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The Cerro Grande Fire – From Wildfire Modeling Through the Fire Aftermath

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Abstract

The Cerro Grande Fire developed from a prescribed burn by the National Park Service at Bandelier National Monument near Los Alamos, New Mexico. When the burn went out of control and became a wildfire, it attracted worldwide attention because it threatened the birthplace of the atomic bomb, Los Alamos National Laboratory (LANL). Was LANL prepared for a fire? What lessons have been learned?

Introduction

In recent years, the size and intensity of wildfires has increased in many areas of the United States. This phenomena has been attributed to both man's interference with nature and climate changes. Dating back to the 1930's, the U.S. population has been encouraged to prevent or extinguish wildfires. And, in recent years, there has been less precipitation resulting in drought conditions in many portions of the U.S. including New Mexico.

Wildfires and Los Alamos

Wildfire History: Over the past fifty years, five major wildfires and more than 300 smaller wildfires have occurred in the vicinity of Los Alamos.[1, 2, 3, 4] Of these five major fires, three have been within the last four years and two have entered LANL property. All of the major fires have been during dry, windy times of the year. Containment of the first four major fires was assisted by weather changes. Unfortunately, the weather changes did not occur quickly enough with the fifth fire, the Cerro Grande Fire.

Planning for Wildfires: As a result of the fires prior to 2000, LANL and Los Alamos County took some actions to prepare for and to minimize the potential impact of wildfires. In 1988, a Mutual Fire Protection Assistance Agreement was revised and signed by the Department of Army Corps of Engineers, Bureau of Indian Affairs, Department of Energy (DOE) - Los Alamos Area Office, United States Forest Service, National Park Service, and the New Mexico Department of Energy, Minerals, and Natural Resources.[5]

Following the 1996 Dome Fire, an interagency wildfire management team consisting of the National Park Service, LANL, DOE, Los Alamos County, US Forest Service, the State of New Mexico, and San Ildefonso Pueblo was formed.[4] As the need was identified to develop and maintain a wildfire fire fighting capability in the Los Alamos area, several steps were taken. The Los Alamos County Fire Department, which provides fire fighting services to LANL as well as Los Alamos County, trains its fire fighters to fight both structure and wildfires. The DOE permitted the construction of a helicopter pad, command center, and storage of fire fighting supplies at Technical Area (TA)-49.

The local area was also examined to identify what could be done to minimize the impact of future fires.[3, 6] Several of the suggestions from these examinations had either been implemented or were in progress prior to the start of the Cerro Grande Fire. These included: tree and brush thinning on the Laboratory property; tree and brush thinning to create a firebreak around portions of the Los Alamos town site; the maintenance of emergency operations centers (EOC); emergency plan updates including contingencies; and the development and implementation of an emergency notification system within Los Alamos County - an automatic telephone call warning system.

Wildfire Scenario Analysis Before 2000

When the Site-Wide Environmental Impact Statement[3] (SWEIS) was under development in the 1990's, it was recognized during public hearings that wildfires were not common in facility-specific hazard analysis documents. As a result, a wildfire scenario designated as SITE-04 was added to the SWEIS.

The SITE-04 scenario assumed a site-wide wildfire consuming combustible structures and vegetation would occur approximately once every ten years. It was postulated that during the late April to June time frame a wildfire would start to the southwest of LANL near the border of the Bandelier National Monument and the Dome Wilderness Area. Scenario assumptions included: limited access to the fire and limited resources allow the fire to enter the LANL site; the fire moves quickly fueled by favorable meteorological conditions; the fire would sweep across the western part of LANL, enter the canyons, jump roads, and enter the town site; combustible LANL buildings would catch on fire and be destroyed; and the wind would generate spot fires in advance of the main fire.

MACCS was used to calculate population doses from such a fire. The unmitigated mean population dose was estimated at approximately 675 person-rem resulting in approximately 0.34 excess latent cancer fatalities (LCF). The unmitigated dose estimate attributed 625 person-rem from the wildfire consuming buildings and 50 person-rem from burning vegetation and unidentified residual contamination in other buildings and vegetation. Seventy-five percent of this dose estimate was from TA-54. With some mitigation, the dose estimated by the analysis was reduced to 50 person-rem and 0.25 LCF. The analysis also identified a potential for limited exposure to chemicals.

Table 1 summarizes information on the main contributors to the unmitigated dose estimate. The information provided in the table indicates the facilities that were considered of the most interest relative to this scenario. TA-54 shows the highest estimated population dose at 400 person-rem and the Weapons Engineering Tritium Facility (WETF) the next highest with 189 person-rem. The table does not indicate all of the facilities that were evaluated for input to the analysis. However, the table does show that some of the dose estimates were developed based on other scenarios considered in the SWEIS. For instance, aircraft crash and earthquake scenario results were adapted for some of the wildfire analysis. The original aircraft crash analyses included fires from fuels.

Table 1 - SWEIS Wildfire Analysis Data [3]

Facility: Sigma Building (TA-3-66/451)	
Comment: 130 kg of fines in oil, plus 100 electrodes each 1/4-inch thick by 8-inch by 4-ft long. Remain-der of 65,000 kg of depleted ura-nium (DU) is in fixed storage cabi-nets of 1/2-hour resistance. All material is in the basement.	Assessment: The maximum dose from the inventory of 65,000 kg calculated for this scenario was 3 x 10^{-5} rem 50-yr. committed dose equivalent (EDE) at approximately 10 km from the release point.
Information from facility walkdown included 6,484 lb of fuming nitric acid, 3,130 lb of hydrochloric acid, and 490 lb of 48 to 51% hydro-fluoric acid.	Chemicals below grade level and not likely to be affected by fire.
Facility: Weapons Engineering Tritium Facility (WETF), TA-16-205	
Comment: 100 g tritium (H^3) in process; 60 g in tubs and 1,200 g in LP-50 containers in vault storage	Assessment: The maxi-mum dose (MEI) was cal-culated as 0.25 rem at 4.85-km. Doses are less at short-er distances due to plume rise. The population dose is 189 person-rem within the 80.5-km (50-mile) radius.
Facility: Tritium Science Test Assembly (TSTA), TA-21-155	
Comment: 200 g H^3	Assessment: Using the RAD-05 aircraft crash and fire accident, consequences from a 200 g release of tritium oxide were 24 person-rem population exposure and mean MEI dose of 0.012 rem at State Road 502 (360 m away).
Facility: Tritium Science and Fabrication Facility (TSFF), TA-21-209	
Comment: 100 g H^3	Assessment: Scaling of the RAD-05 aircraft crash and fire accident consequences to a 100 g release of H^3 in oxide form results in 12 person-rem population exposure and mean MEI dose of 0.006 rem at State Road 502 (360 m away).

Table 1 - SWEIS Wildfire Analysis Data[3]

Facility: Health Research Laboratory (HRL), TA-43-1	
Comment: 30 liters formaldehyde	Assessment: Evaluated in the SWEIS earthquakes. The ERPG-2 and ERPG-3 distances were 0.17 and 0.1 miles (0.27 and 0.16 km) respectively, under conservative daytime dispersion conditions. The number of people exposed to greater than ERPG-2 and ERPG-3 were 11 and 6 respectively.
Facility: Radiochemistry Laboratory, TA-48-1	
Comment: (No specifics stated in SWEIS)	Assessment: Dissolving wing fire (Scenario 2) 0.3 mrem at 720 m; Alpha wing fire is 5.4 mrem at 720 m or at the Royal Crest Trailer Park; The whole facility fire is postulated at 50 mrem. Chemical exposures at this location are less than ERPG-2.
Facility: Waste drum preparation and domes, TA-54-153, 224, 226, 229, 230, 231, 232, 283, 33, 48, 49, Pad 2	
Comment: Evaluated in RAD-08	Assessment: Conse-quences of the aircraft-initiated fire in RAD-08 were 400 person-rem popu-lation exposure, and a mean MEI dose of 22 rem at both White Rock and Pajarito Road.

Contributions to the wildfire analysis for how a fire might progress were made by the Española District of the Santa Fe National Forest, Bandelier National Monument, the Los Alamos Fire Department, and LANL personnel. As a result of this analysis, some mitigation efforts started before the SWEIS was published.[3]

The Cerro Grande Fire

The Setting: The climate, forest conditions, and the terrain proved to be major factors with the fire.

- Climate: By spring 2000, there had been several years of below normal precipitation in the Los Alamos area. This included the third consecutive year with almost no snow pack in the Jemez Mountains. This lack of moisture resulted in extremely dry forest conditions by late April 2000.
- Forest: As identified earlier, the surrounding forest was dense and overgrown. Housing was encroaching against the forest edges.
- Terrain: The canyon, mesa, and mountain terrain of the Los Alamos area limits highway access routes to Los Alamos.[7]

The Fire Progression: The National Park Service started a prescribed burn on Bandeleir National Monument on Thursday, May 4th. By May 5th, the prescribed burn was more than the assigned staff could handle. With the winds and dry conditions, the prescribed burn became a wildfire. Firefighters were called in to help.

Over the weekend, the wildland fire progressed. Access/escape routes for Los Alamos from the Jemez were restricted. On May 7th, LANL's EOC was activated and evacuations began at LANL and the town site. By May 8th, the threat from the fire caused LANL to be closed to non-essential personnel and the schools and many businesses in Los Alamos County were closed. The closures were still in effect on May 10th when the fire jumped Los Alamos Canyon and the evacuation notice for the Hill (Los Alamos town site) came from the Los Alamos Fire Department. Every available route that was considered safe was used and the evacuation went smoothly and quickly.

Portions of the town started burning during the evacuation. Multiple utility failures were occurring with the loss of electrical power to pump water and low water supplies. Firefighters on the ground were taking risks to attempt to save homes. Those fighting from the air were also assuming extra risk by flying over normally hazardous terrain with dangerously high winds.

By the early morning hours of May 11th, White Rock and portions of Española and Santa Clara Pueblo were also evacuated due to the heavy smoke. However, these evacuations did not go as quickly. It took over six hours to evacuate White Rock. Traffic in and around Española was so heavy that it barely moved. Shelters had also been established in Española. These remained open, but started accepting the additional influx of evacuees from the smoke.

With daylight on May 11th, the damage to the residential areas of Los Alamos became more visible. However, on the evening of May 11th, the fire hit the LANL property harder. It burned over and around the building housing the primary LANL EOC. From the TV coverage, it was evident that frequent explosions were occurring at the Laboratory. By the morning of May 12th, more damage at LANL was visible.

It wasn't until Mothers Day, May 14th, that those who had lost their homes were allowed a brief, escorted bus tour of their neighborhoods. It was also that day that White Rock residents were permitted to return home. For those on the Hill, some were allowed to return home on Monday, May 15th. The fire was contained on June 6th and considered extinguished on September 25th.

The Aftermath: Burned areas were evaluated for rehabilitation by the Burned Area Emergency Rehabilitation (BAER) Team and to identify what new hazards might exist. Flooding concerns were addressed where the only normal flooding concern would be to be caught in a dry arroyo or a canyon when there would be a sudden heavy summer thunderstorm. Water retention and diversion structures were built. One was placed upstream of TA-18. The Los Alamos Reservoir was emptied and strengthened. Mud slides and water carried debris now became a concern. The washout of fill bridges also became a concern. Because of LANL's work, another concern that was expressed was what toxic or hazardous contaminants would be transported by either the rain or the rainwater.

Remote area weather stations were installed in strategic locations to provide warning of heavy precipitation and allow the evacuation of canyons. Access to Los Alamos Canyon was restricted. The roadway access into the canyon was blocked by fences and gates. Personnel and equipment at TA-41 were relocated. Actions were taken to ensure that the remaining structures and items at the Omega West Reactor were secured. Additional air, soil, and water monitoring began.

Impacts of the Fire

Impacts at LANL: Losses at LANL that were identified early included:

- Office trailers containing the only copy of scientists' work
- Vehicles
- Two weeks or more of paid downtime for UC staff
- Cost of recovery plan generation and implementation
- Cost of property protection from flooding and mudslides
- Cost of relocating personnel from canyons and burned or heavily damaged facilities
- Cost of temporary assignments for personnel during the fire
- Cost of temporary assignments for personnel who couldn't return to their work sites after two weeks due to damaged facilities and utilities
- Five of the original atomic bomb assembly structures at V-Site slated for historical preservation

Data on a few of the active LANL facilities are presented in Table 2.

Table 2 - Impacts on Several LANL Facilities

Location	Hazards	Proximity & Impact
TA-3: Chemistry and Metallurgy Research (CMR) Facility	Radioactive materials Chemicals	Burned in canyon to south of Pajarito Road
SIGMA Complex	Depleted uranium (DU) Chemicals	Buildings were not burned
TA-16: Weapons Engineering Tritium Facility (WETF)	Tritium	Burned vegetation within 20 ft of the office transportables supporting WETF, but buildings not burned
TA-18: Los Alamos Critical Experiments Facility (LACEF)	Radioactive materials	Burned trees on mesa to west of site, but buildings not burned
TA-21: Tritium Science and Fabrication Facility (TSFF)	Tritium	Not applicable (NA), but intermittent power outages delayed building reentry
Tritium Systems Test Assembly Facility (TSTA)	Tritium	

Table 2 - Impacts on Several LANL Facilities
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Location	Hazards	Proximity & Impact
TA-46: Building 208 Building 217/218	Radioactive materials -	Crossed Pajarito Road into TA, transportables and vehicles at the TA that were adjacent to Pajarito Road burned
TA-48: Radiochemis-try (RC-1)	Radioactive materials Chemicals	Burned in canyons on both sides of the mesa and up to Pajarito Road south of the site
TA-50: Building 37 - Radioactive Materials Research, Operations, and Demon-stration Facility (RAMROD) Building 69 - Waste Char-acterization, Reduction, and Repack-aging Facility (WCRRF) Radioactive Liquid Waste Treatment Facility (RLWTF)	Radioactive wastes Radioactive wastes Low-level radioactive liquid waste	Burned in canyons on both sides of the mesa and up to Pajarito Burned in canyons on both sides of the mesa and up to Pajarito Road south of the site, buildings were not burned
TA-53: Los Alamos Neutron Science Center (LANSCE)	Residual. radiation in equipment/targe ts when not operating, Radioactive sources, Chemicals Compressed gases Cryogens	Burned in canyon and up to Jemez Road south of the site, buildings were not burned, metal sign for site on Jemez Road burned
TA-54: Area G Radioactive Assay Non-destructive Testing (RANT) Facility Transuranic Waste Inspectable Storage Project (TWISP) Facility	Solid waste disposal site	Burned in canyons on both sides of the mesa and up to Pajarito Road south of the site, buildings and storage areas were not burned
TA-55 Plutonium Facility (PF-4)	Radioactive materials	Burned up to Pajarito Road and in adjacent canyon, buildings were not burned
TA-59: Emergency Operations Center (EOC)	NA	Burned through vegetation adjacent to buildings, buildings were not burned

Longer-term impacts have included:

- The environment, safety, and health emergency declared by the Laboratory on June 5th ended on October 11th.
- Program delays such as bringing the Dual-Axis Radiographic/Radiography Hydrotest (DARHT) facility on line.
- A delay in issuing the environmental assessment on wildfire hazard reduction[1] that had been scheduled for release in June 2000.
- Increased sampling of air, soil, and water.
- Excavating and controlling an underground fire at an old waste dumping site.
- Removal of contaminated soil in canyons to minimize the potential of increased concentrations of radioactive materials or hazardous chemicals in the runoff water.

Benefits of the Fire

LANL and Los Alamos also derived some benefits from the fire. These included:

- Some community connection beyond the Hill for Los Alamos and LANL
- Replace aging structures and infrastructure at LANL and the Los Alamos town site

- Need for local communications recognized
- Community involvement
- Realistic modeling of a fire scenario - The fire scenario in the SWEIS was examined in a special yearbook[7] to see how closely it paralleled the Cerro Grande Fire. The fire closely followed the path selected in the SWEIS fire scenario, but neither breached material containment nor yielded the estimated analytical doses.
- Building code and zoning changes - The county has adopted new fire resistance requirements for new structures.
- Need for defensible space around LANL structures and private homes recognized - As LANL had started doing around its structures several years ago, residents have been clearing vegetation around their homes to provide more protection to their homes from nearby fires. Initiatives have been undertaken to improve existing and to create more fire breaks at LANL in the surrounding area. Throughout the area, additional tree thinning has been done as funding and manpower permit.

Post-Fire Safety Analysis

Table 3 summarizes the information that has been accumulated to date on the treatment of wildfires in the LANL facility safety analysis documents. Not everything that happened at the facilities relative to authorization basis compliance was documented during and immediately after the fire. This was a decision made by DOE.

Table 3 - Post-Fire Safety Analysis

Facility: TA-16 WETF	
Existing: "The Weapons Engineering Tritium Facility Safety Analysis Report," 1989 [8] See next section of this paper	New: See next section of this paper
Facility: TA-18 LACEF	
Existing: "Safety Analysis Report for the Los Alamos Critical Experiments Facility (LACEF) and Hillside Vault (PL-26)," June 1994 (Not reviewed for paper at this time.)	New: BIO in development process Flooding analysis caused a water retention structure to be constructed in the canyon upstream of the TA-18 buildings.
Facility: TA-21-209 TSFF	
Existing: "Safety Assessment for the Tritium Salt Facility TA-21-209," Report No. SA 86-2, June 1986, Revised February 1987 Nothing on wildfires	New: None
Facility: TA-50-01 RLWTF	
Existing: "Final Safety Analysis Report for Radioactive Liquid Waste Treatment Facility at TA-50-01," Volume III, October 1995 Nothing on wildfires	New: SAR in development process
Facility: TA-50-69 WCRRF	
Existing: "Hazard Analysis for Interim Technical Safety Requirements (ITSRs) Waste Characteriza-tion, Reduction, and Repackaging Facility (WCRRF) Technical Area 50," February 2000 Section III. Hazard Analysis Results, page 8: "Fire Safety AC Requirements. ... the AC requirements also address the potential hazard from vegetation and brush both on the WCRRF site and on adjacent sites near the WCRRF boundary." Section IV. Consequence Estimates, page 16: A bounding fire scenario affecting the entire inventory of radioactive material outside Building	(Not reviewed for inclusion in paper at this time.)

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69 was evaluated. MAR = 15 kg of Plutonium (Pu) -239, dose at 1100 m = 1.1 rem Section V. Hazard Analysis Tables, page 44: "1.1.2 Brush fire spreads to stored waste; Risk Rank 3 - undesirable"	
Facility: TA-53 LANSCE	
Existing: "Basis for Interim Operation (BIO) for the 1L Target 2000-	New: (Not reviewed for inclusion in paper at this time.)
2002 Beam Delivery Periods," December 10, 1999 Nothing on wildfires	
Facility: TA-55 PF-4	
Existing: "TA-55 Final Safety Analysis Report," TA-55-PRD-108-01.1, LA-CP-95-169, Rev. 1, August 1996 Chapter 11, Section 11.4.1 Fire Hazards: "The nearest distance from outdoor storage units (chemical storage units, gas bottles, or compressed gas trailers) to stands of trees (approximately 300 ft) is such that the only meaningful exposure from a wild-land fire is flaming debris being thrown long distances; the noncombustible construction of the storage units makes the need for additional protection unnecessary. There are no wildland fire fuels except grasses within the TA-55 protected area and the storage units are located within paved areas. The only combustible construction within the TA-55 protected area are buildings PF-107, PF-189, and PF-218. None of these buildings represent a potential for fire spread between buildings or fire spread to hazardous materials being protected."	New: 90% Draft TA-55 SAR Chapter 3: Identifies forest/brush fires under Other hazards. These are treated as an initiator that could lead to the creation of other hazards and were reviewed for the potential of creating a fire within the TA-55 site boundary, including PF-4, 55-185, and other buildings and areas. Only scenario in Appendix 3B hazard analysis is "Forest fire next to PF-4 impacts facility." No accident analysis.

Analysis for the Weapons Engineering Tritium Facility

WETF was in the process of revising its authorization basis documentation at the time the Cerro Grande Fire started. The following is an example of what one facility experienced with the fire, details on the treatment of wildfires in its safety analysis report (SAR) at the time of the fire, and what is currently proposed for its new documented safety analysis. The new documentation recently went through a 90% review.

Current WETF SAR: The Pajarito Plateau, upon which Los Alamos is situated, has the second highest lightning strike density in the United States. A future lightning strike in the adjacent forests could again threaten the WETF if another wildlands fire were to be initiated. As a result, it will be a firm requirement in the new WETF SAR to maintain the areas surrounding WETF in a condition of U.S. Forest Service Fuel Model 2 or better at all times.

Under Natural Phenomena in the current WETF SAR[8], dated 1989, the following is stated:

"The probability of damage to the WETF from natural phenomena is judged to be small.

Fires: Although fires would be very disruptive at the WETF, the probability of their occurrence is very small. The combustible loading is very small in tritium-handling areas. Every effort is being made to eliminate Class A (wood, textile, paper) and Class B (oil, gasoline, paint, grease) combustibles from the tritium areas. The small quantities (volume and mass) of tritium used at WETF do not substantially increase the combustible loading."

The Cerro Grande Fire Effects on WETF: WETF is directly adjacent to Ponderosa Pine forested areas. In addition to the on-site process buildings, there are several transportable buildings used for offices including some with combustible wood siding exteriors. During the fire in May 2000, the wildfire for the most part remained on the ground burning the fuel available there, except for totally burning a few of the nearby trees. The LANL firefighters brought a bulldozer to the site the day the fire first approached WETF to fell some of the trees and to make a firebreak/road to hopefully protect the transportable buildings and the main facility. A serious concern was that if the transportable buildings were to ignite the fire could generate sufficient heat to ignite part of the exterior of WETF itself.

The firefighters were able to save the process buildings and also protected the more vulnerable transportables. Large quantities of water used to prevent the buildings from burning had cut trenches in the soil around the buildings as it flowed down the hill away from the structures. The fires burned through the area three times over the course of several days. Generally, fuel on the ground was consumed and the pine trees were scorched several feet up their trunks. Burned areas were evident upon return to the site within twenty feet of the transportable buildings.

Fire Hazard Analyses (FHA): The Laboratory's Ecology Group, ESH-20, has provided recommendations for continuing maintenance of the wildlands around WETF[9] and the calculations for predicting fire behavior based on U.S. Forest Service methods. Data from these calculation worksheets were used to estimate the possible heat energy output and size of a flame front for a wildland fire near WETF.

Fire exposure of the Exterior Insulation and Finish System (EIFS) installed on much of WETF has been analyzed in an appendix of the new FHA that is part of the SAR currently being completed. Nuclear facilities in forested areas across the United States could consider performing such an analysis for their locations as part of a future SAR update or upgrade. For WETF, some data from the insulation system's manufacturer is available and has been relied upon to show wildlands fire exposure of the facility exterior is not a problem. The heat flux that WETF would be exposed to during the postulated conservative wildlands fire scenario was calculated and compared to test data provided by the manufacturer of the exterior insulation system. The Southwest Research Institute Test Report concluded that ignition of the tested assemblies does not occur with an exposure of 12.5 KW/m^2 for 20 minutes. The conclusion reported in the FHA is that this test demonstrates that the exterior insulation system is highly unlikely to ignite at lower heat flux exposure levels. The goal of the analysis in the FHA was therefore to show that the heat flux that could be expected from a wildlands fire in the future would be less than the physical experiment exposure which did not result in the ignition of the siding in a 20 minute exposure.

The layout of WETF with respect to the wildlands was measured to gather data for the analysis. From the physical measurements that were taken, the area of a flame front in the burning trees was determined. The percentage of the total flame front radiant energy that would be intercepted by the WETF exterior wall was calculated based upon a rectangular flame front exposing an elemental area of the WETF wall parallel to the flame front plane.

The evaluation was performed based on conservative estimates of the physical phenomena that could occur during a wildlands fire near WETF. U.S. Forest Service Fuel Model 2 was used for the evaluation. Current conditions existing at WETF are less challenging than Fuel Model 2. For the evaluation to remain conservative, wildlands conditions in the proximity of WETF must continue to be maintained within the parameters of Fuel Model 2 or in a less challenging more conservative condition and the physical layout must not be inadvertently changed.

Conservatism in the calculations for WETF using the U.S. Forest Service Model was achieved by basing the scenario on:

- severe drought conditions were assumed to exist at the time of the postulated wildfire in the area of the facility,
- maximum estimated flame length was used for the view factor portion of the calculation,
- minimum estimated flame length for radiant heat flux at the flame front calculation,
- width of the flame front is assumed to be 100 times the width of the exposed wall,
- most exposed elemental area in the WETF wall is tested against the criteria by using heat energy output for a wind driven fire on 5% slope,
- also used a flame front spread rate for a fire with no wind on level ground, and
- the wall was assumed to be exposed at the maximum intensity (nearest flame approach) for the entire time it takes for the flame to travel 10 meters in the direction of the facility wall.

Recommendations from the Valerio Analysis[9]: "Based on Fuel Model 2 data, it is important to control grasses, needles, leaf litter to a maximum height of 6 inches within 100 feet of each building at the WETF complex. Thin trees within 200 feet of WETF so that their canopies do not touch. Keep grasses, needles, and leaf litter to a maximum height of 5 inches within 200 feet of WETF. Maintain fuels under the trees within 200 feet of WETF within the parameters of United States Forest Service Fuel Model 2. Areas between sidewalks and other paved surfaces, and the WETF building walls covered by the Exterior Insulation and Finish Systems should be stripped of vegetation. A non-combustible cover, such as gravel, should be placed over exposed soil to prevent vegetation growth."

The calculated heat flux exposure level of 4.48 Kw/m^2 calculated in the FHA appendix using the Forest Service Model indicates that the exterior insulation system on the process facility is extremely unlikely to ignite under the postulated wildlands fire scenario.

Draft WETF SAR: The draft SAR contains an expanded wildlands fire discussion supported by a analysis[10] and discusses mitigation activities that have occurred at WETF. Prior to the Cerro Grande fire, the trees in the immediate vicinity of WETF had been thinned considerably. Most of the fuel on the ground had also been removed. There was a green belt for some distance around most of the facilities, but trees were still within 50 feet of some of the transportables.

The wildlands fire hazard assessment for WETF, per NFPA 299, Standard for Protection of Life and Property From Wildfire, results in a low hazard rating. The ratings for some adjacent structures are medium and high hazard.

Roof fires from flaming brands or radiant heat are not a concern because of the use of Class A roofing systems throughout WETF. A Class A roof is designed, tested, and listed to be extremely resistive to ignition under this type of fire exposure.

Future: The analysis concerning wildlands fire performed for WETF is the first to be performed for a facility at LANL according to the analysts that completed the study. Some of the facilities at LANL are more protected than WETF in that they are not in the middle of a forest, or they are in the area where only smaller, and less dense pinon trees are present. As additional SARs are updated or upgraded for other LANL facilities, more of the wildlands fire analyses are certain to be performed to determine the risk to the facilities from wildlands fires.

Lessons Learned

Lessons Learned in the Community: Some of the lessons learned at the community level that apply to LANL include:

- Update call lists - Some homes did not receive automated phone calls to evacuate because they were not on the county's list. The automated system does not recognize delivering the message to an answering machine versus a person.
- The evacuation - The multiple exit routes from the Hill versus the one exit route from White Rock made an emergency evacuation easier and faster.
- Emergency planning - Evacuation routes and approaches for White Rock need to be addressed for the future. Since the fire, the Los Alamos County Police have developed an evacuation plan for White Rock. There was no evacuation plan before the fire.
- Utility supplies – Backups and emergency sources may need to be strengthened. Water pumps requiring electricity to function may need alternate emergency power sources.

Lessons Learned at LANL: At LANL, some of the specific lessons learned included:

- Several researchers lost the sole copies of years of their work when transportables were destroyed in the fire. This has emphasized the importance of having backup for irreplacable data.
- Real data now exists on how some of LANL's nuclear, chemical, and explosive facilities withstand fire of this type. What failed and what worked can be evaluated.
- Communications have been increased for those working in remote areas.
- Weather conditions have caused more stoppage of work. Personnel working in canyons and burned areas were pulled out of those areas with the threat of thunderstorms.
- Multiple access routes are helpful. Personnel have been inconvenienced when mudslides closed roads.
- Alternate utility supplies may be desirable.
- The EOC is outdated and cramped.
- A unified command was beneficial - Los Alamos County and Laboratory officials

worked together with DOE in the Laboratory's EOC.
- A single central database of Laboratory employee information is needed.

Lessons Learned from Recovery at LANL: A summary report[11] was prepared identifying LANL's lessons learned during recovery. Management systems, support services and infrastructure, and the workers are discussed in this report. At the time the report was prepared, some workers were still displaced, some programmatic work had not been resumed, and some damaged or destroyed facilities had neither been reopened nor replaced.

- Management systems require that improved institutional guidance on expectations, as well as emergency shutdown, recovery, and restart be provided.
- Support services and infrastructure require that support roles be clarified and infrastructure improved.
- Workers need better communications from management.

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