# General Electric Pre-Universal Export Locomotives

## Preface to the Third Issue

This includes all updates through 2022 February.

A Contents section has been added.

## Preface to the Second Issue

The article has been updated to include supplementary commentaries on several locomotives, based upon information that became available after the first edition was issued, and which was posted to WDL in 2021 April and May.

The locomotives for which supplements have been added are the six-motor 70-tonner, the IRCA Guatemala Co+Bo+Co road-switcher, the PJKA Indonesia Co-2-Co double-ended “shovel-nose”, the MRR Philippines streamliner and modified road switcher, and the WP&Y, Alaska “shovel-nose”.

## Preface to the First Issue

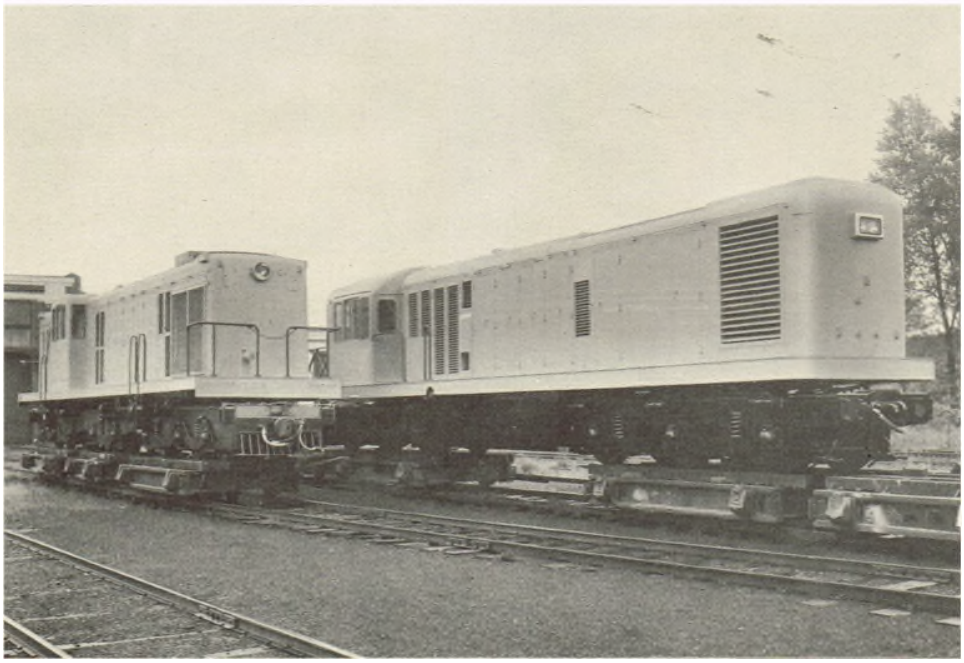
The following article is based upon a series of postings made to the World Diesel Locomotives (WDL) forum over the period 2007 September through 2018 July.

These postings have been edited to ensure that the various locomotive types are presented in chronological order and to update the information provided where applicable.

It is intended that this article will reside in the “Files” area of the WDL forum.

Steve Palmano, Papamoa Beach, New Zealand, 2022 February 24

**TWO DIESEL-ELECTRICS** — a 36-inch gage, 1200 horsepower, 126-tonner (left) and a 1100-horsepower, 42-inch gage, 100 tonner — designed respectively for the National Railways of Colombia and the Queensland Railways of Australia. Both were built at General Electric's Erie Works.



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# General Electric Pre-Universal Export Locomotives

## Contents


| | |
|---|---|
| Preface | 1 |
| Overview | 3 |
| Six-Motor 70-Tonner | 5 |
| Six-Motor 70-Tonner – Supplement | 8 |
| Argentina (LGB) Cooper-Bessemer FV-Engined “Shovel-Nose” | 10 |
| Argentina “Shovel-Nose” Supplement – 2021 September | 13 |
| GE “Shovel-Nose” Family – 2021 May | 16 |
| IRCA Guatemala Co+Bo+Co Road Switcher | 17 |
| IRCA Guatemala Co+Bo+Co Road Switcher – Supplement | 22 |
| Matadi-Leopoldville “Shovel-Nose” | 24 |
| Uruguay Double-Ended “Shovel Nose” | 27 |
| Standard & Broad Gauge Shovel-Nose Units and the GE731 Traction Motor | 29 |
| Queensland Railways 100-Ton Road Switcher | 30 |
| Argentina (LGB & LGM) Alco 244-Engined Shovel-Noses | 35 |
| Brasil 110-Ton Road Switcher | 37 |
| Brasil 110-Ton Road Switcher – Supplement 2021 September | 39 |
| Brasil 110-Ton Road Switcher – Supplement 2021 October | 42 |
| EFCB “110-Ton” Road Switcher and the GE761 Traction Motor – 2021 October | 43 |
| PJKA Indonesia CC200 Class Co-2-Co Double-Ended “Shovel-Nose” | 44 |
| PJKA Indonesia CC200 Class Co-2-Co Double-Ended “Shovel-Nose” – Supplement | 47 |
| PJKA Indonesia CC200 Class Co-2-Co – Supplement 2021 September | 49 |
| PJKA Indonesia CC200 Class Co-2-Co – Supplement 2021 October | 52 |
| Chile “Shovel-Nose” | 53 |
| White Pass & Yukon “Shovel Nose” | 55 |
| White Pass & Yukon “Shovel Nose” – Supplement | 58 |
| White Pass & Yukon Shovel Nose Cab Unit – Supplement 2021 November | 59 |
| Queensland Railways A1A+A1A 70-Ton | 60 |
| Philippines (MRR) Streamliner Unit and Modified Road Switcher | 64 |
| Philippines (MRR) Streamliner Unit and Modified Road Switcher – Supplement | 68 |
| New South Wales Government Railways Cab Unit | 70 |
| Conclusion | 73 |


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# General Electric Pre-Universal Export Locomotives

## Overview

General Electric (GE) was notable for its relatively early development of a range of diesel-electric line-service locomotives specially tailored for export market requirements, with particular reference to Cape, metre and three-foot (CMT) gauge applications. These models were nominally superseded by the export Universal range announced in 1956, although late production overlapped with early production of the Universal models. Accordingly, it is convenient to classify these early GE export locomotives as pre-Universal models.

As a group, these GE locomotives are probably best described as quasi-standard models. Whereas the Universal models were highly standard, with specifications set and published ahead of any orders, the pre-Universals generally appear to have been designed against specific railway requirements, although with adaptability to broader requirements also in mind, and using standard components. GE's approach at the time was not unlike that adopted by British builder English Electric.

In any survey of the GE pre-Universal export models, it is necessary to define which models are included and which are not. Such a definition will be a little arbitrary as unlike the case with the export Universals, which are self-defined, there are no clear-cut boundaries. To start with, the list should include those models that were clearly designed for export markets, whilst generally it would exclude domestic models sold into export markets with only minor modifications. Export models sold into the North American domestic markets would be included.

Following this line of reasoning, the GE pre-Universal export list would definitely include the various cab units and road switchers powered by Alco 12-244 and Cooper-Bessemer FVL12-T engines.

It should also include the six-axle (Co+Co and A1A+A1A) variants of the 70-tonner. Although derived from a domestic model (the standard 70-tonner), the design changes were quite significant, and were very much driven by specific export market requirements. Thus they reasonably satisfy the export model definition. Standard 70-tonners were also exported, but generally these fall outside of the definition, although the Cape and metre gauge versions might be seen as marginal.

Requiring a judgement call is the "small" shovel-nose cab unit, built solely for White Pass & Yukon (WP&Y). Insofar as it was sold only to a North American railway it is neither an export model nor a domestic model that was exported. Still, being designed for the three-foot gauge, it would have fitted many export requirements in dimensional and weight terms, and design-wise it was closely related to the "intermediate" and "large" shovel-nose units, which were export models. On this basis, and because it is unlikely to receive other than passing attention in any survey of GE domestic models, it is logical to treat it as a notional export model.

Finally, the transitional models, cab units and modified road switchers, built for Manila Railroad (MRR) Philippines, may be included. Although GE retroactively included these in its Universal listings as U12C models, they were ordered before the Universal series was announced, and do have some commonality with the other pre- Universal models.

Excluded is the 50-ton model and its 52-ton and 54-ton derivatives, and the related 68-ton twin-engined model. Most of these were exported, but they form a distinct series that that deserves separate treatment.

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## General Electric Pre-Universal Export Locomotives

Thus is derived the following list of GE pre-Universal export models, in approximate order of first appearance:

1. The 6-motor version of the 70 tonner, built for railways in Brasil, Bolivia and Chile, and sold domestically to US Potash, to a total of 96. Also included under this heading is the 6-axle, 4-motor variant of which 12 were built for Queensland Railways (QR), Australia.

2. The "intermediate" shovel-nose cab unit, powered by the Cooper-Bessemer (C-B) FVL12-T engine, built for railways in Argentina and Chile to a total of 74.

3. The triple-bogie (tribo) Alco 12-244 powered road-switcher, built for railways in Guatemala and Colombia to a total of 17.

4. The "large" shovel-nose cab unit, powered by the Alco 12-244 engine, built in several different variants for railways in the Congo, Uruguay, Argentina, Indonesia and Chile to a total of 137. Included as an extension of this group is the Alco 12-244 powered cab unit, of which 6 were built for New South Wales Government Railways (NSWGR), Australia (as its 43 class) with body styling derived from the prototype domestic cab unit no. 750 of 1954.

5. The C-B FVL12-T-powered road-switcher, of which 13 were built for QR.

6. The Alco 12-244 powered 110-ton road-switcher, built for railways in Brasil to a total of 45.

7. The "small" shovel-nose cab unit, built solely for WP&Y to a total of 11, with production extending through 1966.

8. The MRR cab units (10 of) and modified road switchers (20 of), the body styling of the cab units being related to that of prototype no. 750, including the use of fluted side panels.

The above list lays the foundation for a more detailed treatment of the individual models. This is a bit more difficult than for the export Universal series, for which "catalogue" information is available. The accessibility of technical information on the pre- Universal export models varies. Still, it is possible to construct at least an outline description for each model, and then, where appropriate, impute the development steps that linked them, and which eventually pointed to GE's release of the export Universal series.

Except for the MRR cab units and modified road switchers, retroactively included in the U12C list, as far as is known, none of GE locomotives described herein was assigned a model number by GE. However, the Australian trade journal “Railway Transportation” (RT), in its 1974 October issue survey of Australian and New Zealand motive power, assigned a set of “faux” model numbers to GE pre-Universal models then extant in Australia. To be fair to RT, such faux model numbers were shown in parentheses with the comment that they had not been allocated by the builders concerned. But as is the way with such things, they develop a life of their own and are copied and recopied without the qualifying note, and become embedded as if they were the genuine article. These are mentioned in the individual entries for the affected models.

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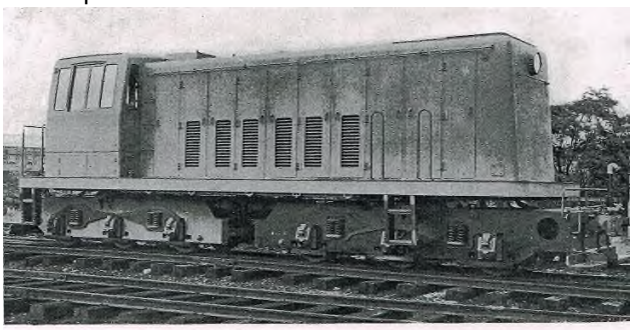
## General Electric Pre-Universal Export Locomotives

### 1947 - Six-Motor 70 Tonner

An interesting aspect of the first three GE post-WWII export models is that they mirrored US domestic practice in including the three basic forms then current, namely a switcher, being the six-motor version of the 70 tonner, a road-switcher, being the design first supplied to IRCA, Guatemala, and a cab unit, being the shovel-nose design first supplied to FC General Belgrano, Argentina.

The export, Co+Co 70 tonner was self-evidently a derivative of the standard domestic 70 tonner, with more axles in order to achieve the lower axle loading typically required for CMT gauge applications. That the Guatemalan road-switchers had links to a domestic model is less evident, but in powertrain terms they were derived from the concurrent 1500 hp Alco-GE domestic road switcher. As with the 70 tonner, they had more axles in order to spread the load, in this case eight in place of six or four. Although the original shovel-nose units did not have any direct connection with any domestic Alco-GE model, they did have some design elements that set them apart from the other pair, and which they shared with the Alco-GE domestic cab units. And to keep axle loading down, they had six axles where four might otherwise have sufficed.

The export 70 tonner was first built in 1948 for two railways in Brasil, namely the EF Sorocabana (EFS), which took 42, and the RV Parana-Santa Catarina (RVPSC), which took 8. Subsequently Mogiana EF took 12 in 1952, bringing the Brasilian total to 62. Other export customers were FC Machacamarca-Uncia in Bolivia, with 2 in 1948, and Chilean State, which took 30 in 1953-54. All of these were metre gauge. Additionally, US domestic operator United States Potash had a pair of three foot-gauge versions.



*Metre-gauge, 141,000-lb. general-purpose diesel-electric locomotive*

On the face of it, the export 70 tonner was essentially a six-motor version of the standard model, with lower cab and reduced width as required to fit the tighter loading gauges associated with CMT gauge railways. Evidently GE studied CMT gauge railway clearances throughout the Americas when designing this model. Unlike the usual case with six-motor derivatives of four-motor designs, there was virtually no weight gain, which implies that the basic design was lightened somewhat.

*One of 30 63-ton diesel electric locomotives each with one Cooper-Bessemer 660 b.h.p. engine, delivered to Chile by G.E.*

Unusual in the diesel world, the export 70 tonner had articulated bogies. This form of construction was commonplace for line-service electric locomotives during the 1930s, and was carried over to quite a few post-World War II (WWII) models, although by the mid-1940s, it had been demonstrated that independent bogie design had advanced to the point where articulation was much less necessary than it had been before then. Whilst conferring some advantages, particularly for electric locomotives with, by the standards of the day, relatively high powers per axle combined with large diameter wheels, articulated bogies also brought with them relatively poor tracking at higher speeds, in the form of high lateral railhead forces, unless they were "tamed" by the use of pilot trucks, of which the four-wheel type was preferable for the highest speeds.

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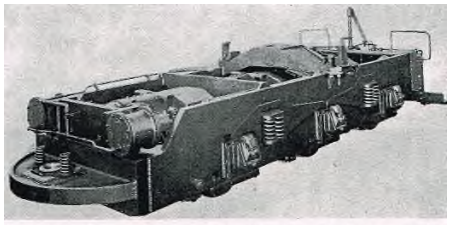
## General Electric Pre-Universal Export Locomotives

Diesel-electric locomotive development generally bypassed the articulated bogie stage and moved directly to the independent bogie concept by the late 1930s, the lower power-per-axle and smaller wheel diameters as compared with electric locomotive practice making this easier. Nevertheless, GE had built some small shunters with articulated bogies, and went on to use this form for some of its export models, to the extent that it was a major user.

In the case of the export 70 tonner, the choice was driven by the need to keep the weight low. Accommodating an independent pair of 3-axle bogies under the standard model would have required a frame extension, which in turn would have added weight. By the use of articulated bogies, not only was the frame extension avoided, but the frame itself, which no longer had to deal with buff and drag forces, could be made lighter. The resultant inferior tracking at higher speeds was probably not judged to be a persuasive negative. Design top speed of the model was 50 mile/h, but with the rail power curve declining rapidly above 32 mile/h due to unloading, it was unlikely that these locomotives would be spending much time at speeds where their tracking qualities were an issue.

The bogies themselves were of the equalized, rigid-bolster, welded type, with relatively thick and deep plate sideframes that had cutouts for the coil primary springs. This design followed GE's pattern for industrial locomotives, including the standard 70 tonner, but was quite unlike anything found on the Alco-GE domestic switchers or line-service locomotives. The same basic type of welded design was used on quite a few of the pre-Universal export models. But in the case of the export 70 tonner, the equalizing beams were unusual. They were overhung rather than being of the drop type, and appear to have been made from relatively thin plate with a profile that had considerable deepening in the vicinity of the springs, such that they required cutouts to accommodate them. I imagine that this particular design aspect was chosen to minimize weight and perhaps sideways projection of the equalizing beams.



*Rear three-axle metre-gauge bogie showing articulation member, compressed air brake cylinders, centre and side bearings, motors, and vacuum train brake swan's neck*

The inter-bogie articulation joint was of the normal single-point type, and the bogies appear to have had single-point loading via the centre-plate. However, I doubt that the bogie tilting and weight transfer control so obtained was a major issue for these locomotives.

More unusual was the use of longitudinally mounted traction motors with right angle drive, the latter being of the hypoid and spur double-reduction type. This allowed the coverage of 3-foot gauge applications without the need to use different traction motors. The wheels were of quite small diameter, at 33 inches, and the bogie wheelbase quite short, at 10'0", with equal axle spacing.

*Double-reduction right-angle drive d.c. traction motor and gear case, type GE-747*

The engine and main generator were the same as for the standard 70 tonner, namely the C-B FWL-6T, set for 660 hp gross, 600 hp traction, at 1000 rev/min, and GE GT571 respectively. The GMG-146 belt-driven combined exciter-auxiliary generator was also the same, as was the inherent characteristic (Lemp 1924) form of load control.

The traction motors were different to the GE748 model used on the standard 70 tonner, being of the self-ventilated GE747 type, connected in permanent series-parallel (2S3P) with one stage of field weakening. The right-angle drive provided a reduction ratio of 9.07:1.

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## General Electric Pre-Universal Export Locomotives

Regarding the control system, I have no direct information, so can only make deductions. Basis mid-1950s data, the standard 70 tonner, in non-MU form, had a mechanically operated throttle. The MU version had an electrically operated 7-notch throttle, using a GE 17MK3 4-cylinder electropneumatic governor operator connected to a Woodward UG8 lever control governor with energize-to-run solenoid shutdown. Whether the export 70 tonner was any different is unknown, but it may be noted that the later A1A+A1A version for Queensland Railways had pneumatic throttle control, so that possibility may not be ruled out. The EFS and RVPSC locomotives were MU-equipped as built, but only for cab-to-cab operation. Judging from photographic evidence, the Chilean State locomotives had MU fittings at the front end, and one assumes, also at the cab end.

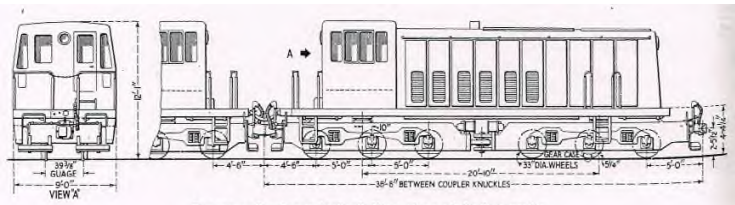

*Diagram showing principal dimensions of the locomotive*

The air braking system on the standard 70 tonner was schedule 14-EL. Again, I have no reason to suppose that the export model was any different. Furthermore, 14-EL was evidently the de facto standard for GE's pre-Universal export models. The EFS and RVPSC locomotives were equipped for vacuum train braking, although fitted with air brakes themselves. As best I can work out, the GE pre-Universal exports equipped for vacuum train braking usually had direct control of train braking, probably via a two-pipe valve. Indirect control may not have arrived until schedule 6-SLV-1. The Brasilian locomotives had provision for parallel operation of the vacuum exhausters, which suggests that there was a vacuum reservoir MU trainpipe, as with the 6-SLV-1 system. (The later schedule 28-LV-1 allowed paralleling of exhausters for brake release without the need for a vacuum reservoir trainpipe.) Although the references I have are not totally clear, it appears that when fitted for vacuum train brakes, this model had an engine-driven (probably belt-driven) exhauster in addition to the engine-driven compressor, rather than a combined compressor-exhauster (expressor) as used on later GE locomotives. The Chilean State, and I think the Mogiana locomotives were equipped for air train braking. I imagine that the FC Machacamarca-Uncia was also an air-braked road, given the altitudes involved. The Chilean locomotives had 14-EL.

Not apparent from any information that I have on hand is where the fuel tank was mounted, clearly there being no room between the bogies as on the standard model. My supposition is that it was between the mainframe longitudinals.

The Co+Co version of the 70 tonner just described led to the A1A+A1A version built for QR in the mid-1950s, and to be described later. But this model did not have a counterpart in export Universal series announced in 1956; the smaller, Caterpillar-powered end-cab models being available only in Bo-Bo form. However, GE did build a handful of 1.05 metre gauge UM10A1A specials for Hedjaz, Jordan Railway in 1974, as long-frame derivative of the U10B.

Sometimes the export 70 tonner has been referred to as the "U6C". This was an informal designation that to the best of my knowledge, was never applied by GE. Whilst there is some logic in the "6C" part, it is imputing "Universal" status to what was definitely a pre-Universal model by nearly a decade. The regular 70 tonner stayed in production for a year or two after the Universal series was announced, but GE did not see fit to assign a “U” designation to it.

Although the last of the export, six-motor 70 tonners were built in 1954, I imagine that GE would have built it right through until the end of 70 tonner production, and therefore into the Universal era had any customers wanted it.

These locomotives were described in the trade journal “Diesel Railway Traction” (DRT) 1948 April, p.74ff, *“Metre-Gauge All-Purpose Diesels for Brazil”.*

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## General Electric Pre-Universal Export Locomotives

### 1947 - Six-Motor 70 Tonner - Supplement

These locomotives were also described in “Railway Age” (RA) 1947 November 27, 9.43ff, “Brazil adds Diesels to its Electrics”.

The RA article was primarily about the Sorocabana and Parana-Santa Catarina metre gauge locomotives, but towards the end of the article it was said:

*“The transverse cross-sectional dimensions were chosen after an extensive study of a multiplicity of clearance diagrams of meter-gage railroads from various parts of the Western Hemisphere.*

*“Besides the application to meter gage, the design of the locomotive can be altered easily so that new locomotives can be built for 36-in. or 42-in. gage within the same general overall dimensions.*

*“The principal changes will be in gage of wheels, truck transoms, brake beams and brake rigging. The locomotive lends itself to repetitive manufacture.”*

Although GE certainly had a history of locomotive exports, particularly the electric variety, the C+C 70-tonner evidently marked the start of its post-WWII development of export diesel-electric locomotives, initially with quasi-standard types, whose design was triggered by a specific railway system need but executed with broad applicability. At a time when it may not have been clear exactly what kinds of diesel locomotives the worldwide railway systems would want and be able to use, particularly in respect of the sub-standard gauges, the quasi-standard approach had its merits. After a few years, once requirements became a lot clearer, the time was ripe for the introduction of a comprehensive standard range, which is what GE did with its export Universals in 1956. Although it was later than both Alco and EMD in offering standard export locomotives, it started with a much broader range that had a strong orientation to CMT-gauge requirements. Perhaps to some extent in response to GE, EMD considerably expanded its model range in one stroke in 1958. Meanwhile Alco made several staged additions to its export range.

To the earlier discussion on the 70-tonner braking system may be added the following.

The vacuum counterpart to the 14EL air brake system was the 14-ELV, which probably dates back to the 1920s, if not earlier. Apparently, it was the default fitting for GE’s pre-Universal exports that went to vacuum-braked roads, so was highly likely what was fitted to the Sorocabana and Parana-Santa Catarina 70-tonners. 14-ELV provided for air brakes on the locomotive, following the 14EL pattern, with vacuum braking for the train, controlled directly by a two-pipe vacuum valve with a horizontal spindle and a vertical control lever. Evidently translation from vacuum to air protocol for synchronous operation of the locomotive air brakes was done in a proportional valve that provided input to the usual 14EL brake distributor. Correspondingly 6-SLV-1 was the vacuum counterpart to the 6SL air brake system, and operated in a similar way. 6SL was much more recent than 14EL, post-WWII I think but I am not sure. Probably GE fitted 6SL and 6-SLV-1 systems to pre-Universal export models at customer request.

With the export Universals in 1956, the initial standard fitments were 6SL for air braked roads, and 6-SLAV-1 for vacuum-braked roads. The “AV” part of the suffix referred to systems that provide for both air and vacuum train braking, but 6-SLAV-1 was also used when only train vacuum braking was required. Possibly this was because primary train brake control was of the air system, with translation to vacuum, meaning that a substantially normal air brake type control stand could be used, avoiding the need for the rather large vacuum brake control valve in the cab. Whether any pre-Universal builds were fitted with 6-SLAV-1 rather than 6-SLV-1 I have not been able to determine. At a later stage, probably in the first half of the 1960s the Universals were moved across to

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the 26L (train air), 28-LV-1 (train vacuum) and 28-LAV-1 (train air and vacuum) systems. Like 6-SLAV-1, 28-LV-1 had air-over-vacuum rather than direct control of the train vacuum brakes.

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## General Electric Pre-Universal Export Locomotives

### 1949 – Argentina (LGB) Cooper-Bessemer FV-Engined “Shovel-Nose”

GE's first export model for line service was the metre gauge, A1A-A1A "shovel nose" cab unit design built for FC General Belgrano (LGB), Argentina, and delivered from mid-1949 onwards. There were 70 of these in a single order, configured as back-to-back semi-permanently drawbar-coupled pairs, although there is no evidence that the units were in any way interdependent.

Unlike the preceding Co+Co 70 tonner and the soon-to-follow Co+Bo+Co road switcher for IRCA, Guatemala, the LGB shovel nose had no obvious domestic model antecedent. At the time, cab units were the norm for line service in worldwide practice, the ascendancy of the road switcher being still a few years away. GE was unusual in choosing the shovel nose form, though. Other American, and some British builders used the streamlined nose-end style of cab unit body, whereas the European builders usually preferred the end-cab style, sometimes borrowing from established electric locomotive and railcar practice. GE's stated reason for its choice was that the shovel nose form made the most was efficient use of platform space, important where locomotives were built to restrictive dimensional and weight restrictions, as was the case with the LGB units. Providing adequate collision protection for the crew was more difficult than with a nose-end design, but GE claimed to have addressed this.

G-E METER-GAGE diesel-electric on Ferrocarril Nacional General Belgrano, Argentina. Pair of cabs is rated 1800 horsepower, weighs 165 tons.

If not initially, then later in life these units acquired the classification DE621. The DE621 was a single-ended shovel nose cab unit of A1A-A1A wheel arrangement, 985/900 hp and weighing 82.5 short tons, of which 55 short tons was adhesive. It was fitted with a C-B FVL12-T engine, this being the 12 cylinder vee counterpart to the FWL-6T engine that GE was already using in the 70 tonner. It was certainly the first GE use of this engine, and probably was the first railway use by any builder. In this installation it was fitted with twin turbochargers, one at each end. At the time, the engine was capable of 1300 hp (gross) at 1000 rev/min, so it was quite significantly derated, to 985 hp at 915 rev/min, for this application. The derating does not appear to have been required for operations at high altitudes, but simply to fit within quite restrictive piston speed and mean effective pressure limits specified by the Argentine State Railways. Even so, for a locomotive of around 1000 hp (gross), GE's best option at the time – using familiar suppliers - was probably a derated FVL12-T, as the FVL8-T would not have reached that power level. The Alco 12-244, although not too far different in weight and bulk, was more highly rated and so would have been more engine than needed for this power level. What is unknown is whether, at the time, GE was already thinking about longer-term use of the Cooper Bessemer engines.

The main generator, at the front of the engine, was a GT577, fitted with the GE triplex auxiliary gear drive in this case respectively connected to an Amplidyne exciter and two auxiliary generators, one for battery charging and the other to supply the motor-driven cooling fan and pair of motor-driven traction motor blowers. The air compressor was driven from the free (rear) end of the engine. There were four GE756 traction motors, connected in permanent series-parallel (2S2P), with two stages of field weakening. The gear ratio was 95:18, and wheel diameter 36 inches. The GE756 appears to have been GE's standard metre gauge traction motor in the immediate post- WWII period, until the arrival of the GE761 circa 1953.

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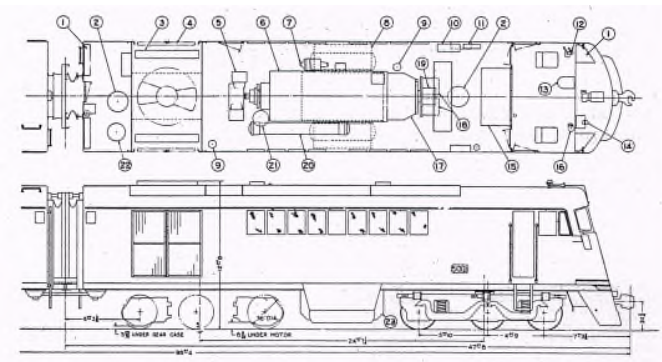
The engine was fitted with the GE electro-hydraulic tachometer-type governor as part of the Amplidyne control system, being a somewhat simpler version of that fitted to the domestic 1500 hp road freight unit. This model may have been the only example where GE used its own governor with the C-B engine. The later C-B-engined Universal models were fitted with the Woodward PG governor with electro-hydraulic speed control and integral load control rheostat.

As was standard for GE's export models of the period, the bogies followed GE industrial locomotive practice, being of the rigid bolster, welded type with plate side frames and outside equalizers. They were fitted with lateral restraint devices (of whose exact nature I am unaware) that was said to allow satisfactory operation of rigid bolster bogies up to the designed top speed of 56 mile/h. Later developments by GE suggest that this goal may not have been fully realized in practice. Bogie location was slightly asymmetric, with the front overhang being a foot longer than the rear overhang.

The DE621 was quite compact, each unit measuring 47'8" from front coupler pulling face to inter-unit drawbar centre. Length over headstocks (end frames) is a more useful parameter for international comparisons where coupler arrangements differ, but that number is hard to find for the various shovel noses, perhaps in part due to their having quite rounded front headstocks. However, working back from the known 46'0" number for the subsequent CFML shovel-nose, which had the same front overhang, but which had symmetrically distributed bogies suggests a number close to 44 ft. By way of comparison the later U9C and U12C models were 46' 4½" over headstocks.



PLAN AND SIDE ELEVATION OF ONE OF THE TWO LOCOMOTIVE UNITS

1. Sand boxes
2. Traction motor blowers
3. Radiators
4. Radiator louvers
5. Compressor
6. Diesel engine
7. Pump set
8. Battery
9. Supercharger oil filter
10. Engine control panel
11. Terminal box
12. Brake valve
13. Controller
14. Cab heater
15. Control compartment
16. Hand brake
17. Main generator
18. Auxiliary generators
19. Exciter
20. Lubricating oil cooler
21. Oil filter
22. Lubricating oil by-pass filter
23. Fuel tank

The air braking system was schedule 14-EL, the GE standard of the period. The DE621 had a left-hand driving position, with control stand to the driver's right and brake pedestal to the left. The control system was described as being of the single-station, multiple unit type, but whether it was possible to operate more than one pair in MU is unknown. From the photographic evidence, there are no obvious signs of front end MU sockets, or cover plates for same.

The 70 units for LGB were followed by 4 closely similar metre gauge units for Chilean State Railways, delivered late 1950/early 1951, as its Dt5000, later Dt10000 class, and intended to haul passenger trains on its northern (Red Norte) network. For these the engine was set to 1050/990 hp at 1000 rev/min. They weighed 77 tonnes total, of which 52.6 tonnes was adhesive. Since GE usually quoted weights in pounds with apparent precision of 3 or sometimes 3½ significant digits, I would estimate the original GE numbers to be 170 000 lb total and 118 000 lb adhesive. They were a little longer than the LGB units, at 49'3" over couplers. This extra length appeared to have been at the rear, as they lacked the truncated rear end of the LGB units. This may have been more easily to accommodate regular drawgear, which the LGB units did not need given their permanent coupling as back-to-back pairs.

Thereafter there were no new or repeat orders for this model, although no doubt GE would have built some had any customers so wanted.

The LGB fleet evidently was long-lived. In later years some were re-engined, and some were rebuilt as double-ended units. Detailed discussion of this aspect is beyond the scope of this series, which

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is oriented towards GE's original activities. The small Chilean fleet was evidently stored out-of-service by the late 1980s, perhaps because there were few passenger trains left to haul.

Clearly the DE621 was a very significant locomotive in terms of the LGB dieselization program, which was early in the CMT gauge world. In fact, LGB appears to have had the first large fleet of CMT gauge diesel-electric line service locomotives of reasonable power output (say 1000 hp, plus or minus) and reasonable speed capability (say above 50 mile/h).

From a GE perspective, it was important as being its first line-service export model, the first designed specifically for relatively light axle loading metre gauge applications, and the first of the very successful shovel-nose family. Particularly in respect of CMT gauge applications, GE was ahead of its American competitors. EMD offered the B12 in 1953, which, in A1A-A1A form was roughly comparable to the DE621 if the latter is considered at its full potential output, and not in its actual derated form.

Perhaps even more importantly, it started GE's long association with the C-B FV engine, and so the road to the 7FDL. And the 12-cylinder engine was the centre-piece of the later export Universal range, including the very successful U20C, a 1960s benchmark in the CMT gauge arena.

GE did not repeat the A1A-A1A wheel arrangement again for a long time. Although it was a logical choice for the DE621, by the end of the 1950s, GE had publicly set its face against it, arguing that Co-Co was a better choice wherever six axles were needed. In an article published in the DRT 1958 December, GE said essentially that where 6 axles were required, Co-Co was preferable to A1A-A1A, and that use of the latter wheel arrangement would likely reduce return on diesel locomotive investment in the majority of cases. GE's export Universal range announced in 1956 consisted entirely of Bo-Bo- and Co-Co models; there were no A1A-A1A variants offered as standard options. In this regard GE differed from both Alco and EMD, both of whom offered A1A-A1A options for some of their standard export models of the period. Following the Chilean shovel-nose model, GE did build an A1A+A1A version of the 70 tonner for QR, although the design work for this may have been done circa 1952.

In the 1970s though, to meet specific customer requirements, GE did return to the A1A-A1A wheel arrangement, building UM10A1A, U15A1A and U18A1A models.

In 1949, cab units were the norm for line service locomotives. Although GE built road switchers for the IRCA, Guatemala in 1950, these were special-purpose locomotives, and it was 1952-53 before the CMT gauge road switchers appeared that could be considered as being suitable for more general applications. And at least for the first half of the 1950s, the cab unit, with load-bearing body structure, may have had a weight advantage that favoured it for low axle loading applications.

These locomotives were described in the trade journal "Railway Age" (RA) 1950 November 25, p.37ff, *"1,800-Hp. Diesels for the Argentine"*.

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## General Electric Pre-Universal Export Locomotives

### Argentina "Shovel-Nose" Supplement – 2021 September

The Argentine State Railway (EFEA) was the first to order and deploy the GE shovel-nose type, which was probably largely shaped by that road's requirements, although GE was no doubt thinking in terms of broader application. Against that background, the commentary made in a "Railway Age" (RA) 1948 August 07 article is interesting and informative. It also shows that the original plan, as stated therein, was modified somewhat before delivery. To quote from the article:

*"The Argentine State Railway has accepted the final design drawings for 65 double-unit Diesel-electric locomotives which the General Electric Company is constructing under an $18,000,000 contract. Featuring compact design with streamlined appearance, the locomotives are being built in three types to meet operating conditions found on Argentina's railroads."*

That contrasts with the fact that the final version of the initial order comprised 35 double-unit locomotives, of one type only. The RA article elaborated on the three types, as follows:

> *"Largest of the three types will be a twin-unit, 2,000-hp, locomotive designed for operation in the Andes, where tracks go up two-and-one-half per cent grades at 15,000 ft. above sea level. Each cab will contain a 1,000-hp. Diesel engine, which will power 6 motor-driven axles. There will be 23 locomotives of this type.*
>
> *"For operation on the plains, especially-daily in the vicinity of Buenos Aires, another twin-unit type will be built which will be identical with the first type, but will have eight instead of 12 motor-driven axles with one idle axle in the center on each truck. Twelve of these locomotives are to be built.*
>
> *"The remainder of the order will consist of 30 locomotives which will have two units nominally rated at 1,000-hp. each. These also will have eight motor-driven axles, but will differ from the other types in that they will be powered by two 500-hp. Diesels in each cab."*

The second, "plains" type, may be recognized as what was actually built for the first order, eventually the LGB DE621 class, with the quantity increased from 12 to 35, the additional 23 apparently displacing the 23 originally envisaged as being of the "Andes" type.

That the "plains" and "Andes" types were to be identical except for the traction motor count indicates that there was a "horses for courses" approach. On the plains, the A1A-A1A wheel arrangement was considered to be satisfactory, the higher capital and running costs of the Co-Co type not being justified. Also, the high speed performance of the A1A-A1A type was probably a bit better. In this vein, it may be noted that in its US domestic locomotive range, Baldwin offered some Co-Co models, two of whose traction motors could be switched out at higher speeds, allowing some extension of the full power curve. Nonetheless, by the late 1950s, GE had set its face against the A1A-A1A wheel arrangement, and recommended that where six axles were required anyway, that Co-Co be chosen. It did later relax this position, and in the 1970s built some export Universals with A1A-A1A running gear.

For the steep grades of the Andes, the Co-Co wheel arrangement was necessary to provide the requisite starting and low-speed tractive effort. Although deleted from the original order, the "Andes" type was subsequently realized in slightly different form, as the LGB DE622 class, single units derived from the Congo Matadi-Leopoldville model fitted with the Alco 12-244 engine, which at the time was more highly rated than the Cooper-Bessemer (C-B) FVL12T, and so had more margin for high altitude derating. One may wonder whether the fairly significant derating applied to the FVL12T engine for the DE621 type, on a gross basis from 1300 hp at 1000 rev/min down to 985 hp at 915 rev/min, was originally worked out for the "Andes" version, and then, for commonality, also applied to the "plains" version. The Alco 12-244 engine in the DE622 was derated from 1600

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to 1200 hp (tractive), so from 1750 to about 1350 hp on a gross basis. That said, EFEA did set upper limits for mean piston speed and mean effective pressure for the DE621 engines, which appear to have determined their actual power and speed settings. Whether this derived from consideration of altitude derating or from durability concerns is unknown.

Evident from the above is what had previously been deduced, is that GE had designed the three-axle bogie for these locomotives to accommodate three traction motors, even though it was sometimes built with two.

The third proposal, with two 500 hp engines per A1A-A1A unit, is intriguing. I had considered that the engine in this case might have been the Caterpillar D397, which was announced circa 1948 third quarter, so would have been in the pipeline when these locomotives were designed. But its 500 hp (gross) initial rating was on an intermittent basis, with 400 hp being the continuous number. That implied around 330 hp on a tractive basis, and probably even less than that if EFEA had applied some derating. So it was not really a fit to the description.

GE did later build a locomotive fitted with two Cat D397 engines, namely a centre-cabbed Co+Co unit for service in Venezuela. It also proposed a twin-D397 design for Queensland Railways, before landing on what was the 1150 class design. But the twin-D397 installation is probably most associated with Davenport, who built both a double-ended cab unit for Thailand, and an end-cab unit with tandem powerplants for Rhodesia.

Another possibility is that the proposal involved a pair of C-B F-series 6-cylinder engines. The 6-cylinder in-line FW6LT was already in service in the GE 70-tonner, so at first glance seems to have been the obvious candidate. But a pair of these would have been significantly heavier than one FVL12T, and probably would have required a longer carbody. The DE621 was built to be within a 29 200 lb maximum axle loading requirement, and each unit weighed in at 165 000 lb. Assuming that the same axle-loading restriction applied to the twin-engined version, then there was not much room for weight growth, 175 000 lb being the limit with maximum loading on all axles. But the C-B F-series did include a vee-6 variant, the FV6, which was quite a bit lighter and shorter than the in-line six, so this seems to have been a more likely choice. One imagines that C-B could have readied a traction version of this in parallel with the same work it was doing for the FV12. That remains speculative, though. Quite why EFEA would have wanted a twin-engined version is unknown, but perhaps it thought that such would be desirable in some applications in order to reduce the risk of total locomotive failure. Evidently there was a rethink on that score, and the idea was abandoned, and without immediate substitution. The planned double units already had two engines, and perhaps that was thought to be insurance enough.

The final part of the RA article:

> *"All 65 locomotives are being constructed at the Erie Works of the General Electric Company, where the first Diesel engine is being readied for test. Deliveries are scheduled to begin in 1949.*
>
> *"Said to have more horsepower per ton than any meter-gage machines ever designed, these locomotives will enable the Argentine railroads to run heavier trains on faster schedules, thus adding to their capacity and giving better service to the country. The design is a direct result of a six-months study which an International General Electric transportation specialist made in Argentina last year."*

The order for 65 double-unit locomotives in three types was reduced to 35 in one type. Something of a partial replacement order was recorded in "Diesel Railway Traction" 1950 December. This was for 30 total single shovel-nose units powered by the Alco 12-244 engine, 5 metre-gauge for "Andes" service, and 25 broad gauge for use on the LGM.

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## General Electric Pre-Universal Export Locomotives

GE's use of the Alco 12-244 engine in export designs was logical, given that it was already used in the domestic Alco-GE locomotive range. The initial CMT-gauge installation was in the IRCA, Guatemala Co+Bo+Co road-switchers. I imagine that the initial shovel-nose design work was done with this engine in mind, as well as the C-B FVL12T.

The RA included an artist's impression of the EFEA double-unit.

### Diesel Road Locomotives Being Built for Argentina

The Argentine State Railway has accepted the final design drawings for 65 double-unit Diesel-electric locomotives which the General Electric Company is constructing under an $18,000,000 contract. Featuring compact design with streamlined appearance, the locomotives are being built in three types to meet operating conditions found on Argentina's railroads.

Largest of the three types will be a twin-unit, 2,000-hp. locomotive designed for operation in the Andes, where tracks go up two-and-one-half per cent grades at 15,000 ft. above sea level. Each cab will contain a 1,000-hp. Diesel engine, which will power 6 motor-driven axles. There will be 23 locomotives of this type.

Artist's drawing of one of the two-unit, 2,000-hp. Diesel-electric locomotives being built by General Electric Company for the Argentine State Railway

For operation on the plains, especially in the vicinity of Buenos Aires, another twin-unit type will be built which will be identical wth the first type, but will have eight instead of 12 motor-driven axles with one idle axle in the center on each truck. Twelve of these locomotives are to be built.

The remainder of the order will consist of 30 locomotives which will have two units nominally rated at 1,000-hp. each. These also will have eight motor-driven axles, but will differ from the other types in that they will be powered by two 500-hp. Diesels in each cab.

All 65 locomotives are being constructed at the Erie Works of the General Electric Company, where the first Diesel engine is being readied for test. Deliveries are scheduled to begin in 1949.

Said to have more horsepower per ton than any meter-gage machines ever designed, these locomotives will enable the Argentine railroads to run heavier trains on faster schedules, thus adding to their capacity and giving better service to the country. The design is a direct result of a six-months study which an International General Electric transportation specialist made in Argentina last year.

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## General Electric Pre-Universal Export Locomotives

### GE "Shovel-Nose" Family – 2021 May

This section provides a few comments about the family connections within this group, separately from the discussion about the individual models.

The Belgrano (LGB) locomotives were the first built, so on that basis would appear to be the start of the series. On the other hand, the Matadi-Leopoldville (CFML) locomotives had lower serial numbers, so might have been ordered, or at least might have been covered by a letter of intent, before the Belgrano group. My best guess though is that they were designed, in outline if not in detail, at the same time. Thus GE arranged the basic design to accommodate either the Alco 12-244 or the Cooper-Bessemer (C-B) FVL-12T engine as required. The rigid bolster bogie design was the same for both, basically a Co bogie, but with the centre motor omitted for the Belgrano unit to make it an A1A. Dynamic braking was optional. And the main braking system could be air (14EL) or air-on-locomotive, vacuum-for-train (14ELV) as required. Either left- or right-hand driving positions could be fitted, with mirror-image control stands. GE used its Amplidyne control system with both engine types.

Overall length and bogie centres appeared to be "rubber" dimensions, determined by specific needs. Whether the Alco 12-244 took up more length than the C-B FVL-12T I don't know, but with a higher output (at the time) it might have required a longer cooling group. Additional length might also have been required to accommodate the dynamic braking unit where fitted, and perhaps the motor-driven secondary exhauster for the air-vacuum brake-equipped units.

The length flexibility also allowed for the accommodation of longer bogies, as required for the standard and broad gauge variants, the inclusion of a second cab when required, and the fitting of a train heating boiler. I suspect, but don't know for sure that the very long Indonesian version also had room for an in-body fuel tank. [It did] Length flexibility went the other way with the "small" version for the White Pass & Yukon.

Overall, I'd say that although GE's development worked might well have been prompted by the LGB and CFML requirements, as well as designing to their individual specifications, GE also studied clearance diagrams, axle loadings, bridge loadings and so on for a wide range of overseas roads, and built into its basic design reasonable flexibility, at least to the extent that it could be done without unduly increasing costs.

The sub-heading for the Railway Age (RA) 1950 November 25 article on the LGB units was: *"The initial success of this locomotive has led to the adoption of the design for similar locomotives with low-weight limitations".* That at least suggested that GE saw it as a quasi-standard design.

The RA 1951 November 19 article on the CFML units was headed *"Export Type Diesel-Electric Locomotives"*, with the sub-heading *"General Electric motive power units are readily adaptable to use on many foreign railroads – Incorporate both multiple unit control and dynamic braking without transition"*. Again that aligned with the quasi-standard approach.

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## General Electric Pre-Universal Export Locomotives

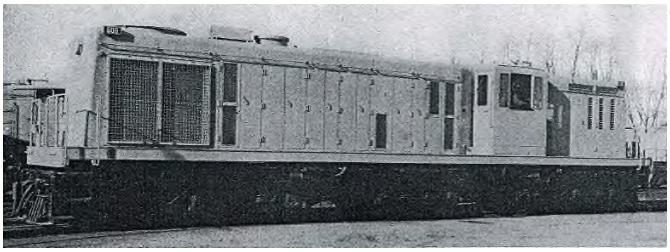
### 1950 - IRCA Guatemala Co+Bo+Co Road Switcher

The third GE export model was the Co+Bo+Co road switcher first built for United Fruit for operation by International Railways of Central America (IRCA) Guatemala as its 600 class, on its three-foot gauge network, and delivered from early 1950.

Initially, IRCA acquired 6 of these locomotives in early 1950, obtaining a further 6 at the very end of 1956. Colombia State Railways bought 5 to essentially the same design, also for operation on its three-foot gauge network, these being delivered late in 1952. Thus a total of 17 were built in the 1950 through 1956 period.

The IRCA locomotives were required to operate on a line that included grades up to 3.6 percent and curves up to 15 degrees; probably their 40 mile/h design top speed capability was more than enough for their planned duties.

The most obvious feature of these locomotives was their Co+Bo+Co wheel arrangement, as far as I know unique to this design. Also as far as I know, they were the only example of a single-frame tribo diesel locomotive fitted with articulated bogies. Even in electric locomotive practice, the articulated tribo arrangement was not very common. GE appears to have been the first to use the tribo form, with some Bo+Bo+Bo 3 kV DC electric locomotives supplied to FC Mexicano from 1924. In these, loading of the centre bogie was conventional, that is direct from the locomotive frame.



As said earlier in connection with the 70 tonner, the use of any kind articulated bogies for diesel locomotives was not commonplace, with GE probably being the majority user, choosing it when it was an appropriate solution; it was not applied indiscriminately.

Above-deck, the IRCA road-switcher was derived largely from the concurrent Alco-GE 1500 hp domestic road-switcher. In order to meet the 15 short ton axle loading limit, 8 axles were required in place of the 4 or 6 of the domestic model. Several wheel arrangement choices would have been available to GE. Whilst GE's thought process is unknown, one can at least look at some of the options that it probably considered. 1-Co-Co-1 and 1-Co+Co-1 readily come to mind; a short time previously GE had built some metre gauge 1-Co+Co-1 3 kV DC electric locomotives for the EFS, and had earlier used this arrangement for various electric locomotives. A disadvantage was that not all locomotive weight was available for adhesion, although offsetting that to some extent was the fact that 1-Co bogies could readily be designed for high adhesion characteristics.

Alternatively, span bolster Bo-Bo-Bo-Bo and Bo-Bo+Bo-Bo designs offered all-adhesion options that could be made relatively flexible in respect of both horizontal and vertical track curvature. GE had recent familiarity with both of these types, the former in connection with the Alco-GE 4500 hp gas turbine electric prototype, and the latter for the Virginian Railway EL-2B AC-DC motor-generator electric locomotives. Incidentally, this pair illustrated the selective nature of GE's running gear choices; the gas turbine locomotive, being designed primarily for fast freight service, had independent span bolsters and lateral motion bogies, whereas the electric locomotive, intended for slower speed heavy-haul service, had articulated span bolsters and rigid-bolster bogies, even though, being of the motor-generator type, it did not have the larger diameter motors and consequently larger diameter driving wheels that were characteristic of contemporary DC and single-phase locomotives.

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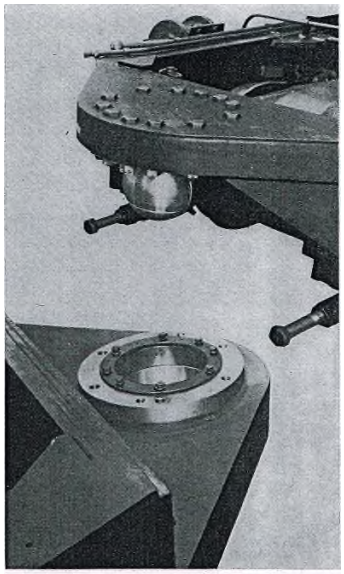
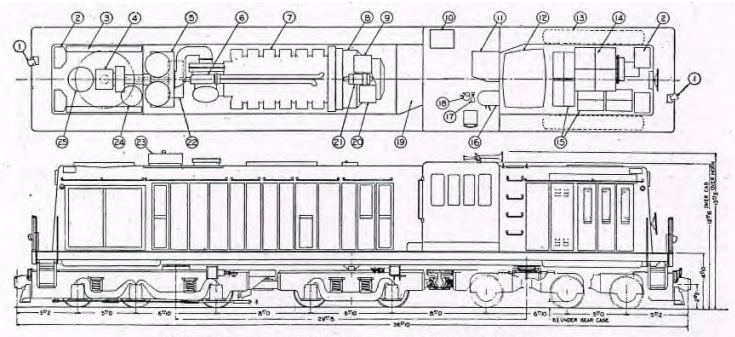
A disadvantage of the span bolster wheel arrangements was that they added weight and height, the latter problematical on narrow gauge railways with restricted clearance diagrams. The IRCA locomotives were 13 ft 5 in high overall, so it is unlikely that a span bolster could have been accommodated. In fact, relatively few span bolster locomotives have been built for CMT gauge applications, with GE probably the builder of the majority.

Perhaps a four-bogie design without span bolsters was considered, but at the time this was without precedent, and would have had constraints in respect of its ability to traverse vertical curves, as well as requiring at least a pair of wide-range lateral motion devices.
Be that as it may, GE chose a tribo design with some interesting features. By choosing articulated bogies, GE effectively avoided the need to equip the centre bogie with a suitable lateral motion control that allowed adequate traverse. Instead, lateral movement of the centre bogie was determined by its articulated connections to the outer bogies. Furthermore, the centre bogie was loaded by the outer bogies through the spherical articulation joints. To facilitate this, the outer bogies had their centre pivots placed midway between their centre and inner axles. In turn this meant that the centre bogie was not constrained by any connection to the locomotive frame. Combined with the fully equalized suspension, this resulted in running gear that allowed considerable vertical as well as horizontal flexibility whilst minimizing interaxle weight transfer. One can wonder what the tracking behaviour was like towards the maximum speed of 40 mile/h, but then that was probably less important than delivering reliable haulage capacity on the grades at around 10 mile/h, for which the articulated bogie arrangement was advantageous. Thus it can be inferred that GE developed an elegant and simple solution to a difficult problem. The use of articulated running gear would also have allowed the mainframe to be lighter.



Ball-and-socket articulation used between trucks



PLAN AND SIDE ELEVATION SHOWING ARRANGEMENT OF EQUIPMENT

1. Multiple unit coupler
2. Sand boxes
3. Radiator
4. Compressor and radiator fan drive
5. Oil bath air filter
6. Supercharger
7. Diesel engine
8. Main generator
9. Auxiliary generator
10. Tool box
11. Auxiliary control compartment
12. Fuel tank
13. Air reservoir
14. Braking resistors
15. Battery boxes
16. Controller
17. Foot valve
18. Brake valve
19. Control compartment
20. Exciter
21. Motor-generator set
22. Air compressor
23. Expansion tank
24. Oil cooler
25. Oil filter

The outer, Co bogies had a wheelbase of 11'10", distributed 5'0" outer and 6'10" inner. The larger inner spacing allowed for the pivot placed between the central and inner axles. Bogie centres were at 29'8", and total wheelbase was 46'4". The centre, Bo bogie had a wheelbase of 6'10".

Bogie construction followed GE industrial locomotive practice, being of the rigid bolster, welded type with plate side frames and outside drop equalizers. As on the export 70 tonner, the traction motors were the self-ventilated GE747 model, mounted longitudinally and driving through hypoid and spur double reduction gear sets, with 33-inch wheels. The overall reduction ratio was 11.5:1.

GE did use the GE747 motor, similarly configured, in some of its industrial switchers. But I don't know whether such applications preceded that on the export 70 tonner, or whether the latter was the first. GE did not have a three-foot gauge traction motor in its range before the GE764 (a truncated GE761) was released in the mid-1950s. Accordingly, the longitudinally mounted GE747 was

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a suitable solution for three-foot gauge applications. It was used again on the 50-ton model released in 1952.

As said, above deck, these locomotives were based upon the contemporary Alco-GE domestic 1500 hp road switcher, although with the addition of dynamic brakes. The engine was the Alco 12-244E, in this case set for 1200 hp (tractive) at 950 rev/min. This setting was determined by the traction motor capacity. Some sources show that the 1956 batch had the 12-244H engine, which would certainly have been possible by late that year. The Colombian batch of 1952 had the 12-244E engine. These operated at high altitude. However, as the engine was significantly derated to start with, additional derating for altitude appears not to have been necessary. For comparison, the Colombian U20C fleet of 1964 was derated to 2020/1870 hp from 2150/2000 hp.

The corresponding main generator was the GT564B. This had a belt-driven Amplidyne exciter and a belt-driven single auxiliary generator, both being mounted (independently) above the main generator. This would have been used for later production, as well, despite availability of the GT581. No GT581 variant with belt-driven auxiliaries was developed until the GT581E for the Alco DL535 in 1961.

The radiator fan was mechanically driven from the free end of the engine, via the air compressor, as on the domestic prototype. This contrasts with the early shovel-nose models, which had electrically-driven radiator fans. With self-ventilated traction motors, no traction motor blowers were required. GE's Amplidyne control system was fitted, with the tachometer type electro-hydraulic engine governor. The traction motors were connected in permanent series-parallel (2S4P) with three stages of field-weakening. Judging by the tractive effort-speed curve, loading was well-maintained up to the maximum speed of 40 mile/h. Continuous tractive effort was 37 000 lbf at 9.5 mile/h. Supervisory transition control was fitted, with two positions, one keeping the motors in full field, presumably for shunting operations, and the other allowing automatic transition through to full weak field. (This same kind of supervisory transition control was also found on some U20C models.) Dynamic braking was manually controlled. Reading from the braking force-speed curve, the peak was about 28 000 lbf at about 12 mile/h; there was a commutation step at 30 mile/h, with reduced braking force being available right through to 40 mile/h. The locomotives were fitted for multiple unit operation, with a single socket at each end. At a guess, they used the Alco-GE 21-wire protocol, but the underlying control system was AAR-compatible. The braking system was schedule 14-EL, GE's apparent export standard.

The body was characterized by an unusually long short hood. This was required to accommodate the fuel tank, the articulated running gear not allowing any space for conventional underslung placement. The short hood also accommodated the dynamic brake resistor and the batteries. One can wonder whether such juxtaposition of the fuel tank and dynamic brake resistor would acceptable in today's safety-conscious world. The driving cab followed GE industrial practice in its outline. The right hand driving position had the control stand on the left, with the brake pedestal immediately behind it. So, unlike preceding LGB shovel-nose model, the throttle and brake controls were not opposite-handed.

Length over couplers was 56 ft 10 in. So the length over the outer bogie headstocks was probably around 53 ft, and the mainframe length about 52 ft, that is, the same as the later U18C and U20C models. The latter did not have to accommodate an above-frame fuel tank, but their design did allow space for a train heating boiler (seldom if ever specified), or alternatively, as used by South African railways, an inertial air filtration system.

The IRCA locomotives weighed 120 short tons. The Colombian locomotives I have seen quoted at both 120 and 126 short tons; with both numbers appearing in different places in the same GE brochure!

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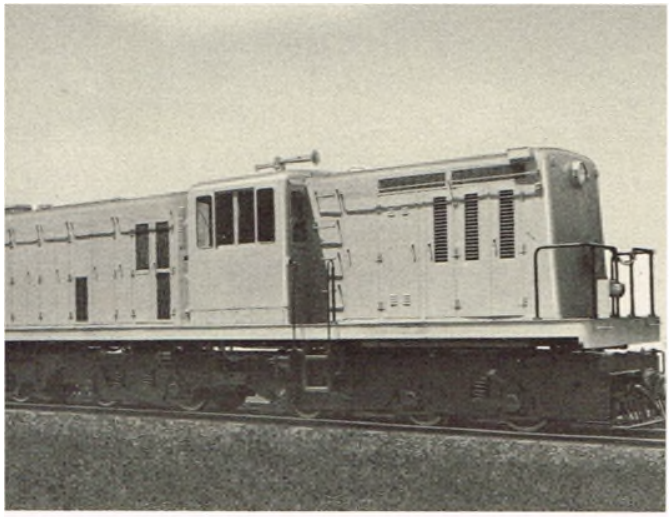
## General Electric Pre-Universal Export Locomotives

I have not seen any information about the service history of these locomotives. The Jane's 1981-82 listing for the National Railways of Colombia (evident successor to Columbian State Railways) includes its 5, so presumably they lasted until circa 1980 at least. They were amongst what became quite a large GE fleet. Colombian National was an earlier buyer of the U12C, and the first to acquire the U20C in 1964, three years after that model was announced. In retrospect, it is perhaps rather surprising that such an iconic model (at least in the CMT gauge world) had such a slow start. IRCA also went on to operate other GE models, including the 50 tonner and the small Universals.

Placing these unusual locomotives in historical context is an interesting exercise. From a GE perspective, the design was its first export road switcher, and led to a long line of 12-cylinder export road switchers, most notably the U20C. If not the direct forbear of the U18C/U20C, it was definitely on the pathway to that model.



**ONE OF FIVE** 1200-horsepower, 126-ton, 36-inch gage diesel-electric locomotives which were built for the National Railways of Columbia.

In a broader sense, they were built early in the dieselization era. Diesel locomotive technology, if not yet quite mature, had moved out of the experimental phase and into the mainstream in 1939 with the EMD FT. The work yet to be done/events yet to happen included the emergence of a credible alternative suppliers in the USA; the adaptation of diesel locomotive technology for use on railways outside of North America, which generally required weight and profile reductions, quite significant in the CMT gauge case; the establishment of or development of existing construction industries in those countries that preferred to build their own; and of course the availability of capital to spend on the locomotives. WWII intervened, such that the process did not start in earnest until around 1946. Probably it also ensured that steam locomotive production survived longer than it otherwise might have done, as to some extent the prompt need for new locomotives of any type indicated retention of old methods for the sake of speed. Even so, if one applies the conventional wisdom of ten years for a paradigm shift, then by 1956 the situation was certainly settling down; during the ten-year period one can expect quite a bit of variety as "odd" solutions are explored that either turn out to be blind alleys or are rendered redundant by quickly improving technology.

Looking specifically at CMT gauge applications, the early 1956 announcement of GE's export Universal range was a major marker. It meant that the vast majority of locomotive requirements could be met by standard models, which were also capable of some adaptation to meet special requirements. Both Alco and EMD had preceded GE with standard models, but GE was first to offer a complete range, and its action evidently provoked its two major competitors into following suit. In the preceding ten years, a particular challenge was how to build higher powered locomotives for CMT gauge railways that had very restrictive axle loading limits and loading gauge profiles, using medium-speed engines that were originally designed for less restrictive standard gauge applications. Sulzer in particular had, since 1939, demonstrated CMT gauge production model capability in the lower power range, up to around 1000 hp, but the challenge was to get well above this. The net result was the use of some unusual multi- axle wheel arrangements in order to spread the weight. After about 1956, these became less necessary and so less common, once the majority of needs could be satisfied by "conventional" wheel arrangements, which group might be described as Bo-Bo/B-B, A1A-A1A, Co-Co/C-C and Bo-Bo-Bo/B-B-B (single-frame). (1-Co-Co-1 was a borderline case, and the locomotives that fall into this group make an interesting case study.)

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## General Electric Pre-Universal Export Locomotives

Against this background, the IRCA road switcher was not out of place; rather it is a good example of the kind of development that might be expected during a paradigm shift period. In fact, it appears to have been the first multiaxle single-frame, bogie-type CMT gauge diesel-electric locomotive, and for a brief period, it might also have been the most powerful (again on a single-frame basis). It might also have been the first example of a line-service road- switcher on the CMT gauge, at a time when cab units were still regarded as the norm. It had a relatively low top speed, 40 mile/h, but this was in keeping with its expected operational duties. By 1956, traction motor development made it possible to meet low speed tractive effort requirements with single-reduction gearing, which typically resulted in top speeds above 50 mile/h, needed or not. A standard U12C, with GE761 motors, had a continuous tractive effort of 43 600 lbf at 7.5 mile/h, and a top speed of 60 mile/h. I don't have the corresponding numbers for the three-foot gauge model with GE764 motors, but they would not have been markedly different.

These locomotives were described in RA 1950 September 16, *"Guatemala Now Using 1,200-Hp. Narrow-Gage Diesels"*, p.57ff.

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## General Electric Pre-Universal Export Locomotives

### IRCA Guatemala Co+Bo+Co Road Switcher - Supplement

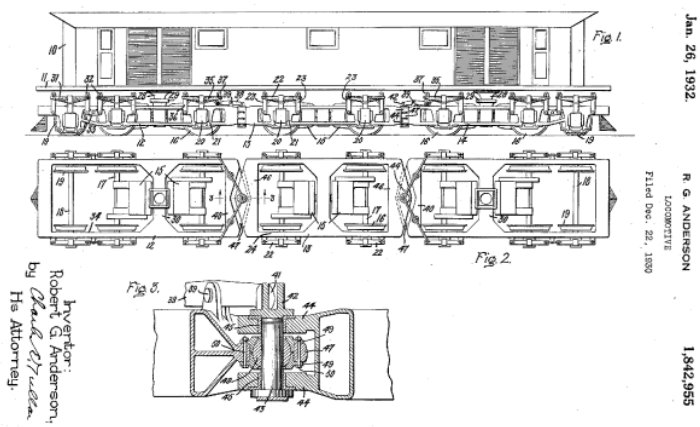
As mentioned in the foregoing, this locomotive had an unusual wheel arrangement on three counts, namely:

1. It was of the tribo type with articulated bogies;
2. The centre bogie had a different axle count (two) to the two outer bogies (three each);
3. It had a unique method of loading and controlling the centre bogie.

On item (1), there was only one precedent, and that was a Bo+Bo+Bo articulated bogie DC electric locomotive that GE had built for the Mexican Railway in 1925. As best I can determine, that was the first tribo locomotive of all. It was evidently the realization of prior GE ideas that had resulted in at least two patents.

Re item (2), the IRCA locomotive was the first so configured, and although the concept was repeated, it remained a minority in the tribo world.

Item (3) was also the result of earlier GE thinking, covered by two patents, US1842995 and US1842973, both of 1932. The former dealt more with the overall concept, whereas the latter focused more on the details of the articulated joints. Both used the same diagram, in which a 1Bo+Bo+Bo1 wheel arrangement was shown by way of example, without being limiting. The 1Bo bogies had three axles in a rigid wheelbase, of which only the centre and inner axles were powered.




By way of description, it is easiest to quote from US1842995:

> *"In current practice a locomotive or car having more than two articulated trucks in connection with its driving mechanism usually has some means for distributing part of the load on the end trucks and part on the intermediate trucks. . This is often accomplished by various means of supporting the weight of the locomotive or car on supports arranged on each truck, but this type of construction has the disadvantage of requiring the support on the intermediate trucks being constructed for lateral motion to provide sufficient flexibility to the construction so that the locomotive or car can easily take curves in the track without liability of derailment.*
>
> *"The object of my invention is to provide a simplified and improved means for distributing the load on all the drivers of the locomotive or car which uses more than two articulated trucks in connection with its driving mechanism and to provide a construction which will easily take curves which may be in the track without liability of derailment. I accomplish this object by providing in combination with a car frame, more than two articulated trucks and means supporting the superstructure of the locomotive or car on the trucks at both ends, and a flexible means for transmitting a portion of the load from the end truck to an intermediate truck at their articulation."*

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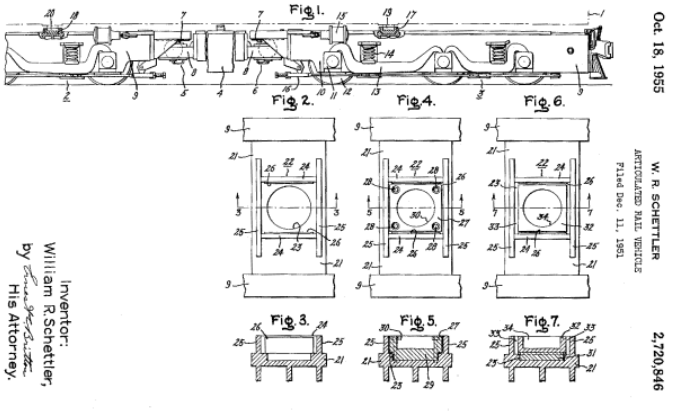
## General Electric Pre-Universal Export Locomotives

It looks very much as if GE had developed a solution that was looking for a problem, the latter eventually arriving with the IRCA requirement, where 8 axles were needed to keep the axle loading to the specified limit and all needed to be powered to provide adequate total traction motor capacity with the available motors that were suitable for the three foot gauge.

It was not a big step from the 1Bo+Bo+Bo1 wheel arrangement of the GE patent to the Co+Bo+Co of the IRCA locomotive. The latter was essentially the former with powered outer axles. The use of three axle outer bogies clearly made it easier to place the pivots in the correct place for weight balance including transfer to the centre bogie, namely between the centre and inner axles of each bogie.

The Co+Bo+Co wheel arrangement was not repeated beyond the IRCA fleet and the Columbian Railways clone, nor were there any subsequent articulated bogie tribo locomotives. That was not surprising, as by the time the IRCA locomotives were built, the articulated bogie form was very much in its twilight. One may see, though, that the chosen wheel arrangement and its specific implementation was the simplest and probably the lightest way to provide the requisite 8 powered axles, given that operating speeds were not so high that articulation of the bogies would be problematical from a riding and tracking viewpoint. A Co-Bo-Co wheel arrangement, or Co+Bo+Co, with the centre bogie loaded directly, would have incurred the need for a wide range lateral motion device, and would have been less flexible when it came to traversing vertical curvature, with more likelihood of material weight transfer between the outer and centre bogies. The last two items may have been important on IRCA's sinuous, steeply-graded route. Bo-Bo-Bo-Bo or Bo-Bo+Bo-Bo, both in GE's post-WWII lexicon, would have, because of their span bolsters, incurred extra complexity, extra weight, and probably an overall height increase. As it happened, GE had a ready-made solution "sitting on the shelf".

A point of detail about this locomotive was that it had interchangeable outer bogies. Typically articulated bogie locomotives with two bogies had non-interchangeable bogies. In part this was because the two parts of the articulation joint were not symmetrical, one usually being a "jaw" and the other a "tongue". Also, one of the main pivots had to accommodate longitudinal sliding motion, whereas the other could be fixed. In the case of the IRCA locomotive with its centre bogie, the outer bogies had identical articulation joints, intended to transfer loading to the centre bogie. Thus one barrier to interchangeability was removed. GE went a step further, by arranging for the outer bogies to be used with either fixed or sliding pivots, accommodated by appropriate adaptor units mounted on the bogies, rather than by basic bogie frame design.




GE patented this aspect of design, as US2720846 of 1955 October 18 (filed 1951 December 11). Perhaps it had incurred quite some amount of effort for a basic running gear type that was obsolescent if not obsolete, but having chosen it as the most appropriate solution for the application, it would appear that GE was being fully diligent about the details.

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## General Electric Pre-Universal Export Locomotives

### 1950 - Matadi-Leopoldville “Shovel-Nose”

In late 1950 emerged a Cape gauge shovel-nose design of which 8 were built initially for Matadi-Leopoldville Railway (CFML), Belgian Congo. Effectively, this was a longer and heavier derivative of the LGB design with the Alco 12-244E engine in place of the C-B unit, Co-Co running gear in place of A1A-A1A, and equipped with dynamic brakes.

The equipment layout was essentially the same, with cab followed by main control frame, then traction motor blower, generator assembly, engine, compressor/exhauster, radiator compartment with vertical radiator panels at the body sides and motor-driven cooling fan, followed by the rear compartment, which in this case included the dynamic brake resistor unit and the supplementary exhauster. The LGB unit, which lacked dynamic brakes and did not require an exhauster, had a second traction motor blower in the rear compartment. Evidently owing to space constraints, the CFML design used just one traction motor blower group.

The extra length, about 2 feet, seems to have been allocated to a longer engine-generator compartment. I do not have comparative engine dimensions, but perhaps the Alco 12-244E with matching generator assembly was a bit longer than the Cooper-Bessemer FVL12T with its matching generator assembly. The radiator panels look to have been a bit longer, as well.

STREAMLINED 1400-horsepower, 100-ton, 42-inch gage diesel-electrics run between Leopoldville, capital of the Belgian Congo, and the Atlantic port of Matadi.

The engine was set for 1400 hp (tractive) at 1000 rev/min, that number suggesting an element of site derating for the hot and humid conditions. The main generator was a GT564C, model, with the triplex auxiliary gear drive unit. Of the three auxiliary machines, one was an Amplidyne exciter, one was an auxiliary generator for battery charging etc., and the third was a second auxiliary generator that supplied the traction motor blower and fan drive. There were six GE 756 traction motors connected in permanent series-parallel (2S3P) driving 36 inch wheels through 95:18 gearing. The continuous tractive effort was 25 000 lbf at 16.5 mile/h.

As the existence of the Amplidyne exciter suggests, these locomotives had the GE Power Plant regulator control system, with the GE electro-hydraulic governor. Probably the latter was a 17MG3 or 17MG6 model; I am not sure about the differences between these two or how and where they were used in practice. One source suggests that they had 5-notch throttle controls. Whilst this is possible, it seems highly unusual, and on the basis that unusual claims require unusual proof, I am inclined to the position that they followed the standard 8-notch pattern used on other locomotives with this form of control. Whilst it is not abundantly clear from the references on hand, there were three stages of field weakening that might have been manually controlled by the selector lever, although I would not outrule the possibility that supervisory control was fitted. Three stages of field

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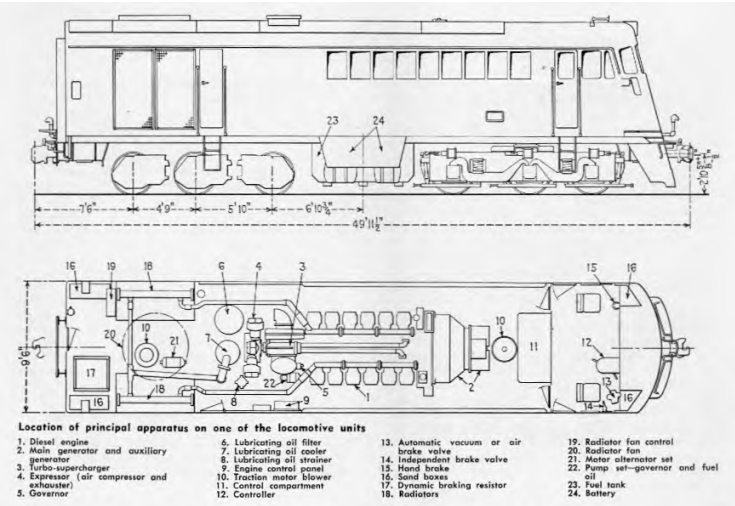
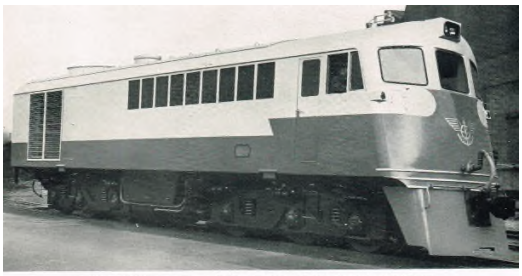
weakening would have aligned with the Alco 12-244E-engined IRCA road-switchers, whereas the CB-engined LGB shovel-nose model had two stages. Top speed was quoted as 50 mile/h. This might have been a route-related restriction rather than a machinery-driven one, given that the LGB locomotives with the same motors, gearing and wheels were quoted as having a 56 mile/h top speed. The dynamic braking system was fitted with automatic current limiting control.




The bogies were essentially to the same welded, plate frame, outside equalized design as on the LGB locomotive, except that the rigid bolster appears to have been lengthened and arched to clear the centre traction motor. The dimensions were the same, namely 10'7" wheelbase divided 4'9" outer and 5'10" inner, with the centre pivots 1½" inboard of the centre axle.

The CFML being a vacuum-braked road, the GE locomotives at interest were fitted for vacuum train braking, although they were air-braked themselves. The primary source of braking power was a combined 3-cylinder compressor-exhauster, belt-driven from the free end of the engine. One cylinder was used for air compression, and the other two for vacuum generation. In comparison the LGB locomotive had an air compressor direct driven from the free end of the engine. Recognizing that engine driven exhausters have limited capacity at lower engine speeds, a motor-driven supplementary exhauster was also fitted. This was powered from the second auxiliary generator. Presumably it operated only when the throttle was in idle or the lower power notches, but I am unable to confirm this. As best I can determine, control of the vacuum train brakes was direct, probably with a two-pipe horizontal shaft driver's brake valve. And quite possibly the driver's straight air brake valve was essentially the same as for the schedule 14-EL air brake system.

The CFML shovel-noses were MU-equipped, and at least based upon photographic evidence, were intended to operate in back-to-back pairs. Total weight was quoted by GE as 100 short tons (200 000 lb), roundly 90 (long) tons.


91-ton 1,600 b.h.p. Baume & Marpent diesel-electric locomotive for Otraco

CFML obtained 8 additional locomotives of the same type in late 1953/early 1954. In this case they were license built by Baume & Marpent (B&M), Belgium, with some of the electrical equipment license-built by Société Electro-Mécanique (SEM), Belgium. There were some relatively minor mechanical design changes, and the continuous tractive effort had increased to 28 500 lbf, although I cannot trace the corresponding speed. The weight was quoted as 91 tonnes. They had horizontally-arrayed twin sealed beam headlamps, whereas the GE originals had conventional single headlamps. These 8 locomotives were supplied alongside 8 Cockerill-Baldwin AS-616-E locomotives of similar capacity, although they were heavier at 96 tons, and were of the end-cab hood unit form, in fact being evident derivatives of the Baldwin AS-616E export road switcher. Two Brasilian railways, the EF Central do Brasil (EFCB) and RVPSC also had side-by-side deliveries of similar-capacity

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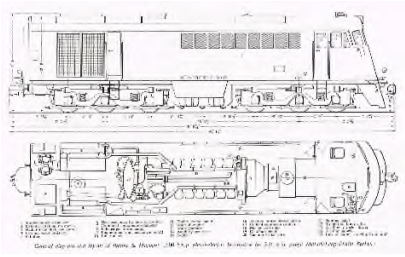
## General Electric Pre-Universal Export Locomotives

GE and Baldwin locomotives in the 1953-54 time period. In 1959, Cockerill supplied 4 more locomotives to CFML, single-ended cab units this time, but with essentially the same powertrain as previously. Whether GE/B&M was in the running for this order is unknown, but perhaps its inability by then to supply replicate units, due to the Alco 244 engine being out-of-production, was a factor.

CFML, like quite a few of the "colonial" railways in Africa, was an early convert to dieselization. At the time that its first GE shovel-nose locomotives were delivered, they were quite possibly the most powerful single-unit CMT gauge examples anywhere, particularly if judged by the 1750/1600 hp output that the Alco 12-244E engine was then capable of in temperate ambient conditions. As far as I know, the CFML GE shovel-nose fleet lasted into the SNCZ era in the 1970s, and possibly longer.



From GE's viewpoint, it now had a 1750/1600 hp, 200 000 lb/90 long ton six-motor CMT gauge unit that would fit the main line requirements of many overseas railways. Although not so many of this specific shovel-nose variant were sold, the 90-ton, six-motor concept proved to be particularly durable, as evidenced by GE's later sales of its U18C, U20C and U22C models.

In a shorter time range sense, the CFML shovel-nose spawned several derivatives that amongst them, accounted for the majority of pre-Universal series export locomotives that GE built. It seems likely that GE embarked upon at least outline design of the Alco 12-244-engined shovel-nose model soon after it started work on the LGB model, hence the significant commonality of the two designs. Whatever its longer-term visions for the Cooper-Bessemer engine might have been, for the time being it still depended upon the Alco 12-244 where higher power outputs were required for export applications, hence the value in designing a broad-application potential locomotive that could accommodate this engine.

The first batch of GE-built locomotives were described in RA 1951 November 19, p.62ff "Export Type Diesel Electric Locomotives".

The second B&M-built batch were described in DRT 1954 April, p.87ff, "Main-Line Locomotives for Africa".

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## General Electric Pre-Universal Export Locomotives

### 1952 - Uruguay Double-Ended “Shovel Nose”

By the end of 1950, GE had produced four export model diesel-electric locomotives, namely the six-motor 70 tonner, the CB-engined shovel-nose cab unit, the eight-motor Alco 12-244-engined road switcher and the Alco 12-244-engined shovel-nose. The 70 tonner and the road switcher covered three foot, metre and Cape gauges, whereas the pair of shovel noses covered the metre and Cape gauges. Thus by now GE had a range of designs that amongst them covered a wide range of CMT gauge applications, including those with restricted axle loadings and limited loading gauges. Furthermore, the larger shovel nose design in particular could also serve as the platform for standard- and broad-gauge models.

*One of the first batch of standard-gauge Alco-G.E. 1,500 h.p. locomotives with a driving cab at each end. The photograph was taken on the G.E. test track at Erie where standard AAR couplers were fitted. Side buffers, central drawhook and vacuum brake hoses appear as the locomotives run in Uruguay*

The early part of 1952 saw the appearance of a double-ended standard gauge Co-Co shovel nose unit for the Administracion Ferrocariles del Estado (AFE) del Uruguay as its 1500 class. This was evidently derived directly from the single-ended CFML Cape gauge model. To accommodate the second cab, the length went from 46 ft over headstocks to around 52 ft. The rear compartment of the CFML version effectively disappeared, as the radiator compartment was adjacent to one of the cabs. It’s an assumption on my part that the equipment layout was essentially the same, except that the AFE locomotive, lacking a rear compartment, did not have the supplementary exhauster. Certainly the limited information that I have refers only to the main three-cylinder compressor-exhauster. As with the CFML unit, the locomotive itself was air-braked, but it was intended to haul vacuum-braked trains. It was not fitted with dynamic braking.

The engine was listed as the Alco 12-244G model, set to 1400 hp (tractive). This seems unlikely at least for the first batch built in 1952, although it could have been the case for the second batch of 1954. More likely the first batch had the 12-244E engine. The main generator model is unknown, other than that it was a 10-pole unit. Probably it was a GT564C or GT581, as it was fitted with the triplex auxiliary gear drive to the two auxiliary generators, the second powering the radiator fan and traction motor blower, and the Amplidyne exciter. The sequence of traction motor connections suggests lower rather than higher capacity, which points to the GT564C. The six traction motors were of the GE 731 model. A reasonable assumption is that for this application, the higher capacity – and probably heavier – GE 752 was not warranted. The traction motor groupings were 3S2P and 2S3P, the latter with two stages of field weakening. Whether the latter was manual or automatic is hard to say; the information on hand suggests that at least supervisory control was fitted. The driving position was on the right-hand side, as on the CFML units.

The bogie design generally followed that of the CFML units, being welded, with plate side frames, a rigid bolster and outside drop-type equalizers. Probably to accommodate the larger standard gauge traction motors, the wheelbase was longer, at 11’6”, distributed 5’2” outer and 6’4” inner. Total wheelbase was 40’4”, the bogie centres distance being unknown.

The weight for the first batch of 20 AFE locomotives built in 1952 was quoted by GE as 112 short tons, and by other sources as 100 long tons, which accords. The weight growth as compared with the CFML prototype was reasonable considering the second cab and the standard gauge traction

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motors and running gear. The second batch of 27, built in 1954, was quoted by some sources as weighing 106 short tons, which equates to 95 long tons. If this is correct, then some lightening took place. Perhaps the design work that GE had meanwhile done for the Indonesian shovel nose variant was folded back into the second AFE batch.

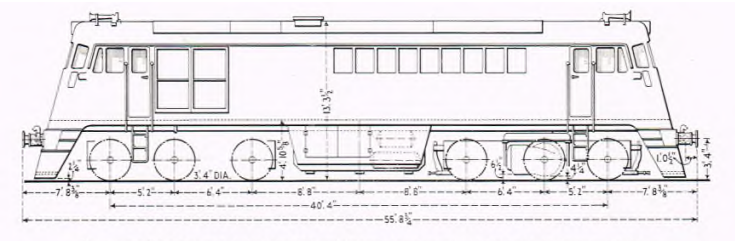

*Diagram of the first batch of Alco-G.E. 100-ton locomotives for the Central Uruguay Railway*

The AFE shovel nose fleet evidently had a very long service life. Whether the Alco engines were updated to the final, 12-244H status I do not know, but it seems likely. In this form, it was said to be a reliable and durable unit.

For GE, this model signaled a broadening of its quasi-standard export models scope beyond the CMT gauge world, this happening about a year ahead of the release of the Alco-GE DL500. Although the latter was soon to become the Alco DL500 following the dissolution of the Alco-GE partnership, for a very short time GE was more-or-less in competition with itself, insofar as the DL500 overlapped with the shovel nose range. The 1952 AFE shovel nose suggests that GE was already planning for an independent future.

The first batch of these locomotives was described in DRT 1953 October, p.222ff, *"Diesel-Electric Locomotives for Uruguay".* The same article also covered the Alco-GE RSC-3 road switchers acquired by AFE at about the same time, and appears to conflate the two, inaccurately referring to the 1500 class as being an Alco-GE product.

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## General Electric Pre-Universal Export Locomotives

### Standard & Broad Gauge Shovel-Nose Units and the GE731 Traction Motor – 2021 October

The GE731 traction motor dated from c.1940 and was used at least on the Alco-GE S-1, S-2, S-3 and S-4 switchers, and the RS-1 road switchers. I suspect that there were other domestic applications.

I imagine that when it came to the standard and broad gauge export shovel-nose units, the 731 was selected as the “best fit”. The 752, although by then available, would have been “overkill”, whilst the metre/Cape gauge 756 may not have had quite enough continuous tractive effort properly to match the adhesive weights. The later 761 probably would have been suitable, but was not yet available when most of the standard/broad-gauge shovel-nose units were designed. But it was used, for example, on the NSWGR 43 class, which was related to the shovel-nose group, and also on the EFEA Argentina Alco DL-540, which was a little heavier than the GE locomotives at interest.

Although the 761 was dimensioned to fit the metre gauge, in terms of capacity it was also intended to cover about 95% of export applications at the time it was designed, the exceptions being the 3-foot gauge, and the very highest axle-loading (say above 20 tonnes) broad/standard gauge locomotives.

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## General Electric Pre-Universal Export Locomotives

### 1952 - Queensland Railways 100-Ton Road Switcher

The next new GE export model that appeared during the course of 1952 was the Queensland Railways (QR) 1150 class, in 1952 August.

The QR 1150 class was the first reasonably conventional export road switcher built by GE, at least if one considers the preceding IRCA, Guatemala model as being unconventional due to its tribo running gear. It was a Cape gauge, 1100 hp (tractive), 90 long ton, Co-Co road switcher powered by the C-B FVL12-T engine, neither fitted for multiple unit operation nor with dynamic brakes.

In an appearance sense, the QR 1150 was distinctive because of its arched cab roof, rounded hood profile and the placement of its bogies at the extreme ends of the frame, with buffers and drawgear mounted on the bogie headstocks rather than the mainframe, although the bogies were not articulated. If one factors out the rounded topsides, it was still a recognizably GE product.

Its profile was the result of the fairly tight QR loading gauge. Its bogie placement was allegedly the result of QR's track and bridge loading requirements for its early diesel-electric locomotives. Accordingly, the 1150 had an axle loading of 15 (long) tons, a bogie wheelbase of 12'6" (equally distributed) and a total wheelbase of 45'0", numbers identical to those of the English Electric-built 1200 class ordered at about the same time. The relatively wide bogie spacing is said to have reflected QR's desire to approximate the weight spread of its Garratt steam locomotives. The bogie centres were at 32'0", putting the pivots 3" inboard of the centre axles.

Certainly, the 12'6" bogie wheelbase was greater than GE had hitherto used on its export models, which tends to confirm the notion that the number was the result of a customer requirement rather than a GE design choice. The same was true of the total wheelbase. For comparison, the later Universal series U18C model had very similar overall length (52 ft), with 40'3" total wheelbase, 11'6" bogie wheelbase (distributed 5'2¾" outer and 6'3¼" inner) and 30'3" bogie centres. That is, the total wheelbase was nearly 5 feet shorter for the same overall length.

Mounting the buffers and couplers on the bogie headstocks, which was unusual for GE in respect of non-articulated bogies, and not very common anyway, may have been done for a couple of reasons, the first being weight saving, in that the sections of the mainframe that were outboard of the bogie centres could be of lighter construction than would be the case if the also had to transmit buff and drag forces. Such weight saving may have offset the possibly higher weight resulting from the relatively long span of the mainframe centre section. The second would be to reduce buffer and coupler overthrow on tight curves, although considering that the similarly dimensioned EE-built 1200 class followed conventional practice, this may well have been a less compelling reason.

The bogies themselves followed GE's established export pattern, being of welded construction with rigid bolsters, plate side frames and outside drop equalizers. The outer ends were extended to mount the buffers and couplers, but this feature had already been seen on the export 70 tonner and the IRCA road-switcher, both of which were of the articulated bogie form.

The relatively long total wheelbase resulted in a locomotive that was probably longer than it really needed to be to accommodate the machinery. The platform length was somewhere in the 51 to 52 ft range, very close to that of the IRCA road switcher, but the latter also had to accommodate the fuel tank and dynamic brake equipment on the platform. The 110-ton road switcher built for EFCB in 1953, at 49'4" over headstocks, was probably more indicative of the "natural" length for this kind of locomotive absent major distribution restrictions. Admittedly the U18C was of similar length to the QR 1150, but it was designed with adequate space for an optional train heating boiler, which would have accounted for around 3 feet of length.

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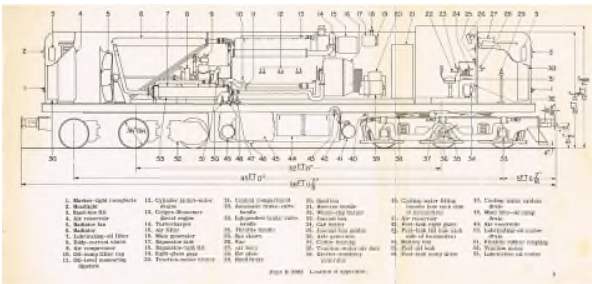
The QR 1150 was fitted with the C-B FVL12-T engine, as previously used in the LGB DE621. In this case it was set to 1320 hp (gross), 1100 hp (tractive) at 1000 rev/min, indicating that there was a modicum of site derating. Unlike the LGB locomotives, this version of the FVL12-T engine had a single turbocharger. It also had a Woodward UG8 governor with lever speed control and solenoid shutdown (of the energize-to-run type), whereas the LGB model had the GE electro-hydraulic governor, probably of the 17MG model. (At least the Chilean derivative has been confirmed as being fitted with the 17MG3.) Engine speed control was pneumatic, and although such an arrangement nominally provides continuous variability between idle and maximum, I understand that the throttle quadrant was notched, with the standard North American number of 8 notches. Certainly, pneumatic throttle control was unusual on GE locomotives, and I speculate that it was adopted as being better than a mechanical linkage on a large locomotive, bearing in mind that GE used mechanical linkages on its non-MU equipped industrial switchers and on the standard 70 tonner.

The main generator was a GT587. How this differed from the GT577 used on the LGB locomotives I do not know. Perhaps it was of higher capacity, but the different number could also signify that it was equipped for belt drive auxiliaries, rather than the gear-driven variety. A GMG-158 belt-driven combined auxiliary generator-exciter unit was fitted.

The governor, speed control and auxiliary generator assembly show that the 1150 was really an outlier amongst GE's contemporary 12-cylinder (Alco and C-B) export models, which all had the more sophisticated GE electro-hydraulic governor and the Amplidyne control system. Rather the 1150 was much more like the smaller, C-B 6-cylinder engined 70 tonner and the Alco-GE 539-engined domestic switchers. Quite why this should be so is something of a mystery.

The type of load control system fitted to the 1150 was probably the same inherent characteristic ("engine stalling") system as used on the 70 tonner. There is no evidence that it had a load regulator rheostat. The use of a speed-switch, as fitted to the early Alco-GE twin-engined domestic passenger units cannot be outruled, though. What is known is that there was provision for reducing engine loading by reducing excitation in the event of coolant over temperature of wheel slip. This might have been achieved by inserting an appropriate resistance in series with the exciter battery field.

The six traction motors were of the GE756 type, driving 36 inch wheels via 95:18 gearing. There were two series-parallel motor groupings, namely 3S2P and 2S3P, with two stages of field weakening for the latter. That is, the transition pattern was 3S2PFS1, 2S3PFS1, 2S3PFS2 and 2S3PFS3. Transition was fully automatic. The 3S2P initial grouping suggests that the GT587 generator did not have sufficient current capacity to handle 2S3P at starting and lower speeds, from which in turn it may be deduced that it was of lower capacity than the GT581, quite reasonable since the latter was originally intended for pairing with the higher output Alco 12-244 engine. A single traction motor blower was fitted, belt-driven from the main generator. Maximum safe speed was quoted as 50 mile/h, but whether this was a railway limit or an equipment limit is unknown, although the fact that the LGB locomotives, with the same traction motor, gear ratio and wheel diameter were quoted as having a 56 mile/h top speed tends to discount the latter. The continuous tractive effort was 31 000 lbf at 10.5 mile/h.



The three-cylinder, 223 ft$^3$/min air compressor was directly driven from the free end of the engine. The vertical-blade, horizontal-shaft cooling fan was also mechanically driven from the rear of the compressor via a two-speed eddy current clutch. In this regard the QR 1150 followed the precedent of the IRCA road-switcher, and not that of the shovel-nose cab units, which had motor-driven fans. A departure from previous GE export locomotive practice was that the radiator panel was mounted horizontally at the top of the

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radiator compartment; in fact this presaged the arrangement that would later be used on the export Universal models. The fan was mounted just behind the radiator panel.

The braking system was schedule 14-EL. This must have been quite rare in Australia, where the local A-7-EL system was preferred by the air-braked railways, although they were both members of the No. 6 family. The bogies were each fitted with six horizontal brake cylinders. The cab had a single right-hand driving position with a control stand that, basis photographic evidence, looks more like those fitted to the 70 tonner and the smaller switchers than that fitted to the preceding mainline locomotives, which had followed domestic line service locomotive practice. This reinforces that idea that the QR 1150 was something of an “in-between” locomotive, including features from both the larger and smaller export models. The brake stand was mounted behind the control stand, to the driver’s left.

Nominally the QR 1150 was designed to meet the QR’s “90 ton” specification, and GE referred to it as weighing 100 (short) tons, which corresponds. However, they came in a little lighter, as the QR roster diagram weight number is 89 tons, and other sources quote 88.1 tons.

QR originally acquired 10 examples, built by GE at Erie. As far as I know, these were ordered shortly after the 10-strong English Electric UK-built 1200 class cab units. Given that at the time, Australia operated under a British Commonwealth preference for imports, QR must have made a persuasive case for the US dollar allocation to pay for its GE locomotives. In fact, it was the only Australian public railway system that acquired US-built units in the period. New South Wales Government Railways (NSWGR) somewhat mitigated the issue by buying 20 of the Alco RSC-3 model from MLW Canada, but in general, the choice was for locomotives that were built locally under licence, although there were some British imports. Following its initial 20 imports, 10 each from the UK and the USA, QR thereafter bought Australian-built locomotives, with a preference for those manufactured in the state of Queensland.

A second batch of 3 1150 class was placed into service in the second quarter of 1956. These were built in New South Wales by Goninan, subcontracting to Australian Electrical Industries (AEI), who built the traction motors, in NSW. AEI was the successor to Australian General Electric, the name change happening late in 1955 after GE sold its shareholding to Associated Electrical Industries, UK.

Originally the first ten locomotives were known as the 1210 class, then, at about the time that the second three were delivered, they were assigned as the 1300 class, eventually becoming the 1150 class in the mid-1960s.

Thereafter GE did not participate in the supply of mainline locomotives to QR until 1983, when it supplied some modified (longer and heavier than standard) U22C models in QR’s 96 ton class. Instead, QR acquired its mainline fleet from Clyde-GM and English Electric, with the former as evident primary supplier from the early 1960s. It appears that manufacturing location rather than technical considerations may have influenced QR’s buying decisions. After the initial imports, QR then turned to Clyde-GM, who had manufacturing capability in NSW, and who was aggressively pursuing the QR business, to the extent of developing its GR12 model largely around QR’s 90-ton requirement. GE also received the small repeat order previously mentioned, and that was also probably contingent upon Australian manufacture. EE did not receive a repeat order until it set up manufacturing capability in Queensland, after which it had a home-state advantage. That kept Clyde-GM on the outside until it entered into an arrangement with Commonwealth Engineering (Comeng) for assembly of its locomotives in Queensland. AEI had tried subcontracting locomotive manufacture to Walkers Ltd, Queensland in the case of the smaller GE units of the QR 1170 class,

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but that was not very successful so was not a model for the future. Goninan had become the Australian GE licensee by 1961, maybe earlier, but might not have been in a position to arrange for assembly in Queensland through a credible subcontractor, which would have put it at a disadvantage. Nevertheless, in the U18C and its U20C successor, GE had a standard locomotive that in dimensional and weight terms would have been a very close match to QR's 90 ton requirement, but I don't know whether it was ever considered by QR. Perhaps the power output (1800 hp for the U18C, 2000 hp for the U20C, both tractive) was higher than QR was looking for. It had found the four-motor Clyde-GM G12, with 21.8 hp/ton of adhesive weight, somewhat slippery for its typical operating conditions, so could well have been apprehensive about the fact that the GE models were in a similar range, 20.0 hp/ton for the U18C and 22.2 hp/ton for the U20C. But by all accounts, these GE models were very "sure-footed". Later EE 90 tonners went to 1800 and then to 2350 hp, but the majority of the 90-ton type bought by QR, right through to 1983, were of 1500 hp.

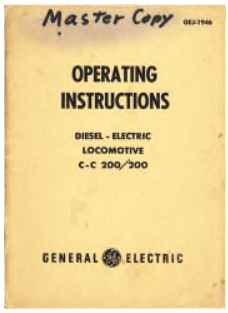
Most of the QR 1150 class fleet lasted until 1987, when the diesel fleet was largely culled of "non-standard" types as a prelude to the major electrification project. Probably their lack of MU capability restricted their utility in later years, but QR did not choose to retrofit any of its mainline locomotives that were originally delivered without MU capability.

From a QR perspective, the 1150 was significant in that it was QR's first class of mainline diesel locomotives, and so started its dieselization process. It also defined the form of QR's predominant main line locomotive species, namely a 90 ton, Co-Co road switcher, that was built over a 30 year period.

For GE, the QR 1150 embodied many of the elements and dimensions that went into the later standard U18C and U20C models, which set something of a benchmark in the CMT gauge world. Accordingly, I am inclined to see it as the primary antecedent to the C-B-engined Universals, although the Brasilian 110-ton road switcher is arguably a secondary antecedent. Whether GE chose the C-B FVL12-T engine with its future plans in mind is unknown. It already had a 90 ton Co-Co cab unit that in most respects might have fitted the QR requirements, namely the CFML Alco 12-244-engined shovel nose design. QR had already ordered a cab unit design from EE, and at one stage was prepared to accept a trial unit of the cab type from Brush, UK. Whether or not it insisted that the 1150 be a road-switcher is unknown. It is known that the 1150 was not a response to the QR tender that resulted in the order for the English Electric 1200 class. Rather it was the result of an iterative dialogue that started with a GE proposal for a twin Caterpillar D397-engined unit, perhaps similar to that which GE built for Venezuela, progressing through a C-B FV8L-T-engined proposal to the final design.

The QR 1150 was GE's second basic design to use the CB FVL12-T engine. The second batch of 3 locomotives represented GE's last use of this engine, before moving on to the FVBL12T that it co-developed with C-B. GE built a total of 87 FVL12-T-powered locomotives for three customers.

In a worldwide context, the QR 1150 must have been one of the first conventional road switchers of reasonable power output built for service on CMT gauge lines. The 15 long ton axle loading limitation did not require an unusual wheel arrangement, but its wide bogie spacing and the mounting of buffers and couplers on the bogie headstocks is, in a small way, indicative of the unusual design approached used by cautious railways during the first decade or so of the "export" dieselization era.




RT assigned the informal model number U/100T to the QR 1150. A possible decode was **U**niversal, 100 short **T**ons. Evidently GE did not see this design as justifying the Universal designation, though, even though the final three were actually built in the Universal era. Rather it described them more prosaically as "C-C 200/200", as used on the operating manual cover.

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## General Electric Pre-Universal Export Locomotives

The QR 1150 was described in an article in RT, 1953 January, p.36ff, *"Diesel-Electric Units for Qld. Rlys."*

A class history was provided in the railfan journal "ARHS Bulletin" (ARHSB) 1999 May, p.163ff, *"The 1150 Class Locomotives of the Queensland Railways"*, by Rod Milne.

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## General Electric Pre-Universal Export Locomotives

### 1953 - Argentina (LGB & LGM) Alco 244-Engined Shovel-Noses

In 1953-54, Argentine National Railways received a second group of GE shovel-nose units, this time with Alco 12-244 engines. This order, reported in DRT 1950 December, comprise five metre gauge units that went to the LGB, and 25 broad gauge units that went to the FC General Mitre (LGM), the former being built before the latter.

The LGB metre-gauge units, later classified as DE622, were similar to those previously built for CFML. They had Alco 12-244E engines, GT581 main generators rather than the GT564 units fitted to the CFML units and GE756 traction motors. They had dynamic braking, and the LGB being an air-braked road, had the 14-EL braking system. Thus they would have lacked the vacuum equipment fitted to the CFML locomotives. The GT581 main generator was the successor to the GT564, having the same frame size, although the latter was still being used in 1953. It could be that the higher capacity GT581, having been specified for the broad gauge units that were part of the same order, was a logical choice for the metre gauge units as well. And although the GE761 traction motor was just available, possibly the GE756 was chosen because it was already used on the large fleet of the earlier GE shovel-nose design, the LGB DE621 class.

These locomotives were used on the Trans-Andine route, at altitudes up to 14 700 ft. It would appear that engine output was adjusted accordingly, to 1200 hp (tractive). GE data show that the continuous tractive effort was 25 500 lbf at 14.5 mile/h, and that the starting tractive effort, at 30% adhesion, was 57 600 lbf. Weight was 96 short tons (86 long tons, 87 tonnes), so they were a little lighter than the CFML units. Maximum speed was 50 mile/h. Other sources show the gross power as 1332 hp, which is plausible.

Dimensionally these Argentinean locomotives were the same as the CFML units. They had the same 10’7” wheelbase, slab-framed rigid-bolster bogies, unlike their broad-gauge counterparts, which had lateral-motion bogies. Evidently it was not seen as necessary for the metre-gauge units, although in 1953 it was available for the 10’7” wheelbase bogies, and was used on the Brasilian 110-ton road-switchers.

The LGM broad-gauge units, later classified as DE211, could be seen as having been developed from the CFML unit with some elements from the AFE 1500 class double-ended-model of 1952. They had the Alco 12-244G engine providing a site rating of 1400 hp (tractive), with the gross power said to be 1530 hp. Why there was a difference in engine iteration is not readily apparent. But it could have been simply that by the time the DE211 units were built, later in 1953, the 12-244G was available, whereas it had not been earlier in 1953 when the DE622 group was built. This engine powered a GT581 main generator and six GE731 traction motors, the latter as had been used on the AFE 1500.

Length between coupling hook centres was 49’3”, which suggests that they had essentially the same body length as the CFML units, namely 46’0” over headstocks. The equipment layout was probably very similar, albeit the Argentinean units lacked the dynamic braking equipment. They had the same arrangement of engine-driven expressor and motor-driven supplementary exhauster. The braking system was 6-SLV-1. I don’t think that this was available when the CFML units were built.

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The running gear was somewhat different. The DE211 had 11'6" wheelbase (5'2" outer, 6'4" inner) bogies as was used for the AFE 1500. But the photographic evidence suggests that the construction was different. Whereas the 1500 bogies were of the slab side-frame type, the DE211 appeared to have had cast pedestal-type sideframes, although not fully-cast frames overall. The bogie pivots were 2¾" inside the centre axles, and spaced at 26'3½", giving a total wheelbase of 37'1". The CFML units (and the DE622) had the centres at 25'2½" and a total wheelbase of 34'11½". Wheel diameter for the DE211 was 40 inches.

A major difference was the provision for lateral motion. Absent a full description of the mechanism used by GE, I can only derive a description from the photographic evidence. At each side of the locomotive, outside of the bogie frames and coincident with their centres were downward projecting brackets or trunnions, each with two longitudinally spaced arms. Between those was a horizontal beam or it might have been a spring link (to provide some secondary suspension) on which was mounted an upward vertical link. The top end of this link appeared to be connected to – and load – a side-to-side crossbar that in turn loaded the bogie centre-pivot. This mechanism was first used on the Brasilian 110-ton road-switchers, to be described in the next chapter, which in production closely followed the LGB units mentioned above but preceded these LGM units.

*One of a batch of G.E. broad-gauge 1,600 b.h.p. locomotives, Argentine National Railways*

Starting tractive effort was 69 000 lbf at 30% adhesion, which indicates a weight of 115 short tons (103 long tons, 104 tonnes). Continuous tractive effort was 36 000 lbf, with associated minimum continuous speed not stated. Maximum speed was 75 mile/h, which suggests why lateral motion bogies were considered desirable. The AFE 1500 had a lower 60 mile/h maximum speed.

These locomotives evidently had long service lives, with some seeing service into the 21st century. The metre-gauge units at least were the subject of a re-engining programme. The Argentine GE shovel-nose fleet was the largest of its kind, totalling 95 units of three varieties.

The DE211 broad gauge units were briefly described in DRT1954 August, p.194, *"Argentine Broad-Gauge Locomotives"*.

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## General Electric Pre-Universal Export Locomotives

### 1953 - Brasil 110-Ton Road Switcher

In 1953-54 EFCB received 40 metre-gauge GE locomotives that were described as 110-ton road switchers. Another 5 were delivered to the RVPSC in 1954.

In mechanical sense, they could be viewed as the road-switcher counterpart to the Matadi-Leopoldville (CFML) shovel-nose cab unit.

Appearance-wise, they were a prelude to the Universal series of road switchers that would be announced in 1956.

Length over headstocks was 49'4". This was longer than the 46'0" of the CFML units, but shorter than the 52'0" of the future U18C, which had space for an optional train heating boiler. It also had end-platforms, which the Universals did not have. These would account for approximately 3 ft, leaving an effective body length of around 46 ft, close to that of the future U12C at 46'4½". Height and width were 13'0" by 8'11". The height was somewhat greater than the 12'0" of the Universals – at least those with Cape and metre gauge capability - but presumably within the EFCB loading gauge and not unusual in the CM gauge world. They had quite rounded cab roofs, also presumably a loading gauge requirement. Nominal weight was 110 short tons, or 100 tonnes, 98 long tons, although I have seen 97 tonnes quoted for the model. That was certainly at the upper end of the CM-gauge range in 1953, where 90 long tons was a good marker at the heavy end. It is unlikely that they were unavoidably this heavy. Rather they were probably built up to the axle loading that the EFCB allowed for maximum starting tractive effort. 100 short tons (90 long tons), as for the later U18C, should have been possible had it been necessary.

It had the same 10'7" wheelbase (4'9" outer, 5'10" inner) welded, slab-framed, outside equalized bogies as on the CFML units, but with the addition of the lateral motion mechanism as previously described for the LGM broad-gauge shovel-nose units. Total wheelbase was 37'2". Bogie centres would have been at 27'5", assuming that the pivots were 1½ inches inboard of the centre axles, as on the CFML bogies, although that might not have been the case.

The long hood looked very similar to the long hood on the IRCA Guatemala Co+Bo+Co road switchers. It is not unreasonable to suppose that the 110-ton platform design was to some extent based upon that as a prototype. Shorten the short hood by removing the fuel tank, now underslung, and the result would be a close match. As a corollary, the equipment layout in the long hood was probably quite similar, although I have not seen a layout diagram for the 110-ton model.

The engine was the Alco 12-244E, the latest version of that powerplant at the time, at its usual setting of 1750/1600 hp. The main generator was the GT564. This was what had been used in the CFML shovel-nose units, and in the IRCA road switchers, although by the time the EFCB locomotives were built, the GT581 was available. I have seen the GT584 recorded as the main generator for these locomotives, but as that model had an upper power input limit of 1200 hp, that is most unlikely on technical as well as circumstantial grounds. More likely GT564 was mis-transcribed as GT584 somewhere along the line. Which version of the GT564 was used is unknown, but I'd say that the GT564C, with gear-driven auxiliaries, and as used on the CFML units, was more likely than the GT564B units with belt-driven auxiliaries as used on the IRCA units. That latter, having self-ventilated traction motors, did not require traction motor blowers, so did not require a triple auxiliary drive in order to power either a second auxiliary generator to supply motor-driven blowers or a mechanically-driven blower. The former arrangement was used on the shovel-noses, but either could have been used on the 110-ton units. I'd pick the mechanically-driven blower as being consistent with the direction in which GE was apparently heading in respect of road-switchers. A mechanically-driven cooling fan, with the air compressor interposed between the free end of the engine and the fan-drive gearbox, was the most likely arrangement in this department. That was what had

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been used on the IRCA units, and although the shovel-noses to date had had motor-driven fans, some future versions would have mechanical drive.

The traction motors were the then-new GE761A1, which was the first version of that series. As best I can determine, the EFCB locomotives were the first application for this new model, which became GE's standard CM-gauge motor, eventually displacing the GE756. These drove 36-inch driving wheels via 94:17 gearing, which allowed a maximum speed of 60 mile/h (96 km/h).

Almost certainly the 110-ton road-switcher had the Amplidyne control system including the GE 17MG, probably 17MG6 electro-hydraulic governor. Traction motor groupings were most likely 2S3P and 6P. The continuous tractive effort number that I have is 20 140 kgf (44 400 lbf) at 12 km/h (7.5 mile/h).

It had dynamic braking. The main braking system was 6-SL, which was a departure from GE's then-standard 14-EL, I imagine at customer request. EFCB's contemporary broad-gauge Alco RS-3 fleet would have had 6-SL, so standardization would have been a likely motive. Perhaps EFCB saw the GE 110-ton model as the metre-gauge counterpart to the RS-3. RVPSC was a vacuum-braked road, so its five were most likely fitted with the 6-SLV-1 braking system, with an engine-driven expressor in place of the air compressor. These are also understood to have been fitted with the Alco 12-244G engine.

The RVPSC five did not stay very long with their original owner, being transferred to EFCB, which then had 45 of the type. I suspect that they may have had too high of an axle loading for much of the RVPSC trackage. On the EFCB the fleet had a long life, well into the Rede Ferroviária Federal S.A. (RFFSA) era with five surviving into the 21st century, two with Ferrovia Centro-Atlântica (FCA) and three with industrial operators. That GE-built locomotives and GE electrical equipment would last this well is not surprising. But it was less probable for the Alco 244 engine. One may surmise that where an operator had a large enough fleet to justify properly learning about the engine's specific needs and the development of dedicated maintenance practices, good results were possible. On the other hand, where they were a minority in a fleet, and different to whatever was the norm, where "different" meant that they were seen as "not as good", then short and troubled lives were the likely outcome.

The 110-ton road-switcher was certainly an important marker on GE's pathway to the export Universals, although in my assessment not quite the progenitor. One may make the case that the starting point was the 100-ton C-B-engined road switcher built for Queensland Railways in 1952, which foreshadowed the U18C.

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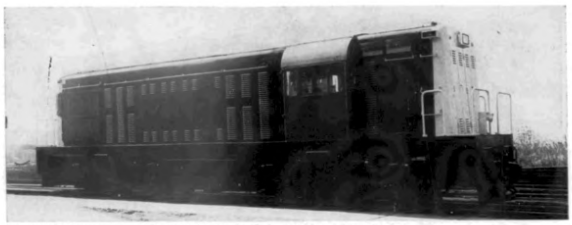
## General Electric Pre-Universal Export Locomotives

### Brasil 110-Ton Road Switcher – Supplement 2021 September

As previously observed, these Central of Brasil (EFCB) and Paraná-Santa Catarina (RVPSC) "110-Ton" Road Switchers do not appear to have been covered by a "Railway Age" article. But there was a 1954 July article in "Railway Locomotives and Cars" (RLC), pp.42,43, albeit specific to the EFCB group. Nonetheless, it is expected that most of the information and data would read-across to the PVPSC group.

The information in the RLC article adds to and in some cases modifies the previous narrative.

In respect of the bogies, it was said"



One of the Brazilian locomotives on the test track of the Erie Works of the General Electric Company.

*"Two three-axle, swing-motion swivel trucks are used. The necessary swing motion for operation on curves is provided by a mechanism located entirely outside the truck frame. This leaves space for mounting a traction motor on each axle and keeps the truck length to a minimum. It thus makes possible a lower, shorter and therefore lighter locomotive. Hardened steel inserts, shaped so as to achieve a rolling action, are used at the top and bottom of the suspension links. The swing motion is cushioned in rubber for easy riding."*

That is the first GE description of its outside swing-link assembly that I have seen. To some extent it appears to have been the product of necessity. The basic fabricated bogie was originally used in rigid bolster form, and had an unusually short wheelbase, 10'7", for a Co bogie. In fact it was first used in A1A form, under the LGB, Brasil double shovel-nose units, but the evidence is that the Co form was part of the original conception. It would appear that the rigid bolster bogie produced less than acceptable tracking and/or riding than some roads were prepared to accept, and so it was necessary to develop a lateral motion successor. There was no room within the existing bogie structure to fit a conventional double swing bolster lateral motion assembly, and a substantial increase in bogie wheelbase to allow such was undesirable. Thus a suitable alternative had to be devised, in the form of the outside swing links, which apparently had enough compliance in their rubber mountings not to interfere with bogie rotation. This mechanism appears to date from 1953. In that year it was used on the metre-gauge 110-ton road switchers, the Cape gauge Indonesian Co-2-Co shovel-nose units, and the broad gauge LGM, Argentina shovel-nose units.

Previously, I stated that the main generator was the GT564. In fact, it was the GT581. So it looks as if in some of the records, GT581, not GT564 was mistranscribed as GT584, the latter being shown on a 1977 roster diagram. In hindsight, it does seem logical that GE would have used its then-current main generator model associated with the Alco 12-244 engine. The associated auxiliaries were gear-driven. The radiator fan, the *two* traction motor blowers, and the air compressor were mechanically driven. Sufficient traction motor cooling capacity was provided such that the engine could remain at minimum speed during dynamic braking.

The six GE761 traction motors had 2S3P, 2S3P weak field, 6P and 6P weak field connections, with automatic transition. The control system was of the amplidyne type, with a GE electro-hydraulic governor (i.e. 17MG type).

Weight was given as 213 600 lb (95.4 long tons, 96.9 tonnes), so a little short of the nominal 110 short tons. Axle loading was 35 600 lb (15.9 long tons, 16.1 tonnes).

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Continuous tractive effort was given as 44 400 lbf, although no corresponding speed was quoted. GE had the habit of doing this, particularly for locomotive models that were available with a range of traction motor gear ratios. Typically it supplied a corresponding tractive effort curve graph, from which one could read off the corresponding speed. In this case though the graph was missing – perhaps an editorial rather than an author choice? Anyway, it tends to confirm the roster diagram numbers, 20 140 kgf at 12 km/h (44 400 lbf at 7.5 mile/h).

**MAJOR DIMENSIONS**

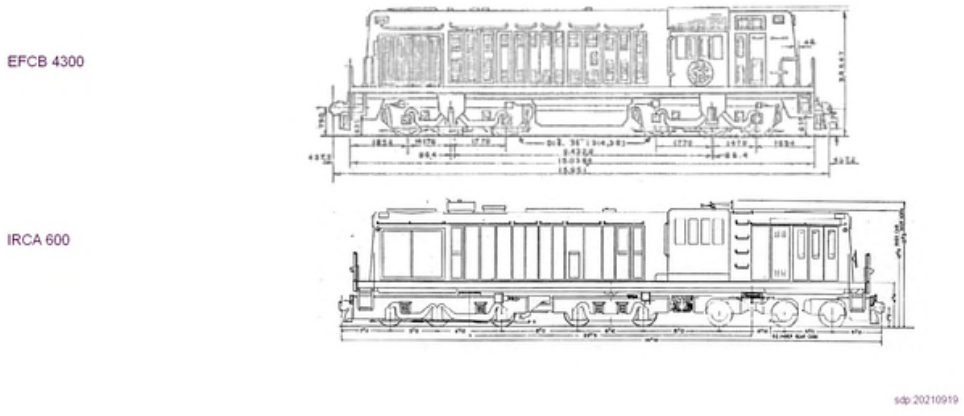
| | |
|---|---|
| Track gage | 39⅜ in. |
| Overall length inside knuckles | 51 ft 6 in. |
| Height | 13 ft |
| Width | 9 ft |
| Truck wheel base | 10 ft 7 in. |
| Overall wheel base | 35 ft 11 in. |
| Wheel diameter | 36 in. |
| Minimum radius curve | 230 ft |
| Weight (fully loaded) | |
| Locomotive | 213,600 lb |
| Per driving axle | 35,600 lb |
| Engine 1,600 hp Alco V-12 | |
| Tractive force and speed | |
| Starting tractive force (at 30 per cent adhesion) | 64,000 lb |
| Continuous tractive force | 44,400 lb |
| Maximum speed | 60 mph |
| Supplies | |
| Fuel | 1,400 gal |
| Lubricating oil | 200 gal |
| Engine cooling water | 250 gal |
| Sand | 24 cu ft |
| Air reservoir capacity | 62,000 cu in. |

Overall length was quoted as 51’6” inside coupler knuckles; the roster diagram shows 15 951 mm (52’4”). Perhaps longer coupler shanks were fitted later on? But the 35’11” quoted by GE for the total wheelbase is well away from the 11 328.4 mm (37’3”) that may be derived from the roster diagram. In this case I think that the error was in the GE data.

According to GE, EFCB group was fitted with the 14-EL braking system, which certainly would have been consistent with GE practice of the time. On the other hand, the roster diagram shows 6SL, which I had assumed was the original fitment. But apparently not so; rather there was a later change from 14-EL to 6SL. Quite probably the RVPSC group were originally fitted with 14-ELV, and then changed to 6SL when they went to the EFCB.

There are enough datapoints to show that during the pre-Universal era, the 14-EL was GE’s standard fitting for air-braked roads, with 14-ELV being used for vacuum braked roads. This regime extends from the Co+Co 70-tonner through to the Manila Railroad streamliners and modified road switchers. There were some exceptions, including the NSWGR 43 class and the QR 1170 class, both Australian built and fitted with the A7EL system, then the norm in Australia. Unknown is what was fitted to the three later Australian-built members of the QR 1150 class, although the 10 US-built originals did have 14EL.

In this diagram, the EFCB “110-Ton” road-switcher is compared with the IRCA, Guatemala Co+Bo+Co road switcher.

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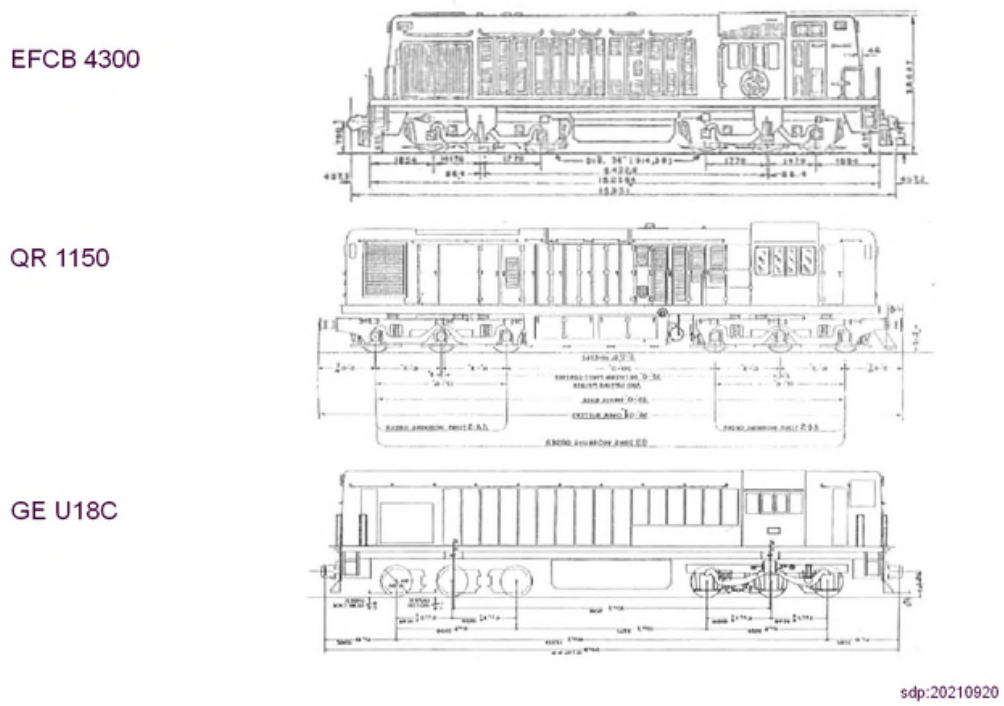
It may be seen that behind the cab, their long hoods are of essentially similar size, and quite possibly have similar equipment layouts. It certainly looks as if the EFCB unit was in part derived from the previous IRCA unit. The latter, of course, had an extended short hood in order to accommodate the in-body fuel tank.

Here, the EFCB unit is compared with both the preceding QR 1150 class and the later GE U18C standard model.




Some sources claim that the 110-ton road switcher was the basis for the later GE export Universal series. But the QR 1150 included some of the elements that were later part of the U18C, including the Cooper-Bessemer FV12 engine.

The QR 1150 was somewhat longer than the EFBB unit, and apparently longer than was strictly necessary to house the machinery. Its bogie wheelbase (12’6”) and total wheel base – the latter quite long in relation to the overall length – were, as I understand it, determined by the need to meet QR’s bridge loading requirements.

The U18C was about the same overall length as the QR 1150. In that case, the extra length, as compared with the EFCB unit, was required to allow space for a passenger car steam heating generator, which was an optional item. (The same space was used for the inertial filtration equipment of the South African Railways U18C1, U20C and U20C1 fleets.) The bogie wheelbase, at 11’6”, was somewhat longer than the 10’7” of the EFCB unit, but still quite short for a relatively high-powered Co design. It might have been about the shortest reasonably possible with the floating bolster bogie design.

In the QR case, history repeated itself with its 2600 class, a somewhat bespoke GE U22C with 12’6” wheelbase bogies and extended overall length.

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## General Electric Pre-Universal Export Locomotives

### Brasil 110-Ton Road Switcher – Supplement 2021 October

These locomotives were mentioned in the GE house journal, “General Electric Review”, 1954 January, as follows:

> *“During the past few years the tempo of foreign railroad dieselization has increased rapidly. As a corollary, the number and diversity of diesel-electric export locomotives has shown a steady increase and in 1953 several significant developments were applied to foreign service locomotives.*
>
> *“Forty of the most powerful diesel-electrics yet built for export by General Electric are now operating on the meter-gage lines of the Central Railway of Brasil. These 1600-hp locomotives use trucks with outside spring hangars [sic] - an unusual design feature.”*

That they were the most powerful export locomotives yet built by GE was an interesting comment. The Alco 12-244 engine was used at its full rating of the time, namely 1750/1600 hp, this having been available since 1950. In previous export applications, it had been derated somewhat, for various reasons, including to suit site conditions or because of traction motor input power limitations.

The outside swing hanger equipment on these locomotives was definitely unusual. Whether the “spring hanger” description was really appropriate is hard to say. Possibly the fact that the rubber mountings provided some compliance was thought to justify the description.

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## General Electric Pre-Universal Export Locomotives

### EFCB “110-Ton” Road Switcher and the GE761 Traction Motor – 2021 October

As best I can determine, the EFCB road-switchers were the first to use the then-new GE761 traction motor.

A brief reference to this motor was provided in “General Electric Review” 1954 January:

“Another forward step in the design of traction motors for diesel-electric locomotives is represented by a new motor that went into production during 1953. It is the counterpart for foreign service of the motor that has become a standard on domestic railroads. The new motor can be used on locomotives for gages as narrow as one meter, and on axle loadings up to 44,000 pounds.”

Although not mentioned by name, it was a clear reference to the GE761, the standard domestic traction motor also mentioned being the GE752. A much more detailed description of the GE761, including its development objectives, was provided in an AIEE paper of 1984 July, #54-189, “A World-Wide Standard Traction Motor for Diesel-Electric Locomotives”.

The GE761 became the primary traction motor used in the Export Universal range announced in 1956. Before then, and following its use in the EFCB road-switchers, it was also used in several other pre-Universal models, including the RVPSC road-switchers, the PJKA, Indonesia CC200 class, the MRR, Philippines streamliners and modified road-switchers, and the NSWGR 43 class.

Before the GE761 arrived, GE had used the GE756 motor in its Cape and metre gauge export road locomotives. In what might be called the GE761 era, there was some further use of the GE756 in the repeat orders for the CFML, Congo 100 class and QR 1150 class., one imagines for fleet commonality It was also chosen for the QR 1170 class, presumably for standardization with the 1150.

The following charts taken from the above-mentioned AIEE paper show where the GE761 traction motor fitted in the GE range.

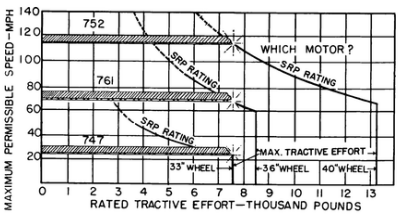


Fig. 1. Comparison of application capacities of standard design traction motors

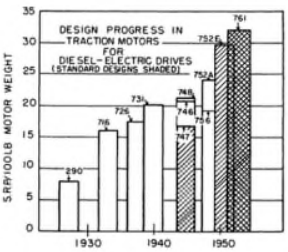


Fig. 4. Graphic representation of progress in design of traction motors for Diesel-electric locomotives

In respect of some of the other motors mentioned in those charts, the GE731 was a domestic standard gauge unit that was also used on the standard and broad gauge shovel-nose units that went to Uruguay (AFE 1500 class), Argentina (LGM) and Chile (FFCCdE D16000 class). The GE747 was the longitudinally mounted, double-reduction model used on the three-foot gauge Guatemala (IRCA 600 class) and Colombia Co+Bo+Co road switchers. At the time, it was GE’s only option for the 3-foot gauge. Later, GE developed the GE764 for that gauge. That was a truncated version of the GE761, and was an option on most of the export Universal line models from the start, but it did have prior use on the US Gypsum 54-tonners, which were related to the earlier 50- and 52-ton export models. It was also used on the US Army lightweight Co-Co prototype, which although was built after the USG 54-ton model, may well have been ordered before them, in which case it might have provided the initial reason for the development of the GE764.

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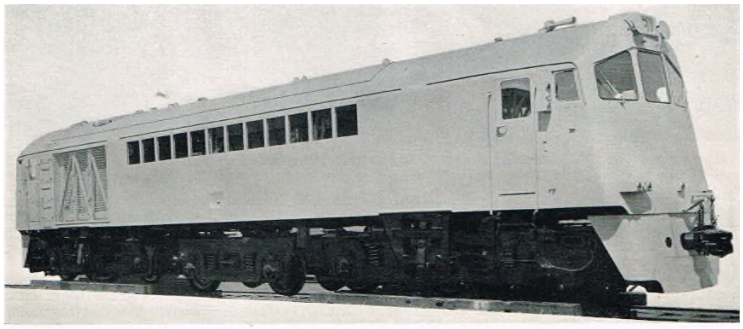
## General Electric Pre-Universal Export Locomotives

### 1953 - PJKA Indonesia CC200 Class Co-2-Co Double-Ended "Shovel-Nose"

The most unusual model in the GE shovel-nose series was the Cape-gauge, tribo, Co-2-Co double-ended variant built for Indonesian Railways (PJKA) in 1953, to a total of 27, as its CC200 class.

The double-ended version of the shovel-nose design had previously appeared in the form of the standard-gauge AFE 1500 class in 1952. The tribo form was new to this series, but GE itself was no stranger to it. The IRCA 600 class road switcher of 1950 had used the articulated Co+Bo+Co wheel arrangement.



1,600 *b.h.p. G.E. 3 ft. 6 in. gauge Co-2-Co locomotive, Indonesian State Railways*

In this case the primary reason for using the tribo arrangement was to keep the axle loading down to 12 tonnes (11.8 long tons), which was the maximum that the PJKA tracks could handle at the time. Given that the basic Co-Co shovel-nose model, as built for CFML, weighed 91 tonnes, that indicated that two extra axles were required. Whilst that might have been done with say the 1-Co-Co-1 wheel arrangement, there was a further item, namely that in the future, following track upgrading that would allow an axle loading of 15 tonnes or so, it would be desirable to be able to convert these locomotives to the conventional Co-Co form. Thus Co-2-Co recommended itself, with the idea that the unpowered centre bogie could simply be removed at some future date, the frame having been designed to run on the two outer bogies alone.

Using the GE numbers, adhesive weight was 158 000 lb (72 tonnes, 70.5 long tons) and total weight was 211 000 lb (96 tonnes, 94 long tons). Some references include the model designation UM/106T, where 106 would correspond to the total weight in short tons, rounded up. As best I can determine, this was not an official GE model number. It rather looks like an RT informal model number. The estimated weight if converted to Co-Co form was 92 tonnes (90.5 long tons).

To accommodate the tribo running gear, the CC200 was longer than all other shovel-nose variants. That opens the question – was it double-ended because that was what PJKA wanted, or was it double-ended because the extra platform space allowed that configuration without further lengthening. That said, the photographic evidence suggests that it might have had shorter cabs than the others in the series, and also that the shovel-noses were of somewhat different profile, apparently being more steeply sloped and having less curvature in plan-view. So perhaps some juggling was needed to accommodate two cabs within the length indicated by the running gear and/or any overall length restriction that its operating situation required. Some body space could well have been taken up by fuel tank(s), given that the centre bogie precluded the use of an underslung tank.

The total wheelbase of the CC200 was 43'2", so nearly three feet longer than that of the AFE 1500, which was 40'4". The number I have for overall length is 17.07 metres, which is 56'0". Whether this was the length over couplers or length over headstocks is unknown. Usually length over couplers/buffers was quoted for the shovel-nose units, perhaps because an exact position for the cab-end headstocks was not obvious. The only shovel-nose for which I have seen a definite length-over-headstocks number is the CFML model, at 46'0". At 56 ft over couplers, the CC200 would have been only marginally longer than the AFE 1500, which was 55'8¾" over buffers, whereas the available photographic evidence suggest that it was noticeably longer. So tentatively at least, I am taking it to be a length over headstocks number. From that, it had a platform length that was around

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3½ ft longer than that of the 1500. Overall height was 12 ft, and overall width was 8'8½", so it had a quite compact profile.

The outer bogie pivot centres were at 31'4". The outer bogies had an 11'10" wheelbase, which number had been seen previously on the Co bogies of the IRCA Co+Bo+Co road-switcher. I doubt though that the intra-bogie spacing was as asymmetrical as on that model. This was a longer wheelbase than had hitherto had been used on Cape-gauge shovel-nose units. Possibly it was required to spread the load on light trackage. The centre carrying bogie had a 7'6" wheelbase. All bogies were of the GE welded, slab-framed outside-equalized type. The Co bogies had the same lateral motion devices as were described for the LGM DE211 broad-gauge shovel-nose model. The centre bogie evidently had a conventional swing bolster with elliptical bolster springs that protruded through cutouts in the sideframe slabs. Presumably the swing bolster mechanism had special arrangements to allow a large degree of only lightly restrained lateral motion. Normally with single-frame tribo locomotives, guidance through curves was provided by the outer bogies only, with the centre bogie moving more-or-less freely in a lateral sense to accommodate the body offset during curving.

The engine was the Alco 12-244E at its usual 1750/1600 hp at 1000 rev/min setting. The main generator was the GT581 with triplex auxiliary drive to an exciter and a pair of auxiliary generators, the second of which supplied the traction motor blowers and the cooling fan motor. Thus it followed the original shovel-nose layout in having electric drive for these items. The six traction motors were of the GE761 type, connected 2S3P and 6P. Field-weakening provision is unknown, but likely was one stage in each grouping. The motors drove 908 mm (35¾ inch) diameter wheels via 92:19 gearing for a maximum speed of 100 km/h (62 mile/h). The wheels were slightly undersized against an expected minimum of 36 inches. Possibly the restricted overall height was a limiting factor. One could say that with the GT581 generator and GE761 motors, the CC200 had an up-to-date electrical system. Continuous tractive effort was 29 600 lbf at 17 mile/h. Starting tractive effort at 30% adhesion was 47 500 lbf.

The cooling system radiators looked to have been generously sized, and were designed to function in ambient temperatures up to 90°F (32°C) and altitudes up to 1500 ft (450 metres). Unlike the 1500, the radiator compartment was not hard up against one of the cabs. There was another short compartment in between that might have housed some auxiliary equipment or perhaps the fuel tanks.

Original equipment was a 3-cylinder expressor, presumably engine-driven, as on the CFML model, as the CC200 was intended to haul vacuum-braked stock. Whether it had a motor-driven auxiliary exhauster is unknown, but that was certainly a possibility. At some stage PJKA converted to air braking, so presumably the expressor was converted into (or replaced by) a compressor. The original braking schedule is unknown, but 6-SLV-1 at least seems possible. There was no dynamic brake, and there is no evidence that these locomotives were equipped for MU operation.

As best I can determine, the 27-strong CC200 fleet, PJKA's first assay into line-service diesel locomotives, operated intact into the 1980s, with progressive diminution thereafter as newer locomotives were taken into stock. One or two may have operated into the 21st century, with CC200 15 preserved in operation condition.

Despite the original intention, they were never converted to the Co-Co wheel arrangement by removal of the centre carrying bogies. Evidently this was because the PJKA trackage generally was not upgraded sufficiently to take a 15.5 tonne axle loading during their primary lifetime. At the beginning of the 1980s, the mainline axle loading limit was still 13.5 tonnes, moving up to 14 tonnes by 1986.

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## General Electric Pre-Universal Export Locomotives

The CC200 was indicative of the difficulties faced by the locomotive builders in the early days of dieselization when it came to adapting their technologies to the needs and constraints of CMT-gauge roads. Most of the major medium-speed engine types had been developed with standard gauge railways in mind. For CMT gauge applications, they had to be fitted into “boxes” that were usually of much smaller cross-sectional dimensions, and these were often accompanied by severe axle loading restrictions. In the 1950s, once one got to the 1200 to 1500 hp and above range, more than six axles were often necessary to spread the weight. This resulted in some “interesting” wheel arrangements with eight or more axles. 1-Co-Co-1 was the most common of these. As far as I know, the CC200 was the only example to use the Co-2-Co wheel arrangement, just as was GE’s Co+Bo+Co model the only one of its type. One may imagine that many railway administrations, whilst foreseeing the diesel future, were reluctant to rebuild their railways to suit the new locomotives until they had tried them, and probably did not have the funds to both buy new locomotives and rebuild. Hence they wanted or preferred that the new diesel locomotives be fitted to their railway systems.

GE was clearly attuned to that situation in its pre-Universal era. And given that its Erie plant was not then involved in the mass production of a few standard models, it was feasible for it to undertake “mixing and matching” to meet specific requirements based upon a standard range of component parts. Once its market was big enough to support a standard range, then economics and price-competitiveness would have dictated that that was the best way to go. Its pre-Universal experience resulted in a well-thought out and comprehensive initial range of Universals that were particularly well-matched to CMT-gauge requirements, and from which “specials”, such as the South African U18C1, were readily derived as required. The combination of progressively decreasing specific weights of diesel engines and rebuilding of the railways to take higher axle loadings largely eliminated the need for more than six axles on mainline power by the early 1970s. And where more than six axles were used thereafter, it was usually to accommodate a much higher power output than was customary.

The PJKA CC200 was described in DRT 1954 April, p.96, “Locomotives for Indonesia”.

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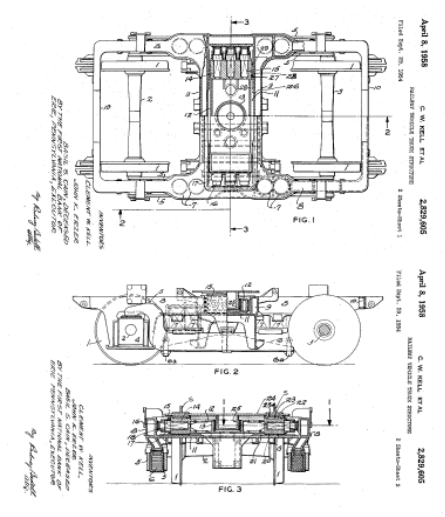
## General Electric Pre-Universal Export Locomotives

### PJKA Indonesia CC200 Class Co-2-Co Double-Ended “Shovel-Nose” - Supplement

Previously I had assumed that the centre bogie had a conventional swing bolster, basis the visibility of the transverse elliptical springs, these typically being associated with swing bolsters and spring planks. On the other hand, GE patent US2829605 of 1958 April 08 (filed 1954 September 29) might well have been applicable. This described a lateral motion bogie for three- and four-bogie locomotives. To quote therefrom:

> *“The invention relates to railway rolling stock, and more particularly to railway trucks adapted for use in locomotives where it is desirable to provide three or more trucks under a rigid body structure. When such locomotives are on curved track, provision must be made to allow for a difference in relative lateral movements of the in dividual trucks in relation to the locomotive body without increasing or decreasing the load on one truck as compared to the load on another truck.*




> *“A principal object of the invention is to provide a truck for locomotives having three or more trucks under a single rigid superstructure body whereby the truck bolster is movable laterally of the truck without changing the vertical relationship of the truck frame relative to the locomotive body. This object is attained without complicating the under-structure of the locomotive body by having the bolster held against longitudinal movement relative to the truck frame but providing coil springs between the frame and bolster for resisting lateral movements of the bolster, and by providing laterally spaced load bearings and a simple non-load bearing swiveling connection between the bolster and the body. If desired, however, the coil springs between the frame and bolster for resisting lateral movements of the bolster can be omitted for the intermediate trucks of a locomotive of this type.*

> *“A specific object is to restrain the truck bolster against movement longitudinally of the truck near the points of its support and of the application of the load thereto. Another object of this invention is to provide a railway truck which shall be simple and effective in operation and which may be economically manufactured and installed.”*

A key point was enabling lateral motion without changing the vertical relationship between the bogie frame and the locomotive underframe. This would not be achieved with swing links. The latter were normally to provide some relative tilt as they moved off-centre, but even if tilting were avoided, there would still be some height change with off-centre movement.

Although the GE patent applied to all bogies of three- and four-bogie locomotives, it may be more than coincidence that the bogie used for illustration was of the two-axle, unpowered type as used under the PJKA CC200. The details of that locomotive’s centre bogie do not fully align with that shown in the patent. Even so, it is not unreasonable to assume that the CC200 bogie had the same type of laterally sliding bolster, probably without the lateral resistance springs given its centre position. The patent bogie had longitudinal leaf springs which transferred some of the load from the bogie frame to the

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equalizing bars, in parallel with the coil springs. Using leaf and coil springs in parallel was not uncommon; it helped to obtain the desired spring rates over the range of oscillation frequencies. Conceivably the CC200 bogie replaced these with transverse leaf springs as typically used for swing bolster bogies, but in this case acting as primary springs.

Also, what might have happened here is that GE needed to develop a sliding bolster for the centre bogie of the CC200, and elected to expand the project to include multi-bogie locomotives generally. Westinghouse had already done that, in its patent US2610285 of 1952 September 16, in which it used a roller platform to provide the lateral motion. This was used in its four-bogie GTEL prototype of 1950, and its three-bogie Ignitron rectifier AC locomotive prototypes of 1951. GE was apparently looking for a simpler (and probably lower cost) approach with sliding surfaces rather than roller platforms. Its inclusion of the four-bogie as well as the three-bogie type may have been to match Westinghouse, although the empirical evidence is that GE preferred the span bolster approach where four bogies were required.

The CC200 was the first tribo locomotive to have an unpowered centre bogie. This form was later adopted by JNR, Japan circa 1962, who deployed Bo-2-Bo AC electric locomotives, and B-2-B and B-1-B diesel-hydraulic locomotives in relatively large numbers.

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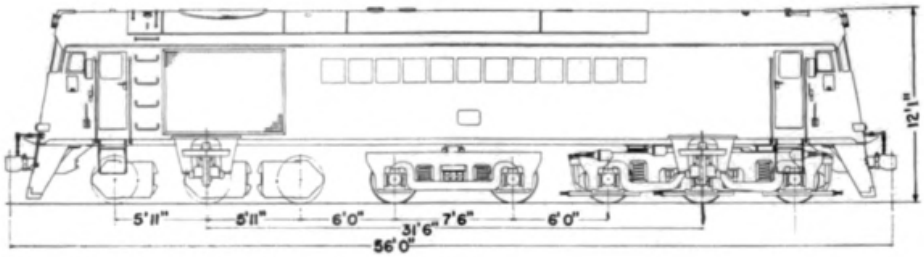
## General Electric Pre-Universal Export Locomotives

### PJKA Indonesia CC200 Class Co-2-Co – Supplement 2021 September

Additional information is available from an article in “Railway Locomotives and Cars” (RLC) for 1954 May, p.55ff.

Firstly is a side elevation drawing, the first I have seen for this locomotive:




Side elevation of the locomotive showing the unusual truck arrangement.

Secondly, some dimensional data:

**LOCOMOTIVE DATA-Major Dimensions**

| | |
|---|---|
| Track gage, in. | 42 |
| Overall length inside knuckles, ft.-in. | 56–0 |
| Height over roof, ft.-in. | 11–11 1/8 |
| Overall height, ft.-in. | 12–1 1/8 |
| Width over cab sheets, ft.-in. | 8–8 |
| Overall width, ft.-in. | 9–3 |
| Truck wheel base, ft.-in. | 11–10 |
| Overall wheel base, ft.-in. | 43–2 |
| Minimum radius of curvature, ft. | 460 |
| Weight (fully loaded): | |
| Total locomotive, lb. | 207,400 |
| Per driving axle, lb. | 25,900 |
| Engine, Alco V-12, hp. | 1600 |
| Transmission: | |
| Driving motors and axles | 6 |
| Diameter of wheels, in. | 35 5/8 |
| Tractive force and speed: | |
| Starting tractive effort force (at 30 per cent adhesion), lb. | 46,600 |
| Continuous tractive force, lb. | 29,600 |
| Maximum speed, mph. | 62 |
| Supplies: | |
| Fuel, gal. | 500 |
| Lubricating oil, gal. | 200 |
| Engine cooling water, gal. | 250 |
| Sand, cu. ft. | 12 |
| Reservoir capacity: Air, cu. in. | 19,600 |
| Vacuum, cu. in. | 9,800 |

The length is given as 56’0” inside the coupler knuckles. With this kind of locomotive, with vertically sloping and horizontally curved ends, it is difficult to know exactly where the headstocks would be. By way of comparison, the B&M-built (Congo) Matadi-Leopoldville (CFML) 100-ton single-ended units, with a similar powertrain, were 46’0” over headstocks and 49’6¾” over coupler knuckles. So we may estimate that the CC200 was around 52’6” over headstocks. That made it 6’6” longer than the CFML locomotive, that extra length accommodating both a second cab and in in-body fuel tank. The CC200 cabs do appear to be a little shorter than those on the other GE shovel-nosed units, and perhaps the shovel noses were more steeply sloped to gain incremental functional cab length. The Uruguay standard gauge double-ended shovel-nose units were 55’8¾” over buffers, so essentially the same length as the CC200. Possibly GE arrived at the CC200 body by starting with the Uruguay model, then shortening the cabs in order to accommodate the fuel tank, which from the drawing looks as if it might be adjacent to the left-hand (#2) cab, although that is unconfirmed.

The main bogie wheelbase, at 11’10”, is somewhat longer than the 10’7” that was the original number for the GE pre-Universal metre/Cape gauge Co bogie. Possibly this lengthening was done to spread the weight, perhaps for bridge loading reasons.

Total weight was 207 400 lb, 92.6 long tons, 94.1 tonnes, with a driving axle load of 25 900 lb, 11.6 long tons, 11.75 tonnes. That implies that the centre, unpowered bogie carried 52 000 lb, so it had more-or-less the same axle loading as the driving axles.

The Alco 12-244 engine drove a GT581 main generator and in turn 6 GE761 traction motors, with connections 2S3P, 2S3P weak field, 6P and 6P weak field, with manual transition. The control

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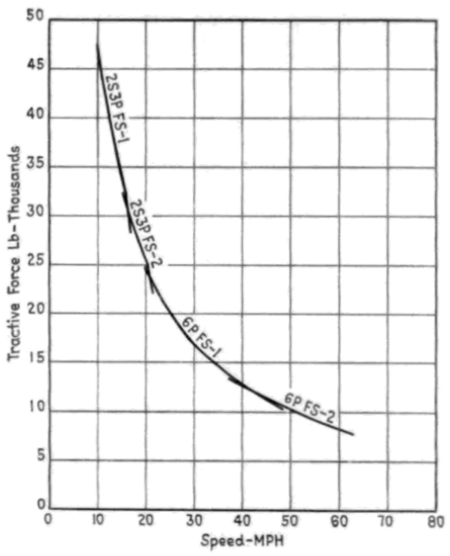
system was of the amplidyne type, with a GE electro-hydraulic governor (i.e. 17MG type). There were three gear-driven auxiliaries, namely an amplidyne exciter, and two auxiliary generators, one supplying the motor-driven traction motor blowers. The radiator fan was mechanically driven. GE was still varying the auxiliary equipment by individual build, although by then it might have settled on mechanical fan drives as the norm.

The continuous tractive effort (CTE) of 29 600 lbf was quoted without a corresponding speed, but that can be read off from the graph provided as being about 17 mile/h.

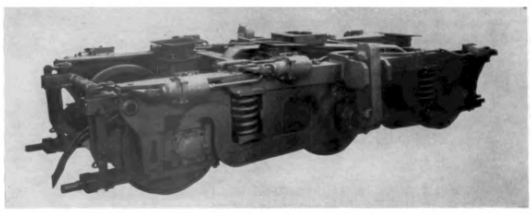



Speed-tractive force curve based on 1,600 hp. input to the generator at 1,000 r.p.m., geared 92/19, wheel diameter 35⅝ in.

This number was a lot different to the ECFB (Brasil) 110-ton road switcher case, which with the same engine and electrical equipment, produced 44 400 lbf at 7.5 mile/h. Gear ratio for the EFCB locomotive, which had 36-inch wheels and a 60 mile/h top speed, is unknown, but was unlikely to have been significantly different to that of the CC200, which had 35$^{5}/_{8}$-inch driving wheels, 92:19 gearing and a 62 mile/h top speed. Thus the difference in CTE could well have been reflective of the amount of traction motor cooling provided, which was adjusted to suit the individual requirements. In that regard, the EFCB locomotive had an abundance of traction motor cooling, as the engine-driven blowers were sized to provide a high capacity at minimum engine speed, as required during dynamic braking. As the CC200 had a much lower adhesive weight, 155 400 lb as compared with 213 600 lb, then an appropriately lower CTE was in order to avoid having an unduly slippery locomotive.

The running gear was described thus:

“All three trucks are of the swing-motion swivel type. The two 3-axle driving trucks have the mechanism for achieving swing motion outside the truck frame. This gives adequate space inside for three traction motors. and yet results in a short and compact truck. The truck frames are fabricated by electric arc welding from rolled carbon steel plates and shapes. The center-plates are built integral with the truck frames. Rolled steel wheels. 35$^{5}/_{8}$ in. in diameter, are used. The end trucks have four sets of carbon steel coil springs. all of which have snubbers. The middle truck uses a conventional swing bolster instead of the outside swing link. It has two sets of three full elliptic springs in addition to four sets of coil springs. The springs on all trucks rest on drop type equalizers. All axles are fitted with grease-lubricated roller bearing journals.”



Three-axle motor truck with swing motion mechanism located outside the truck frame.

Nothing was said about extended lateral motion provision for the centre bogie, something previously thought to have been likely. One is left to suppose that all bogies had a sufficient range of lateral motion, by conventional standards, such that in combination they allowed easy enough curving. Part of the main bogie lateral motion assembly may be seen in this picture.

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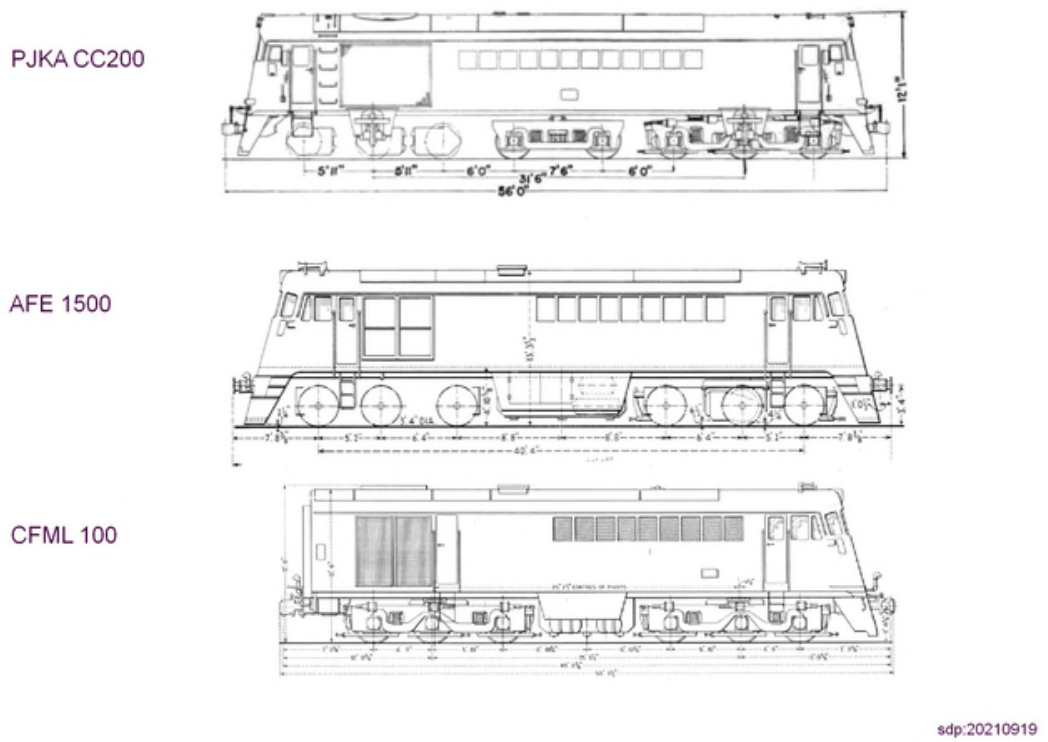
The bottom ends of the swing links engage with the lower end of the trunnion brackets that reach down from the body/frame sides.

The braking system was 14EL-V, the norm for GE pre-Universal models that went to vacuum-braked roads. It was not 6SLV-1 as previously speculated.

This diagram gives an outline of the relativity of the PJKA, Indonesia CC200, AFE, Uruguay 1500, and CFML, Congo 100 class variants of the GE shovel-nose type.




Comparing the CC200 with the 1500, it does appear as if more usable platform space was obtained within about the same overall platform length by shortening the cabs, with some compensation for the so-reduced cab space being obtained by having more steeply-sloped shovel-noses. This gained enough extra length between the cabs for the in-body fuel tank and a longer radiator compartment, and then some.

The AFE 1500 seems to have followed the CFML 100 dimensionally from the #1 cab back to the end of the radiator compartment, thereafter with the 2nd cab displacing the rear compartment and requiring extra platform length. The rear compartment of the 100 contained the dynamic brake equipment, not used on the 100, and the auxiliary brake exhauster. The auxiliary exhauster, motor-driven, appears not to have been fitted to either the AFE 1500 or the PJKA CC200, both relying on the engine-driven expressor alone to create and maintain brake vacuum.

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## General Electric Pre-Universal Export Locomotives

### PJKA Indonesia CC200 Class Co-2-Co – Supplement 2021 October

This locomotive had a couple of mentions in the “General Electric Review”.

From the 1953 January issue:

> *“A great variety of diesel-electric locomotives under construction for export includes an unusual design to meet conditions in Indonesia. The axle load is limited to 12 metric tons, but provision was made for future load increase, following roadbed improvement. To meet this requirement the locomotives were designed with two regular three-axle motor trucks and a two-axle non-motored truck between them. The middle truck can be removed when increased loads go into effect. Then the entire weight of the locomotive will be utilized for traction.”*

From the 1954 January issue:

> *“The 27 locomotives now under construction for Indonesia will operate on 42-in gage track. They also are rated 1600 hp and make use of outside spring hangar trucks. The running gear arrangement is unique in that a 2-axle idle truck is placed between the two 3-axle motor trucks. Its sole purpose is to carry part of the locomotive weight, thus giving a lower weight per axle. When the present modernization program of the railroad is completed, the idle truck can be removed; this will place all weight on the motor trucks and permit the hauling of heavier trains.”*

These confirm the information from other sources. The 1954 comments followed those about the Brasil road switchers. It looks as if construction had started in 1952, probably later in that year.

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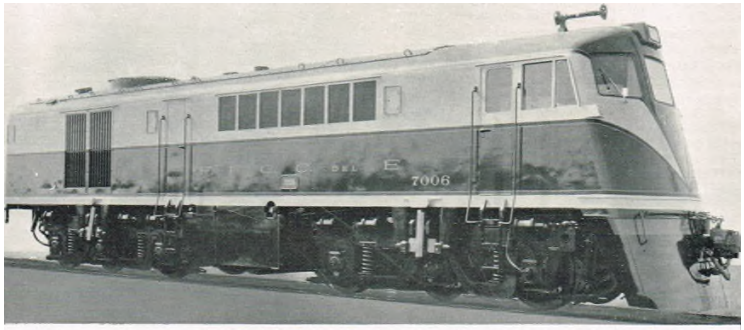
## General Electric Pre-Universal Export Locomotives

### 1954 - Chile "Shovel-Nose"

In 1954, Chilean State Railways received 12 broad-gauge GE shovel-nose units, originally the D7000 class but later the D16000 class. These were essentially derivatives of the Argentinean DE211 class broad gauge model previously described.

They were longer than the DE211, with an extended rear compartment that accommodated a train heating boiler. Length between coupler pulling faces was 54½ ft, so length over headstocks would have been in the vicinity of 51 ft, making it 5 ft longer. This difference comprised a total wheelbase increase of 2 ft, and front and rear overhang increases of 1½ ft. It came out about a foot shorter than the double-cab AFE 1500 class.

Whilst the bogies were similar to those on the DE211, they had a slightly longer wheelbase at 11'10", distributed 5'5" outer and 6'5" inner. The 11'10" number was previously seen on the Co bogie for the IRCA Co+Bo+Co road switchers, although in that case the distribution was 5'0" outer and 6'10" inner. And it was used again for the Co bogie for the Indonesian CC200 class.



*A Co-Co G.E. locomotive with 1,750 b.h.p. Alco engine, 5-ft. 6-in. gauge, Chilean State Railways*

The D16000 was equipped with the Alco 244E engine at its normal setting of 1750/1600 hp. The main generator was the GT581, and it had six GE731 traction motors driving 40-inch wheels through 70:21 gearing for a 75 mile/h (120 km/h) top speed. The control system was of the Amplidyne type with the GE 17MG6 electro-hydraulic governor. Traction motor groupings under manual transition control were 3S2P and 2S3P with field-weakening available for the latter. Continuous tractive effort was 36 100 lbf at 13½ mile/h. Starting tractive effort was 76 500 lbf at 30% adhesion, implying a total weight of 255 000 lb, or 114 long tons (116 tonnes). But different total weight numbers have been quoted for these locomotives, including 112½ long tons and 114.5 tonnes, which numbers could be considered to coincide within the precision associated with locomotive weights. To add to the confusion, GE referred to them as being a "105 Ton" model. Maximum axle loading was 19½ long tons.

An apparent change from earlier shovel-nose models was the use of a mechanically-driven rather than a motor-driven cooling fan. The traction motor blowers though remained motor-driven, from a second auxiliary generator. They hauled air-braked trains, and had the 14EL braking system. The driving position was on the right-hand side.

Chilean State Railways placed a repeat order for another five of this model, which were delivered in 1956 December and 1957 January. That would have made them the final build by GE itself using the Alco 12-244 engine, just following a batch of road-switchers for IRCA Guatemala. However, deliveries of the licence-built NSWGR 43 class, although started in 1956 August, extended until 1957 June. This second batch had the Alco 12-244H engine, but otherwise appear to have been very similar to the first batch. GE described them as "110 Ton" models, although there is no evidence that their weight was any different to that of the first batch. The 244H was the final iteration of the Alco 244 engine, and became available just in time for the final productions that used this engine.

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## General Electric Pre-Universal Export Locomotives

The order for the second batch, recorded in Diesel Railway Traction (DRT) 1956 March, and elaborated upon in DRT 1956 November, was part of a composite order that included 15 70-ton models and 11 of the then-new U9C Universal model, for a total of 31 locomotives. One may suppose that a repeat of the shovel-nose was chosen over the new U18C model, of similar capacity, because it was a type that was already in the fleet, and probably GE could build and deliver it more quickly. That said, Chilean State was already familiar with the Cooper-Bessemer engine in both its 6- and 12-cylinder forms, and that 31-loocmotive order included models with both the older (FWL-6T) and newer (FWBL-6T) 6-cylinder versions. This Chilean order was featured in GE advertising during 1956.

Chilean State Railways had a total of 21 GE shovel-nose units, 4 metre-gauge with the Cooper-Bessemer FVL-12T engine, and 17 broad-gauge with the Alco 12-244 engine. The latter had long service lives, with some members seeing service in the 21st century.

A brief description of these locomotives was included in DRT 1954 October, p.231ff, “Diesel Traction in Chile”.

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## General Electric Pre-Universal Export Locomotives

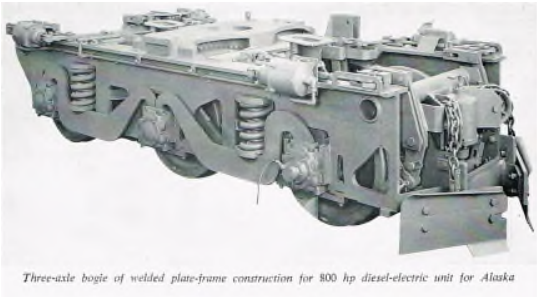
### 1954 - White Pass & Yukon "Shovel Nose"

As previously stated, although in fact a US domestic locomotive, this model was closely related to the export shovel-nose group. Also, the fleet operated/operate across the border into Yukon Territory, Canada, so there is an international aspect.

The White Pass & Yukon (WP&Y) 90 class, with the Co-Co wheel arrangement, first built in 1954, was essentially smaller and lighter version of the established GE single-ended six-axle shovel-nose designs. It had special provisions for operating in a harsh winter climate, and for operating on three foot-gauge track. The existing shovel-nose designs were for metre-gauge and upwards.

Despite the three-foot gauge, these locomotives were not unduly restricted in cross-section, having a width over body of 9'6" and a height over the roof of 12'4½", and 14'1½" over the special ventilation equipment. By way of comparison, the LGB metre-gauge DE621 class was 9'6" x 12'3", and the.CFML Cape-gauge 101 class was 9'8" x 12'11½".

Length over couplers was 45'7¾" as compared with 47'8" for the DE621 and 49'11½: for the CFML 101. Total wheelbase was 30'9" as compared with 34'5" and 34'11½".


Three-axle bogie of welded plate-frame construction for 800 hp diesel-electric unit for Alaska

Bogie wheelbase was 9'9$^{3}/_{8}$" (4'9" outer, 5'0$^{3}/_{8}$" inner) as compared with 10'7" (4'9" outer, 5'10" inner)for both the DE621 and 101. This may have been in deference to the sharp curves (up to 24 degrees, 240 ft (73 metres) radius) on the WP&Y, but it was also connected with the traction motor choice, either as a consequence or cause . It must have been one of the shortest Co bogies ever used. Construction was the same as on the earlier shovel-noses, that is welded slab-framed, rigid bolster and outside equalized. Bogie centres were at 21'2½", and corresponded with the centre axles, there being no offset.

The 90-class equipment layout was normal for a GE shovel-nose unit. The control cabinet was behind the cab, followed the engine-generator set, with generator forward and shaft-driven compressor rearward, then the radiator compartment followed by the rear compartment which I imagine housed the dynamic braking unit. The single traction motor blower and the radiator fan were both motor-driven, supplied by a second auxiliary generator.

The first two 90 class, built in 1954, had the Alco 6-251A engine. This was the first production variant of the 6-251, and only its second application. The first had been in some GE locomotives built in 1953 for Cuba, these being essentially a 70-ton derivative, although they weighed 78 tons. The following nine of the 90 class, built in three batches of three each in 1956, 1963 and 1966, had the Alco 6-251B engine.

GE's choice of the Alco 6-251 engine for these units was an interesting one. That GE should use an Alco engine is hardly surprising, as the 12-244 was its choice for the majority of its pre-Universal

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road locomotives, including those built (and in some cases ordered) after the dissolution of the Alco-GE partnership in 1953. But it had made extensive used of the C-B FW6L-T engine in its 70-ton range since the late 1940s. And at the time that the WP&Y units were designed, it was working with C-B on a major upgrade of its “F” engine, which would result in the FB-series, and which work included the 6-cylinder version. There seemed to have been several factors which pointed to the Alco 6-251 engine in this case. WP&Y probably wanted a bit more power than the FW6L-T could provide. The C-B FB-series engine was ready for road testing in 1954, but not yet ready for production. Alco would have wanted to get its 6-251 engine into service, and may have prevailed upon GE and/or WP&Y to use it in this case. It was probably a fortuitous choice in that it enabled the same engine to be used in the 1963 and 1966 batches, which probably would not have been possible had the C-B engine been chosen.

A power setting of 800 hp (tractive) at 1000 rev/min was the as-built number for the 1963 batch, and as best I can determine, was also applicable to the 1954 and 1956 batches. For example, in DRT 1954 November it was recorded that WP&Y had taken delivery of two GE 800 hp three foot-gauge locomotives. Current WP&Y data gives 930 hp for the first nine and 990 hp for the final three. So at least for the first nine, there was evidently some in-service uprating.

The main generator was the GT584. GE data show that the GT584D4 was the WP&Y variant of that series. As was normal for the GT584, it had a belt-driven combination exciter-auxiliary generator. The second auxiliary generator, a GY24, was said to be mechanically driven from the main generator, which is a little ambiguous. GE data show that the GY24H1 was the WP&Y variant. It might have had a step-up gear drive from the main generator shaft, but more likely I think that it was belt-driven, and mounted atop the main generator. This would have been a similar arrangement to that used on the GT564 main generator of the IRCA 600-series.

The six traction motors were the GHM842 model. This was drawn from the GE mining equipment range. In 1954 GE did not have a three foot-gauge traction motor in its locomotive range. The GE764 was still in the future. For previous three foot-gauge applications, it had used the GE747 longitudinally mounted with a right-angle drive. This must have been seen as unsatisfactory for the WP&Y application. Possibly that was because it would not have been very free-running at the upper end of the speed range. And although the GE747 had been used thus in the 10 ft wheelbase bogies of the Co+Co version of the 70-tonner, perhaps an even shorter wheelbase was required. Hence the choice of a mining equipment motor, designed for narrow and relatively small equipment and so light and compact. In turn this allowed the use of 34 inch wheels, quite small by diesel-electric road locomotive standards. It could have been that the available gear ratios for the GHM842 motor indicated the use of such wheels in order to arrive at both the target maximum speed the desired minimum continuous speed.

The motors were connected 2S3P with an unknown number of field weakening stages, but at least one. The gear ratio was 72:15 and the maximum speed was 40 mile/h. Continuous tractive effort was 24 000 lbf, but I have not found an associated minimum continuous speed. Starting tractive effort varies with adhesive weight, in this case total weight. WP&Y numbers are 167 000 lb (74½ long tons) for the 1954 and 1963 batches, 172 000 lb (77 long tons) for the 1956 batch and 170 000 lb (76 long tons) for the 1966 batch. Railway Gazette (RG) and DRT both quoted 74.7 long tons for the 1963 batch. Based upon the lowest, 167 000 lb number, the starting tractive effort at 30% adhesion would be 50 100 lbf. Maximum axle loading for the 1963 batch was said to be 12½ long tons.

The Alco 6-251 engine was fitted with the Woodward PG governor as standard from the start, usually the PG-EV version with integral load regulator rheostat. I’d guess that the control system was probably similar to that used on the Alco 6-cylinder locomotives, model DL531 et seq. That is, eight heavily drooped main generator curves in the GE fashion, one for each notch, with the load regulator acting as a trimming device over the constant power range for each notch, and the curves

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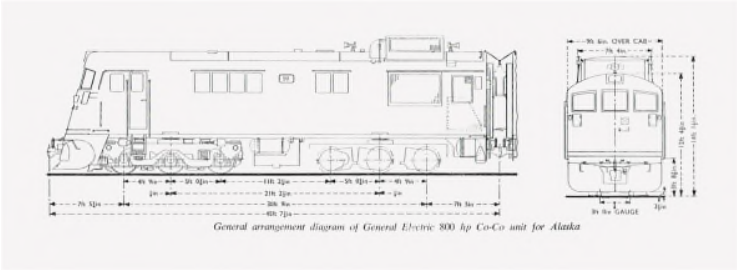
themselves determining the voltage and current limits, crossing the standstill line at reasonably even spacings.

WP&Y data show that all eleven had the 26-L braking system. That could have been original equipment on the 1963 and 1966 batches, but not on the 1954 and 1956 batches, which predated the advent of that system. These might have had 6-SL or 14-EL. The customary North American 26-L installation was of the 4-pipe universal type, backwardly compatible with the 24-RL and 8-EL systems as well as the #6 systems. But conceivably WP&Y would have chosen the three-pipe 26-L variant. Once 26-L became available on GE's export models, that was probably the baseline fitting, with the four-pipe straight and four-pipe universal both options. As already noted, the WP&Y 90 had dynamic braking, appropriate for a road that had grades up to 3.9% (1 in 26).

The WP&Y winter conditions are quite severe, with ambient temperatures as low as -65°F (-54°C), and wind speeds up to 60 mile/h (96 km/h). As well as bolt-on front snow ploughs, the 90 class had some internal "anti-winter" features. The cooling system had electric immersion heaters fed from the main generator to maintain coolant temperature during idling. It also had a heat exchanger to warm the fuel. At least during the winter, I imagine that WP&Y would use an arctic grade fuel, essentially a kerosene cut. The side-mounted panel radiators were half-height, occupying only the upper part of the body each side of the radiator compartment. Presumably that was all that was needed in the prevailing ambient conditions. Above the roofline was mounted a shutter mechanism that allowed the exhaust air from the radiators to be released to atmosphere as per normal, or recirculated back into the body and cab. Air for the traction motor blower was taken from inside the body.



*General arrangement diagram of General Electric 800 hp Co-Co unit for Alaska*

Despite the fact that the 1963 and 1966 batches were built in the GE Universal era (the 1956 batch was on the cusp), to the best of my knowledge GE never assigned a U-series designation to them. From that one could infer that it did not see them as conforming to whatever was its in-house definition for a Universal locomotive. That would suggest that those outside of GE who have assigned informal U-series designations to other GE pre-Universal designs where GE had not done so were flying in the face of evidence that suggests that it was in fact inappropriate.

Some of these 90 class locomotives have been the subject of a rebuilding programme, including re-engining, that might not have been entirely successful. Before that they almost certainly were the last GE shovel-nose models in regular service.

In summary, the WP&Y 90 class was a very close relative to the GE export shovel-nose designs built in the 1949-1957 period. More generally, the sub-1000 hp class of diesel locomotives of the early dieselization era included an interesting variety of cab units, of which this was one.

The 1963 batch of these locomotives were described in DRT 1963 October, p.404ff, "Locomotives for the White Pass and Yukon".

A very similar article was included in RG 1963 November 15, p.546ff, "Diesel-Electric Locomotives for the Yukon".

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## General Electric Pre-Universal Export Locomotives

### 1954 - White Pass & Yukon “Shovel Nose” - Supplement

An error of omission in the above description was the fact that this locomotive design was equipped with dynamic braking, as was desirable for the WP&Y’s steeply-graded route.

Dynamic braking was not uncommon on GE’s pre-Universal export models. It was fitted to the IRCA, Guatemala and the Colombia Co+Bo+Co road switchers, the Matadi-Leopoldville shovel-nose units and the derived Argentinean metre gauge units, the Brasilian 110-ton road switchers, and to the NSWGR, Australia 43 class cab units. All of these had the Alco 12-244 engine and the GE Amplidyne control system as developed for the Alco-GE domestic model range, and so had the associated potential wire dynamic brake control system.

On the other hand, the WP&Y units were fitted with a simpler type of control system, assumed to have been based upon the Woodward PG governor. In turn this would have required a different type of dynamic brake control. Exactly what this was is unknown, but most likely was the same type of control system as was subsequently used on the export Universals.

This was dynamic brake control system was described in US patent 2879462 of 1959 March 24 (filed 1955 March 21), and also in an article “Elements of Electric Transmission” in Diesel Railway Traction (DRT) 1959 December. It was still of the potential wire type, but whereas with the original system, the pertinent control trainwire simply conveyed a control voltage to trailing units, in this case it also supplied the excitation current for the battery fields of the exciters in the trailing units. Thus it was a relatively simple way of ensuring synchronous behaviour of all units. A similar, but not identical system was used in the domestic GE U25B model. In that case, the dynamic brake control trainwire also conveyed motoring excitation current to trailing U25B units. Possibly this dynamic brake control system was also used in the 1954, four-cab unit domestic prototype.

Thus the dynamic brake control system was probably another element of the export Universal series that saw prior use in the pre-Universal export range, along with the floating bolster bogie, the Cooper-Bessemer engine, the GT581 main generator (also used in Alco-GE domestic models) and the GE761 traction motor.

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## General Electric Pre-Universal Export Locomotives

### White Pass & Yukon Shovel Nose Cab Unit – Supplement 2021 November

I have since found a brief article on the initial batch of two WP&Y locomotives, in “Railway Age” 1955 February 14. This confirms that these were fitted with the Alco 6-251A engine, set to produce 800 hp (traction) at 1000 rev/min. Total weight was 167 400 lb (76 tonnes). They were originally fitted with the 14-EL braking system, so in that respect followed GE’s norm of the time. The control and excitation system was described as being of the split-pole type, although nothing was said as to whether it included a load regulator rheostat. Thus that question remains open.

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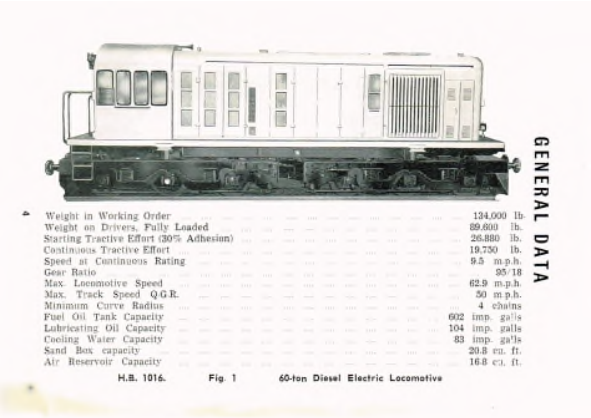
## General Electric Pre-Universal Export Locomotives

### 1956 - Queensland Railways A1A+A1A 70-Ton

Another Australian GE locomotive in the Pre-Universal group was the QR 1170 class. QR, having ordered initial batches of 90-long ton mainline locomotives from both GE and English Electric, next wanted a light, 60-long ton (on six axles) design that could be used on lightly laid main and branch lines, including the Mt. Isa line. Some lines were laid with rails as light as 42 lb/yard, combined with light ballasting, so a 10 long ton maximum axle loading was required. QR issued tender documents in 1951, and in 1952 March contracted with Australian General Electric (AGE) for the supply of 12 locomotives. These were envisaged as being “junior” versions of the GE-built 1150 class main line units, with reasonable commonality of parts and assemblies.

The GE 70-tonner was a logical starting point for the requirement. It had the C-B FWL6-T engine which was half of the FVL12-T used in the 1150. And a six-axle, Co+Co variant had been developed in the late 1940s, in particular for export to Latin American countries. That had used articulated bogies in order to avoid having to extend the locomotive frame to overlap the bogie ends, which would have increased the total weight. It also used longitudinally mounted GE747 traction motors with right-angle double reduction drives. This accommodated a 3-foot gauge version, as well as the metre and Cape gauges. Also, the GE747 motors were quite small and light, so helped with the weight saving. The six motor 70-tonner weighed in at 141 000 lb as compared with the 140 000 lb for the standard four-motor version. The double-reduction drives no doubt increased the specific rolling resistance quite a bit, but that was not a significant issue for the envisaged duties of the locomotives involved.

For QR the weight needed to come down to 134 000 lb (60 long tons). Evidently it [QR] was happy with a four-motor design, so the drop in motor count would have addressed quite a bit of the weight reduction required. That pointed to the A1A+A1A wheel arrangement. For the Cape gauge, there was no need to use a special motor arrangement, and commonality with the 1150 class pointed to the GE756. With mainline operations in mind, both the double reduction gearing and the relatively small wheels (33 inches) of the Co+Co version could well have been seen as disadvantages.




Thus the 1170 class running gear comprised a pair of A1A bogies that followed the usual GE format of the era, welded, slab-framed and outside drop-equalized. Each bogie had a wheelbase of 10’6”, equally distributed, with the bogie centres at 20’8” for a total wheelbase of 31’2”. In comparison the Co+Co version had 10 ft wheelbase bogies with their centres offset 10 inches outwards, at 20’10” centres for a total wheelbase of 29’2”. The QR 1170 was longer, at 41’6” over buffers, say 38½ ft over bogie headstocks, as compared with 38’8” over couplers, say 35 ft over bogie headstocks. A difference was that the QR locomotive had a front platform as well as a rear platform, as did the standard 70-tonner, whereas the Co+Co version had only the rear platform.

There were differences above the frame as compared with the standard 70-tonner. The latter had a single vertical radiator panel mounted crosswise ahead of the engine, with behind it a pusher fan with belt drive from the front of the engine, the air exiting through roof vents ahead of the radiator. The same arrangement had been used on the Co+Co version. In the QR case, the cooling system comprised a pair of side-mounted vertical radiator panels with a roof-mounted vertical-shaft fan.

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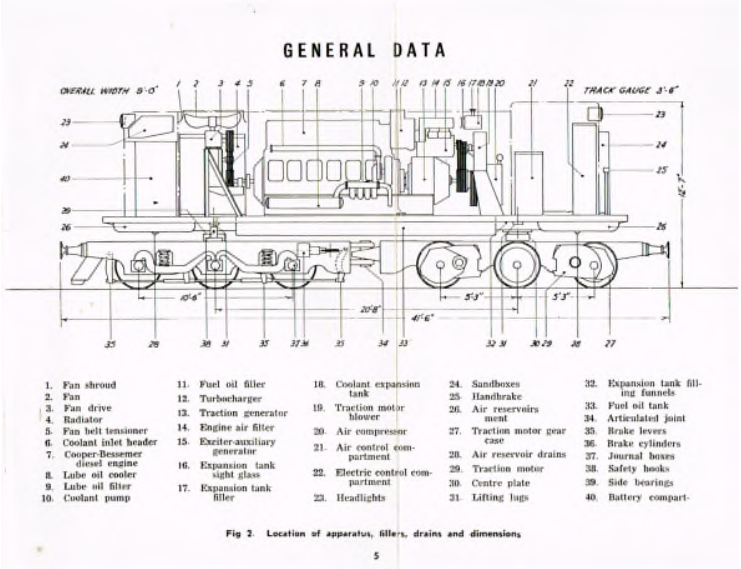
This was driven by a high-mounted right-angle gearbox, in turn belt-driven from the front of the engine. I imagine that this allowed the use of the standard 70-ton engine front end arrangements. A reasonable supposition is that the revised cooling system layout provided extra capacity thought to be desirable for the North Queensland tropical climate in which the locomotives were to operate. Apparently the specification required operation in ambient temperatures up to 127.5°F (53°C). The QR 1170 had the single traction motor blower belt-driven from the end of the main generator as was fitted to the standard model. The Co+Co version had not required this, as its GE747 motors were self-ventilated.

Given that there was no space between the bogies for an underslung fuel tank, an in-frame fuel tank was fitted. A very rounded cab roof, as compared with the standard squarish design, was required to fit the relatively restricted QR loading gauge, but this had been seen before on the 1150 class and also on some relatively standard 70-tonners that AGE had Goninan build for industrial use in Australia.




As said, the engine was the Cooper-Bessemer FWL6-T, said to be a capable of 825 hp (gross) at 1000 rev/min, but with a site rating of 710 hp (gross) and 640 hp (net) at 1000 rev/min. That implies that there had been some uprating of the engine since its initial use at 660/600 hp in the original GE 70-tonner. That model retained those ratings into the early 1950s, but some later standard 70-tonners had a 720 hp (presumably tractive) rating. The main generator was the GT571, standard for the 70-ton series, with its customary belt-driven auxiliary generator-exciter combination. The four GE756 traction motors were connected 2S2P and 4P, with one weak field stage in 2S2P only, which was unusual. Presumably 4P weak field was more than the powerplant could handle. Transition was automatic. These motors drove 36-inch wheels through 95/18 gearing. Continuous tractive effort was 19 750 lbf at 9.5 mile/h, and starting tractive effort at 30% adhesion was 26880 lbf. The maximum speed in QR service was 50 mile/h, but the maximum safe speed was stated to be 62.9 mile/h. Why such precision is hard to fathom, but it was probably close to being a hypothetical number. I think that the articulated bogies would have become quite “lively” with rough riding and poor tracking at above about 40 mile/h. And main generator unloading probably started at around that speed as well, meaning that there would not be much drawbar pull by 60 mile/h.

As was customary for the smaller GE models, the QR 1170 had the Lemp 1924 form of inherent characteristic load control, otherwise known as the engine-stalling type. The throttle had seven notches, as was standard for the 70-ton range. However, it was of the pneumatic type, which was unusual, although not unknown in GE practice. For instance it was used on the US Gypsum 54-ton model. The standard 70-ton model without MU facility had a mechanical throttle control, and the MU version had electrical throttle control. The first four 1170 class members were built without MU equipment but later retrofitted, whilst the final eight were built with MU equipment, the first such on QR. The braking system was the standard Australian A-7-EL system, a departure from 14-EL that was the norm for the 70-ton series.

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## General Electric Pre-Universal Export Locomotives

During the 1950s, AGE usually subcontracted the building of the mechanical parts and locomotive assembly to Goninan. In this case though, at QR's request, the subcontractor was Walkers Limited of Queensland. Starting with this class, QR much preferred its diesel locomotives to be built in-state and maintained this preference into the 1980s at least. Walkers had previously built steam locomotives for QR, and it went on to later build diesel-hydraulic locomotives for QR amongst others. Surprisingly perhaps, its basic diesel-hydraulic design was based upon an NBL prototype.

A consequence of having Walkers as subcontractor was very slow delivery, with the first in service during 1956 January, nearly four years after the contract was placed, and the last arriving in 1958 May. Before the first delivery was made, AGE had become AEI (Australian Electrical Industries), who were thus the supplier of record. The first few were initially classified as 1270, this changing to 1500 during 1956, and again to 1170 in 1965. Initially they were used on lightly laid main lines and branch lines, but as the main lines were upgraded, they became essentially branchline locomotives. As such they were the forerunners of a large fleet of "60-ton" branchline locomotives, supplied by English Electric (EE) and Clyde-GM from 1962 onwards. All of these had the Co-Co wheel arrangement. By the time they were required, EE and Clyde-GM were both embedded as QR's standard suppliers, and GE was no longer in the picture.

The 1170 class were all withdrawn by the first part of 1989, along with many others of the QR's first-generation fleet, essentially made redundant by the electrification project coupled with a decision to standardize on Clyde-GM locomotives.

The QR 1170 class operating manual was issued by AEI. The locomotive was described as "Type A1A+A1A 90/134 4GE756 42GA".

AEM-1001

OPERATING
MANUAL

60-TON
DIESEL-ELECTRIC LOCOMOTIVE
SPECIFICATION No. 4113

TYPE AIA + AIA 90/134
4GE756 42GA

AUSTRALIAN
ELECTRICAL INDUSTRIES
PTY. LIMITED
LOCOMOTIVE DEPARTMENT

Decoding some of that, the adhesive weight was 90 000 lb (40 long tons), the total weight was 134 000 lb (60 long tons), it had 4 GE756 traction motors and it was for the 42 inch (3'6") gauge. As might be expected, there was no model number as such. RT though assigned the unofficial model number "U/67T" in 1974. Possibly this decoded as Universal 67 short Tons, although these locomotives were definitely not GE Universals.

Finally, some thoughts that arise from taking a look at how the QR 1170 fitted into the bigger picture.

The standard GE 70 tonner was essentially a domestic model, although some were exported. But the Co+Co and A1A+A1A derivatives were both designed to meet specific export requirements, which justifies their inclusion in the pre-Universal export group. In fact the last several of the QR 1170 class appear to have been the last GE pre-Universal export models actually delivered.

The articulated A1A+A1A wheel arrangement was quite rare. I think that it may have been used for a small number of electric locomotives, but I am not aware of any diesels, other than the QR 1170, that used it.

Of course, the non-articulated A1A-A1A wheel arrangement was quite common and remains in production. But for a while at least, GE seems to have set its face against it. This wheel arrangement was not an option for any of the Universal models announced in 1956, although one supposes that GE would have built it had any potential customer insisted. In a DRT 1958 December article (1), GE argued that it was better to specify the Co-Co rather than the A1A-A1A wheel arrangement, and its worked example included what could be thought of notional "U9A1A" and "U12A1A" models as well as the U9C and U12C. This was not long after the final QR 1170 was delivered, but then that was a 1952 design. One could take GE's position as being against unpowered axles generally,

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but that did not stop it shortly thereafter from successfully bidding a 1-Co-Co-1 design against a South African requirement. “Universals” with the A1A-A1A wheel arrangement finally appeared in 1974, as the UM10A1A for the Hedjaz Jordan Railway and the UM15A1A for Sudan Railways.

The QR 1170 was one of three early Australian diesel electric locomotive designs that were required to conform to a maximum axle loading of 10 long tons or thereabouts. One of the others was Commonwealth Railways Birmingham/Sulzer/Crompton Parkinson NSU class of 1954 with the A1A-A1A wheel arrangement, generally regarded as a good locomotive. The other was the Western Australian Government Railways (WAGR) Metropolitan-Vickers/Crossley design of 1953 with the anachronistic 2-Do-2 wheel arrangement. These suffered from having a very poorly designed engine. WAGR actually claimed lower dynamic vertical railhead loadings for its design as compared with the other two. But nothing was said about lateral railhead forces, which were likely higher. (2)

(1) DRT 1958 December, p.465ff, “Track Weight and Truck Type”.

(2) RG 1957 March 08, p.274 ff, “Track Loading Fundamentals – 5”.

The QR 1170 was described in an article in RT, 1956 June, p.41ff, “Queensland Rlys Augments Diesel Fleet”.

A class history was provided in ARHSB 1996 January, p.03ff, “The 1170 Class (“PawPaw”) of the Queensland Railways”, by Rod Milne.

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## General Electric Pre-Universal Export Locomotives

### 1956 - Philippines (MRR) Streamliner Unit and Modified Road Switcher

The Cape gauge Manila Railroad (MRR) ordered 40 diesel-electric locomotives from GE in 1955 April. Of these, 10 were 1200 hp (tractive) Co-Co streamlined passenger locomotives, 20 were 1200 hp (tractive) Co-Co modified road switchers primarily for freight service, and 10 were 500 hp (tractive) Bo-Bo switchers. The last-mentioned was a version of GE's 52-ton model. All were delivered during 1956,

The road locomotives were somewhat different to earlier GE productions, although they embodied some previously used elements. They also incorporated some features that would be found in the forthcoming GE Universal series.

The streamliners and the modified road-switchers were essentially the same basic locomotive in two different body forms. The streamliner was of traditional cab unit form, with a nose end. It could be considered to have been a smaller version of the cab units from GE's "rolling laboratory" four-unit set of 1954: It also had similar fluted sides and a row of square-shaped ventilation panels just below the cantrail. The latter was also a feature of GE's pre-Universal shovel-nosed units. The fluted sides were said to add strength to the sidewalls, which suggests that these were true cab units, with structural bodies.

*One of ten 1,325 b.h.p. Co-Co passenger locomotives for service up to 60 m.p.h. on narrow-gauge lines.*

The modified road switchers had a partially streamlined cab end, which included a vestigial full-width nose end that was shorter than that on the streamliner. Also, whereas the streamliner had a two-panel windshield, the modified road-switcher had three panels, a feature that had been used on the shovel-noses. The hood unit with a streamlined front end was not a new idea, having been introduced by English Electric in 1954. The EMD BL2 might be seen as an even earlier predecessor, but it was not a true hood unit in that the main body was partially structural. Also, there had been previous efforts at styling the cab face of end-cab units to make cab-forward operation more presentable, notably by Whitcomb.

*An 81½-ton 1,200 h.p. (traction) Co-Co road-switcher for Manila Railroad*

These locomotives were fitted with the C-B FVBL-8T engine. This had previously been installed on two units of the four-unit "rolling laboratory". The MRR fleet was the first application of a C-B 8-cylinder F-series engine to a production locomotive, as well as being the first such application for any variant of the B-variant engines, which had been significantly uprated as compared with the original version. The FVBL-8T engine was also the powerplant for the future U12B and U12C models.

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The customary power setting for this engine was 1320 hp (gross), 1200 hp (tractive) at 1000 rev/min. Later GE revealed that its early ratings for the B-variant engines covered situations of up to 5000 ft altitude and 113°F ambient temperature. When it moved to UIC ratings circa 1961, exactly the same engine, with the same settings, was stated to be 1420 hp (gross), 1300 hp (tractive). Sources generally agree that the MRR locomotives were 1200 hp (tractive). DRT, in a 1955 October article, quoted their gross power as 1325 hp. On the other hand, GE, in its 1985 and 1990 World Users lists, stated their gross power as 1290 hp. In those lists, the U12C model gross power was given as 1420 hp, which was the later rerated number, and not the originally published 1320 hp number. From that one could infer that the MRR engines were in fact derated, perhaps to accommodate the local ambient temperatures.

The main generator was the GT584E1. This was described by GE, in a 1971 electrical equipment list, as a GT584 variant that was modified to fit the C-B engine and which was a special for MRR. The GT584 was normally associated with the Alco 6-251 engine, but the GE data indicates that it was originally developed for use in 800 hp and 1200 hp yard switchers. So it was working within its originally designed power capacity in the MRR application. Nonetheless, GE chose the larger GT581 model for use in the U12B/C model. Alco also chose the GT581 for use in its DL535 model in which the 6-251 engine had been uprated to 1350/1200 hp, whereas it had used the GT584 in the preceding DL531 model. Which main generator GE had used in the 8-cylinder “rolling laboratory” units is unknown, but with four GE752 traction motors to feed, the GT581 seems to have been more likely.

The GE data is not explicit as to what auxiliary drive arrangement was used. But all other GT584 variants, including the GT584D3 to which the GT584E1 was said to be similar, had the belt-driven combined auxiliary generator and exciter unit as was found on the 6-cylinder Alco models. Given that anything different was likely to have been highlighted by GE, the working assumption is that the GT584E1 had the same. Thus the MRR units differed from the U12B/C not only in having a smaller main generator, but also in the auxiliary drive arrangements. The U12B/C had the triplex gear drive unit with separate auxiliary generator and exciter. It may be noted that the U9B/C, powered by the 6-cylinder C-B engine, did not use a GT584 variant, but rather the GT599A1, which had the triplex gear auxiliary drive.

The traction motors were the GE761 model, by then GE’s standard Cape and metre (CM) gauge type. Normal connections for six of these were 2S3P and 6P. The MRR units might have been different in deference to the main generator current capacity. The later Alco DL531 used 3S2P and 2S3P, so it is at least possible that those combinations were also used on the MRR units. The driving wheels were 38 inches in diameter and maximum speed was 60 mile/h. The gear ratio is unknown, but 93:18, the slowest gearing typically used with the GE761 motor, is a possibility. Continuous tractive effort was given as 37 400 lbf, although without a corresponding minimum continuous speed number. This was quite a bit lower than the 43 600 lbf (at 7½ mile/h) quoted for the U12C when fitted with 60 mile/h gearing. Perhaps the MRR units had a lower mass flow of traction motor cooling air, but it could also have been that main generator current capacity and not the motor current capacity was the limiting factor.

Starting tractive effort at 30% adhesion was 54 600 lbf. This of course was simply weight related, and equated with a total weight of 182 000 lb, which aligns with the 91 short tons (81 long tons, 82.5 tonnes) sometimes quoted for these locomotives. The cab unit was evidently no lighter than the road switcher, which goes against the conventional wisdom that load-bearing bodies allow weight reduction as compared with “strength” underframes. But then even if lighter were possible, the cab units could well have been built up to the target weight for adhesion purposes. At the time, the MRR was working to a 14 long tons maximum axle loading. In comparison, base weight for the U12C was 79 long tons.

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The bogies were a mix of old and new. In build terms, they conformed to the welded, slab-framed, outside equalized style that GE had used for export CMT-gauge road locomotives since 1949. Originally GE had used rigid-bolsters, but introduced an unusual (and quite visible) swing motion arrangement, with the same basic design, during 1953. The first application appears to have been on the metre-gauge 110-ton road switchers for Brasil. One assumes that GE's customers were not entirely happy with rigid-bolster bogies at higher speeds. The MRR locomotives were described as having lateral motion bogies, but without description of the means by which this was achieved. Certainly, the previously used mechanism was absent, and there were no signs of conventional swing links and spring planks. The side view suggests the use of a bolster very similar to that on the Universal floating bolster design. Indirect confirmation of that is provided by a comment in the GE brochure "Built-In Power" of 1961 September. This stated that rubber bolster mounts had been in use for over five years, implying since some time in 1956. As no true Universals with floating bolster bogies were built until 1957 (the 1956 UD18B fleet for Mexico had elliptical bolster springs), the MRR locomotives look to have been the only 1956-built candidates. The MRR bogie secondary suspension thus presaged the export Universals.

The bogie wheelbase was 12'6", split 6'2" outer, 6'4" inner with the centres half an inch behind the centre axles. One could say that 10'7" had been GE's Co bogie norm for CM-gauge units, although there had been some variations. 11'6" was adopted for the Universals with Co-Co running gear. Bogie centres were at 21'9", which gave a 34'0" total wheelbase and 9'0" spacing between the inner axles of the two bogies. Length over the (automatic) coupler pulling faces was 47'6½". Length over headstocks was not given, but may be estimated at 44'3". This was slightly shorter than the 46'4½" of the U12B/C.

I haven't seen an equipment layout diagram, but a good estimate would have the electrical frame behind the cab, followed by the traction motor blower, generators, engine, air compressor and then the cooling system. The MRR was an air-braked road, and these locomotives were fitted with the 14-EL braking system. This had been GE's norm for export road locomotives since 1949, although there were variations. Soon after it adopted the 6-SL system for the export Universals. The MRR locomotives were not fitted with dynamic braking.

How long these locomotives lasted in service I do not know. But one could reasonably have expected 20 to 25 years, which means that they would have overlapped with the first of the GE U14C/15C fleet. Those models of course were successors to the U12C, still using the same basic 8-cylinder engine.

As may be seen, they had some aspects, including the engine, in common with the definitive U12C, but were different in other ways. Nevertheless, GE evidently saw the similarities as persuasive enough to later apply the U12C name, even though that was not used when they were built. Given the differences, one could ask why did GE not use the UM12C moniker. Probably by the time that the retroactive U12C designation was mooted, the UM12C as built for RSR Thailand already existed. But then GE used the UM10B designation for several different variations, so the "M" did not necessarily mean only one set of variations. More persuasive though is that these MRR locomotives preceded the U12C, so they could not really be considered as modified versions of it. Rather they could be seen as simply being an earlier incarnation of the U12C idea.

Being "stepping-stone" models as it were, they were one-offs, with no repeat builds. There was another slightly later pre-Universal cab unit with broadly similar styling, namely the NSWGR 43 class. But mechanically this was generally similar to the preceding larger shovel-nose units rather than being aligned with a future Universal model. One might also say that the modified road switcher concept reappeared in the mid-1990s with the Indonesian version of the U20C, which had a full-width somewhat streamlined "wedge" front. This was also an 8-cylinder model, the U20C designation, hitherto strongly associated with GE's iconic 12-cylinder export model, having been recycled.

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## General Electric Pre-Universal Export Locomotives

A GE advertisement from Diesel Railway Traction 1956 September also provides some insights into the background of the Manila Railroad GE locomotives.

The shunting locomotives were described as being of the standard 52-ton type. The 52-tonner was a derivative of the 50-tonner, and both originated in the pre-Universal era. However, GE – and its customers – seemed to be in no hurry to swing from the 50/52-ton models to the Universal U4B and U6B models that had been announced early in 1956. Thus the 52-tonner was still referred to as a standard model even well into the Universal era.

And that the "standard model" moniker was not used for the MRR modified road switchers and streamliners suggests that at the time, GE viewed them as bespoke specials rather than extensions of the Universal series.

These locomotives were described in DRT 1956 October, p.394ff, *"Total Diesel Working on Manila Railroad".*

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## General Electric Pre-Universal Export Locomotives

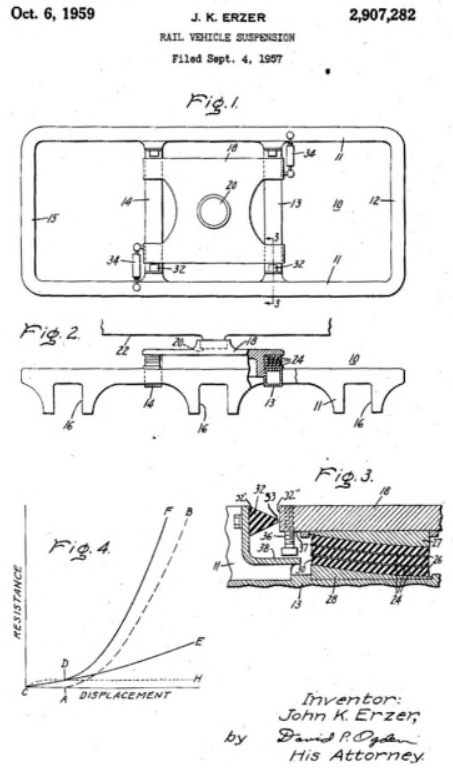
### 1956 - Philippines (MRR) Streamliner Unit and Modified Road Switcher - Supplement

Previously, in discussing the Co-Co running gear of these locomotives, it was said that the available evidence pointed to the fact that they were of the GE floating bolster type.

The GE floating bolster bogie was covered by US patent 2907282 of 1959 October 06, filed 1957 September 04. Evidently GE made the filing after it had started production. The designs would have been in place before the export Universal series was announced in 1956 April. Initially standard on that series were “semicast” bogie frames, with cast one-piece box-type sideframes welded to the transversals. Whether the fully cast option was available from the start is unknown. Possibly it was a slightly later addition to meet the South African Railways (SAR) requirement for its U12B fleet. Be that as it may, there would have been no reason why the floating bolster design could not have been applied to GE’s established slab-frame bogie construction as used for the MRR locomotives. And the timing of the building of these locomotives easily fitted the likely development period of the floating bolster design.

GE’s reasons for developing the floating bolster bogie are best explained by quoting from the patent document:

*“One means of solving this problem of side sway has been to use a swivel bolster hung on "swing hangers.” With a swing hanger support, the locomotive body rests on a swivel bolster which is hung from the truck frame on large support links or pendulum members. The pendulum action of the support links of the swing hangers imparts a banking action to superelevate the body of the vehicle which will inhibit undesirable side sway on curves. However, this swing hanger support is expensive; first, because of the initial cost of the intricate arrangement of heavy steel parts, and second, because of the additional length required for a truck where the traction motors on each of the axles occupy all of the useful space between the axles. The addition of swing hangers increases the length of the trucks and, consequently, the length of the locomotive. These increases in length add useless weight and cost to the locomotive. Moreover, the minimum allowable turning radius is increased.*




*“However, because of the riding characteristics of the swing hanger which cause the banking action of the locomotive cab on curves, the railroads have found this supporting system to be the most satisfactory despite these disadvantages,*

*“Therefore, an object of my invention is to provide a reliable, simple, and inexpensive rail vehicle construction wherein the body of the locomotive is supported on a truck providing controlled lateral motion combined with a predetermined banking action during lateral motion.*

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## General Electric Pre-Universal Export Locomotives

> *"In accordance with one modification of my invention, a rail vehicle body is supported on the truck by means of a swivel bolster resiliently mounted on the truck. Banking action is obtained by the use of curved rubber support pads between the bolster and the frame of the truck which cause the bolster to be banked as it swings."*

GE achieved a wheelbase of 11'6" for the export Universal standard Co bogie, which was quite short for a lateral motion design. The MRR locomotives had 12'6" wheelbase bogies, which would have been enough for a swing bolster design. It could have been that that number was determined by MRR track or bridge loading requirements. The floating bolster bogie was a significant feature of the export Universal line-service models throughout their production run, so the MRR locomotives were a stepping-stone in respect of this important feature.

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## General Electric Pre-Universal Export Locomotives

### 1956 - New South Wales Government Railways Cab Unit

Another GE export model that was a late user of the Alco 12-244 engine was the standard-gauge Australian New South Wales Government Railways (NSWGR) 43 class.

The order for six locomotives was placed upon Australian General Electric (AGE) in 1954 June, at the same time as were ordered six similar capacity locomotives from Clyde-GM, which became the NSWGR 42 class.

At that time, NSWGR was operating a fleet of 20 MLW-built Alco-GE RSC-3 road switchers which had been delivered in late 1951 and early 1952. These had been ordered through AGE. It would appear that orders for Alco-GE locomotives could be placed through either Alco or GE offices. NSWGR thus had familiarity with both the Alco 244 engine and GE electrical equipment, and also with AGE as a supplier. By 1954 Alco and GE had gone their separate ways, although GE was still using some Alco 244 engines for its own export models. GE was well experienced in designing and building locomotives specifically for export market requirements. Alco was not new to exporting as such, but it was new to designing special export models rather than modifying domestic markets. Its first effort, the DL500 “World” locomotive, had been announced in mid-1953, initially as an Alco-GE model, but very shortly afterwards as an Alco model. Alco itself did not make arrangements with an Australian partner, namely A.E. Goodwin, until some time in 1954. Thus it may not have been in a position to bid for the NSWGR business that was placed in 1954, and presumably the subject of tenders issued sometime before that, and for which local manufacture was probably a necessity.

AGE already had an association with Goninan as a subcontractor for building GE designed locomotives. Goninan later became a GE licensee, but it was not such in 1954. AGE itself could build some of the electrical equipment. For NSWGR, GE designed a conventional cab unit that bore some resemblance to its domestic “rolling laboratory” of 1954, and also to the MRR streamliners that appeared at about the same time as the 43 class. However, the 43 lacked the fluted sidewalls. Whether NSWGR specified a cab unit, or whether GE or AGE saw that was what the competition was likely to offer is unknown. But it was a departure from GE’s established shovel-nose form. Nevertheless, internally the 43 was much like the Chilean broad-gauge shovel-nose units. It had a mechanically driven cooling fan and motor-driven traction motor blowers.

The Alco 12-244H engine was set for 1750/1600 hp. It had the GE Amplidyne control system with the GE 17MG6 electro-hydraulic governor. The main generator was the GT581. This fed six GE761 traction motors. For a standard gauge unit this was a departure from the previously-used GE731. But on the other hand, the GE761 had a high capacity as Cape-metre (CM) gauge motors went, and had earlier been used on Cape-gauge shovel-nose units. The 93:18 gearing with 40 inch driving wheels allowed a maximum speed of 71 mile/h. The GE761 was also the motor that Alco chose as standard for its DL500 model. Motor groupings were 2S3P and 6P, with one weak field stage in each, and automatic transition. Continuous tractive effort was 42 900 lbf at 11.3 mile/h, and maximum starting tractive effort was 71 000 lbf. This corresponded to 30% adhesion against the total weight of 105.5 long tons.

The cast frame bogies, supplied by Bradford-Kendall in Australia, were of the Commonwealth double-swing bolster type with a 13’9” wheelbase. They looked to have been very similar to the bogies used on the Alco DL500 design. GE probably had access to that design from the Alco-GE years, but it might have been a standard Commonwealth design anyway. Assuming that NSWGR specified a cast frame lateral motion bogie, and given that Bradford-Kendall, a Commonwealth licensee, was the logical Australian domestic supplier for cast bogie frames, then a relatively standard design was the likely outcome. Bogie centres were at 28’9” for a total wheelbase of 42’8¾”.

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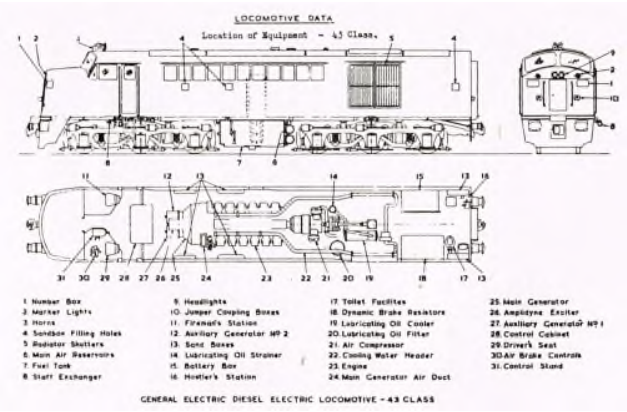
## General Electric Pre-Universal Export Locomotives




At 53'10¼" over headstocks, the 43 was somewhat longer than the Chilean D16000. The nose end, which did not appear to contain any major equipment, accounted for some of this. The relatively long rear compartment, behind the radiator assembly, accommodated the dynamic braking equipment, and on the left-hand side, a hostler's driving station. The main driving position in the cab was on the left-hand side, as was normal for the Australian standard and broad gauge roads. The 43 had a proper left-hand control stand, whereas as far as I know, the NSWGR 40 class had a right-hand control stand rotated by approximately 180 degrees. I am not sure why that was, as GE did have a left-hand control stands available, as used on the LGB DE621 class shovel-nose units. The air braking system was the Australian standard A-7-EL, and as said, the 43 was equipped with dynamic braking.

They were equipped for MU working, and were compatible with all other NSWGR line-service locomotives from the 42 class onwards. In fact they were largely electrically compatible with the 40 class, but the latter had manual transition and the older 21-pin MU jumper sockets rather than the 27-pin type that became the North American standard. One could say that NSWGR was ahead of the curve in requiring universal MU interworking capability. It was perhaps fortuitous that EMD, for technical reasons, used potential wire dynamic brake control on its export models, otherwise there would have been a difference between the EMD and GE control systems.

The six members of the class were delivered over the period 1956 August through 1957 June, which overlaps the 1956 December through 1957 January delivery period for the second batch of the Chilean D16000 class. Thus the 43 fleet included the last locomotives built new with the Alco 12-244 engine.

Even before the 43 class entered service, events had taken a different turn that made perpetuation of this class unlikely, aside from the fact that any future derivatives would have had to use a different powerplant. (A successor with the C-B FVLB-12T engine is quite imaginable, though.)

During 1954 Australian company Goodwin had become the Alco licensee, and fairly soon obtained an order from South Australian Railways for its DL500 model, powered by the very new Alco 12-251 engine. This fleet was delivered under its own power over NSWGR tracks, for which purpose it was fitted with standard gauge bogies. Thus NSWGR was able to test the DL500, and was evidently impressed. In 1957 March it placed an initial order for 10 as its 44 class, and this type then became NSWGR's standard mainline locomotive, with an eventual fleet total of 160. An interesting fact is that the first 40 of the 44 class were built with GE761 motors, but that NSWGR later swapped these for the GE731 type, hitherto strongly associated with GE's own standard and broad gauge export builds.

Thus the small 43 class fleet was destined to be a minority, which is seldom a pathway to a long service life. Added to that was that the Alco 244 engine, even at its best, was not likely to be as durable or reliable as the later 251. NSWGR's 12-244 powered 40 class fleet, which at 20-strong gave some "weight" to the 244 presence, was traded into to Goodwin during 1970-71, after which the 43s were a very small minority, and gone by 1979. One, namely 4306, is preserved in operational condition.

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## General Electric Pre-Universal Export Locomotives

Before deliveries of the 43 class commenced, AGE had become Australian Electrical Industries, AEI. In the second half of 1955, GE sold its share of AGE to Associated Electrical Industries (AEI UK), and the company was renamed as Australian Electrical Industries. Thus AEI became the suppler of record for the 43 class. It also assumed responsibility for two QR orders previously placed upon AGE, namely the 1150 class repeat and the 1170 class. AEI thereafter built both GE and AEI (UK) electrical equipment, much of it for supply to Goodwin for inclusion in Alco locomotives. Whether it was still able to bid GE locomotives for new business I do not know. During or at least by 1961, Goninan, who had previously built GE-design locomotives under subcontract to AGE, became GE's Australian licensee, and then offered the GE Universal range in Australia. But by then the die had been cast, and the Australian State and Commonwealth roads had aligned themselves with other major builders, leaving the door closed to GE.

In hindsight, one might say that GE, despite its initial success in the Australian mainline locomotive business, suffered from two discontinuities in the critical mid-1950s period when durable relationships with the various railways were established. The first was the corporate shuffling which meant that there was not a single defined licensee in that time. The second was the model line discontinuity between GE's pre-Universal era, for which the Alco 12-244 was the major powerplant, and the Universal era, with the C-B-series engine.

The 43 class seems to have been the subject of some puzzlement to observers. A typical comment was *"These locomotives are unusual in having Alco power units in GE-designed bodies"*. In fact they were not really unusual. In the 1950-57 period, GE supplied a total of 198 export line-service locomotives powered by the Alco 12-244 engine. Of these 184 were built by GE itself, and 14 by licencees or subcontractors. The 43 class was at the very tail end of this total, so the population was well established by the time that it arrived. At least by my own analysis, the 43 was simply a logical development in the series, and not some kind of "oddball". But part of the apparent confusion stems from the fact that the pre-Universal GE models seem to have remained largely hidden from view until the internet age. GE as a diesel locomotive builder was also quite obscure until the US domestic U25B arrived. Another point of difficulty may have been that even during the Alco-GE era, GE built locomotives on its own account, and to compound this, many of these had Alco powerplants, but were not Alco-GE locomotives.

Sometimes the NSWGR 43 class is shown as having the GE model number UM/118T. But it was not so. That was a faux model number assigned by RT. I don't know what was intended by UM/118T, but I'd guess Universal, even though they were pre-Universal; Modified, even though they were not obviously a modified version of anything else; and 118 short Tons.

The NSWGR 43 class was described in RT 1957 February, p.28ff, "NSWGR Takes Delivery of New Streamlined Dual Service Diesels".

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## General Electric Pre-Universal Export Locomotives

### Conclusion

The preceding discussion of GE pre-Universal exports covers a total locomotive build of 441, of which 428 were exported, with 13 going to US domestic operators. The overall build period was 1947 through 1966, with the exports being built over the shorter 1947 through 1958 period. The latter overlapped with the start of the GE Universal era, the first builds of which were late in 1956.

Of the 428 locomotives exported, 106 were general purpose units of the end-cab hood type, whilst 322 were line service units. Of those, 95 were road switchers or modified road switchers, and 227 were cab units. The latter comprised 211 of the shovel-nose type and 16 of the normal streamlined type. The shovel-nose total swells to 222 when the 11 built for the White Pass & Yukon Railroad, Alaska are added in.

The exported locomotives went to railways in Argentina, Australia, Belgian Congo, Bolivia, Brasil, Chile, Colombia, Guatemala, Indonesia, the Philippines and Uruguay. In all cases they were the first diesel locomotives, beyond small shunting units, deployed by their respective operators, and in most cases, the first in their respective countries, Australia being an exception here. The country list shows a Latin American preponderance, but Asia, Africa and Australasia are all represented. Overall it is essentially a southern hemisphere list. Admittedly, Philippines is in the northern hemisphere and Indonesia straddles the equator, but today both are viewed as “southern” countries.

95 of the exports were of standard or broad gauge. The balance of 333 were in the CMT gauge group. One could say that GE designed its pre-Universal export locomotives primarily for the latter gauge group, but that these designs were readily adaptable to wider gauges. It also addressed the needs of the three-foot gauge, the minority in the CMT group, and one that required special consideration, particularly when it came to traction motors. The reasonable occurrence of this gauge in Latin America, clearly a major target market for GE, was probably a factor.

Country counts were:

| | |
|---|---|
| Argentina | 100 |
| Australia | 31 |
| Belgian Congo | 16 |
| Bolivia | 2 |
| Brasil | 107 |
| Chile | 47 |
| Colombia | 5 |
| Guatemala | 12 |
| Indonesia | 27 |
| Philippines | 30 |
| Uruguay | 47 |

All but 44 of the exports had six axles. The Co-Co wheel arrangement was dominant, with 204 built. But there were also Co+Co, at 94, A1A-A1A at 74 and A1A+A1A at 12. The 44 exceptions all had eight axles in tribo form, 17 Co+Bo+Co and 27 Co-2-Co. Both of these were unique wheel arrangements, with, in the Co+Bo+Co case, what is believed to be a unique bogie loading arrangement. In the independent bogie era, GE still used articulated bogies where specific circumstances indicated that it was advantageous to do so.

Power outputs went up to 1750 hp (UIC gross), which was at or close to the top level for CMT gauge locomotives of the period. For the higher power output export models, GE used the Alco 12-244 engine, with which it was familiar from its participation in the Alco-GE partnership. It was also the last user of that engine. For intermediate and lower power outputs it used respectively the

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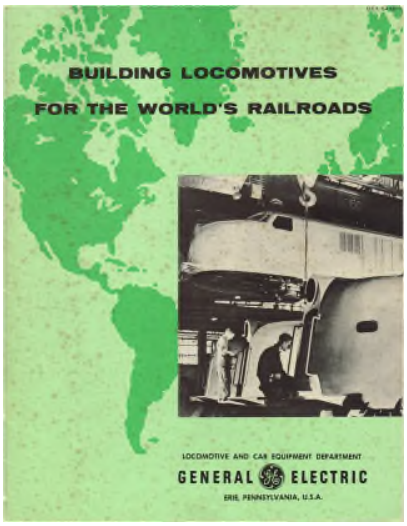
C-B FVL12-T and FWL-6T engines. Its association with the C-B "F" series engines started with its use of the FWL6-T in its domestic 70-ton model in 1946, and of course led to the joint development of the FB-series engine that in time became the GE 7FDL. First production use of the FB engine was in the MRR streamliners and modified road switchers built in 1956, which were fitted with the FVBL-8T. The Alco 6-251 engine was not used in any of the export models considered here, but it was used in the WP&Y shovel-nose fleet.

Engine installation counts were:

| | |
|---|---|
| Alco 12-244 | 205 |
| C-B FWL-6T | 106 |
| C-B FVL12-T | 87 |
| C-B FVBL-8T | 30 |

Most of these export locomotives, 399, were built by GE itself at its Erie Plant. 8 were built by B&M in Belgium. 9 were built by Goninan in Australia as a third party subcontractor to AEI, nee AGE, although Goninan later became the Australian GE licensee. And 12 were built in Australia by Walkers as a third party subcontractor to AGE/AEI. Some of the electrical equipment for the B&M-built locomotives came from GE licensee SEM, and some for the Goninan- and Walkers-built locomotives came from AGE/AEI. AEI (owned by AEI UK) apparently inherited from AGE the right to build GE electrical equipment. An odd fact is that it was building GE electrical equipment for Goodwin-Alco locomotives before the 1959 agreement whereby AEI (UK), and so AEI (Australia) became a supplier of AEI electrical equipment to Alco.




In this period, GE really was designing and building diesel-electric locomotives for the world market, and not simply adapting domestic designs. And in focussing on the CMT gauge group, it had to address tight clearance loading gauges and restricted axle loadings, in some cases extremely so. In 1956 January, essentially on the eve of the launch of its Universal series, GE issued a sales brochure (GEA-6449) entitled "Building Locomotives for the World's Railroads". This illustrated many of the above-mentioned locomotives, as well as GE's broader output including electric and gas-turbine types.

The learnings from its pre-Universal locomotive range were incorporated by GE into its 1956 Universal range, in which seven of the nine initial models were clearly configured for CMT gauge applications with restricted clearances and low-to-moderate axle loadings, and which had a three-foot gauge traction motor option. The three major US diesel locomotive builders of the time, Alco, EMD and GE all adopted different approaches to the export market, but it is fair to say that GE was ahead of the other two in offering a comprehensive CMT-gauge oriented range.

Virtually all of the railways (or their successors) who acquired GE pre-Universal models went on to buy Universal models. The railways of Argentina, Bolivia, Brasil, Colombia and Guatemala were all very early or relatively early purchasers of GE Universals. In the Congo, Indonesia and the Philippines, GE Universal purchases were not made until the 1970s. In Australia, QR waited until 1983 whilst NSWGR did not buy any Universals, nor did the railways of Uruguay.

As a group, the GE pre-Universals were notable because they comprised a significant part of the part of the early diesel fleets in the "southern" countries, and initiated the main line dieselization process in many of them. They were built to fit the railway systems that operated them, in an era

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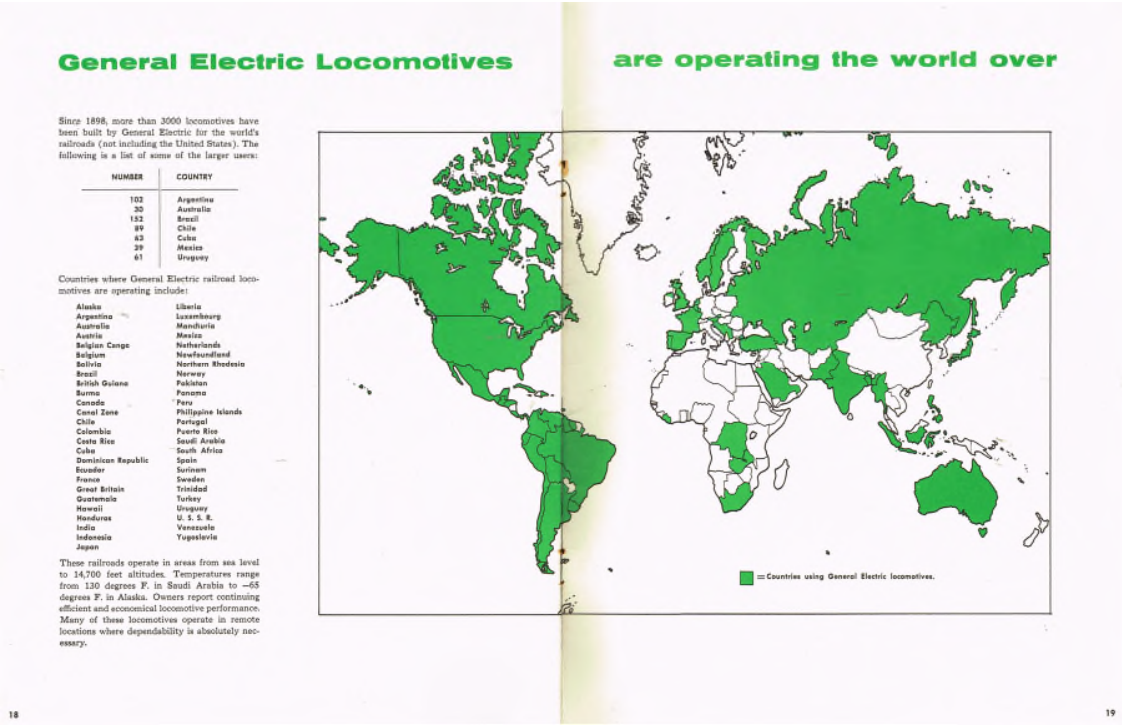
when rebuilding those systems to fit standard “northern” locomotives would have been out of the question. As such they were designed to address some quite severe engineering challenges, and this resulted in some quite unusual solutions. Up until the end of the period at interest, mid-1958, I don’t think that any other exporting diesel locomotive builder had covered quite the same range of applications as had GE, with UK builder English Electric probably in second place.

From GE GEA-6449 1956 January “Building Locomotives for the World’s Railways”,



## General Electric Locomotives are operating the world over

Since 1898, more than 3000 locomotives have been built by General Electric for the world's railroads (not including the United States). The following is a list of some of the larger users:

| NUMBER | COUNTRY |
|---|---|
| 102 | Argentina |
| 30 | Australia |
| 152 | Brazil |
| 89 | Chile |
| 43 | Cuba |
| 39 | Mexico |
| 61 | Uruguay |

Countries where General Electric railroad locomotives are operating include:

Alaska, Argentina, Australia, Austria, Belgian Congo, Belgium, Bolivia, Brazil, British Guiana, Burma, Canada, Canal Zone, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, France, Great Britain, Guatemala, Hawaii, Honduras, India, Indonesia, Japan, Liberia, Luxembourg, Manchuria, Mexico, Netherlands, Newfoundland, Northern Rhodesia, Norway, Pakistan, Panama, Peru, Philippine Islands, Portugal, Puerto Rico, Saudi Arabia, South Africa, Spain, Surinam, Sweden, Trinidad, Turkey, Uruguay, U. S. S. R., Venezuela, Yugoslavia

These railroads operate in areas from sea level to 14,700 feet altitudes. Temperatures range from 130 degrees F. in Saudi Arabia to −65 degrees F. in Alaska. Owners report continuing efficient and economical locomotive performance. Many of these locomotives operate in remote locations where dependability is absolutely necessary.

= Countries using General Electric locomotives.

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