California/San Dimas Technology and Development Center Trip Report

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Introduction

On January 31 and February 4, 2008, I met with personnel at the U.S. Forest Service's San Dimas Technology Development Center (TDC) and the San Diego Fire Department. The following report outlines the findings and results of the meetings.

Purpose/objectives

The purpose/objectives of the trip were to:

- establish a research relationship with a similar research agency,
- learn about spark arresters and the locomotive spark program,
- discuss FPInnovations research on tank baffle systems,
- learn about the remote start pump system developed by San Dimas,
- discuss future collaborations for research to achieve common goals, and
- observe San Diego Fire Department night time helicopter operations.

Primary contacts

- Available upon request from Jim Thomasson, 780-865-6978

US Forest Service San Dimas Technology Development Center

I met with San Dimas TDC personnel on January 31 and the morning of February 4. We began with introductions and a discussion of the objectives of the meeting. I gave a brief history of the Chisholm fire and how it led to my research position in the area of wildfires along railway corridors. I was given a tour of the facilities and test labs, and reciprocal presentations on the capabilities and activities of TDC and Feric were made. Throughout the day, we discussed a variety of topics and projects.

Railway fires, causes, and spark arresters.

The San Dimas qualification process for spark arresters used in federal lands was discussed. All vehicles used in forested lands from ATVs to locomotive engines require approved spark arresters tested at the San Dimas lab. San Dimas is the holder of the QPL for spark arrestors and does all qualification testing. The causes of fires seen by TDC researchers are the same as here: carbon sparks, brake failure, bearing failure, and track grinding. In the 1970s, the TDC conducted research into the distance sparks will transfer. The test was very elaborate, with 1/2 mile of 2" wax blanket laid along the tracks. The test results showed 45 ft from centerline as the general rule for spark transfer but there is little additional information to support the number. When the data has been located, the TDC will share it with Feric. Although the research was done years ago, locomotives haven't changed much and the results are likely still applicable to some degree. There may be a case for adding to the research rather than repeating it.

The turbocharged engines have removed much of the source for carbon fires but poor maintenance can lead to carbon ejection. These newer engines do not require a spark arrester.

The TDC researchers also mentioned that Australia had done/is doing railroad fire research and I will follow up on that information.

Remote start pump

We discussed the remote start pump developed by the TDC, viewed the prototype, and reviewed the pros/cons of the design (Figures 1 and 2). It was productized by Wildfire Equipment. The unit has not selling well because of the expense and lack of suitable applications. The availability of the prototype for use means a production model does not have to be purchased. The unit is relatively reliable, and lights were added to show whether the motor was running and water flowing.

Figure 1. Prototype Remote Start Pump: note priming motor on the right.

Figure 2. Wildfire RemStart Control Box Prototype – Initial technology based on remote car starter.

Burn over protection

The TDC has a project developing crawler tractor burnover protection. Our NWT site would give the ultimate test in a large fire and the TDC envisions being ready for the testing in 2009.

Baffle protection

Another area of common interest was baffle protection and the tests we had done on the 400 gal slip tank. Results were surprising to the TDC researchers as they had thought the difference would have been larger than what we measured. They stated that the baffle protection was a very common request by the agencies as a safety improvement. Vehicle accidents with water tenders were the second biggest cause of deaths behind heart attacks during fire operations. The researchers had planned to test fire engines with 400-700 gal tanks but based on our data, the group felt that the results would show even be less difference with the bigger, heavier engine. We discussed the reasons for the results and they may do further tests on much larger tanks (greater than 1500 gal). They liked the Feric instrumentation approach and may devise a standard test using that procedure. If we do further testing, we could collaborate on the research work, with Feric testing the smaller tanks and TDC testing the larger tanks (10,000+ gal). There is soon to be a standard for water delivery systems in the USFS.

Library

I looked through the library and arranged for some documents to be copied. I brought the following documents back:

- Ignition Characteristics of Internal Combustion Engine Exhaust Products, San Dimas, September 1980
- Exhaust Particle Ignition Characteristics, technical report #12, University of California, Riverside
- Fire Start Potential of Railroad Equipment, San Dimas, September 1979
- Spark Arrestor Performance Tests, University of California , Los Angeles, Report 52-23, December 1952
- Spark Arresters for Motorized Equipment, University of California, Berkley, Bulletin 577, July, 1934
- Ignition Time vs Temperature for Selected Forest Fuels, San Dimas, November 1974
- Liquid Tank Baffles, San Dimas, March 2000.
- Firefighter Hand Tools, Biometric Analysis, San Dimas CD
- Helicopter Yarding Tool, San Dimas CD.

Additional documents related to locomotive testing will be sent by mail.

General Impressions

The biggest thing I saw was the similarity of answers that we are both seeking and the potential for collaborative research. Whether we share the work, or conduct joint testing, the results can only be positive. Further research can lead to increased sample size for experiments and avoid duplication of similar tests. This trip has further developed our collaboration and I have made valuable contacts.

I also met with the San Dimas Technology Center Director, and he has given us an open invitation to sit in on the Center's Steering Committee meetings as observers.

San Diego Fire-Rescue Department

I met with the Crew Chief for the night flying operation at the airport site. The equipment used for night flying operations is a restricted ITT Model F4949 Generation 3 night vision goggle (NVG) (Figure 3).

Ergonomics

The NVG attaches to a standard flight helmet with a specific bracket. The unit is heavy on the nose and this weight is offset by the battery packs attached to the rear of the helmet. Additional weight is added to the battery pack to balance the helmet. Some neck strain is experienced after long hours due to pressure on the nose and the overall weight of the device and helmet. When set up properly on the helmet, the device is about 1" from the eye and the wearer can look under the NVG to scan the cockpit instruments/take notes etc.

Operations

The San Diego Fire-Rescue Department operates a Bell 212 equipped for rescue and fire operations (Figures 4 and 5), with a 3 person crew consisting of a pilot, crew chief (winch operator), and rescue medic. Three crews work the machine. The pilots work 10 days on and 20 days off, 24 hours a day, but are limited to 6 hours night flying. They usually fly 3-4 hours /day under fire conditions. If the flight hours are too great in any one day, an additional pilot is called in. The Crew Chief and Medic work on the Kelly Fire Schedule, like the rest of the Fire Service and common in California. They work 24 hour shifts, one on, one off, and after 4 shifts on, they are off for 6 consecutive days, and then 4 more shifts on (alternating with 24 off) and then 4 consecutive days off.

Figure 3. ITT F4949 NVG attached to flight helmet. Battery pack attached to rear of helmet (4 AA).

Figure 4. San Diego Fire Bell 212 Fire/Rescue Helicopter.

Figure 5. Microwave system for transmitting live image data to ICP (FLIR usually).
Also receives data updates from the ground.

The helicopter operates under VFR (visual flight rules) at night, and the Federal Aviation Authority rules state that the pilot and crew chief must be on goggles at all times. The helicopter is not equipped to operate under IFR (instrument flight rules) and is operated as a single pilot operation. A Bell 412 is on order and will be IFR-capable but will operate under VFR rules for night operations. IFR use is envisioned to be airport to airport transfers but the main objective is close-in support operations.

Flight Operations

The helicopter flies 400-600 hours/year, of which one-third is at night, and one-half of the total is training. The night activities are search and rescue, fire fighting and training. The rescue hoist operations are seen as the most valuable aspect and they also have the highest risk (Figure 6). Rescue hoist operations are the most common night time mission. Bucket operations were tried but abandoned as the rotor wash picks up the water and the NVG cannot see through the mist created causing a white out. It is also limited due to depth perception issues and lack of a suitable point of reference. The helicopter is tank equipped, and at night, they always ground fill from designated sites only (Figure 7).

Figure 6. Rescue Hoist used for most of their operations.

Figure 7. Hydraulic pump on tank snorkel can fill the tank in under 10 seconds.

NVG Operations

The goggles provide very good resolution images, almost like eye vision. The NVG unit is auto-iris and adjusts automatically to light levels. It does adjust to bright lights but the effect is to wash out the view as the unit adjusts to a greater range of light. The helicopter is equipped with blackout blankets in the chin bubbles to stop the ground lights from affecting the goggles. This is another reason why vertical referencing activities like bucketing cannot be done effectively. The instrument lighting had to be changed to be NVG compatible. When flying, the Night Sun Searchlight tends to overwhelm the NVG, so the common practice is to aim the standard searchlight at the canyon wall 90 ° from travel and that provides enough illumination for flying up the narrow canyons.

The night time use requires extensive operator training and recognition of the different types of light seen, especially for depth perception. Depth perception is the biggest issue with use as it is difficult to tell if objects are 20 or 100 feet away. This has a big implication for vertical work. Generally the perception errs on the high side (you think you are 50 feet away when you are actually 200 feet). Scan pattern in the cockpit is different than daytime flying due to the restricted field of view (40° compared to 200° for normal vision) and NVG sensor's reaction to movement. The user needs to scan in short bursts and dwell at each point for a second or so to allow the brain to interpret the image.

The external scan for changing weather conditions is also different than in daytime operations with consistent weather. When the operator is concentrating on NVG activities, a change in weather may not be noticed. It has happened that the helicopter has flown up into the clouds while flying up the coastal valleys and concentrating on the ground. Flying under night conditions with NVG is more demanding than daytime operations and the pilots and crew chiefs must be very aware of changing conditions.

Fire Operations

The NVG unit amplifies existing ambient light. Light must be visible from the hotspot to be seen with the NVG. Small flames are readily seen and this method has proven useful for finding small hotspots. In some cases, these spots can be clearly seen from the air while ground crews would need to look hard to find them. The helicopter is also fitted with a FLIR sensor (Figure 8) so the two methods of hot spot identification can be correlated. The crew chief stated that the FLIR was more effective in finding the actual hidden hotspots than the NVG. He thought that if there was no flame, the NVG would not see the spot. The pilot thought the opposite. Informal Feric testing with a Gen 1 NV device showed no image without visible flame. A heated surface was not visible.

Figure 8. FLIR mounting, Night Sun Search light, Standard searchlight – Note Standard Searchlight is all that is needed for the NVG. Night Sun is too bright in most situations.

Training

Initial training was done by Aviation Specialties Inc of Boise Idaho which provides NVG training as well as NVG flight training. Once trained, the operator works under procedures developed by San Diego Fire-Rescue Department. All recurrent training is handled in-house.

History

The fire-rescue helicopter with night capability has been operating for 3 years without incident and it has been deemed a success. The night hoist rescue has saved many people and is one of the reasons the night operations continue. The unit works with stable funding from the City of San Diego, State of California, and casino profits. It is one of three agencies that conduct night fire operations. The others are Los Angeles County, and City of Los Angeles. Night flight operations are part of the San Diego's mandated operations, and it was not known if the other agencies flew at night on a regular basis.

Impressions

The operation looked very professional and the helicopter was well equipped. The capabilities and procedures were practiced and well documented. There is potential for wider forest fire application. The ability to deliver water during the lower fire activity period at night would allow ground crews to safely access these spots before they flare up with the heat of the following day. These operations should become more common when NVG technology is less restricted and less costly.

Documents

Night Operations Manual, San Diego Fire and Rescue, Chapters 1-9
Chapter 1 – Introduction
Chapter 2 – History
Chapter 3 – Aeromedical Considerations
Chapter 4 – Components and Characteristics
Chapter 5 – Terrain Interpretation
Chapter 6 – NVG Pilot Training

Chapter 7 – Firefighting
Chapter 8 – Rescue and EMS
Chapter 9 – Large Fire GO-NO-GO Checklist
Chapter 9 - Night and Mission Checklists
Chapter 9 – Nighttime Operational Period Checklist
Chapter 9 – NVG Mission GO-NO-GO Checklist
Chapter 9 – NVG Preflight Preparation for Use
Chapter 9 – NVG Preflight Weather Observation Checklist

Conclusion

The trip was very beneficial as it opened up contacts for the future and provided documentation/discussion of previous research. It showed the potential for collaborative research that can benefit both agencies. The information and interactions gave me new ideas as to general directions of the research on railway corridors. The San Diego Fire Department gave me good access to the crews, procedures and the helicopter. They offered to take me up on an operation but I declined until we have a project on the subject. Night firefighting will contribute to achieving fire suppression results for less cost, more efficiently and with reduced manpower. In all, the trip was good as it has allowed me to think about the future.

If you want more information about this trip, please call Jim Thomasson at 780 865 6978.