Some Locomotive Boiler Statistics

British Railways Maintenance Costs 1953-57

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published in SLS Journal Sept Oct 2004

Transcribed by Chris Newman from a photocopy of the original – July 2013

Introduction

The publication of Arthur Cook's "Raising Steam on The LMS" in 1999 prompted some discussion in the pages of the SLS Journal as to the relative merits, from the maintenance standpoint, of the diverse design practices of the "Big Four" and BR.

Tapered or parallel? Round topped or Belpaire? Steel or copper? These were the questions.

Additional to the statistics in Cook's volume, some additional data has been gathered from the writings of E.S. Cox: "British Standard Steam Locomotives". Hopefully, I have devised a rational costing footing to allow for the diversity of size, in order that the figures may be more meaningfully compared.

Although many questions remain unanswered, some illumination has proved possible.

Available Data

Table 1 incorporates all of the Cook and Cox data. The far column puts the costs on a specific basis: Costs/1000sq.ft of heating surface per 1000 miles run. This and the adjacent column are adjusted to 1954 prices.

Additional to this data, a ten year record of the principal Class 8 boilers has been obtained from the National Railway Museum. These cover shopping frequency, mileages and boiler renewals, rather than the actual maintenance costs. They nevertheless give some insight into the varying regional practices. These will be discussed later.

Observations on Table 1

Table 1, which incorporates all the available data, with some classes exampled over a three or four year period. This gives some indication of how costs could vary year on year.

The actual spread of costs is very high, with a ratio (highest to lowest) of 11.5 to 1 in terms of pence/mile. When adjusted to the specific basis of cost per 1000sq.ft/1000 miles, this ratio increases to no less than 14.2 to 1. Quite what befell the GW County Class boilers in 1954 is an unknown.

The generally favourable figures for the LNER Pacific boilers could be taken to indicate some benefit in favour of round topped fireboxes, but the type 100A narrow firebox boiler used on the B1s and O1s does not repeat this trend. Likewise, the round topped WD 2-8-0 boiler, it only being exceeded in costs by the County. There may have been other factors at work, reducing the apparent maintenance costs of the LNER Pacific boilers, which will be examined later.

BRITISH RAILWAYS – BOILER MAINTENANCE COSTS								TABLE 1
Category	Class	Boiler Type	Working Pressure lbs/sq.in	Heating Surface sq.ft	Year	Maintenance cost pence/mile	Maintenance pence/mile 1954 Prices	Maintenance 1000sq.ft/1000 miles
Wide Firebox	Al	117/118	250	2461	1954	0.96	0.96	£1.63
	A3	94	220	2692	1954	1.45	1.45	£2.24
	A4	107	250	2575	1954	0.8	0.8	£1.29
	A2/1	109	220	2431	1954	1.26	1.26	£2.16
	A2/2	118	225	2461	1954	1.01	1.01	£1.71
	A2/3	117	250	2461	1954	1.12	1.12	£1.90
	V2	109	220	2431	1954	1.93	1.93	£3.31
	Merchant Navy	-	280	2451	1954	0.63	0.63	£1.07
	West Country	-	280	2122	1954	0.42	0.42	£0.82
	Duchess	1X	250	2807	1954	2.7	2.7	£4.01
	71000	BR13	250	2490		0.95	0.95	£1.59
	Britannia	BR1	250	2474	1954	0.88	0.88	£1.48
					1955	0.95	0.91	£1.54
					1956	0.65	0.58	£0.98
					1957	1.09	0.94	£1.58
	Clan	BR2	225	2073	1956	0.79	0.71	£1.42
					1957	0.69	0.59	£1.20
	9F	BR9	250	2015	1955	1.53	1.53	£3.16
Express Narrow Firebox	King	No.12	250	2013	1954	1.32	1.32	£2.73
	Castle	No.8	225	1964	1954	1.83	1.83	£3.88
	Converted Scot	2A	250	1863	1954	1.00	1.00	£2.24
	Jubilee	3A	225	1639	1954	0.94	0.94	£2.39
	Lord Nelson	-	220	2002	1954	1.78	1.78	£3.70
Mixed Traffic Narrow Firebox	BR5	BR3	225	1650	1954	0.88	0.88	£2.22
					1955	0.68	0.65	£1.65
					1956	0.85	0.76	£1.92
	Black 5	3B	225	1650	1954	1.24	1.24	£3.13
					1953/55	0.74	0.74	£1.87
	B1	100A	225	1676	1954	1.95	1.95	£4.85
	Hall	No.1	225	1841	1954	2.48	2.48	£5.61
	Grange	No.1	225	1841	1954	2.49	2.49	£5.64
	County	No.1	280	1714	1954	4.89	4.89	£11.89
Freight Narrow Firebox	Stanier 8F	3C	225	1648	1954	1.51	1.51	£3.82
	O1	100A	225	1676	1954	2.24	2.24	£5.57
	G.W. 28xx	No.1	225	1841	1954	2.56	2.56	£5.79
	W.D. 2-8-0	-	225	1841	1954	3.34	3.34	£7.56
Small Mixed Traffic Narrow Firebox	BR4 4-6-0	BR4	225	1444	1956	0.71	0.63	£1.83
					1957	1.26	1.09	£3.13
	BR4 2-6-0	BR7	225	1206	1957	1.51	1.30	£4.50
	BR3 2-6-0	BR6	200	1042	1957	0.83	0.72	£2.86
	BR2 2-6-0	BR8	200	1025	1957	0.94	0.81	£3.29
	BR4 2-6-4T	BR5	225	1366	1957	0.47	0.41	£1.24
	BR3 2-6-2T	BR6	200	1042	1957	0.99	0.85	£3.41
	BR2 2-6-2T	BR8	200	1025	1957	0.43	0.37	£1.51
All	Averages					1.36	1.32	£2.98

Notes to Table 1

1. This gives all the statistical data available from E.S. Cox's "British Standard Steam Locomotives" and A.F. Cook's "Raising Steam on the LMS".
2. Heating surface areas do not include superheaters.
3. The costs (old pence) shown in the penultimate column have been adjusted where necessary to the 1954 price index.
4. The costs in the far column (decimal) are as 3 above, but on the basis of cost per 1000 sq ft of heating surface per 1000 miles run.

Cost Range - High/Low Examples at 1954 Prices			
Class	**Year**	**Cost 1000sq.ft/1000 miles**	**Cost Index**
GW County	1954	£1.89	399
WD 2-8-0	1954	£7.56	254
GW 28XX	1954	£5.59	188
All		£2.98	100
Merchant Navy	1954	£1.07	36
Britannia	1956	£0.98	33
West Country	1956	£0.82	28

There could also be wide scatter between the same boiler type applied to different classes, as exampled by the BR8 boilers flitted to the Class 2 tender and tank engines.

Class	**Year**	**Cost 1000sq.ft/1000 miles**	**Cost Index**
Class 2 2-6-2T	1957	£1.51	51
Class 2 2-6-0	1957	£3.29	110

The differences here are probably no more than the possible year on year scatter for a particular class.

British Railways Standard Locomotives

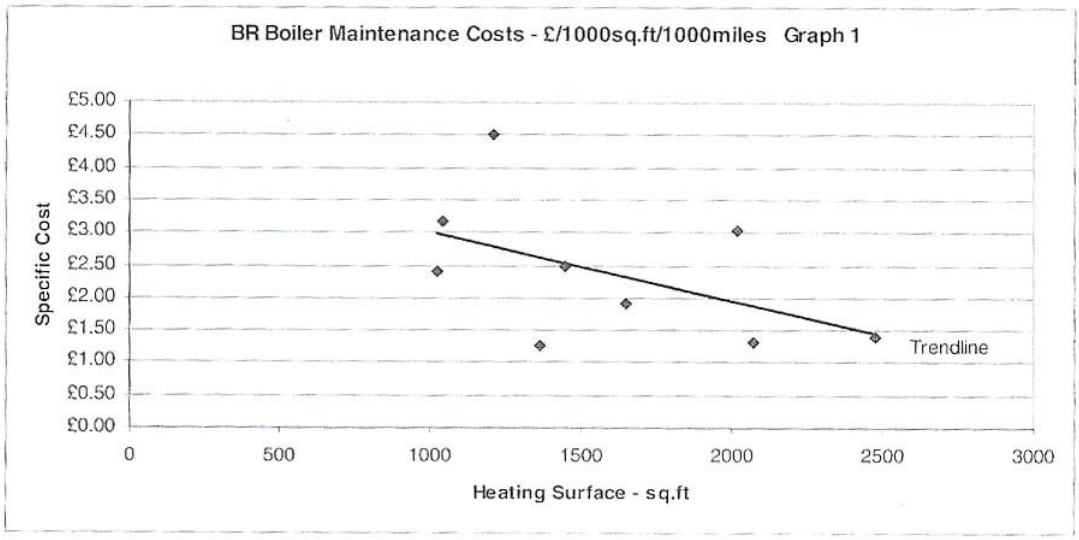
British Railways - Boiler Maintenance Costs							**Table 2**
Class	Boiler Type	Working Pressure lbs/sq.in	Heating Surface sq.ft	Year	Maintenance cost pence/mile	Maintenance pence/mile 1954 Prices	Maintenance 1000sq.ft/ 1000 miles
Britannia	BR1	250	2474	1954-57	0.89	0.83	£1.40
Clan	BR2	225	2073	1956/57	0.74	0.65	£1.31
9F	BR9	250	2015	1955	1.53	1.47	£3.04
BR5	BR3	225	1650	1954	0.80	0.76	£1.92
BR4 4-6.0	BR4	225	1444	1956	0.99	0.86	£2.48
BR4 2-6.0	BR7	225	1206	1957	1.51	1.30	£4.50
BR4 2-6-4T	BR5	225	1366	1957	0.47	0.41	£1.25
BR3 2-6-0 & 2-6-2T	ORB	200	1042	1957	0.91	0.79	£3.16
BR2 2-6-0 & 2-6-2T	BR8	200	1025	1957	0.69	0.59	£2.40

Notes

1. Here the data for the BR standard boilers in Table 1 has been consolidated, e.g. Britannia, Clan and BR5 data for 1954/57 has been averaged, and the BR6 and BR8 boilers for tender and tank engines averaged as common groups.
2. Other notes as for Table 1.

All regions were responsible for maintaining some BR standard boilers, but the BR1 and BR2 boilers for the Britannias and Clans were the exclusive responsibility of Crewe. Apart from the BR7 boilers, which seem to have had a bad year in 1957, the cost spread is quite small. This would seem to reflect reasonable uniform costing procedures across the regions. Direct labour, material and immediate supervision costs would obviously be covered, but exactly what the imposed LMS practice of including for 'Departmental Administration Costs' covered, is uncertain.

The higher maintenance costs of the 9F BR9 boiler, compared to the not too dissimilar Britannia BR1 boiler, is probably attributable to the much lower annual mileages run. As a consequence, the periods between boiler overhauls were much longer. Boiler deterioration was to some extent time related rather than miles run. The costs in Table 2 have been plotted against size in Graph 1. The trend suggests that small boilers are relatively expensive to maintain, but again, the slower accumulation of mileage may be a factor.



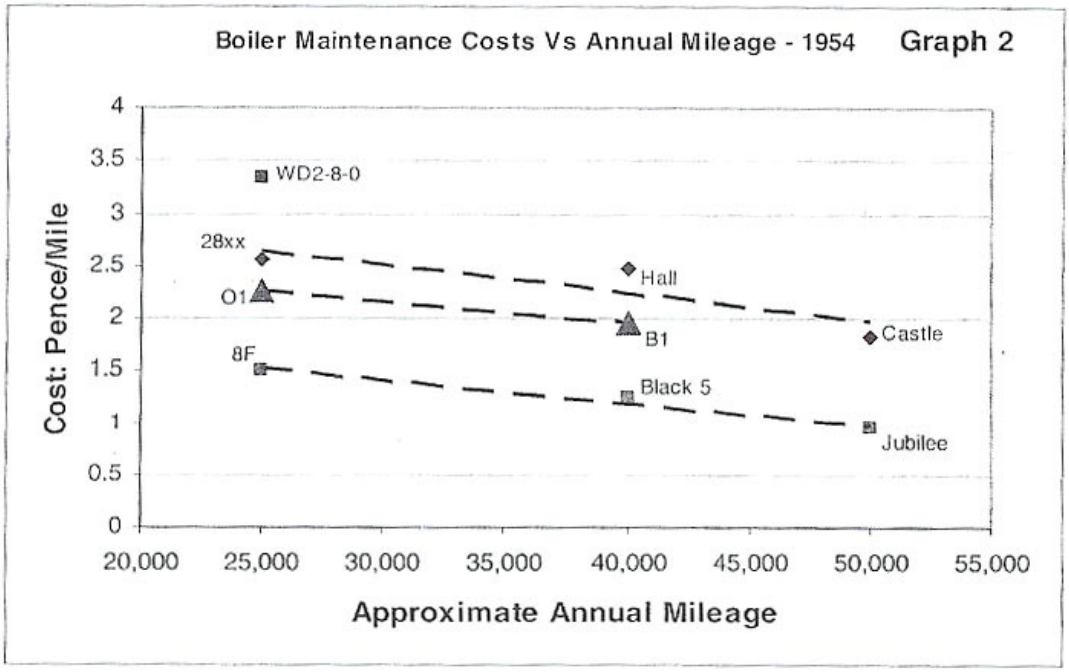
Some apparent Cost Trends

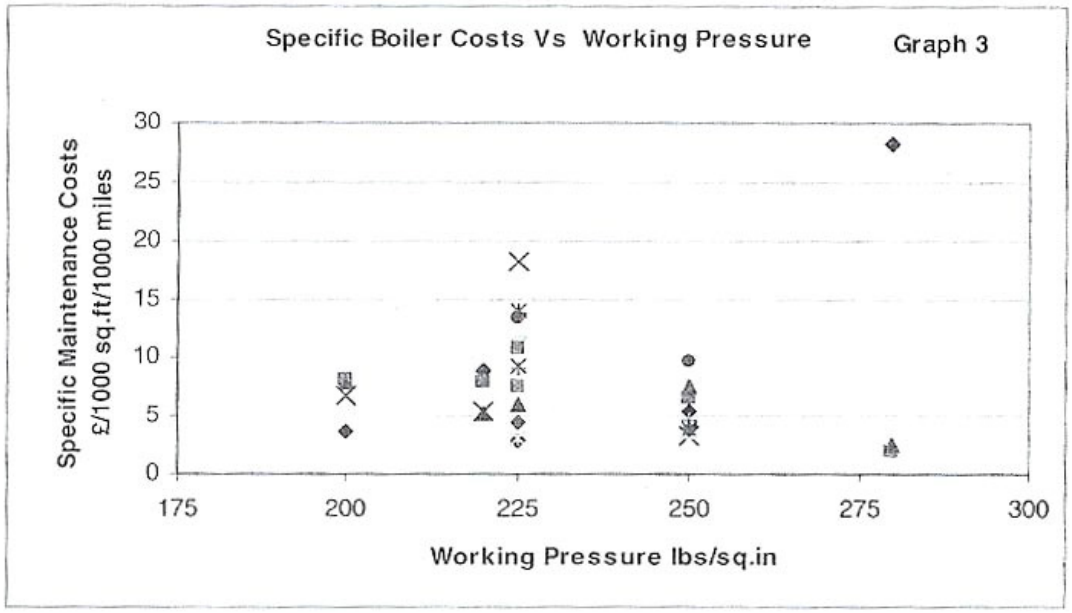
Graph 2, which examines identical or generically similar boilers with the common working pressure of 225psi, clearly demonstrates the influence of traffic duties when boiler maintenance is costed on a mileage basis. As already implied, the cause seems fairly obvious; the longer time taken in traffic accumulating shopping mileage will produce a commensurate deterioration of the boiler.

In Graph 3, there seems to be little evidence, the late Dr. Tuplin and common logic notwithstanding, that reducing the working pressure brings lower maintenance costs. If there is a trend here, it seems if anything to indicate the reverse to be true, which inherently, seems unlikely. It appears likely that other operating factors are more significant, as evidenced by Graph 2. This leads to the conclusion that the effects of working pressure on maintenance costs, amid all the other factors, were relatively slight, always provided the boilers concerned were engineered and maintained to an equal standard.

Table 3 ranks the various boilers in terms of costs and category. There has been some consolidation of the data, hence the differing median value to Table 1. As a group it appears that wide fireboxes, taking 7 of the first 10 places, offer some advantages as far as costs are concerned. The LNER boilers in particular appear to have been very successful. It is tempting to attribute this to the round topped fireboxes, but the cheapest wide fireboxes are Belpaire (as is the worst!) The Britannias were in the same order of costs as the Doncaster products, but were probably still too youthful to be truly

comparable. Harvey reports (Bill Harvey's "60 Years In Steam" - David & Charles, 1986) problems developing from 1957 onwards, not to crisis levels but enough to have influenced the figures from thereon. This same reservation applies to all the BR Standard boiler statistics.





The Stanier boilers appear to be on top as far as narrow fireboxes are concerned, but any conclusions vis a vis Belpaire versus Round Topped are again not possible because the generically similar GWR boilers appear the be inferior to the round topped LNER boilers but better than the round topped WD. The GWR boiler performance, given the claims made over many decades for Churchward's developments, is perhaps disappointing. Cook suggested inferior water treatment as a possible cause, but the evidence

here is unclear. The Bullied boilers were said to be far more expensive than shown above prior to the introduction of the TIA water treatment system.

Swindon repairs were reputed to be more expensive and thorough than elsewhere, but unless this was reflected in lower maintenance costs, i.e. it was truly preventative, what was the point? The County figure seems somewhat "off the scale" of things. Simply a misleading year, or possibly even a reporting error?

Specific Boiler Maintenance Costs by Category **Table 3**

Pos'n	Wide Firebox	Narrow Firebox Express	Narrow Firebox Mixed Traffic	Narrow Firebox Freight	Narrow Firebox Small Mixed Traffic	Cost/1000 sq.ft/1000 mites	Cost Index £3.60 = 100
1	West Country					£0.82	23
2	Merchant Navy					£1.07	30
3					BR 2-6-4T	£1.35	38
4	A4					£1.29	36
5	Clan					£1.31	36
6	Britannia					£1.40	39
7	Al					£1.63	45
8			BR5			£1.92	53
9	A3	Converted Scot				£2.24	62
11		Jubilee				£2.39	66
12					BR2 2-6-0 & 2-6-2T	£2.40	67
13					BR4 4-6-0	£2.48	69
14		King				£2.73	76
15	9F					£3.04	84
16.			Black 5			£3.13	87
17					BR3 2-6-0 & 2-6-2T	£3.16	88
18	V2					£3.31	92
19		Lord Nelson				£3.70	103
20				Stanier 8F		£3.82	106
21		Castle				£3.88	108
22	Duchess					£4.01	111
23					BR4 2-6-0	£4.50	125
23			B1			£4.85	135
24			Hall			£5.51	153
25				O1		£5.57	155
26			Grange			£5.64	157
27				28xx		£5.64	157
28				WD 2-8-0		£7.56	210
29			County			£11.89	330
					Average	£3.50	100

(To be continued)

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(Continued from July/ August 'Journal' p.193)

New Information

The summary in the previous part of this article is about as far as the Cook/Cox data leads without resort to pointless speculation. Some more information has since come to light however which makes it clear there was considerable regional variation in the assessment of economic boiler life and the frequency of boiler renewal. This information has come from two sources.

The first was a ten year shopping and replacement record for Class 8 boilers, which turned up fortuitously with some mileage records of the roller bearing A1s and annual mileage records for various ex LNER types. At first the ten year boiler record was overlooked, so its significance went unnoticed.

General Repairs, Boiler Lifts & New Boilers - 10 Year Averages & Statistics 1951-1960 Table 4

Class	Miles/ General Repair	Months/ General Repair	Days on Works	New Boilers Fitted									
				1951	1952	1953	1954	1955	1956	1957	1958	1959	Total
Princess Royal	169,808	32.0	45										0
Duchess	195,993	32.7	39	1									1
A1	122,789	20.9	31		4		2	2		1			9
A4	107,257	19.6	35		8	5				4		8	25
Merchant Navy	195,934	40.9	53										0
King	104,261	24.6	40	3	8	9	5	6	3				34

Notes to Table 4:

1. Yeadon's Register of the A4 Pacifics shows a further 11 boilers fitted in 1960 and 2 in 1961.
2. At General Repairs the boiler was lifted and replaced with either a repaired or a new boiler. The single new Duchess boiler in 1951 was the last of the working stock of 6 spares.

Two things are evident from Table 4 vis-a-vis the differing practices of the LMS and LNER. Firstly, the LNER lifted, and secondly scrapped boilers, at much lower mileages than the LMS. Further evidence on this latter point appears later. A corollary here is that the LMS must have thought it economic to carry out more extensive and expensive repairs. The specific maintenance costs for the A1 and A4 boilers, as has been shown, were significantly lower than those for the Duchess (at least for the years in question), by a factor of nearly 3 to 1. It is possible that the more frequent overhaul of LNER boilers produced economies on the 'little and often' principle, but it seems more likely that relatively early boiler replacement was the more significant factor, as will be shown.

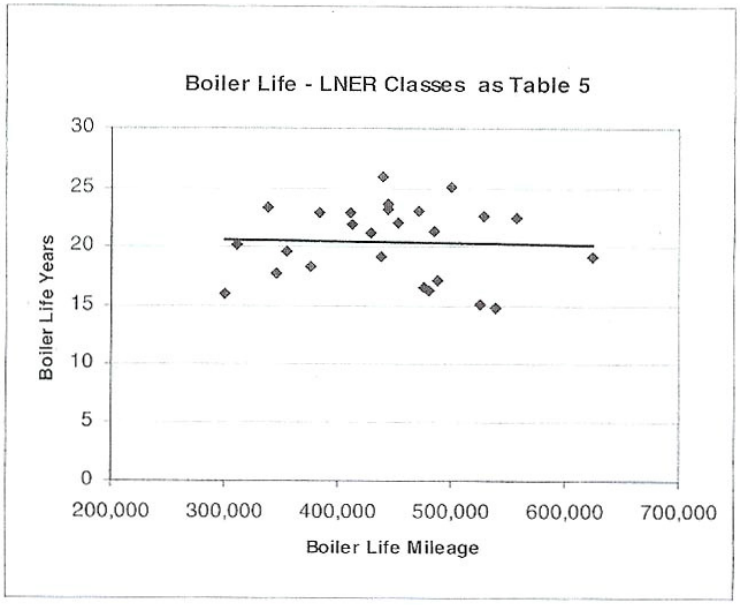
Swindon was, I believe, something of a UK pioneer in the technology of copper welding. This enabled longer boiler lives to be realised, and it was this process that revolutionised LMS practice in the Stanier era. In 1951 a complete renewal programme for the King boilers got underway, by which time the oldest boilers were 25 years old. By contrast, the oldest Princess Royal boilers were 30 years old by the time of the first withdrawals. It seems to have been much the same for all Stanier boilers; no

replacement boilers being built. It is not known if any boilers were recovered as spares, when mass withdrawals got underway in the 1960s.

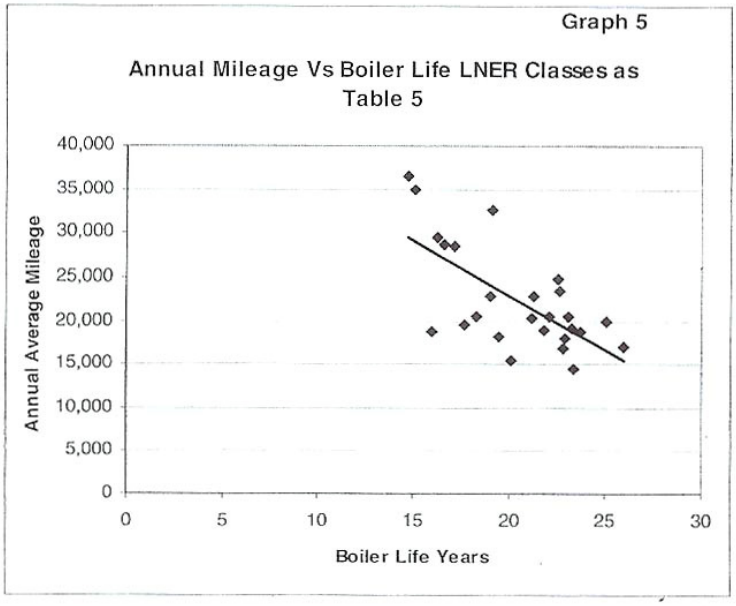
LNER — Scrap & Build

Some years ago Geoffrey Hughes passed me some of Willie Yeadon's research notes, among these were details of life mileages for 26 medium sized boilers of ex-LNER origin. These are set out in Table 5 and Graphs 4 & 5.

Graph 4



Graph 5



Notwithstanding the scatter, some clear trends seem apparent. Firstly, the average boiler life is about 20 years irrespective of mileage. Secondly, low annual mileage could sometimes extend boiler life to about 25 years. And thirdly, the minimum boiler life is about 15 years irrespective of annual mileage. This last conclusion is perhaps less well founded, no figures for high annual mileage engines being available. Yeadon's Register of LNER Locomotives makes it possible to identify individual boilers and identify scrapping dates, at least for the original batch of A4 boilers before the practice of using some at reduced pressure on the A3s was adopted. In the end, a total of 84 A4 boilers were constructed, the last in 1961.

Some Final Boiler Mileages at Scrapping (Ex LNER) Table 5

Class	Diagram	Engine	Miles	Age Years	Miles/Annum
B17	100	2813	479.852	16.25	29.529
		2868	475,360	16.58	28,671
J27	57	2892	412,443	21.83	18,893
		1225	344,777	17.67	19,512
		2357	382,995	22.83	16,776
		1056	375,304	18.33	20,475
		1213	354,280	19.5	18,168
		2340	470.726	23.08	20,395
		2353	444,469	23.25	19,117
		1005	310,101	20.08	15,443
		1221	410,181	22.92	17,896
		917	500,579	25.08	19,959
		2386	428,759	21.17	20,253
		2350	337,674	23.33	14,474
B16	49	934	485,075	21.33	22,741
		1379	528,828	22.66	23,338
		936	452,683	22.08	20,502
		924	300,308	16.0	18,769
		937	557,790	22.5	24,791
D49 J38 J39	97	N/A	624,391	19.17	32,571
		N/A	539,272	14.75	36 561
		N/A	526,306	15.08	34,901
		N/A	437,402	19.08	22.925
V1	102	N/A	487,587	17.17	28,398
Averages			**444,261**	**20.4**	**22,338**

The original A4 boiler's average life was about 14-15 years. Assuming an annual average of 60,000 miles this translates to 900,000 miles at best. The cost of a not too dissimilar Britannia boiler in 1953 was £6,193. Capitalisation alone, on the basis of 900,000 life mileage, would be 1.65d/mile or £2.67/1000sq.ft/1000 miles. Since this is twice the value quoted by Cook for the A4s, it is clearly evident that these costs did not include capitalisation costs of replacement boilers. In other words, the apparently low maintenance costs of LNER pacific boilers relative to the LMS are misleading, and in all probability the overall LNER boiler maintenance/renewal costs were less economic.