

ASC-TR-95-1005

EXCALIBUR® KNIFE FOR LIFE PRODUCT EVALUATION REPORT

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Aeronautical Systems Center
Weapons, Air Base and Range Product Support Office
ASC/VXO
314 W. Choctawhatchee Ave., Suite 104
Eglin AFB, FL 32542-5717

26 October 1995

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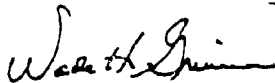
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WADE H. GRIMM
Program Manager

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13. ABSTRACT (Maximum 200 words) Final report of the commercial technology exploitation evaluation of a pneumatically powered rescue saw produced by Eliminator Industries Inc. of Riviera Beach, Florida. The evaluation was conducted by the 650 Air Base Wing, 95 Civil Engineering Group, Fire Protection Division at Edwards AFB, California between 1 and 5 May 1995. This evaluation was part of a continuing program to explore commercial off the shelf technology for application to Air Force firefighting requirements. The system met user requirements and has been recommended for addition to table of allowance 490, making it available to Air Force fire departments worldwide.					
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DEPARTMENT OF THE AIR FORCE
AERONAUTICAL SYSTEMS CENTER (AFMC)
EGLIN AIR FORCE BASE, FLORIDA



26 Oct 95

MEMORANDUM FOR HQ AFCEA/CEXF

FROM: ASC/VXO
314 Choctawhatchee Ave., Suite 104
Eglin AFB, FL 32542-5717

SUBJECT: Excalibur® Knife for Life Product Evaluation Report
(Ref: Test Plan, February 1995)

1. PURPOSE AND BACKGROUND. The purpose of this test was to assess the effectiveness and suitability of the Excalibur® Knife for Life manufactured by Eliminator Industries Inc. The goal was to evaluate an air powered disc cutting tool similar to the K-12 that would be lighter and not dependent upon gasoline, especially in a bare base environment. No light weight air powered disc cutter could be located in the commercial sector, but a unique new air powered rescue saw has been developed primarily for automobile extraction/rescue. The system evaluated uses an air powered saw to assist firefighters during rescue of injured or trapped personnel from aircraft or other vehicles. The evaluation was part of a continuing effort to explore commercial off the shelf technology for application to Air Force firefighting requirements. The goal is to provide cut away capability through aircraft metal, composite and canopy materials for firefighters. The evaluation was managed by the 650 ABW/CEF at Edwards AFB, California, between 1 and 5 May 95.

2. SYSTEM DESCRIPTION. The Excalibur® Knife for Life is pneumatically powered from any regulated 150-200 PSI source; SCBA bottle or fire truck air system. The Knife for Life is packaged in an aluminum housing and operates a reciprocating saw blade at 22,000 strokes per minute through a stroke length of $\frac{3}{4}$ inch. The control head weighs 2.8 pounds and operates very well underwater. The unit evaluated has a 25 foot expandable air hose and a single stage 4500 pound pressure regulator. The system has a glass cutting blade, effective on windshield glass, tempered glass and sheet rock/drywall. Two different metal cutting blades are available. One with 18 teeth per inch is recommended for aluminum, lexan, lucite, plastics, and fiberglass. The one with 24 teeth per inch is recommended for steel. The back of the control head has a glass penetration cutting edge to make a puncture point in windshields so that the glass cutting blade can achieve a solid cutting edge in the glass. The set stows in a vinyl coated canvas carry bag. The evaluation tool was serial number 362423.

3. METHOD. A series of materials, primarily aircraft components were cut with the Excalibur® Knife for Life. The materials were scrap pieces which were held in place for cutting by a boot on a slightly elevated surface. This resulted in more vibration than would normally exist on aircraft components still attached to an airframe. During all test activities the saw was powered with a 4500 PSI SCBA bottle. Lubrication provided by the manufacturer was used on all materials except wood. In all cases, multiple cuts were made to determine how the blade would react once it was dull from a cut. The manufacturer recommends a new blade for every rescue situation, while used blades are reserved for training/practice. Initial cuts in some materials were made with used blades due to the limit of blades available. Test activities were video recorded.

4. OBJECTIVES AND RESULTS. The following objectives were used to assess effectiveness, compatibility, reliability, maintainability, and availability of the Excalibur® Knife for Life when used to provide fire/rescue personnel assistance in aircraft and vehicle rescue, actual and training situations.

a. Objective E-1. Assess the effectiveness of the Knife for Life to provide access to aircraft and other vehicles during training and emergency response scenarios. The measure of effectiveness is system performance and time required to cut through various materials to rescue a trapped aircrew or passengers in an emergency environment. The criteria is not established. **Results:** The knife was used to cut as many different panels of material as available at the test location. The tool was used to cut wood, fiberglass panels, sheet metal, stainless steel, galvanized Steel pipe, solid stainless steel round stock, ½ inch steel plate, titanium alloy, B-2 composite material, A-37 aircraft skin (aluminum), an unspecified high temp honeycombed metal, A-37 canopy (plexiglas), and F-16 canopy (lexan). The performance of the tool is summarized in table 1.

b. Objective S-1. Assess the compatibility of the Knife for Life with the operational environment. The measure of effectiveness is a subjective evaluation of interoperability with other emergency response equipment and personnel. The criteria is not established. **Results:** The P-10 rescue vehicle used during this evaluation, has no vehicle air system. The P-19, P-23, and P-28 aircraft rescue fire fighting vehicles, although equipped with an air system, provide a maximum air pressure of 130 PSI, below the 150 PSI recommended for the tool. When powered by air from a Scott 4.5 thirty minute bottle, the maximum cutting time was 1 minute 15 seconds, while a Scott 4.5 one hour bottle provided up to 2 minutes 40 seconds of cutting time (different materials). Heat dissipation from the blade was a problem. A second individual was needed to apply lubrication during cutting operation and the lubrication proved to be marginally adequate, especially when making subsequent cuts on the same blade. Without lubrication teeth would brake off the blade, it would dull rapidly, and the temper on the blade would be lost. The vibration of the tool required two hand operation and after a single operation, user's remarked about hand and arm fatigue. The manufacturer recommendation is to use the tool in an up and down motion, but it must also be drawn through the material, actions requiring some technique and practice. The cutting operation would slow down when encountering any structure underlying the aircraft skin

TABLE 1
EXCALIBUR® CUTTING PERFORMANCE

TEST EVENT	BLADE USED	NEW or USED	MATERIAL	THICKNESS inches	CUT inches	TIME min:sec	BEGIN/END AIR PRESSURE	EASE OF PENETRATION	EASE OF OPERATION
1	918	New	Wood (Pine)	2 1/2	3 1/2	0:22	4000/3000	Good	Smooth /Steady
2	↓	Used	Wood (Pine)	2 1/2	3 1/2	0:18	3000/2000	Good	Smooth /Steady
3	↓	Used	Fiberglass	1/8	12 1/2	0:15	2000/0	Good	Excessive vibration
4	924	New	Sheet Metal	1/16	41	0:23	4000/3300	Very Good	Little resistance
5	↓	Used	Sheet Metal	1/16	41	0:20	3300/2500	Good	Jagged Edge
6	↓	Used	Stainless steel	1/4	31	2:10	2500/0	Good	Slow/steady
7	↓	Used	Stainless steel	1/4	approx. 26	2:40	4000/0	Good	Excessive frost on tool & hose
8	924	New	Galvanized Steel Pipe	1/4" wall	1 3/4 OD	0:30	4000/1000	Good	Blade very dull after cut
9	↓	Used	Same as 8	1/4" wall	1 3/4 OD	0:36	2 bottles	Good	Easy
10	↓	Used	Stainless Steel Wt training Bar	1	1	1:53	2800/0	Good	Easy
11	↓	Used	Same as 10	1	1	0:50	4500/1500	Good	Slow/Steady Blade bent to one side during cut
12	924	New	Steel	1/2	1 3/4	1:05	4500/0	Slow	Cut okay with bent blade
13	924	New	Titanium Alloy	1/8	5 1/2	2:25	4500/0	OK	Very Slow, blade hot, smoking
14	↓	Used	Titanium Alloy	1/8	3 1/2	2:05	4000/0	Slow	Very very slow, will hardly cut, some sparks
15	918	New	B-2 Composite w/ reinforcing ribs	1/4	22	2:15	3000/0	OK	Surging through material
16	↓	Used	B-2 Composite w/ reinforcing ribs	1/4	20	2:20	3000/0	OK	Blade dulled/lost temper
17	918	New	A-37 Canopy (plexiglas)	1/8	12	1:09	2000/0	Tool Hammer very effective	Did not finish cut
18	↓	Used	A-37 Canopy (plexiglas)	1/8	12	0:43	2000/0	Very good	Quick/Smooth
19	918	New	F-16 Canopy (Lexan)	1/2	12	1:10	4000/2000	Hammer won't penetrate edge start	Easy operation around turns
20	↓	New	F-16 Canopy (Lexan)	1/2	10	0:35	2000/0	Edge start	Slow/Steady, plastic melting, blade still sharp
21	924	New	A-37 Skin (Aluminum)	1/8	25	1:00	4000/2800	Edge start	Slow/Steady, blade still sharp
22	↓	Used	A-37 Skin (including rib)	1/8	28	1:10	2800/1200	Hammer punched good start hole	Good through skin
23	↓	Very Used	High Temp Metal Honeycombed	1/4	1/2	0:15	4000/2800	Poor	Barely cut struts
									Blade looking dull after cut
									Blade broke off at mounting 2" of missing teeth

(support struts). Some form of skin penetration was required to get the saw started, otherwise the saw would bounce around on the material. The saw was easy to set up quickly, an air bottle or a cutting blade could be changed out in less than a minute.

c. Objective S-2. Assess the reliability, maintainability, and availability (RM&A) of the Knife for Life. The measure of effectiveness is serviceability of the unit. The criteria is not established. **Results:** The middle two inches of the four inch blade receives the majority of wear and heat build up. The air regulation system would accumulate frost using the pressurized SCBA tanks. The regulator performed well under these conditions, but it was allowed to defrost between test events (ambient temperature approximately 70 °F). The tool itself got extremely cold during operation and required the use of gloves (normally worn during rescue work). Although daily lubrication is recommended, no instructions advise where to lubricate. Set screws for changing blades can easily be lost if backed off too far, also the special wrench could easily be misplaced in a field response scenario.

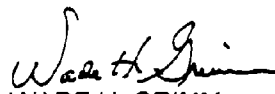
5. CONCLUSIONS. The Excalibur[®] Knife for Life cut all material presented, which were representative of materials encountered in a rescue situation. Speed and ease of penetration varies with material thickness and composition. Several demonstration cuts were presented in the video documentation illustrating the K-12 rescue saw. The large disc cutter was quicker than the Excalibur[®], on large exterior panels, but is too large to work in a confined space such as inside a cockpit or under an automobile dash board. Blade lubrication on the Excalibur[®] is fairly critical, occupying two individuals for most cutting tasks. When structural support members (i.e. aircraft ribs) are encountered, cutting speed can slow to approximately half speed, depending upon the size of a rib or strut. New aircraft composite materials may drive improvements to existing blade technology; as a minimum, a new blade should be used for all new rescue cuts. Users noted that hand and forearm muscles would be devitalized after a few minutes of steady cutting due to tool vibration (22,000 strokes per minute) and the manufacturer recommended technique of moving the saw in an up and down motion to fully utilize the cutting blade. In all video taped evaluation cuts, the sawing motion with the tool yielded faster cutting speeds through all materials. An edge or hole was required to start the tool cutting operation or the blade would bounce along the surface of a material. The use of SCBA compressed air resulted in the tool becoming too cold to use without gloves although the tool itself did not freeze-up during any test events. In colder climates (tested at 70 °F), frost formation could become a concern, but no test results indicate this as a problem. Use of dry compressed air or nitrogen gas could minimize the chilling effect that produces frost, but would result in a dedicated pneumatic source, not interchangeable with other SCBA equipment. It operates without dependency on gasoline and can accept regulated high pressure nitrogen or compressed air from bottles or a constant high pressure source. Spare parts must include replacement blade holding screws in a field environment. Training/practice with the tool can definitely effect the speed of cutting as demonstrated by different evaluation participants. Evaluators were impressed with the tool's ability to cut all materials presented and felt it a valuable asset in the rescue vehicle inventory.

6. RECOMMENDATIONS. This tool compliments, but does not replace, the large K-12 disc cutter currently part of the Air Force rescue inventory. It cut all materials identified in Table 1 and is especially useful in confined spaces where the K-12 saw cannot access. However, follow-on evaluation should determine if operation in a cold environment from SCBA bottles causes any freeze-up of the tool or regulator. Suggested improvements to the tool are:

a. An automatic lubrication system for the blade, possibly using some bleed air from the source.

b. An improved blade designed for the exotic materials incorporated in new generation aircraft.

In the interim, recommend the Excalibur[®] be stock listed and added to Table of Allowance 490 as required.


WADE H. GRIMM
Program Manager

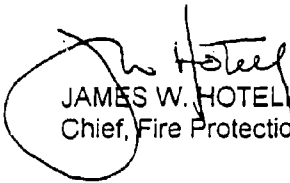
Attachments

1. Tool photos.
2. Distribution.

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Concur/~~non-concur~~ with the recommendations in this report.

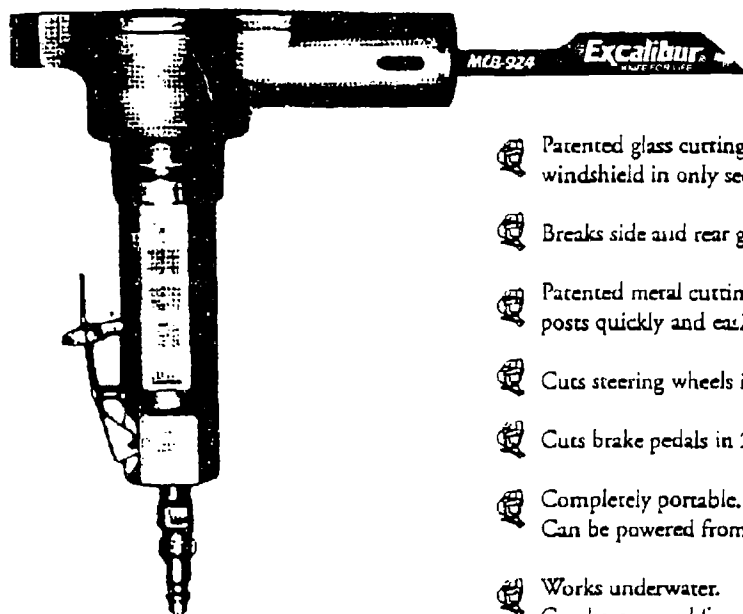

JAMES W. HOTELL
Chief, Fire Protection Division

TOOL PHOTOS

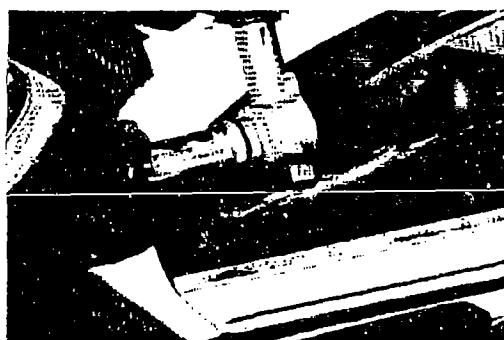
Excalibur®

KNIFE FOR LIFE

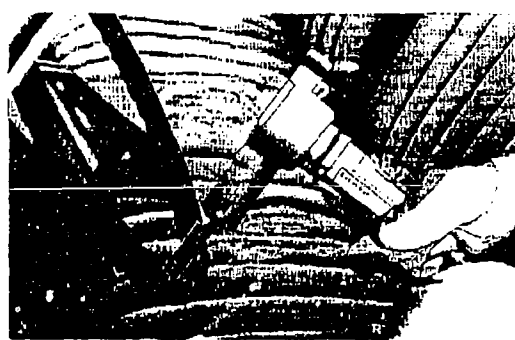
THE NEXT GENERATION
IN EXTRICATION



-  Patented glass cutting blade removes any windshield in only seconds.
-  Breaks side and rear glass with a touch.
-  Patented metal cutting blade cuts A, B, and C posts quickly and easily.
-  Cuts steering wheels in 10-20 seconds.
-  Cuts brake pedals in 20-30 seconds.
-  Completely portable.
Can be powered from a SCBA 2216 or 4500.
-  Works underwater.
Can be powered from a separate dive tank.
-  Invented by rescue professionals.



Penetrator tip on back of tool.



Tool cuts glass, plastic, metal and fiberglass.

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