



Battery-Powered Rescue Tools for Vehicle Extrication

Assessment Report

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Science and
Technology





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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, LLC, NUSTL conducted an assessment of commercially available battery-powered rescue tools for vehicle extrication. This equipment falls under the AEL reference number 03SR-02-TPHY, titled Tools, Power, Hydraulic, Pneumatic.

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

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 response personnel use extrication tools to cut, spread, and pull sections of vehicle body structures to create space for accessing and removing a person who is trapped and may be injured following an accident. Battery-powered spreading and cutting tools for vehicle extrication fall under AEL reference number 03SR-02-TPHY, titled “Tools, Power, Hydraulic, Pneumatic.”




From October 25–27, 2022, the Systems Assessment and Validation for Emergency Responders (SAVER) program conducted an operational assessment of commercially available battery-powered rescue tools for vehicle extrication (hereafter, extrication tools) at General Motors Milford Proving Ground in Michigan. This assessment focused specifically on National Fire Protection Association (NFPA) 1936 compliant spreaders with a 28-inch spread and cutters that have a High-Strength Materials Cut and Level Performance Rating (F) NFPA 1936-Rating.

Nine subject matter expert first responders, each with at least 15 years of experience, served as evaluators for the assessment. They assessed three cutters and three spreaders according to specifications and in operational scenarios. Products were scored in more than 20 evaluation criteria on scale from 1 to 5, where 1 means the product met none of their expectations and 5 means it exceeded expectations.

Evaluators concluded that four of the tools assessed, two cutters and two spreaders, met all their expectations and two tools, one cutter and one spreader, met most of their expectations. Overall scores ranged from 3.5 to 4.3. The following table presents the overall scores as well as the category scores for each product based on tool type. Products are listed in order from highest to lowest overall score.

The purpose of this assessment report is to provide emergency responders with information that will guide their agencies in making operational and procurement decisions. Emergency responder agencies should consider overall capabilities, technical specifications, and limitations of extrication tools in relation to their agency’s operational needs when making equipment selections.

Overall Cutter Scores Summary Table

Product	Overall Score	Overall	Capability	Usability	Affordability	Maintainability	Deployability
HURST S789 E3		4.2	4.5	4.1	3.9	4.4	4.1
Holmatro Pentheon PCU50		4.0	4.0	4.2	3.3	4.3	4.5
Genesis C236-SL3 EForce		3.5	3.2	3.2	3.9	3.9	3.7
Key: 1 (least favorable) to 5 (most favorable)							

Overall Spreader Scores Summary Table




Product	Overall Score	Overall	Capability	Usability	Affordability	Maintainability	Deployability
HURST SP555 E3		4.3	4.6	4.2	3.9	4.4	4.2
Holmatro Pentheon PSP40		4.0	4.2	4.0	3.3	4.1	4.4
Genesis S49-SL3 EForce		3.5	3.0	3.4	4.2	3.8	3.5
Key: 1 (least favorable) to 5 (most favorable)							



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1.0 INTRODUCTION

From October 25–27, 2022, the Systems Assessment and Validation for Emergency Responders (SAVER) program conducted an operational assessment of commercially available battery-powered rescue tools for vehicle extrication (hereafter, extrication tools) at General Motors Milford Proving Ground in Michigan. This assessment focused specifically on products compliant with the National Fire Protection Association (NFPA) Standard on Rescue Tools, NFPA 1936 [1]. Only NFPA 1936 compliant spreaders with a 28-inch spread and cutters that have a High-Strength Materials Cut and Level Performance Rating (F) NFPA 1936-Rating were assessed. The purpose of the assessment was to obtain information on extrication tools that will be useful in making operational and procurement decisions. Assessment activities were based on recommendations gathered from a focus group of subject matter experts with experience using extrication tools that was conducted in April 2022. The “Battery-Powered Rescue Tools for Vehicle Extrications Focus Group Report” [2], can be found in the SAVER Documents Library at <https://www.dhs.gov/science-and-technology/science-and-technology-directorate/saver/st-battery-powered-rescue-tools-vehicle-extrication>.

1.1 Participant Information

Nine subject matter experts assessed the extrication tools following assessment procedures developed by NUSTL and DAGER Technology, LLC (DAGER). Evaluators were selected for the assessment based on their respective geographic location and experience using extrication tools. Each participant’s professional information is listed in Table 1-1.

Table 1-1 Evaluators’ Professional Backgrounds

Evaluator Discipline	Years of Experience	State
Fire Services/Engineer	15–20	CO
Fire Services	20–25	IL
Fire Services	15–20	NY
Fire Services	30–35	NY
Fire Services	15–20	TX
Fire Services	25–30	TX
Fire Services	20–25	VA
Fire Services	15–20	TX
Emergency Response	15–20	Washington DC Area

1.2 Assessed Products




Six extrication tools, three cutters and three spreaders, were selected and acquired for the assessment based on market research and recommendations from the April 2022 focus group. Product selection criteria identified specifications, attributes, or characteristics a product should possess to be considered for the assessment and can be found in Table 1-2 below.

Table 1-2 Product Selection Criteria

Product Type	Product Selection Criteria	Notes	Additional Criteria
Cutter	High-Strength Materials Cut and Level Performance Rating (F) NFPA-1936 Rating ¹	This performance rating was designed to address high-strength materials used in some modern vehicle roof pillars. This is identified by an alphanumeric rating ranging from F1–F9.	The device with the highest F-rating per manufacturer will be selected.
	Lowest weight	If more than one cutter per manufacturer has an F-cut rating, priority will be given to the product with the lowest weight.	If more than one cutter per manufacturer has an F-Rating and negligible difference in weight, the device with a cutter opening between 7–11 inches will be selected.
Spreader	28-inch spread	If more than one spreader per manufacturer is available, priority will be given to the product with a 28-inch opening.	If more than one spreader per manufacturer with a 28-inch opening is available, the device from the newest line will be selected.

The six products from three vendors included in the assessment are shown in Tables 1-3 and 1-4.²




Table 1-3 Identified Cutter Key Specifications

Product	Battery-Powered	NFPA 1936 F-Rating	Dimensions	Weight	Battery Type	Cutter Opening
 Genesis Rescue Systems/C236-SL3 EForce	✓	✓	39.1 x 10.2 x 9.5 inches	51.8 pounds	Milwaukee M28 Battery	8.3 inch
 Holmatro/Penttheon PCU50	✓	✓	35.1 x 10.6 x 10.8 inches	47.4 pounds	Holmatro 28V Battery	7.2 inch
 HURST Jaws of Life / S789 E3	✓	✓	35.7 x 10.5 x 10 inches	52.2 pounds	HURST 90-53-14 5Ah Battery	8.07 inch

¹ Optional F# testing was added in the most recent release of NFPA 1936 for manufacturers that claim the ability of their tool to cut high-strength materials. This test was designed to mimic the materials used in some modern vehicle roof pillars.

² A fourth vendor, AMKUS Rescue Systems, manufacturer of additional products identified for inclusion, the ION iC750 cutter and ION iS281 spreader, declined to participate in the SAVER Assessment.

Table 1-4 Identified Spreader Key Specifications

Product	Battery-Powered	28-inch Spread	Dimensions	Weight	Battery Type	Lowest Spreading Force (LSF)
 <p>Genesis Rescue Systems/S49-SL3 EForce</p>	✓	✓	38.7 x 11.1 x 9.5 inches	45.6 pounds	Milwaukee M28 Battery	11,475 pounds
 <p>Holmatro/Pentheon PSP40+</p>	✓	✓	37.6 x 10.6 x 10.9 inches	42.8 pounds	Holmatro 28V Battery	8,790 pounds
 <p>HURST Jaws of Life/ SP555 E3</p>	✓	✓	36.3 x 10.4 x 10 inches	46.7 pounds	HURST 90-53-14 5Ah Battery	11,016 pounds
<p>+ Note: The Holmatro Pentheon PSP050 was initially identified for participation in the assessment, however, Holmatro brought the PSP40. This tool was assessed because it met the identified requirements of being battery-operated and having a 28-inch spread.</p>						



2.0 EVALUATION CRITERIA

The SAVER focus group on Battery-Powered Rescue Tools for Vehicle Extrication identified 25 evaluation criteria and assigned each criterion to 1 of the 5 established SAVER assessment categories described below:

- **Affordability** criteria relate to the total cost of ownership over the life of the product, including purchase price, training costs, warranty costs, recurring costs, and maintenance costs.
- **Capability** criteria relate to product features or functions needed to perform responder relevant tasks.
- **Deployability** criteria relate to preparing to use the product, including transport, set up, training, and operational/deployment restrictions.
- **Maintainability** criteria relate to the routine maintenance, storage, calibration, and minor repairs performed by responders as well as included warranty terms, duration, and coverage.
- **Usability** criteria relate to ergonomics and the relative ease of use when performing responder relevant tasks.

The focus group participants assigned weights, indicating the level of importance of each evaluation criterion and the five SAVER assessment categories. Evaluation criteria were weighted on a 1 to 5 numerical scale, with 1 indicating that an evaluation criterion is of minor importance and a 5 indicating that an evaluation criterion is of utmost importance.

The SAVER assessment categories were then assigned a percentage to represent each category's importance relative to the other categories. Table 2-1 presents the evaluation criteria and their associated weights as well as the percentages assigned to the SAVER categories. Evaluation criteria are defined in Appendix A.

Three criteria identified by the focus group – NFPA 1936 Certified, Intrinsic Safety and Cutter Placement – are not included in Table 2-1 as they were not assessed. All tools were NFPA certified and were not intrinsically safe. The Cutter Placement criterion was only relevant to combination tools, which were not assessed, and therefore were not relevant to the assessment. Additionally, the NFPA 1936 Performance Rating criterion is only relevant to cutters, so spreaders were not assessed against it. This resulted in cutters being assessed against 22 criteria and spreaders against 21. Nine criteria were assessed operationally, and the remaining criteria were assessed by reviewing manufacturer-provided specifications.

Table 2-1 Evaluation Criteria

SAVER CATEGORIES				
Capability	Usability	Affordability	Maintainability	Deployability
Category Weight 30%	Category Weight 30%	Category Weight 20%	Category Weight 15%	Category Weight 5%
Evaluation Criteria				
Battery Life Efficiency Weight: 5	Ergonomics Weight: 5	Replacement Battery Cost Weight: 5	Training Weight: 5	Start-up Time Weight: 5
Battery Performance Weight: 5	Ease of Use Weight: 5	Initial List Price Weight: 4	Customer Service Weight: 4	Mounting Options Weight: 2
Durability Weight: 5	Portability Weight: 5	Warranty/Service Plans Weight: 4	In-House Maintenance Weight: 3	Storage Conditions Weight: 2
NFPA 1936 Performance Rating Weight: 5	Compatibility with PPE Weight: 5			
Visual Displays Weight: 5				
Battery Operating Conditions Weight: 4				
Accessories Weight: 2				
Anti-Jam Release Weight: 1				
LED Lights Weight: 1				

3.0 ASSESSMENT METHODOLOGY

Each product was assessed in two phases: (1) specification assessment and (2) operational assessment. Focus group participants previously provided recommendations on which criteria should be evaluated with a specification assessment or an operational assessment. In some cases, criteria may be evaluated by both.

Throughout the assessment, evaluators worked in teams of three. NUSTL and DAGER data collectors observed evaluators as they completed the assessment activities.

3.1 Phase 1: Specification Assessment

During the specification assessment, evaluators assessed each product based on manufacturer-provided information. Product information was confirmed by manufacturers prior to the assessment.

Evaluation criteria assessed during this phase included the following:	
Evaluation Criteria Assessed	
Battery Performance	
Durability	
NFPA 1936 Performance Rating (cutter only)	
Battery Operating Conditions	
Accessories	
Replacement Battery Cost	
Initial List Price	
Warranty and Service Plans	
Training	
Customer Service	
In-House Maintenance	
Mounting Options	
Storage Conditions	



Figure 3-1 Familiarization Sessions Conducted by HURST (top), Holmatro (center) and Genesis (bottom)

3.2 Phase 2: Operational Assessment

During the operational assessment, evaluators became familiar with each product's proper use, capabilities and features. The vendors and manufacturers assisted evaluators with product familiarization. Evaluators then assessed each cutter and spreader based on their hands-on experience using it. The extrication tools were assessed in two scenarios: (1) Undamaged Vehicles and (2) Rollover Vehicles.

3.2.1 Undamaged Vehicles

Evaluators responded to a call in which an occupant (mannequin) is said to be unresponsive in a locked, undamaged vehicle. Evaluators arrived on scene, approached the vehicle and assessed the conditions. Evaluators determined immediate extrication was required. Evaluators donned necessary personal protective equipment (PPE), turned on their cutters, and began gaining access to the vehicle by cutting doors and then moving on to the pillars. Once the cuts were sufficient, spreaders were used to expand the vehicle components (e.g., doors, trunk, roof) until the mannequin could be accessed and safely removed.

Evaluation criteria assessed during this scenario included the following:

Evaluation Criteria Assessed
Battery Operating Time
Visual Displays
LED Lights
Ergonomics
Ease of Use
Portability
Compatibility with PPE
Start-up Time
Anti-jam Release



Figure 3-2 Undamaged Vehicle

3.2.2 Rollover Vehicles

Evaluators responded to a call of a rollover vehicle, leaving the occupant (mannequin) trapped and hanging upside down while secured by their seat belt. The evaluators arrived on scene, approached the vehicle, and assessed the conditions. The impact on the vehicle caused damage to the door, passenger compartment and pillars. Evaluators donned the necessary PPE and stabilized the vehicle before performing extrication techniques. Once they confirmed with the data collector that the vehicle was appropriately stabilized, they turned on the cutters and begin the extrication process. Because of the damage to the vehicle, evaluators had limited space to work with to safely extricate the occupant. Once the cuts were sufficient, spreaders were used to expand the vehicle components until the occupant could be accessed and safely removed.

Evaluation criteria assessed during this scenario included the following:

Evaluation Criteria Assessed
Battery Operating Time
Visual Displays
LED lights
Ergonomics
Ease of Use
Portability
Compatibility with PPE
Start-up Time
Anti-jam Release



Figure 3-3 Overturned Vehicle

3.3 Data Gathering and Analysis

After each scenario, data collectors used a questionnaire to record the evaluators' scores for each product, according to the evaluation criteria listed in Section 2.0. The questionnaire included specific questions for each criterion that the data collectors read to the evaluators. Evaluators then scored the criteria using the following 1 to 5 scale:

- 1) The product meets none of my expectations for this criterion.
- 2) The product meets some of my expectations for this criterion.
- 3) The product meets most of my expectations for this criterion.
- 4) The product meets all my expectations for this criterion.
- 5) The product exceeds my expectations for this criterion.

Once all assessment activities were completed and scored, evaluators had an opportunity to review their criteria ratings and comments for all products and adjust them as necessary. Criteria that were rated multiple times throughout the assessment were assigned final averaged ratings by the evaluators. The overall averaged assessment and category scores were calculated for each product using the formulas in Appendix B.

Data collectors also captured comments on advantages and disadvantages as well as general comments regarding the assessed products and the assessment process.

The evaluators' comments were reviewed and are summarized in this assessment report.

4.0 ASSESSMENT RESULTS

Overall scores for the extrication tools ranged from 3.5 to 4.3. Assessment results are presented in Tables 4-1, 4-2, and 4-3, respectively, while additional details and evaluator comments on each product are provided in Sections 4.1 and 4.2. Evaluators concluded that four of the tools assessed – two cutters and two spreaders – met all their expectations and two tools – one cutter and one spreader – met most of their expectations.

Table 4-1 presents the overall assessment score and category scores for each cutter and Table 4-2 presents that information for each spreader. Products are listed in order from highest to lowest overall score throughout this section. Calculation of the overall score uses the raw scores for each category, prior to rounding. Products with the same overall score are listed in order based on the raw data. Category definitions are provided in Appendix A.

Table 4-1 Cutter Assessment Results

Product	Overall Score					Overall	Capability	Usability	Affordability	Maintainability	Deployability
HURST S789 E3	<div><div></div></div>					4.2	4.5	4.1	3.9	4.4	4.1
Holmatro Pentheon PCU50	<div><div></div></div>					4.0	4.0	4.2	3.3	4.3	4.5
Genesis C236-SL3 EForce	<div><div></div></div>					3.5	3.2	3.2	3.9	3.9	3.7
<div><div></div><div></div><div></div><div></div><div></div><div></div></div> <div>012345</div> <div>Key: 1 (least favorable) to 5 (most favorable)</div>											

Table 4-2 Spreader Assessment Results

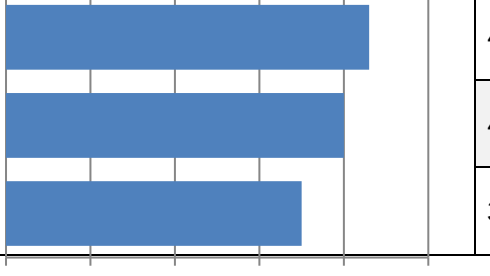

Product	Overall Score	Overall	Capability	Usability	Affordability	Maintainability	Deployability
							
		4.3	4.6	4.2	3.9	4.4	4.2
		4.0	4.2	4.0	3.3	4.1	4.4
Genesis S49-SL3 EForce		3.5	3.0	3.4	4.2	3.8	3.5
Key: 1 (least favorable) to 5 (most favorable)							

Table 4-3 presents the average evaluation criteria scores the products received from the evaluators for each evaluation criterion. A green, fully shaded circle represents the highest rating, while a red, unshaded circle represents the lowest rating.

Table 4-3 Evaluation Criteria Ratings

Key		Cutters			Spreaders		
 (<1.5) (1.5-2.5) (2.5-3.5) (3.5-4.5) (4.5-5)							
Category	Evaluation Criteria	HURST S789 E3	Holmatro Pentheon PCU50	Genesis C236-SL3 EForce	HURST SP555 E3	Holmatro Pentheon SPS40	Genesis S49-SL3 E Force
Capability	Battery Performance*						
	Battery Operating Time						
	Durability*						
	NFPA-1936 Performance Rating*+				N/A	N/A	N/A
	Visual Indicators						
	Battery Operating Conditions*						
	Accessories*						
	Anti-Jam Release						
	LED Lights*						
Usability	Ergonomics						
	Ease of Use						
	Portability						
	Compatibility with PPE						
Affordability	Replacement Battery Cost*						
	Initial List Price*						
	Warranty and Service Plans*						
Maintainability	Training*						
	Customer Service*						
	In-House Maintenance*						
Deployability	Startup Time						
	Mounting Options*						
	Storage Conditions*						

* These criteria were assessed by specification only

+ Indicates a criterion is applicable only to cutters

4.1 Cutters

4.1.1 HURST, S789 E3

The HURST S789 E3 cutter, shown in Figure 4-1, weighs 52.2 pounds and measures 35.7 inches long, 10.5 inches wide, and 10.0 inches high. The tool has a cutter opening of 8.1 inches and an NFPA cutter rating of A8/B9/C8/D9/E9/F5. The tool has an operating noise level of 67 dBA. The HURST S789 E3 has an MSRP of \$14,000, which includes the cutter, two batteries, and a battery charger. Each tool has a HURST warranty that covers defects in material (hardware and electronics) and workmanship for three years from the date of manufacture for the original owner. After three years, the warranty is for parts replacement only (no labor) and covers an additional seven years.



Figure 4-1 HURST S789 E3

Image Credit: HURST Jaws of Life

The HURST S789 E3 received an overall assessment score of 4.2. Evaluator comments provided throughout the assessment are reported below, grouped by SAVER category. In each category, the criteria are listed according to their order of importance as assigned by the focus group.

4.1.1.1 Capability

The HURST S789 E3 received a capability score of 4.5. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Battery Performance:** Seven evaluators indicated that the S789 E3 cutter's battery performance exceeded their expectations based on the manufacturer-provided specification of 60 minutes. One evaluator added that the ability to plug the battery into the charger and leave it there, knowing that the battery is equipped with safety settings to not charge when not needed, was beneficial for operations and maintenance.
- **Battery Operating Time:** All evaluators indicated that the battery operating time either exceeded or met all their expectations. Most evaluators were able to continuously use the cutter for at least 60 minutes, which was the timeframe identified by the manufacturer. Two evaluators noted the auto-shutoff of 60 minutes was useful for continuous operations.
- **Durability:** Eight evaluators indicated that the durability of the HURST S789 E3 cutter exceeded their expectations. Evaluators were impressed by the ability to submerge the S789 E3 in up to 11 feet of water for 60 minutes and that the S789 E3 creates a log of significant drops of the tool to assess any damage. One evaluator commented that the battery located at the end of the tool could easily be bumped, potentially impacting durability.
- **NFPA 1936 Performance Rating:** The S789 E3 cutter is rated to cut F5 materials. All evaluators found this to either exceeded or meet all their expectations.
- **Visual Displays:** All evaluators indicated that the visual displays on the HURST S789 E3 exceeded or met all their expectations. The lights were bright enough to be visible during daylight operations, shown in Figure 4-2. Evaluators noted that the layout, position, and variety of displays were beneficial to operations. Additionally, a battery-life indicator display on the back of the battery allows those on scene to obtain situational awareness without having to ask the operator for battery-life status.



Figure 4-2 S789 E3 Visual Displays

- **LED Lights:** Overall, evaluators found the LED lights met all or most of their expectations. The S789 E3 is equipped with two LED lights, which evaluators found to be very bright and even visible during daylight hours. However, evaluators noted that additional lights would be preferred and that the placement of the lights was not ideal as an operator's hand placement would partially cover the LEDs while the tool is in use, limiting the amount of visibility provided.

4.1.1.2 Usability

The HURST S789 E3 cutter received a usability score of 4.1. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Ergonomics:** Eight evaluators indicated the ergonomics of the HURST S789 E3 cutter met all their expectations. The evaluators found the weight of the S789 E3 to be evenly distributed, making the tool well balanced. Additionally, the star grip valve, sometimes referred to as the throttle, was well received as it enabled operators to use the cutter in any position. The power button must be pressed and held for approximately one second to turn the tool off (i.e., it could not be turned off the power button is accidentally pressed during operations), which was well received. One evaluator indicated the S789 E3 met most of their expectations, citing that the handle made the tool only operable in one direction. Two evaluators indicated they'd prefer a 360-degree handle for more versatile movements.
- **Ease of Use:** All evaluators indicated that the cutter exceeded or met all their expectations. The star grip valve, or throttle, was well received and made the tool easy to use as it can be operated with just an index finger or thumb and eliminates the need for the operator to move their entire hand. All evaluators found the widened "box cut" design of the HURST S789E cutter blades, shown in Figure 4-3, to be beneficial, noting that the "box cut" blades cut and compressed metal without causing the tool to pivot or pulling the operator into the vehicle. One evaluator commented that the S789 E3 cutter was easy to use and, when combined with the box cut blades, was effective enough that the tool did not need to transfer into its second stage to make cuts.
- **Portability:** One evaluator found the S789 E3 cutter to exceed their expectations, seven found it to meet all their expectations, and one found the cutter to meet most of their expectations. While they noted that the tool was heavy (52.2 pounds) the cutter's design, including the placement of the control handle in the rear of the tool and the carrying handle at the front of the tool, makes the S789 E3 balanced and easily transportable, as show in Figure 4-4.
- **Compatibility with PPE:** All evaluators indicated the cutter exceeded or met all their expectations when operating the tool while wearing PPE (e.g., duty uniforms or turnout gear and gloves). Evaluators noted they had no problems operating the tool, turning the tool on or off, or changing batteries while wearing gloves. Specifically, one evaluator noted the tabs on the collar of the cutter made it easy to operate even when wearing gloves.

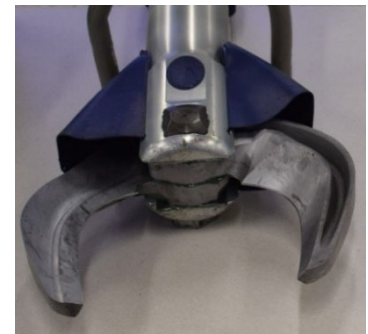


Figure 4-4 S789 E3 "Box Cut" Blades



Figure 4-3 Evaluator Leveraging the S789 E3's Front Handle During Operations



4.1.1.3 Affordability

The HURST S789 E3 received an affordability score of 3.9. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Replacement Battery Cost:** Replacement and extra batteries are available for purchase at a cost of \$800 each; eight evaluators determined that this met all their expectations, while one evaluator found replacement battery cost to meet most of their expectations. One evaluator commented that the price of the batteries is worth the excellent performance of the battery. Another evaluator commented that they were not an advocate for proprietary batteries prior to using the HURST tools, but they were impressed by the performance of the proprietary batteries compared to some commercial off-the-shelf batteries.
- **Initial List Price:** The HURST S789 cutter has an MSRP of \$14,000, which comes with two batteries and a charger. The price of the tool met all the expectations of five evaluators, most of the expectations of three evaluators, and some of the expectations of one evaluator. Two evaluators said this was too expensive, but the majority found it reasonable as it was comparable to other battery-powered cutters on the market.
- **Warranty/Service Plan:** The HURST S789 E3 cutter comes with a lifetime warranty. If the S789 cutter fails within the first 10 years, HURST will fix it. The warranty covers parts and labor for the first three years and only parts for years 3 through 10. The HURST proprietary batteries come with a 3-year warranty and are good for 1,000 full charge cycles. The HURST warranty exceeded expectations for four evaluators and met all expectations for five evaluators.

4.1.1.4 Maintainability

The HURST S789 E3 received a maintainability score of 4.4. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Training:** All evaluators indicated that HURST's training offerings, which include on-site training with a regional specialist at the time of delivery, met or exceeded all their expectations.
- **Customer Service:** Customer service is provided via regional dealers; annual service contracts are available and priced by dealers individually. Most evaluators found HURST's customer service to exceed or meet all their expectations, while one evaluator stated it met most of their needs.

4.1.1.5 Deployability

The HURST S789 E3 received a deployability score of 4.1. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Start-Up Time:** All evaluators indicated that the S789 E3 either exceeded or met all their expectations. This was attributed to there being either no, or very minor, hesitation between turning the tool on and being able to use it. Additionally, one evaluator noted that when the tool is turned on, it picks up at the power level in which it was turned off at (e.g., if tool is turned off at full power, it turns on at full power), which was viewed as a time saver during extrication operations.
- **Storage Conditions:** The SP555 E3 storage conditions include a temperature range of -22 °F to +140 °F, which met the expectations of all evaluators.

4.1.2 Holmatro, Pentheon PCU50

The Holmatro Pentheon PCU50 cutter, shown in Figure 4-5, weighs 47.4 pounds and measures 35.1 inches long, 10.6 inches wide, and 10.8 inches high. It has a cutter opening of 7.2 inches. The PCU50 has an MSRP of \$14,000, which includes the cost of the tool, two batteries, and a charger.



Figure 4-5 Holmatro Pentheon PCU50

Image Credit: Holmatro

The Holmatro Pentheon PCU50 cutter features a 30-degree offset and a 360-degree rear handle. The cutter has a two-stage throttle, slow and fast, and electronics that optimize its performance to maintain pressure once in position.

The Holmatro Pentheon PCU50 received an overall assessment score of 4.0. Evaluator comments provided throughout the assessment are reported below, grouped by SAVER category. In each category, the criteria are listed according to their order of importance as assigned by the extrication tools focus group.

4.1.2.1 Capability

The Holmatro Pentheon PCU50 received a capability score of 4.0. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Battery Performance:** The PCU50 battery has state-of-charge indicators that display the battery's life across five bars, circled in Figure 4-6. The battery loses 1–2% of performance per month when stored. All evaluators indicated that the battery performance met all their expectations; two evaluators attributed their scores to the ability to charge the battery on the tool and the ability to daisy chain charging stations, which allows more than one battery to recharge at a time.
- **Battery Operating Time:** The battery operating time varies based on use but on average ranges between 55 and 75 minutes. It takes approximately one hour to fully charge a battery. Seven evaluators indicated that the battery time and time to charge met all their expectations, while two said it met most. Three evaluators noted the battery lasted longer during the testing scenarios and one said that the amount of time they used the cutter during the test scenario could possibly equal a full day of work in the field.
- **Battery Operating Conditions:** The battery for the PCU50 can operate in a temperature range of –4 to 131 degrees Fahrenheit. Evaluator responses were mixed regarding the battery operating conditions; three evaluators noted that asphalt can reach temperatures out of the tool's specifications, becoming an issue if they set the tool down during a rescue. Another evaluator said the tool's specifications exceeded their expectations, as they believed the temperature range was appropriate for most climates in the United States.



Figure 4-6 Holmatro Pentheon PCU50 Battery Indicator

4.1.2.2 Usability

The Holmatro Pentheon PCU50 received a usability score of 4.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Ergonomics:** The PCU50 exceeded or met the expectations of eight evaluators. This was attributed to most evaluators valuing the 30-degree cutter head, shown in Figure 4-7, which allowed for additional space between the evaluator and the vehicle. One evaluator who said the ergonomics of the PCU50 met some of their expectations, noted it created a slight hindrance, referring to an operational learning curve, while another agreed that while there was a learning curve the feature overall was positive. The battery placement and power buttons had mixed feedback; three evaluators stated the battery was in a position where it was hard to turn it off and on, one evaluator suggested it should be recessed because it would be hard to turn off the battery if the tool was in a tight space during operations, and one evaluator stated the battery placement on the tool made the overall tool well balanced, making it easier to carry. Some evaluators experienced instances of the tool twisting and rotating towards the interior of the vehicle during operations, which they attributed to the torque. They commented that users would need to operate the tool carefully to ensure the tool doesn't migrate into vehicle compartments where there could be risk to passengers and operator safety.
- **Ease of Use:** The throttle feature was reported as easy to use, although two evaluators noted it took time to learn the correct way to turn the throttle to open or close the cutter, and two other evaluators stated it was intuitive. One evaluator stated they found it beneficial that they could hear a change in pitch to indicate that they should stop throttling and another said the balanced body of the tool helped with ease of use. Evaluators found the PCU50 to exceed or meet all their expectations related to ease of use.
- **Portability:** Evaluators had mixed feedback on portability. Six evaluators found it exceeded all their expectations, one reported it met most of their expectations and two evaluators found it to meet some. The PCU50 featured a bar in the middle of the 360-degree handle that some evaluators found was too small for practical use; they could not fit their hand around the bar while using gloves and did not even use it to carry the tool. Most evaluators agreed the 360-degree handle made it easy to carry and the tool overall was well balanced; one evaluator noted that the battery placement contributed to the well-balanced nature of the tool.




Figure 4-7 360 Degree Handle and 30 Degree Cutter Head

4.1.2.3 Affordability

The Holmatro Pentheon PCU50 received an affordability score of 3.3. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Replacement Battery Cost:** The proprietary batteries come with a two-year warranty. Batteries are available for purchase at \$734 each. Four evaluators found this to meet all their expectations, and one of the four implied that the replacement battery cost is an acceptable



part of owning the tool. Five evaluators found this to meet some or most of their expectations, which was attributed to the cost being too high.

- **Initial List Price:** The PCU50 has a list price of \$14,000 and comes with two batteries and a charger. Two evaluators found this met some or most of their expectations as they thought it was too expensive, but the majority found it reasonable since it was comparable to other battery-powered cutters.
- **Warranty/Service Plan:** The warranty/service plan was the lowest scored assessment criterion for the PCU50, with five evaluators saying it met most of their expectations and four evaluators saying it met some. The PCU50 has a warranty that provides lifetime coverage for deficiencies in material and workmanship for the original owner but with one year of coverage for electronics and two years of coverage for batteries. Three evaluators commented specifically on the coverage for electronics, noting that they thought one year wasn't sufficient and that the circuit board should last longer and thus should have longer coverage. One evaluator noted that the warranty seemed to have many exclusions and uncertainties.

4.1.2.4 Maintainability

The Holmatro Pentheon PCU50 received a maintainability score of 4.3. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Training:** Operational training is included with the purchase of PCU50. There are also trainings and videos available online. This exceeded or met all expectations of eight evaluators. One evaluator, who said this met most of their expectations, expressed concerns about the additional cost for agencies to send personnel to in-person training. Another evaluator found it advantageous that vendor representatives are located in every state within the United States to help facilitate training needs. Evaluators also noted that the training available to allow for in-house service is beneficial; one of these evaluators added that this training offering is not common.
- **Customer Service:** According to the vendor, customer service is available by phone, email, and video from 8:00 a.m.–6:00 p.m. Eastern Time and any time at local distributors. All evaluators noted that the stated customer service exceeded or met their expectations. Evaluators noted they could get a start on resolving issues by connecting with customer service and leveraging vendor representatives in their respective states. One evaluator mentioned that tools frequently need to be sent back to the manufacturer for servicing, thus emphasizing the need for good customer service.
- **In-House Maintenance:** The manufacturer recommends yearly maintenance and states that agencies can be trained to do their own; six evaluators found this to exceed or meet all their expectations. Two evaluators said it met most of their expectations because they found it to be inconvenient to have to send staff to the vendors site to be trained on how to perform in-house maintenance. However, another evaluator said it was reasonable even with refresher training needed every three years and appreciated the wired connection feature used for running diagnostics on the tool.

4.1.2.5 Deployability

The Holmatro Pentheon PCU50 received a deployability score of 4.5. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Start-up Time:** The start-up time was the highest scored assessment criterion for the PCU50. All evaluators said it exceeded or met their expectations. Some evaluators indicated they

were impressed that the tool was powered on and ready to be used with the push of a button. Other evaluators were not quite as impressed but did acknowledge that it was quick.

- **Mounting Options:** Seven evaluators found the mounting options available to exceed or met their expectations, while two found it to meet some. The PCU50 has chargers capable of daisy-chaining that allow multiple batteries to charge simultaneously, including the battery stored on the tool. Two evaluators mentioned this would be advantageous to their operations. The daisy chain feature prioritizes the battery on the tool when charging. There isn't a vendor-provided mount for the tool, but the tool can be kept on a charger in vehicles or buildings. One evaluator mentioned that having a specific mount available from the manufacturer would likely provide better protection. Most other evaluators made comments indicating they preferred not to have a specific mounting assembly because it provided them more storage options. One evaluator noted that not having a manufacturer mounting solution is more convenient because they wouldn't have to have the vendor involved in any repairs of that component.
- **Storage Conditions:** The vendor stated that the PCU50 would need to be stored in temperatures from -4°F to 131°F . Six evaluators indicated that this temperature range exceeded or met all their expectations and believed the storage conditions would permit them to store and charge the tool within the vehicle's compartments. Three evaluators, who stated storage conditions met some of their expectations, said that temperatures in vehicle storage compartments can exceed 131°F in summer months.

4.1.3 Genesis, C236-SL3 EForce

The Genesis C236-SL3 EFORCE cutter, shown in Figure 4-8, weighs 51.8 pounds and measures 39.1 inches long, 10.2 inches wide, and 9.5 inches high. The tool has a cutting opening of 8.3 inches with an NFPA cutter rating of A8/B9/C8/D9/E9/F4. The C236-SL3 EFORCE has an MSRP of \$13,740, which includes the cost of the tool, two batteries, and a charger.

The Genesis C236-SL3 EFORCE received an overall assessment score of 3.5. Evaluator comments provided throughout the assessment are reported below, grouped by SAVER category. In each category, the criteria are listed according to their order of importance as assigned by the extrication tools focus group.



Figure 4-8 C236-SL3 EFORCE
Image Credit: Genesis Rescue

4.1.3.1 Capability

The Genesis C236-SL3 EFORCE received a capability score of 3.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Battery Performance:** The C236-SL3 is powered by a non-proprietary battery, specifically the Milwaukee Lithium Ion Battery 5 AH with REDLINK intelligence feature that has overload and discharge protection that prevents battery damage. The tool idles at 5% power with an auto tool shut off after 30-seconds to save battery power. Two evaluators indicated the Genesis C236-SL3 met all their expectations and five indicated that battery performance met most of their expectations. Two evaluators found the battery performance met some of their expectations; one of these evaluators attributed their score to the battery life not being sufficient for a single operation. There was mixed feedback on the auto shut off feature—

some appreciated that it helped to save battery while others thought that the tool shut off too quickly and could interfere with operations.

- **Battery Operating Time:** The battery has an estimated run time of 20–25 minutes and charges in less than an hour. Actual run times vary depending on the workload placed on the tool. Two evaluators indicated the Genesis C236-SL3 met all their expectations and four of the evaluators indicated that battery operating time met most of their expectations. Three of the evaluators thought the battery operating time met some of their expectations. One evaluator noted that it ran longer than the estimated specification time.
- **Durability:** The IP Rating of the Genesis C236-SL3 is IP54. A DiveX waterproof cover accessory is available for underwater operations. The majority of evaluators indicated the tool met all or most of their expectations. One of the evaluators who said it met most of their expectations noted they physically felt a lot of heat and friction during operations. One of the evaluators said it met some of their expectation and expressed concern that the plastics used for the handle and battery housing, shown in Figure 4-9, would be susceptible to damage.
- **Visual Displays:** Six evaluators indicated the Genesis C236-SL3 met most of their expectations with the visual displays. One evaluator indicated it met some expectations and two stated it met none; one of these evaluators noted the battery display was not user-friendly due to the battery being positioned at the rear of the cutter. Another evaluator would have preferred a larger battery indicator so that the operator could glance down and view the operating status of the battery without interrupting operations.
- **Accessories:** The Genesis C236-SL3 accessories include traditional cutting blades or NXTGEN (next generation) cutting blades. The NXTGEN blades are cutting inserts made of high strength alloys and cost \$700. Traditional replacement blades cost \$2,200. Six evaluators indicated the accessories exceeded their expectations, one indicated that it met all expectations, and two indicated it met most expectations. Evaluators appreciated the NXTGEN blade inserts and the ability to replace the cutting blades quickly and easily. One evaluator, however, preferred the traditional blade on the C236-SL3 based on the shape of the NXTGEN blades.
- **Anti-Jam Release:** The Genesis C236-SL3 trigger system allows the tool to be reversed even if the operator's hand becomes trapped by tool migration. The sound of the Genesis C236-SL3 changes when the tool is maxed out, allowing the operator to back the tool out of the cut. Six evaluators stated the C236-SL3 met some of their expectations and three said it met none of their expectations. Evaluators pointed out that the only jam release procedure for a battery that dies during extrications is to hot swap the battery. While the evaluators appreciated the ability to hot swap batteries, they were concerned that the battery or their hand could be jammed against the vehicle when the battery died.
- **Battery Operating Conditions:** The battery for the Genesis C236-SL3 can operate in a temperature range of -4° to $+132^{\circ}$ Fahrenheit. The battery operating conditions exceeded one of the evaluator's expectations and met all expectations of two. Five of the evaluators indicated that the battery operating conditions met most of their expectations. One evaluator stated it met some expectations, noting temperatures in some regions can exceed the upper limit of the range.



Figure 4-9 Close View of the High Impact Plastics Used for Handle and Battery Housing

- **LED Lights:** The Genesis C236-SL3 has four LEDs mounted in the control handle. Four evaluators indicated the LED lights met all expectations, four of the evaluators indicated the lights met most of their expectations, and one evaluator stated the lights met some expectations. One evaluator, who said the LED lights met most of their expectations, commented that the lights would be better positioned forward of the front hand grip, instead of in the control handle, so the lights would not be blocked by the operator's hand on the front grip.


4.1.3.2 Usability

The Genesis C236-SL3 received a usability score of 3.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Ergonomics:** Evaluators had mixed feedback on the adjustable front hand grip, the control lever (throttle), and the balance of the Genesis C236-SL3. Two evaluators indicated the ergonomics of the Genesis C236-SL3 met all their expectations, four of the evaluators indicated it met most of their expectations, and three stated it met none of their expectations. Some evaluators found the rotational front grip useful for maneuvering, but others had trouble locking it. One evaluator commented that the tool slipped and dropped because the front grip could not be adequately locked and was not well balanced. Another evaluator found no value in the adjustable handle and one struggled to lift it over their head because of the rotating front grip. Most found the control lever (throttle) placement and operation to be ideal (e.g., moving the selector right or left to open or close the cutter). One found the control lever challenging to use when operating in the underhanded position, shown in Figure 4-10. Evaluators did note at times the cutter migrated during operations and in some instances pulled the evaluator near the vehicle.
- **Ease of Use:** Evaluators provided mixed feedback on the ease of use of the Genesis C236-SL3. It exceeded the expectations of one evaluator, met all expectations of five, met most expectations of two evaluators, and met some expectations of one. One evaluator commented that the control lever (throttle) was very intuitive and another mentioned that the feathering of the variable speed was valuable. Another evaluator mentioned it felt as though the cutter was migrating into the car during cuts and it took a bit to get used to the grip. Evaluators also found it inconvenient to change the battery during operations.
- **Portability:** Five evaluators indicated the portability of the Genesis C236-SL3 met all their expectations; one of these evaluators found the narrow body made it easier to carry. Two of the evaluators indicated it met most of their expectations and two evaluators stated it met some of their expectations. These evaluators noticed the weight and length caused an imbalance of the tool, impacting the ability to maneuver. While most of the tools were around the same weight, two evaluators noted the combination of weight and balance issues made the Genesis C236-SL3 difficult to transport.



Figure 4-10 Evaluator Uses the Tool in an Underhanded Position

- 
- **Compatibility with PPE:** Four evaluators indicated the compatibility with PPE met all their expectations while three evaluators stated it met some of their expectations. Two evaluators said that it met most of their expectations, noting that the knob of the adjustable handle got caught on their turnout coat and that the tool twisted while cutting, which made it difficult to use while wearing PPE. Similarly, another evaluator said the fixed position of the toggle switch made it more difficult to use gloves.

4.1.3.3 Affordability

The Genesis C236-SL3 received an affordability score of 3.9. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Replacement Battery Cost:** The Genesis C236-SL3 uses a non-proprietary Milwaukee 28V Battery System at a cost of ranging from \$160–\$230, depending upon the seller. Six evaluators indicated the battery replacement cost exceeded their expectations and the three other evaluators indicated it met all their expectations.
- **Initial List Price:** The Genesis C236-SL3 has an MSRP of \$13,740, which includes two batteries and a charger. One evaluator indicated the list price for the Genesis C236-SL3 exceeded his expectations, four evaluators stated it met all their expectations, two stated it met most of their expectations, and two said it met some of their expectations. One evaluator noted that while the price is too high, the lifetime warranty gives some justification for the initial cost.
- **Warranty/Service Plans:** The Genesis C236-SL3 comes with a lifetime warranty on the tool and electronics, and a 3-year warranty on the battery from Milwaukee. Genesis has a 24-hour on-site repair service and if the tool needs to go back to the manufacturer, a loaner tool will be provided. Six of the evaluators indicated the Genesis C236-SL3 warranty/service plan exceeded or met all their expectations, noting the lifetime warranty shows confidence in the product by the community. Three evaluators stated it met some of their expectations as the Genesis warranty/service plans were not clear and they did not know whether the user needed to register the tool and if the warranty only covered parts or covered parts and labor.

4.1.3.4 Maintainability

The Genesis C236-SL3 received a maintainability score of 3.9. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Training:** Genesis offers in-service training, at no cost, with the purchase of the tool as well as local training at the crash course village on-site at Genesis. Seven evaluators indicated the available training options exceeded or met all their expectations, while two evaluators stated it met most of their expectations. Evaluators appreciated the flexibility and scalability offered for all department sizes.
- **Customer Service:** Genesis offers 24-hour on-site service repairs and provides a loaner tool if repairs need to take place at the manufacturing facility. The majority of the evaluators indicated the customer service, as described, exceeded or met all their expectations and one evaluator stated it met most of their expectations.
- **In-House Maintenance:** Evaluators provided mixed feedback on the in-house maintenance criterion. One evaluator indicated the in-house maintenance exceeded expectations as the ability to conduct in-house maintenance and the availability of a loaner program allows departments to stay fully prepared and equipped for response operations. Two evaluators stated that Genesis' in-house maintenance met all their expectations, and four stated it met

most of their expectations. One evaluator said that the Genesis in-house maintenance met some of their expectations and another said it met none of their expectations. One of these two evaluators found the vendor lacked detail on what end-user maintainability exists and whether agencies could certify in-house technicians. The other evaluator was skeptical that Genesis could train someone to rebuild and maintain the tool in one day.

4.1.3.5 Deployability

The Genesis, C236-SL3 received a deployability score of 3.7. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Storage Conditions:** The Genesis C236-SL3 has a storage temperature range of -4 to 132°F . Four of the evaluators indicated the temperature storage condition of the Genesis C236-SL3 exceeded or met all their expectations; one of these evaluators stated the range would allow for varied storage options and another stated the range exceeds the most likely areas where they would be stored. Five stated it met most of their expectations, attributing this to excessive heat in some regions of the country.

4.2 Spreaders

4.2.1 HURST, SP555 E3

The HURST SP555 E3, shown in Figure 4-11, weighs 43.9 pounds and measures 36.3 inches long, 10.4 inches wide, and 10.0 inches high. The spreader has a spreading distance of 28.7 inches with standard tips. Its highest spreading force is 16,186 pound-force (lbf) and its lowest spreading force is 11,016 lbf. The SP555 E3 spreader has a pulling distance of 22.4 inches with a highest pulling force of 10,341 lbf, and lowest pulling force of 6,925 lbf. The tool has an operating noise level of 67 dBA. The HURST SP555 E3 has an MSRP of approximately \$16,000, which includes the spreader, two batteries, and a battery charger. Each tool has a HURST warranty that covers defects in material (hardware and electronics) 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.



Figure 4-11 HURST SP555 E3

Image Credit: HURST Jaws of Life

The HURST SP555 E3 received an overall assessment score of 4.3. Evaluator comments provided throughout the assessment are reported below, grouped by SAVER category. In each category, the criteria are listed according to their order of importance as assigned by the focus group.

4.2.1.1 Capability

The HURST SP555 E3 received a capability score of 4.6. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Battery Performance:** Seven evaluators indicated that the SP555 E3's battery performance exceeded their expectations based on the manufacturer-provided specification of 60 minutes. One evaluator added that the ability to plug the battery into the charger and leave it there,

knowing that the battery is equipped with safety settings to not charge when not needed, was beneficial for operations and maintenance.

- **Battery Operating Time:** All evaluators indicated that the battery operating time either exceeded or met all their expectations. Most evaluators were able to use the spreader for at least 60 minutes, which was the timeframe identified by the manufacturer. Two evaluators noted the auto-shutoff time of 60 minutes was useful for continuous operations.
- **Visual Displays:** The majority of the evaluators indicated that the visual displays on the SP555E3 exceeded their expectations, while it met all expectations of the other evaluators. The lights were bright enough to be visible during daylight operations, shown in Figure 4-12 (left), which includes a closeup image of the main switch, battery indicator, load indicator, illumination direction indicator, and warning and control lights. Evaluators noted that the layout, position, and variety of displays were beneficial to operations. Additionally, a battery-life indicator displays on the back of the battery, shown in Figure 4-12, allows those on the scene to obtain situational awareness without having to ask the operator for battery life status.



Figure 4-12 HURST SP555 E3 Visual Displays (left) and Rear Battery Status Visual Display (right)

- **LED Lights:** Overall, evaluators found the LED lights met most of their expectations. The SP555 E3 is equipped with two LEDs, shown in Figure 4-13. Evaluators found the LED lights to be very bright and even visible during daylight hours but would have preferred having additional lights. It was also noted that the placement of the lights was not ideal because they're in a location where an operator's hand would partially cover the LEDs in use, limiting the amount of visibility provided.

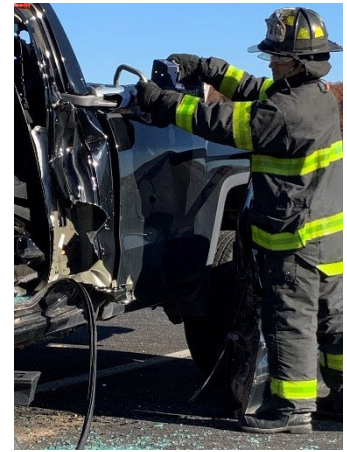


Figure 4-13 LED Lights on SP555 E3 (left), LED Lights Visible During Daytime Operations (right)

4.2.1.2 Usability

The HURST SP555 E3 received a usability score of 4.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Ergonomics:** Eight evaluators indicated the SP555 E3 met all their expectations as they found the weight to be evenly distributed, making the tool well balanced. Additionally, the star grip valve, sometimes referred to as the throttle, was well received because it enabled operators to use the spreader in any position and because it had to be pressed and held to turn the tool off (i.e., it could not be turned off if accidentally pressed during operations). One evaluator indicated it met most of their expectations, citing that the handle made the tool operable in only one direction. Two evaluators indicated they'd prefer a 360-degree handle for more versatile movements.
- **Ease of Use:** All evaluators indicated that the spreader exceeded or met all their expectations. The throttle, shown in Figure 4-14, was well received and made the tool easy to use as it can be operated with just an index finger or thumb and eliminates the need for the operator to move their entire hand.
- **Portability:** Overall, evaluators found that the SP555 E3 met all their expectations related to portability. While they noted that the tool was heavy, weighing in at 43.9 pounds, the spreader's design, including handle and control handle construction and placement, made it balanced and easily transportable, as show in Figure 4-15.
- **Compatibility with PPE:** All evaluators indicated the spreader met all or most of their expectations when operating the tool while wearing PPE (e.g., duty uniforms or turnout gear and gloves). Evaluators noted the tabs on the collar of the spreader made it easy to operate, even when wearing gloves. Additionally, there were no difficulties observed or reported while working the throttle or removing batteries while wearing gloves.



Figure 4-14 HURST SP555 E3 Throttle (circled)



Figure 4-15 HURST SP555 E3 Being Transported

4.2.1.3 Affordability

The HURST SP555 E3 received an affordability score of 3.9. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Replacement Battery Cost:** Replacement and extra batteries are available for purchase at a cost of \$800 each; eight evaluators determined that this met all their expectations, while one evaluator found replacement battery cost to meet most of their expectations. One evaluator commented that the price of the batteries is worth the excellent performance of the battery.
- **Initial List Price:** The HURST SP555 E3 spreader has an MSRP of \$16,000, which comes with two batteries and a charger. Two evaluators said this was too expensive, but the majority found it reasonable as it was comparable to other battery-powered cutters on the market.
- **Warranty/Service Plan:** The SP555 E3 comes with a lifetime warranty, which is expected to be approximately 10 years. The warranty covers parts and labor for the first three years and only parts for years 3 through 10. The HURST proprietary batteries come with a 3-year warranty and are good for 1,000 full charge cycles. The HURST warranty exceeded expectations for four evaluators and met all expectations for five evaluators.

4.2.1.4 Maintainability

The HURST SP555 E3 received a maintainability score of 4.4. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Training:** All evaluators indicated that HURST's training offerings, which include on-site training with a regional specialist at the time of delivery, exceeded or met all their expectations.
- **Customer Service:** Customer service is provided via regional dealers; annual service contracts are available and priced by dealers individually. Most evaluators found HURST's customer service to exceed or meet all their expectations, while one evaluator stated it met most of their needs.

4.2.1.5 Deployability

The HURST SP555 E3 received a deployability score of 4.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Start-Up Time:** All evaluators indicated that the SP555 E3 either exceeded or met all their expectations. This was attributed to there being either no, or very minor, hesitation between turning the tool on and being able to use it. Additionally, one evaluator noted that when the tool was turned on, it picked up at the power level in which it was turned off at (e.g., if the tool is turned off at full power, it turns on at full power), which was viewed as a time saver during extrication operations.
- **Storage Conditions:** The SP555 E3 storage conditions include a temperature range of -22°F to $+140^{\circ}\text{F}$, which met the expectations of all evaluators.

4.2.2 Holmatro Pentheon PSP40

The Holmatro Pentheon PSP40 Spreader, shown in Figure 4-16, weighs 42.8 pounds and measures 37.6 inches long, 10.6 inches wide, and 10.9 inches high. The tool uses a five-stage pump and has a spreading distance of 28.5 inches. The PSP40's highest spreading force is 15,557 lbf and its lowest spreading force is 8,790 lbf. The tool has a pulling distance of 24.1 inches. Its highest pulling force is 11,623 pounds and lowest pulling force is 6,070 pounds. The tool has an operating noise level of 67 dBA at 13 feet. The Holmatro Pentheon PSP40 has an MSRP of \$12,340, which includes two batteries and a charger.



Figure 4-16 PSP40 Spreader

Image Credit: Holmatro

The Holmatro Pentheon PSP40 Spreader received an overall assessment score of 4.0. Evaluator comments provided throughout the assessment are reported below, grouped by SAVER category. In each category, the criteria are listed according to their order of importance as assigned by the extrication tools focus group.

4.2.2.1 Capability

The Holmatro Pentheon PSP40 Spreader received a capability score of 4.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Battery Performance:** Three evaluators indicated that the Pentheon PSP40 Spreader's proprietary battery performance exceeded their expectations based on the manufacturer-provided specification of 60 minutes. Two evaluators added that the ability to charge the Holmatro batteries on the tool and in the charger using the daisy chain cord was a nice feature. Two evaluators also added that the emergency restart feature of the battery to remove the tool from a spread without hot swapping batteries was a valuable safety feature.
- **Battery Operating Time:** Four evaluators indicated that the Pentheon PSP40 Spreader's battery operating time of approximately one hour exceeded their expectations based on the manufacturer-provided specification of 60 minutes. Most evaluators were able to use the spreader for at least 60 minutes, which was the timeframe identified by the manufacturer. One evaluator noted that the PSP40 Spreader's battery operating time exceeded the amount of time that they would need to use it during an extrication operation.
- **Durability:** The PSP40 has an IP rating of 57, which exceeded the expectations of five evaluators, met the expectations of three evaluators, and met some of the final evaluator's expectations. Several evaluators believed the curved battery design would protect the battery if the tool were dropped. One evaluator indicated that while the tool can be submerged, his expectation is that it should be able to be submerged at least six feet under water.
- **Visual Displays:** The Holmatro proprietary battery has state-of-charge indicators on the battery, shown in Figure 4-17. Two evaluators indicated that the visual displays on the PSP40 exceeded their expectations, four said the displays met all their expectations, and three evaluators indicated that the displays only met some of their expectations. While some evaluators had no difficulty seeing the green, yellow, and red indicator lights on the proprietary Holmatro battery, other evaluators had difficulty seeing the indicator lights, especially in bright sun, and felt that the indicator lights could be brighter. Two evaluators commented that the yellow and red lights were especially hard to see. Two evaluators indicated that the lights were not intuitively placed (i.e., on the side of the tool) and required the operator to look for them.
- **Accessories:** Five of the evaluators found the accessories for the PSP40 to exceed their expectations. However, four evaluators indicated that the accessories met some or most of their expectations. Four evaluators did not like the design of the shore power accessory for the PSP40. This accessory uses a battery adapter on the tool to allow the PSP40 to operate on normal household power (110V AC). The evaluators found the transformer box is too close to the tool, as shown in Figure 4-18.



Figure 4-17 Holmatro Battery with State of Charge Displayed

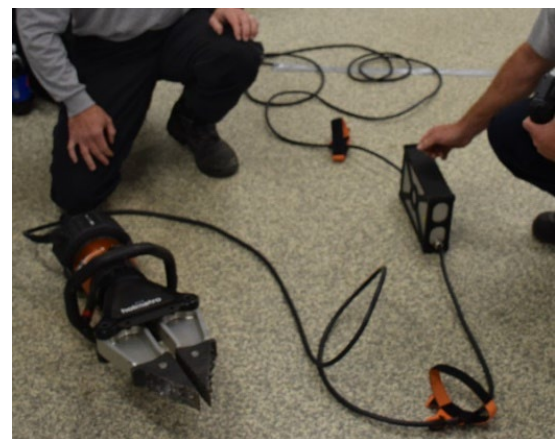


Figure 4-18 Holmatro Shore Power Adaptor

- **Anti-jam release:** All evaluators indicated that the battery operating time either exceeded or met all their expectations. All the evaluators indicated that they appreciated the PSP40 reserve battery feature that allows the operator to restart the tool to remove it from a spread without “hot swapping” the drained battery. Several evaluators did not like the danger of trapping the operator’s hand on the control handle; the Holmatro PSP40 does not have a guard on the control handle, so if the operator lets their control hand be pulled into the vehicle as they are making a spread, it is possible to trap that hand and not have the ability to reverse the tool using the trapped hand.
- **Battery Operating Conditions:** Holmatro batteries can operate in temperatures from -4°F to 131°F . Six evaluators indicated that the Holmatro battery operating conditions exceeded or met all their expectations. The other three evaluators said the battery operating conditions met most of their expectations. These evaluators were concerned that extreme temperatures in the southern states (e.g., highway surface temperature and interior storage) may exceed the Holmatro’s battery operating conditions.

4.2.2.2 Usability

The Holmatro Pentheon PSP40 Spreader received a usability score of 4.0. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Ergonomics:** The Holmatro PSP40 Spreader has a curved proprietary battery in the middle of the tool, as highlighted in Figure 4-19, a 360° handle at the front of the tool, and a throttle control handle at the rear of the tool. Two evaluators found the ergonomics of the PSP40 to exceed their expectations and six evaluators indicated that it met all their expectations. One evaluator found the PSP40 met most of their expectations. Many evaluators appreciated the ability to manipulate the PSP40 spreader using the 360-degree front handle and found the tool comfortable to use and well balanced. However, several of the evaluators did not like the rotating control throttle handle at the rear of the tool and cited safety concerns that the operator’s hand could become trapped on the control handle and the operator would not be able to reverse the tool to free the hand. During one scenario, an evaluator found the PSP40 to stick mechanically, resulting in it continuously operating and causing concern.
- **Ease of Use:** The majority of evaluators found the Holmatro PSP40 spreader to exceed or meet all their expectations, specifically noting that the front handle and control throttle in the rear was easy to use. However, two evaluators noted it took time to learn which way to turn the throttle to open and which way to turn to close the cutter. Two other evaluators stated it was intuitive. One evaluator stated they appreciated that the tool stopped when it reached maximum pressure. Another said the balanced body of the tool helped with ease of use. One evaluator commented that the startup button on the PSP40 should be recessed or require a double push to turn off because it may be too easy to shut off.



Figure 4-19 Holmatro’s Curved Battery (circled) on the PSP40

- **Portability:** Six evaluators indicated that the Holmatro PSP40 exceeded or met all their expectations for portability, finding the tool to be well balanced due to the body of the tool featuring a curved battery. Two of these evaluators commented that they did not get tired during or after operating the PSP40. Three evaluators indicated that it met some or most of their expectations, suggesting that a larger gap around the bar in the middle of the 360-degree carrying handle would allow the operator to more comfortably grip the tool to carry it down range (bar in handle shown in Figure 4-20). These evaluators could not fit their gloved hands in this gap to carry the tool in a natural and comfortable fashion.



Figure 4-20 Holmatro PSP40 Carrying Handle (circled)

4.2.2.3 Affordability

The Holmatro PSP40 received a deployability score of 3.3. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Replacement Battery Cost:** Replacement batteries are available for purchase for \$734. Six evaluators indicated that the Holmatro PSP40 battery replacement cost met most or some of their expectations. Three evaluators said that it met some of their expectations; one of these evaluators found the configuration of the battery (arched into the tool) to be valuable but indicated that the battery replacement cost of more than \$700 was expensive.
- **Warranty/Service Plans:** The Holmatro PSP40 spreader received its lowest ratings for Warranty and Service Plans. Most of the evaluators indicated that the warranty and service plans met most or some of their expectations. While Holmatro offers a lifetime warranty that covers defects in material and workmanship and a two-year warranty for batteries, the internal electronics are only covered by the warranty for one year. Most of the evaluators commented that the electronics warranty was too short.

4.2.2.4 Maintainability

The Holmatro PSP40 Spreader received a maintainability score of 4.1. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Training:** Operational training is included with the purchase of the Holmatro PSP40 spreader. There are also training and videos available online. Six evaluators indicated that training for the PSP40 spreader exceeded or met their expectations. One evaluator found it advantageous that vendor representatives are located in every state within the United States to help facilitate training needs. Evaluators also noted that the training available to allow for in-house service is beneficial. Three evaluators said the offerings met most of their expectations; one of these evaluators expressed concern about the additional cost for agencies to send personnel to in-person training but noted the benefit of being able to repair equipment in-house with the completion of said training.
- **Customer Service:** According to the vendor, customer service is available by phone, email, and video from 8:00 a.m.–6:00 p.m. eastern time and any time at local distributors. All evaluators noted that the stated customer services exceeded or met their expectations. Evaluators noted they could get a start on resolving issues by connecting with customer service and leveraging

vendor representatives in their respective states. One evaluator mentioned that tools frequently need to be sent back to the manufacturer for servicing, thus emphasizing the need for good customer service

- **In-House Maintenance:** Holmatro recommends annual service on the PSP40 by a Holmatro-trained technician, but they offer training for agencies to service their own tools by attending a weeklong course offered by Holmatro in Maryland for \$1,700, plus travel expenses. This training requires recertification every three years. Seven evaluators found Holmatro's in-house maintenance to exceed or meet their expectations, highlighting the benefit of having a wired connection feature to run diagnostics on the tool. Two evaluators indicated that it met most of their expectations, noting the cost and need to travel to Maryland for the training did not meet their expectations as it would be a burden on department resources, which could limit personnel's ability to attend.

4.2.2.5 Deployability

The Holmatro PSP40 spreader received a deployability score of 4.4. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Start-up time:** Five evaluators indicated that the PSP40 exceeded their expectations for start-up time and four evaluators indicated that it met their expectations. The evaluators commented that once you turned it on it was ready to go.
- **Storage Conditions:** Five evaluators indicated that the PSP40 storage conditions exceeded or met their expectations. Four evaluators indicated that the storage conditions met some of their expectations and expressed concern that storage conditions could be outside the operable temperature range (-4°F to 131°F) as not all response vehicles are temperature controlled and compartments can exceed 131°F .

4.2.3 Genesis S49-SL3 EForce

The Genesis S49-SL3 EFORCE, shown in Figure 4-21, weighs 45.6 pounds and measures 38.7 inches long, 11.1 inches wide, and 9.5 inches high. It has a spreading distance of 28.9 inches. The tool's highest spreading force is 17,100 lbf and lowest spreading force is 11,475 lbf. It has a pulling distance of 22 inches. Its highest pulling force is 12,150 lbf and lowest pulling force is 6,750 lbf. The Genesis S49-SL3 has an MSRP of \$13,825, which includes two batteries and a charger.

The Genesis S49-SL3 EForce received an overall assessment score of 3.5. Evaluator comments provided throughout the assessment are reported below, grouped by SAVER category. In each category, the criteria are listed according to their order of importance as assigned by the extrication tools focus group.

4.2.3.1 Capability

The Genesis S49-SL3 EForce received a capability score of 3.0. Evaluator feedback on evaluation criteria related to this SAVER category included:



Figure 4-21 S49-SL3 EFORCE

Image Credit: Genesis Rescue Systems

- Battery Performance:** The S49-SL3 EForce operates off a Milwaukee Lithium Ion 5 AH battery. Evaluators provided mixed feedback on the battery performance; two evaluators stated the battery performance met all their expectations, two said it met most and five evaluators stated met some of their expectations. One evaluator noted that the battery is not as readily available as the Milwaukee M18 battery, which runs many other tools. The spreader has a 30-second auto shut off feature, which three evaluators found to be inconvenient to their operations; a 45–60 second timeframe would have been preferred. Two evaluators stated they didn't have adequate time to stop and look for their next move, or get into the right position, before having to turn the spreader back on.
- Durability:** Most evaluators agreed that the Genesis S49-SL3 EForce could have benefitted from increased durability. Four evaluators stated the durability exceeded or met all their expectations. The –22°F to +140°F temperature range was attributed to the reason for the tool exceeding expectations for one evaluator. Five evaluators found it met most of their expectations. It was noted that the tool can still be affected by water despite the optional accessory of a waterproof bag. Two evaluators noted that the plastic housing felt delicate and that they handled this spreader with more care than others. For example, one evaluator said they would stop and reposition instead of pushing the spreader to its limits for fear of causing damage. Additionally, one evaluator noted they could envision a situation in which the battery could be torn off because of its location on the rear part of the spreader's handle.
- Visual Displays:** The battery indicator lights on this tool don't stay constantly lit—the user must press a button, and sometimes adjust their positioning, to check the remaining battery life. Evaluators took issue with this feature, noting that the user will not notice the tool is dying while working and the user cannot rely on the sound/feel of the tool to know battery is low. Six evaluators found this feature to meet most of their expectations and two evaluators stated visual displays met none of their expectations. One evaluator didn't mind the limited display and stated the product met all their expectations because they would put a new battery on when the one in use dies.
- Anti-Jam Release:** Five said the anti-jam release for the S49-SL3 EForce met some of their expectations and three evaluators stated the tool met none of their expectations. Evaluators were concerned with the anti-jam release performance of this tool. In one instance, the tool did not depressurize; rather it stopped and stayed in place until the battery was changed. Had the battery died when the tool was up against a B-post, the user would not be able to swap the battery. The lack of a release mechanism did not matter as much for a spreader as opposed to its cutter counterpart, but all evaluators had concerns. One evaluator stated the product met most of their expectations, noting that the anti-jam release mechanism does not matter as much for spreaders as it does for cutters as spreaders won't shift left or right or pivot and put the user's hand at risk of getting stuck.



Figure 4-22 Genesis S49-SL3 EForce Used to Spread the Door of an Upside Down Car

4.2.3.2 Usability

The Genesis S49-SL3 EForce received a usability score of 3.4. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Ergonomics:** One evaluator found the S49-SL3 to meet all their expectations, six found it met most of their expectations, one said it met some of their expectations, and another said it met none of their expectations. While evaluators appreciated the simplicity of the trigger that powered the tool, one noted they bumped it a few times before getting used to it and another noted the user had to stand to the side of the tool in order to operate it effectively. It was described as intuitive but not always convenient and one evaluator mentioned a user's finger may begin to feel fatigued more than with a traditional throttle mechanism. The main complaint by evaluators was the fixed bar handle (though one evaluator did find it useful). They stated it felt awkward, not well balanced, and in particular it felt "tail heavy." It also limited the user's ability to hold the tool in certain positions. One evaluator also noted that the battery pack at the back of the tool, shown in Figure 4-23 (above), restricted their job at times as it would shut down and they would have to get in a different position to achieve the job. They stated, "We had to move our body more than moving the machine."
- **Ease of Use:** Seven evaluators stated the ease of use exceeded or met all their expectations, while the remaining two evaluators thought it met most or some of their expectations. Evaluators appreciated the trigger button, circled in Figure 4-24, because it had a static position and therefore it was easy for them to know which way their tool was moving. More traditional throttle gears may cause some disorientation when operating underhand or in other precarious positions. Two evaluators specifically called out the benefit of the ability to feather the trigger. The two-stage motor was well received because it left no guessing as to when the tool was shifting gears (it gave an auditory indication of the operation) and it was easy to turn on and off.



Figure 4-23 Genesis S49-SL3 EForce Battery Pack (circled) During Operations



Figure 4-24 Trigger Button (circled) on the Genesis S49-SL3 EForce During Operations



4.2.3.3 Affordability

The Genesis S49-SL3 EForce received an affordability score of 4.2. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Replacement Battery Cost:** While the evaluators felt the price of replacement batteries was reasonable (commercially available with an estimated price range of \$160–\$230, depending on seller), one evaluator expressed concern when considering the price against the performance. The battery cost exceeded all the evaluators' expectations, barring one who stated it only met most of their expectations.
- **Warranty/Service Plans:** The warranty/service plans exceeded or met the expectations of six evaluators. Three evaluators said this met some or most of their expectations as the warranty/service plans were not clear and did not specify whether the user needed to register the tool and if the warranty only covers parts or includes labor. Since these tools can be a great expense to some agencies, knowing all the costs that may be associated with the life of the tool is imperative.

4.2.3.4 Maintainability

The Genesis S49-SL3 EForce received a maintainability score of 3.8. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Training:** Genesis offers in-service training, at no cost, with the purchase of the tool as well as local training at the crash course village on-site at Genesis. Eight evaluators stated the training offered exceeded or met all their expectations. One found it met some of their expectations, as they were skeptical of potential unstated costs.
- **In-House Maintenance:** Evaluators found the vendor lacked detail on what end-user maintainability exists and whether agencies could certify in-house technicians. Three evaluators found the in-house maintenance offered to exceed or meet all their expectations and six found that it met most or some of their expectations.

4.2.3.5 Deployability

The Genesis S49-SL3 EForce received a deployability score of 3.5. Evaluator feedback on evaluation criteria related to this SAVER category included:

- **Start-up Time:** While evaluators liked that the startup time was instantaneous, the 30-second time limit for standby mode proved limited for some. This led to five evaluators to state it met all their expectations, two most of their expectations, and two indicated it met some of their expectation.
- **Storage Conditions:** Eight evaluators stated the storage conditions met all or most expectations. One evaluator stated that it met some, noting that the inability to charge the battery while on the tool is a limiting factor.

5.0 SUMMARY

Table 5-1 and Table 5-2, respectively, summarize the advantages and disadvantages of each cutter and spreader product as identified by the evaluators.

Individual responder agencies that intend to purchase extrication tools should carefully research the capabilities and features of available tools to identify products best suited to their operational needs.

Table 5-1 Cutters Advantages and Disadvantages







Manufacturer/Product		Advantages	Disadvantages
 <p>HURST/S789 E3</p>		<ul style="list-style-type: none"> • “Box cut” designed blades cut and compress metal without causing the tool to pivot • Longest manufacturer-reported battery operating time • Bright, well-positioned, and comprehensive visual display layout • Additional battery-life indicator display on the back of the tool allows for situational awareness to those on scene 	<ul style="list-style-type: none"> • Placement of LED lights is not ideal as an operator’s hand would partially cover the LED, limiting visibility • Battery location at the back of the tool could impact durability
MSRP: \$14,000	Overall Score: 4.2		
 <p>Holmatro/Penttheon PCU50</p>		<ul style="list-style-type: none"> • Front handle and control throttle in the rear are easy to use • Well balanced due to the curved battery, battery placement, and rear handle • Ability to charge the battery on the tool and another in the charger using daisy chain • Audible change in pitch to indicate a user can stop throttling 	<ul style="list-style-type: none"> • Battery replacement cost • Bar in the middle of the 360-degree carrying handle offers limited space to fit gloved hands to carry the tool in a natural and comfortable fashion • Non-recessed power button can lead to accidental shut off • Some difficulty seeing the indicator lights, especially in bright sun
MSRP: \$14,000	Overall Score: 4.0		
 <p>Genesis/C236-SL3 EForce</p>		<ul style="list-style-type: none"> • NXTGEN blades cutting insert availability • Ideal control lever (throttle) placement and operation • Comprehensive training offerings (in-service training at no cost as well as a crash course village on-site at Genesis) 	<ul style="list-style-type: none"> • Unbalanced due to length and design of backend • Adjustable handle further detracted from ergonomics as the locking mechanism resulted in continued movement during use and transportation • Lowest manufacturer-reported battery operating time
MSRP: \$13,740	Overall Score: 3.5		

Table 5-2 Spreaders Advantages and Disadvantages

Manufacturer/Product		Advantages	Disadvantages
 <p>HURST/SP555 E3</p>		<ul style="list-style-type: none"> Longest manufacturer-reported battery operating time Star grip valve (throttle) allows the spreader to be operated in any position Brightness, layout, position and comprehensive visual displays Additional battery-life indicator display on the back of the tool allows for situational awareness to those on scene 	<ul style="list-style-type: none"> Placement of LED lights is not ideal as an operator's hands would partially cover the LED, limiting visibility Battery location at the back of the tool could impact durability
MSRP: \$16,000	Overall Score: 4.3		
 <p>Holmatro/Pentheon PSP40</p>		<ul style="list-style-type: none"> Front handle and control throttle in the rear is easy to use Well balanced due to the curved battery, battery placement and rear handle Ability to charge the battery on the tool and another in the charger using daisy chain The tool stops when it reaches maximum pressure 	<ul style="list-style-type: none"> Battery replacement cost Bar in the middle of the 360-degree carrying handle offers limited space to fit gloved hands to carry the tool in a natural and comfortable fashion Non-recessed power button can lead to accidental shut off Some difficulty seeing the indicator lights, especially in bright sun
MSRP: \$12,890	Overall Score: 4.0		
 <p>Genesis/S49-SL3 EForce</p>		<ul style="list-style-type: none"> Easy to use Trigger button's static position makes it easy to know which way the tool was moving Comprehensive training offerings (in-service training at no cost as well as a crash course village on-site at Genesis) 	<ul style="list-style-type: none"> Unbalanced due to length and design of the backend The backend design restricts use, which required evaluators to alter positions and techniques Lowest manufacturer-reported battery operating time
MSRP: \$13,825	Overall Score: 3.5		



6.0 ACKNOWLEDGEMENTS

NUSTL thanks the assessment evaluators for their valuable time and expertise. Their insights and recommendations will assist responder agencies with making procurement decisions and guide the planning and execution of future SAVER projects. Appreciation is also extended to the Chicago Fire Department (Illinois), Dallas Fire-Rescue Department (Texas), Denver Fire Department (Colorado), Hurst Fire Department (Texas), Loudoun County Fire and Rescue (Virginia), New York City Fire Department (New York), and the United States Secret Service for allowing the evaluators to participate in this SAVER assessment, to General Motors for hosting, and to the Michigan State Police for facilitating.



7.0 REFERENCES

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- [2] K. Dooley, M. Norman, E. Morefield, and T. Lynch, "Battery-Operated Rescue Tools for Vehicle Extrication Focus Group Report," Department of Homeland Security Science and Technology Directorate, National Urban Security Technology Laboratory, 2022.
- [3] "IP Ratings," International Electrotechnical Commission, 2021. [Online]. Available: <https://www.iec.ch/ip-ratings>.



APPENDIX A. EVALUATION CRITERIA DEFINITIONS

Capability

Battery Performance: The battery performance and longevity as provided by the manufacturer and includes battery charge time.

Battery Operating Time: The run time while the tool is in use, built-in power saving features such as auto shut-off and standby mode, and the run time while the tool is in standby mode (where applicable).

Durability: The extrication tool's ability to withstand a variety of environmental conditions. This includes water, shock, and drop resistance. Military specifications (MIL-SPEC), military standards (MIL-STD), and ingress protection (IP) ratings can serve to evaluate extrication tools for durability.

NFPA 1936 Performance Rating: The results of various tool performance characteristics when tested by a third-party, independent laboratory in accordance with standards set forth in NFPA 1936 (2020). NFPA 1936 standardized tests applicable to battery-powered cutters and combination tools include an alphanumeric cutting performance levels for various material categories expressed as A#/B#/C#/D#/E#. This cutting performance level is based on the ability of a cutter to cut specific grades and thicknesses of formed steel stock. An optional F# test was added for manufacturers who claim the ability of their tool to cut high-strength materials.

Visual Indicators: The character or graphical displays of features such as battery status, power status, or force exertion.

Battery Operating Conditions: The environmental conditions that a battery can withstand (e.g., extreme temperatures).

Accessories: The additional components that can be used with an extrication tool to enhance its capabilities.

Anti-Jam Release: The ability of the device's blades or arms to decompress or depressurize should the battery die during operation.

LED Lights: The light emitting diodes that are incorporated into the exterior of the extrication tools to aid the operator's visibility when using the device.

Usability

Ergonomics: The design of the tool for physical ease of use, which includes maneuverability, balanced handle (e.g., thumb levers, activated throttles, twist grips), and battery placement.

Ease of Use: The intuitiveness of using the tool and making configuration adjustments including navigating through menus.

Portability: The ease with which the tool can be moved from one location to another, which includes the weight of the device including battery.

Compatibility with PPE: The ease with which the tool can be used with personal protective equipment (PPE) such as gloves.



Affordability

Replacement Battery Cost: The expense incurred when the battery needs to be replaced. It also includes whether the battery is commercial-off-the-shelf or proprietary.

Initial List Price: The manufacturer's suggested retail price. This does not include bulk discounts.

Warranty and Service Plan: The period of time and terms of coverage in which a vendor will replace or repair equipment that is not functioning properly.

Maintainability

Training: The content and format of resources included with initial purchase.

Customer Service/Vendor Accessibility: The resources and technical support provided by vendors, including a loaner policy, manuals, reference materials, and hours of vendor availability either by phone or online.

In-House Maintenance: The inspections and component replacements that can be performed by technicians within the user's agency or department, rather than having to be returned to the vendor or other approved service provider for maintenance.

Deployability

Startup Time: The amount of time needed after powering on, or exiting standby mode, until the tool becomes usable.

Mounting Options: The ability for the extrication tool to be affixed to various platforms, such as in-vehicle brackets.

Storage Conditions: The tool must be stored to maintain its efficacy (e.g., temperature-controlled environment, case durability, docking stations).

APPENDIX B. ASSESSMENT SCORING FORMULA

The overall assessment score for each product was calculated using the product's averaged criterion ratings and category scores. An average rating for each criterion was calculated by summing the evaluators' ratings and dividing the sum by the number of responses.

Category scores for each product were calculated by multiplying the average criterion rating by the criterion weight assigned by the focus group, thus resulting in a weighted criterion rating. The sum of the weighted criterion scores was then divided by the sum of the weights for each criterion in the category as seen in the formula and example below:

Category Score Formula

$$\frac{\sum(Average\ Criterion\ Rating \times Criterion\ Weight)}{\sum(Criterion\ Weights)} = \text{Category Score}$$

Category Score Example ⁱⁱⁱ

$$\frac{(4.3 \times 4) + (5 \times 4) + (4 \times 3) + (4.5 \times 3) + (4.5 \times 3)}{4 + 4 + 3 + 3 + 3} = 4.5$$

To determine the overall assessment score for each product, each category score was multiplied by the percentage assigned to the category by the focus group. The resulting weighted category scores were summed to determine an overall assessment score as seen in the formula and example below:

Overall Assessment Score Formula

$$\sum(Category\ Score \times Category\ Percentage) = \text{Overall Assessment Score}$$

Overall Assessment Score Example

<u>Capability</u>	<u>Usability</u>	<u>Affordability</u>	<u>Maintainability</u>	<u>Deployability</u>						
(4.0 × 33%)	+	(4.2 × 27%)	+	(4.2 × 20%)	+	(3.8 × 13%)	+	(4.5 × 7%)	=	4.1

ⁱⁱⁱ Examples are for illustration purposes only. Formulas vary depending on the number of criteria and categories assessed and the criteria and category weights.

APPENDIX C. INGRESS PROTECTION LEVELS (IP CODE)

This section provides information on the levels of ingress protection as specified by the two-digit designations in the IEC 60529 standard [3]. Table C-1 provides levels of solid ingress protection (first digit). Table C-2 provides levels of liquid ingress protection (second digit).

Table C-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

Table C-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 60 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