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# Granite Mountain IHC Entrapment and Burnover Investigation

Yarnell Hill Fire – June 30, 2013

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Prepared for:

Arizona Division of Occupational Safety and Health

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Prepared by:



Wildland Fire Associates

November, 2013

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# ACRONYMS

ACRONYM	DESCRIPTION
<b>- A -</b>	
A/G	Air to Ground
ADC	Arizona Dispatch Center
ADOSH	Arizona Division of Occupational Safety and Health
AFMO	Assistant Fire Management Office
AOBD	Air Operations Branch Director
ASFD	Arizona State Forestry Division
ASM	Aerial Supervision Module
ATGS	Air Tactical Group Supervisor
<b>- BC -</b>	
BCMG	Base Camp Manager
BLM	Bureau of Land Management
BRIHC	Blue Ridge Interagency Hotshot Crew (Hotshots)
C&G	Command and General (Staff)
COML	Communications Unit Leader
<b>- DEF -</b>	
DIVS	Division Supervisor
DOC	Department of Corrections
FBAN	Fire Behavior Analyst
FMO	Fire Management Officer
FSC	Finance Section Chief
<b>- GH -</b>	
GIS	Geographic Information System
GM	Granite Mountain Hotshots
GMIHC	Granite Mountain Interagency Hotshot Crew (Hotshots)
HEQB	Heavy Equipment Boss
<b>- I -</b>	
IA	Initial Attack/Incident Action
IAP	Incident Action Plan
ICT1	Incident Commander Type 1
ICT2	Incident Commander Type 2
ICT3	Incident Commander Type 3
ICT4	Incident Commander Type 4
ICP	Incident Command Post
IHC	Interagency Hotshot Crew (Hotshots)
IMT	Incident Management Team
IMT2	Incident Management Team, Type 2

ACRONYM	DESCRIPTION
<b>- JKLMN -</b>	
LAT	Large Air Tanker
LCES	Lookouts Communication Escape Routes and Safety Zones
LSC	Logistics Section Chief
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration
NWCG	National Wildfire Coordinating Group
NWS	National Weather Service
<b>- OPQR -</b>	
OSC	Operations Section Chief
ORDM	Ordering Manager
PSC	Planning Section Chief
RH	Relative Humidity
ROS	Rate of Spread
ROSS	Resource Ordering Status System
<b>- S -</b>	
SAIT	Serious Accident Investigation Team
SEAT	Single Engine Air Tanker
SOF	Safety Officer
SPGS1	Structure Protection Group 1 Supervisor
SPGS2	Structure Protection Group 2 Supervisor
SPUL	Supply Unit Leader
STPS	Structure Protection Specialist
SWCC	
<b>- T -</b>	
TAC1	Tactical Frequency 1
TAC3	Tactical Frequency 3
TIME	Time Unit Leader
<b>- UWXYZ -</b>	
UTV	Utility Terrain Vehicle
WFA	Wildland Fire Associates
WFDSS	Wildfire Decision Support System
WFSA	Wildland Fire Situation Analysis
VLAT	DC-10 Very Large Air Tanker
YFD	Yarnell (Volunteer) Fire Department

## INTRODUCTION

On June 30, 2013, 19 members of the Granite Mountain Interagency Hotshot Crew died after being entrapped and burned over on the Yarnell Hill Fire in Yarnell, Arizona. The purpose of this document is to provide:

- ▲ A TIMELINE OF EVENTS THAT OCCURRED BETWEEN THE TIME OF IGNITION ON JUNE 28 AND THE ENTRAPMENT AND BURNOVER ON JUNE 30;
- ▲ AN ANALYSIS OF THE FIRE BEHAVIOR AND FIRE WEATHER ON JUNE 30;
- ▲ A DISCUSSION OF OVERHEAD MANAGEMENT, STRATEGIES AND TACTICS USED ON THE FIRE, AND DOCUMENTATION OF DECISION POINTS LEADING UP TO THE ENTRAPMENT AND BURNOVER THAT CLAIMED THE LIVES OF THE FIREFIGHTERS.

This document was prepared by Wildland Fire Associates (WFA) under contract with Arizona Division of Occupational Safety and Health (ADOSH). Wildland Fire Associates participated in the investigation by ADOSH that included visits to the deployment site, interviews, reviews of incident documents including weather maps and data, and communication logs and field notes.

During this investigation, we looked at all phases and aspects of the Yarnell Hill Fire that we thought were relevant. In doing so, we made numerous requests for data and information pertinent to this incident. Through ADOSH, we were given access to all information and personnel that we requested with the exception of the employees of the USDA Forest Service. The USDA Forest Service declined the request to allow their employees to be interviewed for this investigation.

### WILDLAND FIRE ASSOCIATES

Wildland Fire Associates is a private company staffed with career wildland fire managers who are highly trained and have many years of experience from initial attack and hotshots through Type 1 Incident Command and Area Command. The five-member team that reviewed incident documents, conducted interviews and wrote this report are:

- ▲ DAN O'BRIEN, TEAM LEADER
- ▲ ELIZABETH ANDERSON, DEPUTY TEAM LEADER
- ▲ BARRY HICKS, ANALYSIS OF FIRE OPERATIONS & AVIATION
- ▲ DAVE LARSEN, ANALYSIS OF FIRE OPERATIONS & OVERHEAD TEAM
- ▲ DARRELL SCHULTE, FIRE BEHAVIOR ANALYST

Curricula vitae are located in Appendix A.

## TIMELINE

This timeline includes details from the 2013 Arizona Fire Season Outlook, as well as events as they occurred on the Yarnell Hill Fire from ignition to the time of the entrapment and burnover.

### PRE 2013 FIRE SEASON ACTIVITIES

On March 28, 2013, the Arizona Fire Season Outlook was released by the Arizona State Forestry Division (ASFD). The area of Yavapai County that includes Yarnell was listed as having high fire potential due to low live fuel moistures, and the county as a whole was predicted to see a moderate increase in fire potential compared to the 2012 fire season:

*“The chaparral vegetation type on State lands around Prescott, Yarnell, Mayer, and Bagdad is expected to have a below average live fuel moisture that will lead to high fire potential. Many of the chaparral stands are older with a high dead/live ratio that may prove resistant to control efforts due to the low live fuel moistures. Seasonal new fine fuel growth has been delayed due to the dry winter & late seasonal moisture.”*

*“Temperatures and ground moistures have not started the green up/growth of seasonal grasses. Grass loading is expected to be average in the perennial grasslands areas in the 3000 to 5000 foot elevations near Cordes Junction, Mayer, Prescott Valley, Chino Valley, Verde Valley, and Peeples Valley. Fire potential is predicted to be moderate to high in these areas.<sup>1</sup>”*

### YARNELL HILL FIRE TIMELINE NARRATIVE

*June 28, 2013*

On June 28 at approximately **1700** hours, the Yarnell Hill Fire was started by a lightning strike. The initial report was made to the Arizona Dispatch Center (ADC) at approximately **1740** by the volunteer fire department in Congress, Arizona (10 miles southwest of Yarnell, Arizona).

An ASFD Assistant Fire Management Officer (AFMO), who is also a qualified Incident Commander Type 3 (ICT3), traveled to Yarnell to be closer to the location of multiple new fire starts that resulted from the lightning activity.

Land jurisdiction in the Yarnell area includes private land, Arizona State Lands Department (for which Arizona State Forestry has fire suppression responsibilities) and Bureau of Land Management (BLM). The AFMO met with the BLM Fuels Specialist to coordinate actions on fires on either jurisdiction.

The Air Tactical Group Supervisor (ATGS) for the Doce Fire was requested to fly over the area to size-up the Yarnell Hill Fire and look for any more fires started by lightning. The ATGS stated that the Yarnell Hill Fire was in a boulder field with no vehicle access. The initial assessment was that the fire was less than a half-acre, only active in one corner and did not pose a threat to structures or people. Based upon the initial assessment, the inaccessibility of the fire and concerns about being able to adequately support firefighters overnight, the AFMO, who had become the initial attack Incident Commander (ICT4) at approximately **1940**, decided to delay initial attack of the fire until the following

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<sup>1</sup> 2013 Arizona Fire Season Outlook, Arizona State Forestry Division, March 28, 2013. page 10.

morning. The ICT4 planned for suppression activities the following morning and ordered two Arizona Department of Corrections (DOC) crews, a Type 6 engine and a Type 3 helicopter.

The strategy for the fire was full suppression. The tactic for the next day was to use a helicopter to transport people to and from the fire. A spot weather forecast was received at **2207**.

*June 29, 2013*

At **0651**, the ICT4 requested that the Single Engine Air Tanker Base at Wickenburg Airport be opened so that two Single Engine Air Tankers (SEATs) could be used. The plan was to use fire retardant on the north and south sides of the fire, but leave the west and east flanks open. There was a two-track road on the east side of the fire.

In the morning, a BLM Representative took a flight to update the status of the fire. The Yarnell Hill Fire was estimated to be approximately eight acres with little fire activity. From this assessment, the ICT4 and BLM Representative jointly developed an initial attack plan to put six firefighters from the DOC Lewis Crew and one helitack crewmember on the fire using the helicopter for transportation. ICT4 also planned to remove the firefighters from the fire by 1530 due to lightning risk from afternoon storms.



Figure 1. Photo taken by a Granite Mountain Interagency Hotshot Crew (GMIHC) member on two-track road early on June 30, 2013 during test-fire operations.

At **1011**, ICT4 requested a helicopter to shuttle crews.

The SEATs arrived mid-morning and dropped fire retardant on the flanks of the fire, each SEAT making two retardant drops to hold the fire perimeter.

At **1100**, a BLM helicopter transported seven firefighters to the top of the ridge. The one helitack and six DOC Lewis Crew firefighters hiked in the rest of the way into the fire.

At approximately **1225**, the ICT4 reported the fire size was about two acres. The ATGS reported that the fire retardant had secured the south and west flanks, and indicated that a ridge flanked the fire to the north and that a two-track road secured the eastern flank.

At **1442**, the ICT4 released the ATGS and the SEATs because the fire was holding on all four sides and no other fires ignited the previous day were still burning. The original plan by ICT4 was to fly crews down off the fire by **1530**.

At **1500**, a weather alert for thunderstorms was issued by the National Weather Service (NWS). However, the storms dissipated prior to reaching the Yarnell Hill Fire.

At **1540**, the ICT4 released the BLM brush engine and a local Peoples Valley fire engine that were being held in the event any new fires from the lightning on June 28 appeared.

During the afternoon, the temperature reached a high of 116°F (recorded in Phoenix, Arizona).

At **1600**, weather conditions were hot and dry. Winds from the west-southwest increased which led to increased fire activity.

At **1610**, the ICT4 requested two SEATs and the ATGS to return to the Yarnell Hill Fire. The ADC sent one SEAT but held the second aircraft so that it could be available for the Dean Peak Fire.

About **1630**, the Yarnell Hill Fire jumped the two-track road on the east side of the fire, despite lack of winds associated with thunderstorm activity. ICT4 indicated to ADC that there were concerns about containment, and at **1655** ordered a Type 1 Heavy Helitanker and a Large Airtanker (LAT).

At **1730**, 13 firefighters were assigned to contain the fire that had jumped the two-track road. The Yarnell Hill Fire was estimated at six acres. At some point near this time, the ICT4 learned that the DOC Lewis Crew was out of chainsaw gas which seriously hindered their effectiveness in chaparral.

Near the time the fire jumped the two-track road, approximately **1730**, the BLM representative who was a qualified ICT3 made an inquiry to the ICT4 whether the ICT4 wanted the BLM representative to “take over the fire.” The ICT4 declined the offer.

At **1742**, additional requested air resources declined dispatch due to high winds and severe weather between their home base and the fire location. The ICT4 continued to use SEATs to drop fire retardant on the Yarnell Hill Fire.

Soon after **1743**, dispatch offered a Very Large Air Tanker (VLAT) from Albuquerque in place of a heavy air tanker that could not respond due to weather. Based on discussion with ATGS and the local BLM representative, the ICT4 declined the VLAT offer.

Between **1730** and **1924**, the fire behavior and complexity continued to escalate. Based upon his interview and dispatch logs, ICT4 communicated a request to ADC for an Incident Commander Type 3 (ICT3), and then changed it to a State of Arizona Incident Management Team (IMT2) with the intention of having them take over the fire on June 30. ICT4 voiced concerns about potential threats to Peeples Valley and Yarnell, Arizona, in the following 24 to 48 hours. In addition, two structure group specialists were requested (one for the north end of the fire at Model Creek and Peeples Valley, and one for the south end of the fire at Yarnell and Glen Ilah). The ICT4 also requested three Interagency Hotshot Crews (IHC). Three IHCs were assigned to the Yarnell Hill Fire: Blue Ridge IHC, Granite Mountain IHC, and Arroyo Grande IHC (who ultimately missed the assignment due to mechanical problems).

At **1924**, the fire burned into chaparral to the north and northeast. Temperatures were above 100°F and relative humidity was 12%. Sustained winds of 10 miles per hour were reported with gusts up to 20 miles per hour out of the south and southwest. Estimated flame lengths were reported between 10 to 20 feet, and rate of spread was estimated at 5 to 10 chains per hour (1 chain = 66 feet).

“Not everyone agreed with the selected strategy and tactics. We were not gonna put it out with aircraft. Apparently they had tried aircraft on Saturday. That didn’t hold.” ~ ADOSH interview with SPGS2

By **1938**, the Yarnell Hill Fire was an estimated 100 acres. The fire was approximately one mile from structures in Peoples Valley and 2.5 miles from Yarnell, Arizona.

At **2200**, the dispatch logs note that the ICT4 ordered additional resources including 14 engines, six water tenders, two Type 2 Hotshot Crews, two bulldozers, and numerous aircraft.

At approximately **2340**, the Structure Protection Group 1 Supervisor (SPGS1) arrived. After a briefing from ICT4, SPGS1 was assigned to structure protection for Yarnell and began assessing infrastructure threats, including structures at risk, road networks and location of safety zones, including Boulder Springs Ranch as well as other locations for structure protection personnel. The second Structure Protection Group 2 Supervisor (SPGS2) arrived late in the evening of June 29 and worked with SPGS1 and the ICT4 to order additional resources and start formulating a plan for June 30. SPGS2 described abnormally active fire behavior throughout the night. 13 firefighters remained on the fire.

*June 30, 2013*

On June 30, the ICT4, BLM Representative and SPGS1 met at **0100** to discuss using roads for indirect attack and the use of point protection strategy (a firefighting strategy that involves protecting specific points from the fire while not actively trying to line the entire fire's edge<sup>2</sup>).

Between **0000 - 0400** minimum temperatures ranged from 70 to 80°F and maximum relative humidity ranged from 25 to 35%.

At **0300**, the ICT4, SPGS1 and SPGS2 ordered additional resources.

Afterwards at **0330**, the SPGS2 and ICT4 discussed the fire situation, very active fire behavior and probable outcomes for the strategy.

At **0700**, a discussion between the ICT4, personnel from the previous shift, and incoming personnel occurred and continued as personnel moved to the Incident Command Post (ICP) at Model Creek School. The discussion included the incoming Incident Commander Type 2 (ICT2), two Operations Section Chiefs (Planning OSC and Field OSC), SPGS1, a fire behavior analyst (FBAN), and deputies from the Yarnell County Sheriff's Office. The Granite Mountain IHC (GMIHC) Superintendent, who had arrived prior to this meeting, listened in on much of the information sharing.

All personnel present were informed of the fire situation and tactics for June 30. The GMIHC Superintendent was assigned as the Alpha Division Supervisor (DIVS A), transferring leadership of the crew to the GMIHC Captain. The GMIHC were assigned to DIVS A with the task of establishing the anchor point at the heel of the fire, using direct and indirect attack.

"The fire burned actively until about 0330, maybe 0400. You could still see a lot of flames until about 0600. Could see light smoke, but that's a deceptive thing, if you're around fire much, you know that there's still a lot of heat out there." ~ ADOSH interview with SPGS2

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<sup>2</sup> ICS-209, page 2.

After **0700** and before leaving for the ICP, the ICT2 informed everyone that the first priority was to have an air operations plan developed so that air resources could operate safely over the fire. ICT2 stated:

*“...the second priority was that we had people at the school that were gathering and that there would be a briefing of those resources. And that none of us were to go anywhere including ICT4 until we got that briefing done at the school to give clear leader intent.”<sup>3</sup>*

This briefing occurred at **0930**. GMIHC was not at the 0930 briefing at the ICP because they had already been given their assignment and had departed for the fire. The ICT2 stated in an interview that, at that time, he was unaware that the GMIHC had not been at the 0930 briefing.

At approximately **0800**, the GMIHC arrived at the ICP. DIVS A received an operational briefing from the Field OSC which included a safety briefing and weather forecast. The SPGS1 took them through Yarnell and they stopped along Sesame Street. They discussed the location of the safety zone at the Boulder Springs Ranch, and the SPGS1 reminded the DIVS A that the crew also had the previously burned black area as a safety zone. In addition, during their internal crew briefing, all GMIHC crewmembers were told the escape routes would be into the burned area or back to the crew carriers.



Figure 2. Photo taken by a GMIHC member on two-track road early on June 30, 2013 during test-fire operations.

At **0854**, a VLAT was ordered by ICT4. The Incident Command Post (ICP) was designated at the Model Creek School in Peoples Valley.

At **0900**, the Blue Ridge Interagency Hotshot Crew (BRIHC) arrived at the ICP and received a briefing.

At **0930**, the incoming ICT2 and overhead team members and firefighters were briefed by ICT4 at the ICP. Immediately after the briefing, the Planning OSC assigned several resources to Structure Protection Group 2 to protect homes. Sometime after the briefing, the Planning OSC directed the SPGS1 to

assess structures in the Yarnell area. SPGS1 confirmed that most homes were indefensible with available resources.

The BRIHC was instructed by Field OSC to drive to the fire area and to meet with the SPGS1 on their way to the fire. Soon after, DIVS A contacted BRIHC to discuss the fire.

At approximately **0930**, DIVS A was briefed over the radio by a helitack crewmember who had been on the fire overnight. Weather and fire behavior observations were relayed to DIVS A along with a fire size estimate of 500 acres. DIVS A was at the top of the ridge near a helispot.

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<sup>3</sup> ADOSH Interview with ICT2.

At **1000**, during a reconnaissance flight, a helicopter crewmember saw the GMIHC. The crew was about 100 yards from the fire's edge, heading for the burned area. By this time, the BRIHC had been assigned to connect their line with GMIHC's line.

At **1022**, formal transfer of command from ICT4 to ICT2 was announced via radio.

Around **1030**, the BRIHC parked their crew carriers next to the GMIHC carriers. The BRIHC Superintendent and Captain unloaded their utility task vehicle (UTV) and continued along Sesame Street. They encounter SPGS1 who requested a Heavy Equipment Boss (HEQB) to manage a dozer. The dozer was to clear out the two-track road on both sides as far as possible to provide access and prepare for a possible burnout. BRIHC assigned one of their squad leaders, a qualified HEQB, to help.

The BRIHC Superintendent and Captain scouted the fire edge while the HEQB took the dozer as far as an old abandoned grader to push a clear area around it. HEQB turned in the direction of the saddle near GMIHC's anchor point, then planned to turn around and clear out the two-track road between Sesame Street and Shrine Road. During these operations, the remaining crewmembers of the BRIHC stayed with the crew carriers.

"Fire behavior was extreme and it occurred early in the day... There was a line of fire a mile and ½ long... There were 40 to 50 foot flame-lengths at 1030 in the morning... It was moving early that morning. This is unusual for Arizona." ~ ADOSH interview with SPGS2

At **1030**, the SPGS2 described the head of the fire as a 1.5-mile line of fire at the north end towards Peeples Valley.

At **1045**, the Yarnell County Sheriff's Office issued evacuation notices to the residents of Model Creek and the Double Bar A Ranch.

At **1100**, the fire front in the basin was moving to the northeast. The tactics were to continue to use SEATs at the heel of fire. Fire activity continued to increase as the day got warmer and drier. Cumulus clouds built up to the north. Planning OSC contacted DIVS A via radio to determine if DIVS A could see the cloud formations. DIVS A indicated that he could see the clouds and would keep an eye on the weather.

By this time, the BRIHC Superintendent and Captain reached the old grader and were able to see GMIHC working on the east side of the ridge, slowly burning off the two-track road. Over the radio, the BRIHC Superintendent and Captain noted that the GMIHC was trying to get the fireline connected with the two-track road so the fire could not burn back up the ridge.

Based on the escalating fire danger, the ICT2 informed the State of Arizona FMO that the Yarnell Hill Fire needed a full IMT2.

At **1130**, fire behavior became much more active. Fire personnel became engaged in structure protection.

Between **1130** and **1145**, the GMIHC conducted burnout operations, and DIVS A and ATGS discussed tactical options. ATGS directed two SEAT drops at **1136** and **1145** directly onto the burnout operations.

DIVS A indicated via radio that the drops were not what he wanted. As a result of the drops, GMIHC shifted tactics from building indirect line to going direct along the fire edge. During this same period, a short squad of the GMIHC moved to the west side of the ridge and tied into the burned area and steep rocky terrain. DIVS A considered this connection a good anchor point.

At **1154**, after driving the two-track road on a UTV, the BRIHC Superintendent and Captain met DIVS A and the GMIHC Captain at the anchor point. Over the next half hour, they discussed tactics and agreed to use a GMIHC crewmember as a lookout (GM Lookout). The GM Lookout identified a lookout spot down near the old grader at the bottom of the slope, and the GMIHC Captain agreed it would be a good vantage point. DIVS A and the GMIHC Captain discussed communication problems which included inappropriate tone guards on some radios with the BRIHC Superintendent and Captain.

Between **1200 – 1230**, a weak southwest-northeast frontal boundary developed west of the fire locations.

At **1204**, ICT2 held a quick meeting with Command and General Staff, during which a VLAT was dropping retardant on the fire. On top of the ridge, the short squad of the GMIHC rejoined their crew on the east side of the ridge near the anchor point.

At **1210**, Division Supervisor Zulu (DIVS Z) arrived at the BRIHC crew carriers and called DIVS A to discuss a division break and resource assignments. DIVS Z also had radio problems, so he used a BRIHC crew radio to talk with DIVS A over the Blue Ridge intra-crew frequency. DIVS A and DIVS Z could not agree on the division break location or associated supervisory responsibilities.



Figure 3. Photo taken by a GMIHC member on two-track road early on June 30, 2013 during retardant drop on their burn out operations.

At **1227**, the BRIHC Superintendent and Captain left the top of the ridge and brought the GM Lookout down to the old grader site and drop him off to be a lookout for BRIHC and GMIHC. The BRIHC Superintendent and Captain continued to drive roads looking for a way to connect the planned suppression action.

At **1230**, radio communication frequency changed to Tactical Frequency 3 (TAC3) due to increased communication from SPGS2.

At **1239**, the GM Lookout was dropped off at the old grader. After hiking to the lookout spot (roughly 120 yards north of the old grader), both DIVS A and the GM Lookout confirmed they had a good view of each other and the fire edge. At

this time, the head of the fire had pushed north toward structures in Peoples Valley. The fire was also backing towards the GMIHC location. Drainages were located between the crew and the fire. The crew anticipated the fire would become more active around mid-afternoon, and expected no additional support because the focus of aircraft and firefighters was at the head of the fire on the north end. Consequently, the GMIHC planned to construct line directly along the fire edge. When GMIHC reached

a rock face they stopped to eat lunch. After lunch, the crew worked their way back, reinforcing their line as they went, ensuring they had a good anchor point.

For lookouts, they had DIVS A on a knob, GM Lookout down by the grader and GMIHC Captain near the anchor or in the immediate vicinity of the crew. Each of these individuals had been looking out for the other two lookouts, the crew and the fire. In the event the fire changed direction, the GM Lookout had geographic trigger points established for the crew and for himself. The crew had on-going contact with the BRIHC, SPGS1, and Planning OSC and talked among themselves about the incoming thunderstorms. They also contacted air resources and adjoining forces as needed.

At **1300**, the weak southwest-northeast frontal boundary sharpened and slowly moved over the fire area. The ASFD District Forester and the ICT2 developed a complexity analysis. Based upon this analysis, the ICT2 recommended ordering a full Type 2 IMT. However, the District Forester and the State FMO changed the recommendation to a Type 1 IMT and placed the order through ADC.

By **1330**, the fire had advanced towards the ICP and forced personnel to move vehicles to keep them from being burned.

At **1402**, the FBAN received a weather update from the NWS. The FBAN was informed that thunderstorms were predicted to occur east of the fire and might produce wind gusts up to 35 to 45 miles per hour with winds out of the northeast. This information was relayed to Planning OSC and Field OSC via Tactical Frequency 1 (TAC1).

At **1420**, the resources assigned to Structure Protection Group 2 located north of the fire retreated due to the fire near the Double Bar A Ranch.

At **1447**, the second Aerial Supervision Module (ASM2) arrived to relieve ASM1. After a 10 minute briefing, ASM2 met an arriving VLAT and supported structure protection north of the fire. However, fire conditions changed which shifted priorities towards Yarnell. The ATGS was still on scene overhead.

At **1500**, the outflow boundary originated from thunderstorms to the northeast of the fire area.

At **1526**, the FBAN received an update from the NWS. North to northeast winds of up to 40 and 50 miles per hour were now expected from the thunderstorm outflows. This information was relayed to Planning OSC and Field OSC via TAC1.



Figure 4. Photo taken by a GMIHC Crew member on two-track road on June 30, 2013.

At **1530**, winds changed course by 90° to the south-southwest. There was approximately three miles of an active flaming front. Between **1530** and **1545**, Planning OSC and DIVS A discussed the thunderstorm cells both to the north and south of the fire. Also at this time, the wind picked up and shifted direction from the southwest to the west-northwest. There was spotting and heavy ash fell onto fire personnel working in the youth camp area. The two-mile flanking fire started to look like a head fire and was moving to the southeast.

At **1540**, the fire reached the first geographic trigger point for SPGS1 and an evacuation of the city of Yarnell was requested. DIVS A called Planning OSC and communicated that the retardant line and dozer lines were compromised but that GMIHC was in the burned area.

At **1545**, the SPGS1 met up with Field OSC. The Field OSC called ASM2, indicating that the winds were getting erratic and requested that ASM2 check on the GMIHC when they got a chance.

At **1550**, several communications occurred at or near the same time. Field OSC called DIVS A by radio to make sure that DIVS A was aware of the latest weather update. DIVS A confirmed the update and noted that the winds were getting “squirrely” on the ridge. DIVS A informed Field OSC that GMIHC moving off the top.

At around the same time, the ATGS informs DIVS A that the fire was headed toward Yarnell and could reach the town in one to two hours. In addition, the GMIHC’s crew carriers were in the path of the fire. DIVS A acknowledged this information and planned to address the problem.

At about **1550**, the GM Lookout was taking weather observations when the GMIHC Captain called to relay the weather update. GM Lookout acknowledged the message and continued to take weather observations. By the time the GM Lookout completed the weather observations and scanned the surroundings as well as the crew location, the fire had started building and the wind was beginning to shift. GM Lookout recognized the fire had hit the first trigger point established for his safety. After informing the GMIHC Captain, GM Lookout moved towards the open area at the old grader. The GMIHC Captain received the information relatively calmly.

As the GM Lookout hiked toward the grader, he noted the options open to himself including an alternate lookout spot further up the road, a possible shelter deployment site near the grader, and a little clearing just down from his original lookout spot where he could deploy his fire shelter if needed. The BRIHC Superintendent was driving back to meet DIVS A for a face-to-face meeting. He met with the GM Lookout as he reached the grader.

The BRIHC Superintendent and Captain picked up GM Lookout with their UTV, and called GMIHC on the radio. GMIHC informed BRIHC Superintendent and Captain that they had good visibility, they were in the burned area and they were assessing their situation. As GM Lookout departed the lookout spot, he believed the GMIHC was in the black and were watching the fire and that DIVS A was scouting<sup>4</sup>.

“...it wasn’t like an outflow. It was pushing the fire in this direction. It wasn’t a ten-minute bust and things got back to normal. It was two solid hours...”  
~ ADOSH interview with SPGS2

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<sup>4</sup> ADOSH Interview with GM Lookout.

Between **1550** and **1554**, some GMIHC crewmembers took photos of the fire and sent text messages to family members about the fire.

At **1555**, fire was burning along the ridge north of Yarnell. The SPGS1 lost use of an air-to-ground radio frequency, and communication was interrupted. The BRIHC Superintendent dropped the GM Lookout off at the GMIHC Superintendents truck. The GMIHC crew carriers were moved. On the GMIHC intra-crew frequency, GM Lookout heard the DIVS A and GMIHC Captain discussing the options of whether to stay in the black or to move<sup>5</sup>.

At **1558**, ATGS abruptly leaves the fire and goes to Deer Valley. He turned air tactical operations over to ASM2 who was busy dealing with lead plane duties at the time. ASM2 got a very brief update from ATGS that did not include division breaks locations and the location of the on-the-ground firefighters<sup>6</sup>. ASM2 had been ordered as a lead plane because ATGS functions were covered.

At **1600**, the fire reached Yarnell, Arizona and evacuations were underway. About this time, the ASM2 overhears radio communication referring to a safety zone. ASM2 contacted Field OSC to clarify the exchange. Planning OSC confirmed that the GMIHC was in “a good place,” in the burned area. ASM2 was asked to check on the crew, but it was not an urgent request. Soon after, ASM2 communicated directly with DIVS A. DIVS A informed ASM2 that they were moving and indicated that everything was okay.

At **1604**, a GMIHC crewmember sent a photo of the fire to family members with a text message about the fire.

At **1618**, the outflow boundary neared the northern end of fire area moving at 16 miles per hour.

At **1620**, thunder was heard by fire personnel near Yarnell.

At **1622**, the fire had reached the second geographic trigger point and firefighters in the Shrine area started moving out of the area towards Highway 89. The BRIHC had left the fire area and attempted to contact the SPGS1 to affirm that the rest of the firefighters were out of the fire area.

At **1624**, Dopplar radar showed a fire plume at a height of approximately 31,500 feet that grew to 38,700 feet by **1633**.

At **1630**, the outflow boundary moved across the southern end of fire. Also at this time, firing operations are completed in the Peeples Valley area. The wind changed direction and fire activity diminished in this area.



Figure 5. Photo taken from Congress, Arizona on June 30, 2013. Courtesy of Matt Oss.

<sup>5</sup> ADOSH Interview with GM Lookout.

<sup>6</sup> ADOSH Interview with ASM2.

At **1634**, the outflow boundary crested the ridge for the first time in the direction of Yarnell (Figure 5, previous page).

At **1637**, ASM2 flew a drop path for a VLAT north of Yarnell from west to east. This drop went over DIVS A location at the time. DIVS A communicated with ASM2 confirming the drop path. ASM2 circled the south end of the fire above Yarnell to line up a final flight path for a tanker drop.

At **1639**, ASM2 was in the middle of a discussion with Field OCS on the air-to-ground frequency when an over-modulated and static-filled transmission came over the air-to-ground frequency. More broken communication was exchanged and due to poor reception, ASM2 could only understand fragments. The rapid advance of the fire toward Yarnell had generated much radio traffic about structure protection. ASM2 assumed the broken and unclear transmission was one of the structure protection units calling to request a retardant drop. ASM2 did not suspect it was GMIHC since they had been in a safe area when he talked to them earlier.

By **1640**, the last firefighters, with the exception of the GMIHC, reached Highway 89 and confirmed on TAC1 with SPGS1 that they were safe. At approximately the same time, SPGS1 directed ASM2 to drop retardant at his discretion to stop the fire from reaching Yarnell.

At **1642**, the outflow boundary crested the ridge for the second time (Figure 6).

Between **1640** and **1642**, the final communication occurred between GMIHC, the ASM2, and Field OSC. The exchange affirmed that GMIHC needed air support. Field OSC released ASM2 from structure suppression to help GMIHC. ASM2 contacted DIVS A to request their location. DIVS A informed ASM2 that their escape route had been cut off and that they were preparing a deployment site. They were burning out the brush around them. ASM2 asked if they were on the south side of the fire and DIVS A affirmed that location. That was the last communication with DIVS A.

Soon after **1642**, the GMIHC deployed their fire shelters and were overrun by the Yarnell Hill Fire.



Figure 6. Photo taken from Congress, Arizona on June 30, 2013.  
Courtesy of Matt Oss.

## FIRE BEHAVIOR AND FIRE WEATHER SUMMARY

The review completed by WFA of the documented weather and fire behavior events during the Yarnell Hill fire (June 28 to 30, 2013) concurs with the Serious Accident Investigation Team (SAIT) Final Report detailing the weather and fire behavior events of the Yarnell Hill Fire (published on September 23, 2013). The following summary will contain analysis as well as excerpts from the SAIT Final Report and from other independent sources.

### Fire Environment

Central Arizona is in the physiographic Transition Zone, typified by an overall northwest-trending, mountainous terrain. As indicated by its title, the Transition Zone is a large area between the northern half of Arizona typified by the semi-arid Colorado Plateau, and the southern half of Arizona that is part of the large Basin and Range Province.

The Transition Zone has characteristics from both regions, consisting of steep, rugged terrain interspersed by valleys. Because of this, weather conditions can vary within relatively small areas.

Within this large physiographic region, the Weaver Mountains are located in central-west Yavapai County, bounded by the Hassayampa River, and typical of the Transition Zone. The Yarnell Hill Fire occurred roughly in the center of the Weaver Mountains.

Elevations in the fire area ranges from 4,500 to 6,052 feet above sea level. The immediate area is bounded by a north-south trending mountain ridge to the west (see Figure 7), with a spur-ridge, trending west-northwest to the east-southeast, projecting from the main ridge at about the mid-point of the fire and extending towards Yarnell, Arizona.

Relatively flat terrain typify the northeastern side of the fire area. Slopes of up to 50%, with isolated steeper sites, can be found on the western ridges of the fire area.

Rock outcroppings in the fire area are common and scattered throughout the hills west of Yarnell, Arizona.

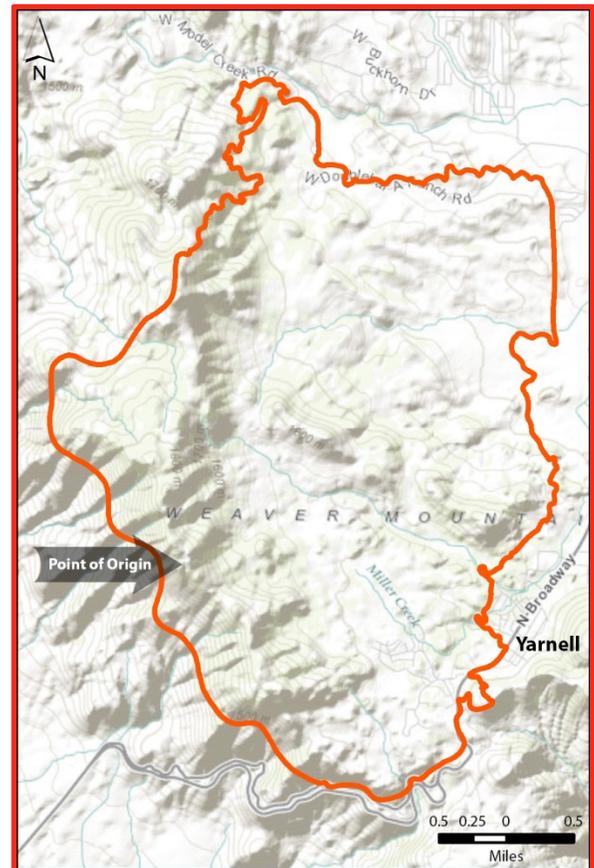


Figure 7. Topographic map west of Yarnell, Arizona. The Yarnell Hill Fire perimeter outlined in red, and the point of origin indicated with a large, black arrow.

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## Fuel/Vegetation Conditions

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Prior to the Yarnell Hill Fire, the area west of Yarnell, Arizona supported scattered, short trees such as juniper (*Juniperus deppeana*) within dense stands of brush consisting of chaparral species such as turbinella oak (*Quercus turbinella*), catclaw acacia (*Acacia greggii*), and manzanita (*Arctostaphylos spp.*). The brush vegetation varied in height from three to eight feet depending on site conditions.

Due to better soil conditions (higher moisture), drainages on the site supported thicker and taller vegetation. There was also a heavier than average cured grass component in the fuel complex due to abundant rain during the 2012 monsoon season.

In addition, no major vegetation disturbance are known to have occurred in the fire area for more than 40 years (the last documented fire was in 1966).

These conditions characterize substantial fuel continuity, both horizontally and vertically, which has the potential to support high fire rate of spreads and intensities, which in turn can introduce challenges to firefighter mobility.

On June 30, 2013, recorded fine fuel moistures (an indication of the probability of a fire start or the ease at which a fire will start) were:

- ▼ 6% FOR SHADED FUELS AND
- ▼ 3% FOR NON-SHADED FUELS.

Calculated probability of ignition was:

- ▼ 60% IN THE SHADE AND
- ▼ 90% IN NON-SHADED AREAS.

Live fuel moisture (an indication of the water stress on live vegetation as well as the flammability of live fuel) measurements were taken five miles from the fire location. These indicated varying levels of deviation from average. Ceanothus and mahogany had much lower than average moisture contents while juniper and oak were at or slightly above average<sup>7</sup>. The National Live Fuels Database records indicate that the Sonoran Scrub Oak live fuels were also below average in their moisture content as of June 15, 2013<sup>8</sup>.

Coupled with the right weather conditions, these fuel characteristics ensure moderate to extreme fire behavior.

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<sup>7</sup> Yarnell Hill Fire, SAIT Report, September 23, 2013.

<sup>8</sup> See Appendix B – National Fuel Moisture Database Figure B-1.

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## Fire Weather

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The National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) monitors and assesses climatic weather data that describe drought conditions. For the months leading up to the Yarnell Hill Fire, the described drought conditions indicated an abnormally dry fuel bed in the fire area.<sup>9</sup>

Coupled with the unusually low live fuel moisture readings, these conditions prompted the Predictive Services Section of the Southwest Coordination Center (SWCC) to issue a Fuels and Fire Behavior Advisory that discussed the area's fire potential. This included a section titled *Concerns to Firefighters and the Public*. Below is their list of concerns:

- ▲ SURFACE FIRE WILL QUICKLY TRANSITION TO CROWN FIRE AND ONLY REQUIRES LOW TO MODERATE SURFACE FIRE INTENSITY TO TRANSITION.
- ▲ ACTIVE/RUNNING CROWN FIRE HAS PRODUCED LONG RANGE SPOTTING UP TO ONE MILE UNDER THE INFLUENCE OF AN UNSTABLE ATMOSPHERE.
- ▲ ACTIVE FIRE BEHAVIOR CAN EXTEND WELL INTO NIGHT AND EARLY MORNING HOURS EVEN WITH MODERATE RELATIVE HUMIDITY (RH) RECOVERY.
- ▲ THUNDERSTORM ACTIVITY WILL CREATE A MOSAIC PATTERN OF SURFACE FUEL MOISTURES. SURFACE FIRE INTENSITY AND FIRE BEHAVIOR MAY CHANGE ABRUPTLY WHEN FIRES CROSS THESE BOUNDARIES OF MOIST AND DRY SURFACE FUELS.

On pages 68 to 76 of the SAIT Final Report, the weather discussion describes a very detailed analysis of the weather events and timing of these events during the Yarnell Hill Fire. The Cliff Mass weather blog also gives a detailed analysis of the thunderstorm movements and outflow progression as it impacted the Yarnell Fire area on June 30, 2013<sup>10</sup>. These summaries show a clear progression of weather and fuel conditions that would lead to extreme fire behavior.

Specifically, the Stanton RAWS weather graphs<sup>11</sup> for the 30th of June 2013 clearly indicate a shift in wind direction as it occurred at the Stanton site, approximately four miles south-southeast of Yarnell. At around 1700, the Stanton RAWS wind speed readings also indicate an abrupt increase in the sustained winds from 10 to 25 miles per hour, as well as wind gusts increasing to over 40 miles per hour in that same time frame. With the outflow boundary moving at about 16 miles per hour<sup>12</sup>, the outflow should have impacted the fire area at least one half hour earlier assuming the fire's northern edge was in the Peoples Valley area at the time.

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<sup>9</sup> See Appendix B – Figures B-2 and B-3.

<sup>10</sup> Cliff Mass Weather Blog: The Yarnell Hill Fire: The meteorological Origins (Yarnell Hill Fire, SAIT Report, September 23, 2013, accessed on October 28, 2013).

<sup>11</sup> See Appendix B – Figures B-4, B-5, B-6.

<sup>12</sup> SAIT Final Report, page 72.

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## USING WEATHER AND FUEL CONDITIONS TO PREDICT FIRE BEHAVIOR

The National Fire Danger Rating System (NFDRS) takes into account current and antecedent weather, fuel types, and both live and dead fuel moisture to predict burning conditions and threat of fire<sup>13</sup>. The aim of the system is to provide fire fighting personnel with qualitative and/or numeric indices to describe an area's protection needs, and are based on pre-determined fuel models.

Below is a presentation of the NFDRS fuel models that represent fuels found in the Yarnell area at the time the Yarnell Hill Fire occurred.

*Fuel Model B represents mature, dense fields of brush 6 feet or more in height. One-fourth or more of the aerial fuel in such stands is dead. Foliage burns readily. Model B fuels are potentially very dangerous, fostering intense fast-spreading fires. This model is for California mixed chaparral generally 30 years or older. The B model may be used for the New Jersey pine barrens. The F model is more appropriate for pure chamise stands.*

*Fuel Model K represents slash fuels from light thinnings and partial cuts in conifer stands.. Typically the slash is scattered about under an open overstory. This model applies to hardwood slash and to southern pine clearcuts where the loading of all fuels is less than 15 tons per acre.*

*Fuel Model T represents the bothersome sagebrush-grass types of the Great Basin and the Intermountain West. The shrubs burn easily and are not dense enough to shade out grass and other herbaceous plants. The shrubs occupy at least one-third of the site. Fuel Model T might be used for immature scrub oak and desert shrub associations in the West, and the scrub oak-wire grass type in the Southeast.*

*Fuel Model G is used for dense conifer stands where there is a heavy accumulation of litter and downed woody material. Such stands are typically over-mature and may also be suffering insect, disease, wind, or ice damage - natural events that create a very heavy buildup of dead material on the forest floor. The duff and litter are deep and much of the woody material is more than 3 inches in diameter. The undergrowth is variable, but shrubs are usually restricted to openings. Types meant to be represented by Fuel Model G are hemlock-sitka spruce, Coast Douglas-fir, and wind-thrown or bug-killed stands of lodgepole pine and spruce. This model is often used as a reference for tracking the effects of long-term drought on an area's fuels.*



Figure 8. Helm's Ranch pre-fire photo of fuels and topography.

Using the Stanton RAWS historical data (13 years of weather data) and Fuel Model B (California chaparral) pocket card as prepared for the Tonto National Forest, the Energy Release Component (ERC) for June 30, 2013 was 119. This ERC value is above the 90th percentile and indicates that only

<sup>13</sup> USFS – Wildland Fire Assessment System website (<http://www.wfas.net/index.php/nfdrs-fuel-model-static-maps-44>, access on November 3, 2013).

10% of the 13,252 days from 1968 to 2009 were hotter and drier than the conditions on June 30, 2013. The prepared pocket cards for this area and this time period shows that two significant historical fires occurred in 2000 and 2004 with ERC's of 113 and 119. Using the NFDRS pocket card prepared for the Prescott Forest West Zone<sup>14</sup> (which encompasses the Yarnell area) and using the Stanton RAWS data in a NFDRS Fuel Model G, the calculated ERC for June 30, 2013 was 108.

If the fire fighters on the Yarnell Hill Fire had either the Tonto National Forest or Prescott National Forest Pocket Card, and during a briefing were told that the predicted ERC for the day (June 30, 2013) was 100 or greater in any fuel model, the pocket card would have indicated an elevated potential for large, rapidly growing, and difficult to manage fires<sup>15</sup>.

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## Fire Behavior

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Fire personnel analyse fire behavior to provide fire fighters in the field with current and anticipated fire behavior based upon current and predicted fire weather and fuel conditions. [BehavePlus](#) is a Microsoft Windows software application used to predict wildland fire behavior for fire management purposes, and is designed for use by trained, professional wildland fire planners and managers familiar with fuels, weather, topography, wildfire situations, and the associated concepts and terminology. Using the recorded local weather as well as the observations recorded by various fire personnel on the Yarnell Hill Fire, the following fire behavior outputs were modeled using BehavePlus.

On June 30, 2013, the Fire Behavior Analyst (FBAN) selected two fuel models from a set of 40 fuel models developed by Scott and Burgan<sup>16</sup> that best matched the existing vegetation and fuel loadings in the Yarnell area.

The FBAN chose to use GS2 which represents a Grass-Shrub fuel bed with moderate grass loads, high spread rates and moderate flame lengths. This model represents shrubs up to 3 feet high. The primary carrier of fire in this model is grass and the moisture of extinction is low. This model would best represent the grass-sage areas within the Yarnell Hill Fire area.

The FBAN also chose to use SH5 which represents a high load, dry climate shrub fuel complex where the primary carrier of fire is woody shrubs and shrub litter. Depth of fuels is 4 to 6 feet with a high rate of spread and very high flame lengths are possible. The moisture of extinction in this model is high. This fuel model would best represent the chaparral-like conditions for the Yarnell area fuels and is a good choice.

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<sup>14</sup> The Prescott National Forest West Zone pocket card is based on two weather stations, Crown King and Iron Springs RAWS, both of which are within 40 miles of the Yarnell Hill Fire area.

<sup>15</sup> Appendix B – Figures B-7 to B-12.

<sup>16</sup> Scott and Burgan, 2005, RMRS-GTR-153.

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Using model SH5, the following fire behavior outputs were produced for the June 30 conditions, using a mid-flame windspeed from 5 to 40 miles per hour.

MIDFLAME WIND SPEED MI/H	RATE OF SPREAD (MAX) MI/H	FLAME LENGTH FT
0	.1	5.9
5	1.1	18.2
10	2.4	26.1
15	3.8	32.3
20	5.2	37.7
25	6.8	42.5
30	8.4	46.9
35	10.1	51.0
40	11.8	51.0

Table 1. Rate of spread and flame length predictions.

The Rate of Spread (ROS) is the speed at which the fire could travel under the modeled weather and fuel conditions. Table 1 shows the outputs in miles per hour for ROS. Before the wind shift impacted the Yarnell Hill fire, the measured windspeeds at Stanton RAWS were an average of 10 to 15 miles per hour, the expected rate of spread would have been up to 3.8 miles per hour at the head of the fire, with flame lengths up to 30 feet in the brush model. This would help explain the difficulty of control that the suppression forces were having with the Yarnell Hill fire as it headed north and west toward Peeples Valley.

After the wind shift and increase in wind speed occurred, with the outflow boundary reaching the fire area and the wind speeds increased to 40 miles per hour, the ROS would have reached up to 12 miles per hour for the flaming front. With wind speeds of this nature, spotting (lofting of embers ahead of the flaming front which in turn can start new fires) would have been irrelevant as the fire was moving so fast any spots would have been immediately over run by the flaming front. As noted in the SAIT report, when the fire moved around the granite ridge and the GMIHC were again able to see the fire, they would have had from 4 to 6 minutes to prepare a deployment site.

The SAIT report modelled the fire's spread, intensities and flame lengths using the Wildfire Decision Support System (WFDSS). The following figures are Google Earth™ outputs from this modeling effort and they are used to clarify the fire's rapid spread and change in direction.

At 1000, the model used the existing perimeter and indicated potential flow paths for the fire as it spread to the north toward Peeples Valley (Figure 9 – next page).

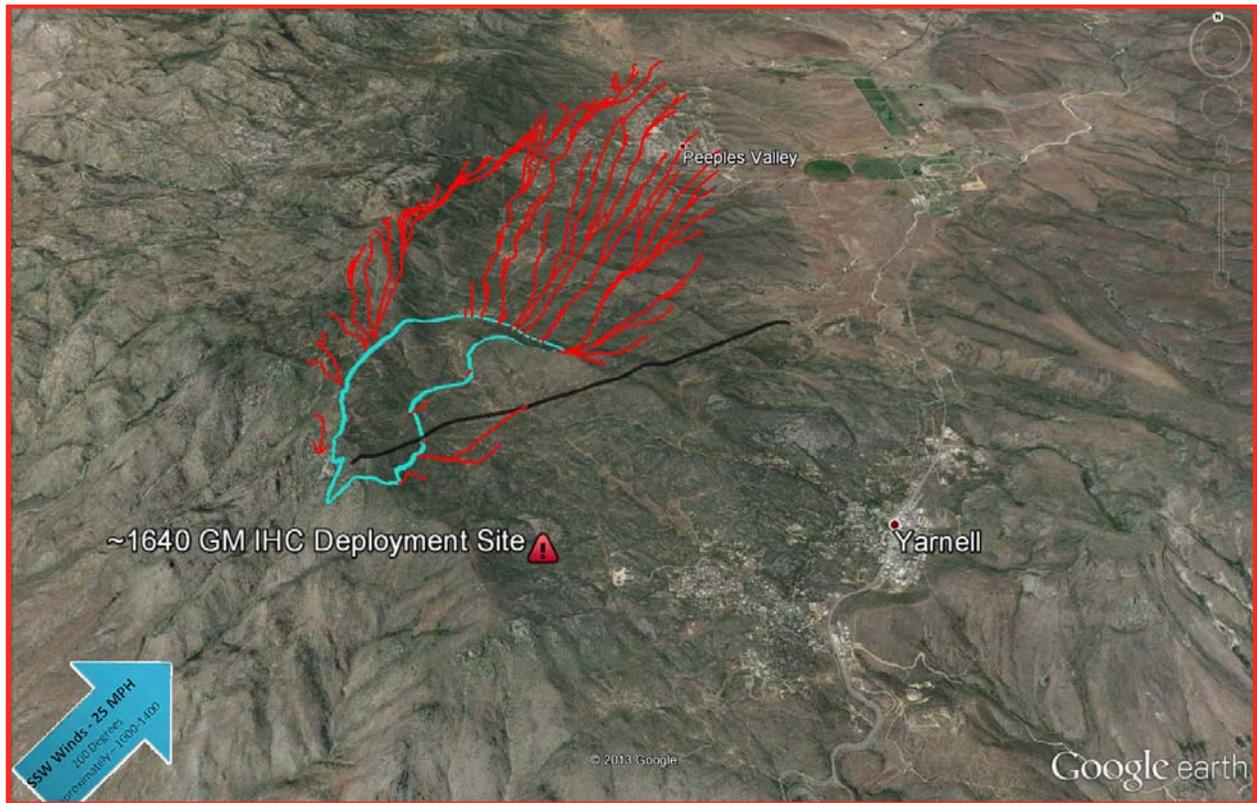


Figure 9. Yarnell Hill Fire outlined in cyan. Red lines indicate fire growth and path, and the black line represents aerial suppression efforts. The deployment site is labeled and marked with a red triangle. Winds are shown from the south-southwest at 25 miles per hour. Photo courtesy of SAIT, 2013.

At 1500, the fire had spread to the east of Peeples Valley and is beginning to turn toward Yarnell (Figure 10).

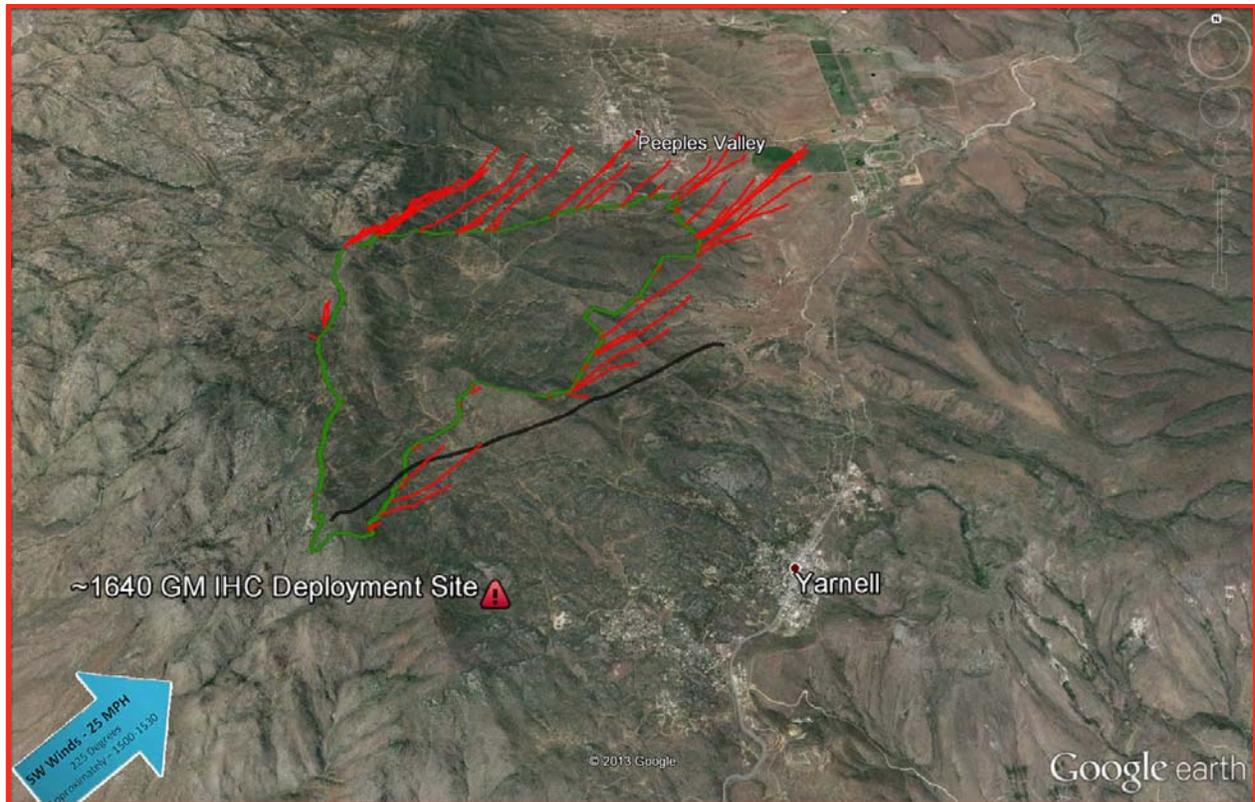


Figure 10. Yarnell Hill Fire outlined in green. Red lines indicate fire growth and path, and the black line represents aerial suppression efforts. The deployment site is labeled and marked with a red triangle. Winds are shown from the southwest at 25 miles per hour. Photo courtesy of SAIT, 2013.

Between 1600 and 1630, the fire has moved further east and crossed the retardant line and dozer line as it moves toward Yarnell (Figure 11).

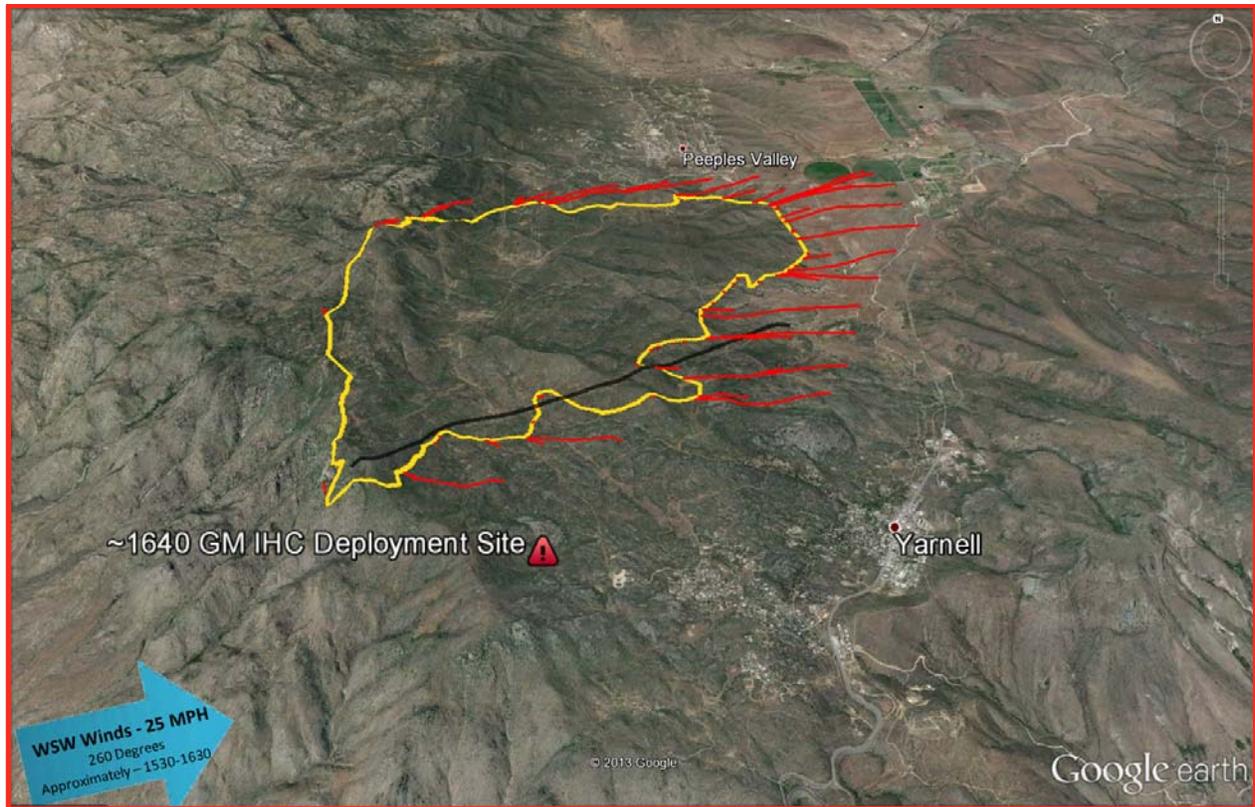


Figure 11. Yarnell Hill Fire outlined in yellow. Red lines indicate fire growth and path, and the black line represents aerial suppression efforts. The deployment site is labeled and marked with a red triangle. Winds are shown from the west-southwest at 25 miles per hour. Photo courtesy of SAIT, 2013.

By 1650, the model shows it past the deployment site and the Boulder Ranch and entering Yarnell (Figure 12).

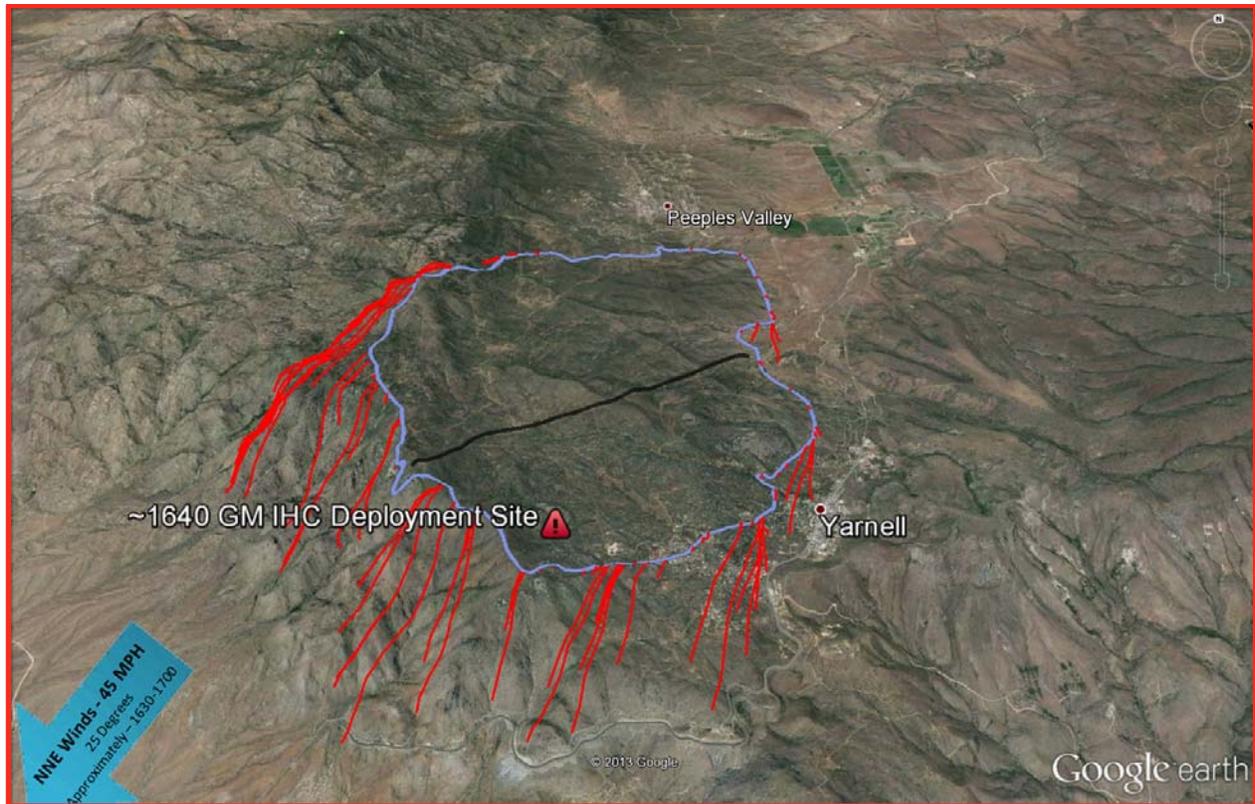


Figure 12. Yarnell Hill Fire outlined in purple. Red lines indicate fire growth and path, and the black line represents aerial suppression efforts. The deployment site is labeled and marked with a red triangle. Winds are shown from the north-northeast at 45 miles per hour. Photo courtesy of SAIT, 2013.

Oriented due north, Figure 13 shows the Wind Wizard modeling results that indicate winds speeds and directions as the fire burns through the deployment site. Wind speeds could have reached above 50 miles per hour in the area of the deployment.

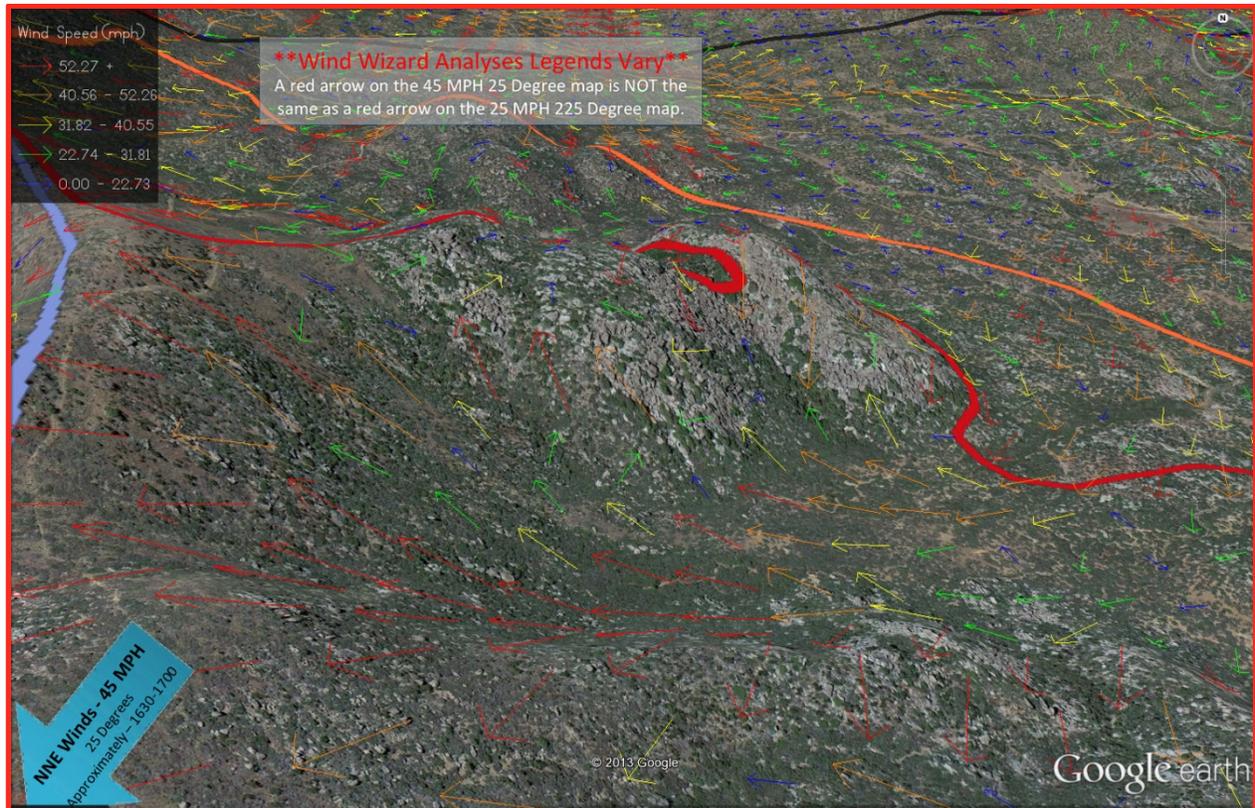


Figure 13. Deployment site at foreground, center of map. Photo courtesy of SAIT, 2013.

As modeled for the SAIT Final Report, the fire spread would have involved two flaming fronts after the frontal boundary began driving the fire to the southeast and then to the south. The first front would have moved up through the valley past the lunch spot, and over the two-track to crest on the ridge above the lunch spot and two-track area.

From a vantage point to the south at Congress, Arizona, the following two photos were taken of the Yarnell Hill Fire at approximately the time of the burnover. The first shows the outflow boundary as it crested the ridge prior to the fire running up through the deployment site to the ridge. And the second shows the outflow boundary as it continues over the ridge and the fire has run up through the deployment site and south to the ridgeline (Figures 14 and 15 on next page).



Figure 14. Yarnell Hill Fire, June 30<sup>th</sup>, 2013, approximately 1640. Photo courtesy of Matt Oss.



Figure 15. Yarnell Hill Fire, June 30<sup>th</sup>, 2013, approximately 1640. Photo courtesy of Matt Oss.

## DISCUSSION

The following discussion identifies areas of concern where difficulties existed on the Yarnell Hill Fire. Our conclusions are based upon professional experience and the industry standards for wildland fire that include the 10 Standard Firefighting Orders, 18 Watch Out Situations, Lookouts Communication Escape Routes and Safety Zones (LCES), 2013 Interagency Standards for Fire and Aviation Operations (Red Book), Incident Response Pocket Guide (IRPG), and the Wildland Fire Incident Management Field Guide (PMS 210).

The analysis of the decision making process has led to the identification of four primary areas of concern:

- ▼ ARIZONA STATE FORESTRY DIVISION
- ▼ YARNELL HILL FIRE INCIDENT MANAGEMENT
- ▼ DEPARTURE FROM STANDARD PRACTICES
- ▼ FATIGUE

Below we highlight the specific conditions and events that support why these four areas of concern resulted in the burnover.

### PRE-EXISTING CONDITIONS IN YARNELL

Yarnell, Arizona is a classic example of the wildland urban interface (WUI) situation. The structures within town are located in chaparral scrubland that had not burned in at least 40 years. The Yavapai Communities Wildfire Protection Plan approved in 2004 provides direction for hazard fuel removal on lands including the Yarnell area. The Bureau of Land Management has been working to reduce hazard fuels in Peeples Valley and Yarnell. Between 2005 and 2011, \$169,000 was spent in the Yarnell area to clear 375 acres, and \$27,500 was spent in 2007 to clear 40 acres near Peeples Valley<sup>17</sup>.

Based upon the Arizona State Forestry Division (ASFD) 2013 Season Outlook released in March 28, 2013, the state of Arizona was in a drought situation. Fine fuel moistures were approaching single digits as early as late March and the Energy Release Component was above normal and trending upward. Yavapai County had live green fuel moistures in chaparral that were below normal. Yarnell was mentioned as having chaparral with below average live fuel moisture and older chaparral stands with high dead-to-live ratio that may “prove resistant to control efforts due to the low live fuel moistures.” The dry winter and late spring precipitation had led to a delay in new seasonal fine fuel growth. The conclusion of the report is that the Yarnell area had high fire potential<sup>18</sup>.

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<sup>17</sup> AZCentral.com, Brush Clearing Saved Homes, July 17, 2013.

<sup>18</sup> 2013 Arizona Fire Season Outlook, page 10.

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## Arizona State Forestry Division

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The ASFD is responsible for fire suppression operations on 22 million acres of State Trust land and private property located outside of incorporated communities<sup>19</sup>. ASFD has employees that work on three districts and in the state office. Each District has a District Forester who, in the case of the Phoenix District, also fills the role of FMO. The Phoenix District Office maintains field offices in Prescott and Yuma, and has three fire crew coordinators throughout the District. Yarnell is part of the Phoenix District.

ASFD responds to an average of 476 wildfires annually (based upon a 10 year average, with 2006 having substantially more fires than the other nine years), which burn an average of 24,000 acres per year. ASFD supports twelve 20-person Arizona DOC fire crews, supplemental summer preparedness resources, and has cooperative agreements with 250 fire departments and federal agencies<sup>20</sup>.

ASFD had the authority for the suppression of Yarnell Hill Fire.

### INCIDENT ACTION PLAN

The Arizona Revised Statute 37-623 Section on Wildfire Suppression Strategies states that wildfire suppression operations shall be conducted to

*“minimize both suppression costs and resource losses, consistent with resource values to be protected and shall consider fire behavior, the availability of suppression resources, the values of the natural resources and property at risk, and potential cost of suppression.”*

In order to meet the intent of this statute, a comprehensive and coherent Incident Action Plan (IAP) should have been articulated. An IAP “contains objectives reflecting the overall incident strategy and specific tactical actions and supporting information for the next operational period. The plan may be oral or written.”<sup>21</sup>

Based upon incident documents and interviews, we believe that the ICT4 worked hard to develop and convey the incident strategy and tactics to resources as they arrived on the fire. However, given the complexity of the rapidly evolving fire situation, the ICT4 did not adequately brief incoming resources on June 29 or provide a written IAP for the incoming IMT2 on June 30.

Based upon our interview with ICT2, we have concluded that when ICT2 arrived at the Incident Command Post (ICP) he observed an obviously fatigued ICT4. Realizing that the fire situation was very dynamic and intensifying, ICT2 took over the fire despite the fact that certain key members of the team had not yet arrived. ICT2 provided the 0930 briefing to resources that had arrived at the ICP. Some resources were not at the 0930 briefing because they had already been assigned and working on the fireline. Based upon incident documents and interviews, ICT2 was working in a diligent and professional manner, although the situation was deteriorating.

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<sup>19</sup> Arizona State Forestry Division website (<http://www.azsf.az.gov/>, accessed on November 3, 2013).

<sup>20</sup> Arizona House of Representatives, Committee on Agriculture and Water, Minutes of Meeting, March 3, 2011.

<sup>21</sup> NWCG Glossary of Wildland Fire Terminology.

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The ultimate result was that ICT4 and ICT2 failed to convey a coherent strategic plan for suppressing the fire that was uniformly understood by ground and air resources from initial attack through the entrapment and burnover. An IAP with formalized strategies and tactics known to all resources assigned to the Yarnell Hill Fire, starting with initial attack, would have decreased the amount of confusion and miscommunication that occurred.

### EFSA AND AGENCY ADMINISTRATOR BRIEFING

The ASFD failed to give clear management direction to the incoming IMT2 because they had not completed the Escaped Fire Situation Analysis (EFSA) required by their own policy for fires escaping initial attack<sup>22</sup>. A Complexity Analysis was not completed until June 30, after the IMT2 had taken over the fire. ASFD published their Wildland Fire Situation Analysis (WFSA) decision on July 4. The ICT4, acting as Agency Administrator, provided the briefing for IMT2.

## Yarnell Hill Fire Incident Management

The following is a discussion of the decision points starting with the ignition of the Yarnell Hill Fire and ending with the entrapment and burnover. We examined the decisions that were made through the lens of the outcome and, where appropriate, suggest where different decisions could have been made based upon current policy and guidelines.

### QUALIFICATIONS

During our investigation, we reviewed the Incident Qualifications for significant personnel assigned to the Yarnell Hill Fire. We found that everyone was qualified for the positions in which they were serving.

We also examined the Type 1 Certification for the Granite Mountain Interagency Hotshot Crew (GMIHC), along with the training records for each firefighter. We have determined that GMIHC met the Type 1 Crew qualification. Each of the firefighters met the basic qualifications for the positions they held on GMIHC.

### INITIAL ATTACK

At approximately 1700 on June 28, the Yarnell Hill Fire was started by lightning. The Air Attack Group Supervisor (ATGS) for the Doce Fire was requested to fly over the Yarnell area and size up the fire. The ATGS said that the fire was in a boulder field with no vehicle access. The size-up also included that the fire was less than half an acre, only burning on one side, and did not appear to pose a threat to structures or people. A conference with the Yarnell Fire Department (YFD) personnel confirmed that the fire was inaccessible by road. The ICT4 decided not to initially attack the fire until the following morning based upon the ATGS size-up, input from YFD, and concerns about firefighter safety. The decision to defer initial attack was made without input from the District Office because the AFMO was the duty officer for the day. The ICT4 planned for initial attack the following morning.

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<sup>22</sup> Arizona State Forestry Division, Policies and Procedures, September 23, 2008. Note: The EFSA has been replaced by the Wildland Fire Decision Support System (WFDSS).

Initial attack on the morning of June 29 was delayed because a helicopter large enough to move the six-person crew safely to the site and evacuate them if needed was not available. People with local area expertise did not tell him about local trails and roads that could be used to hike in to the fire.

By mid-afternoon on June 29, the fire jumped over the two-track trail. ICT4 started ordering additional resources. The initial attack forces had clearly failed to “stop the fire and put it out in a manner consistent with firefighter and public safety and values to be protected.”<sup>23</sup> ASFD did not declare that the fire had escaped initial attack. Had they made that declaration, the decisions from that moment forward would have been proactive, rather than reactive. Based upon the Wildland Fire Incident Management Guide (PMS 210), the ICT4 would have completed a complexity analysis, implemented risk management protocols from Incident Response Pocket Guide (IRPG), determined and documented incident objectives, and reviewed the Extended Attack Safety Checklist. Based upon interviews and incident documents, we have found no evidence that this occurred.

### STRATEGIES & TACTICS

The initial strategy for the Yarnell Hill Fire was full suppression. Direct attack was made on June 29 with Single Engine Air Tankers (SEAT) dropping fire retardant by mid-morning. A Hotshot Crew arrived at the fire around 1100. The Hotshot Crew continued direct attack throughout the day. Direct attack by the SEATs was discontinued in the early afternoon. The full suppression strategy was modified to include point protection for Peeples Valley and Yarnell by the evening of June 29.

By the morning of June 30, tactics still included direct attack on the ridge at the south end of the fire by GMIHC, with aviation resources being used to slow the spread of the fire on the north and east flanks. Structure protection tactics and trigger points were established in Peeples Valley and Yarnell.

Planning OSC and DIV A decided that GMIHC would establish an anchor point using the burned area and flank using direct attack whenever possible. GMIHC was to join their line with the dozer line at the bottom of the hill and then work to the north in an effort to keep the fire out of Yarnell and Peeples Valley.

The S-336 Tactical Decision Making in Wildland Fire Course textbook contains a section on appropriate tactics in the Southwest which says that direct attack works well on small fires. However, when planning for larger fires

*“a number of items need to be considered before deciding on strategy; topography, fire behavior and intensity, rate of spread, availability of needed resources, logistics in moving and supplying firefighters and of course, probability of success... Indirect attack is also used, especially in lower elevation fuel types. Acreage is often sacrificed for lower suppression costs and higher probability of success. Direct attack on a fast moving desert or brush fire is seldom successful. Using natural barriers and roads when burning out is very common...”*

Based upon incident documents and interviews, we found no evidence that a risk assessment for the strategies and tactics were examined. We also could not find evidence that the probability of success for the chosen strategy and tactics was examined.

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<sup>23</sup> NWCG Glossary Definition of Initial Attack.

An alternative to the implemented tactics could have been to establish the anchor point as they did, burn out along the two-track trail that existed at the top of the ridge, and then burn out along the jeep trail that they used to hiked in, ending at the old grader. This tactic would entail indirect attack with burnout, and would have provided a secure line from the ridgetop to the valley floor. This tactic would have supported the strategy of point protection in Peoples Valley and the town of Yarnell. This concept is displayed in Figure 15.

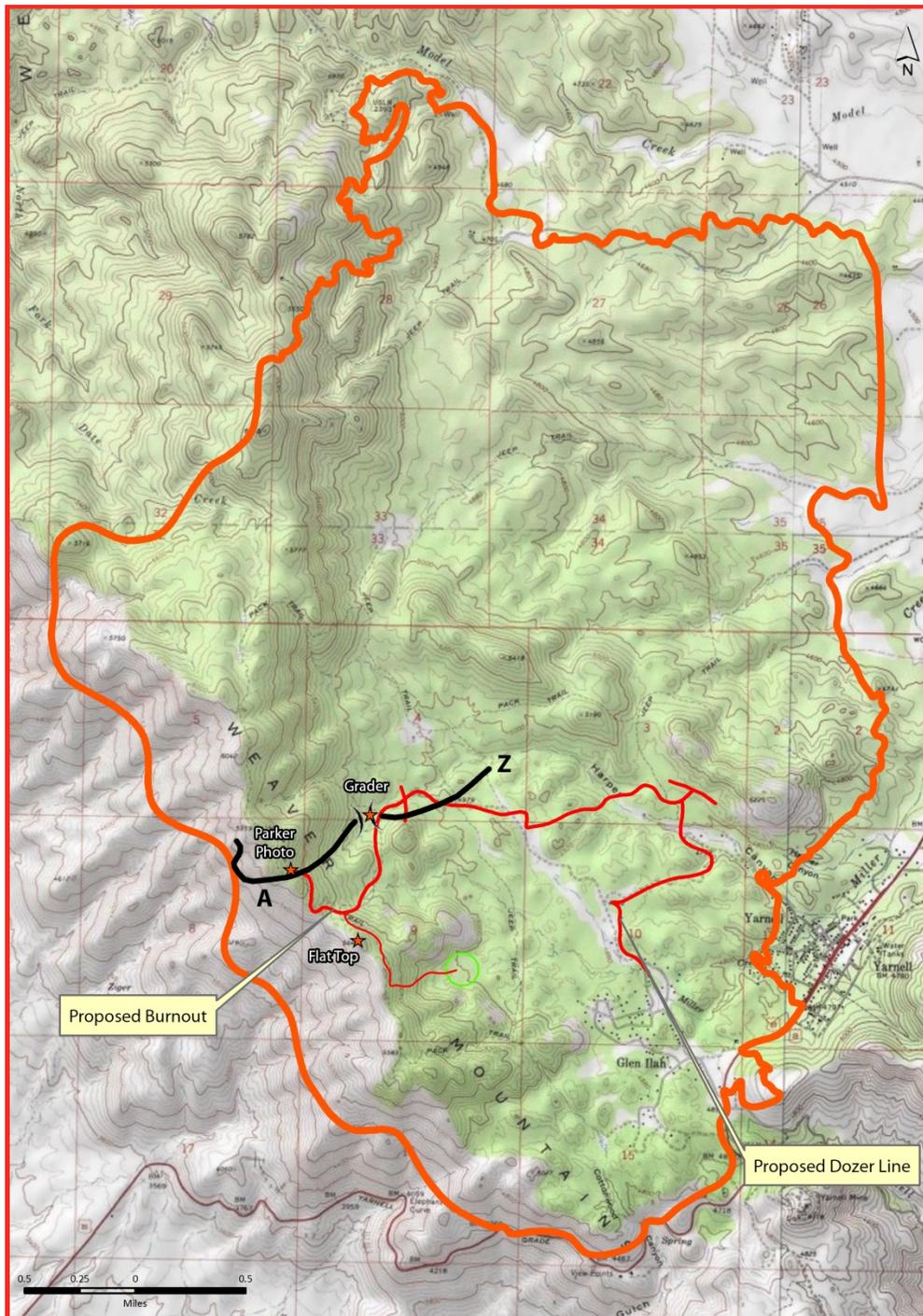


Figure 15. Yarnell Hill Fire's final outline perimeter (thick, orange outline). Topographic map showing proposed burnout and dozer line. Deployment site marked with a green circle.

Based upon interviews and incident photos, our opinion is that GMIHC was trying to ignite a test fire in anticipation of burning out indirect line along the two-track that they used to walk in when SEAT drops extinguished their burn out. GMIHC was then told by ATGS to go back to direct attack. From the interviews and incident documents, it is unclear whether the DIVS A spoke with Field OCS about the SEAT extinguishing the test fire. Also unclear is whether DIVS A spoke to Field OSC about GMIHC retreating to the burned area because the tactic of building direct line was not feasible.

## RISK MANAGEMENT

Safe implementation of the strategy and tactics requires constant reevaluation due the continual change in predicted and observed fire behavior. One of the main requirements of risk management is to identify trigger points for reevaluating strategies and tactics being applied on the fire. ICT4 initially selected a tactic of direct attack for the Yarnell Hill Fire, including the establishment of an anchor point and flanking the fire as it headed to the north and east. This tactic was not fully implemented on June 29. As a result, early in the morning of June 30, a decision to have GMIHC establish the anchor point and make a direct attack on the fire was made between Planning OSC and DIVS A during a conversation at the Yarnell Fire Station. Neither Planning OSC nor GMIHC had actually seen the fire.

The chosen tactics had the following limitations:

- ▼ THE SUSTAINED LINE PRODUCTION RATE OF A 20-PERSON CREW IN THE CHAPARRAL BRUSH TYPE IS ONLY 436 FEET AN HOUR, THE SLOWEST PRODUCTION RATE OF ANY FUEL MODEL<sup>24</sup>.
- ▼ FIREFIGHTERS USING HAND TOOLS ARE EFFECTIVE ONLY AGAINST FLAME-LENGTHS OF ABOUT 3.5 FEET BECAUSE OF THE HEAT GIVEN OFF BY THE FIRE<sup>25</sup>.
- ▼ THE RATE OF SPREAD ESTIMATES FOR THE YARNELL HILL FIRE EXCEEDED 436 FEET PER HOUR WITH FLAME LENGTHS GREATER THAN 3.5 FEET.

At the June 30 noon meeting between IMT2 Command and General Staff, they discussed current perimeter control efforts and decided to continue with existing strategy and tactics.

On June 30, the fire moved to the northeast, then to the east, and eventually to the south. The SPGS2 reported flame lengths of 40 feet with rates of speed up to 16 miles per hour occurred, yet no one seemed to recognize these signs as trigger points that should have led to a change in tactics and relocation of GMIHC. The probability of success for the chosen tactic of establishing an anchor point and flanking the fire diminished greatly each time the fire changed direction. We found no evidence that:

- ▲ GMIHC OR DIVS A SUGGESTED TO PLANNING OSC THAT THE TACTIC WOULD NOT WORK,
- ▲ THAT PLANNING OSC FOLLOWED UP WITH DIVS A OR GMIHC TO GET THEIR IMPRESSION OF THE CHANCE FOR SUCCESS,
- ▲ OR THAT IMT2 REEVALUATED THE TACTICS OR DISCUSSED MOVING GMIHC SO THAT THEY COULD REENGAGE WHERE THEY WOULD BE EFFECTIVE.

<sup>24</sup> Wildland Fire Incident Management Field Guide, 2013, PMS-210, page 109.

<sup>25</sup> 2010 Incident Response Pocket Guide (IRPG), page 79.

## ARIZONA INCIDENT MANAGEMENT TEAM

According to the 2013 Southwest Area Mobilization Guide,

*“The Arizona Divisions of Forestry and Emergency Management jointly sponsor the Arizona Incident Management Team (Arizona IMT). The team consists of employees of the Forestry Division and other areas of State government and from fire departments throughout the State. While the majority of the team’s experience is wildland fire, the team is organized with “multi-hazard” intent and is used to manage a wide range of incidents and events at the local, State, and Federal levels within Arizona as well as other areas of the country. The Arizona IMT can be configured and will respond to meet the requirements of almost any all-risk incident up to and including a Type 2 level. The team will respond as a Type 3 IMT, as a Type 2 Short IMT, as a Type 2 Long IMT, or as ordered depending on the needs and desires of the Agency Administrators responsible for the incident.”<sup>26</sup>*

The Arizona Incident Management Team, referred to as IMT2, was ordered as a “short team” and arrived without some of its key members. The following discussion outlines what happened based upon dispatch logs, interviews and daily logs. The importance of the discussion is that the team that arrived was already short-handed and had to fill in with people that were not part of the initial team order. This led to an organization that lacked the initial cohesion needed to successfully take over a complex fire.

The initial team order did not include a Safety Officer (SOF) as suggested by the Southwest Area Mobilization Guide for ordering a short Type 2 Team<sup>27</sup>. The SOF regularly assigned to the team was unavailable due to injury. Orders for two SOFs were placed on the evening of June 29 that went unfilled. They were re-ordered on the next day at 1230 with a request that they arrive by 1700. The responding SOFs arrived separately at 1455 and 1530 on the afternoon of June 30. The SOFs were assigned on the fire shortly before the entrapment and burnover. The SOF duties include “monitoring and assessing hazardous and unsafe situations, and developing measures for assessing personnel safety.”<sup>28</sup>

The individuals who filled the Operations Section Chief (OSC) positions were not originally ordered as OSCs, although they were both qualified. One individual was originally ordered as an Incident Commander Type 3, but was reassigned as Planning OSC when he arrived on the fire. Field OSC was originally ordered as a Division Supervisor, but reassigned when he arrived on the fire. The Air Support Group Supervisor (ASGS) and Air Operations Branch Director (AOBD) were ordered as part of the original team order. The rest of the Operations Section was filled with individuals who were ordered as individual resources, not as part of the formal team. This includes the individuals assigned as Structure Protection Specialists (STPS).

The Planning Section Chief (PSC) was ordered as part of the team, but did not arrive at the ICP until late afternoon. The Fire Behavior Analyst (FBAN) was also part of the initial team order and arrived in time for the 1000 briefing. A GIS Specialist was ordered as part of the team; however this position is not listed in the final organization chart of those assigned to the fire.

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<sup>26</sup> 2013 Southwest Area Mobilization Guide, page 60-10.

<sup>27</sup> 2013 Southwest Area Mobilization Guide, page 60-7.

<sup>28</sup> NWCG Glossary of Terms.

The initial team order did not request a Logistics Section Chief (LSC), but the person who filled that role was ordered as a Based Camp Manager (BCMG) in the initial team order. The initial team order did request an Ordering Manager (ORDM), a Supply Unit Leader (SPUL) and a Communications Unit Leader (COML). The COML did not arrive until after the 1000 briefing.

The Finance Section Chief (FSC) was originally ordered as the Cost Unit Leader (COST). A Time Unit Leader (TIME) was on the original order.

The results of IMT2 initially missing key people or having them arrive after the morning briefing led to the following deficiencies as the team took the fire over from IMT4.

- ▼ THE PSC WOULD HAVE BEEN ABLE TO BRING FOCUS AND COHERENCE TO THE 1000 BRIEFING AND DISTRIBUTE MAPS TO ALL RESOURCES.
- ▼ AN SOF ON-SITE THE MORNING OF JUNE 30 WOULD HAVE VIEWED THE FIRE AND FIRELINE ASSIGNMENTS STRICTLY FROM A SAFETY VIEWPOINT, NOT THE TASK-ORIENTED VIEWPOINT OF AN OSC.
- ▼ COML WOULD HAVE BEEN ABLE TO HELP THE TEAM TO ESTABLISH CONSISTENT COMMUNICATIONS WITH GROUND AND AIR RESOURCES BEFORE THEY LEFT THE ICP.
- ▼ ICT2 HAD TO ASSUME ALL THE MISSING FUNCTIONAL DUTIES WHICH WAS A SIGNIFICANT WORKLOAD.
- ▼ THE TEAM THAT WAS ASSIGNED TO THE FIRE LACKED THE COHESIVENESS THAT IS EXPECTED WHEN A TEAM IS ORDERED.

As soon as the ICT2 saw the scope and potential of the fire, he started seeking the closest qualified resources, including a SOF, through every channel available to him. The ICT2 called resources directly and bypassed the Resource Ordering Status System (ROSS) to ensure that people with the necessary skills were in place as soon as possible to assist fighting the fast moving chaparral fire. The ICT2 had little choice but to accept the fire on the morning of June 30, however the job was made more difficult based upon the way the team was ordered. They did not arrive as a cohesive and functioning unit and spent the day trying to bring order to a very chaotic situation.

Communications on the Yarnell Hill Fire were inadequate from the time IMT2 arrived because the COML arrived late. COML was not available to clone radios at the morning briefing. Tone guards were also a problem. Lack of communication is a significant safety problem.

An additional problem with the way the team arrived is that without a PSC, maps are not readily available to resources going to the fireline. GMIHC was not provided with a map or aerial photo by ICT4 when they arrived on the fire. A map would have helped the crew estimate how far the Boulder Springs ranch site was away from the lunch spot and evaluate alternative escape routes including the two-track road to Boulder Springs Ranch. Visually, the ranch looks close from the top of the ridge where GMIHC initiated their descent into the canyon. The heavy brush in the canyon, combined with the rocky nature of the area, made travel difficult and slow. They may have underestimated the speed with which the fire was moving.

## BRIEFINGS

On June 30, the IMT2 morning briefing at 0930 lacked necessary effectiveness because many Command and General Staff members had not arrived at the fire. The ICT2 had to present many parts of the briefing that should have been presented by other Command and General Staff positions because the PSC, SOF, COML and one of their usual OSC's had not arrived at the ICP by the time of the briefing. ICT4 was present to assist with the briefing as needed.

Based upon incident documents and interviews, it appears that most of the information flow for GMIHC occurred through informal conversations prior to departing to the fireline at 0800. GMIHC and DIVS A were not at the 0930 briefing.

A good example of the lack of communication from the briefing that occurred on June 30 was the test fire that GMIHC was igniting. During the morning at the top of the ridge, GMIHC was planning to burnout a small section of line to create the fire perimeter down to a two-track road. While they were igniting the test fire, two SEAT retardant drops extinguished their test fire between 1130 and 1145. The Air Tactical Group Supervisor (ATGS) did not know the purpose of the burning and dropped retardant on it, forcing GMIHC to go to direct attack on the fires perimeter. Planning OSC failed to inform ATGS of the tactics for the fire. During our interview with the ATGS on ASM1, he stated that they did not have a firm understanding of where the division breaks were. He stated that they could see the dozer, but did not understand its mission. The dozer was constructing a contingency line from west to east, which when complete, would allow a firing operation to be conducted when conditions were favorable. If ATGS had known this, they could have reinforced the dozer line with retardant instead of picking a location just to the north.

## UNCLEAR DIVISION BOUNDARIES

Neither DIVS A nor DIVS Z was at the 0930 briefing at the ICP. At different times, Field OSC instructed DIVS A and DIVS Z to establish the division boundary. DIVS A thought that DIVS Z wanted to establish the Division break somewhere near the top of the hill, which would leave Division A with only the top of the ridge heading north. DIVS Z could not figure out how to establish the Division break with DIVS A and traveled back to ICP to seek clarification. DIVS Z also was unclear as to how to initiate effective suppression actions. During an interview, DIVS Z stated that "there was just no good ways to connect any dots at that time. It was just really difficult to see anyway to connect a piece of line."

ATGS of ASM1 believed that Division A was on the western edge of the fire along the ridgeline heading north from the heel of the fire. Planning OSC thought that Division A was working from the anchor point to the East, down-slope to the valley floor. Planning OSC also thought that the western edge of the fire perimeter was not a major concern because the fire could not move to the west over the ridge without encountering a change in aspect, vegetation types and prevailing wind direction.

## OPERATIONAL OVERSIGHT

The Blue Ridge Interagency Hotshot Crew (BRIHC) spent part of their time waiting for an assignment and part of their time working on improving the dozer line. The dozer encountered a locked gate and "No Trespassing" sign which stopped line production. The objective for the dozer was to construct line from the old grader to the east to anchor into a physical feature that would allow for a burnout to protect

Yarnell. This objective was established by STPS1, and it is unclear as to whether Field OSC and Planning OSC were aware of this plan.

DIVS A did not feel that GMIHC needed the help from BRIHC. However, GMIHC made little progress in establishing an anchor point. With limited resources available, Planning OSC could have used both GMIHC and BRIHC in Division A to establish the anchor point and connect with the dozer line. Assigning both GMIHC and BRIHC to work together would have used the concept of mass action. The crews would have been able to burnout from the top of the ridge to the dozer line fairly quickly. Giving the crews separate assignments appears to be a result of poor communication, which led to poor coordination.

### COMMUNICATION BETWEEN DIVS A AND OPERATIONS

The fire situation deteriorated throughout the day of June 30. The incoming IMT2 personnel had to orient themselves to the current fire behavior, the resources currently on the fire and plan for the impending wind shift. There had to be a coherent flow of information between Field OSC and ATGS, and between Field OSC and DIVS A. The Field OSC was limited by the lack of a PSC who would translate the conceptual plan into an actual plan to be implemented on the ground. Based upon our interviews, we believe that none of the following items were intentional, but a function of an overwhelming and understaffed situation.

Planning OSC stated that “since we had not developed a plan...as we got...things going we would just assign them out.”

The decision to establish the anchor point and flank the fire was made between Planning OSC and DIVS A during a conversation that occurred while standing in the Yarnell Fire Station early in the morning of June 30. Neither OCS Plans nor DIVS A had actually seen the on-the-ground fire situation. Once GMIHC had arrived at their work area, Planning OSC should have asked if the burned area was an adequate safety zone in the event of extreme fire behavior. If GMIHC did not consider the safety zone adequate for an extreme fire behavior situation, then their assignment would have been changed to one that would be in a safer area.

Once the SEAT drops had extinguished the test fire that GMIHC was igniting, the crew tried to build direct handline, which subsequently failed. We found no evidence that DIVS A notified Planning OSC that the tactic of going direct had failed. Such a notification should trigger a reassessment of both strategy and tactics.

Planning OSC did make efforts to check on the crew with helicopter flyovers and radio calls in the morning and early afternoon. During an interview, Planning OSC said that he believed that GMIHC was safe because they were located in over 200 acres of previously burned landscape, some of which had been cold for 24-36 hours. By 1540, the first trigger point in Yarnell was breached and STPS1 called for an evacuation of the town. A short time later, the fire reached the second established trigger point and was breached which called for all structure protection personnel to retreat to their pre-identified safety zones. Planning OSC was standing with STPS1 when these commands were made.

GMIHC did not stay in the burned area safety zone. They moved toward a previously identified safety zone at Boulder Springs Ranch. Planning OSC did overhear a radio transmission from GMIHC saying

to someone that they were using their predetermined route to the structures. Although Planning OSC believed as long as the crew had one foot in the burned area they would be safe, earlier in the day, he should have discussed with GMIHC whether the burned area was an acceptable safety zone.

Some Incident Management Teams require Division or Group Supervisors to call back to the ICP by a specified time to confirm that the requirements of LCES have been put in place. This protocol was not in place on the Yarnell Hill Fire.

## Departure from Standard Practices

In determining the standards that guide professionals in the field of wildland fire management, we identified the 2013 Interagency Standards for Fire and Fire Aviation Operations (Red Book) and Wildland Fire Incident Management Field Guide (PMS 210) as established industry standards. We also referred to Arizona Revised Statutes and City of Prescott guiding documents as needed. In addition to these resources, we also used the 10 Standard Firefighting Orders and LCES. Through our interview process, a clear picture emerged that ground-level firefighters treat the 10 Standard Firefighting Orders and LCES as rules and upper level managers tend to treat the Orders as guidelines. As a result of our observations, we have chosen to treat the 10 Standard Firefighting Orders and LCES as rules because they should have guided the actions of GMIHC on June 30.

### 10 STANDARD FIREFIGHTING ORDERS

We have applied the 10 Standard Firefighting Orders to the Yarnell Hill Fire:

1. *Keep informed on fire-weather conditions and forecasts.*

Planning OSC briefed GMIHC on fire weather conditions and forecasts at the Yarnell Fire Department during the morning of June 30. The crew was later informed twice over the radio about weather warnings from the National Weather Service concerning approaching thunderstorms with associated strong winds.

2. *Know what your fire is doing at all times.*

GMIHC was positioned on a ridgeline that had an unobstructed view of the fire movement and

The 10 Standard Firefighting Orders were developed by a Task Force in 1957. The expectation was that firefighters would memorize them and use them to keep themselves safe.

The project was undertaken after the Inaja Fire in California where 11 firefighters died. The effort to develop the 10 Standard Firefighting Orders also led to the development of the fire shelter and Nomex clothing for wildland firefighters, and a call for improved training especially in the area of fire behavior. The Inaja Fire of 1956 was viewed by some as the final straw in a series of fire fatalities:

1943 Hauser Creek, CA, 11 fatalities

1949 Mann Gulch, MT, 13 fatalities

1953 Rattlesnake, CA, 15 fatalities

1956 Inaja, CA, 11 fatalities

The 10 Standard Firefighting Orders were written in an attempt to provide rules that would be able to stop the increasing number of fire fatalities.

intensity. The crew had a lookout posted for much of the day. Their lookout eventually had to move because the fire reached pre-established trigger points that meant that he was in danger from the fire. GMIHC no longer had a lookout after their lookout evacuated his position. ATGS was in the air above the fire when GMIHC decided to change locations; however the crew did not ask ATGS to serve as their lookout.

*3. Base all actions on current and expected behavior of the fire.*

GMIHC based their actions on the fire behavior they had observed for several hours.

*4. Identify escape routes and safety zones, and make them known.*

GMIHC had identified their vehicles and the Boulder Springs Ranch as good safety zones. The Ranch site was large and well-constructed, with wildfire in mind. The site withstood the flames of the Yarnell Hill Fire as it burned around the Ranch. The buildings sustained very little damage and the owners stayed in the main house as the flaming front passed. Granite Mountain had several escape routes to select from. We could find no evidence that they timed or improved the escape route to Boulder Springs Ranch.

*5. Post lookouts whenever there is possible danger.*

GMIHC posted a lookout when they were building direct handline. However, GMIHC did not have a lookout posted during their descent to the safety zone. The lookout had left his post because trigger points used to ensure his safety had been breached. During the critical period when GMIHC was traveling to the safety zone, the lookout was moving the crew vehicles to a safer location as requested by his supervisor. Based on interviews, we found no evidence that GMIHC requested that ATGS or anyone else in a position to see the crew's location, watch the fire for them as they traveled to Boulder Springs Ranch.

*6. Be alert. Keep calm. Think clearly. Act decisively.*

Evidence shows that even up to and including their last radio transmission, DIVS A and GMIHC were alert, unimaginably calm, thinking clearly, and taking decisive actions.

*7. Maintain prompt communications with your forces, your supervisor, and adjoining forces.*

GMIHC maintained communications with everyone on their crew and division. DIVS A had some difficulty maintaining communication with Planning OSC. GMIHC did not notify their supervisor that they planned to move to an alternate safety zone.

Planning OSC ineffectively communicated the tactics to be used for the day with all of his forces. There is evidence that the aerial resources did not understand tactics being used by forces on the ground. There is also evidence that DIVS A and DIVS Z could not agree where the division break should be placed.

8. *Give clear instructions and insure that they are understood.*

ASFD failed to:

- ▼ PROVIDE A WFSA OR WFDSS DOCUMENT AND RATIONALE FOR SELECTING ITS SUPPRESSION ALTERNATIVE TO THE IMT2;
- ▼ PROVIDE THE IMT2 WITH CLEAR WRITTEN DIRECTION IN THE FORM OF A DELEGATION OF AUTHORITY LETTER, WHICH IS CONSIDERED TO BE MARCHING ORDERS BY INCIDENT COMMANDERS;
- ▼ THE PLANNING OSC DID NOT GET AVIATION RESOURCES AND GROUND RESOURCES ON THE SAME TACTICAL PLAN. GMIHC WAS ATTEMPTING TO BURN OUT FIRELINE AND ATGS ORDERS TWO RETARDANT DROPS ON THEIR BURNOUT. SIMILARLY, THE STRUCTURE PROTECTION GROUP WAS USING A DOZER TO CONSTRUCT CONTINGENCY LINE NEAR YARNELL, BUT THE AVIATION RESOURCES CHOOSE TO DROP RETARDANT ON A SIMILAR VECTOR CLOSE TO THE DOZER LINE. AIR RESOURCES MISSED THE OPPORTUNITY TO REINFORCE THE DOZER LINE WITH RETARDANT BECAUSE THEY WERE NOT PROPERLY COORDINATED WITH THE STRUCTURE PROTECTION GROUP.

9. *Maintain control of your forces at all times.*

GMIHC died together in a very small space. No one ran. This is a testament to the exceptional leadership abilities of GMIHC Superintendent and Captain.

10. *Fight Fire Aggressively, having provided for Safety First*

ASFD had a strategy of full suppression using the tactic of direct attack. When the tactic failed, the managers of the fire did not reassess the strategy or tactics. A reassessment should have resulted in GMIHC moving to an area of the fire where they would have been safe and could be used effectively.

Although GMIHC successfully followed most of the 10 Standard Firefighting Orders and LCES, this section discusses the errors that were made by the crew.

The LCES checklist suggests that more than one escape route be available and that escape time and safety zone size requirements will change as fire behavior changes. GMIHC initially had multiple escape routes, including the ability to walk back to their vehicles (an option that was closed off when the vehicles were moved to safety). A second escape route was to travel south along the ridge towards the Boulder Springs Ranch and turn east at the descent point. However, this escape route had not been scouted, timed, marked or improved. At the descent point, they had a third option of turning to the west, escaping over the ridge and down to Highway 89 on the Congress side of the mountain. A fourth option would have been to continue along the two-track road to the south and east to the Boulder Springs Ranch. There is no evidence that GMIHC had scouted and timed alternative escape routes or checked

LCES was designed to be a simple way to ensure that fireline resources have identified their Lookout, Communication, Escape Route and Safety Zone. LCES reinforces the 10 Standard Firefighting Orders and 18 Watch Out Situations.

the escape route they used for loose soils, rocks or excessive vegetation. There is also no evidence that the crew had evaluated the escape time versus the potential rate of spread based upon the afternoon weather forecast.

A second error made by GMIHC is that they did not have a lookout when they made the descent to Boulder Springs Ranch. GMIHC did a very good job of having a lookout posted while they established the anchor point and constructed line. Based upon interviews and incident documents, we could find no evidence that they requested a lookout as they traveled towards Boulder Springs Ranch.

Finally, GMIHC had an obligation to notify their supervisor where they were moving and what route they would be traveling. The confusion that surrounded the search for the crew after the entrapment and burnover illustrates the importance of notifying the supervisor.

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## Fatigue

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Based upon interviews, fatigue appears to be a factor in the decisions that were made by ICT4 during the Yarnell Hill Fire. Timesheet records indicate that he had worked 28 days straight as of June 28. ICT4 sized the fire up on the evening of June 28 before returning home for the night. The following morning, he arrived in Yarnell and started a shift that would last for over 30 hours. The Incidence Response Pocket Guide states that going 24 hours without sleep affects your decision-making ability the same way a blood-alcohol-content of 0.10 would<sup>29</sup>. This level of exhaustion could impair decision-making ability and situational awareness.

Fatigue may have been a factor for GMIHC as well. Their work records indicate that they had worked 28 out of 30 days during the month of June. The crew had worked 13 of a 14-day tour. Although technically not a violation of the work-rest guidelines, cumulative fatigue resulting from working 28 out of 30 days may have been a factor in their decision making process.

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<sup>29</sup> IRPG, PMS 461, January 2010.

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## CONCLUSIONS

We have determined that the following factors directly contributed to the entrapment and burnover:

- ▲ FIRE BEHAVIOR WAS EXTREME AND EXACERBATED BY THE OUTFLOW BOUNDARY ASSOCIATED WITH THE THUNDERSTORM. THE YARNELL HILL FIRE CONTINUALLY EXCEEDED THE EXPECTATIONS OF FIRE AND INCIDENT MANAGERS, AS WELL AS THE FIREFIGHTERS.
  - ▲ ARIZONA STATE FORESTRY DIVISION FAILED TO IMPLEMENT THEIR OWN EXTENDED ATTACK GUIDELINES AND PROCEDURES INCLUDING AN EXTENDED ATTACK SAFETY CHECKLIST AND WILDLAND FIRE DECISION SUPPORT SYSTEM WITH A COMPLEXITY ANALYSIS.
  - ▲ THE INCIDENT MANAGEMENT DECISION PROCESS FAILED TO RECOGNIZE THAT THE AVAILABLE RESOURCES AND CHOSEN ADMINISTRATIVE STRATEGY OF FULL SUPPRESSION AND ASSOCIATED OPERATIONAL TACTICS COULD NOT SUCCEED. THIS ALSO REMAINED THE CASE WHEN THE STRATEGY CHANGED FROM FULL SUPPRESSION TO A COMBINATION OF POINT PROTECTION AND FULL SUPPRESSION.
  - ▲ RISK MANAGEMENT WEIGHS THE RISK ASSOCIATED WITH SUCCESS AGAINST THE PROBABILITY AND SEVERITY OF FAILURE. ASFD FAILED TO ADEQUATELY UPDATE THEIR RISK ASSESSMENT WHEN THE FIRE ESCAPED INITIAL ATTACK LEADING TO THE FAILURE OF THEIR STRATEGIES AND TACTICS THAT RESULTED IN A LIFE-THREATENING EVENT.
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## APPENDIX A - Curricula Vitae

**DAN O'BRIEN, B.S.**

**SENIOR CONSULTANT**

Mr. O'Brien is an expert in fire and aviation with over 40 years with the National Park Service. Mr. O'Brien has held the positions of Smokejumper, Hotshot Crew Supervisor and Air Attack Supervisor. He has served as Chief of Fire and Aviation Management in three regions in the National Park Service. Mr. O'Brien has been Fire and Aviation Management Officer in several parks, and Assistant Fire and Aviation Management Officer for Glacier National Park.

Mr. O'Brien served on various Regional Coordinating Groups from 1991 to 2000, and served as Multi-Area Group Coordinator for the Rocky Mountain Region. He has held several positions in the Incident Command System including Incident Commander Type II, Fire Use Manager Type I, National Park Service Agency Liaison to Area Command Team and Incident Commander II on multiple type II fire incidents over a 10-year period. He has also consulted for four law firms concerning wildland fire cases.

**ELIZABETH ANDERSON, M.S.**

**SENIOR CONSULTANT**

Ms. Anderson is an expert in fire ecology and is the Chief Operating Officer for Wildland Fire Associates. She started her federal career working on a helitack crew and in natural resources management with the National Park Service. Her career includes eight years working for the USDA Forest Service in prescribed fire and fuels management, and as a District Fire Management Officer. Ms. Anderson has over 12 years of providing consulting services to federal land management agencies that include environmental planning, fire management planning, fire staff recruitment services, and fire ecology expertise. She has specialized in providing scientific fire ecology information and research to assist fire managers make prescribed fire and fuels treatment decisions.

Ms. Anderson served for over four years as a member of the Fire Monitoring Steering Committee for the National Park Service. The committee provided the direction and oversight for the national fire ecology and fire effects monitoring program. She spent over four years establishing a regional fire ecology program and implementing a fire effects monitoring program to measure the short and long-term effects of prescribed fire on natural and cultural resources. She was also a member of a team that developed a comprehensive fire management and ecology brochure for the National Park Service.

**WILLIAM BARRY HICKS, B.S.**

**SENIOR CONSULTANT**

Mr. Hicks is an expert in Aviation Management on wildfires. Mr. Hicks has served as Aviation Coordinator on National Area Command Team from 1994-2003 and on complex fires throughout US and numerous hurricane assignments. He served as a fire expert advisor to a consortium of ranchers in Mexico in 2010 on perhaps largest wildfires Mexico has experienced. He also served on Chief's Principal Representative Team in Oregon & Washington in 2007 for fires in excess of \$10,000,000. He was requested to advise on the use of the Evergreen 747 dropping retardant on these fires and as a Team participant on Interagency Smokejumper Delivery System study 2004-2005. Mr. Hicks was an

advisor to the US Coast Guard for aviation on BP Oil Spill in 2009 and worked a Special Assignment to Columbia Shuttle Disaster recovery efforts.

Mr. Hicks began his career with the U.S. Forest Service in positions such as smoke jumper, engine crew and working on a hotshot crew. He became a smoke jumper squad leader and a base manager before becoming a Fire Management Officer, District Ranger, and then a Regional Aviation Officer.

**DAVE LARSEN, B.S.**  
**SENIOR CONSULTANT**

Mr. Larsen is an expert in fire management and the tactical application of resources in fire suppression. Mr. Larsen has held the positions of Incident Commander Type I, Deputy Incident Commander Type I, Incident Commander Type II, Prescribed Burn Boss Type I, Prescribed Fire Manager Type I, and Fire Use Manager Type I.

Mr. Larsen's fire management experience includes work as a fire lookout, district engine foreman and crewmember, district trail crewmember, district brush disposal crew and a hot shot crew supervisor. Mr. Larsen was a District Fire Management Officer as well as a Forest Fire Management Officer for the Helena National Forest. Mr. Larsen's expertise includes All-Risk Incident Commander including Hurricanes Katrina and Rita Operation Section Chief, Type II, and Fire Behavior Analyst, Type II. Additionally, Mr. Larsen has Instructed S290, S390, S490, S339, S330, I400 and other ICS courses.

**DARRELL SCHULTE, B.S.**  
**SENIOR CONSULTANT**

Mr. Schulte's expertise is in analyzing and predicting fire behavior. Mr. Schulte has 22 years of experience working on Incident Management Teams nationally as a Fire Behavior analyst, including 18 years of experience as a Long Term Fire Behavior Analyst. His career includes serving as Assistant Forest Fire Management Officer, District Fire Manager officer, hotshot crew supervisor, Assistant District Fire Management Officer supervising a 20-person brush disposal crew, and supervising district engine and fire crews. He is an expert user of Firefamily Plus, FlamMap, Farsite, as well as an Analyst and User for WFDSS.

Mr. Schulte has worked on interdisciplinary teams and NEPA planning efforts for over 33 years specializing in fire and fuels management. Mr. Schulte participated in the 1995 Interagency Management Review for the South Canyon Fire by analyzing the availability and use of Fire Behavior Analysts during the 1994 fire season. He has served as an expert witness and fire behavior consultant for legal firms. Additionally, Mr. Schulte has instructed S130, S190, S230, S231, S390, S490, S590, and RX 590 classes, as well as other ICS classes, nationally.

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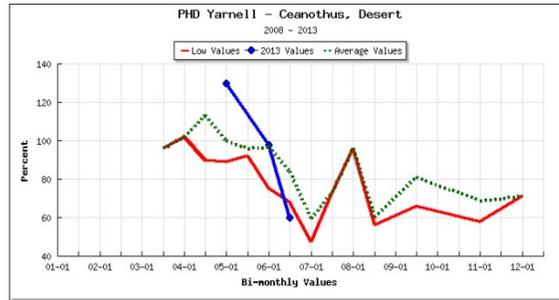
# APPENDIX B - Fire Behavior and Weather Supporting Graphics

## National Fuel Moisture Database

### PHD Yarnell (Bi-monthly Data)

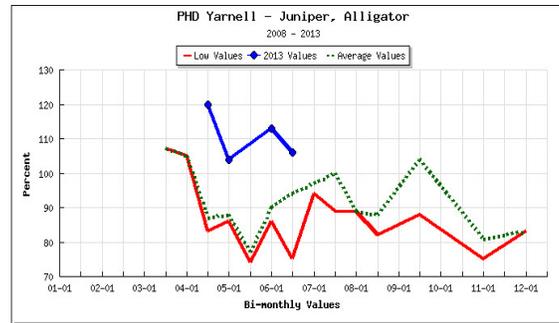
[Site Information](#) | [Stanton RAWs](#) | [Close the Report](#)

Gray background indicates that no current year data is available



PHD Yarnell - Ceanothus, Desert

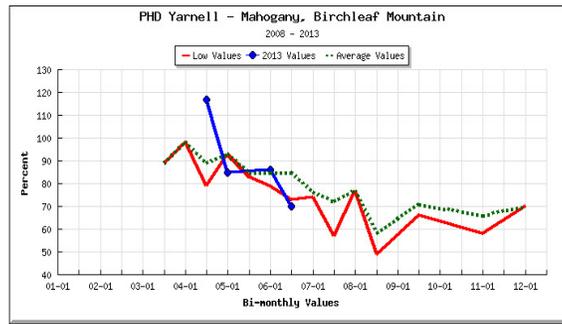
	01-01	01-15	02-01	02-15	03-01	03-15	04-01	04-15	05-01	05-15	06-01	06-15	07-01	07-15	08-01	08-15	09-01	09-15	10-01	10-15	11-01	11-15	12-01	12-15
2013									130		98	60												
Avg							96	102	113	100	96	97	84	59	73	96	60		81			69		71
Low							96	102	90	89	92	75	68	47	73	96	56		66			58		71



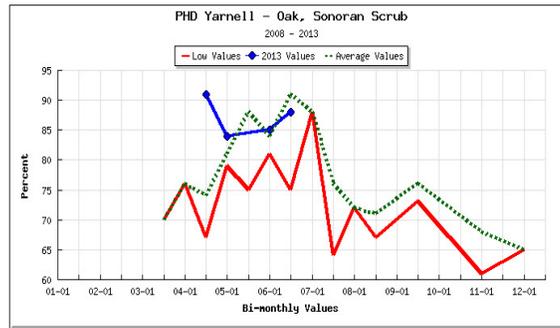
PHD Yarnell - Juniper, Alligator

	01-01	01-15	02-01	02-15	03-01	03-15	04-01	04-15	05-01	05-15	06-01	06-15	07-01	07-15	08-01	08-15	09-01	09-15	10-01	10-15	11-01	11-15	12-01	12-15
2013									120		113	106												
Avg							107	105	87	88	77	90	94	97	100	89	88		104			81		83
Low							107	105	83	86	74	86	75	94	89	89	82		88			75		83

Figure B-1. National Live Fuel Moisture Database for Yarnell, 2008 – 2013 (continued on next page).



PHD Yarnell - Mahogany, Birchleaf Mountain																								
	01-01	01-15	02-01	02-15	03-01	03-15	04-01	04-15	05-01	05-15	06-01	06-15	07-01	07-15	08-01	08-15	09-01	09-15	10-01	10-15	11-01	11-15	12-01	12-15
2013								117	85		86	70												
Avg							89	98	89	93	85	85	85	76	72	77	58		71			66		70
Low							89	98	79	93	83	79	73	74	57	77	49		66			58		70



PHD Yarnell - Oak, Sonoran Scrub																								
	01-01	01-15	02-01	02-15	03-01	03-15	04-01	04-15	05-01	05-15	06-01	06-15	07-01	07-15	08-01	08-15	09-01	09-15	10-01	10-15	11-01	11-15	12-01	12-15
2013								91	84		85	88												
Avg							70	76	74	81	88	84	91	88	76	72	71		76			68		65
Low							70	76	67	79	75	81	75	88	64	72	67	73			61		65	

Figure B-1. National Live Fuel Moisture Database for Yarnell, 2008 – 2013.

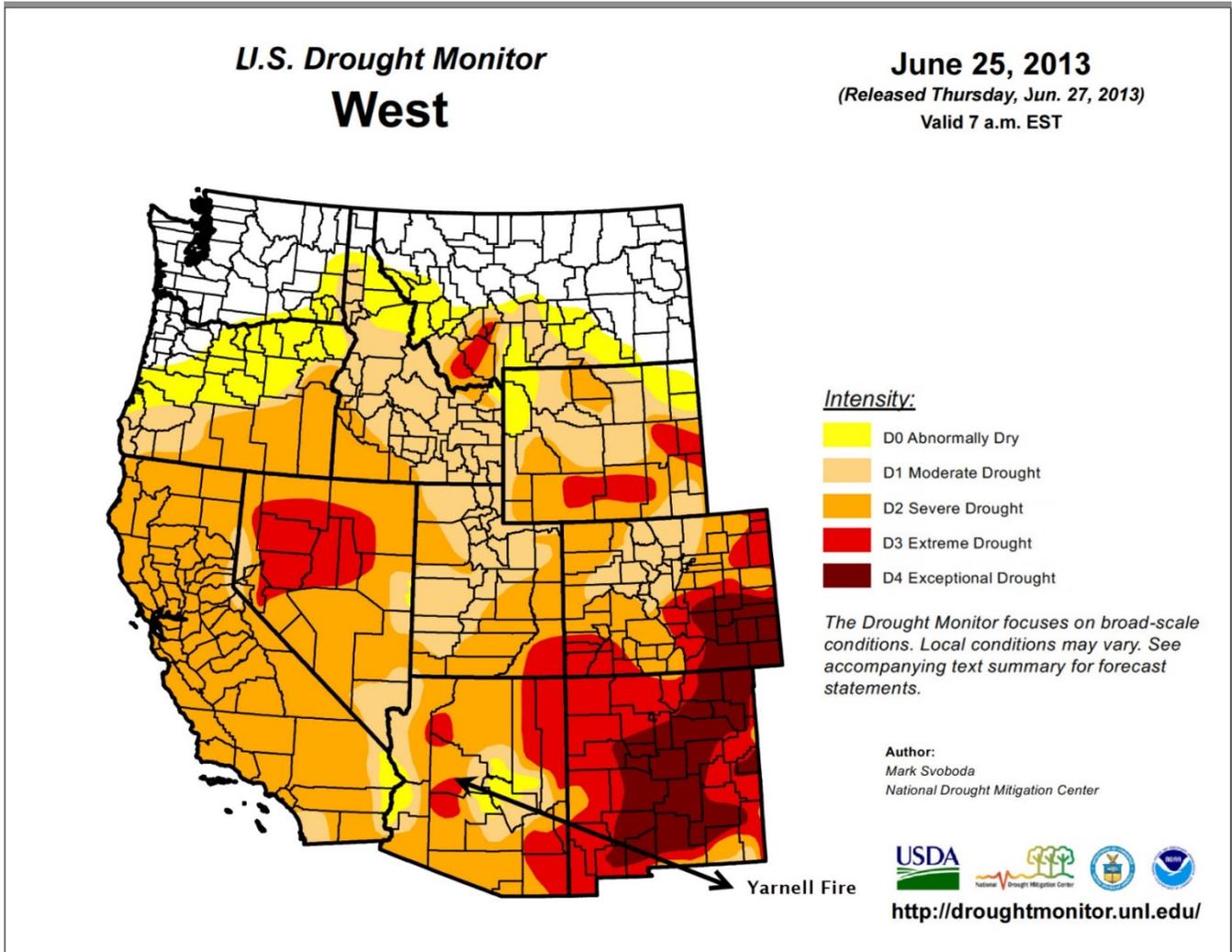


Figure B-2. U.S. Drought Monitor for the western United States for June 25, 2013.

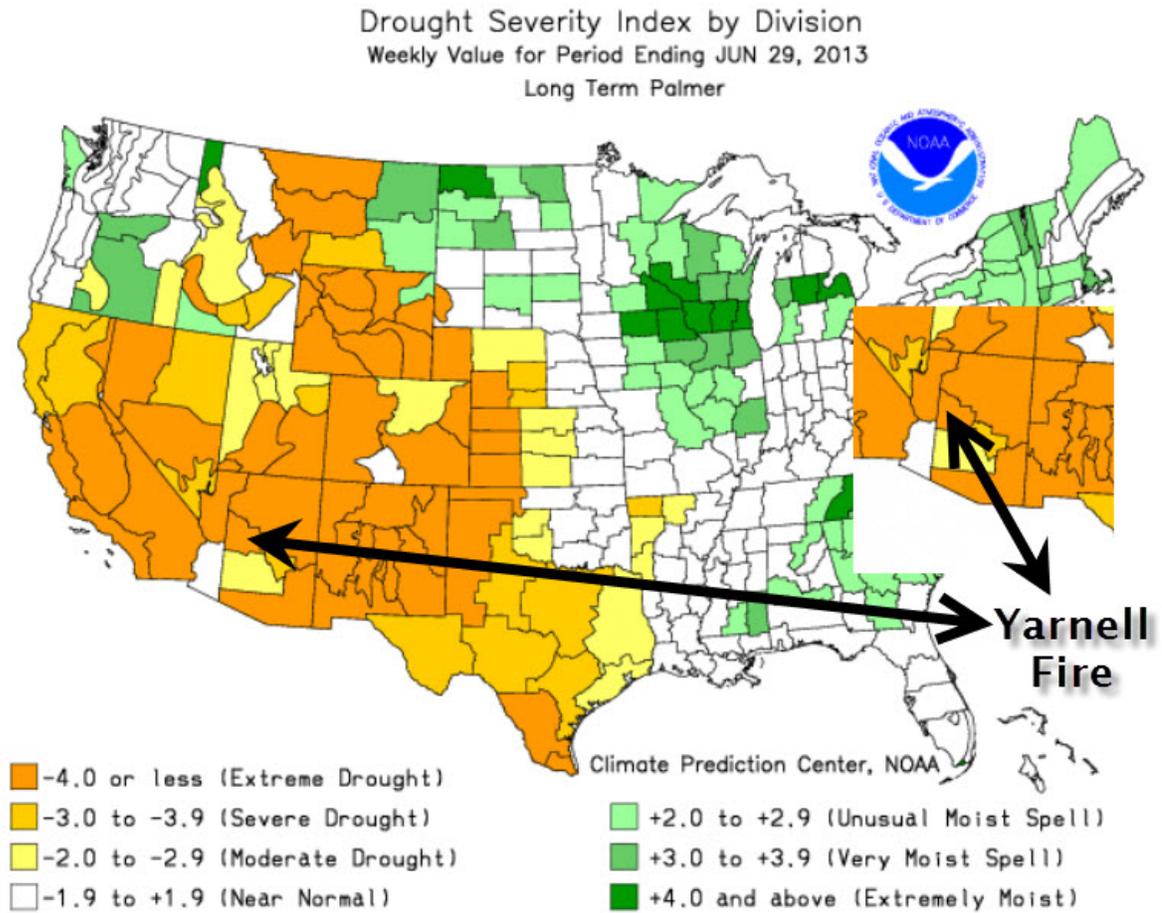


Figure B-3. Drought Severity Index by Division, June 29, 2013.

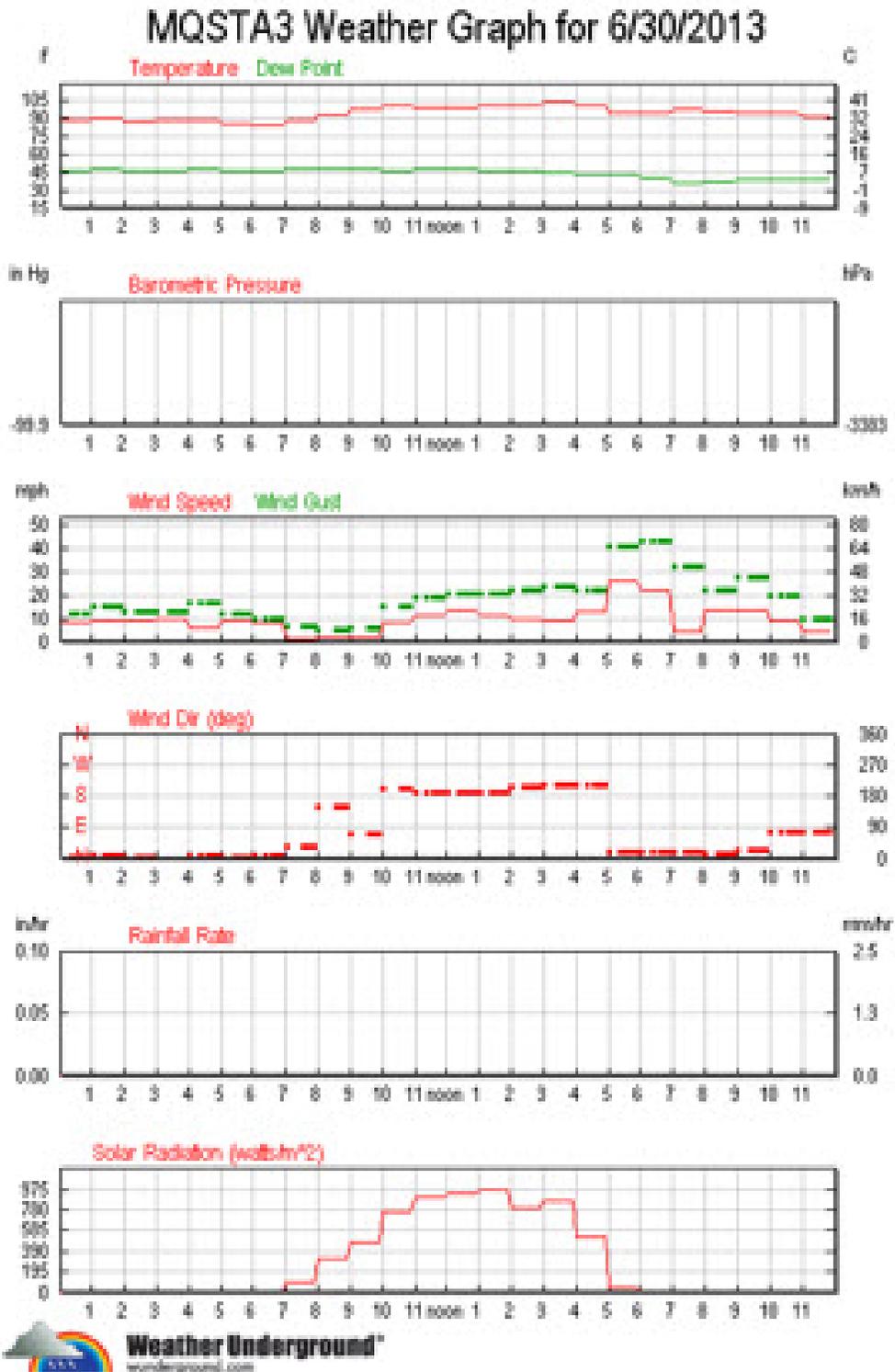


Figure B-4. MQSTA3 Weather Graph showing temperature, wind speed, wind direction, and solar radiation for June 30, 2013.

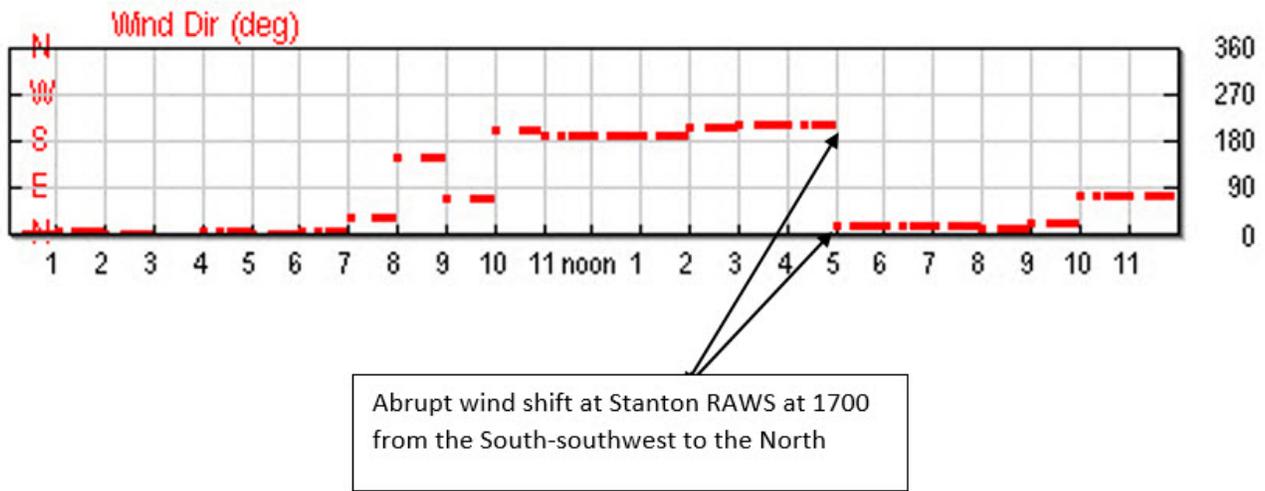


Figure B-5. Weather data graph detail showing wind direction shift on June 30, 2013.

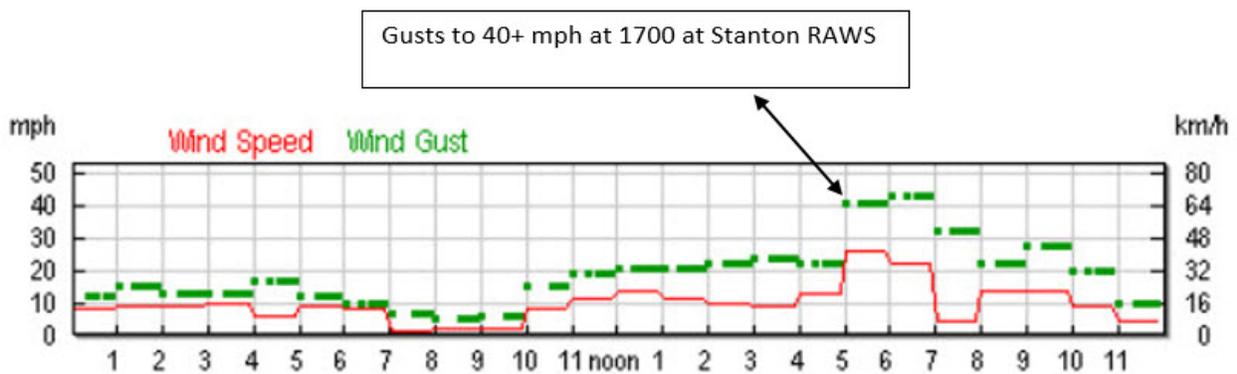


Figure B-6. Weather data graph detail showing wind speed increase on June 30, 2013.

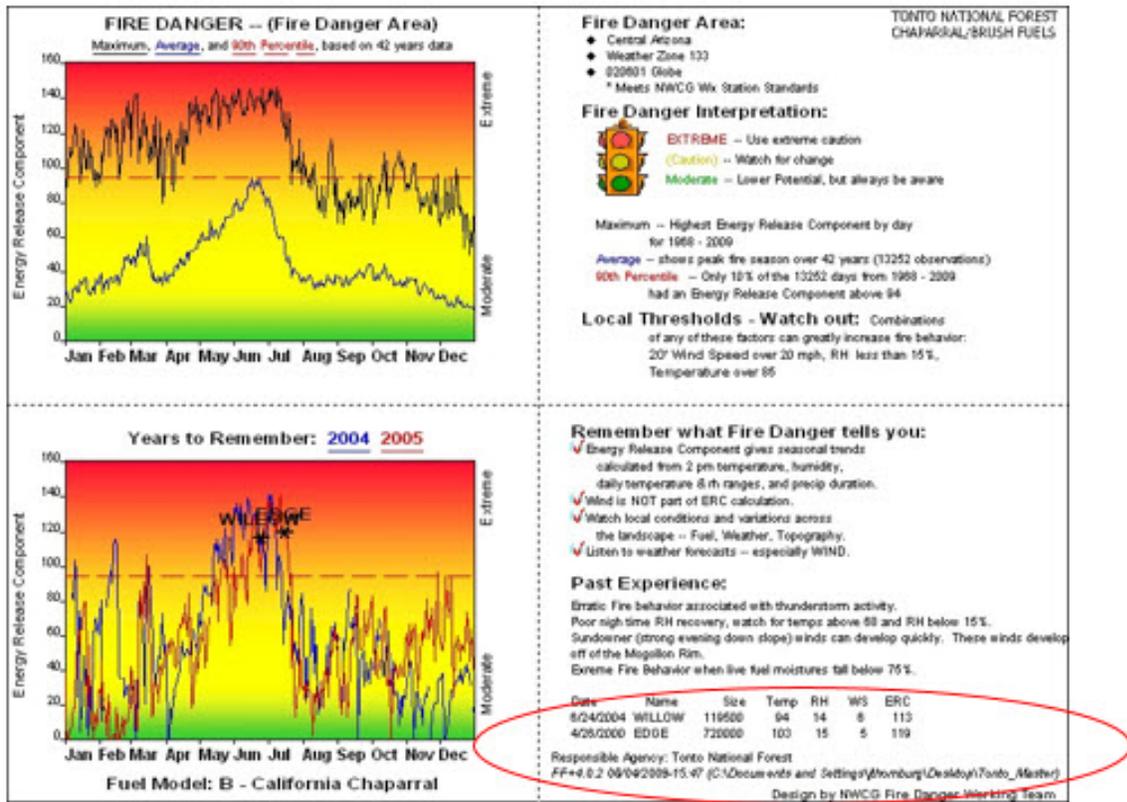


Figure B-7. Tonto National Forest, Chaparral/Brush Fuels Fire Danger pocket card.

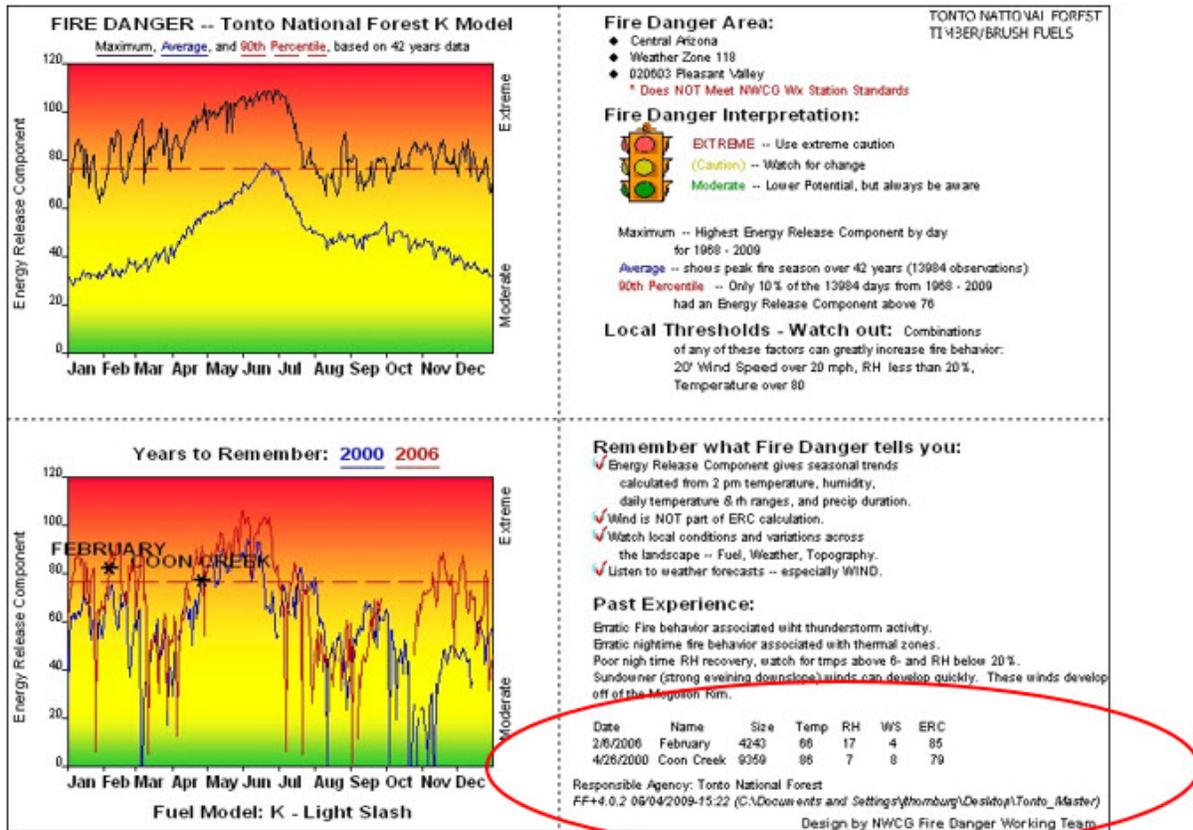


Figure B-8. Tonto National Forest, Timber/Brush Fuels Fire Danger pocket card.

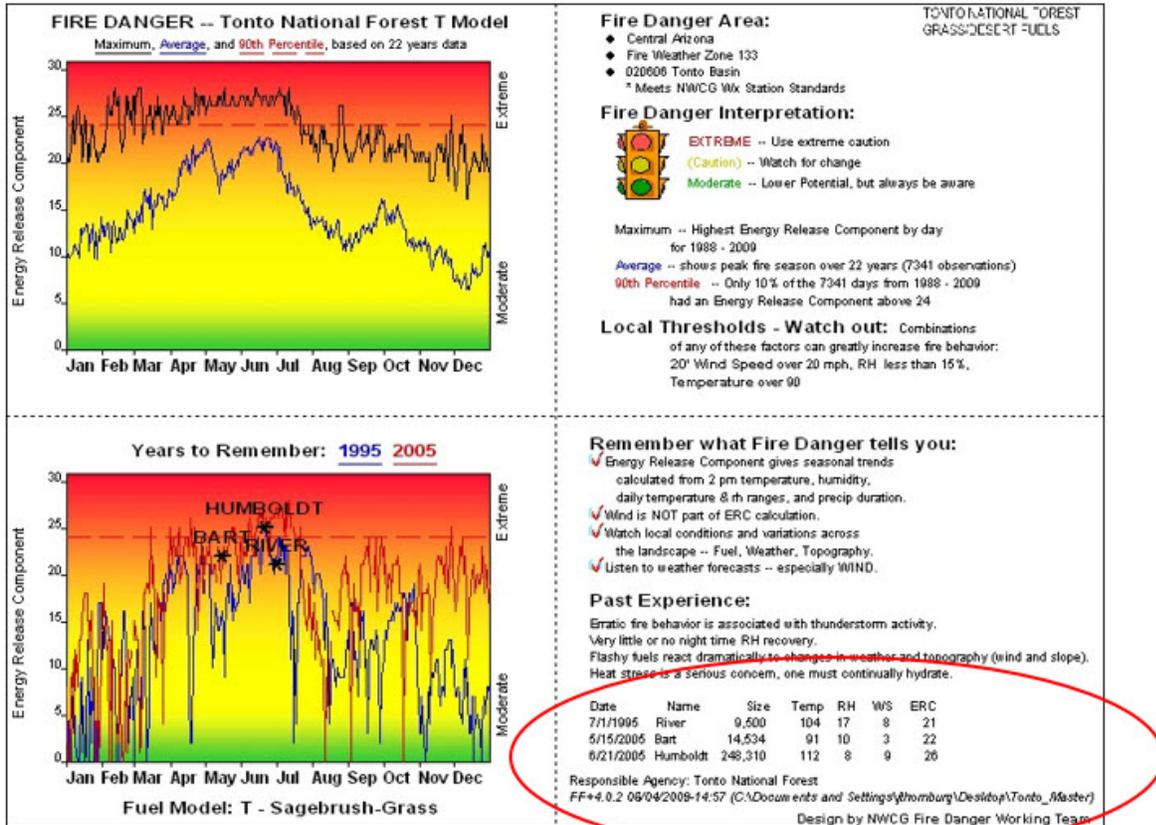


Figure B-9. Tonto National Forest, Grass/Desert Fuels Fire Danger pocket card.

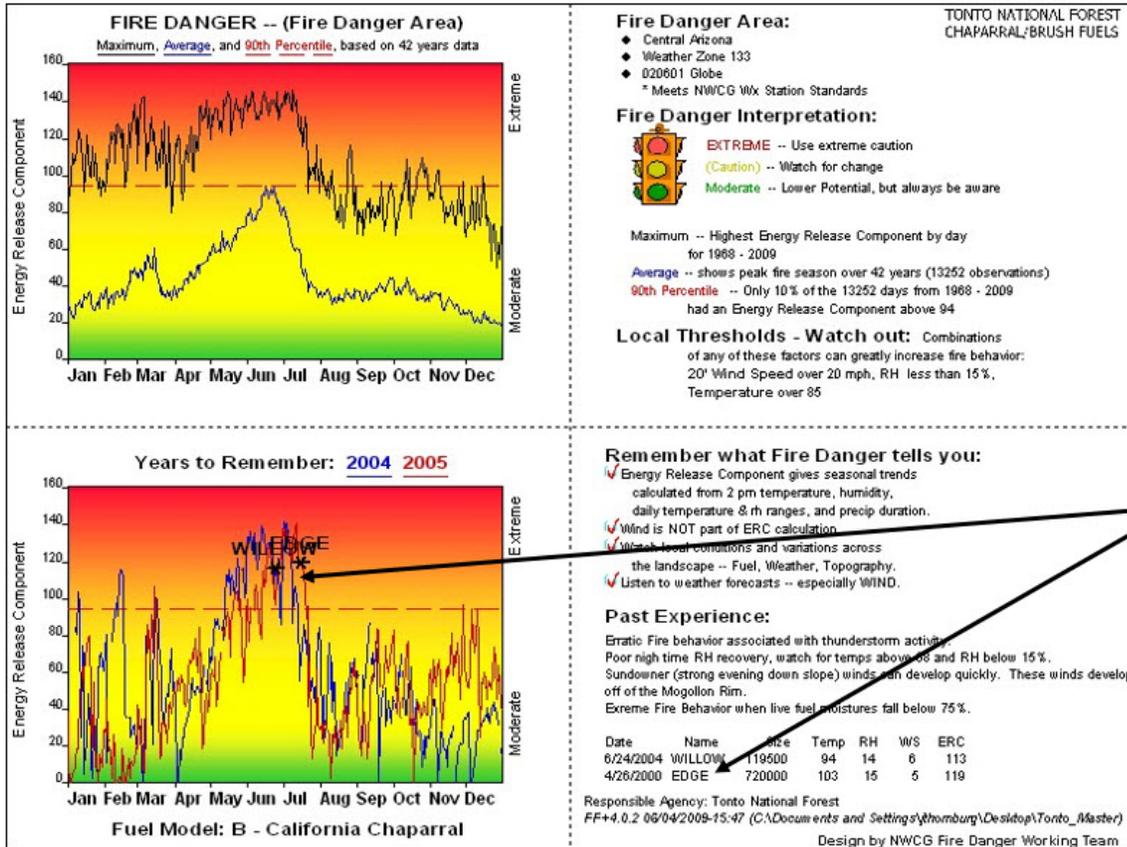


Figure B-10. Tonto National Forest, Chaparral/Brush Fuels Fire Danger pocket card showing past fire events with an ERC above 100.

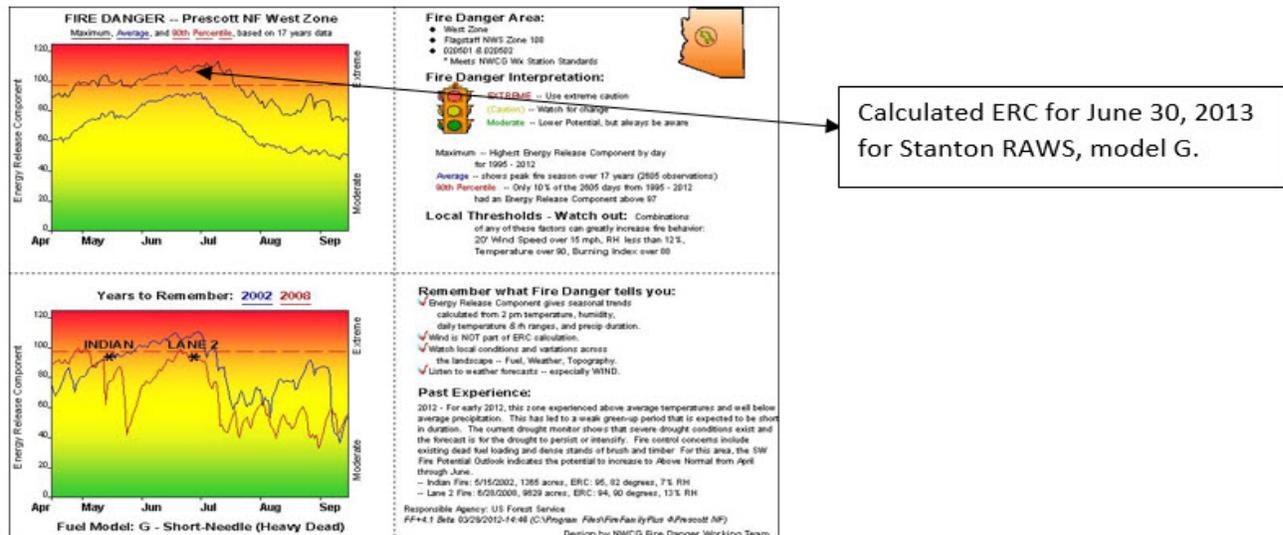


Figure B-11. Prescott NF West Zone, Short Needle Fuels Fire Danger pocket card showing the calculated ERC above 100 for June 30, 2013.

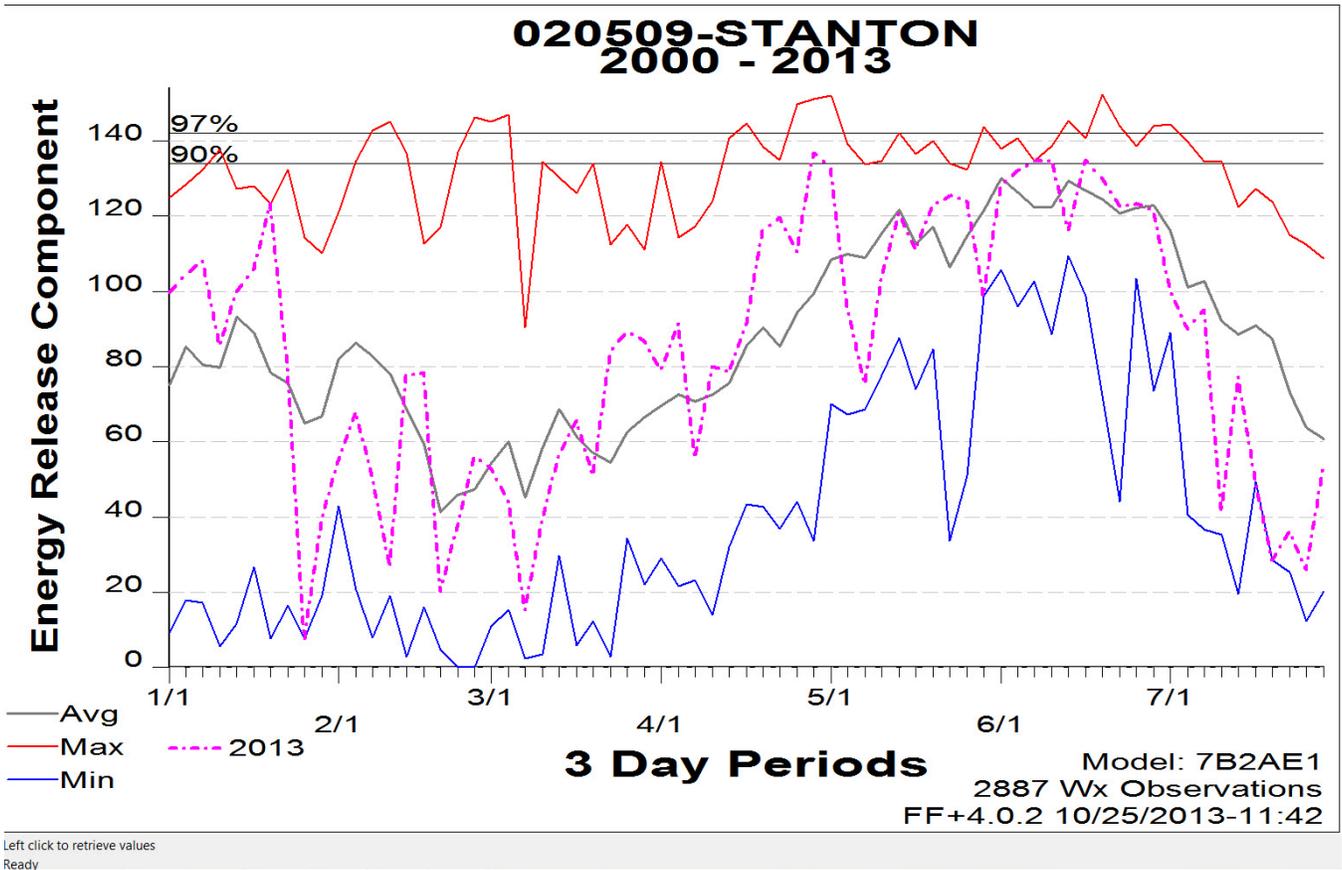


Figure B-12. Fire Family Plus ERC output graph for the Stanton RAWS weather station.

## APPENDIX C – Glossary

**Acceptable Fire Risk** - The potential fire loss a community is willing to accept rather than provide resources to reduce such losses.

**Action Plan** - Any tactical plan developed by any element of ICS in support of the incident action plan.  
Also: Incident Action Plan

**Assigned Resources** - Resources checked in and assigned work tasks on an incident.

**Advancing Fire** - That portion of the fire with rapid fire spread with higher intensity which is normally burning with the wind and/or up slope. Also called: forward fire, or a run. Synonym: **Head Fire**

**Aerial Detection** - A system for, or the act of discovering, locating, and reporting fires from aircraft.

**Aerial Observer** - A person specifically assigned to discover, locate, and report wildland fires from an aircraft and to observe and describe conditions at the fire scene.

**Aerial Reconnaissance** - Use of aircraft for detecting and observing fire behavior, values-at-risk, suppression activity, and other critical factors to facilitate command decisions on strategy and tactics needed for fire suppression.

**After Action Review (AAR)** - A professional discussion of an event, focused on performance standards, that enables Agency Administrators and firefighters to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses. An After Action Review is a tool incident command personnel and units can use to get maximum benefit from every incident. It provides a daily review of the day's actions: - Identify and discuss effective and non-effective performance. Candid insights into specific firefighter, leader, and unit strengths and weaknesses from various perspectives. - Feedback and insight critical to actions that were not standard operating procedures, or those that presented safety problems. - Lessons learned and how to apply them in the future.

**Agency Administrator** - Managing officer of an agency, division thereof, or jurisdiction having statutory responsibility for incident mitigation and management. Examples: NPS Park Superintendent, BIA Agency Superintendent, USFS Forest Supervisor, BLM District Manager, FWS Refuge Manager, State Forest Officer, Fire Chief, Police Chief. Also: Line Officer

**Agency Certification** - The process whereby the employing agency or contractor documents that the individual is fully qualified to perform duties and responsibilities for a specified position.

**Agency Dispatch** - The agency or jurisdictional facility from which resources are allocated to incidents.

**Agency Dispatcher** - A person working within an agency organization who processes resources to and from incidents. Also: Dispatcher

**Agency Representative (AREP)** - This ICS position serves as the point of contact for an assisting or cooperating agency which has been delegated authority to make decisions on matters affecting that agency's participation at the incident and reports to the Liaison Officer.

**Agency/Area Coordination Center** - A facility which serves as a central point for one or more agencies to use in processing information and resource requests. It may also serve as a dispatch center for one of the agencies.

**Agency** - An agency is a division of government with a specific function, or a non-governmental organization (e.g., private contractor, business, etc.) that offers a particular kind of assistance. In ICS, agencies are defined as jurisdictional (having statutory responsibility for incident mitigation), or assisting and/or cooperating (providing resources and/or assistance).

**Air Attack Base** - Permanent facility at which aircraft are stationed for use in air attack operations.

**Air Attack** - The deployment of fixed-wing or rotary aircraft on a wildland fire, to drop retardant or extinguishing agents, shuttle and deploy crews and supplies, or perform aerial reconnaissance of the overall fire situation.

**Air Tactical Group Supervisor (ATGS)** - This ICS position is responsible for directing and coordinating airborne aircraft operations and management of an incident's airspace and reports to the Air Operations Branch Director.

**Air Tanker** - Fixed-wing aircraft certified by FAA as being capable of transport and delivery of fire retardant solutions.

**All Terrain Vehicle (ATV)** - Any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other terrain. Synonym: Off-road Vehicle

**Anchor Point** - An advantageous location, usually a barrier to fire spread, from which to start constructing a fireline. The anchor point is used to minimize the chance of being flanked by the fire while the line is being constructed.

**Appropriate Management Response (AMR)** - Any specific action suitable to meet Fire Management Unit (FMU) objectives. Typically, the AMR ranges across a spectrum of tactical options (from monitoring to intensive management actions). The AMR is developed by using Fire Management Unit strategies and objectives identified in the Fire Management Plan.

**Aspect** - Cardinal direction toward which a slope faces.

**Assigned Resources** - Resources checked in and assigned work tasks on an incident.

**Assignments** - Tasks given to resources to perform within a given operational period, based upon tactical objectives in the incident action plan.

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**Assistant** - Term used as a title for subordinates of the command staff positions. In some cases, assistants are also assigned to unit leader positions in the planning, logistics, and finance/administration sections. Qualifications, technical capability, and responsibility of assistants are normally less than those of the person holding the primary position.

**Assisting Agency** - An agency directly contributing tactical or service resources to another agency. Also: Cooperating Agency, Supporting Agency

**Attack a Fire** - Limit the spread of fire by any appropriate means.

**Attack Time** - The starting date, hour, and minute of the first suppression work on a fire.

**Attack Unit Response** - The response of one attack unit to a fire or other emergency with no regard for the number of return trips to that same fire or emergency.

**Average Annual Precipitation** - The expected amount of annual rainfall. Average annual precipitation is an important component to determining the Keech-Bryam Drought Index (KBDI).

**Average Relative Humidity** - Part of the National Fire Danger Rating System (NFDRS). The mathematical average of the maximum and minimum relative humidities measured at a fire weather station from one basic observation time to the next.

**Awareness** - The continual process of collecting, analyzing, and disseminating intelligence, information, and knowledge to allow organizations and individuals to anticipate requirements and to react effectively and safely.

**Backing Fire** - Fire spreading, or ignited to spread, into (against) the wind or downslope. A fire spreading on level ground in the absence of wind is a backing fire. That portion of the fire with slower rates of fire spread and lower intensity normally moving into the wind and/or down slope. Also called: heel fire.

**Barrier** - Any obstruction to the spread of fire. Typically an area or strip devoid of combustible fuel.

**Base Manager (BCMG)** - This ICS position is responsible for ensuring that appropriate sanitation, security, and facilities management services are provided at the Incident Base and reports to the Facilities Unit Leader.

**Base** - The location at which primary logistics functions for an incident are coordinated and administered. There is only one base per incident. (Incident name or other designator will be added to the term "base.") The incident command post may be collocated with the base. The location of initial attack forces. Also: Camp

**Brush Fire** - A fire burning in vegetation that is predominantly shrubs, brush, and scrub growth.

**Brush** - A collective term that refers to stands of vegetation dominated by shrubby, woody plants, or low growing trees, usually of a type undesirable for livestock or timber management.

**Burn** - An area burned over by wildland fire. To consume fuel during rapid combustion. A fire in progress or under investigation.

**Burning Conditions** - The state of the combined factors of the environment that affect fire behavior in a specified fuel type.

**Burning Out** - Setting fire inside a control line to consume fuel located between the edge of the fire and the control line.

**Burning** - Decomposition of material by the application of heat and oxidation.

**Burnover** - An event in which a fire moves through a location or overtakes personnel or equipment where there is no opportunity to utilize escape routes and safety zones, often resulting in personal injury or equipment damage.

**Camp** - A geographical site(s), within the general incident area, separate from the incident base, equipped and staffed to provide sleeping, food, water, and sanitary services to incident personnel.

**Chain of Command** - A series of management positions in order of authority.

**Check-in** - The process whereby resources first report to an incident. Check-in locations include incident command post (ICP), base or camps, staging areas, helibases, or direct to a tactical assignment. Also: Reporting Locations

**Chief** - The ICS title for individuals responsible for command of functional sections: Operations, Planning, Logistics, and Finance/Administration.

**Class of Fire** - As to kind of fire for purpose of using a proper extinguisher: Class A - Fires involving ordinary combustible materials (such as wood, cloth, paper, rubber, and many plastics) requiring the heat absorbing (cooling) effects of water, water solutions, or the coating effects of certain dry chemicals, which retard combustion. Class B - Fires involving flammable or combustible liquids, flammable gases, greases, and similar materials where extinguishment is most readily secured by excluding air (oxygen), inhibiting the release of combustible vapors, or interrupting the combustion chain reaction. Class C - Fires involving live electrical equipment where safety to the operator requires the use of electrically nonconductive extinguishing agents. Class D - Fires involving certain combustible metals (such as magnesium, titanium, zirconium, sodium, potassium, etc.) requiring a heat absorbing extinguishing medium not reactive with burning metals. Also: Size Class of Fire

**Command** - The act of directing, and/or controlling resources by virtue of explicit legal, agency, or delegated authority.

**Communications Unit Leader (COML)** - The ICS position responsible for supervising the Communications Unit. Reports to the Service Branch Director or Logistics Section Chief.

**Communications Unit** - An organizational unit in the Logistics Section responsible for providing and maintaining communication services at an incident. May also be a facility (e.g., a trailer or mobile van) used to provide the major part of an incident communications center.

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**Cooperating Agency** - An agency supplying assistance including but not limited to direct tactical or support functions or resources to the incident control effort (e.g. Red Cross, law enforcement agency, telephone company, etc.).

**Coordination** - The process of systematically analyzing a situation, developing relevant information, and informing appropriate command authority of viable alternatives for selection of the most effective combination of available resources to meet specific objectives. The coordination process (which can be either intra- or interagency) does not involve dispatch actions. However, personnel responsible for coordination may perform command or dispatch functions within limits established by specific agency delegations, procedures, legal authority, etc.

**Crew** - An organized group of firefighters under the leadership of a crew boss or other designated official.

**Dead Fuels** - Fuels with no living tissue in which moisture content is governed almost entirely by absorption or evaporation of atmospheric moisture (relative humidity and precipitation).

**Delegation of Authority** - A statement provided to the incident commander by the agency executive delegating authority and assigning responsibility. The delegation of authority can include objectives, priorities, expectations, constraints and other considerations or guidelines as needed. Many agencies require written delegation of authority to be given to incident commanders prior to their assuming command on larger incidents.

**Detection** - The act or system of discovering and locating fires.

**Direct Attack** - Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel.

**Direct Line** - Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel.

**Discovery Time** - Elapsed time from start of fire (known or estimated) until the time of the first discovery that results directly in fire suppression action.

**Discovery** - Determination that a fire exists. Location and reporting of a fire is not required as is with detection.

**Dispatch Center** - A facility from which resources are assigned to an incident.

**Dispatch** - The implementation of a command decision to move a resource or resources from one place to another.

**Division Supervisor (DIVS)** - The ICS position responsible for supervising equipment and personnel assigned to a division. Reports to a Branch Director or Operations Section Chief.

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**Division** - The ICS organization level between the branch and the task force/strike team. Divisions are used to divide an incident into geographical areas of operation. Divisions are established when the number of resources exceeds the span-of-control of the operations chief.

**Dozer** - Any tracked vehicle with a front mounted blade used for exposing mineral soil.

**Drought Index** - A number representing the net effect of evaporation, transpiration and precipitation in producing cumulative moisture depletion in deep duff or upper soil layers.

**Duty Week** - Regular number of hours worked per week by a full-time firefighter, excluding overtime.

**Energy Release Component (ERC)** - The computed total heat release per unit area (British thermal units per square foot) within the flaming front at the head of a moving fire.

**Entrapment Avoidance** - A process used to improve the safety of personnel on the fireline, which emphasizes tools and tactics available to prevent being trapped in a burnover situation. This process includes appropriate decision making through risk management, application of LCES, use of pre-established trigger points, and recognition of suitable escape routes and safety zones.

**Entrapment** - A situation where personnel are unexpectedly caught in a fire behavior-related, life-threatening position where planned escape routes or safety zones are absent, inadequate, or compromised. An entrapment may or may not include deployment of a fire shelter for its intended purpose. These situations may or may not result in injury. They include "near misses."

**Escape Route** - A preplanned and understood route firefighters take to move to a safety zone or other low-risk area. When escape routes deviate from a defined physical path, they should be clearly marked (flagged).

**Evacuation** - An organized, phased, and supervised withdrawal, dispersal, or removal of civilians from dangerous or potentially dangerous areas, and their reception and care in a safe area.

**Extended Attack** - Suppression activity for a wildfire that has not been contained or controlled by initial attack or contingency forces and for which more firefighting resources are arriving, en route, or being ordered by the initial attack incident commander.

**Extreme Fire Behavior** - "Extreme" implies a level of fire behavior characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously.

**Fine Fuel Moisture** - The probable moisture content of fast-drying fuels which have a timelag constant of 1 hour or less; such as, grass, leaves, ferns, tree moss, pine needles, and small twigs (0-1/4").

**Fine Fuels** - Fast-drying dead or live fuels, generally characterized by a comparatively high surface area-to-volume ratio, which are less than 1/4-inch in diameter and have a timelag of one hour or less. These fuels (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry.

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**Fire Agency** - Official group or organization compelled and authorized under statutes or law to control fires within a designated area or upon designated lands.

**Fire Behavior Analyst (FBAN)** - Person responsible to the planning section chief for establishing a weather data collection system and for developing fire behavior predictions based on fire history, fuel, weather, and topography.

**Fire Behavior** - The manner in which a fire reacts to the influences of fuel, weather, and topography.

**Fire Crew** - General term for two or more firefighters organized to work as a unit.

**Fire Danger Rating PocketCard for Firefighter Safety** - A communication aid designed to help firefighters develop an awareness of the local fire situation by providing a visual reference to fire danger rating.

**Fire Death** - Fire casualty which is fatal or becomes fatal within one year of the fire.

**Fire Detection** - Act or system of discovering and locating fires.

**Fire Duty** - Actual physical engagement in firefighting service as distinguished from staff work at headquarters or maintenance division; work at an individual fire done by an individual firefighter or by a company.

**Fire Perimeter** - The entire outer edge or boundary of a fire.

**Fire Qualifications** - Computerized interagency summary of fire suppression qualifications of listed personnel. Available information includes fire training record, fire experience record, and physical fitness testing score for each individual.

**Fire Shelter** - An aluminized tent offering protection by means of reflecting radiant heat and providing a volume of breathable air in a fire entrapment situation. Fire shelters should only be used in life threatening situations, as a last resort.

**Fire Suppression** - All work and activities connected with control and fire-extinguishing operations, beginning with discovery and continuing until the fire is completely extinguished.

**Fire Weather Forecast** - A weather prediction specially prepared for use in wildland fire operations and prescribed fire.

**Fire Weather Station** - A meteorological station specially equipped to measure weather elements that have an important effect on fire behavior.

**Fire** - Rapid oxidation, usually with the evolution of heat and light; heat fuel, oxygen and interaction of the three.

**Firebreak** - A natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work.

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**Firefighter** - Person whose principal function is fire suppression.

**Fireline Intensity** - The product of the available heat of combustion per unit of ground and the rate of spread of the fire, interpreted as the heat released per unit of time for each unit length of fire edge. The primary unit is Btu per second per foot (Btu/sec/ft) of fire front. The rate of heat release per unit time per unit length of fire front. Numerically, it is the product of the heat yield, the quantity of fuel consumed in the fire front, and the rate of spread.

**Fireline** - The part of a containment or control line that is scraped or dug to mineral soil.

**Flame Height** - The average maximum vertical extension of flames at the leading edge of the fire front. Occasional flashes that rise above the general level of flames are not considered. This distance is less than the flame length if flames are tilted due to wind or slope.

**Flame Length** - The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity.

**Flame** - A mass of gas undergoing rapid combustion, generally accompanied by evolution of sensible heat and incandescence.

**Flank Fire** - A firing technique consisting of treating an area with lines of fire set into the wind which burn outward at right angles to the wind.

**Flanking Fire Suppression** - Attacking a fire by working along the flanks either simultaneously or successively from a less active or anchor point and endeavoring to connect two lines at the head.

**Fuel Class** - Part of the National Fire Danger Rating System (NFDRS). Group of fuels possessing common characteristics. Dead fuels are grouped according to 1-, 10-, 100-, and 1000-hour timelag, and living fuels are grouped as herbaceous (annual or perennial) or woody.

**Fuel Model** - Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

**Fuel Moisture Content** - The quantity of moisture in fuel expressed as a percentage of the weight when thoroughly dried at 212°F.

**Fuel Type** - An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of spread or resistance to control under specified weather conditions.

**Fuel** - Any combustible material, especially petroleum-based products and wildland fuels.

**General Fire Weather Forecast** - A forecast, issued daily during the regular fire season to resource management agencies, that is intended for planning of daily fire management activities, including daily staffing levels, prevention programs, and initial attack on wildfires. Also called presuppression forecast.

**General Staff** - The group of incident management personnel reporting to the Incident Commander. They may each have a deputy, as needed. The General Staff consists of: Operations Section Chief, Planning Section Chief, Logistics Section Chief, and Finance/Administration Section Chief.

**Geographic Information System Specialist (GISS)** - The incident support position responsible for collecting and maintaining geospatial data and providing geospatial analysis and producing products (maps, etc.) in support of wildland fire incident planning. GISS is utilized in support of incident management, assigned to an ICS organization's Situation Unit.

**Global Positioning System (GPS)** - A system of navigational satellites operated by the U.S. Department of Defense and available for civilian use. The system can track objects anywhere in the world with an accuracy of approximately 40 feet.

**Green-up** - Green-up for the 1978 version of NFDRS model is defined as the beginning of a new cycle of plant growth. Green-up usually occurs once a year, except in desert areas where rainy periods can produce a flush of new growth more than once a year. Green-up may be signaled at different dates for different fuel models. Green-up should not be started when the first flush of green occurs in the area. Instead, the vegetation that will be the fire problem (represented by the NFDRS fuel model associated with the weather station) when it matures and cures should be identified. Green-up should start when the majority of this vegetation starts to grow.

**Hotshot Crew** - A number of individuals that have been organized and trained and are supervised principally for operational assignments on an incident.

**Handline** - Fireline constructed with hand tools.

**Head Fire** - A fire spreading or set to spread with the wind.

**Head of a Fire** - The most rapidly spreading portion of a fire's perimeter, usually to the leeward or up slope.

**Hotshot Crew** - Intensively trained fire crew used primarily in hand line construction (Type-1).

**Humidity** - General term referring to the moisture content of the atmosphere.

**Incident Action Plan (IAP)** - Contains objectives reflecting the overall incident strategy and specific tactical actions and supporting information for the next operational period. The plan may be oral or written. When written, the plan may have a number of attachments, including: incident objectives, organization assignment list, division assignment, incident radio communication plan, medical plan, traffic plan, safety plan, and incident map. Formerly called shift plan.

**Incident Base** - Location at the incident where the primary logistics functions are coordinated and administered. (Incident name or other designator will be added to the term Base.) The incident command post may be collocated with the base. There is only one Base per incident.

**Incident Command Post (ICP)** - Location at which primary command functions are executed. The ICP may be collocated with the incident base or other incident facilities.

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**Incident Command System (ICS)** - A standardized on-scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

**Incident Commander (ICT1, ICT2, ICT3, ICT4, or ICT5)** - This ICS position is responsible for overall management of the incident and reports to the Agency Administrator for the agency having incident jurisdiction. This position may have one or more deputies assigned from the same agency or from an assisting agency(s).

**Incident Management Team** - The incident commander and appropriate general and command staff personnel assigned to an incident.

**Incident Objectives** - Statements of guidance and direction necessary for the selection of appropriate strategy(s), and the tactical direction of resources. Incident objectives are based upon agency administrators direction and constraints. Incident objectives must be achievable and measurable, yet flexible enough to allow for strategic and tactical alternatives.

**Incident Organization** - Resources, together with a complement of overhead personnel, calculated to be sufficient to provide fire efficient incident management.

**Incident Overhead** - All supervisory positions described in the Incident Command System.

**Incident** - An occurrence either human-caused or natural phenomenon, that requires action or support by emergency service personnel to prevent or minimize loss of life or damage to property and/or natural resources.

**Indirect Attack** - A method of suppression in which the control line is located some considerable distance away from the fire's active edge. Generally done in the case of a fast-spreading or high-intensity fire and to utilize natural or constructed firebreaks or fuelbreaks and favorable breaks in the topography. The intervening fuel is usually backfired; but occasionally the main fire is allowed to burn to the line, depending on conditions.

**Initial Action** - The actions taken by the first resources to arrive at a wildfire or wildland fire use incident. Initial actions may be size up, patrolling, monitoring, holding action or aggressive initial attack.

**Initial Attack Crew** - Specially trained and equipped fire crew for initial attack on a fire.

**Initial Attack (IA)** - A planned response to a wildfire given the wildfire's potential fire behavior. The objective of initial attack is to stop the fire and put it out in a manner consistent with firefighter and public safety and values to be protected.

**Inmate Crew** - Any fire crew composed of prison inmates or wards.

**Leader** - The ICS title for an individual responsible for a task force, strike team, or functional unit.

**Lightning Fire** - Wildfire caused directly or indirectly by lightning.

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**Live Fuel Moisture Content** - Ratio of the amount of water to the amount of dry plant material in living plants.

**Live Fuels** - Living plants, such as trees, grasses, and shrubs, in which the seasonal moisture content cycle is controlled largely by internal physiological mechanisms, rather than by external weather influences.

**Live Woody Moisture Content** - Ratio of the amount of water to the amount of dry plant material in shrubs.

**Local Agency** - Any agency having jurisdictional responsibility for all or part of an incident.

**Logistics Section Chief (LSC1 or LSC2)** - This ICS position is responsible for supervising the Logistic Section. Reports to the Incident Commander and is a member of the General Staff. This position may have one or more deputies assigned.

**Logistics Section** - The ICS section responsible for providing facilities, services, and supplies in support of an incident.

**Lookout** - A person designated to detect and report fires from a vantage point. A fire crewmember assigned to observe the fire and warn the crew when there is danger of becoming trapped.

**Major Disaster/Catastrophe** - Any natural catastrophe or, regardless of cause, any fire, flood, or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance.

**Management Action Points/Trigger Points** - Geographic points on the ground or specific points in time where an escalation or alternative of management actions is warranted. These points are defined and the management actions to be taken are clearly described in an approved Wildland Fire Implementation Plan (WFIP) or Prescribed Fire Plan. Timely implementation of the actions when the fire reaches the action point is generally critical to successful accomplishment of the objectives. Also called **Trigger Points**.

**Mid-Flame Windspeed** - The speed of the wind measured at the midpoint of the flames, considered to be most representative of the speed of the wind that is affecting fire behavior.

**Military Time** - The 24-hour clock system where midnight is 2400, one minute after midnight is 0001 and progresses to 2400 daily.

**Mobile Radio** - A two way radio unit on mobile apparatus (instead of base stations), usually semi-permanently attached to the apparatus.

**Multi-Agency Incident** - An incident where one or more agencies assist a jurisdictional agency or agencies. May be single or unified command.

**Mutual Aid Agreement** - Written agreement between agencies and/or jurisdictions in which they agree to assist one another upon request, by furnishing personnel and equipment.

**Mutual Aid** - Assistance in firefighting or investigation by fire agencies, without regard for jurisdictional boundaries.

**National Fire Danger Rating System (NFDRS)** - A uniform fire danger rating system that focuses on the environmental factors that control the moisture content of fuels.

**National Wildfire Coordinating Group (NWCG)** - A group formed under the direction of the Secretaries of the Interior and Agriculture to improve the coordination and effectiveness of wildland fire activities and provide a forum to discuss, recommend appropriate action, or resolve issues and problems of substantive nature.

**Natural Barrier** - Any area where lack of flammable material obstructs the spread of wildfires.

**NWCG Standard** - A defined behavior, action, process, or equipment type, agreed upon by the National Wildfire Coordinating Group for wildland fire performance, and is necessary to meet consistent, interagency fire management activities.

**Objective** - A description of a desired condition; quantified and measured, and where possible, with established time frames for achievement. Specific, achievable, measurable, time-limited results to be achieved through land management practices, either through a description of a desired condition or the degree of desired change in an attribute.

**One-hour Timelag Fuel Moisture (1-h TL FM)** - Moisture content of one-hour timelag fuels.

**One-hour Timelag Fuels** - Fuels consisting of dead herbaceous plants and roundwood less than about one-fourth inch (6.4 mm) in diameter. Also included is the uppermost layer of needles or leaves on the forest floor.

**One-hundred Hour Timelag Fuel Moisture (100-h TL FM)** - The moisture content of the 100-hour timelag fuels.

**One-hundred Hour Timelag Fuels** - Dead fuels consisting of roundwood in the size range of 1 to 3 inches (2.5 to 7.6 cm) in diameter and very roughly the layer of litter extending from approximately three-fourths of an inch (1.9 cm) to 4 inches (10 cm) below the surface.

**One-thousand Hour Timelag Fuel Moisture (1,000-h TL FM)** - The moisture content of the 1,000-hour timelag fuels.

**One-thousand Hour Timelag Fuels** - Dead fuels consisting of roundwood 3-8 inches in diameter and the layer of the forest floor more than about 4 inches below the surface.

**Operational Control** - The exercise of authority over initiating, conducting, or terminating any operation. Often associated with aviation operations.

**Operational Period** - The period of time scheduled for execution of a given set of tactical actions as specified in the Incident Action Plan. Operational Periods can be of various lengths, although usually not over 24 hours.

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**Operations Section Chief (OSC1 or OSC2)** - This ICS position is responsible for supervising the Operations Section. Reports to the Incident Commander and is a member of the General Staff. This position may have one or more deputies assigned.

**Operations Section** - The section responsible for all tactical operations at the incident. Includes branches, divisions and/or groups, task forces, strike teams, single resources and staging areas

**Overhead** - Personnel assigned to supervisory positions, including incident commander, command staff, general staff, branch directors, supervisors, unit leaders, managers and staff.

**Plan of Attack** - The selected course of action and organization of personnel and equipment in fire suppression, as applied to a particular fire or to all fires of a specific type.

**Planning Meeting** - A meeting held regularly throughout the duration of an incident, to select specific strategies and tactics for incident control operations and to plan for needed service and support. On larger incidents, the planning meeting is a major element in the development of the Incident Action Plan.

**Planning Section Chief (PSC1 or PSC2)** - This ICS position is responsible for supervising the Planning Section. Reports to the Incident Commander and is a member of the General Staff. This position may have one or more deputies assigned.

**Planning Section** - Responsible for the collection, evaluation, and dissemination of tactical information related to the incident, and for the preparation and documentation of incident action plans. The section also maintains information on the current and forecasted situation, and on the status of resources assigned to the incident. Includes the situation, resource, documentation, and demobilization units, as well as technical specialists.

**Point of Origin** - The location where a competent ignition source came into contact with the material first ignited and sustained combustion occurred.

**Protection Area** - That area for which a particular fire protection organization has the primary responsibility for attacking an uncontrolled fire and for directing the suppression action. Such responsibility may develop through law, contract, or personal interest of the firefighting agent (e.g., a lumber operator). Several agencies or entities may have some basic responsibilities (e.g., private owner) without being known as the fire organization having direct protection responsibility.

**Qualifications and Certification** - This subsystem of NIIMS provides recommended qualification and certification for those personnel responding to an incident regionally or nationally, allowing for the development of local minimum standards to meet local needs. Standards typically include training, experience, and physical fitness.

**Rate of Spread** - The relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire, as rate of forward spread of the fire front, or as rate of increase in area, depending on the intended use of the information. Usually it is expressed in chains or acres per hour for a specific period in the fire's history.

**Relative Humidity (RH)** - The ratio of the amount of moisture in the air, to the maximum amount of moisture that air would contain if it were saturated. The ratio of the actual vapor pressure to the saturated vapor pressure.

**Required Experience** - Documented, satisfactory performance in a specified position needed to qualify for another (usually higher level) position. Required experience cannot be challenged.

**Required Training** - A course or courses that must be completed prior to initiating a position task book. Training which has been identified as required cannot be challenged; an agency equivalent course may be used as a substitute when the course meets or exceeds a required course's learning and performance objectives.

**Resource Order** - The form used by dispatchers, service personnel, and logistics coordinators to document the request, ordering or release of resources, and the tracking of those resources on an incident.

**Resource Ordering and Status System (ROSS)** - A national system that provides automated support to interagency and agency dispatch and coordination offices. The system will provide current status of resources available to support all-risk activities; enable dispatch offices to exchange and track resource ordering information electronically; enable dispatch offices to rapidly and reliably exchange mission-critical emergency electronic messages.

**Response** - Movement of an individual firefighting resource from its assigned standby location to another location or to an incident in reaction to dispatch orders or to a reported alarm. Activities that address the short-term, direct effect of an incident, including immediate actions to save lives, protect property, and meet basic human needs. Also includes the execution of emergency operations plans as well as mitigation activities designed to limit the loss of life, personal injury, property damage, and other unfavorable outcomes.

**Responsible Fire Agency** - Agency with primary responsibility for fire suppression on any particular land area.

**Retardant Base** - Ground facilities for mixing, storing, and loading fire retardant into air tankers.

**Retardant Drop** - Fire retardant cascaded from an air tanker or helitanker.

**Retardant** - A substance or chemical agent which reduces the flammability of combustibles.

**Risk** - The chance of fire starting as determined by the presence and activity of causative agents. A chance of suffering harm or loss.

**Saddle** - Depression or pass in a ridgeline.

**Safety Briefing** - A safety briefing emphasizes key safety concerns on the incident and is presented at each briefing session. The safety briefing should contain information to alert incident personnel of potential risk/hazard considered to be most critical.

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**Safety Officer** - A member of the command staff responsible to the incident commander for monitoring and assessing hazardous and unsafe situations, and developing measures for assessing personnel safety.

**Serious Accident Investigation Team (SAIT)** - A formal investigation team that is organized with the purpose of conducting an accident investigation for an occurred serious accident. The team is given full authorization to conduct the investigation from involved agencies through letter of delegation.

**Shrub** - A woody perennial plant differing from a perennial herb by its persistent and woody stem; and from a tree by its low stature and habit of branching from the base.

**Single Resource** - An individual, a piece of equipment and its personnel complement, or a crew or team of individuals with an identified work supervisor that can be used on an incident.

**Situation Analysis** - Analysis of factors which influence suppression of an escaped fire from which a plan of attack will be developed; includes development of alternative strategies of fire suppression and net effect of each.

**Sizeup** - The evaluation of the fire to determine a course of action for suppression.

**Smoke** - Small particles of carbon, tarry and water vapor resulting from the incomplete combustion of carbonaceous materials such as wood, coal or oil.

**State Forest** - Forests owned and administered by a state, and not by a federal government.

**Structural Fire Protection** - The protection of homes or other structures from wildland fire.

**Strategy** - The general plan or direction selected to accomplish incident objectives.

**Structure Protection Plan** - A plan developed by the Structure Protection Specialist that provides operational guidelines to suppression resources responsible for providing wildland fire structure protection.

**Structure Protection Specialist (STPS)** - An individual responsible for developing an incident's structure protection plan, providing tactical direction and recommendations to incident planning and operations on efficient and safe utilization of resources assigned to provide wildland fire structure protection.

**Structure** - A constructed object, usually a free-standing building above ground.

**Supervisor** - The ICS title for individuals responsible for command of a division or group.

**Supply Unit Leader (SPUL)** - The ICS position responsible for supervising the Supply Unit. Reports to the Support Branch Director or Logistics Section Chief.

**Suppression** - All the work of extinguishing or confining a fire beginning with its discovery.

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**Survival Zone** - A natural or cleared area of sufficient size and location to protect fire personnel from known hazards while inside a fire shelter. Examples include rock slides, road beds, clearings, knobs, wide ridges, benches, dozer lines, wet areas, cleared areas in light fuels, and previously burned areas. These are all areas where you expect no flame contact or prolonged heat and smoke.

**Tactics** - Deploying and directing resources on an incident to accomplish the objectives designated by strategy.

**Ten-hour Timelag Fuel Moisture (10-h TL FM)** - The moisture content of the 10-hour timelag roundwood fuels.

**Thunderstorm** - Localized storm characterized by one or more electrical discharge(s).

**Timelag (TL)** - Time needed under specified conditions for a fuel particle to lose about 63 percent of the difference between its initial moisture content and its equilibrium moisture content. If conditions remain unchanged, a fuel will reach 95 percent of its equilibrium moisture content after 4 timelag periods.

**Transfer of Command** - The ICS management process in which the on-scene incident commander at a specified time hands off command responsibilities to the incident commander that will be taking over incident command.

**Two-Way Radio** – Radio equipment with transmitters in mobile units on the same frequency as the base station, permitting conversation in two directions using the same frequency in turn.

**Type** - Refers to resource capability. A Type 1 resource provides a greater overall capability due to power, size, capacity, etc., than would be found in a Type 2 resource. Resource typing provides managers with additional information in selecting the best resource for the task.

**Uncontrolled Fire** - Any fire which threatens to destroy life, property, or natural resources, and (a) is not burning within the confines of firebreaks, or (b) is burning with such intensity that it could not be readily extinguished with ordinary tools commonly available.

**Values To Be Protected** - Include property, structures, physical improvements, natural and culture resources, community infrastructure, and economic, environmental, and social values.

**Wildfire Suppression** - An appropriate management response to wildfire, escaped wildland fire use or prescribed fire that results in curtailment of fire spread and eliminates all identified threats from the particular fire.

**Wildfire** - An unplanned, unwanted wildland fire including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, and all other wildland fires where the objective is to put the fire out.

**Wildland Fire Serious Accident** - Any accident where one or more fatalities occur and/or three or more personnel are inpatient hospitalized as a direct result, or in support of wildland fire suppression or

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prescribed fire operations. Accident may result in substantial property or equipment damage of \$250,000 or more.

**Wildland Fire Situation Analysis (WFSA)** - A decision-making process that evaluates alternative wildfire suppression strategies against selected environmental, social, political, and economic criteria, and provides a record of those decisions.

**Wildland Fire** - Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire.

**Wildland Urban Interface (WUI)** - The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

**Wind Direction** - Compass direction from which wind is blowing.

**Wind Shift** - For ground observation purposes, a change of at least 45° in the direction of a significant wind, which occurs in a relatively short time frame.

**Wind Speed** - Wind, in miles per hour, measured at 20 feet above open, level ground or as adjusted to meet this standard to compensate for height of ground cover, uneven ground, and nearby obstructions.

**Wind** - The horizontal movement of air relative to the surface of the earth.

**Wind-driven Wildland Fire** - A wildland fire that is controlled by a strong consistent wind.

**Woody Fuel Moisture** - In NFDRS, a calculated value representing the approximate moisture content of the live woody vegetation in the rating area expressed as a percentage of the oven dry weight of the sample.

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