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UNITED TESTING
SERVICES

CPSC REPORT NO. 20180519-A9E35-2147387862
Recall Number 12-117
UL 147 Compliance Failure Submission
February 14, 2019

Hand-Held Torch Failure and Injury Study

Related Brands Including: BernzOmatic, Medina, Worthington, Sears, Ace, and Lenox

Project Technicians: Anthony J. Roston, Manuel Marieiro

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Consumer Product Safety Commission No. 20180519-A9E35-2147387862
Recall Number 12-117, Supplemental Submission

EXECUTIVE SUMMARY

A number of severe burn injuries, including deaths, were caused by failure of certain handheld torch products manufactured by Worthington Industries, and its various subsidiaries and predecessors. The product failures date back to the 1970s despite corrective efforts by the manufacturer, and injuries and deaths continue to occur. A request has been submitted to the CPSC to extend recall number 12-117, issued February 23, 2012, to gas cylinders containing propane fuel, which are sold in the same affected cylinder units but were omitted from the recall. The affected cylinders suffer design defects at the center valve brazed joint area adjoining the center valves to the domed parent metal located on the top of the cylinders. Torch attachments containing a break-away safety feature suffer design defects in that the safety features have limited efficacy and have failed to prevent many cylinder failures. The manufacturer of these products is Worthington Industries. Worthington produces the products under its subsidiaries Worthington Cylinder Corporation and Worthington Cylinder Wisconsin. On July 1, 2011 Worthington purchased "BernzOmatic." Prior to the purchase date these products were manufactured by Worthington for Newell Rubbermaid Inc., which owned the trade name "BernzOmatic." This study therefore extends to all cylinders and torch attachments produced by Newell and its subsidiaries, including Irwin Industrial Tool Company.

Objectives

a) Identify circumstances under which the cylinders may fail, resulting in severe injury or death.

b) Examine destructive test X-RAY, SEM, EDS, and other data to determine if Worthington's manufacturing process complies with the requirements of 49 CFR 178.65.

c) Follow the manufacturer's test procedures and determine if the safety features are adequate to prevent unreasonable risk of injury.

d) Identify defects in the design of the fuel cylinders.

e) Identify defects in the design of the torch attachments containing various safety features.

f) Determine if manufacturing defects exist on one propane cylinder examined in relation to a pending litigation, Peralta v. Worthington, et al., case number 2:17-cv-03195-JJT (Federal Court, Phoenix, AZ).

g) Determine if manufacturing defects exist on a propane cylinder examined in relation to a pending litigation, Bailey v. Worthington, et al., case number 1:16-cv-07548 (Federal Court, Rockford, IL).

h) Determine if manufacturing defects exist on a propane cylinder examined in relation to an injury occurring in Massachusetts to one Mr. Jacob Avery caused by a propane-filled "BernzOmatic" brand cylinder.

i) Determine if manufacturing defects exist on a MAPP fuel cylinder examined in relation to a pending litigation, Shadbolt v. Worthington, et al., No. 18 of 2013, Court of the Queen's Bench for Saskatchewan, Canada.

j) Determine if the fuel cylinders are identical in all relevant respects regardless of their fuel contents (i.e. propane, propylene, Map/Pro, MAPP).

k) Determine if Recall Number 12-117 incorrectly describes the defect in the recalled cylinders.

l) Determine if Recall Number 12-117 should have extended to the propane-filled fuel cylinders.

m) Determine if the recalled fuel cylinders were identical in all relevant respects to the omitted fuel cylinders containing propane fuel.

n) Determine if cylinder brazing process should be replaced by welding process.

o) Determine if a safer alternative product design is available.

Summary of Findings

a) Failures Foreseeable By Manufacturer. In the 1970s the manufacturer correctly identified foreseeable misadventure in that force would often be applied to the tip of the torch attachments and exert leverage on the weak part of the cylinder just below the device mounting threads. This known area of vulnerability will be referred-to in this study as the "center valve brazed joint area".

b) 49 CFR 178.65 Compliance Failure. Failed cylinders in the Peralta and Bailey actions show failure of compliance with 49 CFR 178.65 in that they failed to have "complete penetration of the brazing material throughout the center valve brazed joint area."

c) UL 147 Compliance Failure. Failed cylinders in the Peralta and Bailey actions, and the subject cylinders in general, show failure of compliance with UL 147 sections 5.8, 7.1, 7.3, 7.5, 7.9, 8.2, 12.2, 17.3, 17.5, and 25.1.

d) Safety Feature Failure. The manufacturer's safety test procedures demonstrate that its torch attachment safety feature, called a "fracture groove, is not adequate to prevent cylinder failure and resulting catastrophic injury. Under UL 147 section 12.2 the should fracture on drop tests from 4 feet. However, the Fracture groove features manufactured from approximately June 2005 onward appear designed to fracture on 6 foot drop tests, and many will not fracture unless the cylinder is completely full (approx. 1 lb. 12 oz.). The fracture grooves are inconsistent insofar as one did reach a near-fracture on a 4-foot drop test, evidencing variance in the amount of force required to fracture the fracture grooves.

e) Design Defects In Fuel Cylinders. The manufacturer correctly identifies a defect in the cylinder whereby the neck area just below the device mounting threads is capable of failure upon the application of force to the tip of the torch attachments. However, the manufacturer's torch attachment safety design is inadequate to prevent failure when certain foreseeable conditions are met. One such foreseeable condition is the weakening of the parent metal at the brazed joint area due to flexing, removal, and remounting of the torch attachment over time. One example is cylinder SP-4, which contained copper compound spill-over on the threads, causing the application of repeat forces in mounting and dismounting.

f) Design Defects In Torch Attachments. The torch attachment fracture grooves appear designed to fracture only when used with a cylinder which is 100% full, but largely do not fracture when the cylinder weight is reduced due to fuel depletion during normal use. There were multiple Fracture groove designs, the latest proving to be the most hazardous to protect against foreseeable manufacturing defects at the neck of the cylinder. The trigger-locking mechanism on the TS4000 torch attachment is a design defect because it enables the user to remove his hand from the trigger and hold the cylinder at the bottom where the application of force to the tip of the torch would result in force being placed at the vulnerable neck area of the cylinder. The Fracture groove design is ineffective when the torch assembly is dropped and lands at various angles.

g) Manufacturing Defects In Peralta Cylinder. In addition to design defects, a manufacturing defect existed on a propane cylinder which caused injuries to Mr. Peralta in Peralta v. Worthington, et al., case number 2:17-cv-03195-JJT (Federal Court, Phoenix, AZ). Failing to meet the requirements of UL 147 section 7.9, The cylinder was weak and substandard at its neck, and sprung a leak which burned Mr. Peralta's hand, causing him to drop it onto the torch tip. The force was insufficient to break the fracture groove, but the cylinder ripped open at the neck, evidencing the manufacturing defect at the neck.

h) Manufacturing Defects In Bailey Cylinder. In addition to design defects, a manufacturing defect existed on a propane cylinder which caused injuries to Mr. Bailey in Bailey v. Worthington, et al., case number 1:16-cv-07548 (Federal Court, Rockford, IL). The tip of the torch lightly tapped against a solid object with force insufficient to cause the Fracture groove to break, but the cylinder breached at the neck, evidencing the manufacturing defect at the neck, and a failure to meet the requirements of UL 147 section 7.9.

i) Manufacturing Defects In Avery Cylinder. In addition to design defects, a manufacturing defect existed on the propane cylinder which injured Mr. Avery in Massachusetts. Failing to meet the requirements of UL 147 sections 17.3 and 17.5, the cylinder was exposed to foreseeable misadventure in the form of heat from a fire, but the heat was insufficient to cause the pressure relief valve to vent, or alternatively, the PRV did not vent as designed and intended. The cylinder breached at the vulnerable neck, separating the entire neck area from the body of the cylinder, evidencing a failure to comply with the requirements of UL 147 section 7.9.

j) Manufacturing Defects In Shadbolt Cylinder. In addition to design defects, a manufacturing defect existed on the MAPP-filled cylinder which injured Mr. Shadbolt in Shadbolt v. Worthington, et al., No. 18 of 2013, Court of the Queen's Bench for Saskatchewan, Canada. As was the case with the Peralta cylinder, and failing to meet the requirements of UL 147 section 7.9, the Shadbolt cylinder had a weak and substandard neck which leaked fuel and ignited, causing Mr. Shadbolt to drop the cylinder. The flame ignited a towel and the cylinder was exposed to heat as it leaked from the neck. Force was then applied to the tip of the torch by movement, but was insufficient to break the fracture groove. The cylinder nevertheless failed at the neck and ripped open, demonstrating manufacturing defects with both the cylinder neck and the PRV.

k) Cylinder Designs Identical for Propane, Mapp, Proylene, Map-Pro. The fuel cylinders are identical in all relevant respects regardless of their fuel contents (i.e. propane, propylene, Map/Pro, MAPP). The braze paste differs on some cylinders, identifying an additional design defect unique to cylinders containing MAPP fuel, and possibly some cylinders which contained propane fuel placed into cylinders intended for MAPP fuel. Therefore, while the design defects of the cylinders are identical in all relevant respects, cylinders containing MAPP fuel included an additional design defect in which the braze paste interacted with the MAPP fuel and weakened the cylinder, failing to comply with UL 147 section 7.1. It appears this defect may extend to propylene cylinders manufactured between the years 2008 and 2012 prior to the recall, if the "MAPP" cylinders were used for the MAP/Pro product after the MAPP fuel was discontinued in 2008.

l) Product Recall of 2012 Is Flawed. The product recall by Worthington Cylinders implemented on February 23, 2012 incorrectly describes the defect or otherwise omits mention of the defect of the brazed joint (neck). Worthington states in discovery (p.2:24-26) that the seal (o-ring) into which the torch attachment tube is inserted had "compatibility issues" (p.3:7-8) with the MAP/Pro and MAPP fuels, but not with propane. However, UTS has several pre-recall MAPP cylinders in its study inventory, all manufactured not later than the year 2008 (11 years ago), and none evidence any compatibility with the pre-recall seal materials. Two of those MAPP cylinders were opened and there is no evidence of caustic reaction. Therefore, while the stated reason for the recall is a caustic reaction between the MAPP and propylene fuels and the seal, it appears that the recalled cylinders also all contained the tripartite braze compound which contained phosphorus causing embrittlement and failure of the steel at the neck, as found by Expert Mr. Puttlitz (¶ 7) in the Mr. Tran case, in which failure of the brazed joint caused his death. The defect which should have been disclosed therefore is that the neck of the cylinder is unreasonably weak and prone to failure. The defect remains unresolved on the non-refillable tall (NRT) cylinders containing propane fuel, but does not appear to exist on the non-refillable short (NRS) cylinders.

m) Product Recall of 2012 Wrongly Omitted Propane Cylinders. The February 23, 2012 recall should have extended to the propane-filled fuel cylinders. Failure to recall these cylinders has lead to injuries and death, including the death of Ms. Marmont in a case pending on Los Angeles, Marmont v. Worthington, et al., 2:16-cv-00848-JAK-RAO.

n) Recalled Cylinders Identical to Non-recalled Propane Cylinders. The fuel cylinders recalled on February 23, 2012, containing "MAP-PRO, PROPYLENE AND MAPP" fuels, are the same cylinders used for the propane fuel in all relevant respects, excepting the seal material which UTS was unable to find to be caustic, but the propane cylinders were not included in the recall and continue to fail (Bailey, Peralta, Marmont, Avery).

o) Brazing Process Should Be Replaced by Welding Process. HSE in the UK (Section 8) prohibits brazing and mandates welding as the proper and superior method of assembly.

p) Alternative Safer Designs Exist. A safer alternative product design is available and already exists in a product the manufacturer calls a "non-refillable short" ("NRS") Those cylinders do not show evidence of failure. Other safer alternative designs are available and presented below.

Recommendations

1. Use welding instead of brazing for assembly as directed in HSE in the UK (Section 8) .

2. Immediate recall of all non-refillable tall cylinders (NRT), regardless of the type of fuel content, informing of vulnerability at the neck area of the cylinders.

3. Either discontinuation of the NRT cylinders, or increasing the steel thickness

from .021" to a thicker gauge to be determined for efficacy by appropriate engineering process.

4. If the NRT cylinders are not to be recalled, implement the safety sleeve or inverted mount designs shown at the conclusion of this report.

5. Comply with the requirements of UL 147.

6. Comply with UL 147 sections 7.3 and 7.4 for protection against rust and corrosion (Marmont fatality).

7. Redesign the Fracture groove features of the TS4000 torch attachments to fracture under less force akin to the force required to fracture the newer UL2317 design, meeting the requirements of UL 147 section 12.2.

8. Include a large and bold warning advising the user that sometimes the cylinders will fail at the neck and may cause injury or death, meeting the requirements of UL 147 section 25.1.

9. Include a large bold warning advising that over time, due to flex and repeated mounting and dismounting of the torch units, the cylinders weaken at the neck and can fail.

10. Establish an expiration date to avoid use of cylinders which may have rusted over time.

11. Remove the trigger-lock mechanism from the heavy TS4000 and TS7000 torch attachments.

12. Recall the TS4000 torch units and replace them with units which do not have the trigger lock feature and which have Fracture groove features that will fracture under much less force.

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1. INTRODUCTION

Handheld torch products are widely sold and used in the Continental United States and Canada, where this study is focused. These products consist of fuel cylinders and torch attachments. The fuel cylinders of concern are called "non-refillable tall" ("NRT") and contain propane, MAPP, and Propylene (MAP/Pro) fuels.

The cylinders were produced by the same manufacturer under various brand names.

The cylinders were originally manufactured for Newell Rubbermaid Incorporated and were marketed and sold by its division, Irwin Industrial Tool Company, under the brand name "BernzOmatic". In earlier years of production the cylinders were manufactured by Western Industries. In September 2004 Worthington Industries purchased the manufacturing facility from Western and continued with the manufacturing of the cylinders for Newell Rubbermaid. The cylinders were at that time manufactured at its facility located in Chilton, Wisconsin. The MAPP product was discontinued by Newell in early 2008 and replaced by propylene gas under the trade name, "MAP/Pro," while the propane cylinders are still produced.

In 2008 Newell (Irwin Industrial) sued Worthington Cylinder Wisconsin for breach of contract. On February 26, 2010 Newell obtained a jury verdict in the amount of $13,002,247.00 (ref. Irwin v. Worthington, 2:08-cv-00291-MR, North Carolina). However, on July 1, 2011 Worthington purchased BernzOmatic from Newell (Irwin Industrial) for $51.0 million.

During the various entity changes it was noted that propane-filled cylinders were failing at the neck area just below the threads to which the torch attachments affix.

This area is referred to as the "brazed bushing" and are governed under 49 CFR 178.65. The failures were apparently noted approximately in 1979, leading to creation of a failure report by one Mr. Roger L. Maxon, an internal quality control upper management employee at Newell. A safety feature was invented and designed by Newell's employee, Mr. John M. Nelson, an engineer in the product engineering department. Mr. Nelson's safety feature was called a "Fracture groove," which was a break-away point on the torch attachment intended to cause the tip of the torch to snap off if force should be applied to the tip of the torch.

The first version of the Fracture groove was implemented approximately in 1980.

At the time Mr. Nelson designed the Fracture groove feature, Bernzomatic's main business was the manufacture and distribution of gas fired torches and DOT 39 14.1 oz propane cylinders. However, Worthington began producing MAPP cylinders for Bernzomatic in 2004, and these products were also experiencing some failures at the center valve brazed joint area. The Fracture groove feature was therefore also used on the MAPP cylinders in hopes of preventing failures occurring at the center valve brazed joint area. The Fracture groove feature continued through several revisions to present, and is presently used with the propane and propylene cylinders, as well as older MAPP cylinders which remain in use by pre-2012 product purchasers.[1]

From the 1980s until present many persons have suffered severe burn injuries due to failure occurring at the center valve brazed joint area, and in some instances, failures which resulted in fatal explosions. This comprehensive study addresses these product failures and their causes, and is a culmination of a large body of expert reports and materials generated by metallurgists and other professionals employed by the manufacturer as well as the various injury victims over the course of approximately 15 years.

2. TEST PROTOCOL

The test protocol used by UTS was sequenced as follows:

1. Fact Review. Review facts and details of failure of the Peralta, Bailey, Avery, and Shadbolt cylinders. UTS personally interviewed each of these four injury victims.

2. Fact Verification. Obtain as much detail of the product failures from personal interviews, videos, transcripts, notes, and declarations of injury victims Mr. Peralta, Mr. Bailey, Mr. Avery, and Mr. Shadbolt.

3. Manufacturer Test Procedure Review. Review relevant portions of deposition videos of Worthington's designated representative Mr. Steven T. Gentry, and its selected knowledgeable witness employee Mr. Michael Ridley at Newell Brands (formerly Newell Rubbermaid), as well as the manufacturer's procedures disclosed in discovery, to determine the design methods and procedures Worthington and Newell use at their manufacturing facilities to design and safety-test the subject cylinders and torch attachments.

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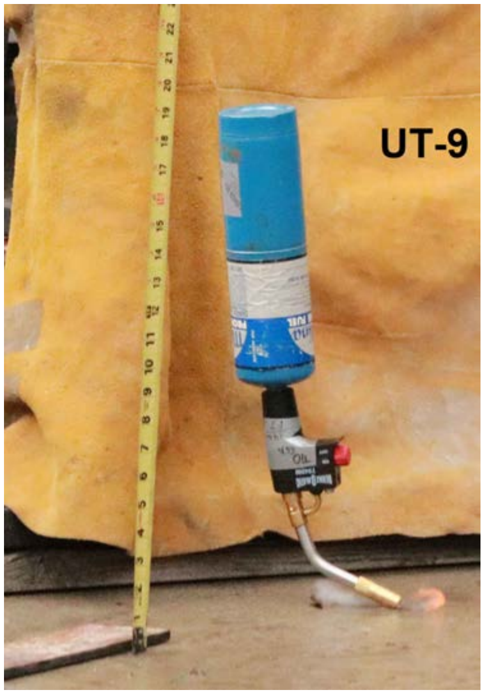
[1] MAPP cylinders were sold after MAPP was discontinued, until the recall of February 23, 2012.

4. Manufacturer Test Procedure Replication. Replicate the test procedures used by Worthington and Newell for the NRT cylinders and torch attachments containing the Fracture groove safety features.



5. Reasonable Cylinder Sample Variety. Obtain a reasonable quantity of NRT cylinders containing propane, MAPP, and propylene fuels in varying quantities and of varying product ages/vintages.

6. Cylinder Detail Recording. Record the production dates, weights, and condition of each of the test NRT cylinders.

7. Reasonable Torch Attachment Sample Variety. Obtain a reasonable quantity of torch attachments of varying vintage and varying Fracture groove designs, manufactured by Newell and by Worthington.

8. Torch Attachment Detail Recording. Record the production dates and condition of the torch attachments.

9. Cylinder and Torch Mating Recording. Record the NRT cylinder and torch identification numbers to identify the torch unites attached to the respective cylinders.

10. Drop tests Per Manufacturer Procedures. Perform "drop tests" of the subject cylinders in the manner described by Mr. Gentry and Mr. Ridley.

11. Videotape Drop Tests. Videotape in slow motion the drop tests.

12 High-Speed Photographs of Drop Tests. Take high speed (1/4000) photos of the drop tests.

13. Immediately Document Test Results. Immediately document the test results after each test performed.

14. Inversion Tests. Perform "BLEVE" inversion tests to rule-out the possibility of failure occurring due to use of the products in an inverted position.

15. Videotape Inversion Tests. Videotape the "BLEVE" testing.

16. Hard-Swing On Tip of Torch. Perform very hard "full-arm" swing tests whereby the cylinder and torch assemblies are first lit, then swung hard by arm movement, causing the torch tips to strike against a solid cement surface.

17. Videotape Hard-Swing on Tip of Torch. Videotape in slow motion the full-arm swing tests.

18. High-Speed Photographs of Hard-Swing To Tip. Take high-speed (1/4000) photos of hard swing to tip of torch.

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19. Hard-Swing Below Fracture Groove. Perform very hard “full-arm” swing tests whereby the cylinder and torch assemblies are first lit, then swung hard by arm movement, causing the torch to strike, both above as well as below its Fracture groove (to the extent possible), against a solid cement surface.

20. Videotape Hard-Swing Below Fracture Groove. Videotape in slow motion the full-arm swing below the Fracture groove tests.

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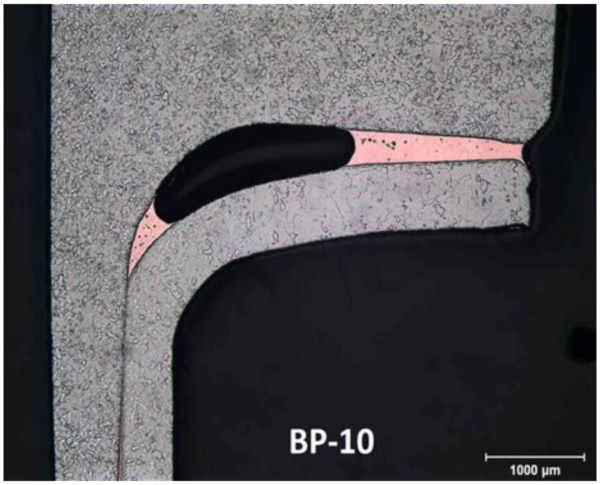
21. High-Speed Photographs of Hard-Swing Below Fracture Groove. Take high-speed (1/4000) photos of full-arm swing below the Fracture groove tests.

22. Review Destructive Test Results. Review X-RAYS, “SEM,” “EDS,” and other test results from destructive testing performed on the Peralta and Bailey cylinders in Minnesota on 9/4/18 and 9/5/18, and inspect seals for caustic interaction.



23. Review DOT 39 Compliance. Review the destructive test results for the Bailey and Peralta cylinders for compliance with 49 CFR 178.65.

24. Review Cumulative Expert Reports. Review expert reports, photos, and opinions from several NRT cylinder failure cases spanning approximately 15 years.

25. Determine if brazing should be replaced by welding.

26. Evaluate Alternative Designs. Evaluate existing alternative designs and recommend additional alternative designs.

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A-2
BERNZOMATIC
MAPP GAS
DANGER
W4F14W
MAP//Pro
M17
PROPANE
FUEL
P16
PROPANE
P13
W12U28


BERNZOMATIC
TS4000
ON
OFF
X-16


BERNZOMATIC
MAP//Pro
DANGER
M17
X-7


X-8
TS4000
M17

3. Daubert Guidance In Test Protocol

Guidance in determining the most appropriate test protocol included a good understanding of matters which the United States Federal Courts consider in determining admissibility of expert testimony. The Court applies guidelines from two seminal decisions:

- *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993) and

- *Daubert v. Merrell Dow Pharmaceuticals*, 43 F.3d 1311 (9th Cir. Cal. 1995).

The Courts give weight and consideration to the following when reviewing expert testimony for consideration of admissibility:

1. whether the expert's methodology has been tested or is capable of being tested;
2. whether the technique has been subjected to peer review and publication;
3. the known and potential error rate of the methodology;
4. whether the technique has been generally accepted in the proper scientific community; and
5. whether the expert opinion is "litigation generated."

Using Daubert guidance, we reviewed the various test procedures and scientific evidence contained on the several expert reports generated by the manufacturer as well as by other injury victim plaintiffs over the course of approximately 15 years. We observed that virtually all expert testimony and opinions were rendered in the field of complex molecular science, including metallurgy with focus on factors such as improper braze compound heating, interaction between phosphorus and the steel components of the cylinders, and other scientific data which ultimately did not touch upon issues of simple mechanical failures. We find that the most reliable and appropriate method for determination of the existence of manufacturing and design defects is replication of the manufacturer's test processes, namely the application of force to the tip of the torch to determine efficacy of the Fracture groove safety features and vulnerability of the center valve brazed joint area. The manufacturer's tests render the best results because they meet squarely meet Daubert scrutiny, are set forth in UL 147 section 12, and are logical and simple to understand.

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4. Pre-testing Observations

Prior to conducting our tests Worthington derived a destructive test protocol for the Peralta and Bailey cylinder:

Worthington Protocol

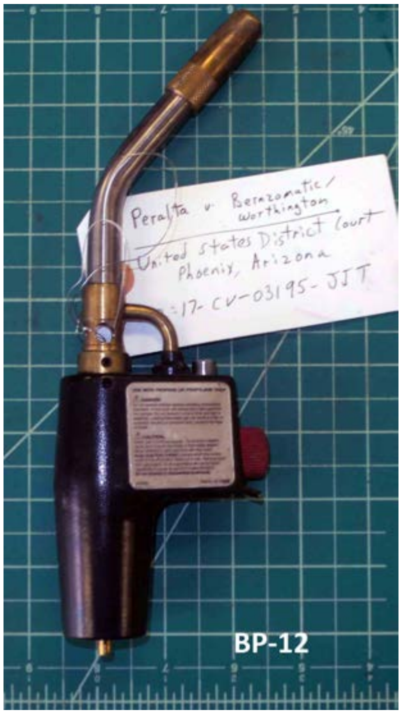
Worthington then performed destructive testing on September 4, 2018 and September 5, 2018 at a reputable test facility:

Materials Evaluation and Engineering
13805 1st Avenue North Suite 400
Plymouth, MN 55441
Tel. 763-449-8870
www.mee-inc.com

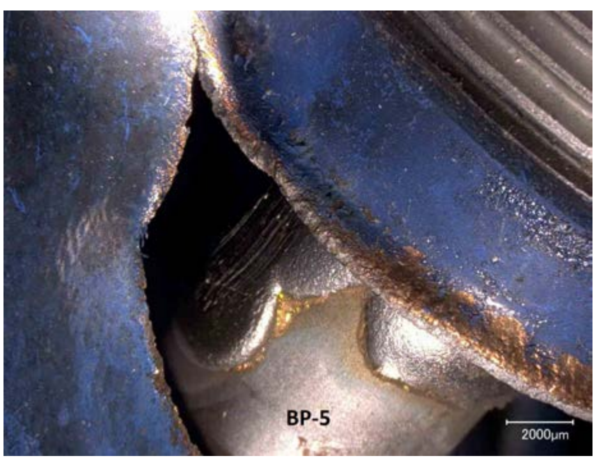
Counsels for Worthington, Mr. Peralta, and Mr. Bailey were present, and detailed photographs and records of the test procedures and results were produced. UTS reviewed these materials. The photographs, scanning electron microscope (SEM) images, x-ray images, energy dispersive spectrometry (EDS) analysis, material element tables, and other test results are posted at the following links:

Bailey Cylinder Destructive Test Materials
Peralta Cylinder Destructive Test Materials

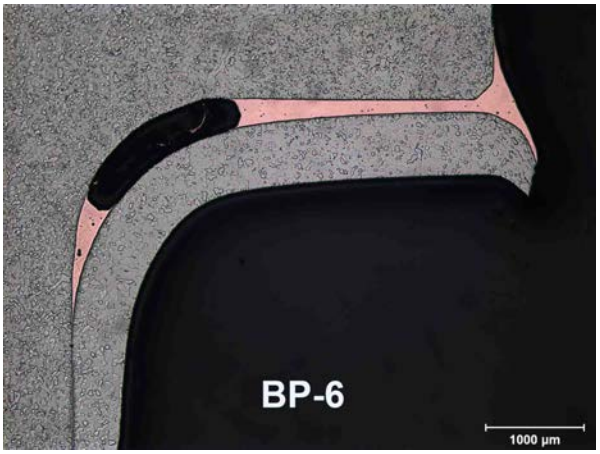
Peralta Bailey

	
Peralta torch attachment	Bailey torch attachment

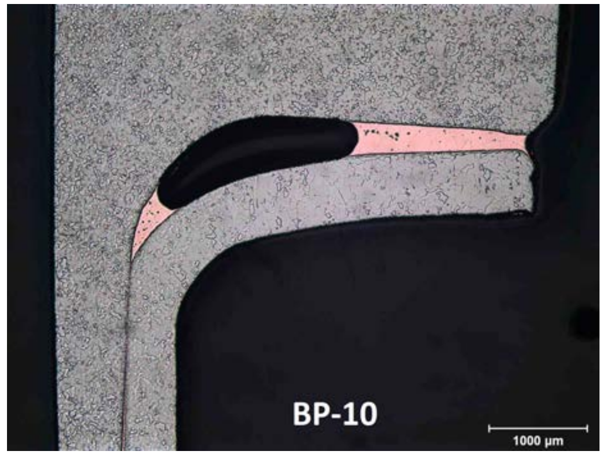
The Peralta and Bailey cylinders evidenced failures at the neck in the area of the brazed joint and were nearly identical.

	
Peralta cylinder failure	Bailey cylinder failure

The x-ray images revealed that the Peralta and Bailey cylinders contained identical impermissible voids in the brazing compound at the center bushing just below the device mounting threads.

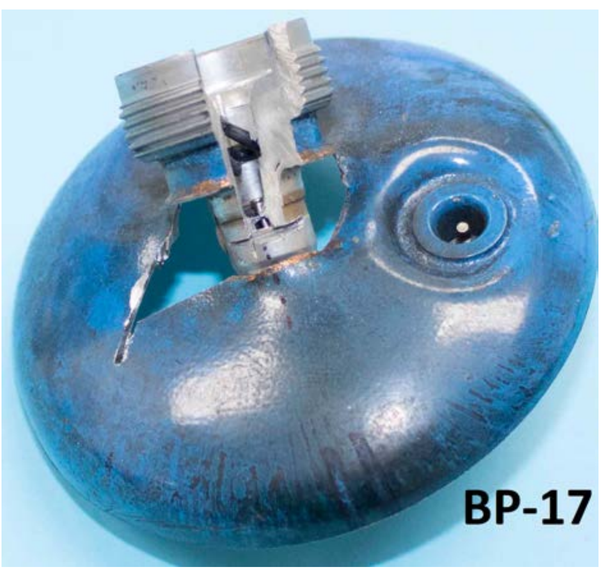


Peralta Center Valve Braze Void



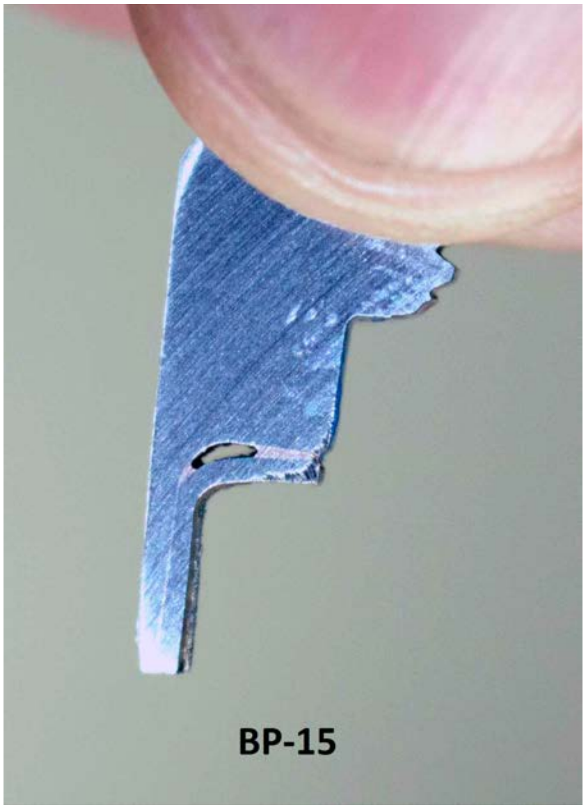
Bailey Center Valve Braze Void

The x-ray samples were taken from the center valve cross-sections of the Bailey and Peralta cylinders.



Peralta sample removal area

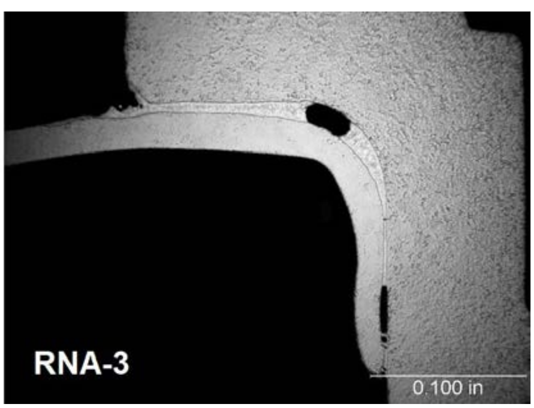
Bailey sample removal area

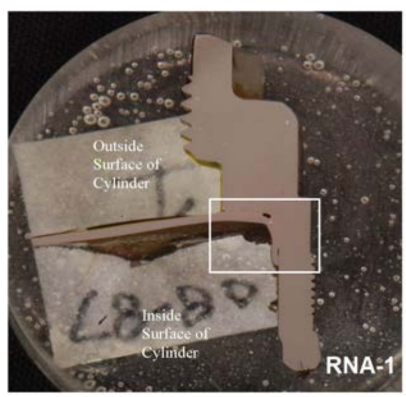


Bailey cylinder valve section

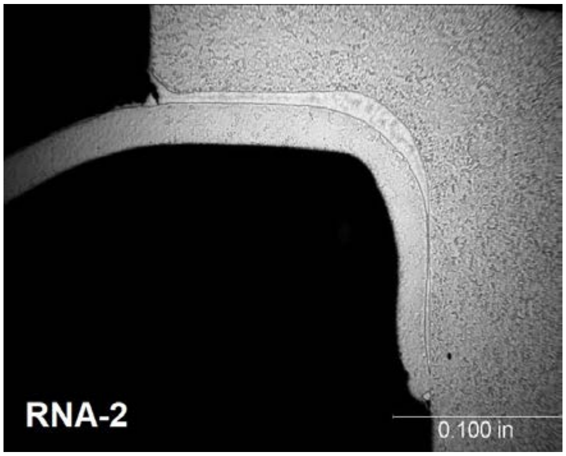
test sections were taken from the center valves of Bailey and Peralta cylinders

The impermissible voids noted on the Bailey and Peralta cylinders evidence a compliance failure with [DOT 39] and [UL 147], and are generally identical to voids noted by an expert witness metallurgist [Dr. Robert Anderson in his study of another injury case in the year]2008.

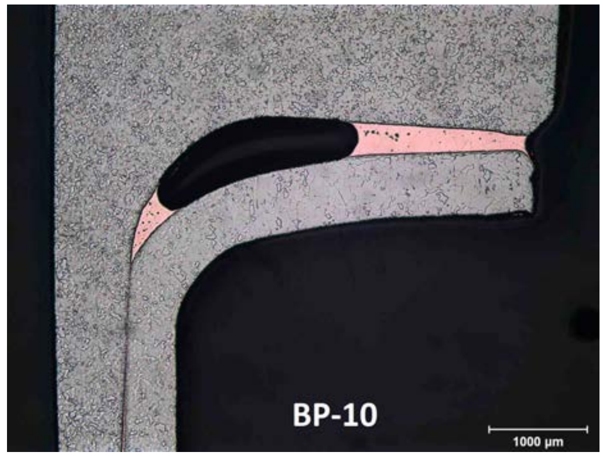




Expert Anderson's cross-section photo evidence an identical manufacturing defect on another NRT cylinder in relation to [Plaintiff] v. Worthington, et al., 07-cv-2107-MMA.



Proper braze, no voids



Improper - voids (Bailey)

Dr. Anderson identified the test cylinders as: W10G57E, W11G152W, and W8G230E, and noted that "[T]he brazing materials have large voids in the bulk and smaller voids in the interface between the cylinder walls and the valve housing."

Link to Dr. Anderson's report, 7/25/08

Dr. Anderson pointed out that the voids are at the brazed bushings near the points of failure, and evidence a compliance failure with the Federal Government's manufacturing requirements, commonly known as the Dept. of Transportation "DOT 39" requirements, which are found in Title 49, Chapter I, subchapter C, Part 178 of the U.S. Federal Register, cited as 49 CFR 178.65. The requirements are found at the following link:

DOT 39 requirements

Mr. Gentry's Explanation of DOT 39 requirements
(Exh. 4 to Declaration)

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DOT 39 mandates:

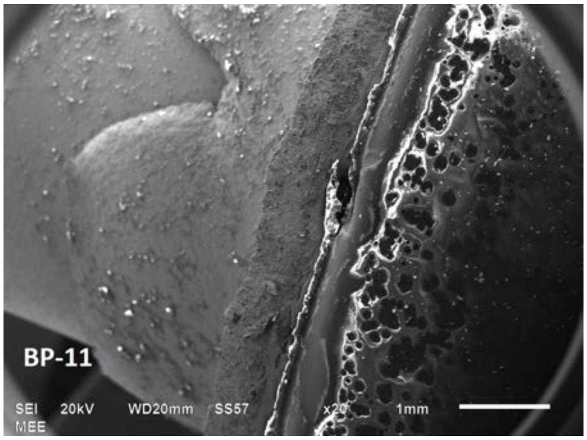
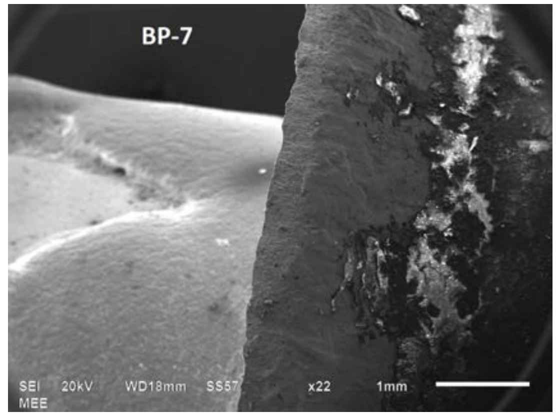
> "Brazed seams must be assembled with proper fit to ensure complete penetration of the brazing material throughout the brazed joint."

Other DOT 39 mandates include the following:

- Minimum width of brazed joints must be at least four times the thick-ness of the shell wall.
- Brazed seams must have design strength equal to or greater than 1.5 times the minimum strength of the shell wall.
- Welded seams must be properly aligned and welded by a method that provides clean, uniform joints with adequate penetration.
- Welded joints must have a strength equal to or greater than the minimum strength of the shell mate-rial in the finished cylinder.

The Bailey and Peralta cylinders also failed to comply with DOT 39 requirements, evidencing manufacturing defects which resulted in failure of the parent steel in the center valve brazed joint area. It is axiomatic in the welding industry that reduced weld surface area will result in increase in stress to the parent metal because the forces are focused only at the point of fusion of the weld or braze to the parent metal. The void shifts stress to the point of contact where the tear in the steel occurs:

The SEM images also show that the Bailey cylinder had additional manufacturing defects evidenced by comparison to the Peralta Cylinder SEM images.

 Bailey edge of ripped metal at valve	 Peralta edge of ripped metal at valve

As Dr. Anderson pointed out, DOT 39 requirements include the following mandates:

- Material with seams, cracks, laminations, or other injurious defects not permitted.
- The surface finish must be uniform and reasonably smooth.
- Inside surfaces must be clean, dry, and free of loose particles.
- No defect of any kind is permitted if it is likely to weaken a finished cylinder.

Other cylinders examined by UTS and held in inventory visually evidenced non-compliance with DOT 39 requirements, as noted by the voids where the center valves meet the parent steel dome surface of the cylinders. The voids as seen on the SEM and x-ray images are identical whether the cylinders contain MAPP or propane fuel. The only noted difference in the cylinders was that some were assembled using an all-copper brazing paste, while others contained paste comprised of braze paste consisting of Copper (43-47%), Ethylene glycol (5-10%), Nickel (24-27%), and Phosphorus (3-4%). The compounds are identified on the material safety data sheet attached to Mr. Gentry's declaration dated October 10, 2008.

Link to Material Safety Data Sheet

Different safety data sheets produced on different dates and for different fuels specify the type of paste intended for use based on the type of fuel in the NRT cylinders. Mr. Gentry attests that MAPP cylinders use paste comprised of copper, nickel, and phosphorous because pure copper braze will react with the MAPP fuel (Gentry decl. ¶ 7), and yet the specification document describing the tripartite compound appears to be for use with the propane cylinders. Worthington's NRT specification document dated December 30, 2004 indicates that the braze paste comprised of "304252 copper/nickel brazing paste on seam & fittings maximum copper 60% by weight, and that these cylinders were manufactured in the Chilton, Wisconsin propane department. In comparison, on Worthington's specification document for the NRT cylinders dated 5/14/13, the braze paste is pure copper, as further explained by Mr. Gentry. On ¶ 4 of Mr. Gentry's declaration he attests that "[T]he propane and propylene cylinders are essentially identical in construction," and that "[B]oth utilize a copper paste." It therefore appears that Worthington has used NRT cylinders containing either the pure copper paste, or the tripartite paste, interchangeably on their MAPP and propane/propylene products. Indeed Bernzomatic's former operations manager, Mr. David Thomas, has disclosed this improper use of the wrong NRT cylinder paste for the type of fuel placed in the cylinders. Mr. Thomas also disclosed Bernzomatic's failure to comply with the requirement under DOT 39 to discard defective lots of cylinders when defects are found, and defects were clearly corrected by welding instead:

(on shelf at Home Depot 2/5/12 - manufacturer repaired braze by welding)

(on shelf at Home Depot - manufacturer repaired braze by welding)

Welding evidences repairs, not discarding of the lot as mandated by DOT 39, while the color of the compound on the propylene cylinder on the left evidence apparent use of the tripartite compound on those cylinders until the 2012 recall. It therefore appears that the recall was at least in part based on the manufacturer's concern of interaction between the tripartite compound and the steel. The fact that the propane cylinders, containing the full copper compound, were not also recalled, also suggests concerns over failures attributed to use of the tripartite compound.

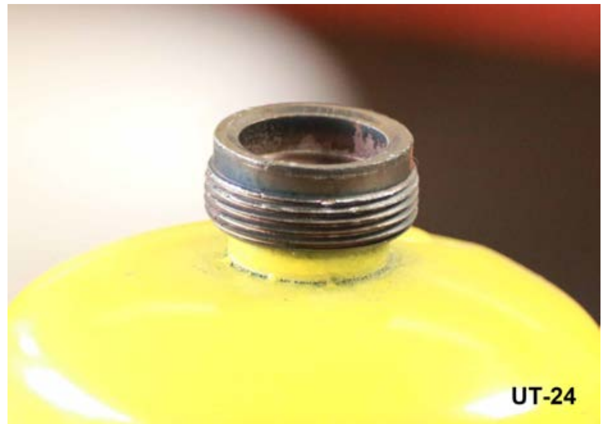
Link to Mr. Thomas' statement.

Mr. David Thomas disclosed that the cylinders were failing at the warehouse. Mr. Thomas' predecessor, Mr. Nelson, also disclosed the occurrence of these failures, while both operations managers / engineers referenced internal memos and expert reports disclosing these failures. However, UTS does not merely rely on statements of Bernzomatic's former operations managers, but has noted that these failures have been occurring for many years as disclosed on enumerable lawsuits, including the following:

Bailey
Barrett
Carranza
Peralta
Pelz
Marmont (fatality)
Muniz
Roland
Sandoval
Segrest
Shadbolt
Shalaby
Siphene
Tatum
Tran (fatality)
Tucker
Vanderlinde
Welch
Wessner
Wooden

The number of cylinder failures occurring at the center bushing area of the brazed joint are quite telling. The manufacturer acknowledges that the center bushing area of the brazed joint is a weak point in the cylinder and will fail upon the application of force to a tip of a torch.

The defects noted above and in the many cases filed with the Courts exist on the NRT cylinders containing both types of fuel, often times with voids visible to the eye without the magnification.

 found new on shelf at Home Depot	 new, in expert's inventory of Peralta/Bailey cases

Heavy rust was also observed on cylinders kept in dry indoor storage (a garage).

 (Tested in 2008 then placed in dry storage)	 sample placed in dry storage in 2010

UL 147 and DOT 39 require reasonably adequate rust and corrosion protection. Quality control is lacking in this area as well.

6. Pre-testing Conclusions

6.1 Defective Recall Overlooked Propane Cylinders

The February 23, 2012 recall is defective because Mr. Gentry attests that the propylene and propane cylinders are identical, but only the MAPP and propylene (MAP/Pro) cylinders were recalled, overlooking the propane cylinders. The manufacturer's belief that a caustic reaction exists between seal (o-ring) material made of epichlorhyrden and propylene and MAPP fuels (resp. 16) appears to be in error as our inventory cylinders are more than 11 years old and show no evidence of caustic reaction. Simply, the recall should have disclose that cylinders are failing at the neck because the neck area is substandard and unreasonably weak.

6.2 Recall Not Posted At Retail Outlets - Ineffective

The February 23, 2012 recall is not posted anywhere other than on the internet, and most consumers would not search for it. The recall should be posted at all retail outlets selling these products, on the shelf, to inform purchasers.

6.3 Metallurgical Testing Is Insufficient

Metallurgical test results of the Bailey and Peralta cylinders did not identify any defects in the materials. The steel was manufactured to specification, and the braze compound was full copper on both cylinders. Therefore, while metallurgy may be useful in determining broadly if manufacturing or design defects exist, it is insufficient as it only identifies voids in the braze compound. The appropriate trade discipline is welding and brazing because the sole defects found in the Bailey and Peralta cylinders, and the majority of failures recited in various court cases, evidenced weakness to the center joint areas, brazing irregularities, and impermissible voids in the brazing material. Moreover, while brazing is permitted under the United States' DOT 39 requirements, brazing is not permitted in other countries. The Health & Safety Executive, an entity located in the U.K., issued a report in January 2000. The report is found at the following link:

Link to HSE SPECIFICATION FOR WELDING STEEL NON REFILLABLE TRANSPORTABLE PRESSURE RECEPTACLES DOT - 39 (HSE)

Paragraph 8 of the report states that "[B]razing for any purpose whatsoever is prohibited." All seams must be welded. Welding is a process by which the base metal as well as the filler metal is melted, and each forms a molten material or a weld pool. This weld pool solidifies to make a strong joint. Unlike welding, only the filler metal is melted in the brazing technique. The filler metal is melted in-between the parts that have to be joined. The wetting that is formed in between the joints gets solidified and gives the joint more strength.

Brazing is similar to soldering. For brazing, the parts of the two metals that have to be joined should be free from oxides. In brazing, the metals that have to be joined together are not heated to their melting points, but only the filler metal is heated just above the melting point. The difference that can be seen between brazing and welding is in the temperatures. In welding, high temperatures are needed. But in brazing, the temperature is a bit lower than that of the temperature used in welding. We therefore conclude that welding and brazing principles present a more appropriate trade discipline for determination of whether failed cylinders, including those in the Peralta, Bailey, Shadblot, and Avery matters, although the rate of error may only be entirely eliminated by using the "process of elimination" method.[2]

UTS notes that Dr. Robert Anderson was disqualified as an expert on an earlier NRT cylinder failure matter because he did not make a nexus between the braze paste void and the cylinder failure. Here a nexus exists with respect to the Bailey and Peralta cylinders because the only noted manufacturing defects were voids in the braze paste, the failures occurred at the outmost edge of the braze paste, and all other possible causes of failure were eliminated, as demonstrated below. However, it is not necessary to make a finding that voids in the braze paste caused the cylinder failures, because the manufacturer's own drop test procedures establish the manufacturing defects with zero rate of error by way of the process of elimination. Simply, every theory of failure must be tested to eliminate theories which are impossible. We find that when this is done, all theories of failure are eliminated except for the presence of manufacturing defects, and that these manufacturing defects were foreseeable and

[2]The method of elimination is iterative. One looks at the answers, determines that several answers are unfit, eliminates these, and repeats, until one cannot eliminate any more. This iteration is most effectively applied when there is logical structure between the answers – that is to say, when by eliminating an answer one can eliminate several others. In this case one can find the answers which one cannot eliminate by eliminating any other answers and test them alone – the others are eliminated as a logical consequence.

defined by the manufacturer. The most reliable method for determination of the cause of failure is replication of the manufacturer's drop tests and theories of failure, as set forth in UL 147 section 12.2.

7. Test Setup

The test setup is focused upon the weak point of the cylinder disclosed by the manufacturer:

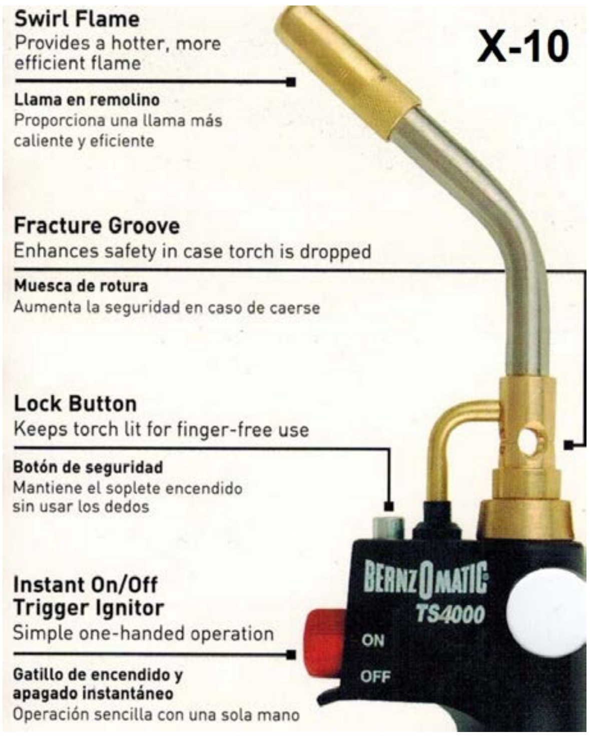
> https://www.bernzomatic.com/Using-a-Torch/Glossary
>
> Fracture groove - A designed-in failure point in the torch, so that when the torch and cylinder are dropped, the fracture groove will fail prior to the cylinder center bushing failing. If the center bushing fails, then an 8 to 10-foot flame will erupt from the cylinder. Example: UL2317 Manual Torch, TS4000 High Heat Torch.

UTS observes that the manufacturer re-posted the fracture groove disclosure with omission of the words "extremely large" that were present in the year 2010:

> http://www.bernzomatic.com/bernzomatic/consumer/jhtml/glossary.jhtml (1/12/10)
>
> Fracture Groove: A designed in failure point in the torch, so that when the torch & cylinder are dropped, the fracture groove will fail prior to the cylinder center bushing failing. If the center bushing fails, then an **extremely large** 8 to 10 foot flame will erupt from the cylinder. Examples of torches with a fracture groove are: UL2317, JT680, JT681, JT539, TS4000, TS7000. [Emphasis added.]

The manufacturer changed the Fracture groove design over the years.

In addition, the manufacturer did not only delete the words, “extremely large” from its posted description of the Fracture groove feature, but it also removed the description of the Fracture groove feature from the packaging:



2008 package discloses the fracture groove safety feature on the packaging

present-day package has removed disclosure of the fracture groove feature from the packaging

deletion of the words “extremely large” and removal of the Fracture groove description from the package suggest the manufacturer (presently Worthington) was aware of the defects described above, drawing focus to the need for testing of the Fracture groove feature in the manner described by Worthington’s Mr. Gentry and Newell’s Mr. Ridley.

Finally, the Fracture groove feature was invented by Mr. Nelson to address the cylinder failure at its brazed joint area as disclosed by Mr. Thomas, further supporting the drop test procedure as the most appropriate to ascertain the defects at issue.
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The process of elimination begins with identification of all theories of product failures expressed by the manufacturer in the many lawsuits. Worthington and Newell invariably allege user misuse as the cause of failure of injury based on five theories:

1. Dropping of the torch assembly onto the tip of the torch.

2. Strong Strike of the tip of the torch assembly against a solid object or surface.

3. Strong Strike of the torch assembly against a solid object or surface, with the point of contact being below the safety fracture groove.

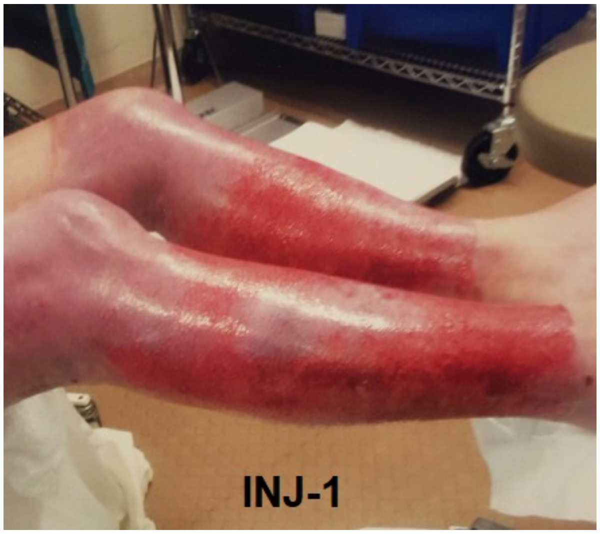
4. Using the torch assembly in an inverted position, causing a boiling liquid expanding vapor explosion ("BLEVE"). or

5. Exposing the torch assembly to excessive heat, causing it to explode.

The Bailey and Peralta failures present the most common fact pattern for failure of the subject cylinders and torches. In most instances failure of the cylinders is the result of the application of force to the tip of the torches equipped with the Fracture groove safety features. Most of the failures evidence the application of leveraged force to the tip of the fracture groove-equipped torch attachments. UTS therefore began its investigation by review of the sworn testimony of Mr. Bailey and Mr. Peralta describing the manner with which they were using their respective torch assemblies at the time of failure.

Mr. Bailey

Mr. Bailey was using a propane-filled NRT cylinder with a model UL2317 torch attachment equipped with the Fracture groove safety feature. Both products were manufactured by Worthington. Mr. Bailey was using the torch to burn leaves on the ground. Mr. Bailey was holding the assembly by the lower part of the cylinder. He was moving the torch assembly gently back and forth when the tip of the torch gently tapped against a tree trunk. The force was insufficient to fracture the Fracture groove, and insufficient to cause bending or deformity to the top dome of the cylinder at the center valve brazed joint area. Nevertheless the parent metal tore apart and the highly pressurized propane content caused severe burn injuries to Mr. Bailey. The injury pattern was nearly identical to another injury case (Doe) involving another failed NRT cylinder under virtually identical circumstances:

 Mr. Bailey	 Doe
 Mr. Bailey	 Doe

In both instances the product was held at the lower portion of the cylinder, and light force was applied to the fracture groove-equipped torch attachment, insufficient to cause fracture. Nevertheless both cylinders failed identically at the area of known vulnerability, the center valve brazed joint area.

Peralta

Mr. Peralta was using a propane-filled NRT cylinder with a model TS4000 torch attachment equipped with the Fracture groove safety feature. Both products were manufactured by Worthington. Mr. Peralta picked up the torch assembly and lit it without incident, then began using the assembly to light a fire in his fireplace at his home. While the product was in use a flame suddenly emitted from the neck of the cylinder, at the area of known vulnerability, burning Mr. Peralta's hand. Mr. Peralta quickly discarded the torch assembly, causing the tip of the fracture groove-equipped torch to strike the floor. The force was insufficient to fracture the fracture groove, and insufficient to cause bending or deformity to the top dome of the cylinder at the center valve brazed joint area. Nevertheless the parent metal tore apart and the highly pressurized propane content caused severe burn injuries to Mr. Peralta. The circumstances were nearly identical to another injury case (Vanderlinde) involving another failed NRT cylinder under virtually identical circumstances, with exception in that the Vanderlinde cylinder did not have an initial failure before it dropped to the floor.

Mr. Vanderlinde's cylinder was sitting on a metal surface approximately 24" above a cement floor. Mr. Vanderlinde knocked it over, and it landed on the fracture groove-equipped tip, but the Fracture groove did not fracture. The Fracture groove is designed to fracture on 6-foot drops, therefore the 2-foot drop was insufficient to cause the groove to fracture. The cylinder breached at its neck instead, evidencing the defect.

Mr. Peralta dropped the cylinder after the leak in the neck caused his hand to burn. The cylinder assembly fell no more than 3 feet. As was the case with the Vanderlinde cylinder, because the drop was less than 6 feet, the Fracture groove did not fracture, and yet the cylinder breached at the neck, as did the Vanderlinde cylinder.

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Mr. Peralta's and Mr. Vanderlinde's injuries were nearly identical:

Mr. Peralta

Mr. Vanderlinde

Mr. Peralta

Mr. Vanderlinde

Worthington's proffered experts and authorized representatives were Mr. Gentry and Mr. Ridley. Both representatives described the drop tests Worthington and Newell have used in determining the amount of force necessary to cause fracture of the Fracture groove features of the torches so that these safety features protect against failure occurring at the center valve brazed joint area. The test setup followed by UTS replicated each theory of causation. UTS commenced by careful review of the Fracture groove failure test procedures used by the manufacturer. The test process described by Mr. Gentry was the dropping of the torch and cylinder assembly from four feet:

Link: Gentry test procedure

The test process as described by Mr. Ridley was to drop the assembly from six feet:

Link: Ridley test procedure

UTS obtained a reasonable number of test cylinders containing propane, MAPP, and propylene (MAP/Pro). The cylinders were of different ages and contained fuel in varying quantity. Each cylinder was weighed, its identification number recorded, and the torch unit with which it was tested was identified numerically.

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UTS obtained a reasonable number of torch attachments of varying ages and different Fracture groove designs, as well as units which pre-dated the Fracture groove feature. All units were manufactured by Worthington and/or by Newell Brands ("BernzOmatic"). The units included the TS4000 model used by Mr. Peralta, older versions of the TS4000 designed to fracture under less force, the UL2317 model used by Mr. Bailey, a newer version of the UL2317 designed to fracture under less force, and a late model design designed to bend under much less force than the former designs. All units were carefully inspected prior to testing.

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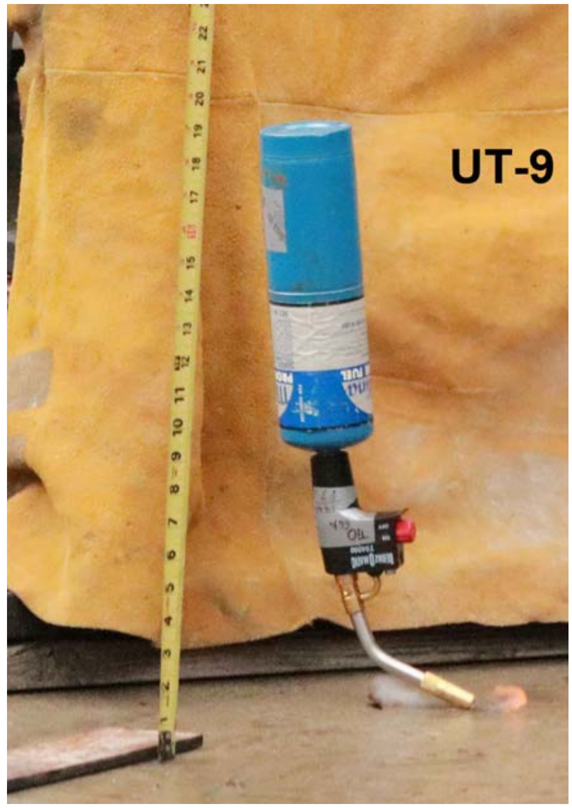
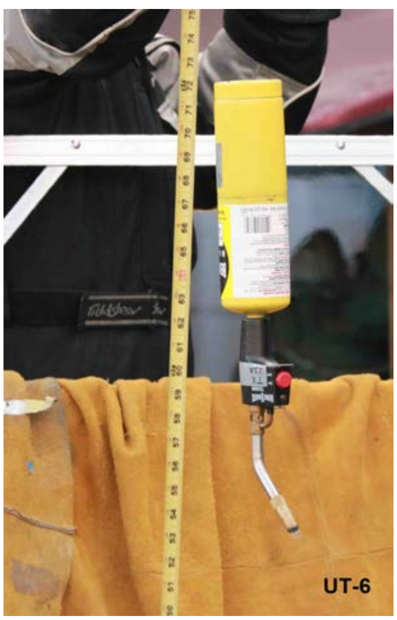
UT-8


UT-9


UT-6


UT-13

8. Test Videos

UT26 hardswing_TS4000

UT27 hardswing_UL2317

UT28 bleve test

UT29 bleve test

UT30 bleve test

UT31 back and forth tip on propane

UT32 back and forth tip on MAPP

UT33 propane droptest

UT34 propane droptest

UT35 propane droptest

UT36 propane droptest

UT37 propane droptest

UT38 propane droptest

UT39 propane droptest rotation and impact on side of cylinder

UT40 propane droptest

UT41 MAPP droptest

UT42 MAPP droptest

UT43 MAPP droptest

UT44 MAPP droptest

UT45 MAPP droptest

UT46 Bottom of cylinders sometimes unstable causing fall

UT47 bleve test

UL48 hardwing

4-foot drop tests

9. Test Results

PROPANE CYLINDER AND TORCH 6' DROP AND STRESS TESTS
PERFORMED JANUARY 20, 2019

Exh. #, Date code	wt	Torch	drop ht.	Observation summary
P1 99457DG	1 lb 10.625 oz	**T3 56A**	**6'**	FG did not fracture, cylinder neck bent on impact
P2 129115DG	1 lb 10.125 oz			preserved
P3 DG129448	1 lb - 4.125 oz			preserved
P4 98522-1	1 lb - 4.125 oz	**T7 41**	**6'**	FG earlier design (pre-2005), fractured well and protected cylinder. Cylinder barely bent at the neck.
P5 DG 109029	1 lb - 4 oz			preserved
P6 W7G174	15.5 oz.	**T6 90**	**6'**	FG did not fracture, cylinder bent on impact
P7 888-1 DG	1 lb. - 5.5 oz	**T10 66A**	**6'**	FG new in pack dated 2010, FG did not fracture, cylinder did not bend. 2nd test FG did not fracture, cylinder bent more

P8 28810-DG	1 lb. - .125 oz	**T1 22A**	**6'**	FG did not fracture but was on the verge of breaking (bent), cylinder bent
P9 8868-1 DG	1 lb. - 5 oz			preserved
P10 (DG 10...?)	1 lb. - 10.625 oz			preserved
P11 (illegible)	1 lb- 7.625 oz			preserved
P12 (illegible)	1 lb.- .75 oz.			Empty cylinder, FG did not fracture, cylinder bent at neck. 2nd drop resulted in FG nearly breaking, cylinder bent more
P13 W12U28	1 lb. - 12.25 oz			bleve test:
P14 W12U28	1 lb - 12.375 oz	**T11 36B**	**6'**	bleve test: flame continued uninterrupted, no flare, no difference in performance
P15 W12U28	1 lb - 12.125 oz	**T1 22A**	**6'**	bleve test: bleve test: flame continued uninterrupted, no flare, no difference in performance. drop test: landed on angle on tip and struck cylinder denting top side, FG did not fracture, cylinder bent

4-FOOT DROP TESTS 2/13/19

SP-1 W12U28E	1 lb-12.625 oz	ST-1	4'	TS4000 latest design fracture groove bent, close to fracture. Cylinder did not bend at the dome.
SP-2 W12U28W	1 lb-12.625 oz	T4	4'	TS4000 older design with the "line" fracture groove, fractured through on back side. Cylinder did not bend at the dome.
SP-3 W12U28W	1 lb-12.375 oz	ST-2	4'	TS4000 newer style fracture groove, did not fracture. Cylinder bent very slightly at the dome.
SP-4 W12U28E	1 lb-12.375 oz	ST-3	4'	Newly purchased UL2317, fracture groove broke all the way through, cylinder did not bend at the dome. Noted difficulty installing torch attachment as copper compound was on the threads.

MAPP CYLINDER AND TORCH 6' DROP AND STRESS TESTS
PERFORMED JANUARY 20, 2019

Exh. #, Date code	wt	Torch	drop ht.	Observation summary
M1 W9G35W	1 lb- 14.125 oz			preserved
M2 W9G352	l lb- 14.125 oz			preserved
M3 W9G35W	1 lb- 15 oz			preserved
M4 W10G47W	1 lb- 15.375 oz			preserved
M5 W9G35W	1 lb- 14.75 oz	**T2 23A**	**6'**	**FG broke as designed, however cylinder also bent on impact**
M6 W8E108W	1 lb - 1.125 oz			preserved
M7 W11G14E	1 lb- 14.875 oz			preserved
M8 8C4W	1 lb- 12.125 oz	**T1 22A**	**6'**	**FG bent to near fracture, cylinder bent**
M9 W11G149W	15 oz.	**T6 90**		**FG did not break on first drop, but bent considerably. cylinder did not bend significantly**
M10 DG11081	15.5 oz			
M11 88769DG	15.375 oz	**T5 14A**	**6'**	**FG did not fracture, cylinder bent**

M12 W5E98W	1 lb-15.375 oz			preserved
M13 W4F33W	1 lb-15.375 oz			**bleve test: No problems**
M14 W4F70E	1 lb-14.125 oz			**bleve test: No problems**
M15 W3H23E	1 lb-12.25 oz			**bleve test: No problems**
M16 W3H23E	1 lb-12.5 oz			preserved
M17 W12L27C	1 lb-10.5 oz			preserved
M18 W4F14W	2 lb-3.5 oz			in package

10. Heat Failures - PRV Failures

Our study extends to three cylinders failing due in part to exposure to heat and flame in which additional defects to the pressure relief valves were noted:

1. Marmont v. Worthington, et al., 2:16-cv-00848-JAK-RAO, propane cylinder exploded due to exposure to heat and noted failure of the pressure relief valve, resulting in the death of Ms. Astrid Marmont.

2. Shadbolt v. Worthington, et al., No. 18 of 2013, Court of the Queen's Bench for Saskatchewan, Canada, MAPP cylinder had identical initial failure as Peralta (leak at the neck) causing Mr. Shadbolt to drop the cylinder. Assembly landed on tip of TS4000 torch. Fracture groove did not fracture, but flames emitted under pressure from breach of brazed joint, leading to secondary ignition of towels. Cylinder was exposed to some amount of heat, causing cylinder to explode. The PRV did not vent.

3. Jacob Avery cylinder, propane cylinder exposed to heat from burning leaves and debris below a deck at Mr. Avery's home. PRV did not vent, cylinder failed at braised joint and evidenced pressurized explosion.

A detailed study was done in 2006 by Health and Safety Laboratories in the UK, and a report was generated titled,

> "The Behaviour of 'Bernzomatic' MAPP and Propane Cartridges When Exposed to Heat and Flame"

The test established that the NRT cylinders were designed to vent from a pressure relief valve when exposed to heat and flame. The PRV was designed to prevent over-pressurization of the cylinder which could otherwise lead to catastrophic failure. In the test it was noted that several pressure relief valves failed, resulting in explosion.

Marmont

The Marmont cylinder PRV was tested and vented at approximately 650 PSIG, whereas the cylinder was designed to withstand 900 PSIG. Unsurprisingly the steel ripped a full 360° at the brazed joint, and the center valve with the torch attachment separated entirely off the cylinder. The failure resulted in the death of Ms. Marmont.

Shadbolt

Mr. Shadbolt's cylinder had the same initial defect as did Mr. Peralta's in that after he lit the torch a flame emitted from the neck of the cylinder, causing him to drop the assembly. The drop was from about 3 feet. The assembly landed on the top of the torch, causing the brazed joint to breach further, and the flames ignited towels on the floor. The flames heated the breached cylinder, which still had pressurized fuel content. The PRV did not vent. Instead, the cylinder ripped wide open as shown.

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<u>Avery</u>

Mr. Avery's cylinder was sitting on a deck and exposed to heat caused by leaves burning under the deck. The PRV did not vent. Unsurprisingly the steel ripped a full 360° at the brazed joint, and the center valve with the torch attachment separated entirely off the cylinder, as did the Marmont cylinder.

Failure of the NRT cylinders when exposed to heat and flame occurs due to the PRV failures observed on the HSE report, evidencing an additional manufacturing defect. This defect invariably results in over-pressurization, with the pressure finding its way to the vulnerable center valve brazed joint area of the cylinder.

11. CONCLUSIONS

1. Worthington's expert quality control manager Mr. Gentry, its expert Mr. Eagar, (transcript pp. 147-148), and Newell's expert quality control manager Mr. Ridley all testified that upon the application of strong force to the tip of the Fracture groove equipped torch attachments, the Fracture groove features will fracture and prevent cylinder failure. However, upon very light application of force to the Fracture groove of the Bailey and Peralta cylinders, the cylinders ripped open at their center bushing brazed joints, evidencing that the cylinders were defective. The same was observed on photographs of the many other cylinders in other lawsuits. Upon the application of force insufficient to fracture the Fracture groove, those cylinders also failed, evidencing defect of those cylinders.

2. The NRT cylinders suffer from design defects recognized by the manufacturer in that the manufacturer acknowledges the likelihood of failures occurring at the center valve brazed joint area, and designed the Fracture groove safety feature in hopes of preventing these failures. However, it is not necessary for these cylinders to suffer such weakness at the center valve brazed joint area. If the housing thread assembly is recessed into the cylinder and the torch is designed to be inserted into the cylinder, lateral force to the tip of the torch would be absorbed by the recess wall. Furthermore, the manufacturer already has a safer alternative design, the "non-refillable short" cylinders, which are wider and distribute force over a greater span of steel. The non-refillable short cylinders are not known to fail at the center valve brazed joint area. Finally, use of a thicker gauge steel at the upper dome of the cylinder is certain to strengthen the center valve brazed joint area and prevent its failure under such light forces.

3. The NRT cylinder design is defective because the cylinders often suffer metal fatigue at the brazed joints due to constant flexing of the torch attachments and

the stresses caused by repeatedly screwing the attachments on and off.

4. The manufacturer on occasion "fixed" poorly brazed joints, as observed by cylinders found on the shelf at Home Depot, and discerned by comparing the welded cylinders to poorly brazed cylinders also found on the shelf at Home Depot.

welded cylinder found as photographed on the shelf at Home Depot

Poorly brazed joint as found on the shelf at Home Depot.

Bernzomatic/Worthington Map/Pro cylinder found on shelf at Home Depot, El Cerrito, CA, as shown, on February 12, 2012, evidences weld repair then sale as a new cylinder.

5. The NRT cylinders suffer from design defect due to brazing instead of welding.

6. The Bailey cylinder evidenced a manufacturing defect because it failed under far less force than all the cylinders UTS tested, and did not have any significant bending or deformity (if any at all) at the dome. Every cylinder tested showed significant bending and deformity at the dome, and none failed. Therefore a

failure without showing deformity necessarily occurs under substandard force, rendering the cylinder defective. Moreover, the force applied to the top of the fracture groove-equipped torch was far too low to fracture the fracture groove. All the cylinders tested by UTS remained intact, even when swung forcefully onto a concrete floor. This evidences that even massive force will not breach a non-defective cylinder. The only way Mr. Bailey's cylinder could have failed without fracturing the Fracture groove and without bending at the dome is due to defect of the cylinder, causing it to breach under far less force than it was designed to withstand. In terms of test figures, the fracture grooves are designed to fracture at about 26 foot-pounds of force, whereas the cylinders are designed to withstand far in excess of 35 foot-pounds, and they do - when not defective. The cylinders will bend at the dome at 15 foot-pounds of force, therefore a failure without significant bending at the dome necessarily means the cylinder failed at less than 15 foot-pounds of force, far below the force required to fracture the fracture groove. Mr. Bailey was using the UL2317 torch tip, which tested and fractured on the 4-foot drop tests. The combined evidence of failure of the torch Fracture groove to fracture and absence of bending on the dome of the cylinder define the failure of his cylinder as being due to manufacturing defect, with failure of the Fracture groove feature to protect against the foreseeable occasional manufacturing defects.

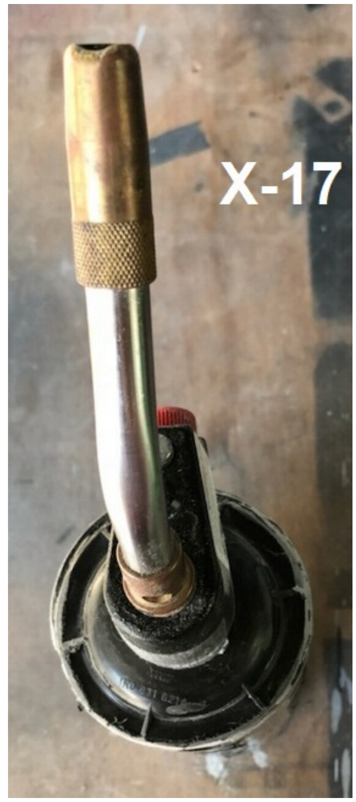
7. The Peralta cylinder failed the same way as did the Bailey cylinder, only the Peralta cylinder evidenced an additional manufacturing defect in that it sprung a leak at the neck during normal use. Under the Consumer Expectation Test, the user would never expect such a failure to occur under normal use.

8. The early design Fracture groove feature fractured on four-foot drops, and this would afford an added measure of protection as compared to the present-day Fracture groove design of the TS4000. The present day UL2317 will fracture under much lower force, affording more protection. However, the Bailey and Peralta cylinders did not sustain anywhere near the amount of force required to fracture any version or iteration of the Fracture groove design because they were defective.

9. The Marmont, Avery, and Shadbolt cylinders suffered the additional manufacturing defect of pressure valve failure.

12. SAFER ALTERNATIVE DESIGN

UTS designed a cartridge for placement of the cylinder during use and storage:



The cartridge is reusable and can be used on existing NRT cylinders.

UST also designed a safer alternative cylinder:

By recessing the center valve and tapering the torch attachment to allow for insertion and attachment into the center valve, the brazed joint is protected from lateral forces, and the Fracture groove will fracture upon application of force to the tip of the torch without breach of the cylinder.

A safer alternative already exists as well:

The non-refillable short cylinders show no signs of failure. Of all the lawsuits found on the Court's PACER system, only one was found in which the center bushing of the NRS cylinder allegedly failed. However, the recessed valve design would also make the NRS cylinder safer. An expiration date may prevent failures related to rust or flexing and mounting-dismounting of the torch attachments.

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TECHNICIAN CERTIFICATION

UTS, by way of Mr. Anthony Roston and Mr. Manuel Marieiro, hereby certify that they have performed all of the testing and data entry as shown on the photos and videos linked herein, and have personally reviewed all of the linked documents and materials. UTS further personally interviewed Mr. Peralta, Mr. Bailey, Mr. Shadbolt, and Mr. Avery.

Dated: February 14, 2019

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Anthony J. Roston

Dated: February 14, 2019

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Manuel Marieiro