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# Design and Development by RITES for Exports

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## Prologue

RITES, from its very inception, has been instrumental in exporting rolling stock and management technology to various countries. In this Paper, the Author, who is in the forefront of it all, brings out the historical evolution of the company's

export operations as well as the recent design & development break-through in export of rolling stock. A very informative Paper for all interested in the Management Consultancy being provided by 'the infrastructure people'.

- Editor

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In railway transportation sector, various railway systems in Asia and Africa have looked towards Indian Railways (IR) for Technical Assistance leveraging Indian Railways expertise in design, manufacture, maintenance and operations of its rolling stock and related assets. This led to the emergence of RITES in 1974 for rendering services in Railway Technology. With the technical strength and back-up of Indian Railways, RITES has rendered integrated consultancy and expert services for supply and maintenance of rolling stock including locomotives, institutional management and technical support for new railway projects and rehabilitation and modernisation of existing railway systems in Asia and Africa.

In the early years, RITES expertise was sought for deployment of specialists for Technical Assistance programmes, many of them funded by World Bank, UNDP, ADB etc, for Management Support Services, Rehabilitation/Revitalization studies and effecting system improvements in Rolling Stock Maintenance in diverse countries such as Bangladesh, Cambodia, Ghana, Indonesia, Jordan, Kenya, Mexico, Mozambique, Philippines, Tanzania, Zambia, Zimbabwe. The credibility and high brand

equity enjoyed by RITES enabled RITES to secure prestigious assignments for complete Operations and Maintenance of Railway Systems in Nigeria (1979-82) and the Baghdad - Al-Qaim- Akashat section in Iraq (1987 - 1990). These were the largest projects executed by RITES overseas, with the stationing of a large multi-disciplinary team of railway experts.

### **Promoting Indian Railway Technology and Capability**

RITES has been at the forefront in promoting and showcasing IR's capability for manufacture of a wide variety of locomotives and rolling stock over multiple gauges. For this purpose, a separate Strategic Business Unit called Expotech Division was set up by RITES in the mid-nineties to provide an integrated single-window package for exports, which would provide total solutions for meeting the requirements of foreign railways in the areas of:

- Assessment studies for rehabilitation of railway systems.
- Technology and product selection.
- Facilities planning for Rolling Stock Maintenance.
- Technical Assistance for Modernization/upgrade of workshops including supply, installation and commissioning of machinery and plant.
- Supply, commissioning and maintenance support including supply of spares for locomotives and passenger coaches.
- Leasing, operations and maintenance of rolling stock.
- Rehabilitation of locomotives and rolling stock.
- Training of foreign railway personnel for maintenance of IR locomotives and rolling stock.

***As a result of these ventures in the international market, RITES has made a significant breakthrough in export of locomotives and rolling stock to Metre Gauge and Cape Gauge systems in Africa.***

One of the earliest Technical Assistance programmes undertaken by Expotech was a World Bank funded project in 1996 for Royal Railways of Cambodia (CFC) when RITES carried out a study for rehabilitation of wagons, their conversion into container flats and rehabilitation of wagon repair workshop. Tender specifications were finalized; spares, tools, machinery and plant ordered, installed and commissioned,

or rehabilitation of wagons & upgrading workshop maintenance facilities. The physical rehabilitation of wagons was monitored by RITES, and this resulted in completion of this project in time and revival of freight train running between Sihanouk Ville and Phnom Penh.

Another noteworthy consultancy project awarded to Expotech Division was to implement a corrosion prevention programme for phosphate wagons in Tunisian Railways (SNCFT) in 1996. RITES was required to undertake a study of repercussions of transporting phosphate, in moist form (in place of dry), and the impact of water content in the phosphate on the SNCFT wagons. This was done through a series of tests and analysis at various stages of transportation. Thereafter, RITES was required to develop engineering drawings, material and equipment specifications and technical supervision to carry out necessary repairs on phosphate carrying wagons to enable these to carry humid phosphate without accelerated corrosion.

Some of the recent projects providing Technical Assistance include:

- i. Upgrading diesel locomotive maintenance facilities in Sri Lanka.
- ii. Workshop modernization & equipment supply for CFM Railway, Angola.
- iii. Asset review studies for Kenya, Zambia.
- iv. Review of rolling maintenance facilities in Myanmar.
- v. Setting up DMU maintenance facilities in Sri Lanka. This is a turnkey project for setting up DMU sheds at 3 different locations with installation and commissioning of M&P.

### **Early Export Projects**

In the initial stages, rolling stock exports were largely confined to BG and MG markets in Asian countries. The thrust was on ensuring that the product conformed to the end-users' operating and technical requirements. Some of the project exports were :

- Fifteen passenger coaches and 72 bogies to Vietnam.
- Fifteen new YDM4 locos to Vietnam.
- Four locos and 18 coaches to Nepal.
- Ten in-service YDM4 locos & signaling equipment to Myanmar.

- Ten new WDM2 & 10 new YDM4 locos to Bangladesh.
- Eight new WDM2 and 2 new 2300 HP (BG) locos to Sri Lanka.

### **Diversification of Product Portfolio**

Arising out of large-scale gauge conversion on Indian Railways (IR), there was a perception among metre-gauge (MG) countries in Asia around 2000-01, that technical back-up support from IR may not be available for MG locomotives and rolling stock. Intense marketing efforts were re-directed to Africa wherein, the requirements in the African market for MG rolling stock were markedly different due to different ambient and operating conditions. In addition, a large number of countries in Africa had Cape Gauge (1067 mm track gauge) systems, necessitating a totally different type of product-mix fit for export. RITES, in close collaboration with RDSO, DLW, RCF and ICF was able to :

- identify the gaps in the existing product range of PUs requiring a new range of products (including MG) to be designed, developed and manufactured.
- suggest substantial modifications to the existing products to cater for revised customer requirements.
- collaborate with IR Production Units regarding modifications to be carried out on prototypes developed for export, based on field trials.

The results of these collaborative efforts have been highly successful. RITES has made strategic entry into Francophone MG countries in West Africa such as Senegal, Mali & Benin whose terms of reference were hitherto European rolling stock manufacturers and technology. Similar demand for IR locomotives has been generated in Angola, Mozambique and Democratic Republic of Congo (Cape Gauge systems).

The recent project exports include:

- Five new 2300 HP Cape Gauge locos to Sudan.
- Three new Cape Gauge YDM4 & 10 in-service YDM4 locos to Sudan.
- Four new 2300 HP MG locos to Mali and Senegal.
- Eighty MG passenger coaches to Senegal & Mali.
- Two new 2300 HP Cape Gauge & one YDM4 Cape Gauge loco to CFM railway, Angola.
- Forty-one Cape Gauge passenger coaches to CFM railway Angola.

- Two Cape Gauge Diesel Multiple Unit train-sets to CFM railway Angola.
- One self-propelled Cape Gauge Accident Relief Train to CFM railway Angola.
- Eleven new YDM4 & 36 new MG coaches to Myanmar.
- Twenty in-service YDM4 locos to Myanmar.
- Three in-service YDM4 locos to Benin.
- Six in-service Cape Gauge YDM4 loco to CDN railway, Mozambique.
- 3000 HP Cape Gauge loco for Mozambique.

### **Ongoing Export Projects**

These include:

1. Supply of fifteen BG High Horse Power DMU train-sets to Sri Lanka. These DMUs with aerodynamic profile will have stainless steel shell structures similar to LHB type coaches (with narrower width), with FRP interiors and toilets; to be manufactured by Integral Coach Factory (ICF).
2. Supply of four air-conditioned MG DMU train-sets to PTB Railway, Senegal to be manufactured by Rail Coach Factory (RCF).

***Both these projects are prestigious export projects with a number of innovative design features.***

### **Design and Development Projects**

The noteworthy design & development projects undertaken for customizing project exports include:

- 2300 HP MG loco with air-conditioned cab for Malaysia (2002). This was the first loco with air-conditioned cab inducted in Malaysian Railways (KTMB).
- YDM4 loco fitted with Cape Gauge bogies for African market.
- Double-cab MG YDM4 loco for Bangladesh.
- 2300 HP Cape gauge locomotive for African countries. This design was a modified design of the highly successful 2300 HP MG locomotive designed for Malaysia.

- 2300 HP BG locomotives with shorter wheel base and superior curve negotiability for Sri Lanka.
- Five different types of Cape Gauge passenger coaches including first class (sleeper & day coaches), second class (day coach) , luggage-cum-brake van and restaurant car for Angola.
- Three-coach set Cape Gauge Self-Propelled Accident Relief Train for Angola.
- Eight- coach set Cape Gauge Diesel Multiple Units (DMUs) for Angola.
- End-on-generation (EOG) MG day coaches for the first time for Senegal.
- MG Restaurant Car for Mali.
- 3000 HP loco for Cape Gauge. Primary focus is for Mozambique.
- Conversion of in-service BG WDM7 locomotive to Cape gauge 2300 HP locomotive.
- Design and development of High Horse Power BG DMUs with narrower width, stainless steel shell structures of LHB type, aerodynamic nose profiles, FRP interiors and toilets.
- Design and development of AC MG DMUs.

Many of the above-mentioned projects were greenfield projects started from scratch and based upon the functional and operating requirements of foreign railways. Other projects were based upon the feedback received by RITES from overseas project offices manned by IR personnel.

### **2300 HP MG Loco and Cape Gauge 2300 HP Loco**

New design and development features in 2300 HP MG locomotive for Malaysia in 2002 and for Cape Gauge 2300 HP locomotive for Sudan in 2007 include first-ever air-conditioned driving cabs in Malaysian Railways, high efficiency turbo-supercharger of ABB make, traction Motors fitted with roller bearing suspension bearings, and nickel cadmium batteries. It also has pressurised control compartment, Air Drier unit for better reliability of Air brake valves, secondary suspension system for bogies with superior riding quality and 251 plus cylinder heads with superior thermal characteristics. Improved Engine Air intake system, Panel mounted Air Brake Valves for easy maintainability and use of Control and Power Terminals Boards for better maintainability are also some new features which have been provided in these locos. Induction of

twin beam headlights for better visibility and reliability, Electro-pneumatic compressor governor, special driver's seat with superior ergonomics, comfort and pneumatically controlled height adjuster, improved cooling arrangement for compressor inter and after-cooler air, venting arrangement of alternator exhaust air to reduce engine room temperature and development of improved and standardised bogie frames for Cape Gauge 2300 HP locomotives are some of the new features on these locos.

### **3000 HP Cape Gauge Loco**

Design features for 3000 HP Cape Gauge locomotive for Mozambique include development of Cape gauge bogie frames for 3000 HP locomotive, Microprocessor control for excitation & propulsion, controls & wheel creep, air-conditioned driver's cab (with RMPU) fitted with refrigerator and hot plate and ergonomically designed cab interior similar to GM locomotive layout with powder coated stainless steel finish. It also has stick type master controller similar to GM loco design, and uses ABB turbo-supercharger with fuel efficient modified camshafts and steel cap pistons with 251 plus cylinder heads. Roof mounted dynamic blower motor, use of inertial engine air filters and inertial self-cleaning type car body filters, centrifugal oil cleaner in lube oil system and use of GE 761-ANR Traction Motors with roller bearing suspension are some of the new features added to the loco. Further, microprocessor based engine governor, high tensile CBC and draft gear, IGBT inverter based AC small motors for crank case and fuel pump, E-beam cables for better insulation and strength and higher thermal capability, LED type marker lights and flasher lights are part of its new specification.

### **IR YDM4 Loco for Export**

Design of the standard IR YDM4 locomotives was upgraded to improve fuel efficiency, maintainability, and aesthetics for export with introduction of AC/DC transmission and "E" type excitation system for all new YDM4 export locomotives. Introduction of fuel-efficient engine with ABB Turbo and modified camshafts with 140° overlap, use of steel cap pistons and 251+ cylinder heads with superior thermal characteristics and ergonomically designed driver's cab was also done.

Modification of brake piping system and induction of panel mounted air brake systems, induction of microprocessor controlled speed recorders, modified air intake filtration system by provision of cyclonic air filtration system, modified YDM4 bogies with two-stage suspension by fitment of hydraulic shock absorbers in place of friction snubber assembly arrangement for Vietnam locomotives and modification of locomotive couplers with fitment of CBC couplers instead of ABC couplers are also some new design features added to this loco. Further, fitting of Vigilance Control Device, improved design of cattle guards and stainless steel hand rails, use of Nickel Cadmium batteries, use of polyurethane painting, use of twin-beam headlights, LED marker lights, driver's reading lights, design and development of fabricated locomotive bogies to suit Cape

Gauge, modification of air intake for air compressor, retro-fitment of improved stand-alone filter for air compressor, re-design and sealing of locking arrangement for engine room, compressor room and generator room to prevent ingress of sand and improved filter arrangement for dynamic braking grid compartment louvers to prevent sand ingress, are also included.

### **MG Coaches**

Innovative features of MG Coaches exported to Senegal and Mali in 2006-07 include design and development of End-on-Generation (EOG) MG coaches for the first time, design and development of MG air-conditioned restaurant cars for the first time, use of Stainless Steel pipes for Air Brakes, RMPU AC units for MG air conditioned coaches instead of underslung units, use of PE-AL-PE types of pipes for plumbing, high build epoxy application for special corrosion prevention, wide windows in AC coaches, central diffuser lights and stainless steel luggage racks.

There were design changes in MG coaches supplied to Myanmar in 2006 which included re-design of coach shell to shorter length of 55 ft. to suit operations on steep curves, re-design of couplers with fitment of CBC type in place of conventional ABC type, re-design of roof cavity in shell to accommodate top-loading of stainless steel water tanks and induction of ergonomically designed revolving-cum-reclining seats for upper-class and ordinary day coaches. These upper class coaches being revolving-cum-reclining type, are superior to conventional IR MG coach Upper Class seats. A 110V system for lights and fans instead of 24V DC system was also designed for MG coaches. Induction of electronic regulators for controlling ripples in electric supply, induction of low maintenance batteries and re-design of guard's brake van to accommodate Public Address Room and communication equipment were also some of the modifications done on the MG coaches.

### **Conversion of BG WDM7 Loco to Cape Gauge**

The conversion of in-service BG WDM7 locomotive to Cape Gauge 2300 HP locomotive was undertaken with the fitment of ABB turbo-supercharger with fuel efficient modified camshafts and steel cap pistons with 251 plus cylinder heads. Other features included use of microprocessor based governor, inertial air-intake system and Maotti-type maintenance free filters and GE 761-ANR Traction Motors. Further, Stick type master controller similar to GM loco design, microprocessor control and ergonomically designed driver's cab were also added.

### **Business Process Re-Engineering : Emerging Markets for Leasing & Rehabilitation of Locomotives & Rolling Stock**

#### **Leasing of locomotives**

In the continuing endeavour to expand railway business and showcase IR expertise, RITES Expotech Division has embarked upon an ambitious programme to

diversify its activities. Since 1997, leasing of in-service locomotives commenced in Tanzania with a contract for wet lease of ten in-service YDM4 locos for an initial period of three years. RITES stationed a small team of maintenance personnel in Tanzania for servicing the locomotives with guaranteed uptime availability of the locomotives for traffic use. ***This leasing contract marked the entry of DLW built diesel locomotives through RITES into Africa and:***

- generated subsequent demand in Sudan, Angola, Mozambique, Senegal, Mali and Benin for Indian Railway locomotive technology (MG and Cape Gauge).
- Demand for higher horse power diesel locomotives from India.
- Additional leasing contracts in other railway systems.

The leasing model was a phenomenal success and paved the way for disposal of a large number of surplus MG locomotives, either on outright sale or on lease. The Tanzania lease contract was renewed successively seven times till 2007 when the erstwhile Tanzanian Railway Corporation was transformed into Tanzanian Railways Limited (TRL), with RITES as the Concessionaire for 25 years. Currently, there are 25 YDM4 locomotives on lease with TRL, Tanzania. In addition, similar model has been adopted for 2 other railway systems, both in Mozambique, viz. CCFB & CFM(S) wherein, another fifteen Cape Gauge YDM4 (and one 2300 HP Cape Gauge) locomotives are in operation.

All leased locomotives are given a thorough overhaul in IR workshops/sheds with modifications and value addition done initiated by RITES. These include ergonomically re-designed cabs, fuel efficient kits with ABB turbos and modified camshafts, vigilance control devices, paperless speed recorders, retro-fitment of air brake, CBC couplers etc. Conversion to Cape gauge systems is done (if required), to give optimized service and these are inherently superior to the original YDM4 design.

Enquiries for lease of RITES locomotives have also been received from a number of other African countries.

### **Leasing of passenger coaches**

RITES has achieved another breakthrough with commencement of lease of twenty-three in-service MG coaches in Tanzania. These passenger coaches were completely refurbished in GOC workshop with superior interior fittings, furnishing, lighting and air-braked system before being shipped to Tanzania.

### Rehabilitation of Locomotives and Rolling Stock

One of the major emerging areas of business in the international market is rehabilitation of locomotives. RITES embarked on this route since 2005. The major locomotive rehabilitation projects undertaken are :

- a. Four Hitachi locomotives of Sudan at GOC workshop.
- b. Ten 73 class locomotives of Tanzania.
- c. Three 88 class locomotives of Tanzania.
- d. GE locomotive of CCFB, Mozambique.

#### 88 Class Loco

The rehabilitation of two 88 class locomotives (originally supplied by MLW, Canada) was done with its complete re-engineering and modifications undertaken at DMW, Patiala. The remaining locomotives will be rehabilitated in Tanzania where the engine will be upgraded from 2000 HP to 2300 HP. Engine blocks will be reclaimed by welding, stress relieving and machining of crankshaft & camshaft bores and liner seats. The locomotives will be fitted with steel cap pistons, fuel efficient cam shafts and ABB high capacity turbo-superchargers, with switchover to E type excitation, fitment of Dual control stands, high capacity compressors and panel mounted air brakes, use of air drier units, new radiator fan drives and complete re-wiring with E-beam power and control cables. Fitment of mechanically bonded radiators, plate type oil coolers and bag type air intake filters, use of centrifugal type lube oil system, paperless speed recorders with inbuilt memory, fitment of vigilance control devices and electronic water level indicators are the other add-on features, which will be undertaken.

#### Conclusion

Project exports undertaken by RITES have given a tremendous boost to highlight IR's expertise for re-engineering, design and manufacturing capability with value addition done by RITES to customize locomotives and rolling stock as per end user requirements. It has also given an opportunity to RDSO and Production Units/workshops to understand the operating and technical requirements of different railway systems in the world as well as for IR personnel to maintain locomotives and rolling stock in environments which are very challenging and quite different from Indian Railway conditions.

At present, MG locomotives and rolling stock enjoy a wide acceptability in African markets as well as a revival in Asian markets. In addition, for the first time, a brand new product range manufactured by IR Production Units has been developed for Cape Gauge systems. A niche market for cost-effective exports has been established in Cape Gauge countries for locomotives, passenger coaches and Diesel Multiple Units manufactured in IR Production Units and maintained by RITES.

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**Wagons Before & After Rehabilitation in Cambodia**



**Phosphate Carrying Wagons in  
Tunisian Railways (SNCFT)**

**Passenger Coach  
for Vietnam**



**BG loco exported to  
Bangladesh**



**2300 HP Loco for Malaysia  
(KTMB)**

**3000 HP Cape Gauge Loco  
for CFM, Mozambique**



**RITES Supplied 2300 HP Loco &  
Coaches in Inaugural Run, Angola**

**First Class Day Coach  
(Cape Gauge), Angola**





**Inside Views of Restaurant Car for PTB Railway, Senegal**



**Leased YDM4 in Tanzania**

**Cape Gauge YDM4 Loco in operation  
in Mozambique**



**Hitachi Loco  
Before Rehab**



**Hitachi Loco  
After Rehab**



**73 Class Loco Before Rehab**

**73 Class Loco After Rehab**

