WHEEL SEPARATIONS ON TRACTOR-TRAILERS A Brief to the Ontario Ministry of Transportation and the Ministry of the Solicitor General and Correctional Services
(Provided below is an exerpt from the full 20-page brief. For a copy of the full report, please contact PEO at (416) 224-1100)

Working Group on Tractor-Trailer Wheel Separations:

- John F. Clayton, P.Eng., Vice-President, FAMEX Engineering (Chair)
- Victor J. Artem, CET, Senior Research Technologist, Research and Development,
- Petro-Canada Lubricants
- Dr. Peter C. Birkemoe, P.Eng., Professor, Dept. of Civil Engineering, University of Toronto
- Dr. Lalit Malik, P.Eng., Manager, Metallurgical Technology, Fleet Technology Ltd.
- Ronald J. Twigg, P.Eng., President, Glencor Engineering Ltd.
- Thomas R. Wood, P.Eng., Consulting Engineer, Metals Failure Analysis, T.R. Wood
- Consulting
- John H.F. Woodrooffe, Principal, Roaduser Research International
- Ron Covello, P.Eng., Manager, Vehicle Standards Office, Ministry of Transportation (Ex-Officio)

PEO Government Affairs Committee
September 18, 1995

Executive Summary

Wheel separations on tractor trailers have become a matter of great public concern. This year, there have been more than 17 such separations in Ontario; a number received extensive coverage in the news media. This coverage highlighted what has been a long-standing problem, and led the Ministry of Transportation to implement new truck-safety inspection measures in spring 1995.

Since then, additional incidents of wheel separation and other trucking accidents have prompted the newly elected Progressive Conservative government to direct the Ministry of Transportation and the Ministry of the Solicitor General and Correctional Services to produce jointly a long-term highway safety plan due in early October. A Coroners Inquest is also scheduled for early October to look into the causes of two wheel separation accidents which resulted in fatalities earlier this year.

Preventing wheel separations on tractor-trailers raises many complex issues. The obvious solutions may be better maintenance and informed inspection. Other solutins may exist. All must be practical and economically feasible.

Analysis of the Problem

In Ontario, detailed technical data about these recent wheel separation incidents or other transportation accidents are not made available in the public domain as they are in other countries, such as the United States. As a consequence, organizations concerned with public safety can neither analyze basic technical information about specific wheel separation incidents, nor conduct a statistical analysis of the various causes of wheel separation over a specific period of time.

In the absence of such information, Professional Engineers Ontario has called upon the extensive collective experience of the forensic engineering community to draw its conclusions.

There appear to be a number of possible causes of wheel separation, ranging from the liberal axle weight and configuration regulations in Ontario to wheel assembly component failures.

However, the most common cause of wheel separations is inadequate servicing and maintenance of double-cap nut disc wheels, referred to as stud-piloted wheels or as Budd wheels. Stud-piloted wheels are usually employed in pairs (duals) with four to an axle. The dual wheels are secured by two nuts (inner wheel nut and outer cap nut) per stud. The inner wheel and the inner wheel nut are, in fact, completely obscured and cannot be inspected without removing the outer wheel. It is extremely difficult to inspect this type of wheel for deterioration of parts and assembly.

The recent advent of the hub-piloted wheel is an improvement over the stud-piloted system, primarily because one flanged cap nut per stud secures both the inner and outer wheels in each dual. When a stud breaks in the hub-piloted wheel, it is instantly recognizable as a failure. However, this design does not overcome the problem of detecting cracked studs. It should be noted that there is insufficient data to assess statistically the anticipated improvement or potential failure mechanisms of hub-piloted wheels. The same is true for flange nuts which have been developed in conjunction with the hub-piloted wheel.

Corrosion is a major problem for all wheel systems. This is especially true in Ontario where the presence of salt on the roads during winter months accelerates the corrosion process of steel a hundred fold. The corrosion process is ongoing, regardless of whether a tractor or trailer is in use.

During installation and maintenance procedures, precise torquing is a major contributor to the safe operation of a stud-piloted wheel. Over-torquing can occur and cause disc distortion, disc-hole damage, stud deformation and stud breakage. More importantly, it may cause time-delayed fracture of the wheel studs at their root, through hydrogen embrittlement. Under-torquing generally results in the nuts backing off; uneven torquing can produce cracked discs, distortion and imbalance.

Maintenance and inspection without understanding is only partially effective. At present, there is no requirement for the licensing or training of tire mechanics or inspectors. Further, no specialized training is required for licensed mechanics to work on heavy trucks and trailers; and, there are no consistent guidelines for servicing trailers.

A problem that has surfaced in recent years is the use of substandard, grey market or counterfeit spare parts and components in tractor-trailer disc wheels. These parts may be of inferior quality and are lacking in quality control and may falsely indicate that they are manufactured to specification. Counterfeit parts even carry the manufacturers designation and part numbers.

Conclusions

1. A general lack of statistical and technical data and specific accident information has hindered the preparation of this brief.
2. Training, maintenance and inspection are inadequate. Tire mechanics and inspectors are not required to be licensed.
3. The most reliable wheel design appears to be the spoked wheel configuration.
4. A major cause of wheel separation has been associated with stud-piloted wheels, which are generally regarded as being maintenance-sensitive.
5. A general lack of understanding of the significance of torque and its relation to the stress induced in studs leads to increased potential for failure.
6. Many of the problems associated with stud-piloted wheels appear to have been overcome by the advent of hub-piloted wheels and flanged single nut fasteners, but are as yet unproven.
7. Corrosion seems to be an important factor in the general deterioration of all wheel systems in southern Ontario. This is associated with a phenomenon called hydrogen embrittlement, which appears to be contributing to stud failure.
8. Liberal axle loading allowances and eccentric axle configurations have undoubtedly contributed to wheel separation, as well as contributing to the rapid deterioration of Ontarios highways.
9. There is evidence that substandard, grey market or counterfeit parts are circulating in Ontario. However, it is unknown what impact such parts have had on public safety.
10. The practice of taking trailers out of service for long periods and then reintroducing them into service without adequate inspection is dangerous.
11. The incidence of wheel separations may never be reduced to zero, but it is anticipated that the potential for such accidents would be significantly reduced through the implementation of the recommendations incorporated in this brief.

Recommendations

To help reduce the incidence of wheel separations in tractor trailers, Professional Engineers Ontario makes the following recommendations:

1. Statistical and technical data should be made available upon request to organizations and individuals with a mandate for public safety.

2. All available wheel separation accident data should be examined for a correlation between wheel separation and vehicle design issues. Statistics on hub-piloted wheels should be compiled and analyzed.
3. Stud-piloted wheels require a preventive maintenance program and guidelines associated with qualified inspection.
4. Standards of training for maintenance and inspection of heavy-duty vehicles need to be established, upgraded regularly, and regulated. This is particularly true for tire mechanics.
5. Mechanics and inspectors should attend OEMand after-market parts manufacturers seminars and study groups, and should pursue other training opportunities.
6. Means of mitigating the effects of corrosion on wheel systems should be undertaken.
7. Vertical and lateral wheel loads should be estimated on the basis of Ontario weight and dimension regulations; the effect of these loads on trailer performance and highway deterioration should be evaluated.
8. A permanent log book documenting every trailers service and maintenance history should be mandatory. Failure to maintain and produce such a log should be a punishable offence.
9. There should be a continuing search for substandard, grey market and counterfeit parts in Ontario to which the trailer log book will make a significant contribution.
10. Penalties for those identified as having attempted to circumvent maintenance and safety requirements for either tractors or trailers must be sufficiently severe to provide a deterrent.
11. Quality control procedures should be implemented by OEMs and after-market parts manufacturers.