PROBLEMS WITH WOOD BORING BEETLES IN POLES

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Summary

The following report summarizes a series of investigations performed by BC Hydro involving Lodgepole pine poles that failed while in service. The poles in question were of 1969 vintage, thermally treated with Pentachlorophenol. It was determined that the Golden Buprestid beetle was responsible for the initial damage which precipitated fungal attack and a further infestation by a variety of other wood boring insects. Based on these failures and other points of concern related to the use of Lodgepole pine, BC Hydro deemed it necessary to revise its wood pole specification to require a mandatory sterilization period for all pine poles manufactured for purchase by BC Hydro.

Introduction

In March of 1998, reports were received from BC Hydro line crews on Vancouver Island regarding an unusually high number of premature wood pole failures. They also identified a substantial number of in-service poles that were in need of stubbing or replacement. Test and Treat personnel described these poles as containing extensive internal decay. Several insect exit holes were also noted on the structures, indicating an infestation by some type of wood boring insect. Initially, it was suspected that carpenter ants were responsible for the failures since several ants had been observed on the surface of the poles. The presence of frass on ground surrounding the structures also supported this conjecture. Of interest, was the fact that the failures were limited to Penta treated Lodgepole pine poles purchased and installed in 1969/1970.

Earlier, in December of 1993, similar failures had been reported in the northern Okanagan district of British Columbia. These failures did not generate a lot of attention since only a few poles were involved and the failures occurred during a winter snowstorm. The adverse weather conditions at that time did not allow for a thorough examination of the poles that failed. When the details of the report from Vancouver Island were compared with those received from the Okanagan, it was noted that there were several factors that linked both incidents. These factors included the age and species of the poles, the type and method of treatment and the presence of oval shaped insect exit holes.

An investigation was launched to assess the severity of the problem on Vancouver Island and to determine the root cause of the failures. Several in-service poles that had been identified for replacement were targeted for this investigation. In addition, it was decided to visit three separate locations to confirm whether or not the failures were all related. These locations were Ladysmith and Duncan on Vancouver Island and Gabriola Island, which is situated due east of the city of Nanaimo. The participants in this investigation were Dexter Tarampi of BC Hydro Distribution Maintenance and Leon Joseph of BC Hydro Corporate Quality Assurance.

Methodology

The investigative procedure included a visual examination of the surface condition of each pole. Wood core samples and resistograph readings were taken to assess the remaining strength and shell thickness of the poles that were tagged for replacement. Samples of the frass from the interior of the poles and from the surrounding ground were collected for examination. The shape and size of the insect exit holes were measured to help identify the species of insects infesting the structures. In addition, trees and fallen logs located in the immediate vicinity of the poles were examined to determine if they, too, had experienced a similar attack. Prior to this investigation, Dr. Robert Duncan, of Forestry Canada, was contacted for technical advice. He graciously provided several publications that greatly assisted in the insect identification process.

A search of BC Hydro's records was initiated for the purpose of identifying any possible irregularities or circumstances related to the pine poles that were purchased in 1969. Local pole suppliers were also contacted to inform them of the situation and to request any information that they might have available that would shed light on this problem.

Investigation - 1998

Upon arrival at the selected sites, it was very evident that the reports received from the field were completely accurate. Though the exterior surface of the poles appeared to be in very good condition, wood core samples and resistograph readings revealed severe internal fungal attack and extensive insect mining. The tests performed by the investigative team were limited to the ground line and points extending 2 meters up the length of the poles. It was determined that the portion of the heartwood that had been damaged varied from 40% to 100%. In several poles, only the treated sapwood shell was intact and supporting the structures. The insect infestation included that of carpenter ants, termites, pill bugs and wood wasps. Though it was apparent that these insects had caused significant amounts of damage, of greater concern was the presence of Golden Buprestid beetle tunneling and exit holes.

The Golden Buprestid Beetle

The Golden Buprestid beetle, *Buprestis aurulenta,* is a metallic woodborer that is native to western North America, ranging from central British Columbia to southern California. It is known to cause an extensive amount of damage to wood in service, which often goes undetected until such time that the adult beetles cut their exit holes. Though the Golden Buprestid prefers Douglas fir, it is also known to attack true firs, pines, spruce and western red cedar. The larvae generally excavate their mines in the sapwood portion of a log, but will also occasionally attack the heartwood.

The appearance of the beetle is quite spectacular and easy to distinguish. (figure 1) Its wings and head are a brilliant metallic green with a red line along the outer and inner edges of the elytra. The glossy underside of the beetle is a brilliant bronze/gold color. An adult beetle measures approximately 20 mm in length by 8 mm in width. When in flight, its rigid wings cause an easily heard buzzing sound.

Adult beetles lay their eggs on recently dead trees, dying trees, or unseasoned logs. They are particularly attracted to trees with bark injuries such as those caused by forest fires, logging or lightning. Eggs are laid in crevices and scars, which hatch within a couple of days. The newly emerged larvae bore into the wood and excavate mines that are enlarged as the larvae grow in size. Newly hatched larvae are about 2mm long and mature ones may reach 38mm in length. (figure 2) The appearance of the larvae is creamy white with brownish mouthparts. Its abdomen is long and slender and abruptly segmented.

The larvae entrance holes are very tiny (.5mm), which poses a real challenge for wood graders to detect at the time of manufacturing poles or timbers. Especially during adverse weather conditions, the presence of entrance holes can easily go undetected. Adding to the problem, is the likelihood that the initial attack is confined to only one small location on a log. From that point, the tunneling of the larvae can extend throughout the entire length of a pole or a timber.

It is important to note that these beetles do not attack logs once the bark has been removed and will not infest milled timbers or wooden structures. In the documented cases of severe damage to buildings caused by the Golden Buprestid beetle, in all instances, the infestation occurred prior to bark removal and the milling of timbers. Such was the case of the popular Orpheum Theatre in Vancouver. During a roof replacement, timbers that had been salvaged from the Taylor River forest fire on Vancouver Island were purchased at a "bargain price". These timbers contained Golden Buprestid larvae. This resulted in serious damage to the theatre when the emerging beetles exited the timbers and tunneled through the tar and gravel roof. This allowed moisture to enter the structure, resulting in serious water damage to the theatre. The end result was a very costly replacement of the newly reconstructed roof. This calamity could have been avoided if the timbers had been properly kiln-dried prior to installation.

There appears to be some difference of opinion regarding the initial depth of penetration of the larvae and the amount of strength loss caused by their tunneling. In the case of the BC Hydro poles, it was noted that the tunneling in the heartwood was not confined to any particular depth of penetration. In addition, the direction of travel of the tunnels varied from perpendicular along the grain to horizontal across the grain. It was also noted that the beetle exit holes tended to be located on the face of the pole receiving the greatest amount of direct sunlight. This would seem to indicate that the temperature of the wood plays a factor in encouraging the pupation cycle.

The elliptical exit holes, which measure approximately 4mm by 8mm, are quite distinctive and easily identified. (figure 3) Though the holes themselves cause little damage, their presence provides entrance points for moisture and a host of other wood destroying organisms and insects. It was observed on several poles, that wood wasps and carpenter ants were using these open doorways to access the untreated heartwood.

By far, the most remarkable feature of this species of beetle, is its life span. While most wood boring insects enjoy a life span that ranges between 1 to 5 years, the Golden Buprestid beetle would seem to be from another world. In the forest, its larval stage generally lasts 2 to 4 years, but when active in wood subjected to seasoning and low humidity, such as, wood poles, it can span as much as 60 years prior to pupation. The damage that a single larva can inflict in this amount of time is substantial. While there may not be any visual evidence of an infestation, woodpeckers can easily pinpoint the larvae by honing in on its audible chewing. It was noted that woodpecker exploration holes served as a very good indicator that a structure had being subjected to beetle attack. Some poles contained numerous drilling sites that varied in size from10mm to150mm in diameter.

Investigation – 2000

In February of 2000, a report was received from Telus safety personnel concerning several joint use poles that were discovered to contain extensive internal decay at the telephone attachment plant. These poles were installed on Cortes Island, which is situated in the Inside Passage separating Vancouver Island from the mainland of British Columbia. Once again, the focus of attention was on 1969 vintage, Penta treated Lodgepole pine. A meeting was arranged with Telus personnel, who provided several photographs and a sample of a pole section containing beetle exit holes. It was decided at this meeting that a second investigation was necessary in order to formulate an action plan that would resolve this issue and prevent a repetition in new pine poles. Dave Yu, of BC Hydro Distribution Engineering and Planning and Robert Huffer, of BC Hydro's Joint Use Department joined the original investigative team. The Campbell River district office provided the services of a line crew and a bucket truck to facilitate access to the entire length of the poles.

On May 31,2000, the team set out on the three-ferry voyage to Cortes Island. Upon arrival, it was very quickly determined that a different approach was needed to deal with poles damaged by the Golden Buprestid beetle. Prior to this report, the investigative team had primarily focussed its attention on the lower portions of the poles being examined. It was never suspected that the internal damage could be equally severe in the upper portions. The discovery made by Telus personnel clearly demonstrated that the entire length of each pole had to be examined.

The first observation that indicated the severity of the problem on Cortes Island was the extensive woodpecker damage inflicted on the structures. Several poles were riddled with exploration drilling sites and holes sufficient in size for a team member to fully extend his arm, upward and downward, inside a pole. The detection of beetle exit holes at all heights of the structures indicated that the damage of the Golden Buprestid was present throughout the entire pole length. Wood core samples and resistograph readings confirmed that the heartwood of the majority of the poles had been completely destroyed. (figure 4) In excess of 90 poles had to be replaced on Cortes Island alone.

Arrangements were made for the team to be present when several of the infested poles were removed from service. These poles were sectioned and split apart so that the team could probe the insect galleries and collect specimens for examination. This exercise was successful in capturing a Golden Buprestid larva and several fully mature beetles. Using a drawknife, several entrance holes were shaved in attempt to establish the initial depth of penetration of the larvae. In all cases, it was determined that the newly hatched larvae had penetrated the heartwood. Unfortunately, the presence of extensive decay in the heartwood area made it impossible to determine the precise depth of initial penetration.

It was also discovered that a number of the adult beetles, that had exited the poles, returned to their exit holes to die. Their corpses were located at the base of the holes, just inside the untreated heartwood. The absence of frass in these exit holes indicated that the beetles had reached the surface, making it possible for them to leave the structures. Why they chose to return is uncertain. Possibly, they were overcome by the effects of chewing through the Penta treated sapwood.

Another point of interest that was noted concerns the variety of insects that were found to be living within very close proximity to one another. In one pole, a carpenter ant gallery was located approximately 30mm away from a termite gallery. Immediately below the termite nest, was a gallery of pill bugs. In addition, several wood wasp and weevil nesting areas were located in the same pole. No doubt, the presence of all these insects provided a very attractive food source for the woodpeckers in the area.

The Telus discovery also raised serious concerns regarding BC Hydro's test and treat procedure for Lodgepole pine. Traditionally, only a superficial visual examination of the upper portion of in-service poles was made at the time of inspection. If the tests performed in the vicinity of the groundline yielded good results, then, the balance of a pole was assumed to be in equally good condition, if not better. The possibility of having to fumigate pine poles at higher levels of structures had to be contemplated.

Discussion

Several questions had to be addressed; relevant to how the Golden Buprestid beetles came to be in the poles and how they survived the treatment process. These questions were:

(1) Why did the Penta treating solution not kill the young Buprestid larvae?

The answer pointed to the frass that is tightly packed in the tunnels excavated by the larvae. Unlike the coarse texture of the frass of carpenter ants and termites, the frass of the Golden Buprestid is very fine in texture and appears to contain a mixture of wood extracts and some form of beetle secretion that hardens to form a protective barrier. A careful sectioning of the tunnels revealed that the Penta treating solution had only penetrated the frass a very short distance into the heartwood (approximately 10mm). Whether or not pressure treating would have made a difference in penetrating the frass is not known.

(2) Why did the temperature of the thermal treating process not kill the larvae?

At the early stages of growth, the Buprestid larvae should have been located in close proximity to the sapwood/heartwood interchange. At that depth, the temperature and duration of the thermal treatment cycle should have been sufficient to sterilize the wood in that area, thus killing the larvae. It would appear that the initial penetration of the larvae must have been much deeper into the heartwood then would normally be expected. It is also possible that the moisture content of the pole stock was well below the fiber saturation point. This would have allowed the treating plant to reduce the duration of the treatment cycle and still achieve the desired chemical penetration.

(3) Why were the failures limited to 1969 vintage, Lodgepole pine?

Unfortunately, it is not possible to answer this question with absolute certainty. The only information available on which to base a plausible conclusion, is an informal BC Hydro Interoffice memo dated 1969. The contents of this memo focussed on a decision to purchase a number of fire-kill poles that had been offered to BC Hydro, by a supplier, in that year. Apparently, these poles had been salvaged from a forest fire area in Idaho. A retired BC Hydro employee who had been involved in wood pole procurement in 1969 vaguely recalled this agreement. This assumption was further verified by a discussion with two individuals in the wood pole industry, who also recalled an acquisition of fire-kill pole stock from Idaho.

The CSA 015 Wood Utility Poles and Reinforcing Stubs standard condones the use of fire-kill material provided that there is no charring of the surface of the poles. (CSA-015 3.3.(b) This standard also imposes the following limitations on insect damage: "Insect damage, consisting of holes 1/16 in. or less in diameter, or surface scoring or channeling shall be permitted." (3.4.6) The entrance holes of the Golden Buprestid, the mountain pine and the ambrosia beetle, all fall into this category. While the latter two, do not pose a significant threat to a treated pole, the entrance holes of the Golden Buprestid beetle most certainly do. This is especially true, in the case of poles that have been treated with waterborne salts, since the temperature of such treatments does not reach a sterilization level.

The fact is, that most wood pole graders lack the expertise to differentiate one insect entrance hole from another, This poses a danger that the entrance holes of the Golden Buprestid beetle would most likely be ignored. Without proper sterilization, the larvae can easily survive the treating process, thus posing a danger of future problems for the customer. Clearly, greater control and special precautions should be considered relevant to the use of fire-kill material. Pole suppliers must also exercise great care when purchasing pole stock that has been stored for any length of time, with the bark still on the logs. The removal of all bark, as soon as possible, including the bark in knot inclusions, will serve to protect pole stock from attack by woodbores such as the Golden Buprestid beetle.

Conclusion

The investigations performed by BC Hydro staff positively linked all the failures to the Golden Buprestid beetle. The established reproductive traits of this woodborer and the tests performed by the BC Hydro investigative team, confirmed that the buprestid larvae were present in the poles, prior to the purchase and installation. Considering how difficult it is to recognize the buprestid's entrance holes, BC Hydro is convinced that the pole supplier was completely unaware of the infestation. To prevent future problems of a similar nature, BC Hydro revised its wood pole specification to require a mandatory sterilization period for all new pine poles. The parameters of time and temperature for this period were based on the U.S. Department of Agriculture handbook formula and figures for calculating the temperature of wood. It was also decided to prohibit the use of fire-kill material for poles intended for sale to BC Hydro.

These investigations also served to demonstrate that greater attention must be given to the upper portions of in-service poles, during the test and treat examinations. The lack of an accurate database highlighted BC Hydro's need to keep better records of all wood pole purchases and installations. It also revealed that greater attention was needed in the area of reporting and recording details of failures that occur in the field. To ensure the safety of BC Hydro's customers and line crews, the investigative team intends to arrange additional visits to other areas where 1969 vintage pine poles are in service. The intent is to remove all poles that display evidence of Golden Buprestid activity.

References

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*** Figures 1, 2, & 3, courtesy of John McLean, UBC Faculty of Forestry.***

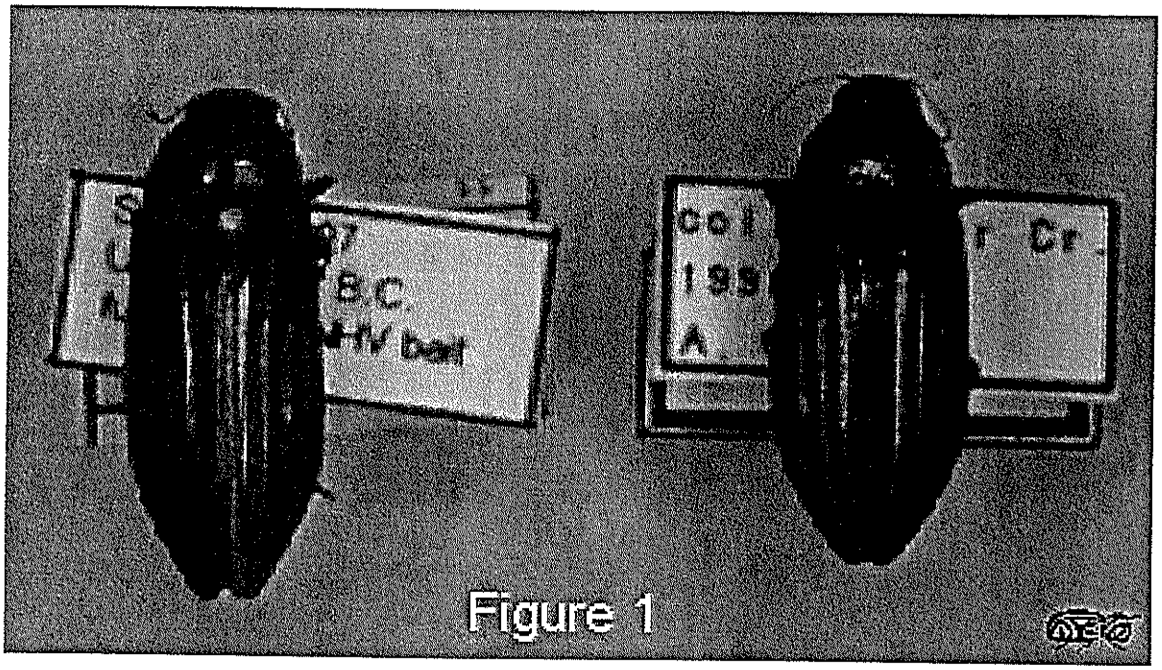

Figure 1

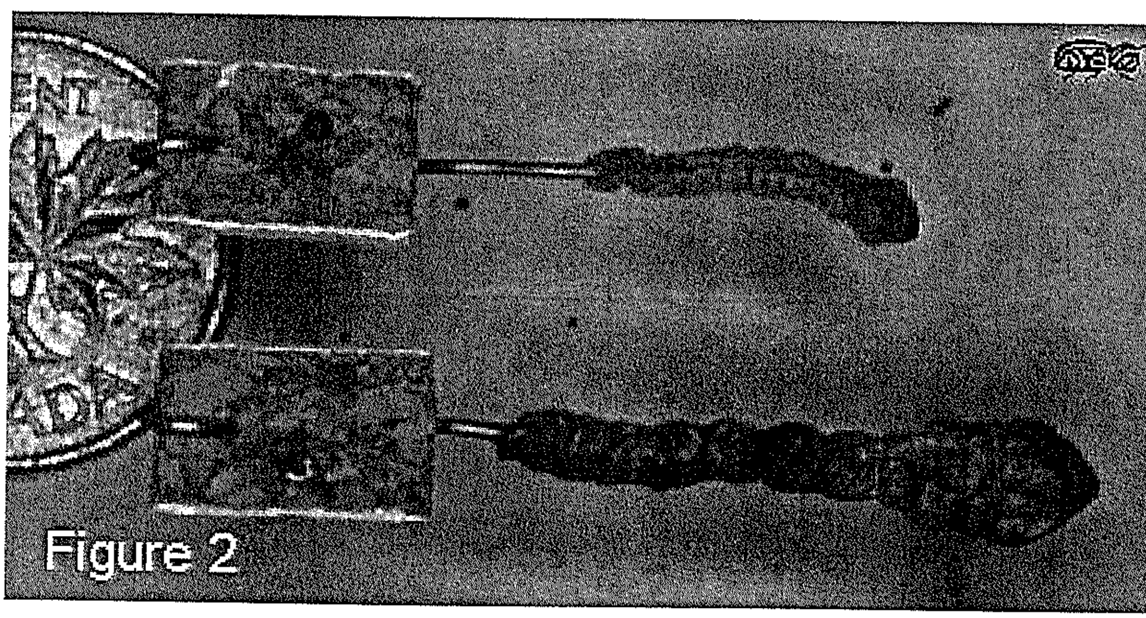

Figure 2

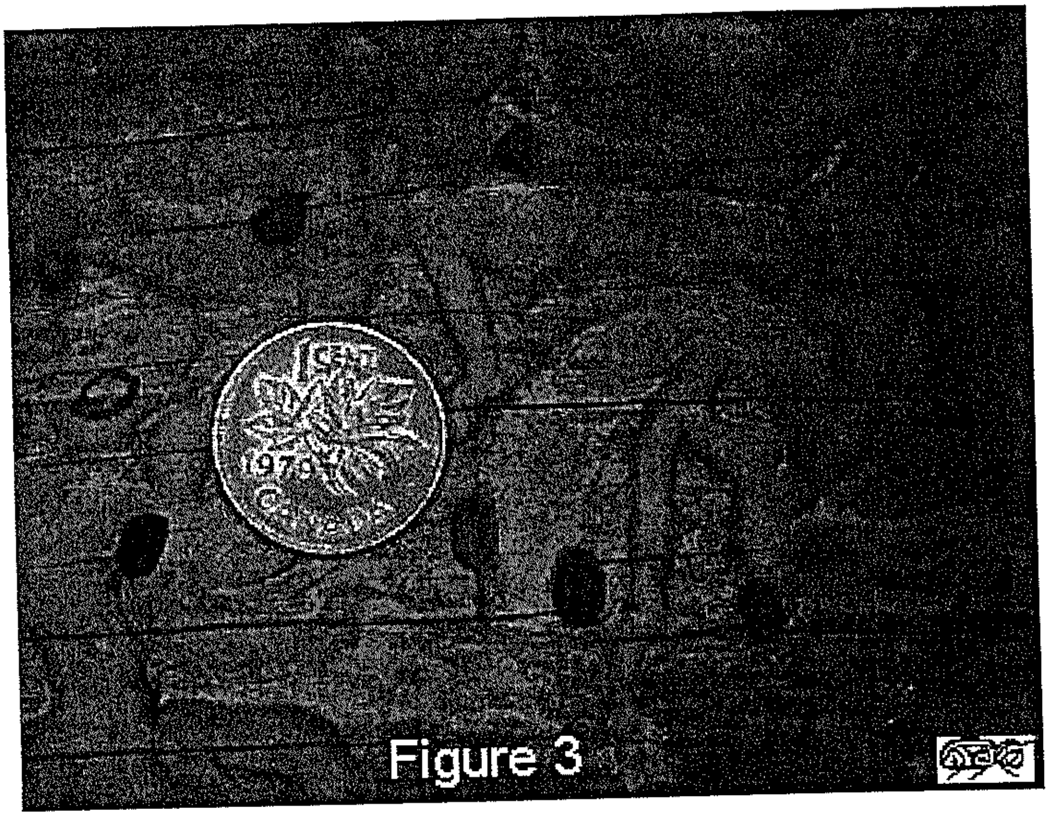

Figure 3

Figure 4