

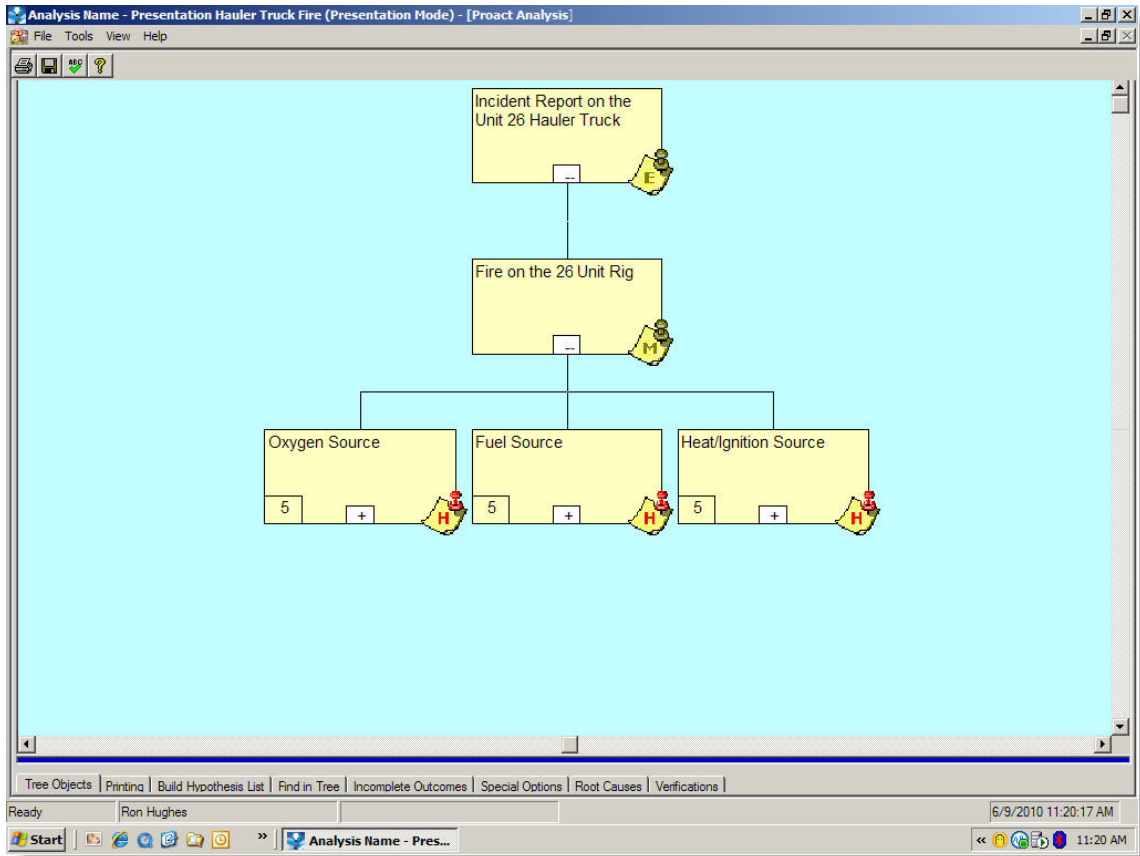
## Analyzing fires using PROACT® Methodology and Software Case Study: Hauler Truck Fire

On the surface analyzing fires would appear to be difficult due to the amount of destruction normally involved with these types of catastrophic incidents. Therefore what is needed is a logical approach to uncover the root causes associated with the failure under investigation. What appears to be difficult becomes easy when sound logic with accurate verification of facts quickly lead the investigator through the cause and effect



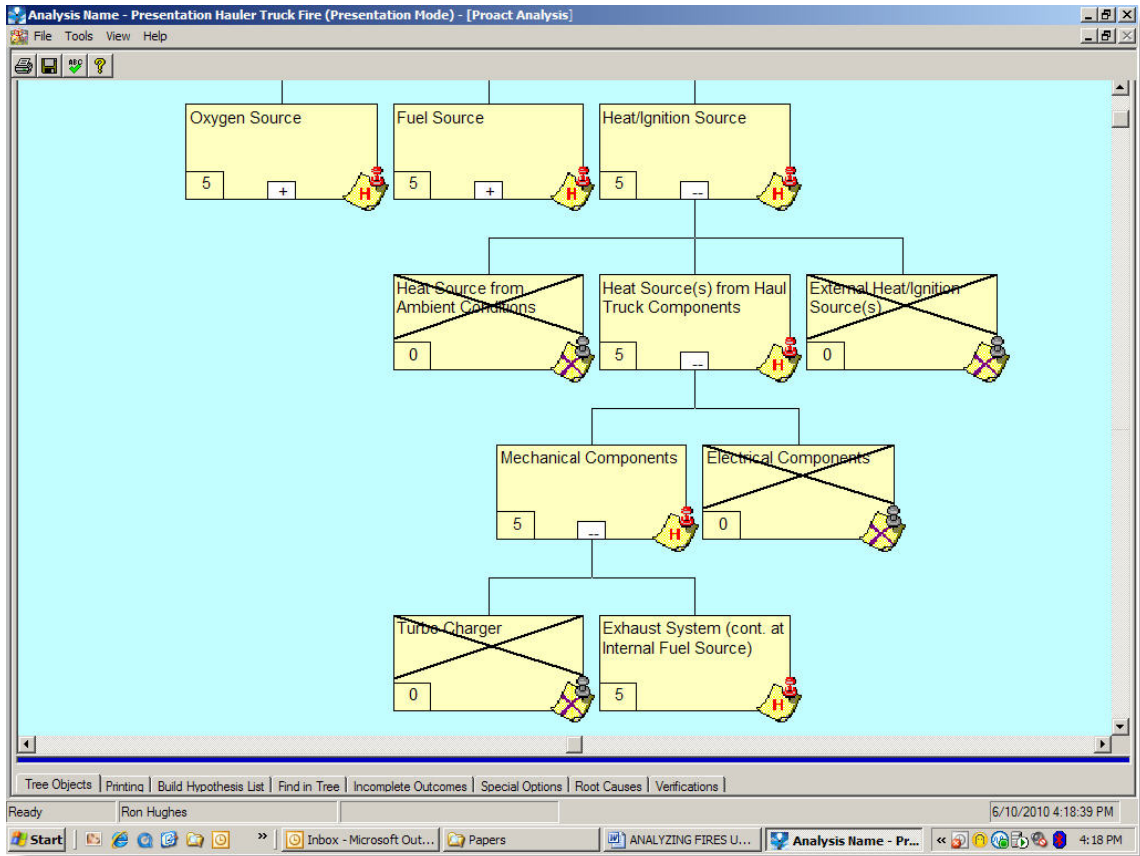
relationship that led to the undesired and unexpected event – in this case the fire. The PROACT® methodology is perfect for working through this relationship and PROACT® the software package is a great way to document and store the information used to validate the findings of the investigation. To illustrate how PROACT® works to solve these types of failures consider the following example of an incident investigation by one of our clients for a fire that occurred on a hauler truck at a mining operation.

Developing the top box which is actually a description of the failure is done by describing why you care and the observed or known failure modes. In this case we care because of a MSHA required incident report on the Unit 26 hauler truck and the mode is the observed Fire on the Unit 26 Rig.



The first level of hypotheses is easy as any fire must have an oxygen, fuel and heat/ignition source or else the fire just could not happen. These three hypotheses (modes) are therefore the standard breakdown for any fire or explosion.

As taught in RCI's PROACT<sup>®</sup> methodology training the next step is to prove or find where these sources of the fire originated. Obviously since there was an observed fire the three components of the fire were indeed present at the time of the incident. Now the question becomes "how can" we have these three modes, or more precisely where did they come from in this incident. Once all the possibilities are uncovered the analysis part actually is the verification of which of these hypotheses were responsible, and equally as important which were not, for the fire being analyzed.



Starting with the oxygen source it was determined that the oxygen present during the fire had to come from either an external or internal source. A review of the design and construction of Unit 26 haul truck showed that there are no pneumatic systems or components that could have supplied the oxygen source necessary for the fire under investigation. Therefore, the ambient conditions had to be the source for the oxygen that supplied the fire. Note that since there are no possibilities for uncovering any root cause for the oxygen source from the ambient conditions the analyst moves to another mode and refers to that mode for continued logic tree construction.

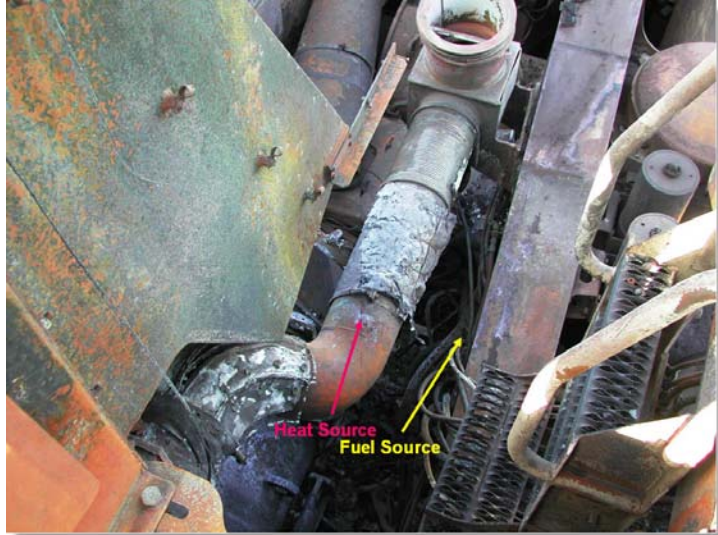
By being as broad and all inclusive as possible the heat/ignition source must have come from one, or a any combination of the three, possible contributors, i.e. the ambient conditions, hauler truck components or an external source such as flame cutting or welding during mine operations. A review of work orders and interviews with the appropriate mine personnel proved there were no situations where the ambient conditions or work activities in the mine could have provided the heat source of the fire. This leaves only the hauler truck itself which can be divided into either mechanical or electrical components.

The PROACT<sup>®</sup> methodology teaches analyst to follow the evidence trail in order to uncover cause and inspection of the hauler truck clearly shows the heat path going from the bottom center of the vehicle up towards the cab area. During inspection of the heat

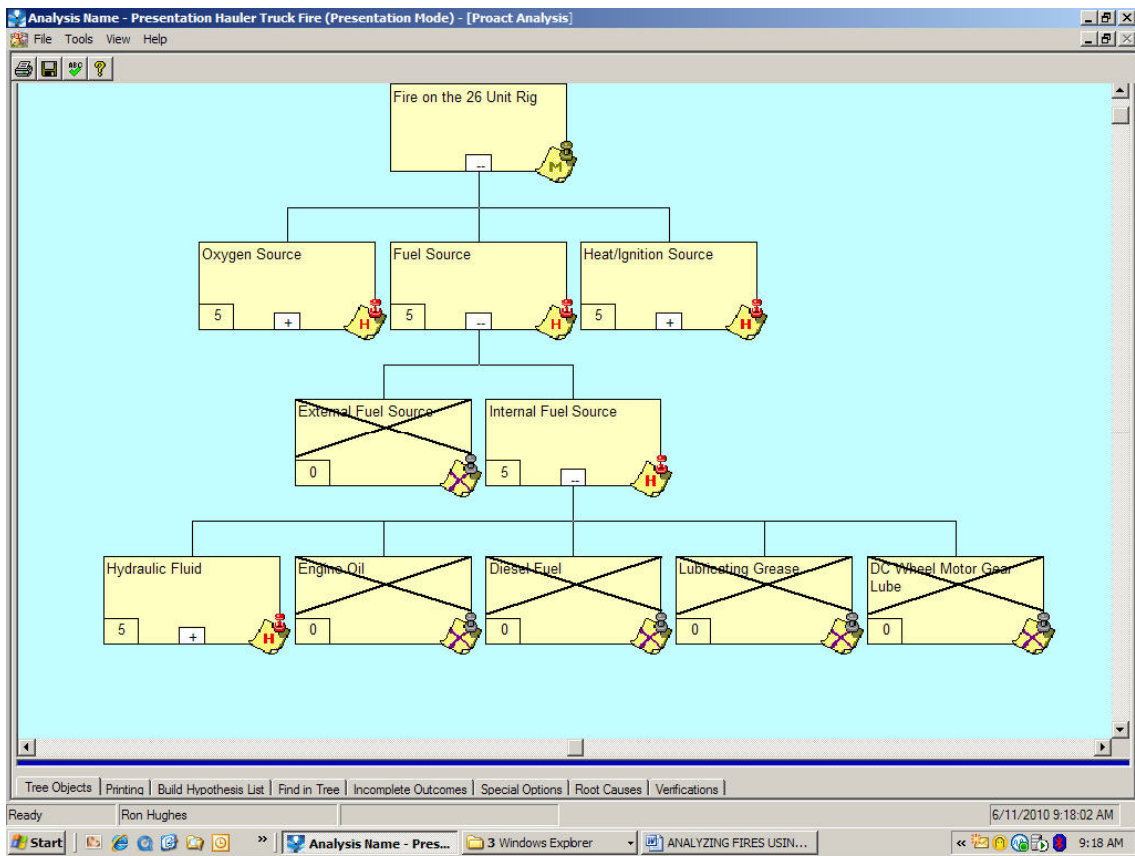
path ash is found on the exhaust piping located in the center lower area of the vehicle. This is clearly the location of the heat source.



Having determined the heat/ignition source the analyst moves to the final mode/hypothesis (fuel source) and refers to that mode for continued logic tree construction.

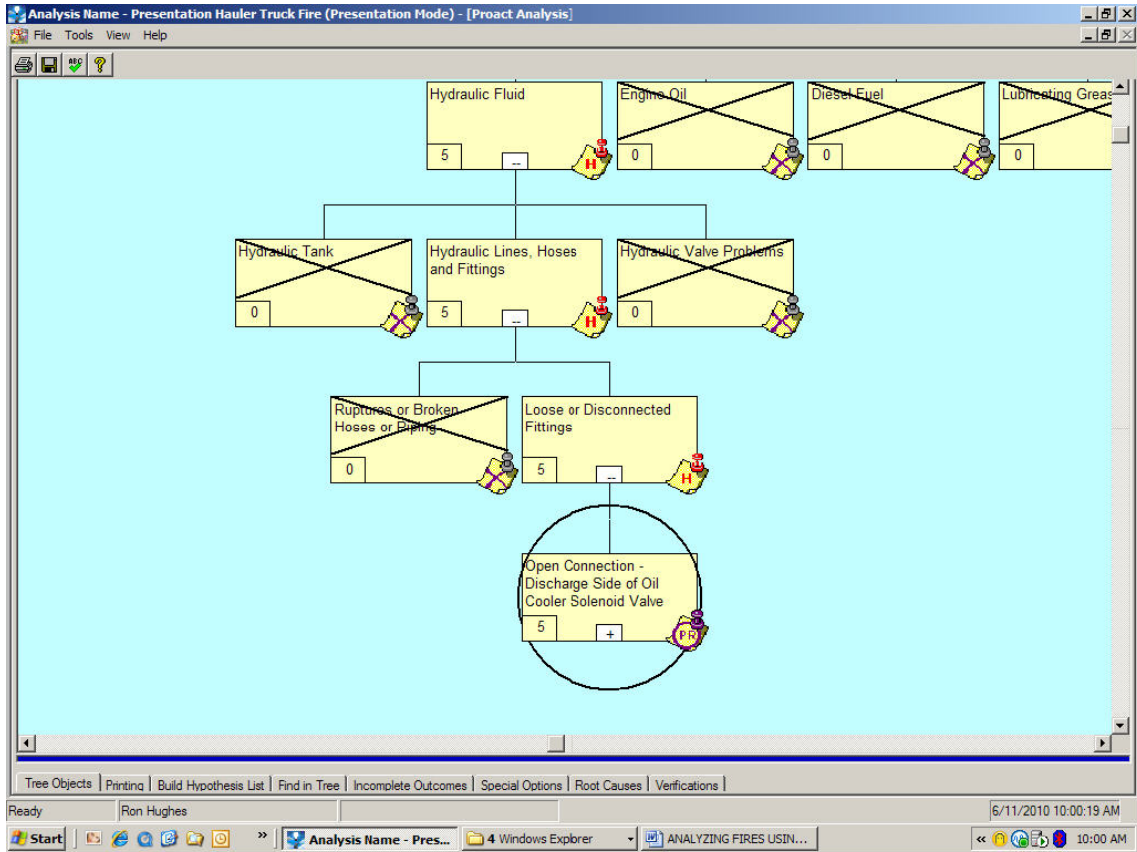


Just like the oxygen and heat/ignition sources, the fuel had to come from either an external or internal source. An external fuel supply for the fire is extremely unlikely but possible so therefore this hypothesis must be explored. An external fuel source is easily eliminated as nothing outside of the vehicle itself could have provided the fuel for the fire under investigation.

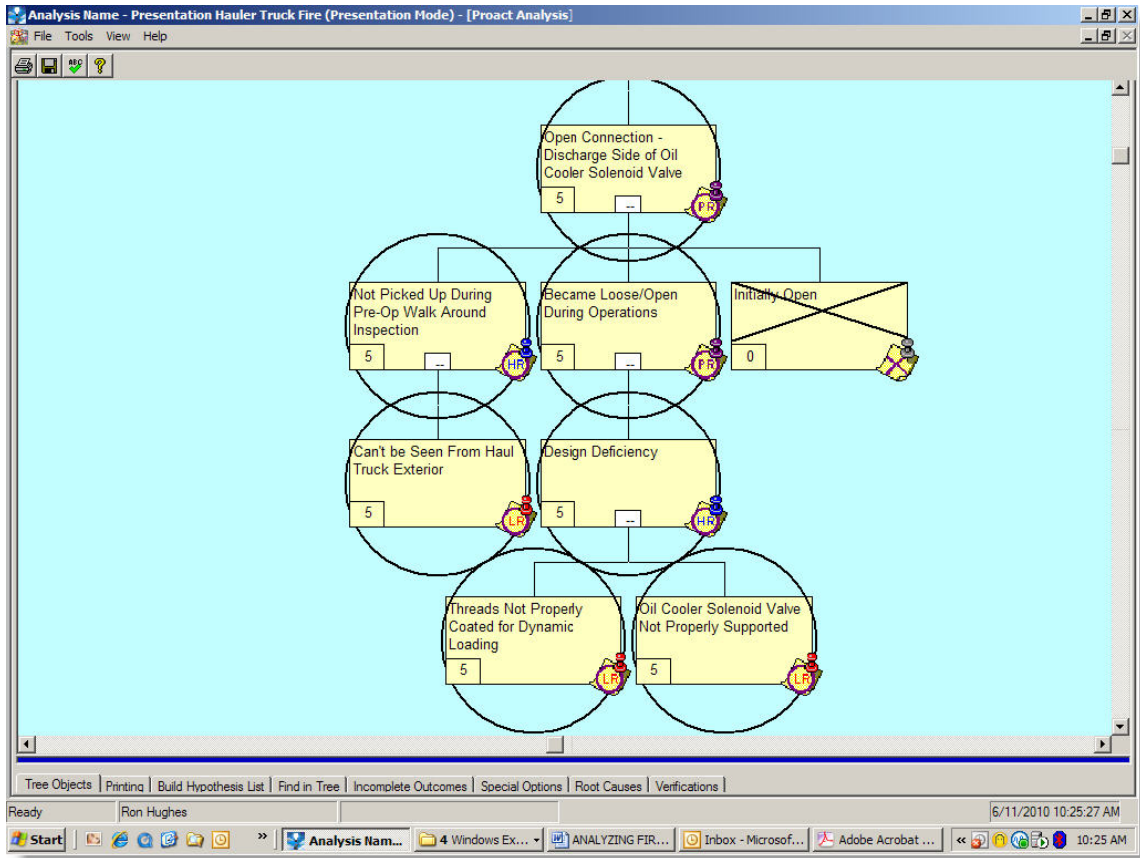


Five potential fuel sources are determined to be present on the vehicle, engine oil, diesel fuel, lubricating grease, DC wheel motor gear lube and hydraulic fluid. Although the damage to the vehicle is quite significant, all of these sources are found to be intact and

full with the exception of the hydraulic fluid and the diesel fuel which are found to be empty. However, the diesel fuel system has remained intact and the loss of the fuel can be contributed to the extreme heat present during the fire causing the fuel to evaporate. This leads to a more thorough inspection of the hydraulic system. Again following the PROACT<sup>®</sup> methodology and tracing the heat path, the source of the fuel is quickly found to be an open connection of the discharge side of the Oil Cooler Solenoid Valve.



This open connection is the physical thing that if corrected would have prevented or eliminated the incident under investigation (the fire) and therefore is labeled as a physical root cause of the failure. There are three possibilities for this valve connection being open. It was either initially open (which is determined not to be true), not picked up during initial walk around inspection by the operator (found to be true since it can not be seen from outside the vehicle and therefore the human and latent root causes) or became loose during vehicle operations (proved true by the evidence seen on the threaded connection another proven physical root cause).



Continuing to explore how the connection can become loose during operations it is determined by further examination of the threads that the valve had become loose during operations due to a design deficiency (another identified human root). This was due to the fact that the valve was inadequately supported (actually had no support) and that there was no locking or threading lubrication for the connection.

As a result of this analysis the client inspected the rest of his hauler truck fleet for possible similar failure symptoms (leveraged the analysis). Several vehicles received maintenance to prevent this sporadic failure from becoming a chronic problem throughout the fleet.

This example illustrates how a structured methodology such as PROACT<sup>®</sup> not only makes what appears to be a complicated analysis simple to solve but easy to manage when using PROACT<sup>®</sup> the software package.