Heritage Report - The Blackstone E range

by Trevor Owen

The Blackstone E range of diesel and dual fuel engines is probably known to many Members as it was in production in the period from 1950 onwards for over 50 years with total engine production exceeding well in excess of 10,000 units. This article covers the history of this highly successful range.

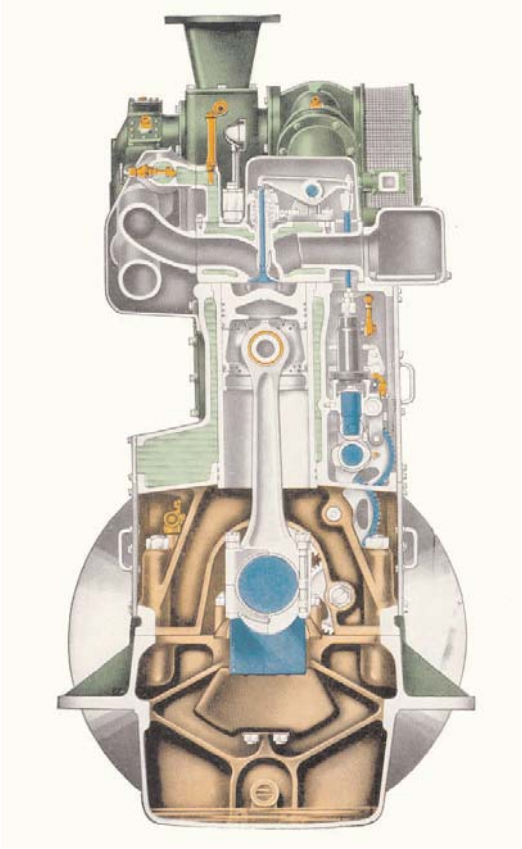


Figure 1 - Cross section of Blackstone E Mark 1 single bank engine

The origins of the Blackstone E range engine can be traced back to the EPV range which was manufactured at Stamford from 1934 to 1950 in 2 to 8 cylinder form with an 8.75 inch bore and 11.5 inch stroke and with ratings of up to 40 bhp per cylinder at 600 rpm. This engine range was produced in significant numbers and it was a logical progression in the post war period to design a new engine using the same bore and stroke as the existing range.

The 'new' E range was introduced in 1950 with the EV range rated at 45 bhp per cylinder operating at 600 rpm, and the original EPV production ceased immediately. The design was conventional for the era with a cast iron crankcase, fully machined crankshaft, cast iron cylinder housing, centrifugally spun iron liners, forged steel connecting rods, aluminium pistons, and a two valve cast iron cylinder head. The engine featured a high proportion of cast iron components to utilise the on site foundry facilities to best advantage and to keep production costs down. Engines were produced in 2, 3, 4, 6 and 8 cylinder configurations from 1950 onwards.

Further significant developments in output and operational speed followed as the core design was developed over the decades up to the ultimate rating of 250 bhp per cylinder achieved with the final rating for the vee form E Mark 2 range.

For power generation purposes the main application was in 50 hertz markets and hence there was keen interest in achieving maximum output at appropriate 50 hertz speeds with 1000 rpm being the ultimate goal which was achieved in the early 1970s. Two distinct major assembly configurations existed within the production range following the significant upgrading achieved with the release of the ET and EW engines in 1966. Most of the subsequent development work was based around the 1966 upgrade, leading eventually to the EZSL 1000 rpm engine as the ultimate development on the E 'Mark 1' range within the limitations of the major components.

The earlier ER/S engine build specification was however retained in production for the significant

Table 1 – Evolution of the Blackstone E range

Year	Type	Rating BHP per cyl	Speed RPM	Design detail
1950	EV	45	600	Naturally aspirated
1951	EVS	66	600	Turbocharged
1954	ERS	82	750	Turbocharged
1959	ESS	100	900	Turbocharged
1966	EWSL	125	900	Turbocharged & Intercooled
1970	ECSL	125	1000	Turbocharged & Intercooled
1972	EZSL	156	1000	Turbocharged & Intercooled
1979	ESL Mark 2	182	1000	Turbocharged & Intercooled
1983	ESL Mark 2	202	1000	Turbocharged & Intercooled
1986	ESL12/16 Mk 2	250	1000	Turbocharged & Intercooled

volumes of low rated engines purchased for use in developing areas of the world where ultimate reliability was required at the most competitive price. Whilst 2 and 3 cylinder engines were discontinued by 1974 the 4 cylinder engine remained in production into the 1980s.

The twin bank engine design was a logical development of the core design to double the power output without any significant investment in the Stamford works apart from gear cutting machinery. The first of these units was produced in 1958 and took the available power band up to 1320 bhp. Specific information on the twin bank was covered in an article published in the Power Engineer Volume 11 Issue 4 in September 2007 (also available as a pdf copy via the heritage section in the Member's area at www.idgte.org). Production of the twin bank commenced with the lower rated EV/R engine builds but moved rapidly to the higher rated ETSL engine builds from 1966 onwards.

In the original plans for development of the Stamford product range in the early 1970s a new high speed base load engine was conceived leading to the MB190 design which would extend the available power range to 2 mWe. At an early stage it was apparent that the MB190 would be more expensive to build and also conservative market areas might not accept a 1500 rpm engine.

Hence the E range was given a new lease of life with the E Mark 2 where the remit was to extend the existing single bank design to produce the highest output in the shortest timescale. This led to the successful development of the E Mark 2 with much of the development work being completed at the Mirrlees Blackstone Stockport factory. A number of inherent problems with the original design were addressed including the provision of four valve cylinder heads to improve combustion, and the fitting of external fuel pumps to avoid the problems of fuel diluting the lubricating oil with the original enclosed fuel system. A primary requirement was that as many components as possible would be interchangeable with E Mark 1 engines although in practice this mostly applied to the higher rated versions of the earlier design.

The E Mark 2 proved to be successful and sold well, although demand also continued for the lower rated versions of the E Mark 1 for many years. Mirrlees Blackstone went on to offer the E Mark 2 on heavy fuel operation from 1982 onwards although not many were supplied for such use. It was produced in 5, 6, 8 and 9 cylinder in line configurations.

From 1979 onwards the twin bank engine remained in production as the original ESL Mark 1 build with only small numbers being sold, mainly to existing users. It was apparent that the twin bank concept

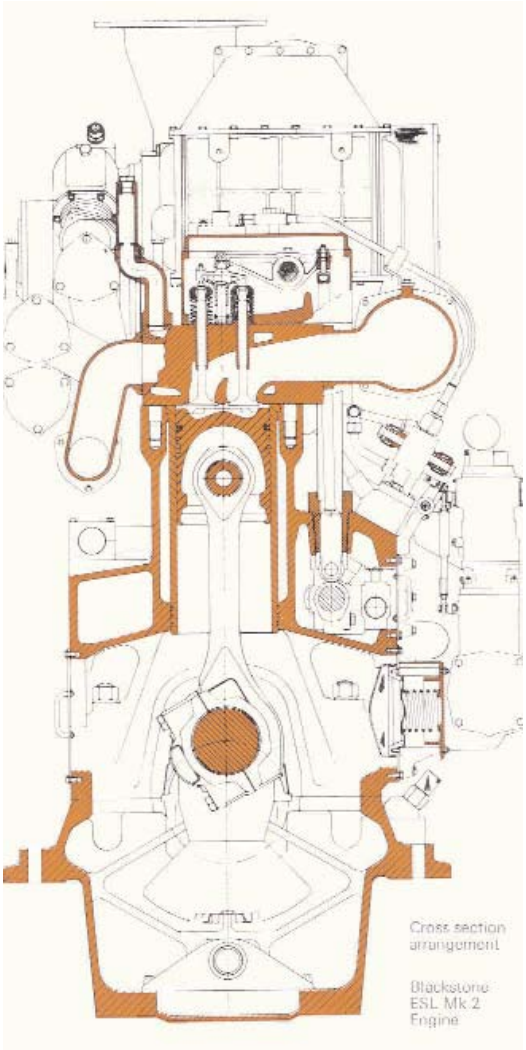


Figure 2 - Cross section of Blackstone E Mark 2 in line engine

could not be developed further as a cost effective product and hence a vee form engine development of the E Mark 2 commenced in the 1980s, leading to its release in 12 and 16 cylinder configurations in 1985. The key difference compared with the in line Mark 2 engine was the use of a totally new frame design with an underslung crankshaft. A three piece palm end connecting rod was incorporated along with a new 4 valve cylinder head with six holding down bolts. These engines featured a 45 degree vee angle to produce a compact power unit. An unusual feature of the design was the provision of a flat belt drive arrangement for auxiliary pumps at the free end which eliminated expensive gears and also allowed for rapid changing of pumps in service.

Higher ratings were possible as this was in effect a totally new engine and an output of 250 bhp per cylinder at 1000 rpm was offered at 19.74 bar bmep. This extended the available power band to 2.8 mWe with an ESL16 Mk2.

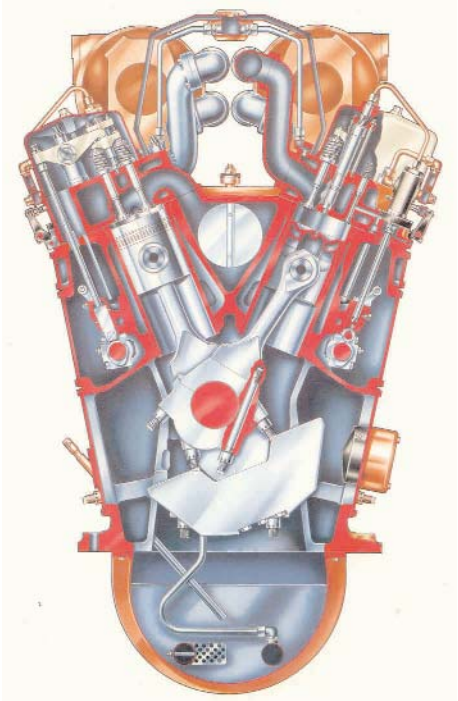


Figure 3 - Cross section of Blackstone E Mark 2 vee form engine

Dual Fuel Engines

A dual fuel version of the E range was developed to run on gas with pilot injection of fuel oil to achieve combustion using a hydraulic control system. The earliest design featured an auxiliary camshaft which operated the pilot fuel pumps and gas inlet valves. Later versions from the 1960s featured additional cams fitted to the standard camshaft. The dual fuel engine continued to sell in small numbers for most of the production life of the E Mark 1 with relatively few competitors in this niche market. Typical applications included power generation, compressor drives and pumping applications at gas works, sewage works, and total energy plants.

The Industrial Market

The E range was sold mainly for industrial power generation either as standby or for base load power generation although small numbers of engines were sold for other industrial applications including water pump and compressor drives. The engine sold well around the globe with the major overseas markets in the 1970s being Iran, Saudi Arabia, and Nigeria.

In the UK most engines were sold for standby power for industrial applications or for strategic applications such as for the Post Office Telecommunications section (later British Telecom). In the early 1970s around 200 E range engines were sold to BT for standby power in larger telephone exchanges and control centres across the UK making Mirrlees Blackstone by far the dominant supplier in the sector. For this application

Figure 4 - Blackstone ESL 12 Mark 2 vee form engine

engines were required to accept 110% load within 15 seconds of the start signal, and this favoured the lower rated designs. Most of the sales were of ERS6 sets at 320 kWe and ETS8 sets at 510k at 750 rpm, and being of modest rating these engines could achieve the BT test requirements without problems. Most of these engines ran very few hours in service but provided essential power to keep the telephone system operational during power outages.

A major improvement in competitive positioning of the E range in the power generation market occurred in 1972 following the release of the EZSL 8 engine at 1000 rpm as this unit provided an 880kWe generating set at a competitive cost . This development boosted sales in the UK and other markets alongside the more traditional sales of lower rated units for developing countries.

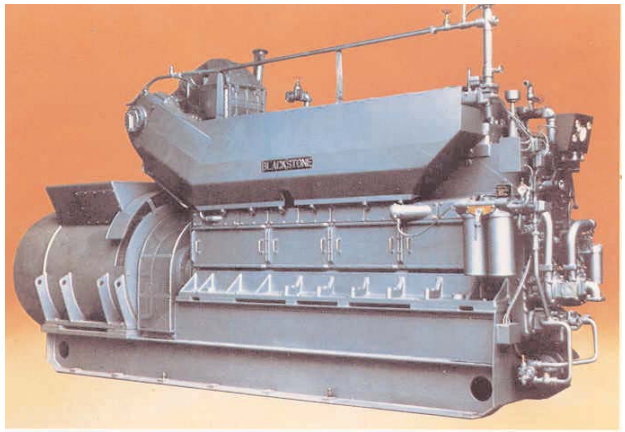


Figure 5 Typical Blackstone EZSL 8 Mark 1 generating set which dominated sales in the 1970s

The E range demand in the mid 1970s was sufficiently high that long delivery periods were applicable for new orders. The company therefore decided to produce a series of stock generating sets

Table 2 - Blackstone Engine Nomenclature

The Blackstone works had a well established but complex system for engine designation codes, engine production reference numbers, and part numbers.

The designation coding used for the E range from 1950 until the mid 1970s was as follows

E	Engine Type
V	Original design engine operating up to 625 rpm
R	Development of original design of engine operating up to 775 rpm
S	Development of original design of engine operating up to 900 rpm
T	1966 higher output design operating up to 750rpm
W	1966 higher output design operating up to 900 rpm
B	1970 development of original engine build operating up to 1000 rpm
C	1970 development of higher output design operating up to 1000 rpm
X	1972 development of higher output design operating up to 750 rpm
Y	1972 development of higher output design operating up to 900 rpm
Z	1972 development of higher output design operating up to 1000 rpm
S	Turbocharged
L	Intercooled designed for full rated output up to 500 feet above sea level
A	Intercooled with compensation to give full rating up to 4000 feet above sea level
H	Intercooled with compensation to give full rating up to 6000 feet above sea level
X	Intercooled with compensation to give full rating up to 8000 feet above sea level
DF	Dual fuel
T	Rail Traction

In the mid 1970s rationalisation took place to achieve costs reductions through simplified production and stocking requirements at Stamford. This also had the benefit of simplifying the engine designation codes. Thereafter the engine build became standardised on the following basis

E	Naturally aspirated up to 750 rpm using the original ER engine build
ES	Turbocharged up to 7500 rpm using the original ERS engine build
ESL	Turbocharged and intercooled using the latest EZSL engine build

The ESL nomenclature continued through to the E Mark 2 range which was only available in turbocharged and intercooled form.

to a universal build standard in both 50 and 60 hertz configurations occasionally supplemented by cancelled production units. This produced a steady stream of additional orders from clients willing to pay for generating sets on short delivery. The most popular unit was the ESL 8 1000 rpm set rated at 880 kWe and fitted with air to air radiator cooling which allowed operation at ambient temperatures up to 50^{O}C.

During the 1970's Cummins became very competitive with their KTA range at 1500 rpm in the same power range as covered by the E range and there was a gradual erosion of sales as the market moved towards such lower initial cost engines at 1500rpm. The in-line E Mark2 restored some of the competitive edge with 1 mWe capability at 1000 rpm . The next significant boost came with the release of the ESL12/16 Mark 2 vee form range as this raised the competitive power band to 2.8 mWe compared with 1.7 mWe with the ESL16 twin bank.

The Marine Market

For marine applications the E range was used for propulsion of smaller ships and also for auxiliary power generation on larger vessels. The twin bank version provided a useful facility to decrease the output shaft speed for propulsion purposes, and a further feature was the ability to isolate one bank from the drive system in an emergency situation. The E Mark 2 was also successful in the marine market.

Rail Traction Market

In rail traction the E range had limited success in the 1950s through a dedicated company, Lister Blackstone Traction Ltd, which was formed with a specialist sales team. British Rail selected the Blackstone ER6T engine rated at 350 bhp at 680 rpm for use in the Class 10 shunting locomotives and a total of 75 were supplied from 1953 to 1962.

These locomotives were taken out of service in the early 1970s as this class was in a minority compared with the far larger English Electric Class 08. Most locomotives were sold on for further use with the National Coal Board and other industrial users.

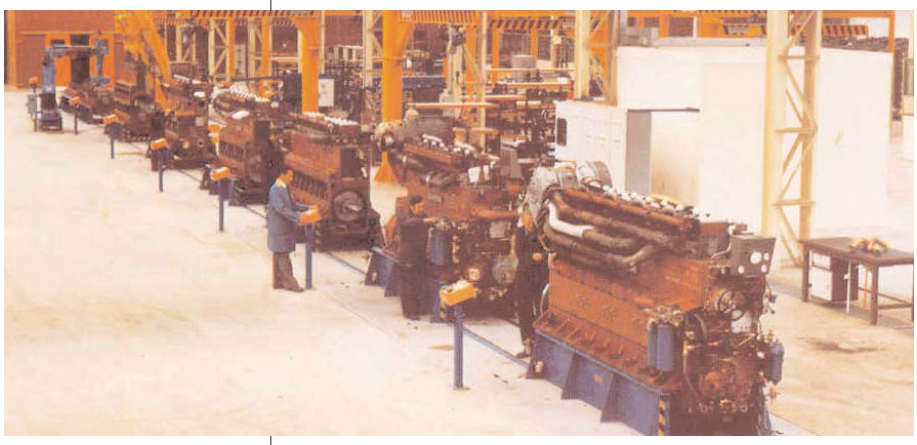
A prototype diesel electric locomotive was manufactured by BTH using a twin bank ERS12T engine rated at 1100 bhp at 800 rpm and was named "The Explorer". The locomotive was supplied to East African Railways. The locomotive still exists and is earmarked for preservation.

Production

The Stamford works produced the E range in substantial numbers and used a track system for assembling the engine beds and frames from the outset. Each major component was fitted onto wheels running in a railway track and the operatives moved each assembly by hand from one work position to the next. This worked well for the first three decades with production figures of 16 cylinder lines per working day being achieved in the 1970s. To support such production numbers a computer controlled stock control system had been installed as early as 1964 with fully automated issue of purchase orders and other supporting documentation. In addition the production of agricultural equipment under the Lister name was finally stopped in the early 1970s and the production areas re-allocated to meet growing demands for more engines.

A new facility was opened in 1966 for the testing of vertical engines with provision for about 20 engines on test at any time with full supporting services including testing of complete generating sets up to 11 Kv. In 1971 Lloyd's Register of Shipping awarded a certificate for batch and line produced machinery on the basis of the Blackstone design, manufacture and control systems at the Stamford works. This was the first certificate ever awarded to a UK diesel engine factory.

The Stamford factory further benefited from major investment by the Hawker Siddeley Group in the 1970s with new offices, upgraded electric melt foundry, a new component storage and handling facility, and a new track assembly system. The new production and storage system facility was commissioned in 1979 with each major component assembly being completed at a series of dedicated work stations supplied with the right component kits for each operation. Each production unit was moved from one position to another on support frames running on rails using a push button automated control system. A custom designed handling unit lifted the cylinder housings onto the bedplates for the final assembly stage. Provision was made for the E range to be manufactured alongside the MB190 but this option was not developed further as that range only sold in small numbers. The new



Figures 6, 7, and 8 Views of the 1979 track assembly of Blackstone E range Mark1 engines

production facility was unfortunately not utilised to the full as declining markets, increased competition, and global over capacity dramatically affected E range sales in the 1980s.

Production of the E range continued in declining numbers until the last E range engine left Stamford in March 1994. Production was transferred to the Mirrlees Blackstone factory at Hazel Grove, Stockport and the range continued to be built in the Mark 2 form for a number of years thereafter. The range survived the takeover by MAN B&W Diesel in June 2000, but was eliminated from brochures shortly thereafter. The last engine was probably manufactured as component parts for assembly in India by the local Modi Mirrlees Blackstone Ltd operation.

Control Systems

The Stamford works incorporated a specialist engine control unit which was able to design and manufacture automatic engine control systems in the 1950s and 60s ranging from a simple push button start through to a fully integrated power station management system. Various trade names were adopted including Motormatic for electric motor starting, and Airmatic for air starting. The automated control systems included ALEC (Automated Load and Electrical Control) and POP (Programmed Optimised Power). These systems were marketed until the early 1970s when proprietary systems from external sources were generally adopted as more cost effective options.

The most complex sale achieved with the Blackstone control system was for the fully automatic control of a total energy plant with three similar power stations each containing five 1 MW E range 16 cylinder twin bank dual fuel generating sets. This required automatic starting, synchronising, load sharing, power management, and clock comparator frequency control of all fifteen sets. This was a major challenge with a gas burning engine in the days before solid state systems became established.

Operational Results

In general the E type performed well in a wide variety of applications and conditions across the globe and fast developed a reputation for reliability. Replacement parts were generally in good supply due to the high volumes produced and there were many agents or company depots stocking parts and providing service around the globe. In later years a substantial market developed in the supply of used parts and in reinstalling engines in new applications.

Problems were mainly limited to issues such as fuel dilution of the lubricating oil due to leakage from the enclosed fuel injection system on the E Mark 1 design. Another regular issue which irritated many operators was leakage of lubricating oil from the side doors leading to black stains on the engine and surrounding area. This was partially resolved in the higher rated E Mark 1 engines with the introduction of an ingenious crankcase extractor which used a small bleed of combustion air to create a vacuum via a simple venturi device. This modification along with the use of better joints produced some improvement.

Blackstone Service Scheme

One advanced marketing feature of the Blackstone service operation for industrial power generating sets in the UK in the 1960s was the provision of service books along similar lines to those provided with cars at that time except that there were more vouchers per book. Each voucher was clearly marked with either the operating hours or real time elapsed and acted as a postage paid card to order the service. A price list was provided with a fixed cost for the defined service at most locations on the British mainland. Two different books were issued one for base load and the other for standby power generation along with schedules of the work covered for each defined interval. The scheme worked well for smaller operators who did not have the skills or manpower to handle service work. The scheme was supported by a network of service engineers each with a van and located around the UK.

Heritage

The Anson Engine Museum (http://www.enginemuseum.org) inherited material from the Mirrlees Blackstone Stockport works and some of this relates to the Blackstone E range since both sales and development activity was carried out at Stockport at various times. In particular they have the E Range Mark 2 model engine on display.

As far as the Blackstone works in Ryhall Road, Stamford is concerned the front section of the works was demolished many years back to make way for a small out of town retail complex. Some buildings of the original works such as the original works test building remain intact in the area furthest away from the road at the time of writing this article and form part of a local industrial estate. A McDonalds outlet now exists to one side of what would have been the main façade facing Ryhall Road. The last connection with the site ended in early 2003 when the remaining service operation was transferred to another location.

The Stamford Museum has a section on the Blackstone factory history and its products and is located on Broad Street, Stamford PE9 1PJ which is

Figure 9 Model Blackstone ESL8 Mark 2 on display at the Anson Engine Museum

just a short distance away from the original Blackstone showroom. A specialist website covering the Blackstone engine ranges and the Stamford works history in considerable detail exists at:

http://www.oldengine.org/members/blkstone/front.htm

In addition there is also a short history of the Blackstone works at:

http://www.stamfordliving.co.uk/the_industry_of_stamford

Significant numbers of E range engines remain in service with ongoing demand for spares and service. There are few engines in preservation at present. Five Class 10 shunting locomotives with ERT6 engines are known to exist with various UK rail preservation groups and the locomotive 'Explorer' as supplied to East African Railways with an ERS12T set still exists.

Acknowledgements

Most of the pictures used in this article were taken from manufacturer's publications except for Figure 9 which was taken by the author.

The author wishes to acknowledge the kind assistance given by Michael Key in reviewing the draft article. Michael is the former curator of the Stamford Museum and runs the above mentioned Blackstone specialist website.