



GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS

Technical specification

For

Design and Development of “Variable Turbine Geometry (VTG) technology based turbocharger” for DLW built 16 cylinder 3100/3300/3600 HP Alco Engine for Indian Railways

Specification No. TS/ED/ 2015/78

Engine Development Directorate  
Research Designs and Standards Organisation  
Manak Nagar, Lucknow- 226 011(India)

## 1. Introduction:

Engine Development Directorate (EDD) of Research Design and Standards Organization, Lucknow (RDSO) under Ministry of Railways wants to pursue development of a Turbocharger (TC) with variable turbine geometry (VTG) for DLW built 16 cylinder 3100/3300/3600 HP Alco engines of Indian Railways (IR). These engines are large bore diesel engines capable of producing power from 3100 to 3600 HP. VTG turbine design consists of mounting nozzle vanes on a rotation axis so that the supply of air mass to the engine can be modulated depending on load points under ambient conditions through a control system. The benefits expected to be are reduction in fuel consumption over the duty cycle, reduction in thermal loading and exhaust gas temperature, lower emissions etc. with main benefits at mid load operations. General and environmental requirements are given in Annexure I. Technical specification of the engine is given in Annexure II & III. Typical duty cycle for IR diesel locomotives are given in Annexure IV.

VTG turbocharger may be fitted either on a mechanical fuel injection fitted diesel locomotive or on EFI/CReDI [Electronic Fuel Injection system/Common Rail electronic Direct Injection] fuel injection system fitted locomotive.

## 2. Scope of project:

- 2.1 Replacing the existing turbocharger with a Variable Turbine Geometry (VTG) technology based turbocharger.
- 2.2 Variable Turbine Geometry (VTG) technology based turbocharger would be fitted both on new locomotives and retrofitted on existing locomotives during rebuilding or during POH.
- 2.3 No other component besides the turbocharger would be replaced on the engine. Envelope sanctity of mating assemblies shall be retained. Engine shall not require major modification for fitment of Variable Turbine Geometry (VTG) technology based Turbocharger and its adaptation parts
- 2.4 Use of Variable Turbine Geometry (VTG) should result in reduction in fuel consumption over base line on Alco engine fitted with mechanical fuel injection or EFI or CReDI fuel injection system, with or without miller timing based stiffer unit camshaft. Firm should be willing to do requisite optimisation and support IR for the same.
- 2.5 It will be responsibility of the firm for prove-out of the turbocharger offered by them. Capability and resources assessment of the sub-vendor, if any, engaged by the firm shall be the responsibility of the firm's.
- 2.6 The turbocharger being offered should be compliant to use on Biodiesel, in addition to the high speed diesel. (With major fuel content of High Speed Diesel)
- 2.7 Optimize air/fuel ratio at all load points.
- 2.8 No increase in the peak cylinder pressure of the engine beyond the base engine (125 bars) and engine exhaust emissions.
- 2.9 Variable Turbine Geometry (VTG) technology based turbocharger would first be fitted on the engine test bed at RDSO and tested for engine performance. After it is found to meet the acceptance criteria, it will be fitted on a locomotive, load tested and field tested, for performance for a period of 6 months.

- 2.10 RDSO will share all relevant data with the successful tenderer after signing of a Non Disclosure Agreement with Engine Development Directorate. Format for the same is enclosed as Annexure VII.
  - 2.11 Firm should be willing to take the responsibility of the overall system integration testing / optimization & validation of the Variable Turbine Geometry (VTG) technology based turbocharger on the test engine of Alco at RDSO as well as the Alco locomotive in coordination with Indian Railways.
- 3. Acceptance criteria:**
- Following acceptance criteria are required to be met as per performance test on the RDSO test bed:
- 3.1 Reduce duty cycle fuel consumption by 2% over IR duty cycle on a DLW built 16 cylinder 3300 HP Alco engine of Indian Railways, fitted with mechanical fuel injection system and high efficiency turbocharger like TPR 61, GE etc., considered as base line.
  - 3.2 Result in reduction in turbine inlet temperatures during mid load operations as compared to base line.
  - 3.3 Duty cycle key engine exhaust emissions should be better than that of base line.
- 4. Pre-dispatch inspection:**
- Inspection of the scoped supply would be carried out by representative of Engine Development Directorate at successful firm's manufacturing facility without any additional cost before shipment of the same. Expense for travel to and fro to the firm's premises, boarding and lodging of the IR personnel shall be borne by IR. The firm should indicate for each equipment the relevant specification to which the equipment would be type tested. The firm should demonstrate, supported with documentation, capability of Variable Turbine Geometry (VTG) technology based turbocharger in term of boost pressure and air mass flow rate on the turbocharger test stand. Type test program should be drawn up by the firm's in consultation with RDSO, ED Dte.
- 5. Performance test on RDSO Engine Test Bed:**
- 5.1 Performance of engine fitted with Variable Turbine Geometry (VTG) technology based turbocharger shall be validated on the test bed of RDSO on a DLW built 16 cylinder 3300 HP Alco engine at Engine Development Directorate, Research Designs & Standards Organization (RDSO), Lucknow, India.
  - 5.2 The Alco engine would be run at close to predetermined speed and load points during the test as per Annexure V. The optimization will be done under similar conditions and combination of components. The engine will be loaded by a hydraulic dynamometer controlled by AVL test commander. For calculation of corrected horsepower and brake specific fuel consumption, Alco formula will be used. Performance parameters will be recorded in direction of descending order of load and speed.
  - 5.3 The firm in consultation with RDSO should draw up the optimization programme.
  - 5.4 Detail of data acquisition system of the test bed is at Annexure VI.
  - 5.5 Performance tests on RDSO Engine Test beds would be carried out for a period of around two months after complete assembly.

**6. Performance test on Locomotive:**

After the validation of the system performance on Alco engine test bed at Engine Development Directorate, RDSO, system would be fitted on DLW built 16 cylinder 3300 HP Alco locomotive. After load test on the locomotive, its maintainability and reliability under field conditions (Reliability Verification Testing) would be jointly monitored by RDSO and the manufacturer for 6 months. All problems noticed during this period would be logged and a satisfactory solution found.

**7. Training:**

The firm shall be willing to train five IR personnel for two weeks in the new technology at the time of prove-out on engine test bed.

**8. Deliverables:**

- 8.1 Turbocharger with all required adaptation parts - one loco set.
- 8.2 Manufacturing / Lay-out & Outline drawing of the Variable Turbine Geometry based Turbocharger.
- 8.3 One complete set of bill of materials, specifications, drawings, user manual, including detailed dimensioned drawings of the interfacing dimensions except the proprietary design details.
- 8.4 Full technical support and update for a period of minimum two years after successful installation and commissioning.

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## Points for Guidance

## 1. General Requirements

Variable Turbine Geometry (VTG) technology based turbocharger should be suitable for rail traction service which is characterized by wide, fluctuating, cycle load patterns and extended intervals of operation at idle and full load. The firm should ensure that the components should be so designed that the safety of the locomotive and personnel are not compromised

## 2. Environment requirements

Variable Turbine Geometry (VTG) technology based turbocharger should be able to work satisfactorily in the following environmental conditions

SN	PARAMETER	LIMITS
1	Maximum temperature (Atmospheric)	55 <sup>0</sup> C (However, the air temperature inside the engine compartment may reach up to 70 <sup>0</sup> C)
2.	Humidity	100% saturation during rainy season
3.	Rainfall	Very heavy in certain areas
4.	Atmospheric conditions during hot weather	Extremely dusty and desert terrain in certain areas
5.	Costal area environment conditions	The locomotive and turbocharger should be designed to work in coastal areas where the environment is humid and salt laden

## Engine data – 16 cylinder DLW built 251-B Alco engine

1.	Application	Rail traction diesel (Indian Railways, Broad gauge) 3100,3300 HP, 3600 HP
2.	Engine type	DLW built 251-B engine
3.	No. of cylinders	16
4.	Configuration	'V'
5.	Cycle	4 stroke
6.	Bore	9"(228.6 mm)
7.	Stroke	10.5"(266.7mm)
8.	Compression ratio	11.75:1
9.	Ratio of con rod length to crank radius	4
10.	Fuel injection (at full load)	
	Spill port closing	22.0 degree CA BTDC
	Duration of injection	Approx.34 degree CA
	Pumps	17 mm plunger dia, 20mm stroke
	Nozzles	0.35 mm dia. 9 holes, 157-degree spray angle, 90-degree tip angle.
11.	Firing order	1R 1L, 4R 4L, 7R 7L ,6R 6L, 8R 8L, 5R 5L, 2R 2L, 3R 3L
12.	Valves (4 valve head) Air inlet open	72 degrees CA before TDC
	Air inlet close	48 degrees CA after BDC
	Exhaust open	66 degrees CA before BDC
	Exhaust close	66 degrees CA after TDC
	Valve dia	7.62 cm
	Max. valve lift	2.04 cm
	Port diameter	7.40 cm
13.	Turbocharger	One per engine
14.	After cooler	Single water-cooled.

NOTE: These figures are indicative and can be used only for approximate guidance

## Annexure-III

Engine performance data at full load- 16 cylinder DLW built 251-B engine (mechanical fuel injection system) as available at test bed-

SN	Parameter	3100 HP	3300 HP
1.	Engine speed	1050 rpm	1050 rpm
2.	BMEP	14.25 bar approx.	15.75 bar approx.
3.	Turbo inlet temperature	485°C (approx.)	500°C (approx.)
4.	Average cylinder head exhaust temperature	415°C (approx.)	
5.	Vacuum at compressor air intake	400 mm H <sub>2</sub> O-g approx.	
6.	Compressor outlet pressure	1.60 bar-g approx	1.82 bar-g approx.
7.	Pressure drop across after cooler	0.1 bar approx.	
8.	Inlet manifold pressure (engine air gallery)	1.55 bar approx.	1.77 bar approx.
9.	Exhaust pressure before turbine	1000 mm of Hg approx	
10.	Turbine outlet pressure (Exhaust)	440 mm H <sub>2</sub> O g approx. on engine test bed.	
11.	Maximum cylinder pressure	125 bar	

NOTE: These figures are indicative and can be used only for approximate guidance

## Annexure--IV

Typical Indian railway operating duty cycle for diesel locomotives

NOTCH	FREIGHT SERVICE %	PASSENGER SERVICE %
Idle	60	49
1 <sup>st</sup>	3	6
2 <sup>nd</sup>	5	7
3 <sup>rd</sup>	3	5
4 <sup>th</sup>	4	4
5 <sup>th</sup>	4	7
6 <sup>th</sup>	5	5
7 <sup>th</sup>	6	5
8th	10	12

Extracted from RDSO report no.-MP-Misc. – 204, Feb. - 2008

## Operating point at various notches for Alco 251B engine

NOTCH	3100 HP			3300 HP	
	RPM	LOAD (N)	POWER (HP)	LOAD (N)	POWER (HP)
8 <sup>th</sup>	1050±3	21600±50	3100	22997±50	3300
7 <sup>th</sup>	950±3	19082±50	2500	20316±50	2640
6 <sup>th</sup>	850±3	16018±50	1870	17029±50	1980
5 <sup>th</sup>	750±3	13826±50	1430	14475±50	1485
4 <sup>th</sup>	650±3	10616±50	950	11135±50	990
3 <sup>rd</sup>	550±3	8138±50	615	8773±50	660
2 <sup>nd</sup>	450±3	5471±50	330	5361±50	330
1 <sup>st</sup>	350±3	2984±50	145	3336±50	165
Idle	350±3	2131±50	105	2131±50	105

NOTE: These figures are indicative and can be used only for approximate guidance

## Data acquisition system of Alco engine test bed

1. AVL test commander, capable of real time only measurements on 176 channels, controls the engine. The test commander controls the dynamometer coupled to the diesel engine. Different parameters like speed, load, torque, power, temperature and pressure at various critical location of engine are measured and recorded. The test commander operates on “Window NT” operating system with “PUMA 5” engine monitoring and testing software.
2. The high-speed data acquisition system (HSDA) of M/s AVL is used to measure online high-speed parameters of engine such as Cylinder pressure, Fuel line pressure, Injector needle lift etc.
3. AVL frequency based fuel balance measures the online Brake Specific Fuel Consumption and rate of fuel flow. Fuel leak-off is measured separately. The rate of leak off amount is subtracted from the rate of fuel flow to get the exact consumption of fuel.



## MUTUAL NON-DISCLOSURE AGREEMENT

This Non-Disclosure Agreement is made on of this ..... day of ..... 2012 between the President of India acting through ..... Research Designs and Standards Organisation (hereinafter referred to as "RDSO"), an Office of the Ministry of Railways, Government of India and having its Head Office at Manak Nagar, Lucknow-226011 and,

M/s **XX** a Company incorporated under the Companies Act, 1956 and having its Registered Office at .....(hereinafter referred to as "**XX**")

*(Each reference to "**XX**" in this Agreement shall be deemed to include its respective subsidiaries, affiliates and sister companies or any other organization in which **XX** has an ownership stake or over which **XX** can exert control, each of which/such party shall cause to observe the requirements of this Agreement with respect to the information disclosed by RDSO to **XX** under this Agreement. )*

The parties wish to (PLEASE MENTION THE PURPOSE) of mutual interest and in connection with this opportunity, each party may disclose to the other party certain confidential technical and business information which the disclosing party desires the receiving party to treat as confidential.

Now, therefore, in consideration for the premises and obligations set forth herein, it is hereby agreed that :

### Definition of Confidential Information

1. For purposes of this Agreement, "**Confidential Information**" shall mean any data or information that is proprietary to the Disclosing Party and not generally known to the public, whether in tangible or intangible form, whenever and however disclosed, including, but not limited to (1) any scientific or technical information, relating to the invention, design, process, procedure, formula, improvement, technology, method for operation and manufacture of products (2) manufacturing drawing and all information referred to in such manufacturing drawings (3) all type of data collected either from either parties to this agreement or any existing, potential, past customer of either parties to this agreement during interview, survey or through telephonic conversation, letters or any other means while and during carrying out the assignment mentioned above (4) costs, margins and pricing (5) any concepts, reports, data, know-how, works-in-progress, designs, development tools, specifications, computer software, source code, object code, flow charts, databases, inventions, information and trade secrets (6) marketing studies, strategies, or projections, operations, business plans and performance results relating to

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the past; (7) information, documents and materials relating to the financial management and other business conditions, prospects, plans, procedures and affairs which either parties to this agreement holds confidential or considers proprietary and has not publicly disclosed and (8) names of developmental programs, sales or marketing plans, or references to next generation products and new product introductions, which is transmitted or communicated by RDSO to the party of the other part of this agreement.

Provided that information disclosed orally or by observation will be treated as **Proprietary Information**, only if the same is confirmed as confidential in writing within a period of three (3) days from its disclosure;

Confidential Information need not be novel, unique, patentable, copyrightable or constitute a trade secret in order to be designated Confidential Information. The Receiving Party acknowledges that the Confidential Information is proprietary to the Disclosing Party, has been developed and obtained through great efforts by the Disclosing Party and that Disclosing Party regards all of its Confidential Information as trade secrets.

## **TERMS AND CONDITIONS**

### **2. Confidentiality Obligations :**

- a. All Proprietary Information and confidential information which is transmitted or communicated by Disclosing Parties shall in all cases be held in confidence by Receiving Parties and it shall not directly or indirectly, in any way, reveal, report, publish and disclose or transfer to any third party unless written consent of the Disclosing Parties is first obtained. Except that, Receiving Parties has the right to disclose such information to its own employees, consultants and representatives who are bound by an obligation of confidentiality and who need to know such information for the purpose specified hereinabove.
- b. Receiving Parties shall advise each of the persons to whom it provides access to any of the Confidential Information, that such persons are strictly prohibited from making any use, publishing or otherwise disclosing to others, or permitting others to use for their benefit or to the detriment of the Disclosing Party, any of the Confidential Information, and, upon Request of the Disclosing Party, to provide the Disclosing Party with a copy of a written agreement to that effect signed by such persons.

- c. Receiving Parties agrees to use the Confidential Information solely in connection with the current or contemplated relationship between the parties and not for any purpose other than as authorized by this Agreement without the prior written consent of an authorized representative of the Disclosing Party. No other right or license, whether expressed or implied, in the Confidential Information is granted to the Receiving Party hereunder. Title to the Confidential Information will remain solely in the Disclosing Party. All use of Confidential Information by the Receiving Party shall be for the benefit of the Disclosing Party and any modifications and improvements thereof by the Receiving Party shall be the sole property of the Disclosing Party.
- d. Receiving Parties agrees to protect and safeguard the Confidential Information against unauthorized use, publication or disclosure; For the purpose of protecting Proprietary Information received from Disclosing Parties hereunder, Receiving Parties will use efforts commensurate with those it employs for the protection of corresponding information of its own, including as a minimum, alerting its employees of the confidential and sensitive nature of the Proprietary Information of Disclosing Parties, and will make disclosure to its employees only on a need-to-know basis and using appropriate safe-keeping procedures for Proprietary Information.
- e. Receiving Parties agrees not to use any Confidential Information to unfairly compete or obtain unfair advantage vis-a-vis Disclosing Parties
- f. Receiving Parties agrees to comply with any other reasonable security measures requested in writing by the Disclosing Parties
- g. Receiving Parties agrees to refrain from directly contacting or communicating by whatsoever means to the Source(s) of Information without written consent of the Disclosing Party
- h. Receiving Parties agrees to undertake not to disclose any names and their particulars to third parties without the written consent by the Disclosing Parties

**3. Exceptions:**

Notwithstanding the provisions of Paragraph 2 of this Agreement Receiving Parties shall not be required to maintain confidentiality or be restricted in its use of any Proprietary Information which:

- i. was in the public domain at the date of disclosure to Receiving Parties;
- ii. becomes public knowledge during the term of this Agreement without breach of this Agreement;
- iii. Receiving Parties can show that it was in its possession with the full right to disclose prior to its receipt from or disclosure by Disclosing Parties;
- iv. disclosure of which is required by law or by order of a court of competent jurisdiction;

*However, it is expressly agreed that the data information collected during carrying the assignment by RECEIVING PARTIES shall form part of the confidential information and shall be governed by this agreement.*

**4. Compelled Disclosure of Confidential Information.**

Notwithstanding anything in the foregoing to the contrary, the Receiving Party may disclose Confidential Information pursuant to any governmental, judicial, or administrative order, subpoena, discovery request, regulatory request or similar method, provided that the Receiving Party promptly notifies, to the extent practicable, the Disclosing Party in writing of such demand for disclosure so that the Disclosing Party, at its sole expense, may seek to make such disclosure subject to a protective order or other appropriate remedy to preserve the confidentiality of the Confidential Information; provided in the case of a broad regulatory request with respect to the Receiving Party's business (not targeted at Disclosing Party), the Receiving Party may promptly comply with such request provided the Receiving Party give (if permitted by such regulator) the Disclosing Party prompt notice of such disclosure. The Receiving Party agrees that it shall not oppose and shall cooperate with efforts by, to the extent practicable, the Disclosing Party with respect to any such request for a protective order or other relief. Notwithstanding the foregoing, if the Disclosing Party is unable to obtain or does not seek a protective order and the Receiving Party is legally requested or required to disclose such Confidential Information, disclosure of such Confidential Information may be made without liability.

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6. **Term:**

This Agreement shall be effective from the date of execution of this agreement and shall remain in force for a period of 5 (five) years from the date of the said execution.

7. **Termination:**

Either party hereto, upon written notice to the other, may terminate this Agreement. Such termination shall be effective thirty (30) days after receipt of such notice. All obligations arising under this Agreement shall survive any termination or expiration of this Agreement and any confidentiality obligations will remain in effect for a period of five (5) years from date of first disclosure hereunder. Upon termination or expiration of this Agreement, any **Proprietary Information** received by Receiving Parties pursuant to this Agreement shall be returned, together with all copies thereof.

8. **Notice of Breach.**

Receiving Parties shall notify the Disclosing Party immediately upon discovery of any unauthorized use or disclosure of Confidential Information by Receiving Parties or its Representatives, or any other breach of this Agreement by Receiving Parties or its Representatives, and will cooperate with efforts by the Disclosing Party to help the Disclosing Party regain possession of Confidential Information and prevent its further unauthorized use.

9. **Return of Confidential Information.**

**Receiving Parties** shall immediately return any **Proprietary Information** received in pursuance to this Agreement and redeliver to the other, all tangible material embodying the Confidential Information provided hereunder and all notes, summaries, memoranda, drawings, manuals, records, excerpts or derivative information deriving there from and all other documents or materials ("Notes") (and all copies of any of the foregoing, including "copies" that have been converted to computerized media in the form of image, data or word processing files either manually or by image capture) based on or including any Confidential Information, in whatever form of storage or retrieval, upon the earlier of (i) the completion or termination of the dealings between the parties contemplated hereunder; (ii) the termination of this Agreement; or (iii) at such time as the Disclosing Party may so request; provided however that the Receiving Party may retain such of its documents as is necessary to enable it to comply with its document retention policies. Alternatively, the Receiving Party, with the written consent of the Disclosing Party may (or in the case of Notes, at the Receiving Party's option) immediately destroy any of the foregoing embodying Confidential Information (or the reasonably non recoverable data erasure of computerized data) and, upon request,

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certify in writing such destruction by an authorized officer of the Receiving Party supervising the destruction).

**10. Rights, Remedies and Restrictions.**

Both parties acknowledge that the Confidential Information to be disclosed hereunder, is of a unique and valuable character, and that the unauthorized dissemination of the Confidential Information would destroy or diminish the value of such information. The damages to Disclosing Party that would result from the unauthorized dissemination of the Confidential Information would be impossible to calculate. Therefore, Receiving Parties acknowledges that :

- (a) Disclosing Parties possesses and will continue to possess proprietary information that has been created, discovered or developed by or on behalf of disclosing parties by third parties, which information has commercial value and is not in the public domain;
- (b) Unauthorized use or disclosure of Proprietary Information is likely to cause irreparable injury not readily measurable in monetary damages;
- (c) In the event of an unauthorized use or disclosure, Disclosing Parties shall be entitled to, without waiving any other rights, recourses or remedies to which it may be entitled under this Agreement, at law or in equity, such injunctive or equitable relief as may be deemed proper by a court of competent jurisdiction ;
- (d) Disclosing Parties and its licensors retain all right, title and interest in and to the Proprietary Information including without limiting the generality of the foregoing, title to all materials whether provided by or on behalf of Disclosing Parties.
- (e) Any authorized use or disclosure by the proprietor, agents representatives, advisors, directors, officers or employees of receiving parties shall be deemed to be an unauthorized use or disclosure by receiving parties and that receiving parties shall indemnify and hold harmless Disclosing Parties from and against any and all damages, losses, costs, expenses and attorneys' fees incurred as a result of such breach.
- (f) This agreement shall remain in force notwithstanding any change in the ownership, management, constitution, merger and amalgamation etc. of Receiving Parties.

- (g) Any failure by either party to enforce the other party's strict performance of any provision of this Agreement will not constitute a waiver of its right to subsequently enforce such provision or any other provision of this Agreement.

**11. Severability of Provisions:**

Should any part of this Agreement be declared invalid by a court of law, such decision shall not affect the validity of any remaining portion which shall remain in full force and effect as if the invalid portion was never a part of this Agreement when it was executed. As it is, the parties' intent that this Agreement be enforced to the fullest extent permitted by law, such invalidated section shall be deemed amended so as to avoid the reasons for its invalidity. Should the severance or amendment of any such part of this Agreement materially affect any other rights and obligations of the parties hereunder, the parties hereto will negotiate in good faith to amend this Agreement in a manner satisfactory to the parties.

**12. Non-Assignability:**

Neither party hereto shall, directly or indirectly, assign or purport to assign this Agreement or any of its rights and obligations in whole or part to any third party without the prior written consent of the other party.

**13. Warranty.**

Each Party to this agreement warrants that it has the right to make the disclosures under this Agreement. **no warranties are made by either party under this agreement** **Whatsoever.** Each party to this agreement acknowledges that although they shall endeavor to include in the Confidential Information all information that they believe relevant for the purpose, however no representation or warranty as to the accuracy or completeness of the Confidential Information is being made by the Disclosing Party. Further, Disclosing Party is not under any obligation under this Agreement to disclose any Confidential Information it chooses not to disclose.

**14. Amendment:**

Subject to Paragraph 9 above, this Agreement shall not be amended, modified or altered, except in writing, duly accepted and executed by both parties.

**15. Governing Law:**

This Agreement shall be governed by and construed in accordance with the laws of India. Any dispute arising out of this Agreement or interpretation of any provision of this agreement or arising out of execution of this agreement shall be referred to the arbitrator nominated by the **RDSO** in accordance with Indian Law. The disputes shall be subject to the jurisdiction of the Courts at Lucknow, India only.

**16. Entire Agreement :**

This Agreement constitutes the entire agreement and understanding of the parties hereto, and no representations or promises have been made that are not fully set forth herein.

**17. Notices:**

Any notices or communications required or permitted to be given hereunder, from either party to the other will be given in writing to the attention of the persons listed below, or to other such addresses or addressees as may hereafter be designated in writing for notices by either party to the other and may be delivered by hand, deposited with a nationally recognized overnight carrier, electronic-mail, or mailed by certified mail, return receipt requested, postage prepaid, in each case. All such notices or communications shall be deemed to have been given and received (a) in the case of personal delivery or electronic-mail, on the date of such delivery, (b) in the case of delivery by a nationally recognized overnight carrier, on the third business day following dispatch and (c) in the case of mailing, on the seventh business day following such mailing.

If to **RDSO** :

Attention : **Sri ....., Jt. Director  
Engine Development Directorate,  
Research Designs and Standards Organisation (RDSO)  
Manak Nagar, Lucknow – 226011**

If to:XX

Attention : **Sri.....  
.....**



IN WITNESS WHEREOF, the parties hereby or authorized agents thereof, have executed this Agreement, as of the date first above written i.e. ....which shall be binding upon them and their respective successors and assigns, as of the day and year first above written.

For RDSO	For XX
Name : Shri .....	Name : .....
Designation : Jt. Director	Designation :
Witness :	Witness :