USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Eicks Fire Smokejumper Fatality

Learning Review – Technical Report

Spring 2022

Table of Contents

Table of Contents 2
Eicks Fire Smokejumper Fatality 4
Executive Summary 4
Introduction 4
Technical Focus Group Sessions 4
Organizational Focus Group Session 4
Sensemaking Reports 4
Foreword 6
Event Narrative 7
The Smoke Report 7
Background 7
May 24 Sequence of Events 8
Afterward 24
In Memoriam 25
Technical Report 26
Introduction 26
Sensemaking 27
Jump Timing 28
The Mission: A Spotter's Responsibility 29
Jump Spot Selection 30
Streamers 32
Stick sizes and Configuration 34
Flying a Parachute: A Parachute Pilot's Responsibility 35
Tim's Flight 37
Performance 41
Wind and Turbulence 42
Appendices 46
Appendix A 46
Malpai Borderlands Group's 2021 Fire Communication Map 46
Appendix B 47
Eicks Fire Timeline – May 24, 2021 47
Appendix C 48
Acronym/Abbreviation Index 48

Appendix D 49
2021 Eicks Fire Parachute Industry Subject Matter Expert Report 49
References 55

Eicks Fire Smokejumper Fatality

Executive Summary

Introduction

On May 24, 2021, Tim Hart was seriously injured on a fire jump in Hidalgo County, NM, and passed away from his injuries on June 2. The USDA Forest Service (Agency; USDA FS) initially assembled a team to conduct a Facilitated Learning Analysis (FLA), but after his passing, the team transitioned to follow the Coordinated Response Protocol and the Learning Review process (CRP/LR). In the weeks following the accident, the Learning Review (LR) team worked to collect information to build a complex event narrative. The team completed the incident narrative, vetted it with contributors, and began the sensemaking process by convening focus groups in support of both the technical and organizational reports.

Technical Focus Group Sessions

From July 26 to 31, 2021, a series of in-person technical focus group sessions were held at smokejumper bases in McCall, ID; Missoula, MT; and Redmond, OR. The focus groups consisted of day-long sessions with smokejumpers from five United States Department of Agriculture Forest Service (Agency; USDA FS) and two Bureau of Land Management (BLM) bases that focused on the technical aspects of smokejumper operations.

Organizational Focus Group Session

On September 22 and 23, 2021, a two-day in-person organizational focus group session was held in Missoula, MT. The focus group consisted of experts in fire and forest management and was structured for a discussion on organizational learning and systemic problems that participants identified in the draft narrative.

Both technical and organizational focus group participants had the opportunity to read the draft narrative prior to their focus group meeting and were asked to provide their professional assessment.

Sensemaking Reports

The LR team used these focus group sessions to support the creation of two distinct documents: (1) the technical sensemaking report—with input from parachute industry experts, researchers, Agency program managers, and the smokejumper community—that attempts to make sense of and learn from aspects directly related to smokejumping; and (2) the organizational report, which focuses its inquiry up and out from the smokejumper operation to highlight learning opportunities throughout the surrounding system.

Technical Report

The technical sensemaking report's goal is to make sense of Eicks Fire smokejumper operations during this incident. While learning opportunities are focused on smokejumper operations, those outside the smokejumper community also have learning opportunities. With input from parachute industry experts, researchers, Agency program managers, and the smokejumper community, we designated three primary

waypoints influential to the outcome of this incident: (1) jump timing; (2) the mission: a spotter's responsibility; and (3) flying a parachute: a parachute pilot's responsibility.

The LR team and technical focus group participants identified these waypoints as having the greatest potential to yield understanding and opportunities to learn. Each waypoint and accompanying sub-sections can be used as independent learning products to initiate discussions and sensemaking for readers.

Foreword

On Monday, May 24, 2021, resources responded to a fire on private land seven miles north of the United States-Mexico (US-Mexico) border in Hidalgo County, New Mexico. During a late afternoon fire jump, Smokejumper Tim Hart landed on a rocky slope at the base of a ravine. Tim's injuries were severe, and despite immediate care from emergency medical technicians (EMTs) and a well-coordinated air ambulance response, he passed away on June 2, 2021. A West Yellowstone Smokejumper with 6 years of smokejumper experience, Tim was a base squad leader and a qualified incident commander Type 3 (ICT3). The following narrative reviews the background of area fire management and then walks through the day's events from the perspective of individuals involved in the Eicks Fire response.

The Smoke Report

On May 24, 2021, a road crew worker saw smoke on the Diamond A Ranch, located in the Bootheel of New Mexico, as he looked into the Rattlesnake Drainage at the southern end of the Animas Mountains. He reported the smoke to the Ranch Manager at around 1100, who immediately called it in to the Silver City Interagency Dispatch Center (Silver City Dispatch).[1]

Background

The Bootheel area of southwestern New Mexico is a challenging place to fight fire. This desert region is known for high elevation, rugged terrain, limited access, and poor communication. Rocky peaks rise 3,000 feet above the valley floor, and three mountain ranges break the air into a turning kaleidoscope. The Animas Mountains, extending north-south for about 30 miles along the Continental Divide, cut through the center of the area and wind down to 6,000 feet near the United States-Mexico (US-Mexico) border. Valley bottoms are characterized by dry conditions, light flashy fuels, and few roads. In addition, law enforcement must be on scene for security because of criminal activity near the US-Mexico border. Bureau of Land Management (BLM) policy[2] states that if law enforcement is not present on fires south of Interstate 10 (I-10), firefighters need to be off the line before dark.

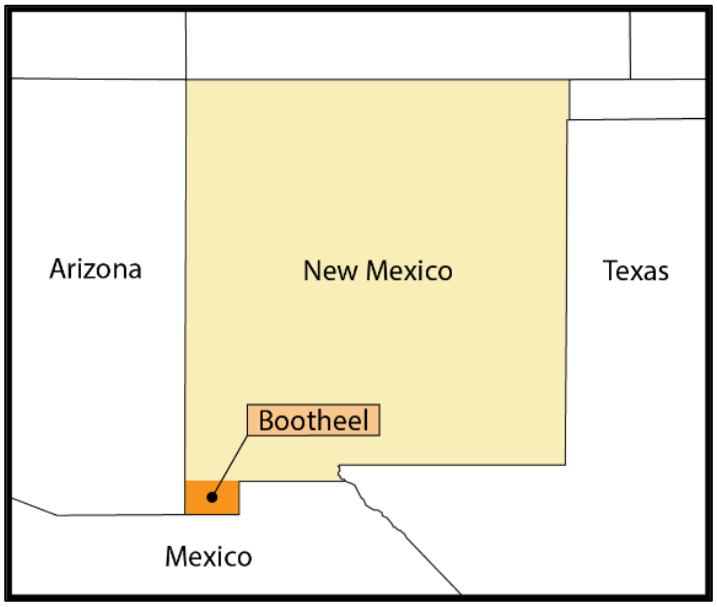


Figure 1. The Bootheel in southwestern New Mexico.

The Bootheel area closest to the national border consists of vast sections of remote, arid grazing land. Area private landowners (Malpai Borderlands Group) develop an annual wildfire response plan (see Malpai Borderlands Group's 2021 Fire Communication Map, Appendix A). The Diamond A Ranch manages just over 500,000 acres within the Malpai Borderlands Group. In most of the nearly million acres within the ranching cooperative, fire is managed for resource objectives and contained as the light flashy fuels burn down to dirt roads or other barriers. Usually short in duration, wildfires often exceed 10,000 acres.

At the end of May in New Mexico's southwest corner, temperatures were already climbing towards their July peak. Over 2 years had passed with little monsoonal moisture. Fuel moistures were a month ahead of average, pushing the burning index into the 90th percentile. Red flag warnings were becoming common.

[1] The Silver City Interagency Dispatch Center, located in Silver City, NM, dispatches resources for New Mexico Department of Energy, Minerals, and Natural Resources, the Bureau of Land Management, and the USDA Forest Service.

[2] "The Border Risk Area is for fires occurring south of I-10...Las Cruces District BLM employs a policy that all fires occurring in the Border Risk Area requiring a night operation must have an LEO on scene." *2021 Las Cruces BLM District Office Fire Operations Standard Operating Procedures Guide.*

Three active fires were currently burning in the state's southern half. Silver City, NM, hosted two single engine air tankers (SEATs), 20 smokejumpers, and a jump plane (J-13).[3]

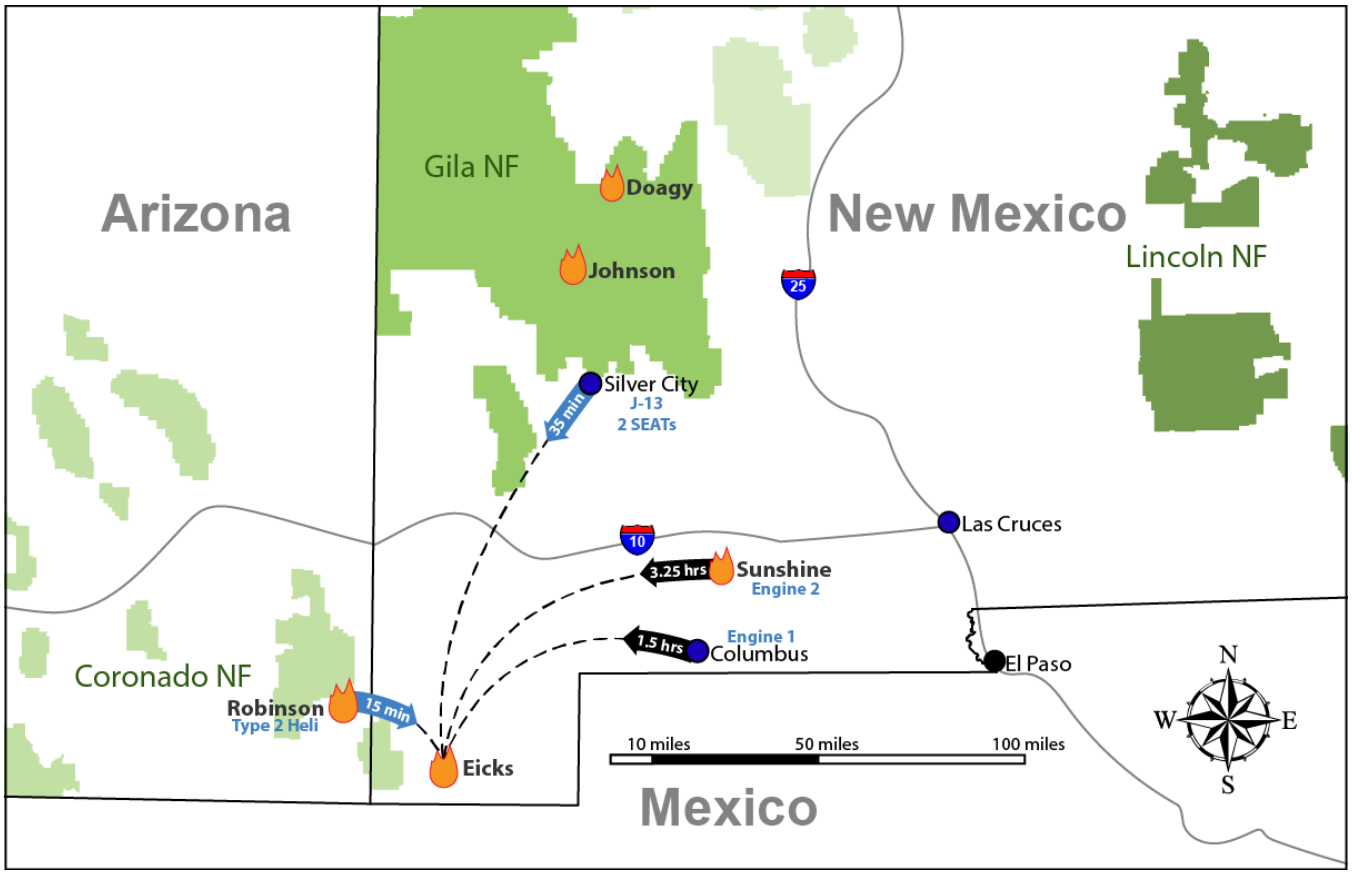


Figure 2. This figure shows area active fire locations along with original locations of resources sent to the Eicks Fire on May 24.

Smokejumpers have been coming to the Gila National Forest (Gila NF) since 1947, and crews are typically comprised of personnel from all permanent USDA FS smokejumper bases. USDA FS Regions 1 and 3 established a working agreement in the late 1990s to share fire resources. Smokejumpers perform many duties to support the Gila NF and Region 3 in spring and early summer, including fuels work and fire suppression. In 2021, the Missoula Smokejumpers opened the Silver City smokejumper sub-base on May 17.

May 24 Sequence of Events

Leadership Response and Atypical Plan to Suppress

As soon as the smoke report came in to Silver City Dispatch, the Assistant Center Manager (ACM) and Initial Attack Dispatcher (IA Dispatcher) attempted to notify the New Mexico Department of Energy, Minerals, and Natural Resources (EMNRD Forestry Division; State) Socorro District[4] Duty Officer (DO) of the new start. The report placed the fire on private land, where the State was responsible for fire

[3] J-13 is a Dornier 228, a twin-turboprop utility aircraft.

[4] The New Mexico Department of Energy, Minerals, and Natural Resources (EMNRD Forestry Division) Socorro District has offices in Socorro and Silver City.

protection.[5] The EMNRD Forestry Division Fire Management Officer (DFMO), who was filling the Socorro District DO role at the time, was out of cell service. Next, they notified the BLM Duty Officer (BLM DO) of a possible fire in New Mexico's Bootheel. The BLM DO tried to call the Socorro District DO directly at 1120, but after several unsuccessful attempts, was informed he was "out of pocket." Silver City Dispatch worked with EMNRD Forestry Division and the BLM DO to respond to the fire with BLM resources, a common practice for State fires because of limited resources and delayed response time from the Socorro, NM, office. For this incident, the nearest available State engine was 7 hours away from the fire.

The Socorro District DO was meeting with a Congressional Delegation on the Doagy Fire when he received a voicemail about the new start. Having been in this position for several years, he had a longstanding relationship with Bootheel landowners. While the new start was located in a "Manage for Multiple Objective/Contain & Control" area on the Malpai Borderlands Group's 2021 Fire Communication Map, he was aware that the Diamond A Ranch Manager was concerned about the effects of the area's "unprecedented drought." The vegetation had still not recovered from the OK Bar Fire that burned 80,000 acres in 2018. According to the Ranch Manager, the ranch supports 10,000 head of cattle along with numerous "priority natural communities."[6] Already the lowlands were mostly grazed out. For the past 25 years, the Diamond A had followed a hands-off approach towards fire management, allowing fire to play a more natural role in the ecosystem. Fire suppression was usually delayed until the fire came down into the flats where firefighters could utilize roads or natural barriers. This year in their pre-season meetings and phone conversations with EMNRD Forestry Division, the group had discussed 2021 being a "suppression year." They didn't plan to take action on every fire, but where appropriate, they were opening the door to aggressive suppression of fires up on the hill. As soon as the Socorro District DO was notified, he contacted the Ranch Manager to confirm that he wanted to suppress the fire on the Diamond A Ranch. The Ranch Manager said, "Please, please, please put this fire out," realizing this would be the first time in his 25-year tenure that they would suppress a fire up on the hill.

Forty-five minutes after the initial fire report, the Socorro District DO passed on the direction for full suppression to the Silver City Dispatch ACM and the BLM engine crews. Normally for State fires, Silver City Dispatch would coordinate with the Socorro District DO each time an Incident Commander (IC) ordered aviation assets. In years past, EMNRD Forestry Division had expressed concern at the cost of the BLM's ordering retardant. His instructions now were to "suppress the fire 100 percent; authorize responding resources to utilize slurry; order more resources if needed." The intent from the Socorro District DO and the landowner was to keep the fire small. The Silver City Dispatch Aircraft Dispatcher deconflicted the airspace over the fire area, and the ACM contacted the Radio Technician to make sure the local repeater was operational.

Smokejumpers Considered, Then Ordered

The Gila NF Forest Supervisor was also at the Doagy Fire meeting with the delegation. During the meeting, the EMNRD Forestry Division District Forester (DF) gave a briefing for the State of New Mexico

[5] The EMNRD Forestry Division has statutory responsibility for wildfire suppression on all non-federal, non-municipal, non-tribal, and non-pueblo lands. The State is divided into six districts. Each district office works with volunteer and paid fire departments and cooperating agencies in the suppression of wildfire and protection of New Mexico citizens. Coordination of funding opportunities and programs are handled through the State office in Santa Fe. Specific information can be found using the links on this page. *http://www.emnrd.State.nm.us/SFD/FireMgt/Fire.html*

[6] The Nature Conservancy holds Conservation easements on the Diamond A Ranch and others in the Malpai Borderlands Group and has identified several communities and species of interest for conservation. The Nature Conservancy has identified this area as "one of the most significant natural sites in the nation."

Bootheel Communications

Repeaters

The Bootheel of New Mexico has one repeater on Gillespie Peak. This repeater has several shadows due to large terrain features throughout the Bootheel. An older repeater site was located to the east on the Big Hatchets, but the facility requires expansion to install modern equipment. The site is in a Wilderness Study Area and the expansion has not been authorized. On September 9, 2019, the BLM completed the National Environmental Policy Act (NEPA) analysis required for the placement of a BLM communication shelter and repeater on private land (San Luis repeater site). However, because the Animas Foundation is having trouble establishing an agreement with US Border Patrol for use of their building on Gillespie Peak, they will not allow the BLM to place a repeater on their private property. On May 4, 2020, the BLM sent the Animas Foundation the Reciprocal Agreement documents for final legal review. To date, they have not received a response.

Satellite Phones

In April 2021, the entire BLM went through a change in service providers for satellite phones. Each state had to solicit a contract for new providers. Field personnel were unaware that there would be a disruption and significant gap in coverage. New SIM cards were needed to continue service while waiting for the new contracts. Because of poor radio communications in the Bootheel, satellite phones are critical to communicating with dispatch.

and mentioned that the Socorro District DO had to step out to deal with a new start in the Bootheel. This was the first that the Gila NF Forest Supervisor heard of the fire in the Bootheel. He excused himself from the briefing and spoke to the Socorro District DO in the parking lot, who mentioned to the Gila NF Forest Supervisor that there was a new start, and he might need some qualifications on the fire. He wondered if smokejumpers would be a possibility. The two discussed the option of having the jumpers drive or fly to the fire. The Socorro District DO said, "I don't need them to jump the fire but just need the quals. We can drive them there." The Gila NF Forest Supervisor supported using smokejumpers to provide qualified overhead, adding, "This is how we often use them on the Gila." He promoted the idea of driving the jumpers to the fire, noting that he believed it was a "good risk management decision." The Socorro District DO remembers the conversation as a casual discussion of potential options of how to staff the fire and did not continue the conversation about whether to jump or drive with the BLM DO or other fire personnel.

At 1201, BLM Engine E-1 (Engine E-1) was dispatched to the smoke report via phone. The engine was from a northern New Mexico district but had prepositioned for initial attack and had been patrolling near Columbus, NM, roughly 100 miles from the fire report. While enroute, the Engine got an update from the BLM DO. EMNRD Forestry Division wanted to suppress this fire, saying, "Every tool in the toolbox is available." This was a sharp departure from the typical response in this area. Captain E-1 contacted the Diamond A Ranch Manager and confirmed he wanted 100 percent suppression of the fire and approved of retardant use. He also asked for help in navigating the ranch roads, but the Ranch Manager was on the other side of the Animas Mountains, meaning at least a 4-hour delay before he could meet with Engine E-1. Instead, he provided the gate access codes and directions to the fire area over the phone. At 1255, Captain E-1 ordered two SEATs.

Air Attack 01 (AA-01) was flying over a fire in the Diablo Range to the north. At 1158, Silver City Dispatch requested to borrow the AA platform for a quick size up and within 30 minutes they had an update: "15 acres in grass and brush, moderate spread potential and no visible road access." AA-01 then returned to the Johnson Fire.

At 1315 the BLM DO contacted the ACM to check on the availability of Smokejumpers, specifically an ICT3. The ACM coordinated with the Gila NF Duty Officer (Forest DO) to check availability. The Forest DO called the Silver City Smokejumper Duty Officer (SMKJ DO) to let him know "there's a fire they anticipate going

to a Type 3." The SMKJ DO confirmed they had an ICT3 on the first load. The Forest DO also brought up the security concerns of staffing incidents near the US-Mexico border. They discussed the ICT3 response options, and the SMKJ DO offered to send a qualified IC by ground, or a load of smokejumpers including a qualified ICT3 by air with drivers and vehicles to support incident operations and border security requirements. The first load, knowing a request could come at any time, started looking over maps and monitoring Wildweb[7] for details about the new start.

BLM Engine E-2 (Engine E-2) was wrapping up operations on the Sunshine Fire when they overheard traffic about the new fire in the Bootheel. Captain E-2 contacted the BLM DO via cell phone and relayed they were available for initial attack from the Sunshine Fire. At 1227 Engine E-2 and a chase truck with trailer and utility terrain vehicle (UTV) were dispatched to the fire. The fire's location was a 157-mile drive away. They heard the size up from AA-01, and Captain E-2 requested a dedicated AA.

At 1335, Engine E-1 was five miles out and had the smoke in sight. Captain E-1 assumed command of the fire. Both Engines continued to work their way towards the fire. As Engine E-1 picked their way further into the ranch, radio and cell phone coverage deteriorated. The Engine continually had to find higher ground for cell service or to hit the repeater. Captain E-1, now the Incident Commander (IC), contacted the recently assigned dedicated Air Attack, AA-02, to confirm the SEATs were enroute and asked about the possibility of utilizing smokejumpers. AA-02 advised there was a load of smokejumpers in Silver City and that they could be useful given the limited terrain and access.

> ***"If we didn't have an Air Attack on scene, we wouldn't have had any commo with those guys."***
>
> ***- Gila NF Fire Staff Officer***

AA-02 arrived over the fire at 1425, where two SEATs out of Silver City were dropping on the newly named Eicks Fire. The fire was on top of a knob burning in grass and brush, backing downhill and making small pushes. Area communication continued to be poor, and resources on the fire needed AA-02 to relay requests to Silver City Dispatch. The Gila NF Fire Management Officer (FMO) stated, "Comms in the Bootheel are a problem." The BLM has plans to add a repeater, but the project has been delayed for 2 years. In addition, the BLM engine crews were having satellite phone issues (see sidebar "Bootheel Communications").

At 1446 the Eicks Fire IC ordered a load of smokejumpers and a Type 3 helicopter. Still an hour out, Engine E-2 heard broken traffic about smokejumpers being requested. Captain E-2 was surprised. He had been on the Socorro District for 12 years, and this area didn't typically use aggressive suppression. He felt it was ill-advised to jump the fire in the afternoon based on safety concerns and the BLM District policy on border fires. Without armed law enforcement on scene, all resources would have to hike off the fire before dark and then drive two hours to a nearby town. Still in cell service, Captain E-2 called the ACM on his cell phone and expressed his concerns: "We don't jump the Bootheel; it is a pile of rocks and there are weird winds coming off of the Animas Mountains. We had a bad experience last time we jumped this."[8] Captain E-2 then called the IC (Captain E-1) on the direct tactical channel to express his concerns, but he focused on security issues, believing that his safety concerns would be considered too "political."

[7] Wildweb is a public-facing listing of WildCAD incidents by dispatch center. http://www.wildcad.net

[8] The Learning Review team researched the records for jumps in this area during the timeframe referenced. They found one other jump recorded in this area between 2009 and 2021, and no injuries were reported on that jump.

"We cannot jump them if we don't have security in place; they will need to be off the hill tonight...slow the roll; there is a lot going on here," he said.

The IC then raised AA-02 on air-to-ground and repeated this information. He advised that if jumpers were used, a helicopter should be ordered to pull them off the hill before dark unless the jumpers drove to the fire. AA-02 relayed this information to Silver City Dispatch with an email detailing the IC's concerns: "IC is concerned that if we don't have a way to get the jumpers off via helicopter that we should not use jumpers. So the[y] need to fill the helicopter prior to jumpers." She followed up with a radio call to verify they had received the information. The ACM told the Aircraft Dispatcher to let the Silver City Smokejumpers know about the security concerns when she called the base.

The ACM coordinated with Agency DOs and bordering interagency dispatch centers to identify a law enforcement officer (LEO) for the Eicks Fire. A resource order was placed regionally and nationally with no fill. The ACM called the Socorro District DO to request the use of New Mexico State Police since no federal LEOs were available. The Socorro District DO stated he would coordinate with the State Police and the Border Patrol to check availability.

Just before 1500, the Silver City Aircraft Dispatcher placed a call to the Smokejumper Base to let them know an IA load had been ordered for the Eicks Fire. The first load immediately began suiting up. She explained the security policy for fires south of I-10. The SMKJ DO said they understood the policy and had chase vehicles and drivers assigned to support the jump load. The Aircraft Dispatcher asked the SMKJ DO if they felt comfortable jumping a fire close to the border. He said they were comfortable with the assignment and would assess jump conditions once they were on scene. When the kneeboard[9] arrived 15 minutes later, the Smokejumpers were already suited up, ready to get on the plane. By 1515, J-13 was airborne, and two chase vehicles headed south towards the Eicks Fire. This would be the first fire jump out of Silver City for the season.

Streamers & Check Sets

To determine wind information, spotters use streamers, which are 20-foot-long pieces of colored, weighted crepe paper. Prior to each jump, first set ("initials'') and check sets are dropped at 1,500 feet above ground level (AGL). The spotter can determine air conditions based on a streamer's flight, landing location, and descent time.

Average wind direction and average wind speed are determined from a streamer's release point and landing location, starting with an initial set and confirmed by a check set. Wind speed is calculated in "yards of drift" and can be converted to mph. For example, 400 yards of drift converts to an average wind speed of 12 mph.

The presence of up- or down-air can be determined by timing a streamer's descent. The streamers' last check set is more important than earlier sets, as they are passing through the same body of air that the jumper will.

The first set of streamers is dropped directly over the jumpspot and determines the pattern to fly for consecutive check sets.

A check set (or check sets) is dropped to confirm the exit point for the round canopy at 1,500 feet AGL and converted for the Ram-Air canopy at 3,000 feet AGL.

Streamer information is one of many considerations spotters and smokejumpers use to help determine a "go/no go decision," and spotters share this information with each smokejumper prior to exit.

Pre-Jump Activities

AA-02 requested relief over the fire for 1630 and continued to work the two SEATs. J-13 made contact with AA-02 at 1530. As the jump plane approached the fire, the Jumpers noticed wispy smoke described as "light and switchy." The fire was around 25 acres, burning in grass and juniper with a low spread rate. The smoke laid over in places, and the fire was partly lined with retardant. The flight to the fire had been through smooth air with minimal turbulence. After anticipating a complex Type 3 incident, a small fire

[9] A kneeboard is the official dispatch order for the jumpers, containing known fire information, including location.

with minimal fire behavior, light winds, and big open jumpspots seemed ideal. The Jumpers believed they could make a real difference on the ground in these conditions.

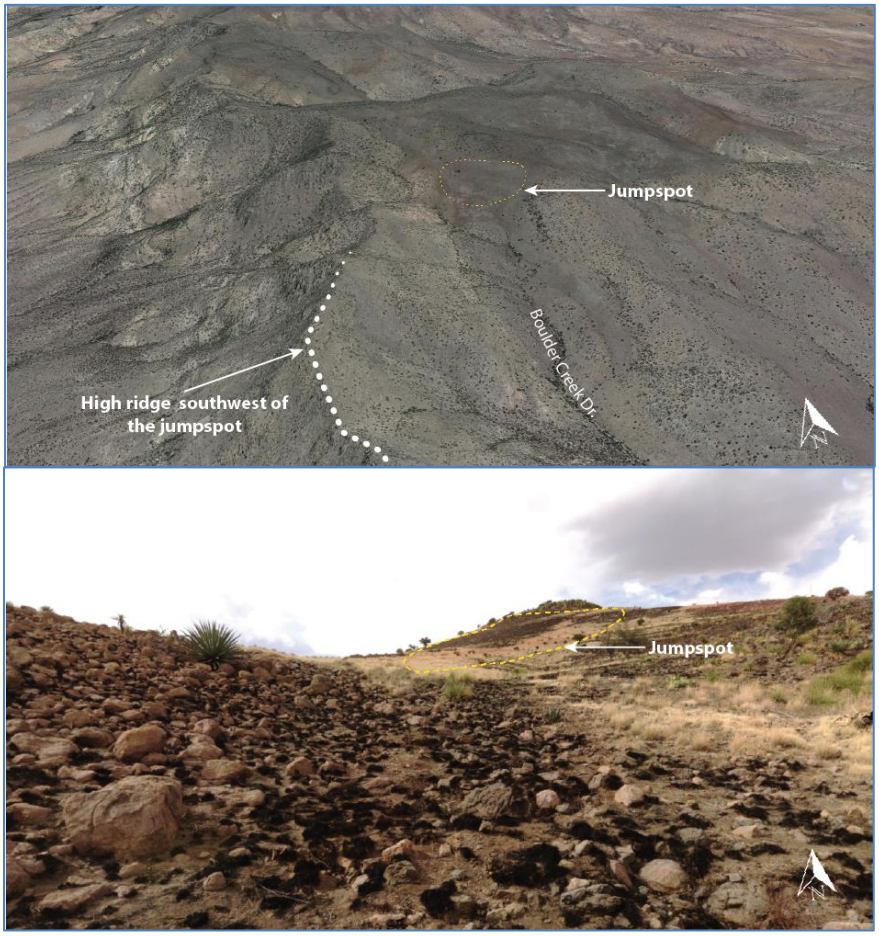


Figure 3. Aerial (above) and ground-level versions of the Eicks Fire jumpspot.

At 1549 J-13 arrived on scene and established communications with the Eicks IC on air-to-ground. They confirmed the frequencies and went through a plan rundown. The first Jumper (also known as the Jumper-in-Charge or JIC), both Spotters, and the Pilot all wore headsets and could communicate as the plane did a high-level recon. The JIC wore a headset during this part of the mission so he could hear radio traffic from the ground and communicate with the Spotters. He and the Aft Spotter looked at several potential jumpspots near the fire and farther down the ridge. The IC was still making his way into the fire and requested help on the southern end. They looked at two potential jumpspots near the fire's south end. The first was on the top of a ridge with scattered junipers. They made a low pass and saw a fence line running through the middle of the spot. According to the Aft Spotter, "We didn't like it because the wind was aligned across the longer and skinnier spot, and the fire was still active with no retardant line." The second spot was an open slope, "perfectly aligned with the wind," and "would work better for Jumper flights." They did a low pass over the spot, following the Boulder Creek drainage out so the spot was visible out the left side of the plane. The Pilot reported the air to be "smooth and uneventful" during the below 500-foot above ground level (AGL) pass. The Spotter noted that even though the spot itself was open and grassy with a few scattered yuccas, "the opposing slope and drainages were rocky, especially as you moved down drainage." As the plane climbed out of the low pass, the Aft Spotter confirmed with the Jumpers that it was okay to move on to throwing streamers at this spot. The plane set up for an initial streamer run at 1,500 feet AGL as the JIC passed on radio frequencies and other incoming information to the rest of the Smokejumpers.

The Aft Spotter grabbed two streamers[10] from the bag at his knees and put his head out the door to check that the plane was lined up with the spot. He pulled his head in to give a "right!" correction to the Pilot, then put his head out again to see the spot begin to pass underneath the plane. He threw the streamers "just inside of the prominent juniper in the spot" and immediately called to the Pilot, "Streamers away." Hearing

[10] See *"Streamers & Check Sets"* sidebar.

this, the Pilot banked into a wide left-hand circle, allowing the Jumpers to see the streamers out the left side of the plane as they fell.

The streamers were carried on a west wind to the leeward side of the bowl that formed the jumpspot. It took about 00:01:10 for them to hit the ground and indicated about 400 yards of drift (about a 12-mph wind). The Pilot lined up to do a "streamers to spot" run.[11] This second set of streamers drifted from the release point, and when they got over the fire near the ridge, they "just hung there for like a minute." It took 00:02:55 for these streamers to make it to the ground. The JIC and the Aft Spotter agreed on two possibilities. Either the streamers were "light," meaning some of the sand providing weight to the streamers may have leaked out, or the streamers had been caught in an upward column of air from the convective heating from the fire. For the Jumpers on board, up-air wasn't a big deal as it is encountered as a normal condition on many jumps, especially in the afternoon in desert country. According to one Smokejumper on the load, "We deal with that down here." The Spotter called out the streamer times to the load of Jumpers, adding that if the next set of streamers showed a similarly long hang time, then they would move about a mile down canyon to another spot in the flats and try there. The plane flew two more passes over the release point, the Spotter throwing streamers each time. These two additional sets showed more normal times to the ground at 00:01:16 and 00:01:20. The final check set landed squarely in the spot.

When the Aft Spotter saw the last set of streamers land in the spot, he turned to look down the line of Jumpers and asked, "You okay with that?" They gave their approval of the spot and the streamers with nods and thumbs-ups.

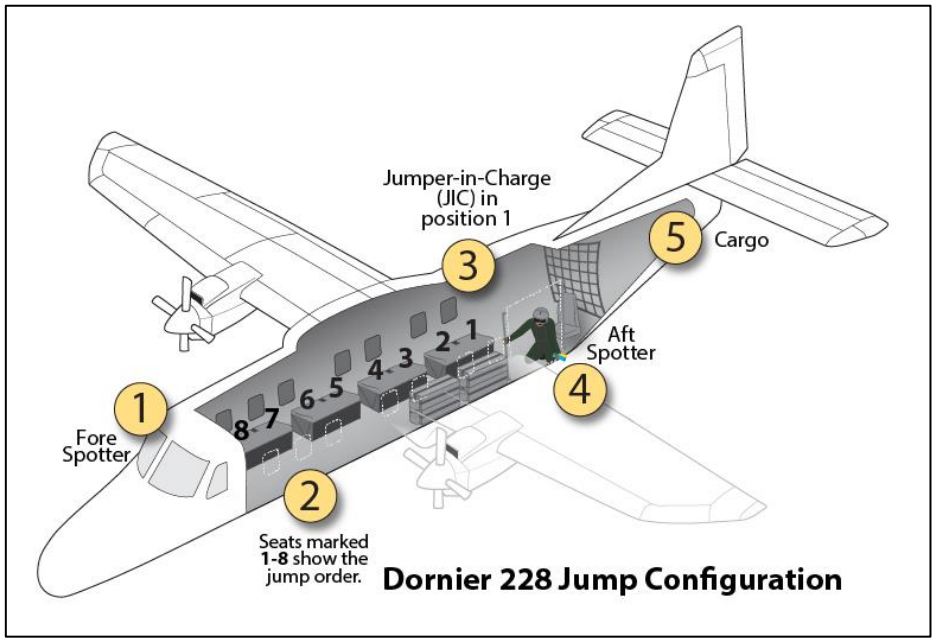


Figure 4. An interior diagram showing Smokejumper locations before the May 24 jump.

Engine E-2 finally arrived on the ranch at 1543. The two Engines met at Miner Tank, on the north side of San Luis Pass Road, about 3 miles southwest of the fire (see Figure 7). Once they parked, Captain E-2, the IC, and two crewmembers loaded into the UTV to find better access. The remaining crew members stayed with the vehicles to assure they were secure, a standard precaution this close to the border. The UTV worked its way in, navigating "boulders the size of trash dumpsters." They picked a rough path on the top of a ridge, following one of the ranch's fence lines. Once on top, they continued the slow trek towards the black. When they arrived, they estimated the fire to be 30 to 50 acres, 60 percent active, and primarily backing. They could see jump operations taking place at the fire's south end.

[11] A "streamers to spot" run takes the plane from the streamer's landing spot to the selected jumpspot. The aft spotter counts how long it takes to get from the streamers to the spot, then counts that same number again from the spot to where he will release the check set.

As the plane climbed to jump altitude (3,000 feet AGL), the Aft Spotter addressed the Jumpers. He said he expected to jump one stick of two, then two sticks of three, but would wait to hear a report back from the first two Jumpers. The JIC took off the flight helmet and replaced it with his jump helmet, turning to his jump partner (JP) to discuss their plan. The jumpspot was bracketed by rocks in the drainages below and up on the ridge to the north and east. The JIC eyed the rocks on the knob and the fire location. He suggested flying a left-hand pattern, putting him downslope of the jumpspot, which would let him see the spot in full amphitheater view during his flight (see Figure 5). Jumper 2 passed along that the rest of the load was planning on doing a right-hand pattern so they weren't overflying the fire. The JIC reiterated his desire to do a left-hand pattern. They agreed to make an assessment in the air.

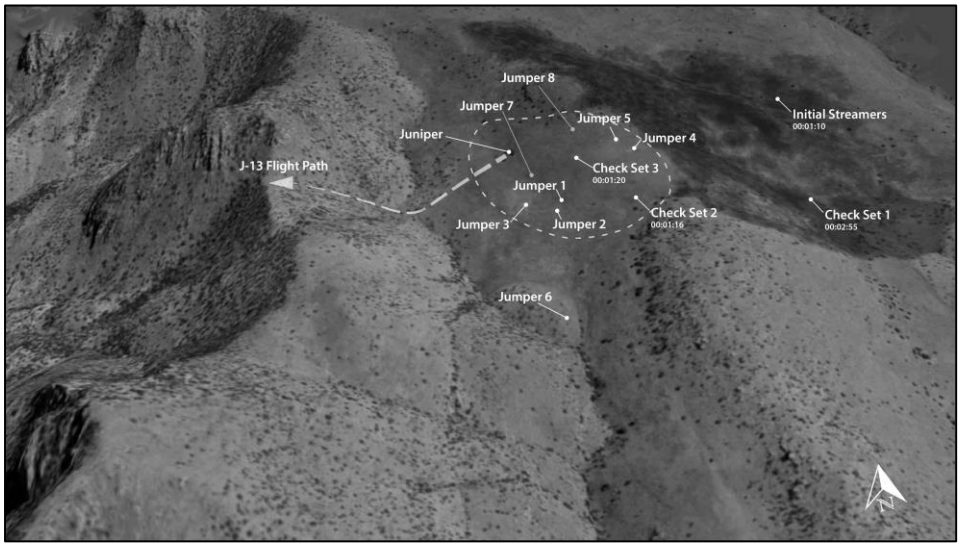


Figure 5. The Eicks Fire jumpspot looking north.

The plane flew its downwind leg as the Aft Spotter began his briefing. He called out, "Two Jumpers, ready and tight?" With a nod from the first two Jumpers, he said, "Hook up!" The Jumpers connected the static line that would deploy their drogue chutes [12] upon exit. The briefing each Jumper received before going out the door was "pretty standard:" "See the streamers? See the spot? We're flying a standard into-the-wind pattern, 3,000 feet AGL. Streamers are showing 400 yards of drift. Hazards are the rocks up on the ridge and the ones in the drainages. Jumpspot elevation is 6,100 feet. Are you armed?[13] Any questions?" As the plane turned out of its base leg and into the wind, the Aft Spotter said, "Turning final; 3,000 feet; get in the door." The JIC sat down in the open door, placing his feet on the outside step of the plane. The Spotter leaned his head out the door, looking for the release point. He pulled his head in just shy of the main ridge to the west of the jumpspot, as the plane soared over a low saddle. He instructed the Jumper to get ready, checked the static line connection once more, and thumped the JIC with a balled fist in the shoulder, initiating his exit from the plane. Jumper 2 immediately replaced the JIC in the door and set up, waiting for the thump on his left shoulder that would tell him his static line was good and he was over the release point. "Thump," and he exited the aircraft.

The JIC flew a left-hand pattern and set up for a final approach 150 yards inside of the ridgetop to avoid expected ridgetop compression. He faced into the wind on final, looking down the drainage. With good vertical separation between the two, Jumper 2 felt more comfortable with a right-hand pattern and determined it would be safe to fly a right-hand pattern without causing any airspace conflict. He took the

[12] A Drogue chute is the device used to deploy the main canopy once a jumper leaves the plane. It resembles a small round parachute.
[13] Armed refers to the Automatic Activation Device or AAD (part of Ram-Air reserve system). When active, the device releases the reserve canopy automatically if certain barometric pressures and airspeeds are detected. Spotters confirm with each jumper before exit they have "armed" the AAD.

same final approach into the jumpspot as Jumper 1. They both experienced a very "floaty" ride downslope. The JIC flared,[14] and his feet touched the ground, giving him the softest landing of his career. Jumper 2 flew downslope at half-brakes, and between 50 and 20 feet he attempted to land three to four times but was lifted back up by upslope winds. They both eventually landed in the jumpspot, slightly downslope from the streamers.

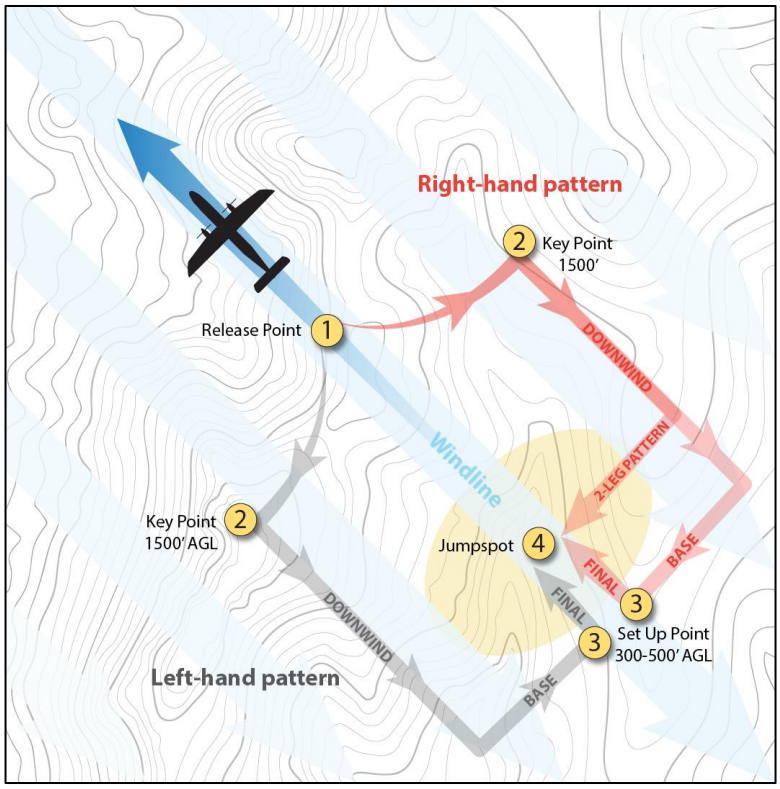


Figure 6. This windline diagram demonstrates left- and right-hand patterns.

The JIC briefly talked with his JP about conditions before calling up to the jump plane and deciding to send the rest of the Jumpers. He called up to the plane on their air-to-ground channel, reporting there was a lot of wind up high, and it was "floaty down low...sporty final, tough to get out of the air...but had good luck working the slope down drainage." With this feedback, the Aft Spotter decided to "play it safe" and go with a 2-2-2 stick configuration for the remainder of the load. The next three Jumpers had planned on a right-hand pattern and quickly adjusted to the updated sticks. The Spotter looked back at the remaining Jumpers and held up two fingers, "Two Jumpers ready and tight? Hook up!" Jumpers 3 and 4 hooked up their static lines and Jumper 3 got in the door. Just before the release point, the Aft Spotter pulled his head in, checked the static line, and thumped Jumper 3 to cue his exit. As Jumper 3 exited, Jumper 4 reached out with his right hand to grab the long vertical handle just to the right of the door opening. He "fumbled in the door…failed to get my right hand into position." As he finally grasped the handle to swing into the door, the Aft Spotter grabbed the Jumper's arm to stop him. The Spotter assessed they had traveled too far past the release point for the Jumper to make it to the spot. The Spotter called to the Pilot, "One Jumper away," and the plane began its wide left-hand circle to prepare for the next stick to exit. Jumper 3 flew a right-hand pattern and rode the same slope as the first stick. Jumper 4 sat back on the bench seat and mentally switched gears. "The Aft Spotter helped me with unhooking my static extender, passing it back to the new second person in the stick and re-hooking to the first-person extender." The Aft Spotter then looked back to the remaining Jumpers, held up two fingers and said, "Two Jumpers ready and tight?" but as he did so Jumper 6, Tim, suggested a three-person stick. The Aft Spotter looked at the Jumpers in flight and on the ground and decided it would be okay. The three Jumpers had watched the previous canopy flights and quickly made a plan. They decided on a two-legged right pattern, splitting the slope into lanes. Jumper 4 would be furthest up the ridgeline. "We felt like we had enough time to get on the same page; didn't feel rushed," Jumper 4 said. Jumper 5 even had time to talk with Tim about their vertical separation, saying, "I don't know if I am going to do bomb turns or just sink." According to Jumper 4, Tim replied, "No problem, do what you need; I'll just hang out." Jumpers 4 and 5 said they felt comfortable with the plan

[14] A flare is a Ram-Air parachute handling maneuver that slows the forward motion and descent rate in preparation for landing. It is typically executed 10 to 15 feet off the ground by evenly pulling the steering toggles into a braking position.

and believed Tim did as well. Jumper 4 was now in the door, the first Jumper in the stick of three. He leaned back slightly to allow the Spotter to peer around him. The Spotter pulled his head in slightly before the release point to allow time for three exits, going through the same checks and thumps as in the previous sticks. All three Jumpers exited the plane smoothly.

Jumper 4 was a light Jumper and "did five bomb turns, which would put most too low, but put me in a good spot," over terrain that was slightly higher than the jumpspot. He came out of the turns still over landable terrain. He was facing what he thought was into the wind, but ended up being slightly crosswind. He was facing away from the spot towards the west, trying to feel out the wind direction. At his altitude he was experiencing instability, "like when you were in a stall…directional instability…like if you were getting burbles[15] off a tree wall," with the canopy turning side-to-side over what looked like consistent terrain. It was unexpected behavior. He made a turn onto final and realized he was flying faster and dropping faster than expected. "I've never come out of the air like I did on final." He thought they may have misread the terrain. The jumpspot was rounded convexly to the west and north and concave to the east and south. Approaching the ground, he knew Jumper 5 was close and didn't want to deviate from the plan. He felt the only turn he could make would be towards Jumper 5, so he "took what I had," downwind, dropping out of the air fast. He had a late flare "into a bunch of rocks…and piled in pretty hard…took me a second to get myself together…rung my bell pretty good."

As soon as Jumper 5 was under canopy, he looked for his jump partners and the jumpspot. They all had good vertical separation. At around 800 feet, as he crossed the drainage, he noted turbulent air that "felt like being in an elevator, dropping and falling." He realized he wasn't going to make the set-up point[16] and did not want to fly into rising terrain. He still had good separation but felt like he was "descending faster than a round canopy would" and took a lane on the contour of the slope. He noted Tim was behind him and to his left still with good vertical separation, but once he encountered the "down-air" his focus was on trying to get to a good landing spot. He was at half-brakes and realized he wasn't coming into the wind. Instead, he had quarter tailwind and didn't have the altitude to make a turn and risk having his canopy become unstable. "I didn't want to make a crazy turn...the ground was coming up fast." He chose to maintain his heading and flare, but from half-brakes "there was nothing," and he hit hard into rising terrain. Dazed, with the wind knocked out of him, he heard Jumper 3 yelling to ask if he was okay. Once his head cleared, he removed his helmet and threw it in frustration. The nearby Jumpers who had noted his landing with concern were relieved, taking it as a sign that he was not seriously injured.

The Jump Accident

With Jumpers 4 and 5 on the ground, attention focused on Tim. He was still 200 yards southeast of the jumpspot and three-quarters of the way up the boulder-strewn ridge south of the bowl. He was flying up drainage 200 to 300 feet above the drainage bottom, hands positioned at quarter-brakes to full run. Those who could see the flight remember him flying in this direction for one to three seconds before the canopy turned 90 degrees to the left towards the center of the drainage. The cause of the 90-degree turn is unknown, as no one witnessed a left toggle input initiating the turn. At approximately 200 feet AGL,[17] the canopy increased in speed and "came out of the air super-fast, like he got caught in a burble." The JIC turned to Jumper 2, who had a streamer held high as a wind indicator for the other Jumpers, and exclaimed, "Are you seeing this right now?" Tim's hands were on the toggles, and the JIC thought, "You need to

[15] A burble is an informal way Jumpers refer to turbulence, whether it is thermal or mechanical.
[16] A set-up point is the optimum position to begin the final approach for landing; this position in the pattern begins after the last directional turn of the base leg. In a formal pattern, this point would be at the junction of the base and final.
[17] There is some variability here between interviews, ranging between 100 to 300 feet.

turn, anywhere but where you are on final," and waited for a turn at the last second. The JIC said he had "never seen an angle of attack on a Ram-Air[18] like that before." The JIC and Jumper 2, without another word, began running towards where Tim was going to land, calling to him without hearing a response.[19] Tim had landed on the side of the drainage, uphill into "rocks the size of garbage pails."

Remaining Jumper Landing Experiences (Jumpers 7 and 8)

The last two Jumpers (7 and 8) slid down the bench seat towards the rear of the plane and hooked up their static lines to the extenders. The Aft Spotter had decided to go around again to allow for greater separation between the three-person stick and this final one. Jumpers 7 and 8 were confirming their plan to do a right-hand pattern along the rocky knob at the north end of the bowl, turning base just southwest of the saddle and final along the retardant line. Once in the air, Jumper 7 had great vertical separation, ending up well below Jumper 8. Once Jumper 7 was over the spot, he turned into the wind and was coming straight down at half-brakes. On final he "crabbed"[20] and experienced a "gust up canyon," resulting in the sensation of running with the wind. He loaded the canopy and executed a good flare, landing fast but not hard. Jumper 7 landed on a contour uphill of the first stick's landing spot.

Coming over the ridge nearest the release point, Jumper 8 felt compression winds that tilted him forward. As he got lower, the transport winds diminished and he experienced up-air, then down-air,[21] riding out the vertical activity by facing into the wind and crabbing toward the spot. Jumper 8 turned down canyon once he was over the rocky face at the top of the knob. At about 200 feet AGL, he experienced considerable turbulence and began moving at a "really high rate of speed." He descended along the slope about 10 to 15 feet above the ground at half-brakes and flared. His feet drug on the ground and he was initiating his parachute landing fall (PLF) when he was picked back up 20 feet and came down again with a downhill PLF among softball-sized rocks. He assessed himself and his equipment. His radio and water bottle broke from impact with the rocks. He had a small bump on his forearm but beyond that was okay. Both Jumpers reported that their canopies were being influenced into turns that were not initiated by their toggle inputs.

The Aft Spotter watched the last two Jumpers exit the plane safely, their canopies opening as expected. He called once again to the Pilot, "Jumpers away," cueing the Pilot to initiate the familiar left-hand circle. The Aft Spotter called down to the JIC to inquire about the Jumpers' needs for cargo. The response from the JIC was immediate. "We have an injured Jumper. We need the trauma gear."

Incident Within an Incident Response (IWI)

When the JIC and Jumper 2 arrived at Tim's landing spot, they found him lying prone and motionless. Though it was clear that a head/neck injury had been sustained, the most pressing concern was whether he was breathing. The Aft Spotter called back to determine "if it was a red or a yellow, and if they needed a medevac." Seconds later the response came back. "Red critical...unconscious...weak pulse...need air ambulance with a flight nurse."

---

[18] A Ram-Air parachute is a type of parafoil (nonrigid airfoil with an aerodynamic cell structure that is inflated by the wind) parachute used to lower one's descent speed to achieve safe arrival on the ground.

[19] The landing site was obstructed from responding Jumper's view.

[20] Jumper 8 was upslope (northwest of the spot) west of the prominent knob and facing WNW. Crabbing is when he, in half or greater brakes, lets up on his right-hand, turning the canopy slightly to the south, downslope, and towards the wind line. An example is a canoe ferrying across a river: staying in the same place along the length of the river but traversing the width of the river by angling the nose of the canoe slightly towards the desired direction.

[21] Jumper 8 attributes this turbulent air to some combination of thermic activity, surface heating, and/or ridge compression.

Hearing this, the Aft Spotter reached back and unclipped the netting across the rear cargo compartment to access the trauma gear. Up in the front of the plane, the Fore Spotter called AA-02, requesting to stay over the jumpspot for a red medical and stating, "We are going to descend for a cargo run with med gear." The Aft Spotter called the ground to get the injured Jumper's location so they "didn't throw the med gear on them." The last stick of Jumpers was just landing as the plane set up for the cargo run. J-13 descended and lined up from north to south along the drainage to the west of the rocky knob at the top of the jumpspot. As the plane approached the jumpspot, the Aft Spotter realized the conditions had changed significantly from when they did their initial low pass. He had to lock his knee in the space between the vertical handrail and the side of the plane to keep from being thrown around. As he threw the trauma gear, his feet left the ground, and he was thrown back by the force of pushing the cargo out of the plane. The plane continued down the drainage and out into the flats to the south, clearing the airspace to allow two SEATS to drop on the opposite side of the fire. The SEATs also reported the presence of turbulence to AA-02.

"I was amazed how fast the conditions changed."
- J-13 Pilot

While the SEATs were dropping, the Aft Spotter confirmed with the JIC that the trauma gear had landed in a good spot. J-13 set up for a final cargo run with two bundles of cubies containing water. The Aft Spotter got ready for another bumpy cargo run, bracing his elbow and knee around the vertical handrail. Waiting for the call from the Pilot to throw the cargo, the Aft Spotter was lifted up and thrown back down as one bundle of cubies was pulled from his grip and fell from the plane. The Spotter was thrown back into a sitting position and wasn't able to get the second set of cubies out in time. He had to put his feet in front of the box so they wouldn't inadvertently fall out of the plane as they flew down the drainage. "It was the roughest cargo run" the Aft Spotter had ever experienced. The Pilot agreed, adding that if any additional cargo was requested, they would have to locate a different drop zone. "I was amazed how fast the conditions changed," said the Pilot. They had experienced air speed variance +/-10 knots within a second or two on the cargo run, indicating very turbulent air. The jump plane climbed back to altitude to act as a communication link between the Jumpers on the ground and AA-02.

AA-02 continued to provide communication between the incident and Silver City Dispatch. She could see the injured Jumper's parachute in a ravine below a prominent ridge. "He was far away from the jumpspot." She relayed the limited patient information and requested air-to-air and air-to-ground frequencies for the air ambulance.

The relief Air Attack, AA-03, had taken off from Roswell, NM, at 1600. At 1630 they overheard a radio transmission between AA-02 and Silver City Dispatch: "…red critical, patient unconscious, weak pulse." They were still 45 minutes out from the fire, but the two AA platforms began their transition early to ensure there was no break in coverage over the ongoing medical incident.

"I couldn't imagine being in that situation without EMT training."
- Jumper 7

By the time the final stick of Smokejumpers had landed, all hands[22] were called to come to the injury site. Four of the seven Smokejumpers assisting were EMTs. "I couldn't imagine being in that situation without EMT training," said Jumper 7. The JIC took command of the Incident Within an Incident (IWI). On his

[22] ISMOG 4.2.7 First Aid Training must include between 8 and 24 hours of classroom and practical instruction consisting of a basic multimedia first aid course or equivalent basic, emergency care course.

way up the hill to retrieve his GPS[23] from his jump gear, he passed Jumper 7 and told him to "stay calm and get an 8-line[24] going." He identified a landing zone for the helicopter but worried as the winds began picking up. He identified a second landing area higher up on the ridgetop. He realized the parachutes would be a helicopter hazard and began to quickly secure them in anticipation of the air ambulance landing. At the Fore Spotter's prompting, the JIC turned his radio to Group 7 to ensure communication with AA-02. He gave her coordinates for the helispot. He was still unable to establish communication with the IC or Silver City Dispatch and continued to communicate through J-13 and AA-02.

Once on scene, Jumper 7 started to fill in the 8-line medical incident report but realized he was needed to assist with patient care. He began helping with the immediate need to remove the bulky gear for a patient assessment.

The trauma kit and traverse rescue stretcher (TRS) arrived from the plane. In addition to other patient assessment and care, EMTs began assisted ventilations using a bag valve mask (BVM), supplementing with 6 liters/minute oxygen to conserve oxygen as long as possible. At this rate the oxygen supply would be expected to last approximately one hour.

Fifteen minutes after the medical call was made, the jump plane relayed that an air ambulance from Silver City, Native Air, was approximately 45 minutes out. The oxygen level was increased from 6 liters/minute to 8 liters/minute. A second Agency helicopter with transport capability had also been ordered, as well as a ground ambulance.

Why do we order multiple ambulances?

During the Eicks Fire medical incident, Silver City Dispatch routed three ambulance options to the scene. Why did they locate an additional helicopter and a ground ambulance if Native Air was already on the way?

Air ambulance helicopters may not have the same protocols or pilot qualifications as Agency aircraft. They may arrive on scene and have to turn down an assignment because of high winds, tree cover, hazards, or slope. The level of care provided by an air ambulance is superior. If an Agency helicopter is available, they may be able to transport the patient off the hill to a suitable landing spot. They can also reduce the time to advanced care by meeting the air ambulance midway. In some conditions, the ground ambulance may be the best option.

The Gila NF Aviation Officer puts together a training each spring with Native Air, the Forest helicopter, and the Smokejumper base. The long-term relationship with Native Air enabled a rapid response with minimal patient information.

With the stress and seriousness of the incident setting in with everyone on-scene, one EMT instructed everyone to take a deep breath and encouraged the group, saying, "We have this." This calmed everyone down, and things began to run a bit smoother. Once the TRS was assembled, the patient was transferred securely, with a C-collar in place and secondary injuries splinted. Five people then moved the patient from the injury site 100 to 150 yards up the hill to a flat spot where a helicopter could land for transport.

Once the patient was in place to be picked up, two EMTs continued to monitor him and provide assisted ventilations using the BVM while others started getting jumper gear picked up and away from the fire. One Smokejumper at this time also grabbed flagging and made an 'X' on the ground to notify the helicopter Pilot where to land. Within 15 minutes of the patient being ready for transport and the landing zone being established, Native Air arrived on scene. The patient was then transported in the TRS onto the

[23] GPS stands for Global Positioning System, an accurate worldwide navigational and surveying system based on the reception of signals from an array of orbiting satellites.

[24] An 8-line is familiar terminology for a medical incident report, ICS 206 WF.

Native Air stretcher and carried to the helicopter. The patient was loaded at 1746, making the patient extraction time about 1 hour and 15 minutes.

Clearing Channels & Tracking Resources

Silver City Dispatch has five Agency repeaters and two BLM repeaters. As soon as AA-02 notified them of the medical, the South Zone IA dispatcher cleared the South radio channels for priority medical traffic.

Silver City Dispatch uses a Moducom radio system, common in Agency dispatch centers. Some systems are set up to broadcast on one tone of each repeater, which saves time when getting information out to the entire dispatch area. Silver City Dispatch was able to simulcast to a few of the repeaters, but then dispatchers had to continue to clear traffic individually on the north forest repeaters. Resources who were tracking with dispatch didn't hear the initial call clearing all radio traffic and continued to call in. The North Zone IA dispatcher continued to clear the radio traffic and also communicated with zone duty officers. One duty officer actively assisted. He/she communicated with all their tracked resources over the phone, then sent a text to the dispatcher to let him know all resources were accounted for.

Silver City Dispatch Activities – 1630 Onward

As soon as the medical call came into Silver City Dispatch, the Aircraft Dispatcher and the South Zone IA Dispatcher (SZ IA Dispatcher) locked eyes. "Do you want to take traffic and I'll document?" the Aircraft Dispatcher asked. "CLEAR RADIO FOR EMERGENCY TRAFFIC." They cleared the radio over the local repeaters (see sidebar "Clearing Channels & Tracking Resources"). The Moducom radio system at Silver City was not set up to simulcast to every repeater, so dispatchers had to individually clear several channels on the north forest zones. The many repeater shadows[25] in their dispatch area meant that a lot of the field resources didn't copy the initial clearing of the radio. Dispatchers continued to have to re-clear the radio for the Eicks Fire traffic. AA-02 relayed a brief patient update and requested frequencies, and the Aircraft Dispatcher asked for coordinates for a landing zone. Silver City Dispatch had not received an 8-line with patient information, mechanism of injury, or landing zone coordinates. The ACM coordinated with Native Air to launch the air ambulance. He told them, "I do not have any medical information other than it is a red medical unconscious firefighter, but we need to launch the ship. I will provide you with information as I get it." They were hesitant to launch the aircraft without a landing zone identified. He stayed on the phone with the Air Ambulance Dispatcher. Native Air had enough trust in their request to launch, and he was able to provide the landing coordinates once the air ambulance was enroute. Native Air, the Agency helitack crew, and the Smokejumpers usually went through medical training scenarios at the airport each spring, although 2020 and 2021 trainings had been cancelled due to COVID-19 restrictions. This ongoing relationship ensured quick communication, packaging, and the use of compatible medical equipment.

Within 15 minutes, the Air Ambulance departed Silver City enroute to the Eicks Fire. The SZ IA Dispatcher passed along the air-to-air and the air-to-ground frequency for Native Air from AA-02. At the same time, the North Zone IA Dispatcher (NZ IA Dispatcher) was working to get a ground ambulance to a staging area near the fire. Three and a half years of 9-1-1 dispatching gave him the language he needed to route an advanced life support (ALS) ambulance from Hidalgo County to a remote intersection near the border. He knew the county maps did not share the same labels as Silver City Dispatch, and they would not have the same road designators. Noticing activity on automatic flight following (AFF), he spoke up: "There is an Agency helicopter just over the Arizona

[25] Shadows in radio communications jargon refers to areas of poor or nonexistent radio coverage due to terrain interference. Radio waves are blocked by terrain features such as mountains, so if a mountain is between you and a radio repeater, that feature will block (shadow) your access to that repeater, causing you to be unable to use the repeater to communicate with Dispatch, etc.

border." The SZ IA Dispatcher had noticed it too. The ACM had been working to order Native Air and was now rapidly moving through other medevac options. His attention was on the National Guard medevac helicopters. He was working with the State to activate a hoist-capable ship with a paramedic from Ft. Bliss. The Agency helicopter, not staffed with EMTs, did not seem like the best option to him. Silver City Dispatchers were working like a pit crew, each focused entirely on their own portion of the emergency. The ground ambulance could hear Native Air on the EMS frequencies and didn't understand why they were still needed. The NZ IA Dispatcher asked the ACM if he should cancel any of the ambulances responding. He emphatically replied, "No, we will not cancel any resources until the patient is in the air and enroute to the hospital (see sidebar "Why Do We Order Multiple Ambulances?")." The NZ IA Dispatcher fought to keep the ground ambulance coming to the staging area. The Aircraft Dispatcher continued to monitor aircraft and update the WildCAD medical log. The Dispatch Assistant routed phone communication so the IA dispatchers weren't overwhelmed. The SZ IA Dispatcher continued to take all incident radio traffic. A request came in from the Smokejumpers on the ground asking if there was any closer air evacuation available. She made the decision to call Tucson (AZ) Interagency Dispatch Center (Tucson Dispatch Center), asking to use their helicopter.

The Gila NF DO was advised of the red medical with an unconscious subject at 1640; he immediately notified the Gila NF FMO and the Gila NF Aviation Officer. The Gila NF DO and FMO went into Silver City Dispatch to support the medical incident and reduce additional phone traffic for dispatch staff.

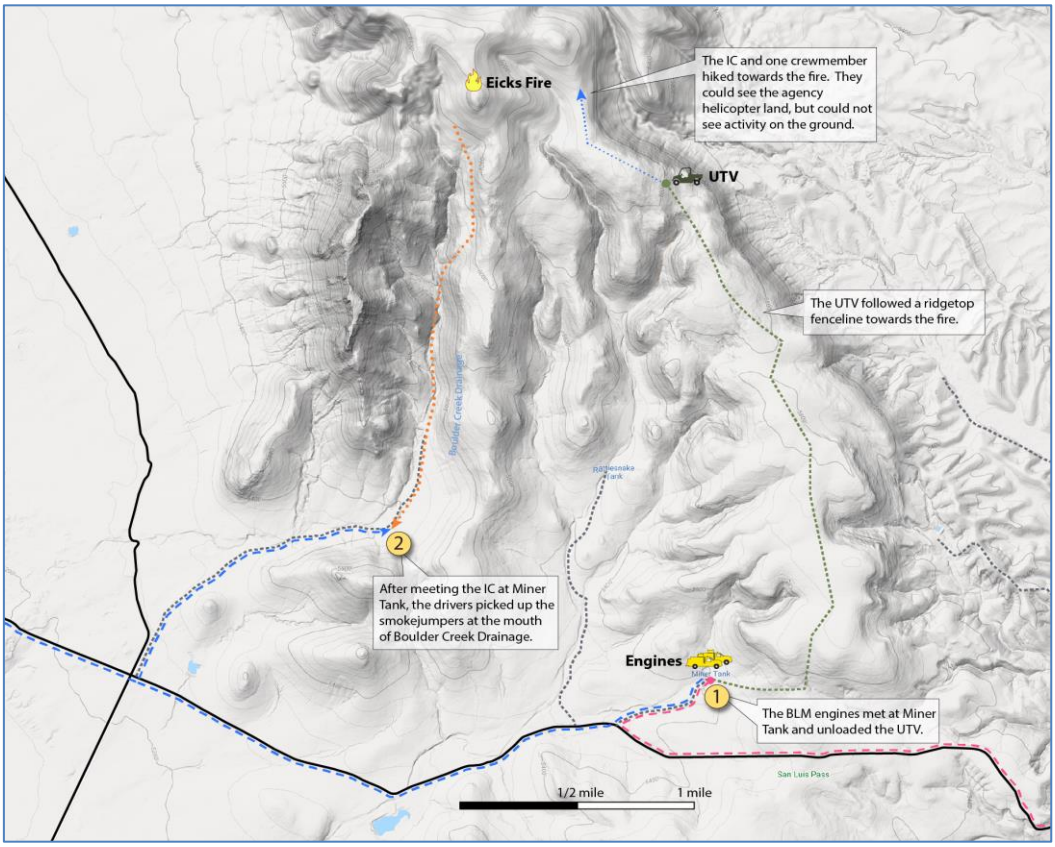


Figure 7. The Engine Crews worked their way into the fire from Miner Tank, and the Smokejumper chase vehicles picked up the Smokejumpers at the bottom of the Boulder Creek Drainage.

Silver City Dispatch broadcast across command at 1631: "CLEAR RADIO FOR EMERGENCY TRAFFIC." The Eicks Fire Engine personnel were still working their way into the fire. Several minutes later, AA-02 called the IC, asking, "Are you aware of the medical on this fire?" The IC had not been contacted. He was monitoring air-to-ground, but the medical incident was running on a different frequency and AFF was on the Signal Peak repeater, not Gillespie. AA-02 advised him that J-13 had a red critical; patient was unconscious, with a weak pulse and difficulty breathing. The IC tried to contact the Jumpers on the ground over BLM SOA[26] several times. Unable to reach them, he copied the traffic with AA-02 and requested she continue to be the relay back to Silver City Dispatch, as she had the best communication with those involved. He also requested an IWI IC be designated. The UTV had pushed as far as it could go towards the fire, but the terrain became rougher. A canyon still separated them from the fire. The Eicks Fire IC and one crewmember dismounted the UTV to navigate their way to the edge of the black on foot. Once they reached the southeast edge of the black, the IC was able to use the tactical, air-to-ground, and command channels, although coverage was still spotty. He decided to stay in this area to ensure communications.

When they got the request, Tucson Dispatch Center immediately rerouted H-001 from the Coronado National Forest (AZ) towards the Eicks Fire. They stopped to reconfigure and pick up three EMTs off a nearby Hotshot Crew, as Tucson Dispatch Center was not aware EMTs were already on the ground. Silver City Dispatch passed along the landing zone coordinates and frequencies.

AA-03 took over the incident at 1715, as AA-02 and J-13 reluctantly departed to refuel. At 1750, Native Air checked into the airspace. The Native Air and Agency helicopter arrived within five minutes of each other. AA-03 held H-001 and allowed Native Air to come into the landing zone, as they were able to provide advanced care to the patient. The Native Air Pilot tried approaching the spot from several directions because of the strong, shifting winds in the bowl. "I used every damn bit of power to get in or out; that was rough," said the Pilot. "It surprised me." Once they were on the ground, air ambulance personnel were able to transfer directly onto their stretcher, load, and go. "The packaging was essential for getting in and out quickly," he said. The Air Tactical Group Supervisor (ATGS) trainee onboard AA-03 said it was one of the smoothest medevac operations he had seen.

The fire continued to back towards the Jumpers and their scattered gear after Native Air lifted, and AA-03 brought the SEATs in to the fire's south edge to stop progression downhill. The first SEAT experienced significant down-air. From their vantage point above, AA-03 was concerned the SEAT wouldn't be able to pull out of the drop. The second SEAT dropped from a higher elevation for safety.

The remaining seven Jumpers began to pack up their gear. The Agency helicopter offered to help with gear transport off the hill, but with the 30-minute time estimated to gather gear, the ship had to depart due to fuel constraints. The Jumpers began the hour and a half hike out to the mouth of Boulder Creek Canyon to meet with the drivers sent earlier that afternoon. While they hiked, AA-03 remained on scene and helped the incoming drivers navigate to the closest rendezvous point, saving the Jumpers an additional mile of hiking. The seven individuals loaded their packs into the rigs around sundown and returned to Silver City in the dark.

[26] SOA stands for Scene of Action and is the same as a tactical frequency.

Afterward

Tim Hart was taken by air ambulance to a Level I Trauma Center in El Paso, TX. The Eicks Fire continued to grow over the next three operational periods, reaching 941 acres. Air tankers checked the fire growth with retardant drops, and a Type 3 helicopter supported ground crews with bucket work. At the end of shift on May 26, 58,136 gallons of retardant had been applied. By May 27, a Type 3 organization was in place, with 47 personnel on the fire. A fire investigator and State LEO determined the fire's cause to be a camp/warming fire. The fire was contained on May 29 at 1719, then controlled on May 31 at 1800 and unstaffed at the end of shift.

In Memoriam

Figure 8. Tim David Hart, West Yellowstone Smokejumper.

Tim David Hart was a smokejumper. He spent a fire career with this goal in mind. Tim spoke only when he had something to say, and when he spoke, people listened. He enjoyed time by himself; time with friends and loved ones; and time enjoying silence and embracing mystery. Tim created, led, and quietly shared his passion and his brilliance with a wry smile and confidence that was as unique as he was.

Introduction

On May 24, 2021, Smokejumper Tim Hart was fatally injured on a fire jump in southern New Mexico and passed away on June 2. Tim began as a smokejumper rookie in 2016 and was trained on the United States Department of Agriculture Forest Service (Agency; USDA FS) Ram-Air parachute system.[27] He was beginning his sixth season as a smokejumper, with a record of 95 jumps (73 proficiency and 21 fire). In 2021, he was on his third stint as a Silver City, NM, Smokejumper detailer. Tim had two previous fire jumps out of Silver City, one each in 2018 and 2019 on the Gila National Forest (Gila NF). Over that same time period, he had three proficiency jumps out of Silver City, all at the Fort Bayard practice jumpspot, the most recent on May 22, 2021.

The goal of the Learning Review (LR) Technical Sensemaking Report is to learn from this incident. This requires us to set the scope of the inquiry to find the best opportunities to learn from the technical aspects of this incident. Using input from parachute industry experts, researchers, Agency program managers, and the Smokejumper community, we designated eight waypoints influential to this incident's outcome. Focus groups held in McCall, ID; Missoula, MT; and Redmond, OR, included representatives from seven bases. The LR team and technical focus group participants identified these waypoints as having the greatest potential to yield understanding and learning opportunities. The technical report sections proceed chronologically, tracing the chain of events that began with Silver City Smokejumpers preparing for a dispatch.

Below is a brief summary of the fatality incident based on eyewitness accounts and supporting documentation the LR team acquired during the Coordinated Response Protocol (CRP) process.

A Brief Summary

Tim was the sixth of eight Smokejumpers on the plane, the third in a stick of three Smokejumpers. While only portions of his flight were witnessed, it can be stated with confidence that the last 5 to 8 seconds of Tim's flight was in excess of 400 yards[28] to the right (south) of the windline.[29] The flight's final portion was over identified ground hazards in an area down drainage from the intended jumpspot. The base leg was parallel to the main ridge, flying up drainage. After his canopy turned, his final leg initially flew downslope, but in the final two seconds there was a slope reversal as he crossed the bottom of the drainage. During

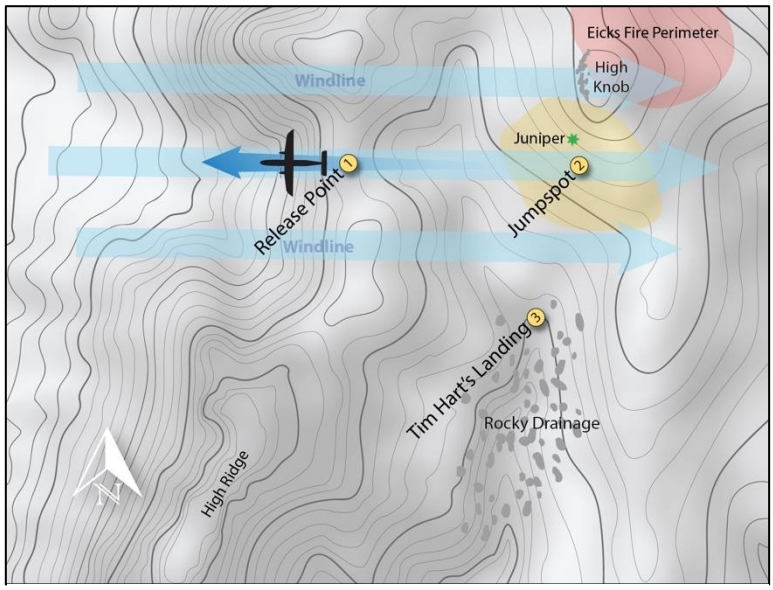


Figure 9. This diagram depicts locations relevant to the incident amid land contour lines.

[27] The same parachute system Tim was flying on the Eicks Fire.

[28] The distance of 400 yards is the estimate from the official windline, the one from the release point to the juniper tree in the spot. This may not be where Tim saw the windline; it is possible that because the first three Smokejumpers landed lower on the slope (right of the windline), Tim's perception was that he was closer to the windline than he actually was.

[29] A windline is a line going through the release point to the jumpspot, aligned with the wind direction.

the last portion of flight, his canopy was observed pitching forward, resulting in a rapid rate of descent and forward speed. He landed into rising terrain at the bottom of a small spur drainage.

Based on accounts from fellow Smokejumpers and damage to Tim's gear, it does not appear he was able to effectively flare[30] his canopy before striking rising terrain at a high rate of descent and speed. According to those on the ground who saw his flight—his jump partners and pilots (SEAT, jump plane, air attack, and medevac)—and from wind models obtained by the LR team, mechanical and thermal wind turbulence was a significant factor affecting the final seconds of Tim's flight. The environmental conditions appear to have changed from those identified by the streamers and experienced by the first two sticks of Smokejumpers. The environmental change in conditions was first experienced by the third stick of Smokejumpers, Tim's jump stick.

Post-accident, the jump equipment involved was sent to the National Technology and Development Program (NTDP), where a team thoroughly reviewed equipment and documented the findings. The parachute and jump-related equipment were determined to be functioning as intended.

Sensemaking

Each report section is designed for use as an individual learning tool, borrowing from key waypoints within the broader learning review narrative of "what happened" during the Eicks Fire Smokejumper mission. Where appropriate, additional resources are cited, along with suggested actions and learning products to help facilitate learning and improvements within the broader system of Smokejumper operations.

The following three learning sections with five sub-sections are identified as having the greatest opportunities for learning from the Eicks Fire Smokejumper fatality incident:

- Jump Timing
- The Mission: A Spotter's Responsibility
  - Jump Spot Selection
  - Streamers
  - Stick Sizes and Configurations
- Flying a Parachute: A Parachute Pilot's Responsibility
  - Performance
  - Wind and Turbulence

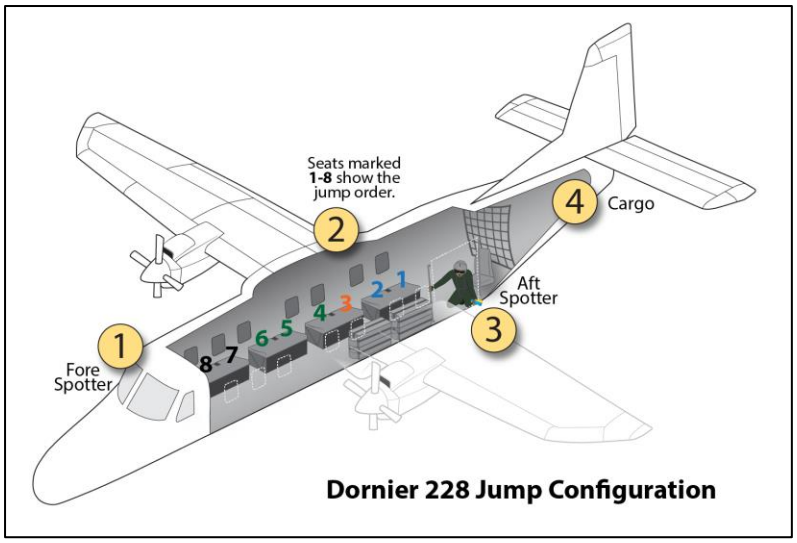


Figure 10. This interior diagram of the Jump Plane shows Jumper positions prior to their jumps.

[30] A flare is a Ram-Air parachute handling maneuver that slows the forward motion and descent rate in preparation for landing. It is typically executed 10 to 15 feet off the ground by evenly pulling the steering toggles into a braking position.

Jump Timing

The Eicks Fire was first reported at 1100, and the intent for full suppression was provided by the Socorro District DO to Silver City Dispatch at 1145. An hour and a half later, the closest BLM engine arrived on scene and took over as IC. The Smokejumpers first received information about a potential dispatch at 1315 from the Gila NF DO, who informed the SMKJ DO that *"there's a fire they anticipate going to a Type 3*." The Smokejumpers had two ICT3-qualified personnel and prepared for multiple scenarios: sending an ICT3 as a single resource; sending an ICT3 by vehicle with smokejumper support; or sending a load of smokejumpers with an ICT3 by plane. Reviewing these options is common as information and intent moves through the process of ordering resources, but in the case of the Eicks Fire, an additional two hours (at 1515) lapsed before the order for a load of Smokejumpers came in and the jump plane (J-13) departed. The Eicks fire was located on private land with State protection where several factors brought about a deviation from the area's preset fire response plan[31] to full suppression.

> ***"Why did it take so long to get the resource order? I understand that there was a lot going on, but if you're gonna pull the trigger, pull the trigger."***
>
> ***- Participant, Technical Focus Group #3***

Decisions beyond the smokejumper's control often influence jump timing and mission complexity. It is important to learn from identifying mission complexity that smokejumpers inherit, as it can be an opportunity to better understand the interface between the Smokejumper Program and broader decision-making at the organizational level.

> ***"In turbulent country, around 2:00 to 4:00 in the afternoon is probably the worst time to be out there."***
>
> ***- Participant, Technical Focus Group #3***

The unfolding chain of events and the time that lapsed before Smokejumpers received a resource order are not unique to this incident. In fact, during the incident learning review, LR team smokejumper subject-matter experts (SMEs) and smokejumper focus group participants noted that mid- to late-afternoon dispatches are relatively common. This is meaningful because atmospheric conditions become amplified as surface heating intensifies during the late afternoon period, affecting parachute flying, aircraft use, and fire behavior.[32] Flying or going into jump operations during the afternoon may not always increase risk, but according to one of the LR team's smokejumper SMEs, "By waiting until 1630 to jump we have stacked the deck against the smokejumpers (firefighters); they have less margin (USDA FS Office of Learning, 2014) to work with." Extensive discussions took place in the LR focus groups and among the LR team about how the Smokejumper Program can build margin into their decision-making processes while at the same time delivering high quality fire management services under conditions often encountered during the afternoon.

Discussion Questions

Smokejumper-Specific

1. The LR team heard from the smokejumper SMEs and the technical focus group participants that the sooner smokejumpers are ordered to a fire, the greater margin and decision space they typically have.

[31] Malpai Borderlands Group's 2021 Fire Communication Map, Appendix A.
[32] Turbulence Training Aid.

a. How and where has the Smokejumper Program successfully communicated this message?
b. How and where did it work?
c. How can successful communication strategies be replicated?

2. What are the benefits and challenges of receiving an early request?

General

1. Where have you seen incident resource ordering and response working well and not so well?
2. What is your role in working towards an efficient and effective incident response?

The Mission: A Spotter's Responsibility

> ***"The safe delivery of Smokejumper personnel and paracargo is the Spotter's ultimate responsibility. With that responsibility comes the burden of making correct decisions under stressful situations. The pressure a Spotter feels in staffing a fire cannot outweigh proper risk management assessment and decision-making."***
>
> ***- 2016 NSTG, 3-1-37***

This section covers the aspects of the jump mission up to the point to where the Smokejumpers and their cargo leave the aircraft. As noted in the adjacent quote, spotter(s) are responsible for this part of the mission. Rather than ignoring complexity in decision-making processes, the Eicks Fire narrative embraces complexity as a way to capture the overall effect of interactive components, conditions, decisions, and actions that occur during "the safe delivery of smokejumper personnel and paracargo (NSTG, 2016, p. 3-3-1). The spotter's(s), jumper in charge's (JIC), and pilot's(s) jobs are to gain awareness of conditions influencing complexity and navigate multiple trade-offs to arrive at a mission profile that best meets objectives and reduces complexity to its lowest level. This section touches on how complexity during the Eicks Fire emerged and how the subjective concept of judgment can influence decisions and actions.

Because of the presence of inherent uncertainty and the subjective nature of trade-offs, the task of managing complexity while meeting mission objectives is not linear. The Eicks Fire narrative recognizes that while there are prescribed aspects of the jump mission, such as smokejumper preparation procedures, other aspects require less prescription and greater degrees of judgment. As one LR focus group participant put it, "Good spotting is a matter of good judgment." The LR team uses the term judgment as it is described in the book Noise by Daniel Kahneman and others where they explain, "A matter of judgment is one with some uncertainty about the answer and where we allow for the possibility that reasonable and competent people might disagree" (Kahneman et al., 2021).

Judgment as defined in this way highlights a potential problem with using the above-quoted phrase "correct decisions." This phrasing appears to assume there is a single and objective-correct course of action. This assumption is flawed because it does not acknowledge the subjectivity and uncertainty inherent during operations. Variability in judgments should be expected. Therefore, the objective in making sense of the Eicks Fire should be to look for opportunities to determine how much variability among judgments is acceptable; work to reduce variability where appropriate; and find ways to improve operational tolerance to the expected variability among judgments.

Discussion Questions

Smokejumper-Specific

1. Is the smokejumper operational environment sufficiently predictable to rely on judgment; i.e., is the past a good predictor of the future?
2. How much variability is acceptable for judgments in decision-making processes when there are multiple, context-dependent, and fluid variables to consider?
3. How much smokejumper experience is enough to be an expert in making critical decisions based on judgment? How do we evaluate expertise?
4. What opportunities are there to build tolerance to variability in judgments into smokejumper mission processes and procedures?

General

1. When in your work do you have to "navigate multiple trade-offs to arrive at a mission profile that best meets objectives and reduces complexity to its lowest level"?[33]
   a. What does navigating multiple trade-offs look like?
   b. How can you improve your own judgment-making process to better your individual performance?
   c. What does this tell you about existing complexities in your own system of work?
   d. What changes would you make to "improve operational tolerance to the expected variability among judgments"?

Jump Spot Selection

The 34-minute flight from Silver City was described as flying "through smooth air with minimal turbulence." At 1549, J-13 was over the fire. From the plane, the Smokejumpers were pleased to observe minimal fire activity, particularly after they were, as one Smokejumper stated, "anticipating a complex Type 3 incident…a small fire with minimal fire behavior, light winds, and big open jumpspots seemed ideal." This would be the first fire jump of the year out of Silver City and the mood, as described by those in the plane, was good. The uncertainties stemming from the unknown fire conditions were resolved. The fire looked catchable and at this point there was no indication of broad-scale atmospheric turbulence.

"Jump spots are selected by the Spotter to maximize the potential for operational effectiveness while minimizing risk. A Jumper needs to be cognizant of the different factors inherent to any jumpspot so that the intent is realized. A Jumper has veto authority over the spot selected if the Jumper doesn't believe he/she can safely jump the spot."

-2021 USDA FS RATG, p. 127

The fire was located at the south end of the Animas range at about 6,400 feet above sea level (ASL). The IC stated that he "was still making his way into the fire and requested help on the southern end." This presented a cognitive anchor (The Decision Lab, 2021) of where to look for potential jumpspots, first on the hill near the fire's south edge, then down in the flats about a mile to the south.

[33] Think 10: "Fight fire aggressively, having provided for safety first." Ten Standard Firefighting Orders, PMS 110.

Jumpspot selection is a part of every jump mission and is the spotters' responsibility with input and buy-in from the JIC, smokejumpers on the load, and the pilot (everyone else). The objective is to balance the tactical, strategic, and logistical considerations to meet mission objectives while maximizing the margin for safety and reducing mission complexity. Conditions being considered may include but are not limited to "presence/absence of turbulence, clean landing area, safe from fire, close to anchor point, close to work area, close to water sources, close to road, unlikely to damage parachutes, and natural or easily cleared helispot" (Ram-Air Training Guide, [RATG], 2021, p. 126). These judgments are the product of individual and group sensemaking based on training, standard operating procedures, interpretation of real-time environmental conditions, and personal experiences that inherently contribute to decision-making. In practice this can be summarized as finding the jumpspot that makes the most sense and can be jumped safely, with the intent of making a new selection if the conditions are not acceptable or if the identified hazards are considered too dangerous. On the Eicks Fire, the Smokejumpers decided that searching for spots up on the hill rather than down in the flats was the best judgment based on safety, complexity, and mission objectives.

After the decision was made to jump on the hill near the fire's south end, the Smokejumpers looked at two potential jumpspots. They decided to go with a spot at the head of the Boulder Creek Drainage because it was open and grassy with only a few scattered yuccas, and it was well aligned with the predominant west wind. The spot was relatively large, extending all the way up to the fire's edge. The Spotter described a juniper tree towards the upper end of the spot as the target for streamers. The hazards identified during the low pass of the spot selection process—rocks and the fire's edge—[34] seemed manageable. The jumpspot was close to the planned work area on the fire's south end (where the IC had requested help). The low pass itself was, according to the pilot, "smooth and uneventful." The Spotters and Smokejumpers agreed to move on to throwing streamers to assess wind speed and character (see narrative sidebar "Streamers & Check Sets").

Discussion Questions

Smokejumper-Specific

1. What, if anything, could help the spotters/smokejumpers navigate this complex, multi-faceted, trade-off analysis?
2. How do smokejumpers determine what the fire management priority is when balancing all the factors?
3. The IC's request to jump on the fire's south side focused the Smokejumpers' search for a jumpspot to that area. The concept of anchoring (The Decision Lab, 2021) is important in this context. Where else in smokejumper operations do you think the concept of anchoring may apply?

General

1. How would you set up the spotter/smokejumpers for success, knowing that many decisions in spotting require the balance of multiple context-dependent variables?
2. What complex, multi-faceted trade-off analyses do you have to navigate in your job? What helps/hinders the navigation of those decisions?
3. What aspects of your work lend themselves to the cognitive anchoring bias?

[34] Of note, the ridge to the west that the LR team believes contributed to the turbulence felt by the third stick was not indicated as a hazard in the Spotter's briefing. It does not appear that the ridge in question was believed to be a hazard at the time.

Streamers

During the Eicks Fire, the initial set of streamers were thrown at 1,500 feet AGL, which indicated 400 yards of drift (12 mph windspeed) and took 00:01:10 to reach the ground, landing east of the saddle in the northeast corner of the intended jumpspot. The first check set was released 400 yards upwind from the jumpspot and was reported to be suspended "for like a minute" over the fire. The streamers drifted for 00:02:55 before hitting the ground, landing well east of the jumpspot. The JIC and Aft Spotter discussed the possibility of this first check set of streamers either being light in weight or getting caught in the fire's convection. To establish an assessment (and in alignment with the Spotter's training), the Spotter threw two additional streamer check sets from the same release point.[35] Both sets landed in the intended jumpspot and were suspended within a normal time frame (set 3: 00:01:16, set 4: 00:01:20) prior to hitting the ground. The Spotter, in consultation with the JIC and with Smokejumper buy-in, judged that the streamers were showing acceptable conditions and proceeded with the jump.

> ***"The decision not to drop because of wind is one of the toughest a Spotter must make. When Smokejumpers are unable to jump a fire because of wind, a Fire Management Officer (FMO) must make alternative initial attack arrangements. Dry runs contradict the concept of Smokejumpers being the fastest, most economical tool to use for initial attack on fires. However, no fire is worth hurting a person, and no FMO wants to be confronted with the complication of a medical evacuation."***
>
> ***- 2016 Smokejumper Training Guide, 3-1-57***

From the moment they are thrown out of the plane to when they land on the ground, streamers are a valuable tool to evaluate air behavior. Once released, streamer activity in the air and flight time provides information back to the smokejumpers and spotters. As one smokejumper SME noted, "The good thing about streamers is they are very simple and it gives you "real-time" awareness...it is not a perfect science, but it's pretty good and has been used for so long we know how to use them."[36] The LR team noted considerable variability in what is perceived as acceptable streamer time and behavior from both the smokejumper SMEs and the technical focus group participants. The 2016 National Smokejumper Training Guide (NSTG) recognizes that "differences in judgment" are inevitable and suggests maximum limits to horizontal windspeed (streamer distance measured in "seconds of flyover"). "A 15 mph [10 seconds of flyover] wind is about maximum for safe round jumping; 30 mph [20 seconds of flyover] wind is about maximum for safe Ram-Air jumping," but the 2016 NSTG does not provide guidance for vertical wind conditions (streamer time to the ground). During the LR Focus Groups, the LR team heard greater consensus around the concern for a short streamer time (indicating "down-air") than for a long streamer time (indicating "up-air"). According to the Ram-Air Training Guide (RATG), "In vertically calm air at sea level, streamers will take 70 to 75 seconds to fall 1,500 feet. Usually, the Spotter will feel comfortable with anything over 60 seconds" (RATG, 2021, p.134; NSTG, 2016, p. 3-1-49). LR focus group participants reported that streamer times in the mid- to low-50 seconds were of greater concern than times in the 90 seconds and above range. The second set of streamers landed at 175 seconds. Focus group participants also reported a wide spectrum of judgment about what the second set of streamers meant.

[35] "Any time rugged terrain, a tight jumpspot, high winds, etc., are a factor, a Spotter should not hesitate to spend the time to drop two or more sets of check streamers," U.S. Forest Service National Smokejumper Training Guide.
[36] Learning Review Team Member, Smokejumper SME.

Reactions ranged from not very concerning to very concerning though nearly all smokejumper SMEs agreed that the two additional check sets of streamers showing "normal" streamer times reduced their concern. In addition to these complexities, spotters must balance any remaining concerns against organizational pressures to demonstrate the widely accepted "concept of Smokejumpers being the fastest most economical tool to use for initial attack on fires" (National Smokejumper Training Guide, p. 3-1-57). While it is difficult to measure organizational and social pressures, it would be naïve to say that these pressures do not exist.

When the LR team questioned the smokejumper SMEs and the technical focus group participants about the benefits and challenges of streamers, they received little support for investing in more technologically sophisticated tools to check windspeed in real-time. Despite the limitations and low-resolution information from streamers, their low complexity and high utility enables streamers to remain the spotter's go-to tool.

Discussion Questions

Smokejumper-Specific

1. Streamers provide valuable information that because of context require subjective evaluation (or judgment).
   a. How do judgment, noise, intuition, and expertise affect what is considered reliable information?
   b. How much variability in judgment about the meaning of the information streamers provide is acceptable?
   c. At what point does the spotter determine this is not a good spot/time?
2. Do streamers provide enough information to allow experts to make highly intuitive decisions? How should anomalies in streamer time be treated?
3. What are the trade-offs to consider when deciding to throw more streamers?
4. Streamers provide low-resolution information to the spotter/smokejumpers. What are the opportunities/challenges of adding more technology to this process?
5. "Streamers show the wind conditions on the windline," (smokejumper SME). On any given jump, what are the chances that the conditions several hundred feet away are drastically different?
6. According to the NSTG, "Dry runs contradict the concept of smokejumpers being the fastest most economical tool to use for initial attack on fires."
   a. How do you think the smokejumper perception of the program being "on the chopping block" impacts the pressure of avoiding dry runs? (as described in the Eicks Fire Organizational Report).
   b. How do we help ourselves navigate organizational and social pressures in our decision-making processes?

General

1. What trade-offs exist between other information solutions that we have in wildland fire such as a belt weather kit versus a constant weather feed on a device?
2. How much and what kind of information is appropriate in operations?
3. Similar to smokejumpers deciding whether the conditions are acceptable to jump, wildland firefighters are taught to "fight fire aggressively, having provided for safety first."[37] How do we know when we have done this?

[37] Ten Standard Firefighting Orders, PMS 110.

Stick sizes and Configuration

> ***"His intuition was telling him to go with smaller stick sizes; that's why he opted to go with twos, and there was a disruption, and he still went back to two-person sticks. It was only when there was a recommendation from a Jumper to go to three-person sticks that he changed."***
>
> ***- Technical Focus Group #3***

Managing the configuration of smokejumper exits has a significant influence on the mission's complexity.

After receiving buy-in from the Smokejumpers while judging conditions to proceed with jump operations were acceptable, the Aft Spotter lined out the Smokejumpers. A key decision for the Spotter during this phase is how many Jumpers will go out the door on each pass over the release point. The group of Jumpers exiting the plane together on each pass over the release point is known as a "stick." According to the 2016 NSTG, a "two-smokejumper stick is standard."[38] The Aft Spotter's initial plan was to begin with a stick of two, followed by two sticks of three pending feedback from the initial Smokejumper stick once on the ground. This information would help define the final stick configuration (who was jumping with whom and each Smokejumper's position within the stick) and in turn, the Smokejumpers in those sticks would begin developing a plan. Initial feedback from the first stick relayed up-air down low. Subsequently the Aft Spotter elected to continue jump operations with stick sizes of two for the remainder of the load.[39] However, Smokejumper 4's being held in the door led to an uneven number of Smokejumpers left on the aircraft. The plan to continue with two-person sticks remained the same but shifted the grouping, resulting in the last Smokejumper going out as a single stick. As the Spotter called for the next two Smokejumpers (Jumpers 4 and 5), Smokejumper 6 (Tim) then suggested sending a stick of three, and in that moment, the Aft Spotter accepted. Smokejumpers 4, 5, and 6 then quickly verbalized their plan, with Tim adding," ...do what you need, I'll just hang out." After this stick of three exited, the Spotter, noting that the three Smokejumpers were still in the air, decided to take an additional lap before having the final stick (Smokejumpers 7 and 8) exit.

> ***"We're gonna try to limit the jump to a single complexity. We might not do the multi-person stick; it's already got multiple complexities going on, whether it's terrain, streamer time, high wind."***
>
> ***-Technical Focus Group #1***

In making a judgment, the spotter attempts to balance increasing safety, reducing complexity, and meeting mission objectives. Smaller stick sizes mean more passes and longer time over the fire while larger stick sizes increase the opportunity for airspace conflict among the smokejumpers. Each stick configuration change alters who is jumping with whom and each person's jump order position. Each change also necessitates a new plan among jump partners (JPs). All of this is happening within the cadence of the jump plane flying its pattern, making decisions and actions time-sensitive.

[38] We arrived at this conclusion by referencing the "Aircraft and Characteristics/Procedures Specific to Aircraft" tables in the NSTG. "*Two-smokejumper stick is standard*," was listed for each plane that had a table.

[39] Keep in mind that this not only changed who was jumping with whom, but each smokejumper's position in the stick. A difference exists in what is expected of each smokejumper between being first, middle, or last in the stick. Every smokejumper is trained to operate successfully in each position, but the expectations differ depending on the smokejumper's position in the order.

Discussion Questions

Smokejumper-Specific

1. If, as was stated earlier, judgments have "some uncertainty about the answer and where we allow for the possibility that reasonable and competent people might disagree" (Kahneman et al., p.43), how can spotters assess whether their judgments are correct? What metrics exist?
2. What processes, procedures, and training can be implemented or improved to help the spotter navigate the "increasing safety, reducing complexity, and meeting mission objectives" balancing act?
3. The Smokejumper Program is well known for cultivating an environment that empowers everyone to speak up. That's good, right? Are there downsides to that during some aspects of the operation?
4. How much variability in judgments among spotters is acceptable?
5. What would be the trade-offs if spotters were to lean towards a more prescriptive approach (i.e., a checklist and established rules)?

General

1. What parts of your work have the biggest effect on increasing or decreasing complexity? What control do you have to influence that complexity?
2. Does your work environment empower everyone to speak up? When is that needed, and when is it not?
3. Where in your work are judgments required? How much variability in judgments is acceptable?

Flying a Parachute: A Parachute Pilot's Responsibility

Patterns

> ***Pattern – A formal plan of guiding the parachute to a landing where the Jumper takes into account the direction of the wind and flies in a sequence of downwind leg, base leg, and final approach in order to have the proper angle of descent and be faced into the wind on landing."***
>
> ***-2021 RATG Definition, p. 162***

Once the smokejumper leaves the aircraft, the burden of responsibility to land safely turns to the smokejumper flying the parachute – the parachute pilot. Many variables exist along the smokejumper's flight path, but the concepts of piloting a parachute generally remain the same. Every jump is different, so the parachute pilot must use judgment to apply basic concepts to each new scenario. Once out of the plane, the smokejumpers go through a "jump count" while under a Drogue parachute.[40] Jumpers then pull a chest-mounted "Drogue release handle" to initiate the main parachute opening sequence. Once the main canopy has successfully opened, jumpers proceed through the initial checks. Next, they move into a position in relation to the jumpspot and fly a prescribed pattern towards the jumpspot.

[40] A Drogue chute is the device used to deploy the main canopy once a jumper leaves the plane. It resembles a small round parachute.

Patterns are flown to get jumpers into a jumpspot in an organized, predictable, and safe manner (see Figure 11). The pattern legs on a standard pattern—downwind, base, and final—follow traffic patterns aircraft use for landing. Arriving to an acceptable "set-up point" (start of the final) is considered by many to be the most critical in having an accurate and safe jump. Parachute pilots must arrive to a set-up with sufficient altitude to make adjustments on their final descent while "minimizing flight over hazards (RATG, 2021, p. 120). Parachute pilots decide whether to do a left- vs. a right-hand pattern. When jumping into terrain with the intention of landing on a hillside or a ridge (or even if the shape of the spot dictates), the pattern needs to be adjusted so pilots are not exposing themselves to leeside turbulence or slope soaring [41] down a hill. In these cases, parachute pilots will try to set up on a contour or along the ridge and fly to the desired spot while making adjustments for changes in wind direction and velocity. Often referred to as a "base to final" or a "2-leg pattern," the set-up and final leg remain the most important part of the descent, and in order to get to an appropriate set-up, parachute pilots need to position themselves by adjusting for wind conditions and flying to that set-up point.

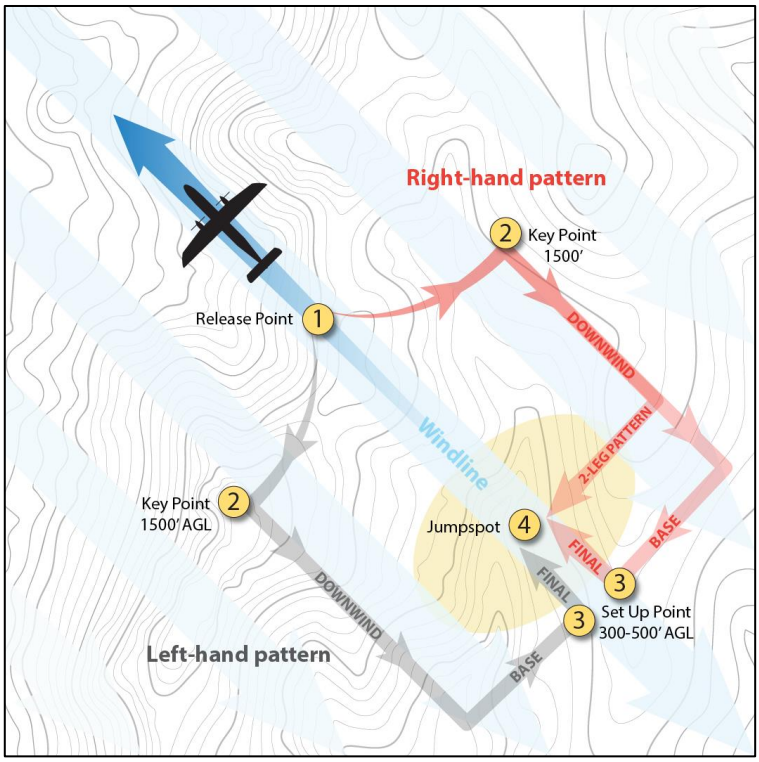


Figure 11. This windline diagram demonstrates left- and right-hand patterns.

First and Second Stick

On the Eicks Fire, Jumpers 1 and 2 chose different patterns. This uncommon situation resulted from both Jumpers thinking they were in agreement. As previously mentioned, it is ultimately a parachute pilot's decision which pattern to fly. However, being predictable and managing airspace is critical. Flying different patterns is not ideal or encouraged, but it does allow for judgment or change in conditions. If conditions change, parachute pilots will make adjustments to their pattern to ultimately get to a set-up point at 300 to 500 feet AGL. Even though Smokejumper 1 and Smokejumper 2 did separate left and right patterns, they both arrived at a similar set-up point with vertical separation and ultimately had successful jumps. Smokejumper 3 did a right-hand pattern and arrived at a similar set-up point with a similar end result.

> ***"PLAN B – An optional plan for steering and landing the parachute, the Jumper should make in the airplane and be ready to implement if wind conditions, hazards, or the flight of jump partners change."***
>
> ***-2021 RATG Definition, p. 162***

[41] Slope soaring is a term used to describe the condition of when a parachutist is flying downslope, typically on final, and the angle of decent closely parallels the slope angle meaning the parachutist can remain at the same distance above the ground as they move downslope.

Third Stick

Reviewing the third stick reveals several points. Smokejumpers 4 and 5 were not able to get to the desired set-up point, encountering excessive "down-air." Ultimately, they took a quarter tailwind final approach into rising terrain, resulting in harder landings. Smokejumpers 1, 2 and 3, after observing Smokejumpers 4 and 5 land un-injured, focused attention on Tim (Smokejumper 6) with concern about his location. It is unknown how Tim arrived to the point where fellow Smokejumpers observed him farther off of the windline and down drainage to the south. This unexplained location is key to understanding how Tim found himself in such a challenging spot, leeside of a prominent terrain feature and flying over a narrow rocky canyon. Based on modeling and evaluating site conditions, it is most likely that by being farther off of the windline than the other Smokejumpers, Tim encountered turbulence in excess of the parachute's limitations (Gerdes & Kitto, 2021) not represented by the initial streamer run. In conversations with smokejumper and parachute industry SMEs, it was noted that any pilot of any skill level in a similar situation would likely have been unable to prevent a hard landing (Kitto, W. & Gerdes, M., 2021).

Tim's Flight

In this section the LR team explores possible conditions and/or scenarios to shed light on the foundational question in this technical sensemaking: How did Tim get down canyon from the rest of the Smokejumpers to where he was first observed? We ask this question not to find fault but rather to understand: How might a smokejumper in future jumps find themselves in a similar position?

These possible conditions/scenarios by no means resolve the first question; however, recognizing their influence in how jump patterns are determined could help minimize the potential of future catastrophic outcomes by helping to answer the second question.

Wind and Turbulence

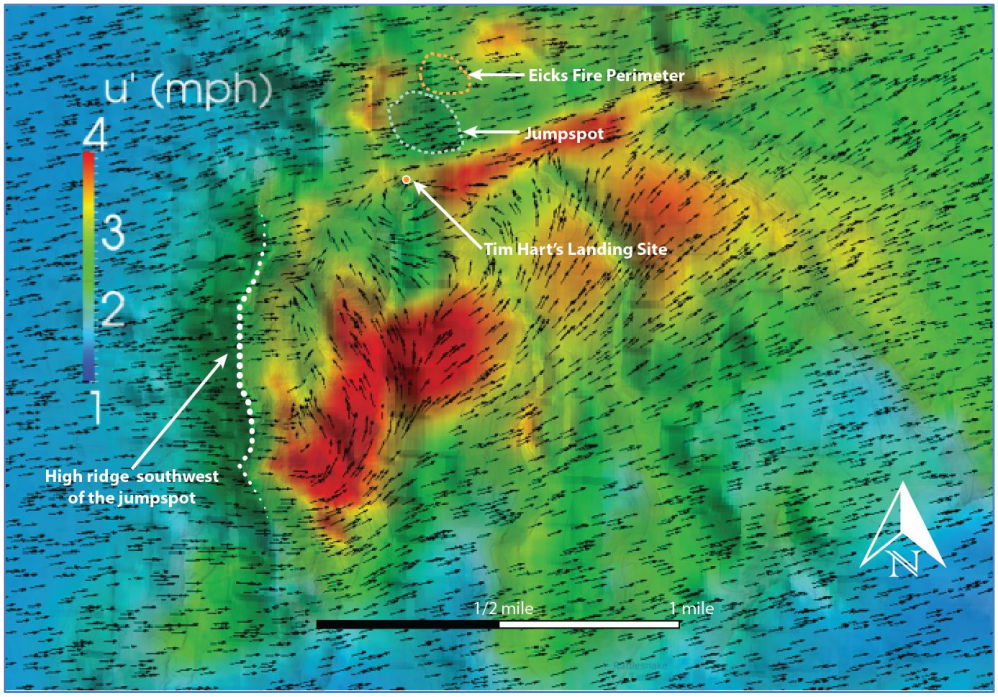


Figure 12. Average turbulent velocity fluctuations (u') about the mean velocity and mean wind vectors (the black arrows) on a terrain-following surface at 300 feet AGL. The reds and oranges indicate areas of higher turbulence. Note the re-circulation zone in the mean flow near the landing site; this is a region of strong vertical wind shear, with westerly flow aloft and easterly flow near the ground.

Wind and turbulence the Smokejumpers experienced on the jump supports wind modeling and SME evaluation that the prominent ridge to the west (upwind of the spot) was the primary cause of a significant wake zone affecting the jump area (see "Wind and Turbulence"). There is no definitive way to determine how Tim got farther off the windline than the other Smokejumpers, but it is very likely that even before the eyewitnesses saw Tim's flight, he was influenced by this wake-zone turbulence. The eyewitness accounts of the final seconds of Tim's flight corroborate with wind modeling and SME's assertion that flying into this area of rotor contributed significantly to the hard landing.

While the conditions existed for the presence of this wake zone throughout the jump operation, the narratives from the Smokejumpers suggest the third stick was the first to experience significantly changed conditions from that of the streamers. Perhaps conditions were different between Smokejumpers of the same stick. Tim (third Smokejumper in the stick) may have encountered different turbulence (wind and thermal) and as a result was not able to go in the desired direction.

With hindsight, time, and access to industry experts and wind modeling, the presence and extent of the turbulent wake zone appears obvious, but it is important to note that during the low pass and the counter-clockwise pattern that the jump ship flew, the ridgeline that produced the mechanical turbulence would have been to the Smokejumpers' backs as they looked out the plane's left windows. Perhaps the Smokejumpers on the load did not see the ridge or recognize its potential effect on conditions.

The Jump Spot

The jumpspot was approximately five acres, which is considered to be a very large jumpspot.[42] The appearance of this "good deal" jumpspot might have triggered a collective sigh of relief that the first jump out of Silver City is not on a high, rocky, timbered ridgetop into a postage stamp-sized jumpspot. Large spots can allow jumpers to feel comfortable, focusing less on jumpspot accuracy. Smokejumpers may

[42] This is an approximation because the jumpspot was never clearly defined as is typical for this kind of terrain. It was a large open slope with scattered rocks, yuccas, and a juniper. The larger rocks in the canyon below the spot were identified, demarcating it to the south and the ridgelines to the north, east, and west.

target the general larger area instead of a specific optimal point within the jumpspot; or as one technical focus group member phrased it, "…lures you away from the 'Aim Small, Miss Small' approach." The area free of observable hazards like rocks, trees, ridgelines, etc. looked big, but we know now from wind modeling that portions of the open area were likely within the wake zone of mechanical turbulence (invisible hazards) from the ridgeline to the west. Based on these conditions, hazard-free areas of the jumpspot during the Eicks Fire were likely a lot smaller than they originally appeared.

The Aft Spotter identified the juniper in the middle of the spot as the initial streamer release point to the Pilot, Fore Spotter, and the JIC when he was lining up the plane with the streamers to spot run. He may have also mentioned this in his briefing to the Smokejumpers, but we do not know whether the Smokejumpers understood the juniper to be the focal point for the spot or just a handy reference for the Spotter. None of the Smokejumpers appeared to be, or talked about, aiming for the juniper.

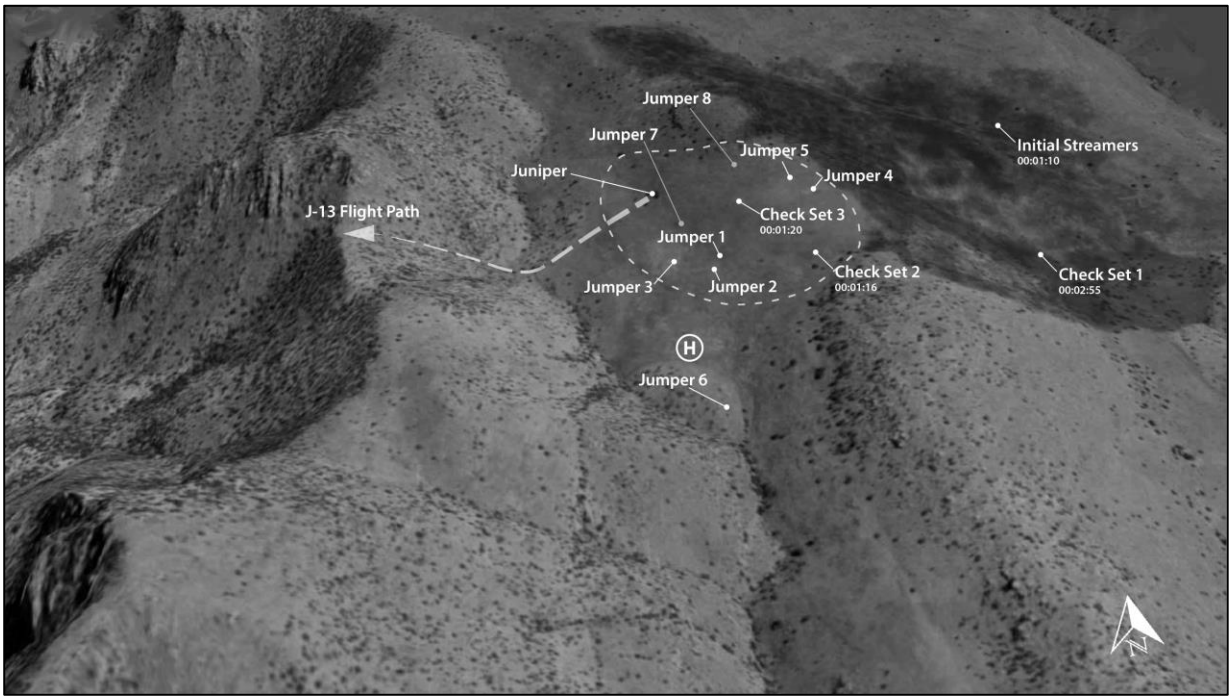


Figure 13. Smokejumper and streamer landing locations and helispot location.

Observing Other Jumpers

Well into the sensemaking process, an idea surfaced that seemed to resonate with both smokejumper SMEs and focus group participants. Even if the Smokejumpers understood that the jumpspot was centered around the juniper, the two Smokejumpers in the first stick and the single Smokejumper in the second stick landed well below the juniper near what would become the helispot (see Figure 13). Did the rest of the Smokejumpers' perception of the intended jumpspot/landing site shift south to where Smokejumpers 1, 2, and 3 landed? If so, could this have shifted Tim's downwind leg further south? Tim was approximately 400 yards south of the windline (between the release point and the juniper), but it may not have seemed that far off if he interpreted the windline to be closer to where Smokejumpers 1, 2, and 3 landed. In this case feedback from preceding Smokejumpers on wind conditions may not be relevant if subsequent Jumpers are flying significantly different patterns.

Lost/Disoriented

It is possible that Tim was disoriented. The jumpspot was in a bowl comprised of multiple ridges and slopes. It is difficult to know how common this situation is, because even if initially disoriented, most smokejumpers orient themselves in time for it to have a negligible effect on their pattern. Cues can be utilized to regain orientation, including the smokejumpers already on the ground, the fire's location, prominent terrain features, and ground track.[43] One scenario the LR team explored was that Tim was initially disoriented, and by the time he re-oriented, atmospheric conditions prevented him from making his way back to the windline and the spot. It would be interesting to explore how common disorientation is and if there are factors that influence its prevalence.

The Last Seconds of Flight

While it is appropriate to try to make sense of Tim's entire flight, we only have eyewitness accounts for the flight's last seconds, and our focus is on that part. The LR team, technical focus group participants, and industry experts all agree that Tim faced rapidly diminishing decision space in those last few seconds. Research clearly articulates that people in these acutely stressful situations perceive, think, and behave very differently than they would otherwise (Lighthall, 2012; Yu, 2016).[44] Our intent should therefore be to frame his perceived decisions and interpret his actions in order to inform how we help jumpers navigate high-stress situations in the future.

In the last seconds, Tim was flying north, up drainage, parallel with the east ridge and heading back towards the windline. Subsequently, Smokejumpers on the ground observed a 90-degree left turn across the drainage toward the west. No eyewitnesses reported seeing any toggle inputs. During the site visit, LR team members saw how it might be possible that Tim was hoping to make it to a flat spot (what later became the medevac spot; see helispot in Figure 13) just downslope from where Smokejumpers 1, 2, and 3 landed, or that he was trying to turn back towards his release point. The question still remains whether Tim intentionally turned and the eyewitnesses just missed the hand movements,[45] or was the turn the result of severe turbulence?

The answer to this question is less important than a discussion of what steps can be taken to help individuals navigate stressful situations and ways to improve operational tolerance to reduce the chances of people finding themselves in situations with rapidly diminishing decision space.

Indications from eyewitnesses and from the position in which Tim was found when fellow Smokejumpers arrived to assist him suggest that he did not flare. It is unknown why he did not attempt to flare, or if he did so and no one could judge if it slowed his descent rate in the last second(s) of his flight. The LR team would again suggest that Tim was very likely experiencing extreme levels of acute stress and any action or inaction should be considered within that context.

---

[43] Ground track is the principle used to understand how you are moving in relation to the ground because of the influence of wind. A jumper can look down at the ground and observe as they fly in a given direction if they are slipping to one side or another. This provides an indication of the wind direction and can help re-orient the jumper.

[44] The link between stress response and decision-making: When flooded with a rush of stress hormones, the prefrontal cortex becomes blocked. This part of our higher brain actively processes information, accesses creative thinking, helps us deal with complex decisions, and manage risk. This blockage causes a distinct trade-off between the speed and accuracy of our decision-making. (https://www.linkedin.com/pulse/flight-fight-freeze-decision-making-elephants-sarah-liyanage-denney/).

[45] All the eyewitnesses who saw Tim in the last seconds of his flight were immediately concerned. This acute stress would have had significant impacts to their perception and cognition as well. They were hyper-focused and could easily miss details like hand position.

Discussion Questions

Smokejumper-Specific

1. Based on the description of the patterns flown, what is your reaction? Were they within or outside accepted norms?
2. What are you not "seeing" during the low pass and while in a flight pattern during jump operations? What are ways to mitigate this?
3. Have you ever become disoriented once under canopy? What factors cause it to happen more/less? What techniques do you use to re-orient yourself?
4. If the 90-degree turn was pilot-induced, was he trying to get to the flat spot and misjudged the distance, or was he trying to get the canopy "into the wind"?
5. What is the potential outcome if Tim maintains flight up canyon and lands on a contour (canopy does not make 90-degree turn)? How do you typically decide between two bad options?
6. What possibilities are there to improve individual performance and operational tolerance in these situations where decision space is rapidly decreasing?
7. If Tim didn't flare, why not? Have you ever witnessed someone not flaring or done it yourself? Why didn't they/you flare?

General

1. What aspects of "rapidly diminishing decision space" stand out to you relating to your work?
2. What tools do you have in place to increase individual performance and cultivate operational tolerance for critical situations?
3. How much room for variability is accepted in your workplace norms and standards? Is it an appropriate amount?

Performance

Variability among smokejumper patterns flown and landing locations, directions, and characteristics were evident on the Eicks Fire. Several potential sources of this variability are possible, some of which we have addressed in other parts of this document. In this section the LR team explores individual performance as a variability source.

To make sense of variability, the LR team walked through a thought exercise to frame how performance could influence this variability. Did the variability result from any of the following?

- Relatively skilled smokejumpers having
  - a great day
  - an average day
  - an off day
- Relatively unskilled smokejumpers having
  - a great day
  - an average day
  - an off day

"There was considerable variability in the patterns flown, and equivalent variability in the judgments of those patterns among focus group participants."

- Learning Review Team Lead

Answering these questions provides insight to how variability is normally perceived and how much and what kind of variability is normally tolerated. Unfortunately, the LR team could not answer these questions

because consistent records of individual performance do not exist for either parachute flying or spotting beyond what is on record for individuals during rookie training.

Performance is a key component to the Smokejumper Program. An individual spotter or smokejumper's performance in decision-making and judgment calls has a direct correlation to the safety and integrity of the operational system that supports smokejumping. Nationally, federal smokejumper programs (BLM and USDA FS) place a premium on performance. As an example, the smokejumper rookie training program uses performance measures to determine a candidate's success. In order to graduate, a rookie smokejumper's performance is tracked, and a satisfactory performance record is needed. Although all jumps continue to be critiqued after rookie training, it appears a formal performance record is not maintained.

It is important to understand the role of performance as a source of variability to identify areas from which the Smokejumper Program can learn. The LR team believes an accessible, consistent record of individual performance could improve individual growth and provide programmatic insight.

Discussion Questions

Smokejumper-Specific

1. What does a "high level of performance" look like and how is it measured, tracked, utilized, etc.?
2. Wide versus Narrow: What prescriptions designate a defined distance off the windline, and how are they evaluated?
3. How does the perception of "too wide of a pattern" rate in a jump's performance?
4. How often does "too wide of a pattern" result in catastrophic or serious outcomes?
5. How much room does the organization allow for performance variability?
6. How does performance contribute/correlate to safety?
7. How can we decrease performance variability, i.e., help individuals perform at a high level of accuracy/intuitiveness/improvisation/reliability and increase safety?
8. What are the effects of physical and emotional distractions like airsickness, sleep deficits, and stress on smokejumper performance?
9. What conditions exist that could lead skilled smokejumpers to not perform on par with their skills?
10. What are options for smokejumpers whose skills are not on par with a needed skill level?

General

1. What are areas in your work where high degrees of demonstrated skill and performance are needed for success?
2. Do you measure and track performance?
3. How do you account for subjectivity in evaluating performance?

Wind and Turbulence

Wind and turbulence encountered on the Eicks fire can be categorized into the following: (a) general winds, (b) terrain winds, (c) mechanical turbulence, and (d) thermal turbulence. An area of severe turbulence most likely existed to the south of the jumpspot due to upwind terrain features and the confluence of general and terrain-driven winds.

Streamers and the subsequent wind modeling support the information derived from the streamers in both the vertical and horizontal planes in the area of the identified windline (release point to intended jumpspot). It is important to recognize that the streamers only show the conditions in the column of air they pass through and do NOT reflect conditions outside of the streamer flight path.

General Winds

Based on meteorological data and wind modeling, it is reasonable to assume that the streamers represented the general winds for the time of day well. The models show general winds coming from the west/southwest at around 8 to 18 mph, with some variation based on altitude AGL. The jumpspot itself was in near alignment with a saddle on the ridgeline to the west with a ridgeline approximately 100 feet higher than the jumpspot. Modeling during the time of the accident shows consistent direction of flow of the general winds at a velocity of 8 to 18 mph.

Terrain Winds

Up-canyon winds (anabatic flow) were likely present in the north/south-oriented Boulder Creek. Any up-canyon winds would have increased Tim's ground speed during the lower portion of his flight as he flew up canyon. Additionally, the meeting of up-canyon winds with the general winds would result in an area of turbulence and erratic winds. Wind modeling shows significant turbulence at and near the accident site. Models also show the wind being more consistent and less turbulent at the jumpspot.

Mechanical Turbulence

The prominent ridge to the west and upwind of the jumpspot was a likely source of severe turbulence in the area of the accident site. The ridge rises sharply 1,500 feet from the valley bottom; was oriented perpendicular to the general winds; and has a jagged profile. Upwind of the accident site, the ridge rises ~550 feet above Tim's landing spot. Wind modeling based on the wind velocity, the upwind terrain height, and the relatively short distance between the prominent ridge to the west shows significant mechanical rotor turbulence at the accident site and in some cases reaching into the jumpspot. Rotor turbulence tumbles and flows in multiple directions, with changes in wind direction and velocity. This mechanical turbulence is considered the most significant contributing factor of the resulting fatality. According to some industry experts, the boundaries of mechanical rotor turbulence can be very specific, often times within 10 to 12 feet. Travelling south of the designated jumpspot would result in greater likelihood of a smokejumper experiencing severe mechanical turbulence due to upwind alignment and proximity to the prominent high, jagged ridge. The accident occurred in this location. The streamers would not have identified this mechanical rotor turbulence because the streamer release point was in line with the more consistent flow coming through the saddle on the windline towards the jumpspot.

Thermals

Looking at the large flat valley leading up to the mountains, the terrain fits all of the requirements of a prominent thermal "wick" with heat accumulating on or near the west-facing slopes (Gerdes & Kitto, 2021). It is reasonable to conclude that afternoon temperatures and surface heating resulted in thermal generation (turbulence) and "up-air," not only in the jumpspot itself but also on the adjacent west facing aspect near the release point. It is not suggested that a large thermal event was the primary cause of the fatality, but thermal activity would have increased the complexity of canopy flight. The timing of the triggering and release of thermals from terrain cannot be accurately predicted (Kitto & Gerdes, 2021; see

Appendix E), but it was noted that in addition to rotors, thermal activity would be a significant factor to consider.

Leeside vs. Lee slope[46]

Typical discussions about landing leeside[47] would focus on everything on a ridge's back side or lee slope.[48] The lee slope is easier to identify because jumpers can see it, whereas seeing the leeside turbulence is much more difficult and is essentially an invisible hazard. When discussing leeside, we are generalizing air flow turbulence, also referred to as mechanical turbulence or wake zones, which are all a function of the following: wind velocity, wind direction, obstacle height, and obstacle jaggedness. On the Eicks Fire we see how the potential leeside turbulence can vary depending on many factors, and the extent of the turbulent zone can even extend to the "windward side" of an adjacent slope. Based on the wind direction and terrain, a parachute would experience significantly different conditions as far east as Tim's landing area and parts of the intended jumpspot due to the rotor produced by the predominant ridge upwind (southwest) of the jumpspot.

Models and Industry Expert Opinions

According to wind modeling (Forthofer & Wagenbrenner, 2021) and consultations with industry experts, the accident area featured all key ingredients for extremely turbulent air: leeside mechanical rotors, thermal triggers, and upslope anabatic flow (Kitto & Gerdes, 2021). It is expected in the specific accident site, and can be seen on the modeling, that there would have been air circulating, moving downward/upward and laterally. Tim's parachute was observed flying up drainage, most likely with a tail wind, through sinking and rising air at a high-brake setting (full to quarter run). The observed 90-degree turn, nose-down pitch, without observed pilot input, supports the presence of turbulence. Parachute pitch angle can be affected by flying through areas of rapid wind shear, such as in a rotor, which may explain the sudden nose-down pitch attitude observed by other Jumpers on the ground (Kitto & Gerdes, 2021).

It was noted that a parachute flying downwind and up drainage is highly problematic due to the resulting high ground speed combined with rapidly decreasing altitude above the ground (a high-closing speed with the terrain caused by flying downwind in an upslope direction). The pilot was observed to be flying without brake input in these final seconds. The net result would have been very little time to react and few "good options" available to choose. With these circumstances, reactions would need to be "immediate and perfect" (Nolan, 2021).

Discussion Questions

Smokejumper-Specific

1. What are the proper techniques for executing downwind landings?
2. What techniques are used to stabilize an unstable canopy?
3. What is your understanding of wake zone turbulence and the conditions that affect it?
4. What does it mean when we instruct smokejumpers, "Do not land leeside"? Are we concerned more with leeside or lee slope?
5. How good are spotters and smokejumpers at identifying the invisible hazards surrounding a jump?

[46] RATG Definition, (2021), p. 160.
[47] The downwind side of an area that is blocked by a terrain feature or other obstacle, usually associated with turbulent air.
[48] The downwind or back side of a ridge that is blocked by the rising terrain of the ridgeline and likely containing a hazard of turbulent air.

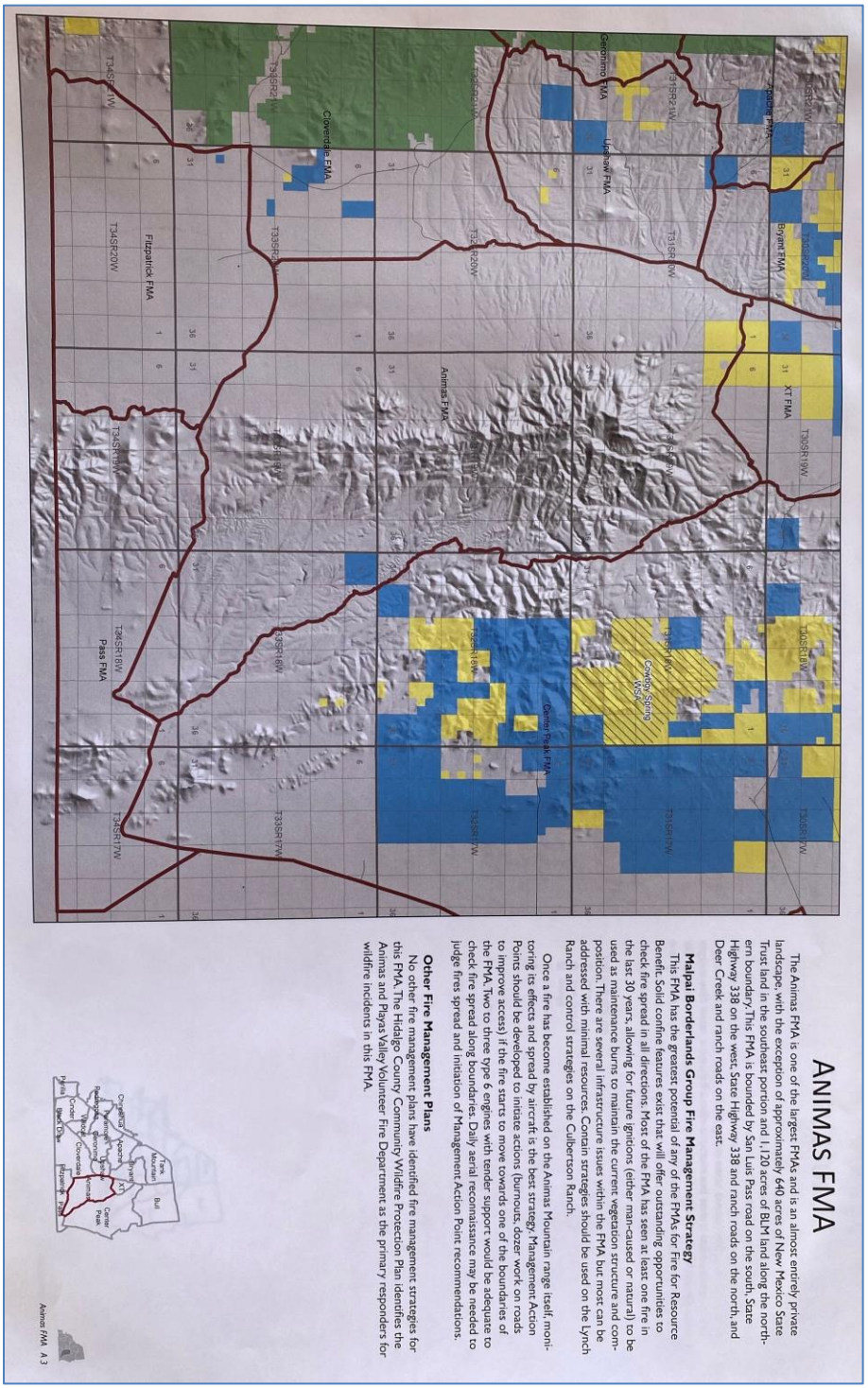
General

1. Wind is a key condition influencing wildland fire behavior. How well do you understand the effects of topography and surface heating on wind and turbulence?

Appendices

Appendix A

Malpai Borderlands Group's 2021 Fire Communication Map



Appendix B

Eicks Fire Timeline – May 24, 2021

1101 – Fire reported to Silver City Dispatch

1158 – Borrowed AA (AA-01) from another fire for a size-up

1201 – BLM Engine 1 dispatched to fire

1227 – BLM Engine 2 dispatched to fire

1230 – AA-01 gave size-up; Engine 2 requested dedicated AA

1255 – Engine 1 ordered SEATs

1315 – Gila NF DO phoned SMKJ DO to inform him of a potential Type 3 incident

1332 – SEATs enroute from Silver City 12 minutes

1335 – Engine 1 took command of the fire

1425 – AA-02 arrived on-scene

1446 – IC ordered SMKJ (T3 helicopter and SEC1[49] also ordered)

1500 – Silver City Dispatch phoned SMKJ DO requesting IA load

1515 – J-13 enroute to fire

1532 – J-13 in contact with AA

1543 – Engine 2 arrived at the ranch

1549 – J-13 arrived on scene; established communications with IC

1617 – Jump operations began

1630 – Jump injury occurred

1640 – Gila NF DO is notified of injury

1649 – Native Air ambulance is 45 minutes out

1654 – Landing zone coordinates given

1657 – JIC requested closer air resource; ground ambulance enroute

1720 – J-13 and AA-02 off fire, enroute to Silver City for fuel

1730 – Agency helicopter enroute with EMTs on board

1734 – Agency helicopter is 10 minutes out (according to Tucson Dispatch)

1739 – Native Air on scene/checked in with AA-03

1746 – Patient loaded

1753 – Native Air enroute to El Paso, TX

1803 – Remaining Jumpers began hike-out

1844 – Native Air arrived at El Paso hospital

1912 – AA-02 returned to fire; transitioned with AA-03

2130 – Remaining Smokejumpers reached vehicles

2346 – Smokejumpers arrived back in Silver City

[49] SEC1 (Security Specialist Level 1) is a National Wildfire Coordinating Group position to provide safeguards needed to protect personnel and facilities from loss or damage.

Appendix C

Acronym/Abbreviation Index

AA – Air Attack

ACM – Assistant Center Manager

Agency – United States Department of Agriculture Forest Service (AKA USDA FS)

AGL – Above Ground Level

ASL – Above Sea Level

ATG – Air Tactical Group

ATGS – Air Tactical Group Supervisor

BLM – United States Bureau of Land Management

BVM – Bag Valve Mask

Cohesive Strategy – National Cohesive Wildland Fire Management Strategy

CRP/LR – Coordinated Response Protocol and the Learning Review Process

DF – New Mexico State Socorro District Forester

DFMO – District Fire Management Officer

DO – United States Bureau of Land Management Duty Officer, New Mexico State Socorro Duty Officer

EMNRD Forestry Division – New Mexico State Forestry Division (New Mexico Department of Energy, Minerals, and Natural Resources)

EMT – Emergency Medical Technician

FLA – Facilitated Learning Analysis

Forest DO – Forest Duty Officer

FMO – National Forest Fire Management Officer

Gila NF – Gila National Forest

IA – Initial Attack

IC – Incident Commander

ICT3 – Incident Commander Type 3

IWI – Incident Within an Incident

J-13 – Jump Plane

JIC – Jumper-in-Charge

JP – Jump Partner

LEO – Law Enforcement Officer

LR –Learning Review

NSTG – National Smokejumper Training Guide

NZ IA Dispatcher – North Zone IA Dispatcher

PLF – Parachute Landing Fall

RATG – Ram-Air Parachute Training Guide

SEAT – Single Engine Air Tanker

SEC1 – Security Specialist Level 1

Silver City Dispatch – Silver City (NM) Interagency Dispatch Center

SMKJ – Smokejumper

SMKJ DO – Silver City Smokejumper Duty Officer

State – State of New Mexico

SZ IA Dispatcher – South Zone IA Dispatcher

Tucson Dispatch Center –Tucson (AZ) Interagency Dispatch Center

USDA FS – United States Department of Agriculture Forest Service (AKA Agency)

US-Mexico – United States-Mexico

UTV – Utility Terrain Vehicle

Appendix D

2021 Eicks Fire Parachute Industry Subject Matter Expert Report

Kitto, W., & Gerdes, M. (2021). Eick's Fire Parachute Industry Subject Matter Expert Report. Unpublished.

Summary

Atmospheric conditions that would be challenging to backcountry parachutists of any experience level were generally present during the time of the accident.

The jumpers who approached the LZ and landed without injury did so in an area not far from, but *significantly different from*, that of the accident pilot.

The accident pilot flew into an area where the conditions were not only challenging, but most likely intolerable (turbulence in excess of the parachute's limitations), i.e. any pilot of any skill level on any similar equipment would likely have been unable to prevent a hard landing, due to rotor. Mechanical rotor turbulence alone or combined with thermal turbulence can easily create "unflyable" conditions.

Uncontrolled flight into terrain resulted from a combination of underestimating the significance of the thermal and mechanical turbulence present at the time of the approach and landing, and the accident pilot's as-yet unexplained decision to fly deeper into the lee of the terrain directly upwind of the intended LZ than the approach and landing patterns flown by other pilots in the group.

We were asked to point out "*...lessons that could be learned, or areas that may provide additional learning for our agency"*.

We do not see training deficiencies as the primary cause of this accident.

Site Assessment

The jump location was at the southern tip of the Animas Mtns. Directly upwind of the LZ to the southwest lies a large flat-bottomed valley & dry lakebed which is more than 60 square miles in size. The LZ is located inside of the first prominent terrain feature encountered as we trace the windline (on the day) from the dry lakebed to the northeast, downwind.

This terrain fits all of the requirements of a prominent thermal "wick" for heat accumulating on or near the west-facing slopes lining the eastern edge of the valley. These slopes were facing directly into the sun and wind (at the time of the accident) and rise 1,500' vertically from the nearest low point in the basin. As a theoretical example, at the time of the accident (16:30), a sailplane pilot in search of lift would be drawn to these west-facing slopes, as they meet all of the criteria for thermal generation (turbulence) and a paraglider pilot who wanted to gain altitude in thermals would likely choose to overfly the 6,500' MSL high point on the ridge just west of the accident site.

Zooming in, the LZ itself is located at the top of a long south-facing draw. A north-south oriented ridge forms the western edge of said draw. Directly to the west and west-southwest of

the “main” LZ, *this ridge is approximately 100 feet higher in elevation than the areas where seven of the eight jumpers landed***.**

To the west and southwest of Jumper 6’s landing spot, *this ridge is 400-500 feet higher in elevation*. Jumper 6 landed closer to the lee-side terrain, and deeper in the draw, approximately 250 feet from the beginning of the main upslope. The other seven jumpers landed between 500-700 feet from the beginning of the upslope terrain.

The terrain is irregular and varied, and taking measurements from slightly different locations on each ridgeline results in a range of distances. By any practical measure, Jumper 6 landed significantly closer to higher terrain in a narrower section of the valley.

The boundaries of mechanical rotor turbulence can be very specific, oftentimes just a few dozen feet. According to the narrative, Jumper 6 flew his approach more than 1000 feet to the south, and closer to the highest section of the ridgeline upwind of the LZ, than his colleagues.

The Near-Surface Conditions

All seven first-person accounts described unexpectedly rough air which affected the jumper’s approaches to some degree. The wind models and the report in general lead us to consider these aspects of terrain and wind in the vicinity of the LZ:

1. First and foremost, rotor (mechanical turbulence) generated by the ridgeline west of the LZ.
2. Thermal activity encouraged by a 1.5 mile long south-facing draw downslope of the LZ.
3. Thermal activity created by the prominent west face of the ridge -- an ideal thermal trigger for heat accumulating in the large basin directly upwind of the LZ.

It is reasonable to conclude that there was rotor turbulence generated by the forecast wind passing over the ridgeline to the west, that >90F surface temps with a freezing level at a typical height for the season virtually guaranteed the presence of thermal activity (“up air”), and that the topography of the surrounding terrain (in particular the ridgeline to the west) is ideal for thermal turbulence generation (the “wicking” of heat accumulated upwind of the accident site).

The main LZ where 7 of 8 jumpers landed was basic in character, but the conditions were challenging enough to make the approach and landing spicy, in the vernacular. Their main LZ was less occluded by high terrain upwind (100’ differential as opposed to 400-500’), in a more open part of the draw, and was composed of a more forgiving surface (less rocky).

The accident jumper flew into an area where rotor turbulence would have been more severe, due to his approach taking him behind higher terrain. He also made his approach over a narrower section of the draw, reducing the available options for a safe landing. He would have encountered rotor and thermal turbulence that was likely much worse than the already challenging conditions experienced by the other seven.

Had Jumper 6 chosen to fly his approach pattern 500-1000’ further to the north, he may have avoided the worst of the mechanical turbulence and had an approach and landing similar to the other jumpers.

Conditions: Key Factors

These points are given consideration by backcountry parachutists and XC paragliders.

- The importance and effect of the movement of heat in the near-surface layers of the atmosphere.
- Slope aspect and elevation and its potential effect on the air we fly within.
- Surface temps and the lapse rate / temperature gradient.
- Fires themselves as generators of lift and turbulence.
- The identification of invisible hazards being of equal importance to identification of visible hazards, i.e., calling a jumper's attention to rocks, powerlines, fences, is critical; equally critical is identifying and discussing the likely (or guaranteed) hazards of mechanical turbulence & thermal activity / anabatic flow.

The ridgeline upwind of Jumper 6's estimated approach would be a red flag to an experienced jumper planning an approach in that area. It is unclear from the narrative whether Jumper 6 planned to make his approach there. Other suitable approach patterns well to the north of Jumper 6's were discussed and executed by the other seven jumpers.

By flying deeper into the lee behind the ridge, Jumper 6 exposed himself to worse conditions, while simultaneously giving himself fewer options to land, and over worse terrain. This compounding of negative factors would have happened quickly. What is unclear is why the approach was made so far south.

We could speculate that

1. he wanted to observe the jumpers landing in front of him decide which direction to make his final approach
2. he wanted to give his colleagues more separation,
3. he encountered a piece of thermal turbulence that prevented him from penetrating into the wind in the direction desired,
4. We acknowledge there are other unknown possibilities.

Jumper 6 Final Approach

Regarding the last 200 vertical feet of Jumper 6's flight, a hard landing on the lee side of a ridgeline over which 12-18+ mph winds are crossing is understandable. Mechanical turbulence is severe, and predictable only in its severity. A thermal event in or near the rotor of 12-18 mph wind conditions can result in gusts of >20 mph from unpredictable directions.

Rotor turbulence resembles the eddies behind rocks in a river. It tumbles and flows largely in the opposite direction of the main wind, with gusts and segments pushing in every direction (up, down, laterally). The area specific to the accident featured all of the key ingredients for "rough air" on that day: thermal trigger location, leeside rotor, upslope anabatic flow.

In the specific accident location, we could expect to find air moving vertically downward to the bottom of the draw and then circulating back up the east-facing slope directly above and to the west of the accident site. This air would be moving at speeds similar to the wind just over the ridge, and could be encouraged or backed up, at times, by an anabatic flow climbing the draw.

Jumper 6's canopy was observed to make a 90 degree left turn and sudden nose down pitch attitude with no observed pilot input. This tracks with the potential effects of rotor turbulence.

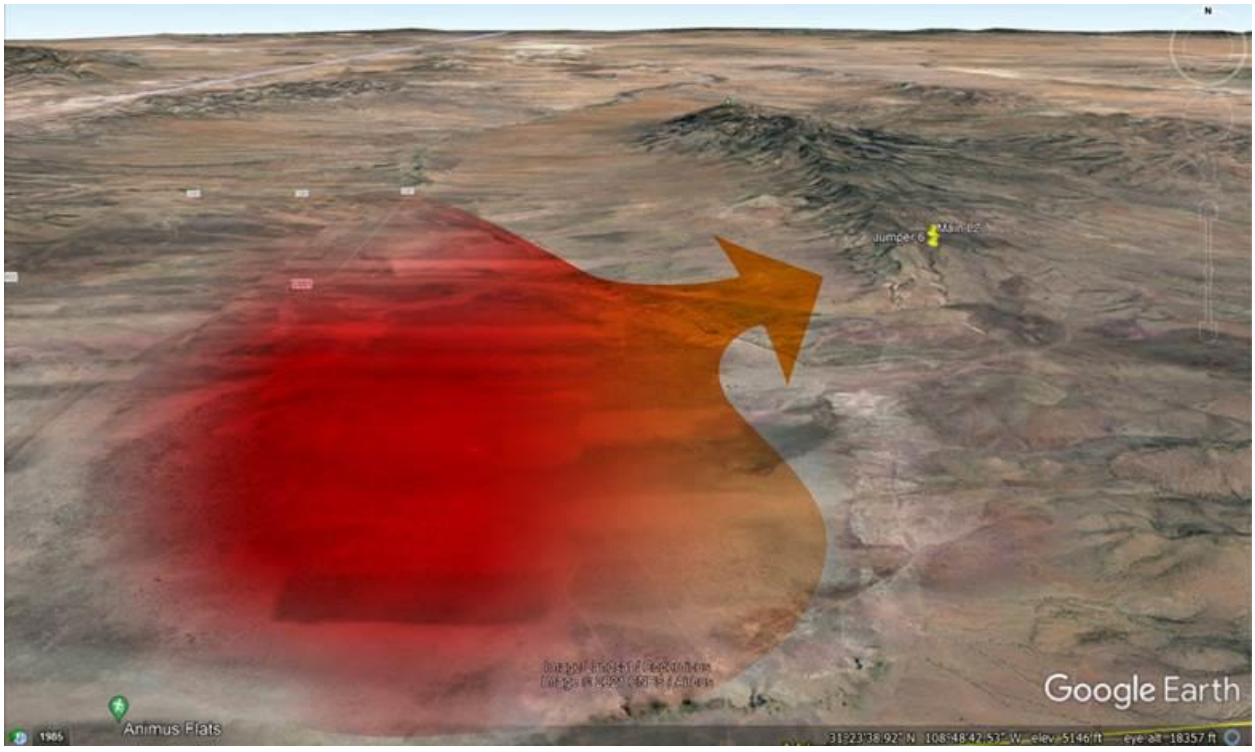
A conservative estimate puts the tailwind potential for his up-canyon leg and final left turn at 10-20+ mph, in sinking air. Parachute pitch angle can be affected by flying through areas of rapid wind shear, such as in rotor, which may explain the sudden nose-down pitch attitude observed by other jumpers on the ground.

Based on the forecast, the conditions on the windward side of the ridge to the west of the LZ would be soarable for the parachutes being flown by the group. Even on the lee side of the ridge, over a gentler / shallower slope, several jumpers reported difficulty descending while on final. The windward, sun-baked, and larger ridge to the west would have been even more buoyant and soarable. A maxim of ram-air canopy flight is that if there is enough lift to keep you up on the windward side, then there is more than enough wind and rotor turbulence to ruin your day on the lee side.

Heat & Rotor

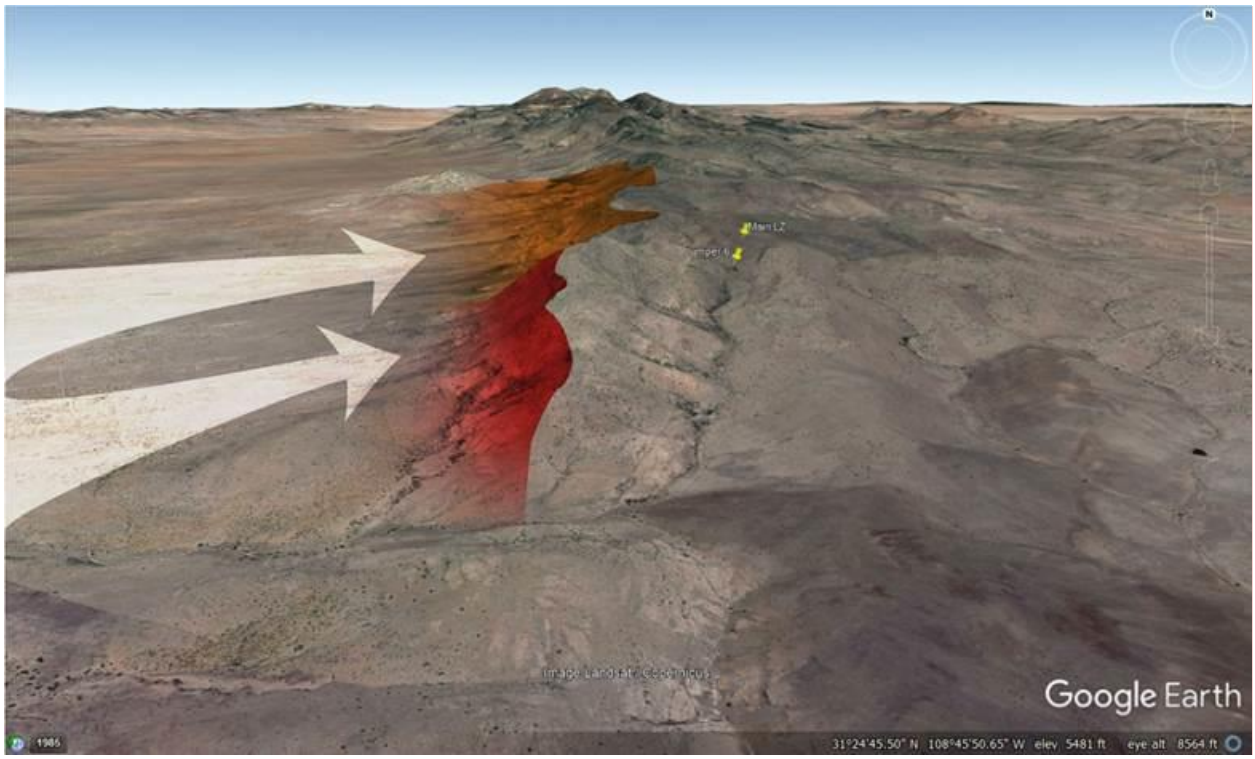
The following graphics are not computer models or meant to represent the conditions precisely. Rather, they are to call attention to likely sources of thermal and anabatic turbulence, and to point out how significantly different (more in rotor) Jumper 6's approach to landing was, being so much further south and therefore more in the lee of higher terrain.

The timing of the triggering and release of thermals from terrain cannot be accurately predicted. Therefore we are not suggesting that a large thermal event was the cause. However, thermals (in addition to rotor turbulence) would be on our mind as we assessed this location as a potential LZ in the conditions reported on the day of the accident.

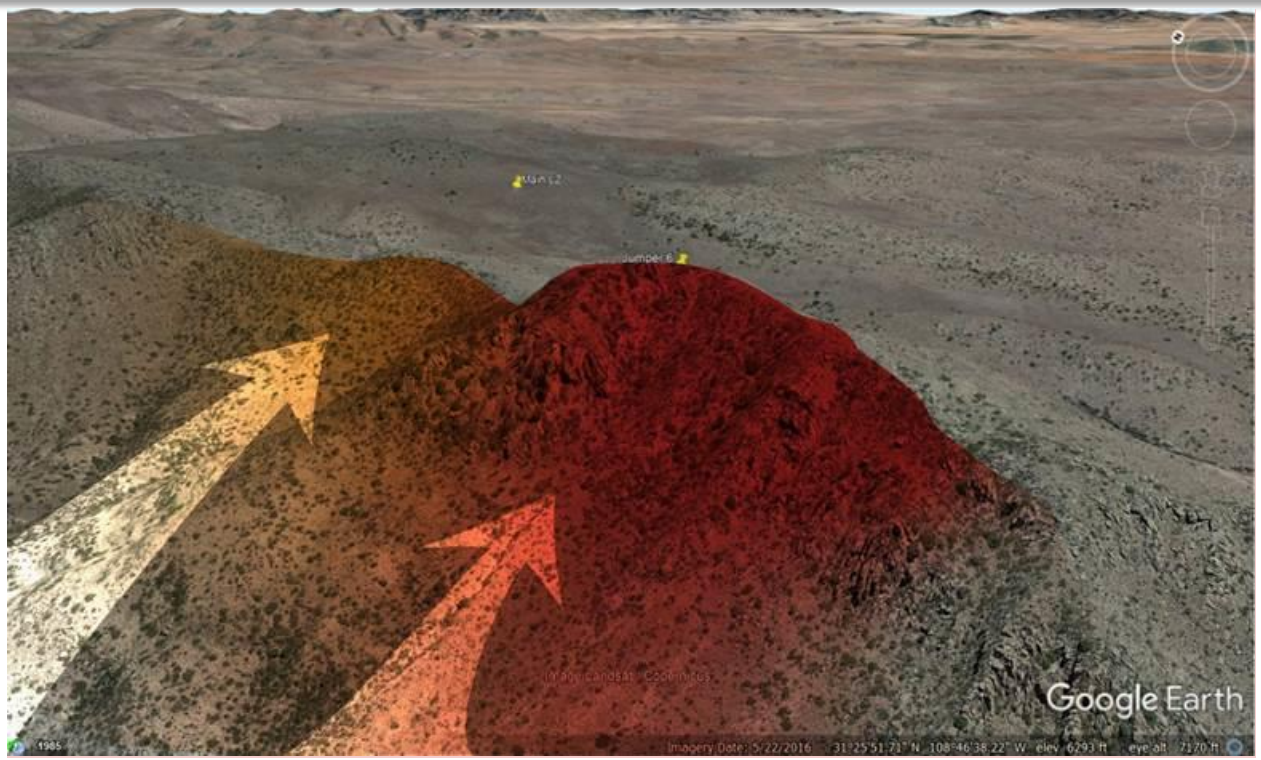


An illustration of the dry lakebed and valley to the west of the LZ and the direction this heat would be influenced to.

Jumper 6 landed behind higher terrain. From this perspective it is less clear that Jumper 6 landed further west, closer to the ridge than the main LZ was, but that is also notable.



In addition to the prevailing wind pushing over the ridge to the west of the LZ, there would also be pulses of anabatic flow climbing the 1.5 mile long draw directly to the south of the LZ (that flow is not pictured).



Approximate wind direction, showing Jumper 6's landing area being closer behind taller terrain compared to the main LZ.

Bios: Matt Gerdes, Will Kitto, Squirrel LLC

Matt Gerdes has 20 years in ultralight aviation and human flight. Paragliding since 2001, he has held paraglider instructor and tandem-instructor ratings. He has 1200 BASE jumps in alpine terrain, 4000 skydives, and over 1000 flight hours in paragliders and speed wings, all with zero injuries. He is an FAA private pilot, and has trained JSOC personnel in skydiving and paragliding disciplines. Matt founded Squirrel LLC in 2012 and has been a managing member of Ozone Paragliders since 2004. He is the author of The Great Book of BASE.

Will Kitto is a member of the USA Parachute Team, multiple time US National Champion Canopy Formation Skydiver, and parachute co-designer at Squirrel LLC. He has over 6000 skydives and 1000 BASE jumps with zero injuries. He works with Squirrel and Next Level Flight training JSOC personnel.

References

Decision Lab (The). Anchoring Bias. Why we tend to rely heavily upon the first piece of information we receive. Retrieved 2021 from https://thedecisionlab.com/biases/anchoring-bias/

Forthofer, J., & Wagenbrenner. (2021). USDA Forest Service Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Conversations with agency scientists and wind modelers.

Kahneman, D., Sibony, O., & Sunstein, C.R. (2021). *Noise: A Flaw in Human Judgment*. Hatchette Book Group, NY, NY.

Kitto, W., & Gerdes, M. (2021). Eicks Fire Parachute Industry Subject Matter Expert Report. Unpublished.

Lighthall, M.M. "Years of research have shown that stress influences cognition." Risk and Reward Are Processed Differently in Decisions Made Under Stress. Current Directions in Psychological Science. 2012;21(1):36-41. doi:10.1177/0963721411429452.

Nolan, John. (October 15, 2021). Parachute Industry Subject Matter Expert. Email Correspondence.

USDA Forest Service. (2016). National Smokejumper Training Guide.

USDA Forest Service. (2021). Ram-Air Parachute Training Guide.

USDA Forest Service Office of Learning. Drawscience Media Solutions. (2014). An Introduction to the Concept of Margin. Retrieved 2021 from https://www.youtube.com/watch?v=B5CCqmxgc3s

Weather.gov. Turbulence. Retrieved 2021 from https://www.weather.gov/source/zhu/ZHU_Training_Page/turbulence_stuff/turbulence/turulence.htm

Wikipedia. New Mexico Bootheel. Retrieved 2021 from https://en.wikipedia.org/wiki/New_Mexico_Bootheel

Yu, R. (2016). "Neurobiology of Stress." Stress Potentiates decision biases: A stress induced deliberation-to intuition (SIDI) model. Department of Psychology, National University of Singapore; Singapore Neurobiology/Ageing Programme, Life Sciences Institute, National University of Singapore, Singapore; Singapore Institute for Neurotechnology (SINAPSE), Center for Life Sciences, National University of Singapore, Singapore. Elsevier.