

ERMELO-RICHARDS BAY IN RETROSPECT

INTRODUCTION

Development of the Ermelo-Richards Bay operation has over the years presented Spoornet with a long and rich learning curve in the heavy haul field. It has evolved into a prototype and test bed for a host of new developments and spawned a deeper understanding of many aspects of railways.

HISTORICAL BACKGROUND

The line was opened in 1976, starting with diesel-electric locomotives six-in-multiple. It was planned to convey ** million tonnes per annum, but since then the tonnage has grown by leaps and bounds. Although not anticipated, there in due course developed an orderly upward progression to ultimately exploit the full potential and capabilities of the line and its personnel.

Early electrification at 25kV AC established a trend toward larger loads. Perhaps at this time the biggest hindrance was fear of the unknown. Although at the time the Sishen-Saldanha line was already in electric operation, the Ermelo-Richards Bay line passed through topographically more severe country, and electric traction was at that time seen as an energy-saving plan. The potential of electric traction was unknown and treated with suspicion. For this reason loads peaked at around 80 wagons. Locomotives were 25 kV AC thyristor controlled, built in four series (7E, 7E1, 7E2 and 7E3) by various manufacturers.

In due course increased capacity was required, and all-round limit-stretching was initiated. One of the first options was increasing axle load. This raised trailing tonnage to around 6400 tonnes. However, it was appreciated that much more development was required. At this time it was decided to bite the bullet of significantly heavier electrically hauled loads. At the same time, it was considered necessary to realign the track at certain sites to ease the gradient to remain within acceptable coupler force limits. A new class of locomotive was acquired, the 11E. This has a mass of 168 tonnes on six axles, and ratings at rail of 3,9 MW in traction and 4,5 MW in rheostatic braking. A new wagon of 26 tonnes per axle was designed to facilitate an all-round optimization of the scheme. These have been built to the same basic design in three series (CCL⁻⁵, CCL⁻⁷ and CCL⁻⁸), each incorporating the lessons of past service experience, 3CR12 body plating and higher strength draw-gear components. The fleet will number **** at the end of the current build.

The need to relay the line coincided with a full capacity train service. To facilitate the civil works, the number of trains was reduced by combining them into double length trains. The original substation capacity was adequate for trains of around 14 000 tonnes gross. It introduced one of the most insightful phases of the project, in that previously subliminal aspects of train handling and locomotive-track interaction became perceptible. As the class 11E locomotives were commissioned, it became possible to control 200-wagon trains from the head end only. This made it attractive to deploy diesel locomotives on the rear of the train to assist on long ascending gradients. This phase therefore applied mixed diesel and electric consists, which was a way around the temporary substation capacity during easing of the gradients. Successful development of the driving techniques has now suggested the use of diesel locomotives in multiple with electric locomotives for peak lopping on lines which convey a wide range of train types and tonnages. This phase provided insight into train handling techniques using multiple consists and their effects on track struc-

ture. This is arguably one of the deepest insights from the experiences on this line--it addressed the most significant problem with electric heavy-haul, namely the economic impossibility of providing full power rating at all points on the line under all circumstances. This problem has wider implications than has been appreciated previously.

The ultimate concept, 200-wagon trains, was introduced in February 1989. These had relatively small teething problems, mainly in the areas of holding brake and train breaks. These were successfully overcome during commissioning. The fleet of class 11E locomotives originally commissioned was 45 strong. This permitted a service of seven to eight 200-wagon trains per day. The remaining traffic is handled in trains of up to 100 wagons by the various series of class 7E locomotives. The veracity of the original 200-wagon train design concept has been vindicated by subsequent capacity upgrades, as described below. This is particularly interesting because when an opportunity for change presented itself, an extension of the original concept was preferred over possible alternatives.

Market expansion and successful operation of the 200-wagon trains has generated a need for more such trains. The 50 locomotives in Class 7E1 are therefore currently being upgraded to also work 200-wagon trains. Because they are derived from the previous generation of 21-tonne axle-load locomotives, they cannot match the tractive effort of the Class 11E locomotives. They will therefore be operated six-in-multiple. Their original electric brake rating was restricted to 1,7 MW, amongst other to limit peak braking force at low speed. However, the power electronics and traction motors were originally rated at 3 MW per locomotive, its original rating in traction. This enabled the required 18 MW of electric braking to be obtained by increasing the number of electric brake stacks from two to three and up-rating them slightly. The exhauster was removed to provide space, and hence these locomotives now become air-brake-only. Holding brakes are also being fitted, to facilitate holding a train after stopping on steep downgradients. The tractive effort in traction will be switchable, to limit the tractive effort of six 7E1's to no more than that of four 11E's in multiple.

DIFFICULTIES AND ACHIEVEMENTS

The Ermelo-Richards Bay project has over the years been honoured with awards from professional societies. Civil project 19**. Associated Scientific and Technical Societies for advances in heavy haul trains, at the time of the award for the double length trains, then the heaviest electrically hauled trains in the world. This achievement has subsequently been surpassed by the 200-wagon trains running on the same line. In 1990 the South African Institution of Mechanical Engineer's Projects and Systems Award was taken by the 200-wagon trains. One of the remarkable achievements is of men from all disciplines and walks rising to the demands of the challenge to enter the unknown and make it work. This has instilled an invincible spirit in those closely associated with the project.

One of the most difficult problems, whose solution ultimately provided greatly enhanced understanding of relationships, was an appreciation of energy transfer and hence of forces between locomotives and track. The standard of driver training and skill which was ultimately produced was such that dynamic longitudinal loading could be kept within extremely low values, typically less than ten percent of the quasi-static coupler force on long ascending gradients. This meant that four class 11E locomotives in multiple can at low speeds apply critical values of tractive effort to the track. This realization has profound implications for track maintenance, a challenge which has been successfully addressed by developing resilient pads between rail and sleeper.

Insight into energy consumption has been provided by the developments in train handling. The changeover from in-train locomotives to head-end-only motive power demonstrated that care needs to be taken of what happens to energy consumption. It was found that high tractive and braking forces, but particularly high tractive forces could loosen the track structure to the extent that energy consumption could increase--i.e. there is a covariance of energy consumption and track maintenance requirements.

During this development phase it was also perceived that higher speeds did not necessarily increase energy consumption. It was found that given suitable locomotive train handling, the trains could run faster and at the same time consume less energy and lighten the maintenance on the track. The importance of stable bogies, radial in this case, and powerful electric braking, have emerged as lessons for the future.

CONCLUSION

An inevitable question which arises during development of a project of this nature is, Where do the limits lie? The answer may not be immediately useful, but access to the personnel and equipment while it is still current was regarded as vital. Questions such as the ultimate length of a train need to be answered, in the light of a discernible probing toward electrically controlled brake systems. How manageable is slack action as trains get longer and heavier? Do human drivers possess the potential skills required? Are there any step-functions which may impede or thwart future leaps of faith?

To answer to these questions and probe such limits, Sishen-Saldanha was revisited in 1989. Firstly, an electrically hauled 440-wagon ore train of 47 000 tonnes was run, transplanting Coal line train handling techniques to the easier gradients and topography of Sishen Saldanha. It was found that handling was within the accustomed paradigm, and that personnel were at ease. Transmission of automatic braking applications proved somewhat problematic, necessitating the initiation of brake applications from both ends of the train. This provides useful insight into the limitations of response of the AAR direct release system, particularly regarding thoughts of electric automatic brake operation at some time in the future. Thereafter, a 660 wagon train of 71 000 tonnes was operated. This taught that whereas control of the 440 wagon train was relatively easy, control of train action ultimately becomes a task which could not routinely be expected of a human driver. Yet, given two drivers brake valves, system operation was stable though understandably somewhat more sluggish than on a shorter train.

FUTURE DIRECTION

Whilst history has frequently taught that it is imprudent to proclaim the end of a development route, the writer does feel that heavy haul technology has developed to a threshold which would best be crossed by new insights. We have attained a plateau of development on which refinement rather than new breakthroughs are taking place. Perhaps the most fundamental question which must be answered is, is there a need for such future development? When it comes, Spoornet has positioned itself to contribute an ability to stop at nothing.