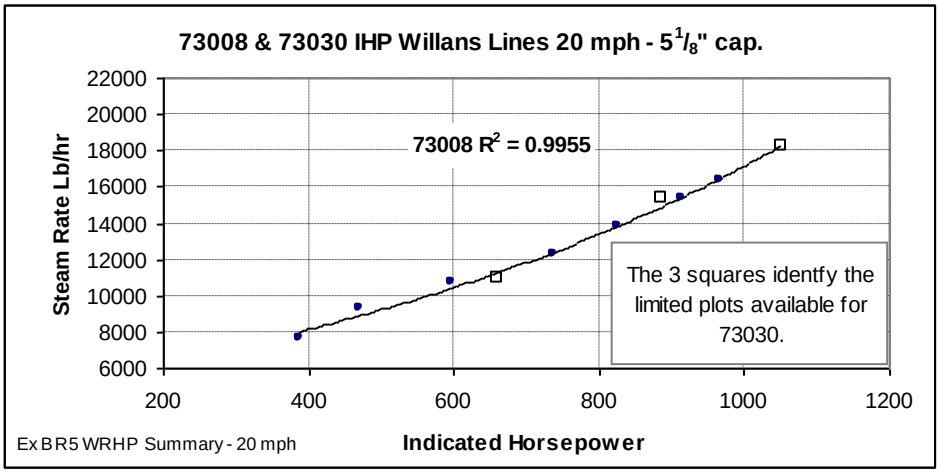
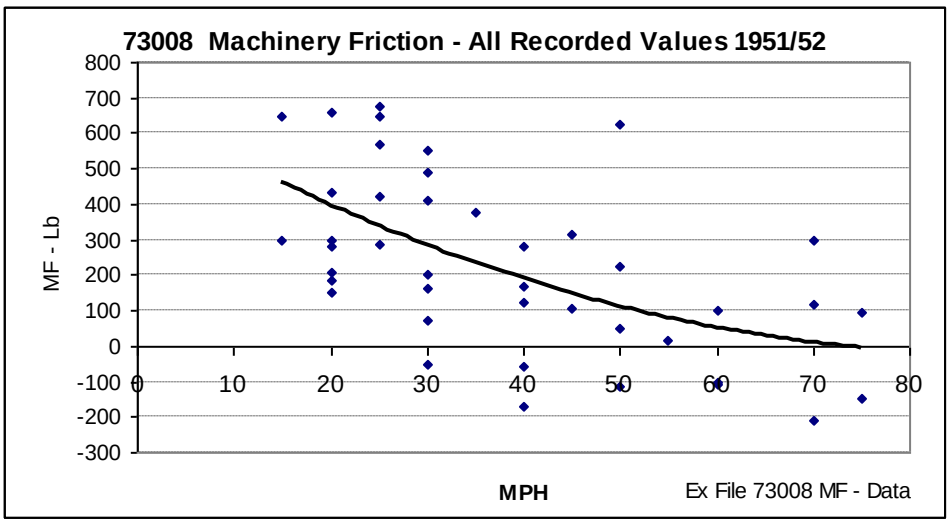
Locomotive Resistance - 7 July

I've recently identified a serious plotting error in my letter 14th April. This concerned the graph comparing the indicated horsepower data plots for BR5s 73008 and 73030 at 20 mph when fitted with $5^1/_8$" blastpipe caps. Two of the three plots shown for 73030 were erroneous, misidentified data having been entered. I should have been suspicious at the time since the separation of the two data sets was more than might be expected. Entering the corrected data, as below, and contrary to the original outcome, it shows no separation of the two data sets beyond normal scatter.

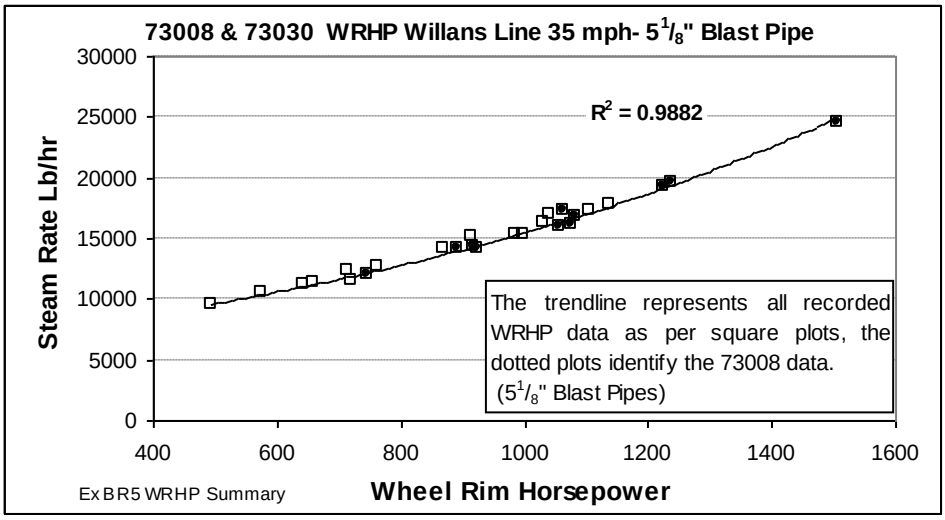


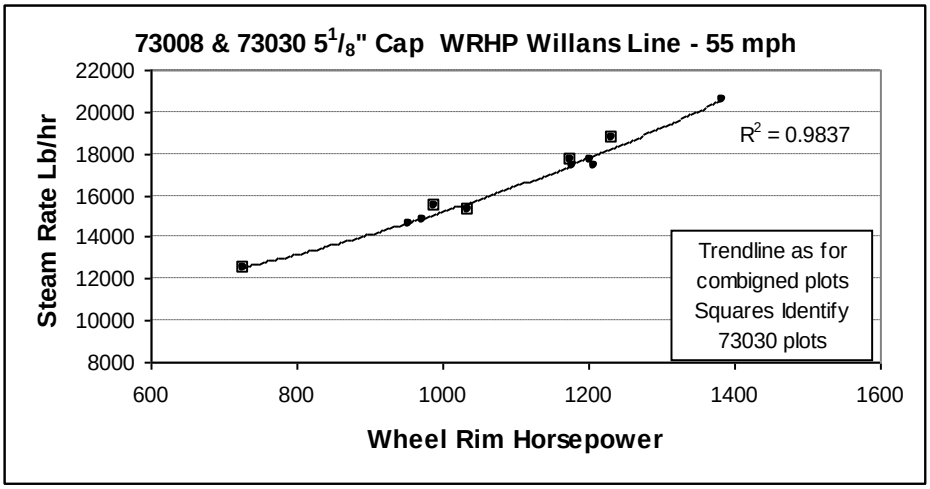
The available IHP data at higher speeds for 73008 and 73030 when fitted with a $5^1/8$" blastpipe was only coincident at 35, 55, and 70 mph, and such it is was very meagre, respectively amounting to no more than 4, 4, and 5 IHP plots *in total for the two engines*: insufficient to support any comparative plots. The 73008 tests took place when negative MF data was still being encountered with undue frequency. This tendency increased markedly with rising speed as plotted below.



The incidence of negative MF outcomes clearly increases as a function of speed. Merchant Navy class 35022 showed similar traits, although the slope was less marked, the magnitude and frequency of negative outcomes was greater.

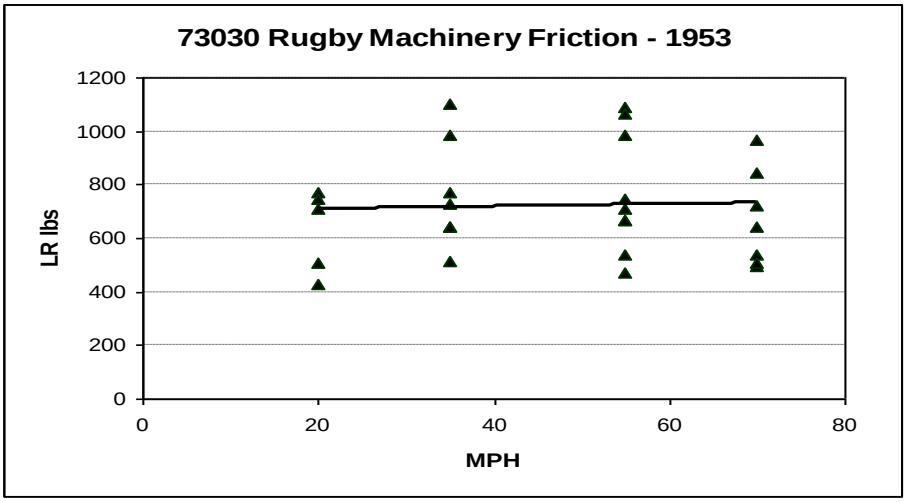
The available WRHP data at higher speeds for 73008 and fitted with the $5^1/_8$" blastpipe cap is sufficient for plotting Willans Lines, as in the two examples below for 35 and 55 mph. The recorded data is consistent across the two-test series.





The MF data scatter diagram for 73030, as below shows a dramatic improvement; negative MF values have been wholly eliminated. The plots shown include the data for all three blast pipe caps tested. The trend line shown is virtually constant, at about 725 lb. Such an outcome compares with the shallow dish shaped trend lines generated by 42725, 45722, 46165, and 46225. Such outcomes are to some extent down to the chance influence of the scatter pattern. As the example below shows, the speed groupings may develop an upward

or downward bias, in this instance the latter at 20 mph.



This concludes what is essentially a corrective note, plus little supplementary information. I see John Knowles has submitted another letter a few days ago, 4th July. In due course I will have a look at it, but it will be some time before I do so. Among other projects, I am currently busy putting together, what will, inter alia, form a definitive vindication of the Amsler dynamometer at the Rugby test plant.

Regards,

Doug Landau

From Doug Landau – October 2017

Locomotive Resistance

This is just an interim note to report research on the Rugby Test Station NRM archive in late September. The programme I set myself for the day proved over ambitious, and much of the material I had requested went untouched.

My key interest was the chronology and record of events during the commissioning and early working up phases of the test plant1949- 50. It was not until quite late in the afternoon that some key material sufficient for the objective was discovered, but much important material not related to the Amsler dynamometer had to be skipped over as time ran out. Certain key dates were however established. Below is a brief summary of the record.

The initial commissioning of plant with WD 2-10-0 73799 commenced on 26 November 1948. Initially only 10 test runs were completed. It is unlikely any serious testing occurred during this phase, more a case of finding out how and if everything worked, so I did not trace this far back in the record. Some indicating tests with Caprotti Black 5 44752 followed before 73799 returned for a further 20 tests, bringing the plant test runs total to 50 on 13th April 1949. The replacement for the “old bag of bones” was another WD 2-10-0, 73788, making its first test run on 22nd April 1949, completing just three test runs before the first of three interruptions for D49 4-4-0 62764 indicating tests of the Reidinger poppet valve gear. These breaks were probably to undertake modifications of the dashpot damper system, of which there were many. Eventually 73788 completed 46 test runs on the plant, the last, run 144, was on 19th December 1949. The two intermediate test sequences both lasted for only 3 test runs, as had the initial

tests. It seems probable that on all three occasions it was quickly established that it was a case of “back to the drawing board” in regard to the damper modifications.

At this period Carling was writing progress reports to the railway executive on a weekly basis, and the ‘Damping Dashpot Investigation’ was a hot topic; because of pending modifications he sometimes had to report “in abeyance”. In a letter 21 March 1949, which coincides with 73799’s final stint on the test plant, Carling reports; “the dashpot can increase drawbar pull 100%.” By the time 73788 was on the plant, some modifications to the dashpot appear to have met with a modicum of success; writing on 27 April 1949, Carling was able to report “error approximately halved.” Not good enough however, it was probably the last of the three tests completed in 10 working days. The dashpot was first tested drained of oil on 4th November 1949, details of the run notes: ”Run made with dashpots drained of oil (Run 126), in order to investigate amount of oscillation and to obtain values of drawbar pull unaffected by dashpots.” Writing to the Railway Executive on the 7th November, Carling reports; “There is now no reasonable doubt that differences of oil pressure in the dashpots account for the whole of the falsification of the record of drawbar pull on the Amsler table. A special test was carried out on Friday afternoon when the dashpots had been emptied of oil preparatory to fitting the new type of damping control, which is promised for delivery on the 7th November. This test was intended to explore the possibility of in the manner believed to be used at Vitry, i.e. with no dashpots in action. It was found the locomotive oscillations were very severe at 3 or 4 miles per hour, but became quite reasonable at high speeds of 45, 40, 35 and 30 miles per hour. The locomotive was behaving quite satisfactorily as far as oscillation was concerned at 25 miles per hour but before a test could be finished slipping occurred and before the speed could be steadied the blowing of a fuse in the electrical control circuits prevented completion of the test.”

“It had been expected that it would have been possible to run the locomotive at a speed as low as 20 miles per hour, but not much below this figure, as the calculated critical speed with the present number of Bellville washers in the drawgear is 12 miles per hour.”

“The outcome of this test is an indication that it should be quite feasible to run a Class 5 4-6-0 on the plant without using dashpots at speeds of 25 miles per hour and upwards. It is possible that, by reducing the number Belleville washers, a run at a speed below the critical for that locomotive and spring combination could be achieved, thus completing the speed range down to slightly below15 miles per hour, which is the slowest speed at which this class of locomotive can be run on the plant at full power.”

The next locomotive on the plant was Black 5 45218. Writing on 23rd January 1950, Carling was able to report:

“Tests with 4-6-0 L.M.R Class 5 Locomotive 45218”

“It has been definitely established that this locomotive can be run on the test plant at all speeds without oil in the damping dashpots. The locomotive has now been thoroughly run in and testing up to any speed desired will commence next week.”

By the time of this development, the dashpot problem had been passed to the research department at Derby, while some of the modifications and correcting some imbalance in the system had brought about a reduction in amplification of the drawbar pull, it seemed impossible to eliminate. Experiments with different types of oil and reducing the friction had no effect. The dashpot was manufactured by Heenan and Froude; I was surprised to find it incorporated a pump, having previously imagined is was a simple displacement device. The pump pressurisation was adjustable, in the examples seen it was ‘set’ at 15lb/sq.in (‘nominal’). On Run No. 130 11th November 1949, the pump was shut off for the 40 and 45 mph tests, resulting in an increase in the drawbar pull discrepancy.

Other points of interest gleaned from the NRM are listed below.

The mediating mechanism gear ratio was reduced by a factor of about 3 sometime in 1950. As first installed it was overactive, and subject to excessive wear. It was further reduced in 1953 by a similar amount, bringing the ratio down to about one 10th of the original provision.

The dynamometer integrating mechanism was refurbished at the back end of 1953.

The 'Summary of Improvements to Plant Equipment in 1953' lists 13 items ranging from a milling machine safety guard to a Marine type clock for the firing platform. The changes to the mediating gear referred to above are listed along with improvements to thermocouples, the manometer bank, and the Farnboro' Indicator diagram converter. The Amsler pump motor was replaced.

The summary list for improvements in 1954 could only be briefly examined. Of the 20 or so items listed, many, such as improved mess room facilities and data storage racks, were not relevant to technical matters. Of interest were roller scrapers to stop slipping; a new improved spark generator "much improved" Farnbro' indicator elements (July); an exhaust injector flow meter installed; and dead weight testing for pressure gauges;

The files contained many original worksheets, such as a plot of Bellville washer deflection and hysteresis characteristics; the latter effect was low, the washers being arranged in a set of opposing single pairs. The results of a routine static dynamometer load test on the 36.000lb scale in 1953 found errors ranging from -0.34 to - 0.7%, averaging -0.57%. On the 12,000lb scale there was 1.87% error (112lb) at a pull of 6,000 lb; at a pull of 12,000 lb the error had fallen to 15lb. 0.125%.

It was apparent the test plant underwent continuous development and improve- ment.

My promised "simple proof" of the Amsler dynamometer is almost finished, but completion will have to wait a while yet, pending attention to some late running commitments. The time taken so far is not for the basis of the proof, which is very simple, but extracting supporting empirical evidence from the highly suspect DBHP data contained in the BR test bulletins for the locomotives tested at Rugby is another matter. These suspicions are not my invention, for as Report L116 clearly states: "In all cases where locomotive trials at Rugby have been followed by road tests carried out with the LMR Mobile Test Plant there has been a lack of reconciliation of the results to the extent that values of locomotive resistance obtained by subtracting Drawbar TE from Rugby Cylinder TE have not been acceptable." These shortcomings were attributable to a failure to control steam rates to the nominal values set for the road tests. L116 report gives some guidance in regard to correcting the drawbar data for the 9F, but none whatever for the BR5 and Britannia. Only report R13 for the Duchess has corrected DBHP data as derived from Report L109. In this instance the 'simple proof' and the empirical evidence are in close accord.

Doug Landau