NGV Motori srl
Via R.Amundsen 01
P.IVA 01735660357
42010 Gavassa
REGGIO EMILIA - ITALIA
info @ ngvmotori.it www.ngvmotori.it

Tel. 0039 – 0522 - 506153
Fax 0039 – 0522 – 506146

COMPANY PROFILE

&

Activity Description

NGV Motori srl
Via R.Amundsen 01
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info @ ngvmotori.it www.ngvmotori.it

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INTRODUCING NGV MOTORI SRL

I N D E X

NGV Motori srl
Via Amundsen 1
P.IVA 01735660357
42010 – Gavassa (REGGIO EMILIA) - ITALIA
luca @ ngvmotorisrl.191.it
www.ngvmotori.it

Tel. 0039 – 0522 - 506153
Fax 0039 – 0522 - 506146

TECHNICAL QUESTIONNAIRE

To be filled up and sent back to NGV

Engine Manufacturer : ☐

Manufacturer engine model name: ☐

Displacement (cc) : ☐

Type : **N. Aspirated** ☐ **Turbo** ☐ **Intercooler** ☐

N° Cylinders : ☐

Power (HP) : ☐ **Rpm** ☐

Torque (Nm) : ☐ **Rpm** ☐

Engine Voltage (V) : **24** ☐ **12** ☐

Cooling system : **Water** ☐ **Air** ☐

Injection pump type : **Mechanical** ☐ **Electronic** ☐

Gearbox : **Mechanical** ☐ **Automatic** ☐

Accelerator : **Mechanical** ☐ **Electronic** ☐

Pneumatic system : **Yes** ☐ **No** ☐

Notes:

Date: _____

FOREWORD

First of all, we would like to stress following elements enabling you to get the correct picture about the nature of our approach to the process of engines modification and the fundamentals of our enterprise.

The activity of the founders of NGV Motori is born, under the name of “TRUCK SERVICE”, more than 50 years ago in a mechanical workshop for maintenance of all kind of engines (at the beginning only for gasoline and Diesel combustion engine and, after 1950, also for gas fuelled engines).
In our area (Emilia region) there has always been a great concentration of companies investing a lot of efforts in the study of the technologies involved in the modification from gasoline alimented engines, into gas fuelled (bi-fuel conversions), with the presence today of several worldwide technology-leading companies operating in the production of devices devoted to the conversion of engines working from petrol to LPG and CNG.
Our technicians have taken advantage of all these pioneering experiences and have assimilated, from the dawn of its existence, the common sense of this technology.

NGV Motori Srl is certified as “ engine and components manufacturer “ (see enclosed certificate No.006/06/BO of the Italian Ministry of Transports) and is also certified ISO 9001-2000 IQNet and ISO 9001-2000 CSQ (see enclosed certificates).

Long time ago is born the idea to adapt the owned skill to the revolutionary transformation from Diesel into dedicated CNG and LPG engines. It is obvious that due to the lack of fixed rules to perform this kind of modifications it has been unavoidable to experiment all possible ways to reach the necessary level of skill and to grant the suitable grade of reliability of all technical innovations. This process has taken long time and a lot of efforts. Today, we can say that the transformation to CNG or LPG of a Diesel engine is always the result of following elements:

- A compromise between the original engine and the expected final product
- Long years of technical experience
- Knowledge in out-sourcing all the appropriate and most reliable components
- A management who is in the position to harmonize all the steps involved in the process

The philosophy adopted by our company in the methods of our transformations is based on following ground elements:
- Simplicity of the project
- Reliability
- Inexpensiveness
- Easy maintenance and environmental friendliness

More in details, the adoption of our transformation kit enables a relatively simple operating procedure due to the limited number of parts and the easy understanding of its basics.

We have chosen this solution because its simple concept allows to obtain an optimal performance avoiding the installation of complicated devices or sophisticated mechanical technology always subject to possible failures or creating side problems.
...**A mass transportation vehicle shall run !!!**....
all trouble stopping the machine is fatally bound to expenses and loss of benefits. Reducing the break downs is resulting in costs savings and less troubles.
The competitive cost of our kit, the reliability, the easy maintenance works and the favourable pollution reduction of the converted engines makes of our system an appreciated benchmark in this field.

There are other more complicated and expensive solutions, proposed by well-known manufacturers, showing many peculiar devices expected to satisfy several additional, yet more or less, useless tasks that, at least here in Europe, have often caused recurring events of malfunctions mainly attributable to trifles that deeply disappointed the customers because of the increasing costs of maintenance and the diseases of vehicles stops.
We don’t say that ours is the best viable solution, but we are fully aware that this is the optimum reachable on the basis of the a.m. elements.

Ministero delle Infrastrutture e dei Trasporti

S.I.I.T. n.4 EMILIA ROMAGNA – MARCHE
SETTORE TRASPORTI
Commissione del Controllo di Conformità
Centro Prova Autoveicoli di BOLOGNA

CERTIFICATO N° 006/06/BO

- Visti gli articoli 75, 77, 107, 109 e 114 del Codice della Strada, approvato con D.Lgs. 30/04/1992 n° 285 e successive modificazioni e integrazioni, nonché i relativi Decreti di attuazione;
- Viste le Direttive comunitarie che prevedono l'obbligatorietà della effettuazione di verifiche presso gli stabilimenti di produzione del Costruttore;
- Visto il Decreto Dirigenziale 25 novembre 1997, pubblicato sulla Gazzetta Ufficiale n° 278 del 28 novembre 1997 - Serie Generale -;
- Vista le circolari D.C. IV n° B109 del 10.12.1997 e prot. n.42/MOT2/CCC del 5.06.2003;
- Visto Decreto Ministeriale 2 maggio 2001, n° 277, pubblicato sulla Gazzetta Ufficiale n° 160 del 12 luglio 2001 e successivo di adeguamento;
- Visto il verbale n° 6006/CC/BO del 14.02.2006 redatto dalla Commissione del Centro Prova Autoveicoli di Bologna, designata con proprio provvedimento prot. n. 4088/19(3) del 14.11.2005;

Si dichiara

il Costruttore: NGV MOTORI S.r.l.
con sede in: Via R. Amundsen, 1 - 42010 Gavassa (RE) - ITALIA

per gli impianti di produzione siti in :

via R. Amundsen, 1 - 42010 Gavassa (RE)

via Baccne, 13/4 - 42029 Masone (RE)

e per il prodotto : **ENTITA' TECNICA MOTORI ED ENTITA' TECNICHE PER MOTORI**

Idoneo alla produzione di serie

Il presente certificato ha la validità di anni due .

Bologna, 14/02/2006

IL DIRETTORE delegato
dott. ing. Eduardo DONZELLI

CISQ is a member of IQNet
THE INTERNATIONAL CERTIFICATION NETWORK
www.iqnet-certification.com

IQNet, the association of the world's first class certification bodies, is the largest provider of management System Certification in the world. IQNet is composed of more than 30 bodies and counts over 150 subsidiaries all over the globe.

CSQ
www.imq.it

CERTIFICATO N.
CERTIFICATE N. **9190.NGVM**

SI CERTIFICA CHE IL SISTEMA QUALITA' DI
WE HEREBY CERTIFY THAT THE QUALITY SYSTEM OPERATED BY

NGV MOTORI SRL

VIA AMUNDSEN 1 - 42100 REGGIO EMILIA (RE)

UNITA' OPERATIVE
OPERATIVE UNITS

VIA BACONE 13/4 - 42029 MASONE (RE)

E' CONFORME ALLA NORMA
IS IN COMPLIANCE WITH THE STANDARD

ISO 9001:2000

PER LE SEGUENTI ATTIVITA'
FOR THE FOLLOWING ACTIVITIES

Assemblaggio e montaggio parti meccaniche per autobus, trasformazione alimentazione da diesel a gas, assistenza veicoli pesanti, assemblaggio gruppi cogenerazione
Assembling and installation of bus mechanical parts, engine conversion from diesel to CNG, heavy duty vehicle maintenance, cogeneration plant assembling

Riferirsi al manuale della qualità per l'applicabilità dei requisiti della norma ISO 9001:2000
Refer to quality manual for details of applications to ISO 9001:2000 requirements

IL PRESENTE CERTIFICATO E' SOGGETTO AL RISPETTO DEL REGOLAMENTO PER LA CERTIFICAZIONE DEI SISTEMI QUALITA' E DI GESTIONE DELLE AZIENDE
THE USE AND THE VALIDITY OF THE CERTIFICATE SHALL SATISFY THE REQUIREMENTS OF THE RULES FOR THE CERTIFICATION OF COMPANY QUALITY AND MANAGEMENT SYSTEMS

PRIMA EMISSIONE	EMISSIONE CORRENTE
FIRST ISSUE	*CURRENT ISSUE*
2000-12-21	2003-12-15

IMQ S.p.A. - VIA QUINTILIANO, 43 - 20138 MILANO

CISQ è la Federazione Italiana di Organismi di Certificazione dei sistemi di gestione aziendale

CISQ is the Italian Federation of management system Certification Bodies

FEDERAZIONE CISQ
www.cisq.com

SINCERT EA: 22a

SGQ N°0004
SGA N°0002
SCR N°0008
PRD N°0008

Membro degli Accordi di Mutuo Riconoscimento EA e IAF
Signatory of EA and IAF Mutual Recognition Agreements

La validità del presente certificato è subordinata a sorveglianza annuale e al riesame completo del Sistema di Qualità con periodicità triennale secondo le procedure dell'IMQ

The validity of the certificate is submitted to annual audit and a reassessment of the entire Quality System within three years according to IMQ rules

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

IQNet and its partner

CISQ/IMQ-CSQ
hereby certify that the organization

NGV MOTORI SRL

VIA BACONE 13/4 - 42029 MASONE (RE) Italy

for the following field of activities

Assembling and installation of bus mechanical parts, engine conversion from diesel to CNG, heavy duty vehicle maintenance, cogeneration plant assembling

Refer to quality manual for details of applications to ISO 9001:2000 requirements

has implemented and maintains a

Quality Management System

which fulfills the requirements of the following standard

ISO 9001:2000

Issued on: 2003 - 12 - 15

Registration Number: IT - 17889

Fabio Roversi
President of IQNet

Gianrenzo Prati
President of CISQ

IQNet partners*:
AENOR *Spain* AFAQ *France* AIB-Vinçotte International *Belgium* ANCE *Mexico* APCER *Portugal* CISQ *Italy* CQC *China* CQM *China* CQS *Czech Republic* DQS *Germany* DS *Denmark* ELOT *Greece* FCAV *Brazil* FONDONORMA *Venezuela* HKQAA *Hong Kong* ICONTEC *Colombia* *IMNC Mexico* IRAM *Argentina* JQA *Japan* KEMA *Netherlands* KFQ *Korea* MSZT *Hungary* Nemko Certification *Norway* NSAI *Ireland* ÖQS *Austria* PCBC *Poland* PSB Certification *Singapore* QMI *Canada* RR *Russia* SAI Global *Australia* SFS *Finland* SII *Israel* SIQ *Slovenia* SQS *Switzerland* SRAC *Romania* TEST St Petersburg *Russia*
IQNet is represented in the USA by the following partners: AFAQ, AIB-Vinçotte International, CISQ, DQS, KEMA, NSAI, QMI and SAI Global
*The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com

NGV Motori srl
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42100 – (REGGIO EMILIA) - ITALIA
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Tel. 0039 – 0522 – 506153
Fax 0039 – 0522 - 506146

THE COMPANY

Ngv Motori with its long experience in the field of the applied mechanics on transportation vehicles, concentred its operation of the last 10 years on the mass and heavy transportation vehicles (urban and extra urban buses, Heavy and Light trucks) following two main sections:

A) Manufacturing and maintenance of vehicles under appointment of the main local manufacturers (i.e. Autodromo scrl, Bredamenarini Bus, Man and others).
B) Conversion of Diesel engines into CNG or LPG dedicated and Dual Fuel operations.

Our peculiarities enable us to excel at both these activities.

With a specific reference to the conversion of Diesel engines into CNG or LPG dedicated (only gas) and Dual Fuel (mixture of diesel and gas) engines, NGV as engines manufacturer, is operating in various countries all over the world and often in co-operation with some important engine manufacturers such as Mercedes, Iveco, Tata, Isuzu, Hiunday, Hino, Perkins.

Our activity is carried out in two different plants. One of them, which is strictly dedicated to the vehicles maintenance and assembling, has a covered building of 1.500 Sqm. and a vehicle yard of 5.000 Sqm.
The second plant has a covered area of 2.200 Sqm. and a open air yard of 5.500 Sqm.
This plant is equipped with the latest technology and with two very sophisticated test bench units (the third one is under construction) dedicated to the study of the conversion to CNG and LPG of a wide range of Diesel engines.
The manpower employed by NGV is today composed of about 45 workers on direct basis and of about another 80 units from other external operators.

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CONSIDERATIONS ABOUT CNG/LPG CONVERSION OF DIESEL ENGINES

There is a growing awareness that the use of alternative fuels such as compressed natural gas (CNG), can make an appreciable change and difference in keeping our environment clean and healthy.

Based on these facts, NGV Motori is offering a safe, commercially viable and environmental friendly technology by introducing a conversion system that would enable busses and trucks that run on diesel to run efficiently on Natural Gas (either in CNG/LPG Dedicated version or in Dual Fuel operations).
An engine that runs on either of the above mentioned alternate clean gaseous fuels is a “no compromise” single fuel power unit with high performance. The obvious advantages are low exhaust emissions, elimination of harmful particulate matter and fuel economy.

NGV Motori Started about 50 years ago to research the use of alternate fuels like Compressed Natural Gas (CNG) or Liquid Petroleum Gas (LPG) to be used in Automotive industry. In the seventies, taking cue from Environmentalists in the United States of America, the European Community apprehended the dangers of Pollution; especially Pollution caused by use of automobiles and took the initiative by enforcing strong but fair anti pollution laws for the industry.

NGV Motori has been in the forefront of European companies who are providing alternate fuel systems and technologies for the automobile and stationary engine industry. The company has the proud achievement of converting the first in use diesel bus to dedicated CNG mode in Europe (year 1998).

Conclusion:

The need to reduce emissions will continue to increase all over the world, particularly in densely populated areas. NGV will continuously maintain its focus on research and development efforts, thereby finding solutions and introducing new technology for reducing noise and exhaust pollution.

Using CNG provides many benefits that include:

- Economy. Natural Gas offers a considerable savings in fuel cost as it costs less than Diesel and Gasoline.
- Safety. Natural Gas (especially CNG) is inherently safer than Gasoline and other fuels.
- Plentiful Alternative. Natural Gas is a proven alternative to the limited supply of Diesel and Gasoline
- Low Maintenance.

By reducing vehicle emissions while retaining the drivability, the use of Alternate clean fuel will enable urban transport to achieve acceptance and growth in the general public.

With a flexible outlook based on practical and viable application of expertise and technology, NGV can respond to the market demands and meet the ever-growing need of environment friendly urban and extra-urban transport

With a clear focus on safety, viability and efficiency, NGV will be involved in bringing alternative fuel systems that will immensely improve the urban transport system and will result in a cleaner and a safer environment. With our multiple years of experience in various conditions and various types and model of vehicles, NGV provides the system and technology for effective CNG and LPG conversion backed by technical and product support. If so required, NGV will assist in setting up the proper infrastructure, impart training to manpower and set up a procurement and material management system to enable seamless and effective operations.

REFERENCE LIST

of main concluded agreements and of orders in progress at the date of 31st March 2007

Customer	Engine	Value Euro	Year	Reference		Pcs
EGYPT						
Petrobell	Iveco 8140.47 - 4 Cyl.	420.000	1996	Mr. Kamar	eamkamar@yahoo.com	25
Isuzu (manufacturer)	Isuzu 4HF1-T	1.000.000	2007			500
INDIA						
Nugas LTD	Leyland 401 - 6 Cyl	500.000	2001	Mr. Handa	+91 11 7231955	800
Nugas LTD	Tata 692 – 6 Cyl.	1.000.000	2001	Mr. Handa	+91 11 7231955	3000
IRAN						
Iran Khodro Diesel	Mercedes OM 457 - 6 Cyl.	4.000.000	2006/07	Mr. Damircheli	a_damircheli@aframail.com	2500
Iran Khodro Diesel	Hyundai D4AL - 4 Cyl.	3.500.000	2006/07	Mr. Damircheli	a_damircheli@aframail.com	2500
Motorsazan	Perkins 135 TI 4Cyl.	400.000	2007	Mr. Dadashz	info@motorsazan.com	500
BANGLADESH						
Prosperity Intl.	Hino EH 700 - 6 Cyl.	400.000	2005	Mr. A. Huque	pil@bdmail.	100
Prosperity Intl.	Hino EH 07C - 6 Cyl.	150.000	2005	Mr. A. Huque	pil@bdmail.	50
Isuzu (manufacturer)	Isuzu 4HG1-T	600.000	2007	Mr. Sugiura		300
MYANMAR						
Ministry of Industry (MI2)	MITSUBISHI 6D	1.000.000	2005-6	Mr D. Low	swlow@kianann.com.sg	300
Ministry of Industry (MI2)	ISUZU 6QA1	800.000	2005-6	Mr D. Low	swlow@kianann.com.sg	400
Ministry of Industry (MI2)	NISSAN PE6D	800.000	2005-6	Mr D. Low	swlow@kianann.com.sg	800
Ministry of Industry (MI2)	NISSAN PE6D T + MIX	500.000	2005-6	Mr Donald Low	swlow@kianann.com.sg	500
THAILAND						
NGEC	Hino EH 07C - 6 Cyl.	400.000	2006	Mrs Warawan	wwn@asimar.com	300
NGEC	Hino EH 07D - 6 Cyl.	350.000	2006	Mrs Warawan	wwn@asimar.com	200
KPT	MIX Motori	350.000	2007	MrZaw Lay	zawlay@myanmar.com.mm	500
PAKISTAN						
ANA - Automotive	Hino EH 07C - 6 Cyl.	200.000	2007	Mr Husaim	khayam.husain@acpl.com.pk	200
OMVL	Serie Hino	2.000.000	2007	Mr Husaim	khayam.husain@acpl.com.pk	1000
COLOMBIA						
AUTOFRANCIA	ISUZU NPR	400.000	2007	Mr Londono	calondono@autofrancia.com	200
GRUPO GUINA	ISUZU NKR	200.000	2007	Mr Quintero	grupodinagnc@yahoo.com	100

AUTODROMO
car innovation
modena

MODENA, 02/02/99

SPETTT.LE
N.G.V. MOTORI SRL
V.EMILIA S.STEFANO 31
42100 REGGIO EMILIA

OGGETTO: Trasformazione motori a gas.

I buoni risultati ottenuti sui motori da Voi trasformati nel 1994, quando ancora eravate TRUCK'S SERVICE, la costante disponibilità e professionalità che ci dimostrate, ci fanno ben sperare per possibili future esperienze comuni circa il tema di cui all'oggetto.

Nei prossimi giorni promuoveremo un incontro per approfondire l'argomento qui solo accennato.

Distinti saluti.

CARR.AUTODROMO MODENA
MANOCCHIA ANTONIO
resp.ufficio acquisti

Carrozzeria Autodromo Modena
Soc. Coop. a r.l.
Via Malavolti, 18 - 41100 Modena
Tel. 059/250360 - Fax 059/250088

Cod. Fisc. / Part. IVA 00159760362

GENERAL INFORMATION

We are specializing in transformation of Diesel engines into CNG (or LPG) fed motors.
Due to the fact that there are no existing standard conversion kits suitable for every kind of engine (unlikely what it happens for petrol engine conversions) each model/brand of Diesel engines must be treated as a completely new matter and it will be necessary to complete a specific technical study in order to detect the appropriate combination of the conversion kit components and the necessary structural engine modifications.

Our experience ranges from small diesel engines to the biggest powerhouse stationary engines. In any case a conversion program is normally articulated in following steps:

A: Engine modifications
B: Dedicated kit arrangement and installation
C: Gas cylinders / piping / fittings and their installation on the converted vehicle

Step "A" is normally performed in our workshop for the first engine (prototype) sent to us by the customer; while this activity will be performed by customer technician in their country for the following engines.
Also in our workshop we make the study of the most appropriate and convenient "KIT" for the specific engine (step "B").
Step "C" activities is provided by the customer in his country (we can assist the Client for the outsourcing of the materials and give some information about the installation).

The step A (for the prototype only) will include:

1) Drawings and technical information for further engine modifications in Customer's country
2) Dedicated manual for installation and trouble shooting
3) Kit supply based on the required technical and emission peculiarities.
4) Testing of the modified engine on our test bench for performances, temperatures.
4) Emission tests
5) Endurance tests (500 hours heavy duty cycle)
6) Training to Customer's technicians for engine modification and kit installation

In order to give an idea about the power and emission tests performed in our premises we are herewith enclosing some examples of reports referred to some of the engines we already have converted.
Additionally we enclose also some certificates of engines homologations we have obtained on some converted engine and the basic kit list for the dedicated (100% gas) conversion .

MODULARIO
Trasporti - 41

Imposta di bollo assolta mediante versamento in c/c postale di cui all'art. 7 della L. 18.10.73 n° 613 e succ. modific.

41 M.T.N.

Ministero dei Trasporti e della Navigazione

DIPARTIMENTO DEI TRASPORTI TERRESTRI

Unità di Gestione della Motorizzazione e della Sicurezza del Trasporto Terrestre

MOT 3 – VEICOLI DI MASSA SUPERIORE A 3,5 TONNELLATE – MACCHINE AGRICOLE – A.T.P.

COMUNICAZIONE

E3

riguardante: RILASCIO DELL'OMOLOGAZIONE

di un tipo di motore a gas naturale (G.N.), quale entità tecnica indipendente per quanto riguarda le emissioni di gas inquinanti in conformità al Reg. n° 49.

Omologazione n° **E3 49R 021338** Estensione n° //

1.	Marchio di fabbrica o nome commerciale del motore	NGV MOTORI
2.	Tipo motore	9392.76.80 T.I.
3.	Tipo di combustione:	accensione comandata
3.1.	Tipo di carburante:	metano
4.	Nome e indirizzo del costruttore	NGV Motori s.r.l. V. Emilia S. Stefano, 31 Reggio Emilia (Italia)
5.	Nome e indirizzo dell'eventuale rappresentante del costruttore	non ricorre
6.	Depressione massima ammessa all'aspirazione	0.9 kPa
7.	Contropressione massima ammessa:	35.5 kPa
8.	Potenza massima ammissibile assorbita dai dispositivi azionati dal motore: Intermedia 0 kW Nominale 0 kW	
9.	Eventuali limitazioni di impiego:	vedi appendice scheda informativa
10.	Livelli di emissione: Valori della prova di emissione a 13 modi: CO: 1.7 g/kWh HC: 0.3 g/kWh Nox: 2.3 g/kWh PT: 0.042 g/kWh determinato tramite un flusso parziale	
11.	Motore presentato per le prove il	02.12.98

12.	Servizio tecnico incaricato delle prove	C.P.A. Emilia Romagna -Toscana
13.	Data del verbale rilasciato da questo servizio	18.12.98
14.	N° del verbale rilasciato da questo servizio	W1877/BO
15.	Ubicazione del marchio di omologazione sul motore	basamento motore sotto degasatore olio
16.	Località	Roma
17.	Data	24.05.2000
18.	Firma	IL DIRETTORE (dott. ing. Alessandro De Grazia)

19. Alla presente comunicazione sono allegati i seguenti documenti recanti il numero di omologazione sopraindicato:
1 copia completa dell'allegato I al presente Regolamento con allegati i relativi disegni e schemi.

GOVERNMENT OF INDIA
MINISTRY OF DEFENCE
VEHICLES RESEARCH & DEVELOPMENT ESTT.
AHMEDNAGAR - 414 006.
PHONE : 0241 - 548401 - 09 (9 Lines)
e-mail : vred@vsnl.com
Fax : 0091-241-548410.

VEL-NCAT/TTG/CNG/NUGAS 11 SEPT '01

M/s Nugas Technologies India (P) Ltd
A-21-22 G T Karnal Road Industrial Area
Azadpur
Delhi – 110 033

SUB : EXTENSION OF CERTIFICATION

REF : Your letter No.NGT/VRDE/01-02/16 dt. 3/9/01

Kindly note that a certificate bearing No.TE/2001/18/CMVR/126 dt. 9 July '01 was issued by us regarding type approval of CNG kit No.NGT/NGV of M/s NGV MOTORI, Italy as fitted on TATA LP 1510/52 bus submitted by you. It may be noted that as per the MORTH (erstwhile MOST) Notification bearing GSR No.99(E) dt. 9/2/2000 and the clarification issued by MORTH vide their letter No.RT-11011/11/99-MVL dt. 8.8.2001, this certificate is valid for CNG conversion on any vehicle manufactured upto March 2000, with engine capacity from 1301 cc upto 5675 cc.

2. The above conversion is valid upto 08-07-2006 i.e. 5 years from the date of issue of the above referred certificate or till the validity of the above referred Notification/amendment therein, whichever is earlier.

3. It may further be noted that the onus of verification of fitness / compliance with roadworthiness/safety requirements / proper functioning of the CNG conversion system on each and every vehicle converted under the above certification lies with you.

Thanking you,

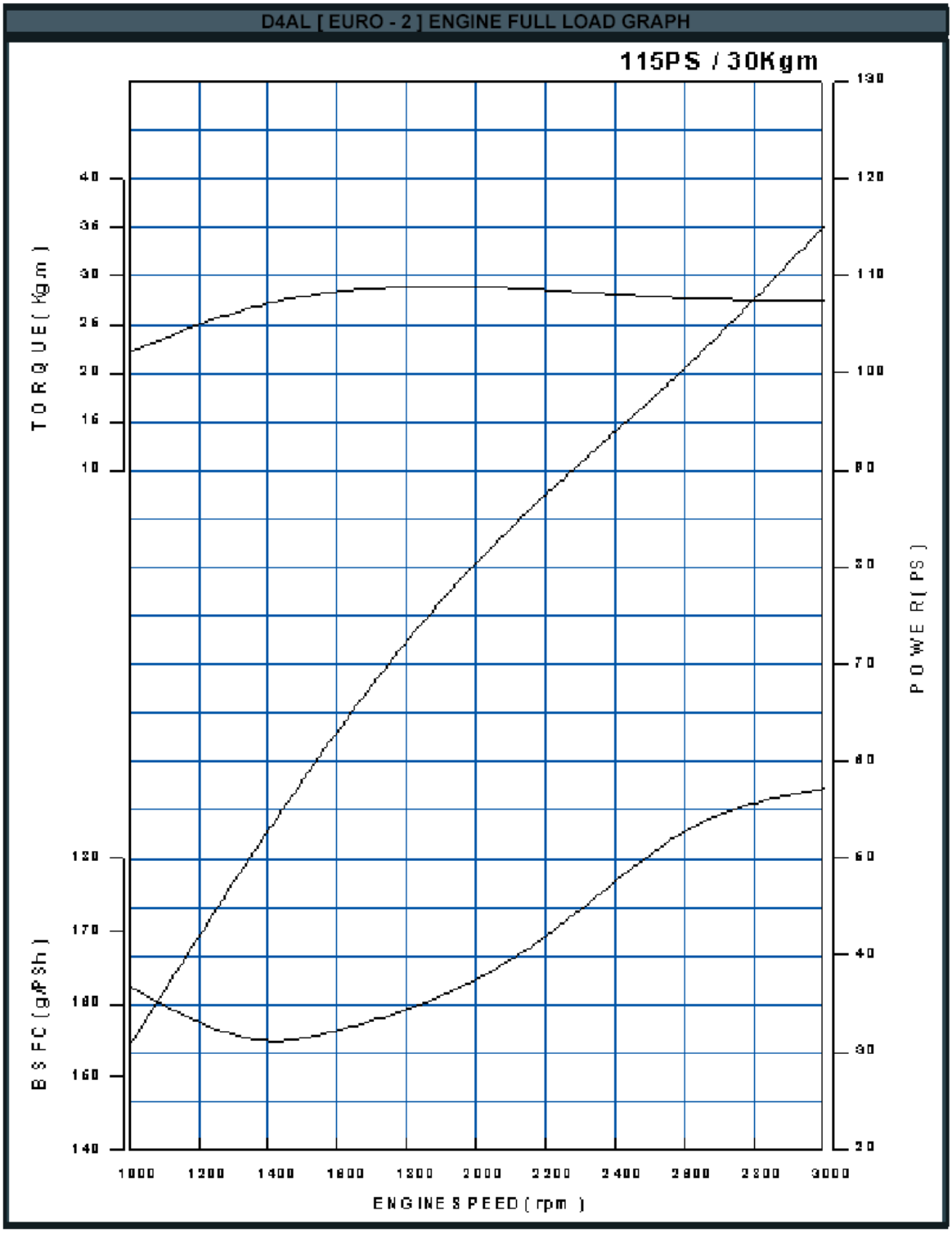
Yours faithfully,

N. Karuppaiah

Scientist 'E'
(N. KARUPPAIAH)
for DIRECTOR, VRDE

Hyundai diesel EG performance curve [EURO-II]

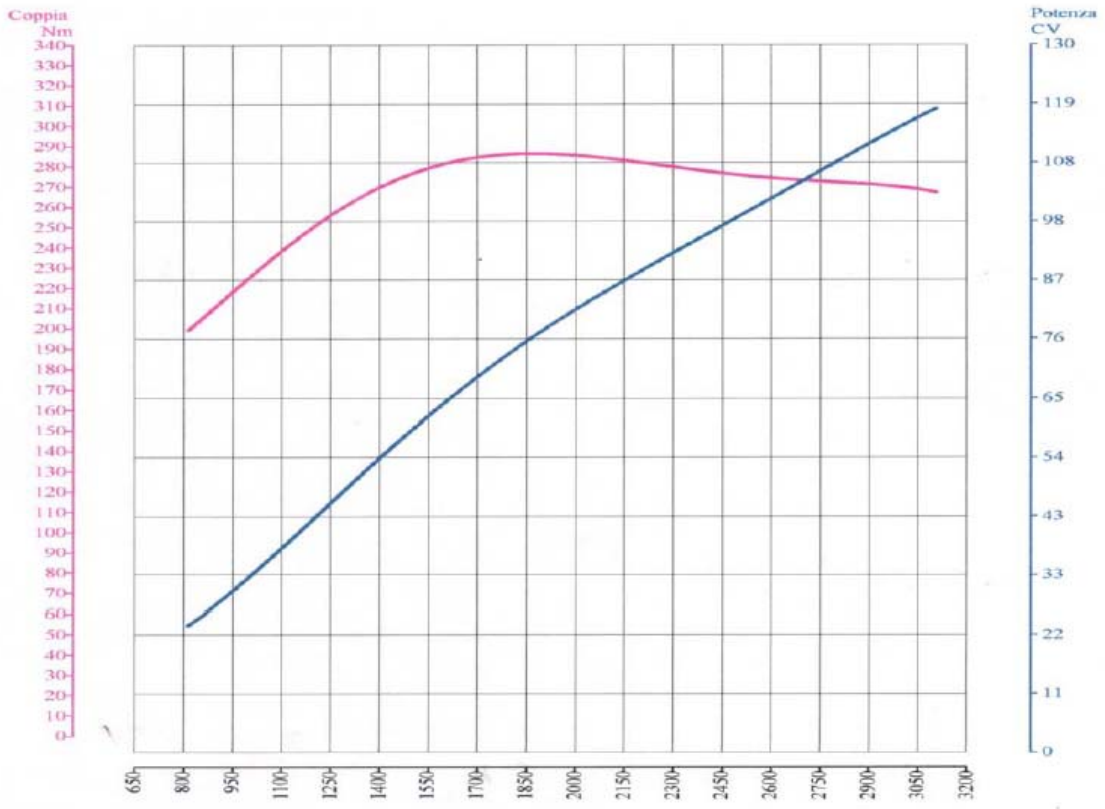
Home > Hyundai diesel EG performance curve



NGV
SALA PROVA

Customer: IKD	Motore :" HIUNDAY	Type: D4AL	Number: 03
n° cylinder: 4	C/C: 3300	Fuel: C.N.G.	Data Prova 21-07-03

PROVA



NGV
TEST BENCH

Customer:IKD	Motore :HYUNDAI	Type:D4AL	Number: 03
CYLINDER: Numero Cilindri :4	Cilindrata [cm³] :3300	Tipo di Carburante :CNG	Data Prova: 210403

N°	Giri	P. corr. 1	P. corr. 2	Coppia corr.	Potenza	Coppia	P.atm.
	rpm	kW	kW	Nm	kW	Nm	mBar
1	816	18	18	206	17	198	1052
2	1014	25	25	237	24	229	1052
3	1200	32	32	257	31	248	1052
4	1399	41	41	279	39	269	1052
5	1597	49	49	295	47	283	1052
6	1807	56	56	298	54	287	1052
7	1999	62	62	298	60	286	1053
8	2218	68	68	291	65	278	1054
9	2409	74	74	292	70	279	1054
10	2610	79	79	288	75	275	1054
11	2802	83	83	284	80	271	1055
12	3004	89	89	282	85	269	1055
13	3107	92	92	281	87	268	1055

N°	T. H2O IN	T. H2O OUT	T. Pre-Kat 1	T. Pre-Kat 2	T. Aria coll.	T.amb.	C 1	C 2	C 3	C 4
	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
1	85	90	503	494	79	57	589	573	613	591
2	78	85	506	499	79	56	570	553	592	576
3	81	85	525	517	83	56	588	570	607	592
4	76	80	565	559	96	58	637	614	654	637
5	77	85	591	585	109	58	671	641	684	666
6	82	86	614	609	112	59	690	662	706	686
7	80	84	643	641	110	61	714	680	727	709
8	77	82	669	665	111	63	731	706	738	734
9	76	83	679	676	109	64	742	716	755	745
10	77	81	694	691	113	64	762	737	776	762
11	79	83	702	699	116	65	771	747	782	774
12	77	82	712	708	122	66	783	765	795	788
13	76	80	718	715	126	66	793	774	806	797

N°	P. coll 2	P. coll 1	Cons. Spec.	Consumo	Cons. aria
	Bar	Bar	g/kwh	kg/h	NM3H
1	-0,07	0,07	254,74	4,5	64,0
2	-0,07	0,13	230,30	5,8	82,9
3	-0,07	0,22	229,98	7,4	101,8
4	-0,07	0,34	228,88	9,4	124,1
5	-0,07	0,50	237,16	11,7	147,6
6	-0,07	0,52	234,92	13,3	170,3
7	-0,07	0,52	231,45	14,4	183,4
8	-0,07	0,49	234,51	15,9	195,7
9	-0,08	0,53	231,68	17,1	206,4
10	-0,08	0,57	232,23	18,3	228,9
11	-0,08	0,60	242,39	20,2	246,6
12	-0,08	0,66	244,64	21,7	262,8
13	-0,08	0,71	247,90	22,7	275,6

B O S C H
diagnosi gas di scarico

Versione BEA: V1.00-ITA
versione AMM: 5575
N°.d'omologaz.:
N°.di serie.:
Pr.taratura: 29.05.2004

Versione DTM: V1d03
N°.d'omologaz.:
N°.di serie.:

Data: 21.07.2003 Tempo: 11:51
cCNG

RISULTATI MISURAZIONE

Temp. [°C]	giri [/min]	Lambda	CO [%vol]	CO2 [%vol]	HC [ppm vol]	O2 [%vol]	NO [ppm vol]	COcor [%vol]
---	---	1.033	0.226	10.70	312	1.42	1313	0.248
---	---	1.023	0.079	11.00	303	1.06	1966	0.086
---	---	0.981	0.135	11.51	306	0.15	1219	0.139
---	---	0.968	0.519	11.21	308	0.15	949	0.555
---	---	0.981	0.197	11.44	303	0.18	1468	0.203
---	---	0.978	0.233	11.41	296	0.14	1294	0.240
---	---	0.980	0.255	11.38	283	0.17	1420	0.263
---	---	0.968	0.579	11.18	271	0.13	1227	0.591
---	---	0.959	0.828	10.94	261	0.10	1102	0.844
---	---	0.984	0.192	11.36	248	0.18	1944	0.199
---	---	0.957	0.883	10.96	252	0.07	1227	0.895
---	---	0.962	0.754	11.01	246	0.09	1361	0.769
---	---	0.961	0.789	11.01	242	0.09	1411	0.802

Emission - Hyunday D4AL

	Pa mbar	rev. rpm	torque Nm	power kW	TBA °C	TBU °C	Pv Ric mbar	Tv Ric °C	PAvol Nm3/h aria	Pgas kg/h consumo	Vgas Nm3/h consumo	HC ppm	CO ppm	CO2 %	NOx ppm	O2 %	HC13 g/h*f	CO13 g/h*f	NOx13 g/h*f
1	1020	826	4	1,0	21	17,5	1014	50	0,1	2,29	3,20	677	13	7,83	37	6,29	5,2	0,0	0,1
2	1020	1980	28	6,0	21	17,5	1014	35	1,0	4	5,59	275	247	10,45	15	1,33	2,9	0,8	0,1
3	1020	1981	69	14,0	21	17,5	1014	35	65,0	3,73	5,21	103	272	10,1	55	2,4	1,7	1,3	0,4
4	1020	1976	138	28,0	21	17,5	1014	35	101,0	2,78	3,88	92	96	8,92	200	4,66	1,3	0,4	1,4
5	1021	1984	213	44,0	21	17,5	1014	35	140,0	2,46	3,44	79	190	8,57	261	5,02	1,0	0,7	1,7
6	1021	1986	285	59,0	21	17,5	1014	36	175,0	2,28	3,18	74	150	8,37	330	5,46	2,9	1,7	6,3
7	1021	796	6	1,0	21	17,5	1014	35	0,1	2	2,79	878	12	8,93	35	4,18	8,1	0,0	0,2
8	1021	2999	274	86,0	21	17,5	1014	38	269,0	2,42	3,38	58	161	9,35	542	3,68	0,9	0,7	3,9
9	1023	2999	202	64,0	21	17,5	1014	40	207,0	2,56	3,58	56	406	9,27	314	3,58	0,2	0,4	0,5
10	1023	2996	132	41,0	21	17,5	1014	41	152,0	2,9	4,05	52	60	10,01	306	2,69	0,2	0,1	0,5
11	1024	2991	68	21,0	21	17,5	1014	41	105,0	3,5	4,89	71	143	11,23	61	0,58	0,3	0,2	0,1
12	1024	3006	30	10,0	21	17,5	1014	40	66,0	4	5,59	70	129	11,43	23	0,2	0,3	0,2	0,0
13	1025	768	4	1,0	21	17,5	1014	36	0,1	2	2,79	705	10	9,11	22	5,07	4,3	0,0	0,1

Tot	**0,9**	**0,2**	**0,5**
Euro 2	1,1	4,0	7,0
percentuale per limiti EURO2	78,8%	4,8%	6,5%

TRANSLATION FROM THE ORIGINAL TEST REPORT DOCUMENT

TEST CARRIED OUT AFTER 60.000 KM. RUNNING

AT/gv/40/04

Buttigliera d'Asti, 28 Giugno 2004

Spett.le
N.G.V. MOTORI SRL
VIA AMUNDSEN N°1
42100 GAVASSA RE

Telefax 0522 506146

ANALYSIS OF A COMPETITOR'S MOTOR OIL

We state here below the test results of analysis carried out on the sampled product:

ANALYSIS RESULTS	
Aspect	Opalescent fluid
Color	Brown
Mass	O,871
Viscosity at 40°C, Kg/l	84,15
Viscosity at 100°C, mm2/s	12,41
Viscosity at –25°C, mPa.s	8000
Viscosity index	143
Acidity, mg KOH/g	1,54
Total Base. KOH/g	8,81
Dispersing action test	Good

The analysis, that have been carried out on the delivered sample, confirm that the tested oil is of the type SAE 15W-40, as evidenced by its viscosity at low temperatures (-25°C) the level of which is over the maximum value settled for a SAE 10W (7000 mPa.s).
Other characteristics are acceptable although it is evidenced a slight opalescence caused, most likely, by the presence of water.

Fuchs Lubrificanti S.p.A.
Giancarlo Valtesio
Product Manager – Automotive Division
(trasmissione automatica)

c.c. sig. M. Bottazzi

CERTIQUALITY SETTORE CERTICHIM Certificato n. 1369

Fuchs Lubrificanti S.p.A.
Capit. Soc. i.v. € 4.160.000
nr. R.I. MI 05179190011
nr. R.E.A. 1231900
nr. Meccanografico MI 099875

Sede amministrative e stabilimento:
14021 Buttigliera d'Asti AT
Via Riva, 16
Telefono 011/9922.811
Partita IVA 08578570155
Codice Fiscale 05179190011

Telefax
011/9921.632
011/9922.857

TECHNICAL ASPECTS OF A COMPLETE ENGINE CONVERSION

For the conversion of the engines from Diesel to CNG or LPG it is necessary to modify several engine components, install new elements or devices.
Each one of these parts is listed in this section under: Group A-B-C-S lists.
(In this case the example is referred to a Hino engine)

GROUP "A" LIST

The raw materials are selected each time accordingly to the final products purposes .
I.e. : if the final required item is a lambda sensor housing in stainless steel with an external diameter of 25 mm. the raw material will be a stainless steel rod of an appropriate diameter (over 25mm.) cut at the proper length with the suitable equipment.

All parts listed under "A" are manufactured by third parts on the basis of our study and specifications, (drawings, indication of the raw materials etc.) in order to achieve the best possible engine modification. Drawings and items specifications are included in the present manual. These specifications are the issue of long years personal experience of our skilled technicians and of several practical applications on many, different engines.

Therefore, there are no routine quality tests run on these parts, but only a technical conformity certificate, issued by the manufacturer, stating the nature and the art of the product. At our end, the specimen of each one of these parts and devices are tested in a practical way on the engine test bench.

GROUP "B" LIST

(for dedicated conversion only)

The modification of a Diesel engine is always the result of a compromising between the original motor and the final target to be obtained. In fact, every engine has to be modified in a different way. It doesn't exist a general rule valid for all brands or engine types.
Once again, the experience of our technicians, the kind of philosophy we adopt in the achievement of a conversion and the final parameters we shall obtain, are marking the steps leading us to carry out the appropriate actions on several parts of the original engine.

I.e.: - How to modify the piston head in order to increase the cubic capacity of the cylinders and, consequently, reduce the compression ratio near to the optimum of 10.0/ 12.0 : 1.
The only way to know how to hollow out and to shape the upper body of the piston is to saw it vertically through and see how deep to turn out material on the bench lathe, without to jeopardize the cooling oil ducts (if existent) or affect the strength of the walls of the device itself.

The same way, based on this kind of experience, we have to go also for all the modifications mentioned under group "B" .

GROUP "C" LIST

In our documentation all items listed under group C will be provided with all necessary details such as: Brand name, commercial specification i.e. spare parts code number etc. enabling the final customer to purchase them on the market.

All the important parts specified under group "C" are supplied to us by leading companies who have obtained the certification ISO 9001 and, therefore, we assume that the quality of their products has already been tested at the origin and that their peculiarities and performances are fully complying with the highest standards we expect.

GROUP "S"

Some of the components of the kit are marked with an additional Letter ""S". It means that these components cannot be locally manufactured or purchased since they are STRATEGICAL for the functioning and safety of the whole system. These items will be supplied exclusively by NGV.

MODIFICATION OF PARTS SUB "B"

(for dedicated conversion only)

Here below we are drawing up a more detailed explanation of some basic modifications to be carried out on the original parts of the engine for the application of our "kit". The related drawings will be included in a specific section of the final manual

PISTONS

The transformation of a Diesel engine to the CNG or LPG fuel involves the reduction of the original compression ratio down to a range of 10.0/12.0 : 1 (or even lower) which is the optimum for a correct CNG combustion. To this purpose it is necessary to increase the capacity of the cylinder removing material from the piston head.

In the past there have been some attempts to reach the same result inserting a metallic spacer mask or flange between the engine basement and the cylinders head but the obtained results have not been enthusiastic because of thermal and dynamic problems arose for some reasons. Additionally the unshaped burning chamber is not always granting the necessary turbulences. This solution has been, in fact, generally abandoned. The solution we have opted for, turned out to be the most viable and efficient on the long run.
How to hollow out the material from the piston in order to perform the reduction of the compression ratio ? This operation can be done only after a careful study of the body of the piston and the thickness of its walls.

For this study it is fundamental to longitudinally saw through a piston and check the consistence of the spaces where it is possible to operate.

The action of hollowing out the piston shall be done with a bench lathe under consideration of following elements:

- The piston head should be shaped in such a form that can ease the necessary turbulences for a correct mixing of air and gas and consequently obtain an optimal combustion. (In most engines the “Hebron” shape has been the appropriate one).
- In shaping the piston head we had to consider that wall should bear a minimum thickness of about 10 mm. while the material thickness at the level of the oil ducts had to be kept at a minimum of 4 or 5 mm. Additionally the experience demonstrated that the acute angles results to be sometimes subject to material damages in case of detonation and therefore it is advisable to round up these angles. These rounded edges grant a better turbulence in the cylinder chamber.

CYLINDER HEAD

The cylinder heads owe to be modified for the spark plug housing hole. With the finality of simplifying the work and to avoid drilling additional holes in the head and preserve us from always possible technical complications, we normally choose to utilize the same hole of the injectors, duly widened and threaded.
However, sometimes, the injectors hole is not positioned in the ideal location of the burning chamber allowing the sparks plug to properly ignite the CNG/LPG air mixture, but the only viable solution is to drill very carefully the original diesel injector holes, avoiding to go too close to the water cooling chambers of the engine head.
A special attention has to be dedicated to the location of the valves because there could be the risk that, drilling a larger hole for the spark plugs, the integrity of the valves be endangered or that some existing water ducts be damaged. It is therefore necessary to saw the motor head and verify the viability of this operation.

THROTTLE VALVE APPLICATION

The throttle valve is manufactured under our design and specifically conceived to satisfy the peculiarities of the CNG and LPG engines. Its installation is subject to prior determination of the correct location on the intake manifold in order to grant the best possible and most uniform supply of the CNG/LPG air mixture to all the cylinders. In our past experiences, this kind of unbalanced fuel supply to the cylinders, ended in temperature increases in the order of the 100°C with some consequent problems for the engine.
The right location for a 6 cylinders engine is, normally, the middle of the intake manifold, in order to have a balanced feeding with temperatures at an acceptable level.

VALVE SEATS

The seats of the valves in some cases must be replaced.
On the Diesel engines of older generation we have noticed a high wear of the seats themselves with a resulting loss of efficiency. In the last years, with the increase of performances and because of the modern features of the engines, these valve seats have been built with better and more resistant materials. In any case, sometimes it could be advisable to replace also the original valves with new specific gas valves produced with more resistant steel.

EXAMPLE KIT LIST (HINO ENGINE)

1	Gas Reducer	700.A01.001	S
2	Water piping ID 12	700.A01.002	C
3	Clamps Water pipe	700.A01.003	C
4	Gas pipe ID 25	700.A01.004	C
5	Clamps Gas pipe	700.A01.005	C
6	Gas stepper motor 203	700.A01.006	CS
7	Gauge manometer with sensor	700.A01.007	C
8	Throttle valve	700.A02.001	AS
9	TPS	700.A02.002	CS
10	Metallic elbow Intake-Throttle	700.A02.003	A
11	O-Ring throttle valve	700.A02.004	C
12	Air pipe ID 80	700.A02.005	C
13	Clamps ID 80	700.A02.006	C
14	Mixer	700.A02.007	AS
15	Air pipe ID 100	700.A02.008	C
16	Clamps ID 100	700.A02.009	C
17	Lambda sensor	700.A03.001	CS
18	Lambda sensor housing	700.A03.002	C
19	Lighting coils	700.P01.001	CS
20	Lighting coil bracket	700.P01.002	A
21	Screw 8 x 25 + Washer	700.P01.003	C
22	Spark plug cable set	700.P01.004	CS
23	Spark plug	700.P01.005	CS
24	Pick-up sensor + screws	700.P02.001	CS
25	Toothed wheel holder	700.P02.002	A
26	Pick-up sensor holder	700.P02.003	A
27	Pick-up holder bracket	700.P02.004	A
28	Screw 8 X 20 + Washer	700.P02.005	C
29	Elastic pin	700.P02.006	C
30	Thooted wheel	700.P02.007	AS
31	Screw 6x15 + Washer	700.P02.008	C
32	Exhaust valve seats set	700.P03.001	AS
33	Intake valve seats set	700.P03.002	AS
34	Valve rubber ring	700.P03.003	C
35	Engine plug	700.P04.001	CS
36	Engine plug flange + Screw	700.P04.002	A
37	Spark Plug Housing	700.P05.001	A
38	Spark Plug housing washer 14x20x1	700.P05.002	C
39	Screw 8x35 + washer	700.P05.003	C
40	Viton O-ring	700.P05.004	C
41	Electronic control system	700.P06.001	CS
42	ECU Wiring harness	700.P06.002	CS
43	Piston		B
44	Head		B

AVERAGE ECONOMICAL ESTIMATE OF COSTS

(for dedicated conversion only)

As a matter of fact it is possible to convert to CNG or LPG almost all existing Diesel engines. This conversion is possible both for new as for used engines. The difference is only in the kind of approach to these situations. For both the procedures it is necessary to consider following general points:

1. In order to justify the costs for the preparation of one or more prototype/s it is mandatory that the final number of engines to be converted ranges from 2 to 3 hundreds units (of same brand and type).
2. It will be necessary to assist the conversion workshop/the manufacturer at their own plant.
3. It is necessary to grant a full range of technical information referred to the working procedures and give to the final operators a clear and exhaustive training granting a state of the art and reliable engine conversion.

For the conversion of in use engines the following elements have to be considered:

1. The engines for the conversion to CNG or LPG should have an acceptable mechanical life expectation
2. Besides of the parts that owe to be mechanically modified, all the other components should be revised and overhauled.
3. It will be necessary to schedule the appropriate lay-out of the conversion shop and also in terms of appropriate machinery, tooling and specific instruments needed for the structural engine modifications and for the assembling of the kit on the vehicles.

For the conversion of engines during their production (or first assembling) the elements to be taken in consideration are:

1. Create a specific department for the structural modifications to be achieved on the engine itself. This operational unit should interface with the normal production chain.
2. In the same location there will be carried out all the assembling works of the kit components pertaining to the engine, (i.e. new valve seats + valves, spark plug bushing + plugs, toothed wheel, coil etc.)

The prototyping works include :

1. Study of the peculiarities of the engine under conversion and decision of the kind of technical approach for that specific motor.
2. Supply of the necessary masks for the further engine modifications and for the assembling of the kit.
3. Training of the customers technicians in their Country and/or in Italy covering the mechanical and electronic aspects of the conversion operations.
4. Assistance for the preparation of the first vehicle and its first road run.

5. Delivery of technical documentation including:

    - List of the structural modifications of the engine parts including technical explanations and drawings/pictures.
    - List of all the kit components with technical specifications and drawings/pictures
    - Wiring harness and electrical connections schemes
    - Block diagram
    - Trouble shooting
    - Detailed assembling instructions with pictures and drawings.
    - Test bench certificates.

The procedures and the general costs related to this prototyping phase may vary and depends from the type of engine, from the kind of fuel supply (mixer or injectors type) from the final vehicle configuration, from the expected pollution targets, from the required type of certificates and from the eventually required special tests.

We are here below giving an approximate preview of the costs related to the conversion of Diesel engines into CNG or LPG dedicated engines. Please note that these figures are indicative only:

Prototyping :

- 4 and 6 Cylinder engines up to 140 HP = from €uro 90.000 to €uro 120.000
- 4 and 6 Cylinder engines over 140 HP = from €uro 120.000 to €uro 170.000

Kits:

- Kits for engines up to 140 HP (for Euro 2 target) = from €uro 2.000 to €uro 3.000
- Kits for engines over 140 HP (for Euro 2 target) = from €uro 3.000 to €uro 4.500

For engines with gas injection the costs increase of about 15%.

For engines of 8 Cylinders the prices may strongly vary depending from their characteristics.

With reference to the prototyping costs we point out that, once the customer purchased a minimum agreed number of conversion kits, we are available for a partial refund of them.

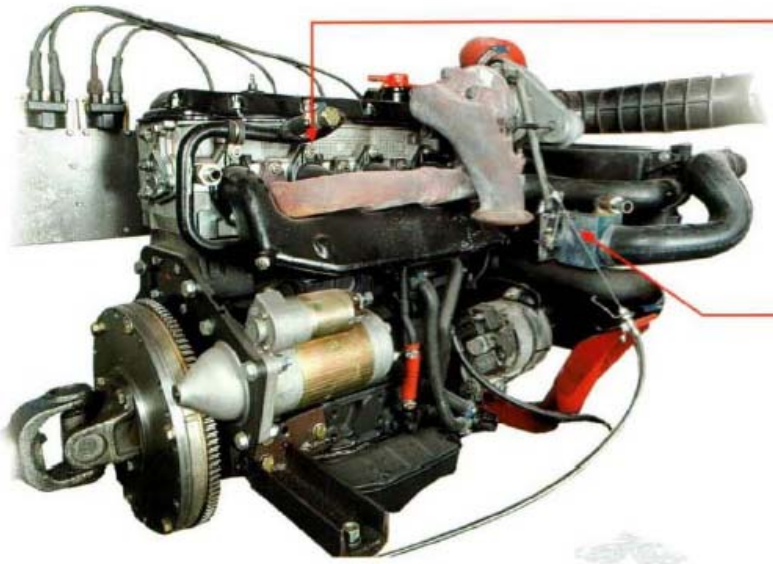
The time of amortization of the conversion investments are depending from the daily Km. run by the vehicle and of the difference between the price of the Diesel and of the CNG.
To this purpose it is important to know that 1 Litre of Diesel is corresponding to 1,3 m3 of Methane.

ESEMPIO DI TRASFORMAZIONE

Referenza Motore 9392.76.80 - quattro cilindri - cavalli 125 a 2750 giri

CONVERTION EXAMPLE

Engine References 9392.76.80 - four cylinder HP 125/2750 rev



Sostituzione dei pistoni.

The replacement of the pistons.

Modifica collettore d'aspirazione con applicazione di una valvola a farfalla e miscelatore aria/metano.

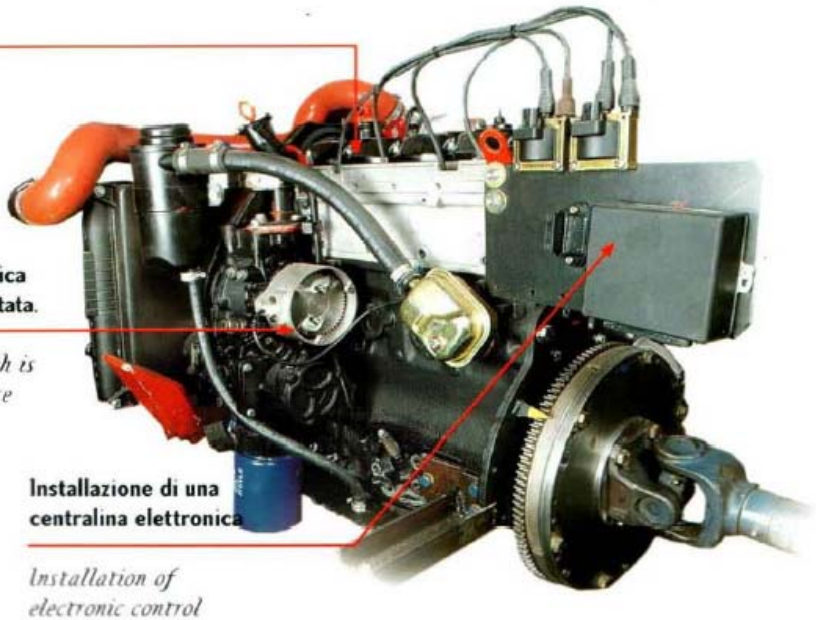
The modification of the induction manifold with the application of a throttle valve and of an air/gas mixer.

Eliminato il sistema di iniezione.

The elimination of the injection system.

Applicazione delle candele al posto degli iniettori.

The application of the sparkling plugs in the place of the injectors.



Applicato accensione elettrica comandata tramite ruota dentata.

The electronic ignition which is controlled by an applied face gear.

Sostituzione valvole e sedi valvole.

The replacement of the valves and of the valve seats.

Installazione di una centralina elettronica.

Installation of electronic control system.

Primo e unico prototipo di autobus con motore trasformato ed omologato in Italia costruito per **l'ATAF di Firenze**.

The first and only prototype of bus with an engine which was converted and type-tested in Italy and built for ATAF-Florence

Uno dei 6 autobus alimentati a Metano consegnati alla **Croazia**.

One of the six buses with a CNG engine which were delivered to Croazia.

Autobus convertito a metano realizzato in 27 esemplari per il mercato egiziano.

A bus converted to CNG built in 27 items for the egyptian market.