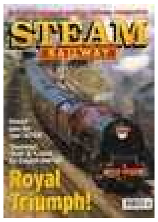
A NEW STEAM LOCOMOTIVE DESIGN FOR MAIN LINE SERVICE

This is the unabridged text of a two article series about the 5AT project, written by David Wardale. A slightly abridged version appears in Steam Railway magazine's June 2002 edition No. 272 and July 2002 No 273.



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PART 1: GENERAL CONSIDERATIONS

Some four years ago I wrote an article entitled Whither Steam Now? (Steam Railway, April 1998) questioning the future of main line heritage steam and suggesting the form a new steam locomotive for charter service might take. Four years on we still have heritage traction hauling main line specials, so it might be thought my predictions of hard times ahead were unfounded. However the difficulties of operating such locomotives on a modern railway are always increasing. Consider that:

SAR Class 26 No. 3450 "The Red Devil"

1. Normal scheduled passenger and freight services, which charter trains must fit in with, are becoming ever more frequent and faster. To obtain satisfactory timetable paths for charter services on densely trafficked main lines will therefore become increasingly difficult using motive power which cannot keep up with the speeds of other trains and which requires inconvenient halts for supplies.
2. The consequences of locomotive failure become more serious on an ever more crowded railway.
3. The safety requirements for train operation are becoming ever more rigorous, a trend which is driven by the changing conditions of railway operation, i.e. denser traffic and higher speeds.

Reflecting these trends (which will accelerate if the investment programme now planned for Britain's railways is implemented) Railtrack's conditions for allowing steam traction to operate over its network have already changed. Gone are 'grandfather rights' which accepted that locomotives were safe to run because they had done so in the past. Instead every locomotive operating on Railtrack controlled infrastructure is now assessed by engineering and safety standards that are hard, and in certain respects impossible, for heritage traction to meet.

Heritage locomotives do not therefore satisfy current requirements and are allowed to operate only because Railtrack accepts their non-conformance with its standards. But this comes at a price - heritage traction is limited to 75 mph and 15 000 miles per annum, restrictions which are imposed to make the risk, which operating such locomotives poses to other users of the railway network, acceptably low.

Main line steam charters will ultimately have to run faster to slot in with other services, otherwise arranging suitable paths for them will become impossible, but higher speeds will only be allowed if steam complies more closely with modern safety requirements and demonstrates an ability to operate reliably at continuous high speed - both of which will be difficult to achieve with locomotives over 40 years old (or new ones built to designs of that era).

Railtrack has anticipated these problems. Its Railway Group Standard GM/RT2000, 'Engineering Acceptance of Rail Vehicles' states:

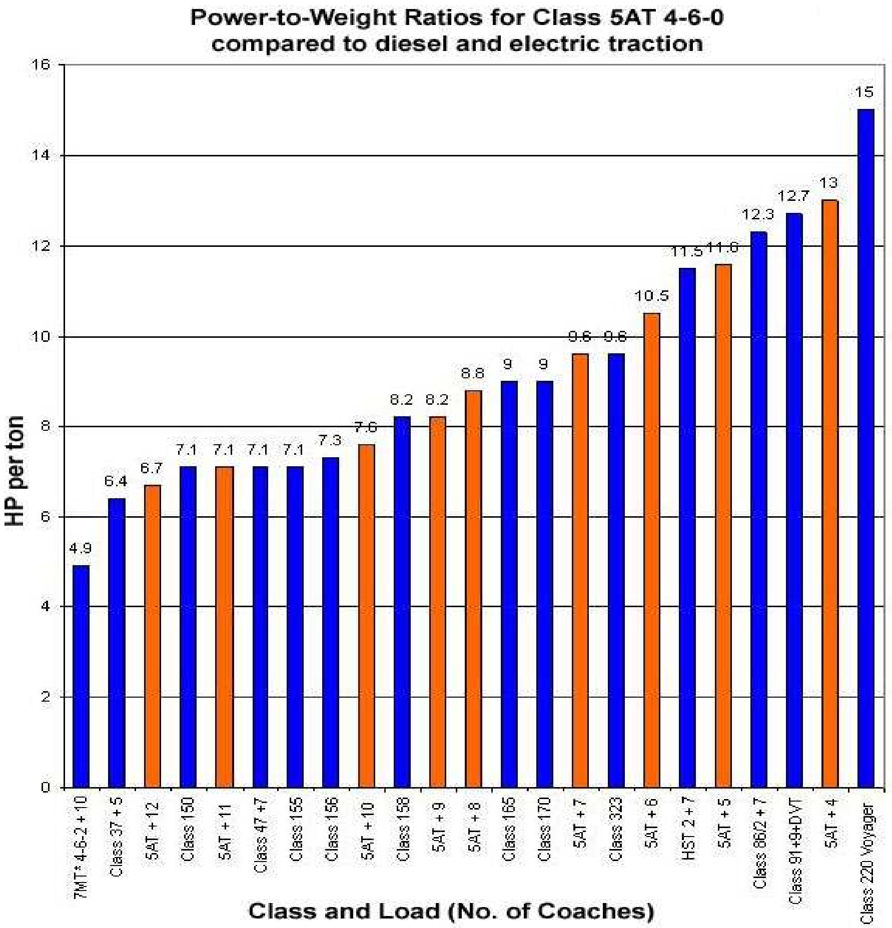
"Where there is growing risk from continued operation of non-conforming vehicles, including heritage and special service trains, the Directorate shall normally give five years' advance notice of intention to withdraw all certification and to prohibit any future re-certification."

This should make alarm bells ring concerning the future of main line steam. It is obvious that the risk to the punctual and safe operation of the railway from heritage locomotives will grow as these locomotives become older and speeds and traffic density rise. Railtrack (or its eventual successor) will demand higher safety and reliability from heritage steam, and the cost of delivering this, even if technically feasible, will forever escalate. It also brings home that steam is only allowed to operate by the grace of Railtrack A change of personnel or thinking at Railtrack, a serious incident involving steam, or simply a feeling that the risk it poses on main lines has become too great to accept, any of these could result in a steam ban. At worst this could be a blanket withdrawal of the right of heritage steam to run on all main lines, although a more likely initial scenario is that steam will get banned route by route as routes are upgraded and their services become more frequent and / or faster. Such routes are likely to be those serving main population centres, where most of the charter train business probably originates, the secondary routes to which steam may be increasingly confined being not necessarily where charters can be most profitably operated.

The railway is now very different from that on which steam used to run in regular service, a difference which is constantly increasing as the railway adapts itself to a changing world. The time will therefore inevitably come when the limitations of heritage locomotives will force them off main line rails. If steam is to survive on the main line it will need to fit in more seamlessly with a modern railway, and this has prompted the present writer and some of his associates to explore the possibility of producing a new locomotive of the type suggested in my 1998 article. The aim of this proposal is to have a steam locomotive working charter trains at speeds which are compatible with those run by modern traction, and which could be intensively utilised to give an adequate return on its appreciable capital cost. The new locomotive would therefore have to be accepted for operation on Railtrack lines without the limits imposed on heritage steam.

The proposed locomotive has been designated the Class 5AT, the '5' in recognition of it being based on the size and format of the BR Class 5MT 4-6-0, and the 'AT' standing for Advanced Technology. The drafting of a business plan for the proposal has given some insight into the difficulties that such a scheme would face, and has resulted in interesting feedback and suggestions from various people in the railway industry.

Firstly, Railtrack's five years' notice of intention to withdraw all certification from heritage steam would be insufficient time to develop a new locomotive - eight years would seem to be about the minimum time required to get a new design in service if starting from scratch. Railtrack has advised that the proposal would have to undergo the same full engineering acceptance procedure as any other new locomotive design, which is much more rigorous than that applied to heritage traction. It follows that if it were to be accepted on this basis it would not be classed as a heritage vehicle and would not be subject to any future ban that may be imposed on heritage steam, thereby realising one of the project's main aims. However to avoid the possibility of a truly steamless railway, onto which it might be very difficult to reintroduce even non-heritage steam, it would appear wise not to wait for any ban to be announced before starting work on such a project. Rather, an advanced steam locomotive should already be running and its performance proven whilst Railtrack's existing policy still applies.



The question of the technical acceptability of the proposal to the railway industry is heavily linked to safety considerations. Acceptance of any vehicle for operation on Railtrack controlled infrastructure involves an assessment of the operational risk by various authorities, e.g. Railtrack itself, Railway Safety and H. M. Railway Inspectorate. Railtrack's engineering acceptance procedure is designed to ensure that new rolling stock is safe to run in its intended service and is generally compatible with the rest of the railway, and involves compliance with specifications given in the company's Railway Group Standards. There are 34 such standards, plus 14 additional codes, which appear to be relevant to any new design of steam locomotive.

They cover features ranging from such simple items as the yellow warning panel at the ends of locomotives (not required on heritage steam), to not so simple ones, such as modes of structural collapse and energy absorption under collision conditions. Certain features of the proposed locomotive would be dictated by the necessity of satisfying these Railway Group Standards to the maximum possible extent. In general, it is expected that the Class 5AT would relate to these standards in three ways:

1. Areas where full compliance could be demonstrated at the design stage. This could be achieved for all details which are not constrained by the very nature of steam traction.
2. Areas where full compliance could be designed into the locomotive, but where proof of this would require testing, such as braking performance, track forces and ride quality.
3. Areas where steam traction's fundamental nature may prevent full compliance from being achieved, such as the impossibility of directly obtaining a completely unobstructed view ahead from the cab front windows.

All three areas involve potential difficulties. For example, the design of any new vehicle must be certified compliant by a Conformance Certification Body (CCB), but in this case there would be many areas where there is no precedent which a CCB could use for guidance regarding the proposal's acceptability - how many steam locomotives have been built with (intentional) energy-absorbing zones? The same problem would apply to components not covered by the Railway Group Standards but which have a bearing on safety and reliability, such as the engine's reciprocating parts, the design of which would have to be in advance of anything yet seen in steam locomotive engineering. Approval of the design would therefore be likely to prove difficult and expensive.

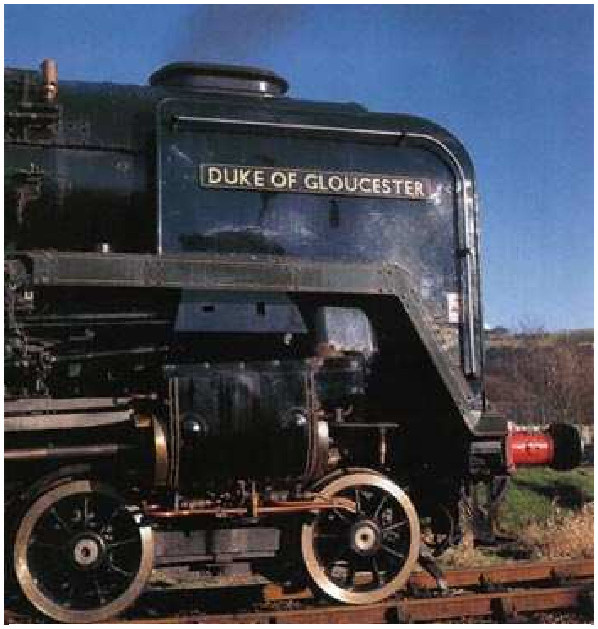
However, it is the last of the above three areas, i.e. the basic trade-off between the need to retain the steam locomotive's classical form and aesthetic appeal and the consequent non-compliance with certain Railway Group Standards, which would be the key issue in the question of the proposal's acceptability for safe operation. Specific derogation for each item of non-compliance with the mandatory requirements of the Railway Group Standards would have to be sought by making a sound case that such non-compliance did not compromise safety. Risk assessment would then be carried out by the authorities concerned to determine if the operating risk was as low as reasonably practical, in which case certificates of derogation might be granted. This risk assessment would naturally be linked to the operating speed and annual utilisation of the locomotive - the greater these were, the more rigorous the safety case would have to be. This being so, it is unlikely that clearance would be given for high-speed operation or more intensive utilisation without convincing practical demonstration of high-speed safety and reliability. The probable best scenario would be for initial acceptance to run on Railtrack lines to be granted with similar restrictions to those imposed on heritage traction, and for these restrictions to be progressively relaxed as the Class 5AT demonstrated its reliability and suitability for safe operation at higher speeds.

The basic aims of the present proposal have already been put to Railtrack for its consideration and advice. From its reply it is clear that the first step in the engineering acceptance process for the Class 5AT (and indeed for any new design of steam locomotive) would be a rigorous point-by-point review of the locomotive's compliance with the Railway Group Standards, listing specific areas of non-compliance and the degree of non-compliance in each case. This safety case would then have to be presented to Railway Safety for its views on possible ways forward for the project in relation to engineering acceptance. As permission to operate the locomotive at its full potential would depend on the ultimate outcome of this process, this work would appear to be the correct starting point for the whole project, and as such it could be undertaken as a feasibility study into the very possibility of high-speed and relatively frequent main line steam locomotive operation.

Railtrack has also advised that the fitting of automatic train protection (ATP) systems to rail routes, and the equipping of the locomotive with such a system, which may be technically possible, would be likely to significantly mitigate a number of risks due to non-compliance.

The acceptability of the locomotive to the operator (such as EWS Ltd.) and its staff should present no great difficulties, as steam crews should be attracted to the exhilarating performance which the new locomotive would offer. The functions of the driver and fireman would be basically the same as on any steam locomotive, although improved controls and the elimination of the manual labour of firing, either through oil firing or mechanical coal firing, would make their tasks easier. Nevertheless the art of driving and firing a steam locomotive, the practising of which is one of the main attractions for volunteer crews, would still be very much an ingredient of successful operation. Crews would naturally have to be passed for working at the locomotive's maximum continuous operating speed, 112.5 mph (180 km/h) being the target figure.

The other main aspect of the proposal's acceptability to the railway industry is its commercial attractiveness to the locomotive's owner and its users (charter train operators). The business plan predicts good profitability for the Class 5AT over its anticipated operational life of thirty years, either on the basis that it is hired out to charter operators in the same manner as heritage steam, or used together with dedicated stock as a unique tour train. However in order to generate a profit the locomotive would have to be fairly intensively utilised - profitability calculations have been made on the assumption that it would be utilised at an annual rate equivalent to three 200-mile trips per week. Whether or not there would be sufficient demand for this to be realised might ultimately depend on the reaction to the locomotive of the railway enthusiast community and the general public. The latter is already taking over as the main customer for charter trains, and does not have the same attachment to steam traction as the enthusiast. One of the main charter operators has advised that for its average customer what is at the head of a train is not so important any more, which reduces both the commercial value of steam traction and the premium which can be charged for steam haulage. This, together with the presumed lower cost of using diesel or electric traction in charter service (this assumes the Class 5AT would be operated on a fully commercial basis without its costs being distorted by the factors applicable to heritage steam, such as volunteer labour), would diminish the commercial attractiveness of the proposal to charter operators.



BR Class 8 Pacific No 71000 “Duke of Gloucester”

The question of whether even steam enthusiasts are sufficiently interested to justify the proposal must also be raised. What is not wanted - or not shown to be wanted - will not materialise. There are many who see the rightful function of steam operations as preserving or recreating the past, and for them any proposal for a new design of locomotive lacks the essential element of historical preservation. Whilst we can promote the Class 5AT as a new and exciting shape on the rails, the preservationist would rather see old shapes restored or replicated. Both points of view are valid, but the latter ignores the writing on the wall for main line heritage operations. At some point - no one knows exactly when - it will surely be a case of new steam or no steam at all.

PART 2: THE CLASS 5AT 4-6-0

The Class 5AT (Advanced Technology) 4-6-0 proposal is for a new high-performance steam locomotive for the haulage of high-speed main line charter trains. It would be a 'state of the art' design giving the kind of all-round performance which may be mandated for main line service in the future and which significantly exceeds that of former steam, yet without sacrificing the steam locomotive's rugged simplicity, nor its aesthetic appeal. It would feature the following general characteristics, so as to have the highest level of acceptability to all sectors of the railway industry involved in charter train operation.

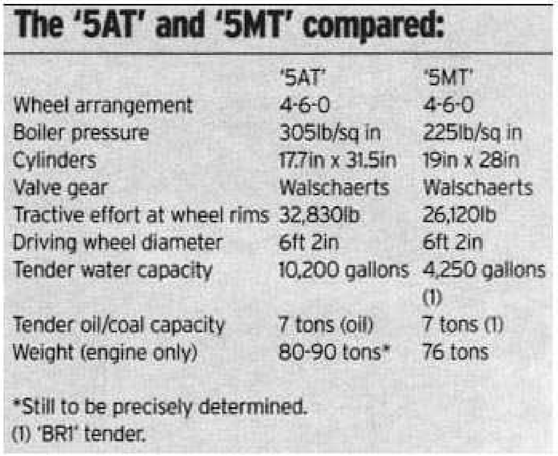
1. High power/weight ratio, the key to high-speed capability.
2. High thermal efficiency.
3. High maximum operating speed, as required for slotting in with other traffic.
4. High level of inbuilt safety, incorporating many operational and safety features mandated by Railtrack, Railway Safety and HM Railway Inspectorate.
5. High reliability, giving high availability for service. (Reliability is one issue of immediate concern to Railtrack and the charter train operators. Heritage steam is not reliable - in fact by a more scientific criterion than that normally used, relating operational reliability to maintenance input, it never was.)
6. Low fuel and water consumptions.
7. Long operating range between supplies replenishment, a consequence of the low fuel and water consumptions and the use of a high-capacity tender.
8. Low overall operating cost.
9. High route availability.
10. High level of convenience for operating crews.
11. Aesthetically attractive for creating the true steam 'ambience' and a striking 'image'.
12. Environmentally friendly operation, e.g. minimal pollution.

An engineering specification has been drawn up for the Class 5AT as part of the project's business plan, but here we will confine ourselves to points of general interest to the enthusiast.

When considering the following it should be remembered that for an ideal design the overall concept and the details must both be right, but that compromises in both are inevitable in practice.

Firstly some of the design's proposed vital statistics and predicted performance data are given (most figures are converted from SI metric to Imperial units for those who may be unfamiliar with the former). The performance figures reflect what is attainable from present 'state of the art' design, which owes much to the work of Chapelon and Porta.

1. Engine weight in working order = 80 ~ 90 metric tons (depending on the leading bogie load, which would only be determined at the detail design stage). The maximum axle load would be 20 metric tons (same as the BR Class 5) and the adhesive weight 60 metric tons.
2. The tender weight with full supplies = 80 metric tons, giving an overall engine and tender weight with full supplies of 160 - 170 metric tons. Assuming oil fuel, the tender would carry 7 metric tons of oil and 10 200 gallons of water.
3. The approximate length over buffers of engine and tender = 72 feet 6 inches, with an approximate overall engine and tender wheelbase of 62 feet.
4. The working boiler pressure = 305 lb/in^2, coupled wheel diameter 6 feet 2 inches (same as the BR Class 5), and the two cylinders 17.7 inches diameter x 31.5 inches stroke. This would give a nominal starting wheel rim tractive effort of 32 830 lb. and a starting factor of adhesion of 4.03.
5. Walschaerts valve gear with piston valves would be used, probably two valves per cylinder each of about 7 inches diameter, tentatively with 2.6 inches steam lap and 0.4 inches exhaust lap.
6. The rated maximum steam supply (cylinder plus auxiliary steam) from the boiler would be approximately 37 500 lb. per hour and the maximum steam temperature = 842°F (450°C). Exhaust steam feedwater and combustion air preheaters would be fitted.
7. The maximum rated drawbar power on level tangent track would be some 2 535 hp at 71 mph (113 km/h) when carrying the high capacity tender. The maximum indicated cylinder power is predicted to be 3 460 hp at 106 mph (170 km/h), equal to 43.3 hp per ton of engine weight for an 80 ton engine.
8. The overall thermal efficiency of the locomotive, when oil fired, referred to the cylinder output corresponding to the maximum rated drawbar power = 14.1% (this would not be the locomotive's maximum figure). The corresponding indicated specific steam consumption, based on steam to the cylinders only, = 11.2 lb. per hp-h.
9. The maximum continuous operating speed = 112.5 mph (180 km/h). The locomotive would be designed for some 10% overspeed, i.e. 125 mph. Note that this would be the design speed and does not imply permission to operate at such a speed.
10. The operating range at constant maximum drawbar power, i.e. 2 535 hp at 71 mph, would be some 350 miles based on fuel supply and 230 miles based on water supply. 2535 drawbar hp at 71 mph equates to the haulage of a 1 075 ton 29 coach train, and with the trailing loads more likely to be found in service (say 300 - 500 tons) the full-power ranges would be significantly greater than the above figures, and greater still under average service conditions (i.e. at an average power which is less than the maximum).



The '5AT' and '5MT' compared:

	'5AT'	'5MT'
Wheel arrangement	4-6-0	4-6-0
Boiler pressure	305lb/sq in	225lb/sq in
Cylinders	17.7in x 31.5in	19in x 28in
Valve gear	Walschaerts	Walschaerts
Tractive effort at wheel rims	32,830lb	26,120lb
Driving wheel diameter	6ft 2in	6ft 2in
Tender water capacity	10,200 gallons	4,250 gallons (1)
Tender oil/coal capacity	7 tons (oil)	7 tons (1)
Weight (engine only)	80-90 tons*	76 tons

*Still to be precisely determined.
(1) 'BR1' tender.

The rationale behind basing the design (excluding the tender) on the size and format of the British Railways Standard Class 5MT 4-6-0 design of 1951 now needs to be explained. The reasons are as follows.

1. Given the level of power:weight ratio now possible in steam traction (i.e. in excess of 40 continuous indicated hp per ton of engine weight, compared to about 30 hp per ton for the very best of heritage steam) it is an appropriate size of locomotive for its intended duty - nothing larger would be required.
2. The deep firebox of a 4-6-0 has, size for size, a higher evaporative capacity than a shallow firebox boiler, and is ideally suited to burning oil or coal (using the Gas Producer Combustion System).
3. Basing the design on an existing one would significantly reduce the design complexity, time and cost.
4. All overall dimensions constrained by the moving structure gauge being kept within those of the BR Class 5MT would facilitate route acceptance.
5. The route availability would be high - it would be a 'go-anywhere' type.
6. A modest size locomotive would allow a large tender without exceeding the permissible length for turning facilities, this in turn maximising the very important parameter of operating range between supplies replenishment.
7. The relatively small taper boiler would give good forward visibility from the cab and good exhaust lifting, factors of paramount importance to safe operation at high speed.
8. The 4-6-0 is the quintessential British locomotive type, and the Class 5 may be considered to be the quintessential 4-6-0. It is considered most appropriate to build on this tradition, and the present proposal would define the current limit of performance for this type of locomotive.

BR "Standard" Class 5MT No 73069

Some might question the use of a 4-6-0 for very high speed, but it should be noted that Chapelon's 125 mph proposals of the 1930's and 40's were likewise 4-6-0's. The important parameter of adhesive weight would be adequate in a 4-6-0 at high speed, indeed it is worth noting that 4-6-0's can have the same level of adhesive weight as much larger 4-6-2's and

4-6-4's - very few European locomotives of these two wheel arrangements exceeded the adhesive weight of the GWR 'King' Class 4-6-0's. However modern traction combines high-speed capability with rapid acceleration, the latter requiring high low-speed tractive effort and therefore more powered axles than the three of a 4-6-0. Unfortunately more coupled axles would mean either a longer engine wheelbase, increasing the design difficulties and correspondingly reducing the permissible size of the tender, or smaller coupled wheels, which would limit maximum speed. We therefore come up against one of steam traction's inherent limitations, i.e. the difficulty of designing a locomotive for both high tractive effort and high speed. For the present, high speed has been judged more important than rapid acceleration. Should the latter prove more desirable an 8-coupled design would be indicated, perhaps based on the LMS 8F but with a heavier axle load, a type which would also be more useful on steeply-graded lines. However with such a design we could not expect a continuous maximum speed of more than about 85 mph, which is not significantly more than that of heritage steam nor, it is thought, adequate for tomorrow's main line conditions.

Like the BR Class 5, the new locomotive would be a 2-cylinder simple. Realistic alternatives would be a 3-cylinder simple or 3-cylinder compound, the unattractiveness of a two-throw crank axle in a high-power locomotive ruling out four cylinders. A comprehensive comparison was made of 3-cylinder versus 2-cylinder simples, from which it was seen that the advantages of three cylinders lay mostly in the realm of mechanical factors affecting performance, and the disadvantages in extra complexity and associated costs. In the final balance three cylinders gave no net advantage over two, a conclusion which no doubt echoes that found by the majority of steam engineers in the past.

As the present writer is no expert on compound locomotives, people more knowledgeable in this field, including Porta, were consulted. Their arguments in support of compounding were carefully considered, but a 3-cylinder compound was finally rejected, primarily because of the following:

(i) insufficient space for adequate l.p. cylinder volume;

(ii) the need for resuperheat and/or a l.p. cylinder steam jacket, with attendant complexity;

(iii) doubts about the possibility of adequate internal streamlining downstream of the h.p. cylinders at high speed and high steam flow rate;

(iv) improvements in simple engine design, which have to a greater or lesser degree negated the various advantages of compounding for a high-speed locomotive;

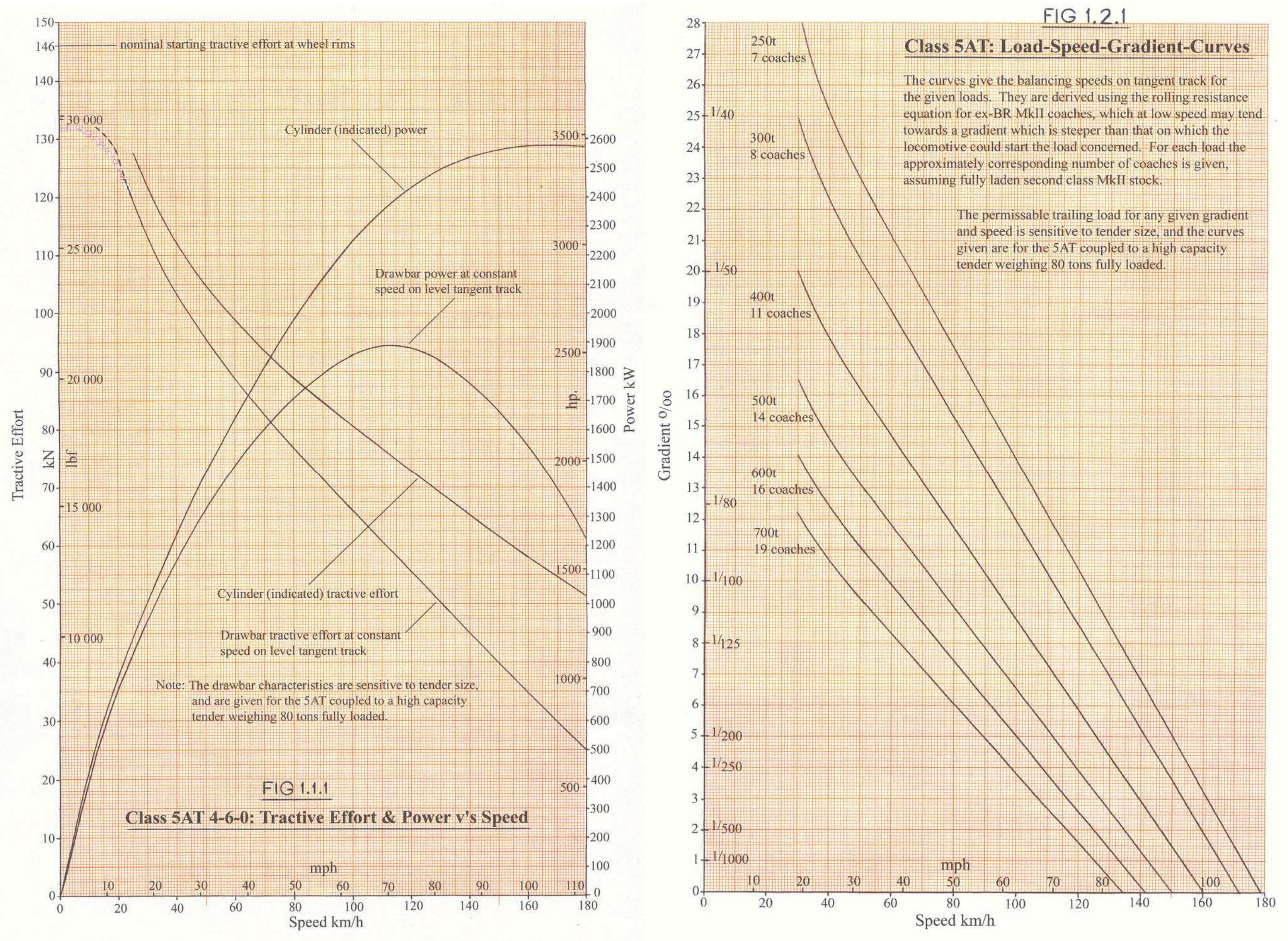
(v) general complexity;

(vi) the extra design workload and manufacturing cost, bearing in mind that the project's intellectual and financial resources would probably be limited; and

(vii) lack of experience with compound locomotives of almost all those who might be involved with the project.

In short, although a compound might give better thermal performance, more especially at lower speeds, its potential advantage when comparing current 'state of the art' simple and compound design was not considered sufficient to justify the extra design and manufacturing cost which a compound would entail. As implied by point (i) above, the very restricted British moving structure gauge is a factor working against compounding, and as one of the compound experts has put it, 'perhaps the French were wise to build compounds, and the British wise not to'.

A thoroughly modern 2-cylinder simple would show little or no inferiority to multi-cylinder engines in respect of thermal performance. Mechanically, however, it is a different story. One of my correspondents has called the 2-cylinder engine 'barbaric', and he is correct. The problem is one of balancing - ideal balancing of a 2-cylinder locomotive with cranks at 90 degrees is not possible, and the problem gets worse as speed increases. At its proposed maximum continuous operating speed of 112.5 mph the drivers of the Class 5AT would be revolving at 8.5 revolutions per second, and with the long piston stroke the mean piston speed would be 2 666 feet per minute ('Mallard's was some 2 300 at 126 mph). The key to solving the resultant balancing problem would be to keep the mass of the reciprocating parts to the absolute minimum, certainly no more than 550 lb. (250 kg) per cylinder, and it must be stressed that this would be critical to the acceptability of a 2-cylinder locomotive for the envisioned speeds. By further refinement of the best former practice in the design of lightweight reciprocating parts, plus the use of an engine-tender connection allowing the tender mass to contribute effectively in absorbing fore- and aft forces due to the unbalanced component of the reciprocating masses, it is believed that satisfactory balancing could be achieved whilst limiting the dynamic augment ('hammer blow') to an acceptable figure.



Estimated Performance Curves for 5AT Locomotive (from Fundamental Design Calculations)

Another area critical to the success of the proposal would be the design of the combustion equipment. To achieve an evaporation of 37 500 lb. of steam per hour would require a heat release rate in a BR 5MT - size firebox of 3.2 x 105 Btu per hour per cubic foot of firebox volume, or 1.9 x 106 Btu per hour per square foot of grate area. Such a high level can be reached - it has been achieved before with oil firing, and would be possible burning coal using the Gas Producer Combustion System - but achieving it with high combustion efficiency would be a difficult problem. The preferred fuel would be gas oil/diesel fuel.

It has been mentioned that high reliability is an important factor. This is because (i) in-service failures which disrupt other trains will be increasingly less tolerated, (ii) the intensive servicing and maintenance which steam received in the past (and which is still required on today's heritage locomotives) will become too costly, and (iii) spare parts will be expensive as they tend to be special items manufactured in small quantities. In its truest sense reliability means that locomotives must give high reliability 'on the road' with the minimum of maintenance effort. Even at the present state of the art reliability and simplicity do go together, and the format of the Class 5AT - a 2-cylinder single expansion 4-6-0 - is about as simple as a main line locomotive can be. Reliability is also very much a question of good detail design, and every attention would be given to this point at the detail design stage. Naturally features of proven high reliability, such as roller bearings, would be incorporated to the maximum possible extent. The level of reliability would be such that it is expected that major overhauls would only be required at approximately 250 000 mile intervals, with intermediate overhauls (dictated by tyre wear) at some 125 000 mile intervals, and major servicing (e.g. boiler washouts) at a minimum of 12 500 miles.

The foregoing has described just some of the important parameters having a bearing on the Class 5AT 4-6-0 design. It is a proposal which may be considered to be in the nature of a pilot scheme, to demonstrate the extent to which high-performance steam traction can satisfy the various requirements involved in the running of steam charters on tomorrow's railways, with the aim of securing their long-term future.

Finally, the main benefits to charter train operators offered by the Class 5AT 4-6-0 would be as follows.

1. Offering more power, higher maximum speed and longer range than heritage steam, it would allow higher charter train speeds and make it easier to arrange suitable paths for such trains.
2. A higher average speed would mean that long-distance charters could be run in less time, making them more attractive to customers who do not necessarily wish to spend too long on a train and increasing the list of possible destinations.
3. The possibility of very high speed behind steam traction should be a commercially exploitable factor.
4. The long operating range would offer the operator greater flexibility in the choice of routes and minimise the logistical problems of providing supplies.
5. The running and maintenance costs would be low due to the low fuel and water consumptions and high reliability respectively.
6. The use of 'shadow' diesel locomotives following steam charters to cover for possible engine failure could be dispensed with, giving a corresponding cost saving.
7. The new and striking appearance of the locomotive should generate interest and attract passengers.
8. Last, but most important of all, the very possibility of being able to run steam charters in the future may depend on such a locomotive as here proposed becoming available.