

COMMENTS by L. D. PORTA on the NTSB Report of Findings in the Gettysburg Accident

Following is a transcription of Mr. Porta's handwritten comments to the Chairman of the NTSB on their findings in the Gettysburg Accident. I supplied Mr. Porta with a copy of the NTSB Report, and asked him to comment on the findings. His handwritten document is included along with this transcription so that his sketches may be seen and associated with their particular area of the discussion.

Often times, Mr. Porta's discussion uses English words that may not be familiar in our American daily lexicon - such as "a plane glass" means a "flat glass".

I had to learn how to listen to Livio and hear what he was saying as well as what he MEANT. Most of our discussions took a lot of time for us to discuss meanings and spellings of English words and/or the use of some American slang (and differences with British slang). I spoke differently to Livio than I did to any of my American friends - I had to learn to think about what I was saying - think about the meaning of the words and decide whether another word would be better to use. About twenty minutes was spent once when I had a question about a "brass" plaque. It took some discussion to reach the understanding that I should have known to use the word "bronze" - which was instantly understood.

I hope that much discussion will follow the reading of this paper. AND that the discussion will result in our subscription to Mr. Porta's recommendations. His experience and understanding of this subject is to be recognized and respected. These are facts - not opinions. They should be treated with such respect; they should be accepted; and we should change the way we do things to align with Mr. Porta's experience. If so, we will all be the better for it!

"We will never give up!"

Best regards;
Gary P. Bensman

Buenos Aires, 17 Nov. 1997.

Mr. James E. Hall, Chairman
The National Transportation Safety Board
Public Inquiry Section, RE-51,
490 L' Enfant Plaza, SW
Washington, D.C. 20594.
Estados Unidos. (*United States*)

Dear Sir:

Steam Locomotive Firebox Explosion on the
Gettysburg Railroad, near Gardens, Penna.
June 16, 1995

Mr. Gary P. BENSMAN suggested to me to make some comments on Report of the (*above*) heading. Being much interested, for professional reasons, the subject makes a most good case for analysis.

(For didactic reasons, what follows is written in the third person.)

On P-1, it is stated that . . ." those responsible for maintaining, repairing and operating loc. No. 1278 lacked the specialized training and experience that have long been judged to be prerequisites for the safe operation of steam-locomotive equipment". Of course this is unacceptable; but the point is that

NOBODY KNOWS WHAT HE DOES NOT KNOW-
UNTIL (*LATER*) HE KNOWS IT.

This is an elementary principal of logic. The boy at six does not know, say, about logarithms. And also he does not know that he does not know; until he, at the age of 15, learns logarithms. Then, and only then, he realizes that when he was 6 he did not know about logarithms. Thus, NO ONE OF THE VARIOUS PEOPLE INVOLVED was knowledgeable that their knowledge about steam locomotives was poor. The fact that some 150 locomotives are operated by 82 organizations tells about the importance of this question. Do the people involved have the necessary skills?

"This accident illustrates the hazards that are always present in the operation of steam locomotives."

This sweeping statement leads to think that a steam locomotive is a kind of dangerous BOMB; far more hazardous is the common automobile! One out of every two Americans have been or will be involved in serious automobile accidents in their lives! (*And they accept this!* LDP) So, the solution is not to ban steamers out of the rail scenario. There are far more accidents for people slipping on the bathroom than those who have been killed by locomotive boiler explosions all along the locomotive history! So, please delete the word ALWAYS.

There have been a number of faults. The check valve leakage should have not been tolerated by the ENGINEER responsible for the machine. He was probably well aware that the injector had considerable difficulty to prime (only those knowing the trick can do with it), and therefore should not have accepted the engine in such condition.

On P.5 it is stated that the “second fireman checked the water glass every 5 minutes” and that the engineer leaned back from his seat “about three times during the trip”. This is absolutely unacceptable!! The engineer must (*have*) a CONTINUOUS look on the glass so that he can tell himself at any moment what water he has.

Fig. 3 shows some inconsistencies. The lower cock MUST be three inches above the highest point of the crown; same for the glass. The flow in the “combustion area” is not as shown. The grate is ~ 4 inches above the indicated position. These minor errors reduce the authority of the report.

Whether the company was able or not to “meet the FRA’s definition of certifying an engineer” (P.11), is unimportant. In the past, it is well known that there were men satisfying the corresponding requisites but were known to be incompetent.

A 3-1/8" above the highest point of the crownsheet is too little, especially for long boilers. The 3" dimension has remained unchanged since the days of saturated machines and rather low evaporations. A current boiler evaporates 12 pounds of water per square foot per hour. What about a CHAPELON’s 240 P doing 24 or the writer’s No. 3477 doing 28? In the latter case the water disappears from the glass at double rate, perhaps 1 inch every 30 seconds or more if the steam pressure is falling because of indifferent steaming. A review of this dimension is necessary. Yet that does not mean that ALL American locomotives should get 4, 5 or 6 inches.

The present writer has no experience on low water alarms or protection devices. However, he thinks that the protection afforded by thermic syphons or T-circulators is a very real one; the latter being preferable because they can easily be installed. However, this installation is to be made by authorized people showing adequate capacity for the work.

Some 15 years ago, this writer made a trip to Centralia accompanying a Royal Hudson, also a Canadian machine not too different from No. 1278. He was surprised to find just only one glass and the three cocks tapped directly to the back of the boiler. The water on the glass was rather lazy to oscillate, while the three cocks showed that the Canadian steam people were not aware (LIKE MANY MOTIVE POWER PEOPLE ALL OVER THE WORLD!) that such cocks give false readings ALWAYS in the sense of showing a higher, unsafe water level. THIS IS UNFORGIVABLE SIN whichever be the good records of Canadian locomotives. A tube of course is never to be viewed favorably when compared to a plane (*flat*) glass. Neither the owners, nor the engine men have a technical capacity or experience to discuss these matters, and so it is taken for granted that what the Canadians did in their golden times had to be taken as an article of faith. After judging what the crew did, and the not-free steaming of the boiler, the conclusion was: someday an explosion will occur. And it happened, not on the same machine, but on one affected by the same “imperfections”.

The missing pressure gage for the feed pump is unforgivable. The poor previous results leading to it being taken off were for sure due to the inadequacy of the gauge itself. A robust type must be selected with a top pressure reading of say, 500 psig. The pump is so important, that TWO gauges are to be provided, both located near the normal sight (as per the figure) so that the crew receives a CONSTANT signal of effective, positive feed to the boiler.

The Chairman of the Board should try to convince air people that a good illumination of instruments can be dispensed with!

Yes: “such limited fluctuations clearly indicates a problem with the glass and that normal fluctuation is as much as 4 +/- 2 inches; a water level movement of only ½" is a serious indication of an obstructed glass”. THE ENGINEER SHOULD HAVE KNOWN IT! The spindles were 75 to 85% plugged with scale!

The NATIONAL BOARD OF PRESSURE VESSEL INSPECTORS is a different agency from the ASME. Their code is all too full of legal dispositions. They have added the Supplement H especially related to locomotive boiler; which is not mentioned in the report.

Ca. 1918, THE BUREAU OF LOCOMOTIVE INSPECTION of the ICC made extensive and very serious tests that proved that gage cocks give FALSE indications of the water level. Since the idea that the cocks are faithful have been carved with hammer and chisel in the brains of many generations of engineers, the tremendous loss of face that would have resulted in eliminating (or banning) them overnight could be unbearable; so the BOTTLE was invented by the Americans. There are no bottles in France, Germany, England, Argentina, India, Central Europe, etc., and in several of these countries THERE ARE NO COCKS.

All stem to the fact that it is universally accepted that in the boiler there is a water level, i.e. a water “mirror” plane whose height is defined by the law of communicating vessels. That is what ALL textbooks and instructions issued say. But since BERNOULLI 's time, it is well known that said law is valid only when the liquid is at rest. But in the boiler, the water circulates at velocities on the order of 3 to 6 Ft/ second, hence having a dynamic head of, say, 8 inches or more, thus making invalid such a principal as proven by the BUREAU's tests. The world did not care too much about experiments carried out by “crazy Americans for their particular problems”. The only reference to these experiments, to the best of the writer's knowledge, appeared in Germany ca. 1920 in the Zeitschrift der Vereins der Deutsche Ingeimeme (ZUDI). But of course, nobody in German Railway at that time took ANY care to incorporate such ideas to the picture of water behavior in the boiler (*). The actual circulation in the boiler is much different from that depicted in P.26 of the report. In the figure, it is seen that the pattern is very much like that depicted in the familiar advertisement of NICHOLSON's.

(*). Take for example “ Die Dampflokomotive”, TELERESS reprint. 1993, Berlin. “ Nach der gesetz der komunizierenden Rohren stellt sich daher stets gleicher Wassenstand wie im Kessel ein.” (P.262).

But the circulation is not created by density differences originated in temperature differences because the water becomes warmer, but (as the general theory of water circulation for water tube boilers states) on the greater or lesser amount of bubbles both resulting from the heat transfer (especially in the firebox area) and the auto-evaporation resulting from the diminishing pressure obtaining when the flow goes upwards. Thus, at point A, the volume fraction occupied by steam is roughly 40%, and the velocity in the order 3 to 5 ft/sec. This leads to the formation of the jump B which the ICC Inspectorate measured.

By the sides, there is also a jump because the water is also ascending by the firebox lateral passages. The whole circuit, as measured by the present writer, is run in some 5 to 10 seconds, and the overall mass flow about . . . 500 times the steam production. Thus, the top surface of the water is far from being a plane as depicted in ALL text books. Besides, the upper part of the flow is a mixture of steam bubbles and water, and there is a foam layer, there is a gradual transition towards “pure” steam, much like occurs when boiling milk. But this has been olympically IGNORED by railway people, even as it was clearly established ca. 1920. As the report states on P.27, . . . “while the gage cocks may indicate PLENTY of water, in reality there may be little or no water over the crown sheet.” NO engineer has ever been told that so as not to use cocks as attached to the back sheet. On the third paragraph on P.27, it is stated:

“. . . This arrangement ensures that the water glass (located on the column) and the gage cocks indicate the same and true water level.”

ABSOLUTELY FALSE: there is no such a “level” but an irregular “surface” which at best contains a foamy material on top or even reaches the top of the steam space. So, THERE IS NOT SUCH A THING AS WATER LEVEL. Thus, the picture given in Fig. 15 is basically wrong.

British boiler gages have cock controls which clearly show when their position is fully open or not. This is not the case for American type control valves, which therefore should be checked by the crew just when they put their feet on the footplate for the first time: it is not surprising that explosions occurred as reported on P.29. This writer knows about serious accidents due to partially opened top cocks.

The CMO of the Valley Railroad at Essex, Conn. reported that . . . “the turret valve of the injector was shut off”. UNBELIEVABLE!!! The engineer responsible for it should be sent to the jail!

After a very extensive series of tests carried out ca. 1970 by INTI (Institute Nacional de Tecnologia Inantrial, Argentina) as requested by the Belgrano Ry., Argentina, and until a better evidence is offered to him, the writer proposes to ENFORCE the use of Polyamide antifoams for ALL locomotives just to insure pure steam (contamination less than 2 ppm) and just a little of foam disturbing the top water surface.

A molten current fuse plug DOES NOT SERVE AS EFFECTIVE PROTECTION because it does not die out (*kill*) the fire as he has witnessed. May be that NATHAN plugs are effective if applied as one plug for every 400 square inches of grate surface area. But NATHAN

plugs must be confectioned according to strict procedures otherwise they will drop (at times) even with a full glass of water in the boiler. THIS DOES NOT MEAN THAT ORDINARY PLUGS SHOULD NOT BE INSTALLED!

INSURERS SHOULD BE REQUIRED TO INSPECT (P.35 of the report). However, one should note that locomotive, stationary, power plant, marine or naval boilers have their peculiarities so that each type should have specific building and inspection code: hence its own inspectorate collecting the corresponding experiences, which at times may be in opposition for different areas.

It is impossible for the law to contemplate all possible cases so that reliance on the Inspector criterium is unavoidable. This is not wrong if adequate appeal levels are provided: he per force, has to adhere to his subjective experience and practical expertise. (P.36).

“[The water] was too low because of the cumulative result of a number of steam locomotive boiler maintenance and operational factors that resulted from a lack of training, knowledge and application” (P.39)

Nothing is more true. But, WHAT TO DO TO AVOID THE REPETITION OF THE ACCIDENT? That is the big question; far more important than to establish responsibilities, the latter being a frequent way to solve the problem.

UNBELIEVABLE!! The steam pressure was falling from 230 to 175 psig in spite of the pump being shut off and the injector inoperative!!!

It is a false belief of the engineer that . . .” having less water in the boiler is better for steaming”. Keeping a low water with the injector or the pump on with a firm, steady pressure is the best insurance against explosions. Experience tells that, invariably, melted plugs or explosions NEVER occur in the case of free steaming boilers. But, as is well known, free steaming is more difficult at high steaming rates because ALL (except the writer’s) drafting systems lead to lower excess air. This is due to the fact that beyond ~ 12 psig back pressure, the flow is supersonic; therefore calling for a DE LAVAL exhaust nozzle. The present writer designs the nozzle as per the figure.

There is no difficulty in working with a very low water level provided that (a) the crew is familiar with the locomotive, the route, the train, etc.

(b) that the feed apparatus work INSTANTANEOUSLY at the requirement, both deserving full confidence. Heat transfer is NO greater because of a higher (*or lower*) water level.

Impossible to believe: the light for the water glass did not work! (P.41)

Unbelievable: . . .” the train crew had no reliable way to determine whether the feed pump pressure was overcoming the boiler pressure and delivering water into the boiler!

WHAT TO DO TO IMPROVE THE SITUATION?

- a) Enforce the existing law in full detail: it resulted from a 150 year-old experience over 100,000 locomotives.
- b) The existing law should, from time to time, be reviewed so as to incorporate the new knowledge available concerning boiler circulation, water treatment physio-chemistry, etc.
- c) For example:
 - a. abandoning the concept of communicating vessels. (What is the water level in a boiling milk pot?)
 - b. absolutely banning the use of gage cocks fixed to the boiler back
 - c. reviewing the minimum height of water above the crown, etc.
- d) These matters should receive wide publicity because they will make a sensible contribution to the boiler art in general.
- e) T-circulators are to be universally applied to existing or new locomotives.
- f) As is the case for the ASME and BPV Inspectors, a committee of experts is to be established concerning the whole locomotive boiler technology review.
- g) Most important, any locomotive boiler should be engineered, operated and maintained by PROFESSIONAL people, not by volunteers only.
- h) Supplement H of the NBIC should be incorporated to the law.
- i) The use of modern, Polyamide antifoams is to be enforced.
- j) Both fireman and engineer must have a water pump gauge within their line of sight

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