Heavy Equipment Investigation #1

ENGINEERING REPORT

June 2006

PREPARED FOR: **INSURANCE COMPANY #1**

ATTENTION: **MS. ERIKA SLOVINOF**

INSURED: **CONSTRUCTION COMPANY #1**

DATE OF LOSS: **JUNE 2005**

LOSS LOCATION: KENTUCKY

POLICY NUMBER: N/A

CLAIM NUMBER: <omitted>

IC1 FILE NUMBER: <omitted>

Introduction

On June 2005, a Heavy Equipment Vehicle (Heavy Vehicle) caught fire while being operated by the insured, Construction Company #1, at a Kentucky construction site. The Heavy Vehicle had been rented by the insured from Equipment Supplier #1 of Kentucky and had been operated less than 3½ hours to the time of the fire event.

On June 2005, Ms. Erika Slovinof of the Insurance Company #1 contacted Investigation Company #1 and requested Investigation Company #1's assistance in determining the origin and cause of the fire. The author of this report, Scott A. Jones, P.E., C.V.F.I. and Senior Mechanical & Electrical Engineer of Investigation Company #1, (812) 944-9988, was assigned to conduct the fire origin and cause investigation.

The author's observations and conclusions from an inspection of the Heavy Vehicle and an exemplar Heavy Vehicle, review of service history records provided by Ms. Slovinof, review of the *Caterpillar Disassembly and Assembly Manual* provided by Ms. Slovinof, review of the ACORD Property Loss Notice and photographs provided by Ms. Slovinof, and interview of the Heavy Vehicle operator at the time of the loss are included in this report.

Background

Interview with Heavy Vehicle Operator, Mr. Jon Kane, Supervisor

On June 2005, the author interviewed Mr. Kane, who was operating the subject Heavy Vehicle at the Kentucky construction site at the time of the fire loss. Mr. Kane reported that he had 20 years experience operating heavy equipment and had worked for the insured for approximately 6 months to the time of the loss as a Supervisor. Mr. Kane reported that he had approximately 1 year experience operating the Caterpillar 615 model scraper.

Mr. Kane reported the events preceding and during the fire loss as follows:

- Ripsaw heavy equipment movers of Indiana delivered the subject Heavy Vehicle to the Kentucky construction site on the Friday preceding the fire loss.

- Mr. Kane arrived at the construction site on the day of the loss, <omitted>. He reportedly started operating the subject Heavy Vehicle at approximately noon. He did not add fuel or perform maintenance of any kind. The Heavy Vehicle had not been operated since its delivery to the job site on Friday.

- Mr. Kane reported that he successfully moved several loads of earth. At approximately 3:20 P.M., he had filled the rear bowl and had just started raising the bowl when he heard a loud "pop" sound and noted that hydraulic fluid was spraying upon the right operator's cab window.

- From his experience, he believed that a hydraulic tube and/or hose had ruptured, and in response, he immediately turned the operator's key to "off" and moved the throttle down to shut off the engine.

- While he was moving the throttle down, the region outside the operator's cab erupted into flames.

- Fearing for his life, Mr. Kane evacuated the operator's cab.

- Mr. Kane dialed 9-1-1 to alert the Fire Department of the fire. He reportedly attempted to combat the fire with a hand-held fire extinguisher, which was ineffectual at extinguishing the 30 to 40 foot flames emanating from the Heavy Vehicle.

- Mr. Kane reported that the Fire Department arrived 10 to 15 minutes after notification and extinguished the fire using water.

Observations

On June 2005, the author inspected the subject Heavy Vehicle at Equipment Supplier #1 in Kentucky. Mr. Danny Noonan, Supervisor at Equipment Supplier #1 met and directed the author to the loss unit, which was parked within the fenced and guarded periphery of the Equipment Supplier #1 facility. Mr. Noonan reported that the loss unit had been moved to the Equipment Supplier #1 facility following the fire loss.

The Caterpillar 615C Series II unit was marked as shown in *Photograph 1* with serial number identification <omitted> (*Photograph 2*). The driver's side of the unit appeared with extensive fire damage in the center pivot (i.e., articulating) joint as shown in *Photograph 3*. The cab region and upper portion of the engine compartment were heat/fire damaged as shown in the front view in *Photograph 4*. The heat damage in the articulation region appeared as shown in the passenger's side view in *Photograph 5*. There was no observed fire damage in the rear (i.e., bowl) section as shown in *Photograph 6*.

The fire damage to the hydraulics tubes and hoses at the articulation region is shown in *Photograph 7*.

There was little observed fire damage within the diesel engine compartment situated to the right and below the operator's cab as shown in *Photograph 8*. Nearly all plastic and elastomer materials within the compartment were intact.

The fire had consumed nearly all plastic, urethane, and elastomer materials within the operator's cab. All glass windows in the cab had been melted/broken out from the heat of the fire. The cab steering wheel and controls appeared as shown in *Photograph 9*. The fuse panel within the cab was extensively heat damaged as shown in *Photograph 10*, but none of the conductors within the region showed conductor-to-conductor or conductor-to-ground shorting. The operator's seat and fire extinguisher, presumably used by Mr. Kane, appeared as shown in *Photograph 11*.

Parted hydraulic tubes and a loose electrical conductor appeared at the driver's side of the articulating joint as shown in *Photographs 12 and 13*. Detailed inspection of the loose conductor (*Photograph 14*) revealed that the ends of the conductor had been soldered to their associated terminations (*Photograph 15*). A push pin connector appeared without indications of high resistance heating in the mid span of the conductor as shown in *Photograph 16*.

A rubber hose situated at the driver's side of the articulation joint, presumably utilized in the hydraulic system, had burned away as shown in *Photograph 17* and detailed in *Photograph 18*.

Articulating Joint Interface Hose/Tube Inspection

The hoses and tubes at the hydraulic interface were extensively damaged by heat and flames as shown in *Photograph 19*. A group of 8 tubes traveled up the back of the backbone structure for the bowl (*Photographs 21 and 22*). A group of flexible hoses met the tubes and proceeded aft to the hydraulic cylinders for the elevator, bowl, and suspension.

Close inspection of the tube/hose interface (*Photograph 20*) revealed that the rubber tube supports had been completely consumed by the fire. In addition, one of the hoses (i.e., driver's side, lowest hose) had completely separated from the associated crimp joint.

The author created ***Figure 1*** from *Photograph 23* to assist the reader in understanding the layout of the failed crimp joint.

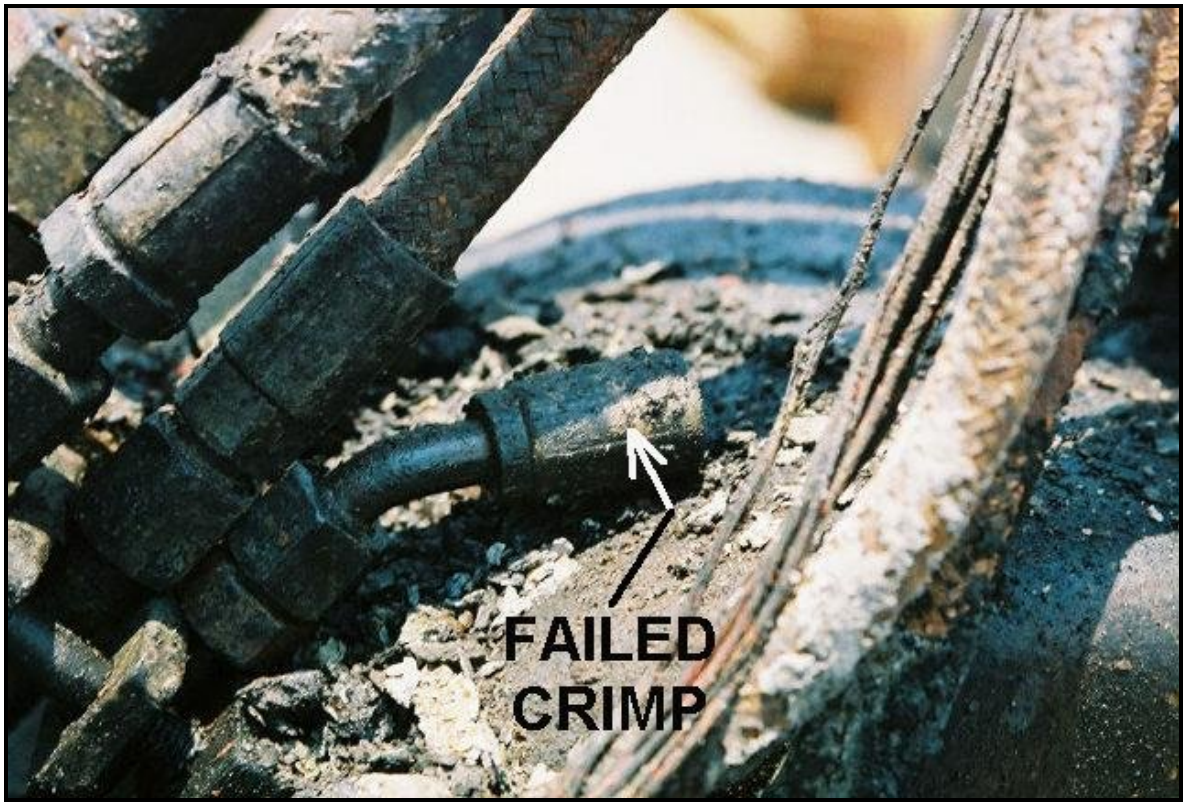

Figure 1 - Failed Hose Crimp Connection

The author utilized a thin stylus to probe inside the crimp connection for remnants of hose or reinforcement material. There was no hose or reinforcement material present within the crimp connection. A charred hose end, which presumably was a portion of the noted hose, was positioned at the top of the articulation joint as shown in *Photograph 24*.

Exemplar Inspection

On the day of the inspection, the author noted a similar Caterpillar 615C being utilized for training at a Equipment Supplier #1 equipment practice area. The author obtained permission from the driver to photograph the unit.

The articulating joint interface hose/tube interface appeared as shown in *Photograph 25*. The affected hose showed a pressure rating of 2610 psi (*Photograph 26*), and the tubes that proceeded down the backbone appeared as shown in *Photograph 27*.

Discussion/Conclusions

Comparison of the photographs of the tubes mounted upon the backbone (*Photographs 21 and 22* – affected unit and *Photograph 27* – exemplar) revealed a similar construction and routing with no anomalies noted between the units.

Comparison of the tube/hose interface (*Photograph 20* – affected unit and *Photograph 25* – exemplar) revealed that the connections at the interface did not share a common geometry. Specifically, with reference to ***Figure 1***, the failed hose crimp joint was connected to a 45º adapter fitting, which in turn was connected to the backbone tube. Examination of the same tube/hose connection of the exemplar in *Photograph 25* revealed a straight adapter in place.

The author created ***Figure 2*** to assist the reader in understanding the differences between the two units.

Figure 2 - Straight Adapter (Exemplar - Shown) Versus 45 Degree Adapter (Affected Unit)

In an attempt to learn the proper geometry of the interface, the author consulted the *Caterpillar Disassembly and Assembly Manual* provided by Ms. Slovinof. The proper (i.e., design) geometry of the adapters used at the tube interface was shown for the passenger's side only in Illustration 249 (*Caterpillar Disassembly and Assembly Manual – p. 57).* The Manual showed no depictions of the affected, driver's side of the interface.

In an attempt to understand the maintenance history of the subject unit, the author reviewed the maintenance records for the subject unit that were provided by Ms. Slovinof. The records revealed the maintenance history for a Cat 615C Series II Scraper with Serial number <omitted> and *not* the affected unit with Serial Number <omitted>.

Summary

The driver of the Heavy Vehicle at the time of the fire witnessed the release of what he considered to be hydraulic fluid upon the right operator's cab window immediately preceding the eruption of fire in the same region.

The author's examination of the affected unit revealed no indications of an inadvertent grounding of a power conductor upon a hydraulic hose, frame, or author appurtenance in the region of first observed fire.

However, the author did discover a single hydraulic hose that had pulled from its respective crimp joint (reference ***Figure 1***). As noted in the Observations section of this report, the geometry of the tube/hose interface did not follow the geometry of an exemplar Caterpillar 615C Scraper examined at Equipment Supplier #1.

It is believed with a reasonable degree of engineering certainty that the first fuel to the fire was hydrocarbon-based hydraulic fluid that was released to the environment when the noted hydraulic hose crimp connection suddenly and catastrophically failed during operation of the subject Heavy Vehicle. It is believed with a reasonable degree of engineering certainty that the ignition source for the fire was the exposed exhaust stack situated to the right of the operator's cab. Diesel exhaust stacks situated downstream of the turbocharger exhaust have a surface temperature in excess of 900º F, well above the auto ignition temperature of hydrocarbon-based oils.

The insured reported no maintenance, fueling operations, or any other acts that would have affected the physical integrity of any hydraulic system on the affected unit. *It is believed with a reasonable degree of engineering certainty that Equipment Supplier #1 provided the subject Heavy Vehicle to the insured with the subject hydraulic hose in a deleterious condition, which led to the catastrophic failure and consequential fire*. Conditions that

promote catastrophic failure of a crimp joint include a poorly formed crimp of hose insert material and a routing from original assembly or defective maintenance that does not leave the hose in the lowest energy condition possible (e.g., sharp radii bends).

It is believed with a reasonable degree of engineering certainty that the insured, Construction Company #1, had no responsibility for the conditions that led to the subject fire event. Due to the sudden and catastrophic nature of the event, it is believed with a reasonable degree of engineering certainty that the insured, Construction Company #1, could have not have anticipated or taken actions to prevent the fire event. Upon discovery of the fire, Construction Company #1 attempted to mitigate fire damage by immediate application of fire suppression powder.

The analysis and conclusions are based upon information reviewed to date, plus general engineering knowledge and experience. Information reviewed at a later date may warrant modifying or augmenting the conclusions.

We appreciate the opportunity to work with you on this evaluation. Pending further direction, this file is considered closed. Please let us know whether we can be of further assistance to you.

Sincerely,

Investigation Company #1

Scott A. Jones, P.E., C.V.F.I.
Senior Mechanical Engineer & Electrical Engineer