were completed safely.

Site 3, Figure 1

Site 3, Figure 2

3.2.4 Site #3

Site #4 was an equipment familiarity refresher drill involving a relatively large island-based suburban volunteer agency. This drill was intended to familiarize all members with all types of extrication equipment, both manually powered and/or self-powered.

The hydraulically powered rescue tools that were available at the scene were composed of the following devices: Hurst (two-person) 32B spreader; Hurst (one-person) spreader; Hurst cutter; Hurst rams Hurst 5000 electric power unit, and Hurst/Chrysler powered two-cycle gas power unit.

The various operations that were undertaken as well as the equipment used arc as follows:

1) Side and rear glass removal with a spring-loaded center punch, biel tool, pike-head axe (pike portions), Haligan tool (spike portion)
2) windshield removal using a windshield glass saw
3) various door openings and/or removal with a Hurst spreader and hand-powered socket set
4) lower A-pillar cut with Hurst cutters
5) dash roll using a 30" Hurst ram, 20" Hurst ram (see Figure 3); over-the-hood steering column pull with a chain-type come-along
6) A, B, C pillar cuts using a Milwaukee Super Sawzall
7) access to passenger rear seat on two-door vehicle through body panels with a Milwaukee Super Sawzall

Extrication times were recorded when possible; however, two vehicles were being "worked on" concurrently. Therefore. it was difficult to observe and document times on all operations. All operations were completed relatively efficiently and without any major delays. Since scene operations were conducted with hand tools on one vehicle and power tools on the other vehicle, there naturally were variance in terms of times required to complete a specific operation.

No problems were observed with tool performance/efficiency or safety. It should be noted that during stabilization efforts, one vehicle was stabilized with step blocks inserted in an inverted fashion. It did not apparently detract from the overall stability of the vehicle; however, there does exist the potential for these to "work loose" in a prolonged a ggressive extrication effort. An additional safety precaution that was taken (seldom seen in this area), was to place a short length of large diameter hose over the remaining segments of the various A, B, and/or C pillars following the pillar cut as in a roof-roll operation (Figure 4).

No tool modifications were observed, nor had any modifications been performed on any type of tool used by this agency. It should be noted, however. that this drill was conducted in the evening and floodlights were needed. The engine company that carried an onboard generator was some distance from the scene, so a remote hand-carried generator was used to power the floodlights as well as the Hurst 5000 electric power unit. Apparently, with the floodlights in use and the power unit in use, the generator could not withstand the draw of these items and would trip its circuit breaker. After several of these instances occurred, the electric power units were disconnected and the Hurst/Chrysler two-cycle gas power unit put on line. It was unclear which generator normally is used to power the Hurst power unit.

Site 4, Figure 3

Site 4. Figure 4

3.2.5 Site #5

Site #5 was an equipment familiarity refresher drill involving a suburban volunteer agency. This drill was intended primarily to refresh the members on the Amkus spreaders and cutters. These particular Amkus tools run off an electric power unit, which in turn is powered from the heavy rescue truck's generator (the heavy rescue truck carries all rescue/extrication equipment).

The various operations that were undertaken, as well as the equipment used, are as follows:

1) windshield removal with a windshield glass saw (for demonstration only), flat-head axe
2) side glass removal with a spring-loaded center punch
3) left and right door opening with Amkus spreaders
4) left and right door removal at hinges, A and B pillar cuts, roof cut (for roof roll) with Amkus cutters

Extrication times were recorded and no excessively long times were obtained. One door was somewhat difficult to open, as the door skin tore loose prior to the door actually opening (Figure 5)

Tool efficiency/performance and safety were not a concern. All tools operated efficiently, no unsafe procedures were observed. However, complete vehicle stabilization was not truly achieved-only three "corners" of the vehicle were stabilized with step blocks, while the fourth step block was next to the vehicle and it was never installed.

No tool modifications were observed nor had any tool modifications been performed or attempted on any type of tool used by this agency. However, the agency did perform some alterations to the Amkus electric power unit. The standard I IO-volt motor on the power unit was deemed insufficient or not dependable enough. This I IO-volt system was replaced by a user-installed 220-volt motor, which also operates off the rescue truck's onboard generator.

Site 5, Figure 5

3.2.6 Site #6

Site #6 was a hands-on extrication equipment training session for career firefighter recruits, involving a relatively large urban career agency. Specifically, this session was led by one of this metro area's front-line rescue/engine companies.

The equipment used in this class came from this engine company. The rescue equipment available for use was as follows: Hurst 33B spreader (two person). Hurst cutter-, and Hurst rams. Ail were powered with an upgraded four-cycle, 4-HP gas power unit. which replaced a11 older two-cycle gas power unit. Also used were a Hurst accessory kit and Vetter 27 and 32 ten air bags.

The various operation and the equipment used were as follows:

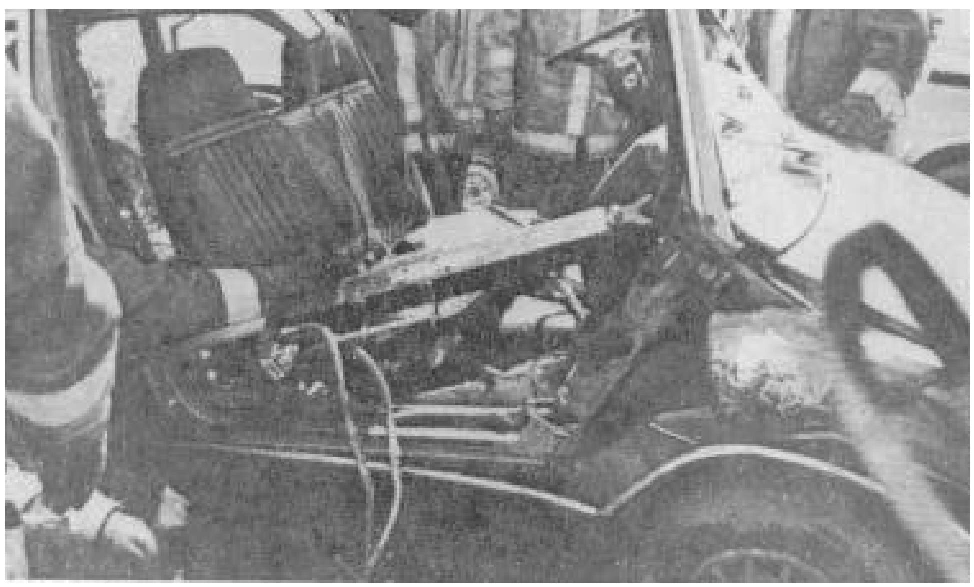
1) vehicle lift and stabilization with box cribbing and 22 and 32 Vetter air bags (see Figure 6) and Hurst 32B spreader
2) windshield removal with a “Can-opener” style windshield glass tool
3) side glass removal with a spring-loaded center punch
4) various door openings/removal with the Hurst 32R spreader
5) steering column pull (done in stages to display various setups), an over-the-hood pull. vertical pull from the roof through the windshield area using the Hurst 32B spreader
6) an upper and lower A pillar cut using a Hurst cutter
7) a dash roll with Hurst rams (see Figure 7)

Extrication times could not be obtained accurately, as this was a training session and, therefore, there were many stops in each operation for additional instruction+. Tool performance/efficiency, as well as safety, were not concerns. All tools performed relatively efficiently. Safety was drilled into the recruits. including both victim and rescuer safety, and no unsafe or dangerous procedures were observed. Vehicle stabilization was discussed thoroughly. Time was not devoted, however, to actual vehicle stabilization efforts at this session, but rather the focus of the session was to allow more hands-on time with the equipment.

No tool modifications were observed. nor had any been performed on any type of tool used by this agent). However, this agency did fabricate some devices that it currently uses:

1) a 1/4-inch flat steel plate (diamond plate) used for lifting surface for air bags.
3) the "can-opener” style windshield tool was fabricated from a scraped truck leaf spring.

Site 6, Figure 6



Site 6, Figure 7

3.2.7 Site #7

Site #7 was an equipment familiarity drill session for "rookie" firefighters, involving a rural volunteer agency. This session was led in part by the department's training officer and by a senior officer.

The equipment used in this drill was carried primarily on the heavy rescue truck. The equipment that was available included: a Hurst 5000 gas power unit (upgraded from an older style two-cycle unit); a Hurst 32B (two-person) spreader; Hurst cutters; and Hurst rams.

The operations that were performed include the following:

1) door opening/removal using Hurst 32B spreaders
2) door hinge cut with a Hurst cutter
3) windshield trim removal with a baling hook
4) windshield cut (not removal) with "hammer-type"glass tool
5) steering column pull (over the hood) with Hurst 32B spreaders
6) A-pillar cut and roof cut with a Hurst cutter

Extrication times were not readily available, due to interruptions to allow for additional instruction. It should be noted that a simulated victim was extricated from the driver's seat prior to vehicle stabilization. The only heavy rescue work performed to allow for victim removal was the opening of the left door with the Hurst 32B spreaders. Later in the session, "standard" extrication operation procedures, i.e., stabilization, elimination of battery source connections, etc., were performed. There were no problems observed with tool efficiency/performance. No tool modifications were observed, nor had any modifications been performed on any type of tool used by the agency. The agency did, however, upgrade the Hurst power unit from the older style Hurst two-cycle gas power unit to a Hurst four-cycle gas power unit.

3.2.8 Site #8

Site #8 was an equipment familiarity refresher drill involving a relatively large suburban volunteer agency. The rescue equipment that was available for use at this drill was as follows: Amkus spreaders, cutters, and rams. Various load rating air bags and a sawzall were available but not used.

The operations undertaken, along with the equipment used, are as follows:

1) side and rear glass removal using a spring-loaded center punch;
2) A, B, and C pillar cuts with Amkus cutters
3) various door opening/removals with Amkus spreaders
4) steering column pull (over-the-hood) using Amkus spreaders
5) dash roll with Amkus rams; and vehicle lift weight Amkus spreaders. The windshield was removed intact with the entire roof assembly. When the A-pillars **were** cut, a segment of three to four inches in length was removed. Then the B and C pillars were cut, and the spreaders used to expand the area that had been cut out. By pulling the windshield out of its lower weatherstripping, it allowed the glass to come off with the balance of the roof assembly.

Extrication times were recorded where possible. All operations were completed efficiently. There were no problems observed regarding tool efficiency or safety. No tool modifications were observed nor had any been performed or attempted on any type of tool used by the agency.

3.2.9 Site #9

Site #9 was a hands-on extrication equipment training session for career firefighter recruits conducted at the New York State Fire Academy. The recruits all were from urban agencies of various sizes.

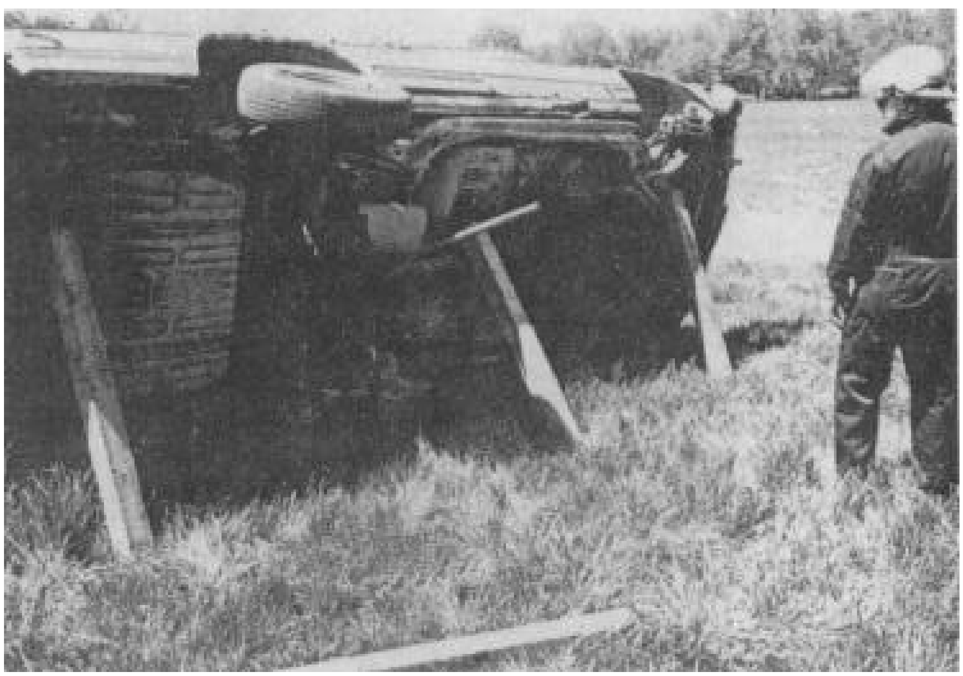
The equipment used in this class is used by the academy in its various training courses. All the equipment was supplemented by a large array of Amkus equipment. The operations that were undertaken and the equipment that was used are as follows:

1) overturned vehicle stabilization using cribbing and high-lift jacks (see Figures 8 and 9)
2) side and rear glass removal with a sprin g-loaded center punch, Haligan tool (spike), and pike head axe (pike), windshield wiper arm (without wiper blade), solid radio antenna whip (non-telescoping)
3) windshield removal with pike head axe (flat portion). and windshield saw
4) access to nader pin (enlargement or increased access for spreader) with Haligan tool
5) door openings/removal with Amkus and Holmatro spreaders
6) door pull (beyond normal travel) using a come-along
7) A and B pillar cuts with a standard hack saw, Holmatro and Amkus cutters; body panel (skin) cuts/removal using a biel tool ("can-opener" portion) and pneumatic chisel
8) C pillar cut with Milwaukee super sawzall
9) roof rib cuts with the Milwaukee super sawzall

Extrication times could not be accurately obtained due to the instructional purpose of the session and the fact that five vehicles were being worked on concurrently. No problems were observed regarding tool performance/efficiency or safety. All tools performed relatively efficiently. Both victim and rescuer safety were discussed in depth throughout the session. No tool modifications were observed, nor had any been performed on any type of tool used at the training session. However, some seldomly seen procedures were demonstrated, such as the windshield wiper arm and radio antenna whip to remove side or rear glass.

The use of the windshield wiper arm and/or the solid radio whip antenna were presented as a means of displaying the feasibility of using nonconventional "tools" In an urgent need situation. The use of non-conventional "tools" was intended to convey the concept that the vehicle itself may well present the equipment required to accomplish the extrication procedure. These procedures were not intended for everyday use.

Site 9, Figure 8



Site 9. Figure 9

3.2.10 Site #10

Site #10 was an equipment familiarity refresher drill involving a mid-size suburban/rural volunteer agency. The rescue equipment that was available for use at this drill was as follows: Phoenix combination spreader/cutter tool, Phoenix cutter, Phoenix rams and Blackhawk pneumatic chisel.

The operations that were conducted were as follows:

1) side glass removal with a spring-loaded center punch;
2) door openings with the Phoenix combination tool;
3) hinge cuts with the phoenix cutter;
4) access to latch assembly with a “hammer-type” panel cutter and Blackhawk pneumatic chisel;
5) A and B pillar cuts and roof cuts with the Phoenix cutters and Phoenix combination tool;
6) windshield removal with windshield glass saw; and
7) steering column pull (over the hood) with a Phoenix combination tool with webbing accessary.

The Phoenix combination spreader/cutter was inserted into the window opening of the left front door with one arm of the tool inside and one outside the door. The tool was then closed, thereby squeezing the door and ultimately increasing access to the latch area.

No tool efficiency/performance or safety problems were observed. Some tools were used in applications that were perhaps better suited to other types of tools, thus resulting in some reduction in efficiency. No tool modifications were observed, nor had any been performed or attempted on any type of tool used by the agency.

3.2.11 Site #11

Site #11 was a basic hand tool course led by an instructor for the New York State Office of Fire Protection and Control. The host agency was a suburban volunteer agency; the course was attended by several other volunteer firefighters. The intent of this course was to educate firefighters as to how to achieve the same or nearly identical results in vehicle dismantling with common hand tools as compared to specialized rescue tools.

The various operations that were undertaken, as well as the equipment used on them, are as follows:

1) side glass removal with a spring-loaded center punch and Haligan tool (spike portion)
2) rear glass removal using a solid radio whip antenna
3) body panel cuts (body skin cut to reveal door latch system) with a flat-head axe and sledge hammer, ram-type chisel, and pneumatic chisel

Extrication times were recorded if possible, although there were several delays in each operation for instructional purposes. Extrication times for the various operations were somewhat longer with hand tools than times obtained for the same operations conducted with power equipment. A safety concern when using the Haligan tool (or similar tool) to remove side glass is that the shaft of the tool must be allowed to strike the vehicle's body, and the "spike" must be allowed to strike low in the corner of the window. This prevents the head of the tool from penetrating too far into the passenger compartment. However, this procedure was not observed. No tool modifications were observed, nor had any been performed or attempted on any type of tool in service.

The use of the windshield wiper arm and/or the solid radio whip antenna was presented as a means of displaying the feasibility of using nonconventional "tools" in an urgent need situation. The use of non-conventional "tools" was intended to convey the concept that the vehicle itself may well present the equipment required to accomplish the extrication procedure. These procedures were not intended for everyday use.

Considering the relatively widespread acceptance of the spring-loaded center punch as the tool of choice for side or rear glass removal, coupled with its comparatively low cost, the alternative "tools" discussed here are unlikely to be widely used in the fire service as the front line or primary side/rear glass removal tool.

3.2.12 Site #12

Site #12 was an extrication equipment drill involving a rural volunteer agency. The agency did not possess specialized rescue equipment, and used basic or common manually powered equipment. However, a neighboring company also participated and used its Phoenix rescue tools. The equipment that was available at this drill was as follows: Phoenix combination spreader/cutter; Phoenix cutter; and Phoenix rams.

Various operations that were observed as well as the equipment used on them are as follows:

1) windshield trim removal with a biel tool
2) windshield removal using a windshield glass saw
3) door opening and removal with a Phoenix combination
4) A-pillar cut with a Phoenix combination tool

Extrication times were recorded. All operations were completed efficiently and no excessively long times were observed. No problems with tool efficiency/performance or safety were observed. All tools were operated safely. even with relatively new or potentially unskilled operators, and no unsafe or hazardous procedures were observed. Vehicle stabilization was discussed but not required as the vehicle had no wheels and was resting on its frame. The duration of this drill was cut short due to very inclement weather. No tool modifications were observed nor had any been performed or attempted on any type of tool used by this agency.

3.3 Conclusions of In-Field Observations

Throughout the field observations no misuse of equipment was observed and all tools performed relatively well at their intended tasks. A summary of the frequency with which various tool types were used is presented in Table 3.3- 1. It was unfortunate that no extrication of late model vehicles was observed. The lack of new vehicles for extrication training sessions is due in part to their limited availability, but primarily because it is cost prohibitive. Based on our experience, it appeared rescuers are not receiving training on extrication techniques appropriate for late model vehicles because older model vehicles are more readily available and less costly.

It was apparent during the field observations that training sessions provided a wealth of benefits to the rescuers. Sufficient familiarity with the equipment will allow the user to rapidly deploy the equipment with confidence in an emergency situation. A key point evident throughout the training sessions was that it was in the rescuer's best interest to "keep an open mind." It is imperative to realize that there is always more than one way to achieve the intended goal. If one approach does not seem to be making any appreciable progress in the extrication process, perhaps a different approach or a different type of tool would be worth considering. One area that the fire/rescue services of the United States can take immeasurable pride in is their innovation. No matter how much drilling or practicing is completed, a situation will always arise that will test the abilities of the rescuers and their equipment to the maximum and it is this innovative ability that will allow them to see beyond their current dilemma and find the solution.

It is this innovation and far-sightedness that has shaped the fire/rescue service and the equipment it uses, and will continue to provide improvements that will benefit everyone.

Table 3.3-l Field Observations: Tool Types - Frequency of Use

Frequency of Use	Tool Types
1	Air bag
2	Baling hook
3	Biel tool/pry axe
3	Come-a-long
1 2	Cribbing
3	Haligan tool - (spike portion)
1	High-lift jacks
5	Hydraulic ram
5	Hydraulic spreader - (two-person)
4	Hydraulic combination spreader/puller
6	Hydraulic spreader/puller
12	Hydraulic cutter
1	Misc. Hand tools - (socket set)
5	Pneumatic chisel
2	Radio antenna - (solid whip type)
1	Ram-type tool
3	Reciprocating saw
1	Sheet metal panel cutter - (hammer type)
9	Spring-loaded center punch
2	Standard hack saw
4	Various axes
6	Windshield glass tool - (windshield saw)
2	Windshield glass tool - (hammer type)
1	Windshield wiper arm (without wiper blade)
1	Windshield glass tool - (can-opener type)

4 Nationwide Vehicle Extrication Equipment Users' Survey

4.1 Overview

The survey was conducted to identify the types of vehicle extrication equipment currently in service across the United States and to evaluate the safety and efficiency of the equipment. The survey participants were vehicle extrication equipment users with hands-on experience. The intention of the survey was to identify any areas where new or enhanced equipment could improve the extrication process.

4.2 Survey Design and Methodology

It was determined that approximately one-third (11,OOO) of the 34,000 fire and rescue departments in the United States perform vehicle extrication. Based on time, funding limitations, and the need to limit input to a workable amount of data, it was determined that no more than 325 surveys would be distributed. Three hundred and sixteen surveys were sent out. Sixteen of the surveys were sent to recipients who were selected by the USFA Project Officer and the data collected from this group were treated separately from the main database. Copies of the cover letters and survey that were sent to participants can be found in Appendix A.

The first phase of the survey sampling methodology was to identify major urban, small urban. suburban, and rural areas. These areas were defined as follows:

Major Urban. Cities with populations over 200,000.

Small Urban. Cities with populations of 100,000 to 200,000 that are not suburban areas surrounding a major metropolitan area. and whose fire departments may consist of both career and volunteer personnel.

Suburban. Built-up, developed areas that are primarily residential with populations of 25,000 or more and adjacent to a larger city. and whose fire departments likely would consist of almost entirely volunteers.

Rural. Agricultural or other non-urban areas in town or surrounding areas with populations of fewer than 25,000, and whose fire department\ likely would consist of almost entirely volunteers.

For the major urban areas, one survey was sent to each of the 75 most populated cities as determined from the 1990 Census. The targeted survey recipients were from city- or county-based fire departments or emergency services agencies that perform vehicle extrication for a metropolitan area. Survey recipients were instructed to use their own discretion as to whom in their particular department should complete or provide input to the survey based on level of experience with vehicle extrication equipment.

To select small urban, suburban, and rural survey recipients, state fire marshals (or state fire training directors as alternates) were contacted. Each state representative was asked to provide the names of fire departments or emergency services organizations which perform vehicle extrication in their state for each of the small urban, suburban and rural categories. Names for each category were received from all 50 states. The names were combined into an aggregate list for each of the three population categories. From each of the category lists. 75 survey recipient names were selected randomly.

Figure 4.2-1 provides an overview of the survey sampling methodology. The locations from which survey participants were selected can be seen in Table 4.2-1.

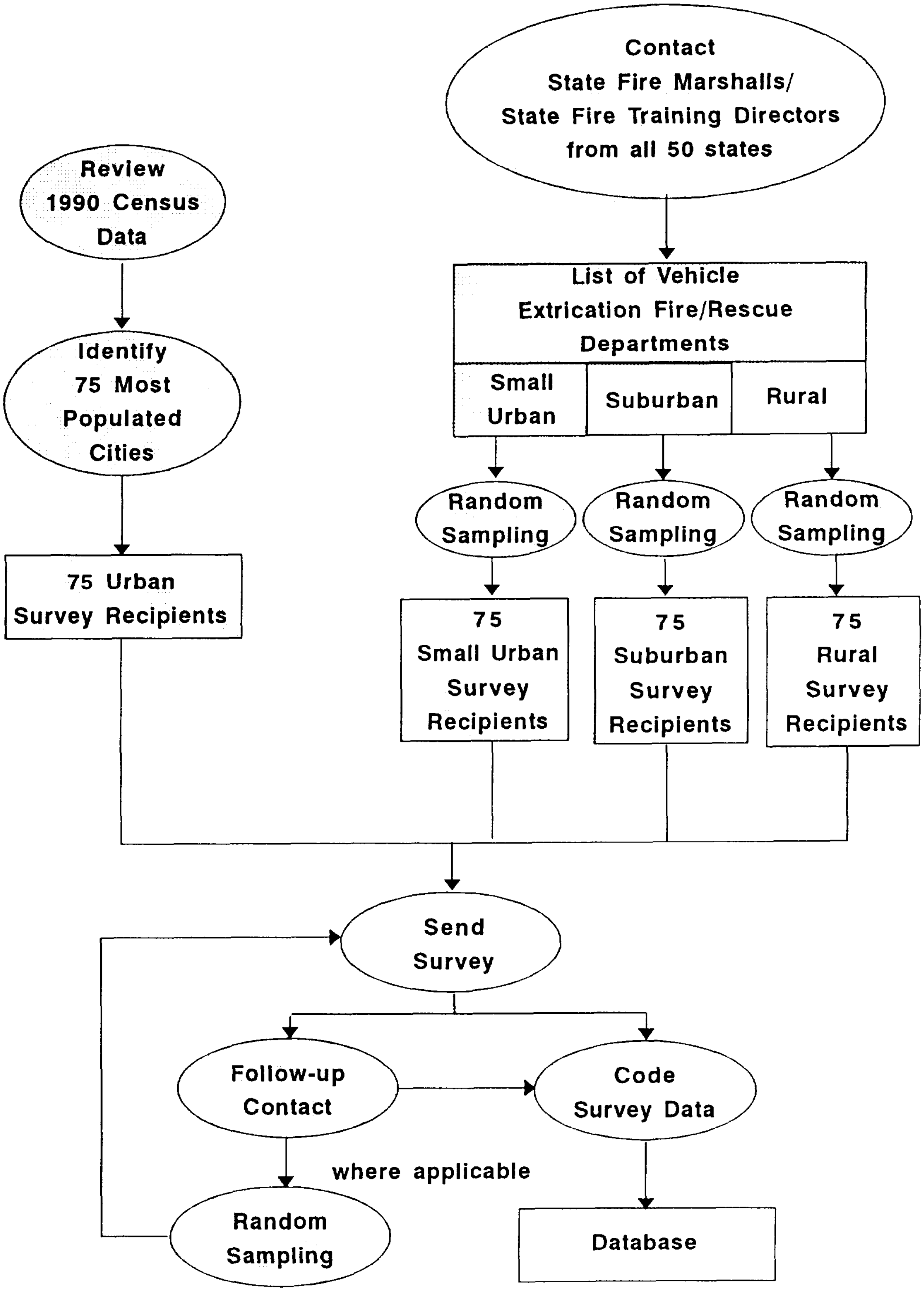


Figure 4.2-1 Survey Sampling Methodology

Table 4.2-1 Locations of Survey Recipients

Survey Participant	CODE	Region
Los Angeles, CA	M-2	W
Philadelphia, PA	M-5	NE
San Diego, CA	M-6	W
Dallas, TX	M-8	S
San Jose, CA	M-11	W
Baltimore, MD	M-13	S
Jacksonville, FL	M-15	S
Columbus, OH	M-16	NC
Memphis, TN	M-18	S
Washington, DC	M-19	S
Boston, MA	M-20	NE
Seattle, WA	M-21	W
El Paso, TX	M-22	S
Denver, CO	M-26	W
Austin, TX	M-27	S
Fort Worth, TX	M-28	S
Oklahoma City, OK	M-29	S
Portland, OR	M-30	W
Kansas City, MO	M-31	NC
Long Beach, CA	M-32	W
Tucson, AZ	M-33	W
St. Louis, MO	M-34	NC
Atlanta, GA	M-36	S
Oakland. CA	M-39	W
Pittsburgh, PA	M-40	NE
Minneapolis, MN	M-42	NC
Tulsa, OK	M-43	S
Honolulu, HI	M-44	W
Cincinnati, OH	M-45	NC
Miami, FL	M-46	S
Fresno, CA	M-47	W
Omaha, NE	M-48	NC
Toledo, OH	M-49	NC
Buffalo, NY	M-50	NE
Santa Ana, CA	M-52	W
Mesa, AZ	M-53	W
Colorado Springs, CO	M-54	W
Tampa, FL	M-55	S
Louisville, KY	M-58	S
Birmingham, AL	M-60	S
Arlington, TX	M-61	S
Norfolk, VA	M-62	S
Las Vegas, NV	M-63	W
Corpus Christi, TX	M-64	S
St. Petersburg, FL	M-65	S
Rochester, NY	M-66	NE
Jersey City, NJ	M-67	NE
Riverside, CA	M-68	W
Anchorage, AK	M-69	W
Lexington, KY	M-70	S
Aurora, Co	M-72	W
Baton Rouge, LA	M-73	S
Stockon, CA	M-74	W
Raleigh, NC	M-75	S

Survey Participant	CODE	Region
Searcy, AR	SU-1	S
Hartford, CT	SU-4	NE
Melbourne, FL	SU-6	S
Port Richey, FL	SU-9	S
Hollywood, FL	SU-10	S
Savannah, GA	SU-11	S
Albany, GA	SU-12	S
Waycross, GA	SU-13	S
Athens, GA	SU-14	S
Hilo, HI	SU-15	W
Des Moines, IA	SU-16	NC
Fort Wayne, IN	SU-19	NC
Gary, IN	SU-22	NC
Kansas City, KS	SU-24	NC
New Iberia, LA	SU-26	S
Worcester, MA	SU-27	NE
Springfield, MA	SU-28	NE
Sterling Heights, MI	SU-31	NC
Lansing, MI	SU-33	NC
Branson, MO	SU-34	NC
Independence, MO	SU-36	NC
Mebane, NC	SU-40	S
Sparks, NV	SU-42	W
Reno, NV	SU-43	W
Jamestown, NY	SU-44	NE
Ogdensburg, NY	SU-46	NE
Watertown, NY	SU-49	NE
Utica, NY	SU-50	NE
Niagara Fall, NY	SU-52	NE
Dayton, HO	SU-55	NC
Salem, OR	SU-58	W
Milwaukie, OR	SU-59	W
Allentown, PA	SU-60	NE
Rapid City, SD	SU-63	NC
Knoxville, TN	SU-64	S
Mequite, TX	SU-65	S
Irving, TX	SU-66	S
Abilene, TX	SU-67	S
Salt Lake City, UT	SU-69	W
Chestervield, VA	SU-71	S
Edmonds, WA	SU-72	W
Bellevue, WA	SU-75	W

Survey Participant	CODE	Region
Fort Smith, AR	S-3	S
Boulder, CO	S-6	W
Jay, ME	S-19	NE
Ft. Fairfield, ME	S-20	NE
Davison. MI	S-26	NC
Black Jack, MO	S-27	NC
Gulfport, MS	S-23	S
Hickory, NC	S-32	S
Concord, NH	S-34	NE
Passaic, NJ	S-35	NE
Santa Fe, NM	S-36	W
Hobbs, NM	S-37	W
Carlsbad, NM	S-38	W
N. Las Vegas, NV	S-40	W
Little Falls, NY	S-42	NE
Albany, NY	S-46	NE
Springfield, OR	S-48	W
Cranston. RI	S-50	NE
Coventry, RI	S-51	NE
Johnston, RI	S-52	NE
Cumberland, RI	S-54	NE
Cumberland, RI	S-56	NE
Newport, RI	S-57	NE
Greenville, SC	S-58	S
Jackson, TN	S-63	S
Kingsport, TN	S-64	S
Port Orchard, WA	S-66	W
Kenosha, WI	S-71	NC
Brookfield, WI	S-72	NC
Greenfield, WI	S-73	NC
Charleston, WV	S-75	S

Survey Participant	CODE	Region
Texarkana, AR	R-2	S
Conway, AR	R-3	S
Yuma, AZ	R-4	W
Rehoboth Beach, DE	R-8	S
Waynesboro, GA	R-11	S
LaGrange, GA	R-12	S
Colby, KS	R-15	NC
Murry, KY	R-16	S
Portland, ME	R-19	NE
Gorham, ME	R-23	NE
Plainwell, MI	R-24	NC
Eureka, MO	R-26	NC
Hazen, ND	R-32	NC
N. Hampton, NH	R-34	NE
Jackpot, NV	R-39	W
Castalia, OH	R-42	NC
Edinboro, PA	R-45	NE
Platteville, WI	R-66	NC
Ashippun WI	R-68	NC
New Glarus, WI	R-69	NC
Chippewa Falls, WI	R-70	NC
Lancaster, WI	R-73	NC

As instructed in the cover letter accompanying the survey, survey recipients returned blank surveys when the survey had been sent to the wrong department/organization or if their department/organization had no experience in the operation of vehicle extrication equipment. For each of the six blank surveys that were returned another recipient name was selected randomly from the corresponding population category. Followup telephone and written contacts were made to survey recipients when no response to the survey was received. In some cases the recipients had not received the original survey and subsequently were sent a second copy.

Of the 300 surveys originally sent out, the following were received: 54 urban, 42 small urban, 31 suburban, and 22 rural participants (149 total). Of the 16 survey participants selected by the USFA Project Officer 6 responses were received. The data from the six surveys are not included in the database analyses but are included in the recommendations in Section 6.0.

The survey participants were coded according to the population size of their area and their geographic location. Determination of geographic regions was based on the system used in the 1990 census and is demonstrated in Figure 4-2.

POPULATION SIZE	GEOGRAPHIC LOCATION
Major Urban	Northeast
Small Urban	North Central
Suburban	South
Rural	West

Census Regions

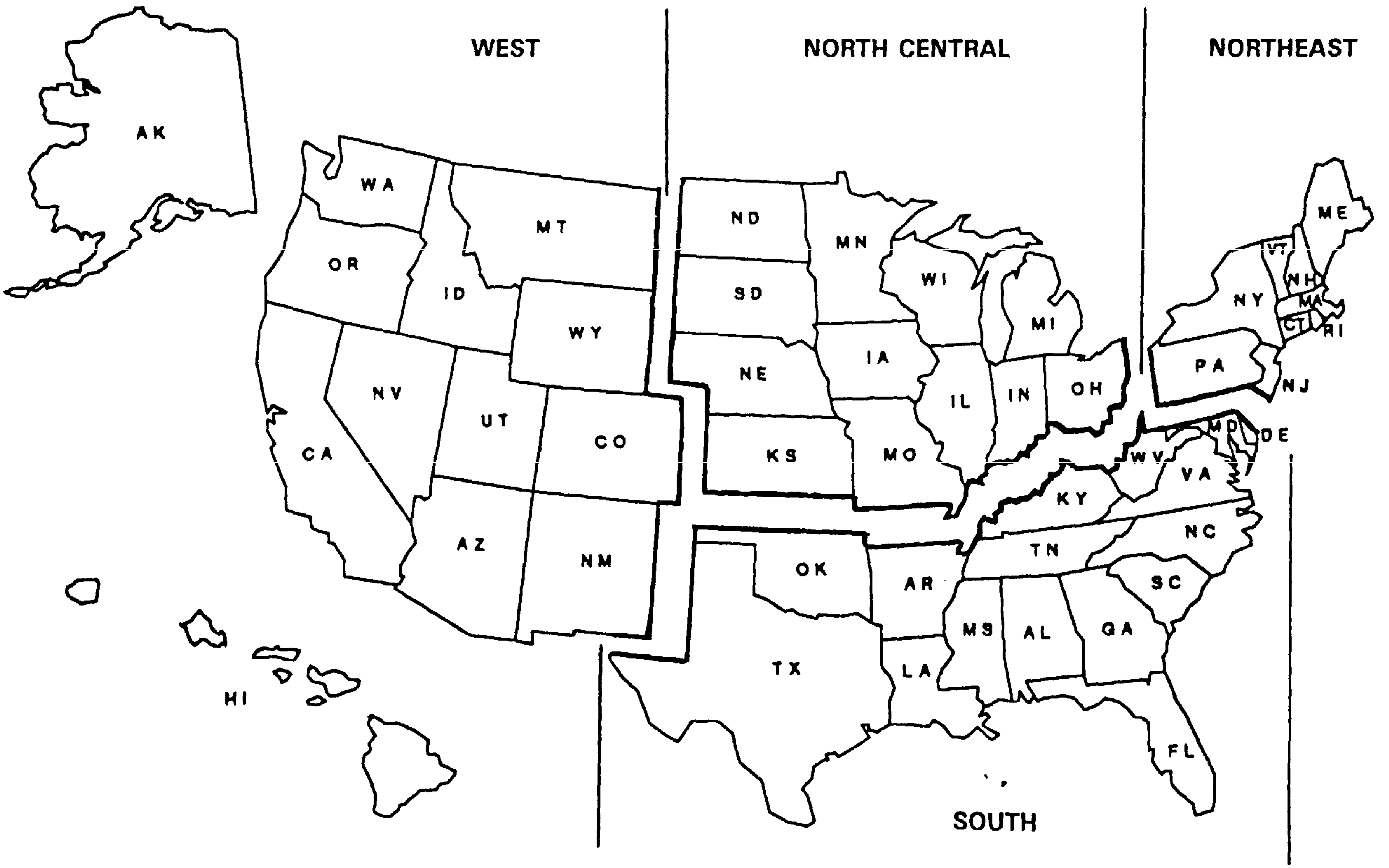


Figure 4.2-2 1990 Census Map

4.3 Results

When the surveys were received, the responses were coded and entered into the database using EXCEL software. The coding in most cases was either already quantitative or easily converted to a quantitative value. In some cases, however, particularly when responses required open-ended comments, some interpretation of the data was required. In these instances, consistency of interpretation was maintained by having the same two researchers code the comments individually, compare ratings, and reach agreement on the coding.

Each of the following six sections, 4.3.1 - 4.3.6, provides survey information on a specific tool type. The format followed in each section, when appropriate, includes: 1) a pie chart showing response percentages of the total population for each evaluation category: 2) a table of response percentages and number of responses of the total population for each evaluation category; 3) tables of response percentages and number of responses analyzed by population category and geographic location; and 4) tables of comments on improvements/modifications, including number of responses and percentage of responses, by total population. The final section. 4.3.7, provides fire/rescue agency information.

Due to the limited size and exploratory nature of the project, only basic statistics are provided (e.g., percentages and means). No tests of significance were conducted. The data were analyzed according to population size and geographic location in order to identify any differences due to the requirements of a particular community size or the demands specific to a geographic region. When no differences were apparent among the groups, however, no discussion of the data is provided. It is also important to be aware that all comments that were made by survey participants were included, regardless of sample size. This means that in some cases a particular comment may have been made only by one or two participants. It was felt that more information could be gained regarding tool performance by takin g this approach (e.g., a great idea for improving a tool may only have been thought of by one person). In order to provide some means of evaluating the importance of a particular comment, however, each comment is accompanied with the number of times the comment occurred. As it was not the intent of the survey to compare different manufacturers' products, comments were modified when they contained specific brand names of tools to reflect a general tool type, when possible, or else they were excluded from the report. The comment "Need more, newer, or better tools" occurred frequently throughout the survey and conveyed the need of the participant's agency to improve its tool inventory. Since this comment is extrinsic to the evaluation of tool design, it is not included in the discussion of the results, but it is included in the data tables.

4.3.1 Hand Tools-Description

This category is defined as any relatively small tool whose function is completely dependent upon the operator. The operator must provide all energy needed to make the tool functional. Examples of hand tools include basic mechanics' tools, bolt cutters, come-alongs, etc.

4.3.1.1 General Satisfaction - Hand Tools

As shown in Figure 4.3.11-1, 47 percent of all participants were very satisfied with hand tool performance, 44 percent said they were somewhat satisfied, 3 percent were somewhat dissatisfied, and one percent was very dissatisfied. Five percent of responses were no comment. Data for population and geographic categories are presented in Table 4.3.1.1-1.

Comments regarding satisfaction with hand tools, as shown in Table 4.3.11-2, were 87 percent not applicable/no comment, and 13 percent were comments regarding satisfaction. The comments were: other tools do the same job better than hand tools, hand tools are used infrequently, and hand tools are the most used tool type.

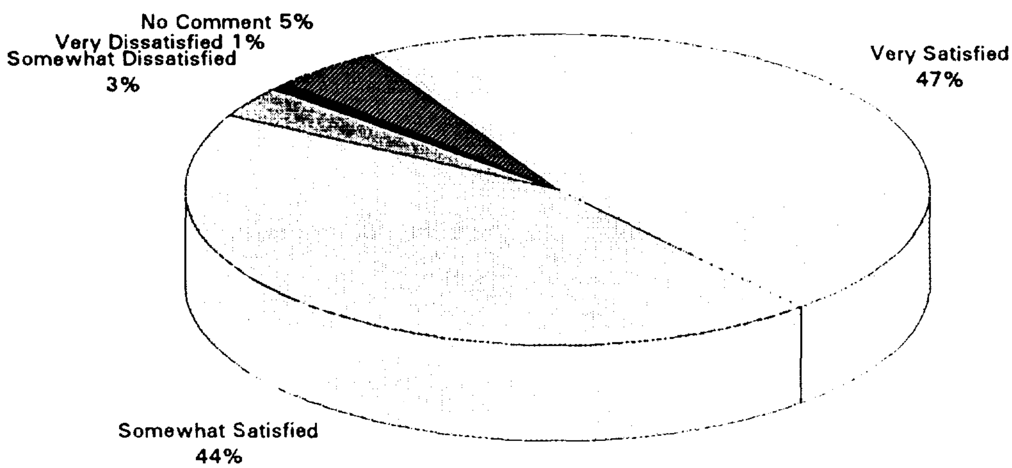


FIGURE 4.3.1.1-1 HAND TOOLS - SATISFACTION RATING

TABLE 4.3.1.1-1
HAND TOOLS - SATISFACTION RATING

Total Responses by Population

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Population Count
Total # of Resp.	**70**	**66**	**5**	**1**	**7**	**149**
Total % of Resp.	**47.0%**	**44.3%**	**3.4%**	**0.7%**	**4.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Population Count
Urban	26	23	1	0	4	54
Small Urban	17	19	3	0	3	42
Suburban	15	16	0	0	0	31
Rural	12	8	1	1	0	22
Total	**70**	**66**	**5**	**1**	**7**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Population Count
Urban	48.1%	42.6%	1.9%	0.0%	7.4%	100.0%
Small Urban	40.5%	45.2%	7.1%	0.0%	7.1%	100.0%
Suburban	48.4%	51.6%	0.0%	0.0%	0.0%	100.0%
Rural	54.5%	36.4%	4.5%	4.5%	0.0%	100.0%

REGION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Region Count
North Central	13	16	1	1	1	32
North East	11	19	0	0	1	31
South	28	18	2	0	2	50
West	18	13	2	0	3	36
Total	**70**	**66**	**5**	**1**	**7**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Region Count
North Central	40.6%	50.0%	3.1%	3.1%	3.1%	100.0%
North East	35.5%	61.3%	0.0%	0.0%	3.2%	100.0%
South	56.0%	36.0%	4.0%	0.0%	4.0%	100.0%
West	50.0%	36.1%	5.6%	0.0%	8.3%	100.0%

TABLE 4.3.1.1-2
HAND TOOLS

Comments on Satisfaction by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	130	86.7%
Comments	20	13.3%
Total Comments	**150 ***	**100.0%**

Comments	Number of Responses	Percentage of Responses
Need more, newer, or better tools	13	65.0%
Other tools do same job better	3	15.0%
Hardly used	3	15.0%
Most used tool type	1	5.0%
Total	**20**	**100%**

* Multiple responses were permitted

4.3.1.2 Ease of Operation - Hand Tools

Five percent of all participants rated hand tools as very easy to operate, 35 percent said they were easy to operate, 4 percent said somewhat easy and 3 percent said they were not easy to operate. Fifty-three percent of all responses were no comment. The data are provided in Figure 4.3.1.2-1 Population and geographic data are provided in Table 4.3.1 .2-1. Since ease of operation and effectiveness were evaluated together in the same question, it was difficult to separate the comments that were made. Therefore, it was decided to include all of the comments in the following section on tool effectiveness. Data for total response by population, population category and geographic location are given in Table 4.3.1.2-1.

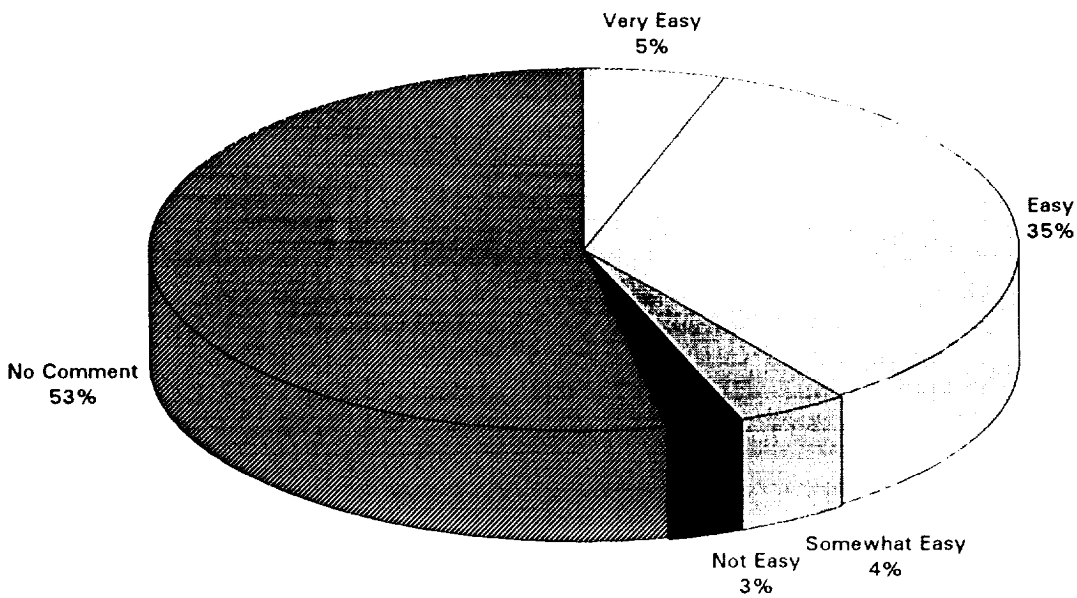


FIGURE 4.3.1.2-1 HAND TOOLS - EASE OF OPERATION RATING

TABLE 4.3.1.2-1
HAND TOOLS - EASE OF OPERATION RATING

Total Responses by Population

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Population Count
Total # of Resp.	**8**	**52**	**6**	**4**	**79**	**149**
Total % of Resp.	**5.4%**	**34.9%**	**4.0%**	**2.7%**	**53.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Population Count
Urban	6	20	1	1	26	54
Small Urban	0	16	4	2	20	42
Suburban	2	10	1	0	18	31
Rural	0	6	0	1	15	22
Total	**8**	**52**	**6**	**4**	**79**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Population Count
Urban	11.1%	37.0%	1.9%	1.9%	48.1%	100.0%
Small Urban	0.0%	38.1%	9.5%	4.8%	47.6%	100.0%
Suburban	6.5%	32.3%	3.2%	0.0%	58.1%	100.0%
Rural	0.0%	27.3%	0.0%	4.5%	68.2%	100.0%

REGION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Region Count
North Central	0	15	0	1	16	32
North East	1	9	3	1	17	31
South	4	15	2	2	27	50
West	3	13	1	0	19	36
Total	**8**	**52**	**6**	**4**	**79**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Region Count
North Central	0.0%	46.9%	0.0%	3.1%	50.0%	100.0%
North East	3.2%	29.0%	9.7%	3.2%	54.8%	100.0%
South	8.0%	30.0%	4.0%	4.0%	54.0%	100.0%
West	8.3%	36.1%	2.8%	0.0%	52.8%	100.0%

4.3.1.3 Effectiveness - Hand Tools

Of all responses on hand tool effectiveness, as depicted in Figure 4.3.1.3-1, 13 percent of the responses were very effective, 32 percent were effective, 5 percent were somewhat effective, one percent was not effective and 49 percent were no comment. Population and geographic data are provided in Table 4.3.1.3-1.

Responses to the effectiveness/ease of operation of hand tools were 65 percent not applicable/no comment, 25 percent comments on tool problems and 15 percent comments on tool assets. Some more frequently made comments on hand tool performance problems were: the operator determines the effectiveness of hand tool; hand tools have limited uses and are limited to small jobs; the soft jaws on bolt cutters make them ineffective to use; bolt cutters are ineffective in tight areas; and come-alongs are hard to deploy. Comments on performance assets included: hand tools are simple to use and hand tools are sturdy and reliable/dependable. Data arc provided in Table 4.3.1.3-2.

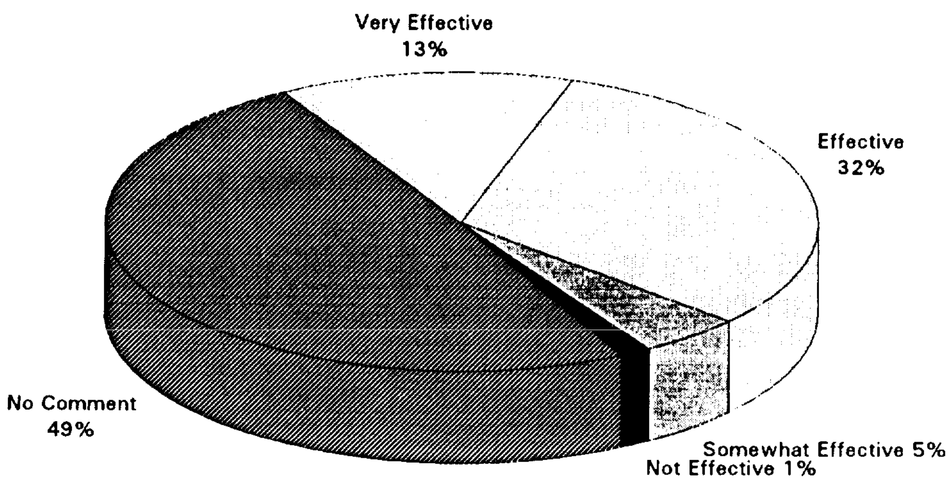


FIGURE 4.3.1.3-1 HAND TOOLS - EFFECTIVENESS RATING

TABLE 4.3.1.3-1
HAND TOOLS - EFFECTIVENESS RATING

Total Responses by Population

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Population Count
Total # of Resp.	**20**	**47**	**7**	**2**	**73**	**149**
Total % of Resp.	**13.4%**	**31.5%**	**4.7%**	**1.3%**	**49.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Population Count
Urban	11	17	3	0	23	54
Small Urban	2	16	2	1	21	42
Suburban	5	9	2	0	15	31
Rural	2	5	0	1	14	22
Total	**20**	**47**	**7**	**2**	**73**	**149**

Percent of Responses

Urban	20.4%	31.5%	5.6%	0.0%	42.6%	100.0%
Small Urban	4.8%	38.1%	4.8%	2.4%	50.0%	100.0%
Suburban	16.1%	29.0%	6.5%	0.0%	48.4%	100.0%
Rural	9.1%	22.7%	0.0%	4.5%	63.6%	100.0%

REGION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Region Count
North Central	3	11	0	1	17	32
North East	2	11	3	0	15	31
South	11	12	3	1	23	50
West	4	13	1	0	18	36
Total	**20**	**47**	**7**	**2**	**73**	**149**

Percent of Responses

North Central	9.4%	34.4%	0.0%	3.1%	53.1%	100.0%
North East	6.5%	35.5%	9.7%	0.0%	48.4%	100.0%
South	22.0%	24.0%	6.0%	2.0%	46.0%	100.0%
West	11.1%	36.1%	2.8%	0.0%	50.0%	100.0%

TABLE 4.3.1.3-2
HAND TOOLS

Comments on Effectiveness/Ease of Operation by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	105	64.8%
Comments on Tool Problems	40	24.7%
Comments on Tool Assets	17	10.5%
Total Comments	**162 ***	**100.0%**

Comments on Performance Problems	Number of Responses	Percentage of Responses
Operator determines effectiveness	11	27.5%
Limited uses/small jobs	5	12.5%
Bolt cutters - soft jaws	5	12.5%
Bolt cutters - ineffective in tight areas	4	10.0%
Come-along - hard to deploy	4	10.0%
Slow or slower than other tools	2	5.0%
Heavy	2	5.0%
Tool failure	2	5.0%
Requires more effort/manpower	1	2.5%
Handle lengths	1	2.5%
Come-along - heavy	1	2.5%
Come-along - obsolete	1	2.5%
Come-along - not durable	1	2.5%
Total	**40**	**100%**

Comments on Performance Assets	Number of Responses	Percentage of Responses
Simple	7	41.2%
Sturdy	2	11.8%
Reliable/dependable	2	11.8%
Controllable	1	5.9%
Low maintenance	1	5.9%
Work well in tight areas	1	5.9%
Works well with other tool types	1	5.9%
Only tools for some jobs	1	5.9%
Versatile	1	5.9%
Total	**17**	**100.0%**

* Multiple responses were permitted

4.3.1.4 Storage Efficiency - Hand Tools

Storage of hand tools was evaluated according to three criteria: 1) adequacy, 2) safety, and 3) accessibility.

Adequacy. As shown ;n Figure 4.3.1.4-1, 54 percent of the total responses indicated that storage of hand tools was adequate, 3 percent somewhat adequate, 9 percent indicated that storage was not adequate, and 34 percent had no comment. Population and geographic data are provided in Table 4.3.1.4-1.

Safety. Fifty percent of all responses indicated that storage of hand tools was safe, while one percent stated that it was somewhat safe and one percent stated that storage was unsafe, Data are provided in Figure 4.3.1.4-2. Population and geographic data are included in Table 4.3.1.4-2.

Accessibility. Fifty-eight percent of a11 responses indicated that storage of hand tools was accessible, while 4 percent said somewhat accessible and another 4 percent said that storage was inaccessible. Data are provided in Figure 4.3.1.4-3. Table 4.3.1.4-3 contains population and geographic data.

Of the responses to hand tool storage improvements. as listed in Table 4.3.1.4-4, 5 percent were no improvement, 64 percent were not applicable/no comment and 31 percent were improvement suggestions. Some improvements more frequently cited were: more storage space. lower compartments, pull-out drawers/trays, more compartmentalized storage and use of mounting clips.

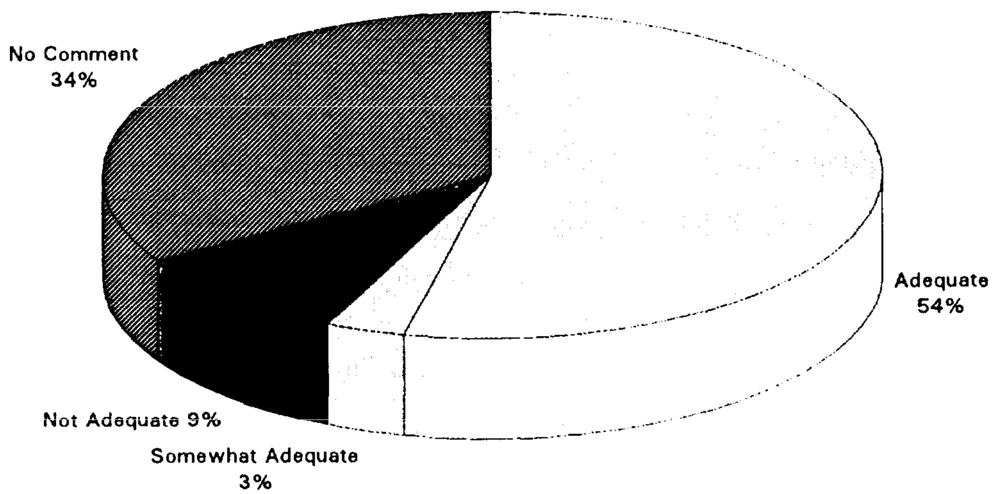


FIGURE 4.3.1.4-1 HAND TOOLS - STORAGE ADEQUACY RATING

TABLE 4.3.1.4-1
HAND TOOLS - STORAGE ADEQUACY RATING

Total Responses by Population

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Population Count
Total # of Resp.	**80**	**5**	**14**	**50**	**149**
Total % of Resp.	**53.7%**	**3.4%**	**9.4%**	**33.6%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Population Count
Urban	32	2	6	14	54
Small Urban	19	2	3	18	42
Suburban	18	1	3	9	31
Rural	11	0	2	9	22
Total	**80**	**5**	**14**	**50**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Population Count
Urban	59.3%	3.7%	11.1%	25.9%	100.0%
Small Urban	45.2%	4.8%	7.1%	42.9%	100.0%
Suburban	58.1%	3.2%	9.7%	29.0%	100.0%
Rural	50.0%	0.0%	9.1%	40.9%	100.0%

REGION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Region Count
North Central	13	0	4	15	32
North East	11	2	7	11	31
South	32	1	2	15	50
West	24	2	1	9	36
Total	**80**	**5**	**14**	**50**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Region Count
North Central	40.6%	0.0%	12.5%	46.9%	100.0%
North East	35.5%	6.5%	22.6%	35.5%	100.0%
South	64.0%	2.0%	4.0%	30.0%	100.0%
West	66.7%	5.6%	2.8%	25.0%	100.0%

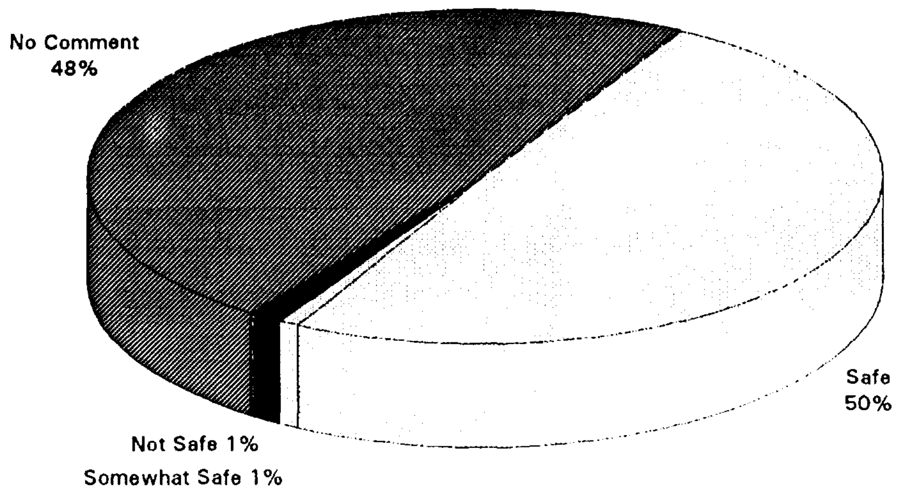


FIGURE 4.3.1.4-2 HAND TOOLS - STORAGE SAFETY RATING

TABLE 4.3.1.4-2
HAND TOOLS - STORAGE SAFETY RATING

Total Responses by Population

	Safe	Somewhat Safe	Not Safe	No Comment	Population Count
Total # of Resp.	**74**	**1**	**2**	**72**	**149**
Total % of Resp.	**49.7%**	**0.7%**	**1.3%**	**48.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Population Count
Urban	27	0	2	25	54
Small Urban	19	1	0	22	42
Suburban	16	0	0	15	31
Rural	12	0	0	10	22
Total	**74**	**1**	**2**	**72**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Population Count
Urban	50.0%	0.0%	3.7%	46.3%	100.0%
Small Urban	45.2%	2.4%	0.0%	52.4%	100.0%
Suburban	51.6%	0.0%	0.0%	48.4%	100.0%
Rural	54.5%	0.0%	0.0%	45.5%	100.0%

REGION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Region Count
North Central	14	0	0	18	32
North East	11	1	1	18	31
South	31	0	0	19	50
West	18	0	1	17	36
Total	**74**	**1**	**2**	**72**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Region Count
North Central	43.8%	0.0%	0.0%	56.3%	100.0%
North East	35.5%	3.2%	3.2%	58.1%	100.0%
South	62.0%	0.0%	0.0%	38.0%	100.0%
West	50.0%	0.0%	2.8%	47.2%	100.0%

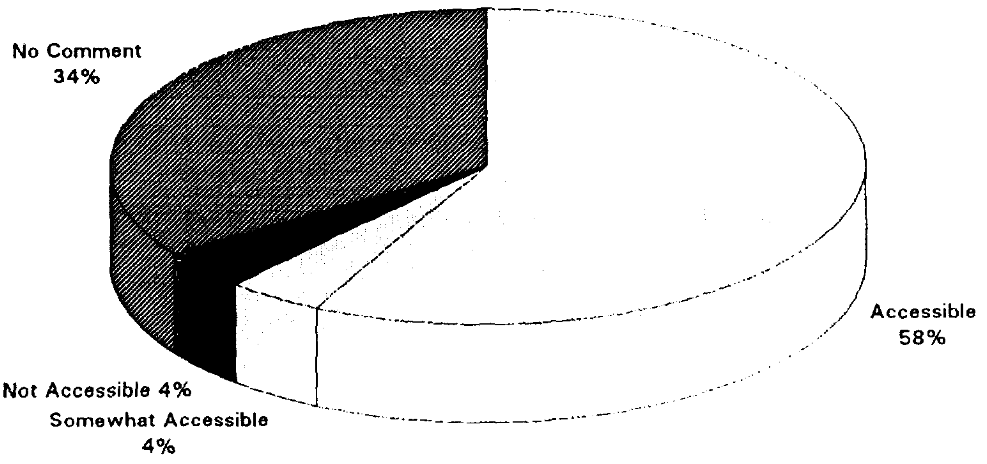


FIGURE 4.3.1.4-3 HAND TOOLS - STORAGE ACCESSIBILITY RATING

TABLE 4.3.1.4-3
HAND TOOLS - STORAGE ACCESSIBILITY RATING

Total Responses by Population

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Population Count
Total # of Resp.	**86**	**6**	**6**	**51**	**149**
Total % of Resp.	**57.7%**	**4.0%**	**4.0%**	**34.2%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Population Count
Urban	34	1	2	17	54
Small Urban	23	1	2	16	42
Suburban	17	2	1	11	31
Rural	12	2	1	7	22
Total	**86**	**6**	**6**	**51**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Population Count
Urban	63.0%	1.9%	3.7%	31.5%	100.0%
Small Urban	54.8%	2.4%	4.8%	38.1%	100.0%
Suburban	54.8%	6.5%	3.2%	35.5%	100.0%
Rural	54.5%	9.1%	4.5%	31.8%	100.0%

REGION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Region Count
North Central	17	1	0	14	32
North East	17	1	4	9	31
South	32	2	1	15	50
West	20	2	1	13	36
Total	**86**	**6**	**6**	**51**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Region Count
North Central	53.1%	3.1%	0.0%	43.8%	100.0%
North East	54.8%	3.2%	12.9%	29.0%	100.0%
South	64.0%	4.0%	2.0%	30.0%	100.0%
West	55.6%	5.6%	2.8%	36.1%	100.0%

TABLE 4.3.1.4-4
HAND TOOLS

Comments on Improvements for Storage by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	8	5.1%
Not Applicable/No Comment	99	63.5%
Suggestions for Improvements	49	31.4%
Total Comments	**156 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
More storage space	7	14.3%
Lower compartments	7	14.3%
Pull-out drawers/trays	7	14.3%
Custom-design compartments	7	14.3%
More compartmentalized	6	12.2%
Easier access	5	10.2%
Supply mounting clips with tools	4	8.2%
Larger compartments	3	6.1%
Overhead doors with mounts	1	2.0%
Lockable storage	1	2.0%
Built-in tool box	1	2.0%
Total	**49**	**100%**

* Multiple responses were permitted

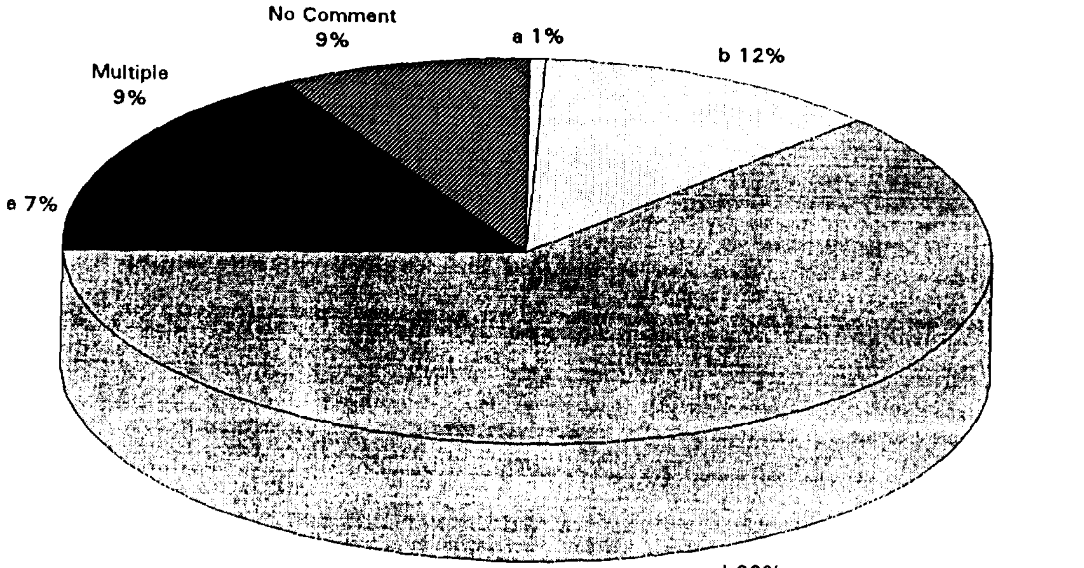
4.3.1.5 Portability - Hand Tools

Mounting type. As shown in Figure 4.3.1.5-1, one percent of all responses addressed hard mount, 12 percent were partial hard mount, 62 percent were remote/hand carry, 7 percent were other, 9 percent were multiple types of mounting, and 9 percent of all responses were no comment. Population and geographic data are provided in Table 4.3.15-1.

Number of persons needed to carry rating. As depicted in Figure 4.3.1.5-2, 71 percent of all responses indicated that 1 to 2 persons were needed to carry hand tools, 13 percent said 2 persons, 3 percent said 3 to 6 persons were needed and 13 percent of responses were no comment. Population and geographic data are listed in Table 4.3.1.5-2.

Number of persons needed to operate. Seventy-three percent of all respondents indicated that 1 to 2 persons were needed to operate hand tools, 11 percent said 2 to 3 persons, 3 percent said 3 to 6 persons and 13 percent of responses were no comment (see Figure 4.3.1.5-3). Population and geographic data are provided in Table 4.3.1.5-3

Of all the responses to improvement of hand tool portability, as provided in Table 4.3.1.5-4, 11 percent were no improvement, 83 percent were not applicable/no comment and 6 percent were improvement suggestions. The suggestions for improvement were: lighter weight hand tools; the use of a roll-up/soft-sided tool box; and the use of a small truck for hand tools only.



KEY: a - Hard mount b - Partial mount c - Remote/wheels d - Remote/hand carry e - Other

FIGURE 4.3.1.5-1 HAND TOOLS - PORTABILITY MOUNTING TYPE RATING

TABLE 4.3.1.5-1
HAND TOOLS - PORTABILITY MOUNTING TYPE RATING

Total Responses by Population

Mounting type *	a	b	c	d	e	Multiple	NO Comment	Population Count
Total # of Resp.	**1**	**18**	**0**	**92**	**11**	**14**	**13**	**149**
Total % of Resp.	**0.7%**	**12.1%**	**0.0%**	**61.7%**	**7.4%**	**9.4%**	**8.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	NO Comment	Population Count
Urban	0	8	0	32	2	5	7	54
Small Urban	1	5	0	22	5	4	5	42
Suburban	0	4	0	21	3	3	0	31
Rural	0	1	0	17	1	2	1	22
Total	**1**	**18**	**0**	**92**	**11**	**14**	**13**	**149**

Percent of Responses

Mounting type *	a	b	c	d	e	Multiple	NO Comment	Population Count
Urban	0.0%	14.8%	0.0%	59.3%	3.7%	9.3%	13.0%	100.0%
Small Urban	2.4%	11.9%	0.0%	52.4%	11.9%	9.5%	11.9%	100.0%
Suburban	0.0%	12.9%	0.0%	67.7%	9.7%	9.7%	0.0%	100.0%
Rural	0.0%	4.5%	0.0%	77.3%	4.5%	9.1%	4.5%	100.0%

REGION CATEGORY

Number of Response

Mounting type *	a	b	c	d	e	Multiple	NO Comment	Region Count
North Central	0	4	0	19	1	3	7	54
North East	1	1	0	18	2	8	5	42
South	0	9	0	29	6	2	0	31
West	0	4	0	26	2	1	1	22
Total	**1**	**18**	**0**	**92**	**11**	**14**	**13**	**149**

Percent of Response

Mounting type *	a	b	c	d	e	Multiple	NO Comment	Region Count
North Central	0.0%	7.4%	0.0%	35.2%	1.9%	5.6%	13.0%	100.0%
North East	2.4%	2.4%	0.0%	42.9%	4.8%	19.0%	11.9%	100.0%
South	0.0%	29.0%	0.0%	93.5%	19.4%	6.5%	0.0%	100.0%
West	0.0%	18.2%	0.0%	118.2%	9.1%	4.5%	4.5%	100.0%

" a - Hard mount b - Partial hard mount c - Remote/wheels d- Remote/hand carry e- Other

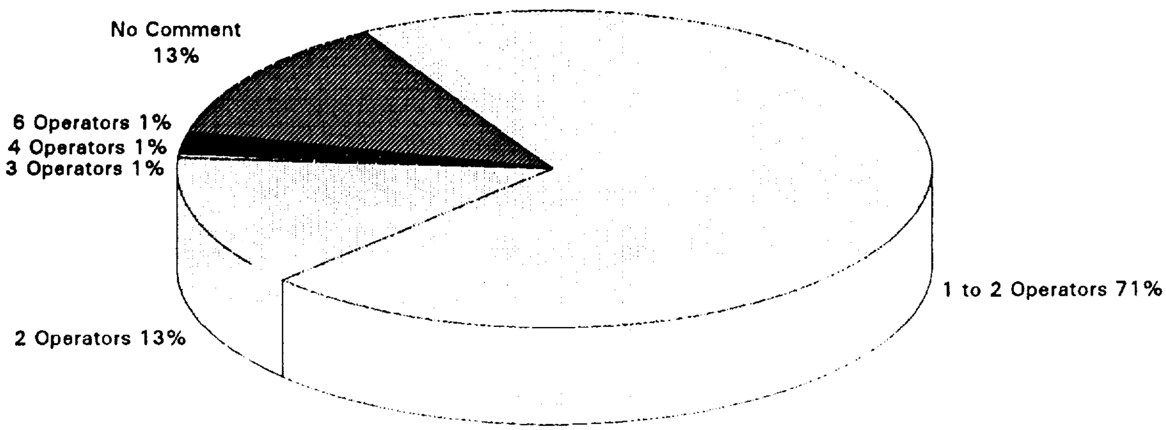


FIGURE 4.3.1.5-2 HAND TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

TABLE 4.3.1.5-2
HAND TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

Total Responses by Population

# Operators	1 to 2	2	3	4	6	No Comment	Population Count
Total # of Resp.	**106**	**20**	**1**	**2**	**1**	**19**	**149**
Total % of Resp.	**71.1%**	**13.4%**	**0.7%**	**1.3%**	**0.7%**	**12.8%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	5	No Comment	Population Count
Urban	39	5	1	1	1	7	54
Small Urban	30	4	0	0	0	8	42
Suburban	23	6	0	0	0	2	31
Rural	14	5	0	1	0	2	22
Total	**106**	**20**	**1**	**2**	**1**	**19**	**149**

Percent of Responses

Urban	72.2%	9.3%	1.9%	1.9%	1.9%	13.0%	100.0%
Small Urban	71.4%	9.5%	0.0%	0.0%	0.0%	19.0%	100.0%
Suburban	74.2%	19.4%	0.0%	0.0%	0.0%	6.5%	100.0%
Rural	63.6%	22.7%	0.0%	4.5%	0.0%	9.1%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	6	No Comment	Region Count
North Central	20	5	1	1	0	5	32
North East	19	6	0	0	1	5	31
South	39	5	0	0	0	6	50
West	28	4	0	1	0	3	36
Total	**106**	**20**	**1**	**2**	**1**	**19**	**149**

Percent of Responses

North Central	62.5%	15.6%	3.1%	3.1%	0.0%	15.6%	100.0%
North East	61.3%	19.4%	0.0%	0.0%	3.2%	16.1%	100.0%
South	78.0%	10.0%	0.0%	0.0%	0.0%	12.0%	100.0%
West	77.8%	11.1%	0.0%	2.8%	0.0%	8.3%	100.0%

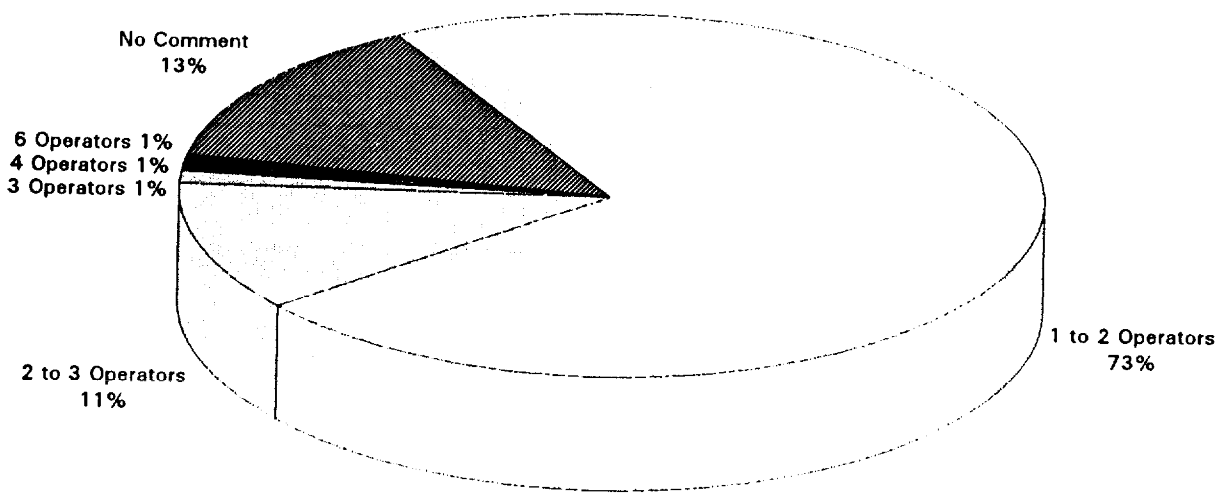


FIGURE 4.3.1.5-3 HAND TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

TABLE 4.3.1.5-3
HAND TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	3	4	5	No Comment	Population Count
Total # of Resp.	**108**	**17**	**2**	**1**	**1**	**20**	**149**
Total % of Resp.	**72.5%**	**11.4%**	**1.3%**	**0.7%**	**0.7%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	4	5	No Comment	Population Count
Urban	39	6	1	1	0	7	54
Small Urban	30	4	1	0	0	7	42
Suburban	24	4	0	0	0	3	31
Rural	15	3	0	0	1	3	22
Total	**108**	**17**	**2**	**1**	**1**	**20**	**149**

Percent of Responses

Urban	72.2%	11.1%	1.9%	1.9%	0.0%	13.0%	100.0%
Small Urban	71.4%	9.5%	2.4%	0.0%	0.0%	16.7%	100.0%
Suburban	77.4%	12.9%	0.0%	0.0%	0.0%	9.7%	100.0%
Rural	68.2%	13.6%	0.0%	0.0%	4.5%	13.6%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	5	No Comment	Region Count
North Central	22	3	1	0	1	32	32
North East	21	3	1	1	0	5	31
South	37	6	0	0	0	7	50
West	28	5	0	0	0	3	36
Total	**108**	**17**	**2**	**1**	**1**	**20**	**149**

Percent of Responses

North Central	68.8%	9.4%	3.1%	0.0%	3.1%	15.6%	100.0%
North East	67.7%	9.7%	3.2%	3.2%	0.0%	16.1%	100.0%
South	74.0%	12.0%	0.0%	0.0%	0.0%	14.0%	100.0%
West	77.8%	13.9%	0.0%	0.0%	0.0%	8.3%	100.0%

TABLE 4.3.1.5-4
HAND TOOLS

Comments on Improvements for Portability by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	16	10.7%
Not Applicable/No Comment	124	83.2%
Suggestions for Improvements	9	6.0%
Total Comments	**149 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	6	66.7%
Roll-up/soft-sided tool box	2	22.2%
Small truck for hand tools only	1	11.1%
Total	**9**	**100%**

* Multiple responses were permitted

4.3.1.6 Safety Aspects - Hand Tools

Of all the responses to hand tool safety concerns, as shown in Table 4.3.1.6-1, 52 percent were none in particular, 32 were not applicable/no comment and 16 percent were safety concern comments. Some more common comments were: tool slippage; flying debris, hand tool performance limits; tool failure; tool weight; and sharp edges created by hand tools.

Personal Safety Equipment (see Table 4.3.1.6-3):

Available for use. Sixty-nine percent of all participants indicated that they had ear protection equipment available for use, 96 percent had eye and foot protection available, 95 percent had hand, body, and head protection available, and 20 percent had other types of protection equipment available for use. The other percentages of the participants' responses were no comment/not used.

Used by personnel. Fifty-two percent of respondents indicated that they used ear protection equipment, 96 percent used eye, hand, head, and foot protection, 94 percent used body protection equipment, and 22 percent said they used other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

Required to be used. Forty-eight percent of participants said they were required to use ear protection, 95 percent were required to use eye, hand. head, and foot protection, 93 percent were required to use body protection, and 18 percent said they were required to use other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

TABLE 4.3.1.6-1
HAND TOOLS

Comments on Safety Concerns by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
None in Particular	82	51.9%
Not Applicable/No Comment	51	32.3%
Safety Concerns	25	15.8%
Total Comments	**158 ***	**100.0%**

Safety Concerns	Number of Responses	Percentage of Responses
Tool slippage	5	20.0%
Flying debris	4	16.0%
Tool limits	3	12.0%
Tool failure	3	12.0%
Tool Weight	3	12.0%
Creates sharp edges	3	12.0%
Sparks	2	8.0%
Rescuer over-exertion	1	4.0%
Pinch points	1	4.0%
Total	**25**	**100%**

* Multiple responses were permitted

TABLE 4.3.1.8-2
HAND TOOLS - SAFETY EQUIPMENT RATING

Number of Responses	EAR Comment	EAR No Comment/ Not Used	EYE Comment	EYE No Comment Not Used	HAND Comment	HAND No Comment/ Not Used	BODY Comment	BODY No Comment/ Not Used	HEAD Comment	HEAD No Comment/ Not Used	FOOT Comment	FOOT No Comment/ Not Used	OTHER Comment	OTHER No Comment/ Not Used
Available for use	102	47	143	6	142	7	141	8	142	7	143	6	29	120
Used by personnel	77	72	144	5	143	6	140	9	143	6	143	6	32	117
Required to be used	72	77	142	7	141	8	138	11	141	8	141	8	27	122
Percent of Response														
Available for use	68.5%		96.0%		95.3%		94.6%		95.3%		96.0%		19.5%	
Used by personnel	51.7%		96.6%		96.0%		94.0%		96.0%		96.0%		21.5%	
Required to be used	48.3%		95.3%		94.6%		92.6%		94.6%		94.6%		18.1%	

“Percentages were calculated for each individual type of protective device based on e total of 149 participants.

4.3.1.7 Modifications - Hand Tools

Sixty-seven percent of all responses on hand tool modifications, as depicted in Table 4.3.1.7-1, were no modifications, 31 percent were not applicable/no comment and 2 percent were comments on modifications. The comments included fabricated handle extensions and fabricated hacksaw from machine blade.

TABLE 4.3.1.7-1
HAND TOOLS

Comments on Modifications by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Modifications	100	67.1%
Not Applicable/No Comment	46	30.9%
Modifications	3	2.0%
Total Comments	**149**	**100.0%**

Modifications	Number of Responses	Percentage of Responses
Fabricated handle extensions	2	66.7%
Fabricated hacksaw from machine blade	1	33.3%
Total	**3**	**100%**

* Multiple responses were permitted

4.3.1.8 Potential Improvements - Hand Tools

Of the total responses on hand tool improvements, as depicted in Table 4.3.1.8-1, 51 percent were no improvements, 34 percent were not applicable/no comment and 15 percent were improvements. Some of the suggestions for improvement were: lighter weight hand tools; rubber/plastic/fiberglass handles; better handle length; and better alloys.

TABLE 4.3.1.8-1
HAND TOOLS

Comments on Improvements by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	78	50.6%
Not Applicable/No Comment	53	34.4%
Suggestions for Improvements	23	14.9%
Total Comments	**154 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	10	43.5%
Rubber/plastic/fiberglass handles	4	17.4%
Better handle lengths	2	8.7%
Better alloys	2	8.7%
Multi-use tools	1	4.3%
Standardize tool sizes	1	4.3%
Come-along switching mechanism	1	4.3%
Bolt cutter - better cutting edge	1	4.3%
Luminous working ends	1	4.3%
Total	**23**	**100%**

* Multiple responses were permitted

4.3.2 Manually Powered Tools-Description

Tools in this category serve to increase the level of incoming operator energy/power to a higher level of energy output. The power source, however, is still the human operator. Examples include various ram-type tools, and portapower equipment jacks.

4.3.2.1 General Satisfaction

As it can be seen in Figure 4.3.2.1-1, nearly three-quarters of the respondents were either very or somewhat satisfied with manually powered rescue tools. Only nine percent of the respondents were somewhat or very dissatisfied with this type of tool. A comparison of geographic regions showed that participants located in the south tend to use manually powered tools less than other regions. Data for total response by population, population category, and geographic location are given in Table 4.3.2.1 - 1, and comments are provided in Table 4.3.2.1-2. Of the comments on problems that were made, approximately 19 percent indicated that other tools did the same job better or preferred to use powered/hydraulic tools; 28 percent said they used the tools infrequently.

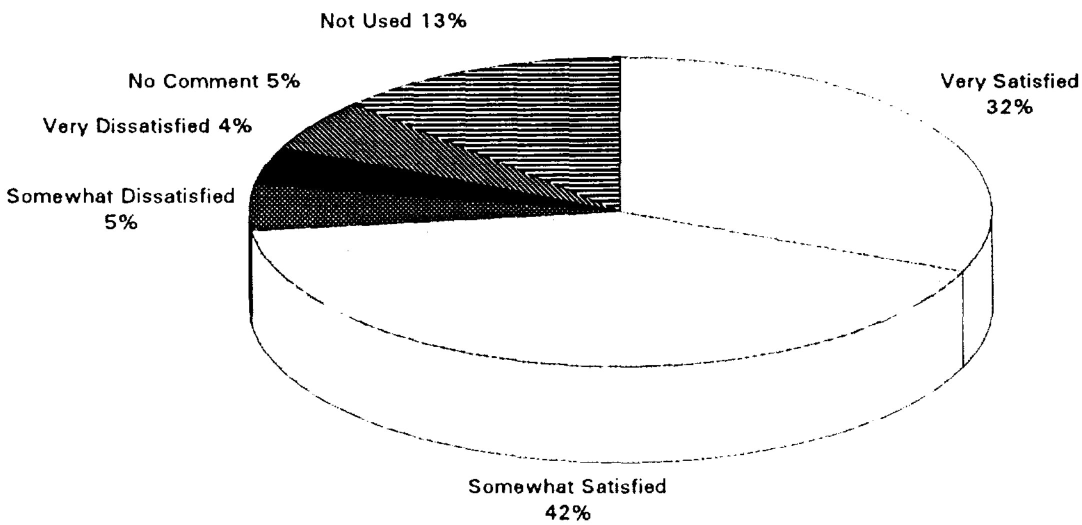


FIGURE 4.3.2.1-1 MANUALLY POWERED TOOLS - SATISFACTION RATING

TABLE 4.3.2.1-1
MANUALLY POWERED TOOLS - SATISFACTION RATING

Total Responses by Population

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Total # of Resp.	**47**	**62**	**7**	**6**	**8**	**19**	**149**
Total % of Resp.	**31.5%**	**41.6%**	**4.7%**	**4.0%**	**5.4%**	**12.9%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	25	18	3	1	2	5	54
Small Urban	7	21	1	2	3	8	42
Suburban	10	13	2	1	3	2	31
Rural	5	10	1	2	0	4	22
Total	**47**	**62**	**7**	**6**	**8**	**19**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	46.3%	33.3%	5.6%	1.9%	3.7%	9.3%	100.0%
Small Urban	16.7%	50.0%	2.4%	4.8%	7.1%	19.0%	100.0%
Suburban	32.3%	41.9%	6.5%	3.2%	9.7%	6.5%	100.0%
Rural	22.7%	45.5%	4.5%	9.1%	0.0%	18.2%	100.0%

REGION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	8	17	1	2	1	3	32
North East	9	17	0	1	1	3	31
South	17	14	3	2	4	10	50
West	13	14	3	1	2	3	36
Total	**47**	**62**	**7**	**6**	**8**	**19**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	25.0%	53.1%	3.1%	6.3%	3.1%	9.4%	100.0%
North East	29.0%	54.8%	0.0%	3.2%	3.2%	9.7%	100.0%
South	34.0%	28.0%	6.0%	4.0%	8.0%	20.0%	100.0%
West	36.1%	38.9%	8.3%	2.8%	5.6%	8.3%	100.0%

TABLE 4.3.2.1-2
MANUALLY POWERED TOOLS

Comments on Satisfaction by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	120	75.5%
Comments	39	24.5%
Total Comments	**159 ***	**100.0%**

Comments	Number of Responses	Percentage of Responses
Need more, newer, or better tools	12	30.8%
Hardly used	11	28.2%
Other tools do same job better	6	15.4%
Not used	4	10.3%
Prefer powered/hydraulic tools	4	10.3%
Used with other tool types	2	5.1%
Total	**39**	**100%**

* Multiple responses were permitted

4.3.2.2 Ease of Operation - Manually Powered Tools

As depicted in Figure 4.3.2.2-1 , 30 percent of the total respondents indicated that manually powered tools were easy or somewhat easy to operate and 11 percent rated the tools as somewhat or not easy to operate. Close to half of the participants did not provide a rating of how easy it was to operate manually powered tools. This may have been due to the fact that evaluation of ease of operation and effectiveness of the tools were combined into one question in the survey and participants tended to give general responses to the question rather than addressing each of the evaluation criteria separately. Since ease of operation and effectiveness were evaluated together in the same question, it was difficult to separate the comments that were made. Therefore, it was decided to include all of the comments in the following section on tool effectiveness. Data for total response by population, population category, and geographic location are given in Table 4.3.2.2-1.

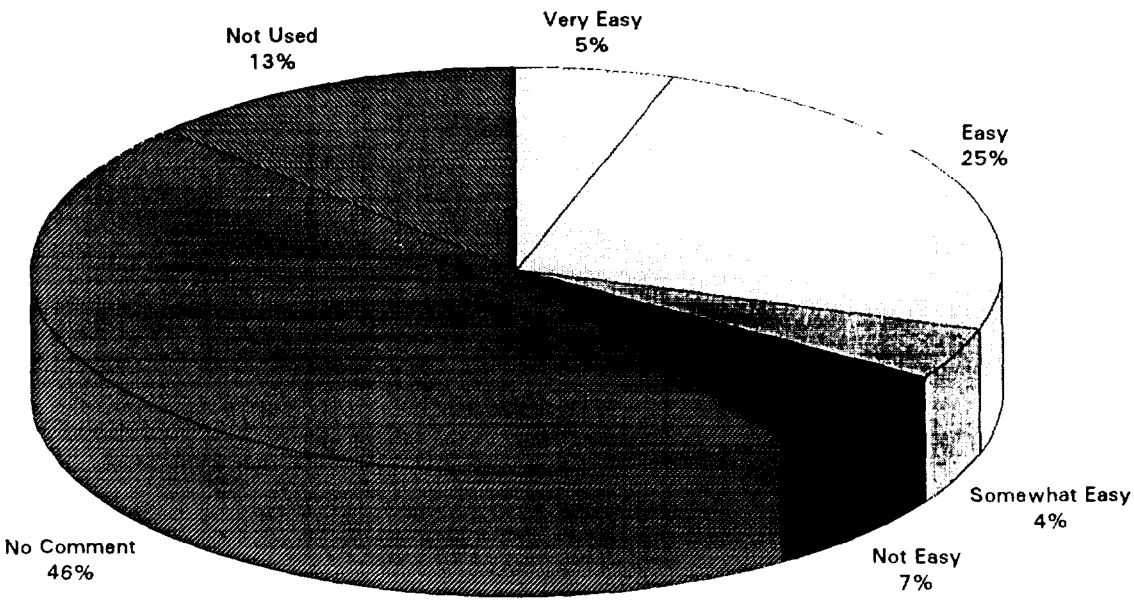


FIGURE 4.3.2.2-1 MANUALLY POWERED TOOLS - EASE OF OPERATION RATING

TABLE 4.3.2.2-1
MANUALLY POWERED TOOLS - EASE OF OPERATION RATING

Total Responses by Population

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Total # of Resp.	**8**	**37**	**6**	**10**	**69**	**1 9**	**149**
Total % of Resp.	**5.4%**	**24.8%**	**4.0%**	**6.7%**	**46.3%**	**12.8%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	5	14	0	4	26	5	54
Small Urban	2	10	2	2	18	8	42
Suburban	0	7	3	1	l8	2	31
Rural	1	6	1	3	7	4	22
Total	**8**	**37**	**6**	**10**	**69**	**19**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	9.3%	25.9%	0.0%	7.4%	48.1%	9.3%	100.0%
Small Urban	4.8%	23.8%	4.8%	4.8%	42.9%	19.0%	100.0%
Suburban	0.0%	22.6%	9.7%	3.2%	58.1%	6.5%	100.0%
Rural	4.5%	27.3%	4.5%	13.6%	31.8%	18.2%	100.0%

REGION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	0	14	0	2	13	3	32
North East	2	5	3	1	17	3	31
South	3	10	2	5	20	10	50
West	3	8	1	2	19	3	36
Total	**8**	**37**	**6**	**10**	**69**	**19**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	0.0%	43.8%	0.0%	6.3%	40.6%	9.4%	100.0%
North East	6.5%	16.1%	9.7%	3.2%	54.8%	9.7%	100.0%
South	6.0%	20.0%	4.0%	10.0%	40.0%	20.0%	100.0%
West	8.3%	22.2%	2.8%	5.6%	52.8%	8.3%	100.0%

4.3.2.3 Effectiveness - Manually Powered Tools

As seen in Figure 4.3.203-1, 38 percent of the total population rated manually powered tools as very effective or effective and 14 percent rated the tools as somewhat or not effective. Approximately 48 percent of responses were either not used or no comment was made. As discussed previously, this may have been due to the combined nature of the question in which effectiveness and ease of operation were evaluated. Urban agencies were more satisfied with the effectiveness of manually powered tools than agencies from other population categories. Data for total response by population, population category and geographic location are given in Table 3.3.2.3-1 and comments are provided in Table 4.3.2.3-2.

Six times more comments on problems than comments on assets were given. The most common comment (33% of comments on problems) was that manually powered tools were slower than other types of tools that could be used to perform the same tasks. Participants also reported that the tools were heavy. cumbersome. required more effort or manpower to operate, and had limited uses. Comments on assets. though less frequently reported, stated that the tools were lighter, more mobile than other tools used for the same tasks, and useful for light work.

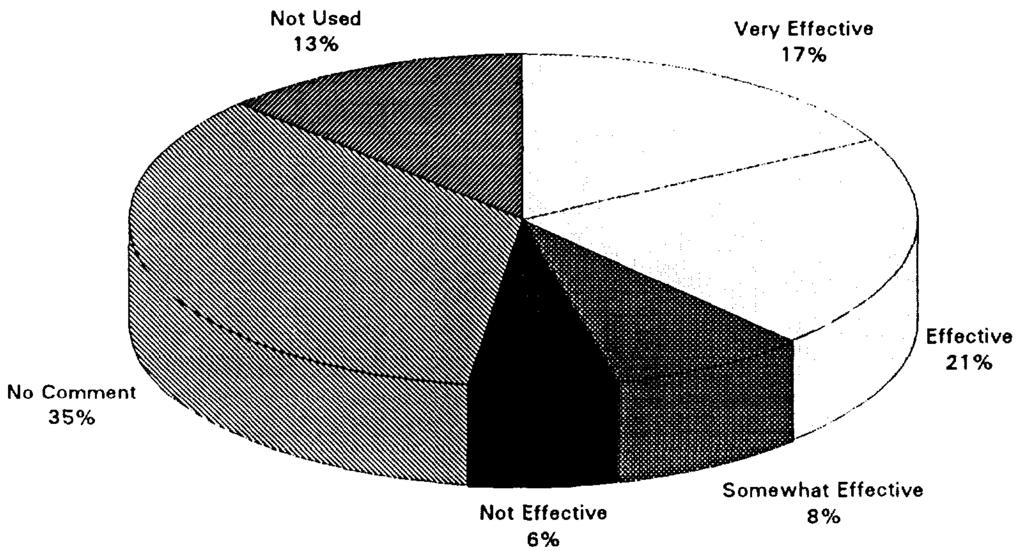


FIGURE 4.3.2.3-1 MANUALLY POWERED TOOLS - EFFECTIVENESS RATING

TABLE 4.3.2.3-1
MANUALLY POWERED TOOLS - EFFECTIVENESS RATING

Total Responses by Population

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Total # of Resp.	**26**	**31**	**12**	**9**	**52**	**19**	**149**
Total % of Resp.	**17.4%**	**20.8%**	**8.1%**	**6.0%**	**34.9%**	**12.8%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	17	9	6	3	14	5	54
Small Urban	3	10	1	4	16	8	42
Suburban	3	8	3	2	13	2	31
Rural	3	4	2	0	9	4	22
Total	**26**	**31**	**12**	**9**	**52**	**19**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	31.5%	16.7%	11.1%	5.6%	25.9%	9.3%	100.0%
Small Urban	7.1%	23.8%	2.4%	9.5%	38.1%	19.0%	100.0%
Suburban	9.7%	25.8%	9.7%	6.5%	41.9%	6.5%	100.0%
Rural	13.6%	18.2%	9.1%	0.0%	40.9%	18.2%	100.0%

REGION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	4	10	1	1	13	3	32
North East	3	9	7	0	9	3	31
South	10	7	2	5	16	10	50
West	9	5	2	3	14	3	36
Total	**26**	**31**	**12**	**9**	**52**	**19**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	12.5%	31.3%	3.1%	3.1%	40.6%	9.4%	100.0%
North East	9.7%	29.0%	22.6%	0.0%	29.0%	9.7%	100.0%
South	20.0%	14.0%	4.0%	10.0%	32.0%	20.0%	100.0%
West	25.0%	13.9%	5.6%	8.3%	38.9%	8.3%	100.0%

TABLE 4.3.2.3-2
MANUALLY POWERED TOOLS

Comments on Effectiveness/Ease of Operation by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	114	69.9%
Comments on Tool Problems	42	25.8%
Comments on Tool Assets	7	4.3%
Total Comments	**163 ***	**100.0%**

Comments on Performance Problems	Number of Responses	Percentage of Responses
Slow or slower than other tools	14	33.3%
Heavy/cumbersome	6	14.3%
Requires more effort/manpower	5	11.9%
Limited uses/small jobs	4	9.5%
Less powerful	3	7.1%
Operator determines effectiveness	2	4.8%
Portapower - hard to deploy	2	4.8%
Tool failure	1	2.4%
Spreader - limited stroke	1	2.4%
Portapower - high maintenance	1	2.4%
Portapower - low capability	1	2.4%
Jacks - hard to deploy	1	2.4%
Jacks - heavy	1	2.4%
Total	**42**	**100%**

Comments on Performance Assets	Number of Responses	Percentage of Responses
Light/lighter	2	28.6%
More mobile	1	14.3%
Easy to deploy	1	14.3%
Useful for light work	1	14.3%
Quiet	1	14.3%
Works well in tight areas	1	14.3%
Total	**7**	**100.0%**

* Multiple responses were permitted

4.3.2.4 Storage Efficiency - Manually Powered Tools

Storage of manually powered tools was evaluated according to three criteria: 1) adequacy 2) safety, and 3) accessibility.

Adequacy. As shown in Figure 4.3.2.4-1, 49 percent of the total responses indicated that storage of manually powered tools was adequate and only 5 percent stated that storage was not adequate. Population and geographic data are provided in Table 4.3.2.4-1.

Safety. Forty-two percent of all responses indicated that storage of manually powered tools was safe, while one percent stated that storage was unsafe. Data are provided in Figure 4.3.2.4-2. Population and geographic data are provided in Table 4.3.2.4-2.

Accessibility. Fifty percent of all responses indicated that storage of manually powered tools were accessible, while 3 percent said that storage was inaccessible. Data are provided in Figure 4.3.2.4-3. Population and geographic data are provided in Table 4.3.2.4-3.

Comments on improvements for storage can be found in Table 4.3.2.4-4. Almost 80 percent of the participants did not comment on storage improvements. This could be due to the fact that a large percentage of respondents rated storage as adequate, safe, and accessible. The most commonly made comments for improvement were the need for larger storage compartments, more storage space, and easier access to storage space. Other improvements included lower compartments, compartmentalization/custom design of storage space, and slide-out drawers/trays,

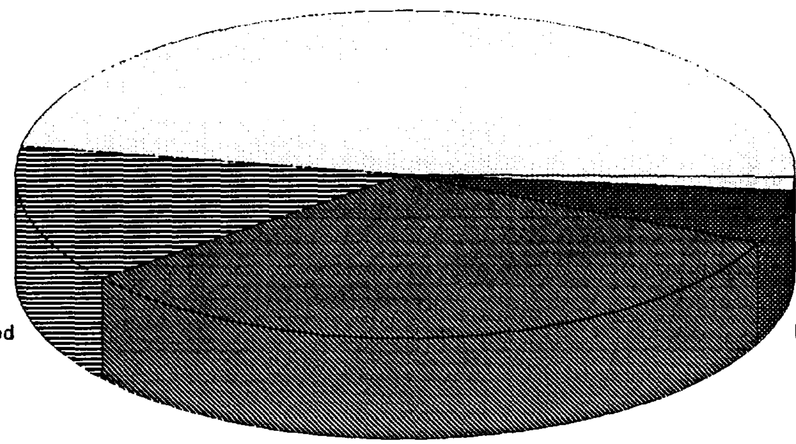


FIGURE 4.3.2.4-1 MANUALLY POWERED TOOLS - STORAGE ADEQUACY RATING

TABLE 4.3.2.4-1
MANUALLY POWERED TOOLS - STORAGE ADEQUACY RATING

Total Responses by Population

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Total # of Resp.	**71**	**2**	**8**	**48**	**20**	**149**
Total % of Resp.	**47.7%**	**1.3%**	**5.4%**	**32.2%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	27	0	4	18	5	54
Small Urban	17	1	3	13	8	42
Suburban	16	1	0	11	3	31
Rural	11	0	1	6	4	22
Total	**71**	**2**	**8**	**48**	**20**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	50.0%	0.0%	7.4%	33.3%	9.3%	100.0%
Small Urban	40.5%	2.4%	7.1%	31 .O%	19.0%	100.0%
Suburban	51.6%	3.2%	0.0%	35.5%	9.7%	100.0%
Rural	50.0%	0.0%	4.5%	27.3%	18.2%	100.0%

REGION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	18	0	1	10	3	32
North East	13	2	2	11	3	31
South	23	0	4	13	10	50
West	17	0	1	14	4	36
Total	**71**	**2**	**8**	**48**	**20**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	56.3%	0.0%	3.1%	31.3%	9.4%	100.0%
North East	41.9%	6.5%	6.5%	35.5%	9.7%	100.0%
South	46.0%	0.0%	8.0%	26.0%	20.0%	100.0%
West	47.2%	0.0%	2.8%	38.9%	11.1%	100.0%

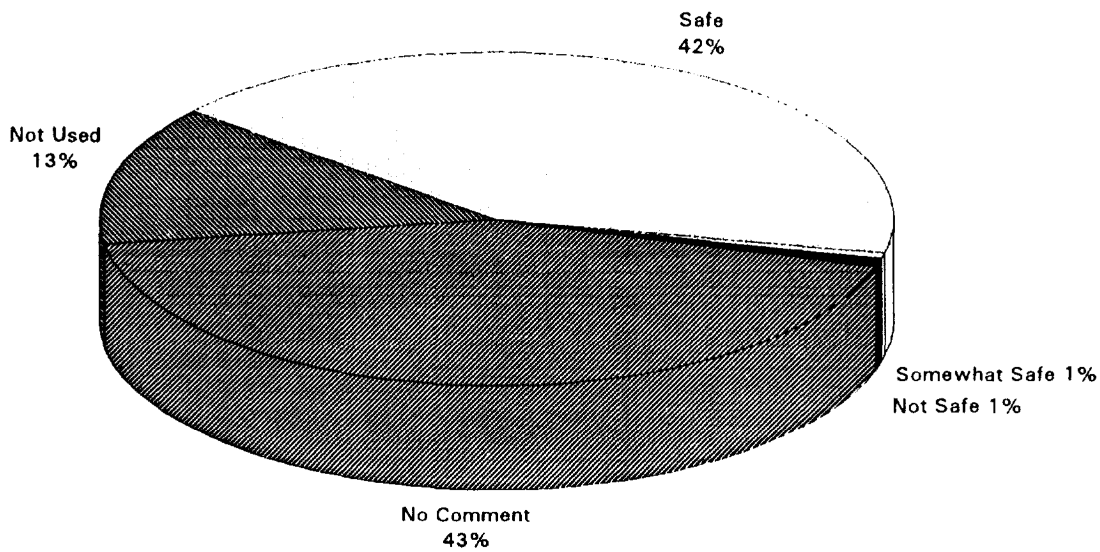


FIGURE 4.3.2.4-2 MANUALLY POWERED TOOLS - STORAGE SAFETY RATING

TABLE 4.3.2.4-2
MANUALLY POWERED TOOLS - STORAGE SAFETY RATING

Total Responses by Population

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Total # of Resp.	**63**	**1**	**1**	**64**	**20**	**149**
Total % of Resp.	**42.3%**	**0.7%**	**0.7%**	**43.0%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	21	0	1	27	5	54
Small Urban	17	1	0	16	8	42
Suburban	14	0	0	14	3	31
Rural	11	0	0	7	4	22
Total	**63**	**1**	**1**	**64**	**20**	**149**

Percent of Responses

Urban	38.9%	0.0%	1.9%	50.0%	9.3%	100.0%
Small Urban	40.5%	2.4%	0.0%	38.1%	19.0%	100.0%
Suburban	45.2%	0.0%	0.0%	45.2%	9.7%	100.0%
Rural	50.0%	0.0%	0.0%	31.8%	18.2%	100.0%

REGION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	14	0	0	15	3	32
North East	15	1	0	12	3	31
South	20	0	0	20	10	50
West	14	0	1	17	4	36
Total	**63**	**1**	**1**	**64**	**20**	**149**

Percent of Responses

North Central	43.8%	0.0%	0.0%	46.9%	9.4%	100.0%
North East	48.4%	3.2%	0.0%	38.7%	9.7%	100.0%
South	40.0%	0.0%	0.0%	40.0%	20.0%	100.0%
West	38.9%	0.0%	2.8%	47.2%	11.1%	100.0%

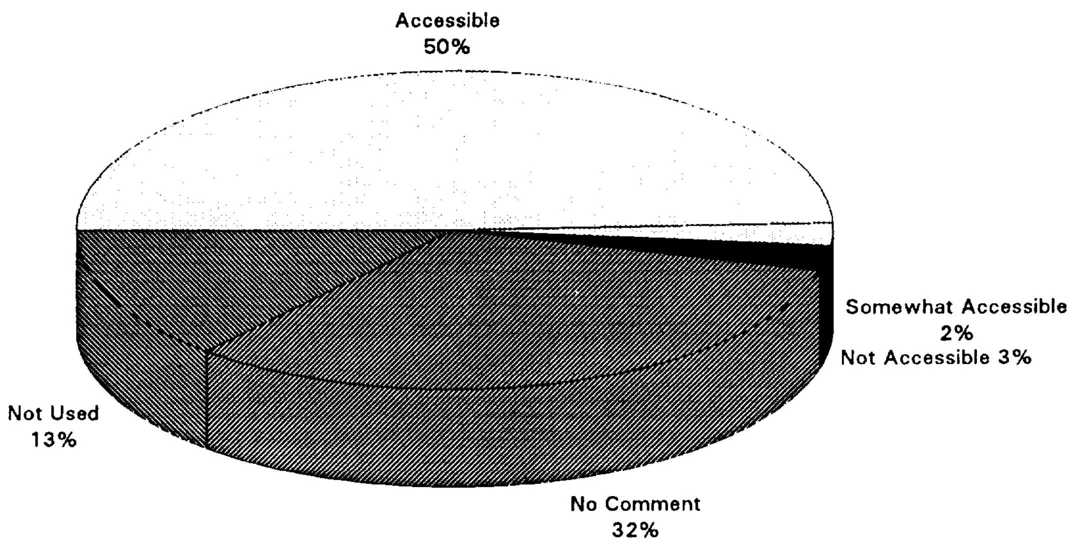


FIGURE 4.3.2.4-3 MANUALLY POWERED TOOLS - STORAGE ACCESSIBILITY RATING

TABLE 4.3.2.4-3
MANUALLY POWERED TOOLS - STORAGE ACCESSIBILITY RATING

Total Responses by Population

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Total # of Resp.	**74**	**3**	**4**	**48**	**20**	**149**
Total % of Resp.	**49.7%**	**2.0%**	**2.7%**	**32.2%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	25	1	1	22	5	54
Small Urban	20	1	1	12	8	42
Suburban	16	1	1	10	3	31
Rural	13	0	1	4	4	22
Total	**74**	**3**	**4**	**48**	**20**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	46.3%	1.9%	1.9%	40.7%	9.3%	100.0%
Small Urban	47.6%	2.4%	2.4%	28.6%	19.0%	100.0%
Suburban	51.6%	3.2%	3.2%	32.3%	9.7%	100.0%
Rural	59.1%	0.0%	4.5%	18.2%	18.2%	100.0%

REGION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	19	0	0	10	3	32
North East	16	1	3	8	3	31
South	24	1	0	15	10	50
West	15	1	1	15	4	36
Total	**74**	**3**	**4**	**48**	**20**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	59.4%	0.0%	0.0%	31.3%	9.4%	100.0%
North East	51.6%	3.2%	9.7%	25.8%	9.7%	100.0%
South	48.0%	2.0%	0.0%	30.0%	20.0%	100.0%
West	41.7%	2.8%	2.8%	41.7%	11.1%	100.0%

TABLE 4.3.2.4-4
MANUALLY POWERED TOOLS

Comments on Improvements for Storage by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	8	5.2%
Not Applicable/No Comment	126	82.4%
Suggestions for Improvements	19	12.4%
Total Comments	**153 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Larger compartments	6	31.6%
More storage space	3	15.8%
Easier access	3	15.8%
Lower compartments	2	10.5%
More compartmentalized	2	10.5%
Slide out drawers/trays	2	10.5%
Custom-design compartments	1	5.3%
Total	**19**	**100%**

***** Multiple responses were permitted

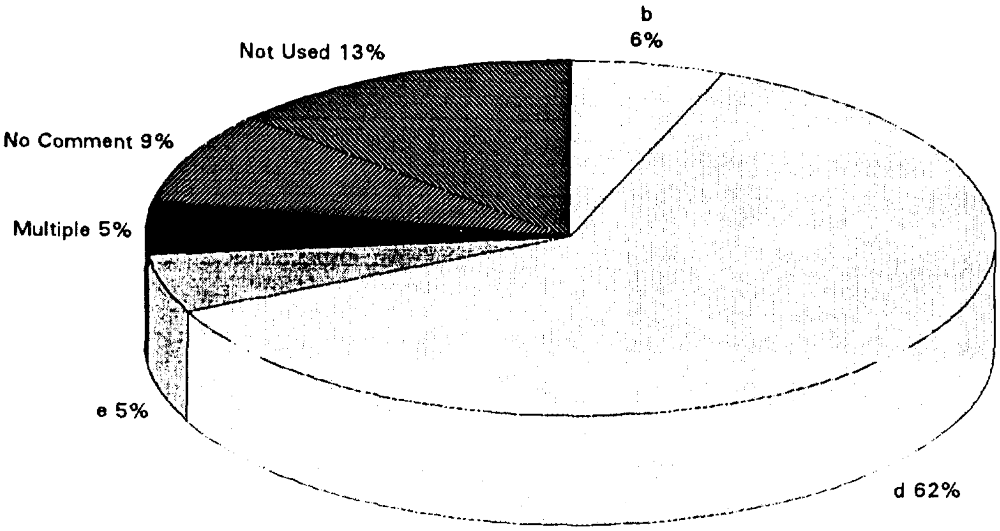
4.3.2.5 Portability - Manually Powered Tools

Mounting type - As depicted in Figure 4.3.2.5-1, 6 percent of participants use partial hard mount for manually powered tools, 62 percent were remote/hand carry, 5 percent used other mounting types, 5 percent used a combination of mounting types, and the remaining responses were no comment or not used. Table 4.3.2.5-1 presents data by population category and geographical region.

Number persons needed to carry - Forty-seven percent of all participants indicated that 1 to 2 persons were required to carry manually powered tools, as shown in Figure 4.3.2.5-2. Nineteen percent of responses were 2 to 3 persons, and one percent said 4 persons were needed. Data analyzed by population category and region are provided in Table 4.3.2.5-2.

Number of persons needed to operate - As shown in Figure 4.3.2.5-3, 46 percent of all responses indicated that 1 to 2 persons were needed to operate manually powered tools. Seventeen percent indicated 2 operators, and 4 percent said 3 or 4 operators were required. Data analyzed by population category and region are provided in Table 4.3.2.5-1.

As can be seen in Table 4.3.2.5-4, approximately 84 percent of the total responses were not applicable/no comment. The most common comment on problems was the need to have lighter weight tools. Also mentioned were the need to have wheels on manually powered tools, and to improve handles on jacks.



KEY: a - Hard mount b - Partial mount c - Remote/wheels d - Remote/hand carry (

FIGURE 4.3.2.5-1 MANUALLY POWERED TOOLS - PORTABILITY MOUNTING TYPE RATING

TABLE 4.3.2.5-1
MANUALLY POWERED TOOLS - PORTABILITY MOUNTING TYPE RATING

Total Responses by Population

Mounting type *	a	b	c	d	e	Multiple	NO Comment	Not Used	Population Count
Total # of Resp.	**0**	**9**	**0**	**92**	**8**	**7**	**13**	**20**	**149**
Total % of Resp.	**0.0%**	**6.0%**	**0.0%**	**61.7%**	**5.4%**	**4.7%**	**8.7%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	0	4	0	36	2	2	5	5	54
Small Urban	0	2	0	21	4	2	5	8	42
Suburban	0	2	0	20	2	1	3	3	31
Rural	0	1	0	15	0	2	0	4	22
Total	**0**	**9**	**0**	**92**	**8**	**7**	**13**	**20**	**149**

Percent of Responses

	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	0.0%	7.4%	00%	66.7%	3.7%	3 7%	9.3%	9.3%	100.0%
Small Urban	0.0%	4.8%	00%	50.0%	9.5%	4.8%	11.9%	19.0%	100.0%
Suburban	0.0%	6.5%	0.0%	64.5%	6.5%	3.2%	9.7%	9.7%	100.0%
Rural	0.0%	4.5%	0.0%	68.2%	0.0%	9.1%	0.0%	18.2%	100.0%

REGION CATEGORY

Number of Responses

Mounting type	a	b	c	d	2	Multiple	No Comment	Not Used	Region Count
North Central	0	2	0	21	1	4	1	3	32
North East	0		0	20	1	2	4	3	31
South	0	4	0	27	4	1	4	10	50
West	0	2	0	24	2	0	4	4	36
Total	**0**	**9**	**0**	**92**	**8**	**7**	**13**	**20**	**149**

Percent of Responses

	a	b	c	d	2	Multiple	No Comment	Not Used	Region Count
North Central	0.0%	6.3%	0.0%	65.6%	3.1%	12.5%	3.1%	9.4%	100.0%
North East	0.0%	3.2%	0.0%	64.5%	3.2%	6.5%	12.9%	9.7%	100.0%
South	0.0%	8.0%	0.0%	54.0%	8.0%	2.0%	8.0%	20.0%	100.0%
West	0.0%	5.6%	0.0%	66.7%	5.6%	0.0%	11.1%	11.l%	100.0%

* a - Hard mount b - Partial hard mount c - Remote/wheels d - Remote/hand carry e - Other

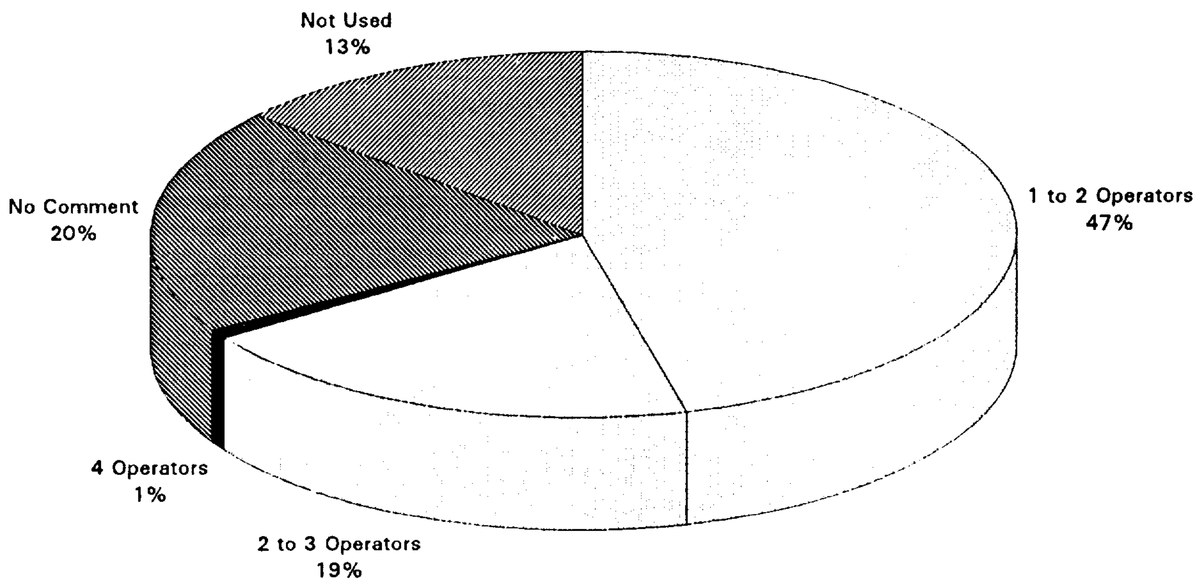


FIGURE 4.3.2.5-2 MANUALLY POWERED TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

TABLE 4.3.2.5-2
MANUALLY POWERED TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Population Count
Total # of Resp.	**69**	**29**	**1**	**30**	**20**	**149**
Total % of Resp.	**46.3%**	**19.5%**	**0.7%**	**20.1%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Population Count
Urban	30	8	1	10	5	54
Small Urban	18	9	0	7	8	42
Suburban	13	7	0	8	3	31
Rural	8	5	0	5	4	22
Total	**69**	**29**	**1**	**30**	**20**	**149**

Percent of Responses

Urban	55.6%	14.8%	1.9%	18.5%	9.3%	100.0%
Small Urban	42.9%	21.4%	0.0%	16.7%	19.0%	100.0%
Suburban	41.9%	22.6%	0.0%	25.8%	9.7%	100.0%
Rural	36.4%	22.7%	0.0%	22.7%	18.2%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Region Count
North Central	13	8	0	8	3	32
North East	13	8	0	7	3	31
South	22	10	0	8	10	50
West	21	3	1	7	4	36
Total	**69**	**29**	**1**	**30**	**20**	**149**

Percent of Responses

North Central	40.6%	25.0%	0.0%	25.0%	9.4%	100.0%
North East	41.9%	25.8%	0.0%	22.6%	9.7%	100.0%
South	44.0%	20.0%	0.0%	16.0%	20.0%	100.0%
West	58.3%	8.3%	2.8%	19.4%	11.1%	100.0%

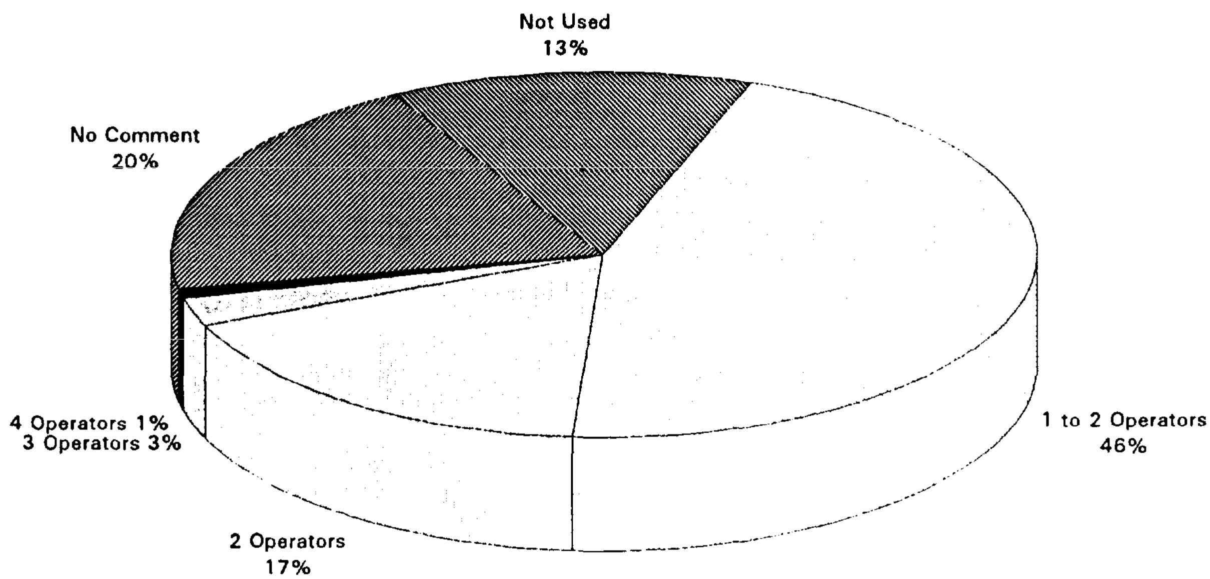


FIGURE 4.3.2.5-3 MANUALLY POWERED TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

TABLE 4.3.2.5-3
MANUALLY POWERED TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

Total Responses by Population

# Operators	1 to 2	2	3	4	No Comment	Not Used	Population Count
Total # of Resp.	**68**	**26**	**4**	**1**	**30**	**20**	**149**
Total % of Resp.	**45.6%**	**17.4%**	**2.7%**	**0.7%**	**20.1%**	**13.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	No Comment	Not Used	Population Count
Urban	32	5	2	0	10	5	54
Small Urban	11	9	1	0	7	8	42
Suburban	17	8	1	0	8	3	31
Rural	8	4	0	1	5	4	22
Total	**68**	**26**	**4**	**1**	**30**	**20**	**149**

Percent of Responses

Urban	59.3%	9.3%	3.7%	0.0%	18.5%	9.3%	100.0%
Small Urban	26.2%	21.4%	2.4%	0.0%	16.7%	19.0%	100.0%
Suburban	54.8%	25.8%	3.2%	0.0%	25.8%	9.7%	100.0%
Rural	36.4%	18.2%	0.0%	4.5%	22.7%	18.2%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	No Comment	Not Used	Region Count
North Central	11	8	1	1	8	3	32
North East	14	6	1	0	7	3	31
South	24	7	1	0	8	10	50
West	19	5	1	0	7	4	36
Total	**6 8**	**26**	**4**	**1**	**30**	**20**	**149**

Percent of Responses

North Central	34.4%	25.0%	3.1%	3.1%	25.0%	9.4%	100.0%
North East	45.2%	19.4%	3.2%	0.0%	22.6%	9.7%	100.0%
South	48.0%	14.0%	2.3%	0.0%	16.0%	20.0%	100.0%
West	52.8%	13.9%	2.8%	0.0%	19.4%	11.1%	100.0%

TABLE 4.3.2.5-4
MANUALLY POWERED TOOLS

Comments on Improvements for Portability by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	12	8.1%
Not Applicable/No Comment	125	83.9%
Suggestions for Improvements	12	8.1%
Total Comments	**149 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	10	83.3%
Need wheels	1	8.3%
Jack - better handles	1	8.3%
Total	**12**	**100%**

* Multiple responses were permitted

4.3.2.6 Safety Aspects - Manually Powered Tools

Approximately 41 percent of responses were not applicable/no comment, and 38 percent were no concerns, as shown in Table 4.3.2.6-1. Approximately 60 percent of the safety concerns referred to tool slippage and tool stability. Another 18 percent of comments were regarding tool failure. Other comments included those that identified seal/hose rupture. caustic fluid. the absence of a safety valve, and flying debris as safety concerns.

Safety Equipment Rating (see Table 4.3.2.6-2):

Available for use. Fifty-seven percent of all participants indicated that they had ear protection equipment available for use, 82 percent had eye protection available, 81 percent had hand, head, and foot protection available, 79 percent had body protection available, and 23 percent had other types of protection equipment available for use. The other percentages of the participants' responses were no comment/not used.

Used by personnel. Forty-one percent of respondents indicated that they used ear protection equipment, 81 percent used eye and foot protection, 83 percent used hand and head, 80 percent used body protection equipment, and 21 percent said they used other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

Required to be used. Forty percent of participants said they were required to use ear protection, 81 percent were required to use eye protection, 83 percent were required to use hand and head protection, 80 percent were required to use foot protection. 79 percent were required to use body protection, and 17 percent said they were required to use other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

TABLE 4.3.2.6-1
MANUALLY POWERED TOOLS

Comments on Safety Concerns by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
None in Particular	61	38.4%
Not Applicable/No Comment	65	40.9%
Safety Concerns	33	20.8%
Total Comments	**159 ***	**100.0%**

Safety Concerns	Number of Responses	Percentage of Responses
Tool slippage	10	30.3%
Tool stability	10	30.3%
Tool failure	6	18.2%
Seal/hose rupture	2	6.1%
Pinch points	1	3.0%
Flying debris	1	3.0%
Caustic fluid	1	3.0%
No safety valve	1	3.0%
Time consuming	1	3.0%
Total	**33**	**100%**

* Multiple responses were permitted

TABLE 4.3.2.8-Z
MANUALLY POWERED TOOLS - SAFETY EQUIPMENT RATING

	EAR		EYE		HAND		BODY		HEAD		FOOT		OTHER	
Number of Responses	Comment	No Comment/ Not Used	Comment	No Comment Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used
Available for use	85	64	122	27	120	29	118	31	121	28	121	28	34	115
Used by personnel	61	88	121	28	123	28	119	30	123	26	120	29	31	118
Required to be wed	59	90	121	28	123	26	118	31	123	26	119	30	26	123
***Percent of Responses**														
Avsilabls for use	57.0%		81 .S%		80.5%		79.2%		81.2%		81.2%		22.8%	
Used by personnel	40.9%		81.2%		82.6%		79.9%		82.6%		80.5%		20.8%	
Required to be used	39.6%		81.2%		82.6%		79.2%		82.6%		79.9%		17.4%	

*Percentages were calculated for each individual type of protective device based on a total of 149 participants.

4.3.2.7 Modifications - Manually Powered Tools

As can be seen in Table 4.3.2.7-1, approximately 62 percent of responses indicated no modifications for manually powered tools. An additional 35 percent of responses were not applicable/no comment. Modifications that were mentioned included the addition of a shackle and hook from the lifting step of a jack, high-pressure hoses, a ground pad for lift tools, and a ram support bracket.

TABLE 4.3.2.7-1
MANUALLY POWERED TOOLS

Comments on Modifications by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Modifications	93	62.0%
Not Applicable/No Comment	53	35.3%
Modifications	4	2.7%
Total Comments	**150 ***	**100.0%**

Modifications	Number of Responses	Percentage of Responses
Added shackle & hook to lifting step	1	25.0%
Fabricated ground pad for lift tools	1	25.0%
Fabricated ram support bracket	1	25.0%
Switched to high pressure hoses	1	25.0%
Total	**4**	**100%**

*Multiple responses were permitted

4.3.2.8 Potential Improvements - Manually Powered Tools

Approximately 19 percent of all responses referred to comments on improvements, while the remaining responses were either no improvements (38 percent) or not applicable/no comment (43 percent). As shown in Table 4.3.2.8-1, the most common improvement was to design lighter weight manually powered tools (33 percent of improvement comments). Also mentioned, among other improvements, were to design a larger base and switching mechanism on jacks and provide an assortment of heads; design manually powered tools with greater stability, a lower failure rate, that are easier to use and faster to set up; and to use machined/forged parts, instead of cast parts, with better alloys. Comments on specific tools included a simpler, easier to set up portapower design, a portapower with a two-stage hand pump, color-coding of portapower components; a jack with a larger switching mechanism, an assortment of heads for jacks; a one-piece rabbit tool; a pump with a larger knob, and a pump mounted to a board.

TABLE 4.3.2.8-1
MANUALLY POWERED TOOLS

Comments on Improvements by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	60	38.2%
Not Applicable/No Comment	67	42.7%
Suggestions for Improvements	30	19.1%
Total Comments	**157 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	10	33.3%
Jack - larger base	2	6.7%
Longer reach	2	6.7%
Less tool failure	2	6.7%
Better alloys	1	3.3%
Greater stability	1	3.3%
Jack - assortment of heads	1	3.3%
Jack - larger switching mechanism	1	3.3%
Machined/forged parts, not cast	1	3.3%
Multi-use tools	1	3.3%
One piece rabbit tool	1	3.3%
Portapower - 2-stage hand pump	1	3.3%
Portapower - color-coded components	1	3.3%
Portapower - quicker set-up	1	3.3%
Portapower - simplify use	1	3.3%
Pump - larger knob	1	3.3%
Pump - mount to board	1	3.3%
Shoring - type device with pivoting pad	1	3.3%
Total	**30**	**100%**

* Multiple responses were permitted

4.3.3 Cutting Tools-Description

This category refers to tools that are self-powered and that perform cutting/sawing operations. They require the operator to guide and direct, but not power the tool. Examples include reciprocating saws, abrasive saws (K12 type), and oxyacetylene torches.

4.3.3.1 General Satisfaction - Cutting Tools

As can be seen in Figure 4.3.3.1-1) 85 percent of respondents were very or somewhat satisfied with cutting tools. Seven percent indicated that they were either somewhat or very dissatisfied with the tools. It also appears (see Table 4.3.3.1-1) that urban and small urban participants were slightly more satisfied with cutting tool performance than suburban and rural participants.

Of the responses that were given on satisfaction with cutting tools, 80 percent were not applicable/no comment, and 19 percent were comments on satisfaction (see Table 4.3.3.1-2). The comments that were most commonly made were: cutting tools were used infrequently or not used at all; a preference for reciprocating saws as compared to abrasive saws; and a preference for chainsaws over abrasive saws.

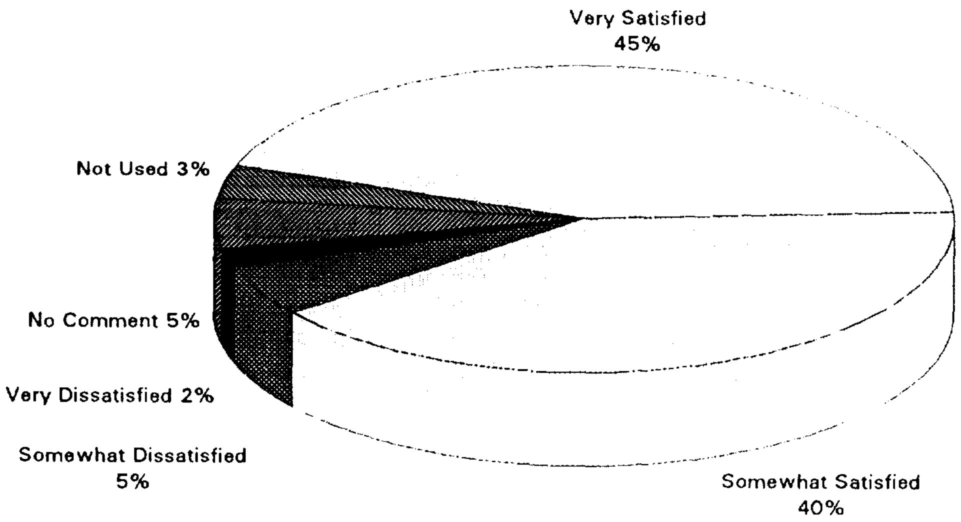


FIGURE 4.3.3.1-1 CUTTING TOOLS - SATISFACTION RATING

TABLE 4.3.3.1-1
CUTTING TOOLS - SATISFACTION RATING

Total Responses by Population

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Total # of Resp.	**65**	**60**	**8**	**3**	**8**	**5**	**149**
Total % of Resp.	**43.6%**	**40.3%**	**5.4%**	**2.0%**	**5.4%**	**3.4%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	26	20	4	1	3	0	54
Small Urban	18	21	0	0	2	1	42
Suburban	11	12	2	0	3	3	31
Rural	10	7	2	2	0	1	22
Total	**65**	**60**	**8**	**3**	**8**	**5**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	48.1%	37.0%	7.4%	1.9%	5.6%	0.0%	100.0%
Small Urban	42.9%	50.0%	0.0%	0.0%	4.8%	2.4%	100.0%
Suburban	35.5%	38.7%	6.5%	0.0%	9.7%	9.7%	100.0%
Rural	45.5%	31.8%	9.1%	9.1%	0.0%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	12	14	1	2	1	2	32
North East	16	11	2	0	2	0	31
South	25	18	2	1	3	1	50
West	12	17	3	0	2	2	36
Total	**65**	**60**	**8**	**3**	**8**	**5**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	37.5%	43.8%	3.1%	6.3%	3.1%	6.3%	100.0%
North East	51.6%	35.5%	6.5%	0.0%	6.5%	0.0%	100.0%
South	50.0%	36.0%	4.0%	2.0%	6.0%	2.0%	100.0%
West	33.3%	47.2%	8.3%	0.0%	5.6%	5.6%	100.0%

TABLE 4.3.3.1-2
CUTTING TOOLS

Comments on Satisfaction by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	122	80.8%
Comments	29	19.2%
Total Comments	**151 ***	**100.0%**

Comments	Number of Responses	Percentage of Responses
Need more, newer, or better tools	8	27.6%
Hardly used	7	24.7 %
Prefer reciprocating saw to abrasive saw	4	13.8%
Not used	4	73.8%
Prefer chainsaw to abrasive saw	2	6.9%
Reciprocating saw better safer	1	3.4%
Use Reciprocating saw only	1	3.4%
Prefer hydraulic tools	1	3.4%
Other tools do same job better	1	3.4%
Total	**29**	**100%**

* Multiple responses were permitted

4.3.3.2 Ease of Operation - Cutting Tools

As shown in Figure 4.3.3.2-l) 5 percent of all participants rated cutting tools as very easy to operate 24 percent rated them as easy, 6 percent somewhat easy, and 4 percent not easy. Fifty-seven percent of responses were no comment and 4 percent of participants said they did not use cutting tools. Data for population and geographic categories are presented in Table 4.3.3.2-l. Since ease of operation and effectiveness were evaluated together in the same question, it was difficult to separate the comments that were made. Therefore, it was decided to include all of the comments in the following section on tool effectiveness.

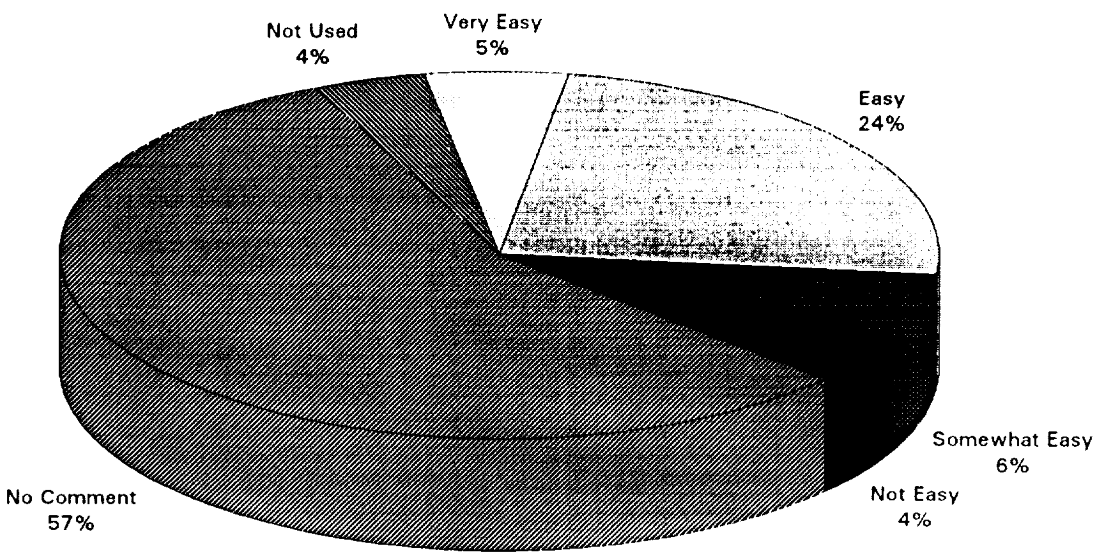


FIGURE 4.3.3.2-1 CUTTING TOOLS - EASE OF OPERATION RATING

TABLE 4.3.3.2-1
CUTTING TOOLS - EASE OF OPERATION

Total Responses by Population

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Total # of Resp.	**8**	**36**	**9**	**6**	**84**	**6**	**149**
Total % of Resp.	**5.4%**	**24.2%**	**6.0%**	**4.0%**	**56.4%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	5	13	3	5	27	1	54
Small Urban	7	14	3	0	23	1	42
Suburban	7	5	7	0	21	3	37
Rural	1	4	2	1	13	1	22
Total	**8**	**36**	**9**	**6**	**84**	**6**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	9.3%	24.1%	5.6%	9.3%	50.0%	7.9%	100.0%
Small Urban	2.4%	33.3%	7.1%	0.0%	54.8%	2.4%	700.0%
Suburban	3.2%	16.7%	3.2%	0.0%	67.7%	9.7%	100.0%
Rural	4.5%	18.2%	9.7 %	4.5%	59.7 %	4.5%	700.0%

REGION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	0	9	1	1	19	2	32
North East	0	7	1	2	21	0	31
South	5	9	6	2	26	2	50
West	3	17	7	7	78	2	36
Total	**8**	**36**	**9**	**6**	**84**	**6**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	0.0%	28.7 %	3.1%	3.1%	59.4%	6.3%	100.0%
North East	0.0%	22.6%	3.2%	6.5%	67.7%	0.0%	700.0%
South	70.0%	18.0%	12.0%	4.0%	52.0%	4.0%	100.0%
West	8.3%	30.6%	2.8%	2.8%	50.0%	5.6%	100.0%

4.3.3.3 Effectiveness - Cutting Tools

Seventeen percent of all participants rated cutting tools as very effective, as can be seen in Figure 4.3.3.3- 1. Twenty-four percent of responses were rated as effective, 5 percent were somewhat effective. and 6 percent indicated that the tools were ineffective. Forty-four percent of responses were no comment, and 4 percent do not use cutting tools. Population and geographic data are provided in Table 43.33-1.

Comments on the effectiveness/ease of operation of cutting tools are provided in Table 4.3.3.3-2. Forty-nine percent of responses were not applicable/no comment, 42 percent were comments on tool problems, and 9 percent were comments on tool assets. The most commonly cited comments on cutting tool problems, were that they: arc heavy/cumbersome; pose a safety hazard; are difficult to start; have limited used; and are loud/noisy. Some comments on cutting tool performance assets included: versatile, light-weight, and start easily.

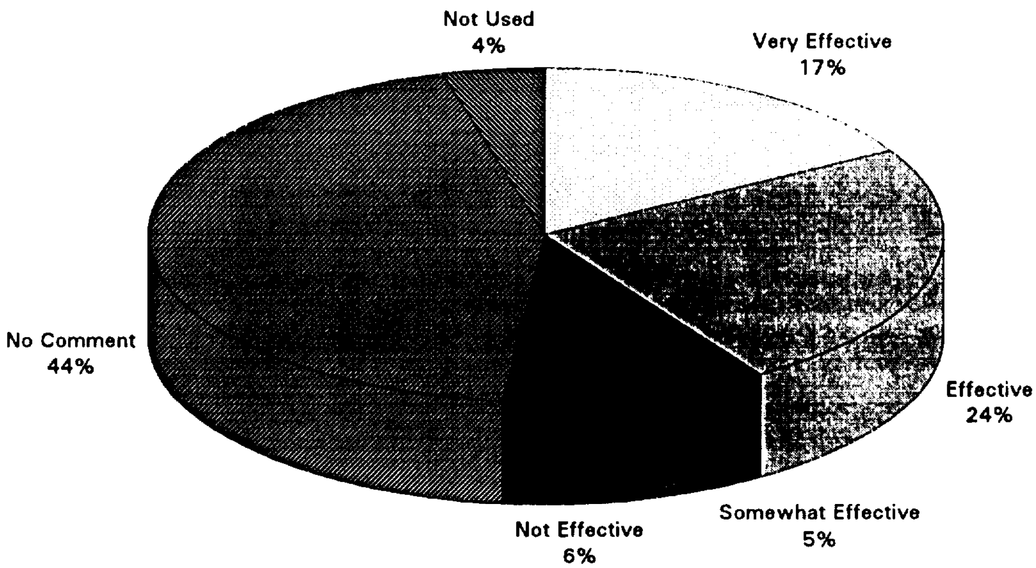


FIGURE 4.3.3.3-1 CUTTING TOOLS - EFFECTIVENESS RATING

TABLE 4.3.3.3-1
CUTTING TOOLS - EFFECTIVENESS RATING

Total Responses by Population

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Total # of Resp.	**25**	**36**	**7**	**9**	**66**	**6**	**149**
Total % of Resp.	**16.8%**	**24.2%**	**4.7%**	**6.0%**	**44.3%**	**4.0%**	**100.%**

POPULATION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Count	Population Count
Urban	12	14	4	6	17	1	54
Small Urban	4	13	1	2	21	1	42
Suburban	4	8	1	1	14	3	31
Rural	5	1	1	0	14	1	22
Total	**25**	**36**	**7**	**9**	**66**	**6**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Count	Population Count
Urban	22.2%	25.9%	7.4%	11.1%	31.5%	1.9%	100.0%
Small Urban	9.5%	31.0%	2.4%	4.8%	50.0%	2.4%	100.0%
Suburban	12.9%	25.8%	3.2%	3.2%	45.2%	9.7%	100.0%
Rural	22.7%	4.5%	4.5%	0.0%	63.6%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	3	10	1	2	14	2	32
North East	2	6	0	2	21	0	31
South	12	9	5	3	19	2	50
West	8	11	1	2	12	2	36
Total	**25**	**36**	**7**	**9**	**66**	**6**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	9.4%	31.3%	3.1%	6.3%	43.8%	6.3%	100.0%
North East	6.5%	19.4%	0.0%	6.5%	67.7%	0.0%	100.0%
South	24.0%	18.0%	10.0%	6.0%	38.0%	4.0%	100.0%
West	22.2%	30.6%	2.8%	5.6%	33.3%	5.6%	100.0%

TABLE 4.3.3.3-2
CUTTING TOOLS

Comments on Effectiveness/Ease of Operation by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	87	49.2%
Comments on Tool Problems	74	41.8%
Comments on Tool Assets	16	9.0%
Total Comments	**177 ***	**100.0%**

Comments on Performance Problems	Number of Responses	Percentage of Responses
Heavy/cumbersome	14	18.4%
Safety hazard	14	18.4%
Starting difficulties	13	17.1%
Limited uses	9	11.8%
Loud/Noisy	5	6.6%
Operator determines effectiveness	4	5.3%
Ineffective in tight areas	3	3.9%
Blade changes during extrication	3	3.9%
Impractical	2	2.6%
Runs poorly	2	2.6%
Blade wear	2	2.6%
Require constant maintenance	2	2.6%
Require support equipment	1	1.3%
Electric saws need power source	1	1.3%
Hard to use controls	1	1.3%
Total	**76**	100%

Comments on Performance Assets	Number of Responses	Percentage of Responses
Versatile	4	25.0%
Light-weight	2	12.5%
Starts easily	3	18.8%
Blade angle- makes it easier to operate	1	6.3%
Dependable	1	6.3%
Powerful	1	6.3%
Fast	1	6.3%
Well-balanced	1	6.3%
Low maintenance	1	6.3%
Good in tight areas	1	6.3%
Total	**16**	**100.0%**

* Multiple responses were permitted

4.3.3.4 Storage Efficiency - Cutting Tools

Storage of manually powered tools was evaluated according to three criteria: 1) adequacy, 2) safety, and 3) accessibility.

Adequacy. As shown in Figure 4.3.3.4-1, 56 percent of the total responses indicated that storage of cutting tools was adequate, one percent stated somewhat adequate, and 7 percent stated that storage was not adequate. Thirty-two percent of responses were no comment. Population and geographic data are provided in Table 4.3.3.4-1.

Safety. Fifty-three percent of all responses indicated that storage of cutting tools was safe, 2 percent were somewhat safe, one percent stated that storage was unsafe, and 40 percent were no comment. Data are provided in Figure 4.3.3.4-2. Population and geographic data are provided in Table 4.3.3.4-2.

Accessibility. Fifty-seven percent of all responses indicated that storage of cutting tools was accessible, one percent said it was somewhat accessible, one percent said that storage was not accessible, and 37 percent were no comment. Data are provided in Figure 4.3.3.4-3. Population and geographic data are provided in Table 4.3.3.4-3.

Of all the responses that were made regarding storage improvements shown in Table 4.3.3.4-4, 8 percent were no improvements, 68 percent were not applicable/no comment and 25 percent were suggestions for improvements. The most common comments that were made included: more storage space; lower compartments; mounting clips; slide-out drawers/trays; and better gasoline storage.

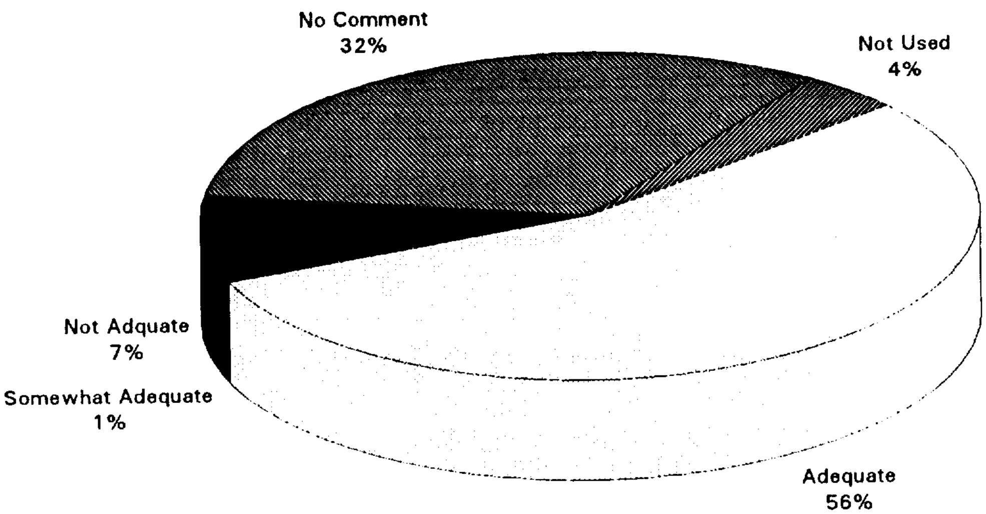


FIGURE 4.3.3.4-1 CUTTING TOOLS - STORAGE ADEQUACY RATING

TABLE 4.3.3.4-1
CUTTING TOOLS - STORAGE ADEQUACY RATING

Total Responses by Population

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Total # of Resp.	**82**	**2**	**11**	**48**	**6**	**149**
Total % of Resp.	**55.0%**	**1.3%**	**7.4%**	**32.2%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	31	0	6	16	1	54
Small Urban	24	0	5	12	1	42
Suburban	15	2	0	11	3	31
Rural	12	0	0	9	1	22
Total	**82**	**2**	**11**	**48**	**6**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	57.4%	0.0%	11.1%	29.6%	1.9%	100.0%
Small Urban	57.1%	0.0%	11.9%	28.6%	2.4%	100.0%
Suburban	48.4%	6.5%	0.0%	35.5%	9.7%	100.0%
Rural	54.5%	0.0%	0.0%	40.9%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	17	0	3	10	2	32
North East	18	1	2	10	0	31
South	26	0	3	19	2	50
West	21	1	3	9	2	36
Total	**82**	**2**	**11**	**48**	**6**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	53.1%	0.0%	9.4%	31.3%	6.3%	100.0%
North East	58.1%	3.2%	6.5%	32.3%	0.0%	100.0%
South	52.0%	0.0%	6.0%	38.0%	4.0%	100.0%
West	58.3%	2.8%	8.3%	25.0%	5.6%	100.0%

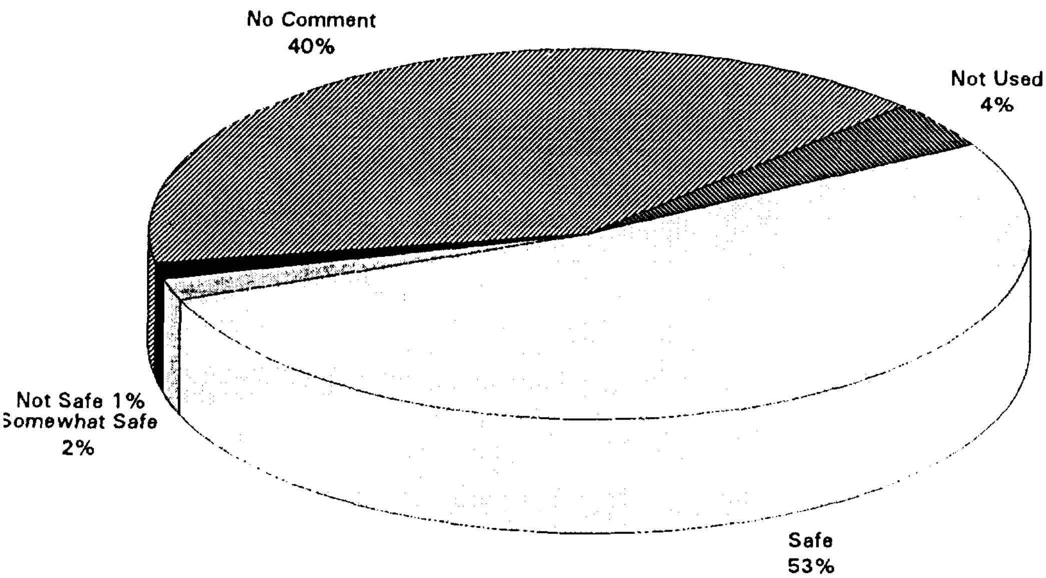


FIGURE 4.3.3.4-2 CUTTING TOOLS - STORAGE SAFETY RATING

TABLE 4.3.2.4-2
CUTTING TOOLS - STORAGE SAFETY RATING

Total Responses by Population

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Total # of Resp.	**78**	**3**	**2**	**60**	**6**	**149**
Total % of Resp.	**52.3%**	**2.0%**	**1.3%**	**40.3%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	27	1	1	24	1	54
Small Urban	23	1	1	16	1	42
Suburban	17	1	0	10	3	31
Rural	11	0	0	10	1	22
Total	**78**	**3**	**2**	**60**	**6**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	50.0%	1.9%	1.9%	44.4%	1.9%	100.0%
Small Urban	54.8%	2.4%	2.4%	38.1%	2.4%	100.0%
Suburban	54.8%	3.2%	0.0%	32.3%	9.7%	100.0%
Rural	50.0%	0.0%	0.0%	45.5%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	13	0	0	17	2	32
North East	21	1	0	9	0	31
South	25	1	1	21	2	50
West	19	1	1	13	2	36
Total	**78**	**3**	**2**	**60**	**6**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	40.6%	0.0%	0.0%	53.1%	6.3%	100.0%
North East	67.7%	3.2%	0.0%	29.0%	0.0%	100.0%
South	50.0%	2.0%	2.0%	42.0%	4.0%	100.0%
West	52.8%	2.8%	2.8%	36.1%	5.6%	100.0%

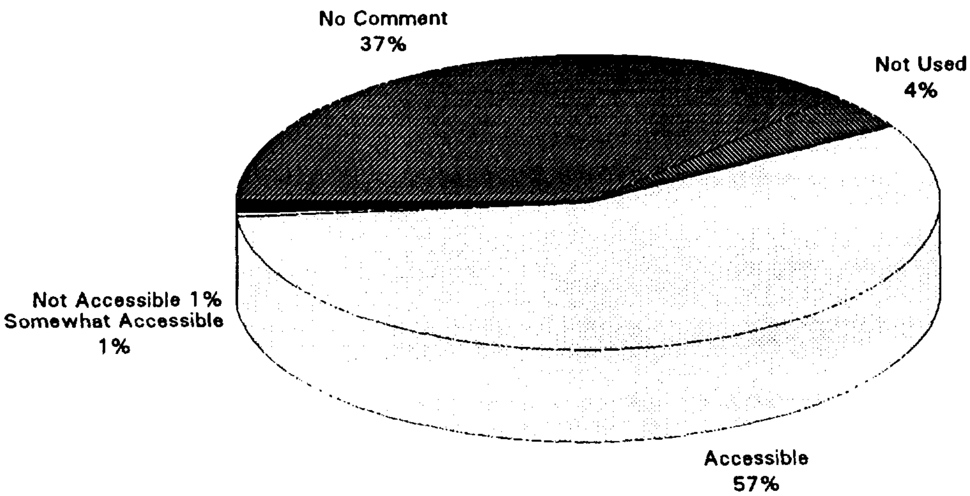


FIGURE 4.3.3.4-3 CUTTING TOOLS - STORAGE ACCESSIBILITY RATING

TABLE 4.3.3.4-3
CUTTING TOOLS - STORAGE ACCESSIBILITY RATING

Total Responses by Population

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Total # of Resp.	**85**	**1**	**2**	**55**	**6**	**149**
Total % of Resp.	**57.0%**	**0.7%**	**1.3%**	**36.9%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	31	0	2	20	1	54
Small Urban	27	0	0	14	1	42
Suburban	17	1	0	10	3	31
Rural	10	0	0	11	1	22
Total	**85**	**1**	**2**	**55**	**6**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	57.4%	0.0%	3.7%	37.0%	1.9%	100.0%
Small Urban	64.3%	0.0%	0.0%	33.3%	2.4%	100.0%
Suburban	54.8%	3.2%	0.0%	32.3%	9.7%	100.0%
Rural	45.5%	0.0%	0.0%	50.0%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	15	0	0	15	2	32
North East	22	0	0	9	0	31
South	28	1	0	19	2	50
West	20	0	2	12	2	36
Total	**85**	**1**	**2**	**55**	**6**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	46.9%	0.0%	0.0%	46.9%	6.3%	100.0%
North East	71.0%	0.0%	0.0%	29.0%	0.0%	100.0%
South	56.0%	2.0%	0.0%	38.0%	4.0%	100.0%
West	55.6%	0.0%	5.6%	33.3%	5.6%	100.0%

TABLE 4.3.3.4-4
CUTTING TOOLS

Comments on Improvements for Storage by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	12	7.6%
Not Applicable/No Comment	107	67.7%
Suggestions for Improvements	39	24.7%
Total Comments	158 *	100.0

Suggestions for Improvements	Number of Responses	Percentage of Responses
More storage space	11	28.2%
Lower compartments	5	12.8%
Mounting clips	5	12.8%
Slide out drawers/trays	4	10.3%
Better gasoline storage	4	10.3%
Larger compartments	2	5.1%
More compartmentalized	2	5.1%
Custom-design compartments	2	5.1%
Better access	2	5.1%
Square carrying cases	1	2.6%
Torch - smaller bottles	1	2.6%
Total	**39**	**100%**

* Multiple responses were permitted

4.3.3.5 Portability - Cutting Tools

Mounting type. As can be seen in Figure 4.3.3.5-1, one percent of all responses regarding mounting type stated hard mount, 6 percent were partial hard mount, one percent said remote/wheels, 64 percent were remote/hand carry, 7 percent were other, 9 percent were multiple types of mounting, 8 percent were no comment, and 4 percent were not used. Population and geographic data are provided in Table 4.3.3.5-1.

Number of persons needed to carry. As depicted in Figure 4.3.3.5-2, 57 percent of all responses indicated that 1 to 2 persons were needed to carry cutting tools, 15 percent indicated 2 persons, and 3 percent said 3 to 6 persons were required. Twenty-one percent of responses were no comment and 4 percent were not used. Population and geographic data are provided in Table 4.3.3.5-2.

Number of persons needed to operate. As shown in Figure 4.3.3.5-3, 64 percent of all responses indicated that I to 2 persons were needed to operate cutting tools, 9 percent said 2 persons, and 2 percent said 3 or 4 persons. Twenty-one percent of responses were no comment, and 4 percent were not used. Population and geographic data are provided in Table 4.3.3.5-3.

Of all the responses that were made regarding improvements for portability, 8 percent were no improvement, 81 percent were not applicable/no comment, and I I percent were suggestions for improvements. As shown in Table 4.3.3.5-4, the most common suggestions included lighter weight and carrying straps. Some of the other comments were: a lighter storage box; a saw designed for hands-free carrying; smaller bottles for torch; mount power plant with wheels; and mount power plant with reel.

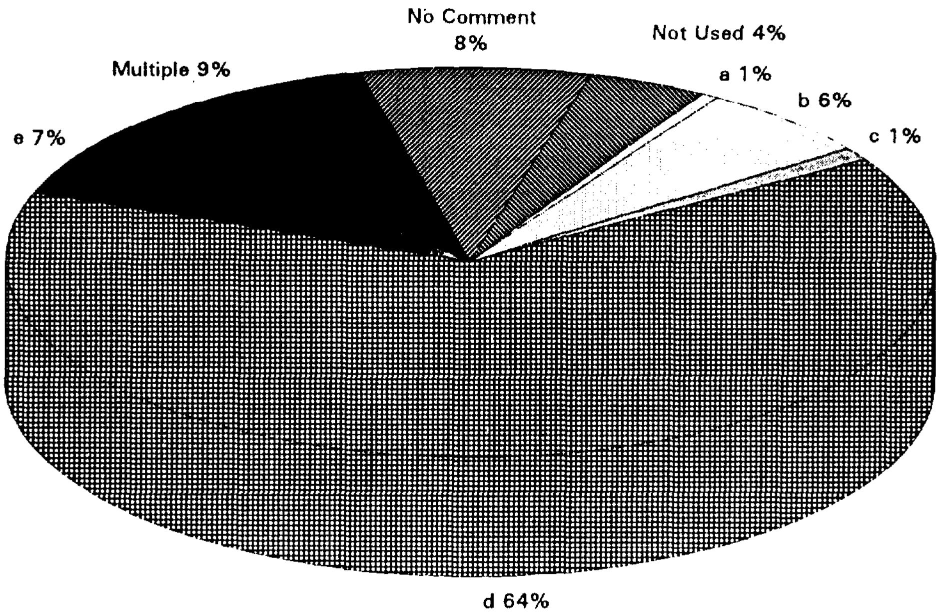


FIGURE 4.3.3.5-l CUTTING TOOLS - PORTABILITY MOUNTING TYPE RATING

TABLE 4.3.3.5-1
CUTTING TOOLS - PORTABILITY MOUNTING TYPE RATING

Total Responses by Population

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Total X of Resp.	**1**	**9**	**2**	**96**	**10**	**13**	**12**	**6**	**149**
Total % of Resp.	**0.7%**	**6.0%**	**1.3%**	**64.4%**	**6.7%**	**8.7%**	**8.1%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	1	3	0	35	5	6	3	1	54
Small Urban	0	4	1	22	5	5	4	1	42
Suburban	0	1	1	23	0	0	3	3	31
Rural	0	1	0	16	0	2	2	1	22
Total	**1**	**9**	**2**	**96**	**10**	**13**	**12**	**6**	**149**

Percent of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	1.9%	5.6%	0.0%	64.8%	9.3%	11.1%	5.6%	1.9%	100.0%
Small Urban	0.0%	9 5%	2.4%	52.4%	11.9%	11.9%	9.5%	2.4%	100.0%
Suburban	0.0%	3.2%	3.2%	74.2%	0.0%	0.0%	9.7%	9.7%	100.0%
Rural	0.0%	4.5%	0.0%	72.7%	0.0%	9.1%	9.1%	4.5%	100.0%

REGION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Region Text
North Central	0	3	1	20	1	2	3	2	32
North East	0		0	23	0	4	3	0	31
South	0	4	1	29	6	4	4	2	50
West	1	1	0	24	3	3	2	2	36
Total	**1**	**9**	**2**	**96**	**10**	**13**	**12**	**6**	**149**

Percent of Response

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Region Text
North Central	0.0%	9.4%	3.1%	62.5%	3.1%	6.3%	9.4%	6.3%	100.0%
North East	0.0%	3.2%	0.0%	74.2%	0.0%	12.9%	9.7%	0.0%	100.0%
South	0.0%	8.0%	2.0%	58.0%	12.0%	8.0%	8.0%	4.0%	100.0%
West	2.8%	2.8%	0.0%	66.7%	8.3%	8.3%	5.6%	5.8%	100.0%

"a - Hard mount b. Partial hard mount c - Remote/wheels d - Remote/hand carry e - Other

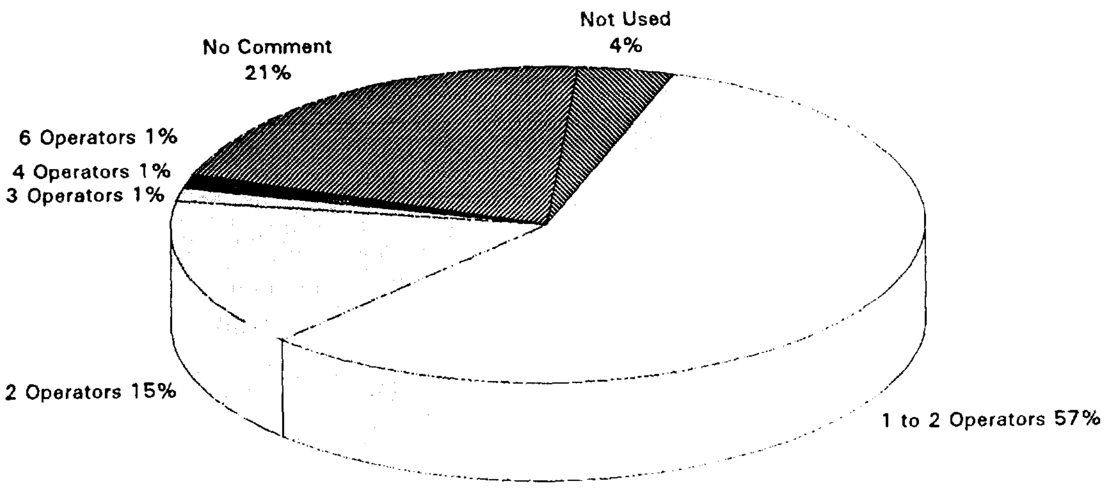


FIGURE 4.3.3.5-2 CUTTING TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

TABLE 4.3.3.5-2
CUTTING TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

Total Responses by Population

# Operators	1 to 2	2	3	4	6	No Comment	Not Used	Population Count
Total # of Resp.	**85**	**23**	**2**	**1**	**1**	**31**	**6**	**149**
Total % of Resp.	**57.0%**	**15.4%**	**1.3%**	**0.7%**	**0.7%**	**20.8%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	6	No Comment	Not Used	Population Count
Urban	36	5	0	1	1	10	1	54
Small Urban	22	10	2	0	0	7	1	42
Suburban	14	4	0	0	0	10	3	31
Rural	13	4	0	0	0	4	1	22
Total	**85**	**23**	**2**	**1**	**1**	**31**	**6**	**149**

Percent of Responses

Urban	66.7%	9.3%	0.0%	1.9%	1.9%	18.5%	1.9%	100.0%
Small Urban	52.4%	23.8%	4.8%	0.0%	0.0%	16.7%	2.4%	100.0%
Suburban	45.2%	12.9%	0.0%	0.0%	0.0%	32.3%	9.7%	100.0%
Rural	59.1%	18.2%	0.0%	0.0%	0.0%	18.2%	4.5%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	6	No Comment	Not Used	Region Count
North Central	18	7	0	0	0	5	2	32
North East	22	1	2	0	1	5	0	31
South	24	12	0	0	0	12	2	50
West	21	3	0	1	0	9	2	36
Total	**85**	**23**	**2**	**1**	**1**	**31**	**6**	**149**

Percent of Responses

North Central	56.3%	21.9%	0.0%	0.0%	0.0%	15.6%	6.3%	100.0%
North East	71.0%	3.2%	6.5%	0.0%	3.2%	16.1%	0.0%	100.0%
South	48.0%	24.0%	0.0%	0.0%	0.0%	24.0%	4.0%	100.0%
West	58.3%	8.3%	0.0%	2.8%	0.0%	25.0%	5.6%	100.0%

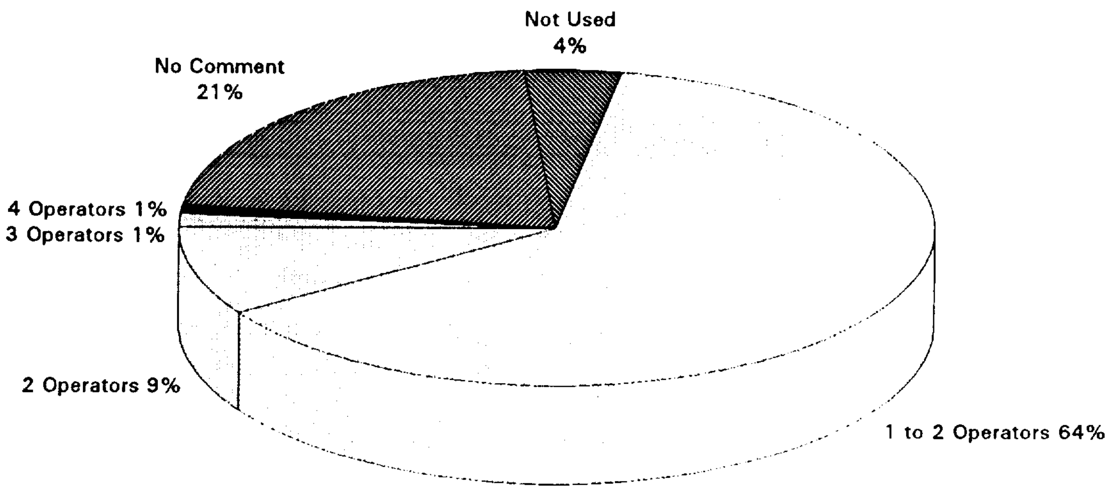


FIGURE 4.3.3.5-3 CUTTING TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

TABLE 4.3.3.5-3
CUTTING TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

Total Responses by Population

# Operators	1 to 2	2	3	4	No Comment	Not Used	Population Count
Total # of Resp.	**9 4**	**14**	**2**	**1**	**32**	**6**	**149**
Total % of Resp.	**63.1%**	**9.4%**	**1.3%**	**0.7%**	**21.5%**	**4.0%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2	9	3	No Comment	Not Used	Population Count
Urban	36	4	1	1	11	1	54
Small Urban	15	2	0	0	4	1	22
Suburban	16	2	0	0	10	3	31
Rural	27	6	1	0	7	1	42
Total	**94**	**14**	**2**	**1**	**32**	**6**	**149**

Percent of Responses

Urban	66.7%	7.4%	1.9%	1.9%	20.4%	1.9%	100.0%
Small Urban	68.2%	9.1%	0.0%	0.0%	18.2%	4.5%	100.0%
Suburban	51.6%	6.5%	0.0%	0.0%	32.3%	9.7%	100.0%
Rural	64.3%	14.3%	2.4%	0.0%	16.7%	2.4%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2	3	4	No Comment	Not Used	Region Count
North Central	21	3	0	0	6	2	32
North East	23	1	1	1	5	0	31
South	28	7	1	0	12	2	50
West	22	3	0	0	9	2	36
Total	**94**	**14**	**2**	**1**	**32**	**6**	**149**

Percent of Responses

North Central	65.6%	9.4%	0.0%	0.0%	18.8%	6.3%	100.0%
North East	74.2%	3.2%	3.2%	3.2%	16.1%	0.0%	100.0%
South	56.0%	14.0%	2.0%	0.0%	24.0%	4.0%	100.0%
West	61.1%	8.3%	0.0%	0.0%	25.0%	5.6%	100.0%

TABLE 4.3.3.5-4
CUTTING TOOLS

Comments on Improvements for Portability by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	12	8.0%
Not Applicable/No Comment	122	81.3%
Suggestions for Improvements	16	10.7%
Total Comments	**150 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	7	43.8%
Carrying straps	4	25.0%
Lighter storage box	1	6.3%
Saw - hands-free carrying	1	6.3%
Torch - smaller bottles	1	6.3%
Mount power unit with wheels	1	6.3%
Mount power unit with reel	1	6.3%
Total	**16**	**100%**

* Multiple responses were permitted

4.3.3.6 Safety Aspects - Cutting Tools

Of the total number of responses on safety concerns for cutting tools, 20 percent were none in particular, 24 percent were not applicable/no comment, and 56 percent were comments on safety. The most frequent safety concerns were: sparks; ignition potential/fire hazard; noise; high heat/hot metal; and saw kickback potential. Other concerns were: flying debris; moving parts on saws; saw blades buckling, chain/blade failure on saws; and sharp edges. Data are provided in Table 4.3.3.6-l.

Safety Equipment Rating (see Table 4.3.3.6-2):

Available for use. Sixty-five percent of all participants indicated that they had ear protection equipment available for use, 91 percent had eye, hand, head, and foot protection available, 90 percent had body protection available, and 24 percent had other types of protection equipment available for use. The other percentages of the participants responses were no comment/not used.

Used by personnel. Fifty-three percent of respondents indicated that they used ear protection equipment, 91 percent used eye and hand protection, 90 percent used head protection, 88 percent used foot protection, 89 percent used body protection equipment, and 20 percent said they used other types of protection equipment. The other percentages of the participants' responses were no comment/ not used.

Required to he used. Fifty-two percent of participants said they were required to use ear protection, 91 percent were required to use eye and hand protection, 89 percent were required to use body and head protection, 88 percent were required to use foot protection, and 19 percent said they were required to use other types of protection equipment. The other percentages of the participants responses were no comment/not used.

TABLE 4.3.3.6-1
CUTTING TOOLS

Comments on Safety Concerns by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
None in Particular	39	19.6%
Not Applicable/No Comment	48	24.1%
Safety Concerns	112	56.3%
Total Comments	**199 ***	**100.0%**

Safety Concerns	Number of Responses	Percentage of Responses
Sparks	38	33.9%
ignition potential/fire hazard	24	21.4%
Noise	9	8.0%
High heat/hot metal	8	7.1%
Saw - kickback potential	7	6.3%
Flying debris	4	3.6%
Saw - moving parts	4	3.6%
Saw - buckling	3	2.7%
Saw - chain/blade failure	3	2.7%
Sharp edges	3	2.7%
Tool control	2	1.8%
Exhaust fumes	2	1.8%
Tool slippage	1	0.9%
Tool weight	1	0.9%
Vibration	1	0.9%
Confined work areas	1	0.9%
Saw - binding	1	0.9%
Total	**112**	**100%**

* Multiple responses were permitted

TABLE 4.3.3.6-2
CUTTING TOOLS - SAFETY EQUIPMENT RATING

	EAR		EYE		HAND		BODY		HEAD		FOOT		OTHER	
Number of Responses	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used
Available for use	97	52	136	13	136	13	134	15	135	14	135	14	35	114
Used by personnel	79	70	135	14	135	14	132	17	134	15	131	18	29	120
Required to be used	70	71	135	14	135	14	132	17	133	16	131	18	28	121
***Percent of Responses**														
Available for use	65.1%		91.3%		91.3%		89.9%		90.6%		90.6%		23.5%	
Used by personnel	53.0%		90.6%		90.6%		88.6%		89.9%		87.9%		19.5%	
Required to be used	52.3%		90.6%		90.6%		88.6%		89.3%		87.9%		18.8%	

“Percentages were calculated for each individual type of protective device based on a total of 149 participants.

4.3.3.7 Modifications - Cutting Tools

Sixty-three percent of all responses on modifications to cutting tools were no modifications, 34 percent were not applicable/no comment, and 3 percent were modifications. The modifications included: color coding connectors/supply lines; glove operable controls; provide a lip on the saw for foot to start; use an acetylene pressure gauge on torches; and use a reel for the torch hose. Data are provided in Table 4.3.3.7-l.

TABLE 4.3.3.7-1
CUTTING TOOLS

Comments on Modifications by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Modifications	95	62.9%
Not Applicable/No Comment	51	33.8%
Modifications	5	3.3%
Total Comments	**151 ***	**100.0%**

Modifications	Number of Responses	Percentage of Responses
Color code	1	20.0%
Glove operable controls	1	20.0%
Saw - lip for foot to start	1	20.0%
Torch - acetylene pressure gauge	1	20.0%
Torch - reel for hose	1	20.0%
Total	**5**	**100%**

* Multiple responses were permitted

4.3.3.8 Potential Improvements - Cutting Tools

Of all responses to cutting tool improvements, 27 percent were no improvement, 41 percent were not applicable/no comment, and 32 percent were improvement suggestions. Some general suggestions were: a sparkless power source; more powerful cutting tools; develop a laser cutting tool; and develop light-duty, initial response cutting tool. Common improvements regarding saws were: lighter weight; better blade guards; improved starting; and stronger blades. Comments regarding torch improvements were lighter weight and smaller size torch. Data can be seen in Table 4.3.3.8-l.

TABLE 4.3.3.8-1
CUTTING TOOLS

Comments on Improvements by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No improvements	44	27.5%
Not Applicable/No Comment	65	40.6%
Suggestions for Improvements	51	31.9%
Total Comments	**160 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Sparkless	7	13.7%
More powerful	2	3.9%
Laser cutting tool	2	3.9%
Light-duty, initial response cutting tool	2	3.9%
Smaller	2	3.9%
Cooling system	1	2.0%
SAWS		
Lighter weight	11	21.6%
Better blade guards	4	7.8%
Improve starting	3	5.9%
Stronger blades	3	5.9%
Quieter	2	3.9%
Reduce vibration	1	2.0%
Protection from moving parts	1	2.0%
Larger foot area for starting	1	2.0%
No 2-cycle engines	1	2.0%
Electric hi-volt ignition	1	2.0%
Non-oil/gas mixture	1	2.0%
Pneumatic reciprocating saw	1	2.0%
Better balance	1	2.0%
Adjustable blade angle	1	2.0%
TORCH		
Lighter weight torch	2	3.9%
Smaller torch	1	2.0%
Total	**51**	**100%**

* Multiple responses were permitted

4.3.4 Pneumatic Tools-Description

This category includes various types of tools that are operated on compressed air pressure. This pressure can be delivered either from a portable cylinder/tank or directly from an air compressor. Examples include chisels, air bags, air shores, etc.

4.3.4.1 General Satisfaction - Pneumatic Tools

As can be seen in Figure 4.3.4. l-l, 88 percent of all participants indicated that they were very or somewhat satisfied with pneumatic tools, while 6 percent were somewhat or very dissatisfied. Participants from the south were more satisfied than participants from other regions. Data for total response by population, population category, and region are presented in Table 4.3.4. l-l.

Approximately 83 percent of comments on satisfaction with pneumatic tools were not applicable/no comment (see Table 4.3.4.1-2). Of the comments on problems, about 38 percent said they used pneumatic tools infrequently, indicated that other tools performed better on the same tasks, or they preferred hydraulic tools.

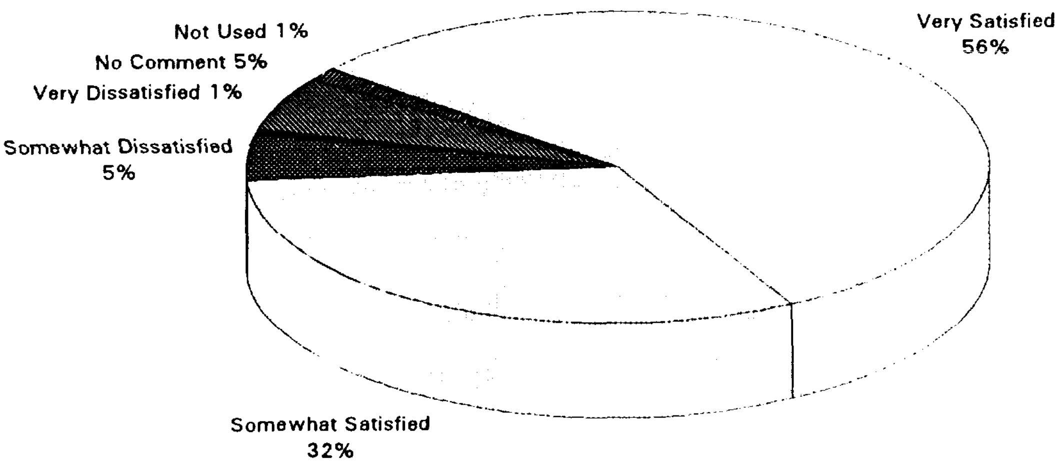


FIGURE 4.3.4.1-1 PNEUMATIC TOOLS - SATISFACTION RATING

TABLE 4.3.4.1-1
PNEUMATIC TOOLS - SATISFACTION RATING

Total Responses by Population

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Total # of Resp.	**84**	**47**	**7**	**1**	**8**	**2**	**149**
Total % of Resp.	**56.4%**	**31.5%**	**4.7%**	**0.7%**	**5.4%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	30	16	6	0	2	0	54
Small Urban	23	17	0	0	2	0	42
Suburban	18	8	1	1	3	0	31
Rural	13	6	0	0	1	2	22
Total	**84**	**47**	**7**	**1**	**8**	**2**	**149**

Percent of Responses

Urban	55.6%	29.6%	11.1%	0.0%	3.7%	0.0%	100.0%
Small Urban	54.8%	40.5%	0.0%	0.0%	4.8%	0.0%	100.0%
Suburban	58.1%	25.8%	3.2%	3.2%	9.7%	0.0%	100.0%
Rural	59.1%	27.3%	0.0%	0.0%	4.5%	9.1%	100.0%

REGION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	16	10	3	0	1	2	32
North East	21	8	0	1	1	0	31
South	30	16	1	0	3	0	50
West	17	13	3	0	3	0	36
Total	**84**	**47**	**7**	**1**	**8**	**2**	**149**

Percent of Responses

North Central	50.0%	31.3%	9.4%	0.0%	3.1%	6.3%	100.0%
North East	67.7%	25.8%	0.0%	3.2%	3.2%	0.0%	100.0%
South	60.0%	32.0%	2.0%	0.0%	6.0%	0.0%	100.0%
West	47.2%	36.1 %	8.3%	0.0%	8.3%	0.0%	100.0%

TABLE 4.3.4.1-2
PNEUMATIC TOOLS

Comments on Satisfaction by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	125	82.8%
Comments	26	17.2%
Total Comments	**151 ***	**100.0%**

Comments	Number of Responses	Percentage of Responses
Need more, newer, or better tools	15	57.7%
Hardly used	6	23.1%
Other tools do same job better	3	11.5%
Prefer hydraulic tools	1	3.8%
Air chisel - under-rated	1	3.8%
Total	**26**	**100%**

* Multiple responses were permitted

4.3.4.2 Ease of Operation - Pneumatic Tools

As depicted in Figure 4.3.4.2-l, 47 percent of all participants indicated the operation of pneumatic tools was very easy or easy, while 8 percent or responses were somewhat or not easy. More participants from the south rated pneumatic tools as easy to operate than participants from other regions. Data for total response by population, population category, and geographic location are given in Table 4.3.4.2-l.

Since ease of operation and effectiveness were evaluated together in the same question, it was difficult to separate the comments that were made. Therefore, it was decided to include all of the comments in the following section on tool effectiveness.

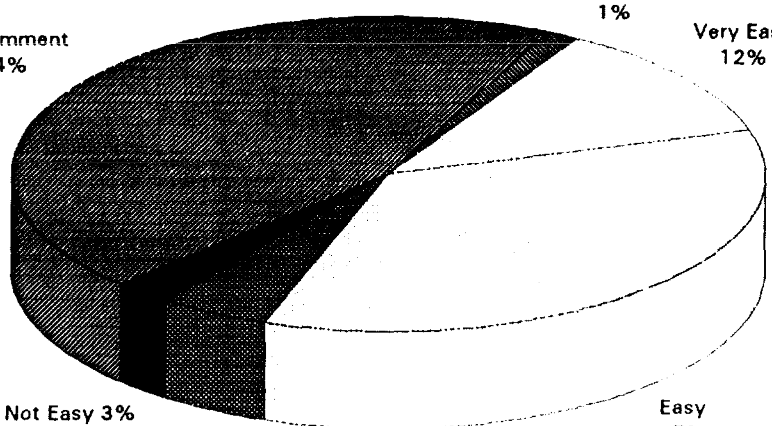


FIGURE 4.3.4.2-1 PNEUMATIC TOOLS - EASE OF OPERATION RATING

TABLE 4.3.4.2-l
PNEUMATIC TOOLS - EASE OF OPERATION

Total Responses by Population

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Total # of Resp.	**18**	**52**	**7**	**4**	**66**	**2**	**149**
Total % of Resp.	**12.1%**	**34.9%**	**4.7%**	**2.7%**	**44.3%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	8	16	3	2	25	0	54
Small Urban	4	15	3	2	18	0	42
Suburban	2	14	1	0	14	0	31
Rural	4	7	0	0	9	2	22
Total	**18**	**52**	**7**	**4**	**66**	**2**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	14.8%	29.6%	5.6%	3.7%	46.3%	0.0%	100.0%
Small Urban	9.5%	35.7%	7.1%	4.8%	42.9%	0.0%	100.0%
Suburban	6.5%	45.2%	3.2%	0.0%	45.2%	0.0%	100.0%
Rural	18.2%	31.8%	0.0%	0.0%	40.9%	9.1%	100.0%

REGION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	4	12	1	1	12	2	32
North East	1	10	4	0	16	0	31
South	10	17	1	2	20	0	50
West	3	13	1	1	18	0	36
Total	**18**	**52**	**7**	**4**	**66**	**2**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	12.5%	37.5%	3.1%	3.1%	37.5%	6.3%	100.0%
North East	3.2%	32.3%	12.9%	0.0%	51.6%	0.0%	100.0%
South	20.0%	34.0%	2.0%	4.0%	40.0%	0.0%	100.0%
West	8.3%	36.1%	2.8%	2.8%	50.0%	0.0%	100.0%

4.3.4.3 Effectiveness - Pneumatic Tools

As can be seen in Figure 4.3.4.3-1, 58 percent of all participants indicated that pneumatic tools were very effective or effective. Five percent of participants felt that the tools were ineffective or somewhat ineffective. Data analyzed by population type and geographic region are presented in Table 4.3.4.3-1.

Of the comments provided in Table 4.3.4.3-2, 65 percent were not applicable/no comment. Almost twice as many performance problem comments were reported than were comments on performance assets. The most common performance problems that were cited included: pneumatic tools are heavy/cumbersome and require a lengthy setup time; air chisels are too noisy, are slow/time consuming to use and have limited use. Other comments included: air chisels have limited air supply and break down frequently; air bags are heavy/cumbersome and time consuming to use; and spreaders/cutters are underpowered and waste air.

The most common performance assets reported included that pneumatic tools were easy to hook up and lightweight. Other comments were that the tools were compact, versatile, sparkless, dependable, easy to control, powerful, and that air bags were quiet.

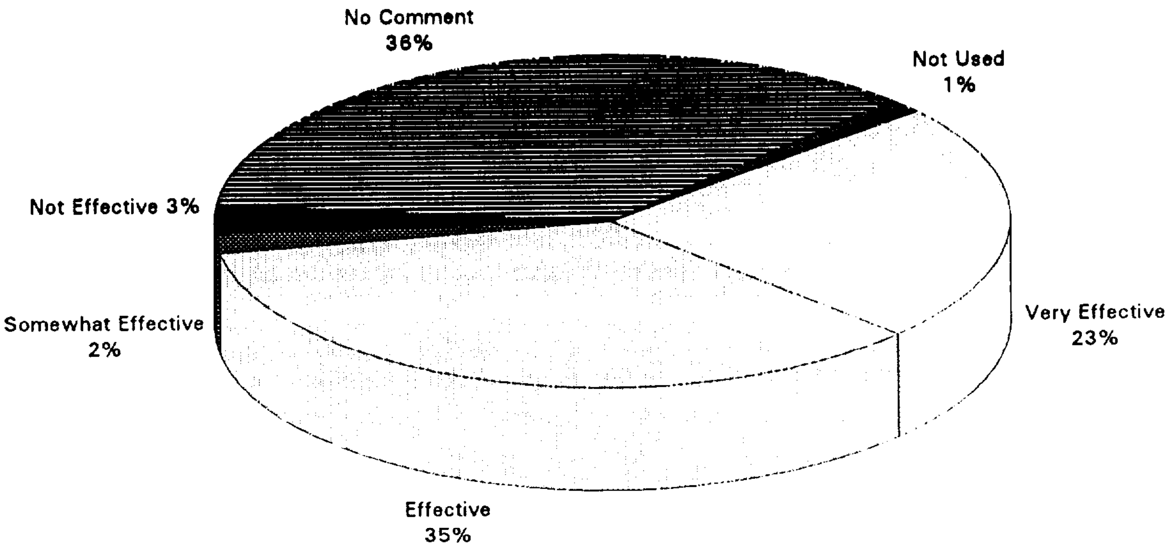


FIGURE 4.3.4.3-1 PNEUMATIC TOOLS - EFFECTIVENESS RATING

TABLE 4.3.4.3-1
PNEUMATIC TOOLS - EFFECTIVENESS RATING

Total Responses by Population

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Total # of Resp.	**35**	**52**	**3**	**4**	**53**	**2**	**149**
Total % of Resp.	**23.5%**	**34.9%**	**2.0%**	**2.7%**	**35.6%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	16	17	1	4	16	0	54
Small Urban	8	16	2	0	16	0	42
Suburban	6	11	0	0	14	0	31
Rural	5	8	0	0	7	2	22
Total	**35**	**52**	**3**	**4**	**53**	**2**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	29.6%	31.5%	1.9%	7.4%	29.6%	0.0%	100.0%
Small Urban	19.0%	38.1%	4.8%	0.0%	38.1%	0.0%	100.0%
Suburban	19.4%	35.5%	0.0%	0.0%	45.2%	0.0%	100.0%
Rural	22.7%	36.4%	0.0%	0.0%	31.8%	9.1%	100.0%

REGION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	7	10	0	1	12	2	32
North East	8	11	0	1	11	0	31
South	15	16	2	2	15	0	50
West	5	15	1	0	15	0	36
Total	**35**	**52**	**3**	**4**	**53**	**2**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	21.9%	31.3%	0.0%	3.1%	37.5%	6.3%	100.0%
North East	25.8%	35.5%	0.0%	3.2%	35.5%	0.0%	100.0%
South	30.0%	32.0%	4.0%	4.0%	30.0%	0.0%	100.0%
West	13.9%	41.7%	2.8%	0.0%	41.7%	0.0%	100.0%

TABLE 4.3.4.3-2
PNEUMATIC TOOLS

Comments on Effectiveness/Ease of Operation by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	109	65.3%
Comments on Tool Problems	37	22.2%
Comments on Tool Assets	21	12.6%
Total Comments	**167 ***	**100.0%**

Comments on Performance Problems	Nurnber of Responses	Percentage of Responses
Heavy/cumbersome (general)	5	13.5%
Air chisel - loud/noisy	5	13.5%
Slow/time consuming (air chisel)	4	10.8%
Lengthy set-up time	4	10.8%
Air chisel - limitations	4	10.8%
Operator determines effectiveness	2	5.4%
Air chisel - limited air supply	2	5.4%
Air chisel - frequent breakdown	2	5.4%
Heavy/cumbersome (airbag)	1	2.7%
Slow/time consuming (airbag)	1	2.7%
Ilndependable	1	2.7%
More maintenance	1	2.7%
Air chisel - weak	1	2.7%
Air chisel - ineffective on some vehicle components	1	2.7%
Airbag - support equipment	1	2.7%
Spreader/cutter - underpowered	1	2.7%
Spreader/cutter - wasteful of air	1	2.7%
Total	**37**	**100%**

Comments on Performance Assets	Number of Responses	Percentage of Responses
Easy hook-up	6	28.6%
Light weight	5	23.8%
Compact	2	9.5%
Versatile	2	9.5%
Sparkless	2	9.5%
Dependable	1	4.8%
Easy to control	1	4.8%
Powerful	1	4.8%
Airbags - quiet	1	4.8%
Total	**21**	**100.0%**

* Multiple responses were permitted

4.3.4.4 Storage Efficiency - Pneumatic Tools

Storage of manually powered tools was evaluated according to three criteria: 1) adequacy, 2) safety, and 3) accessibility. See Tables 4.3.4.4-1 through 4.3.4.4-3 for population and region data,

Adequacy. As shown in Figure 4.3.4.4-1, 60 percent of the total responses indicated that storage of manually powered tools was adequate, and only 7 percent stated that storage was not adequate.

Safety. Fifty-eight percent of all responses indicated that storage of manually powered tools was safe, while 3 percent stated that storage was unsafe. Data are provided in Figure 4.3.4.4-2.

Accessibility, Fifty-nine percent of all responses indicated that storage of manually powered tools was accessible, while 2 percent said that storage was inaccessible. Data are provided in Figure 4.3.4.4-3.

As can be seen in Table 4.3.4.4-4, approximately 77 percent of responses were not applicable/no comment and 8 percent were no improvement. Of the IS percent of comments regarding improvements, the most common comments were more storage space and larger, lower, custom-designed compartments. Also included were: more compartmentalized storage, pull-out drawers/trays, individual tool storage cases, and storage bags for hoses.

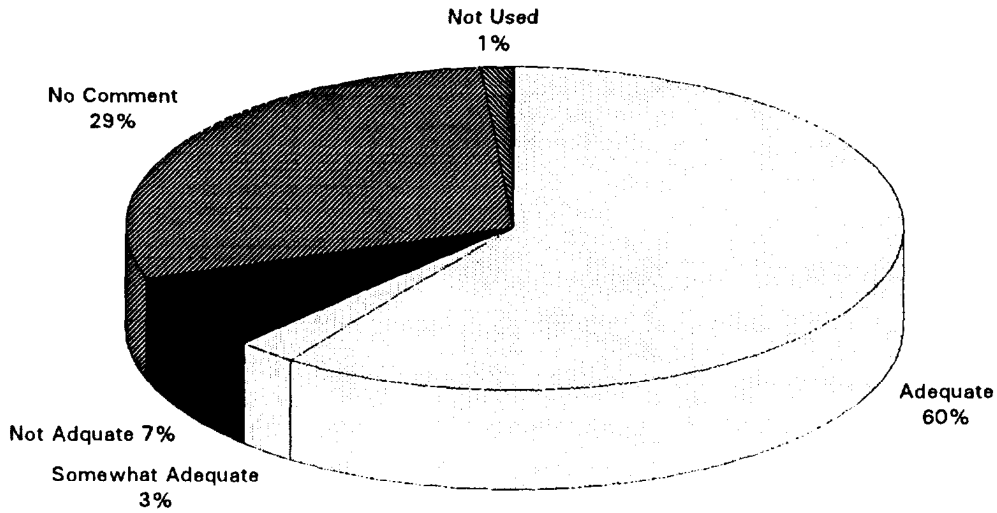


FIGURE 4.3.4.4-1 PNEUMATIC TOOLS - STORAGE ADEQUACY RATING

TABLE 4.3.4.4-1
PNEUMATIC TOOLS - STORAGE ADEQUACY RATING

Total Responses by Population

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Total # of Resp.	**89**	**4**	**11**	**43**	**2**	**149**
Total % of Resp.	**59.7%**	**2.7%**	**7.4%**	**28.9%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	31	3	4	16	0	54
Small Urban	22	1	6	13	0	42
Suburban	21	0	0	10	0	31
Rural	15	0	1	4	2	22
Total	**89**	**4**	**11**	**43**	**2**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	57.4%	5.6%	7.4%	29.6%	0.0%	100.0%
Small Urban	52.4%	2.4%	14.3%	31 .O%	0.0%	100.0%
Suburban	67.7%	0.0%	0.0%	32.3%	0.0%	100.0%
Rural	68.2%	0.0%	4.5%	18.2%	9.1%	100.0%

REGION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	18	0	2	10	2	32
North East	19	1	2	9	0	31
South	34	0	4	12	0	50
West	18	3	3	12	0	36
Total	**89**	**4**	**11**	**43**	**2**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	56.3%	0.0%	6.3%	31.3%	6.3%	100.0%
North East	61.3%	3.2%	6.5%	29.0%	0.0%	100.0%
South	68.0%	0.0%	8.0%	24.0%	0.0%	100.0%
West	50.0%	8.3%	8.3%	33.3%	0.0%	100.0%

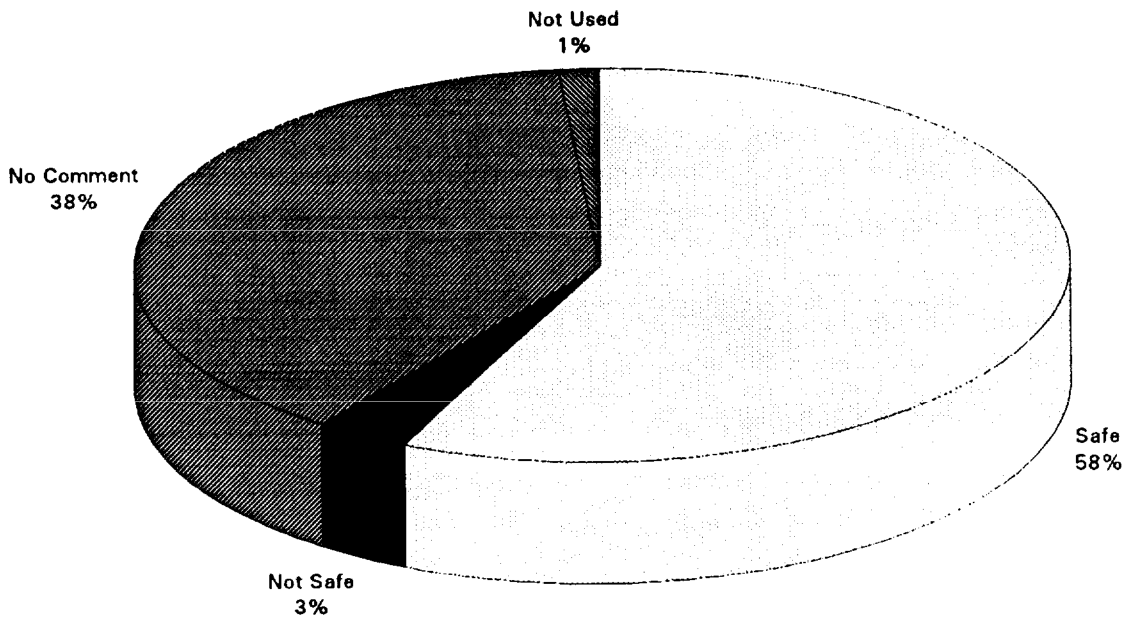


FIGURE 4.3.4.4-2 PNEUMATIC TOOLS - STORAGE SAFETY RATING

TABLE 4.3.4.4-2
PNEUMATIC TOOLS - STORAGE SAFETY RATING

Total Responses by Population

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Total # of Resp.	**85**	**0**	**5**	**57**	**2**	**149**
Total % of Resp.	**57.0%**	**0.0%**	**3.4%**	**38.3%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	27	0	4	23	0	54
Small Urban	22	0	1	19	0	42
Suburban	23	0	0	8	0	31
Rural	13	0	0	7	2	22
Total	**85**	**0**	**5**	**57**	**2**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	50.0%	0.0%	7.4%	42.6%	0.0%	100.0%
Small Urban	52.4%	0.0%	2.4%	45.2%	0.0%	100.0%
Suburban	74.2%	0.0%	0.0%	25.8%	0.0%	100.0%
Rural	59.1%	0.0%	0.0%	31.8%	9.1%	100.0%

REGION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	16	0	0	14	2	32
North East	21	0	1	9	0	31
South	31	0	0	19	0	50
West	17	0	4	15	0	36
Total	**85**	**0**	**5**	**57**	**2**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	50.0%	0.0%	0.0%	43.8%	6.3%	100.0%
North East	67.7%	0.0%	3.2%	29.0%	0.0%	100.0%
South	62.0%	0.0%	0.0%	38.0%	0.0%	100.0%
West	47.2%	0.0%	11.1%	41.7%	0.0%	100.0%

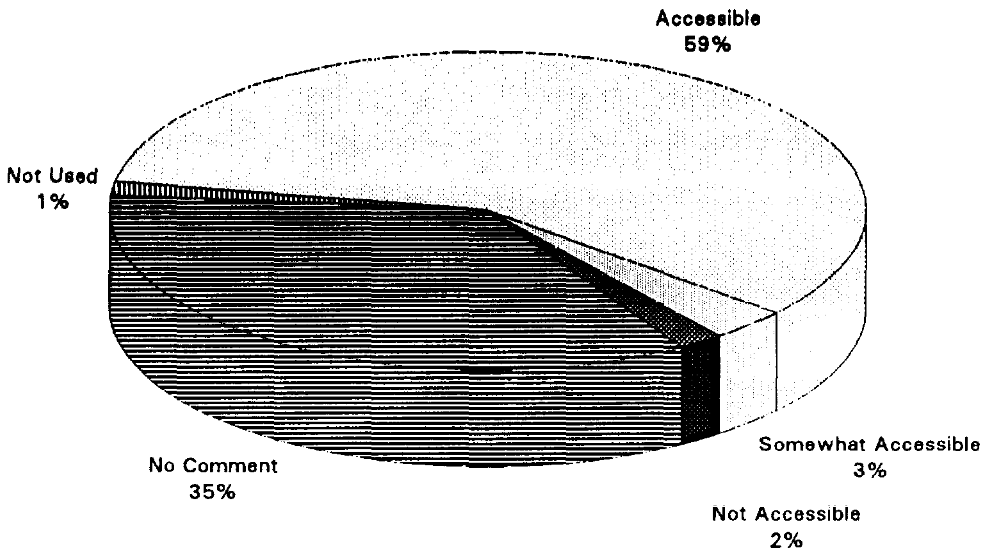


FIGURE 4.3.4.4-3 PNEUMATIC TOOLS - STORAGE ACCESSIBILITY RATING

TABLE 4.3.4.4-3
PNEUMATIC TOOLS - STORAGE ACCESSIBILITY RATING

Total Responses by Population

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Total # of Resp.	**87**	**5**	**3**	**52**	**2**	**149**
Total % of Resp.	**58.4%**	**3.4%**	**2.0%**	**34.9%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	28	3	1	22	0	54
Small Urban	23	1	2	16	0	42
Suburban	22	1	0	8	0	31
Rural	14	0	0	6	2	22
Total	**87**	**5**	**3**	**52**	**2**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	51.9%	5.6%	19%	40.7%	0.0%	100.0%
Small Urban	54.8%	2.4%	4.8%	38.1%	0.0%	100.0%
Suburban	71 .0%	3.2%	0.0%	25.8%	0.0%	100.0%
Rural	63.6%	0.0%	0.0%	27.3%	9.1%	100.0%

REGION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	17	0	0	13	2	32
Korth East	23	0	1	7	0	31
South	29	1	0	20	0	50
West	18	4	2	12	0	36
Total	**87**	**5**	**3**	**52**	**2**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	53.1%	0.0%	0.0%	40.6%	6.3%	100.0%
North East	74.2%	0.0%	3.2%	22.6%	0.0%	100.0%
South	58.0%	2.0%	0.0%	40.0%	0.0%	100.0%
West	50.0%	11.1%	5.6%	33.3%	0.0%	100.0%

TABLE 4.3.4.4-4
PNEUMATIC TOOLS

Comments on Improvements for Storage by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	12	7.9%
Not Applicable/No Comment	117	77.0%
Suggestions for Improvements	23	15.1%
Total Comments	**152 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
More storage space	5	21.7%
Larger compartments	5	21.7%
Lower compartments	3	13.0%
Custom-design compartments	3	13.0%
More compartmentalized	2	8.7%
Pull-out drawers/trays	1	4.3%
Easier Access	1	4.3%
Airbag - recess valves into corner	1	4.3%
Individual tool storage cases	1	4.3%
Storage bag for hoses	1	4.3%
Total	**23**	**100%**

* Multiple responses were permitted

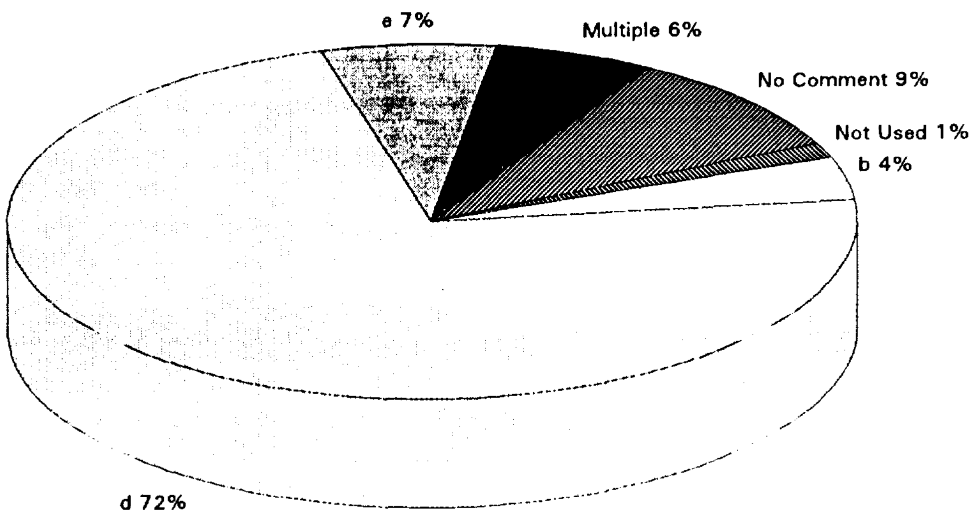
4.3.4.5 Portability - Pneumatic Tools

Mounting type. As depicted in Figure 4.3.4.5-1, 4 percent of participants use partial hard mount for manually powered tools, 73 percent used remote/hand carry, 7 percent used other mounting types, 6 percent used a combination of mounting types, and the remaining responses were no comment or not used. Table 4.3.4.5-1 presents data by population category and geographical region.

Number persons needed to carry. Forty-three percent of all participants indicated that 1 to 2 persons were required to carry manually powered tools, as shown in Figure 4.3.4.5-2. Twenty-three percent of responses were 2 persons, and 4 percent said 3 to 4 or 4 persons were needed. Data analyzed by population category and region are provided in Table 4.3.4.5-2.

Number of persons needed to operate. As shown in Figure 4.3.2.5-3, 40 percent of all responses indicated that 1 to 2 persons were needed to operate manually powered tools. Twenty-six percent indicated 2 to 3 operators and 4 percent said 3 to 4 or 4 operators were required. Data analyzed by population category and region are provided in Table 4.3.4.5-3.

As can be seen in Table 4.3.4.5-4, approximately 87 percent of the total responses were not applicable/no comment. The most common comment on problems was the need to have handles on air bags and air bag support equipment, such as control devices. Also mentioned were the need to have lighter weight pneumatic tools, a doily for air bags, and aluminum air bottles for air chisels.



KEY: a - Hard mount b - Partial mount c - Remote/wheels d - Remote/hand carry e - Other

FIGURE 4.3.4.5-1 PNEUMATIC TOOLS - PORTABILITY MOUNTING TYPE RATING

TABLE 4.3.4.5 - 1
PNEUMATIC TOOLS - PORTABILITY MOUNTING TYPE RATING

Total Responses by Population

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Total # of Resp.	**0**	**6**	**0**	**108**	**10**	**9**	**14**	**2**	**149**
Total % of Resp.	**0.0%**	**4.0%**	**0.0%**	**72.5%**	**8.7%**	**6.0%**	**9.4%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	0	3	0	39	5	3	4	0	54
Small Urban	0	1	0	30	5	1	5	0	42
Suburban	0	1	0	22	0	3	5	0	31
Rural	0	1	0	17	0	2	0	2	22
Total	**0**	**8**	**0**	**108**	**10**	**9**	**14**	**2**	**149**

Percent of Responses

	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	0.0%	5.6%	0.0%	72.2%	9.3%	5.6%	7.4%	0.0%	100.0%
Small Urban	0.0%	2.4%	0.0%	71.4%	11.9%	2.4%	11.9%	0.0%	100.0%
Suburban	0.0%	3.2%	0.0%	71.0%	0.0%	9.7%	16.1%	0.0%	100.0%
Rural	0.0%	4.5%	0.0%	77.3%	0.0%	9.1%	0.0%	9.1%	100.0%

REGION CATEGORY

Number of Responses

Mounting type *	a	b	4	d	e	Multiple	No Comment	Not Used	Population Count
North Central	0	0	0	23	2	2	3	2	32
North East	0	2	0	22	0	4	3	0	31
South	0	3	0	35	5	2	5	0	50
West	0	1	0	28	3		3	0	36
Total	**0**	**6**	**0**	**108**	**10**	**3**	**14**	**2**	**149**

Percent of Responses

	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
North Central	0.0%	0.0%	0.0%	71.9%	6.3%	6.3%	9.4%	6.3%	100.0%
North East	0.0%	6.5%	0.0%	71.0%	0.0%	12.9%	9.7%	0.0%	100.0%
South	0.0%	8.0%	0.0%	70.0%	10.0%	4.0%	10.0%	0.0%	100.0%
West	0.0%	2.8%	0.0%	77.8%	8.3%	2.8%	8.3%	0.0%	100.0%

* a - Hard mount b - Partial hard mount c _ Remote/wheels d - Remote/hand carry e - Other

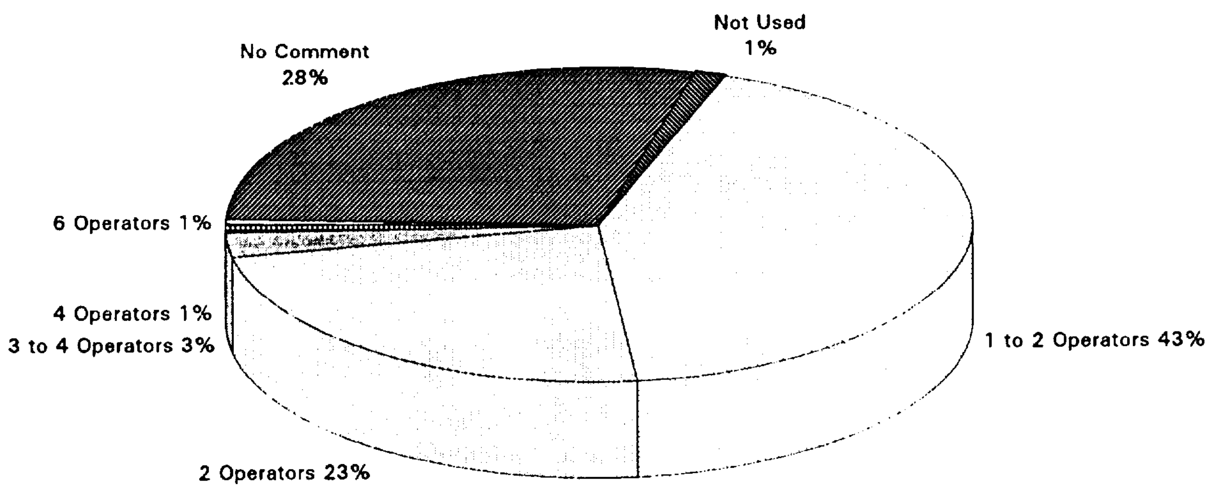


FIGURE 4.3.4.5-2 PNEUMATIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

TABLE 4.3.4.5-2
PNEUMATIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

Total Responses by Population

# Operators	1 to 2	2	3 to 4	4	6	No Comment	Not Used	Population Count
Total # of Resp.	**64**	**35**	**4**	**1**	**1**	**42**	**2**	**149**
Total % of Resp.	**43.0%**	**23.5%**	**2.7%**	**0.7%**	**0.7%**	**28.2%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2	3 to 4	4	6	No Comment	Not Used	Population Count
Urban	26	13	1	1	1	12	0	54
Small Urban	18	13	1	0	0	10	0	42
Suburban	13	5	0	0	0	13	0	31
Rural	7	4	2	0	0	7	2	22
Total	**64**	**35**	**4**	**1**	**1**	**42**	**2**	**149**

Percent of Responses

Urban	48.1%	24.1%	1.9%	1.9%	1.9%	22.2%	0.0%	100.0%
Small Urban	42.9%	31.0%	2.4%	0.0%	0.0%	23.8%	0.0%	100.0%
Suburban	41.9%	16.1%	0.0%	0.0%	0.0%	41.9%	0.0%	100.0%
Rural	31.8%	18.2%	9.1%	0.0%	0.0%	31.8%	9.1%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2	3 to 4	4	6	No Comment	Not Used	Population Count
North Central	13	6	3	0	0	8	2	32
North East	16	6	0	0	1	8	0	31
South	20	17	0	0	0	13	0	50
West	15	6	1	1	0	13	0	36
Total	**64**	**35**	**4**	**1**	**1**	**42**	**2**	**149**

Percent of Responses

North Central	40.6%	18.8%	9.4%	0.0%	0.0%	25.0%	6.3%	100.0%
North East	51.6%	19.4%	0.0%	0.0%	3.2%	25.8%	0.0%	100.0%
South	40.0%	34.0%	0.0%	0.0%	0.0%	26.0%	0.0%	100.0%
West	41.7%	16.7%	2.8%	2.8%	0.0%	36.1%	0.0%	100.0%

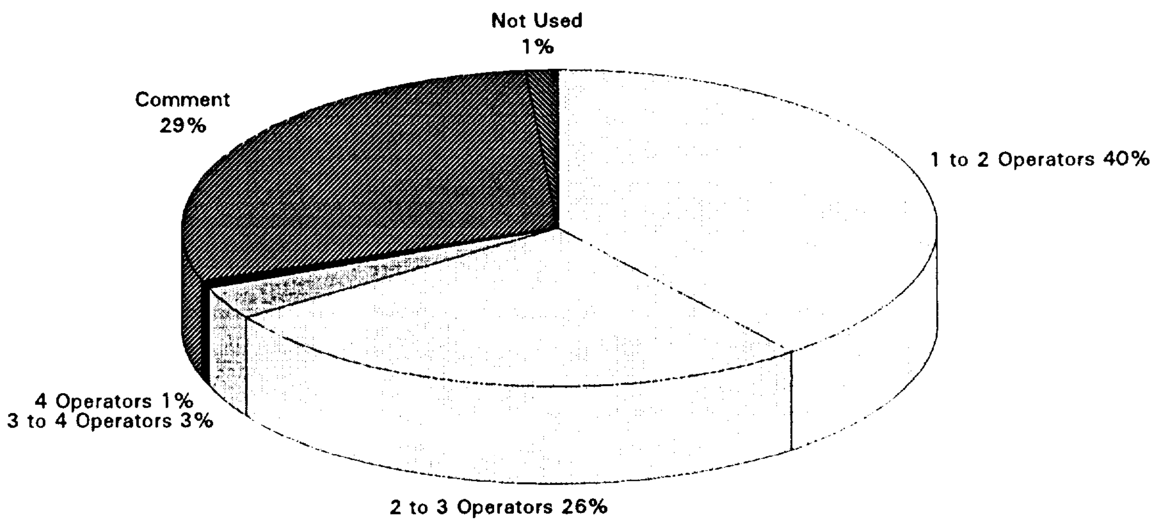


FIGURE 4.3.4.5-3 PNEUMATIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

TABLE 4.3.4.5-3
PNEUMATIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	3 to 4	4	No Comment	Not Used	Population Count
Total # of Resp.	**59**	**39**	**5**	**1**	**43**	**2**	**149**
Total % of Resp.	**39.6%**	**26.2%**	**3.4%**	**0.7%**	**28.9%**	**1.3%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3 to 4	4	No Comment	Not Used	Population Count
Urban	24	15	2	1	12	0	54
Small Urban	18	13	1	0	10	0	42
Suburban	12	5	0	0	14	0	31
Rural	5	6	2	0	7	2	22
Total	**59**	**39**	**5**	**1**	**43**	**2**	**149**

Percent of Responses

Urban	44.4%	27.8%	3.7%	1.9%	22.2%	0.0%	100.0%
Small Urban	42.9%	31.0%	2.4%	0.0%	23.8%	0.0%	100.0%
Suburban	38.7%	16.1%	0.0%	0.0%	45.2%	0.0%	100.0%
Rural	22.7%	27.3%	9.1%	0.0%	31.8%	9.1%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3 to 4	4	No Comment	Not Used	Population Count
North Central	12	8	2	0	8	2	32
North East	13	7	1	1	9	0	31
South	19	17	1	0	13	0	50
West	15	7	1	0	13	0	36
Total	**59**	**39**	**5**	**1**	**43**	**2**	**149**

Percent of Responses

North Central	37.5%	25.0%	6.3%	0.0%	25.0%	6.3%	100.0%
North East	41.9%	22.6%	3.2%	3.2%	29.0%	0.0%	100.0%
South	38.0%	34.0%	2.0%	0.0%	26.0%	0.0%	100.0%
West	41.7%	19.4%	2.8%	0.0%	36.1%	0.0%	100.0%

TABLE 4.3.4.5-4
PNEUMATIC TOOLS

Comments on Improvements for Portability by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	11	7.3%
Not Applicable/No Comment	131	87.3%
Suggestions for Improvements	8	5.3%
Total Comments	**150 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Airbag - handles/package	3	37.5%
Lighter weight	2	25.0%
Dolly for airbags	2	25.0%
Air chisel - aluminum bottles	1	12.5%
Total	**8**	**100%**

* Multiple responses were permitted

4.3.4.6 Safety Aspects - Pneumatic Tools

Of the comments on areas of concern for safety for pneumatic tools (shown in Table 4.3.4.6-1), approximately 30 percent were no concerns, 30 percent were not applicable/no comment, and 40 percent were safety concerns. The most commonly reported safety concerns included air bag stabilization, air chisel loudness, air chisel loss of tip (fly off), tool slippage, and sharp edges created by air chisels. Additional comments, among others, included flying debris and sparks from air chisel, and pressure in hoses and air bags.

Safety Equipment Rating (see Table 4.3.4.6-2):

Available for use. Sixty-nine percent of all participants indicated that they had ear protection equipment available for use, 96 percent had eye, hand. head, and foot protection available, 95 percent had body protection available, and 25 percent had other types of protection equipment available for use. The other percentages of the participants' responses were no comment/not used.

Used by personnel. Fifty-four percent of respondents indicated that they used ear protection equipment, 93 percent used eye, body, and foot protection, 95 percent used head and foot protection, and 17 percent said they used other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

Required to be used. Fifty-four percent of participants said they were required to use ear protection, 93 percent were required to use eye protection, 94 percent were required to use hand protection, 91 percent were required to use body protection, 95 percent were required to use head protection, 92 percent were required to use foot protection, and 17 percent said they were required to use other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

TABLE 4.3.4.6-1
PNEUMATIC TOOLS

Comments on Safety Concerns by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
None In Particular	51	30.0%
Not Applicable/No Comment	51	30.0%
Safety Concerns	68	40.0%
Total Comments	**170 ***	**100.0%**

Safety Concerns	Number of Responses	Percentage of Responses
Airbag - stabilization	14	20.6%
Air chisel - loud/noisy	9	13.2%
Air chisel - loss of tip/fly off	9	13.2%
Tool slippage	6	8.8%
Air chisel - creates sharp edges	6	8.8%
Tool/hose failure	4	5.9%
Air chisel - sparks	4	5.9%
Air chisel - flying debris	4	5.9%
Airbag - puncture/damage	4	5.9%
Air chisel - ignition potential	2	2.9%
Airbag - pressure in hoses	2	2.9%
Air chisel - cylinder transpo. safet	1	1.5%
Airbag - proper pressure	1	1.5%
Airbag - age of bags	1	1.5%
Airbag - great forces	1	1.5%
Air chisel - shatter during use	0	0.0%
Airbag - heavy/cumbersome	0	0.0%
Total	**68**	**100%**

* Multiple responses were permitted

TABLE 4.3.4.6-2
PNEUMATIC TOOLS - SAFETY EQUIPMENT RATING

	EAR		EYE		HAND		BODY		HEAD		FOOT		OTHER	
Number of Response	Comment	No Comment/ Not Used	Comment	No Comment Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment Not Used	Comment	No Comment/ Not Used
Available for use	103	46	143	6	143	6	142	7	143	6	143	6	37	112
Used by personnel	61	66	138	11	142	7	139	10	142	7	139	10	26	123
Required to be used	60	69	138	11	140	9	136	13	141	8	137	12	26	123
***Percent of Response**														
Available for use	69.1%		96.0%		96.0%		95.3%		96.0%		96.0%		24.8%	
Used by personnel	54.4%		92.6%		95.3%		93.3%		95.3%		93.3%		17.4%	
Required to be used	53.7%		92.6%		94.0%		91.3%		94.6%		91.9%		17.4%	

*Percentages were calculated for each individual type of protective device based on a total of 149 participants.

4.3.4.7 Modifications - Pneumatic Tools

Of the responses to pneumatic tool modification shown in Table 4.3.4.7-1, 70 percent were no modification and 26 percent were not applicable/no comment. The comments on pneumatic tool modifications that were reported include: a mounted regulator, an electric rewind reel, a sling or backpack to carry the air bottle for the air chisel, a manifold for two SCUBA tanks, marking air bags with center height, and replacing the spring with a screw in air chisels to prevent the tip from flying off.

TABLE 4.3.4.7-1
PNEUMATIC TOOLS

Comments on Modifications by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Modifications	104	69.8%
Not Applicable/No Comment	38	25.5%
Modifications	7	4.7%
Total Comments	**149 ***	**100.0%**

Modifications	Number of Responses	Percentage of Responses
Manifold for 2 scuba tanks	1	14.3%
Mounted regulator	1	14.3%
Electric rewind reel	1	14.3%
Air chisel - sling to carry air bottle	1	14.3%
Air chisel - replaced spring with screw	1	14.3%
Airbag - marked with center height	1	14.3%
Air chisel - back pack to carry air bottle	1	14.3%
Total	**7**	**100%**

* Multiple responses were permitted

4.3.4.8 Potential Improvements - Pneumatic Tools

Of the comments on pneumatic tool improvements, as shown in Table 4.3.4.8-1, 38 percent were no improvements, 41 percent were not applicable/no comment, and 21 percent were suggestions for improvements. Comments on improvements were divided into categories: air chisels and air bags.

Air Chisels. Comments for air chisel improvements included a more efficient, continuous air supply, a better bit retainer, a better trigger mechanism, design upgrade for a faster, quieter, more powerful and reliable air chisel, standard size air fittings, non-spark bits and more bit varieties.

Air Bags. Comments for air bag improvement included a more damage-resistant bag, able to provide higher lift at a faster rate, square design (instead of round), more efficient air supply, a reel for hose, a preconnected hose reel, a pneumatic reel compressor, a tool belt with dual air bottle, and color-coded hoses.

TABLE 4.3.4.8-1
PNEUMATIC TOOLS

Comments on Improvements by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	60	38.2%
Not Applicable/No Comment	64	40.8%
Suggestions for Improvements	33	21.0%
Total Comments	**157 ***	**100.0%**

Air Chisel	Number of Responses	Percentage of Responses
More efficient air source	4	20.0%
Continuous vehicle air supply	3	15.0%
Better bit retainer	3	15.0%
Better trigger mechanism	2	10.0%
Faster	1	5.0%
Quieter	1	5.0%
More powerful	1	5.0%
Stronger	1	5.0%
Less breakdown	1	5.0%
Standard size air fittings	1	5.0%
Non-spark bits	1	5.0%
More bit varieties	1	5.0%
Total	**2 0**	**100%**

Airbag	Number of Responses	Percentage of Responses
More damage resistant	2	14%
Higher lift	1	7%
Squared, not round	1	7%
Better controls	1	7%
Rate max. “effective” lift	1	7%
More efficient air source	1	7%
More compact	1	7%
Reel for hose	1	7%
Pre-connected hose reel	1	7%
Pneumatic reel compressor	1	7%
Tool belt w/dual air bottle	1	7%
Color-coded hoses	1	7%
Valve - no hose/remain inflated	1	7%
Total	**1 4**	**100%**

* Multiple responses were permitted

4.3.5 Hydraulic Tools--Description

This type of tool is self-powered and generates a force by conveying fluid through a pump system. Examples include spreaders/pullers and cutters.

4.3.5.1 General Satisfaction - Hydraulic Tools

As shown in Figure 4.3.5.1-l, 54 percent of respondents indicated that they were very satisfied with hydraulic tool performance, I percent was somewhat satisfied, 2 percent were somewhat dissatisfied, and none was very dissatisfied. Eight percent of responses were no comment and 4 percent were not used. A larger percentage of rural participants and participants from the north central region were very satisfied with hydraulic tools than were other participants. Data for population and region categories are provided in Table 4.3.5.l-l.

When asked to comment on hydraulic tool satisfaction 89 percent of responses were not applicable/no comment, and 11 percent gave comments (see Table 4.3.5.1-2). Twenty-five percent of the comments were regarding a preference for one brand of hydraulic tool, 19 percent of the comments were that hydraulic tools were used the most, 6 percent were hardly used, and 6 percent were that hydraulic tools worked well for large jobs.

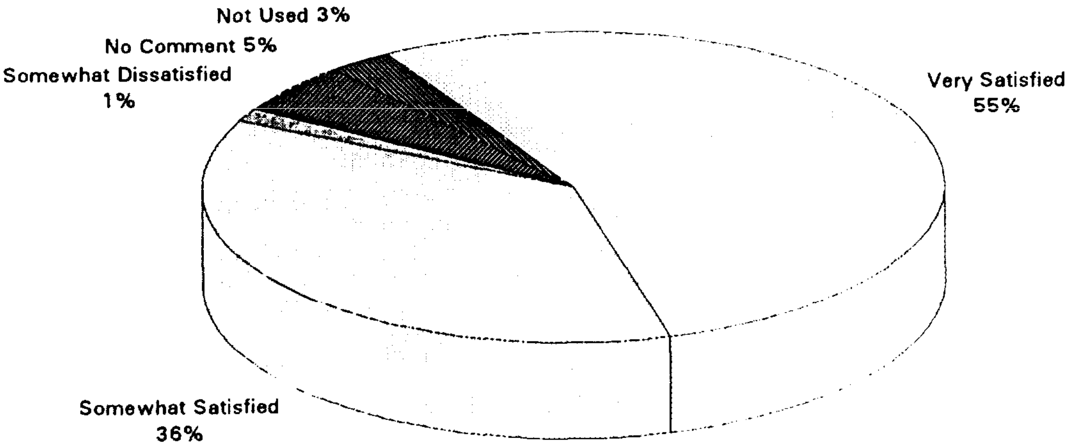


FIGURE 4.3.5. 1-1 HYDRAULIC TOOLS SATISFACTION RATING

TABLE 4.3.5.1-1
HYDRAULIC TOOLS - SATISFACTION RATING

Total Responses by Population

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Total # of Resp.	**81**	**54**	**2**	**0**	**8**	**4**	**149**
Total % of Resp.	**54.4%**	**36.2%**	**1.3%**	**0.0%**	**5.4%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	26	24	0	0	4	0	54
Small Urban	24	17	0	0	1	0	42
Suburban	14	9	2	0	3	3	31
Rural	17	4	0	0	0	1	22
Total	**81**	**54**	**2**	**0**	**8**	**4**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	48.1%	44.4%	0.0%	0.0%	7.4%	0.0%	100.0%
Small Urban	57.1%	40.5%	0.0%	0.0%	2.4%	0.0%	100.0%
Suburban	45.2%	29.0%	6.5%	0.0%	9.7%	9.7%	100.0%
Rural	77.3%	18.2%	0.0%	0.0%	0.0%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	25	5	1	0	0	1	32
North East	17	10	1	0	2	1	31
South	22	23	0	0	4	1	50
West	17	16	0	0	2	1	36
Total	**81**	**54**	**2**	**0**	**8**	**4**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	78.1%	15.6%	3.1%	0.0%	0.0%	3.1%	100.0%
North East	54.8%	32.3%	3.2%	0.0%	6.5%	3.2%	100.0%
South	44.0%	46.0%	0.0%	0.0%	8.0%	2.0%	100.0%
West	47.2%	44.4%	0.0%	0.0%	5.6%	2.8%	100.0%

TABLE 4.3.5.1-2
HYDRAULIC TOOLS

Comments on Satisfaction by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	134	89.3%
Comments	16	10.7%
Total Comments	**150 ***	**100.0%**

Comments	Number of Responses	Percentage of Responses
Need more, newer, or better tools	7	43.8%
Prefer one brand to another brand	4	25.0%
Most used tool type	3	18.8%
Hardly used	1	6.3%
Large jobs	1	6.3%
Total	**16**	**100%**

* Multiple responses were permitted

4.3.5.2 Ease of Operation - Hydraulic Tools

Fourteen percent of participants rated hydraulic tools as very easy to operate, 27 percent as easy, 7 percent as somewhat easy and 3 percent as not easy. Forty-six percent of respondents did not comment, and 3 percent said they did not use hydraulic tools. The data can be seen in Figure 4.3.5.2-1. Data for population and region categories are provided in Table 4.3.5.2-1. Since ease of operation and effectiveness were evaluated together in the same question, it was difficult to separate the comments that were made. Therefore, it was decided to include all of the comments in the following section on tool effectiveness.

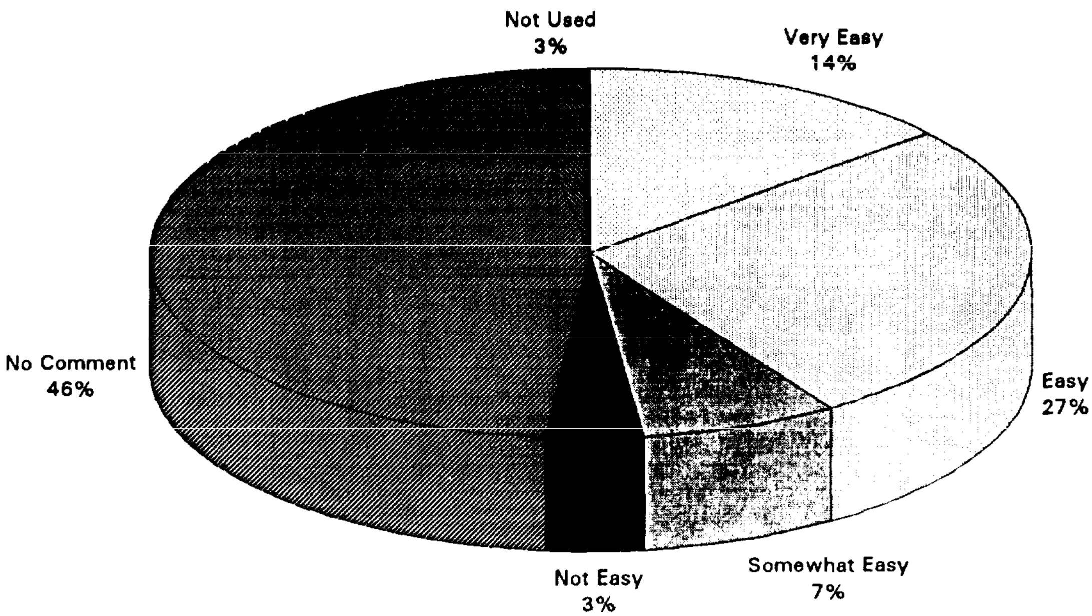


FIGURE 4.3.5.2-1 HYDRAULIC TOOLS - EASE OF OPERATION RATING

TABLE 4.3.5.2-1
HYDRAULIC TOOLS - EASE OF OPERATION RATING

Total Responses by Population

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Total # of Resp.	**21**	**40**	**11**	**5**	**68**	**4**	**149**
Total % of Resp.	**14.1%**	**26.8%**	**7.4%**	**3.4%**	**45.6%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	8	12	7	1	26	0	54
Small Urban	6	12	3	2	19	0	42
Suburban	4	10	1	0	13	3	31
Rural	3	6	0	2	10	1	22
Total	**21**	**40**	**11**	**5**	**68**	**4**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	14.8%	22.2%	13.0%	1.9%	48.1%	0.0%	100.0%
Small Urban	14.3%	28.6%	7.1%	4.8%	45.2%	0.0%	100.0%
Suburban	12.9%	32.3%	3.2%	0.0%	41.9%	9.7%	100.0%
Rural	13.6%	27.3%	0.0%	9.1%	45.5%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	3	9	0	2	17	1	32
North East	6	11	2	1	10	1	31
South	8	10	7	2	22	1	50
West	4	10	2	0	19	1	36
Total	**21**	**40**	**11**	**5**	**68**	**4**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	9.4%	28.1%	0.0%	6.3%	53.1%	3.1%	100.0%
North East	19.4%	35.5%	6.5%	3.2%	32.3%	3.2%	100.0%
South	16.0%	20.0%	14.0%	4.0%	44.0%	2.0%	100.0%
West	11.1%	27.8%	5.6%	0.0%	52.8%	2.8%	100.0%

4.3.5.3 Effectiveness - Hydraulic Tools

As shown in Figure 4.3.5.3-1 39 percent of participants rated hydraulic tools as very effective, 19 percent rated the tools as effective, and 3 percent said they were somewhat effective. Thirty-six percent made no comment, and 3 percent said they did not use hydraulic tools. Fewer participants from the west, as compared to other regions, rated hydraulic tools as very effective. Data for population and region categories are provided in Table 4.3.5.3-1.

Of the total responses that were given, 53 percent were not applicable/no comment, 32 percent were on tool problems, and 16 percent on tool assets. As shown in Table 4.3.5.3-2, 54 percent of the comments on performance problems were that hydraulic tools are heavy/cumbersome. Other comments included: operators determine effectiveness of hydraulic tools; hydraulic tools are ineffective in tight areas; excessive effort/manpower requirement; two-stroke engine is ineffective; starting difficulties, and decrease in power while in use.

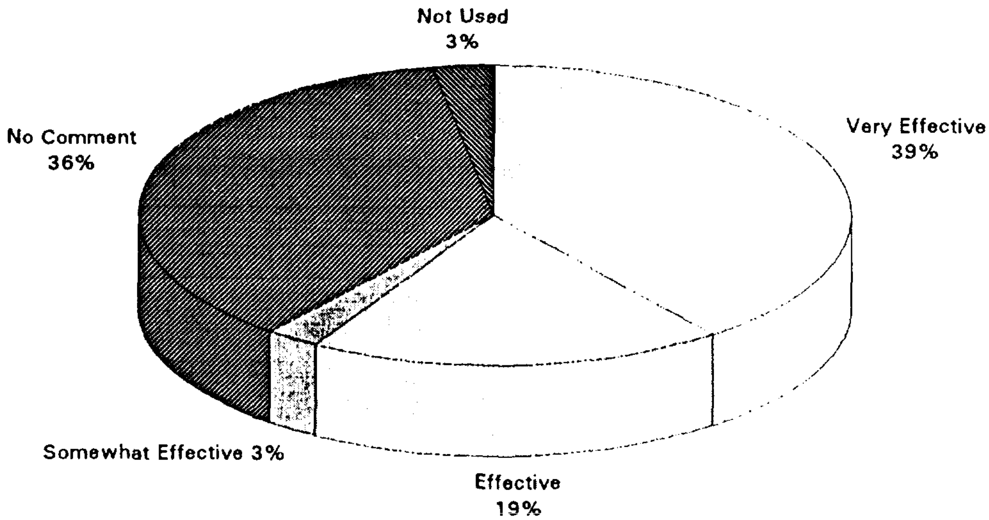


FIGURE 4.3.5.3-1 HYDRAULIC TOOLS - EFFECTIVENESS RATING

TABLE 4.3.5.3-1
HYDRAULIC TOOLS - EFFECTIVENESS RATING

Total Responses by Population

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Total # of Resp.	**59**	**28**	**4**	**0**	**54**	**4**	**149**
Total % of Resp.	**39.6%**	**18.8%**	**2.7%**	**0.0%**	**36.2%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	26	6	2	0	20	0	54
Small Urban	15	12	1	0	14	0	42
Suburban	9	6	1	0	12	3	31
Rural	9	4	0	0	8	1	22
Total	**59**	**28**	**4**	**0**	**54**	**4**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	48.1%	11.1%	3.7%	0.0%	37.0%	0.0%	100.0%
Small Urban	35.7%	28.6%	2.4%	0.0%	33.3%	0.0%	100.0%
Suburban	29.0%	19.4%	3.2%	0.0%	38.7%	9.7%	100.0%
Rural	40.9%	18.2%	0.0%	0.0%	36.4%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	12	7	0	0	12	1	32
North East	14	4	1	0	11	1	31
South	23	9	1	0	16	1	50
West	10	8	2	0	15	1	36
Total	**59**	**28**	**4**	**0**	**54**	**4**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	37.5%	21.9%	0.0%	0.0%	37.5%	3.1%	100.0%
North East	45.2%	12.9%	3.2%	0.0%	35.5%	3.2%	100.0%
South	46.0%	18.0%	2.0%	0.0%	32.0%	2.0%	100.0%
West	27.8%	22.2%	5.6%	0.0%	41.7%	2.8%	100.0%

TABLE 4.3.5.3-2
HYDRAULIC TOOLS

Comments on Effectiveness/Ease of Operation by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	90	52.6%
Comments on Tool Problems	54	31.6%
Comments on Tool Assets	27	15.8%
Total Comments	**171 ***	**100.0%**

Comments on Performance Problems	Number of Responses	Percentage of Responses
Heavy/cumbersome	29	53.7%
Operator determines effectiveness	4	7.4%
Ineffective in tight areas	3	5.6%
Requires more effort/manpower	3	5.6%
Lengthy/difficult set-up time	3	5.6%
2-stroke engines ineffective	3	5.6%
Starting difficulties	2	3.7%
Diminished power while in use	2	3.7%
Loud/noisy	1	1.9%
Slow or slower than other tools	1	1.9%
Unbalanced	1	1.9%
Easily jammed by sand	1	1.9%
Pressure build-up in hose	1	1.9%
Total	**54**	**100%**

Comments on Performance Assets	Number of Responses	Percentage of Responses
Light-weight	6	22.2%
Reliable/Dependable	6	22.2%
Extremely powerful	4	14.8%
Quiet	3	11.1%
Easy set-up	3	11.1%
Easy-to-use controls	2	7.4%
Stable	1	3.7%
Durable	1	3.7%
Controllable	1	3.7%
Total	**27**	**100.0%**

* Multiple responses were permitted

4.3.5.4 Storage Efficiency - Hydraulic Tools

Storage of manually powered tools was evaluated according to three criteria: I) adequacy, 2) safety, and 3) accessibility.

Adequacy. As shown in Figure 4.3.5.4-1, approximately 43 percent of the total responses indicated that storage of manually powered tools was adequate, 4 percent stated somewhat adequate, and 14 percent stated that storage was not adequate. Thirty-six percent of responses stated no comment, and 3 percent stated not used. Table 4.3.5.4-l contains population and geographic data.

Safety. As shown in Figure 4.3.5.4-2, approximately 40 percent of all responses indicated that storage of manually powered tools were safe, I percent was somewhat safe, and 3 percent stated that storage was unsafe. Fifty-four percent of all responses were no comment and 3 percent stated not used. Data for population and geographic categories arc provided in Table 4.3.2.5-2.

Accessibility. As shown in Figure 4.3.5.4-3, 30 percent of all responses indicated that storage of manually powered tools was very accessible, 1 percent was somewhat accessible, and 4 percent indicated that storage was inaccessible. Data are provided in Table 3.3.5.4-3 for population and geographic categories. A larger percentage of north central participants and rural participants rated storage as accessible than participants from other regions. A smaller percentage of suburban participants rated storage as accessible.

Responses to improvements in hydraulic tool storage were 59 percent not applicable/no comment, 36 percent suggestions for improvements, and 5 percent no improvements (see Table 4.3.5.4-4). Of the comments on storage that were made, more storage space was most frequently suggested. Other comments included: larger compartments, slide-out drawers/trays, custom-designed compartments, lower compartments, and mounting brackets.

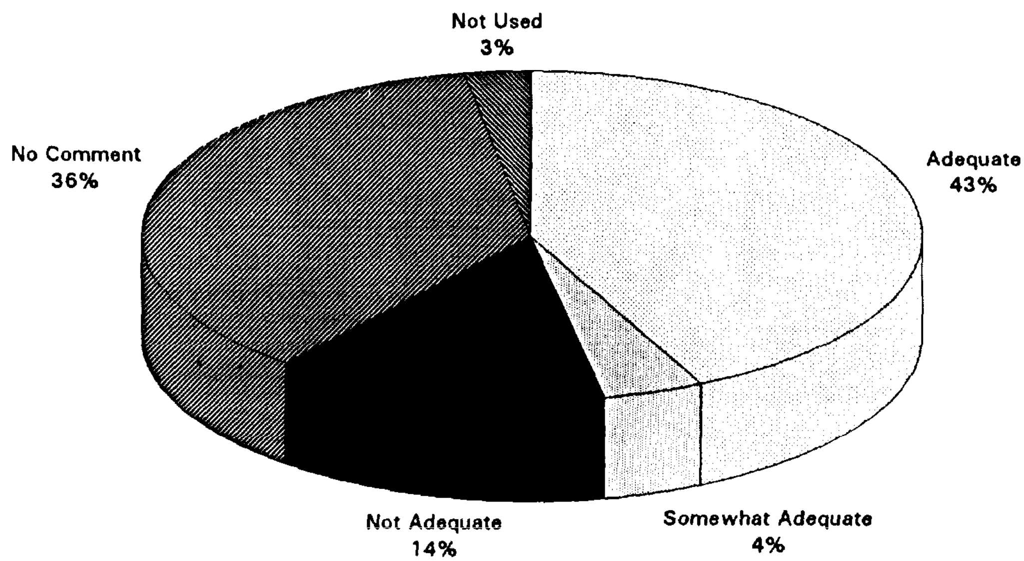


FIGURE 4.3.5.4-1 HYDRAULIC TOOLS - STORAGE ADEQUACY RATING

TABLE 4.3.5.4-1
HYDRAULIC TOOLS - STORAGE ADEQUACY RATING

Total Responses by Population

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Total # of Resp.	**64**	**6**	**21**	**54**	**4**	**149**
Total % of Resp.	**43.0%**	**4.0%**	**14.1%**	**36.2%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Adequate	Somewhat Adeqauate	Not Adequate	No Comment	Not Used	Population Count
Urban	24	1	9	20	0	54
Small Urban	16	4	7	15	0	42
Suburban	9	1	2	16	3	31
Rural	15	0	3	3	1	22
Total	**64**	**6**	**21**	**54**	**4**	**149**

Percent of Responses

	Adequate	Somewhat Adeqauate	Not Adequate	No Comment	Not Used	Population Count
Urban	44.4%	1.9%	16.7%	37.0%	0.0%	100.0%
Small Urban	38.1%	9.5%	16.7%	35.7%	0.0%	100.0%
Suburban	29.0%	3.2%	6.5%	51.6%	9.7%	100.0%
Rural	68.2%	0.0%	13.6%	13.6%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	14	1	4	12	1	32
North East	10	4	5	11	1	31
South	24	1	7	17	1	50
West	16	0	5	14	1	36
Total	**64**	**6**	**21**	**54**	**4**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	43.8%	3.1%	12.5%	37.5%	3.1%	100.0%
North East	32.3%	12.9%	16.1%	35.5%	3.2%	100.0%
South	48.01	2.0%	14.0%	34.0%	2.0%	100.0%
West	44.4%	0.0%	13.9%	38.9%	2.8%	100.0%

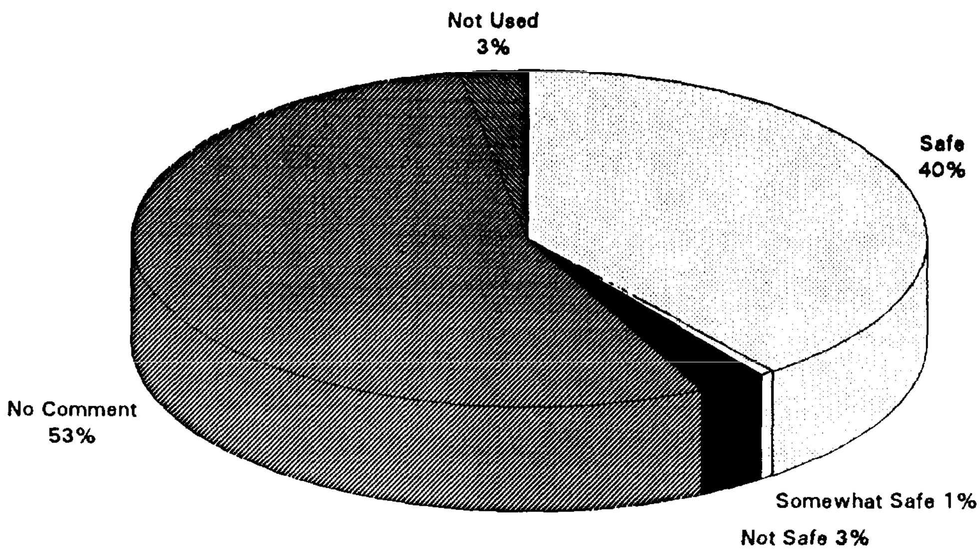


FIGURE 4.3.5.4-2 HYDRAULIC TOOLS - STORAGE SAFETY RATING

TABLE 4.3.5.4-2
HYDRAULIC TOOLS - STORAGE SAFETY RATING

Total Responses by Population

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Total # of Resp.	**59**	**1**	**4**	**81**	**4**	**149**
Total % of Resp.	**39.6%**	**0.7%**	**2.7%**	**54.4%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	21	0	2	31	0	54
Small Urban	17	1	0	24	0	42
Suburban	8	0	1	19	3	31
Rural	13	0	1	7	1	22
Total	**59**	**1**	**4**	**81**	**4**	**149**

Percent of Responses

Urban	38.9%	0.0%	3.7%	57.4%	0.0%	100.0%
Small Urban	40.5%	2.4%	0.0%	57.1%	0.0%	100.0%
Suburban	25.8%	0.0%	3.2%	61.3%	9.7%	100.0%
Rural	59.1%	0.0%	4.5%	31.8%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	14	0	0	17	1	32
North East	11	1	0	18	1	31
South	20	0	2	27	1	50
West	14	0	2	19	1	36
Total	**59**	**1**	**4**	**81**	**4**	**149**

Percent of Responses

North Central	43.8%	0.0%	0.0%	53.1%	3.1%	100.0%
North East	35.5%	3.2%	0.0%	58.1%	3.2%	100.0%
South	40.0%	0.0%	4.0%	54.0%	2.0%	100.0%
West	38.9%	0.0%	5.6%	52.6%	2.8%	100.0%

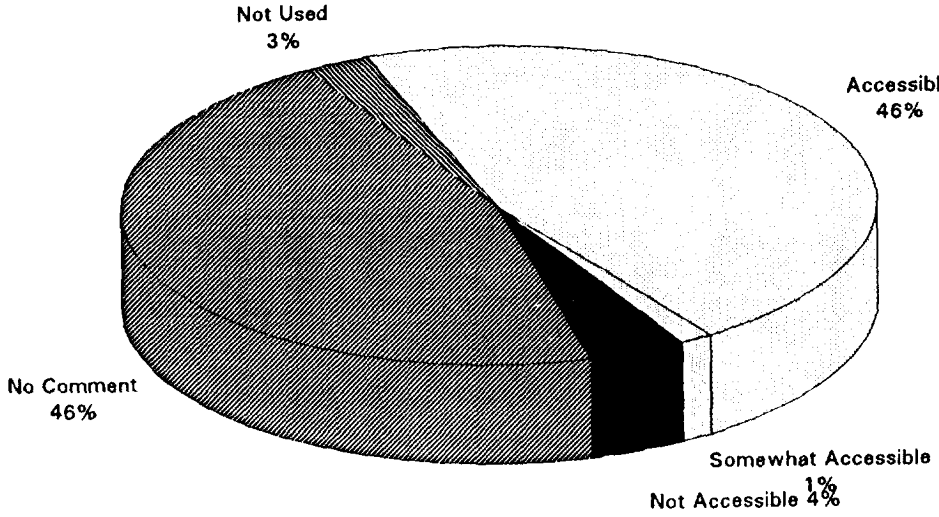


FIGURE 4.3.5.4-3 HYDRAULIC TOOLS - STORAGE ACCESSIBILITY RATING

TABLE 4.3.5.4-3
HYDRAULIC TOOLS - STORAGE ACCESSIBILITY RATING

Total Responses by Population

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Total # of Resp.	**69**	**2**	**6**	**68**	**4**	**149**
Total % of Resp.	**46.3%**	**1.3%**	**4.0%**	**45.6%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	25	0	5	24	0	54
Small Urban	19	1	0	22	0	42
Suburban	9	1	1	17	3	31
Rural	16	0	0	5	1	22
Total	**69**	**2**	**6**	**68**	**4**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	46.3%	0.0%	9.3%	44.4%	0.0%	100.0%
Small Urban	45.2%	2.4%	0.0%	52.4%	0.0%	100.0%
Suburban	29.0%	3.2%	3.2%	54.8%	9.7%	100.0%
Rural	72.7%	0.0%	0.0%	22.7%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	17	0	0	14	1	32
North East	12	1	0	17	1	31
South	24	1	4	20	1	50
West	16	0	2	17	1	36
Total	**69**	**2**	**6**	**68**	**4**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	53.1%	0.0%	0.0%	43.8%	3.1%	100.0%
North East	38.7%	3.2%	0.0%	54.8%	3.2%	100.0%
South	48.0%	2.0%	8.0%	40.0%	2.0%	100.0%
West	44.4%	0.0%	5.6%	47.2%	2.6%	100.0%

TABLE 4.3.5.4-4
HYDRAULIC TOOLS

Comments on Improvements for Storage by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	8	5.0%
Not Applicable/No Comment	94	59.1%
Suggestions for Improvements	57	35.8%
Total Comments	**159 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
More storage space	15	26.3%
Larger compartments	10	17.5%
Slide out drawers/trays	9	15.8%
Custom-design compartments	7	12.3%
Lower compartments	6	10.5%
Mounting brackets	4	7.0%
More compartmentalized	2	3.5%
Supply brackets with equipment	2	3.5%
Easier access	1	1.8%
Better gas/hydraulic fluid storage	1	1.8%
Total	**57**	**100%**

* Multiple responses were permitted

4.355 Portability - Hydraulic Tools

Mounting type. As depicted in Figure 4.3.5.5-1, 2 percent of responses were hard mount, 13 percent were partial hard mount, 2 percent were remote/wheels. 54 percent were remote/hand carry, 5 percent used other mounting types, 18 percent used a combination of mounting types, and the remaining responses were no comment or not used. Table 4.3.5.5-l presents data by population category and geographical region.

Number persons needed to carry. Twelve percent of all participants indicated that I to 2 persons were required to carry hydraulic tools, as shown in Figure 4.3.5.5-2. Fifty-six percent of responses were 2 to 3 persons, and 11 percent said 3 or more persons were needed. Data analyzed by population category and region are provided in Table 4.3.5.5-2.

Number of persons needed to operate. As shown in Figure 4.3.5.5-3, 28 percent of all responses indicated that 1 to 2 persons were needed to operate hydraulic tools. Forty-two percent indicated 2 to 3 operators and 10 percent said 3 to 4 or 4 operators were required. Data analyzed by population category and region are provided in Table 4.3.5.5-3.

As can be seen in Table 4.3.5.5-4, approximately 64 percent of the total responses were not applicable/no comment, and 5 percent were no improvement. The most common comment on problems was the need to have lighter weight hydraulic tools. Other comments included: use dolly/wheels on power unit, hard mount power unit with reel. use longer hoses, put handles on power unit, and put power unit on a slide-out tray.

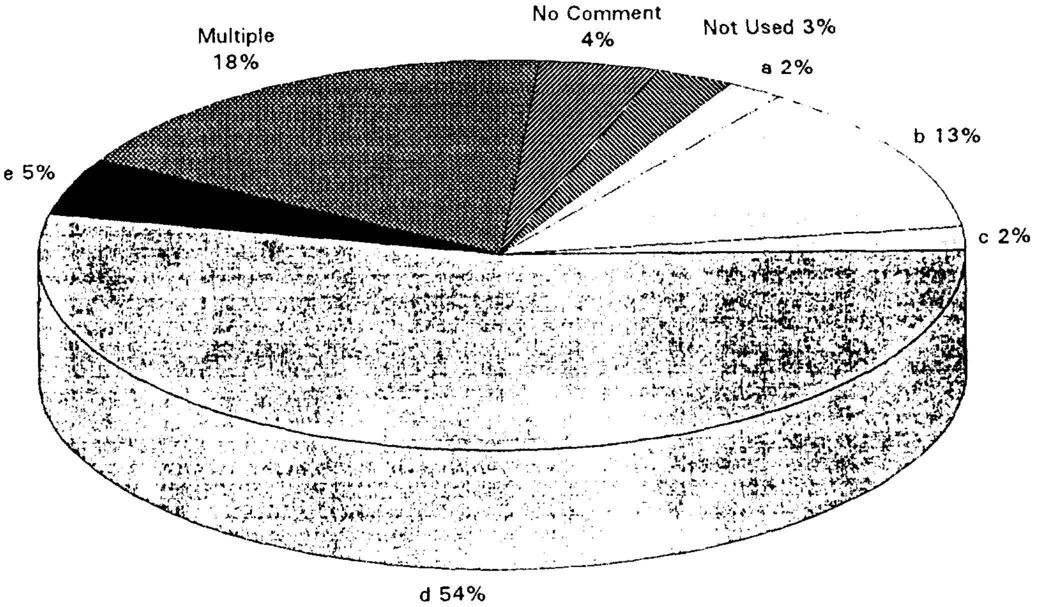


FIGURE 4.3.5.5-1 HYDRAULIC TOOLS - PORTABILITY MOUNTING TYPE RATING

TABLE 4.3.5.5-1
HYDRAULIC TOOLS - PORTABILITY MOUNTING TYPE RATING

Total Responses by Population

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Total # of Resp.	**3**	**19**	**3**	**80**	**7**	**27**	**6**	**4**	**149**
Total % of Rerp.	**2.0%**	**12.8%**	**2.0%**	**53.7%**	**4.7%**	**18.1%**	**4.0%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	1	5	1	25	4	16	2	0	54
Small Urban	0	7	1	24	3	6	1	0	42
Suburban	1	4	1	18	0	1	3	3	31
Rural	1	3	0	13	0	4	0	1	22
Total	**3**	**19**	**3**	**80**	**7**	**27**	**6**	**4**	**149**

Percent of Responses

	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Urban	1.9%	9.3%	1 9%	46 3%	7.4%	29.6%	3.7%	0.0%	100.0%
Small Urban	0.0%	16.7%	2 4%	57.1%	7.1%	14.3%	2.4%	0.0%	100.0%
Suburban	3.2%	12.9%	3.2%	58.1%	0.0%	3.2%	9.7%	9.7%	100.0%
Rural	4.5%	13.6%	0 0 %	59.1%	0.0%	18.2%	0 0 %	4.5%	100.0%

REGION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Region Count
North Central	0	7	2	13	0	8	1	1	32
North East	0	2	1	15	0	10	2	1	31
South	2	9	0	26	4	4	2	1	50
West	1	1	0	24	3	5	1	1	36
Total	**3**	**19**	**3**	**80**	**7**	**27**	**6**	**4**	**149**

Percent of Responses

	a	b	c	d	e	Multiple	No Comment	Not Used	Region Count
North Central	0.0%	21.9%	6.3%	40.6%	0.0%	25.0%	3.1%	3.1%	100.0%
North East	0.0%	6.5%	3.2%	48.4%	0.0%	32.3%	6.5%	3.2%	100.0%
South	4.0%	18.0%	0.0%	56.0%	8.0%	8.0%	4.0%	2.0%	100.0%
West	2.8%	2.8%	0.0%	66.7%	8.3%	13.9%	2.8%	2.8%	100.0%

* a - Hard mount b - Partial hard mount c - Remote/wheels d - Remote/hand carry e - Other

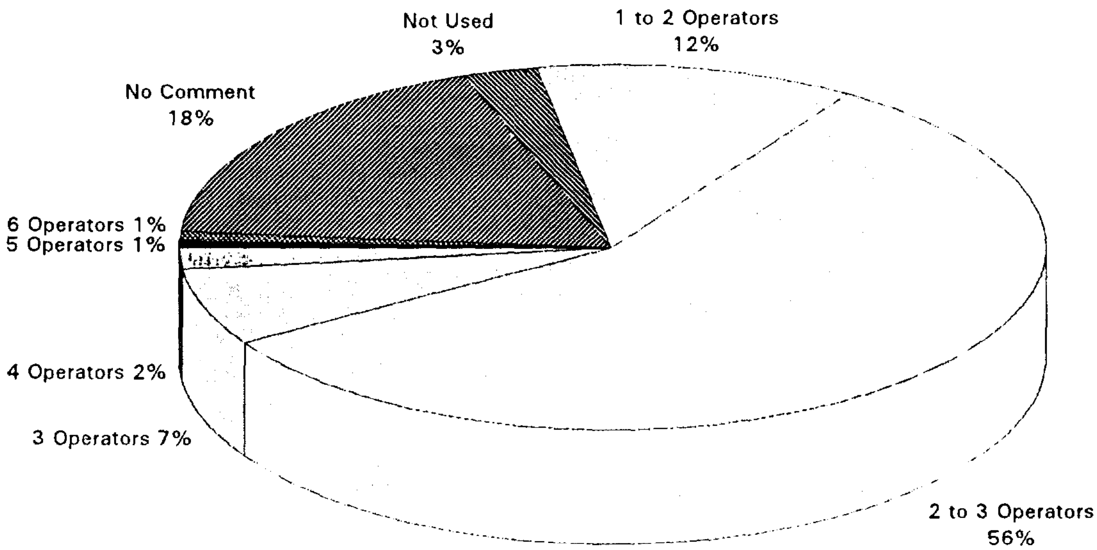


FIGURE 4.3.5.5-2 HYDRAULIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

TABLE 4.3.5.5-2
HYDRAULIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	3	4	5	6	No Comment	Not Used	Population Count
Total # of Resp.	**18**	**85**	**10**	**3**	**1**	**1**	**27**	**4**	**149**
Total % of Resp.	**12.1%**	**57.0%**	**6.7%**	**2.0%**	**0.7%**	**0.7%**	**18.1%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	4	5	6	No Comment	Not Used	Population Count
Urban	6	32	3	1	1	1	10	0	54
Small Urban	5	31	2	0	0	0	4	0	42
Suburban	2	15	2	0	0	0	9	3	31
Rural	5	7	3	2	0	0	4	1	22
Total	**18**	**85**	**10**	**3**	**1**	**1**	**27**	**4**	**149**

Percent of Responses

# Operators	1 to 2	2 to 3	3	4	5	6	No Comment	Not Used	Population Count
Urban	11.1%	59.3%	5.6%	1.9%	1.9%	1.9%	18.5%	0.0%	100.0%
Small Urban	11.9%	73.8%	4.8%	0.0%	0.0%	0.0%	9.5%	0.0%	100.0%
Suburban	6.5%	48.4%	6.5%	0.0%	0.0%	0.0%	29.0%	9.7%	100.0%
Rural	22.7%	31.8%	13.6%	9.1%	0.0%	0.0%	18.2%	4.5%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	3	5	6	No Comment	Not Used	Region Count
North Central	5	14	4	2	0	0	6	1	32
North East	3	18	4	0	0	1	4	1	31
South	9	29	2	1	0	0	8	1	50
West	1	24	0	0	1	0	9	1	36
Total	**18**	**85**	**10**	**3**	**1**	**1**	**27**	**4**	**149**

Percent of Responses

# Operators	1 to 2	2 to 3	3	3	5	6	No Comment	Not Used	Region Count
North Central	15.6%	43.8%	12.5%	6.3%	0.0%	0.0%	18.8%	3.1%	100.0%
North East	9.7%	58.1%	12.9%	0.0%	0.0%	3.2%	12.9%	3.2%	100.0%
South	18.0%	58.0%	4.0%	2.0%	0.0%	0.0%	16.0%	2.0%	100.0%
West	2.8%	66.7%	0.0%	0.0%	2.8%	0.0%	25.0%	2.8%	100.0%

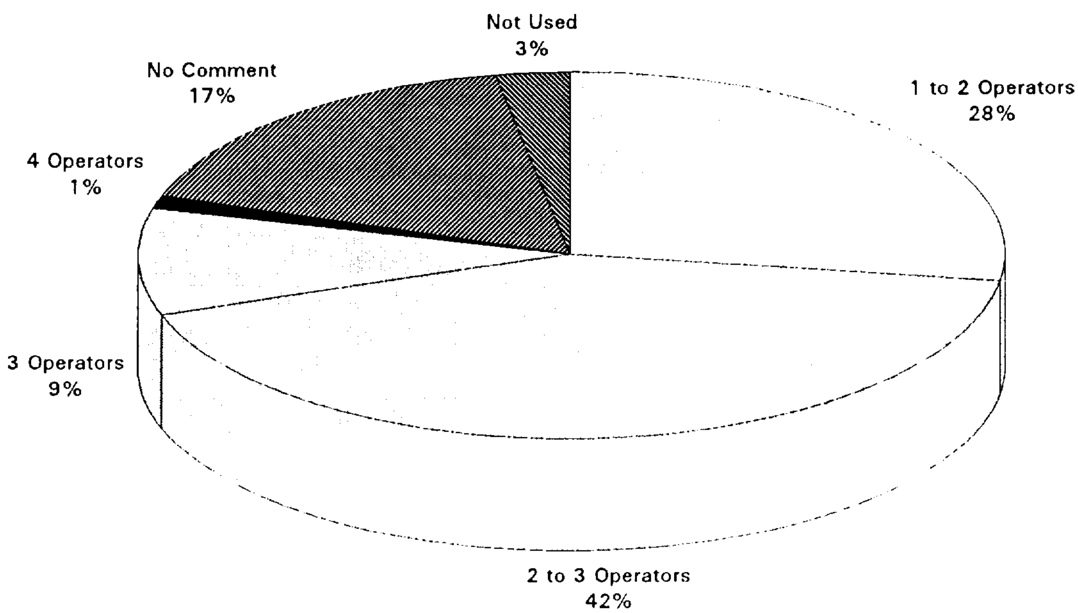


FIGURE 4.3.5.5-3 HYDRAULIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

TABLE 4.3.5.5-3
HYDRAULIC TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	3	3	No Comment	Not Used	Population Count
Total # of Resp.	**41**	**63**	**14**	**2**	**25**	**4**	**149**
Total % of Resp.	**27.5%**	**42.3%**	**9.4%**	**1.3%**	**16.8%**	**2.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	4	No Comment	Not Used	Population Count
Urban	14	27	3	1	9	0	54
Small Urban	14	22	2	0	4	0	42
Suburban	6	10	3	0	9	3	31
Rural	7	4	6	1	3	1	22
Total	**41**	**63**	**14**	**2**	**25**	**4**	**149**

Percent of Responses

Urban	25.9%	50.0%	5.6%	1.9%	16.7%	0.0%	100.0%
Small Urban	33.3%	52.4%	4.8%	0.0%	9.5%	0.0%	100.0%
Suburban	19.4%	32.3%	9.7%	0.0%	29.0%	9.7%	100.0%
Rural	31.8%	18.2%	27.3%	4.5 %	13.6%	4.5%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	4	No Comment	Not Used	Region Count
North Central	10	9	5	1	6	1	32
North East	8	14	4	1	3	1	31
South	15	21	5	0	8	1	50
West	8	19	0	0	8	1	36
Total	**41**	**63**	**14**	**2**	**25**	**4**	**149**

Percent of Responses

North Central	31.3%	28.1%	15.6%	3.1%	18.8%	3.1%	100.0%
North East	25.8%	45.2%	12.9%	3.2%	9.7%	3.2%	100.0%
South	30.0%	42.0%	10.0%	0.0%	16.0%	2.0%	100.0%
West	22.2%	52.8%	0.0%	0.0%	22.2%	2.8%	100.0%

TABLE 4.3.5.5-4
HYDRAULIC TOOLS

Comments on Improvements for Portability by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	8	5.1%
Not Applicable/No Comment	100	64.1%
Suggestions for Improvements	48	30.8%
Total Comments	**156 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	20	41.7%
Dolly/wheels on power unit	13	27.1%
Hard mount power unit with reel	10	20.8%
Longer hoses	2	4.2%
Handles on power unit	2	4.2%
Mount power unit on slide-out tray	1	2.1%
Total	**48**	**100%**

* Multiple responses were permitted

4.356 Safety Aspects - Hydraulic Tools

Of the comments on hydraulic tool safety concerns, 30 percent were none in particular, 35 percent were not applicable/no comment, and 34 percent were safety concern comments. Of the comments the most frequently made were regarding the great forces generated by this type of tool, sharp edges that are created, flying debris, and tool weight. Comments are provided in Table 4.3.5.6-1.

Safety Equipment Rating (see Table 4.3.5.6-2):

Available for use. Sixty-eight percent of all participants indicated that they had ear protection equipment available for use, 95 percent had eye, hand, head, and foot protection available, 94 percent had body protection available, and 21 percent had other types of protection equipment available for use. The other percentages of the participants' responses were no comment/not used.

Used by personnel. Fifty-two percent of respondents indicated that they used ear protection equipment. 95 percent used eye, hand, and head protection, 94 percent used foot protection, 93 percent used body protection equipment, and 21 percent said they used other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

Required to be used. Fifty-two percent of participants said they were required to use ear protection, 94 percent were required to use eye and head protection, 95 percent were required to use hand protection, 92 percent were required to use body protection, 93 were required to use foot protection, and 21 percent said they were required to use other types of protection equipment. The other percentages of the participants responses were no comment/not used.

TABLE 4.3.5.6-1
HYDRAULIC TOOLS

Comments on Safety Concerns by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
None in Particular	49	30.4%
Not Applicable/No Comment	57	35.4%
Safety Concerns	55	34.2%
Total Comments	**161 ***	**100.0%**

Safety Concerns	Number of Responses	Percentage of Responses
Extreme force	11	20.0%
Create sharp edges	8	14.5%
Flying debris	8	14.5%
Tool weight	6	10.9%
Caustic fluid	5	9.1%
Tool slippage	4	7.3%
Pinch points	3	5.5%
Tool limits	2	3.6%
Gas-powered - ignition potential	2	3.6%
Tool stability	1	1.8%
Loud/noisy	1	1.8%
Cause metal to buckle	1	1.8%
Kick back potential	1	1.8%
Power losses	1	1.8%
Hoses burst	1	1.8%
Total	**55**	**100%**

* Multiple responses were permitted

TABLE 4.3.6.6-2
HYDRAULIC TOOLS - SAFETY ECIUIPMENT RATING

	EAR		EYE		HAND		BODY		HEAD		FOOT		OTHER	
Number of Responses	Comment	No Comment Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used
Available for use	101	48	142	7	142	7	140	9	142	7	142	7	31	118
Used by personnel	77	72	142	7	142	7	138	11	141	8	140	9	29	120
Required to be used	77	72	140	9	141	8	137	12	140	9	138	11	31	118
***Percent of Responses**														
Available for use	67.8%		95.3%		95.3%		94.0%		95.3%		95.3%		20.8%	
Used by personnel	51.7%		95.3%		95.3%		92.6%		94.6%		94.0%		19.5%	
Required to be used	51.7%		94.0%		94.6%		91.9%		94.0%		92.6%		20.8%	

*Percentages were calculated for each individual type of protective device based on a total of 149 participants.

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4.3.5.7 Modifications - Hydraulic Tools

Responses to modifications of hydraulic tools were 68 percent were no modifications, 25 percent were not applicable/no comment, and 7 percent were comments on modifications. Of the comments that were made the most common was to design a bracket/unit for ram placement. Also included were: pads on hydraulic tool to distribute load; to mount power unit on a dolly, and to mount reels to power unit. Comments are provided in Table 4.3.5.7-l.

TABLE 4.3.5.7-1
HYDRAULIC TOOLS

Comments on Modifications by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Modifications	101	67.8%
Not Applicable/No Comment	37	24.8%
Modifications	11	7.4%
Total Comments	**149 ***	**100.0%**

Modifications	Number of Responses	Percentage of Responses
Bracket/unit for ram placement	3	27.3%
Pads to distribute load	1	9.1%
Washer for ram adapter	1	9.1%
Mounted on dolly	2	18.2%
Mounted reels to power unit	1	9.1%
Electric rewind reel	1	9.1%
Rubber hose on case bottoms	1	9.1%
Quick disconnect on hoses	1	9.1%
Total	**11**	**100%**

* Multiple responses were permitted

4.3.5.8 Potential Improvements - Hydraulic Tools

Of the responses that were made to hydraulic tool improvements 23 percent were no improvement, 23 percent were not applicable/no comment, and 54 percent were suggestions for improvement. As shown in Table 4.3.5.8-1, 50 percent of the suggestions were regarding lighter weight hydraulic tools. Some of the other comments were: quicker/easier hose connections; noise reduction; less caustic fluid; color-coded hoses; smaller hydraulic tools; hydraulic tools with better balance; better controls/able to use with whole hand with gloves; improved prying tips on spreader, and larger serrated teeth on rams.

TABLE 4.3.5.8-1
HYDRAULIC TOOLS

Comments on Improvements by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	42	23.3%
Not Applicable/No Comment	41	22.8%
Suggestions for Improvements	97	53.9%
Total Comments	**180 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	49	50.5%
Quicker/easier hose connection	7	7.2%
Noise reduction	5	5.2%
Less caustic fluid	4	4.1%
Color coded hoses	4	4.1%
Smaller	3	3.1%
Better balance	3	3.1%
Better controls (whole hand/gloves)	3	3.1%
Spreader - improve prying tips	3	3.1%
Ram - larger serated teeth (for better grip)	3	3.1%
Hard-mounted	2	2.1%
Multi-use tools	2	2.1%
Uniformity among manufacturers	1	1.0%
Breakaway shoulder strap	1	1.0%
Electric power units	1	1.0%
Dual hose reels	1	1.0%
Stronger hoses	1	1.0%
Etched markings	1	1.0%
Power unit adapt to inclines	1	1.0%
Better placement of actuators	1	1.0%
Improve starter	1	1.0%
Total	**97**	**100%**

* Multiple responses were permitted

4.3.6 Miscellaneous Other Tools-Description

This category serves as a catchall for devices that are used in rescue operations but are not actually tools. Examples include webbing, cribbing, rope, pike poles, etc.

4.3.6.1 General Satisfaction - Miscellaneous Tools

As can be seen in Figure 4.3.6.1-l 48 percent of all survey participants were very satisfied with the operation of miscellaneous tools, 39 percent were somewhat satisfied, 3 percent were somewhat dissatisfied, and one percent was very dissatisfied. Eight percent of all responses were no comment, and one percent was not used. Data regarding population and geographic categories are displayed in Table 4.3.6.1-1.

Of all the responses on miscellaneous tool satisfaction, shown in Table 4.3.6.1-2, 89 percent were not applicable/no comment, and 11 percent were satisfaction comments. Some of the comments were: cribbing is an essential tool; miscellaneous tool are effective when used with other tools; and a preference for cribbing as compared to aluminum/steel struts.

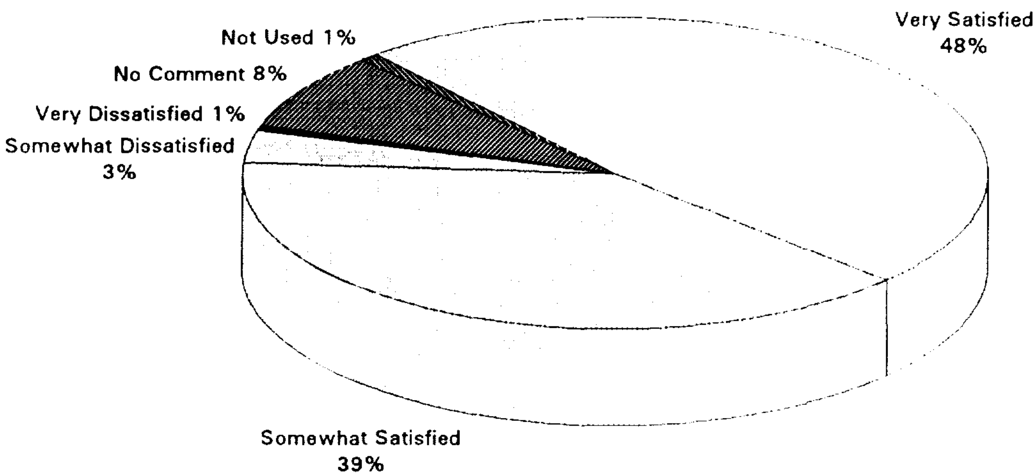


FIGURE 4.3.6.1-1 MISCELLANEOUS TOOLS - SATISFACTION RATING

TABLE 4.3.6.1-1
MISCELLANEOUS TOOLS - SATISFACTION RATING

Total Responses by Population

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Total # of Resp.	**72**	**58**	**5**	**1**	**12**	**1**	**149**
Total % of Resp.	**48.3%**	**38.9%**	**3.4%**	**0.7%**	**8.1%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	26	23	2	0	3	0	54
Small Urban	18	18	2	1	3	0	42
Suburban	16	11	0	0	4	0	31
Rural	12	6	1	0	2	1	22
Total	**72**	**58**	**5**	**1**	**12**	**1**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Population Count
Urban	48.1%	42.6%	3.7%	0.0%	5.6%	0.0%	100.0%
Small Urban	42.9%	42.9%	4.8%	2.4%	7.1%	0.0%	100.0%
Suburban	51.6%	35.5%	0.0%	0.0%	12.9%	0.0%	100.0%
Rural	54.5%	27.3%	4.5%	0.0%	9.1%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	11	15	2	0	3	1	32
North East	15	13	1	0	2	0	31
South	33	14	0	0	3	0	50
West	13	16	2	1	4	0	36
Total	**72**	**58**	**5**	**1**	**12**	**1**	**149**

Percent of Responses

	Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Very Dissatisfied	No Comment	Not Used	Region Count
North Central	34.4%	46.9%	6.3%	0.0%	9.4%	3.1%	100.0%
North East	48.4%	41.9%	3.2%	0.0%	6.5%	0.0%	100.0%
South	66.0%	28.0%	0.0%	0.0%	6.0%	0.0%	100.0%
West	36.1%	44.4%	5.6%	2.8%	11.1%	0.0%	100.0%

TABLE 4.3.6.1-2
MISCELLANEOUS TOOLS

Comments on Satisfaction by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	134	89.3%
Comments	16	10.7%
Total Comments	**150 ***	**100.0%**

Comments	Number of Responses	Percentage of Responses
Need more or better cribbing	6	37.5%
Need more, newer, or better tools	4	25.0%
Cribbing essential	2	12.5%
Used with other tool types	3	18.8%
Perfer cribbing to aluminum steel struts	1	6.3%
Total	**16**	**100%**

* Multiple responses were permitted

4.3.6.2 Ease of Operation - Miscellaneous Tools

As is depicted in Figure 4.3.6.2-1, 5 percent of all the participants indicated that miscellaneous tools were very easy to operate, 32 percent said they were easy to operate, one percent said somewhat easy, and 1 percent said not used. Sixty-one percent of responses were no comment. Population and geographic data can be seen in Table 4.3.6.2-1.

Since ease of operation and effectiveness were evaluated together in the same question, it was difficult to separate the comments that were made. Therefore, it was decided to include all of the comments in the following section on tool effectiveness.

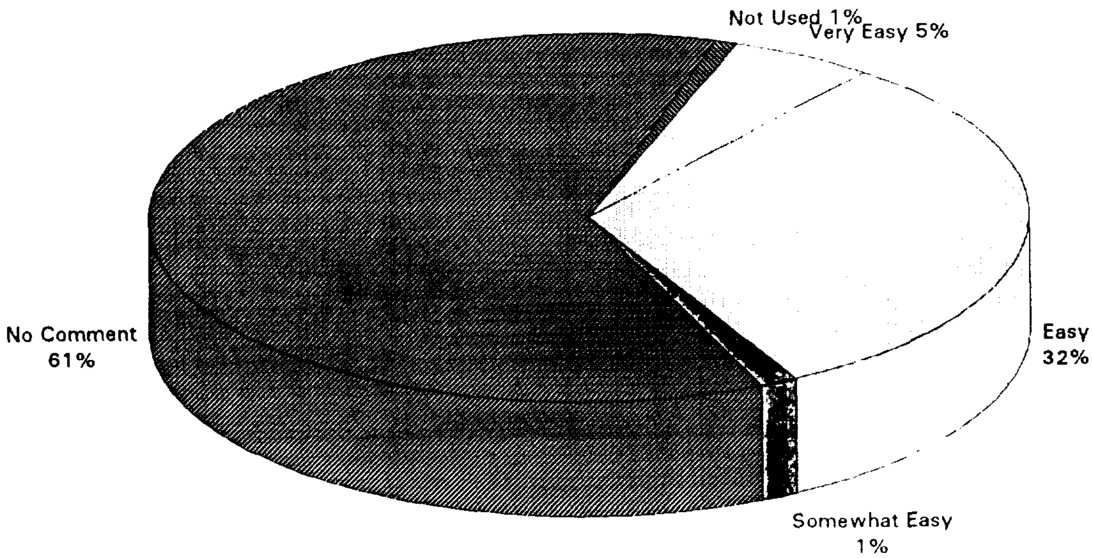


FIGURE 4.3.6.2-1 MISCELLANEOUS TOOLS - EASE OF OPERATION RATING

TABLE 4.3.6.2-1
MISCELLANEOUS TOOLS - EASE OF OPERATION RATING

Total Responses by Population

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Total # of Resp.	**8**	**47**	**2**	**0**	**91**	**1**	**149**
Total % of Resp.	**5.4%**	**31.5%**	**1.3%**	**0.0%**	**61.1%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	5	18	1	0	30	0	54
Small Urban	2	13	1	0	26	0	42
Suburban	0	12	0	0	19	0	31
Rural	1	4	0	0	16	1	22
Total	**8**	**47**	**2**	**0**	**91**	**1**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Population Count
Urban	9.3%	33.3%	1.9%	0.0%	55.6%	0.0%	100.0%
Small Urban	4.8%	31.0%	2.4%	0.0%	61.9%	0.0%	100.0%
Suburban	0.0%	38.7%	0.0%	0.0%	61.3%	0.0%	100.0%
Rural	4.5%	18.2%	0.0%	0.0%	72.7%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	1	9	0	0	21	1	32
North East	2	6	1	0	22	0	31
South	3	19	1	0	27	0	50
West	2	13	0	0	21	0	36
Total	**8**	**47**	**2**	**0**	**91**	**1**	**149**

Percent of Responses

	Very Easy	Easy	Somewhat Easy	Not Easy	No Comment	Not Used	Region Count
North Central	3.1%	28.1%	0.0%	0.0%	65.6%	3.1%	100.0%
North East	6.5%	19.4%	3.2%	0.0%	71.0%	0.0%	100.0%
South	6.0%	38.0%	2.0%	0.0%	54.0%	0.0%	100.0%
West	5.6%	36.1%	0.0%	0.0%	58.3%	0.0%	100.0%

4.3.6.3 Effectiveness - Miscellaneous Tools

Thirteen percent of all participants rated miscellaneous tools as very effective (see Figure 4.3.6.3-l), 32 percent as effective, 1 percent as not used, and 54 percent were no comment. Population and geographic data are presented in Table 4.3.6.3-l.

Of the responses on the effectiveness/ease of operation that were received, 84 percent were not applicable/no comment, I3 percent were comments on tool problems, and 3 percent were comments on tool assets. Some of the more common comments on performance problems with miscellaneous tools were: the operator determines the effectiveness of the tools; miscellaneous tools are slow or slower than other tools; and miscellaneous tools are heavy/cumbersome. Comments on performance assets were that miscellaneous tools can serve multiple uses, and that they are simple to use. Data are provided in Table 4.3.6.3-2.

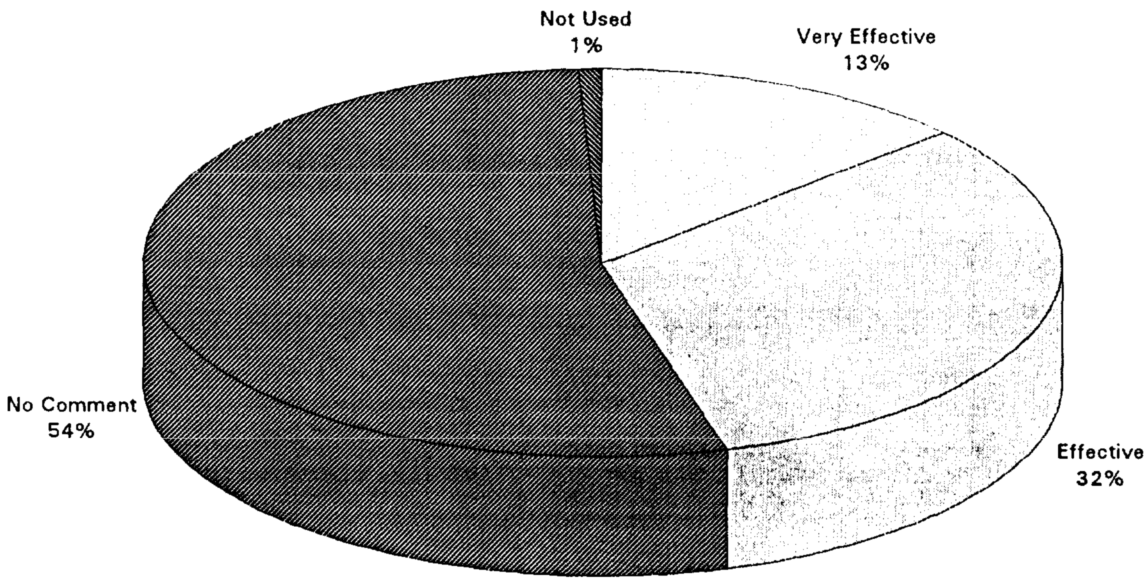


FIGURE 4.3.6.3-1 MISCELLANEOUS TOOLS - EFFECTIVENESS RATING

TABLE 4.3.6.3-1
MISCELLANEOUS TOOLS - EFFECTIVENESS RATING

Total Responses by Population

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Total # of Resp.	**20**	**48**	**0**	**0**	**80**	**1**	**149**
Total % of Resp.	**13.4%**	**32.2%**	**0.0%**	**0.0%**	**53.7%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	10	20	0	0	24	0	54
Small Urban	4	16	0	0	22	0	42
Suburban	4	8	0	0	19	0	31
Rural	**2**	4	0	0	15	1	22
Total	**20**	**48**	**0**	**0**	**80**	**1**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Population Count
Urban	18.5%	37.0%	0.0%	0.0%	44.4%	0.0%	100.0%
Small Urban	9.5%	38.1%	0.0%	0.0%	52.4%	0.0%	100.0%
Suburban	12.9%	25.8%	0.0%	0.0%	61.3%	0.0%	100.0%
Rural	9.1%	18.2%	0.0%	0.0%	68.2%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	3	12	0	0	16	1	32
North East	5	6	0	0	20	0	31
South	9	18	0	0	23	0	50
West	3	12	0	0	21	0	36
Total	**20**	**48**	**0**	**0**	**80**	**1**	**149**

Percent of Responses

	Very Effective	Effective	Somewhat Effective	Not Effective	No Comment	Not Used	Region Count
North Central	9.4%	37.5%	0.0%	0.0%	50.0%	3.1%	100.0%
North East	16.1%	19.4%	0.0%	0.0%	64.5%	0.0%	100.0%
South	18.0%	36.0%	0.0%	0.0%	46.0%	0.0%	100.0%
West	8.3%	33.3%	0.0%	0.0%	58.3%	0.0%	100.0%

TABLE 4.3.6.3-2
MISCELLANEOUS TOOLS

Comments on Effectiveness/Ease of Operation by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
Not Applicable/No Comment	125	83.9%
Comments on Tool Problems	20	13.4%
Comments on Tool Assets	4	2.7%
Total Comments	**149 ***	**100.0%**

Comments on Performance Problems	Number of Responses	Percentage of Responses
Operator determines effectiveness	11	55.0%
Slow or slower than other tools	3	15.0%
Heavy/cumbersome	3	15.0%
Requires more effort/manpower	1	5.0%
Rope too stiff	1	5.0%
Color code ropes	1	5.0%
Total	**20**	**100%**

Comments on Performance Assets	Number of Responses	Percentage of Responses
Multiple uses	2	50.0%
Simple	2	50.0%
Total	**4**	**100.0%**

* Multiple responses were permitted

4.3.6.4 Storage Efficiency - Miscellaneous Tools

Storage of manually powered tools was evaluated according to three criteria: 1) adequacy, 2) safety, and 3) accessibility.

Adequacy. As shown in Figure 4.3.6.4-1, 47 percent of the total responses indicated that storage of miscellaneous tools was adequate, 6 percent were somewhat adequate, 12 percent were not adequate, 1 percent was not used, and 34 percent were no comment. Population and geographic data can be found in Table 4.3.6.4-1.

Safety. Forty-six percent of all responses indicated that storage of miscellaneous tools was safe, 4 percent were somewhat safe, 1 percent was unsafe, 1 percent was not used, and 48 percent were not used (see Figure 4.3.6.4-2). Data for population and geographic categories are provided in Table 4.3.6.4-2.

Accessibility. Forty-eight percent of all responses indicated that storage of miscellaneous tools was accessible, 7 percent were somewhat accessible, 3 percent were not accessible, 1 percent was not used, and 41 percent were no comment (see Figure 4.3.6.4-3). Data for population and geographic categories are provided in Table 4.3.6.4-3.

Of all of the comments that were made regarding improvements for storage, as listed in Table 4.3.6.4-4, 5 percent were no improvement, 73 percent were not applicable/no comment and 22 percent were suggestions for improvements. Some of the common suggestions for improving storage of miscellaneous tools were: more storage space; more or better cribbing storage, larger compartments; and lower compartments.

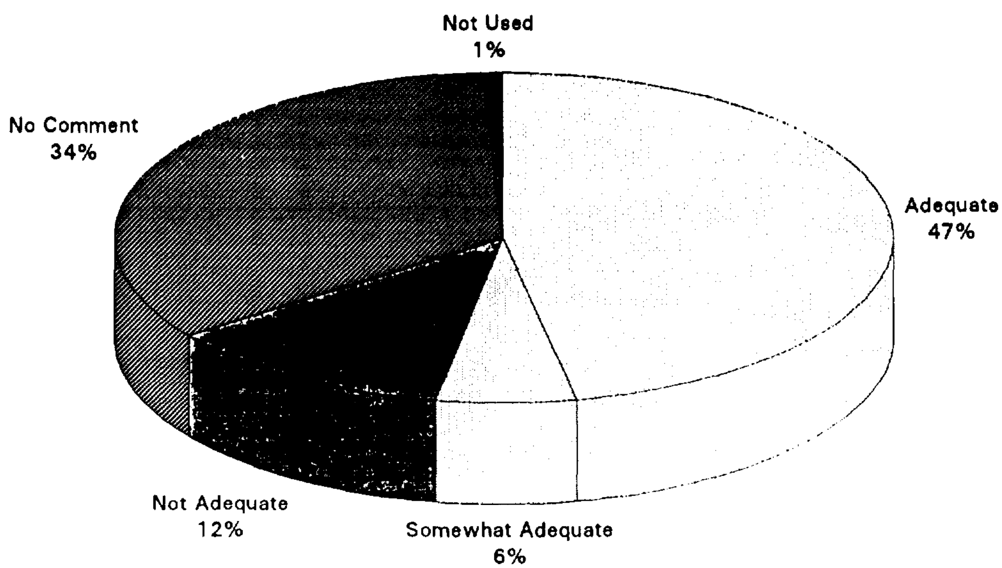


FIGURE 4.3.6.4-1 MISCELLANEOUS TOOLS - STORAGE ADEQUACY RATING

TABLE 4.3.6.4-1
MISCELLANEOUS TOOLS - STORAGE ADEQUACY RATING

Total Responses by Population

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Total # of Resp.	**70**	**9**	**18**	**51**	**1**	**149**
Total % of Resp.	**47.0%**	**6.0%**	**12.1%**	**34.2%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	27	5	9	13	0	54
Small Urban	20	3	6	13	0	42
Suburban	13	1	2	15	0	31
Rural	10	0	1	10	1	22
Total	**70**	**9**	**18**	**51**	**1**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Population Count
Urban	50.0%	9.3%	16.7%	24.1%	0.0%	100.0%
Small Urban	47.6%	7.1%	14.3%	31 .0%	0.0%	100.0%
Suburban	41.9%	3.2%	6.5%	48.4%	0.0%	100.0%
Rural	45.5%	0.0%	4.5%	45.5%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	13	1	3	14	1	32
North East	11	2	5	13	0	31
South	29	1	7	13	0	50
West	17	5	3	11	0	36
Total	**70**	**9**	**18**	**51**	**1**	**149**

Percent of Responses

	Adequate	Somewhat Adequate	Not Adequate	No Comment	Not Used	Region Count
North Central	40.6%	3.1%	9.4%	43.8%	3.1%	100.0%
North East	35.5%	6.5%	16.1 %	41 .9%	0.0%	100.0%
South	58.0%	2.0%	14.0%	26.0%	0.0%	100.0%
West	47.2%	13.9%	8.3%	30.6%	0.0%	100.0%

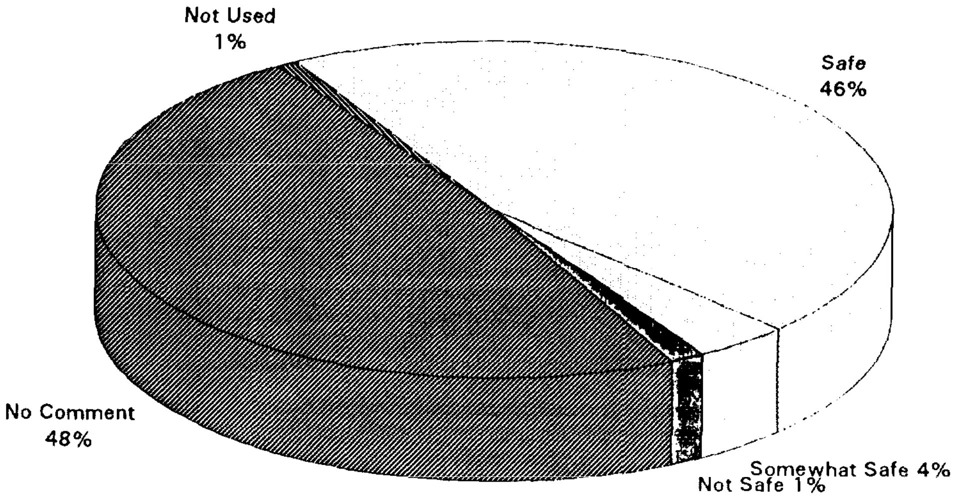


FIGURE 4.3.6.4-2 MISCELLANEOUS TOOLS - STORAGE SAFETY RATING

TABLE 4.3.6.4-2
MISCELLANEOUS TOOLS - STORAGE SAFETY RATING

Total Responses by Population

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Total # of Resp.	**68**	**6**	**2**	**72**	**1**	**149**
Total % of Resp.	**45.6%**	**4.0%**	**1.3%**	**48.3%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	24	3	1	26	0	54
Small Urban	22	2	1	17	0	42
Suburban	13	1	0	17	0	31
Rural	9	0	0	12	1	22
Total	**68**	**6**	**2**	**72**	**1**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Population Count
Urban	44.4%	5.6%	1.9%	48.1%	0.0%	100.0%
Small Urban	52.4%	4.8%	2.4%	40.5%	0.0%	100.0%
Suburban	41.9%	3.2%	0.0%	54.8%	0.0%	100.0%
Rural	40.9%	0.0%	0.0%	54.5%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	13	1	0	17	1	32
North East	13	1	1	16	0	31
South	28	0	1	21	0	50
West	14	4	0	18	0	36
Total	**68**	**6**	**2**	**72**	**1**	**149**

Percent of Responses

	Safe	Somewhat Safe	Not Safe	No Comment	Not Used	Region Count
North Central	40.6%	3.1%	0.0%	53.1%	3.1%	100.0%
North East	41.9%	3.2%	3.2%	51.6%	0.0%	100.0%
South	56.0%	0.0%	2.0%	42.0%	0.0%	100.0%
West	38.9%	11 .l%	0.0%	50.0%	0.0%	100.0%

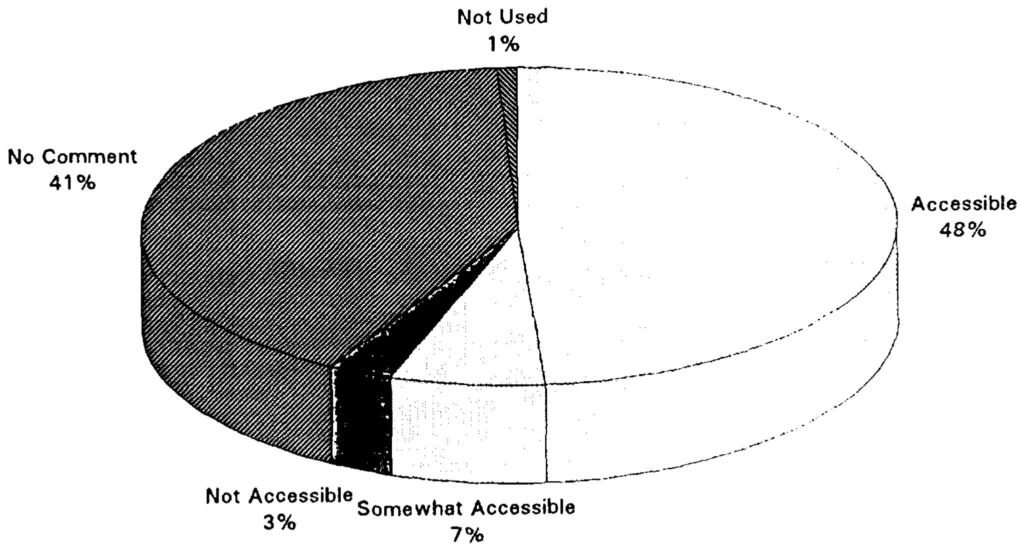


FIGURE 4.3.6.4-3 MISCELLANEOUS TOOLS - STORAGE ACCESSIBILITY RATING

TABLE 4.3.6.4-3
MISCELLANEOUS TOOLS - STORAGE ACCESSIBILITY RATING

Total Responses by Population

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Total # of Resp.	**73**	**10**	**4**	**61**	**1**	**149**
Total % of Resp.	**49.0%**	**6.7%**	**2.7%**	**40.9%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	28	4	3	19	0	54
Small Urban	22	3	1	16	0	42
Suburban	14	3	0	14	0	31
Rural	9	0	0	12	1	22
Total	**73**	**10**	**4**	**61**	**1**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Population Count
Urban	51.9%	7.4%	5.6%	35.2%	0.0%	100.0%
Small Urban	52.4%	7.1%	2.4%	38.1%	0.0%	100.0%
Suburban	45.2%	9.7%	0.0%	45.2%	0.0%	100.0%
Rural	40.9%	0.0%	0.0%	54.5%	4.5%	100.0%

REGION CATEGORY

Number of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	14	3	0	14	1	32
North East	15	1	1	14	0	31
South	28	2	1	19	0	50
West	16	4	2	14	0	36
Total	**73**	**10**	**4**	**61**	**1**	**149**

Percent of Responses

	Accessible	Somewhat Accessible	Not Accessible	No Comment	Not Used	Region Count
North Central	43.8%	9.4%	0.0%	43.8%	3.1%	100.0%
North East	48.4%	3.2%	3.2%	45.2%	0.0%	100.0%
South	56.0%	4.0%	2.0%	38.0%	0.0%	100.0%
West	44.4%	11 .l%	5.6%	38.9%	0.0%	100.0%

TABLE 4.3.6.4-4
MISCELLANEOUS TOOLS

Comments on Improvements for Storage by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	7	4.5%
Not Applicable/No Comment	115	73.2%
Suggestions for Improvements	35	22.3%
Total Comments	**157 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
More storage space	10	28.6%
More or better cribbing storage	9	25.7%
Larger compartments	3	8.6%
Lower compartments	3	8.6%
Supply mounting clips with tools	2	5.7%
Trailor for cribbing when necessary	2	5.7%
Bags for ropes	2	5.7%
Custom-design compartments	2	5.7%
Milk crates for cribbing	1	2.9%
More weatherproof	1	2.9%
Total	**35**	**100%**

* Multiple responses were permitted

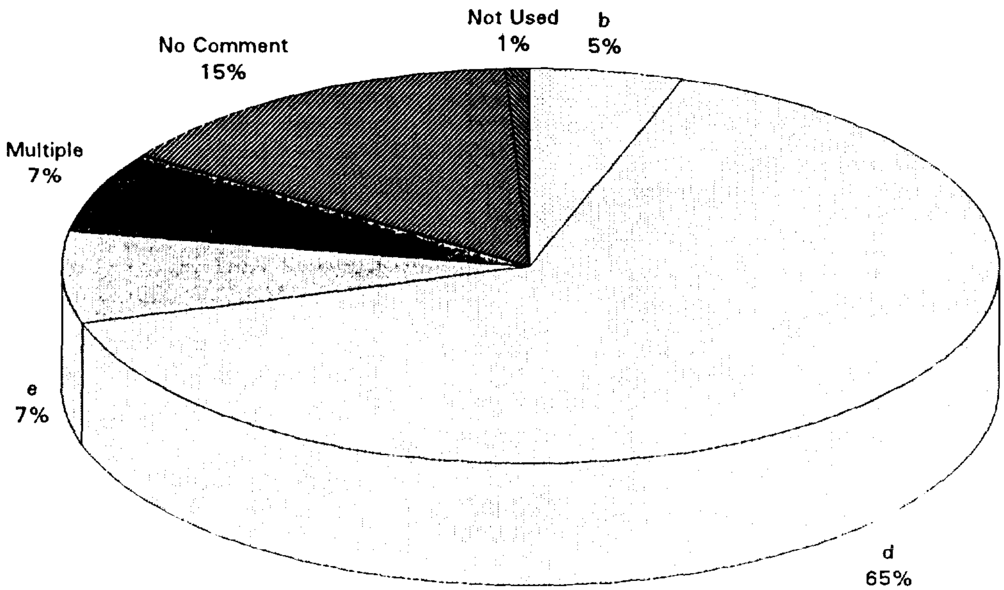
4.3.6.5 Portability - Miscellaneous Tools

Mounting type. As depicted in Figure 4.3.6.5-1, 5 percent of all responses regarding mounting type were partial hard mount, 65 percent were remote/hand carry, 7 percent were other, 7 percent were multiple types, 15 percent were no comment, and 1 percent was not used. Data for population and geographic categories are provided in Table 4.3.65-1.

Number of persons needed to carry. As shown in Figure 4.3.6.5-2, 45 percent of all responses indicated that 1 to 2 persons were needed to carry miscellaneous tools. 11 percent were 2 to 3, 3 percent were 3 to 6 persons, I percent was not used, and 40 percent were no comment. Population and geographic data are provided in Table 4.3.6.5-2.

Number of persons needed to operate. Forty-one percent of all responses indicated that 1 to 2 persons were needed to operate miscellaneous tools, 14 percent indicated 2 operators, 2 percent indicated 4 operators, 42 percent were no comment, and 1 percent was not used (see Figure 4.3.6.5-3). Population and geographic data are provided in Table 4.3.6.5-3.

Of the total responses to improvements for portability of miscellaneous tools, 9 percent were no improvement, 87 percent were not applicable/no comment, and 4 percent were suggestions for improvements. The following comments were made: need lighter weight miscellaneous tools; use a carrying rope to transport cribbing; use roll-up bags for miscellaneous tools: and use a dolly to transport cribbing (see Table 4.3.6.5-4).



KEY: a - Hard mount b - Partial mount c - Remote/wheels d - Remote/hand carry e - Other

FIGURE 4.3.6.5-1 MISCELLANEOUS TOOLS - PORTABILITY MOUNTING TYPE RATING

TABLE 4.3.6.5-1
MISCELLANEOUS TOOLS - PORTABILITY MOUNTING TYPE RATING

Total Responses by Population

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Population Count
Total # of Resp.	**0**	**8**	**0**	**87**	**11**	**10**	**22**	**1**	**149**
Total % of Resp.	**0.0%**	**5.4%**	**0.0%**	**85.1%**	**7.4%**	**6.7%**	**14.8%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Response

Mounting type *	a	b	c	d	4	Multiple	No Comment	Not Used	Population Count
Urban	0	3	0	36	5	5	5	0	54
Small Urban	0	1	0	27	4	2	8	0	42
Suburban	0	3	0	20	2	1	5	0	31
Rural	0	1	0	14	0	2	4	1	22
Total	**0**	**8**	**0**	**97**	**11**	**10**	**22**	**1**	**149**

Percent of Responses

Urban	0.0%	5.6%	0.0%	66.7%	9.3%	9.3%	9.3%	0.0%	100.0%
Small Urban	0.0%	2.4%	0.0%	64.3%	9.5%	4.8%	19.0%	0.0%	100.0%
Suburban	0.0%	9.7%	0.0%	64.5%	0.5%	3.2%	I%.I%	0.0%	100.0%
Rural	0.0%	4.5%	0.0%	63.0%	0.0%	9.1%	19.2%	4.5%	100.0%

REGION CATEGORY

Number of Responses

Mounting type *	a	b	c	d	e	Multiple	No Comment	Not Used	Region Count
North Central	0	1	0	21	2	2	5	1	32
North East	0	1	0	19	2	4	5	0	31
South	0	5	0	34	5	1	5	0	50
West	0	1	0	23	2	3	7	0	38
Total	**0**	**8**	**0**	**97**	**11**	**10**	**22**	**1**	**149**

Percent of Responses

North Central	0.0%	3.1%	0.0%	65.6%	6.3%	8.3%	15.6%	3.1%	100.0%
North East	0.0%	3.2%	0.0%	61.3%	6.5%	12.9%	16.1%	0.0%	100.0%
South	0.0%	10.0%	0.0%	69.0%	10.0%	2.0%	10.0%	0.0%	100.0%
West	0.0%	2.8%	0.0%	63.9%	5.6%	8.3%	19.4%	0.0%	100.0%

* a - Hard mount b - Partial hard mount c - Remote/wheels d - Remote/hand carry a - Other

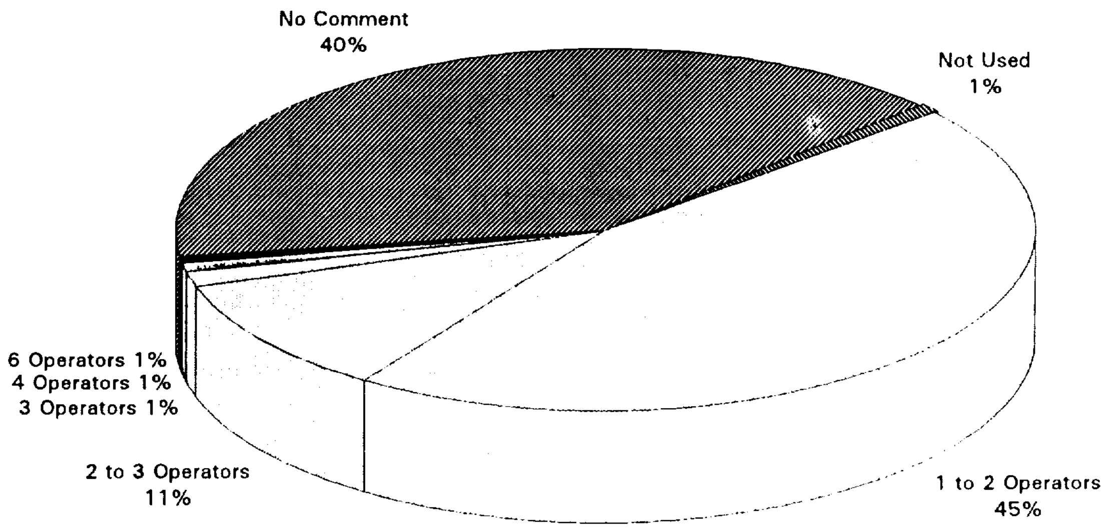


FIGURE 4.3.6.5-2 MISCELLANEOUS TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

TABLE 4.3.6.5-2
MISCELLANEOUS TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO CARRY RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	3	4	6	No Comment	Not Used	Population Count
Total # of Resp.	**68**	**16**	**2**	**1**	**1**	**60**	**1**	**149**
Total % of Resp.	**45.6%**	**10.7%**	**1.3%**	**0.7%**	**0.7%**	**40.3%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	4	6	No Comment	Not Used	Population Count
Urban	28	5	1	0	1	19	0	54
Small Urban	20	7	1	1	0	13	0	42
Suburban	11	2	0	0	0	18	0	31
Rural	9	2	0	0	0	10	1	22
Total	**68**	**16**	**2**	**1**	**1**	**60**	**1**	**149**

Percent of Responses

Urban	51.9%	9.3%	1.9%	0.0%	1.9%	35.2%	0.0%	100.0%
Small Urban	47.6%	16.7%	2.4%	2.4%	0.0%	31.0%	0.0%	100.0%
Suburban	35.5%	6.5%	0.0%	0.0%	0.0%	58.1%	0.0%	100.0%
Rural	40.9%	9.1%	0.0%	0.0%	0.0%	45.5%	4.5%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	3	4	6	No Comment	Not Used	Region Count
North Central	9	6	1	1	0	14	1	32
North East	15	3	1	0	1	11	0	31
South	24	7	0	0	0	19	0	50
West	20	0	0	0	0	16	0	36
Total	**68**	**16**	**2**	**1**	**1**	**60**	**1**	**149**

Percent of Responses

North Central	28.1%	18.8%	3.1%	3.1%	0.0%	43.8%	3.1%	100.0%
North East	48.4%	9.7%	3.2%	0.0%	3.2%	35.5%	0.0%	100.0%
South	48.0%	14.0%	0.0%	0.0%	0.0%	38.0%	0.0%	100.0%
West	55.6%	0.0%	0.0%	0.0%	0.0%	44.4%	0.0%	100.0%

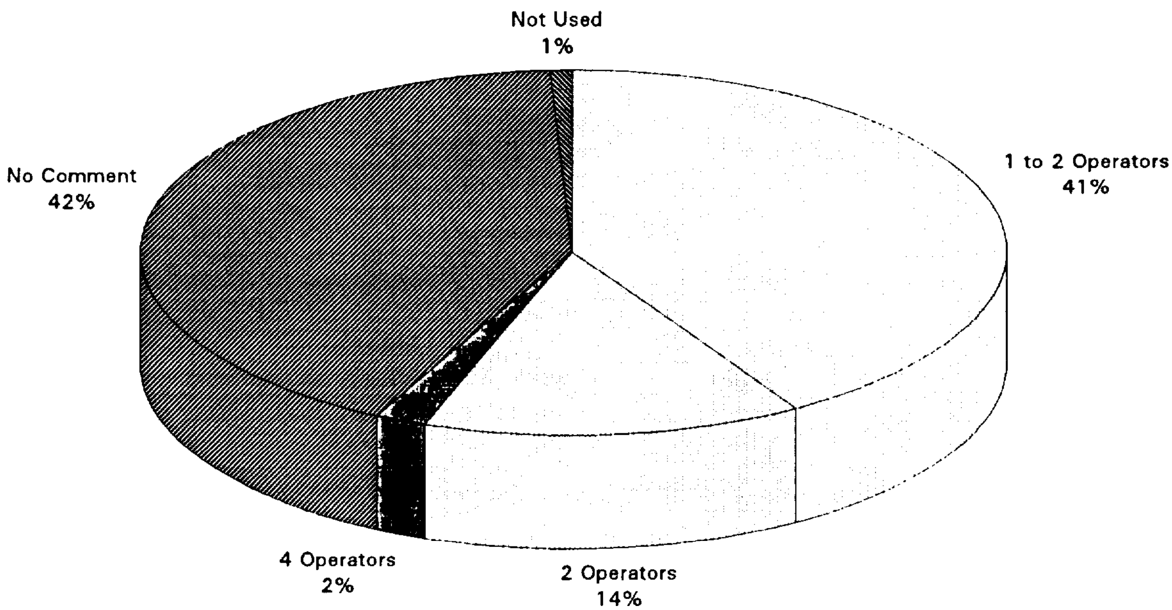


FIGURE 4.3.6.5-3 MISCELLANEOUS TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

TABLE 4.3.6.5-3
MISCELLANEOUS TOOLS - PORTABILITY NUMBER PERSONS NEEDED TO OPERATE RATING

Total Responses by Population

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Population Count
Total # of Resp.	**62**	**21**	**3**	**62**	**1**	**149**
Total % of Resp.	**41.6%**	**14.1%**	**2.0%**	**41.6%**	**0.7%**	**100.0%**

POPULATION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Population Count
Urban	25	7	3	19	0	54
Small Urban	20	8	0	14	0	42
Suburban	9	4	0	18	0	31
Rural	8	2	0	11	1	22
Total	**62**	**21**	**3**	**62**	**1**	**149**

Percent of Responses

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Population Count
Urban	46.3%	13.0%	5.6%	35.2%	0.0%	100.0%
Small Urban	47.6%	19.0%	0.0%	33.3%	0.0%	100.0%
Suburban	29.0%	12.9%	0.0%	58.1%	0.0%	100.0%
Rural	36.4%	9.1%	0.0%	50.0%	4.5%	100.0%

REGION CATEGORY

Number of Responses

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Region Count
North Central	10	6	0	15	1	32
North East	15	3	2	11	0	31
South	20	10	1	19	0	50
West	17	2	0	17	0	36
Total	**62**	**21**	**3**	**62**	**1**	**149**

Percent of Responses

# Operators	1 to 2	2 to 3	4	No Comment	Not Used	Region Count
North Central	31.3%	18.8%	0.0%	46.9%	3.1%	100.0%
North East	48.4%	9.7%	6.5%	35.5%	0.0%	100.0%
South	40.0%	20.0%	2.0%	38.0%	0.0%	100.0%
West	47.2%	5.6%	0.0%	47.2%	0.0%	100.0%

TABLE 4.3.6.5-4
MISCELLANEOUS TOOLS

Comments on Improvements for Portability by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	13	8.7%
Not Applicable/No Comment	130	87.2%
Suggestions for Improvements	6	4.0%
Total Comments	**149 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Lighter weight	2	33.3%
Cribbing - carrying rope	2	33.3%
Roll-up bags	1	16.7%
Cribbing needs dolly	1	16.7%
Total	**6**	**100%**

* Multiple responses were permitted

4.3.6.6 Safety Aspects - Miscellaneous Tools

Of the total responses made regarding miscellaneous safety concerns, 44 percent were none in particular, 48 percent were not applicable/no comment, and 8 percent were safety concerns. Some of the comments made included: tool stability; tool failure; and splintering of cribbing. Data are provided in Table 4.3.6.6-1.

Safety Equipment Rating (see Table 4.3.6.6-2):

Available for use. Sixty percent of all participants indicated that they had ear protection equipment available for use, 89 percent had eye and body protection available, 91 percent had hand, head, and foot protection available, and 22 percent had other types of protection equipment available for use. The other percentages of the participants' responses were no comment/not used.

Used by personnel. Forty-two percent of respondents indicated that they used ear protection equipment, 87 percent used eye and body protection, 91 percent used hand protection, 89 percent used head protection, 88 percent used foot protection equipment, and 19 percent said they used other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

Required to be used. Forty-one percent of participants said they were required to use ear protection, 87 percent were required to use eye and body protection, 91 percent were required to use hand protection, 90 percent were required to use head protection. 88 percent were required to use foot protection, and is percent said they were required to use other types of protection equipment. The other percentages of the participants' responses were no comment/not used.

TABLE 4.3.6.6-1
MISCELLANEOUS TOOLS

Comments on Safety Concerns by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
None in Particular	65	43.6%
Not Applicable/No Comment	72	48.3%
Safety Concerns	12	8.1%
Total Comments	**149 ***	**100.0%**

Safety Concerns	Number of Responses	Percentage of Responses
Tool stability	3	25.0%
Tool failure	2	16.7%
Splintering of cribbing	2	16.7%
Tool slippage	1	8.3%
Chain breakage	1	8.3%
Cable failure	1	8.3%
Winch capacity	1	8.3%
Rope strength	1	8.3%
Total	**12**	**100%**

* Multiple responses were permitted

TABLE 4.3.6.6-2
MISCELLANEOUS TOOLS - SAFETY EQUIPMENT RATING

	EAR		EYE		HAND		BODY		HEAD		FOOT		OTHER	
Number of Response	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment/ Not used	Comment	No Comment/ Not Used	Comment	No Comment/ Not Used	Comment	No Comment Not Used	Comment	No Comment/ Not Used
Available for use	88	61	133	16	135	14	132	17	136	13	135	14	33	116
Used by personnel	62	87	129	20	135	14	129	20	133	16	131	18	28	121
Required to be used	61	88	129	20	135	14	129	20	134	15	131	18	23	126
***Percent of Responses**														
Available for use	59.1%		89.3%		90.6%		88.6%		91.3%		90.6%		22.1%	
Used by personnel	41.6%		86.6%		90.6%		86.6%		89.3%		87.9%		18.8%	
Required to be used	40.9%		86.6%		90.6%		86.6%		89.9%		87.9%		15.4%	

*Percentages were calculated for each individual type of protective device based on a total of 149 participants.

4.3.6.7 Modifications - Miscellaneous Tools

Of the total responses on miscellaneous tool modifications, as shown in Table 4.3.6.7-1, 58 percent were no modifications, 36 percent were not applicable/no comment, and 6 percent were comments on modifications. The comments were: agencies cut their own cribbing; the addition of catch hooks to take up slack; fabricate a short pike pole; the addition of a pulling ring; and the addition of rope handles to cribbing.

TABLE 4.3.6.7-1
MISCELLANEOUS TOOLS

Comments on Modifications by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Modifications	88	58.3%
Not Applicable/No Comment	54	35.8%
Modifications	9	6.0%
Total Comments	**151 ***	**100.0%**

Modifications	Number of Responses	Percentage of Responses
Cut own cribbing	3	33.3%
Added catch hooks to take up slack	2	22.2%
Fabricated short pike pole	2	22.2%
Added pulling ring	1	11.1%
Added rope handles to cribbing	1	11.1%
Total	**9**	**100%**

* Multiple responses were permitted

4.3.6.8 Potential Improvements - Miscellaneous Tools

Of the total comments on miscellaneous tool improvements, 50 percent were no improvement, 43 percent were not applicable/no comment, and 7 percent were suggestions for improvements. Some of the comments included: more durable step chocks; heavier cable; lighter cribbing; more pliable, durable rope; and non-slip cribbing (see Table 4.3.6.8-l).

TABLE 4.3.6.8-1
MISCELLANEOUS TOOLS

Comments on Improvements by Number and Percentage of Responses

	Number of Responses	Percentage of Responses
No Improvements	76	50.0%
Not Applicable/No Comment	66	43.4%
Suggestions for Improvements	10	6.6%
Total Comments	**152 ***	**100.0%**

Suggestions for Improvements	Number of Responses	Percentage of Responses
Cotton/nylon rope	1	10.0%
Heavier cable	1	10.0%
Lighter cribbing	1	10.0%
Lighter weight	1	10.0%
More pliable rope	1	10.0%
Multi-use tools	1	10.0%
Non-slip cribbing	1	10.0%
Rope more durable longer lasting	1	10.0%
Step chocks - cast alloy	1	10.0%
Step chocks - more durable	1	10.0%
Total	**10**	**100%**

* Multiple responses were permitted

4.3.7 Fire/Rescue Agency Information

This portion of the survey provides information regarding the survey participants' fire/rescue agencies.

4.3.7.1 Alarms/Usage

The data collected on number of Motor Vehicle Accident (MVA) alarms per year and frequency of MVA alarms requiring extrication were extremely unreliable. As can be seen in Table 43.7.l-l, the large standard deviations within population and region categories reflect a range of reported alarms that is too wide to be considered real (i.e., the range of reported alarms per year for urban agencies varied from approximately 10 to over 21,000 per year). It can only be speculated that different size areas (i.e., an isolated area in an urban setting versus an entire metro area) were used in making estimates, participants may have responded with the number of alarms they personally were involved with or they may have lacked this information and found it difficult to estimate. Regardless of the cause of extreme variation of data points, these data should not be considered reliable for any of the population or geographic categories.

TABLE 4.3.7.1-1
ALARMS VERSUS USAGE RATING

POPULATION CATEGORY

Responses	# of MVA Alarms/Year		Extrication Frequency of Use	
	Mean	Standard Deviation	Mean	Standard Deviation
Urban	3054	4205	260	379
Small Urban	845	1266	125	269
Suburban	398	635	28	39
Rural	177	332	18	28
Grand Totals	**1426**	**2867**	**135**	**283**

REGION CATEGORY

Responses	# of MVA Alarms/Year		Extrication Frequency of Use	
	Mean	Standard Deviation	Mean	Standard Deviation
North Central	404	633	63	139
North East	546	1402	55	115
South	2377	4072	265	431
West	1858	2694	94	143

4.3.7.2 Type of Agency/Size of Agency

Table 4.3.7.2-1 reflects the number of each type of fire/rescue agency (i.e., career, career/volunteer and volunteer) for each population' and geographic category. Far more participants were from career agencies as compared to other agency types. More participants were from urban career agencies as compared to other population categories, and from southern career agencies as compared to other regions.

TABLE 4.3.7.2-1
TYPE OF AGENCY/SIZE OF AGENCY RATING

POPULATION CATEGORY

Responses	Career Agency	Career/Volunteer Agency	Volunteer Agency	No Comment/ No Response	Population Count	Number of Employees/Members: Mean	Number of Employees/Members: Standard Deviation
Urban	50	2	0	2	54	708	518
Small Urban	34	8	0	0	42	231	151
Suburban	21	7	3	0	31	75	47
Rural	7	8	7	0	22	63	51
Grand Totals	**112**	**25**	**10**	**2**	**149**	**337**	**420**

REGION CATEGORY

Responses	Career Agency	Career/Volunteer Agency	Volunteer Agency	No Comment/ No Response	Region Count	Number of Employees/Members: Mean	Number of Employees/Members: Standard Deviation
North Central	20	6	6	0	32	245	287
North East	21	6	3	1	31	202	201
South	42	7	1	0	50	465	472
West	29	6	0	1	36	361	533
Grand Totals	**112**	**25**	**10**	**2**	**149**	**337**	**420**

4.3.7.3 Conveyance

Table 4.3.7.3-1 contains data on the method of conveying extrication equipment to MVA scene. The rescue company squad truck was the most used method of conveyance for all four population categories. The rescue company squad truck was also the most used method of conveyance for all geographic regions except the west. Participants from the west indicated slightly more use of the ladder company truck.

TABLE 4.3.7.3-1
CONVEYANCE RATING

POPULATION CATEGORY

Responses

	Ladder Co./ Truck	Engine Co.	Rescue Co./ Squad	Ambulance	Other
Urban	30	20	35	2	5
Small Urban	16	21	26	2	4
Suburban	11	11	15	1	1
Rural	2	6	13	0	4
Grand Totals	**59**	**58**	**89**	**5**	**14**

REGION CATEGORY

Responses

	Ladder Co./ Truck	Engine Co.	Rescue Co./ Squad	Ambulance	Other
North Central	9	10	21	1	5
North East	10	10	18	2	2
South	19	23	31	2	5
West	21	15	19	0	2
Grand Totals	**59**	**58**	**89**	**5**	**14**

4.3.7.4 Storage

As shown in Table 4.3.7.4-1, participants from all population and geographic categories indicated that left- and right-side compartments are used more frequently than front or tail-board compartments. The degree to which right- and left-side storage compartments are used is about the same.

TABLE 4.3.7.4-1
STORAGE RATING

POPULATION CATEGORY

Responses

	Front Bumper	Left-side Compartment	Right-side Compartment	Tail-board (rear compartments)	Other
Urban	10	36	35	16	21
Small Urban	4	29	33	17	10
Suburban	2	20	21	14	10
Rural	2	15	13	8	8
Grand Totals	**18**	**100**	**102**	**55**	**49**

REGION CATEGORY

Responses

	Front Bumper	Left-side Compartment	Right-side Compartment	Tail-board (rear compartments)	Other
North Central	4	23	23	12	15
North East	5	22	22	10	8
South	5	34	32	20	15
West	4	21	25	13	11
Grand Totals	**18**	**100**	**102**	**55**	**49**

4.3.7.5 Extrication Times/Problems

Table 4.3.7.5-1 displays the mean and standard deviation for the time taken to extricate an entrapped victim. The mean extrication times ranged from 15 to 18 minutes. The minimum and maximum times that were given for the total population ranged from 3 to 60 minutes. The data are displayed by population and geographic categories.

TABLE 4.3.7.5-1
EXTRICATION TIMES RATING

POPULATION CATEGORY

Responses	Mean	Extrication Times - Minutes Standard Deviation	Maximum	Minimum
Urban	17	7	35	4
Small Urban	15	11	60	4
Suburban	15	8	40	3
Rural	17	8	38	7

REGION CATEGORY

Responses	Mean	Extrication Times - Minutes Standard Deviation	Maximum	Minimum
North Central	18	12	60	5
North East	16	9	40	5
South	15	7	30	3
West	15	7	35	4

4.3.7.6 Vehicle Types

As shown in Table 4.3.7.6-1, participants from all population and geographic categories indicated that mid-size vehicles are most frequently encountered on MVA alarms involving extrication. Compact vehicles were the next most frequently extricated vehicle type for all participants regardless of population or geographic category. Ninety-seven percent of all participants indicated that the vehicles most frequently extricated were 1980-1990 models.

TABLE 4.3.7.6-1
VEHICLE TYPE RATING

POPULATION CATEGORY

Responses

	Luxury/ Full Size	Mid-size	Compact	Subcompact	Pickup Truck	Van	Commercial Vehicle	Other	1990 - Newer	1980 - 1990	Pre 1980
Urban	6	25	21	8	4	3	6	3	3	38	4
Small Urban	2	20	14	3	0	2	0	0	7	26	1
Suburban	0	13	11	3	1	0	0	1	6	16	0
Rural	0	14	9	2	0	1	2	1	2	18	0
Grand Totals	**7**	**72**	**55**	**16**	**5**	**6**	**7**	**5**	**17**	**97**	**5**

REGION CATEGORY

Responses

	Luxury/ Full Size	Mid-size	Compact	Subcompact	Pickup Truck	Van	Commercial Vehicle	Other	1990 - Newer	1980 - 1990	Pre 1980
North Central	2	19	6	2	0	2	2	1	6	19	0
North East	0	13	12	4	1	0	0	1	5	22	0
South	3	27	17	4	1	2	3	0	2	39	1
West	2	13	20	6	3	2	2	3	4	17	4
Grand Totals	**7**	**72**	**55**	**16**	**5**	**6**	**7**	**5**	**17**	**97**	**5**

4.3.8 Survey Tool Inventory

This section contains the tool inventory of the participants' fire/rescue agencies, It is organized according to the six tool type categories. It is presented by population and geographic categories and by total population. Due to the fact that there are different sample sizes of participants per category (i.e., urban - 54 participants, small urban - 42, suburban - 31, rural - 22), comparisons among population categories and geographic categories cannot be made without considering sample size (i.e., there were fewer rural participants than other types of participants and, therefore, the rural tool inventory is smaller than inventories for other population categories. The inventory data provided in the following sections are intended to show the overall distribution of tool types and frequency of use within a given category and to provide information regarding the most frequently used tools for the total population.

4.3.8.1 Hand Tools - (Tables 4.3.8.-1 and 4.3.8.1-2)

Common - Based on the total population, the three most frequently reported common tools were bolt cutters, mechanics; tools and wrenches. This was true for all population and geographic categories. The least reported common tools by all participants were cable cutters, cold chisels and tin shears/tin snips.

<u>Bars</u> - The three most frequently reported bars by all participants were the haligan bar/hooligan tool, the pry bar/straight bar, and the crow bar/wrecking bar. This was true for all population and geographic categories. The least frequently reported bars by the total population were the utility bar, the pinch bar, and the hux bar.

<u>Axes</u> - Based on the total population, the three most commonly reported axes were miscellaneous or unspecified axes, flat head axes and pick axe/pick head axe. This was true for urban, small urban, and suburban participants. and for participants from the northeast, south and west. Rural participants reported havingmore crash axes/biel tools than other axe types, while north central participants reported having more pry axes.

Other - The most common tool by far, for the total population and all population and geographic categories, was the come-along. The next most common tool, for the total population, all population categories, and most geographic regions, was the sledge hammer/maul. Also frequently reported were the windshield/glass cutter, and the claw tool/Hayward. The least common tools were the battering ram and rubber mallet.

TABLE 4.3.8.1-1
LISTING OF HAND TOOLS

HAND TOOLS	Urban	Small Urban	Suburban	Rural	Totals
	POPULATION CATEGORY				
COMMON					
Bolt cutters	52	38	28	21	139
Cable cutters	0	1	1	0	2
Center punch (spring-loaded)	10	11	7	4	32
Cold chisel	2	1	1	0	4
Hack saw	18	10	9	2	39
Mechanic's tools	39	31	21	14	105
Tin shears/tin snips	3	7	1	1	12
Wire cutters	8	4	4	0	16
Wrench (misc. or unspecified)	24	18	12	6	60
BARS					
Crow bar/wrecking bar	16	12	9	2	39
Halligan bar/Hooligan tool	28	22	21	8	79
Hux bar	4	3	1	0	8
Kelly tool/Kelly bar	6	5	2	0	13
Pinch bar	3	1	0	0	4
Pry bar/straight bar	26	17	14	8	65
Utility bar	2	0	0	0	2
AXES					
Axe (misc. or unspecified)	16	14	11	2	43
Crash axe/biel tool	3	3	1	5	12
Flat head axes	16	5	5	2	28
Pick axe/Pick head axe	14	4	6	3	27
Pike axe/Pike head axe	6	2	0	0	8
Pry axe	5	7	6	2	20
OTHER					
Baling/hay hook	3	4	4	2	13
Battering ram	3	2	0	1	6
Claw tool/Hayward	15	9	1	0	25
Come-alongs	38	30	20	17	105
Hand saw	7	4	1	0	12
K-tool	11	2	6	0	19
Pick	7	3	0	1	11
Ram bar/K-bar tools/lockbreak	9	4	3	2	18
Rubber mallet	2	3	1	0	6
Seat belt cutter	4	10	2	1	17
Sledge hammer/maul	21	17	11	5	54
Slim jim	6	3	2	0	11
Utility knife/linoleum knife	3	5	4	1	13
Windshield/glass cutter	13	12	5	4	34

TABLE 4.3.8.1-2
LISTING OF HAND TOOLS

HAND TOOLS	North Central	North East	South	West	Totals
	REGION CATEGORY				
COMMON					
Bolt cutters	31	29	45	34	139
Cable cutters	0	1	0	1	2
Center punch (spring-loaded)	7	4	11	10	32
Cold chisel	0	1	2	1	4
Hack saw	8	8	13	10	39
Mechanic's tools	20	24	37	24	105
Tin shears/tin snips	3	2	4	3	12
Wire cutters	2	1	6	7	16
Wrench (misc. or unspecified)	12	13	21	14	60
BARS					
Crow bar/wrecking bar	5	7	15	12	39
Halligan bar/Hooligan tool	14	21	22	22	79
Hux bar	1	2	4	1	8
Kelly tool/Kelly bar	2	1	7	3	13
Pinch bar	1	0	3	0	4
Pry bar/straight bar	15	13	22	15	65
Utility bar	0	0	1	1	2
AXES					
Axe (misc. or unspecified)	6	11	16	10	43
Crash axe/biel tool	2	3	4	3	12
Flat head axes	3	5	9	11	28
Pick axe/Pick head axe	3	3	9	12	27
Pike axe/Pike head axe	1	2	2	3	8
Pry axe	8	1	5	6	20
OTHER					
Baling/hay hook	3	1	3	6	13
Battering ram	1	0	2	3	6
Claw tool/Hayward	4	4	9	8	25
Come-alongs	23	24	37	21	105
Hand saw	0	3	5	4	12
K-tool	2	3	9	5	19
Pick	0	2	5	4	11
Ram bar/K-bar tools/lockbreak	3	0	6	9	18
Rubber mallet	0	1	3	2	6
Seat belt cutter	4	2	6	5	17
Sledge hammer/maul	10	12	17	15	54
Slim jim	1	1	4	5	11
Utility knife/linoleum knife	2	3	3	5	13
Windshield/glass cutter	6	13	9	6	34

4.3.8.2 Manually Powered Tools - (Tables 4.3.8.2-1 and 4.3.8.2-2)

Jacks - According to the total population, the most commonly reported tools were the hydraulic jack, the miscellaneous or unspecified jack, and the highlift jack. This was true of most population and geographic categories. The northeast and small urban participants reported the bottle jack more frequently than the highlift jack. The least frequently reported tools were the automobile jack and the mechanical jack.

Other - The portapower was by far the most frequently reported tool for the entire population and for all population and geographic categories. Also frequently reported were the manually powered hydraulics and the rabbit tool. Least frequently reported were spread shores.

TABLE 4.3.8.2-1
LISTING OF MANUALLY POWERED TOOLS

POPULATION CATEGORY

MANUALLY POWERED TOOLS	Urban	Small Urban	Suburban	Rural	Totals
JACKS					
Automobile jack	1	0	0	1	2
Bottle jack	5	4	3	3	15
Handyman jack	1	2	0	1	4
Highlift jack	9	3	4	1	17
House jack	1	2	0	1	4
Hydraulic jack	23	12	6	3	44
Jack (misc. or unspecified)	12	12	6	2	32
Mechanical jack	1	0	0	1	2
Railroad jack	2	0	1	0	3
Screw/scissor jack	9	1	0	2	12
OTHER					
Manually-powered hydraulics	13	9	3	2	27
Portapower	29	23	19	17	88
Rabbit Tool	8	6	1	0	15
Ring cutter/pedal cutter	8	3	0	1	12
Spread shores	4	0	0	0	4

TABLE 4.3.8.2-2
LISTING OF MANUALLY POWERED TOOLS

REGION CATEGORY

MANUALLY POWERED TOOLS	North Central	North East	South	West	Totals
JACKS					
Automobile jack	0	1	1	0	2
Bottle jack	1	8	4	2	15
Handyman jack	2	0	0	2	4
Highlift jack	1	4	6	6	17
House jack	0	2	0	2	4
Hydraulic jack	10	8	11	15	44
Jack (misc. or unspecified)	5	9	12	6	32
Mechanical jack	0	1	0	1	2
Railroad jack	0	0	3	0	3
Screw/scissor jack	1	4	2	5	12
OTHER					
Manually-powered hydraulics	3	7	8	9	27
Portapower	25	17	27	19	88
Rabbit Tool	1	8	4	2	15
Ring cutter/pedal cutter	3	3	5	1	12
Spread shores	1	0	0	3	4

4.3.8.3 Cutting Tools - (Tables 4.3.8.3-1 and 4.3.8.3-2)

The circular saw was the most commonly reported tool for the total population and all population and geographic categories. Also frequently reported were the oxyacetylene torch, the chain saw and the reciprocating saw. Unlike other geographic regions, northeastern participants reported more reciprocating saws than chain saws or oxyacetylene torches. Reported infrequently were the sander grinder, plasma cutter, and die grinder.

TABLE 4.3.8.3-1
LISTING OF CUTTING TOOLS

	POPULATION CATEGORY				
CUTTING TOOLS	Urban	Small Urban	Suburban	Rural	Totals
Abrasive/Circular saw	49	36	25	19	129
Chain saw	36	25	13	10	84
Cordless drill	1	1	0	3	5
Die grinder	2	1	0	0	3
Dremel tool	3	1	0	0	4
Drill	4	0	1	3	8
Jack hammer	6	0	0	0	6
Oxy-acetylene torch	36	28	9	12	85
Plasma cutter	2	0	1	0	3
Reciprocating saw	31	17	17	12	77
Sander/Grinder	1	0	0	0	1

TABLE 4.3.8.3-2
LISTING OF CUTTING TOOLS

	REGION CATEGORY				
CUTTING TOOLS	North Central	North East	South	West	Totals
Abrasive/Circular saw	25	26	44	34	129
Chain saw	13	17	33	21	84
Cordless drill	2	1	1	1	5
Die grinder	1	1	0	1	3
Dremel tool	0	2	1	1	4
Drill	2	1	2	3	8
Jack hammer	0	4	0	2	6
Oxy-acetylene torch	15	17	31	22	85
Plasma cutter	1	0	1	1	3
Reciprocating saw	15	23	24	15	77
Sander/Grinder	0	1	0	0	1

4.3.8.4 Pneumatic Tools - (Tables 4.3.8.4-1 and 4.3.8.4-2)

The most commonly reported pneumatic tools for all participants were the air chisel/air hammer and the air bag. Reported infrequently were the air spreader (reported only by the north central. small urban participants), the drill, and air shores (reported only by urban and small urban participants).

TABLE 4.3.8.4-1
LISTING OF PNEUMATIC TOOLS

	POPULATION CATEGORY				
PNEUMATIC TOOLS	Urban	Small Urban	Suburban	Rural	Totals
Air bag	48	38	22	14	122
Air chisel/air hammer	50	36	27	18	131
Air cut-off tool/wizzer saw	13	6	2	1	22
Air shores	6	2	0	0	8
Air spreader	0	2	0	0	2
Drill	6	2	0	0	8
Impact wrench/ratchet	11	6	1	0	18

TABLE 4.3.8.4-2
LISTING OF PNEUMATIC TOOLS

	REGION CATEGORY				
PNEUMATIC TOOLS	North Central	North East	South	West	Totals
Air bag	26	25	40	31	122
Air chisel/air hammer	28	26	44	33	131
Air cut-off tool/wizzer saw	6	7	6	3	22
Air shores	1	2	2	3	8
Air spreader	2	0	0	0	2
Drill	1	1	3	3	8
Impact wrench/ratchet	3	5	7	3	18

4.3.8.5 Hydraulic Tools - (Tables 4.3.8.5-1 and 4.3.8.5-2)

The most commonly reported hydraulic tools were the spreader. cutter, and somewhat less frequently, the ram. Reported least frequently was the combo tool.

4.3.8.6 Miscellaneous Tools - (Tables 4.3.8.6-1 and 4.3.8.6-2)

The most commonly reported miscellaneous tools were cribbing, rope/lifeline, and pike pole. Least frequently reported were the grip hoist/lever hoist and the pulley.

TABLE 4.3.8.6-1
LISTING OF MISCELLANEOUS TOOLS

	POPULATION CATEGORY				
MISCELLANEOUS TOOLS	Urban	Small Urban	Suburban	Rural	Totals
Chains/Cables	12	14	8	9	43
Cribbing	45	39	26	20	130
Grip hoist/lever hoist	4	3	0	0	7
Harness	8	4	3	3	18
Pike Pole	34	26	24	15	99
Pulley	9	1	3	0	13
Rope/lifeline	45	34	24	18	121
Webbing	17	10	5	4	36
Winch	12	6	3	3	24

TABLE 4.3.8.5-1
LISTING OF HYDRAULIC TOOLS

	POPULATION CATEGORY				
HYDRAULIC TOOLS	Urban	Small Urban	Suburban	Rural	Totals
Combo	17	7	6	3	33
Cutter	45	37	23	22	127
Ram	45	30	18	19	112
Spreader	49	41	24	22	136

TABLE 4.3.8.5-2
LISTING OF HYDRAULIC TOOLS

	REGION CATEGORY				
HYDRAULIC TOOLS	North Central	North East	South	West	Totals
Combo	5	5	12	11	33
Cutter	30	27	41	29	127
Ram	25	23	38	26	112
Spreader	30	27	48	31	136

TABLE 4.3.8.6-2
LISTING OF MISCELLANEOUS TOOLS

	REGION CATEGORY				
MISCELLANEOUS TOOLS	North Central	North East	South	West	Totals
Chains/Cables	13	9	14	7	43
Cribbing	27	30	43	30	130
Grip hoist/lever hoist	2	2	1	2	7
Harness	5	3	5	5	18
Pike Pole	21	19	31	28	99
Pulley	4	1	2	6	13
Rope/lifeline	24	26	41	30	121
Webbing	7	6	10	13	36
Winch	7	5	5	7	24

5 Assessment of Interface With Vehicle Design and Extrication Equipment

5.1 Overview

This chapter focuses on the vehicle side of extrication technology. Certain trends in new vehicle design can make extrication difficult. One area of concern is with intruding vehicle components. Section 5.2 identifies vehicle component intrusion results from a real-world crash database. Section 5.3 discusses current design trends in new passenger cars and light trucks. It discusses both design and construction, and material types.

5.2 NASS Search

The 1992 National Accident Sampling System (NASS) data were analyzed to determine how frequently occupants become entrapped in vehicles and which vehicle components intrude into the occupant compartment during a crash. The first part of the analysis was to identify the percentage of crashes in which entrapment occurred. Entrapment, as defined in the NASS database, means that part of the occupant was in the vehicle and was mechanically restrained by a damaged vehicle component; jammed doors and immobilizing injuries, by themselves, do not constitute entrapment. Occupants who are completely or partially ejected and become pinned by their vehicle and some other surface are not considered entrapped. Occupants confined by jammed seat belt buckle release mechanisms also are not considered entrapped.

It was found that of the 11,576 accident cases included in the sample, entrapment occurred in 1.5 percent (174) of the accidents, in 96.1 percent (11 ,128) no entrapment occurred, and in 2.4 percent (274) of the accidents it was unknown if entrapment occurred. The 174 accidents in which entrapment occurred were examined to identify which vehicle components intruded into the occupant compartment. The ordering of intrusions reflects the intrusion severity (i.e., magnitude of intrusion). The results of the analysis are provided in Table 5.2-1.

Table 5.2-l Vehicle Intruding Components

INTERIOR COMPONENTS	COMPONENT #l MOST SEVERE FREQUENCY	PERCENT	COMPONENT #2 2ND MOST SEVERE FREQUENCY	PERCENT	COMPONENT #3 3RD MOST SEVERE FREQUENCY	PERCENT
Steering assembly	44	0.8	35	0.6	37	0.6
Instrument panel left	57	1	88	1.5	51	0.9
Instrument panel center	14	0.2	36	0.6	41	0.7
Instrument panel right	66	1.1	79	1.3	63	1.1
Toe pan	454	7.8	155	2.6	123	2.1
A (Al/A2) pillar	108	1.8	147	2.5	141	2.4
B pillar	135	2.3	176	3	134	2.3
C pillar	38	0.6	31	0.5	26	0.4
D pillar	3	0.1	3	0.1	2	0.0
Door panel (side)	460	7.9	272	4.6	218	3.7
Roof (or convertible top)	206	3.5	187	3.2	182	3.1
Roof side rail	58	1	78	1.3	81	1.4
Windshield	85	1.5	84	1.4	81	1.4
Windshield header	69	1.2	87	1.5	84	1.4
Window frame	22	0.4	31	0.5	26	0.4
Floor pan (includes pan)	179	3.1	167	2.9	157	2.7
Backlight header	18	0.3	22	0.4	24	0.4
Front seat back	163	2.8	129	2.2	97	1.7
Second seat	93	1.6	85	1.5	74	1.3
Third seat	0	0	1	0	0	0.0

Table 5.2-1 Vehicle Intruding Components (cont.)

	COMPONENT #l MOST SEVERE		COMPONENT #2 2ND MOST SEVERE		COMPONENT #3 3RD MOST SEVERE	
Seat cushion	22	0.4	34	0.6	53	0.9
Back door/panel (e.g., tailgate)	54	0.9	21	0.4	13	0.2
Other interior components	29	0.5	37	0.6	36	0.6
Side panel-forward of A pillar	99	1.7	87	1.5	64	1.1
Side panel -rear of A pillar	104	1.8	65	1.1	38	0.6
EXTERIOR COMPONENTS						
Hood	11	0.2	6	0.1	4	0.1
Outside vehicle surface	8	0.1	7	0.1	4	0.1
Other exterior object in the environment	12	0.2	10	0.2	7	0.1
OTHER						
Catastrophic	13	0.2	0	0.0	0	0.0
Intrusion of unlisted components	7	0.1	2	0.0	0	0.0
Unknown	68	1.2	2	0.0	7	0.0
Missing cases	3157	53.9	3693	63.1	3988	68.1
Total	5856	100.0	5856	100.0	5856	100.0

5.3 New Vehicle Trends

This section identities and discusses current design trends in passenger cars and light trucks. The information presented is based on various articles, reference materials, and the author's knowledge of automobile design. The information on new vehicle trends is presented in two sections. Section 5.3.1 discusses new vehicle design and construction, and addresses issues such as body design/structure, new component design, and safety-related design (e.g., supplemental restrains, side door intrusion beams). Section 5.3.2 discusses new vehicle materials and location. This section focuses on the material types and locations that most affect extrication (e.g., roof, door, and body panels). Both sections 5.3.1 and 5.3.2 include discussions related to passenger vehicles, light trucks, and special topics.

The following sections provide an overview of the industry trends related to vehicle design/construction and materials. They are not intended to be a comprehensive review of all aspects of the new vehicles and do not specifically target any particular manufacturer or model. When appropriate, some specific examples are given that identify certain vehicles. The information provided reflects changes in the automobile industry that may directly affect current extrication equipment and techniques. The intent is to increase the reader's awareness of new vehicle designs that may require new or different extrication techniques.

53.1 Design and Construction

This section identifies certain new vehicle body structure and components that are likely to affect vehicle extrication. The new vehicle designs and structures may affect vehicle extrication in a positive or negative manner. For example, increased use of glass may make access to the victim easier. On the other hand, side door intrusion beams may make it more difficult to gain access through the door. The items identified in this section take into account the vehicle design and construction changes that have occurred because of new and future safety regulations.

Two articles (Carr, 1990; 1991) were of particular importance in developing this section. The articles identified certain new vehicle designs, construction, and components that would affect the rescuer's ability to perform vehicle extrication. The articles also outline certain extrication techniques that can be used in dealing with the new vehicle technology. This section will not elaborate on those techniques and the reader should refer to the two articles for more information. A complete bibliography is given at the end of this section.

5.3.1.1 Passenger Cars

A passenger car is a motor vehicle used primarily for carrying passengers. The vehicle types include convertibles, sedans, and station wagons. Passenger cars accounted for 71.5 percent (8,040,000) of all vehicle types involved in vehicle crashes in 1992. All vehicle types include passenger cars, light trucks, large trucks, motorcycles. buses, and other vehicle types (large limousine, motor homes, all-terrain vehicles, farm/construction vehicles). The breakdown by severity was 29,786 (0.4 percent) fatal crashes, 2,925,000 (36.4 percent) iniury crashes, and 5,085,000 (63.2 percent) property damage only crashes.

Passenger car crash safety has improved steadily since the early 1980s. The passenger car fatality rate in 1975 was 2.5 per 100 million vehicle miles traveled. and has dropped to a low of 1.5 in 1991, There also are fewer passenger cars on the road. The number of registered passenger cars dropped by about 500,000 between 1990 and 1991

In general, passenger car body structure has remained fairly consistent in its design. The passenger cars have now relied heavily on the unibody (monocoque) construction for several years. This construction is such that the body and chassis are one unit, and the strength is dependant upon the system as a whole. As quoted from the survey, one rescue company said: “The use of unibody construction seems to result in trapped occupants with relatively minor injuries, and more victims trapped by floor panels that have bent around the victims’ feet.” Another rescue company stated: “Extricating victims from vehicles is becoming harder with the way new cars are being built. Lightweight metal, stronger and better locking systems, no frames, small, etc.”

In smaller unibody vehicles that have been in a frontal crash, there is a tendency for the firewall. floorboard, dashboard, and components under it to intrude in toward the occupants. This intrusion may cause entrapment of the occupants upper and lower body. Energy-absorbing steering column and wheels help absorb the impact forces generated between the driver and steering system. Energy-absorbin g steering columns are attached under the dashboard by shear capsules and are attached at the firewall. As the driver moves forward during a crash, the energy is absorbed by deformation of the steering wheel rim and/or hub, and by collapse of the steering column. The column will shear off at the shear capsules and, by deformation in a bend bracket or collapse of the steering shaft. the remainder of the driver energy imparted to the steering system will be absorbed.

As discussed in the articles by Carr (1990; 1991), the extrication problem is with occupant entrapment by intrusion of the dashboard and not by the steering column. The technique identified that would deal with this type of entrapment is to use the dash-push technique. This technique involves the use of one or two hydraulic rams to quickly lift the dashboard off the victim.

The trend in the automotive industry is to enhance this unibody design through improved construction techniques, styling changes, and better aerodynamics. This has led to passenger cars with a more rounded geometry, smaller frontal area, and more shallow, sloped windshields. In an effort to increase the cabin space, the cab-forward body design has become a more popular choice among automobile manufacturers. Chrysler has made significant use of the cab-forward design in such models as the Chrysler Concorde, Dodge Intrepid, and Eagle Vision. The most obvious body change in a cab-forward design is the slope and curvature of the windshield.

The aerodynamic styling changes have affected the door opening area of newer vehicles. As mentioned by Carr (1991), the new door/roof designs have an impact on patient removal. The author notes that interior roof height and the door height can vary by several inches. It also describes a procedure to handle patient removal under such circumstances.

The technology of spaceframe construction has been used extensively by Saturn in the development of its automobiles. The spaceframe skeletal structure does not depend on any exterior surface panels for stiffness or strength. The body panels are attached to the spaceframe to provide an outer “skin” surface. A general spaceframe geometry is shown in Figure 5.3.1.1-1.

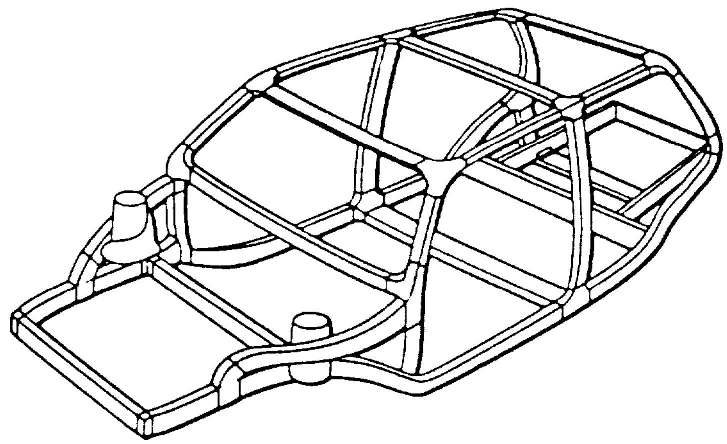


Figure 5.3.1.1-1. General Spaceframe Geometry (Winter, et al. 1990)

The use of glass also has increased significantly over the last several years. For example, the GM all-purpose vehicle (APV) minivan, which included the Trans Sport, Lumina, and Silhouette, has nearly 20 square feet of windshield glass. The automotive industry has developed anti-lacerative glass and heated windshield glass. New vehicle body designs and improvements in glass technology (e.g., solar-control glass) are driving the increased use of glass in automobiles. The increased use of glass results in narrower cross-sections at the A, B, and C pillars. In some vehicles, the windshield and rear window are bonded to the body using a urethane adhesive.

Federal safety regulations and consumer demands have prompted several changes in the design of new vehicles. The most significant is the Supplemental Restraint System (SRS) or Supplemental Inflatable Restraint (SIR) (i.e., an air bag). Driver-side SRSs began to appear in the late 1980s and early 1990s mostly in response to the Federal Motor Vehicle Safety Standard (FMVSS) 208, which requires occupant protection for the driver and passenger. The 208 standard and consumer popularity have made the SRS standard equipment on many vehicles. Passenger-side SRSs have followed the driver side and are now available on many vehicles. Incorporating a passenger-side SRS is more difficult than the driver side; however, the benefits are worth the effort. All passenger cars produced after September 1,1997 will be required to have both driver- and passenger-side SRSs and a manual lap/shoulder belt.

With an SRS-equipped vehicle come certain design changes. Located under the dashboard is a “cross-car beam,” which reacts to the force generated when the SRS is deployed. This beam stretches the entire width of the vehicle. Even with the SRS, the steering column system is still an energy absorbing one, as discussed earlier. The FMVSS 208 requirements state that in a frontal barrier crash, the occupants must meet survivable injury criteria when using just the passive restraint system (i.e., SRS). In order to meet the FMVSS 208 standard, it is necessary to install knee bolsters. Knee bolsters reinforce the lower portion of the instrument panel (IP) and, in some cases, add energy absorbing material to the back side of the panel.

SRSs traditionally have been inflated using a pyrotechnic material combustion. For the Chrysler LHS, New Yorker, and LH models, the passenger SRS inflator is a hybrid design. It combines the traditional pyrotechnic material combustion with the release of compressed gas to inflate the bag. With this system, the inflating gas is cooler and there is much less combustion-product residue. Current literature on SRSs does not mention any other manufacturers that use this technique.

Currently the pyrotechnic material used is sodium azide that is sealed in a strong metal container. Although the sodium azide in its solid state is toxic, there is virtually no chance that a rescue worker would ever contact the chemical. The chemical reaction during a SRS deployment produces hot nitrogen and carbon dioxide gas inside the bag and then cools very rapidly when vented to the passenger compartment. The inflator module that is inside the steering wheel and/or dashboard remains hot. The modules are relatively inaccessible and should pose no threat to rescue personnel. Also, other steering system components will not be hot.

The powdery residue from a deployed SRS consists largely of cornstarch or talcum powder and sodium compounds. This powder is used to prevent the bag from sticking to itself when it is folded inside the module. The sodium components may cause some skin or eye irritation, which can be treated by washing the affected area. SRS sensors are activated by significant frontal or near-frontal crashes only and inadvertent deployment is highly unlikely during normal extrication.

In cases where extrication is necessary and the SRS has not been deployed, the battery cables should be disconnected to ensure that there will be no deployment. As a precaution, however, rescue personnel should minimize the amount of time spent in front or near the SRS during extrication. One other note-if there is a fire in a SRS- equipped vehicle, the SRS systems are designed to self-deploy if internal temperatures reach approximately 300" F.

Because of the increased use of SRSs, automobile manufacturers are replacing the passive (i.e., automatic) torso belt and manual lap belt systems with the traditional three-point manual belt system. Along with this, some manufacturers (e.g., Chrysler, Eagle, and Mazda) are providing height-adjustable front shoulder belts for the driver and, in some cases, the passenger. This feature provides better fitting safety belts for various size occupants. The adjustable shoulder belt increases the amount of material and rigidity over a larger portion of the B-pillar. During extrication, it is important to note the location and amount of reinforced B-pillar when making a cut. There may be vehicles that have the shoulder belt anchor point located in the roof. Also, an increasing number of vehicles are equipped with a torso belt at the rear outboard seating position.

Another safety regulation driving new vehicle design is the FMVSS 214D, Dynamic Side Impact Protection. This is a crash test regulation designed to protect the occupants during a side or T-bone impact and all model year 1997 passenger cars must comply. In order to comply with this regulation, manufacturers are designing passenger cars with door intrusion beams at the front and real doors. Typically, these door intrusion beams are made of ultra-high-strength steel and run longitudinally from the door hinge area to the latch. The rear doors of the Chrysler LHS, New Yorker, and LH models have two-door intrusion beams-an upper and lower. These vehicles also include ultra-high-strength steel beams in the sills to distribute impact load. Some vehicle manufacturers have increased door thickness, adding door padding, and including energy-absorbing material in the door interior.

Child restraint regulations have been in place for many years in all 50 states. To improve safety, convenience, and increase the use of child restraints, manufacturers have developed built-in child restraints, Built-in child restraints have a fold-down seating surface and may contain a flip-up head restraint surface, which then exposes the safety belt harness that is attached to the vehicle structure or seat frame, The built-in child restraints restrain the toddler more like an older child or adult. This type of child restraint cannot be removed from the vehicle as is typical during extrication. Most likely, the seat belt webbing would have to be cut and the child removed using normal patient removal techniques.

Carr (1990; 199 I) discusses two other areas of vehicle design that may impede extrication, A new type of striker bolt, called the miniwedge, is difficult to work on because it is difficult to cut using a reciprocating saw. The cutting time is longer than a Nader bolt or U-bolt. The other potentially dangerous vehicle component is the nitrogen-filled cylinders installed on vehicles with hatchbacks. They also may be located under the hood. One danger is that the compressed gas may be flammable, Techniques have been outlined by Carr(Carr, 1991) to deal with the compressed-gas-filled cylinders.

Other new vehicle design and construction changes include bumper systems that are one-piece molded plastic backed by energy-absorbing honeycomb material. Some vehicle manufacturers have molded nylon fuel tanks. There also is an increased use of plastic components in automobile interiors. In order to reduce the amount of noise in the occupant compartment, some manufacturers are using a sound-absorbing headliner that is composed of recycled plastic bottles. In other cases, sound-deadening material is used in the A-pillars.

Automobile manufacturers have made an effort to increase the body stiffness on many of their vehicles, An increase in stiffness helps improve handing characteristics and reduce noise levels. The increase in stiffness has been achieved by using heavier gauge metal, extra gussets and reinforcements, extensive strengthening of body panel joints, tubular roof headers and rails, and bolt-on braces. In most cases, the increase in stiffness was done with little or no structural weight increase.

5.3.1.2 Light Trucks

Light trucks are trucks of 10,000 pounds gross vehicle weight (GVRW) rating or less, including pickups, vans (full-size and minivans), truck-based station wagons, and utility vehicles, Light trucks accounted for 23,4 percent (2,622,000) of all vehicle types involved in vehicle crashes in 1992 (1992 Motor Vehicle Crash Data from FARS and GES). All vehicle types include passenger cars, light trucks, large trucks, motorcycles, buses, and other vehicle types (large limousines, motor homes, all-terrain vehicles, farm/construction vehicles), The breakdown by severity was 14,626 (0.6 percent) fatal crash, 833,000 (3 1.7 percent) injury crash, and 1,775,000 (67,7 percent) property damage only crash.

The popularity of light trucks has increased steadily as indicated by the number of registered vehicles. In 1975 there were about 20.4 million registered light trucks and in 1991 there were 38.9 million, However, light truck safety has improved steadily according to the fatality rate, In 1980, the fatality rate was 2.6 per 100 million vehicle miles traveled; it has dropped to a low of 1,9 in 1991.

One of the more significant items that has affected light truck design and construction is the fact that there is an increase in the safety regulations that are applicable to light trucks. Because of the increase in their popularity, light trucks now are required to meet many of the same safety regulations that apply to passenger cars. As of September 1, 1991, light trucks with a gross vehicle weight rating of 8,500 pounds or less were required to comply with the FMVSS 208 30-mph barrier crash. As of the same date, light trucks with a GVWR of 10,000 pounds or less were required to have rear seat shoulder belts.

A phase-in program requires light trucks with a GVWR of 8,500 pounds or less to have automatic occupant protection. This will begin September 1, 1994, and by September 1, 1997, 100 percent of the light trucks will be required to have the automatic crash protection. Since the SRS satisfies the automatic crash protection requirements, manufacturers are avoiding the automatic torso belt installation. The SRS requirement for light trucks is that both driver and passenger positions will be required to have a SRS beginning on September 1, 1997. By this date 80 percent of light trucks must comply and after September 1, 1998, 100 percent of light trucks must comply.

Because of these regulations automobile manufacturers are equipping light trucks with SRS systems. As seen in passenger cars, the driver-side SRS has been installed first, but passenger-side SRS systems are being implemented, as in the Chrysler minivans. Along with that, Chrysler minivans also contain the height-adjustable front shoulder belts. The mechanics of the SRS systems in light trucks are the same as those of the passenger cars.

Another safety regulation that now applies to light trucks is the FMVSS 214 side impact protection. Beginning September 1, 1993, 90 percent of light trucks with a GVWR of 10,000 pounds or less were required to meet the static test requirements for side impact protection. After September 1, 1994, 100) percent of light trucks must meet the requirement. The dynamic test requirements for side impact protection that apply to passenger cars are under consideration for light trucks. This regulation has prompted door intrusion beams to be installed in many light trucks. The design of the door beams is similar to the passenger car design, which runs longitudinally from the door hinge area to the latch side and is typically constructed of ultra-high-strength steel.

As of September 1, 1991, all light trucks with a GVWR of 6,000 pounds or less must meet the FMVSS 216 roof crush resistance. This regulation, which has applied to passenger cars for many years, requires the roof and pillar structure to withstand a static load of 1.5 times the GVWR. Research is being conducted to develop a new standard to address the rollover propensity of light duty vehicles. The roof crush standard may lead to light truck designs with stiffer pillar and roof designs. This may be achieved through a redesign of the pillar cross-section or an increase in the metal gauge thickness.

Pickup truck body design, whether small or large, has not changed much over the years. However, following the trend of passenger cars, the body style is becoming more rounded and aerodynamic in order to decrease drag and comply with the ever increasing Corporate Average Fuel Economy (CAFE) standards. While overall body design will not change, the pickup cab will have improved fit between the door and body, and the windshield will take on a more shallow slope, which follows the trend of the passenger car cab-forward design.

Vans typically are thought of in terms of minivans and full-size vans. Minivans are smaller than full-size vans and have unibody construction. Full-size vans include large passenger and cargo vans, and typically have a body-on-frame construction. Minivans are manufactured by both American and Japanese automobile manufacturers, with the most popular minivan being the Chrysler product. The full-size vans are manufactured by Chrysler, Ford, and General Motors.

Body style of the minivans varies greatly among the manufacturers. The extremes can be seen by examining the GM APV, which has a long, sloping front end, and another GM product, the Astro/Safari, which has a shorter, boxed front end. The other minivans, including the Ford Aerostar (being replaced by the Windstar), Chrysler Caravan/Voyager, Mazda MPV, and the Mercury/Nissan Villager/Quest fall somewhere between these two body styles. In general, the minivan consists of standard driver and passenger doors, and a sliding door on the passenger (i.e., right) side of the vehicle. The exception to this is the Mazda MPV. which has a hinged door on the passenger side. Also, the rear door is either hinged at the roof or opens as cargo doors with hinges on the side. Most minivans have full glass around the vehicle; however. some may have sheet metal on both sides and only rear glass.

The full-size vans follow suit with the minivans in that they have hinged driver and passenger doors, and a passenger side sliding door. Also, full-size vans may have either full glass or sheet metal on the sides of the vehicle. Rear doors are of the cargo type that are hinged on the side. The body styles of full-size vans are fairly similar, but recently have become more rounded and aerodynamic.

Built-in child restraints were first introduced by Chrysler in the 1992 model year. Chrysler and GM offer the built-in child restraint in their minivans. Built-in child restraints provide the child with a seating surface and restraint system that is rigidly attached to the seating system structure and cannot be removed from the vehicle as with traditional child restraint seats.

The vehicle conversion industry is a large portion of the light truck market. Conversions are done on minivans, full-size vans, and pickup trucks. The Federal safety regulations that apply to light truck manufacturers also apply to the conversion vehicle industry. Because of this, the safety aspect and quality of conversions have increased over the last several years. Areas of conversion vehicle design and construction that are of interest in vehicle extrication include raised roofs, built-in child restraints, removable seats, and additional window glass.

Raised roofs are fabricated from fiberglass and increase the roof height by six to eight inches. Some conversion vehicles may have bucket seats with built-in child restraints. These typically would be located in the second seating position. Also, some conversion vehicles may have removable seats located at the second seating position. These seats can be removed at the pedestal attachment to the floor. Sometimes. conversion manufacturers install additional glass windows along the side of the vehicle.

Because of the increased popularity of light trucks, the body style, safety, and convenience items found in passenger cars are showing up in the light trucks. This is reinforced by the more aerodynamic body style, SRS systems, safety regulations, built-in child restraints, and others.

5.3.1.3 Special Topics

The California Air Resources Board (ARB) Issued a mandate in 1989 requiring that in the 1998 model year, at least 2 percent of an automobile manufacturers' sales in California be zero-emission vehicles (ZEV) if the automaker sells 35,000 or more cars and light trucks in the state. Because of this, much emphasis and investment have been placed in electric vehicle research and development. The mandate would affect the Big 3 and top four Japanese automakers, all seven of which are developing electric vehicle technology. Both Chrysler and Ford have electric test vehicles in the field and GM will deliver its electric test vehicle this spring. The mandate also has been adopted by New York and will soon go into effect in Massachusetts. There is potential for much of the northeastern U.S. to adopt the mandate.

The major questions that need to be answered during the next several years that the test vehicles are evaluated are whether electric vehicles are economical, cost effective, competitive with gasoline-powered vehicles, technologically ready, and whether the public will pay the price. The basic body design and construction are similar to passenger cars and light trucks; however, the electric vehicles use aluminum and plastic components to make the vehicles as light as possible. The GM vehicle is stated to be very stiff, yet light. Even if electric vehicles do not prove feasible, there may be new vehicle technologies that will spill over to gasoline-powered passenger cars and light trucks. Other smaller electric vehicle research activities also are being conducted throughout the U.S. that are not associated with the Big 3.

Another concept area for vehicles is the development of city cars, also known as low-mass vehicles. Many Japanese manufacturers are developing two-seat mini-vehicles that are electric, gasoline, or hybrid powered. City vehicles are very small and may weigh under 1000 pounds, while attaining normal vehicle speeds. At the 1993 Stapp Conference for automobile safety, however, a presentation on the crash safety of the mini-vehicles indicated that these small vehicles pose an occupant safety problem that must be addressed.

Another concept area to be mentioned is Isuzu’s XU-1 utility vehicle. This vehicle features guliwing front and rear doors. These hinge upward as opposed to the normal hinge location on the A- or B-pillars. If any of these concepts (electric vehicles, mini-vehicles, gullwinged doors) prove feasible, they will pose new challenges for extrication in the future.

5.3.2 Materials and Locations

This section will identify certain new vehicle material types and their commonly used locations in a motor vehicle. The locations discussed are related to those areas of the vehicle that most likely will affect vehicle extrication. The use of new materials in vehicles is driven by many factors that include reduced vehicle weight to meet the Corporate Average Fuel Economy (CAFE) requirements, lower cost, improved dent resistance, and corrosion resistance. Vehicle weight reduction has a cumulative effect. For example, if a lighter weight engine is developed (e.g., aluminum), this can translate into lighter weight suspensions, chassis, body panels, and other components. The use of new materials, especially plastics, is affected by its recyclability, surface, and paint quality and strength, among other things.

Currently, the materials used in the automobile structure and body panels are steel, plastic, and aluminum. There arc four general types of plastics used in vehicles today:

1) compression-molded sheet molding composite (SMC)
2) injection-molded thermosetting bulk molding compound (BMC)
3) reinforced-reaction injection molding (RRIM or RIM) urethane elastomers
4) injection-molded thermoplastics (IMTP)

Other materials such as magnesium, ceramic, and brass are used in vehicles, but they are not located in areas of the vehicle that affect extrication. Figure 5.3.2-1 shows a pie chart of automobile composition by material for 1973 and 1993.

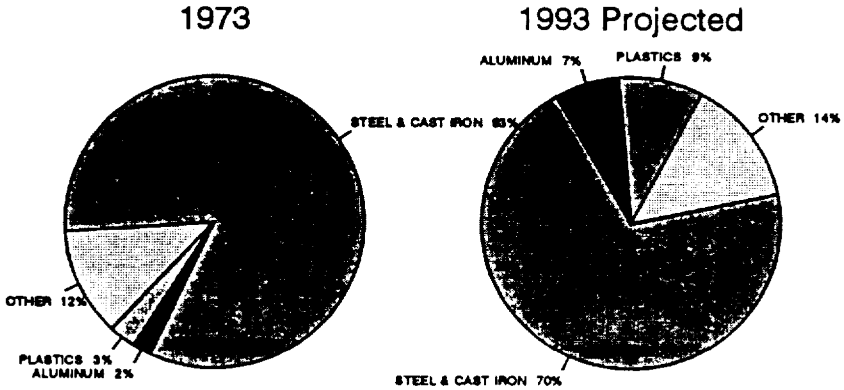


Figure 5.3.2-1 Automobile Composition by Material for 1973 and 1993. (Cornille 1993)

By far, the most commonly used material in automobiles is steel. The steel industry has reacted to strong competition from foreign steel makers and the plastics industry by developing better quality steel products for the automobile industry. Improved steel composition and manufacturing have led to steel body panels that are thinner yet maintain the required strength. Automobile manufacturers are employing a “holistic” body structure design. This technique will optimize weight and stiffness of the entire vehicle instead of part-by-part. Usin g this method, some steel is added to increase the vehicle’s stiffness; however, more steel can he removed from other areas. The advantage is a weight reduction and greater structural stiffness,

Steel is still inexpensive and easy to manufacture while allowing automobile manufacturers to reduce the weight of vehicles. It also has a high strength-to-weight ratio. Steel is a ductile material, which means that it can be deformed to a certain position and remain permanently deformed in that position. Other advantages to steel are its recyclability and its energy absorbing capability during a crash.

Some extrication problems in dealing with the lighter weight steel have been identified, through the survey, by several rescue companies. Some comments were: “Lighter materials that cars are now made of cause them to tear, rather than “POP” apart;” “The lighter weight sheet metals tear much easier, sometimes lengthening extrication time:” and “Sheet metal tears very easily...” Carr (1991) states that when working with door skins that art’ thinner and more likely to tear, “the trick is to avoid tearing the skin by working the tips of your tool into the inner surface of the door and ‘B’ post and then forcing the whole door open.” The advantage to rescue personnel is the experience in dealing with steel body structure.

Although steel is still the material of choice, it is slowly yielding to other materials such as plastic. In general, plastic materials have low ductility and are brittle (i.e., they break instead of stretch). Of the plastic materials, the SMC has the widest range of application and has been used in the Corvette body panels for many years. SMC is a glass fiber reinforced thermosetting polyester/styrene resin. Some of its advantages include:

1) compatibility with steel assembly and painting processes;
2) a coefficient of thermal expansion similar to steel;
3) will not warp or creep;
4) can hold tigh; tolerances;
5) its surface quality is equivalent to steel;
6) its styling flexibility; and
7) it will not dent.

With these advantages and improvements in materials, processing, and equipment, the benefits of SMC are overriding the cost disadvantages. Because of this, there may be cases where a body panel such as the door may be manufactured with a combination of steel and SMC. Also, a flexible SMC has been developed to improve the dent resistance of vertical body panels.

The other major material in plastic body panels that is competing with steel is RIM. RIM material is a low-density reinforced polyurethane that is different yet has qualities similar to the SMC. Areas of vehicles where traditional steel body panels are being replaced with plastic composites are the fender, door, hood, deck lid (trunk lid), liftgate, and roof. However, even with all the advantages that SMC, RIM, and IMTP offer in the area of automotive body panels, they have not replaced the traditional materials as rapidly as expected. Economical high strength steels, computer-controlled fuel injection, low-rolling-resistance tires. and better aerodynamics have been enough to meet the CAFE requirements. However. a strong push in the development and marketing of these materials has continued.

Some problems in dealing with the new plastic body panels have been identified through the survey, and are demonstrated in the following comments: “Plastic composite vehicles are hard to work on”; “All the plastic on new vehicles makes it hard to get a good ‘bite’ to move interior components”; “...the composite materials in some newer vehicles is unpredictable.” Other rescue companies have mentioned difficulty in working with “fiberglass vehicles” and that a roof flap on a composite vehicle breaks instead of flaps.

Aluminum is another material that has been used in automotive body panels, primarily for hoods and deck lids. Aluminum can significantly reduce the weight of a traditional steel body panel, but it is, however, more expensive. Its advantage is that it has a high scrap value. Recently, aluminum has been used in conjunction with plastic and magnesium to develop new automotive body panels and door frames. An aluminum/plastic/aluminum sandwich material has been developed that may be most appropriate for the hood, roof, and deck lid. Another recent development is the design of a magnesium/aluminum door frame. The door frame could facilitate an aluminum, steel or SMC outer door panel.

Because the vast majority of automobile bodies are steel they are designed for welding, with joints that suit welding operations. However, adhesives are likely to play a larger role in cars as automakers turn to steel alternatives. The plastics, composites, and aluminum require adhesives because they are not amenable to welding. Other design changes also call for adhesives, as in bonding front and rear glass directly to the car body so that the glass becomes part of the load-bearing structure, and improving vehicle aerodynamics.

5.3.2.1 Passenger Cars

Steel continuea to be the material of choice used for passenger car structure and body panels. Steel continues to be the leader in terms of percentage of the automobile weight and in the number of steel components that are used. However, in some passenger cars the extensive use of plastic exterior body panels can be seen.

Many passenger cars use plastic materials such as SMC in the grille opening panel, rear taillight, bumpers, and spoilers. However, several automobile manufacturers have made more extensive use of the plastics. Some of the more notable passenger cars that contain a large amount of plastic body panels include the Chevrolet Camaro and Corvette, Pontiac Firebird, and the Saturn passenger cars. Impact of plastic body panels is reflected in the following comment from a survey participant: “The vehicle had a plastic body and splintered when the hydraulic rescue tool was used.”

Aluminum is making a smaller impact on passenger cars than the plastic materials. Honda has introduced the NSX with an aluminum body and parts of the chassis. However, this is a very low volume car with U.S. sales in 1991 of 1,940, and in 1992, the number was just 1,154. Audi has a limited-edition sedan for the 1994 model year that has a production run of under 10,000 units. The Audi was designed with extruded aluminum tubes to form the space frame. Ford currently is examining a small fleet of aluminum Taurus; sedans and Chrysler has an unspecified number of its 1994 Neon subcompacts rendered in aluminum.

5.3.2.2 Light Trucks

Although plastics have been introduced into light trucks, they have not reached the level of use of passenger cars. The one exception is the GM all-purpose vehicles (APV) Trans Sport, Lumina, and Silhouette. This vehicle contains all plastic (SMC and RIM) body panels on a steel spaceframe. Even the fuel tank is a high-density polyethylene. Much of the spaceframe and the composite body panels are held together using adhesives. Figure 5.3.3.2-1 shows the GM APV body design and the materials used.

Rescue personnel have commented directly about extrication on the GM APVs. One survey participant stated: “The new vans with the plastic and fiberglass have given us some problems with the use of hydraulic spreaders. We found the best way to extricate victims in this type of vehicle is to cut the vehicle away from the victim.”

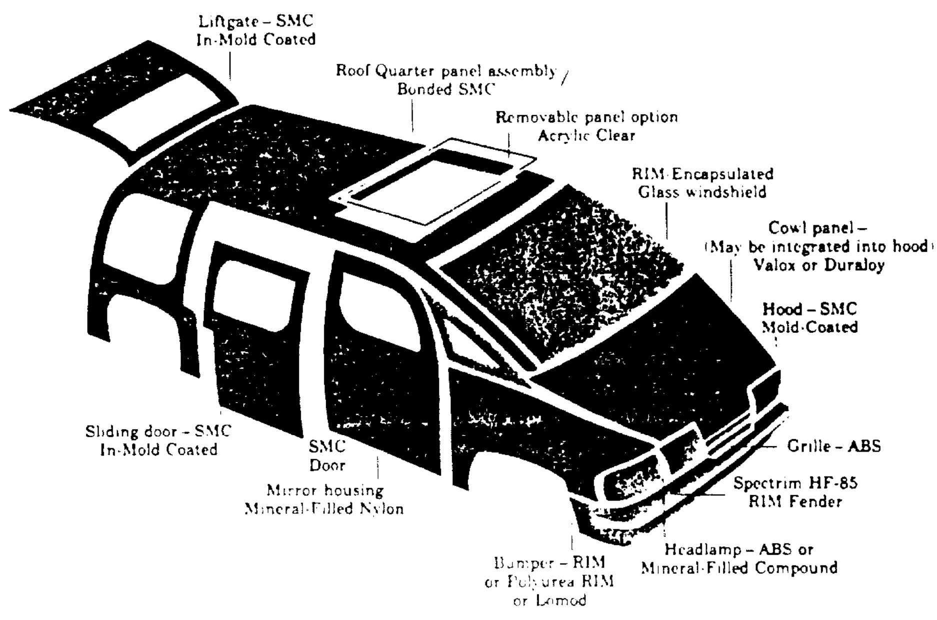


Figure 5.3.2.2-l GM APV Plastic Body Construction (McElroy 1988).

Other light trucks that have plastic body panels include the Dodge Ram Charger (liftgate); Jeep (liftgate and roof assembly); Ford Aerostar (liftgate, cargo door and hood), Ford Bronco (roof), Ford Econoline (hood), and Ford Ranger (pickup box).

Plastic body panels in areas such as doors, roofs, liftgates, and hoods may affect vehicle extrication operations.

5.3.2.3 Special Topics

There may be other advanced material designs that will be used in future vehicle production GM has done research in developing a Kevlar/epoxy and graphite/epoxy composite space frame.

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fhdationsent

6.1 Overview

The purpose of this project was to identify new technologies or enhancement\ that could increase the safety and efficiency of vehicle extrication equipment, particularly with regard to new vehicle design. Particular attention was paid to vehicle design with respect to extrication in Section 5.0, but discussion of the operator-equipment interface thus far has been limited. To identify design requirements of the operator-equipment interface, performance demands unique to fire/rescue operations must be considered.

Many of the tools relied on daily to perform extrication were not expressly designed for fire/rescue operations. Rather, some tools adopted for vehicle extrication originally were designed for general mechanical purposes, construction or auto-body collision work. Fire/rescue requirements for tool design are determined, in part, by work conditions that influence operator performance. For example, the need to wear personal protective clothing and equipment serves to degrade gross and fire motor skills (e.g., heavy work gloves are worn). Visual and auditory performance also may degrade white wearing personal protective equipment. Further, environmental conditions, such as extreme ambient temperatures, low ambient tight environment, affect operator performance. Last, but no less important, the need for rapid response under high stress situations poses design requirements unique to fire/rescue operations. Tools used for vehicle extrication, whether expressly designed for fire/rescue use or not, should be able to meet the performance demands of the firc/rescue operation. In the following section, both vehicle and operator interface with extrication equipment are included in the identification of tool performance problems and design recommendations.

6.2 New Technologies/Enhancement of Vehicle Extrication Equipment

This section attempts to integrate information gained through this project via literature searches, on-site extrication observations, the extrication survey and vehicle design interface assessment, to provide recommendations for enhancing vehicle extrication equipment. Recommendations offered by extrication equipment users who were not included in the survey analysis also are provided, along with the recommendations of contractor personnel.

Each of the six tool types is addressed in a separate section. For cacti tool type, problems regarding tool safety, inefficiency, storage, and portability arc identified and design modification are suggested to address the problems.

A problem encounter-cd in addressing the tool performance comments from the extrication survey was that many comments were made about a general tool category rather than a specific tool (e.g., a comment addressing manually powered tools rather than specifying which type such as a jack). In some cases, it was possible to infer what tool actually was appropriate for the comment and in other instances, an attempt was made to address the comment in a general way.

The recommendations presented in the following section may not be practical or feasible to implement. Trade-offs, such as increased costs for design improvements, have to be investigated. In some cases general recommendation were made since specific solutions to problems are unknown. Further investigation, prototyping, etc., are required to identify and develop optimal design solution.

6.2.1 H

6.2.1.1

Hand Tools (e.g., basic mechanics' tools, bolt cutters, come-alongs)

6.2.1.2 Performance Inefficiencies and Design Recommendations

Problems	Recommendations
Slow/time consuming	*
Heavy	Develop lighter weight design Use lightweight materials (stronger alloys) Use rubber, plastic, fiberglass handles
Tool failure	Use stronger alloys (lightweight) Improve tool design
Requires more effort/manpower	Longer handles for increased leverage *
Light work	*
Limited uses	Design multipurpose tools
Insufficient handle lengths	Increase handle lengths Design handle extensions
Improve handles	Design better handle grips/nonstick grips Use rubber, plastic, fiberglass handles
Easy to misplace	Use retro-reflective (luminous) tape Color code equipment into like categories
Bolt cutters - ineffective in tight areas	Need to identify/design cutting tool effective in tight areas
Bolt cutters -jaws soft	Provide better cutting edge USC stronger alloys (lightweight)
Come-along - too heavy	Use lightweight materials (stronger alloys) Develop lighter weight design
Come-along - hard to deploy	Improve come-along switching mechanism
Hand hacksaws inefficient	Design hacksaw with 2 blades placed in hasp in opposite directions so that each forward/backward movement facilitates a cut
Rachet wrenches lengthy setup	Use preprepared rachet wrenches with sockets and attachments to remove door hinges

*Performance limitations due to the fact that hand tools are powered by operator.

Hand Tools (e.g., basic mechanics' tools, bolt cutters, come-alongs)

6.2.1.3 Storage and Design Recommendations

Problems	Recommendations
Inadequate	Add more storage space Enlarge compartments Supply mounting clips with tools Design overhead doors with mounts Lockable storage
Inaccessible	Lower compartments More compartmentalized Pull-out drawers Custom-designed compartments

6.2.1.4 Portability and Design Recommendations

Problems	Recommendations
Heavy	Develop lighter weight design Use stronger alloys (lightweight)
Cumbersome	Use roll-up/soft-sided tool box

6.2.2 Manually Powered Tools (e.g., various ram-type tools, portapower equipment, jacks)

6.2.2.1 Safety Concerns and Design Recommendations

Problems	Recommendations
Tool stability	Design larger base for jack
Tool slippage	Design ground pad for lift tools Design ram support bracket Design larger serrated teeth
Tool failure	Design more reliable tool
Slow/time consuming	More powerful design Provide 2-stage hand pump
Lengthy setup	Fewer connections Use quick-connects Color code connectors User retro-reflective (luminous) tape
Flying debris	Use personal protective gear Shield victim
Pinch points	Develop safer design Use personal protective gear Provide guard/protection
Caustic fluid	Change fluid type
Pressure buildup	Provide safety valve
Seal/hose rupture	Use high pressure hoses Improve seal design/material
Safe placement of tool for vehicle stabilization	Design positioning device (e.g., long pole) for jack so operator remains at a safe distance from vehicle Design quick setup shoring type device (for vehicles on side)
Using two or more ram extensions produces unstable force on vehicle	Design more stable connection of ram extensions

Manually Powered Tools (e.g.,various ram-type tools, portapower equipment, jacks)

6.2.2.2 Performance Inefficiencies and Design Recommendations

Problems	Recommendations
Heavy	Lighter Design Use lighter weight material (stronger alloys) Use machined/forged parts. not cast
Cumbersome	Develop smaller/more compact design Design one-piece rabbit tool
Hard to operate	Design portapower that is simpler to use Provide longer handle on pump Provide larger switching mechanism for jack Make it easier to change from one tool to another (spreader to ram)
Excessive effort/ manpower requirement	Provide longer handle on pump, greater leverage Provide 2-stage hand pump Simplify design Design one-piece I rabbit tool
Slow/time consuming	More powerful design Provide 2-stage hand pump
Limited uses	Design multiuse tools/attachments Provide assortment of heads for jack
Limited power	More powerful design
Portapower - hard to deploy	Design portapower with quicker setup Color code portapower components Provide quick-connect for extensions
Portapowrr - high maintenance requirement	Design portapower with low maintenance requirement Lessen fluid leaks when changing attachments
Portapower - low capability)	Design more powerful portapower Increase lifting distances Provide greater stroke spreader
Jacks - hard to deploy	Design jacks with quicker setup requirement Color code components Simplify design
Spreader - limited stroke	Greater stroke spreader
Unable to hook chain to jack	Add shackle and hook to lifting step on jack
Power unit - unstable	Mount pump to board

Manually Powered Tools (e.g., various ram type tools, portapower equipment, jacks)

6.2.2.3 Storage and Design Recommendations

Problems	Recommendations
Inadequate	Add more storage space Enlarge storage compartments
Inaccessible	Lower compartments More compartmentalized Slide-out drawers/trays Custom-designed compartments

6.2.2.4 Portability and Design Recommendations

Problems	Recommendations
Heavy	Develop lighter weight design Use lighter weight materials (stronger alloys)
Cumbersome	Develop smaller/more compact design Provide wheels on equipment Provide better handles on jack

6.2.3 Cutting Tools (e.g., reciprocating saws, abrasive saws, oxyacetylene torches)

6.2.3.1 Safety Concerns and Design Recommendations

Problems	Recommendations
Tool weight	Develop lighter weight design Use lighter weight materials (stronger alloys)
Slow/time consuming	Design laser cutting tool
Sparks/ignition potential	Design spark guards Use personal protective gear Shield victim *
High heat/hot metal	Provide cooling system
Creates sharp edges	Cover sharp edges
Lack of initial response tool	Design light-duty, initial response cutting tool
Saw - tool control	Design for better balance
Saw - tool slippage	Design non-slip/gripping tool surface Design better handle grips
Saw - confined work area	Reduce exhaust fumes
Saw - exhaust fumes	Use Alternate power source/no gasoline
Saw - noise	Develop quieter design Separate power unit (keep at a distance) Use alternate power source/no gasoline Design laser cutting tool *
Saw - Vibration	Design for antivibration handle\ *
Saw - moving parts	Use better blade guards Use protection from moving parts Use personal protective gear Shield victim
Saw - flying debris	Design guards/shields Use personal protective gear Shield victim
Saw - chain/blade failure	Use stronger blades
San - binding	Use stronger blade Provide adjustable blade/depth of cut
Saw - kickback potential	*

*Inherent in tool type

Cutting Tools (e.g., reciprocating saws, abrasive saws, oxyacetylene torches)

6.2.3.2 Performance Inefficiencies and Design Recommendations

Problems	Recommendations
Heavy/cumbersome	Use stronger alloy (lighter weight) Develop lighter weight saw design
Time consuming	Develop more powerful design
Require support equipment	*
Hard to use controls	Design controls for ease of use Design whole hand/glove operable controls Design larger handle and trigger for reciprocating saw
Saw - ineffective in tight areas	Design smaller saws Use small wizzer saw
Saw - loud/noisy	Develop quieter design Separate power unit (keep at a distance)
Saw - starting difficulties	Provide larger foot area for starting Provide better starting mechanism Provide electronic hi-voltage ignition
Saw - runs poorly	Do not use Z-cycle engines
Saw - blade wear	Provide longer wearing blade Design Teflon™ coated blade Develop permanently lubricated reciprocating saw blades Provide self-lubrication system for blades
Saw - blade change time-consuming	Develop quick change blade system (no allen wrench required)
Saw - excessive blade changes	Provide longer wearing blade Provide stronger blades
Saw - power source required for electric saws	Develop battery-powered reciprocating saw and wizzer saw with effective power and operating time range Design pneumatic reciprocating saw with increased number of stokes and stroke length equal to electric units
Saw -excessive maintenance	Develop low maintenance design
Reciprocating saw - enhance efficiency	Develop longer reciprocating saw blades
Torch - hard to use	Design built-in ignitor Use reel for hose Design smaller torch

*Inherent in tool type

Cutting Tools (e.g., reciprocating saws, abrasive saws. oxyacetylene torches)

6.2.3.3 Storage and Design Recommendations

Problems	Recommendations
Inadequate	Add more storage space Enlarge compartments Supply mounting clips with tools Design overhead doors with mounts Lockable storage Square carrying casts Smaller bottles for torch Use mounting clips
Inaccessible	Lower compartments More compartmentalized Slide-out drawers/trays Custom-designed compartments

6.2.3.4 Portability and Design Recommendations

Problems	Recommendations
Heavy	Use lighter weight materials (stronger alloy) Use lighter weight storage box
Cumbersome	Use carrying straps Provide hands-free carrying of saw Provide smaller bottles for torch Mount power plant with reel Put wheels on power plant

6.2.4 Pneumatic Tools (e.g., chisels, airbags, airshores)

6.2.4.1 Safety Concerns and Design Recommendations

Problems	Recommendations
Tool failure	Design for reliability
Hose failure	Use high-pressure hoses
Air bag - heavy/cumbersome	Design lighter weight air bag
Air bag - stabilization	Develop squared, not rounded design, for uniform lift
Air bag - slippage	Use better gripping surface/material
Air bag - extreme force	*
Air bag - pressure in hoses	Use high-pressure hoses Use hose with safety valve
Air bag - proper pressure	Develop better controls Use safety shut-off valves
Air bag - puncture/damage	Design more damage-resistant air bag Place wood or some other material between bag and object
Air bag - age	Design more damage-resistant air bag Design longer lasting bag/material
Air chisel - loud/noisy	Develop quieter design (muffle exhaust air)
Air chisel - sparks	Use non-spark bits
Air chisel - sharp edges	Cover sharp edges Use personal protective gear Shield victim
Air chisel - flying debris	Use personal protective gear Shield victim
Air chisel - loss of tip/fly off	Design better bit retainer Replace spring with screw Use personal protective gear Shield victim
Air chisel - bit shatters during use	Design stronger chisel bit
Air chisel - cylinder transport safety	Use sling to carry air bottle Use backpack to carry air bottle Design manifold for 2 SCBA tanks

*Inherent in vehicle extrication

Pneumatic Tools (e.g., chisels, airbags, airshores)

6.2.4.2 Performance Inefficiencies and Design Recommendations

Problems	Recommendations
Heavy	Develop lighter weight design
Cumbersome	Develop more compact design
Excessive maintenance	Develop low maintenance design
Lengthy setup time	Provide preconnected hose reel Color code hose\ Establish standard size air fittings Use retro-reflective (luminous) material on air bag hoses for ease of identification in low-light conditions Provide reel-mounted air supply, with multiple outlets (manifold system)
Inefficient air supply	Use engine and compressor instead of SCUBA bottles
Air bag - slow/time consuming	Use valve/remain inflated without hose Design air bag that inflates faster Provide more efficient air source Provide higher lift
Air bag - heavy	Develop lighter weight design
Air bag - capability)	Mark air bag with center height Rate for maximum effective lift Explore use of hydraulic fluid/water as lifting medium instead of air
Air hag - disassembly	Provide electric rewind reel for hoses
Airbag controls difficult to use	Design larger. back-lit air bag control switches
Air bag - requires support equipment	* Inherent in tool type
Air chise1 - slow/time consuming	Design faster working air chisel Provide more efficient air source Provide continuous air source from vehicle
Air chisel - weak	Design more powerful air chisel Provide more efficient/powerful air source
Air chisel - frequent breakdown/undependable	Develop more reliable design
Air chisel - hard to use	Design better trigger mechanism
Air chisel - limited uses	Design more hit varieties

Pneumatic Tools (e.g., chisels, airbags, airshores)

6.2.4.2 Performance lnefficiencies and Design Recommendations (continued)

Problems	Recommendations
Air chisel - limited air supply	Provide continuous air source from vehicle Design manifold with dual air bottle
Air chisel - ineffective on some vehicle components	Design more powerful air chisel Design more bit varieties
Air impact wrenches - lengthy setup	Use air impact wrenches with prepared sockets, with extensions for door removal, etc.
Spreader/cutter - underpowered	Design more powerful spreader/cutter
Spreader/cutter - wasteful of air	Design more efficient spreader/cutter Provide continuous air source from vehicle

*Inherent in tool type

6.2.4.3 Storage and Design Recommendations

Problems	Recommendations
Inadequate	Add more storage space Enlarge storage compartments Recess valves into corner on air bag Provide storage bag for hoses
Inaccessible	Lower compartments Custom-designed compartments More compartmentalized Pull-out drawers/trays

6.2.4.4 Portability and Design Recommendations

Problems	Recommendations
Heavy	Develop lighter weight design Use composite bottles for air chisel
Cumbersome	Provide handles/package for airbag Provide dolly for airbag Provide reel-mounted air supply with multiple outlets (manifold system)

6.2.5 Hydraulic Tools (e.g., spreaders, pullers, cutters)

6.2.5.1 Safety Concerns and Design Recommendations

Problems	Recommendations
Tool slippage	Enlarge bases Design better gripping surfaces
Tool limits	Develop more powerful design Increase throat depth on combination tool
Tool weight	Develop lighter weight design Use lighter materials (stronger alloys)
Tool balance/stability	Develop better balanced/stable design Provide pads to distribute load
Loud/noisy	Develop quieter design Use alternate power source
Flying debris	Use personal protective gear Shield victim
Pinch points	Shield pinch points/provide guard Use personal protective gear Shield victim
Creates sharp edges	Cover sharp edges Use personal protective gear Shield victim
Causes metal to buckle	Use larger tips on spreaders *
Extreme force	*
Kickback potential	**
Gas-powered/ignition potential	Use alternate power source
Caustic fluid	Change fluid type
Hose failure	Provide stronger hoses
Cutter can rotate, trapping operator's hand against control valve and hard objects	Design cutter for better balance/control with improved operator safety features

*Inherent in vehicle extrication

Hydraulic Tools (e.g., spreaders, pullers, cutters)

6.2.5.2 Performance Inefficiencies and Design Recommendations

Problems	Recommendations
Tool slippage	Design ram support bracket Design larger, serrated teeth Design better gripping tips on ram Design better gripping/nonslip spreader tips
Tool limits	Improve spreader prying tips Increase spreader stroke Increase cutter throat Add manifold to operate more than one tool at a time
Heavy	Develop lighter weight design Use lighter materials (stronger alloys) Develop smaller unit design
Cumbersome	Develop smaller unit design Design multiuse tools Develop collapsible/expandable design
Unbalanced	Design power unit adaptable to inclines Develop better balanced design Develop ram rails that can be attached quickly to kick panels where there is no B-pillar to secure ram against
Hard to use	Design easy to use controls Design whole hand/glove operable controls Increase flexibility of hose couplings at tool heads Design larger trigger switches and easier grip handles Provide bright retro-reflective (luminous), simple control switches
Slow	Increase flow rate
Excessive effort/manpower	Develop lighter weight design
Lengthy/difficult setup	Design quicker/easier hose connection Color-coded connector/supply lines Add etched markings Use retro-reflective (luminous) tape
Lengthy disassembly	Use electric rewind reel
Loud/Noisy	Develop quieter design Use alternate power source
Ineffective in tight areas	Provide smaller design Develop collapsible/expandable design

Hydraulic Tools (e.g., spreaders, pullers, cutters)

6.2.5.2 Performance Inefficiencies and Design Recommendations (continued)

Problems	Recommendations
Starting difficulties	Improve starter Provide electric stxt Develop push-start motors (i.e.. push-button)
Diminished power while in use	Provide more powerful engine
2-stroke engines ineffective	Use 4-cycle engine
Easily jammed by sand	Design better protection of working mechanisms
Pressure buildup in hose	Use stronger hoses Provide pressure relief system
Inadequate durability ot supply lines	Provide more durable supply lines
Frequent breakdown - too fragile	Design stronger spreader arms Design stronger cutter blades

Hydraulic Tools (e.g., spreaders, pullers, cutters)

6.253 Storage and Design Recommendations

Problems	Recommendations
Inadequate	Add more storage space Enlarge compartments Mounting brackets Supply brackets with equipment Design better gas/hydraulic fluid storage Provide bracket/unit for ram placement Mount reels to power unit Provide rubber hose on case bottoms
Inaccessible	Lower compartments More compartmentalized Slide-out drawers/trays Custom-designed compartments

6.2.5.4 Portability and Design Recommendations

Problems	Recommendations
Heavy	Use better alloys/lighter weight Develop lighter weight design
Cumbersome	Hard mount power unit with reel Provide dolly/wheels on power unit Store power unit on slide-out tray Provide longer hoses Provide handles on power unit Provide breakaway shoulder strap

6.2.6 Miscellaneous Other Tools (e.g., webbing, cribbing, rope, pike poles)

6.2.6.1 Safety Concerns and Design Recommendations

Problems	Recommendations
Tool failure	Use heavier chain/cable/webbing Use greater capacity winch Use stronger cribbing
Tool slippage	Design no-slip cribbing
Tool stability	Design more stable cribbing
Chain breakage	Use heavier chain
Cable failure	Use heavier cable
Winch capacity	Design greater capacity winch
Splintering of cribbing	Design stronger cribbing Use alternate material Use hardwood cribbing
Glass splinters in webbing	Design webbing with resistant surface (e.g., plastic coated) Use alternate material

6.2.6.2 Performance Inefficiencies and Design Recommendations

Problems	Recommendations
Tool slippage	Design nonslip cribbing
Tool failure	Use heavier cable
Heavy	Use pulling ring Use rope handle\ for cribbing
Cumbersome	USC short pike pole
Slow	Design multiuse tools Color coded -ropes
More effort/manpower	Design lighter weight cribbing
Cribbing - lengthy setup	Use prepared box of cribbing at 1 and 2 ft heights Use prepared box of cribbing at 3 x 3 ft for heavy vehicles

Miscellaneous Other Tools (e.g., webbing, cribbing, rope, pike poles)

6.2.6.3 Storage and Design Recommendations

Problems	Recommendations
Inadequate	Add more storage space Enlarge compartments Mounting brackets Supply mounting clips with equipment Provide more/better cribbing storage Use crates/trailer for cribbing Use rope bags
Inaccessible	Lower compartments More compartmentalized Slide-out drawers/trays Custom-designed compartments

6.2.6.4 Portability and Design Recommendations

Problems	Recommendations
Heavy	Design lighter weight cribbing Use alternate material
Cumbersome	Use rope bag Provide better means to transport cribbing

APPENDIX A

Mailing Date

Dear Survey Participant:

This survey is being conducted for the Federal Emergency Management Agency (FEMA)/United States Fire Administration (USFA). The purpose of the survey is to evaluate currently used vehicle extrication equipment. If you are experienced in the operation of vehicle extrication equipment, we ask you to complete the survey. If you are not experienced in vehicle extrication equipment operation, please indicate this at the bottom of the page and return the blank survey to us.

The goal of this research program is to identify new technologies or enhancements to vehicle extrication equipment that will improve the safety and efficiency of vehicle extrication. Your participation in the survey is very valuable to the American fire and emergency services community and those they serve. Your comments will be included in the evaluation and will impact the design of future vehicle extrication equipment.

The survey consists of nine pages. Page 1 asks you to list the extrication equipment your agency currently has in service according to six categories of tools. The next six pages (pg. 2-7) ask you questions about the operation of the tools in each of the six categories (i.e., the same questions are repeated for each one of the tool categories). Page 8 asks more general questions about your agency and the extrication operations your agency conducts. We request that you include your name and telephone number on page 8 so that we may contact you in the case we need to clarify anything on the survey. The last page (pg.9) is provided for any additional comments or diagrams you may wish to include in your response to the survey.

If you have any questions regarding the survey, please contact ***********************. Please return the survey to the above address, to the attention of * ** * * * * , Thank you in advance for your participation in the survey.

_____ I am not experienced in extrication equipment operation and I am returning the survey.

Mailing Date

Dear Survey Participant:

This survey is being conducted for the Federal Emergency Management Agency (FEMA)United States Fire Administration (USFA). The purpose of the survey is to evaluate currently used vehicle extrication equipment. Because of your experience and expertise in the operation of vehicle extrication equipment, we are asking you to complete the survey.

The goal of this research program is to identify new technologies or enhancements to vehicle extrication equipment that will improve the safety and efficiency of vehicle extrication. Your participation in the survey is very valuable to the American fire and emergency services community and those they serve. Your comments will be included in the evaluation and will impact the design of future vehicle extrication equipment.

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If you have any questions regarding the survey, please contact ***********************. Please return the survey to the above address, to the attention * * * * * ** * . Thank you in advance for your participation in the survey.

1	**Extrication Equipment Currently in Service-** Please list equipment (including brand names and models) currently in service in your agency :
A	**Hand Tools -** examples include basic mechanic's tools, bolt cutters, come-alongs, etc.
B	**Manually Powered Rescue Tools -** examples include various ram-type tools, portapower equipment jacks
C	**Cutting Tools -** examples include reciprocating saws, abrasive saws (K12 type), oxyacetylene torches
D	**Pneumatic Rescue Tools -** examples include chisels, airbags, airshores, etc.
E	**Hydraulic Rescue Tools -** examples include spreaders/pullers, cutters
F	**Miscellaneous other rescue "tools" -** examples include webbing, cribbing, rope, pike poles, etc.

Please answer questions 2-9 for each piece of equipment noted in response to Question I (A)
HAND TOOLS *examples include basic mechanic's tools, bolt cutters, come-alongs, etc.*

2A **Agency Satisfaction with its Current Equipment** - Circle the item that best describes your level of satisfaction/dissatisfaction with all aspects of your extrication equipment. Please comment:

(a) Very satisfied
(b) Somewhat satisfied
(c) Somewhat dissatisfied
(d) Very dissatisfied

3A **Ease of Operation/Effectiveness** - Please list your views regarding your equipment's operating characteristics and effectiveness when employed.

4A **Storage** - Are the vehicle's storage compartment adequate and is equipment safely stored? Is storage location easily accessible? Describe improvements that could be made.

5A **Portability** - How is equipment secured to the vehicle:

(a) Hard-mounted (non-removable)
(b) Partially hard-mounted
(c) Remote unit on wheels
(d) Remote unit/hand carried
(e) Other__________

Number of people required to carry equipment:____ Operate it: ____

Describe any improvements in portability that could be made:

6A **Safety Aspects** - Are there concerns/areas of potential concern with respect to rescues or victim safety while this equipment is in operation?

7A **Safety Equipment** - Please circle the type(s) of personal protective equipment that is:

Available for your use:		Used by you:		Required to be used:	
(a) Ear	(e) Head	(a) Ear	(e) Head	(a) Ear	(e) Head
(b) Eye	(f) Foot	(b) Eye	(f) Foot	(b) Eye	(f) Foot
(c) Hand	(g) Other(s)____	(c) Hand	(g) Other(s)____	(c) Hand	(g) Other(s)____
(d) Body	________	(d) Body	________	(d) Body	________

8A **Areas for Improvement** - Are there aspects of this equipment that could be different to make it more "user friendly"?

9A **Modifications** - Have you or your agency modified existing commercially available equipment to better suit your needs? If so, what was the modification?

Please answer questions 2-9 for each piece of equipment noted in response to Question 2(B) ***MANUALLY POWERED RESCUE TOOLS*** *examples include various ram-type tools, portapower equipment jacks*

2B **Agency Satisfaction with its Current Equipment** - Circle the item that best describes your level of satisfaction/dissatisfaction with all aspects of your extrication equipment. Please comment:

(a) Very satisfied
(b) Somewhat satisfied
(c) Somewhat dissatisfied
(d) Very dissatisfied

3B **Ease of Operation/Effectiveness** - Please list your views regarding your equipment's operating characteristics and effectiveness when employed.

4B **Storage** - Are the vehicle's storage compartment adequate and is equipment safely stored? Is storage location easily accessible? Describe improvements that could be made.

5B **Portability** - How is equipment secured to the vehicle:

(a) Hard-mounted (non-removable)
(b) Partially hard-mounted
(c) Remote unit on wheels
(d) Remote unit/hand carried
(e) Other ________

Number of people required to carry equipment: _____ Operate it: _____

Describe any improvements in portability that could be made:

6B **Safety Aspects** - Are there concerns/areas of potential concern with respect to rescues or victim safety while this equipment is in operation?

7B **Safety Equipment** - Please circle the type(s) of personal protective equipment that is:

Available for your use:		Used by you:		Required to be used:	
(a) Ear	(e) Head	(a) Ear	(e) Head	(a) Ear	(e) Head
(b) Eye	(f) Foot	(b) Eye	(f) Foot	(b) Eye	(f) Foot
(c) Hand	(6) Other(s)_____	(c) Hand	(g) Other(s) _____	(c) Hand	(6) Other(s) _____
(d) Body	________	(d) Body	________	(d) Body	________

8B **Areas for Improvement** - Are there aspects of this equipment that could be different to make it more "user friendly"?

9B **Modifications** - Have you or your agency modified existing commercially available equipment to better suit your needs? If so, what was the modification'!

Please answer questions 2-9 for each piece of equipment noted in response to Question 1 (C)
<u>CUTTING TOOLS</u> *examples include reciprocating saws, abrasive saws (K12 type), oxyacetylene torches.*

2C **Agency Satisfaction with its Current Equipment** - Circle the item that best describes your level of satisfaction/dissatisfaction with all aspects of your extrication equipment. Please comment:

(a) Very satisfied
(3) Somewhat satisfied
(c) Somewhat dissatisfied
(d) Very dissatisfied

3C **Ease of Operation/Effectiveness** - Please list your views regarding your equipment's operating characteristics and effectiveness when employed.

4C **Storage** - Are the vehicle's storage compartment adequate and is equipment safely stored? Is storage location easily accessible? Describe improvements that could be made.

5C **Portability** - How is equipment secured to the vehicle:

(a) Hard-mounted (non-removable)
(b) Partially hard-mounted
(c) Remote unit on wheels
(d) Remote unit/hand carried
(e) Other ________

Number of people required to carry equipment:____ Operate it:____
Describe any improvements in portability that could be made:

6C **Safety Aspects** - Are there concerns/areas of potential concern with respect to rescues or victim safety while this equipment is in operation?

7C **Safety Equipment** - Please circle the type(s) of personal protective equipment that is:

Available for your use:		Used by you:		Required to be used:	
(a) Ear	(e) Head	(a) Ear	(e) Head	(a) Ear	(e) Head
(b) Eye	(f) Foot	(b) Eye	(f) Foot	(b) Eye	(f) Foot
(c) Hand	(g) Other(s)____	(c) Hand	(g) Other(s) ____	(c) Hand	(g) Other(s)____
(d) Body	________	(d) Body	________	(d) Body	________

8C **Areas for Improvement** - Are there aspects of this equipment that could be different to make it more "user friendly"?

9C **Modifications** - Have you or your agency modified existing commercially available equipment to better suite your needs? If so, what was the modifications

Please answer questions 2-9 for each piece of equipment noted in response to Question I (D)
PNEUMATIC RESCUE TOOLS *examples include chisels, airbags, airshores, etc.*

2D **Agency Satisfaction with its Current Equipment** - Circle the item that best describes your level of satisfaction/dissatisfaction with all aspects of your extrication equipment. Please comment:

(a) Very satisfied
(b) Somewhat satisfied
(c) Somewhat dissatisfied
(d) Very dissatisfied

3D **Ease of Operation/Effectiveness** - Please list your views regarding your equipment's operating characteristics and effectiveness when employed.

4D **Storage** - Are the vehicle's storage compartment adequate and is equipment safely stored? Is storage location easily accessible? Describe improvements that could be made.

5D **Portability** - How is equipment secured to the vehicle:

(a) Hard-mounted (non-removable)
(b) Partially hard-mounted
(c) Remote unit on wheels
(d) Remote unit/hand carried
(e) Other ________________

Number of people required to carry equipment: ______ Operate it. _____
Describe any improvements in portability that could be made:

6D **Safety Aspects** - Are there concerns/areas of potential concern with respect to rescues or victim safety while this equipment is in operation?

7D **Safety Equipment** - Please circle the type(s) of personal protective equipment that is:

Available for your use:
(a) Ear
(b) Eye
(c) Hand
(d) Body
(e) Head
(f) Foot
(g) Other(s) _____ ________________

Used by you:
(a) Ear
(b) Eye
(c) Hand
(d) Body
(e) Head
(f) Foot
(g) Other(s) _____ _________

Required to be used:
(a) Ear
(b) Eye
(c) Hand
(4 Body
(e) Head
(f) Foot
(g) Other(s) _____ ________________

8D **Areas for Improvement** - Are there aspects of this equipment that could be different to make it more "user friendly"?

9D **Modifications** - Have you or your agency modified existing commercially available equipment to better suit your needs? If so. what was the modification?

Please answer questions 2-9 for each piece of equipment noted in response to Question I (E)
HYDRAULIC RESCUE TOOLS *examples include spreaders/pullers, cutters.*

2E **Agency Satisfaction with its Current Equipment** - Circle the item that best describes your level of satisfaction/dissatisfaction with all aspects of your extrication equipment. Please comment:

(a) Very satisfied
(b) Somewhat satisfied
(c) Somewhat dissatisfied
(d) Very dissatisfied

3E **Ease of Operation/Effectiveness** - Please list your views regarding your equipment's operating characteristics and effectiveness when employed.

4 E **Storage** - Are the vehicle's storage compartment adequate and is equipment safely stored? Is storage location easily accessible? Describe improvements that could be made.

5E **Portability** - How is equipment secured to the vehicle:

(a) Hard-mounted (non-removable)
(b) Partially hard-mounted
(c) Remote unit on wheels
(d) Remote unit/hand carried
(e) Other ________________

Number of people required to carry equipment:____Operate it:____
Describe any improvements in portability that could be made:

6E **Safety Aspects** - Are there concerns/areas of potential concern with respect to rescues or victim safety while this equipment is in operation?

7E **Safety Equipment** - Please circle the type(s) of personal protective equipment that is:

Available for your use:		Used by you:		Required to be used:	
(a) Ear	(e) Head	(a) Ear	(e) Head	(a) Ear	(e) Head
(b) Eye	(f) Foot	(b) Eye	(f) Foot	(b) Eye	(f) Foot
(c) Hand	(g) Other(s)______	(c) Hand	(g) Other(s) ______	(c) Hand	(g) Other(s) ______
(d) Body	________________	(d) Body	________________	(d) Body	________________

8E **Areas for Improvement** - Are there aspects of this equipment that could be different to make it more "user friendly"?

9E Modifications - Have you or your agency modified existing commercially available equipment to better suit your needs? If so. what was the modification?

Please answer questions 2-P for each piece of equipment noted in response to Question I (F) ***MISCELLANEOUS OTHER RESCUE TOOLS*** *examples include webbing cribbing, rope, pike poles, etc.*

2F **Agency Satisfaction with its Current Equipment** - Circle the item that best describes your level of satisfaction/dissatisfaction with all aspects of your extrication equipment. Please comment:

(a) Very satisfied
(b) Somewhat satisfied
(c) Somewhat dissatisfied
(d) Very dissatisfied

3F **Ease of Operation/Effectiveness** - Please list your views regarding your equipment's operating characteristics and effectiveness when employed.

4F **Storage** - Are the vehicle's storage compartment adequate and is equipment safely stored? Is storage location easily accessible? Describe improvements that could be made.

5F **Portability** - How is equipment secured to the vehicle:

(a) Hard-mounted (non-removable)
(b) Partially hard-mounted
(c) Remote unit on wheels
(d) Remote unit/hand carried
(e) Other ________________

Number of people required to carry equipment:____ Operate it: ____

Describe any improvements in portability that could be made:

6F **Safety Aspects** - Are there concerns/areas of potential concern with respect to rescues or victim safety while this equipment is in operation?

7F **Safety Equipment** - Please circle the type(s) of personal protective equipment that is:

Available for your use:		Used by you:		Required to he used:	
(a) Ear	(e) Head	(a) Ear	(e) Head	(a) Ear	(e) Head
(b) Eye	(f) Foot	(b) Eye	(f) Foot	(b) Eye	(f) Foot
(c) Hand	(g) Other(s)_____	(c) Hand	(g) Other(s)____	(c) Hand	(g) Other(s)____
(d) Body	______________	(d) Body	______________	(d) Body	______________

8F **Areas for Improvement** - Are there aspects of this equipment that could be different to make it more "user friendly"?

9F **Modifications** - Have you or your agency modified existing commercially available equipment to better suit your needs? If so, what was the modification?

10 **Alarms vs Usage** - Approximately how many motor-vehicle-accident (MVA) alarms is your agency alerted for per year? _______ Of this total number of MVA alarms, approximately how often is heavy extrication involved (frequency of use)? _________

11 Type of Agency/Size of Agency - Circle the item that best describes your agency and indicate size:

(a) Career agency _____ Number of employees
(b) Career/Volunteer Agency _____ Number of employees/members
(c) Volunteer Agency _____ Number of members

12 Conveyance - Method of conveying equipment to MVA scene:

(a) Ladder Co./Truck
(b) Engine Co.
(c) Rescue Co.lSquad
(d) Ambulance
(e) Other ______________________

Size of vehicle ___________ft.
Weight of vehicle___________Ibs.

13 Storage - Location on vehicle of extrication equipment:

(a) Front Bumper
(b) Left-side compartments
(c) Right-side compartments
(d) Tail-board (rear compartment)
(e) Other ______________________

14 Population/Geography - Please circle your approximate area population and geographical setting.

(a) < 10,000
(b) 10,000 to 25,000
(c) 25,000 to 50,000
(d) 50,000 to 100,000
(d) 100,000 to 250,000
(e) 250,000 to 500,000
(f) 500,000 to 1,000,000
(g) > 1,000,000

(1) Urban
(2) Suburban
(3) Rural
(4) Other _____

Although the following two sections are of extreme interest, this information may not by readily available. If possible, an estimation/average would be helpful.

15 Extrication Times What is the average duration of time required to free entrapped victims? ______minutes

If you have encountered any unique problems during extrication, please describe them:

16 **Vehicle Types - What vehicle type is most frequently encountered on MVA alarms involving heavy extrication?** ***(circle one)***

(a) Luxury/full size
(b) Mid-size
(c) compact
(d) subcompact
(e) Pickup truck
(f) van
(g) Commercial vehicle
(h) Other ___________

(1) 1990-newer
(2) 1980-1990
(3) Pre 1980

Name ________________________________ **Telephone (   )** ____- ____

17 ***Please use this space to make additional comments regarding this survey.***

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