

Record Number: 2129

CIS Descriptors: WELDING AND CUTTING  
PULP AND PAPER INDUSTRY  
GASES  
BURSTING

## FATALITY REPORT

### REPORT CHARACTERISTICS:

DONOR: Office of the Chief Coroner  
JURISDICTION: Ontario  
REPORT TITLE: Verdict of Coroner's Jury  
INDIVIDUAL PRESIDING: Dr. D. Cooke, Coroner  
PLACE OF INQUIRY: Trenton  
DATE OF INQUIRY : 1988-11-29

### INFORMATION ABOUT DECEASED:

NAME: Major Matheson  
OCCUPATION: Welder  
INDUSTRIAL SECTOR: Pulp and Paper Industry  
NAME: Michael Rutt  
OCCUPATION: Welder  
INDUSTRIAL SECTOR: Pulp and Paper Industry

### ACCIDENT INFORMATION:

DATE OF FATALITY : 1988-07-12  
PLACE OF ACCIDENT: 1. Premises of Domtar Packaging and Paper Mill. 2. Trent River adjacent to Domtar Packaging Paper Mill.  
BRIEF CAUSE OF DEATH: Massive trauma due to acceleration/deceleration injury.

BRIEF MANNER OF DEATH: Explosion of a gaseous mixture.

#### ACCIDENT DESCRIPTION:

This inquest concerned the circumstances around the death of two welders who died in an explosion at Domtar Packaging on July 12, 1988. The deceased were employees of Trenton Machine Tool which had been contracted by Domtar to erect a 240,000 gallon white water storage tank on the premises of Domtar Packaging in Trenton, Ontario.

This tank had been built with identical dimensions to a preexisting white water storage tank and interconnected to it by a single 2 foot connection at the base. The purpose of the construction of this tank was to provide additional white water storage for this pulp and paper mill to prevent overflow of processed water "white water" into the Trent River at times when the mill processes were being adjusted. The new white water tank had been interconnected with the existing mill processes July 5, 1988.

On July 12, 1988 the three welders were working on top of the tank installing catwalks and safety railings. At approximately 1:36 pm there was an explosion involving this white water tank which caused this tank with dimensions of 32 feet in diameter and 38 feet in height to be raised approximately 70 feet in the air and then 50 feet to one side onto the roof of the papermill. One of the welders was off to the side of the tank working on a catwalk and somewhat miraculously survived with minimal injury. The two other workers who were on the roof of the white water tank at the time of the explosion were hurled each in excess of 300 feet. One of them was thrown into the Trent River and the other completely across the pulp and paper mill onto a paved workarea on the opposite side of the paper mill.

This accident was completely unexpected as it was assumed that this tank contained basically water with a small amount of cellulose fibre, probably less than 150 parts per million.

Although the welders had oxyacetylene equipment with them, it was not in use at the time of the explosion and witnesses to the explosion indicated that the explosion started from substances within this large tank. Subsequently it was calculated that on an optimal basis the energy available in their oxyacetylene tanks could not have resulted in the production of the forces observed in this explosion.

Subsequent investigation indicated that approximately 15 minutes before the explosion, the pulp and paper mill was undergoing a planned shutdown. As a consequence of this, the level of white water in this tank was rising during the 15 minutes or so before the explosion. As the investigation progressed, it was hypothesized that the rising level of water had expelled a mixture of gases in the headspace of this tank out onto the roof of the tank through a vent in the roof. It was hypothesized that either the arc welding or more probably one of the hot grindings of one of the workers ignited this gas on the roof with subsequent explosion of the entire contents of the head space of the tank.

This in the beginning was a completely unexplained phenomenon without previous precedent known at the time on July 12.

The investigators included representatives of the Fire Marshall's office along with Domtar research personnel. Specimens of process water "white water" and other concentrations of cellulose fibre and water were taken from the mill for analysis. Subsequently the Domtar research facility, the forensic science laboratory and the inland Federal Ministry of inland waterways laboratory were able to produce significant amounts of hydrogen gas from specimens. The mechanism of production was felt to be anaerobic bacteria.

It was felt this was likely a newly recognized phenomenon in the pulp and paper industry. A subsequent report of a similar explosion without loss of life dating from September 19, 1987 was published in October 1988. It was further hypothesized that the construction of this white water tank had in effect produced a relatively stagnant environment that was optimal for the anaerobic bacteria to produce hydrogen. In fact as a consequence of this accident this pulp and paper mill was

shutdown for some period of time and within the week after the accident, explosive levels of gas were found in multiple locations within the pulp and paper mill as a consequence of stagnation in various storage chests.

Because most pulp and paper mills are rarely shutdown for longer than 48 hours it was felt that under most circumstances explosive levels of hydrogen gas accumulating would not be expected.

Despite this, samples of white water were taken by Domtar research people from five other pulp and paper mills and four of these pulp and paper mills had white water samples that would generate hydrogen if put under optimal circumstances.

Domtar Packaging, Trenton, Ontario  
Procedure #4  
Hot Work

#### Purpose

The purpose of this procedure is to specify measures that are to be taken prior to commencing "hot work" (welding, cutting, grinding) in order to ensure that explosive gases or combustible material are purged, removed or isolated from the work area. The objective is to

ensure that personnel are not exposed to injury due to gas explosions or fire as a result of such "hot work" and that property damage is prevented.

#### Procedures and Responsibilities

1. When cutting, welding or grinding must be done outside the maintenance shop, a permit shall be obtained from the supervisor of the department in which the work is to take place and a copy sent to the mill fire marshal. It is the responsibility of the department supervisor to determine that the work area is safe for such work. He may consult with the fire marshal should there be any question. The permit shall be good for one eight hour shift only. If the work extends beyond this shift, permits must be renewed for each additional shift.

The department supervisor and the fire marshal shall maintain on file their copies of the permit(s).

Only trained and authorized people are permitted to cut, weld or grind.

2. As a condition of issue of a permit for cutting, welding or grinding on, inside or in the vicinity of, a tank or chest, a thorough check of the area both inside and outside of the tank or chest shall be carried out using the explosimeter in the presence of the person(s) assigned to the work. Should a gas mixture reading cause the explosimeter to register an alarm, the tank or chest must be completely purged and successive tests continued until no alarm occurs.

This procedure shall also be followed prior to issue of a permit for cutting, welding or grinding on pipes or near a tank vent, a chest vent, an overflow point or any opening which may expell an explosive

gas mixture.

Only personnel trained in the use of the explosimeter are to conduct tests and such personnel must enter the final "safe" reading on the permit together with their signature.

Purging of a tank or chest may be done by overflowing the tank or chest with water or by the use of a blower. Pipelines may be purged with air or water as appropriate and isolated where possible.

Should the work period be of extended duration (more than one shift), gas tests must be repeated during successive shifts.

3. In addition, as a condition of issue of a permit and the commencement of cutting, welding or grinding, an inspection shall be made of the work site by the department supervisor and combustible material shall be removed or isolated from the work area to the satisfaction of the supervisor.

4. Where cutting, welding or grinding results in molten material or sparks falling from a higher to a lower level, combustible materials must be removed from the impingement area. If removal is not possible, these materials must be properly covered with metal sheeting or other fire retardant barrier material. In cases where, because of specific conditions, a fire hazard still exists, then an employee will be assigned by the department supervisor to act as fire watch and will be provided with appropriate extinguishing equipment.

Potential presence of explosive gas in such impingement areas shall be recognized and treated in accordance with Section 2.

5. Whenever cutting, welding or grinding proceeds up to the end of shift, an inspection must be made by the department supervisor or personnel assigned by him to assure that nothing is left smoldering or burning. A periodic inspection of the work site shall be made during the following shift.

6. All mobile maintenance cutting, welding or grinding units shall be equipped with a hand type water pumper for spot extinguishing.

7. Extinguishers fully or partially used are to be taken to the maintenance shop and replaced with a spare. This will ensure that the unit is serviced and made ready for reuse. Extinguishers that were assembled at the job for emergency protection but not used should be quickly returned to the station they were temporarily taken from upon completion of the work.

#### RECOMMENDATIONS ISSUING FROM INQUIRY:

General:

1. The pulp and paper industry be alerted as expediently as possible to:
  - a) the existence of the formation of potentially dangerous amounts of hydrogen gas by anaerobic bacteria in processed water eg. white water.

b) that appropriate measures eg. ventilation, agitation and aeration be implemented to minimize stagnation and the production of hydrogen and explosive gases.

c) use of equipment to continuously monitor for explosive gases in identified areas of hazard and log the findings of each examination.

d) installation of a warning system and signs to indicate to employees that levels of gases are dangerously high

2. That the pulp and paper industry and Domtar Inc. verify that the most appropriately qualified individuals at their disposal be utilized in future design changes in mill operations and they be reviewed appropriately before implementation.

3. It is recommended that the legislature consider amendment of the legislation (particularly the Workers' Compensation Act and the Family Law Act) so that, in circumstances similar to those in this matter, the financial recovery of the family of the deceased is not limited to \$2,500.00, which amount is less even than reasonable funeral and burial expenses.

#### 4. Safety:

A) In the area of safety, all industry should provide the workers with information about potential hazards and safety procedures through appropriate updated training sessions.

B) The certification of welding be granted after successful completion of a technical and safety programme.

Safety to "Domtar"

5. That Domtar Inc., Trenton initiate a reliable means of reporting accidents and near misses to its Joint Health and Safety Committee so appropriate recommendations can be made.

6. That measures be taken immediately to verify that all welders and maintenance staff are aware of new "hot work procedures" (see Schedule A, Procedure #4).

#### COMMENTS ON RECOMMENDATIONS BY CORONER:

Recommendation 1 consisting of parts a, b, c and d:

1a. This recommendation was directed at the pulp and paper industry being alerted as quickly as possible to the existence of this new phenomenon of hydrogen gas formation by anaerobic bacteria in various process materials within the pulp and paper industry under ideal conditions. It was felt that a prerequisite for significant formation of hydrogen gas was stagnation of processed materials with the accompanying exclusion of air to optimize the ability of the anaerobic bacteria to ferment the organic material to produce the hydrogen.

1b. Technical information was introduced to indicate that measures to minimize the stagnation of processed materials away from air could

minimize the potential for the production of hydrogen. For this reason it was suggested that measures of agitation and aeration be looked at in the pulp and paper processes. In locations where the potential for production of hydrogen gas still existed, it was proposed that methods of both passive and active ventilation be considered. Passive ventilation being considered forms of ventilation that did not require mechanical assistance such as vents with enough naturally occurring draft to produce evacuation of headspaces in tanks and chests. Active ventilation would include mechanically assisted methods of ventilation such as fans to exchange headspace gases. Expert testimony was received to indicate that bacteria producing the hydrogen were anaerobic bacteria and that while pulp and paper mills were in production the tendency for formation of hydrogen was minimal because of the natural recurring aeration of the process water as it circulated through the pulp and paper mill. Research had indicated that at times of shutdown or in this case, times when defective design produced the equivalent of a shutdown with stagnated process water the risk was most significant for hydrogen production. It was suggested that at times of shutdown with appropriate agitation and aeration in chests or tanks containing materials at risk, the potential for production of hydrogen could be greatly reduced.

1c. This recommendation was directed at the use of monitoring equipment to check continuously for the accumulation of explosive gases in identified areas of hazard such as certain stock chests and white water storage tanks within the pulp and paper mill.

1d. Referred to the addition of signs next to recognized areas of potential accumulation of explosive gases.

As mentioned above all these recommendations were directed not only at the Domtar facility but the pulp and paper industry in general since evidence was introduced to indicate that this was not in all likelihood a unique phenomenon to this pulp and paper mill but in all likelihood the genesis of this problem existed in many pulp and paper mills given the ideal conditions.

Recommendation 2. This recommendation was made in response to testimony indicating that the design of this additional white water storage capacity at this pulp and paper mill had been done in a large measure onsite. In view of the disastrous consequence of this design the jury made this recommendation presumably to encourage Domtar Inc. to verify that their most appropriate qualified individuals were utilized in future for design for this sort of addition to the mill processes or other mill changes.

Recommendation 3. This recommendation was made in response to testimony that indicated that despite any concerns of liability with respect to loss of life in this instance, that the present legislation limits financial recovery of families to \$2500. It was felt that this was probably a quite inappropriate amount of money in 1988.

Recommendation 4.a. This was a fairly generalized recommendation with respect with workers being provided with information of potential hazards and safety procedures, as well as being provided with appropriate training. This recommendation was made specifically in

response to indications that many of the welders in industry were not specifically aware of regulations within the Occupational Health and Safety Act and the Fire Code and that if they had been applied in this situation, they would have in all probability have prevented this accident. Specifically, both the Occupational Health and Safety Act and the Fire Code specify that welding on tanks or pipes must be preceded by procedures that ensure that no explosive substances are present prior to so called hot work i.e. welding, cutting or grinding. Testimony also indicated that the Fire Code as implemented in 1987 indicated that work areas are to be tested for explosive gases prior to work being undertaken.

Testimony was introduced to indicate that neither the subcontractor nor Domtar Inc. had equipment prior to this accident that could measure for explosive gases in work locations such as this or for that matter, anywhere. Although there was considerable discussion about the specific sections in the Occupational Health and Safety Act and

the Fire Code as to whether they were clear enough, the jury chose not to make any specific recommendations about changing the legislation but felt that legislation even though it perhaps might not be ideal was adequate should the information contained in it get into the hands of the individuals actually doing the welding and cutting. Testimony was received from numerous welders during this inquest to indicate that prior to July 12 they had very incomplete appreciation of this legislation if any and also rather incomplete appreciations of the appropriate procedures to follow with respect to safe welding and cutting on tanks and pipes.

4.b. The jury chose to recommend that any certification of welding be granted only after the completion of appropriate technical and safety programs. This recommendation was made in response to testimony indicating that many welders in the industry receive that majority of their training on the job without any requirement for formal technical or safety training. There apparently exists a so called welding ticket that can be obtained by completing certain practical tests but unless welders are formally involved in an apprentice program they may not have any formal technical or safety training. As a consequence of this many welders at present are probably quite unaware of the existing legislation with respect to welding on tanks and pipes, or the principles of the safe procedures it entails.

Recommendation 5. It was recommended that Domtar Inc. at its Trenton Mill initiate a reliable means of reporting accidents and near misses to its joint Health and Safety Committee. This recommendation was made in response to testimony that indicated that although this pulp and paper mill had had, in the recent past, a sign at its entrance indicating 0 accidents over a 9 1/2 year period, that the reality of the safety of the work environment was quite different. By internal means the number of lost time accidents actually reported to the Workers Compensation Board at times was 0 for extended periods of time. It would appear that the reality of this was that many workers were paid their regular salaries to come to work and do light duty; some of which would have to be considered to be of very little productivity. Testimony was introduced to indicate that on occasions individuals came to work on crutches, with casts, and at times in the opinion of the

workers not in an ideal condition to undertake any work. The perceived environment in this mill was such that workers apparently often agreed to work under these circumstances rather than risk being the individual to cause the safety record to be broken. Testimony indicated that there was probably no readily available means

for the Health and Safety Committee to know what the true accident or near accident incidents was in this mill and for this reason its function of optimizing health and safety in the mill was compromised unless more reliable means of reporting accidents and near misses was introduced.

Recommendation 6. This recommendation involved the suggestion that the Domtar management immediately verify that its welders and maintenance staff are aware of the new hot work procedure that had been developed since the explosion on July 12, 1988. Although it was felt by several witnesses for Domtar and outside Domtar that this was quite a reasonable policy, testimony was introduced to indicate that even at the date of this inquest in November the policy had not reached the welders and maintenance staff except via the posting on a bulletin board. Furthermore there was testimony to indicate that the welders and maintenance staff had not even formally been directed to look at the bulletin board but it had been expected that they might come across it. As well, no formal discussion nor explanation of the hot work policy had been undertaken with the maintenance staff. This was felt to be quite inappropriate since it was recognized that one or two out of every ten workers in Ontario are functionally illiterate, so that the simple posting of a fairly complex procedure was completely unacceptable.