GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

DRAFT FUNCTIONAL REQUIREMENT SPECIFICATION
FOR

DESIGN, MANUFACTURING, SUPPLY AND SUPPORT FOR SERVICE AND MAINTENANCE OF HIGH HORSEPOWER NATURAL GAS TURBINE LOCOMOTIVE (HPNGTL) FOR INDIAN RAILWAYS (IR)

Specification No. TS/ED/2011/59 of July 2012

Engine Development Directorate
Research Designs & Standards Organisation
Manak Nagar, Lucknow, U.P., INDIA – 226 011

1.0 INTRODUCTION:

RDSO, Lucknow is planning to develop a high horsepower gas turbine based locomotive for heavy-haul and long haul goods train operations for shortly coming up dedicated freight corridors of Indian Railways. The need for development of high horse power gas turbine based locomotive is mainly due to availability of large reserves of Natural Gas (NG) in India (with new finding of sources being reported regularly), which would facilitate the easy availability and self-dependency of combustible fuel. Additionally the current market price of NG is much lower than Diesel price, which is currently used as traction power to haul existing freight trains. It may also be kept in mind that 80 % of crude petroleum is being imported on date by India. The price of this crude oil is increasing very sharply over the last few years. It is also being forecasted that crude petroleum will last for only next 30-40 years .This makes it all the more important to go for development of a high horsepower locomotive running on alternate fuel ,which is preferably available in India to reduce loss of foreign exchequer.

The additional benefit offered by gas turbine locomotives are more than 50 % reduction in exhaust emissions as compared to present day diesel locomotives running in Indian railways. The operational and maintenance costs would be less due to the less moving parts. The next important factor to be kept in mind is that the Gas turbine locomotive offers best power to weight ratio for a power generator i.e. it is possible to generate 12000 hp only with gas turbine technology.

2.0 SCOPE OF WORK FOR DEVELOPMENT OF THE NGTL:

This specification covers design, manufacturing, supply and support for service and maintenance of High Horsepower Natural Gas Turbine Locomotive (HPNGTL) for Indian Railways (IR). Primarily, the offered locomotive shall be used in the existing IR track to haul freight trains, thereafter, the locomotives to be operated on dedicated freight corridor. (Presently this dedicated freight corridor is under construction in India). After getting sufficient level of confidence / experience and recommendation by the loco designer of such a new concept locomotive, this technology will be further planned for mass scale production in India.

Existing bogie and underframe structure of Indian Railways WDG4 locomotive shall be offered for development of proposed NGTL to the firm qualifies for the NGTL project for Indian Railways. Further testing, maintenance, training to Indian Railways personnel, R&D work (if any to make the locomotive suitable for Indian Railways conditions) and all technical support shall be in the scope of qualified firm(s) willing on NGTL project for Indian Railways. After proving out of the technology/prototype for one year of its successful operation in Indian Railways, series manufacturing of the locomotive may be planned with the assistance (or partnership) of the firm(s) who developed the NGTL for India.

The completion of the project shall generally comprise of following main phases:-

- **i.** Phase-I: The firm shall submit details of the equipments to be used on the NGTL including their weight, footprint, envelope, center of gravity, mass moment of inertia, 3-D models to RDSO, other load conditions, boundary conditions etc. . RDSO shall carry out fitment simulation, vehicle dynamics simulation of these equipments on the WDG4 underframe and bogies for evolving a suitable design. The firm shall collaborate with RDSO during this detailed design and jointly approve the design so developed.
- **ii.** Phase-II: Prototype manufacture, testing and field trials/proving out.- Manufacture of the prototype shall be done at Diesel Locomotive Works, Varanasi. The gas turbine shall be tested at manufacturer test bed before fitment on the locomotive. For this purpose the firm shall supply the gas turbine and other associated equipments to Indian Railways pre-tested and with all valid certificates. IR personnel shall witness the testing of all the equipments. After locomotive testing, the satisfactory performance of the locomotive shall be certified jointly by RDSO and the firm.

iii. Phase-III: Operational and maintenance support by the firm for the codal life of the locomotive.

iv. Phase-IV: Serial production support as and when IR decides to take up serial production.

3.0 CREDENTIALS OF THE FIRMS DESIROUS TO DEVELOP NGTL FOR INDIAN RAILWAYS:

Following are the expected credentials of the firms desirous of participating in this Project for Indian Railways:

1. The firm should have sufficient experience in the design, development, manufacture of LNG/CNG fuelled turbine based locomotive systems and subsystems of capacity not below the requirement of the specification. Such locomotive should have been in successful service for a minimum period of 18 months anywhere in the world. Successful here implies no major failures or breakdowns of the locomotive.

2. The firm should justify capability of design, development, and manufacture of LNG/CNG fuelled turbine locomotive system and its subsystem with its partner(s) (if any). The firm should submit suitable proof of formal agreements and/or partnerships with other such organizations with whom it proposes to undertake the development work. This inter-alia means that collectively the interested firms should have the requisite expertise in the design and development of the offered gas turbine based locomotives including its manufacturing unit/base.

3. The firm along with its partners should have necessary expertise in the following areas:-
   - i. Design of the various subsystems and its elements of the LNG/CNG fuelled turbine locomotive system.
   - ii. Should have sufficient manufacturing, programming, integration and troubleshooting capabilities for hardware and software production.
   - iii. Should have designed and developed similar LNG/CNG fuelled turbine locomotive engines.
   - iv. Should be willing to support the Indian Railways program for the development of the LNG/CNG fuelled turbine systems for the Indian Railways through all Phases as mentioned in scope of the work for development of the project.
   - v. The firm should not have been indicted by any court of law or any regulatory body or any state/central government agency in India.
   - vi. Should be of sound financial standing.

4.0 DISQUALIFICATION:

Indian Railways would like to caution that the respondents shall be ineligible to bid for or participate for development of the project in any one of following cases:-

In regard to matters relating to the security and integrity of the country, any charge sheet by any agency of the government or conviction by a court of law for an offence committed by the company or any sister concern of the company would result in disqualification. The decision in regard to the relationship between the sister concerns would be taken by Indian Railways, based on the relevant facts and after examining whether the two concerns are substantially controlled by the same person/persons.

In regard to matters other than security and integrity of the country, any conviction by a court of law or indictment/adverse order by a regulatory authority against the company or against any sister concern which relates to a grave offence, or would constitute disqualification. Grave offence is defined to be of such a nature that it outrages the moral sense of the community. The decision in

regard to the nature of the offence would be taken on case to case basis after considering the facts of the case and relevant legal principals by Indian Railways.

In regard to matters of International Trade, any conviction by an International Agency like U.N or any other Government besides the Government of India, against the company or against any sister concern which relates to grave offence, or would constitute disqualification.

5.0 DESIRED SYSTEMS ALONG WITH ITS FEATURES REQUIRED FOR NGTL:

(i) The offered system and corresponding subsystem along with their element of proposed NGTL shall be designed to comply with the latest issues of the appropriate International standards satisfying all design/simulation criteria/safety and operational requirements. Safety in all respect shall be given of prime importance, so firm(s) shall take this into an important factor while finalizing the system/subsystem and corresponding various elements for the locomotives in Indian conditions. The safety standards incorporated in the design of the locomotives shall also be clearly indicated in the respective design and also in the offer.

(ii) NGTL offered for Indian Railways shall generally be equipped with following subsystems like:

Gas Turbine Engine (GTE), LNG Carrier Vaporizer, Air intake system, Exhaust duct and Exhaust duct noise suppression system, Control System, GTE Air cooling system and Oil system of gas turbine and generator bearings, Loco Control System, Alternator, Traction Motors, Blow off circuit, engine oil cooling system and lubrication system, AC-AC traction propulsion system, inlet air purification system, are to be developed for gas turbine locomotives for Indian Railways. The features of these sub system should preferably be in line with, as indicated in brief in following paragraphs.

Gas Turbine Engine (GTE):
Capable of delivering minimum 8.3 to 9 MW engine max. Output.
Minimum efficiency of GTE at full load condition 30 %. Higher efficiencies shall be preferable.
Gas turbine shall have electric start system facility.
Monitoring and diagnostic sensors of GTE are to be integrated with locomotive control system.
Gas turbine structure to have provision of inspection holes for facilitating visual inspection of gas air duct and to facilitate easy accessibility of routine maintenance parts.
GTE should be having inlet air purification device, inlet device, low pressure axial compressor and high pressure compressor, combustion chamber, a high pressure turbine, low pressure turbine, a turbine support and a power turbine, heat exchanger, exhaust device and blow off circuit.

LNG Carrier:
Size of the LNG tank with required accessories should be designed to suit the long hood of WDG4 locomotive under frame. It should be within MMD listed at annexure 1.
Locomotive should be capable to give a minimum lead of 800 Km with full tank.

Vaporiser:
Should be able to convert LNG into CNG with minimum loss of heat. The gas to fuel heat exchanger should be installed downstream of power turbine of the engine and be able to provide fuel vaporization under all the gas turbine operating conditions.

Air intake system:
Inlet Air purification system to be designed as independent part of the power unit. This system to be designed to purify air as per engine need. Engine continuous operations to be ensured in case of marginal filter clogging. Air inlet helix lemniscates and the helix itself to be designed of very light material for reduction in weight.

Exhaust duct and Exhaust duct noise suppression system:
Exhaust and exhaust duct noise suppression system to be designed for providing exhaust gases smooth deceleration and suppressing exhaust noise so that the level of a locomotive external noise does not exceed the required values. Design should take into account that its profile should not adversely affect the effectiveness of power unit.
Exhaust system design should also include a heat exchanger for gasification of LNG.
The locomotive shall be designed that noise level should not be more than 60 dBA. The international standards followed for measurement of noise suppression shall also be indicated in the offer.
The exhaust gas temperature measured at 1 m distance from exhaust grid at maximum power rating not to exceed 300 deg C.

Control System:
Diagnostic and control system for GTE to be microprocessor based and integrated with the gas turbine control system.
Design should provide regulation of GT assigned operating conditions and limiting of the critical parameters according to rotor speeds and turbine gas temperature.
Gas turbine engine should be instrumented with adequate number of sensors whose signals are transmitted to the integrated diagnostic and control system on real time basis.

GTE Air cooling system and Oil system of gas turbine and generator bearings:
A blow off circuit may be suitable designed for preventing excessive air heating in GTE high temperature stator parts. A suitable low pressure air feed to be taken from locomotive central air system. Suitable engine oil cooling system to be designed for cooling and lubrication of bearings, gearings and contact seals in assemblies of rotor supports and accessory gear boxes at all engine power settings. Suitable capacity Oil tank to be suitably located on under frame. Oil to be cooled by using cooling capacity of cryogenic fuel gas. Oil cooling system for cooling and lubrication of generator journal bearings is also to be designed with appropriate pumping mechanism. Suitable capacity oil tank to be suitably located on under frame for this purpose.

Loco Control System:
Loco Control System should be equipped with a microprocessor-based control system.
This system shall also be capable to monitor and control locomotive traction power and dynamic braking including GTE power, and critical parameters of the equipment and its sub systems installed in the locomotive, records and indicates faults, and enables to diagnose testing of certain locomotive systems. This system shall also be capable to display panel mounts in the locomotive cab, which also includes a keypad an important interface between the locomotive crew and the locomotive control system.

AC-AC Propulsion system:
The locomotive should be equipped with 3-phase AC-AC transmission system employing propulsion based preferably on IGBT technology. This system to be integrated with loco control system employed for loco operation.

Alternator:
Generator capable of delivering minimum 8.5 to 9.5 MW.
Alternator should be mechanically coupled with GTE and foot mounted. The proposed alternator shall be capable of matching with gas turbine output at different notch positions to deliver the output as per requirement. Alternator should have very high reliability and be highly safe. Alternator should have support thermal state sensors-integrated with gas turbine locomotive health monitoring system.

Traction Motors:
The three-phase asynchronous induction motors of WDG5 EMD design locomotive or WAG9 ABB design locomotive to be preferably used for this locomotive.

Technical data of the motors is attached at annexure-3/1 and 3/2 respectively.
RDSO will provide all relevant information once the motor is accepted by the designer of NGTL.
In case the proposed motor by RDSO does not match with loco performance curve, in that case firm may propose their own motor. In that case technical data / traction motor characteristics curve shall also be submitted to RDSO for evaluation.

(iii) The designed NGTL should also incorporate suitable advanced technologies for driver's information, such as locomotive health monitoring (self-diagnostic feature at start and during operation).

(iv) Locomotive should be designed with keeping safety in mind for human being, environment, human error, and failures; complying with latest relevant Industry and International standards. The locomotive, engine, and various systems should be tamper proof. The firm is expected to offer the state-of-the-art NGTL which would meet or exceed the project goals.

(v) Firm may propose their own configuration (subsystem) provided the locomotive of that design have performed successfully of at least 18 months service anywhere in the world and rating of locomotive shall not be less than the requirement indicated in the specification. Technical information of new system if any, shall be submitted to RDSO.

(vi) The firm shall submit details of the equipments to be used on the NGTL including their weight, footprint, envelope, center of gravity, mass moment of inertia, 3-D models to RDSO, other load conditions, boundary conditions etc. . RDSO shall carry out fitment simulation, vehicle dynamics simulation of these equipments on the WDG4 underframe and bogies for evolving a suitable design. The firm shall collaborate with RDSO during this detailed design and jointly approve the design so developed.

(vii) The firm has to submit equipment specification of major equipment including their capacities, ratings, requirement of working conditions and other relevant information, Test scheme of different equipment including their acceptance criteria and methodology of testing, test scheme of the locomotive for carrying out 'Loco commissioning test', 'Oscillation trial scheme' and 'validation schemes' and, special operational requirement if any to be submitted to RDSO for approval before starting of manufacture of the equipment for the NGTL project of Indian Railways.

(viii) Firm has also to disclose the safety measures considered in design of the equipment and locomotives offered for IR. Any different / special acceptance criteria for the equipment and for gas turbine locomotive followed in their country (or supplied to other country) are also to be disclosed. Any other relevant information / report, if required shall also to be submitted to RDSO. After scrutiny of the information, clearance for prototype manufacture may be granted to firm.

6.0 REQUIREMENT FOR DEVELOPMENT OF NGTL FOR INDIAN RAILWAYS:

i. The operating speed of the locomotive shall be 100 KMPH and the trial speed shall be 110 KMPH with new wheel of 1092mm diameter.

ii. The Maximum moving dimensions for BG rolling stock to be considered for NGTL of Indian Railways is enclosed in the specification at Annexure-1.

iii. The maximum axle load of the locomotive should not exceed 20.32t

iv. The existing track condition and site condition of Indian Railways is attached at Annexure-2

v. The firm should specify the details of the other information, data and drawings needed from Indian Railways for development of the NGTL.

vi. The existing traction motor of WDG5 / WAG9 locomotive shall be offered to the successful tenderer to work out its suitability for NGTL locomotive. The characteristics curves and rating of the motor is given in Annexure-3. In case motor is not suitable, it shall be apprised to RDSO.

7.0 GENERAL REQUIREMENT OF NGTL TO BE FURNISHED BY THE FIRM TO INDIAN RAILWAYS:

i. Details of the equipments to be used on the NGTL including their weight, footprint, envelope, center of gravity, mass moment of inertia, 3-D models to RDSO, other load conditions, boundary conditions etc. Specific fuel consumption notch-wise and characteristics curves of gas turbine engine to be provided by the firm to RDSO for evaluation of engine performance. It is also necessary to indicate output shaft speed (in r.p.m) at which useful service output is developed.

ii. Experimental emission data at all notches and different load and rpm obtained at test bed to be provided by the firm to RDSO. The locomotive should at least comply US EPA tier 4 norms.

iii. Various Maintenance schedules of all subsystem and their equipments of the locomotive shall be furnished and covering all important activities; like requirement of manpower-hour, periodicity, consumables and spares, inventory and their source of procurement. Codal Life of the locomotive including various equipments are also to be specified. Details of special tools and jigs/fixtures required if any, for the maintenance of the Gas turbine locomotive shall also be submitted. The successful tenderer has to submit these information in broad terms to RDSO.

iv. Reliability and Availability: The firm to quote the expected reliability and availability of the complete locomotive. However the reliability and availability of locomotive will be evaluated during trial and operation of the first prototype locomotive in India over 2 years period.

v. Gas turbine control system to be integrated with locomotive control system. Data for specific fuel consumption of NGTL, notch wise fuel consumption per hour and minimum distance covered by locomotive with full tank should be provided.

vi. The firm has to elaborate on the infrastructural requirement for setting up of a refilling station needs for re-feeding of the fuel to NGTL.

vii. The mounting of LNG tank and allied accessories have to be worked out preferably on WDG4 under frame/bogie, details of fitment to be submitted to RDSO for approval.

viii. Transmission coupling between 'turbine engine' and 'alternator' should be rigid and capable to transmit the rotational torque without/ with minimum transmission loss. Allowable limits of radial, axial and angular displacements of shafts of transmission coupling to be furnished to RDSO for approval.

ix. Firm has to disclose the safety norms incorporated / considered for design of LNG carrier and GTE. Major safety features of the LNG bullet and GTE to be clearly brought out in the report. It should also comply the latest international safety standards.

x. The offered equipments of all subsystems shall be designed on state of art technology and to comply with the latest appropriate International standards satisfying all the design, operational and safety requirements.

xi. Break-up of the power absorbed by auxiliary machines shall be furnished in the offer. Design should be such that the absorption of the major portion of power by auxiliary machines shall be taken directly from gas turbine engine, so that maximum utilization of traction power from Traction Alternator could be used for traction application.

xii. 'Lubrication oil system' for Gas turbine engine and for other major equipment shall be indicated in the offer. The system should include the information like capacity of lubrication circuit, dissipation of the heat power by lubrication oil and lubricating oil temperature at rated output, oil pressure, power consumption etc.

8.0 FUEL FOR GAS TURBINE ENGINE:

The fuel to be supplied for fuelling of NGTL locomotives shall be LNG. Chemical composition of the supplied fuel shall generally lie in range as indicated in table-1. The equipment which has to work directly under the such fuel or product of these burnt fuel, shall not degrade the equipment proposed for NGTL for Indian Railways application.

Table-1

Sl.No.	COMPONENTS	LNG Composition Range (mole %)
1.	Methane	83 to 99
2.	Ethane	0.3 to 12.0
3.	Propane	0.2 to 3.6
4.	Iso Butane	0.1 to 1
5.	N-Butane	0 to 0.1
6.	N2	0.03 to 1.40

9.0 PROTO-TYPE DEVELOPMENT, TESTING AND PRODUCTION:

The firm is expected to follow the following path for prototype design and development.

1. Project plan: Submission of technical information as indicated in details at Para no. 12 of this specification required to develop such new technology based locomotive for IR.

2. Literature: Submission of Books, equipment Catalogues/ specification detailing of system and subsystem, etc. in soft and hard copies.

3. Manufacture of prototype locomotive. Building of the locomotive shall be carried out at Diesel Locomotive Works, Varanasi, India based on the manufacturing plan submitted by the firm. All required infrastructure shall be worked out jointly with the firm(s) and RDSO at Diesel Locomotive Works, Varanasi, India. Accordingly plan will be exercised for development of infrastructure required to build the said locomotive in India. The infrastructure for testing of locomotive at Diesel Locomotive Works, Varanasi, India shall be worked out jointly with the firm.

4. Loco Commissioning Trial: Loco Commissioning Trial on the prototype shall be conducted at DLW.

5. Field Trial: Field trials in actual operating condition in India as per the mutually agreed test schedule.

6. Operation and maintenance support: Operation and maintenance support for running of Locomotive is to be provided by the firm for initial two (02) years of the warranty period.

7. All necessary documents, such as, Design manual, Operating manual, Instructions, Maintenance manual, Safety manual, complete parts list with their sources of supply, etc to be provided by firm.

8. Serial production plan: Optimized design has to be arrived at after successful service trial of locomotive for one year in India. Serial production plan of these locomotives may be planned in India after obtaining fresh sanctions from Railway Board.

10.0 TRAINING AND INSPECTION:

(i) The firm shall provide all necessary training to Indian Railways personnel in the new technology at their premises. The firm shall train Indian Railways personnel in operation and maintenance of NGTL. The cost of such training should be included in the submitted budgetary quotation response to this project. Expenses for travel (excluding local travel), boarding and lodging of the Indian Railways personnel shall be borne by Indian Railways.

(ii) The firm shall also develop a test scheme for various major elements of the NGTL and submit it as a part of the project development. Type tests of major equipment(s) shall be witnessed by the RDSO team at manufacturer premises at their cost. RDSO team may be supported by GTRE/Bangalore or HAL Nasik team during testing of GTE.

(iii) The firm shall also develop a stage wise inspection plan identifying interim stages needing inspection by Indian Railways team and submit the plan to RDSO.

The firm shall also formulate and submit an inspection plan and acceptance criteria for complete NGTL before beginning of the field trial during loco commissioning test. The testing shall be witnessed by RDSO and supported by GTE/Bangalore or HAL Nasik team. The test scheme shall be drawn up by the firm and to be submitted to RDSO for approval.

(iv) The prototype kit will be dispatched from supplier's works after the clearance by Indian Railways team. The assembly of prototype kit will be done at Diesel Locomotive Works, Varanasi, India. The firm has to arrange 800 man days of training of Indian Railways officials at their manufacturing premises. One person undergoing 8 hours of training will be treated as one man day.

11.0 WARRANTY:

The supplier shall provide all inclusive warranty for the prototype NGTL manufactured to be free from all defects in design, material and workmanship for a period of two years. The supplier shall, at their expense, replace any part of the system failing or proving unsatisfactory in service, due to any reason whatsoever as determined by Indian Railways, up to a period of two years from the date of it's commissioning into service. The supplier must effect the replacement under the warranty/guarantee as early as possible, but not later than 30 days of the failure and the warranty for the complete NGTL shall stand extended, by the period that is taken to effect the replacement.

12.0 PAYMENT TERM:

The payment terms shall generally be in accordance with the Indian Railways Standard Conditions of contract in accordance with stage wise development of the project. The stage wise development of the project has been divided in 5 main activities and their details are given as below:-

(i) Phase-I: Approval of Detailed Project Plan:- The firm shall submit details of the equipments to be used on the NGTL including their weight, footprint, envelope, center of gravity, mass moment of inertia, 3-D models to RDSO, other load conditions, boundary conditions etc. . Thereafter, RDSO shall carry out fitment simulation studies, vehicle dynamics simulation of these equipments on the WDG4 underframe and bogies for evolving a suitable design. The firm shall collaborate with RDSO during this detailed design and jointly approve the design so developed. Once the design is approved; specification of major equipment including their capacities, ratings, environmental condition of their safe working and other relevant information to be submitted to RDSO. Test scheme of different equipment including acceptance criteria of test results and methodology of testing, test scheme of the locomotive for carrying out 'Loco commissioning test', 'Oscillation trial scheme' and 'validation schemes' and special operational requirement if any – to be submitted to RDSO for approval before starting manufacture of the equipment for the NGTL project of Indian Railways. Firm has also to disclose the safety measures considered in design of the equipment and locomotives offered for IR. Any different / special acceptance criteria for the equipment and for gas turbine locomotive followed in their country (or supplied to other country) are also to be disclosed. Any other relevant information / report / operational condition, if considered in the design of equipment for the offered locomotive for IR shall also be furnished to RDSO. After scrutiny of the information/ submitted document clearance for prototype manufacture may be granted to firm.

(ii) Phase-II: Prototype manufacture, testing and field trials/proving out.- Manufacture of the prototype shall be done at Diesel Locomotive Works, Varanasi. The gas turbine shall be tested before fitment on the locomotive. For this purpose the firm shall supply the gas turbine and other associated equipments to Indian Railways pre-tested and with all valid certificates. IR personnel shall witness the testing of all the major equipments. After locomotive testing, the satisfactory performance of the locomotive shall be certified jointly by RDSO and the firm.

(iii) Phase-III: Operational and maintenance support by the firm for the codal life of the locomotive.

(iv) Phase-IV: Serial production support as and when IR decided to take up serial production.

The schedule of payment shall be as under for various Phases as explained below:

S.No.	Activity	Payment in % of accepted Tender Cost
1	PHASE I	Not more than 5% of accepted cost
2 3	PHASE II (i) Proving out of locomotive at DLW after 'loco commissioning test' (ii) Successful field results of oscillation trial.	 Not more than 75% of accepted cost Not more than 20% of accepted cost

4	PHASE III After completion of Warranty.	Release of 10 % bank guarantee.

Note: Tenderer would need to provide a Bank Guarantee for 10 % of the total accepted cost for the supplied NGTL for which payment has been claimed from Indian Railways, before claiming payment. This Bank Guarantee shall be in vogue for the period of contract and shall be released only after successful completion of warranty period.

13.0 ANNUAL MAINTENANCE CONTRACT AND SPARES:

(i) The complete responsibility for maintaining and supplying of spares and consumables to run the locomotives successfully shall lie with the scope of the firm under the period of warranty. In support of maintaining the locomotive, a team of service engineer (s) to be deputed in India, where the locomotive is to be maintained. Other supports as desired by the team shall be provided by IR officials.

(ii) After completion of first two year of warranty period for successful operation of the locomotive in India, firm has to submit the cost of annual maintenance contract on tri yearly basis, which will be extended regularly. The successful tenderer also has to commit to Indian railways that it will ensure constant and un-interrupted supply of spares and provision of maintenance services for the stipulated codal life of the locomotive.

(iii) In case of irreparable / completely damaged equipment (after warranty period) the firm has to supply/arrange the same to Indian Railways for its fitment in the locomotive. Any design change of the supplied equipment shall be informed to RDSO well in advance.

14.0 CONFIDENTIALITY OF DEVELOPMENT:

All data that is generated as a result of development and testing of the NGTL shall automatically become the sole property of Indian Railways. No part of such information shall be disclosed to any third party without prior written consent of Railway Board, Ministry of Railways, Government of India.

15.0 INTELLECTUAL PROPERTY RIGHTS (IPR):

Undertaking by manufacturer / supplier of GTE. All specification, drawings issued by RDSO shall include a requirement of undertaking to be signed by successful tenderer on "INFRINGEMENT OF PATENT RIGHTS". The undertaking can be as under-

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process use of similar components in design & development of this item and any other factor not mentioned herewith may cause such a dispute. The entire responsibility to settle any such dispute/matters lies with the manufacturer/ supplier.

Details / design / documents given by them are not infringing any IPR and they are responsible in absolute and full measures instead of Indian railways for any such violations. Data, specification and other IP as generated out with Indian railways shall not be unilaterally used without the consent of RDSO and right of Indian railways / RDSO on such IP is acceptable to them.

16.0 DECLARATION OF CONFIDENTIALLY OF SUMBITTED DOCUMENTS BY FIRM (S) SUPPLIES LOCOMOTIVE:

This document and its contents are the property of M/s XYZ (Name of the firm that develops GTE for Indian Railways) or its subsidiaries. This document contains confidential proprietary information. The reproduction, distribution, utilization or the communication of this document or any part thereof, without express authorization is strictly prohibited. Offenders will be held liable for the payment of damages. Indian railways/RDSO is granted right to use, copy and distributes this document for the use of inspection, operation, maintenance and repair etc.

17.0 INFORMATION NEEDED FROM INDIAN RAILWAYS

The successful tenderer may ask the specific information, drawings etc. from RDSO for its use as a reference document for development of the project with prior acceptance of non-disclosure agreement of these documents, if provided by RDSO.

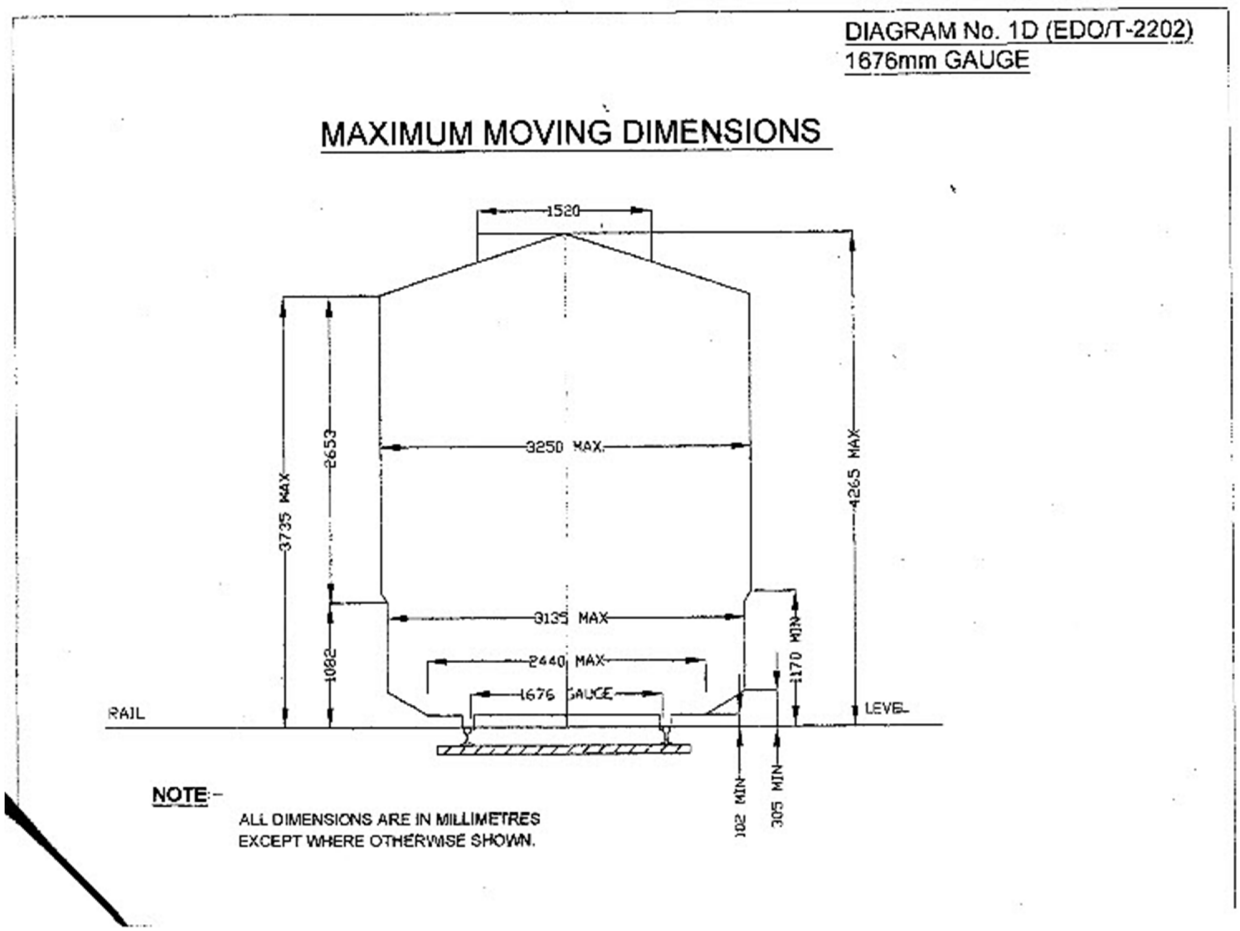
18.0 PROCEDURE FOR LOCO CERTIFICATION:-

Following procedure shall be adopted for certification of the firm of supplied gas turbine locomotive to Indian Railways:-

1. Evaluation of the proposed design from the point of view of performance, operation, safety, reliability, consumption of fuel, maintenance, consumables and spares etc.
2. Type testing of prototype of major equipment developed/offered by firm and scrutiny of the test results.
3. Modifications, if required based on test results - shall have to be carried out by the firm for re-type testing.
4. 'Loco commission test' of the Locomotive at Diesel Locomotive Works, Varanasi, India to be carried out. The test schedule, methodology of tests and acceptance criteria of the tests shall be furnished by the firm to RDSO for review and approval.
5. Modifications, if considered necessary on the locomotive or on any component/ subsystem based on the test results after 'loco commissioning test shall be carried out by the firm again till satisfactory response.
6. Test results / performance curves with the design curve/data earlier provided by the firm in support of appreciation of their design shall be studied mutually with the firm and Indian Railways officials for validation of the system and NGTL.
7. Detailed Field trials on the prototype for confirmation of stability and riding quality under different track condition and speeds shall be conducted as per guidelines laid down in 3rd criteria committee report of RDSO. Final clearance for operation of the Locomotive shall be issued by Motive Power Directorate of RDSO after getting successful field trial results.
8. Reliability and availability of the Locomotive shall be evaluated for minimum successful service period of 1 year in Indian Railways.

19.0 LIST OF ANNEXURES:

Annexure-1 MMD
Annexure-2 Existing track condition and site condition related to Indian Railways
Annexure-3 Characteristics curves of Traction motor



Note: Dimension 3135 is under consideration to 3050.

1.0 REFERENCE FOR SITE CONDITION:

i) Ambient Temp. 50 ° C
iii) Inlet air temp. for traction motors 55 ° C max.
iv) Altitude 600 Meters

Rainfall: Very heavy in certain areas (100% saturation during Monsoon in certain areas). Atmosphere during hot weather: Extremely dusty and desert terrain in certain areas. The NGTL offered shall be designed to work in coastal areas in humid/salt laden atmosphere.

2.0 EXISTING TRACK CONDITION RELATED TO Indian Railways:

Vibrations and shocks**:** The offered TM is capable to withstand the vibrations and shocks in service are as below:

i) Max. Vertical acceleration - 2 g
ii) Max. Longitudinal acceleration - 3.5 g
iii) Max. Transverse acceleration - 1.5 g
('g' being acceleration due to gravity)

Track Parameters:

1.	Gauge Broad Gauge (BG)	1676 mm (nominal)		
2.	Track structure	The track is to a standard of 60 kg, 90 UTS rails on Pre-stressed concrete sleepers of 1660 per km 300 mm depth of ballast cushion below the sleepers. Or 52 kg, 90 UTS rails on Pre-stressed concrete sleepers of 1540 per km 250 mm depth of ballast cushion below the sleepers		
3.	Sharpest curve and turn out to be negotiated	174 m radius. A locomotive is checked for passage in both directions over standard BG 1 in 8.5 turnout. Vogel's layout or its internationally accepted equivalent for negotiability, throw over at head stock & coupler movement with details of clearances.		
4.	Maximum Super elevation	185 mm		
5.	Maximum cant deficiency	100 mm		
6.	Clearance above the rail level	The locomotive shall be so designed that no component shall infringe minimum clearance of 95 mm above rail level with the locomotive fully loaded and wheels in fully worn condition		
7.	Permissible track tolerances		BG Main Line	BG High Speed Route(C&M 1 Vol 1)
		Unevenness (3.6 m base)	< 15 mm	< 10 mm
		Twist (3.6 m base)	< 2.78 mm/meter	< 2.08 mm/meter
		Gauge variation	<± 6 mm	<± 3 mm
		Alignment (versine on 7.2 m chord)	< 5 mm	< 5 mm
		Gauge widening:		
		On curves of > 350m radius	-5mm to +3mm	
		On curves of < 350m radius	Up to +10mm	

Annexure-3/1

Technical Data / Rating of the Traction motor used in WDG5 Locomotive governed by RDSO Specification No.MP.0.2400.72 (Rev-00), Sep-2010:

Sl.No	Parameter	Value
1.	Nominal stall torque	10811 Nm
2.	Nominal continuous torque	7960 Nm
3.	Maximum RMS VL-L	1910 V
4.	Maximum (Continuous) RMS current.	267 A
5.	Input Electrical Power	645 KW
6.	Maximum permissible over speed	3320 rpm
7.	Circuit	Y
8.	Insulation *c*lass	200 ºC

Annexure-3/2

Technical Data / Rating of the Traction motor used in WAG9 Locomotive governed by CLW document No 4TMS.096.069 dated june-2008. :

Sl.No	Parameter	Rated Point	Maximum
1.	Stator Frequency	65 Hz	132 Hz
2.	Motor Voltage (Phase to Phase)	2180 V	2180 V
3.	Stator Current	270 A	393 A
4.	Power Factor	0.88	---
5.	Torque	6330 Kw	9200 Nm
6.	Power	850 Kw	850 Kw
7.	Motor Speed at shaft	1284 / min	2584 / min