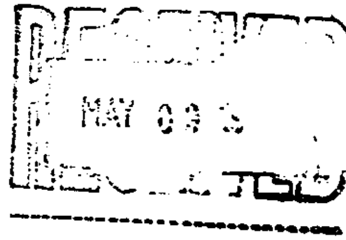

THE MARRE FIRE ENTRAPMENT

OCTOBER 2, 1993

A review of the entrapment incident that occurred on the Marre Fire, September 25 - October 16, 1993. Los Padres National Forest, CA

Larry Russell
Fire Behavior Analyst
Zone Fire Management Officer
Beckwourth/Milford Ranger Districts
Plumas National Forest

Chuck Hartley
Assistant Safety Officer
Assistant District Fire Management Officer
Mt. Baldy Ranger District
Angeles National Forest

Dennis L. Thompson, M.P.A.
Assistant Safety Officer
Deputy Fire Chief/Operations
Kern County Fire Department

Distribution:

Kern County Fire Department Commands 1-5
Kern County Fire Department Battalions 1-7
Larry Russell
Chuck Hartley
Ralph Domansky –
Mike Dougherty
KRN Safety Officers
Type 1 Team Safety Officers
Greg Pisano
Battalion Chief Geoff Wilford
Battalion Chief Steve Gage
Battalion Chief John Walz

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THE MARRE FIRE ENTRAPMENT

OCTOBER 2, 1993

MARRE INCIDENT SUMMARY

The Marre Fire started at approximately 3:30 pm on Saturday, September 25, 1993, on the Marre Ranch in Los Padres National Forest.

Heavy fuels and high winds, coupled with low humidity, generated highly erratic fire behavior during the ensuing days. By September 27, the fire had burned 10,000+ acres of private and National Forest land. A Type 1 Incident Management Team, under the direction of Incident Commander Mike Dougherty, assumed command of the fire in a Unified Command structure with Santa Barbara County Fire Department. The Incident Commander for SBC was Division Chief Dan Gaither.

By September 30, the Marre Fire had burned approximately 32,500 acres, including a small portion of the San Rafael Wilderness. There were about 3,300 firefighters and support personnel assigned to the incident at this point. The west and south flanks of the fire appeared to be holding and the threat to private residences was lessening. Early on the morning of Saturday, October 2, the fire jumped containment lines on the west flank, trapping several pieces of firefighting equipment and personnel in the process. From this

point on, the northwest side of the fire, including the Birabent Canyon and the Zaca drainage, became the area of greatest concern.

By Day 12, Thursday October 7, 1993, the Marre Fire had burned approximately 42,700 acres, but the fire was 90% contained and heavy demobilization of fire fighting resources was underway. On Friday October 8, a Type 2 Incident Management Team took over command of the fire. Full containment was declared at 6:00 pm on that date.

ENTRAPMENT REVIEW TEAM

Entrapment is 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 have been 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."

The entrapment incident that occurred was highly significant to all concerned. The review team established by the incident management was charged with the responsibility of determining, as precisely as possible, the following: what happened; the significant events, circumstances, and decisions that led up to the entrapment; the personal protection measures taken, and their effectiveness; and the lessons to be learned.

The intent of management, and the review team in conducting its examination, was not to place blame or chastise any individual or group; but to identify those positive actions, training and learning processes, and safety concerns that must be considered when confronted with similar circumstances. We are thankful and fortunate that no one received any significant injuries. Equipment was damaged and additional acreage was burned; but none of that means anything compared to the value of human life and safety!

ENTRAPMENT INCIDENT DESCRIPTION

The entrapment occurred in Section 14, Township 8N, Range 18E. See Appendix A and B for mapped location.

Division locations, resource assignments and control operations for the night shift of 10/1/93 included the following:

Division C -- Figueroa Mtn. Road, from 1 mile South of Tunnel Ranch Road to the intersection of Catway Road.

> Division Supervisor (who also had responsibility for Divisions A & B) with 5 single increment engines: E-21, E-11, E-42, E-33, and E-27.
>
> "Mop up and patrol 300 ft. inside fireline. Stockpile any excess equipment/trash at pick-up points."

Division D -- Catway Road, from the intersection of Figueroa Mtn. Road west to the fire's edge, then North to the road from Davy Brown campground to Sulphur Spring.

> Division Supervisor with a Type 3 Engine Strike Team, 4 Crews, and a Water Tender.
>
> "Complete and improve line - 300 ft. inside fireline. Utilize back pack pumps."
>
> NOTE: The fireline north of Catway Road had not been tied in yet, and crews assigned to Division D were assisting Division C with containment of slopovers west of Figueroa Mtn. Road at Figueroa Mountain. The only control efforts applied to that entire section of line were air tanker drops down the ridgeline, which had not been supported by handcrews. An indirect line was being constructed to the north

from the blackline west along Catway Road to the indirect line and then north downhill toward Manzana Canyon. The strategic objective was to keep the fire away from the Zaca Lake area.

At approximately 2200 hours, Operations contacted Branch I to request that the Division Supervisor assigned to Division D be released to be reassigned to Division W day shift, due to his "coyote tactics" experience. Operations asked if Branch I could assign Division D to the Division C Supervisor. Even though that Division Supervisor already had responsibility for three divisions (Divisions A, B, & C), Operations felt that it would be manageable due to the lack of activity in those divisions for the past two operational periods, and because Branch I was located in that area. Branch I agreed and the Division Supervisor was assigned to Division D in addition to A, B & C. As that transfer was made, the former Division D met with his replacement, Branch I, the Task Force Leader in Division D, and the Branch I Safety Officer. They discussed their tactics, resource deployments and priorities. Their primary concern was to hold the fire north of Catway Road, keeping it out of Birabent Canyon to the south. The former Division Supervisor did advise that crews had seen glows to the north of Catway Road the night before, but they had been a long way down toward Manzana Canyon. No one, however, had seen the area in daylight. They did not know the types and continuity of fuels, or how steep it was. Because the TFL had worked the area the night before, Division D asked the TFL to supervise operations in that division. After the meeting, Division D, the TFL and Branch I Safety went west on Catway Road and advised the Task Force engines they could block the road in order to be able to continue their mop-up operations. The last engine, E-3-1 was at the saddle where the blackline turned north from Catway Road, which was still approximately 1/2 mile east of

the Safety Zone. Division C/D asked the engine Captain about his crew working below the road, and he responded that it was no problem, that the winds had been stronger the night before and they were working with one foot in the black. He also advised they had not gone farther than 300 feet below the road up until then. Division C/D's Trainee noticed while standing there that there were several glows way down in the canyon bottoms, but couldn't tell which slopes they were on or how far down. The Trainee then took weather observations, recording a relative humidity of 41% at 2300 hours. Also while they were in the vicinity of E-3-1, the TFL advised Branch I Safety that he had heard an archaeologist was missing, last known to be west of Figueroa Mountain on Catway Road. While Branch I Safety responded to look for the missing person, Division C/D returned to DP-16 where Branch I was located. Going west on Catway road, the safety officer drove through the "Safety Zone" that had been constructed two days before. Other than the dozer operators that built it, and the former night Division D, he was the first and only person working in Division D that night to see it, and he had not seen it in the daylight. In his search, he drove to the end of Catway Road and, unable to locate anyone, then returned to DP-16 where Branch I and Division C/D were located. Division C/D's Trainee again took weather observations, recording a relative humidity of 40% at 0030 hours.

At approximately the same time, Branch II Safety reported sighting a flare-up in Division A near Happy Canyon Road that he believed to be outside the line. When the single engine working in that Division could not be contacted, Branch I asked Branch I Safety to respond and check out the report, along with two engines from Division C and a crew from

Division E. It was later determined that the reported flare-up was an island burning well within the fire's containment line. Branch I Safety had not yet returned to Division D when activity was reported north of Catway Road.

At approximately the same time, E-3-1 started noticing an increase in fire behavior, with a lot of "hot stuff" starting to become active north of Catway Road. The Captain noticed an active spot over the line, approximately 600 feet below the road. The engine crew went down and took care of that spot. When they got back to the engine, the Captain noticed another spot to the north, this time approximately 1,000 feet below the road, and farther to the west away from the blackline. Within a few minutes the spot had grown to what the Captain believed to be 1/4 to 1/2 acre and moving toward an obvious slope. He attempted to notify his Task Force Leader. When he did not answer, he notified Division C/D that he had spotted a well established fire approximately an acre in size, and approximately 1,000 feet down in the canyon. He also reported that he believed it would burn to the ridge top. Hearing the report, the TFL advised Division C/D that he would check it out. Division C/D and his Trainee also started moving that way.

At approximately 0045 hours, the TFL advised Division C/D that he estimated it would take an hour for the fire to reach the ridge. Division C/D advised the TFL to take whatever action was necessary, including firing out, to hold the fire north of Catway Road. He also contacted three of the single increment engines working in Division C to respond. While

driving west on Catway Road, Division C/D could see a glow on the back side of the ridge to the north, but could not see the area in which the fire was burning.

The first Division C engine to reach the area stopped short of the Safety Zone. Even though someone called him on the radio to "come on in, we have a Safety Zone", he was uneasy about it. He was not familiar with the area, having never been there before; they were in an area of heavy fuel, including heavy brush and timber; and he could not clearly see the fire that was burning uphill toward them. From what he could see, he estimated the fire to be 35 - 50 acres, and that it was beginning to crown. Because the radio traffic he heard was consistent with his observations, he assumed the Division Supervisor was aware of the conditions and did not communicate his observations. As he was standing there, another engine from Division C (E-2-7) went by him and into the Safety Zone.

When Division C/D and his Trainee arrived at the Safety Zone, the TFL and four of his engines (E-3-1, E-4-2, E-5-1 and E-3-3) were there. He had not noticed that Engine 2-7 had just pulled in also. He noticed the area had been worked by dozers to create a "Safety Zone", with heavy timber and brush up to the edge of it. He did not notice, however, that the "Safety Zone" was in a saddle. They could not yet see the fire, but it was becoming apparent that they were not going to have another 45 minutes as the TFL had estimated. The firefighters there were already setting up to fire the north side of the road. Division C/D, the TFL, and the task force engine Captains held a quick safety meeting to discuss their options and tactics. Over the objection of one of the Captains, who questioned why

they were even there, that they should get out immediately, it was decided to attempt to fire the north side of the road, and then leave the area by driving back to the east. The use of the Safety Zone was discussed, but direction was given that it only be used if it became necessary. [NOTE: Several of those interviewed stated they felt "comfortable" with the Safety Zone, that it would be adequate to protect them even if the fire did burn over. The placement of a lookout was not discussed.]

Engine 2-7 arrived as the firing operation began. They pulled into the far end of the Safety Zone (near the southwest corner), and began a progressive hoselay. The firing crew set up at the far west end of the Safety Zone (about mid-slope of the knob at the west end), and started firing the north side of the road. They got about half-way across when the trees near the northwest corner of the Safety Zone began to torch, sending embers across the Safety Zone and igniting spots on the south side. At that point, the firing crew and the TFL began running as they fired out the road to the east and out of the Safety Zone, and the engine crews began a frantic effort to catch all of the spots.

Within 15 minutes of Division C/D's arrival at the Safety Zone, the entrapment began with an under-story run with some trees torching at the northwest corner. Within 3 - 4 minutes of the first run, a crown fire hit the west half of the Safety Zone sending a sheet of embers approximately 100 feet overhead. The embers landed south of the Safety Zone and immediately ignited the windrowed brush and trees pushed to the edge by the dozers that created the Safety Zone. At that moment, Division C/D lost sight of the firing crew,

including the TFL, and noticed that the visibility going out of the east end of the Safety Zone was virtually nil due to the smoke from the backfire. At that point, the Division Supervisor made the decision that the only safe thing to do was to stay in the Safety Zone. He directed the engine crews to abandon their hoselay operations, to get into their engines and stay there unless their engines caught fire. Within five minutes of the start of the second run (the first of several crown fire runs), all personnel were inside their vehicles.

Division C/D knew they were in a bad situation, but believed in spite of the extreme heat and smoke that they would be OK. His first concern was that he had lost track of the firing crew and the TFL, and could not account for all personnel. In addition, there was fire now burning on both the north and south sides of the Safety Zone. He got out to check on the engines and noticed flame impingement on the back of Engine 2-7, so he radioed for him to pull up. The engines and the two pickups pulled into the center of the Safety Zone, with their pumps running. Engine 2-7 began to run extremely rough, then its engine died. They attempted to get it started again, without success. When their battery went dead, they got out and attempted to jump start it with one of the other engines. Four of the engines deployed fire shelters inside their vehicles to reflect the heat. Two of the vehicles continued to run their air conditioning, which did give them some relief from the heat and smoke.

With the smoke conditions present, and the possibility of snags or other obstructions in the road, Division C/D knew that escape would be extremely risky, and at the same time their ability to breathe would become more difficult. At one point, the visibility did improve a

little and the Division Supervisor radioed the engines to advise them that if it cleared enough, they would all try to get out. He moved his vehicle slightly to get a better view, and one of the engines began to pull ahead to the east. They hadn't gotten far when they struck the berm on the edge of the road. They backed up, then jumped the berm and drove out of the Safety Zone. No one else attempted to leave at that time due to the restricted visibility and possibility of getting entrapped in an even worse situation.

The fire continued to make runs up the slope north of the Safety Zone. It is estimated that eight to nine separate runs progressed up the hill and burned over the Safety Zone and the personnel in it. The extreme fire behavior generated intense winds and at least 2 - 3 fire whirls. Personnel interviewed indicated that their engines were rocking back and forth from the intense winds generated. One of the fire whirls threw a burning piece of bark approximately 8" x 10" x 3" onto the windshield and hood of Division C/D's pickup.

The heat and smoke conditions were continuing to intensify, with visibility down to three to four feet with their headlights on. The Division Supervisor radioed that he was going to attempt to get out. With his trainee helping to navigate, they were able to drive up the road to the east and out of the Safety Zone. When they topped the hill on the road they came out of the smoke and found the Task Force Leader and the firing crew waiting. The Division Supervisor radioed to the engines still in the Safety Zone that they could get out if they drove slowly and carefully (there were some burning materials in the road but no heavy obstructions). He also advised them that if they were going to attempt it, to do it

soon as the smoke was only going to continue to get worse. The crews all advised that they were going to stay, that the Safety Zone was the safest option.

Division C/D then advised Branch I that all personnel were accounted for; everyone was OK to this point; requested the medics and two ambulances respond to DP-16; and requested Branch I and Branch I Safety respond to the scene. In the meantime, the TFL walked back into the Safety Zone. He contacted Division C/D to advise him everyone was OK and accounted for. He also told him that it was beginning to cool down, that the smoke was bad but they would stay until visibility improved.

Almost an hour later, the TFL came walking out again. He indicated that one of the personnel was having difficulty breathing and another was having leg cramps. He agreed that it was time to get the crews out, but was still concerned about driving them out. At that point, the STL, TFL, STL Trainee and two of the Engine Captains went back toward the Safety Zone. This time, due to a lot of fire still below the road, the STL stopped just at the knob at the east end to serve as lookout.

Branch I Safety moved all of the equipment on the Catway Road back to DP-16, in order to clear the way for the crews coming out and the medical personnel going in. When the rescuers reached the engines, they got everyone together and checked their condition. It was cooler, but still extremely smoky. It was ultimately decided to drive the engines and pickups out (except E-2-7 which would not start), with the two engine Captains guiding them

with headlamps. Within a few minutes, all of the personnel that had been trapped made it out safely.

AFTERMATH

It is estimated that from the time the crews entered the Safety Zone and were burned-over, until they were able to escape, two hours had elapsed. When they got out, their first reaction was one of elation and celebration. It wasn't long, however, till the adrenaline wore off and the reality of the situation and the impacts on their health began to show. Anxiety set in, smoke inhalation and eye irritation problems became apparent, and one of the personnel was in distress with breathing difficulties (later determined to be pneumonia).

Operations directed Branch I and Branch I Safety to address the medical needs of the personnel and to get them back to base, or to a medical facility if needed. Operations took command of the fire situation. The engines, with all of the personnel, were driven to DP-16. Branch I Safety arranged for a bus to transport the personnel to base from DP-16. While there was widespread disagreement at first, and everyone wanted to continue fighting the fire, all agreed later that not allowing them to drive or go back on the line was a prudent decision.

After reaching base at approximately 0830 hours on October 2nd, the personnel involved were later transported to a hotel for R & R. A Post Incident Stress Debriefing was conducted to discuss the incident and its impacts on everyone. Everyone interviewed during this review indicated that the process was definitely a positive experience. The only complaint expressed was that it was cut short - that people still wanted to talk about it when

the debriefing was ended. The CISD did, however, allow the opportunity for feelings, frustrations and anxieties to be expressed and dealt with. Many of the feelings were shared by all, which made them easier to deal with. The supervisors that expressed feelings of guilt, blame or self-doubt were able to hear that their crews were supportive and understanding. Everyone interviewed indicated that they learned many things from the experience that they would remember for a lifetime.

SITE ANALYSIS

The location of the incident was the Catway Road, exactly four miles up from Figueroa Mtn. Road. (See Appendix A, B, and C.) The roadway into the area had grades of up to 10%, and was very narrow. The distance from the blackline E-3-1 was working to the Safety Zone was exactly 1/2 mile. There were no locations along the road to pass safely.

The dozer group, two days prior to the incident, had created a sizeable cleared area in the saddle where the entrapment occurred. They worked for over two hours, with three dozers, to clear the area. The Safety Zone ended up approximately 490 feet long x 250 feet wide (measured at the widest points), completely devoid of any standing fuels. (See Appendix D for sketch map.) The dozer operators' intent was to establish a "true" Safety Zone that would be survivable without the use of shelters. There were no suitable locations to put a Safety Zone on the ridgetops (because the roadway contoured the slope), so the saddle was selected as a logical location.

Fuels around the Safety Zone were a continuous mix of heavy timber (up to 24" diameter), oak and brush; and extended up to the edges of the Safety Zone. The saddle itself was so dense with heavy fuels that the distance that could be observed was less than 100 feet. The night before the incident Division D had been through the area, and noticing several snags and other hazardous fuels next to the Safety Zone, requested fallers to clear the snags and improve the safety and survivability of the area. This work was never done.

The soil in the saddle presented a problem for the engines because it was so soft. It was very easy to get stuck, and the berms left by the dozers created obstacles that made maneuvering difficult. All of the area was not accessible due to the soft soil and other obstacles.

One feature of the Safety Zone and saddle that became important to the crews' survival was the presence of a significant depression in the top of the ridge. (See Appendix E and F.) Examination of the ridge, the burn patterns present, the witness statements, and the engines ultimately being located in the bottom of this bowl, are all indicators that the majority of the heat from the burnover passed over their heads. They still had to contend with a great deal of heat and embers (which were ingested through the intake of E-2-7 and disabled the motor), but not like they would have had to endure if the ridgetop had been rounded.

The road leading from the saddle to the west would have presented an excellent escape route. However, since those present had never seen it in daylight and they had an extremely short period of time to take action, it was not considered as a viable escape route.

FIRE BEHAVIOR ANALYSIS

On October 2, 1993, at approximately 0045 hours, a spot fire was observed approximately 1.5 miles due east of Zaca Peak, in Division D. The legal location was in the S.W. quarter of Section 13, Township 8N, Range 18E. The location of the spot was estimated to be situated in a north-south oriented drainage, at approximately 3,300 feet in elevation. (See Appendix C's map for location.)

The fuels consumed by the spot fire, and its run, were Ponderosa Pine with a heavy understory of oak and mixed chaparral. The dead woody material within the stand was significant. Snags and moderate loadings of 1,000 and 10,000 hour fuels were present. Both horizontal and vertical continuity from the origin of the spot fire to the ridgeline Safety Zone were constant.

The fire weather forecast for the night shift of October 1, 1993 outlined the following conditions:

- The current warming and drying trend will continue.
- North to northeast winds over ridgetops tonight.
- Dry air aloft will work its way down to the surface (a condition referred to as subsidence).
- Lower overnight humidities are expected on mid and upper slopes.

The specific forecast predicted the following conditions:

* Clear skies with valley inversions forming between 2,300 and 2,600 feet.
* Temperatures 72 - 77 midslopes and 66 - 69 on the ridgetops.
* Humidity lower tonight than last night. Humidity 22 - 34 percent above the inversion layer with slight lowering of RH after 2300 hours.
* Ridgetop winds northeast to east 7 - 18 mph with local gusts to 25 mph through the night.
* Slope winds north to northeast 5 - 12 mph. (See Appendix G for Fire Weather Forecast).

The Fire Behavior Forecast cautioned to expect lower fine fuel moisture and the greater potential for fire spread and spotting through the night. Expect the increased fire activity to occur above the inversion at elevations of 2,500 feet and above. The overall fire activity will be more active than previous nights. Locations of particular concern would be north to northeast aspects above 2,500 feet in elevation. Winds within these areas would be in alignment with the slope, and fuels would burn actively. (See Appendix H for Fire Behavior Forecast.)

It has been estimated that the point of origin of the fire run was located at approximately 3,300 feet in elevation on a northeast aspect. The discovery of this spot fire coincides with the report of another flare-up in Division A. The Division A flare-up was also located at approximately 3,300 feet in elevation and on a northeast aspect. The report in Division A came only minutes before the Division D incident. It is believed that the predicted strong northeast winds and low relative humidity surfaced at these locations. The result was a

sudden increase in fire activity. The flare-up in Division A was determined to be a burn out of an island within the fire. The Division D incident was detected at approximately 0045 hours. The fire continued to increase in both size and intensity at a rapid rate. The heavy fuel profile, steep slope (average of 70%), low RH, northeast aspect, and northeast wind combined to align the spot for a major run to the ridgetop and beyond. The rate of spread has been estimated at 50 to 70 chains per hour. The fire reached the ridgetop in less than 1 hour and was thought to be 30 to 45 minutes after discovery.

The fire run hit the ridgetop Safety Zone on the northwest side first. The first assault was described as a fire burning in the brush understory fuels. Shortly after, a crown fire passed through the same area. Four to five more flaming assaults followed while progressively moving to the southeast on the ridgeline. The entire area developed into a major crown fire. The fire quickly spotted across to the south side of the ridge. It has been reported that the majority of the flame, embers, heat and smoke came from the northeast side of the ridge. Only lesser amounts came from the southwest side. During the initial stages of the entrapment, flames, embers and heat were the primary concern. This lasted for approximately 45 to 60 minutes. Once the convection column collapsed, the smoke and carbon monoxide became a threat. This situation would continue for several hours as a result of burnout of the large fuels.

ISSUES AND CONCLUSIONS

L C E S

LOOKOUTS -- Lookouts were not posted prior to the entrapment.

Due to the height/density of the fuels, lack of a good location to view the fire along the road, and thinking they had adequate time to burn out before the fire arrived, posting a lookout (or more than one) was not considered. The Safety Officer was not available at the scene, but was enroute back from the reported flare-up in Division A.

One engine responding from Division C stopped short of entering the saddle because of the fire activity he saw. He got out of his engine to get a better look and decided that holding the ridge "was a loser". He did not report his observations, or convey his concerns to the Division Supervisor because, from the radio traffic he heard, he assumed the Division Supervisor was already aware of the situation.

Each member interviewed indicated that not having at least one lookout was a mistake, one that they won't soon forget.

COMMUNICATIONS -- In addition to normal communications protocols and procedures, several communications related issues were identified:

Use of "local" frequencies -- Some of the engine crews involved in the entrapment had been using their home unit's frequency as a tactical net. While it was not specifically identified in the review to be of significance, there could be at least two negative outcomes in not using frequencies identified in the communications plan:

1) In this case a task force of mixed resources from different regions and agencies had been put together. Not all of the units in the task force had the "local" frequency.

2) Any communications on that frequency could not be monitored by all of the resources working in that area. In this specific case, communications regarding any previous, as well as the current fire activity that led to the entrapment, would not have been known to others. The Division Supervisor and Branch Director would not be aware of activity in their areas of responsibility, which could also be vital information for decision-making.

There was one positive aspect to the use of the "local" frequency as a tactical net in this situation -- the task force units that became involved in entrapment were able to communicate directly with their Task Force Leader, who was initially outside the Safety Zone, without interfering with the other incident communications taking place to respond to the incident. Their ability to hear and talk to a familiar voice had an extremely calming affect on those in the Safety Zone. On at least one occasion a

"local" unit loaned their H.T. to one of the other engines in the Safety Zone when their engine died. Staying in contact with those outside was extremely important to those trapped in remaining calm, responding to directions, and retaining their confidence.

Advising supervisors of significant events or information -- There were instances involved in this incident where specific observations, and information critical to the outcome, were never communicated. Fire activity had been observed in the canyon below the night before. Some of this information had been passed on, but there were others that noticed activity that never said anything about it.

At least two personnel had driven through the Safety Zone prior to the incident, in addition to the dozer operators that constructed it. Unfortunately, neither one saw it in the daylight, and not a great deal of information was passed on to the Division Supervisor that took over that area the night of the incident.

Several personnel interviewed during the review process, talked about observations made just prior to the entrapment, that they never passed on to their supervisors. Due to the amount of activity and the short amount of time involved in responding to the incident when it was first reported, the most common reason given for not reporting it was they didn't want to bother the TFL or Division Supervisor. Some of this information would have been critical in making a more accurate assessment

of the situation, which could have affected the decision to make a stand at the Safety Zone.

Briefing relief personnel and de-briefing at Sitstat -- Decision-making is based on intelligence (accurate, reliable information). Even with the technology of computerized infra-red mapping available, the observations and assessments of personnel in the field is absolutely essential. Based on the information available at the time, that there had been no fire activity in the area for at least two operational periods prior to the night shift of October 1st, Operations developed a tactical plan to deal with what they considered to be a more critical area of the fire. The possibility exists that, had they known of the fire activity observed in the bottom of the canyon the night before, a totally different operational plan would have been considered.

ESCAPE ROUTES -- A minimum of two escape routes available at any given time.

The saddle burnover area did meet this requirement, although no one knew it. The road leading from the saddle to the west would have presented an excellent escape route, providing them with "clear air" in just a few hundred feet. However, since those present had never seen the area in daylight, and had an extremely short period of time to take action, they were not able to check it out or consider it as a viable option.

Escape through the fuels to the south would not have been advisable once the firing operation started because of dense smoke, heat and embers created by the combination of the backfire and entrapment.

SAFETY ZONES -- A true Safety Zone should be large enough to provide complete safety for its occupants without the need to deploy a fire shelter. All Safety Zone locations must be communicated to the situation unit so that accurate mapping can be included in IAP shift map.

The location of a Safety Zone is critical. It should not be constructed in a saddle or chimney because of increased fire activity usually present. The reason saddles are commonly selected (in steep mountainous areas), is because the roads are built on contours and do not normally cross safe areas. Examples include mountain peaks and wide ridges. Roads seldom cross over them and, as such, are not usable (or at least not as readily available).

The burnover area, before construction of the Safety Zone, consisted of a narrow road through a forested area. The dozer group elected to construct a Safety Zone in this area because of how large and relatively flat it was. (They had been unable to find a large enough location in this area of the fire.) They proceeded with construction of the Safety Zone with one medium and two heavy dozers. Many trees were pushed over and the area stripped of vegetation. The dozers did all they could

with the area they had to work with. Additional work was needed, but never completed, in order to make the area "safer". Snags near the edges needed to be felled (a request was made by Division D the night before the entrapment), and the soil in the zone was extremely loose. In this incident, the Safety Zone was truly "marginal", due to limited maneuverability caused by the soft soil and berms, the intensity of the fire behavior that repeatedly hit the saddle from the north, and the intense fire on the south caused by the spotting activity.

Every person involved that was interviewed, however, had no doubts that the area was adequate, and that they were going to make it. It would appear, though, that the Safety Zone's capacity was "maxed out".

STANDARD FIRE FIGHTING ORDERS

Several violations of the Standard Fire Fighting Orders occurred:

1) **"Fight Fire Aggressively but Provide for Safety First"** -- Aggressive fire fighting was taking place. Crews and equipment were deployed in an effort to keep fire out of Birabent Canyon. The mistake was not providing for Safety first.

2) **"Initiate All Actions Based on Current and Expected Fire Behavior"** -- The suppression actions employed by the crews was planned on the expected fire behavior. Relative humidity on the ridge was measured at 41 percent when the burnout was started. The crews did not expect such extreme fire behavior with these humidities.

3) **"Recognize Current Weather Conditions and Obtain Forecasts"** -- The fire weather forecast predicted north to northeast winds and low relative humidities to surface overnight. It appeared that these conditions did occur over portions of the fire above 2,500 feet.

[NOTE: The reliability of forecasts can be increased with the consideration of field-gathered observations. While many of the personnel interviewed, and others on the

firelines, were taking weather observations, very few of them were being reported to Sitstat.]

4) **"Ensure Instructions are Given and Understood"** -- Once the decision was made to burn out the saddle, instructions were, for the most part, clear and understood. The compressed time sequence with rapidly changing conditions made this even more important. The crews responded to instructions with no need for explanation. The instruction to burn out from the west end of the Safety Zone to the east was either not clearly understood or not well thought out. By burning all the way through and out of the Safety Zone to the east, the escape route in that direction was cut off.

5) **"Obtain Current Information on Fire Status"** -- The Division Supervisors had not seen the incident area in daylight. Infra-red equipment was not available on the fire at this time, and the spot or hot spot conditions were not widely known. As a result, all levels of the operations section were unaware of the hazardous conditions.

6) **"Remain in Communication with Crew Members, Your Supervisor, and Adjoining Forces"** -- Another problem with communications, in addition to that previously stated under LCES, was identified. The distances involved on the Marre fire, with a single Division Supervisor responsible for four divisions, made communications from one end of his "division" to the other impossible. When the spot fire in Division A was detected, the Division Supervisor was unable to make contact with

the engine crew in Division A from his location in Division C. As a result, Branch I Safety was asked to respond to Division A to check out the report. The need to respond the safety officer to Division A eliminated the possibility of his assisting with the situation that was about to occur in Division D.

7) **"Determine Safety Zones and Escape Routes"** -- Refer to LCES section above.

8) **"Establish Lookouts in Potentially Hazardous Situations"** -- Refer to LCES section above.

9) **"Retain Control at ALL TIMES"** -- Once the decision was made to hold the ridge and burn out, the Division Supervisor and Engine Captains retained full control. Even though some of the crews had not worked together before, and at least one crew member was experiencing his first fire, all of them displayed a great deal of discipline and control.

[SPECIAL NOTE: ALL PERSONNEL INVOLVED IN THE BURNOVER ARE TO BE COMMENDED FOR THEIR PERFORMANCE, THE DISCIPLINE AND COURAGE THEY DISPLAYED, AND THE CONFIDENT MANNER IN WHICH THEY GAVE AND FOLLOWED DIRECTIONS. THEIR WORKING TOGETHER, FOR EVERYONE'S BENEFIT, MADE ALL OF THE DIFFERENCE IN NOT ONLY

SURVIVING, BUT ALSO KEEPING THE NUMBER AND SEVERITY OF INJURIES AND DAMAGE TO A MINIMUM.]

10) **"Stay Alert, Keep Calm and Act Decisively"** -- The personnel involved kept calm and acted decisively throughout the incident. The biggest problem identified in this area was the potential impact of very long work shifts and lack of sleep on the supervisors' ability to remain alert and to think clearly. Their judgement may have been impaired and incorrect decisions made as a result.

SITUATIONS THAT SHOUT "WATCH OUT"

In review of the 18 "Situations That Shout "Watch Out", it is evident that 9 of the 18 situations were violated in some way:

2) **In country not seen in daylight.**

The new Division D Supervisor or any of the resources from Division C had never seen the area in the daylight. They were unfamiliar with the fuels and topography. They also had never seen the Safety Zone and were unfamiliar with its adequacy.

3) **Safety Zones and escape routes not identified on Maps.**

The Safety Zone had not been identified on the IAP map. All Safety Zones should be identified on shift maps.

4) **Unfamiliar with weather and local factors influencing fire behavior.**

The fire weather and fire behavior forecast for the night shift cautioned to expect greater potential for fire spread and spotting through the night. The increased fire activity would occur above 2,500 feet and would be more active than previous nights. Locations of particular concern would be north to

northeast aspects. The two flare-ups that occurred nearly at the same time in Divisions A and D were within this elevation zone and north to northeast aspect.

The fire weather and fire behavior forecast were both covered at the night shift briefing and were contained within the IAP. For one reason or another, the individuals in command on this night did not heed the warnings contained within the fire weather and fire behavior forecast.

5) **Uninformed on strategy, tactics, and hazards.**

When the night Division D was released midway through the shift, Division C was then assigned responsibilities in Division D. Division C/D was briefed on tactics, resource deployments and priorities for Division D. Division C/D was also advised that crews had seen glows to the north of Catway Road the night before. No one, however, had seen the area in daylight. It was determined that the TFL had worked in the area the night before. Division C/D asked the TFL to supervise operations in Division D.

PROTECTIVE EQUIPMENT AND VEHICLE DESIGN

Engine Loss -- Engine 2-7 stopped running after its second move within the Safety Zone. It was later determined by the mechanic that the air filter caught fire and was sucked into the intake manifold, destroying the motor.

Air Conditioners -- The personnel in units equipped with air conditioners had a much easier time of it. Personnel would trade seats between the air conditioned and non-air conditioned units throughout the two hours they were inside the Safety Zone during the entrapment. In addition to the psychological effect on morale, the air conditioning did provide some relief from not only the heat, but also the extreme smoke conditions.

Window Area -- All large window areas caught radiated heat and made the temperatures inside much higher. One person recorded a temperature of 109° F. inside the cab of the engine in the latter stages of the entrapment. All but one engine placed fire shelters (extras they had put inside the passenger compartment) over the windows to reduce the effect of radiant heat. It was also found that the smaller windows on the Model 61 engines were much more comfortable than the large front units. The operator (who was subjected to the most heat) would place his head in the crew cab to get better air. It appears also that tinted windows would have cut down on the affects of the radiated heat and flame impingement.

Shelters in Cab -- In addition to using them over windows to reduce radiated heat and flame impingement, they later served as emergency blankets. Several of the crew members were wet from cooling each other and fighting the fires on their engines. Once removed from the Safety Zone, several were suffering from a mild form of shock. The crew from the disabled engine used the shelters for some time to keep warm.

Use of Water -- The engines kept their pumps running so that they could jump out and extinguish any fires which threatened them. Several ground fires and equipment fires were suppressed during the duration of the incident. Not having access to this water might have resulted in a different conclusion.

One side note of interest is that two of the engines sustained cracked windshields, believed to be from the application of water on the heated glass.

Cab Boot on Model 61 Engines -- The vinyl boot between the cab and crew compartment caught some embers and burned through. The crew had to put out fire inside the cab of the vehicle when the vinyl burned through. It was fortunate no one was burned by molten vinyl. The fumes given off could not be good, plus the hole allowed smoke and embers to get inside the crew compartment.

Fire-resistant Tarp to Cover Burnables -- Hose packs and other items exposed to the fire and embers ignited from time to time. A tarp/cover of fire resistant material would have

cut down on the problem. Each piece of equipment is different, so they must be addressed separately.

Older-Model Engines -- The older-model engines had numerous openings for fire brands to come through. They were coming through the floor boards, through the vents, around the door seals, and other locations. These crews seemed to be the most uncomfortable. When they took a breather in the newer air conditioned cabs they noticed a remarkable difference, saying "it was like night and day". One crew member also advised of a problem he had with the window crank. Unless he kept his knee under the crank, the window would fall about two inches allowing embers, additional heat and smoke into the cab.

Fiberglass Components -- The fiberglass top on the Bronco was to blame for not being able to get out on the Wenatchee Fire. The Model 61 engines have a fiberglass front end. The NPS engine came through OK, but it was "very hot and smoking" when they got out. Flame impingement on fiberglass might be a problem in the future.

Four-Wheel Drive -- A four-wheel drive unit would have been able to navigate very well in the soft dirt. This would have made this incident somewhat easier to deal with. They could have moved to more remote areas within the Safety Zone.

Oxygen Bottles -- One engine had a small oxygen bottle on hand. Personnel that were able to get a breath of fresh air with it felt much better after the incident was over.

The levels of Carbon Monoxide are believed to be very high after the first hour of the entrapment. The decision by the Division Supervisor to leave when he did, and the subsequent efforts to remove the rest of the personnel was based on the increasing CO levels in the Safety Zone as the fire intensity began to decrease.

CRITICAL INCIDENT STRESS DEBRIEFING

The Critical Incident Stress Debriefing that was conducted proved to be a very positive experience for most everyone involved. It should always be considered in similar situations in the future. Thought should be given to follow-up counseling after the initial debriefing.

WORK/REST CYCLES

The current guidelines concerning work/rest cycles was enacted to provide for adequate rest on project incidents. The guideline provides for one hour off shift for every two hours worked. Adequate rest provides physical recuperation time between work cycles. A clear thought process is essential for fire suppression activities and especially at the Division Supervisor level. The Division Supervisor commands many forces and critical decisions within very short time frames must be made.

One factor that may have contributed to this incident was the violation of the work/rest cycle. Statements were received that some individuals were mentally tired and not thinking clearly. Their thought process was foggy, which made it difficult to think clearly and act decisively. The Division Supervisor on this incident had worked 99.5 hours from his time of dispatch on 9/26/93 through the time of the incident on 10/2/93. During this time period he should have been off shift for 41 hours. He actually had 23.5 hours off shift. The maximum work hours were exceeded by 17.5 hours. The rest cycle was approximately 60% of the minimum required. The Division Supervisor Trainee assigned to this Division should have had 31.5 hours off shift. He actually had 15.5 hours off shift. The rest cycle was approximately 50% of the required minimum.

The Task Force Leader involved was within work/rest cycle guidelines.

RECOMMENDATIONS

TRAINING -- LCES, Standard Orders, Watch-out Situations, Communications, Situation assessment, etc.

AIR CONDITIONING IN ALL FIRE VEHICLES -- Fire apparatus design specifications should include air conditioning in the passenger compartment area(s). In this incident, air conditioning in some of the vehicles did provide the personnel some relief from the heat and extreme smoke conditions. This may have been a contributing factor to not only their survival, but especially to the reduction of pulmonary injuries. Only one person was treated for breathing related problems; and he was diagnosed with pneumonia, which the doctor believed was already present prior to the burnover incident.

SCBA's (in cab if possible) -- Mounting the self-contained breathing apparatus (SCBA) inside the cab interior has definite advantages.

If the seats are equipped with recessed holes, the units can be put on in an emergency (if the air gets bad or a dash must be made to safety) with relative ease. To leave full turnouts/SCBAs on for any length of time in a heated atmosphere would not be recommended, but access to this equipment for the above-mentioned purpose would be beneficial.

It is also suggested that bottles of oxygen be available to reduce the effects of bad air over a prolonged period of time.

SMOKE/CARBON MONOXIDE FILTER MASKS -- According to Dick Mangan, program leader - Fire and Aviation Management Safety and Health Programs, there is no technology currently available which can filter out carbon monoxide. Smoke particulate can be reduced with masks; this may provide some comfort to the wearer. There is research going on by several agencies trying to develop some method of filtration of carbon monoxide, which would have benefits to firefighters.

FIRE SHELTERS IN ENGINE CAB -- Four of the engines trapped in the Safety Zone deployed fire shelters inside the cab of the Engine. The Captains of these four Engines reported a significant drop in temperatures inside the cab when the shelters were placed against the windows. The shelters reflected and insulated the cab windows from the intense heat surrounding the Engines. The shelters had to be spread out and held in place, but the added comfort was well worth the effort.

It would be possible to construct custom window coverings for all engines. Bulk fire shelter material or old unusable fire shelters could be used for construction.

An adequate fastening device could easily be devised so that the coverings would stay in place on their own.

Because of the obvious benefits of covering cab windows with fire shelter material, it is recommended that all engines be equipped with fire shelters or custom covers within the cab.

RESUSCITATION EQUIPMENT -- Fire agencies are increasingly becoming or already are more active in the delivery of EMS services. Whether or not this service is provided to the public, consideration should be given to availability of oxygen to firefighters. Especially when actively involved on significant incidents, such as the Marre fire, fire personnel should be equipped to provide immediate medical aid in the event of injury. Resuscitation equipment provides one of the most critical treatment measures to any significant injury -- providing increased levels of oxygen to the patient. Personnel in this incident had a small oxygen bottle available that was shared to provide at least a short burst of "fresh air" periodically to everyone. Had anyone suffered more significant smoke inhalation injury or difficulty, oxygen therapy would have been critical.

FIRE RESISTANT HOSE BED COVERS -- During the entrapment, the Engines kept their pumps operating so that they could extinguish equipment or threatening ground fires. The intense fire behavior within the Safety Zone subjected the Engines to a continuous shower of firebrands. Firefighters were required to extinguish several equipment fires on top of the Engines. These fires originated within the hose beds in fire hose and gear packs.

A fire-proof cover over the Engine hosebeds would have prevented this problem. Firefighters would not have been required to take action on the equipment fires, and the added exposure would have been eliminated.

It is recommended that research and development be conducted to equip all engines with covers designed to reduce the threat of hosebed fires. The system should be easy to activate, reliable, simple to maintain, and above all, provide adequate protection.

ADHERE TO 2 TO 1 WORK/REST GUIDELINES (except first 24 hours) -- One factor that may have contributed to this accident was the excessive work cycles by some key personnel. As stated previously, the current guideline concerning work/rest cycles was enacted to provide for adequate rest on project incidents. The guideline provides for 1 hour off shift for every 2 hours worked. Adequate rest provides for recuperation time between work cycles. A clear thought process is essential for safe fire suppression activities; and especially at the division supervisor level.

It is difficult, and at times impossible, to achieve the recommended work/rest guidelines during initial attack and extended attack periods. During these times, relief resources may have not yet arrived, and at times are not available. Once the situation has stabilized, every effort should be made to meet the recommended work/rest guidelines.

Where situations dictate excessive work cycles, creative measures should be employed. To reduce long shifts for division supervisors, one approach would be to increase the number of division supervisors. Instead of two division supervisors for a 24- hour period, consider three. This would allow for a 12-hour shift with adequate time for briefing, transportation, on-line orientation, and debriefing. This is only an example of a variety of creative approaches that could be used to help meet the recommended work/rest guidelines.

EXPAND THE USE OF C.I.S.D. -- The use of Critical Incident Stress Debriefing in this case was critical, and the incident management is to be commended for establishing its use. Aside from some coordination difficulties at the time the personnel reached the incident base, the overall process of assigning them to rehab and establishing the CISD went well. Personnel were, after a period of time, able to begin the process of dealing with the emotional affects of the burnover. However, the majority of those interviewed by the review team indicated that they felt the session was terminated too soon. They felt that more opportunity to continue to discuss the incident and personal feelings while the group was together would have been beneficial.

The desire to talk about the event was evident to the review team, as all of the interviews took twice as long as anticipated, with several lasting over an hour. The longest was over two-and-a-half hours. Beyond the need to determine the facts, the review team also wanted to provide those interviewed the opportunity to discuss the incident freely, as well as ask any questions they may have had. In incidents such as this, with the magnitude of the event and

potential for injury and even death, the CISD process should be more than just a single session. Continued counseling must be encouraged in order for personnel to fully recover from the emotional affects.

LOCATE AND CATEGORIZE Safety Zones ON IAP MAPS -- As Safety Zone locations are determined, they must be identified on incident maps. As they are constructed and completed, they should be categorized as to size and the number and types of resources they could provide refuge for. In addition, viable escape routes into and out of Safety Zones should be indicated. Division Supervisors and/or Assistant Safety Officers should inspect Safety Zones in order to evaluate their potential effectiveness, and must communicate this information to both resources in the area and to Sitstat so they may be identified on Incident Action Plan maps. The location of the "Safety Zone" involved in this incident was never communicated. Beyond the dozer operators that constructed it, only two people ever saw it prior to the burnover. Neither of them saw it in daylight or ever realized it was located in a saddle.

IMPROVE INTELLIGENCE GATHERING AND DEBRIEFING PROCEDURES -- Fire activity in the canyon below the Safety Zone where the burnover occurred had been observed the night before. Due to several communications breakdowns, this information was never communicated to incident overhead or Sitstat. Had this information been communicated, the outcome might have been totally different. Operations' ability to prioritize objectives and resource allocations is only as good as the intelligence information

available at the time. The intelligence gathering process must be ongoing and consistent. Supervisors at all levels must be kept informed. As the information is received it must be evaluated and processed. Some information is only important to the resources in the immediate area. However, some information, including fire behavior observations, must be communicated through the I.C.S. chain of command to all levels within the Operations Section, as well as to Sitstat in the Planning Section.

One method to accomplish this, which was adopted by the Incident Management Team involved in this incident, is to establish responsibility for intelligence gathering and the debriefing of Operations and Sitstat with the Division Supervisors. A modified Unit Log has been developed to document such things as weather observations, significant events, fire behavior observations, etc. Division Supervisors are accountable for debriefing Sitstat when they return to base (or the I.C.P.).

FLAME-ARRESTERS IN ENGINE INTAKES -- It has been determined that the strategic placement of a fire screen material in the air intake system of the engine could have prevented the loss of the diesel engine.

It could still be possible to draw direct flame into the engine (impingement only) but all normal fire brands will be screened out. We have installed a few screens already and have encountered no performance problems.

AUXILIARY DRIVING LIGHTS -- One of the primary factors that prevented the personnel and equipment to escape from the Safety Zone was poor visibility. Darkness combined with the dense smoke made it nearly impossible to see the roadway or obstacles such as rocks or logs.

Driving in smoke at night is similar to driving in dense fog at night. Vehicle headlights reflect back and essentially blind the operator. High beam lights are even more reflective than low beams because of the higher intensity and the elevation at which they are focused.

Auxiliary driving/fog lights would help alleviate the blinding effects of the vehicles' main headlights system. Auxiliary lights can be mounted low on the vehicle and are easily adjusted. The beam can be focused in specific areas to reduce the light reflection and increase visibility and safety while driving in marginal conditions.

FULL TURNOUT GEAR TO LEAD VEHICLES OUT -- When the equipment was finally driven out, it was with a person in front, visibility was still poor and lighting bad. This task would have been much safer if the person leading the caravan out had been outfitted in full turnouts. It is very possible that the rescue could have been performed much earlier if turnout/SCBA protection had been available.

The use of a strobe light to the rear of the rescuer should be used. This tactic should be based on specific instructions and training.

SNAGS REMOVED FROM SAFETY ZONE PERIMETERS -- The snags, which were both stacked and standing, on the perimeter of the safety zone created a safety problem for the crews. The stacked trees ignited and increased the radiated heat they were exposed to.

It is recommended that all downed materials be removed if there is a chance that the site could be used as a Safety Zone.

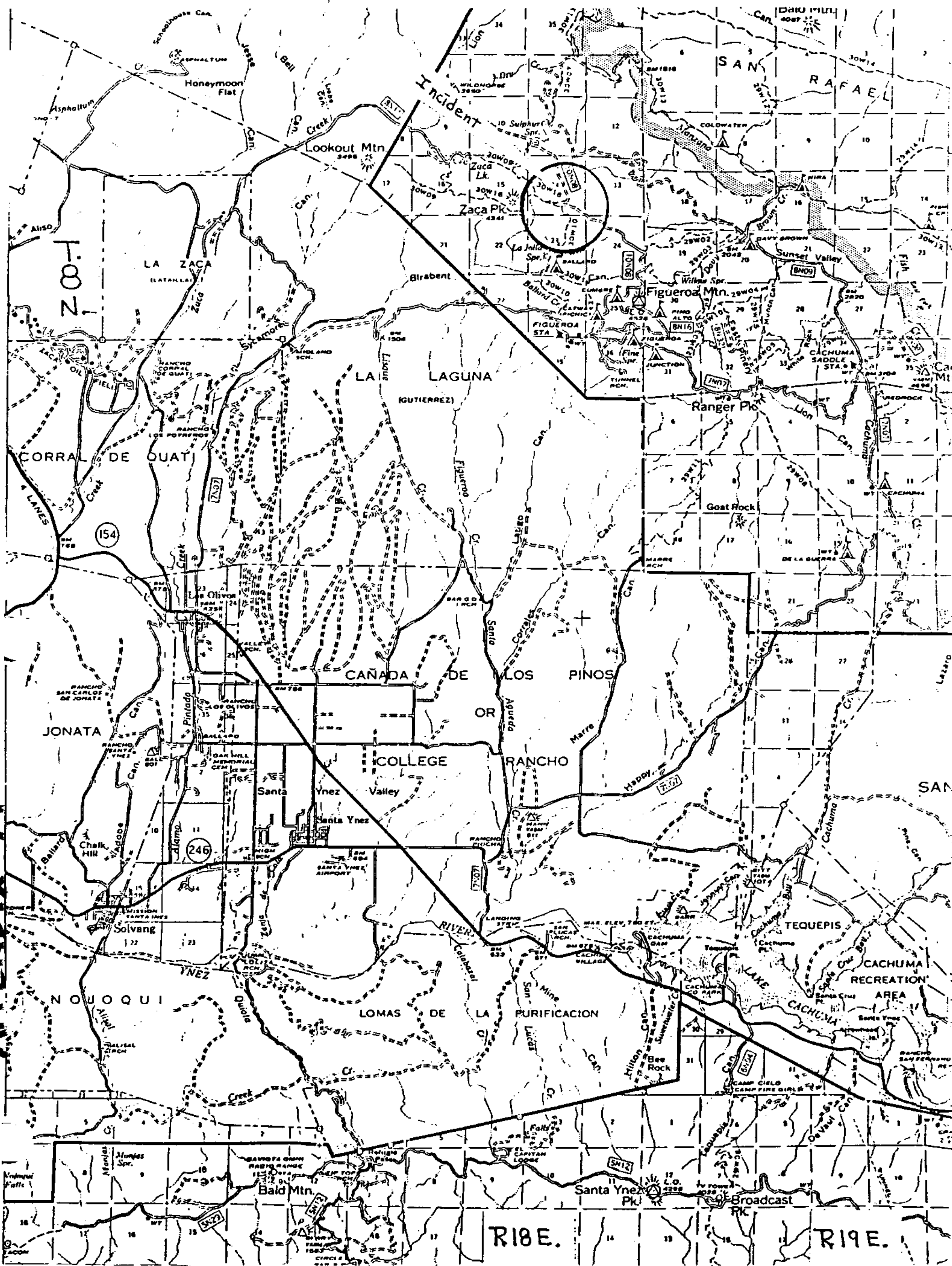
Remove all standing snags around the perimeter that would affect the the individuals. There were several snags left standing on the Safety Zone that radiated heat and sent fire brands down on the trapped individuals.

VEHICLE AM/FM RADIO -- One piece of equipment that provided stress relief for personnel trapped within the Safety Zone was the vehicle mounted AM/FM radio. Several comments from people involved stated that the ability to listen to the radio broadcasts allowed time to pass much faster. It also relieved stress by serving as a distraction to the reality of the situation.

Listening to AM/FM radio broadcasts also helps keep the Engineer and Captain alert on driving operations where fatigue may be a factor. The addition of AM/FM radios in fire vehicles is a positive step and should be continued and/or considered.

APPENDIX A

APPENDIX A

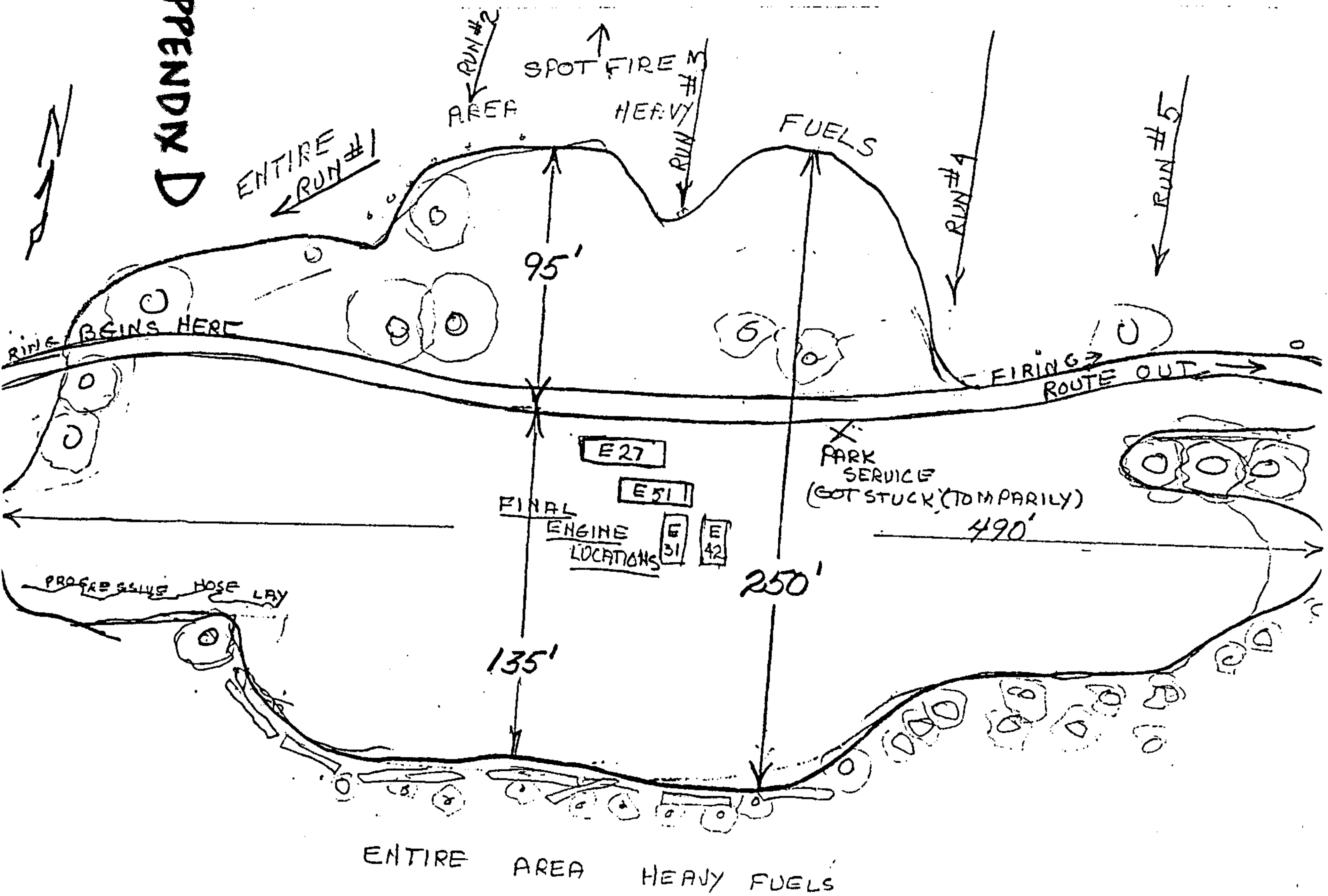


APPENDIX B

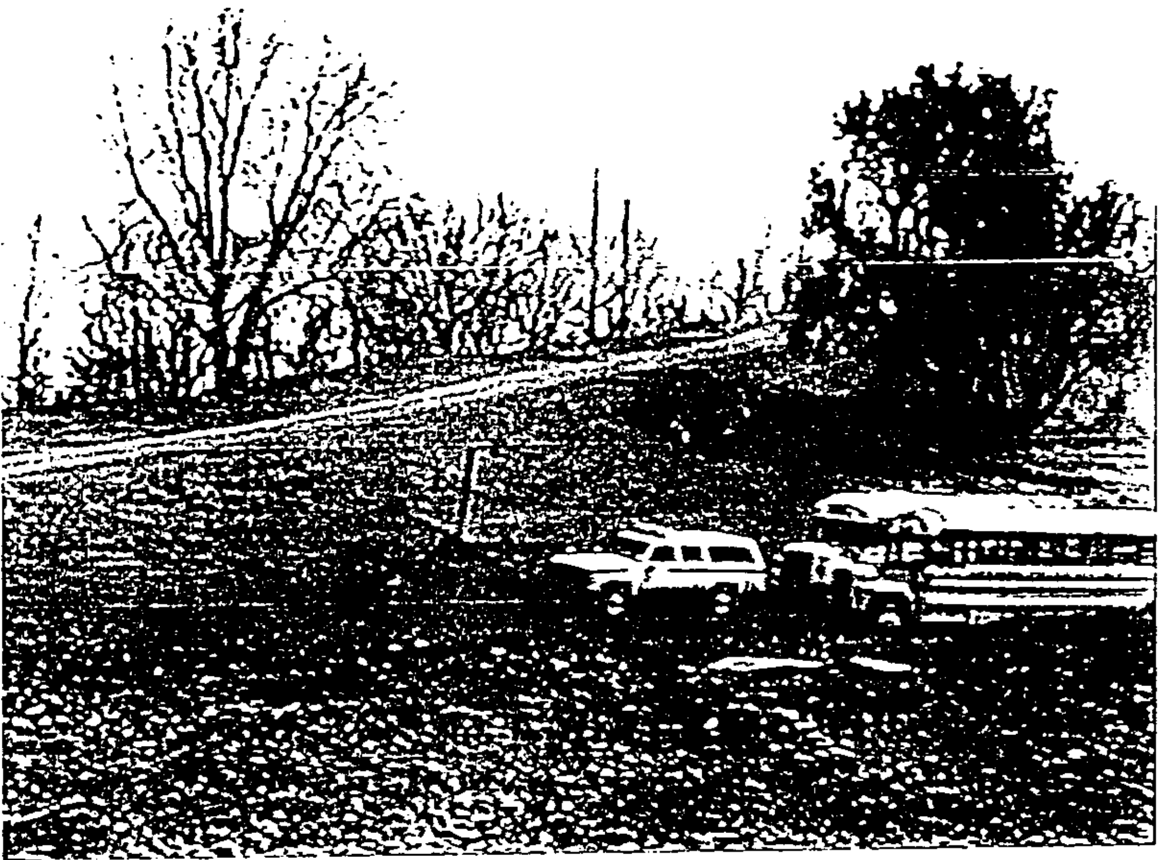
APPENDIX C

APPENDIX D

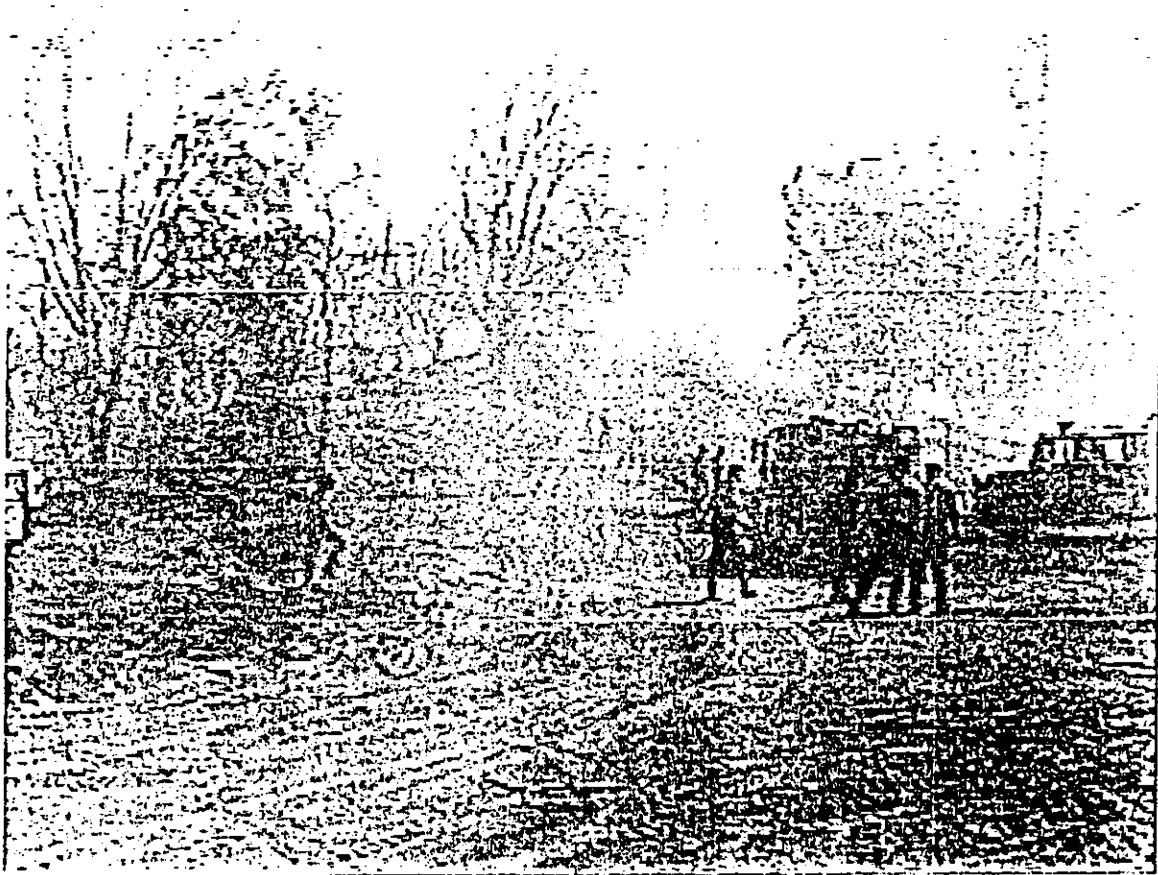
APPENDIX D



APPENDIX E



APPENDIX F



APPENDIX G

APPENDIX H

APPENDIX H.1

FIRE BEHAVIOR FORECAST

FORECAST NO 11

NAME OF FIRE: MARRE

PREDICTION FOR: 10/1/93
NIGHT SHIFT

UNIT: LOS PADRES N.F.

TIME AND DATE
FORECAST ISSUED: 10/1/93 @ 1200 HOURS

SIGNED: RICHARD CARMICHAEL
FIRE BEHAVIOR ANALYST

WEATHER SUMMARY: SEE ATTACHED FIRE WEATHER FORECAST

FIRE BEHAVIOR

GENERAL: LOWERING HUMIDITIES MEAN LOWERING FINE FUEL MOISTURES, THIS WILL RESULT IN A GREATER POTENTIAL FOR LATERAL AND BACKING FIRE SPREAD. WATCH FOR SPOTTING AS LOWER FINE FUEL MOISTURE MEANS A MORE RECEPTIVE FUEL BED. INVERSION TO SET IN AROUND 2300, TOP AROUND 2500 FEET, FIRE ACTIVITY MAY LESSENING A LITTLE BELOW THIS, HOWEVER, THIS FIRE HAS A HISTORY OF DOWNSLOPE SPREAD AND OVERALL FIRE WILL BE MORE ACTIVE TONIGHT.

SPECIFIC: BRANCH I DIVISION C, FIGUEROA MOUNTAIN/CATWAY ROAD - IS CRITICAL TONIGHT. WATCH OUT FOR STRONG RIDGETOP WINDS FROM THE NORTH TO NORTHEAST THROUGHOUT THE NIGHT. SPOTTING ACROSS THE LINE FROM UNBURNED PATCHES BURNING OUT IS POSSIBLE. CHACHUMA SADDLE AND NORTH SOUTH DRAINAGES ABOVE 2500 FEET - PAY PARTICULAR ATTENTION TO THE CHANNELING EFFECT OF THE NORTH AND NORTHEAST WINDS, EXPECT STRONG GUSTY CONDITIONS THROUGHOUT THE SHIFT. BRANCH II DIVISION W BE AWARE THAT WINDS WILL BE IN ALIGNMENT WITH THE SLOPE AND ANY UNBURNED FUEL WILL BURN ACTIVELY, UPSLOPE RUNS POSSIBLE.

AIR OPERATIONS: EXPECT GUSTY WIND CONDITIONS OVER THE FIRE TONIGHT AND TOMORROW MORNING. GUSTY WINDS MAY HAMPER OPERATIONS TO HELISPOTS IN DIVISION W.

SAFETY: REMEMBER TO KEEP ALL FIRE FIGHTING TACTICS IN LINE WITH THE FIRE BEHAVIOR. LOWERING HUMIDITIES AND STRONG WINDS COMBINED, HAVE THE POTENTIAL TO FAN EMBERS CLOSE TO THE LINE AND ANY UNBURNED FUELS MAY BURN ACTIVELY.

APPENDIX H.2

FIRE WEATHER FORECAST

FORECAST NO. 10

NAME OF FIRE: MARRE
UNIT: FRESNO WEATHER

PREDICTION FOR NIGHT SHIFT: 1800-0600
SHIFT DATE : OCT 1,1993

TIME AND DATE NOON PDT
FORECAST ISSUED: OCT 1,1993

LARRY GREISS
Fire Weather Meteorologist

WEATHER DISCUSSION: HIGH PRESSURE ALOFT HAS BUILT A LITTLE STRONGER AND IS CURRENTLY CENTERED OVER NORTHERN CALIFORNIA AND EXTENDS SOUTH ALONG THE SOUTHERN COASTLINE. THE CURRENT WARMING AND DRYING TREND WILL CONTINUE THROUGH SATURDAY UNDER AN INCREASING OFFSHORE PRESSURE PATTERN. THIS DEVELOPMENT WILL KEEP NORTH TO NORTHEAST WINDS OVER THE RIDGETOPS TONIGHT. LAST NIGHT..HUMIDITY RECOVERY WAS FAIR TO GOOD BUT DRY AIR ALOFT CONTINUES TO WORK ITS WAY DOWN TO THE SURFACE. LOWER OVERNIGHT HUMIDITIES ARE EXPECTED ON THE MID AND UPPER SLOPES AND SLOWER RECOVERY IN DRAINAGE BOTTOMS. THE OUTLOOK CALLS FOR LITTLE CHANGE ON SUNDAY..THEN A COOLING TREND WITH INCREASING HUMIDITIES MAY BEGIN AS EARLY AS NEXT MONDAY.

WEATHER FORECAST

WEATHER: CLEAR SKIES. VALLEY INVERSIONS FORMING BETWEEN 2300 AND 2600 FEET.

TEMPERATURES: LOWS TONIGHT 72-77 MID SLOPES, 66-69 ON RIDGETOPS, AND 58-64 IN VALLEY BOTTOMS.

HUMIDITY: LOWER HUMIDITIES OVERNIGHT TONIGHT. MAXIMUM RH 22-34 PERCENT ABOVE THE INVERSION LAYER WITH SLIGHT LOWERING OF RH AFTER 2300. AT LOWER ELEVATIONS AND VALLEY BOTTOMS...45-65 PERCENT.

RIDGETOP WINDS: NORTHEAST TO EAST 7-18 MPH WITH LOCAL GUSTS TO 25 MPH THROUGH THE NIGHT.

SLOPE WINDS: DOWNSLOPE 2-5 MPH EXCEPT NEAR RIDGETOPS..NORTH TO NORTHEAST 5-12 MPH. BELOW THE INVERSION LAYER...LIGHT DOWNSLOPE 1-4 MPH DECREASING TO LIGHT AND VARIABLE AFTER MIDNIGHT.

OUTLOOK FOR DAY SHIFT (0600-1800) SATURDAY
MORNING INVERSIONS LIFTING AND SLOWLY CLEARING DURING MID MORNING OTHERWISE SUNNY. WARMER AND DRIER CONDITIONS. HIGHS 90-97 LOWER SLOPES AND 82-88 HIGHER TERRAIN. DRIER WITH MINIMUM HUMIDITIES 15-22. SLOPE WINDS UPSLOPE 2-6 MPH BY LATE MORNING AND 5-12 MPH DURING THE AFTERNOON. RIDGE WINDS VARIABLE NORTHEAST TO SOUTHEAST 5-12 MPH THROUGH THE AFTERNOON.