



Battery-Powered Combination Rescue Tools for Vehicle Extrication

Market Survey Report

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FOREWORD

The National Urban Security Technology Laboratory (NUSTL) is a federal laboratory within the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T). Located in New York City, NUSTL is the only national laboratory focused exclusively on supporting the capabilities of federal, state, local, tribal, and territorial responders to address the homeland security mission. The laboratory assists responders with the use of technology to prevent, protect against, mitigate, respond to, and recover from homeland security threats and incidents. NUSTL provides expertise on a wide range of subject areas, including chemical, biological, radiological, nuclear, and explosive detection, personal protective equipment, and tools for emergency response and recovery.

NUSTL manages the System Assessment and Validation for Emergency Responders (SAVER) program, which provides information on commercially available equipment to assist response organizations in equipment selection and procurement. SAVER knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: “What equipment is available?” and “How does it perform?” The SAVER program works with responders to conduct objective, practitioner-relevant, operationally-oriented assessments and validations of commercially available emergency response equipment. Having the right tools provides a safer work environment for responders and a safer community for those they serve.

NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, and coordinating with other organizations to leverage appropriate subject matter expertise. In conjunction with DAGER Technology, NUSTL conducted a market survey of commercially available battery-powered combination rescue tools for vehicle extrication. This equipment falls under the AEL reference number 03SR-02-TPHY titled Tools, Power.

SAVER reports are available at www.dhs.gov/science-and-technology/saver-documents-library.

Visit the NUSTL website at www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory or contact the lab at NUSTL@hq.dhs.gov.



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EXECUTIVE SUMMARY

Emergency responders use battery-powered rescue tools to access persons trapped within vehicles. Opening or removing areas of a damaged vehicle from around an injured person could prevent further injury caused when removing them from the vehicle.

Between March 2022 and July 2022, the Systems Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey of commercially available battery-powered spreading/cutting combination tools or “combi tools.” This market survey report is based on information gathered from manufacturer and vendor websites, additional internet research, industry publications, and a government-issued request for information that was posted on the System of Award Management website. The survey identified 18 combination tools from four manufacturers ranging in price from \$10,710 to \$14,950.

Each manufacturer offers models that are capable of both spreading and cutting. The combi tools in this report range in size from 30 lbs. to 61.4 lbs. The combi tools differ in spreading distance, spreading force, cutter opening, and cutter rating. The combi tool spreading distances (also referred to as travel distance) typically range from 10.6 inches to 18.7 inches and cutter openings range from 7.3 inches to 16.1 inches. Generally, as the spreading distances and cutter openings increase, the combi tools become larger, weigh more, and have higher ratings as defined by National Fire Protection Association (NFPA) performance specifications. Seven of the combi tools are powered by readily available commercial-off-the-shelf (COTS) batteries, while 11 use a proprietary battery which in some cases, support enhanced capabilities such as underwater use. Additionally, features such as the capability of in-house maintenance, Ingress Protection rating and training offerings may also be of interest to responder agencies.

The purpose of this report is to provide emergency responders with information that will guide their agencies in making operational and procurement decisions. Each agency should consider overall capabilities, technical specifications, and limitations of battery-powered combination rescue tools for vehicle extraction in relation to their specific operational needs when making equipment selections.

Performance of these products and information included in this report has not been independently verified by the SAVER program.

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1.0 INTRODUCTION

Emergency responders use battery-powered spreading, cutting, and spreading/cutting combination tools (combi tools) for extraction of persons trapped within vehicles. To minimize any further harm, responders use these tools to open or remove areas of a damaged vehicle from around the injured person before removing the victim from the vehicle.

Between March 2022 and July 2022, the System Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey of portable battery-powered spreading, cutting, and spreading/cutting combi tools for vehicle extrication. This market survey report focuses solely on battery-powered combi tools, covering 18 models. Additional reports on cutting and spreading rescue tools will be published at www.dhs.gov/science-and-technology/science-and-technology-directorate/saver/st-battery-powered-rescue-tools-vehicle-extrication. This report is based on information gathered from manufacturer and vendor websites, internet research, industry publications, and a government-issued request for information that was posted on the System of Award Management website, <https://sam.gov/opp/aa6e7232803445b8b51e105545a476ff/view>. The U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T's) Technology Scouting Group also contributed to the market research used in the development of this report.

Products included in this report meet the following criteria:

- Single-person portable
- Battery-powered
- Self-contained
- Compliant with the National Fire Protection Association's "Standard on Rescue Tools," NFPA 1936 [1].

Due diligence was performed to develop a report that is representative of products in the marketplace.

2.0 BATTERY-POWERED VEHICLE EXTRICATION TOOLS OVERVIEW

Emergency personnel responding to automobile accidents may encounter trapped or injured individuals needing immediate medical care and extrication. Inclement weather, inaccessible locations, harsh terrain, and unpredictable environmental conditions can hinder the deployment of patient care and extrication equipment. In some situations, rescue personnel must carry equipment to crash sites at hard-to-reach off-road locations, steep embankments, marshy wetlands or submerged areas. Battery-powered rescue tools for vehicle extrication are more portable than tethered systems and eliminate the need to transport support equipment (i.e., hydraulic pumps, air compressors, and generators), which can increase the speed of responders arriving on the scene.

Once on the scene, first responders often find a damaged vehicle body structure surrounding victims that prevents full access. In these rescue operations, the primary goal in victim extrication is to quickly open or remove the damaged vehicle from around the injured victim, which minimizes the potential for inflicting further physical harm while moving the victim from the vehicle. Battery-powered vehicle extrication tools can provide responders with the ability to maneuver around the vehicle with their equipment and coordinate rescue operations quickly and efficiently.

2.1 Background

Modern rescue tools have their genesis in American stock car racing. George Hurst, a racing equipment manufacturer, observed race crews taking over an hour to extricate a driver from their vehicle following an accident. The crews used slow-cutting circular saws that created sparks, a less than ideal situation in a potentially fuel-soaked area. In 1961, Hurst filed a patent for a hydraulically powered spreading tool to enable track rescue crews to quickly spread apart roll cages to extricate drivers. [2] The original extrication system, the Hurst Rescue Tool hydraulic spreader, was produced in 1971 and, following its successful integration into motorsports, became a resource for emergency services. [3]

Early extrication systems relied on gasoline-powered hydraulic pumps large enough to fill the bed of a pickup truck. These pumps were connected to a handheld spreader unit via two hydraulic hoses. Since their initial design, systems have become smaller and stronger. The introduction of the lithium-ion battery enabled manufacturers to produce all-in-one, portable, handheld vehicle extrication tools with onboard electrohydraulic pumps. These battery-enabled systems are capable of many of the tasks that formerly required using tools with separate power units.

2.2 Current Technologies

Spreaders, cutters, and spreader/cutter combination tools used in vehicle extrication operations have traditionally relied on tethered lines attached to hydraulic pumps to pressurize the hydraulic fluid going to the tool. Battery-powered extrication tools are self-contained hydraulic systems that electrically power an internal high-pressure pump and pistons to control the flow of hydraulic fluid through input and output valves and chambers. These systems typically use a synthetic fluid known as phosphate-ester, which is non-flammable and electrically non-conductive [4]. Battery-powered tools have the advantage of being self-contained, eliminating tangling and tripping hazards from hydraulic hoses or electrical cords. These self-contained systems allowing rescue personnel to operate independently and to use multiple tools (such as spreaders and cutters) simultaneously, providing faster rescue operations. Battery-powered tools also enable first responders to access tighter spaces, reduce tripping hazards, and provide more flexibility to quickly remove mangled metal from around a trapped victim.

Battery-powered rescue tools are somewhat larger and heavier than traditional, tethered rescue tools because they include the power supply and hydraulic unit within one handheld system. Additionally, the run times for the battery-powered tools are limited by the battery used to power the system and incidents may require the use of replacement batteries. Other capabilities listed in the manufacturer-provided specifications (e.g., spreading distance [travel distance], spreading forces, and pulling forces) of battery-powered rescue tools match those of traditional hydraulic rescue tools.

2.2.1 Battery-Powered Combination Tools

Battery-powered combination tools provide both the spreading and cutting capability built into the combi tool's arms. Combi tools typically have a straight serrated cutting blade on the inner edges of the tool arms with tips and the outer portion of the arm configured for spreading or crushing operation. To increase spreading efficacy, the tools often have the option to attach extended tips. Figure 2-1 shows an example of a combination tool with spreaders at the tips and serrated cutters inside the arms. Often, combi tools are not as capable as dedicated spreaders or cutters being used in tandem but can provide spreading and cutting capabilities. However, combi tools are less expensive than purchasing dedicated spreaders and cutters, allowing them to be fielded by more response units. Jurisdictions may equip response units with combi tools and reserve dedicated spreaders and cutter for specialized rescue units.



Figure 2-1 HURST SC258 E2

Image Credit: HURST Jaws of Life

2.3 Key Components

Battery-powered combi tools are comprised of a power source, external operating components (e.g., on/off switch, variable speed control, hand grip) and various attachments for cutting heads/blades and spreader arms/grips. Some manufacturers offer additional features, such as temperature monitoring or the ability to operate under water.

2.3.1 Power Options

Like other battery-powered rescue tools, combi tools are typically powered by a removable, rechargeable, lithium-ion battery pack inserted directly into the body of the tool. Some combi tools use proprietary manufacturer batteries, while others use commercial battery packs common to construction tools like drills and circular saws. Proprietary batteries may have advantages in certain features such as the ability to be charged while installed on the tool. Conversely, agencies may see advantages to common construction tool batteries, including ready availability, relatively lower cost compared to proprietary batteries, and shared use with the agency's other tools such as drills, impact wrenches, reciprocating saws, or metal shears.

Some manufacturers offer flexible options for powering the tools, including external battery packs with increased amp-hour (Ah) capacities versus on-tool batteries. External battery packs, however, require a corded connection to the tool and require the user to wear the battery pack using a shoulder strap. Some manufacturers offer the ability to supply backup power to the tools using an available alternating current (AC) connection, enabling rescuers to continue to work even if all batteries have been expended.

2.3.2 External Operating Components

Battery-powered combination tools commonly have a cylindrically shaped main body, an on/off switch, variable speed control lever, hand grip, and various cutting blades and spreader arm attachments, as shown in Figure 2-2. The tools also have a protective cover that protects the motor from debris and the operator from moving parts. Some systems have a fixed hand grip, while others have rotating or adjustable hand grips that adjust to improve leverage.



Figure 2-2 Genesis 11C-RIT3 EFORCE combination tool with external components labeled

Image Credit: Genesis Rescue Systems

Many combi tools include indicators that monitor the power supply and hydraulic fluid reservoir. Some advanced models have load indicators that shows the pressure range the tool is operating under, the remaining amount of capacity and roll warnings to alert the operator that the blade is off center. Some tools also have temperature sensing and heat-protection mechanisms that protect sensitive electronic components and automatically adjust the speed to protect the motor from burning out. Some tools are designed to operate in unique environments, such as under water.

2.3.3 Combi Tool Spreader Arms and Tips

Many combi tool spreading tips can be replaced in the field to change the size or reach of the spreader or to remove the spreading tips all together to increase the cutting edges' access. Note that some combi tools have fixed tips which do not allow operators to replace the tips as they are integrated into the arm. Combi tool manufacturers may offer a variety of spreading tips with different geometrical shapes and gripping surfaces. Each manufacturer may refer to their tip attachments by different names, but all operate under the same concept. Tip attachments can expand the length of the spreader arm and increase the opening width of the spreader, providing better gripping contact. Figure 2-3 shows the collar studs used to replace spreading tips on the Genesis Rescue System 17C-SL3 EFORCE as well as two different tips used by the combi tool for spreading operations.



Figure 2-3 Genesis Rescue Systems 17C-SL3 EFORCE showing collar stud mechanism to change/remove spreading tips and RIT and Brute Tip accessories

Image Credit: Genesis

The RIT Tip is a flat, wide removable tip intended to provide the user with improved grip in tight spaces. The Brute Tip is designed to provide bite and grip for spreading during extrication procedures.

Similar to spreaders, combi tools may also have the option to add chain-mounting attachments to pull metal and to lift or hoist objects using chains. The pulling method is an alternative to spreading or cutting individual car components, such as dashboards, steering columns, and firewalls. The chains attach to the opened combi tool spreader tips according to manufacturer specifications. When the spreader arms close, the chains are pulled together, creating a pulling action. Figure 2-4 shows the AMKUS iS280 Spreader with the Pulling Chain Package.



Figure 2-4 AMKUS iS320 showing chain package with quick release push button tips

Image Credit: AMKUS

2.3.4 Cutter Head and Blades

The mechanism that opens and closes the blades is the cutter head. Combi tools typically have straight serrated cutting blades. The blades are typically straight to achieve the opening dynamics needed for spreading and the blades are serrated so that the material being cut is pulled into the cutting surface. Each battery-powered cutter has an NFPA cutter rating that indicates its ability to cut various types of metal, including round bar, flat bar, round pipe, square tube, and angle iron. Section 2.7 describes the NFPA cutter ratings in more detail.



Figure 2-5 Holmatro Combi Tool Serrated Blade and Spreader Tips

Image Credit: Holmatro

2.4 Applications

Today's vehicles have engineered crash-deflection zones or points that improve passenger safety by helping absorb impact and direct the crash away from the passenger area. Rescue crews that understand vehicle anatomy and collision crash points can perform timely vehicle extrication as a coordinated team effort. First responders using a combi tool can spread, squeeze, lift, pull, and cut damaged metal to clear a path to the victim or provide an opening for the use of additional tools.

Spreaders, cutters, and spreader/cutter combination tools are all vital pieces of rescue missions, offering a flexible spreading and cutting capability to the team's performance, while conducting life-saving techniques. The combination tool offers both spreading and cutting capabilities to the trained rescue operator and can provide rescuers with an easily deployed and flexible tool for units operating in the field. However, there is no single, preferred tool that provides the multi-functional spreading and cutting speed required during the synchronized vehicle extrication process, as all three types of rescue tools have utility for vehicle extrications.

The focus of this report is on combi tools used in vehicle extrication. However, combi tools are also used for industrial accidents, search and rescue operations in collapsed structures, trench rescue, tactical breaching, and anywhere else there is a need for power cutting, spreading, and pulling.

2.5 Additional Considerations

Battery-powered combi tools are available with various capabilities. Additional features and greater capabilities are typically offset with increased weight and cost. Agencies considering purchasing battery-powered combi tools should refer to their normal vehicle extrication workload and balance their equipment needs with their operational requirements. Basic selection considerations include the weight, dimensions (length, width, height), and ergonomic design of the tool, which will impact the personnel operating the equipment.

Other factors to consider include the following:

- Ease of use
- Portability (i.e. ease of dismounting, carrying, and maneuvering in off-road environments)
- Replacement batteries (proprietary or commercially available)
- NFPA certification
- Specialized tools and training requirements
- Cleaning and decontamination procedures
- Spreader tip replacement procedures
- Warranty agreements
- Maintenance requirements

Agencies may also request a list of authorized service centers and determine if loaner equipment is available during long-term equipment repairs.

2.6 Emerging Technologies

Some manufacturers have begun using Electronic Direct Drive (EDD) technology to replace hydraulics in battery-powered rescue equipment. The EDD technology converts lithium battery power to output force and relies on a gearbox and motor.¹ By not using hydraulics, operators no longer risk contamination of hydraulic fluid from dust, dirt, debris, or moisture, which can damage hydraulic systems. While none of the products in this market survey employ EDD, it is currently commercially available in some cutting and combination cutting/spreading tools².

2.7 Standards/Certification Programs

The National Fire Protection Association (NFPA) 1936, “Standard on Rescue Tools,” 2020 Edition, describes the design, performance, testing, and compliance standards for vehicle extrication tools.

NFPA 1936 includes mandatory design criteria, including safety systems, the use of non-combustible hydraulic fluids, manual control designs, labeling, and many other features intended to improve performance and prevent injury to the operator or persons being rescued.

¹ Text on the RESQTEC website that accompanies a graphic comparing hydraulics with EDD explains: “Fewer steps means greater efficiency. High-energy consuming components (a hydraulic pump, fluid, valves, seals & tubing) all reduce the battery’s runtime, as they use precious battery energy. Eliminating these steps greatly boosts the system’s efficiency.” RESQTEC, “EDD Technology,” [Online]. Available: rescue.resqtec.com/edd-technology-2/. [Accessed 28 March 2022].

² Power Hawk Technologies, Inc., “P-16 Rescue System,” [Online]. Available: www.powerhawk.com/p16-rescue-system. [Accessed 06 July 2022].






To assist responders in selecting equipment appropriate for their intended tasks, NFPA 1936 established requirements on the testing of rescue tools in order for them to be advertised as NFPA-compliant. This testing must be conducted by an Occupational Safety and Health Administration (OSHA)-approved, third-party laboratory. Manufacturers are required to publish these results for each tool for which they wish to claim NFPA compliance. Users should be aware that while NFPA results are third-party tested, manufacturers may still advertise “maximum” force claims for their tools, which may be engineering calculations that cannot be realistically achieved due to other limiting factors, e.g., cutter force after the point where the blade opening has fully closed. This report quotes NFPA highest and lowest spreading force, NFPA highest and lowest pulling forces (where available), and NFPA cutter ratings as measured in third-party testing, not manufacturer’s claimed maximum force specifications.

For spreading, the NFPA 1936 standardized tests applicable to battery-powered combination tools include the spreader opening and travel distance, lowest spreading force (LSF), highest spreading force (HSF), highest pulling force (HPF), lowest pulling force (LPF), and the product’s operating noise level in decibels measured at 4 meters.

For cutting, the NFPA 1936 standardized tests applicable to battery-powered combination tools include the cutter opening measurement, the product’s operating noise level in decibels measured at 4 meters (approximately 13 feet), and the alphanumeric cutting performance levels for various material categories expressed as A#/B#/C#/D#/E#/F#. This cutting performance level is based on the ability of a cutter to cut specific grades and thicknesses of formed steel stock, including:

- A. A-36 hot-rolled round bar
- B. A-36 flat bar
- C. Schedule 40 A-53 grade B round pipe
- D. A-500 grade square tube
- E. A-36 angle iron.

The numeral following the letter designator indicates the increasing thickness of the stock on a scale from 1 to 9, with designated dimensions unique to each test piece. For each of the materials designated A–E, the cutter must, in one continuous motion, completely sever the material. The test must be repeated a minimum of 12 times with the thickest material in each of the five categories. The cutter must sever the thinnest material in each of the five categories to pass the NFPA 1936 cutter test (see Figure 2-6).

Material Category		A Round Bar	B Flat Bar	C Round Pipe		D Square Tube	E Angle Iron
							
Material		A-36 Hot-Rolled	A-36	Schedule 40 A-53 Grade B		A-500 Grade	A-36
Performance Level		Diameter (in.)	Thickness × Width (in. × in.)	Nominal size (in.)	OD × Wall Thickness (in. × in.)	Dimension × Wall Thickness (in. × in.)	Square Dimension × Thickness (in. × in.)
1		⅜	¼ × ½	⅜	0.68 × 0.09	½ × 0.06	½ × ⅛
2		½	¼ × 1	¾	1.05 × 0.11	1¾ × 0.06	1 × ⅛
3		⅝	¼ × 2	1	1.32 × 0.13	1 × 0.08	1¼ × ⅜is
4		¾	¼ × 3	1¼	1.66 × 0.14	1¼ × 0.12	1½ × ⅜is
5		7⁄8	¼ × 4	1½	1.90 × 0.15	1½ × 0.12	1½ × ¼
6		1	⅜ × 3	2	2.38 × 0.15	1¾ × 0.12	1¾ × ¼
7		1¼	⅜ × 4	2½	2.88 × 0.20	2 × 0.15	1½ × ⅜
8		1½	⅜ × 5	3	3.50 × 0.22	2½ × 0.19	2 × ⅜
9		1¾	⅜ × 6	3½	4.00 × 0.23	3 × 0.19	2½ × ⅜

For SI units 1 in. = 25.4 mm.

FIGURE 5.6.13.3 Cut Testing and Level Performance Rating.

Figure 2-6 Cut test and level performance rating chart from NFPA 1936

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With the most recent release of NFPA 1936, an optional F# test was added for manufacturers who claim the ability of their tool to cut high-strength materials. The specific material required for the high-strength materials cutting test is:

- F. Rectangular Tube, Ultra High-Strength, Low-Alloy 4130 steel per American Materials Specifications (AMS) 6371, heat treated to a minimum 32 Rockwell Hardness (HRC) profile per the American Society for Testing and Materials (ASTM) A519/A519M

This test was designed to mimic the materials used in some modern vehicle roof pillars. For material F, the cutter must, in one continuous motion, completely sever the material. The test must be repeated a minimum of six times with the thickest material claimed (see Figure 2-7). Failure to successfully complete the high-strength material cutting test does not constitute failure of the NFPA 1936 cutting test detailed in the preceding paragraphs.


Material Category F Rectangular Tube Ultra High-Strength Low-Alloy 	
Material 4130 per AMS 6371 H/T to min 32 HRC Profile per ASTM A519/A519M	
Performance Level	Outside Dimensions x Wall Thickness
	mm x mm x mm in. x in. x in.
1	25 x 50 x 1.7 1 x 2 x 0.065
2	25 x 50 x 2.1 1 x 2 x 0.083
3	25 x 50 x 3.04 1 x 2 x 0.120
4	50 x 76 x 3.178 2 x 3 x 0.125
5	50 x 76 x 4.78 2 x 3 x 0.188
6	50 x 101 x 4.78 2 x 4 x 0.188
7	50 x 101 x 6.4 2 x 4 x 0.250

FIGURE 5.6.15.1 High-Strength Materials Cut and Level Performance Rating.

Figure 2-7 High-strength materials cut and level performance rating chart from NFPA 1936

*Reproduced with permission of NFPA from NFPA 1936, Standard on Rescue Tools, 2020 edition.
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NFPA 1937, “Standard for the Selection, Care, and Maintenance of Rescue Tools,” 2021 Edition [5], provides best practices for agencies to use in procurement, inspection, operations, ongoing maintenance, and recordkeeping. Prior to purchasing battery-powered rescue tools, agencies should review the selection section of NFPA 1937, particularly as it relates to conducting a risk assessment of the potential hazards anticipated, operating restrictions, usage frequency, service requirements, and environmental factors specific to their jurisdiction.

3.0 SPREADER/CUTTER COMBINATION TOOLS

This section provides product information on 18 battery-powered spreader/cutter combination tools. General characteristics and specifications are provided in Table 3-1. The tools are listed alphabetically by manufacturer in the specifications table and in the tool descriptions. The SAVER program obtained the product information presented in this report directly from manufacturers, vendors, and their websites, from March to July 2022. In some cases, manufacturers do not have or do not publish all available specifications on their tools. It is highly recommended to request and obtain the most current specifications from the vendor or manufacturer when requesting a quote. The information in Section 3.0 has not been independently verified by the SAVER program.

Below are definitions of the product information in Table 3-1, listed in column order.

Weight: Weight in pounds of the tool in a ready-to-use configuration including the battery.

Dimensions: Overall dimensions (in length, width and height given in inches) of the tool in a ready-to-use configuration.

NFPA Highest Spreading Force: The highest spreading force (measured in pound-force (lbf) using a test fixture with a calibrated force-measuring device) as recorded at ten equidistant points along the spreader arms when they are spread to 95% of their opening.

NFPA Lowest Spreading Force: The lowest spreading force (measured in lbf using a test fixture with a calibrated force-measuring device) as recorded at ten equidistant points along the spreader arms when they are closed and calculated at the tips where the tool has the least amount of spreading force.

NFPA Highest Pulling Force: The highest pulling force is recorded at ten equidistant test points along the spreader arms using a test fixture equipped with a calibrated force-measuring device.

NFPA Lowest Pulling Force: The lowest pulling force is recorded at ten equidistant test points along the spreader arms using a test fixture equipped with a calibrated force-measuring device.

Spreading Distance: The travel distance is the linear measurement difference at the spreader tips, with no load on the tool, between the fully closed and fully open positions.


Pulling Distance: How far (in inches) a spreader tool can pull an item using manufacturer-recommended chain attachment accessories as measured from the fully open position to in the fully closed position. (This is a manufacturer specification only as it is not defined by NFPA 1936.)

NFPA Cutter Opening: This refers to the smallest distance between the cutter blade tips with the cutter blades fully opened.

NFPA Cutter Rating: This is a standard measurement for a cutter's performance against various materials, including A: round bar, B: flat bar, C: round pipe, D: square tube, E: angle iron, and F: rectangular tube. The numbers correspond to the thickness of the material. The higher the number, the stronger the tool (see Figures 2-6 and 2-7).

Power Supply: The source of power for the tool unit; for all products in this market survey, a removeable/replaceable battery is specifically identified for each product in Table 3-1.

COTS (Power Supply): This indicates whether the power supply is available as a commercial off-the-shelf (COTS) battery. Combi tools that use a COTS battery are designated with a "Yes," and those that use a proprietary battery from the manufacturer are designated with a "No."



IP Rating: The Ingress Protection (IP) rating identifies the level of protection an electrical enclosure provides against environmental conditions to include solids and liquids. The first digit indicates the protection level against solids and the second digit indicates the protection level against liquids. For example, in an IP54 rating, the “5” means that the tool is dust-protected (but not dust tight), and the “4” means that the tool can withstand water splashing from any direction. Appendix A describes the ratings in full. For products where IP rating information was not available “—” is indicated in the table.

MSRP: The manufacturer suggested retail price (MSRP) in U.S. dollars. It only includes what comes standard with the rescue tool. Sometimes batteries, chargers, and other accessories are not included in the base price and must be purchased separately.

Table 3-1 Battery-Powered Spreader/Cutter Combination Tool Specifications and Features

Spreader/Cutter Combination Manufacturer and Model	Weight (lb.)	Dimensions (L x W x H) (in.)	NFPA Highest Spreading Force (lbf)	NFPA Lowest Spreading Force (lbf)	Spreading Distance (in.)	NFPA Highest Pulling Force (lbf)	NFPA Lowest Pulling Force (lbf)	Pulling Distance (in.)	NFPA Cutter Opening (in.)	NFPA Cutter Rating	Power Supply	COTS (Power Supply)	IP Rating	MSRP
AMKUS Rescue ION iCT516	50.2	33.9 x 9.5 x 9.5	8,920	6,650	15.5	—	—	—	7.3	A6/B6/C6/D7/E7	DeWalt FLEXVOLT 60V	Yes	—	\$10,710
AMKUS Rescue ION iCT716	61.4	36 x 8.7 x 11.6	7,830	6,460	15.6	—	—	—	13.8	A7/B8/C7/D9/E8/F5	DeWalt FLEXVOLT 60V	Yes	—	\$12,000
Genesis 11C-RIT3	32.8	32.4 x 7.6 x 9.5	6,750	5,850	11.2	9,225	7,875	10.9	8.5	A6/B7/C6/D7/E7	M28 Lithium-Ion	Yes	IP54	\$12,240
Genesis 11C-SL3	30	31.9 x 7.6 x 9.5	7,200	5,400	10.6	10,125	7,650	13.9	8.7	A6/B7/C6/D7/E7	M28 Lithium-Ion	Yes	IP54	\$11,560
Genesis 14C-SL3	41.4	36.5 x 9.3 x 9.5	9,000	6,300	14.2	12,600	8,775	15	11.2	A7/B8/C6/D8/E8/F5	M28 Lithium-Ion	Yes	IP54	\$12,240
Genesis 15C-SL3	44.1	36.7 x 9.3 x 9.5	8,775	6,300	14.6	12,150	8,775	14.2	11.6	A7/ B8/ C6/ D8/ E8/ F5	M28 Lithium-Ion	Yes	IP54	\$12,360
Genesis 17C-SL3	46.3	38.1 x 9.3 x 9.5	9,000	6,525	15.9	12,825	8,100	16.0	13.5	A7/B9/C7/D9/E9/F6	M28 Lithium-Ion	Yes	IP54	\$12,800
Holmatro PCT11*	30.4	26.7 x 10.6 x 10.8	11,690	8,992	11.1	—	—	—	7.7	A5/B5/C5/D6/E4/F3	28V Lithium-Ion	No	IP57	\$11,792
Holmatro PCT14*	31.3	28.8 x 10.6 x 10.8	8,992	6,744	14.3	—	—	—	10.9	A5/B5/C5/D6/E4/F3	28V Lithium-Ion	No	IP57	\$12,309
Holmatro PCT17ST	31.7	30.6 x 10.6 x 10.8	7,194	5,620	17	6,070	4,047	16.8	13.9	A5/B5/C5/D6/E4/F3	28V Lithium-Ion	No	IP57	\$13,056

Spreader/Cutter Combination Manufacturer and Model	Weight (lb.)	Dimensions (L x W x H) (in.)	NFPA Highest Spreading Force (lbf)	NFPA Lowest Spreading Force (lbf)	Spreading Distance (in.)	NFPA Highest Pulling Force (lbf)	NFPA Lowest Pulling Force (lbf)	Pulling Distance (in.)	NFPA Cutter Opening (in.)	NFPA Cutter Rating	Power Supply	COTS (Power Supply)	IP Rating	MSRP
Holmatro PCT50*	44.8	35.4 x 10.6 x 10.7	9,554	7,396	15	23,380	17,917	10	12.6	A7/B8/C8/D8/E8/F3	28V Lithium-Ion	No	IP57	\$13,166
Holmatro PCT60	51.6	39.8 x 10.6 x 10.8	10,589	8,813	18.4	23,605	19,423	13.5	15.5	A8/B9/C8/D9/E9/F4	28V Lithium-Ion	No	IP57	\$14,950
HURST SC 258 E2	35.4	34.4 x 8.5 x 11.1	6,500	5,400	12.6	8,320	6,300	13	9.1	A6/B6/C6/D7/E7/F4	HURST eDRAULIC 5 Ampere hours (Ah)	No	IP54	\$12,690
HURST SC 358 E2	44.1	37.7 x 9.3 x 10.9	9,667	7,419	14.5	13,940	9,667	15	12.2	A7/B8/C7/D8/E7/F4	HURST eDRAULIC 5 Ah	No	IP54	\$13,550
HURST SC 758 E2	56.8	41.9 x 10.8 x 11.2	11,016	8,543	18.7	15,512	11,690	13.4	16.1	A8/B9/C9/D9/E9/F5	HURST eDRAULIC 5 Ah	No	IP54	\$13,550
HURST SC 258 E3	34.1	31.2 x 8.3 x 10.0	6,500	5,400	12.6	8,300	6,300	13	9.2	A6/B6/C6/D7/E7/F4	HURST 5 Ah or 9 Ah	No	IP58	\$13,774
HURST SC 358 E3	42.9	34.5 x 9.3 x 10.0	9,667	7,419	14.5	13,940	9,667	15	12.2	A7/B8/C7/D8/E7/F4	HURST 5 Ah or 9 Ah	No	IP58	\$14,611
HURST SC 758 E3	55.7	38.6 x 10.5 x 10	11,691	8,543	18.7	15,512	11,690	13.4	15.7	A8/B9/C9/D9/E9/F5	HURST 5 Ah or 9 Ah	No	IP58	\$14,611
— indicates no data is available.														
* Holmatro also makes a Special Tactics (ST) version that has all the same features and specifications but comes in all black; the price is slightly more.														

3.1 AMKUS Rescue Tools

The AMKUS Rescue Tools ION series combi tools are constructed of an aluminum alloy. The cylindrically shaped housing contains an electric direct-current (DC) motor, hydraulic pump, and electronics used to drive mechanical linkages that drive the spreading arms and cutting blades. Each ION series combi tool operates on a COTS 60V DeWalt FLEXVOLT lithium-ion battery that mounts to the top of the tool. A rotary-wheel control valve actuator controls the motor and hydraulic pump and has three operating positions: open, off (neutral), and close. The control valve actuator is equipped with a “deadman” safety feature, stopping the unit when the operator releases pressure from the actuator.

The startup time for each AMKUS ION series combi tool is instantaneous, and the average run time for the tools is 45 minutes. The tool shuts down automatically after being idle for 20 minutes. The cutter blades and center bolt are designed to be narrow to give the AMKUS combi tool access to spreading and cutting surfaces. Each ION series combination tool has 360-degree, lockable, rotating handles and dual LED lights built into the tool’s handle. The LED lights have three levels of intensity and are powered separately using CR123 batteries. The LED lights have a battery-saving feature that automatically shuts them off after 15 minutes of inactivity.

The AMKUS ION series combi tools are NFPA 1936 compliant. Data on IP ratings or operating noise levels for the AMKUS tools was not available. AMKUS electric motors, batteries, and chargers are not waterproof and are not intended for immersion. AMKUS cutters have an operating temperature range of -25°F to 140°F. AMKUS electric motors, batteries, and chargers are not waterproof and are not intended for immersion. Each tool has an AMKUS warranty that covers defects in material and workmanship for 10 years from the date of manufacture for the original owner. The MSRP for each spreader is listed below under the individual tools. The MSRP does not include the required batteries or battery chargers. The 60V DeWalt FLEXVOLT lithium-ion battery cost is estimated at \$320.

AMKUS carries two models of ION battery-powered rescue combi tools: the iCT516 and the iCT716.

3.1.1 AMKUS iCT516

The iCT516, as shown in Figure 3-1, is AMKUS’s compact combi tool. The iCT516 weighs 50.2 pounds and measures 33.9 inches long, 9.5 inches wide, and 9.5 inches high. The iCT516 has a cutter opening of 7.3 inches and an NFPA cutter rating of A6/B6/C6/D7/E7. The AMKUS iCT516 has a spreader opening of 15.5 inches, highest spreading force of 8,920 lbf, and lowest spreading force of 6,650 lbf. There is no data available on the AMKUS iCT516 Combi Tool for highest pulling force, lowest pulling force, or pulling distance. The AMKUS iCT516 has an MSRP of \$10,710, which does not include the cost of the batteries.



Figure 3-1 AMKUS iCT516

Image Credit: AMKUS Rescue Systems

3.1.2 AMKUS iCT716

The iCT716, as shown in Figure 3-2, is AMKUS's full-sized combi tool. The iCT716 has removable spreading tips to give the cutting blades better access. The iCT716 weighs 61.4 pounds and measures 36 inches long, 8.7 inches wide, and 11.6 inches high. The iCT716 has a cutter opening of 13.8 inches and an NFPA cutter rating of A7/B8/C7/D9/E8/F5. The AMKUS iCT716 has a spreader opening of 15.6 inches, highest spreading force of 7,830 lbf, and lowest spreading force of 6,460 lbf. There is no data available on the AMKUS iCT716 combi tool for highest pulling force, lowest pulling force, or pulling distance. The AMKUS iCT716 has an MSRP of \$12,000, which does not include the cost of the batteries.



Figure 3-2 AMKUS iCT716

Image Credit: AMKUS Rescue Systems

3.2 Genesis Rescue Systems

The Genesis Rescue Systems EFORCE series of battery-powered extrication tools are constructed of anodized aluminum and tool steel housing. Each tool contains an electric DC motor, piston-driven high-pressure hydraulic pump, and electronics used to drive mechanical linkages that open or close spreading arms and cutting blades.

Genesis Rescue Systems uses a commercial-off-the-shelf Milwaukee 28V battery. The Milwaukee batteries have an estimated run time of 20–25 minutes and charge in less than an hour. A push-button indicator shows remaining charge left in the battery. Milwaukee batteries also have overload protection to prevent damage to the tool in heavy use situations and discharge protection to prevent cell damage. Milwaukee batteries have a 3-year warranty.

The Genesis Rescue Systems EFORCE battery-powered tools are activated using the on/off switch on top of the control handle. Each tool has a startup time of about 1–2 seconds. Operating functions using the rocker lever are located below the control handle. The rocker lever controls the opening and closing of the spreader arms. The tool will run as long as the rocker level is actuated.

The Genesis EFORCE battery-powered tools are NFPA 1936 compliant. They have a permissible temperature range of -4°F and $+132^{\circ}\text{F}$. The Genesis EFORCE systems have an IP54 rating (i.e., protected against dust and splashes). Genesis EFORCE tools should not be operated in submerged conditions. Genesis Rescue Systems does not test their tools for noise output, so no noise output data is available. Each Genesis EFORCE has a tool lifetime (estimated at 10 years) manufacturer's defect warranty with no extended warranties. Genesis offers in-service training with the purchase of the tools. Annual service for Genesis tools is recommended. The MSRP for each combination tool is listed under the individual descriptions. The MSRP for the tool does not include the required batteries and chargers. The Milwaukee 28V battery cost is estimated to range from \$160–\$230. Accessories, such as batteries, a charger, RIT Tips, Brute Tips, E-Pack E28 Power Bank, and a USAR RIT Backpack for equipment transport are available for purchase separately.

The Genesis EFORCE series has five models of battery-powered combination tools: 11C-RIT3, 11C-SL3, 14C-SL3, 15C-SLC, and 17C-SLC.

3.2.1 Genesis Rescue Systems 11C-RIT3 EFORCE Combi

The Genesis 11C-RIT3 EFORCE combi tool, as shown in Figure 3-3, weighs 32.8 pounds and measures 32.4 inches long, 7.6 inches wide, and 9.5 inches high. The Genesis 11C-RIT3 has a cutting opening of 8.5 inches and an NFPA cutter rating of A6/B7/C6/D7/E7. The tool's spreading distance is 11.2 inches, highest spreading force of 6,750 lbf, and lowest spreading force of 5,850 lbf. The 11C-RIT3 EFORCE has a pulling distance of 10.9 inches, highest pulling force of 9,225 lbf, and lowest pulling force of 7,875 lbf. The Genesis 11C-RIT3 allows the use of three different tip designs: door opening tips, combination tips, and extension tips. The Genesis 11C-RIT3 has an MSRP of \$12,240.



Figure 3-3 11C-RIT3 EFORCE

Image Credit: Genesis Rescue System

3.2.2 Genesis Rescue Systems 11C-SL3 EFORCE Combi

The Genesis 11C-SL3 EFORCE, as shown in Figure 3-4, weighs 30 pounds and measures 31.9 inches long, 7.6 inches wide, and 9.5 inches high, and has fixed tips. The Genesis 11C-SL3 has a cutting opening of 8.7 inches with an NFPA cutter rating of A6/B7/C6/D7/E7. The tool has a spreading distance of 10.6 inches, highest spreading force of 7,200 lbf, and lowest spreading force of 5,400 lbf. The tool has a pulling distance of 13.9 inches, highest pulling force of 10,125 lbf, and lowest pulling force of 7,650 lbf. The Genesis 11C-SL3 has an MSRP of \$11,560.



Figure 3-4 11C-SL3 EFORCE

Image Credit: Genesis Rescue System

3.2.3 Genesis Rescue Systems 14C-SL3 EFORCE Combi

The Genesis 14C-SL3 EFORCE, as shown in Figure 3-5, weighs 41.4 pounds and measures 36.5 inches long, 9.3 inches wide, and 9.5 inches high, and has fixed tips. The Genesis 14C-SL3 has a cutting opening of 11.2 inches with an NFPA cutter rating of A7/B8/C6/D8/E8/F5. The tool has a spreading distance of 14.2 inches, highest spreading force of 9,000 lbf, and lowest spreading force of 6,300 lbf. The 14C-SL3 EFORCE has a pulling distance of 15 inches, highest pulling force of 12,600 lbf, and lowest pulling force of 8,775 lbf. The Genesis 14C-SL3 has an MSRP of \$12,240.



Figure 3-5 14C-SL3 EFORCE

Image Credit: Genesis Rescue Systems

3.2.4 Genesis Rescue Systems 15C-SL3 EFORCE Combi

The Genesis 15C-SL3 EFORCE, as shown in Figure 3-6, weighs 44.1 pounds and measures 36.7 inches long, 9.3 inches wide, and 9.5 inches high. The Genesis 15C-SL3 has a cutter opening of 11.6 inches with an NFPA cutter rating of A7/B8/C6/D8/E8/F5. The tool has a spreading distance of 14.6 inches, highest spreading force of 8,775 lbf, and lowest spreading force of 6,300 lbf. The 15C-SL3 EFORCE has a pulling distance of 14.2 inches, highest pulling force of 12,150 lbf, and lowest pulling force of 8,775 lbf. The Genesis 15C-SL3 has an MSRP of \$12,360.



Figure 3-6 15C-SL3 EFORCE

Image Credit: Genesis Rescue Systems

3.2.5 Genesis Rescue Systems 17C-SL3 EFORCE Combi

The Genesis 17C-SL3 EFORCE, as shown in Figure 3-7, weighs 46.3 pounds and measures 38.1 inches long, 9.3 inches wide, and 9.5 inches high. The Genesis 17C-SL3 has a cutter opening of 13.5 inches with an NFPA cutter rating of A7/B9/C7/D9/E9/F6. The tool has a spreading distance of 15.9 inches, highest spreading force of 9,000 lbf, and lowest spreading force of 6,525 lbf. The 17C-SL3 EFORCE has a pulling distance of 16 inches, highest pulling force of 12,825 lbf, and lowest pulling force of 8,100 lbf. The 17C-SL3 has an MSRP of \$12,800.



Figure 3-7 17C-SL3 EFORCE

Image Credit: Genesis Rescue Systems

3.3 Holmatro Rescue Systems

The Holmatro Pantheon Combi Tools have removable spreading tips, and feature grip teeth on the cutter blade that bite into the material being cut to prevent the material from being pushed out of the blade, as shown in Figure 3-8. The combi tool cutter also features Holmatro's patented flat central bolt (i-Bolt), as shown in Figure 3-9, that allows the cutter better access to confined spaces due to its smaller size compared to a traditional bolt. The Holmatro Pentheon series of rescue tools feature a stepless speed curve as load increases. This allows the tool to operate continuously across the speed range, where other tools often have steep speed drops as they change to different stages at higher loads. The electric motor and the hydraulic pump share the same shaft, allowing for a smaller tool.

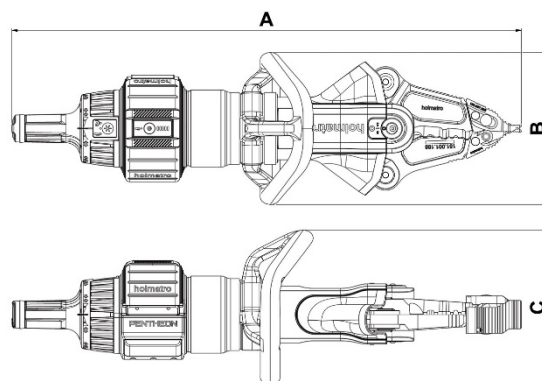


Figure 3-8 Holmatro's combi tool with cutting blades and spreader tips

Image Credit: Holmatro

Holmatro Pentheon combi tools use a proprietary 28.8V battery that has a semi-circular shape that fits around the tool. Holmatro batteries operate for approximately 60 minutes and take about 60 minutes to recharge. LED indicators on the tool, battery, and charger provide information on the battery temperature, state of charge, and state of health. They have a reserve power feature that generates enough power to remove the tool from a spread without “hot swapping” the battery. Using a daisy chained power cord, the battery can be charged while on the spreader (when it is not being operated) via a magnetic connection from the charger. While plugged into the charger, a spare battery and the battery on the tool can charge concurrently; in that case, the battery on the tool is prioritized. LED indicators on the tool, battery, and charger provide information on the battery temperature, state of charge, and state of health.

Holmatro combi tools can operate in low- and high-speed modes using the centrally positioned control handle at the back of the tool. Operators can manipulate the control handle from any position along the 360-degree carrying handle at the front of the tool. The carrying handle has built-in LED lights that are powered by the main battery. Holmatro Pentheon combi tools use an auto start/stop and “deadman” feature to preserve battery life. The Holmatro Pentheon combi tools turn off when not being used and stop at maximum pressure to save energy.

The Holmatro Pentheon series combi tools are NFPA 1936 compliant. They operate in temperatures from -4°F to 131°F and have an ingress protection rating of IP57. The battery packs have an ingress protection rating of IP67. The Holmatro Pentheon Combi Tools can operate while completely submerged in fresh or salt water at a maximum depth of 3.28 feet for 60 minutes. The battery pack can be changed while the tool is submerged.

Annual maintenance by a Holmatro Certified Technician is recommended. Holmatro offers a training program for agencies so that they can conduct in-house maintenance. Each tool has a lifetime Holmatro warranty that covers defects in material and workmanship for the original owner. The electronic circuit boards inside the tools are warrantied for one year and the batteries are warrantied for two years.

The MSRP for each combination tool, which includes two batteries and a charger, is listed below under the individual tools. Optional accessories include an extra battery for \$734 and a 24 VDC battery charger for \$494. Other optional accessories include a daisy chain power cord, on-tool charging cord, extension pipe, tool diagnostics cord, battery diagnostics tool, main power connector, and pulling attachment set for combi tool.

Holmatro carries five models of Pentheon battery-powered rescue combi tools: the PCT11, the PCT14, the PCT17ST, the PCT50, and the PCT60.



Figure 3-9 Holmatro i-bolt design

Image Credit: Holmatro

3.3.1 Holmatro Pentheon PCT11 Combi Tool

The Holmatro Pentheon PCT11 Combi Tool, as shown in Figure 3-9, weighs 30.4 pounds and measures 26.7 inches long, 10.6 inches wide, and 10.8 inches high, and has fixed tips. The tool has a cutter opening of 7.7 inches and NFPA cutter rating of A5/B5/C5/D6/E4/F3. The PCT11 has a spreader opening of 11.1 inches, highest spreading force of 11,690 lbf, and lowest spreading force of 8,992 lbf. There is no data available for the PCT11 for highest pulling force, lowest pulling force, or pulling distance. The tool has an operating noise level of 68 dBA at 13 feet. The Holmatro Pentheon PCT11 has an MSRP of \$11,792. Holmatro also markets a special tactics (ST) version of the PCT11 as PCT11ST. All features of the PCT11ST are the same as the PCT11, except the PCT11ST is made tactically black in color. The PCT11ST has an MSRP of \$12,032.



Figure 3-10 PCT11 Combi Tool

Image Credit: Holmatro

3.3.2 Holmatro Pentheon PCT14 Combi Tool

The Holmatro Pentheon PCT14 Combi Tool, as shown in Figure 3-10, weighs 31.3 pounds and measures 28.8 inches long, 10.6 inches wide, and 10.8 inches high, and has fixed tips. The tool has a cutter opening of 10.9 inches and NFPA cutter rating of A5/B5/C5/D6/E4/F3. The PCT14 has a spreader opening of 14.3 inches, highest spreading force of 8,992 lbf, and lowest spreading force of 6,744 lbf. There is no data available for the PCT14 for highest pulling force, lowest pulling force, or pulling distance. The tool has an operating noise level of 68 dBA at 13 feet. The Holmatro Pentheon PCT14 has an MSRP of \$12,309. Holmatro also markets an ST version of the PCT14 as PCT14ST. All features of the PCT14ST are the same as the PCT14, except the PCT14ST is made tactically black in color. The PCT14ST has an MSRP of \$13,056.



Figure 3-11 PCT14 Combi Tool

Image Credit: Holmatro

3.3.3 Holmatro Pentheon PCT17ST Combi Tool

The Holmatro Pentheon PCT17ST Combi Tool, as shown in Figure 3-11, weighs 31.7 pounds and measures 30.6 inches long, 10.6 inches wide, and 10.8 inches high, and has fixed tips. The tool has a cutter opening of 13.9 inches and NFPA cutter rating of A5/B5/C5/D6/E4/F3. The PCT17ST has a spreader opening of 17 inches, highest spreading force of 7,194 lbf, and lowest spreading force of 5,620 lbf. It has a pulling distance of 16.8 inches, highest pulling force of 6,070 lbf, and lowest pulling force of 4,047 lbf. The tool has an operating noise level of 68 dBA at 13 feet. The Holmatro Pentheon PCT17ST has an MSRP of \$13,056.



Figure 3-12 PCT17ST Combi Tool

Image Credit: Holmatro

3.3.4 Holmatro Pentheon PCT50 Combi Tool

The Holmatro Pentheon PCT50 Combi Tool, as shown in Figure 3-12, weighs 44.8 pounds and measures 35.4 inches long, 10.6 inches wide, and 10.7 inches high. The tool has a cutter opening of 12.6 inches and NFPA cutter rating of A7/B8/C8/D8/E8/F3. The PCT50 has a spreader opening of 15 inches, highest spreading force of 9,554 lbf, and lowest spreading force of 7,396 lbf. The tool has a pulling distance of 10 inches, highest pulling force of 23,380 lbf, and lowest pulling force of 17,917 lbf. The tool has an operating noise level of 68 dBA at 13 feet. The Holmatro Pentheon PCT50 has an MSRP of \$13,166. Holmatro also markets an ST version of the PCT50 as PCT50ST. All features of the PCT50ST are the same as the PCT50, except the PCT50ST is made tactically black in color. The PCT50ST has an MSRP of \$13,166.



Figure 3-13 PCT50 Combi Tool

Image Credit: Holmatro

3.3.5 Holmatro Pentheon PCT60 Combi Tool

The Holmatro Pentheon PCT60 Combi Tool, as shown in Figure 3-13, weighs 51.6 pounds and measures 39.8 inches long, 10.6 inches wide, and 10.8 inches high. The tool has a cutter opening of 15.5 inches and NFPA cutter rating of A8/B9/C8/D9/E9/F4. The PCT60 has a spreader opening of 18.4 inches, highest spreading force of 10,589 lbf, and lowest spreading force of 8,813 lbf. It has a pulling distance of 13.5 inches, highest pulling force of 23,605 lbf, and lowest pulling force of 19,423 lbf. The tool has an operating noise level of 68 dBA at 13 feet. The Holmatro Pentheon PCT60 has an MSRP of \$14,950.



Figure 3-14 PCT60 Combi Tool

Image Credit: Holmatro

3.4 HURST Jaws of Life

The HURST Jaws of Life battery-powered rescue combination spreader/cutter rescue tools (combi tools) are constructed of an anti-corrosive aluminum alloy. The cylindrically shaped housing contains an electric, brushless DC motor, a hydraulic pump, and electronics used to drive mechanical linkages that drive the spreading arms and cutting blades. A star-grip control valve actuator controls the motor and hydraulic pump and is equipped with a “deadman” safety feature that stops the unit when the operator releases pressure from the actuator. Each tool features two LED work lights that are powered by the main lithium-ion tool battery.

Each HURST Jaws of Life series combi tool operates on a proprietary HURST battery that differs between HURST combi tool lines as detailed below. HURST batteries operate for roughly 50 minutes and take approximately two hours to recharge. Each battery mounts to the rear of the tool.

Hurst combi tool blade arms have integral tips for spreading applications. The arms of the tool also contain shackle holes for pulling applications. The combi tools’ arms have straight serrated edges along the inner edges of the arms for cutting. The blades are re-grindable. The blades of the tool are attached to the piston rod via removable links.

The HURST combi tools have a rear, fixed handle forward of the battery, and a crossbar-style handle at the base of the combi tool jaws to provide a 180-degree grip from either side of the tool. All HURST rescue combi tools have an operating temperature range of -22°F to $+140^{\circ}\text{F}$.

All HURST combi tools are NFPA 1936 compliant. Each tool has a HURST warranty that covers defects in material and workmanship for three years from the date of manufacture for the original owner. After three years, the tool is warranted for parts replacement only (no labor) for an additional seven years. HURST Jaws of Life provides training with the purchase of their tools. HURST recommends annual maintenance of their rescue tools. Maintenance can be performed by local HURST dealers or HURST can train agencies to conduct their own annual maintenance.

The MSRP for each combi tool is listed under the individual tool descriptions. All tools are delivered with two tool batteries and a charger for the batteries. HURST produces 110V battery adapters that can be used to directly power the combi tool if 110V AC power is available. Additional batteries, chargers, and accessories can be purchased separately.

HURST Jaws of Life carries two lines of battery-powered rescue combi tools, E2 eDRAULIC and E3 combi tools. The HURST E2 eDRAULIC series of battery-powered rescue combi tools includes three models—the SC258 E2, the SC358 E2, and the SC758 E2—which use the HURST proprietary 5 Amp-hour (5Ah) battery. There are three models of HURST E3 series battery-powered rescue combi tools—the SC258 E3, the SC358 E3, and the SC758 E3—which can be powered by either the HURST 5Ah battery or the larger HURST 9Ah battery.

3.4.1 HURST E2 eDRAULIC Series Combi Tool

E2 series combi tools are IP54 rated, with dust protection and splash protection, but are not rated for underwater immersion. E2 series combi tools use proprietary HURST EXL eDRAULIC 5Ah batteries, which also have an IP54 rating.

3.4.1.1 HURST SC258 E2 eDRAULIC Combi Tool

The HURST SC258 E2 eDRAULIC combi tool, as shown in Figure 3-14, is the smallest and lightest rescue combi tool in the E2 eDRAULIC line. The combi tool weighs 35.4 pounds and measures 34.4 inches long, 8.5 inches wide, and 11.1 inches high, and has fixed tips. The tool has a cutter opening of 9.1 inches and an NFPA cutter rating of A6/B6/C6/D7/E7/F4. The combi tool has a spreader opening of 12.6 inches, highest spreading force of 6,500 lbf, and lowest spreading force of 5,400 lbf. The SC258 E2 eDRAULIC has a pulling distance of 13 inches, highest pulling force of 8,320 lbf, and lowest pulling force of 6,300 lbf. The tool has an operating noise level of 71 dBA. The HURST SC258 E2 eDRAULIC combi tool has an MSRP of \$12,690, which includes the combi tool, two batteries, and a battery charger.



Figure 3-15 HURST SC258 E2

Image Credit: HURST Jaws of Life

3.4.1.2 HURST SC358 E2 eDRAULIC Combi Tool

The HURST SC358 E2 eDRAULIC, as shown in Figure 3-15, weighs 44.1 pounds and measures 37.7 inches long, 9.3 inches wide, and 10.9 inches high. The tool has a cutter opening of 12.2 inches and an NFPA cutter rating of A7/B8/C7/D8/E7/F4. The combi tool has a spreader opening of 14.5 inches, highest spreading force of 9,667 lbf, and lowest spreading force of 7,419 lbf. The SC358 eDRAULIC has a pulling distance of 15 inches, highest pulling force of 13,940 lbf, and lowest pulling force of 9,667 lbf. The tool has an operating noise level of 71 dBA. The HURST SP358 E2 eDRAULIC combi tool has an MSRP of \$13,550, which includes the combi tool, two batteries, and a battery charger.



Figure 3-16 HURST SC358 E2

Image Credit: HURST Jaws of Life

3.4.1.3 HURST SC758 E2 eDRAULIC Combi Tool

The HURST SC758 E2 eDRAULIC, as shown in Figure 3-16, is the heaviest and strongest of the HURST eDRAULIC combi tools. The SC758 E2 weighs 56.8 pounds and measures 41.9 inches long, 10.8 inches wide, and 11.2 inches high. The tool has a cutter opening of 16.1 inches and an NFPA cutter rating of A8/B9/C9/D9/E9/F5. The combi tool has a spreader opening of 18.7 inches, highest spreading force of 11,016 lbf, and lowest spreading force of 8,543 lbf. The SC758 E2 eDRAULIC has a pulling distance of 13.4 inches, highest pulling force of 15,512 lbf, and lowest pulling force of 11,690 lbf. The tool has an operating noise level of 71 dBA. The HURST SP758 E2 eDRAULIC combi tool has an MSRP of \$13,550, which includes the combi tool, two batteries, and a battery charger.



Figure 3-17 HURST SC758 E2

Image Credit: HURST Jaws of Life

3.4.2 HURST E3 Series Combi Tool

The E3 series includes a Turbo function, which allows the combi tool spreader tips and blades to move at faster speeds when the tool is working at low pressure levels. The E3 series combi tools are IP58 rated and have upgraded capabilities to operate submerged in both fresh water and saltwater. The tool is only rated for saltwater submersion when used in conjunction with a proprietary HURST 9 Ah battery. The E3 series adds a control panel with indicators for battery level, a load indicator for working tool pressure, an indicator light for the tool's Turbo function, an indicator light to show that a saltwater-compatible battery is installed, a warning light for electronics temperature, and an illuminated direction indicator showing the direction in which the star grip control is activated.

The E3 series of combi tools has a "Connect" option that is sold as the E3 Connect series. The E3 Connect series of combi tools has the same identical base capabilities as the E3 series but includes an additional Wi-Fi connectivity function. This function enables the tool to wirelessly transmit usage data to HURST's secure cloud servers to facilitate maintenance scheduling, automatically maintain agency usage logs, and conduct detailed error logging.

3.4.2.1 HURST SC258 E3 Combi Tool

The HURST SC258 E3 combi tool, as shown in Figure 3-17, is the smallest and lightest rescue combi tool in the E3 line. The combi tool weighs 34.1 pounds and measures 31.2 inches long, 8.3 inches wide, and 10 inches high, and has fixed tips. The SC258 E3 has a cutter opening of 9.2 inches and an NFPA cutter rating of A6/B6/C6/D7/E7/F4. The combi tool has a spreading distance of 12.6 inches, highest spreading force of 6,500 lbf, and lowest spreading force of 5,400 lbf. The SC258 E3 has a pulling distance of 13 inches, highest pulling force of 8,300 lbf, and lowest pulling force of 6,300 lbf. The tool has an operating noise level of 65 dBA. The HURST SC258 E3 combi tool has an MSRP of \$13,774, which includes the combi tool, two batteries, and a battery charger.



Figure 3-18 HURST SC258 E3

Image Credit: HURST Jaws of Life

3.4.2.2 HURST SC358 E3 Combi Tool

The HURST SC358 E3, as shown in Figure 3-18, weighs 42.9 pounds and measures 34.5 inches long, 9.3 inches wide, and 10 inches high. The SC358 E3 has a cutter opening of 12.2 inches and an NFPA cutter rating of A7/B8/C7/D8/E7/F4. The combi tool has a spreading distance of 14.5 inches, highest spreading force of 9,667 lbf, and lowest spreading force of 7,419 lbf. The SC358 E2 has a pulling distance of 15 inches, highest pulling force of 13,940 lbf, and lowest pulling force of 9,667 lbf. The tool has an operating noise level of 69 dBA. The HURST SP358 E3 combi tool has an MSRP of \$14,611, which includes the combi tool, two batteries, and a battery charger.



Figure 3-19 HURST SC358 E3

Image Credit: HURST Jaws of Life

3.4.2.3 HURST SC758 E3 Combi Tool

The HURST SC758 E3, as shown in Figure 5-19, is the heaviest and strongest of the HURST E3 combi tools. The SC758 E3 weighs 55.7 pounds and measures 38.6 inches long, 10.5 inches wide, and 10 inches high. The SC758 E3 has a cutter opening of 15.7 inches and an NFPA cutter rating of A8/B9/C9/D9/E9/F5. The combi tool has a spreading distance of 18.7 inches, highest spreading force of 11,691 lbf, and lowest spreading force of 8,543 lbf. The SC758 E3 has a pulling distance of 13.4 inches, highest pulling force of 15,512 lbf, and lowest pulling force of 11,690 lbf. The tool has an operating noise level of 69 dBA. The HURST SP758 E3 combi tool has an MSRP of \$14,611, which includes the combi tool, two batteries, and a battery charger.



Figure 3-20 HURST SC758 E3

Image Credit: HURST Jaws of Life

4.0 MANUFACTURER CONTACT INFORMATION

In the United States, most battery-powered rescue tools are sold through dealers based upon location. Manufacturers' websites usually provide links to locate vendors. Additional information on the combi tools included in this market survey report can be obtained from the manufacturers listed in Table 4-1.

Table 4-1 Manufacturer Contact Information

Manufacturer	Address	Phone Number	E-mail or Web Form	Website
AMKUS	4201 Montdale Dr. Valparaiso, IN 46383	(800) 592-6587	https://amkus.com/Support	www.amkus.com
Genesis	2780 Culver Ave. Kettering, OH 45429	(937) 293-6240	https://genesisrescue.com/dealer-locator/	www.genesisrescue.com
Holmatro	505 McCormick Dr. Glen Burnie, MD 21061	(410) 768-9662	info@holmatro.com	www.holmatro.com
HURST	711 N. Post Rd. Shelby, NC 28150	(800) 537-2659	contacthurst@idexcorp.com	www.jawsoflife.com

5.0 CONCLUSIONS

Advancements in batteries, tool design, and performance have greatly improved the capabilities and effectiveness of battery-powered rescue tools. The portability and ease of deployment of battery-powered rescue tools have improved responder access to hard-to-reach areas, decreased setup times and sped up the response to trapped victims.

This market survey report provides information on 18 battery-powered combination rescue tools, all of which are single-person portable, battery-powered, self-contained and NFPA 1936 compliant. Their prices range from \$10,710 to \$14,950. These tools vary in size, weight, features, use, and performance. Each manufacturer offers a range of combi tool models that are capable of both spreading and cutting. They differ based upon spreading distance, spreading force and size as well as cutter opening and cutter rating. The combi tools in this report range in weight from 30 pounds to 61.4 pounds, spreading distances from 10.6 inches to 18.7 inches, and cutter openings from 7.3 inches to 16.1 inches. Typically, as the spreading distances and cutter openings increase, the combi tools become larger, weigh more, and have greater cutter, spreading, and pulling forces, as defined by NFPA performance specifications. Seven of the combi tools are powered by COTS batteries which may be more readily available, while 11 combi tools use a proprietary battery that may offer other capabilities such as the ability to be charged while installed on the tool. Additionally, features such as the capability of in-house maintenance, IP ratings, and training offerings may also be of interest to responder agencies.

Emergency responder agencies should consider overall capabilities and limitations of battery-powered combination rescue tools for vehicle extraction in relation to their agency's operational needs when making procurement or acquisition decisions.

Appendix A. INGRESS PROTECTION LEVELS (IP CODE)

This section provides information on the levels of ingress protection as specified by the 2-digit designations in the IEC 60529 standard [6]. Table A-1 provides levels of solid ingress protection (first digit). Table A-2 provides levels of liquid ingress protection (second digit).

Appendix Table A-1 Levels of Solid Ingress Protection per First Digit of IP Code

Digit	Object Size Effective Against	General Description
0	No Protection	No protection against contact and ingress of solids
1	> 50 mm	Large surfaces, e.g., back of hand, but no protection against deliberate contact with body part
2	> 12.5 mm	Prevents entry of fingers and similarly sized objects
3	> 2.5 mm	Prevents entry of tools, thick wires, etc.
4	> 1 mm	Prevents entry of most wires, screws, large ants, etc.
5	Dust Protected	Dust ingress not entirely prevented but does not enter in sufficient quantity to interfere with satisfactory operation of equipment
6	Dust Tight	No ingress of dust

Appendix Table A-2 Levels of Liquid Ingress Protection per Second Digit of IP Code

Digit	Water Exposure Protection	General Description
0	No Protection	No protection
1	Vertically dripping water	Vertically dripping water has no harmful effects
2	Dripping water, enclosure tilted up to 15 degrees	Vertically dripping water has no harmful effects when enclosure is tilted at an angle up to 15 degrees of normal vertical position
3	Spraying water	Water sprayed at angles up to sixty degrees from the vertical position has no harmful effects
4	Splashing water	Water splashed against the enclosure from any direction has no harmful effect
5	Water jets	Water projected by a nozzle (6.3 mm) against enclosure from any direction has no harmful effects
6	Powerful water jets	Water projected in powerful jets against the enclosure from any direction has no harmful effects
7	Temporary immersion in water	Ingress of water in harmful quantity is not possible when the enclosure is temporarily immersed in water under standard conditions or pressure and time
8	Continuous immersion in water	The equipment is suitable for continuous immersion in water under conditions more severe than for numeral 7

6.0 REFERENCES

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