U.S. Forest Service, National Technology and Development Program (T&D) Fire Equipment Report

Incident: Juniper Swamp Fire
Date: April 23, 2025

Helmet Nomenclature:

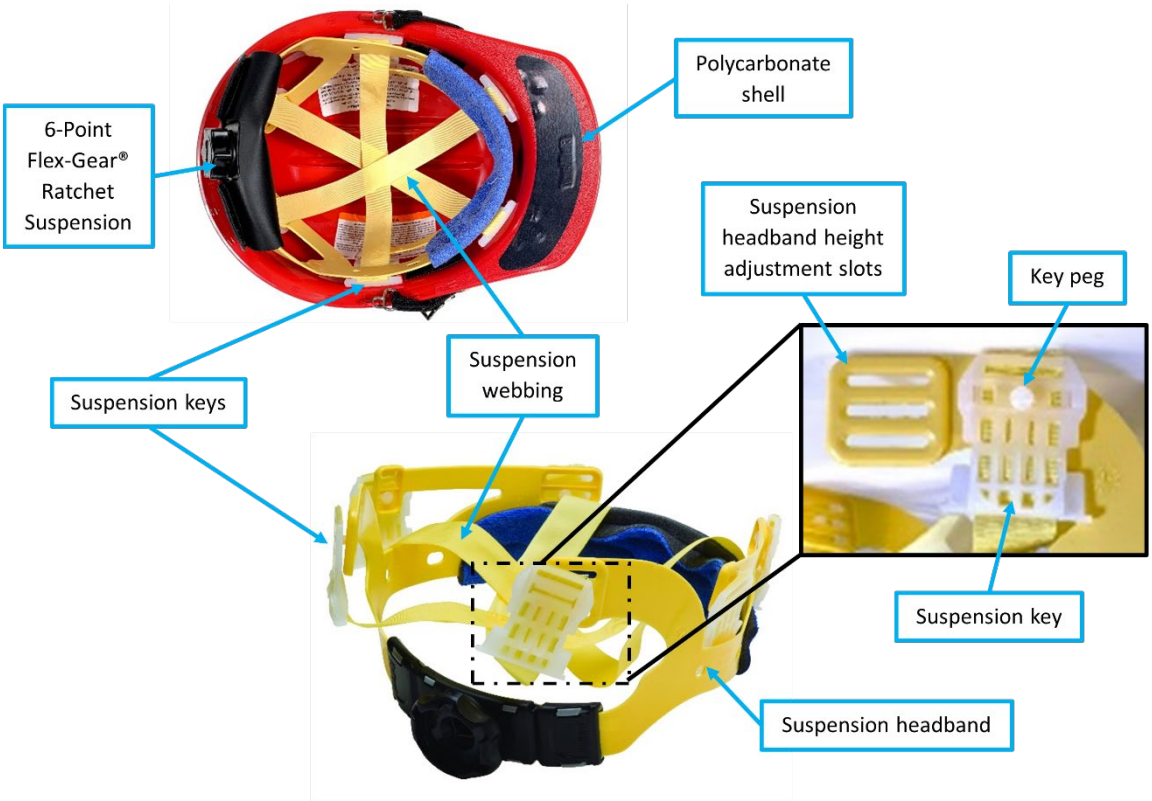

Figure 1: Helmet nomenclature pertinent to this helmet inspection.

Damage type description: Polycarbonate helmets can receive several different types of damage. Scratches, scuffs, crazing, and cracking are the most common.

Scratches and scuffs: Can be felt on the surface of the helmet and can occur during normal use. Minor scratches and scuffs do not affect helmet performance, while deeper scratches may weaken the helmet's performance.

Crazing: Small hairline interconnected cracks or microvoids that can be seen on helmets. Crazing comes from exposure to stress, chemicals, or prolonged ultraviolet light. Loads or stresses can be transmitted along/through crazing because the voids created still contain fine polymer fibrils that bridge the gaps. Crazing is often a precursor to cracking and can indicate material weakening.

Cracking: Fissures or cracks in the material are caused by stress, impacts, and chemical or environmental exposure. Cracks can penetrate partially or completely through the material.

Cracks differ from crazing in that loads and stress cannot transmit through cracks because there are no polymer fibers that bridge the gap. Cracks can lead to material failure under stress or impact and are weak points in the helmet.

Helmet Evaluation:
NTDP conducted a visual inspection of the helmet. Inspection only provides information on what is seen on the helmet and cannot definitively determine if the damage occurred during this incident.

The information and locations described reference the helmet in the position worn.

Date of Inspection: May 29, 2025

Helmet Material: Polycarbonate shell
Date of Manufacture: January 13, 2022
Date Put into Service: Unknown
Storage Conditions: Unknown

Helmet Certifications — National Fire Protection Association (NFPA) 1977 Standard on Protective Clothing and Equipment for Wildland Firefighting, 2016 edition; American National Standards Institute/International Safety Equipment Association (ANSI/ISEA) Z89.1-2009, Type 1, Class E&G.

Shell Condition, Outer Surface — Scuff Marks, Scrapes, Gouges (deep scratches)
The retroreflective striping is not present. Miscellaneous scuffs, scratches, and abrasions present. The more noticeable marks are listed below:

Front – see figure 2.

- Right: crazing present, measurements ranging from 20-26mm
- Center ridge, left aspect: Crazing/scratches ~26mm
- Center ridge, right aspect: Crazing/scratches ~23mm

Figure 2: Crazing and scratches present on helmet front

Right side – see figure 3

- Right ridge, center: Crazing/scratches ~10mm
- U shaped scratch: ~20mm total length

Figure 3: Crazing and scratches. U-shaped scratch identified by red circle.

Posterior – see figure 4

- Center ridge: Crazing/scratches ~10mm
- Left posterior: Scratch ~70mm

Figure 3: Left posterior scratch

Left side – see figure 5

- Center ridge: Gouge ~22mm

Figure 4: Left side center ridge gouge.

Shell Condition, Inner Surface — Scrape

Posterior – see figure 6

- Left Posterior Aspect, Crazing ~15mm

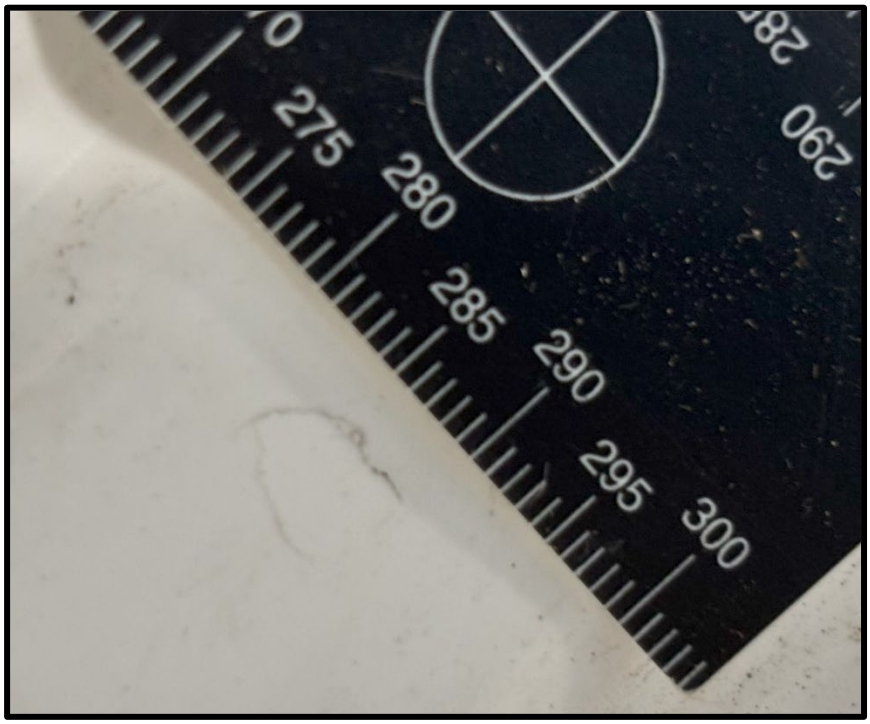

Figure 5: Interior crazing on left posterior aspect.

6-Point Flex-Gear® Suspension — Webbing, Keys and Key Pegs

Keys and key pegs

- Suspension improperly installed in helmet, *see figure 7*
- Right front vertical adjustment slot not attached to key peg, *see figure 8*
- Lateral keys not fully seated into key slot, *see figure 9*
- Back keys: medial aspect of both keys not fully seated, *see figure 10*

Figure 6: Helmet on left has the suspension correctly installed. Helmet on right is from incident and has the suspension incorrectly installed. Note the headband vertical adjustment slots in front of the webbing and visible on the helmet on right but not the helmet on the left.

Figure 8: Right front vertical adjustment not attached to the suspension key post.

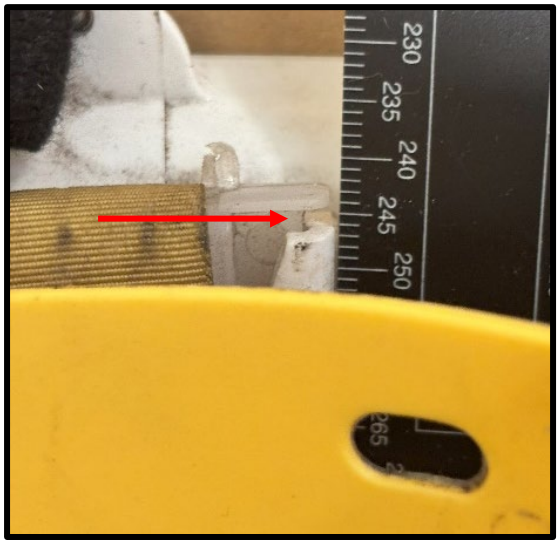

Figure 9: Lateral key not fully seated in key slot

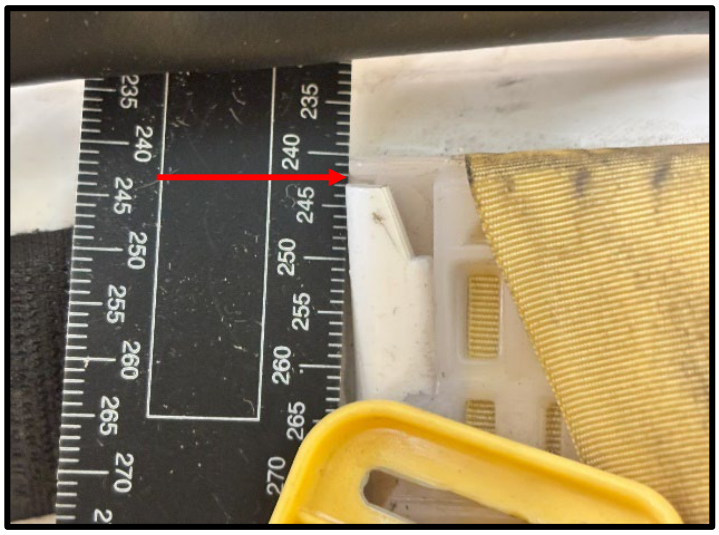

Figure 10: Medial side of back key not fully seated in key slot

Webbing

- Webbing, Right front suspension key: Fraying found on webbing at suspension key. Dirt present on fraying indicates the damage most likely was not associated with this strike, *see figure 11*.
- Webbing, Left lateral key: posterior aspect of webbing is fraying at the suspension key. The fraying is cleaner in appearance (brighter yellow) and is most likely more recent damage, *see figure 12.*

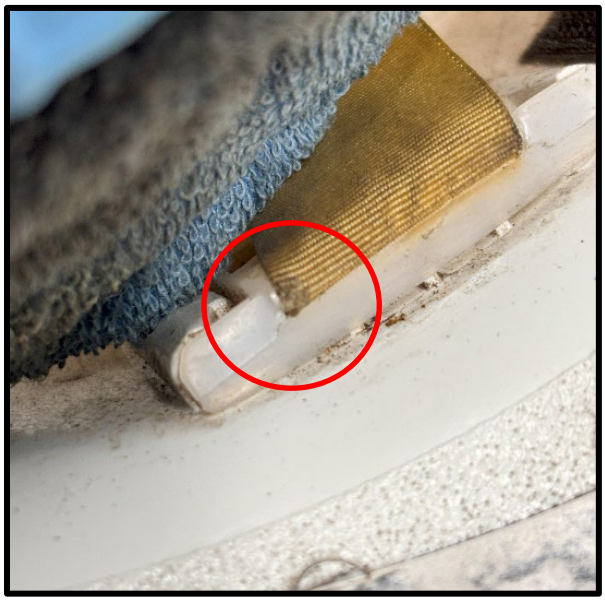

Figure 11: Right front suspension webbing fraying.

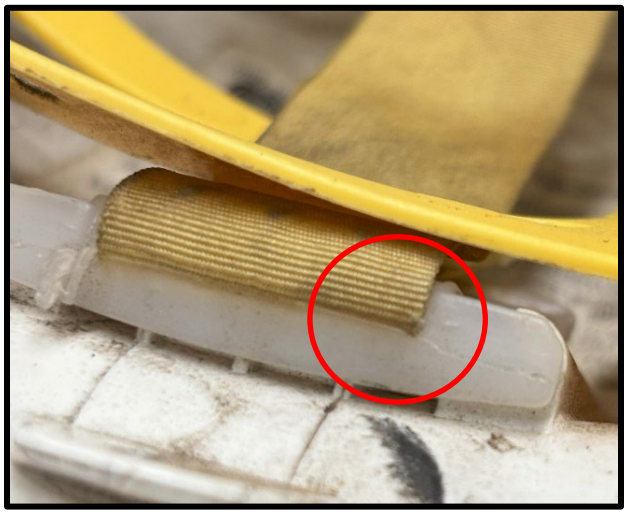

Figure 12: Left lateral suspension webbing fraying.

Inspection Findings—The helmet suspension was not installed according to the manufacturer's instructions. The suspension headband's vertical adjustment slots were placed in front of the suspension webbing, not behind it. Installing the suspension headband in this manner causes the helmet to sit higher on the head by creating tension on the suspension webbing. Impacts or strikes to the helmet shell will most likely exert forces on the key peg/vertical adjustment slots that will increase the likelihood of key pegs coming out of the vertical adjustment slots. This most likely led to the right front vertical adjustment slot disconnecting from the key peg.

Conclusion—The size and rotten condition of the tree transferred less force to the firefighter than would occur with a strike from a solid tree. The firefighter was not knocked to the ground, the helmet remained on their head, and there was no reported loss of consciousness. The incorrectly installed suspension may have reduced the overall protective performance of the helmet, the degree to which is unknown. The helmet provided the firefighter with protection and likely prevented a head injury.

Helmet Inspection Information—Acceptable helmets for fireline use are certified according to NFPA 1977 requirements. Helmet components include an outer shell, inner suspension, and chin strap. These components require periodic inspection and maintenance.

Helmets should be inspected at least monthly, if not more frequently, and should be inspected after an impact or drop to ensure serviceability. See the helmet manufacturer's recommendations for care, replacement, inspection, and installation of suspension components.