ITTEHAD (PRIVATE) LIMITED.

The Spinning Mill

To,
Registrar NEPRA.
NEPRA Tower, Attaturk Avenue (East),
G-5/1, Islamabad Pakistan.
Dated: 03 /11 /2020.
Reference: IPL/HR/20A/2020.

Subject: Electricity Generation and Distribution license for Ittehad (Pvt)Ltd Captive power Plant (3 X 1521 KW) 4.563 MW.

Sir,

I, Mr Asim Maqsood , chief Executive office , being the duly authorized representative of Ms Ittehad (Pvt)Ltd. by virtue of board resolution dated: October 16,2020, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to the Ittehad (Pvt)Limited pursuant to section 3(1) of the regulation of Generation and Distribution of Electric Power Act,1997.

I certify that the documents –in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above said regulations, I further undertake and confirm that the information provided in the attached documents –in-support is true and correct to the best of my knowledge and belief.

A Bankdraft # BCYMF00002351(FT2030803ZP1NC1W)dated:03-11-2020 sum of Rs. 186,944, being the non-refundable license application fee calculated in accordance with schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Dated:03-11-2020.

Mr Asim Maqsood ,

Chief Executive officer

Head Office : Dost Street, Samundri Road, Faisalabad-Pakistan. Ph: 0092-41-8710160~62. Fax: 0092-41-8732904
Mills : 1-Km Jaranwala Road, Khurrianwala, Faisalabad-Pakistan. Ph:0092-41-4360348Fax: 0092-41-4360347

ITTEHAD (PRIVATE) LIMITED.

The Spinning Mill

Corporate Resolution

Resolved that M/s ***ITTEHAD (PRIVATE) LIMITED,*** *1-K.M Jaranwala Road, Khurrianwala,* ***Faisalabad,*** *to file a request with* ***National Electric and Power Regulatory Authority (NEPRA),*** *For obtaining electricity generation & distribution License in below mentioned name and style with complete detail of NTN, GST, Incorporation No, etc.,*

> ***Ittehad (Pvt) Limited,*** *1 – K.m, Jaranwala Road, Khurrianwala, Faisalabad.*
> ***GST No.*** *08 – 90 – 9991 – 870 – 19,* ***NTN No.*** *1422643-0* ***– SECP No.*** *0041077*
> ***Capative Power SNGPL - Consumer No.***

However, Ittehad (Pvt) Limited, *needs to distribute its surplus electricity & steam, if available, to its sister concern units having same directors & in front location, details as below:*

> ***1 - Ittehad Textiles Industries (Pvt) Limited,***
> *1 – K.m, Jaranwala Road, Khurrianwala, Faisalabad.*
> ***GST No.*** *04 – 05 – 5111 – 021 – 28,* ***NTN No.*** *0658559-7*
>
> ***2 - Ittehad Fabrics (Pvt) Limited,*** *1 – K.m, Jaranwala Road, Khurrianwala, Faisalabad.*
> ***GST No.*** *08 – 90 – 9991 – 638 – 28,* ***NTN No.*** *1422637-5*

Resolved Further, *that any one of the following singly:*

Name	***Specimen Signatures***
• *Mr. Asim Maqsood*	
• *Mr. Faisal Maqsood*	

of company whose signatures appear against their names, are hereby authorized in the name of this Company to discuss & negotiate with NEPRA & all its related departments on behalf of the Company or Directors.

RESOLVED FURTHER *that I,* ***Mr. Faisal Maqsood****, Director of M/s* ***ITTEHAD (PRIVATE) LIMITED****., P – 69, Gole Cloth Bazar,* ***FAISALABAD*** *do hereby certify that the foregoing is a full, true and correct copy of the resolution passed by directors of Company in a meeting which was duly and regularly called and held in all respects as required by law and by Articles of Association of the Company at office thereof on* ***October*** *16, 2020.*

I, ***Mr. Faisal Maqsood****, further certify that the said resolution is in force and effect and has not been amended and that specimen signature appearing against their respective names are of the offices authorized to sign for the Company pursuant to this resolution.* ***In witness whereof****, I have set my hand as such Secretary and affixed the Corporate seal of the Company, this day* ***October*** *16, 2020 in presence of the* ***Chief Executive / Director*** *of Company.*

For & on behalf of
ITTEHAD (PRIVATE) LIMITED

Director

Director

For & on behalf of
ITTEHAD (PRIVATE) LIMITED

(Chief Executive / Director)

(Corporate Seal)

Ref. # EMD / IPL / 2837 / October / ***2020.***

Head Office : Dost Street, Samundri Road, Faisalabad-Pakistan. Ph: 0092-41-8710160~62, Fax: 0092-41-8732904
Mills : 1-Km Jaranwala Road, Khurrianwala, Faisalabad - Pakistan. Ph :0092-41-4360348 Fax : 0092-41-4360347

GOVERNMENT OF PAKISTAN

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN
SECP
COMPANY REGISTRATION OFFICE FAISALABAD

CERTIFICATE OF INCORPORATION

(Under section 32 of the Companies Ordinance, 1984 (XLVII of 1984))

Company Registration No. F-0602

I hereby certify that PITTSHAD (PRIVATE) LIMITED

/ / /

/ / /

is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is limited by Shares

Given under my hand at Faisalabad

this 22th day of March

one thousand nine hundred and Two thousand

Fee Rs. 42,700/-

Seal of the Company Registration Office
Government of Pakistan

Additional Registrar
Securities & Exchange
Commission of Pakistan
Companies Registration Office
FAISALABAD.

09 OCT 2002

(TAHIR SAHMOOD)
DY. REGISTRAR
OF COMPANIES
FAISALABAD REGION

CRO-1

PCPPK-Litho/2059/97/DCS&F—29-7-97—12,000 Loose. No. DNJ 20 P.
Dt 21-7-2

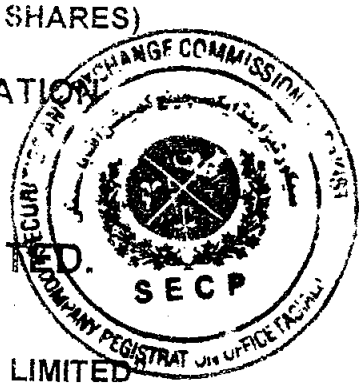
THE COMPANIES ORDINANCE, 1984

(A PRIVATE COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

ITTEHAD (PRIVATE) LIMITED.



I. The name of the Company is **"ITTEHAD (PRIVATE) LIMITED"**

II. The Registered Office of the Company Shell be situated in the Province of Punjab.

III. The objects for which the Company is established are:-

1. To establish and set up Cloth processing unit for the purpose of printing.dyeing and bleaching of cloth.
2. To establish and set-up weaving Factory.
3. To carry on the business of weavers, knitters, combers spinners hosieries manufacturers of fine textile, hosiery fabrics, embroidery fabrics of all kinds and description,readymade garments,silk and man-made fabrics of all kinds and description.
4. To carry on the business of Cloth merchants and to deal in all kinds of cloth.
5. To carry on the business of import and export of all goods, items, commodities, articles and products.
6. To establish and set-up an Embroidery Factory.
7. To erect, maintain, alter, extend, modernize, re-model or otherwise establish, own manage and run various kinds of mills, factories and works, undertake and execute any contract for works involving the supply or use of any machinery and to carry out the auxiliary or other works, comprised of such works.
8. To carry on the business of oil extraction by mechanical or chemical process from cotton seed, mustard, castor-peanuts any other oil producing substances processing and preparing any by-products and generally to manufacture, refine, prepare, and deal in all kinds of oil.
9. To purchase take on lease or otherwise acquire agricultural lands for agricultural purposes and/or for establishing model farms
10. To set up, establish, own, operate, acquire, run and manage processing plants and canning factories for processing, preserving packing and canning shrimps, fish, fruits, vegetable and other edible products for human and animal consumption; and to deal in all kinds of machinery appliances and materials for achieving the objects and to import, export or deal with the same.

22. To distribute among the members of the Company, in kind, any of the property of the Company as permissible under law.

23. To adopt such means of making known the business and products of company by advertising in the press.

24. To appoint legal and technical advisers, and to appoint banker or bankers for the Company, and to pay the necessary expenses for the same.

25. To create depreciation fund, sinking fund, insurance fund or any special or other fund for depreciation, or for repairing, improving, extending or maintaining any of the property of the Company.

26. It is declared that notwithstanding anything contained in the foregoing objects clauses of this Memorandum of Association, nothing contained therein shall be construed as empowering the company to undertake or indulge into the business of a banking company, banking investment, leasing or insurance business as restricted by law or any unlawful operation.

IV. The liability of the members is limited.

V. The capital of the company is Rs.920,000,000/- (Rupees Nine Hundred Twenty Million only) divided into 9,200,000 Ordinary Shares of Rs.100/- Each with power to increase, reduce, consolidate or otherwise reorganize the share capital of the company in accordance with the provision of the Companies ordinance, 1984.

SECP

The Companies Ordinance, 1984

(A PRIVATE COMMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

ITTEHAD (PRIVATE) LIMITED.

PRELIMINARY

1. The regulations contained in Table 'A' in the first schedule to the Companies Ordinance, 1984 as amended up-to-date shall, subject as hereinafter appearing apply to the Company as for the same are applicable to private Companies.

PRIVATE COMPANY

2. The Company is a Private limited Company within the meaning of Section 2 (1) (28) of the Companies Ordinance, 1984 and accordingly:

   (a) No invitation shall be issued to the public to subscribe for any shares, debentures or debenture stock of the company.

   (b) The number of members of the Company (exclusive of the persons in the employment of the Company) shall be limited to fifty, provided that for the purposes of this provision where two or more persons hold one or more shares jointly in the Company, they shall be treated as single member; and

   (c) The right of transfer shares in the Company is restricted in the manner and to the extent hereinafter appearing.

BUSINESS

3. The business of the Company shall include all or any of the objects enumerated in the Memorandum of Association and can be commenced immediately after the incorporation of the Company notwithstanding that a part of the capital has been subscribed.

4. The business of the Company will be carried out at such place or places in the whole of PAKISTAN or elsewhere as the Directors may deem proper of advisable from time to time.

5. The Capital of the Company is Rs.920,000,000/- (Rupees Nine Hundred Twenty Million Only) divided into 9,200,000 Ordinary Shares of Rs.100/- Each with power to increase, reduce, consolidate, or otherwise reorganize the Share capital of the company in accordance with the provision of the Companies ordinance. 1984

6. The shares shall be under the control of the Directors who may allot or otherwise dispose of the same to such persons, firms, corporation or corporations at such terms and conditions and at such time as may be thought fit either at par or at premium or at discount as the Directors may think fit, subject to any permission required by law.

7. The shares in the capital of the Company may be allotted or issued in payment of any property, land, machinery or goods supplied or any services rendered to the Company in promotion or formation of the Company or conduct of its business and any shares so allotted may be issued as fully paid shares.

QUORUM

17. No business shall be transacted at any general meeting unless a quorum of members is present at the time when the meeting proceeds to business save as herein otherwise provided. Two members, present in person holding not less than 25 % of the total voting power either on their own account or through proxies, shall form a quorum for a general meeting.

VOTES OF MEMBERS

18. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person shall have one vote except for election of directors in which case the provisions of section 178 shall apply. On a poll every member shall have voting rights as laid down in section 160.

19. On a show of hands every member present in person shall have one vote and on a poll, every member shall, whether present in person or by proxy, have one vote in respect of each share held by him.

20. In cash of an equality of votes, whether on a show of hands or on a poll, the Chairman of the meeting at which the show of hands, takes place, or at which the poll is demanded shall be entitled to a second or casting vote.

21. The instrument appointing a proxy and the power of attorney or other authority if any under which it is signed or notarially certified copy of that power of attorney or authority shall be deposited at the registered office of the company not less than forty- eight hours before the time for holding the meeting at which the person named, in the instrument proposes to vote. And in default, the instrument of proxy will not be treated as valid. No person shall act as proxy unless be is a member of the Company.

22. (a) Unless otherwise determined the number of Directors shall not be less then two and not more then eleven.

(b) Till the Directors are elected at first annual general meeting the following persons will acts as First Directors of the Company.

1.	ASIM MAQSOOD	2.	NAZIM SHAHZAD
2.	KHUSHNOOD AHMAD	4.	FAISAL MAQSOOD
3.	HAJI MAQSOOD AHMAD	6.	MST. AZRA PERVEEN

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN
SECP
COMPANY REGISTRATION OFFICE FAISALABAD

23. The Directors of the Company shall be elected by the members of the Company in general meeting in the following manner namely subject to the provision of Section 178 of the Companies Ordinance 1984:

(1) A member shall have such number of votes as is equal to the product of the number of voting shares or securities hold by him and the number of directors to be elected:

(2) A member may give all his votes to a single candidate or divide them between more then one of the candidates in such manner as he may choose : and

(3) The candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest number of votes shall be declared and so on until the total number of Directors to be elected have been so elected.

by the company in general meeting shall invalidate any prior act of the Directors which would have been valid if that regulation bad not been made.

32. The Chief Executive of the Company from the date of his appointment and will hold this post till the 1st annual general meeting or unless or until he becomes incapable for post for any reason. The said Chief Executive shall be paid such remunerations as may be decided by the Board of Directors from time to time and duly approved by General Body, subject to the provisions of the Companies Ordinance, 1984.

33. The Chief Executive may from time to time raise or borrow any sums of money for and on behalf of the company from the company or Banks or may himself advance to the company sums on such terms as may be approved by the Board of Directors, from time to time.

34. Without prejudice to the powers conferred to these Articles, the Chief Executive shall, subject to the supervision and control of Board of Directors, have the following powers:-

a) To pay the cost, charges and expenses preliminary and incidental to the promotion, establishment and registration of the company.
b) To take on lease, purchase or otherwise acquire for the company any property, movable or immovable, rights or privileges which the company is authorized to acquire at such price and generally on such terms and conditions as he may think fit.
c) To appoint any person or persons to hold in trust for any company any property belonging to the company or in which he is interested for any other purpose and execute and so all such instruments and things as may be requisite in relation any such trust.
d) To let, mortgage, sell, exchange or otherwise dispose of absolutely or conditionally all or any part of the privileges and undertaking of the company upon such terms and condition and for such consideration as he may think fit.
e) To buy or procure the supply or the plant, machinery, materials, stock-in-trade, stores, fuel, implements, immovable and other movable property required for the purpose of the company.
f) To sell, deal in and dispose of all articles and goods manufactured by the company.
g) To engage, fix and pay the remuneration of and dismiss or discharge all managers, agents, secretaries, clerks, servants, workmen and other persons employed in or in connection with the company's business.
h) To appoint any person or persons to be attorney or attorneys of the company for such purposes and with such powers, authorities and discretions and for such period and subject to such conditions as he may from time to time think fit.
i) To enter into, carry out, rescind, vary all financial arrangements with any bank, person or corporation of or in connection with such arrangements to deposit, pledge or hypothecate property of the Company or the documents representing or relating to the same.
j) To make and give receipts, release and discharge or all moneys payable to the company and for the claims and demands of the company.
k) For and on behalf of the company to draw, accept, endorse and negotiate all such cheques, bill, of exchange, promissory notes, hundies, drafts, Government and other securities as shall be necessary in or for carrying on the affairs of the company.
l) To compound or all allow time to the payments of satisfaction of any debts due to or by the Company and any claims and demands by or against the company and to refer any claims or demands by or against the company to arbitration and observe and perform, the award.
m) To institute, prosecute, compromise, withdraw or abandon any legal proceedings by or against the company of its officers or otherwise, concerning the affairs of the company.

36. The books of account shall be kept at the registered office of the company or at such other place as the Directors shall think fit

AUDIT

37. The Auditors will be appointed every year and their duties regulated in accordance with section 252 to 255 of the Companies Ordinance. 1984.

THE SEAL

38. The Company shall have a common seal and the Directors shall provide for the safe custody of the same. The seal shall not be applied to any instrument except by the authority of the Board of Directors and in the presence of Chief Executive and another Director, who shall sign every instruments to which the seal shall be affixed in their presence. Such signatures shall be conclusive evidence of the fact that the seal has been property affixed.

INDEMNITY

39. in connection with carrying on the business, every director, chief executive or other officers of the company shall be indemnified by the Company from all losses and expenses occasioned by and error of judgment or oversight or his part damage or misfortune whatsoever which happens in the execution of his duties of office unless the same happens though his own dishonesty or willful acts and defaults.

SECRECY

40. except as conferred by law, no member shall be entitled to visit or inspect the work of the Company without the permission of the Directors or to require discovery of any information regarding any details of the company's business or any matter which is or may be in the nature of trade secret, mystery or secret process which may relate to the conduct of the company's business and which in the opinion of Directors will be inexpedient in the interest of the members of the company to communicate to the public.

ARBITRATION

41. Whenever any difference arises between the company on the one hand and any of the members, their executors, administrators or assignees on the other hand, touching the true intent or construction or the incident or consequence of these presents or of the statutes or touching anything then or thereafter done executed omitted or suffered in pursuance of these presents or otherwise relating to the premises or to these presents or to any statute affecting the company or to any of the company every such difference shall be referred to the decision of the arbitrator or arbitrators or umpire under the Arbitration Act as amended.

42. The coast of any incidental to any such reference and award shall be of the discretion of the arbitrator or arbitrators or umpire, respectively who may determine the amount thereof and direct the same to be shared between the attorney and client or otherwise and may award by whom and in what manner the same shall be borne and paid.

WINDING UP

43. If the company is wound up whether voluntarily or otherwise the liquidator may, with the sanction of special resolution, divide among the contributors in specie the whole or any part of the assets of the company.

FEASIBILITY FOR ITTEHAD(PVT) Ltd By 3 x 1.5 MW MTU GENSETS.

(During Pay back Period)

21 th October,2020

MTU Genset

Model	Rating	Qty	Total kW	Remarks
12VL64 @ 400 Volts	1521 KWh	3	4,563	
Total kW			4,563	**Total Power From MTU Gas Genset**

Investment Phase

Model	Amount	Qty	Total	Remarks
12VL64 @ 400V	325,000	3	€ 975,000	with 2 years consumables & 2 years Warranty
Total Genset Price in Euro			**€ 975,000**	
Convert in Rs	196.0		191,100,000	
Heat Recovery Boiler 3TPH	19,685,000	1	19,685,000	
Total Cost Rs			211,785,000	
Duty Factor	5%		10,589,250	
Transportation , loading and unloading Rs			1,000,000	
Installation of 3 x gensets Rs			31,705,800	including Power Cables & Foundation, Panels.
Total new investment Rs			**255,080,050**	

Steam Generation And Hot Water

Stem Generation per Hr	2	Tons		0.6 Ton per engine
Steam Impect @ 2200/Ton	4800	Rs	34,560,000	Rupees saving Per YEAR (10 months)
Note : Will install latter on.				
New investment for HRSG Rs			**34,560,000**	**Total Power From 03 Gas Gensets @ 45 degree C.**

Hours of operation (40 Hrs per year for planed maintenance) **8400 per year** **363 Days**

Total Cost with MTU Engines.

Heat rate of MTU 12VL 64 Gas Engine	0.260	M3/KWh	At 1000GCV Value & 80MN
Current Rate of gas	39	Rs/m3	At 1105 Rs/mmbtu@ $ 6.5
Electric Unit Cost with Gas	10.1	Rs/ Kwh	As per SNGPL Gas rate August-2020.
Total Parts Per Kwh Cost till 80,000 Hours	0.60	Rs/ Kwh	at Current Euro exchange Rate to Rs 193.5
Salaries effect	0.34	Rs/ Kwh	(4 Shifts , total 18 persons , 1,000,000 / month)
Checmicals / maintenance / Lube Oil	0.35	Rs/ Kwh	Rs 1,008,000 per month.
Deprecision @ 10 % per year	0.68	Rs/ Kwh	For total cost on gensets.
Total Unit Cost of MTU Sets	**12.11**	**Rs/ Kwh**	**Including all factors**

ECONOMICAL COMPARISON.

Description	Unit		Total	
Wapda Unit Rate	Rs/KWh		15	As 9 Cents/kwh
MTU Unit Rate	Rs/KWh		12	
Difference at Unit Rate	Rs/KWh		2.8	
Total Ittehad (Pvt)Ltd Operating Load	KWh		3,450	
Total Ittehad Fabrics (Pvt)Ltd Operating Load	KWh		550	
Total Operating load of Ittehad Units @ 95 % of total load	KWh		4,000	**Consider Operating load in net saving**
Savings for Ittehad againt WAPDA per month	Rs		8,150,400	
Transformer losses saving per month (Iron 1% and Copper losses1%) for LT Supply to Units. (Minimum)	KWh	30	322,704	**Transformers will isolate during LT Supply with Gensets.**
Total Savings per month from WAPDA	Rs		8,473,104	
Total Savings per year from WAPDA	Rs		101,677,248	**For Twelve 12 months @ 40 hrs per year planed shutdown.**
Loan pay back with interest per year.	Rs		78,000,000	For Twelve 12 months
Net Savings per year from System	Rs		58,237,248	
Pay back in years (Inv / savings)			4.4	Years

FEASIBILITY FOR ITTEHAD (Pvt) Ltd By 3 x 1.5 MW MTU GENSETS.
(During Pay back Period)

21 th October,2020

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ECONOMICAL COMPARISON.

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Difference at Unit Rate	Rs/KWh		2.8	
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Total Operating load of Ittehad Units @ 95 % of total load	KWh		4,000	**Consider Operating load in net saving**
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Pay back in years (Inv / savings)			4.4	Years

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT
(4.563 MW) 1 KM JARANWALA ROAD
KHURRIANWALA FASIALABAD.

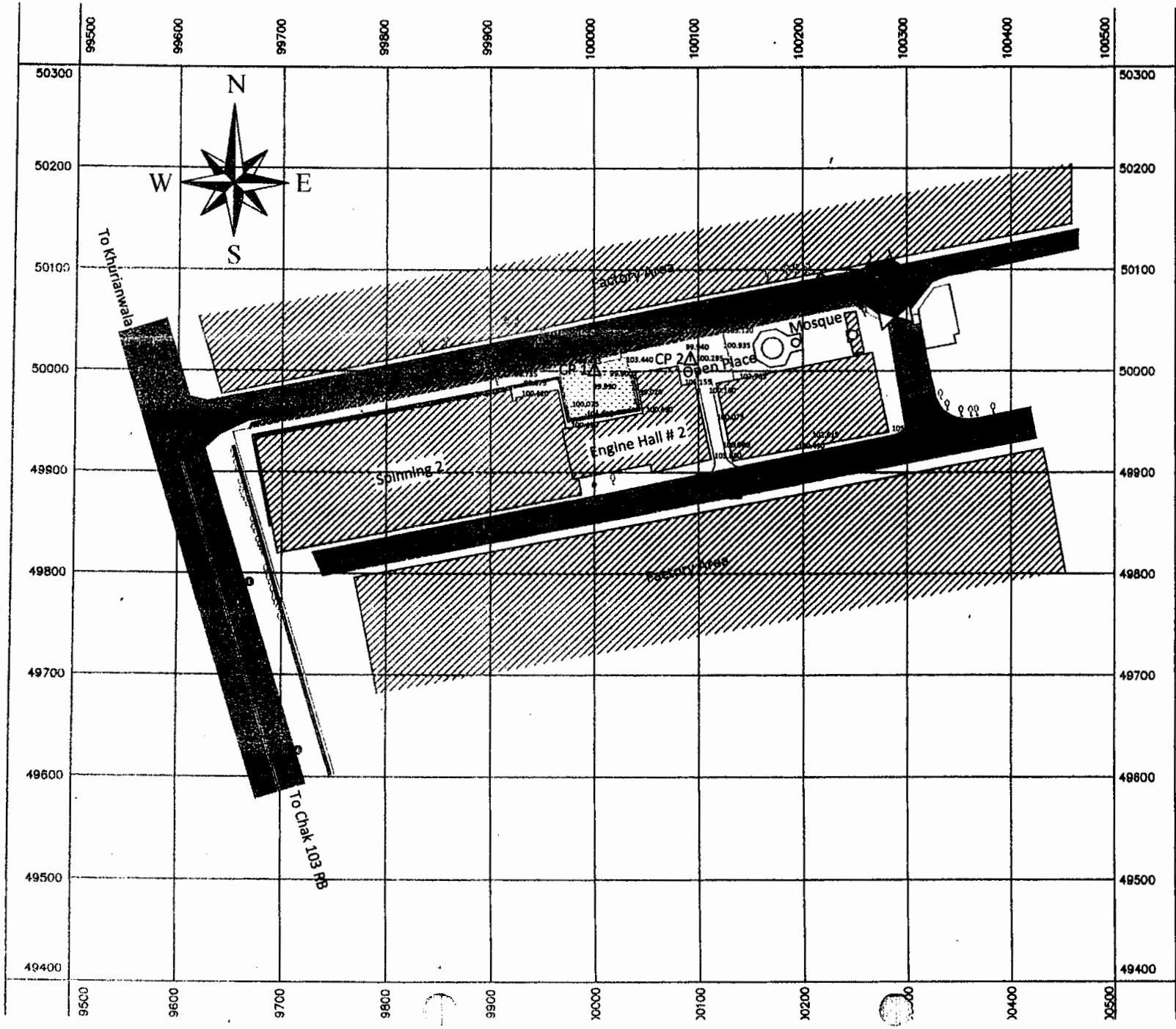
3(5)-A(iv):

LOCATION MAPS , SITE MAP , LAND.

TOTAL LAND :

TOTAL LAND AREA	= 413163 SFT.
TOTAL COVERED AREA	= 237795 SFT.

Attachment : Land registery attached.



LEGEND & SYMBOLS

- BUILDING
- ROAD
- Water Channel
- TREE
- FOOT PATH
- GROUND
- ELECTRIC POLE (EP)
- CONTROL POINT
- WALL

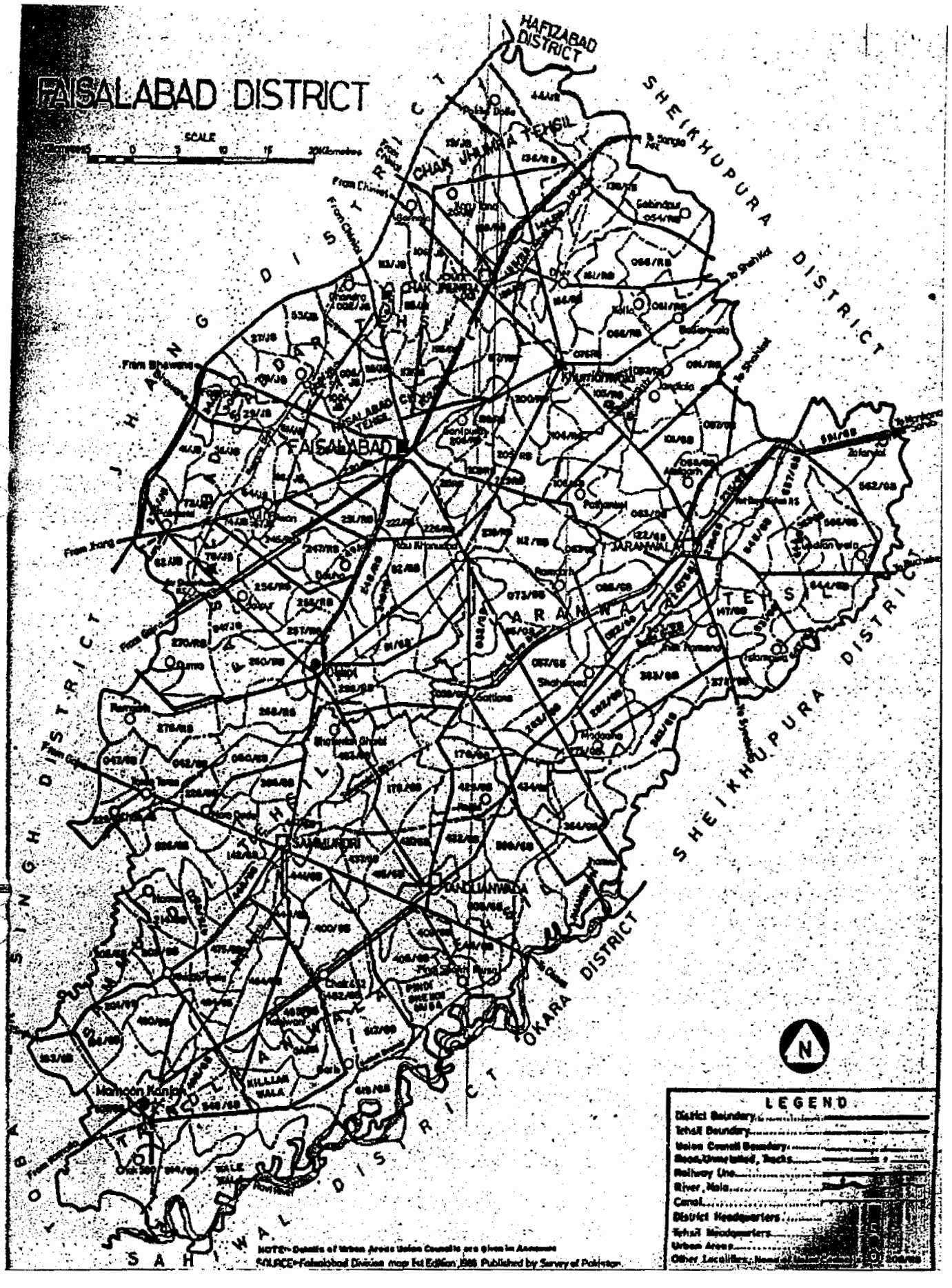
08-JUNE-2018

SCALE: 1:1

0 20 50 100 150

ALL VALUES ARE IN FEET

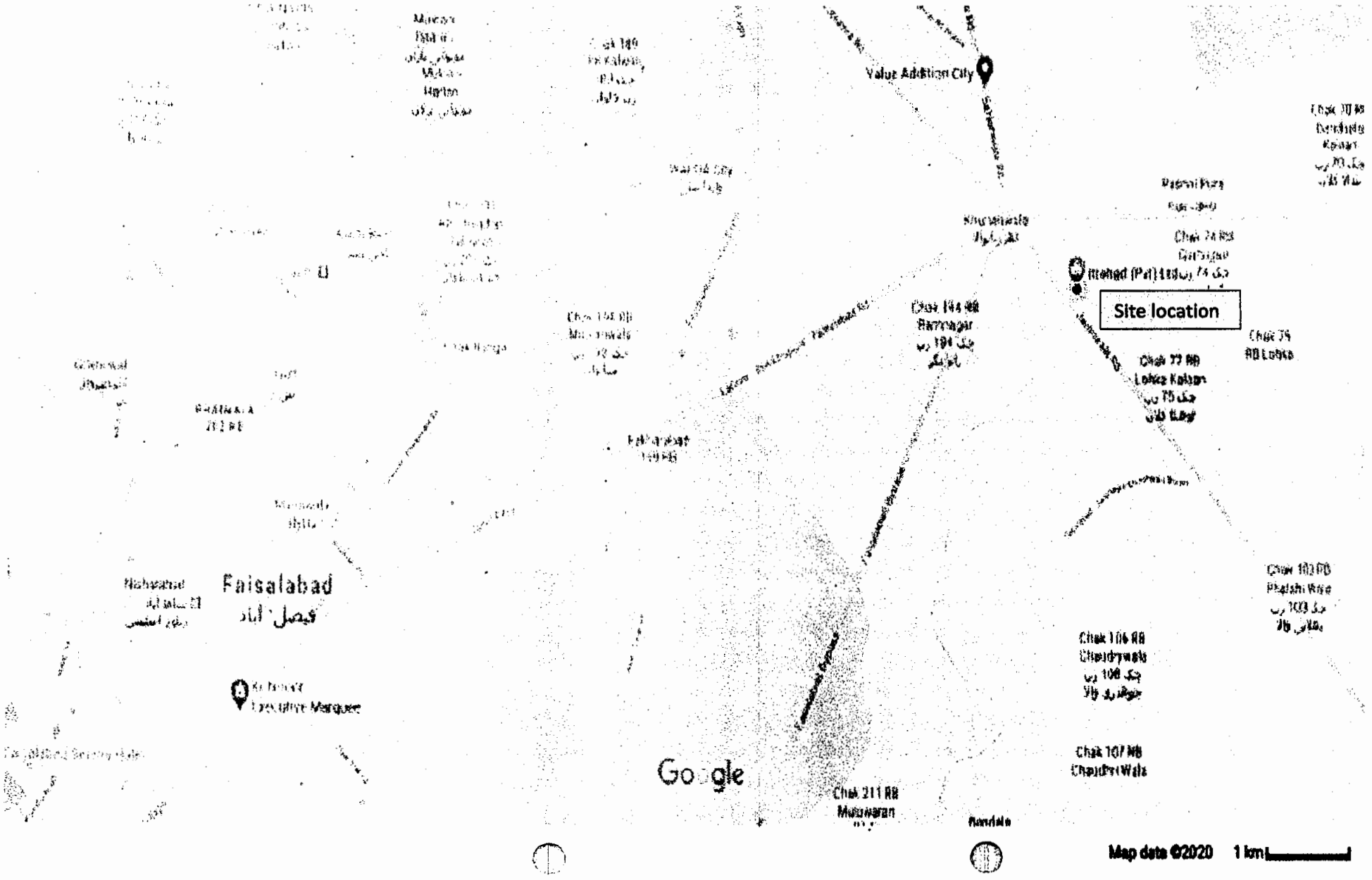
TECHNO SURVEY CONSULTANTS
AYUB CENTRE-FIRST FLOOR
HAJJI ALLAH DITTA ROAD
LINK PECO ROAD
TOWNSHIP,LAHORE
TEL: 0321-4585241 / 0306-4908914



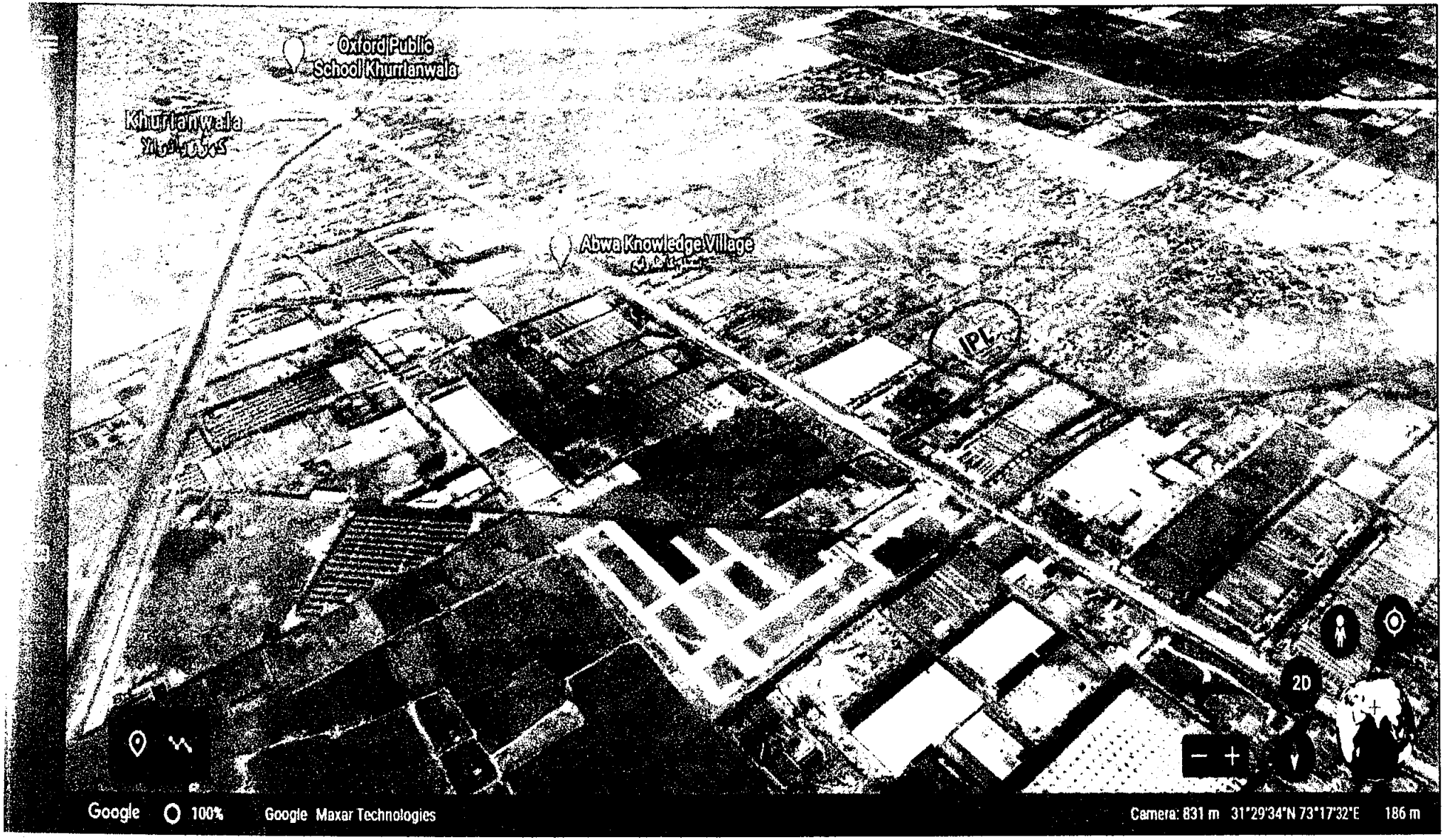
NOTE:- Outside of Urban Areas Union Councils are given in Annexure

SOURCE:-Faisalabad Division map 1st Edition 1988 Published by Survey of Pakistan

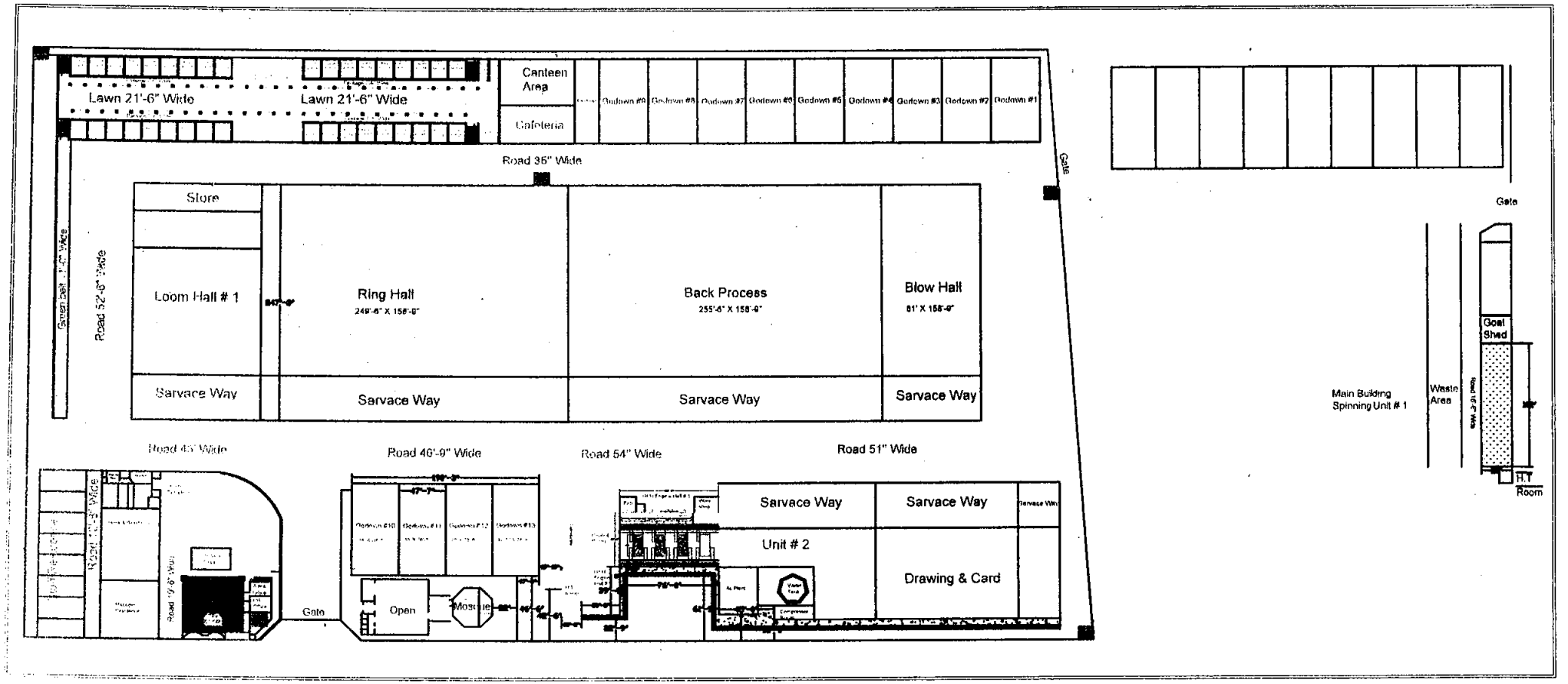
SITE LOCATION OF ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

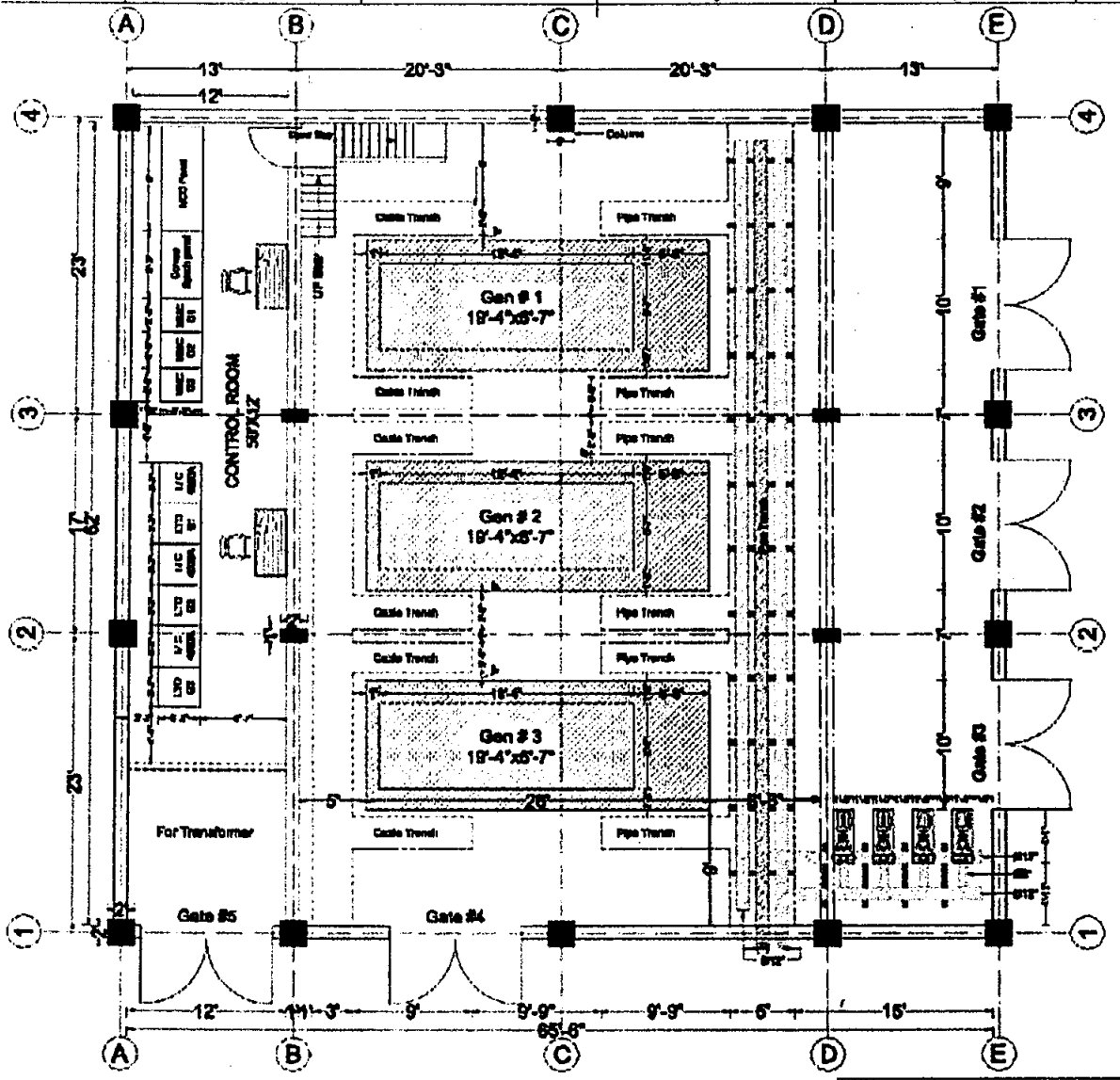


SITE LOCATION OF ILLIAD(PVT) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.



Layout drawing Of Ittehed Spinning Unit





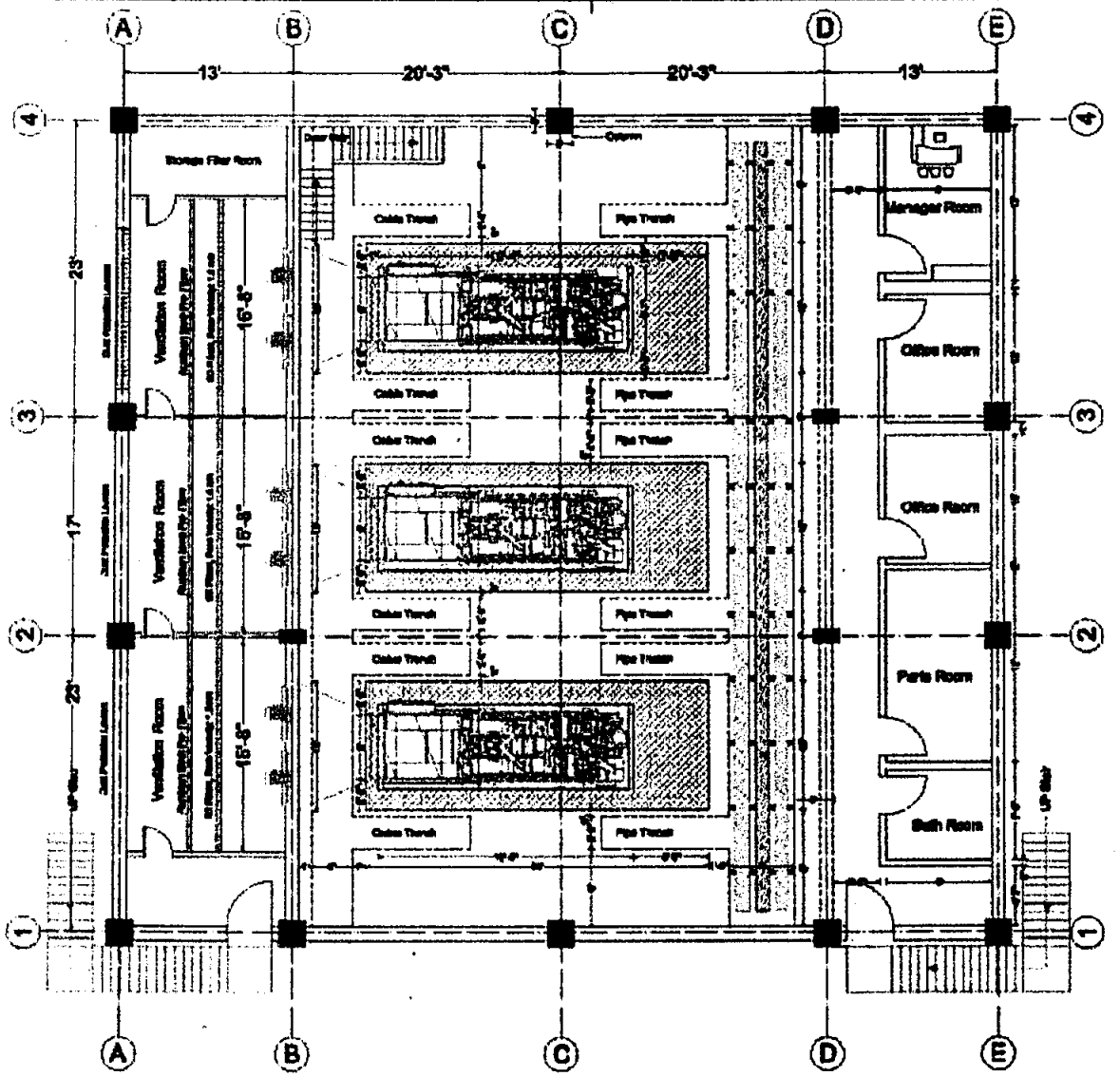
Scale	Revision	Format	Sheet
NTS	0	A4	01
Rizwan	Syed Ahmed	M.Ali	
Drawn By	Checked By	Approved By	

Customer: Ittehad Pvt Ltd

Project Title: Proposed Power House Ground Floor

Drawing-No

R.A ENGINEERING & SERVICES (PVT) LTD



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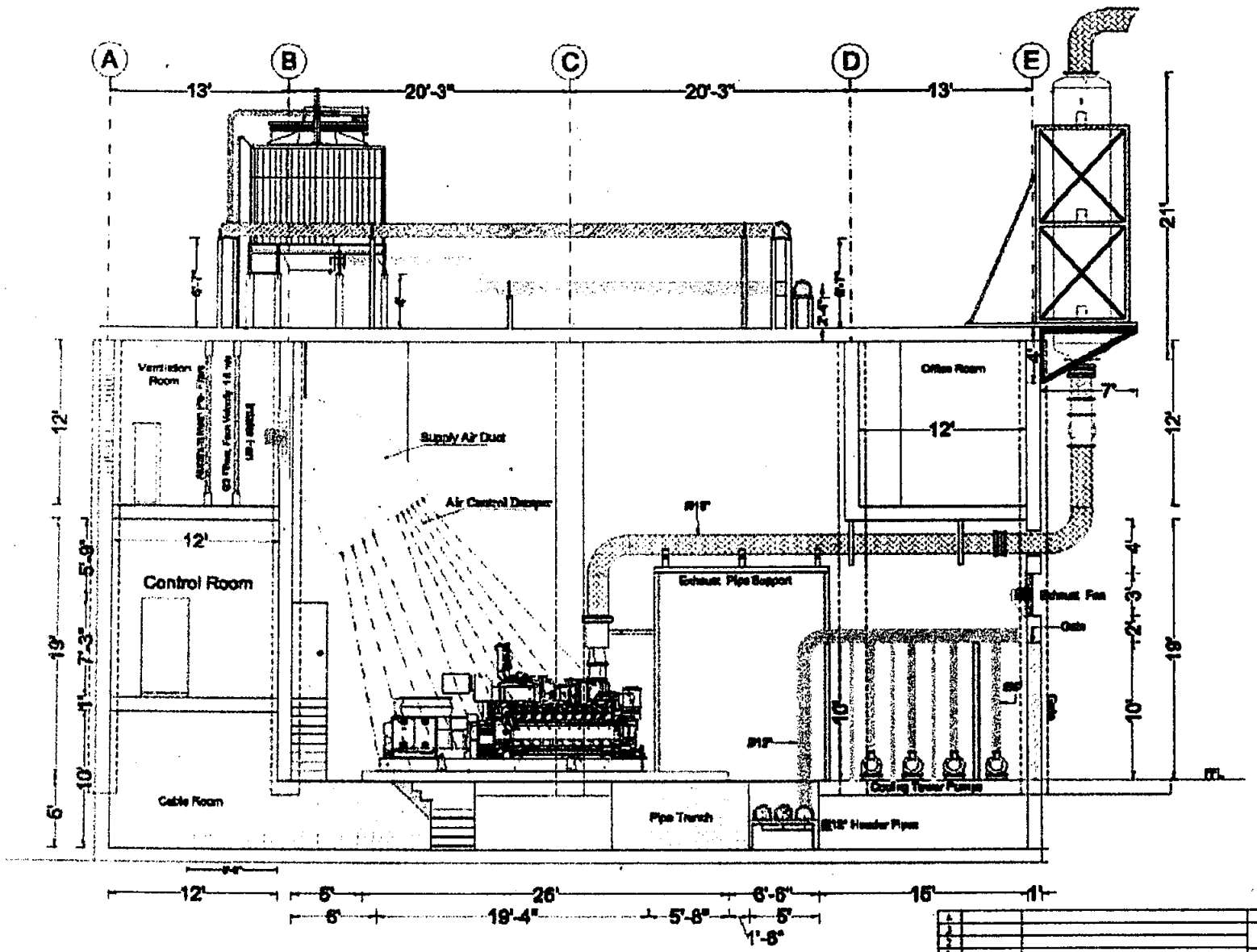
0	07-07-2016		Rizwan	Syed Ahmed	M.Ali
Rev.	Date	Revision Note	Drawn By	Checked By	Approved By
		Customer: Ittehad Pvt Ltd			
		Project Title: Proposed Power House Mezzanine Floor	Drawing-No		

R.A ENGINEERING & SERVICES (PVT) LTD



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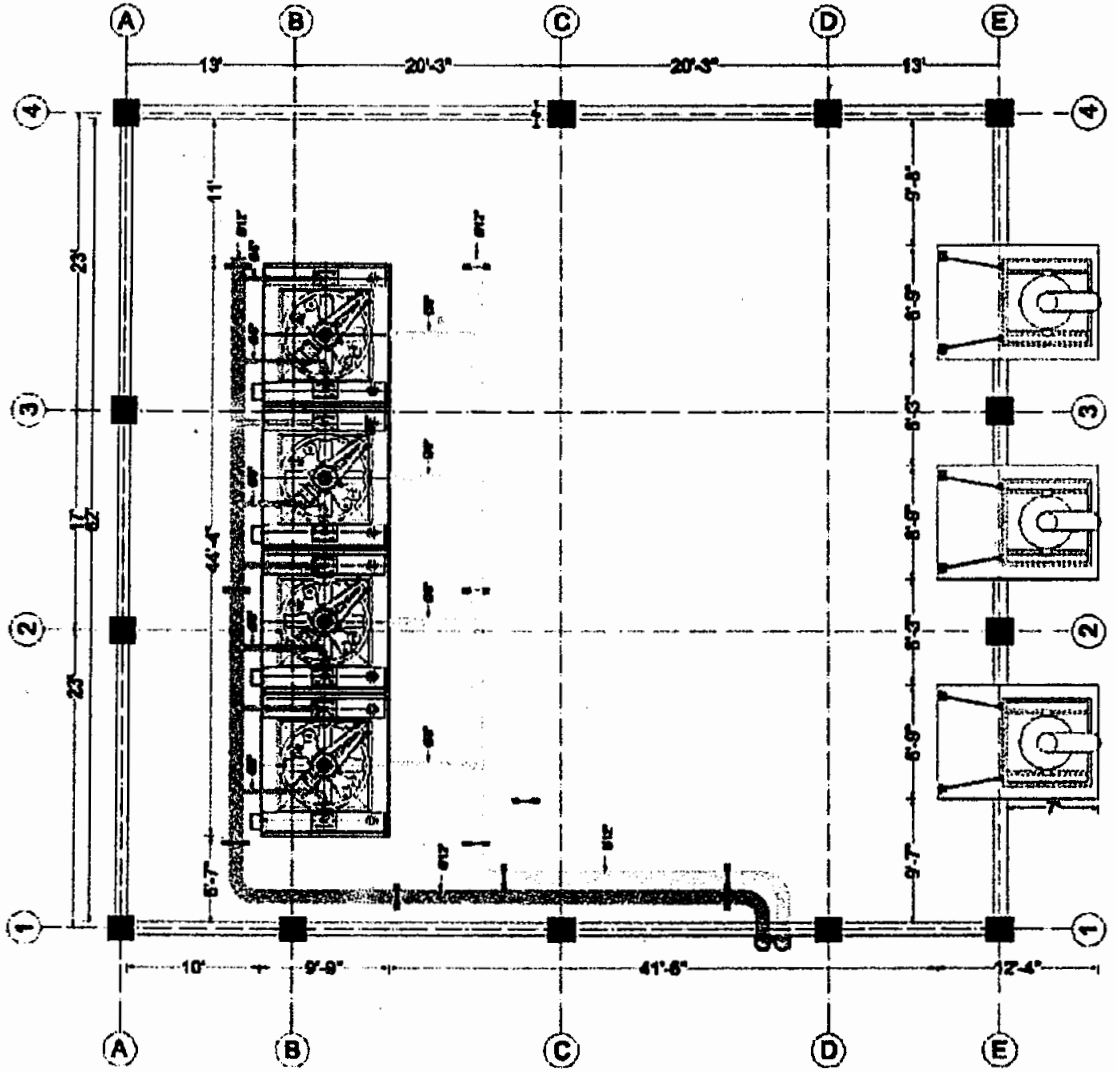
0	07-07-2020		Rizwan	Syed Ahmed	M.Ali
Rev.	Date	Revision Note	Drawn By	Checked By	Approved By
		Customer: Ittehad Pvt Ltd			
		Project Title: Proposed Power House Section View	Drawing-No		

R.A ENGINEERING & SERVICES (PVT) LTD



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Rizwan	Syed Ahmed	M.Ali	
Drawn By	Checked By	Approved By	

Rev.	Date	Revision Note
0	27-07-2020	

Customer: Ittehad Pvt Ltd

Project Title:
Proposed Power House
Roof Top View

Drawing-No

R.A ENGINEERING
& SERVICES (PVT) LTD

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(vi)- TECHNOLOGY, SIZE OF PLANT, NUMBER OF UNITS.

TECHNOLOGY:

GAS GENERATOR SETS "MTU Rolls Royce power systems AG Germany"

SIZE OF PLANT 3 X 12V64FNER_400 V = 4.5 MW

NO OF GAS GENERATORS = 03 Nos

ITTEHAD FACTORIES ELECTRIC LOAD DETAILS:

1x12V64 FNER_400 V MTU Rolls Royce	= 1521 KW
3x12V64 FNER_400 V MTU Rolls Royce	= 4563 KW
Electric consumption of Ittehad (Pvt)Ltd	= 3600 KW
Electric consumption of Ittehad Fabrics (Pvt)Ltd	= 600 KW
Electric consumption of Ittehad Textiles (Pvt)Ltd	= 900 KW

Attachment:

MTU Rolls Royce Gas generator catalog attached for reference.

MTU Onsite Energy GmbH
Gas Power Systems
Dasinger Str. 11
86165 Augsburg
Germany
T +49 821 7480-0

MTU Onsite Energy GmbH - Postfach 10 21 30 - D-86011 Augsburg
Purchaser
Ittehad Private Limited
1km, Jaranwala Road,
Khurrianwala, Faisalabad,
PAKISTAN

Shipping Address
Ittehad Private Limited
1km, Jaranwala Road,
Khurrianwala, Faisalabad,
PAKISTAN

Your reference	Date
PO No. RAE 116250079 Q01-01	**18-Sept-20**
Our work number	Date
tbd	
Author	Phone
Swen WILLI	**+49 821 7480 2322**
e-mail:	
swen.willi@ps.rolls-royce.com	
Terms of delivery	
CFR KARACHI SEAPORT / PORT QASIM, PAKISTAN	
Date of delivery	Time
as per contract approx. 7 months FOB German Seaport	
Costumer No.	Your VAT Registration No.
tbd	not applicable
Invoice-No.	Date if Issue
116250379-001	**18-Sept-20**

Please indicate when making payments, in all correspondance and when making further inquiries

Proforma Invoice

Subject: **Delivery of**
3 (three) gas gensets MTU 12V4000GS
CFR KARACHI SEAPORT / PORT QASIM, PAKISTAN (Incoterms 2020)
to be detailed as follows:

main positions listing as per MTU Offer:

Pos.:	Qty	item description			Unit Price	Total Price
0010	3 pc(s)	**GAS GENSET MTU 12V4000GS, ELECTRICAL OUTPUT 1521 KW, VOLTAGE 400V / 50HZ, WITH ACCESSORIES**			325.000,00 €	975.000,00 €
		Genset Serial Number:	**to be defined with delivery**			
		Custom Tariff No.:	**8502.2080**	**as per Exporter's customs tariff**		
			8502.2090	**as per Importer's customs tariff**		

100 % commercial value CFR KARACHI SEAPORT / PORT QASIM, PAKISTAN: **975.000,00 €**

Country of supply / Country of Origin: Germany

As per contractual agreement payable out of Letter of Credit as follows:
against Packing List, Commercial Invoice, Bill of Lading or Warehouse Receipt
out of an irrevocable confirmed Letter of Credit (L/C)
To be confirmed through:

Commerzbank AG Stuttgart, Germany
BIC: COBADEFF600

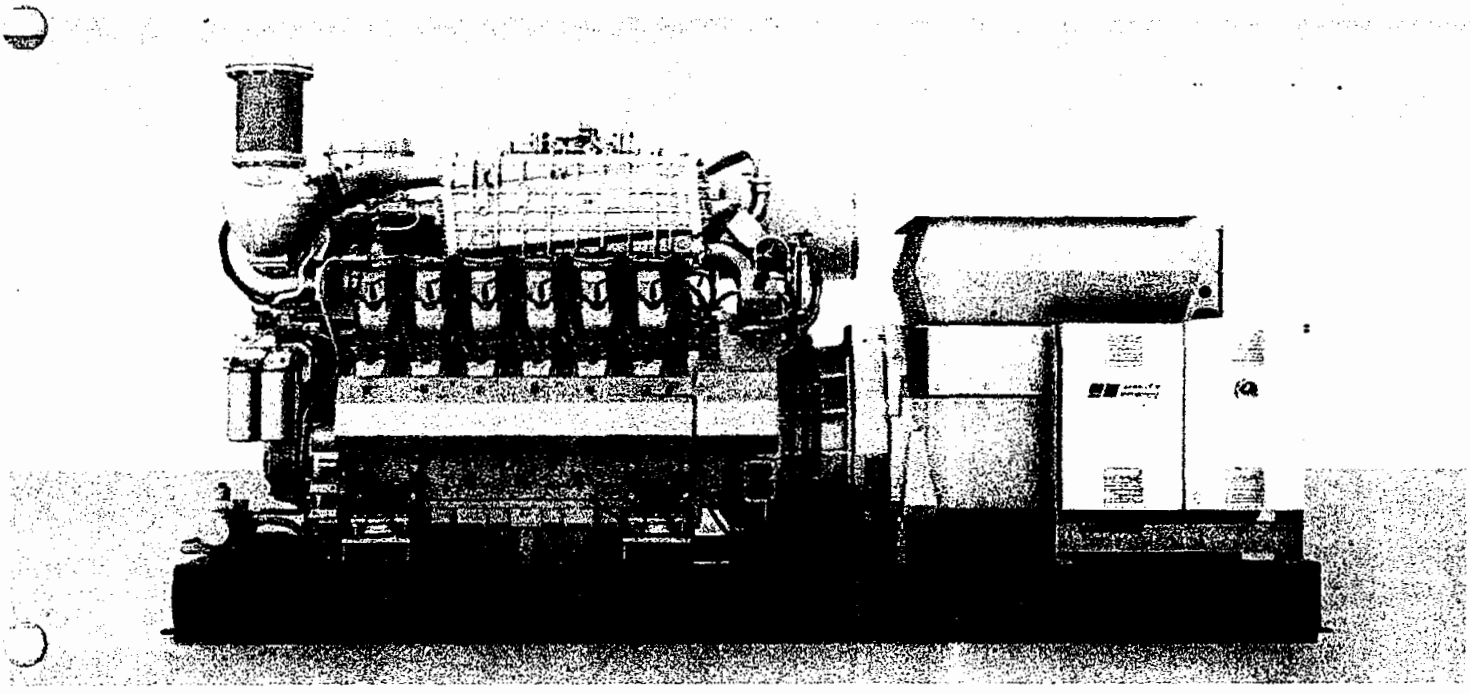
MTU Onsite Energy GmbH
Gas Power Systems
Dasinger Straße 11, 86165 Augsburg, GERMANY

i.V. Swen Willi

mtu A Rolls-Royce solution

DRIVING EXCELLENCE FORWARD:

THE NEW NATURAL GAS-POWERED SERIES 4000.



R.A. ENGINEERING
& SERVICES (PVT.) LTD.
www.raeng.com

Karachi Office:
2nd Floor, Plot No- 18,Sector-47,
Korangi Creek Industrial Area, Karachi-75190
Tel.: 021-35120442-3 Fax:021-35120439

Lahore Office:
6-V-III, Gulberg-III, Lahore, Pakistan.
Tel. No: +9242-35779720-21

Faisalabad Office:
P-25,Al-Hamra Town, Faisalabad, Pakistan.
Tel. No: +9241-2521784-85

R.A. ENGINEERING
& SERVICES (PVT.) LTD.
www.raeng.com

Dear Valued Customer,

After achieving continuous success in Instrumentation, Switch Gear and Rental Business Alhamdulillah **R.A. Engineering & Services** has embarked upon new journey and has entered into Generators Sale's business.

Introducing premium brand of Diesel & Gas Genset based on renowned German Technology. **MTU Onsite Energy** is one of the core brands of **Rolls-Royce Power Systems AG** which is a world-leading provider of diesel and gas engines, complete drive systems, distributed energy systems and fuel injection systems for the most demanding requirements. Introducing premium brand of Gas Genset based on renowned German Technology. MTU is a well known Gas Engine manufacturer worldwide, being the market leader in Europe in CHP application having more than 1000 MW of installed Population worldwide. The subject company is 100 years old and is specialist on Gas engines manufacturing, it says if you have a gas that burns, and MTU has an engine for you.

The product portfolio offered by MTU Onsite Energy includes standardized Gas Gensets for combined heat and power generation within wide range from **120 – 1948 KWel** have a look on below features that are designed:

- Excellent Fuel Consumption 0.24–0.26 Nm^3/ KWh.
- Top overhaul at 21,000 hours.
- Major overhaul at 63,000 hours.
- MTU offers **REMAN** Engine/Parts at the time of Major Overhaul i.e. 63000 hours, which is an economical option & reduces the cost of downtime too.
- Gas supply with electronically controlled gas metering valve.
- Electronic high-voltage capacitor ignition system with one ignition coil per cylinder.
- MTU Onsite Energy Gas Genset series have identical spares, which mean less inventory management.
- Electronic speed governor for speed and power output control with automatic knocking control.
- A complete CHP model is custom made from factory for plug and play, swift installation and lower cost of installation.
- Factory tested with comprehensive performance evaluation
- Rated power is available up to 45°C and 1000m above sea level without de-rated.
- Backed by R.A.Engineering & Services Ltd.
- 24/7 product support.
- Ample parts stock in Pakistan.
- Rental Facility.

MTU has customer base not only in Europe but in USA, Turkey, and Japan along with other major countries thus showing its worldwide and diversified acceptance by worldwide customers proving superior technological features with great savings. We are really thankful for giving support in Instrumentation, Switch Gear and Rental Business; we are willing your same trust & support in Genset Business.

Best Regards

mtu A Rolls-Royce solution | LU-VE exchangers | ComAp | BROAD | ABB | SIEMENS | Governors America Corp.

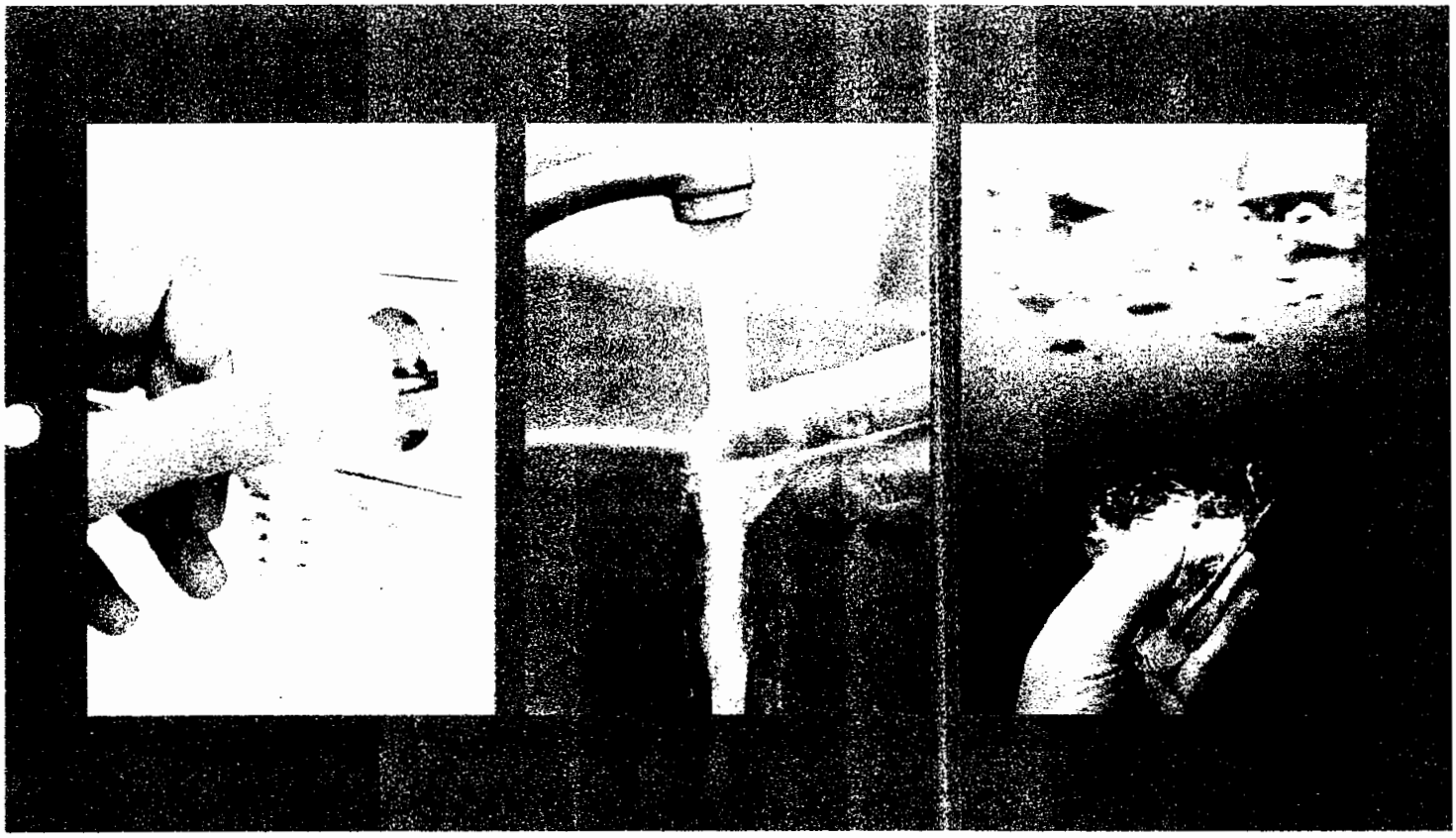
THREE TYPES.
COUNTLESS POSSIBILITIES.

Whatever you require – power with power and heat or even power, heat and cooling – MTU Onsite Energy systems fulfill your demands.

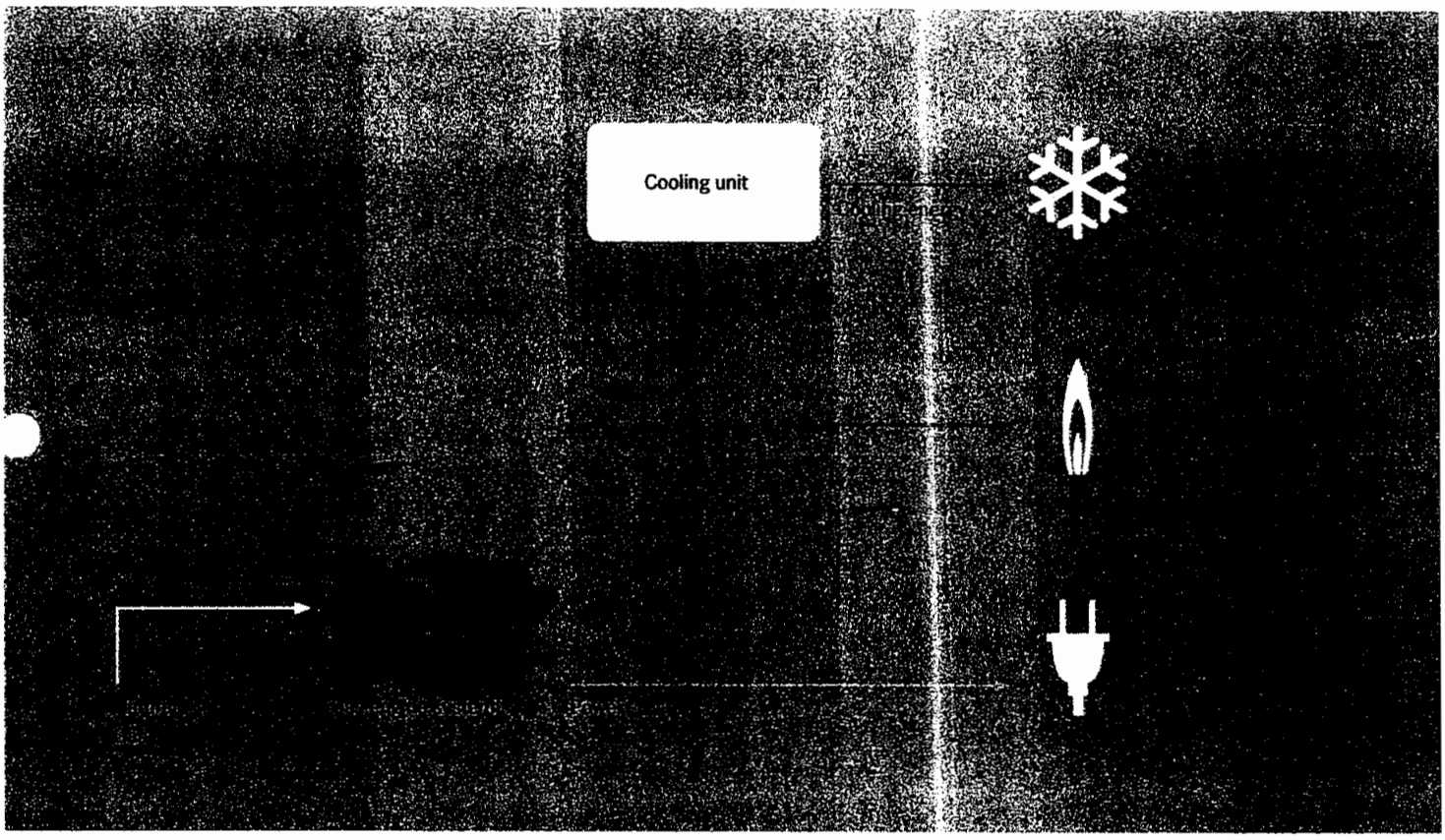
Power supply

Our gas generator sets can be used to provide power around the clock in locations where the power supply is not reliable or even nonexistent. According to the demands, our systems can be designed for grid parallel or off-grid operation.

A special application is power generation for [illegible] that have to be planned and implemented fast and often under [illegible]. Additional [illegible]



Power, heat and cooling supply (CHPC)



NATURAL GAS CHP SYSTEMS: HIGHLY VERSATILE CUSTOMIZED SOLUTIONS.

Our CHP systems powered by natural gas are deployed in numerous applications worldwide.

Building maintenance
Local heat supply is an economically viable alternative to separate heat generation in individual buildings. Its users benefit from various cost advantages. Investment as well as maintenance costs are significantly lower, and since a boiler plant is no longer necessary in each building, additional space can be gained. The CHP system is a reliable, economical and eco-friendly way to cover the heat requirement base load. Heat storage and an additional peak load boiler enable a flexible generation adaptation to the users' heating profile.

Common applications:
// Housing estates
// Swimming pools
// Hotels
// Schools
// Public buildings
// Leisure centers
// Shopping centers

Industry and commerce
Our CHP systems provide energy efficiently and independently to companies with a continuous demand for power, heat or also cooling energy for their production processes. Gas-powered CHP modules from MTU Onsite Energy are also an interesting alternative if the production facilities' capabilities are to be extended. Rather than increasing line capacities, you can invest in a distributed, independent energy solution.

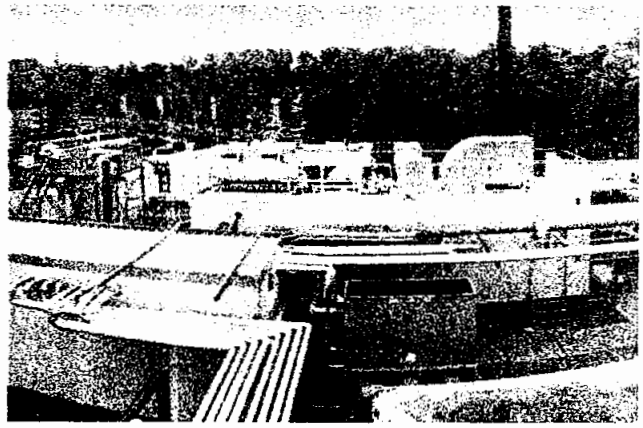
Common applications:
// Food processing
// Chemical production
// Traditional plant and systems engineering
// Greenhouses

Safety-critical applications
For safety-critical applications, a continuous energy supply is essential. Our gas engine systems have proven themselves in numerous environments.

Common applications:
// Hospitals
// Telecommunication centers
// Data centers

Depending on the legal requirements on site, our CHP modules can also take on emergency power generator functions.

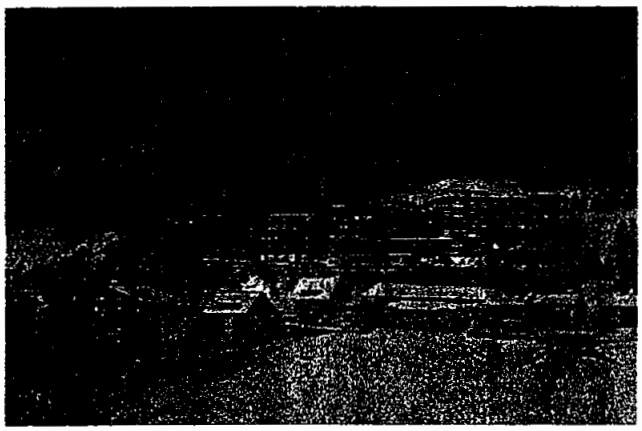
CHP for housing estate in Daugavpils / Estonia: 2 x GR 1999 N5
// Electrical power: 1,999 kW each // Thermal power: 2.2 MW each



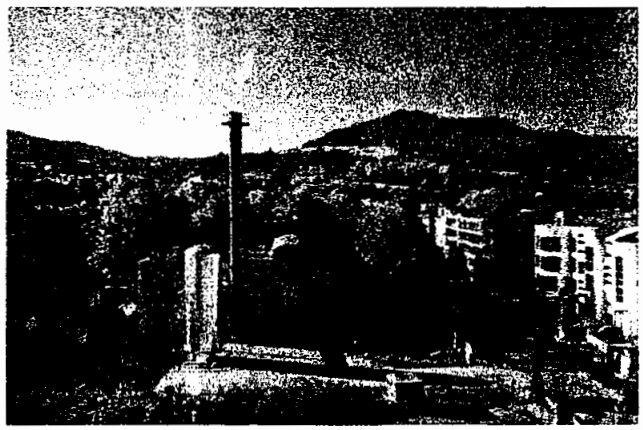
CHP for industrial bakery "Mestemacher" in Gütersloh / Germany: GR 849 N5
// Electr. power: 849 kW // Therm. power: 948 kW // Cooling cap.: 105 kW

CHP for swimming pool in Amberg / Germany: GC 232 N5
// Electrical power: 232 kW // Thermal power: 358 kW

CHP for "United Hospital" Bangladesh: 2 x GB 1166 N5
// Electrical power: 1,166 kW each // Thermal power: 630 kW each



CHP for hotel "Traube Tonbach" in Baiersbronn / Germany: 2 x GC 232 N5
// Electrical power: 232 kW each // Thermal power: 358 kW each



CHP for housing estate "Vauban" in Freiburg / Germany: GR 849 N5
// Electrical power: 849 kW // Thermal power: 1,300 kW

MTU **VALUE**CARE: SUPERIOR SERVICE FOR LONG SYSTEM LIFE AND TOP PERFORMANCE.

Purchasing a MTU Onsite Energy gas power system pays off in many ways. In addition to enhanced performance, efficiency and reliability, we offer a full range of superior service and maintenance support through MTU **Value**Care – a portfolio of value-enhancing products and services designed for peak performance and maximum uptime. Support is always nearby – anytime and anywhere. For your convenience, MTU **Value**Care is available worldwide through our MTU Onsite Energy service network.

MTU **Value**Care includes three product lines:

ValueService

ValueService is a full line of maintenance and repair solutions to help you protect your investment and get the most out of your equipment. From training to Remote Diagnostics, MTU Onsite Energy provides you with all the tools, with support customized to your needs.

// Service Agreements make it easy to plan the cost of maintenance throughout your system's lifecycle. A variety of options are available, including service, repair, maintenance and inspection contracts. The details, terms and periods of each package customized to meet your individual needs, ensuring cost certainty and maximum availability. Professional maintenance is performed by MTU certified technicians, using only genuine MTU new or remanufactured spare parts.

// Comprehensive training is a great way to get maximum efficiency from your equipment. From timely preventive maintenance to minor repairs and simple error corrections, our customized training programs are designed to make your service personnel proficient with MTU Onsite Energy engines and systems – maximizing your return on investment

// "Remote Diagnostics" is a powerful solution that links you directly to a record of your generator set's activity through a secure Internet connection. Through early fault identification, you can act quickly to prevent damage, save on service and repairs, identify spares needed and increase engine efficiency.

ValueSpares

ValueSpares genuine parts and consumables are designed, tested and approved specifically for MTU Onsite Energy systems. Only MTU Onsite Energy can guarantee genuine quality, with **Value**Spares oils, coolants and filters products that are designed to work seamlessly with your equipment for maximum performance and value.

ValueExchange

ValueExchange provides a full range of genuine remanufactured engine products, engineered to ensure robust, reliable performance. A rigorous reconditioning process ensures the same high standards of performance, service life and quality as new products – including design and model updates. As a result, genuine **Value**Exchange products feature the same technological advancements as new products. When you choose **Value**Exchange products, you get genuine quality, speed and peace of mind while lowering costs.

Local support. Worldwide.

Whenever and wherever you need expert support, MTU Onsite Energy specialists are available through our global service network. This continuous and long-term care ensures high availability, dependability and efficiency throughout the lifecycle of your engines and systems. To find your local MTU Onsite Energy distributor, visit www.mtuonsiteenergy.com.

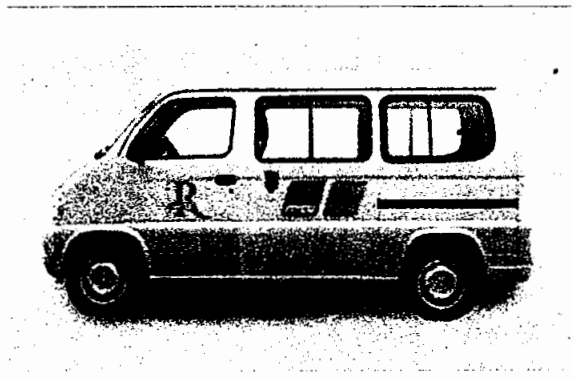
R.A. ENGINEERING
& SERVICES (PVT.) LTD.

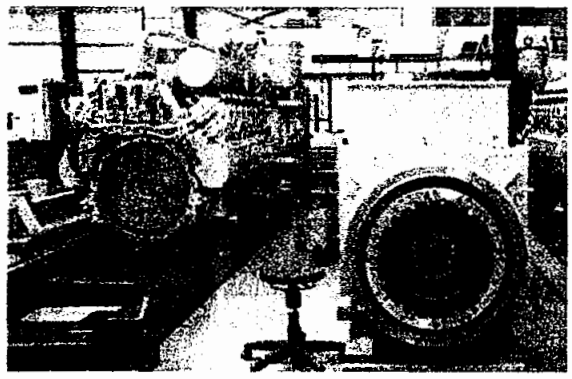
A Rolls-Royce solution

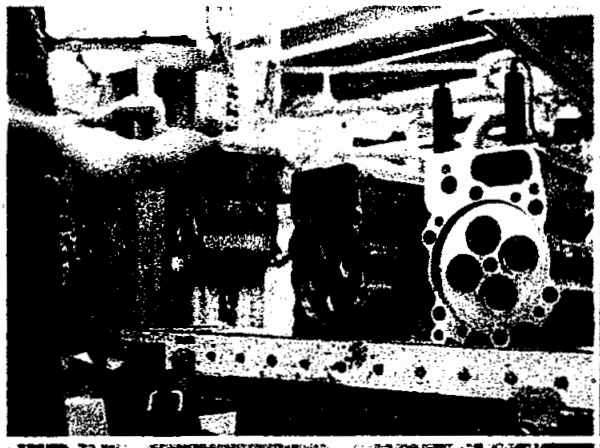
MTU VALUE CARE

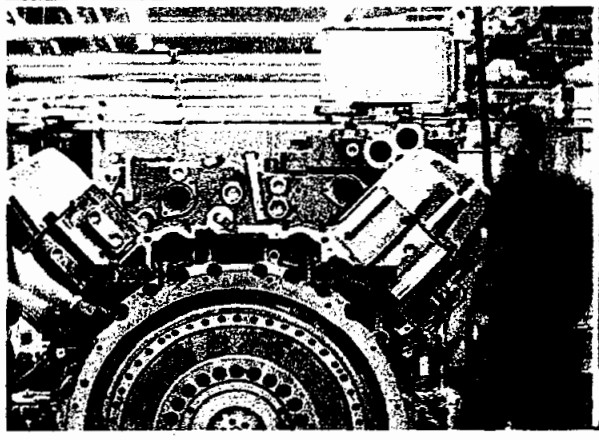
SUPERIOR SERVICE

FOR LONG SYSTEM LIFE AND TOP PERFORMANCE.



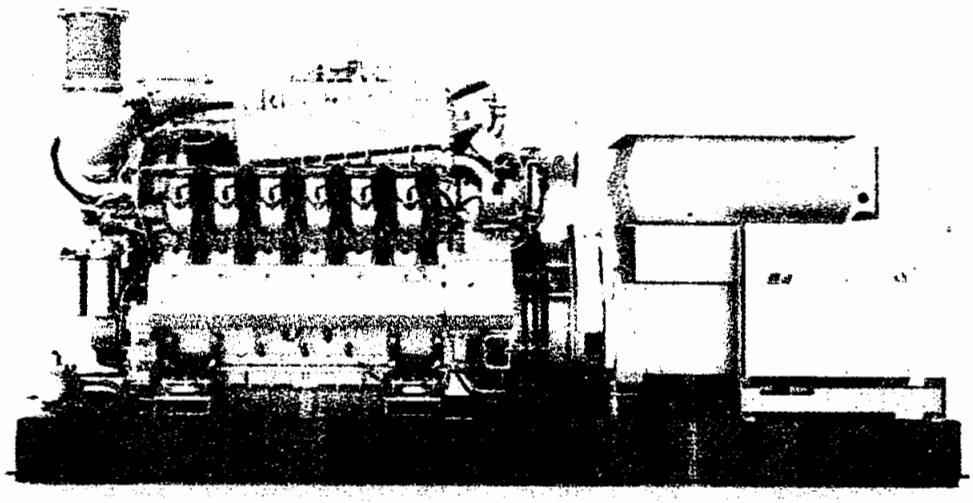






SPLIT-CONFIGURATION CHP SYSTEMS.

Output range TTU – 2 [illegible] kW$_{el}$



Description of individual components:

1 Gas engine
/ /Advanced and proven Series 4000 gas engine optimized for natural gas use. Combustion chambers ensure the highest level of efficiency in this performance category.

2 Generator
/ /Optimally tailored to the engine and made by renowned manufacturers, the generator provides a high level of reliability with the best degree of efficiency.

3 Ignition system
/ /Ignition systems for individual cylinders allow for the most efficient level of operation for all cylinders, even with variable CH_4 content.

4 Mixture cooler
/ /The two-stage mixture cooler with large surface area improves engine performance and heat utilization.

5 Knock detection
/ /Cylinder-specific knock detection and regulation protects the engine from abnormal operating conditions and guarantees safe operation even with natural gas containing low levels of methane.

6 Crank [illegible]
/ /High-quality crankcase ventilation minimizes deposits in the [illegible] intake and combustion chamber and guarantees a continuously high level of performance.

7 Motor Interface Panel (MIP)
/ /Interface with stand-alone Module Control (MTU Module Control MMC).

MTU Module Control (MMC)
/ /The MTU Module Control (MMC) contains all the important functions necessary for controlling the system. All the necessary data required for the CHP system can be accessed from here.
The MMC is housed separately in the control cabinet and is [illegible]

Technical Data Sheet

MTU 8V4000 GS

GG08V4000A1

A Rolls-Royce solution

93800051636_V01_en_PK

Voltage / Frequency	V / Hz	400	/	50
Cooling water temperature (in / out)	°C		78 / 89	
NOx emissions (dry, 5 % O_2)	mg/m³ i.N.		< 500	
Mixture cooler 1st stage water temperature (in)	°C			
Mixture cooler 2nd stage water temperature (in)	°C		53	
Exhaust gas temperature	°C		445	
Catalytic converter			not included	
Special equipment				
Elevation above sea level	m / mbar	100	/	1000
Combustion air temperature	°C		45	
Relative combustion air humidity	%		35	
Standard specifications and regulations				
Energy balance	%	100	75	50
Electrical Power [2) 3)]	kW	776	582	388
Energy input [4) 5)]	kW	1861	1448	1040
Thermal output total [6)]	kW	462	347	246
Thermal output engine (block, lube oil, 1st stage mixture cooler) [6)]	kW	462	347	246
Thermal output mixture cooler 1st stage [6)]	kW			
Thermal output mixture cooler 2nd stage [6)]	kW	32	25	18
Exhaust heat (120 °C) [6)]	kW	(421)	(350)	(268)
Engine power ISO 3046-1 [2)]	kW	800	602	405
Generator efficiency at power factor = 1	%	97.0	96.7	95.7
Electrical efficiency [4)]	%	41.7	40.2	37.3
Total efficiency	%	89.1	88.3	86.7
Power consumption [7)]	kW			
Combustion air / Exhaust gas				
Combustion air volume flow [1)]	m³ i.N./h	3159	2400	1681
Combustion air mass flow	kg/h	4079	3100	2171
Exhaust gas volume flow, wet [1)]	m³ i.N./h	3260	2480	1739
Exhaust gas volume flow, dry [1)]	m³ i.N./h	3015	2289	1602
Exhaust gas mass flow, wet	kg/h	4215	3206	2248
Exhaust temperature after turbocharger	°C	445	475	505
Reference fuel [8)]				
Natural gas			CH_4 >95 Vol.%	
Sewage gas			not applicable	
Biogas			not applicable	
Landfill gas			not applicable	
Fuel requirements [9)]				
Minimum methane number	MN		80	
Range of heating value: design / operation range without power derating	kWh/m³ i.N.		10.0 - 10.5 / 8.0 - 11.0	
Exhaust gas emissions [5) 6)]				
NOx, stated as NO_2 (dry, 5 % O_2)	mg/m³ i.N.	< 500		
CO (dry, 5 % O_2)	mg/m³ i.N.	< 1000		
HCHO (dry, 5 % O_2)	mg/m³ i.N.	< 51		
VOC (dry, 5 % O_2)	mg/m³ i.N.			
Otto-gas engine, lean burn operation with turbocharging				
Number of cylinders / configuration		8	/	V
Engine type			8V4000L32FN	
Engine speed	1/min		1500	
Bore	mm		170.0	
Stroke	mm		210.0	
Displacement	dm³		38.1	
Mean piston speed	m/s		10.5	
Compression ratio			12.1	
BMEP at nominal engine speed min-1	bar	16.8		
Lube oil consumption [10)]	dm³/h	0.18		
Exhaust back pressure min. - max. after module	mbar - mbar		30 - 60	
Generator				
Rating power (temperature rise class F) [11)]	kVA		1402	
Insulation class / temperature rise class			H / F	
Winding pitch			2/3	
Protection			IP 23	
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) [12)]			0.8 / 1.0	
Voltage tolerance / frequency tolerance	%		± 5 / ± 5	
Engine cooling water system				
Coolant temperature (in / out), design	°C	78 / 89		
Coolant flow rate, constant [13) 14)]	m³/h	38.9		
Pressure drop, design [14)] Cv value [13) 15)]	bar / m³/h	1.62	/	31.0
Max. operation pressure (coolant before engine)	bar		6.0	
Exhaust gas heat exchanger (EGHE)				
Exhaust gas temperature (out)	°C			
Coolant temperature (in / out), design	°C			
Coolant volumetric flow, constant [13) 14)]	m³/h			
Pressure drop, design [14)] Cv value [13) 15)]	kPa / m³/h		/	
Min. coolant flow rate / min. operation gauge pressure	m³/h / bar		/	
Max. operation pressure (coolant water)	bar			

Technical Data Sheet

MTU 8V4000 GS

93800051636_V01_en_PK

GG08V4000A1

Mixture cooler 1st stage, external						
Coolant temperature (in / out), design		°C				
Coolant volumetric flow, design, constant [13) 14)]		m³/h				
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h			/	
Min. coolant flow rate / min. operation gauge pressure		m³/h / bar			/	
Max. operation pressure before mixture cooler		bar				
Mixture cooling 2nd stage, external						
Coolant temperature (in / out), design		°C	53 / 54.3			
Coolant volumetric flow, design, constant [13) 14)]		m³/h	23.5			
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h	0.84		/	26.3
Max. operation pressure before mixture cooler		bar			6	
Heating circuit interface						
Engine coolant temperature (in / out), design		°C				
Heating water temperature (in / out), design		°C				
Heating water flow rate, design [14) 16)]		m³/h				
Pressure drop, design [14)]	Cv value [15) 16)]	bar / m³/h			/	
Max. operation gauge pressure (heating water)		bar				
Room ventilation						
Genset ventilation heat [17)]		kW			51	
Inlet air temperature: (min./design/max.)		°C			30 / 35 / 40	
Min. engine room temperature [18)]		°C			15	
Max. temperature difference ventilation air (in / out)		K			20	
Min. supply air volume flow rate (combustion + ventilation) [19)]		m³ i.N./h			10500	
Gearbox		**%**	**100**	**75**		**50**
Efficiency		%	-	-		-
Starter battery						
Nominal voltage / power / capacity required		V / kW / Ah			24 / 9.0 / –	
Filling quantities						
Lube oil for engine		dm³			160	
Coolant in engine		dm³			135	
Coolant in mixture cooler		dm³			15	
Heating water for plate heat exchanger [20)]		dm³				
Lube oil for gearbox		dm³				
Gas regulation line						
Nominal size / gas pressure min. - max. (at gas regulation line inlet)		DN / mbar - mbar	65		/	170 - 250
Engine sound level [21)] (1 meter distance, free field) +3 dB(A) for total A-weighted level tolerance						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	76.3	86.1	88.7	90.0
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	89.1	86.0	87.2	93.8
		Lin dB	98.0			
Sum of pressure levels		dB(A)	96.5			
Sound power level		dB(A)	115.7			
Undampened exhaust noise [21)] (1 meter distance to outlet within 90°, free field) +3 dB(A) for total A-weighted level tolerance						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	101.1	117.9	109.3	103.9
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	96.0	94.2	90.4	85.1
		Lin dB	118.7			
Sum of pressure levels		dB(A)	106.0			
Sound power level		dB(A)	118.2			
Dimensions (aggregate)						
Length		mm			~ 4200	
Width		mm			~ 2000	
Height		mm			~ 2300	
Gross weight (dry weight)		kg			~ 10350 (~ 10000)	
Power derating						
Elevation					specific to the project	
Combustion air temperature					specific to the project	
Mixture cooler coolant temperature (in)					specific to the project	
Methane number					specific to the project	
Boundary conditions and consumables						
Systems and consumables have to conform to the following actual company standards:					A001067	

1) Normal cubic meter at 1013 mbar and T = 273 K
2) Prime power operation will be designed specific to the project
3) Generator gross power at nominal voltage, power factor = 1 and nominal frequency
4) According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency
5) Emission values during grid parallel operation
6) Thermal output at layout temperature; tolerance +/- 8 %
7) Power consumption of all electrical consumers which are mounted at the module / genset
8) Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions
9) Functional capability
10) Reference value at nominal load (without amount of oil exchange)
11) Genset max. 1000 m height of location and max. 40 °C intake air temperature; else power derating
12) Max. allowable cos phi at nominal power (view of producer)
13) Stated values for cooling fluid composition 65% water and 35% glycol, adaption for use of other cooling fluid composition necessary
    The system design must consider the tolerance.
14) Pressure loss at reference flow rate
15) The Cv value declares the volumetric flow in m³/h at a pressure drop of 1 bar. Min. and max. flow rate limits are defined.
16) Stated values for pure water, adaption for other cooling fluid composition necessary
17) Only generator- and surface losses
18) Frost-free conditions must be guaranteed
19) Amount of ventilation air must be adapted to the gas safety concept
20) Assemblies including pipe work
21) All sound pressure levels at nominal load
22) Max. admissible cos phi depending on voltage in accordance with the requirements of the BDEW Mittelspannungsrichtlinie (German Medium Voltage Directive)

Technical Data Sheet

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Voltage / Frequency	V / Hz	400	/	50
Cooling water temperature (in / out)	°C		78 / 92	
NOx emissions (dry, % O_2)	mg/m³ i.N.		< 500	
Mixture cooler 1st stage water temperature (in)	°C			
Mixture cooler 2nd stage water temperature (in)	°C		58	
Exhaust gas temperature	°C		417	
Catalytic converter			not included	
Special equipment				
Elevation above sea level	m / mbar	100	/	1000
Combustion air temperature	°C		35	
Relative combustion air humidity	%		60	
Standard specifications and regulations				
Energy balance	%	100	75	50
Electrical Power [2) 3)]	kW	1521	1141	761
Energy input [4) 5)]	kW	3428	2619	1823
Thermal output total [5)]	kW	849	619	421
Thermal output engine (block, lube oil, 1st stage mixture cooler) [5)]	kW	849	619	421
Thermal output mixture cooler 1st stage [5)]	kW			
Thermal output mixture cooler 2nd stage [5)]	kW	79	49	29
Exhaust heat (120 °C) [5)]	kW	(717)	(605)	(455)
Engine power ISO 3046-1 [2)]	kW	1560	1171	784
Generator efficiency at power factor = 1	%	97.5	97.5	97.1
Electrical efficiency [4)]	%	44.4	43.6	41.7
Total efficiency	%	90.1	90.3	89.8
Power consumption [7)]	kW			
Combustion air / Exhaust gas				
Combustion air volume flow [1)]	m³ i.N./h	5702	4254	2904
Combustion air mass flow	kg/h	7363	5494	3750
Exhaust gas volume flow, wet [1)]	m³ i.N./h	5990	4475	3057
Exhaust gas volume flow, dry [1)]	m³ i.N./h	5354	3990	2720
Exhaust gas mass flow, wet	kg/h	7615	5688	3885
Exhaust temperature after turbocharger	°C	417	455	487
Reference fuel [8)]				
Natural gas			CH_4 >95 Vol.%	
Sewage gas			not applicable	
Biogas			not applicable	
Landfill gas			not applicable	
Fuel requirements [9)]				
Minimum methane number	MN		80	
Range of heating value: design / operation range without power derating	kWh/m³ i.N.		10.0 - 10.5 / 8.3 - 11.0	
Exhaust gas emissions [5) 6)] Compliance with emissions standards only for ≥ 761 kWel				
NOx, stated as NO_2 (dry, % O_2)	mg/m³ i.N.	< 500		
CO (dry, % O_2)	mg/m³ i.N.	< 1000		
HCHO (dry, % O_2)	mg/m³ i.N.	< 65		
VOC (dry, % O_2)	mg/m³ i.N.			
Otto-gas engine, lean burn operation with turbocharging				
Number of cylinders / configuration		12	/	V
Engine type			12V4000L64FNER	
Engine speed	1/min		1500	
Bore	mm		170.0	
Stroke	mm		210.0	
Displacement	dm³		57.2	
Mean piston speed	m/s		10.5	
Compression ratio			12.5	
BMEP at nominal engine speed min-1	bar	21.8		
Lube oil consumption [10)]	dm³/h	0.27		
Exhaust back pressure min. - max. after module	mbar - mbar		30 - 60	
Generator				
Rating power (temperature rise class F) [11)]	kVA		2152	
Insulation class / temperature rise class			H / F	
Winding pitch			2/3	
Protection			IP 23	
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) [12)]			0.8 / 1	
Voltage tolerance / frequency tolerance	%		± 5 / ± 5	
Engine cooling water system				
Coolant temperature (in / out), design	°C	78 / 92		
Coolant flow rate, constant [13) 14)]	m³/h	56.5		
Pressure drop, design [14)] Cv value [13) 15)]	bar / m³/h	2.18	/	38.9
Max. operation pressure (coolant before engine)	bar		6.0	
Exhaust gas heat exchanger (EGHE)				
Exhaust gas temperature (out)	°C			
Coolant temperature (in / out), design	°C			
Coolant volumetric flow, constant [13) 14)]	m³/h			
Pressure drop, design [14)] Cv value [13) 15)]	kPa / m³/h		/	
Min. coolant flow rate / min. operation gauge pressure	m³/h / bar		/	
Max. operation pressure (coolant water)	bar			

Mixture cooler 1st stage, external						
Coolant temperature (in / out), design		°C				
Coolant volumetric flow, design, constant [13) 14)]		m³/h				
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h			/	
Min. coolant flow rate / min. operation gauge pressure		m³/h / bar			/	
Max. operation pressure before mixture cooler		bar				
Mixture cooling 2nd stage, external						
Coolant temperature (in / out), design		°C	58 / 60.1			
Coolant volumetric flow, design, constant [13) 14)]		m³/h	35.3			
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h	0.6		/	46.7
Max. operation pressure before mixture cooler		bar			6	
Heating circuit interface						
Engine coolant temperature (in / out), design		°C				
Heating water temperature (in / out), design		°C				
Heating water flow rate, design [14) 16)]		m³/h				
Pressure drop, design [14)]	Cv value [15) 16)]	bar / m³/h			/	
Max. operation gauge pressure (heating water)		bar				
Room ventilation						
Genset ventilation heat [17)]		kW			85	
Inlet air temperature: (min./design/max.)		°C			30 / 35 / 40.0	
Min. engine room temperature [18)]		°C			15	
Max. temperature difference ventilation air (in / out)		K			20	
Min. supply air volume flow rate (combustion + ventilation) [19)]		m³ i.N./h			18000	
Gearbox		**%**	**100**		**75**	**50**
Efficiency		%	-		-	-
Starter battery						
Nominal voltage / power / capacity required		V / kW / Ah			24 / 9.0 / –	
Filling quantities						
Lube oil for engine		dm³			280	
Coolant in engine		dm³			200	
Coolant in mixture cooler		dm³			20	
Heating water for plate heat exchanger [20)]		dm³				
Lube oil for gearbox		dm³				
Gas regulation line						
Nominal size / gas pressure min. - max. (at gas regulation line inlet)		DN / mbar - mbar	80		/	150 - 250

Engine sound level [21)] (1 meter distance, free field) +3 dB(A) for total A-weighted level tolerance; + 5 dB for single octave level

Frequency	Hz	**63**	**125**	**250**	**500**
Sound pressure level	dB	83.3	87.4	88.6	91.3
Frequency	Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level	dB	90.1	87.3	92.9	103.9
Linear total sound pressure level	Lin dB	104.9			
A-weighted total sound pressure level	dB(A)	104.5			
A-weighted total sound power level	dB(A)	123.9			

Undampened exhaust noise [21)] (1 meter distance to outlet within 90°, free field) +3 dB(A) for total A-weighted level tolerance; + 5 dB for single octave level

Frequency	Hz	**63**	**125**	**250**	**500**
Sound pressure level	dB	118.5	120.3	110.8	102.2
Frequency	Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level	dB	92.9	92.3	92.1	82.5
Linear total sound pressure level	Lin dB	122.8			
A-weighted total sound pressure level	dB(A)	108.4			
A-weighted total sound power level	dB(A)	121.4			

Dimensions (aggregate)		
Length	mm	~ 5100
Width	mm	~ 2000
Height	mm	~ 2300
Gross weight (dry weight)	kg	~ 13500 (~ 13000)
Power derating		
Elevation		specific to the project
Combustion air temperature		specific to the project
Mixture cooler coolant temperature (in)		specific to the project
Methane number		specific to the project
Boundary conditions and consumables		
Systems and consumables have to conform to the following actual company standards:		A001072

1) Normal cubic meter at 1013 mbar and T = 273 K
2) Prime power operation will be designed specific to the project
3) Generator gross power at nominal voltage, power factor = 1 and nominal frequency
4) According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency
5) Emission values during grid parallel operation
6) Thermal output at layout temperature; tolerance +/- 8 %
7) Power consumption of all electrical consumers which are mounted at the module / genset
8) Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions
9) Functional capability
10) Reference value at nominal load (without amount of oil exchange)
11) Generator (at nominal power) max. 1000 m height of location and max. 40 °C intake air temperature; else power derating
12) Max. allowable cos phi at nominal power (view of producer)
13) Stated values for cooling fluid composition 65% water and 35% glycol, adaption for use of other cooling fluid composition necessary
    The system design must consider the tolerance.
14) Pressure loss at reference flow rate
15) The Cv value declares the volumetric flow in m³/h at a pressure drop of 1 bar. Min. and max. flow rate limits are defined.
16) Stated values for pure water, adaption for other cooling fluid composition necessary
17) Only generator- and surface losses
18) Frost-free conditions must be guaranteed
19) Amount of ventilation air must be adapted to the gas safety concept
20) Assemblies including pipe work
21) All sound pressure levels at nominal load, according to ISO 8528-10 and ISO 6798.
    Resonance effects of the connected exhaust line can influence the exhaust noise sound pressure level
22) Max. admissible cos phi depending on voltage in accordance with the requirements of the valid 'Standard specifications and regulations'

Technical Data Sheet

MTU 16V4000 GS

A Rolls-Royce solution

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Voltage / Frequency	V / Hz	**400**	/	**50**
Cooling water temperature (in / out)	°C		**78 / 90**	
NOx emissions (dry, 5 % O_2)	mg/m³ i.N.		**< 500**	
Mixture cooler 1st stage water temperature (in)	°C			
Mixture cooler 2nd stage water temperature (in)	°C		**53**	
Exhaust gas temperature	°C		**434**	
Catalytic converter			**not included**	
Special equipment				
Altitude above sea level	m / mbar	**100**	/	**1000**
Combustion air temperature	°C		**35**	
Relative combustion air humidity	%		**60**	
Standard specifications and regulations				
Energy balance	**%**	**100**	**75**	**50**
Electrical Power [2) 3)]	kW	1562	1172	781
Energy input [4) 5)]	kW	3651	2812	1998
Thermal output total [5)]	kW	863	650	467
Thermal output engine (block, lube oil, 1st stage mixture cooler) [5)]	kW	863	650	467
Thermal output mixture cooler 1st stage [5)]	kW			
Thermal output mixture cooler 2nd stage [5)]	kW	76	52	33
Exhaust heat (120 °C) [5)]	kW	(805)	(663)	(504)
Engine power ISO 3046-1 [2)]	kW	1600	1203	807
Generator efficiency at power factor = 1	%	97.6	97.4	96.8
Electrical efficiency [4)]	%	42.8	41.7	39.1
Total efficiency	%	88.5	88.4	87.7
Power consumption [7)]	kW			
Combustion air / Exhaust gas				
Combustion air volume flow [1)]	m³ i.N./h	6270	4700	3194
Combustion air mass flow	kg/h	8097	6069	4125
Exhaust gas volume flow, wet [1)]	m³ i.N./h	6470	4856	3325
Exhaust gas volume flow, dry [1)]	m³ i.N./h	5991	4485	3064
Exhaust gas mass flow, wet	kg/h	8364	6276	4299
Exhaust temperature after turbocharger	°C	434	463	499
Reference fuel [8)]				
Natural gas			CH_4 >95 Vol.%	
Sewage gas			not applicable	
Biogas			not applicable	
Landfill gas			not applicable	
Fuel requirements [9)]				
Minimum methane number	MZ		80	
Range of heating value: design / operation range without power derating	kWh/m³ i.N.		10.0 - 10.5 / 8.0 - 11.0	
Exhaust gas emissions [9) 6)]				
NOx, stated as NO_2 (dry, 5 % O_2)	mg/m³ i.N.	< 500		
CO (dry, 5 % O_2)	mg/m³ i.N.	< 1000		
HCHO (dry, 5 % O_2)	mg/m³ i.N.			
VOC (dry, 5 % O_2)	mg/m³ i.N.			
Otto-gas engine, lean burn operation with turbocharging				
Number of cylinders / configuration		16	/	V
Engine type			16V4000L32FN	
Engine speed	1/min		1500	
Bore	mm		170.0	
Stroke	mm		210.0	
Displacement	dm³		76.3	
Mean piston speed	m/s		10.5	
Compression ratio			12.1	
BMEP at nominal engine speed min-1	bar	16.8		
Lube oil consumption [10)]	dm³/h	0.36		
Exhaust back pressure min. - max. after module	mbar - mbar		30 - 60	
Generator				
Rating power (temperature rise class F) [11)]	kVA		2150	
Insulation class / temperature rise class			H / F	
Winding pitch			2/3	
Protection			IP 23	
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) [12)]			0.8 / 1.0	
Voltage tolerance / frequency tolerance	%		± 5 / ± 5	
Engine cooling water system				
Coolant temperature (in / out), design	°C	78 / 90		
Coolant flow rate, constant [13) 14)]	m³/h	67.0		
Pressure drop, design [14)] Cv value [13) 15)]	bar / m³/h	2.51	/	43.0
Max. operation pressure (coolant before engine)	bar		6.0	
Exhaust gas heat exchanger (EGHE)				
Exhaust gas temperature (out)	°C			
Coolant temperature (in / out), design	°C			
Coolant volumetric flow, constant [13) 14)]	m³/h			
Pressure drop, design [14)] Cv value [13) 15)]	kPa / m³/h		/	
Min. coolant flow rate / min. operation gauge pressure	m³/h / bar		/	
Max. operation pressure (coolant water)	bar			

Technical Data Sheet

MTU 16V4000 GS

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Mixture cooler 1st stage, external						
Coolant temperature (in / out), design		°C				
Coolant volumetric flow, design, constant [13) 14)]		m³/h				
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h			/	
Min. coolant flow rate / min. operation gauge pressure		m³/h / bar			/	
Max. operation pressure before mixture cooler		bar				
Mixture cooler 2nd stage, external						
Coolant temperature (in / out), design		°C	53 / 55.5			
Coolant volumetric flow, design, constant [13) 14)]		m³/h	28.9			
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h	0.36		/	49.3
Max. operation pressure before mixture cooler		bar			6	
Heating circuit interface						
Engine coolant temperature (in / out), design		°C				
Heating water temperature (in / out), design		°C				
Heating water flow rate, design [14) 16)]		m³/h				
Pressure drop, design [14)]	Cv value [15) 16)]	bar / m³/h			/	
Max. operation gauge pressure (heating water)		bar				
Room ventilation						
Genset ventilation heat [17)]		kW			83	
Inlet air temperature: (min./design/max.)		°C			30 / 35 / 40	
Min. engine room temperature [18)]		°C			15	
Max. temperature difference ventilation air (in / out)		K			20	
Min. supply air volume flow rate (combustion + ventilation) [19)]		m³ i.N./h			18000	
Gearbox		**%**	**100**		**75**	**50**
Efficiency		%	-		-	-
Starter battery						
Nominal voltage / power / capacity required		V / kW / Ah			24 / 2 x 9 / –	
Filling quantities						
Lube oil for engine		dm³			250	
Coolant in engine		dm³			270	
Coolant in mixture cooler		dm³			22	
Heating water for plate heat exchanger [20)]		dm³				
Lube oil for gearbox		dm³				
Gas regulation line						
Nominal size / gas pressure min. - max.		DN / mbar - mbar	80		/-	180 - 250
Engine sound level [21)] (1 meter distance, free field) +3 dB(A) for total A-weighted level tolerance						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	78.3	86.3	89.0	91.5
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	92.1	90.8	99.4	91.7
		Lin dB	102.0			
Sum of pressure levels		dB A	101.8			
Sound power level		dB	121.6			
Undampened exhaust noise [21)] (1 meter distance to outlet within 90°, free field) +3 dB(A) for total A-weighted level tolerance						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	116.9	118.4	108.6	102.9
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	97.3	96.1	91.9	76.1
		Lin dB	121.1			
Sum of pressure levels		dB A	106.5			
Sound power level		dB	118.7			
Dimensions (aggregate)						
Length		mm			~ 5500	
Width		mm			~ 2000	
Height		mm			~ 2300	
Gross weight (dry weight)		kg			~ 15500 (~ 15000)	
Power derating						
Altitude					specific to the project	
Combustion air temperature					specific to the project	
Mixture cooler coolant temperature (in)					specific to the project	
Methane number					specific to the project	
Boundary conditions and consumables						
Systems and consumables have to conform to the following actual company standards:					A001067	

1) Normal cubic meter at 1013 mbar and T = 273 K
2) Prime power operation will be designed specific to the project
3) Generator gross power at nominal voltage, power factor = 1 and nominal frequency
4) According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency
5) Emission values during grid parallel operation
6) Thermal output at layout temperature; tolerance +/- 8 %
7) Power consumption of all electrical consumers which are mounted at the module / genset
8) Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions
9) Functional capability
10) Reference value at nominal load (without amount of oil exchange)
11) Genset max. 1000 m height of location and max. 40 °C intake air temperature; else power derating
12) Max. allowable cos phi at nominal power (view of producer)
13) Stated values for cooling fluid composition 65% water and 35% glycol, adaption for use of other cooling fluid composition necessary
    The system design must consider the tolerance.
14) Pressure loss at reference flow rate
15) The Cv value declares the volumetric flow in m³/h at a pressure drop of 1 bar. Min. and max. flow rate limits are defined.
16) Stated values for pure water, adaption for other cooling fluid composition necessary
17) Only generator- and surface losses
18) Frost-free conditions must be guaranteed
19) Amount of ventilation air must be adapted to the gas safety concept
20) Assemblies including pipe work
21) All sound pressure levels at nominal load
22) Max. admissible cos phi depending on voltage in accordance with the requirements of the BDEW Mittelspannungsrichtlinie (German Medium Voltage Directive)

EDAM / EDAT

Technical Data Sheet

GB1948N5

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20V4000L32

Voltage / Frequency	V / Hz	400		50
Cooling water temperature (in / out)	°C		78 / 90	
NOx emissions (dry, 5 % O_2)	mg/m³ i.N.		< 500	
Intercooler 1st stage water temperature (in)	°C			
Intercooler 2nd stage water temperature (in)	°C		53	
Exhaust gas temperature	°C		472	
Catalytic converter			not included	
Special equipment				
Altitude above sea level [2]	m / mbar	100		1000
Intake air temperature	°C		35	
Relative intake air humidity	%		60	
Standard specifications and regulations				
Energy balance	%	100	75	50
Electrical Power COP, ISO 8528-1 [2] [3]	kW	1948	1461	974
Energy input [4] [5]	kW	4577	3518	2480
Thermal output total [6]	kW	1035	789	560
Thermal output engine (block, lube oil, 1st stage intercooler) [6]	kW	1035	789	560
Intercooler 1st stage water temperature (in) [6]	kW			
Intercooler 2nd stage water temperature (in) [6]	kW	78	50	32
Exhaust heat (120 °C) [6]	kW	(1101)	(891)	(665)
Engine power ISO 3046-1 [2]	kW	2000	1498	1002
Generator efficiency at power factor = 1	%	97.4	97.5	97.2
Electrical efficiency [4]	%	42.6	41.5	39.3
Total efficiency	%	89.2	89.3	88.7
CHP coefficient		1.88	1.85	1.74
Power consumption [7]	kW			
Combustion air / Exhaust gas				
Combustion air volume flow [1]	m³ i.N./h	7594	5719	3913
Combustion air mass flow	kg/h	9807	7386	5053
Exhaust gas volume flow, wet [1]	m³ i.N./h	7848	5915	4052
Exhaust gas volume flow, dry [1]	m³ i.N./h	7243	5450	3723
Exhaust gas mass flow, wet	kg/h	10144	7645	5236
Exhaust temperature after turbocharger	°C	472	497	529
Reference fuel [8]				
Natural gas			H	
Sewage gas			not applicable	
Biogas			not applicable	
Landfill gas			not applicable	
Fuel requirements [9]				
Minimum methane number	MZ		80	
Range of heating value: design / operation range	kWh/m³ i.N.		10.1 - 10.5 / 8.0 - 11.0	
Exhaust gas emissions [5] [6]				
NOx, stated as NO_2 (dry, 5 % O_2)	mg/m³ i.N.	< 500		
CO (dry, 5 % O_2)	mg/m³ i.N.	< 1000		
HCHO (dry, 5 % O_2)	mg/m³ i.N.			
VOC (dry, 5 % O_2)	mg/m³ i.N.			
Otto-gas engine, lean burn operation with turbocharging				
Number of cylinders / configuration		20	/	V
Engine type			20V4000L32FN	
Engine speed	1/min		1500	
Bore	mm		170	
Stroke	mm		210	
Displacement	dm³		95.3	
Mean piston speed	m/s		10.5	
Compression ratio			12.1	
BMEP at nominal engine speed min-1	bar	16.8		
Lube oil consumption [10]	dm³/h	0.68		
Exhaust back pressure min. - max. after engine	mbar - mbar		30 - 60	
Generator				
Rating power (temperature rise class F) [11]	kVA		2560	
Insulation class / temperature rise class			H / F	
Winding pitch			2/3	
Protection			IP 23	
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) [12]			0.8 / 1	
Voltage tolerance / frequency tolerance	%		± 5.0 / ± 5.0	
Engine cooling water system				
Coolant temperature (in / out)	°C	78 / 90		
Coolant flow rate [13] [14]	m³/h	90		
Pressure drop [14] CVs value [13] [15]	bar / m³/h	2.7	/	54.7
Max. operation pressure (coolant before engine)	bar		6	
Exhaust gas heat exchanger (EGHE)				
Exhaust gas temperature (out)	°C			
Coolant temperature (in / out)	°C	/		
Coolant volumetric flow [13] [14]	m³/h			
Pressure drop [14] CVs value [13] [15]	bar / m³/h		/	
Min. coolant flow rate / min. operation gauge pressure	m³/h / bar	–	/	
Max. operation pressure (coolant water)	bar			

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20V4000L32

Intercooler 1st stage, external						
Coolant temperature (in / out)		°C				
Coolant volumetric flow [13) 14)]		m³/h				
Pressure drop [14)]	CVs value [13) 15)]	bar / m³/h			/	
Min. coolant flow rate / min. operation gauge pressure		m³/h / bar			/	
Max. operation pressure in front of intercooler		bar				
Intercooler 2nd stage, external						
Coolant temperature (in / out)		°C	53 / 55			
Coolant volumetric flow [13) 14)]		m³/h	35			
Pressure drop [14)]	CVs value [13) 15)]	bar / m³/h	0.6		/	45.3
Max. operation pressure in front of intercooler		bar			6	
Heating circuit interface						
Engine coolant temperature (in / out)		°C				
Heating water temperatur (in / out)		°C				
Heating water flow rate [14) 16)]		m³/h				
Pressure drop [14)]	CVs value [15) 16)]	bar / m³/h			/	
Max. operation gauge pressure (heating water)		bar				
Room ventilation						
Genset ventilation heat [17)]		kW			113	
Combustion air temperature: (min./design/max.)		°C			30 / 35 / 40	
Min. engine room temperature [18)]		°C			15	
Max. temperature difference ventilation air (in / out)		K			20	
Min. supply air volume flow rate (combustion+ventilation) [19)]		m³ i.N./h			23500	
Starter battery						
Nominal voltage / power / capacity required		V / kW / Ah			24 / 2 x 9 / –	
Filling quantities						
Lube oil for engine		dm³			350	
Coolant for engine		dm³			310	
Coolant for intercooler LT / HT		dm³			23	
Heating water for plate heat exchanger [20)]		dm³				
Lube oil for gearbox		dm³				
Gas regulation line						
Nominal size / gas pressure min. - max.		DN / mbar - mbar		100		180 - 250
Engine sound level [21)] (1 meter distance, free field)						
Frequency		Hz	63	125	250	500
Sound pressure level		dB	82.9	95.9	91.1	97.5
Frequency		Hz	1000	2000	4000	8000
Sound pressure level		dB	93.4	90.0	86.6	100.5
		Lin dB	104.1			
Sum of pressure levels		dB A	102.4			
Sound power level		dB A	122.6			
Undampened exhaust noise [21)] (1 meter distance to outlet within 90°, free field)						
Frequency		Hz	63	125	250	500
Sound pressure level		dB	109.0	110.2	104.2	98.1
Frequency		Hz	1000	2000	4000	8000
Sound pressure level		dB	92.5	89.1	84.6	72.3
		Lin dB	113.5			
Sum of pressure levels		dB A	101.1			
Sound power level		dB A	113.1			
Dimensions (Aggregate)						
Length		mm			5900	
Width		mm			2000	
Height		mm			2400	
Gross weight (dry weight)		kg			18700 (18000)	
Power derating						
Altitude					specific to the project	
Intake air temperature					specific to the project	
Intercooler 2nd stage coolant temperature					specific to the project	
Methane number					specific to the project	
Boundary conditions and consumables						
Systems and consumables have to conform to the following actual company standards:					DK-BS-0002	

1) Normal cubic meter at 1013 mbar and T = 273 K
2) Prime power operation will be designed specific to the project
3) Generator gross power at nominal voltage, power factor = 1 and nominal frequency
4) According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency
5) Emission values during grid parallel operation
6) Thermal output at layout temperature; tolerance +/- 8 %
7) Power consumption of all electrical consumers which are mounted at the module / genset
8) Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions
9) Functional capability
10) Reference value at nominal load (without amount of oil exchange)
11) Genset max. 1000 m height of location and max. 40 °C intake air temperature; else power derating
12) Max. allowable cos phi at nominal power (view of producer)
13) Stated values for cooling fluid composition 65% water and 35% glycol, adaption for use of other cooling fluid composition necessary
14) Pressure loss at reference flow rate
15) The CV value declares the volumetric flow in m3/h at a pressure drop of 1 bar. Min. and max. flow rate limits are defined.
16) Stated values for pure water, adaption for other cooling fluid composition necessary
17) Only generator- and surface losses
18) Frost-free conditions must be guaranteed
19) Amount of ventilation air must be adapted to the gas safety concept
20) Assemblies including pipe work
21) All sound pressure levels at nominal load COP

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Technical Data Sheet

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Voltage / Frequency	V / Hz	400	/	50
Cooling water temperature (in / out)	°C		78 / 92	
NOx emissions (dry, 5 % O_2)	mg/m³ i.N.		< 500	
Mixture cooler 1st stage water temperature (in)	°C			
Mixture cooler 2nd stage water temperature (in)	°C		58	
Exhaust gas temperature	°C		424	
Catalytic converter			not included	
Special equipment				
Elevation above sea level	m / mbar	100	/	1000
Combustion air temperature	°C		35	
Relative combustion air humidity	%		60	
Standard specifications and regulations				
Energy balance	%	100	75	50
Electrical Power [2) 3)]	kW	2028	1521	1014
Energy input [4) 5)]	kW	4672	3560	2473
Thermal output total [6)]	kW	1122	823	563
Thermal output engine (block, lube oil, 1st stage mixture cooler) [6)]	kW	1122	823	563
Thermal output mixture cooler 1st stage [6)]	kW			
Thermal output mixture cooler 2nd stage [6)]	kW	81	46	22
Exhaust heat (120 °C) [6)]	kW	(980)	(814)	(610)
Engine power ISO 3046-1 [2)]	kW	2080	1560	1045
Generator efficiency at power factor = 1	%	97.5	97.5	97.0
Electrical efficiency [4)]	%	43.4	42.7	41.0
Total efficiency	%	88.4	88.7	88.4
Power consumption [7)]	kW			
Combustion air / Exhaust gas				
Combustion air volume flow [1)]	m³ i.N./h	7880	5889	3985
Combustion air mass flow	kg/h	10176	7605	5146
Exhaust gas volume flow, wet [1)]	m³ i.N./h	8274	6190	4194
Exhaust gas volume flow, dry [1)]	m³ i.N./h	7409	5531	3736
Exhaust gas mass flow, wet	kg/h	10522	7868	5328
Exhaust temperature after turbocharger	°C	424	456	490
Reference fuel [8)]				
Natural gas			CH_4 >95 Vol.%	
Sewage gas			not applicable	
Biogas			not applicable	
Landfill gas			not applicable	
Fuel requirements [9)]				
Minimum methane number	MN		80	
Range of heating value: design / operation range without power derating	kWh/m³ i.N.		10.0 - 10.5 / 8.0 - 11.0	
Exhaust gas emissions [9) 8)] Compliance with emissions standards only for ≥ 1014 kWel				
NOx, stated as NO_2 (dry, 5 % O_2)	mg/m³ i.N.	< 500		
CO (dry, 5 % O_2)	mg/m³ i.N.	< 1000		
HCHO (dry, 5 % O_2)	mg/m³ i.N.	< 102		
VOC (dry, 5 % O_2)	mg/m³ i.N.			
Otto-gas engine, lean burn operation with turbocharging				
Number of cylinders / configuration		16	/	V
Engine type			16V4000L64FNER	
Engine speed	1/min		1500	
Bore	mm		170.0	
Stroke	mm		210.0	
Displacement	dm³		76.3	
Mean piston speed	m/s		10.5	
Compression ratio			12.5	
BMEP at nominal engine speed min-1	bar	21.8		
Lube oil consumption [10)]	dm³/h	0.35		
Exhaust back pressure min. - max. after module	mbar - mbar		30 - 60	
Generator				
Rating power (temperature rise class F) [11)]	kVA		2800	
Insulation class / temperature rise class			H / F	
Winding pitch			2/3	
Protection			IP 23	
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) [12)]			0.8 / 0.95	
Voltage tolerance / frequency tolerance	%		± 10 / ± 5	
Engine cooling water system				
Coolant temperature (in / out), design	°C	78 / 92		
Coolant flow rate, constant [13) 14)]	m³/h	74.7		
Pressure drop, design [14)] Cv value [13) 15)]	bar / m³/h	2.88	/	44.7
Max. operation pressure (coolant before engine)	bar		6.0	
Exhaust gas heat exchanger (EGHE)				
Exhaust gas temperature (out)	°C			
Coolant temperature (in / out), design	°C			
Coolant volumetric flow, constant [13) 14)]	m³/h			
Pressure drop, design [14)] Cv value [13) 15)]	kPa / m³/h		/	
Min. coolant flow rate / min. operation gauge pressure	m³/h / bar		/	
Max. operation pressure (coolant water)	bar			

Technical Data Sheet

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Mixture cooler 1st stage, external						
Coolant temperature (in / out), design		°C				
Coolant volumetric flow, design, constant [13) 14)]		m³/h				
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h		/		
Min. coolant flow rate / min. operation gauge pressure		m³/h / bar		/		
Max. operation pressure before mixture cooler		bar				
Mixture cooling 2nd stage, external						
Coolant temperature (in / out), design		°C	58 / 60.2			
Coolant volumetric flow, design, constant [13) 14)]		m³/h	34.3			
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h	0.48	/		50.6
Max. operation pressure before mixture cooler		bar		6		
Heating circuit interface						
Engine coolant temperature (in / out), design		°C				
Heating water temperature (in / out), design		°C				
Heating water flow rate, design [14) 16)]		m³/h				
Pressure drop, design [14)]	Cv value [15) 16)]	bar / m³/h		/		
Max. operation gauge pressure (heating water)		bar				
Room ventilation						
Genset ventilation heat [17)]		kW		119		
Inlet air temperature: (min./design/max.)		°C		30 / 35 / 40		
Min. engine room temperature [18)]		°C		15		
Max. temperature difference ventilation air (in / out)		K		20		
Min. supply air volume flow rate (combustion + ventilation) [19)]		m³ i.N./h		24500		
Gearbox		**%**	**100**	**75**		**50**
Efficiency		%	-	-		-
Starter battery						
Nominal voltage / power / capacity required		V / kW / Ah		24 / 2 x 9 / --		
Filling quantities						
Lube oil for engine		dm³		330		
Coolant in engine		dm³		270		
Coolant in mixture cooler		dm³		25		
Heating water for plate heat exchanger [20)]		dm³				
Lube oil for gearbox		dm³				
Gas regulation line						
Nominal size / gas pressure min. - max. (at gas regulation line inlet)		DN / mbar - mbar	100	/		155 - 250
Engine sound level [21)] (1 meter distance, free field) +3 dB(A) for total A-weighted level tolerance						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	84.8	90.5	90.0	93.0
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	92.5	91.8	99.2	101.4
		Lin dB	104.8			
Sum of pressure levels		dB(A)	104.4			
Sound power level		dB(A)	124.1			
Undampened exhaust noise [21)] (1 meter distance to outlet within 90°, free field) +3 dB(A) for total A-weighted level tolerance						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	113.9	119.8	111.9	104.5
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	97.1	96.8	94.0	83.9
		Lin dB	121.6			
Sum of pressure levels		dB(A)	108.0			
Sound power level		dB(A)	121.0			
Dimensions (aggregate)						
Length		mm		~ 5300		
Width		mm		~ 2000		
Height		mm		~ 2300		
Gross weight (dry weight)		kg		~ 17700 (~ 17000)		
Power derating						
Elevation				specific to the project		
Combustion air temperature				specific to the project		
Mixture cooler coolant temperature (in)				specific to the project		
Methane number				specific to the project		
Boundary conditions and consumables						
Systems and consumables have to conform to the following actual company standards:				A001072		

1) Normal cubic meter at 1013 mbar and T = 273 K
2) Prime power operation will be designed specific to the project
3) Generator gross power at nominal voltage, power factor = 1 and nominal frequency
4) According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency
5) Emission values during grid parallel operation
6) Thermal output at layout temperature; tolerance +/- 8 %
7) Power consumption of all electrical consumers which are mounted at the module / genset
8) Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions
9) Functional capability
10) Reference value at nominal load (without amount of oil exchange)
11) Generator (at nominal power) max. 1000 m height of location and max. 40 °C intake air temperature; else power derating
12) Max. allowable cos phi at nominal power (view of producer)
13) Stated values for cooling fluid composition 65% water and 35% glycol, adaption for use of other cooling fluid composition necessary
    The system design must consider the tolerance.
14) Pressure loss at reference flow rate
15) The Cv value declares the volumetric flow in m³/h at a pressure drop of 1 bar. Min. and max. flow rate limits are defined.
16) Stated values for pure water, adaption for other cooling fluid composition necessary
17) Only generator- and surface losses
18) Frost-free conditions must be guaranteed
19) Amount of ventilation air must be adapted to the gas safety concept
20) Assemblies including pipe work
21) All sound pressure levels at nominal load
22) Max. admissible cos phi depending on voltage in accordance with the requirements of the BDEW Mittelspannungsrichtlinie (German Medium Voltage Directive)

Technical Data Sheet

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Voltage / Frequency	V / Hz	400	/	50
Cooling water temperature (in / out)	°C		77 / 91	
NOx emissions (dry, 5 % O_2)	mg/m³ i.N.		< 500	
Mixture cooler 1st stage water temperature (in)	°C			
Mixture cooler 2nd stage water temperature (in)	°C		58	
Exhaust gas temperature	°C		423	
Catalytic converter			not included	
Special equipment				
Elevation above sea level	m / mbar	100	/	1000
Combustion air temperature	°C		35	
Relative combustion air humidity	%		60	
Standard specifications and regulations				
Energy balance	%	100	75	50
Electrical Power [2) 3)]	kW	2538	1904	1269
Energy input [4) 5)]	kW	5781	4421	3065
Thermal output total [6)]	kW	1441	1082	727
Thermal output engine (block, lube oil, 1st stage mixture cooler) [6)]	kW	1441	1082	727
Thermal output mixture cooler 1st stage [6)]	kW			
Thermal output mixture cooler 2nd stage [6)]	kW	150	90	46
Exhaust heat (120 °C) [6)]	kW	(1243)	(1026)	(774)
Engine power ISO 3046-1 [2)]	kW	2600	1957	1316
Generator efficiency at power factor = 1	%	97.6	97.3	96.4
Electrical efficiency [4)]	%	43.9	43.1	41.4
Total efficiency	%	90.3	90.7	90.4
Power consumption [7)]	kW			
Combustion air / Exhaust gas				
Combustion air volume flow [1)]	m³ i.N./h	9675	7251	4929
Combustion air mass flow	kg/h	12494	9364	6365
Exhaust gas volume flow, wet [1)]	m³ i.N./h	10162	7624	5187
Exhaust gas volume flow, dry [1)]	m³ i.N./h	9090	6805	4619
Exhaust gas mass flow, wet	kg/h	12919	9690	6590
Exhaust temperature after turbocharger	°C	423	453	487
Reference fuel [8)]				
Natural gas			CH_4 >95 Vol.%	
Sewage gas			not applicable	
Biogas			not applicable	
Landfill gas			not applicable	
Fuel requirements [8)]				
Minimum methane number	MN		80	
Range of heating value: design / operation range without power derating	kWh/m³ i.N.		10.0 - 10.5 / 8.2 - 11.0	
Exhaust gas emissions [9) 9)] Compliance with emissions standards only for ≥ 1269 kWel				
NOx, stated as NO_2 (dry, 5 % O_2)	mg/m³ i.N.	< 500		
CO (dry, 5 % O_2)	mg/m³ i.N.	< 600		
HCHO (dry, 5 % O_2)	mg/m³ i.N.	< 60		
VOC (dry, 5 % O_2)	mg/m³ i.N.			
Otto-gas engine, lean burn operation with turbocharging				
Number of cylinders / configuration		20	/	V
Engine type			20V4000L64FNER	
Engine speed	1/min		1500	
Bore	mm		170.0	
Stroke	mm		210.0	
Displacement	dm³		95.3	
Mean piston speed	m/s		10.5	
Compression ratio			12.5	
BMEP at nominal engine speed min-1	bar	21.8		
Lube oil consumption [10)]	dm³/h	0.44		
Exhaust back pressure min. - max. after module	mbar - mbar		30 - 60	
Generator				
Rating power (temperature rise class F) [11)]	kVA		3325	
Insulation class / temperature rise class			H / F	
Winding pitch			2/3	
Protection			IP 23	
Max. allowable p.f. inductive (overexcited) / capacitive (underexcited) [12)]			0.8 / 1.0	
Voltage tolerance / frequency tolerance	%		± 5 / ± 5	
Engine cooling water system				
Coolant temperature (in / out), design	°C	77 / 91		
Coolant flow rate, constant [13) 14)]	m³/h	95.9		
Pressure drop, design [14)] Cv value [13) 15)]	bar / m³/h	2.98	/	56.4
Max. operation pressure (coolant before engine)	bar		6.0	
Exhaust gas heat exchanger (EGHE)				
Exhaust gas temperature (out)	°C			
Coolant temperature (in / out), design	°C			
Coolant volumetric flow, constant [13) 14)]	m³/h			
Pressure drop, design [14)] Cv value [13) 15)]	kPa / m³/h		/	
Min. coolant flow rate / min. operation gauge pressure	m³/h / bar		/	
Max. operation pressure (coolant water)	bar			

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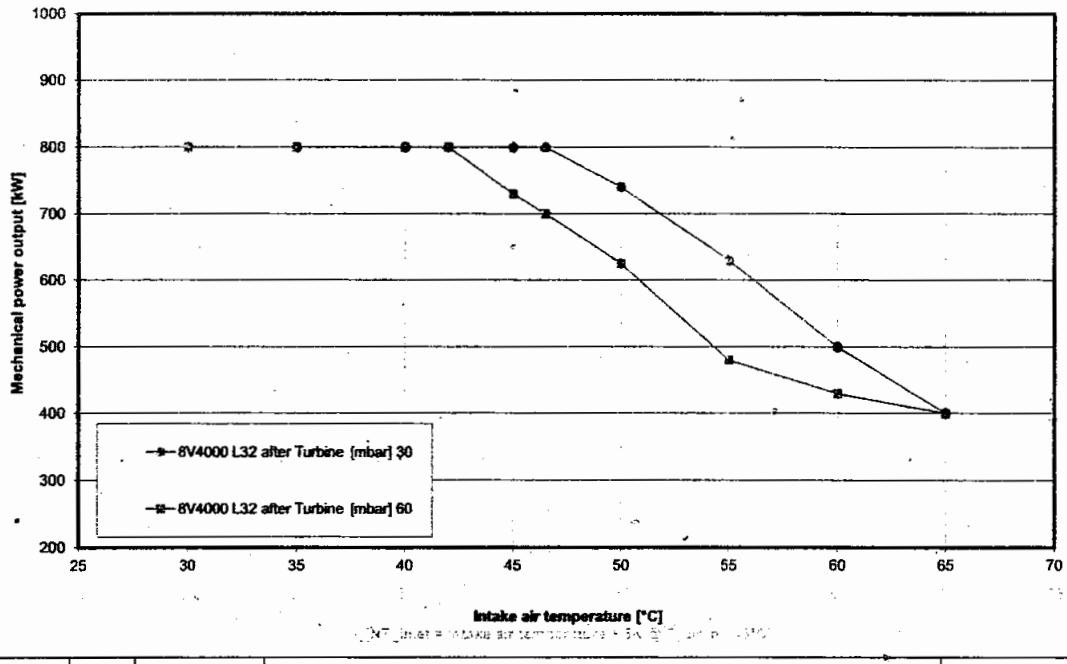
Mixture cooler 1st stage, external						
Coolant temperature (in / out), design		°C				
Coolant volumetric flow, design, constant [13) 14)]		m³/h				
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h		/		
Min. coolant flow rate / min. operation gauge pressure		m³/h / bar		/		
Max. operation pressure before mixture cooler		bar				
Mixture cooling 2nd stage, external						
Coolant temperature (in / out), design		°C	58 / 61.0			
Coolant volumetric flow, design, constant [13) 14)]		m³/h	47.1			
Pressure drop, design [14)]	Cv value [13) 15)]	bar / m³/h	0.96	/		49.2
Max. operation pressure before mixture cooler		bar		6		
Heating circuit interface						
Engine coolant temperature (in / out), design		°C				
Heating water temperature (in / out), design		°C				
Heating water flow rate, design [14) 16)]		m³/h				
Pressure drop, design [14)]	Cv value [15) 16)]	bar / m³/h		/		
Max. operation gauge pressure (heating water)		bar				
Room ventilation						
Genset ventilation heat [17)]		kW		138		
Inlet air temperature: (min./design/max.)		°C		30 / 35 / 40.0		
Min. engine room temperature [18)]		°C		15		
Max. temperature difference ventilation air (in / out)		K		20		
Min. supply air volume flow rate (combustion + ventilation) [19)]		m³ i.N./h		29000		
Gearbox		%	**100**	**75**		**50**
Efficiency		%	-	-		-
Starter battery						
Nominal voltage / power / capacity required		V / kW / Ah		24 / 2 x 9 / --		
Filling quantities						
Lube oil for engine		dm³		450		
Coolant in engine		dm³		310		
Coolant in mixture cooler		dm³		25		
Heating water for plate heat exchanger [20)]		dm³				
Lube oil for gearbox		dm³				
Gas regulation line						
Nominal size / gas pressure min. - max. (at gas regulation line inlet)		DN / mbar - mbar	100	/		165 - 250
Engine sound level [21)] (1 meter distance, free field) +3 dB(A) for total A-weighted level tolerance; + 5 dB for single octave level						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	93.1	95.1	91.5	95.0
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	93.5	92.8	91.8	99.7
Linear total sound pressure level		Lin dB	104.0			
A-weighted total sound pressure level		dB(A)	102.0			
A-weighted total sound power level		dB(A)	122.5			
Undampened exhaust noise [21)] (1 meter distance to outlet within 90°, free field) +3 dB(A) for total A-weighted level tolerance; + 5 dB for single octave level						
Frequency		Hz	**63**	**125**	**250**	**500**
Sound pressure level		dB	118.4	118.9	108.8	100.5
Frequency		Hz	**1000**	**2000**	**4000**	**8000**
Sound pressure level		dB	91.9	91.5	91.8	84.1
Linear total sound pressure level		Lin dB	122.0			
A-weighted total sound pressure level		dB(A)	106.5			
A-weighted total sound power level		dB(A)	119.5			
Dimensions (aggregate)						
Length		mm		~ 6300		
Width		mm		~ 2000		
Height		mm		~ 2400		
Gross weight (dry weight)		kg		~ 20750 (~ 20000)		
Power derating						
Elevation				specific to the project		
Combustion air temperature				specific to the project		
Mixture cooler coolant temperature (in)				specific to the project		
Methane number				specific to the project		
Boundary conditions and consumables						
Systems and consumables have to conform to the following actual company standards:				A001072		

1) Normal cubic meter at 1013 mbar and T = 273 K
2) Prime power operation will be designed specific to the project
3) Generator gross power at nominal voltage, power factor = 1 and nominal frequency
4) According to ISO 3046 (+ 5 % tolerance), using reference fuel used at nominal voltage, power factor = 1 and nominal frequency
5) Emission values during grid parallel operation
6) Thermal output at layout temperature; tolerance +/- 8 %
7) Power consumption of all electrical consumers which are mounted at the module / genset
8) Deviations from the layout parameters respectively the reference fuel can have influence on the obtained efficiency and exhaust emissions
9) Functional capability
10) Reference value at nominal load (without amount of oil exchange)
11) Generator (at nominal power) max. 1000 m height of location and max. 40 °C intake air temperature; else power derating
12) Max. allowable cos phi at nominal power (view of producer)
13) Stated values for cooling fluid composition 65% water and 35% glycol, adaption for use of other cooling fluid composition necessary
The system design must consider the tolerance.
14) Pressure loss at reference flow rate
15) The Cv value declares the volumetric flow in m³/h at a pressure drop of 1 bar. Min. and max. flow rate limits are defined.
16) Stated values for pure water, adaption for other cooling fluid composition necessary
17) Only generator- and surface losses
18) Frost-free conditions must be guaranteed
19) Amount of ventilation air must be adapted to the gas safety concept
20) Assemblies including pipe work
21) All sound pressure levels at nominal load, according to ISO 8528-10 and ISO 6798.
Resonance effects of the connected exhaust line can influence the exhaust noise sound pressure level
22) Max. admissible cos phi depending on voltage in accordance with the requirements of the valid 'Standard specifications and regulations'

Power Derating Curve for 8V4000L32

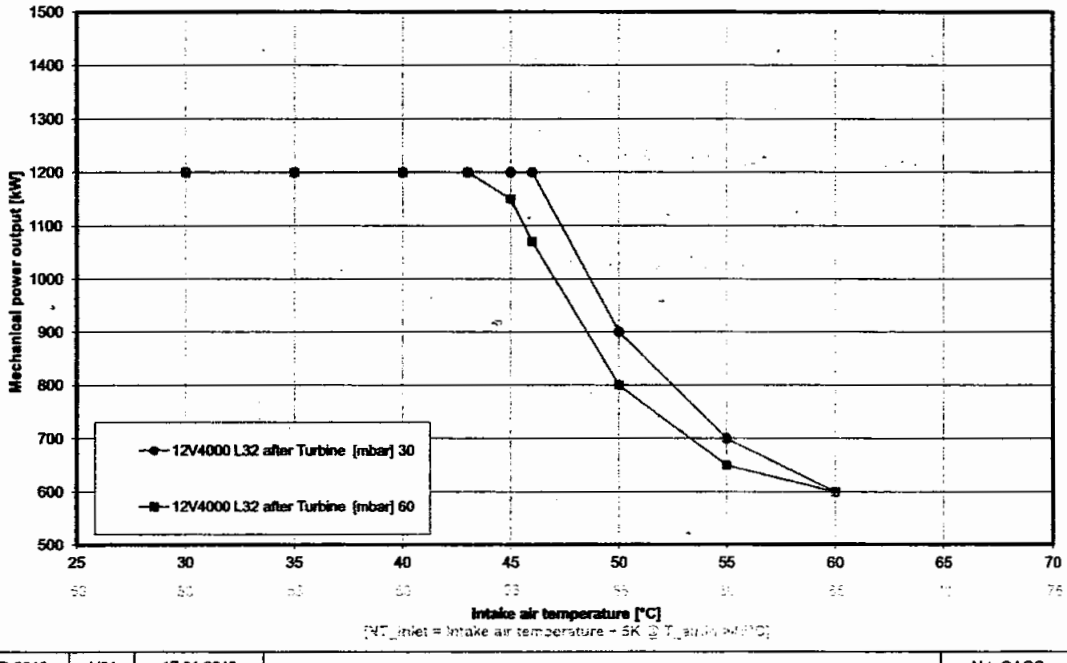
Emission level	NOx 500mg/Nm³ @ 5% O_2
Operation	island mode
Note	Variation intake air temperature & NT_inlet



DK-DR-0008	V01	17.01.2013		Abt. OAGS	1/1

Power Derating Curve for 12V4000L32

Emission level	NOx 500mg/Nm³ @ 5% O_2
Operation	island mode
Note	Variation intake air temperature & NT_inlet

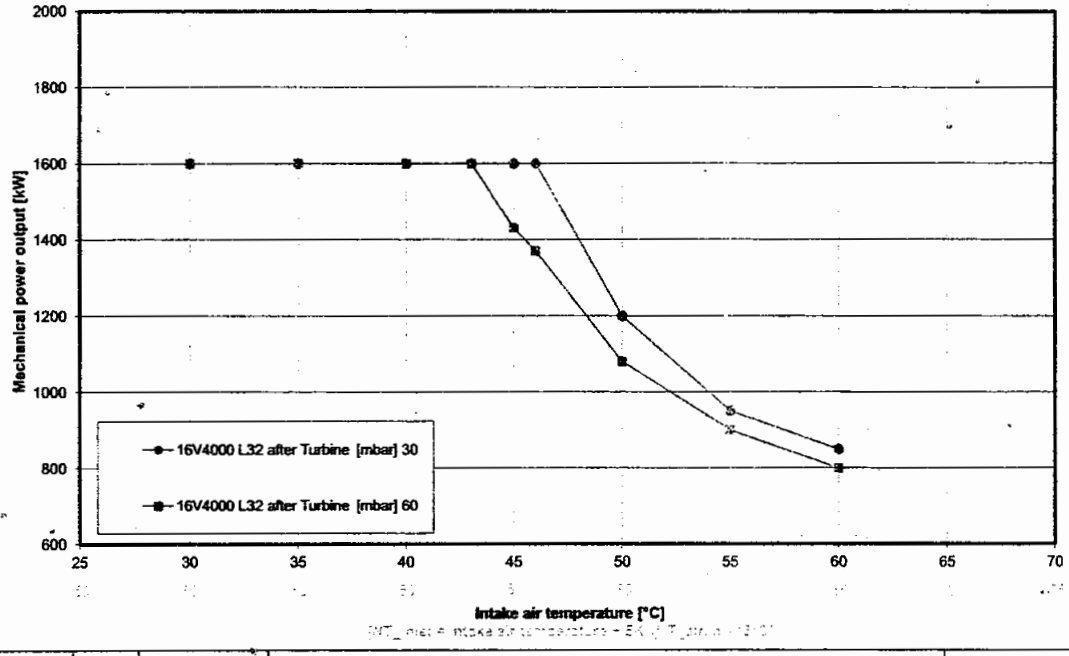


DK-DR-0010	V01	17.01.2013		Abt. OAGS	1/1

Power Derating Curve for 16V4000L32

Emission level NOx 500mg/Nm³ @ 5% O_2
Operation island mode
Note Variation intake air temperature & NT_inlet

A Rolls-Royce solution



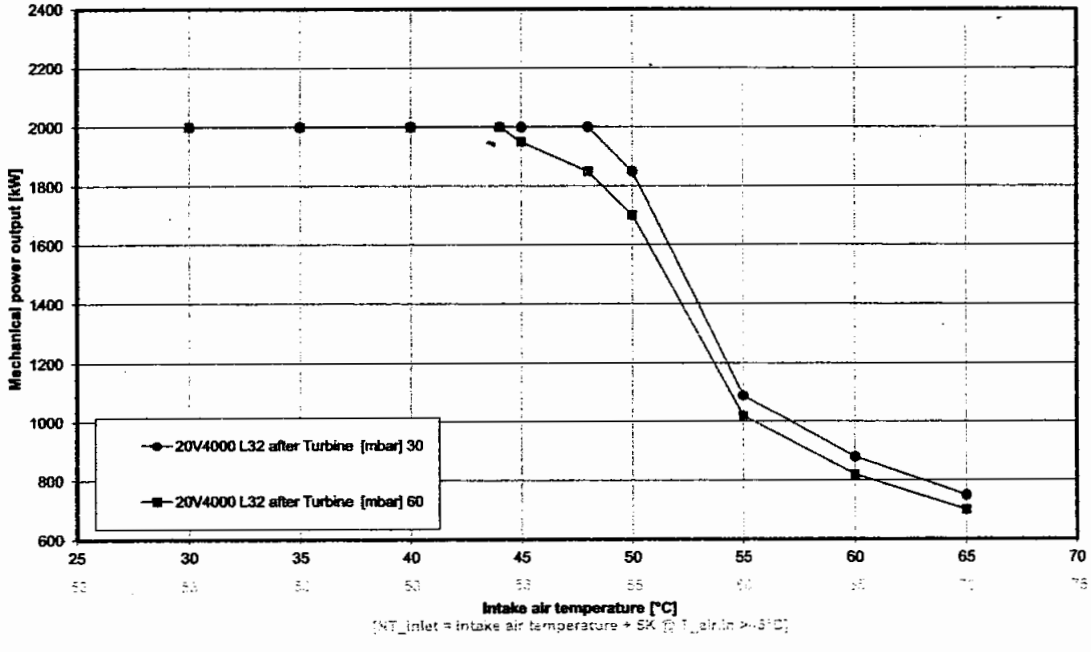
[NT_inlet = intake air temperature + 5K @ T_air,in >35°C]

DK-DR-0012	V01	17.01.2013		Abt. OAGS	1/1

Power Derating Curve for 20V4000L32

Emission level NOx 500mg/Nm³ @ 5% O_2
Operation island mode
Note Variation intake air temperature & NT_inlet

A Rolls-Royce solution



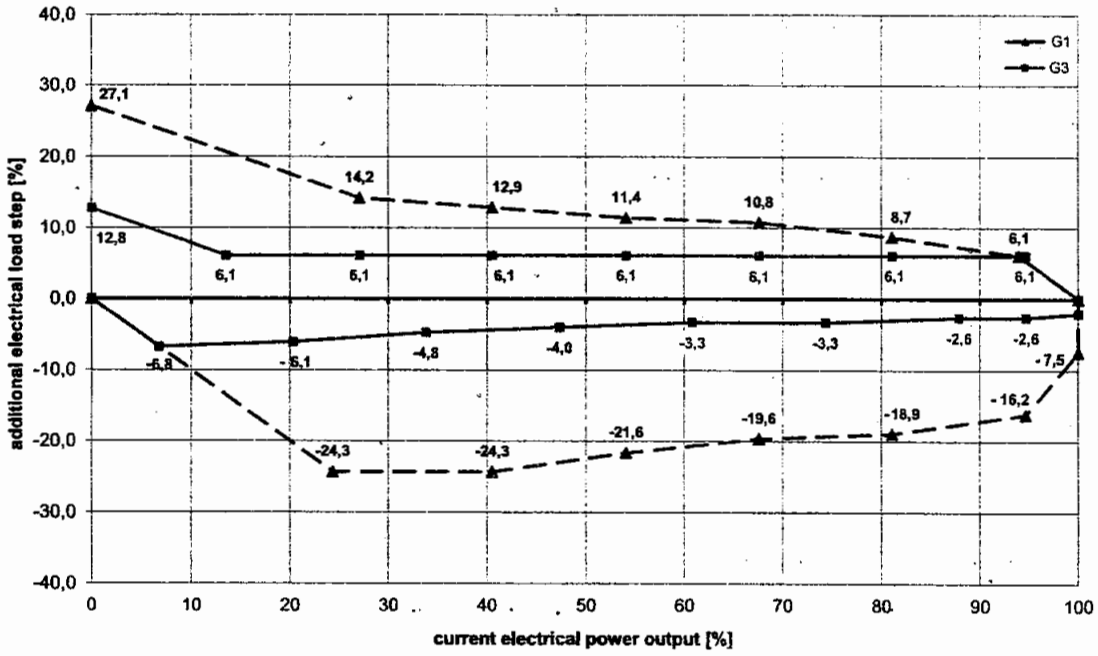
[NT_inlet = intake air temperature + 5K @ T_air,in >35°C]

DK-DR-0005	V01	19.12.2012		Abt. OAGS	1/1

Load Steps Island Mode 8V4000L32 MN80

Emission level	NOx 500mg/Nm³ @ 5% O₂	**Norm**	ISO 8528-5
Generator	PE734C2 Wdg 312	**Inertia**	36,36 kgm²
ß, for G3	till 720 kW	**Note**	For 100% electrical power also regard derating for methan number, inlet air temperature and altitude on site.

A Rolls-Royce solution

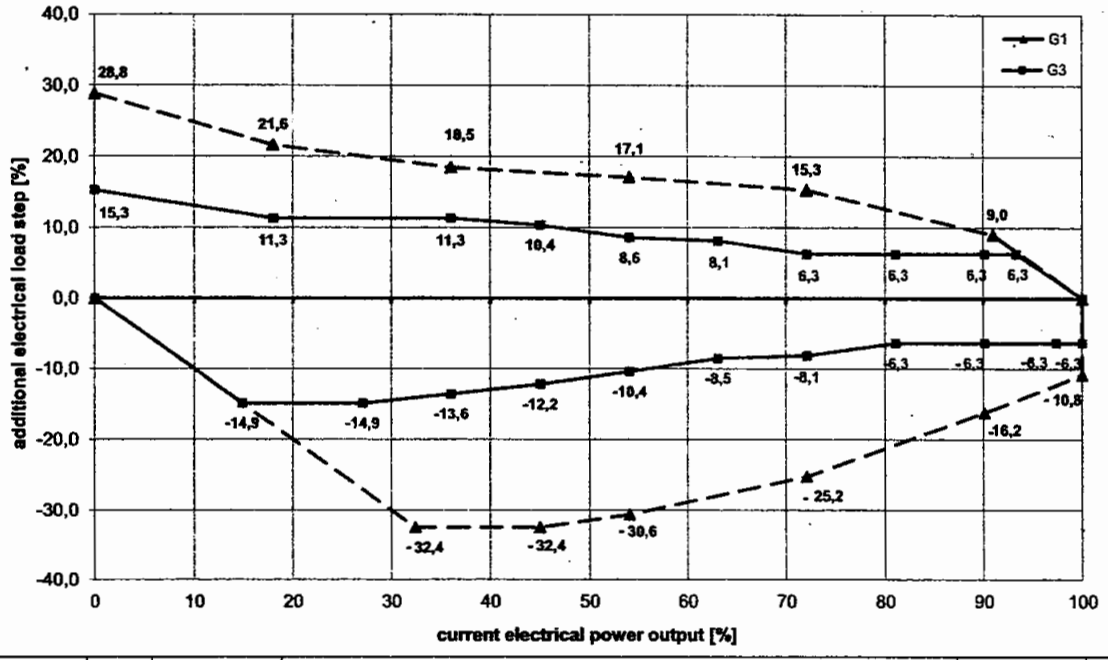


DK-LS-0023	V01	05.02.2013		Abt. OAGS	1/1

Load Steps Island Mode 12V4000L32 MN80

Emission level	NOx 500mg/Nm³ @ 5% O₂	**Norm**	ISO 8528-5
Generator	PE734C2 Wdg 312	**Inertia**	36,36 kgm²
ß, for G3	till 1000 kW	**Note**	For 100% electrical power also regard derating for methan number, inlet air temperature and altitude on site.

A Rolls-Royce solution

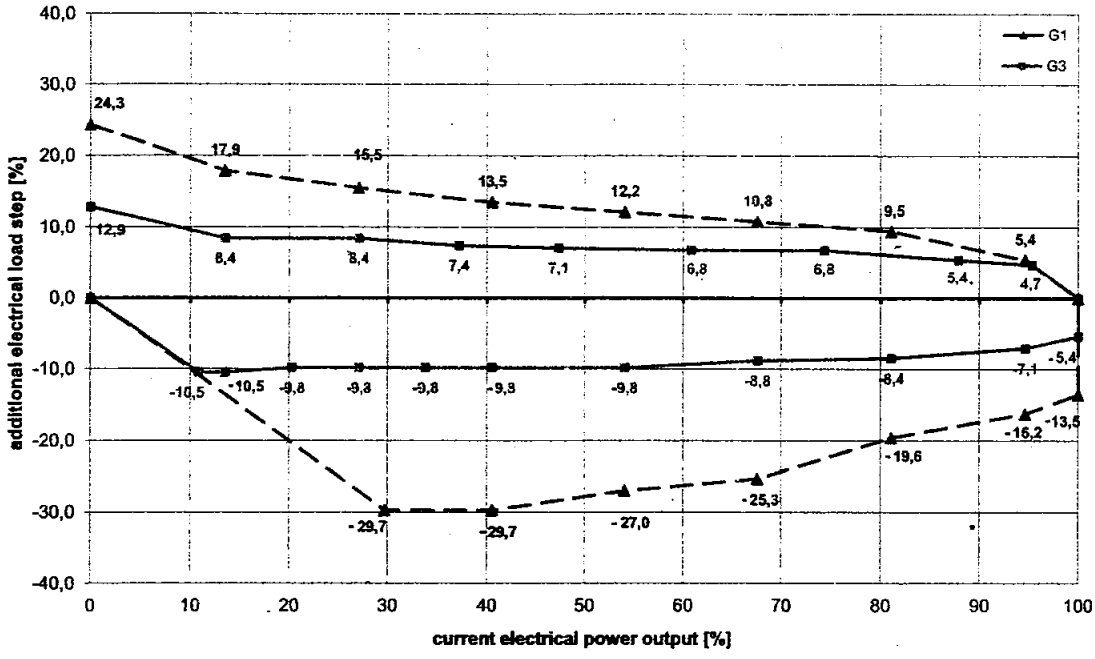


DK-LS-0025	V01	05.02.2013		Abt. OAGS	1/1

Load Steps Island Mode 16V4000L32 MN80

Emission level	NOx 500mg/Nm³ @ 5% O₂	**Norm**	ISO 8528-5
Generator	PE734G2 Wdg 312	**Inertia**	51,33 kgm²
δ_f for G3	till 1560 kW	**Note**	For 100% electrical power also regard derating for methan number, inlet air temperature and altitude on site.

A Rolls-Royce solution

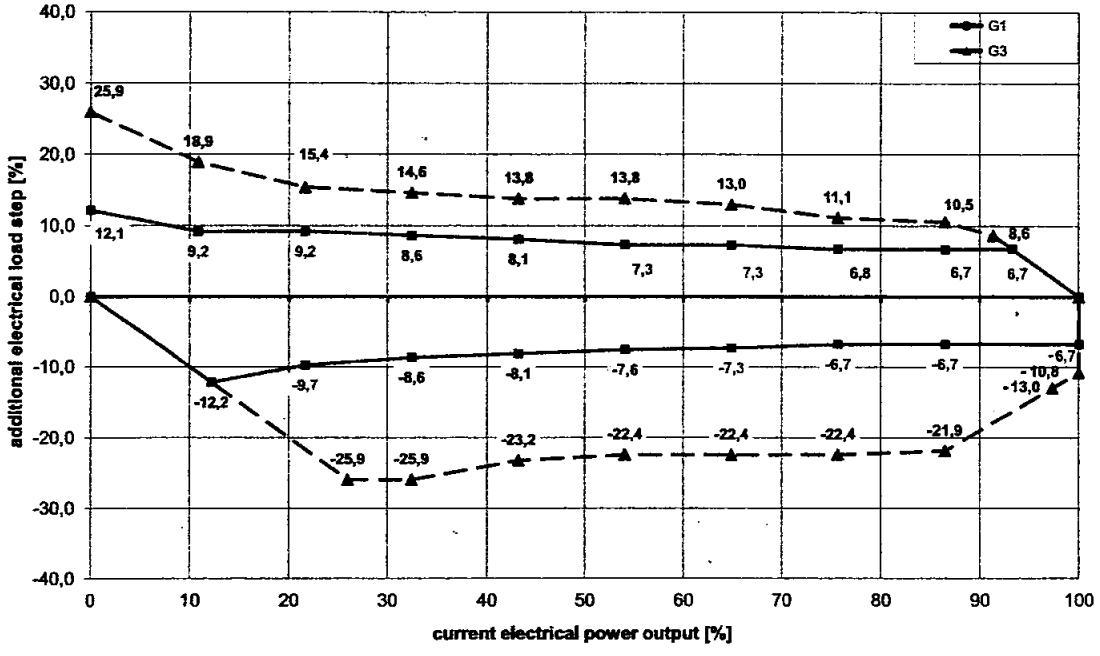


DK-LS-0027	V01	05.02.2013		Abt. OAGS	1/1

Load Steps Island Mode 20V4000L32 MN80

Emission level	NOx 500mg/Nm³ @ 5% O₂	**Norm**	ISO 8528-5
Generator	LVSI804S2 Wdg 12	**Inertia**	80,72 kgm²
δ_f for G3	till 1800 kW	**Note**	For 100% electrical power also regard derating for methan number, inlet air temperature and altitude on site.

A Rolls-Royce solution



DK-LS-0021	V02	24.01.2013		Abt. OAGS	1/1

MTU Onsite Energy
A Rolls-Royce Power Systems Brand

www.mtuonsiteenergy.com

R.A. ENGINEERING
& SERVICES (PVT.) LTD.
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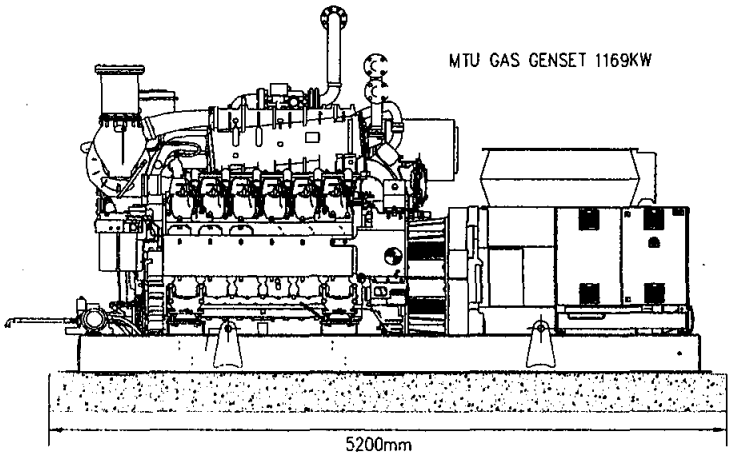
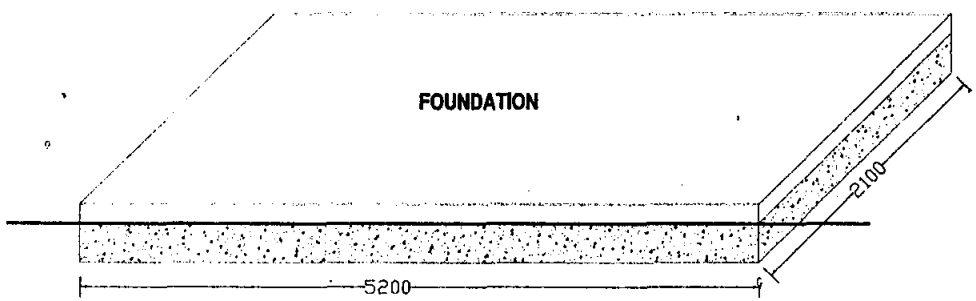
Designed and Produced by DNA design 03008265340



SIDE VIEW FOR GENSET WITH FOUNDATION

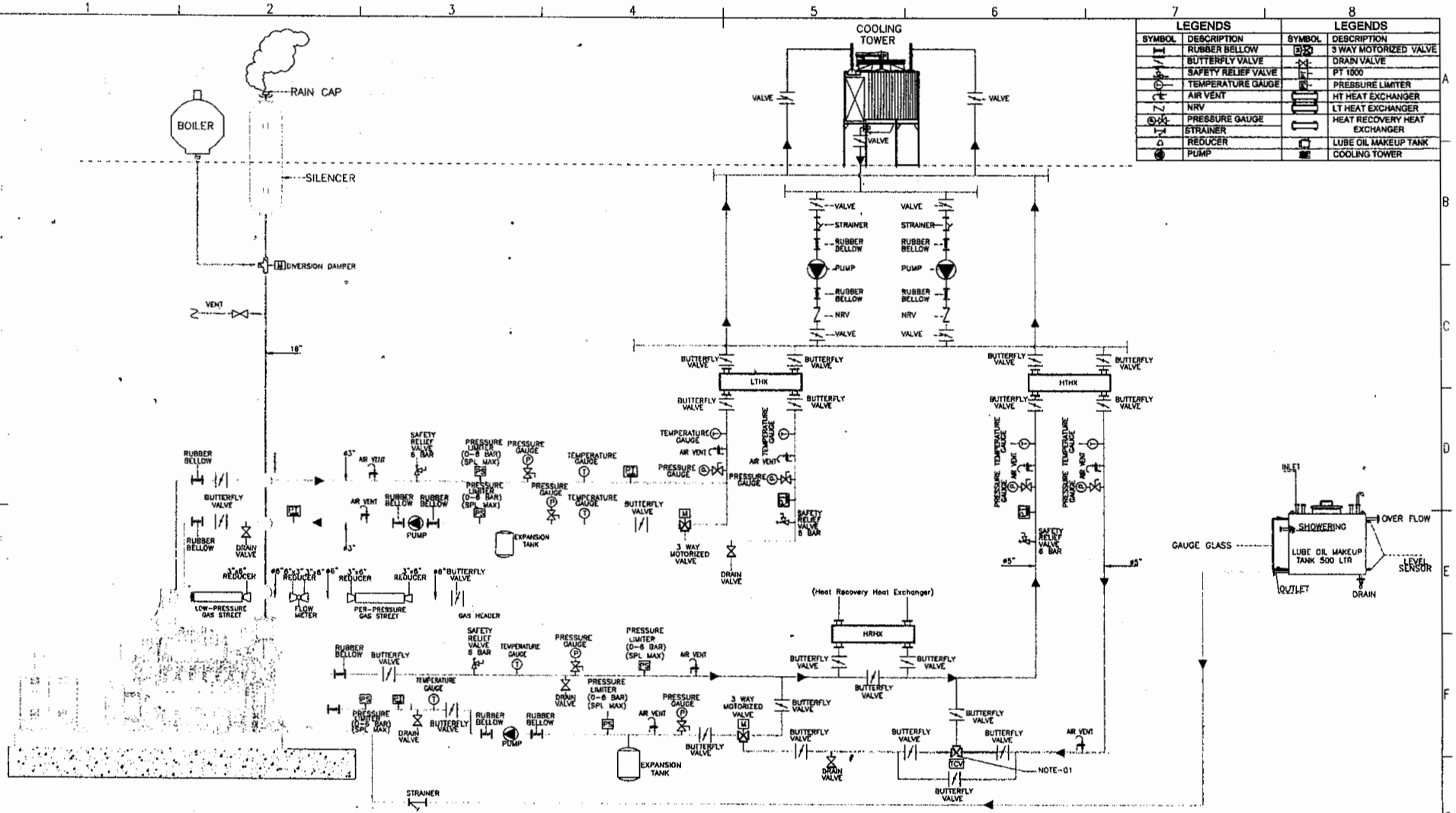


TOP VIEW FOR FOUNDATION

DRY WEIGHT 12500KG
2% OF DRY WEIGHT MUST BE ADDED FOR THE DYNAMIC WEIGHT

ONLY FOR INFORMATION

Rev.3		**Project :**	Scale	N.T.S.	**Client :**	Title : **MTU GAS GENSET 1169KW**	
Rev.2			Date	01-08-2017	R.A. ENGINEERING & SERVICES (PVT.) LTD.	Quantity : 01	Sheet : 1/1 Rev. : 0
Rev.1		**Consultant :**	Worked by	RUR		Drawings # : MTU-12V -FOUNDATION	Work Order # : GENSET GOUNDATION
			Checked by	QR			



LEGENDS		LEGENDS	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	RUBBER BELLOW		3 WAY MOTORIZED VALVE
	BUTTERFLY VALVE		DRAIN VALVE
	SAFETY RELIEF VALVE		PT 1000
	TEMPERATURE GAUGE		PRESSURE LIMITER
	AIR VENT		HT HEAT EXCHANGER
	NRV		LT HEAT EXCHANGER
	PRESSURE GAUGE		HEAT RECOVERY HEAT EXCHANGER
	STRAINER		
	REDUCER		LUBE OIL MAKEUP TANK
	PUMP		COOLING TOWER

NOTE -01:

Ports to be defined as per Manufacturer

- Bypass port from HRHX
- Cooling port from Radiator
- Mixing port toward Engine

Rev.	Date	Revision Note
4		
3		
2		
1		
0		

Customer:

Project Title: MTU 12V L64 P&ID

Drawing-No

Scale	Revision	Format	Sheet
NTS	00	A4	01

Drawn By	Checked By	Approved By
Rizwan	Abdul Rahim	M.Ali

R.A ENGINEERING & SERVICES (PVT) LTD

FBL-4/I-811/1025
Rev-02

October 9, 2020

M/S: Ittehad Textile Weaving.
4Jarranwala Road. Khurrianwala.
Faisalabad – Pakistan.

Cell No.: +92 0302 7875388
Email ID: amjad@ittehadspinning.com

Attention: **Mr. M. Amjad ESQ**

SUBJECT: **PROPOSALS FOR THE SUPPLY OF 01 NOS 3.0 TPH WASTE HEAT RECOVERY STEAM BOILER CONNECTED WITH 03 NO MTU 12V4000 GAS ENGINE.**

Dear Sir,

We thank you for your inquiry regarding supply of One 3.0 TPH Waste Heat Recovery Boiler connected with MTU 12V4000 Gas Engines. We are pleased to submit our Technical cum Commercial Proposal for your kind consideration and perusal.

Please Note. We are pleased to offer you our latest & most efficient WHRC Boiler which is a compact unit and utilizes for higher efficiency & output. Our more efficient design has been practically in operation. Separate Flue Hot Gases pass and anti-corrosion of dew point and no blockage due to ash

Please note that we have successfully supplied, Erection Installation & Commissioning of **WHRB** to **M/s. WestPoint Home Bahrain**, M/s. **Shahzad Textile** Mills Limited, M/s. **Gulf Rental Power 66MW-Gujranwala, M/s. Hira Textile,** M/s. **Arshad Corporation Ltd,** M/s. **Kamal Ltd,** And **Mk Sons Limited**., and also attached customer reference list

More than 650 Nos. Projects like Coal, Biomass, Gas, Oil fired Steam Boilers, Thermal Oil Heaters, Conversions, Waste Heat Recovery Steam Boilers and Up-gradations & Maintenance etc. has been done by FBL Industrial Services.

OEM: **(JN) WUXI JIENENG BOILERS CO. CHINA.**
CHANGZHOU DAYA IMPORT & EXPORT CORP. CHINA.

Our comprehensive proposal consists of the following sections:

Section – A	:	**Price Summary**
Section – B	:	**Technical Specification.**
Section – C	:	**Commercial Terms & Conditions.**
Section – D	:	**Scope of Supplies & Customer responsibilities**

We hope that our offer is in compliance with your requirements and we look forward to receive your valued order. Please do not hesitate to contact us for any clarification.

Yours faithfully,

For **FBL Industrial Services.**

Muhammad Sajid Shahzad
Marketing Manager
0300 6689412

Muhammad Ishtiaq Khan
Design & Proposal Engineer
0345 8188913

PRICE SUMMARY

1 PRICES (Imported Scope) C & F Karachi

DESCRIPTION	PRICE (USD)
1. Waste Heat Recovery Boiler 3.0 TPH Capacity with all essential accessories Included offer. ▪ Boiler Valves & Controls – 01 Lot. ▪ Feed water pumps – 02 Nos. ▪ Electrical Control Panel – 01 No. ▪ Insulation, Cladding and Painting of boiler – 01 Lot.	**85,500/-**
2. Supply Economizer (Fins Tube Type): ▪ Insulation, Cladding and Painting of economizer – 01 Lot. ▪ Valves & Fitting – 01 Lot.	
3. Sea Fright Charges	

Total Price C&F Karachi: 85,500/-

2. PRICES (Local Scope).

DESCRIPTION	COST (PKR)
Feed Water Tank with Deaerator Head, Exhaust Gas Duct, and Blow Down Tank for WHR Boiler. **i. FEED WATER TANK** ▪ Feed Water Tank with Deaerator head, - 01 No. ▪ (Capacity 3,000 Liters) – 01 No. ▪ Steam Sparger Line - 01 No ▪ Valves & Control – 01 Lot ▪ Insulation, Cladding, Painting of Tank – 01 Lot **ii. Chimney, Ducting and Expansion for WHR Boiler.** ▪ Chimney – 03 No. Expansion Bellow – 03 Nos ▪ Duct (Between Boiler to Engine) – 01 No. Per Engine **iii. FIELD PIPING & ELECTRICAL MATERIAL** ▪ Piping & Valves – 01 Lot. ▪ Instruments & Controls – 01 Lot. ▪ Cables & Miscellaneous Electrical Items – 01 Lot. iv. Insulation, Cladding and painting piping as per FBL Battery Limits – 01 Lot. **v. Steam Header & Blow Down Tank – 01 No**	**3,850,000/-**
Total Amount (Exclusive of all taxes)	**3,850,000/-**

(Above Price Exclusive of all Taxes)

3. Cost (Consultancy)

DESCRIPTION	PRICE (PKR)
i. Cost of Supervision/Consultancy of Erection and Commissioning of WHR Steam Boiler.	450,000/-

Consultancy Charges Rs: 450,000/-

(Above Price Exclusive of all Taxes)

4 COST (Labor & Erection & Commissioning)

DESCRIPTION	COST (PKR)
i. Cost of Supervision/Consultancy, Labor Services, Erection and Commissioning of WHR Steam Boiler. • Erection – 01 Lot. • Piping – 01 Lot. • Electrification – 01 Lot. • Commissioning – 01 Lot	850,000/-

(Above Price Exclusive of all Taxes) **Consultancy Charges Rs: 850,000/-**

5 VALIDITY:

DESCRIPTION
▪ Our prices are valid for 15 calendar days from the date of submission of this proposal.

TECHNICAL DATA OF WASTE HEAT RECOVERY STEAM BOILER

1. WASTE HEAT RECOVERY STEAM BOILER 01 No.

The boiler would be supplied as a package unit with necessary control equipment including valves, Instrumentation, Gauges etc.

No of Boiler	03 No.
Design Capacity	**3.0 TPH**
Grass Steam output	**2.80~2.89TPH**
Boiler Type	Triplex WHR Boiler
Configuration	Horizontal, mounted on Saddles
Exhaust Gas Flow Rate @ 100% load (Boiler Inlet)	22089 kg / hr combined
Exhaust Gas Temperature @ 100% load (Boiler Inlet)	417 °C
Operating Pressure	1.0MPA
Design Pressure	1.2MPA
Shell Dia including insulation and cladding	2484mm
Boiler Length including smoke boxes	6000mm
Tube Plate (O.D) 02 Nos.	2,448mm
Heating Surface area without Economizer	3,312.28SQFT
Economizer	1200 SQFT
Feed Water Temp.	90 °C
Boiler Outlet/Steam Temp. Approx.	184 °C
Material of Construction (Shell & Endplate)	GB Standard
Tube Material	GB Standard
Insulation	Rock Wool as per design
Cladding	Pre-painted Sheet
Painting	As per specs

ECONOMIZER – 01 No.

The economizer is mounted on the rear smoke box of the waste heat recovery boiler. Its specifications are as under:

Location	Above exhaust outlet of Boiler.
Type of Tube	Finned Tubes
Tube Material	As per code
Type of Tube	Corban Steel Finned Tubes
Insulation	Rock wool as per design
Painting	As per design
Cladding	Pre-painted Sheet

3 BOILER VALVES, CONTROLS & GUAGES– 01 Lot

Steam stop valve – 01 No.	Imported
Blow down valve – 01 No.	Imported
Feed water inlet valve – 01 No.	Imported
Non return valve – 01 No.	Imported
Pressure gauge for Boiler – 01 No.	Imported
Boiler Water Level Control System – 01 No.	Imported
Water Gauge Glass Assembly – 01 No.	Imported
Pressure Switch – 01 No.	Imported
Safety valve (for Boiler) – 02 No.	Imported
Feed Water Pumps – 02 Nos.	Imported

4 FEED WATER PUMPS (One Operating + One Stand By) – 02 Nos.

These pumps are located adjacent to the feed water tank and are used to supply the feed water to boiler.

Make: OEM SS Vertical

Note: The pump selection is based on the distances from pump discharge to boiler inlet as per battery limit. Any deviation from this will result in a change in pump size as well as proposal cost.

5 ELECTRICAL CONTROL PANEL – 01 No.

The boiler electric control panel is of self standing design and houses all boiler controls, starters, circuit breakers and main isolating switches. The panel is fabricated from steel sheets and painted with powder coated paint.

Panel Class	Suitable for indoor installation
Configuration	Vertical Floor mounted Design.
Panel Controls & accessories are:	Boiler On / Off Selector switch
	Power On indication lamp
	Boiler and Feed Water Levels
	Feed Water Pump On / Off selector switch
	Feed water pump running lamp
	Alarm Mute / Reset button
	Emergency Stop Push button
	Internal Panel Light

6. QUALITY CONTROL DOCUMENTATION **01 Set**

7. OPERATING MANUAL FOR WHR BOILER **01 Set**

LOCAL SCOPE

1 FEED WATER TANK WITH DEAERATOR – 01 No.

Feed water tank would be of cylindrical construction made from carbon steel plates. Water is pre- Heated in this tank before supply to boiler.

Volumetric Capacity	3,000 Liters
Configuration	Horizontal supported on saddles.
Material of Construction	A-36 or Equivalent
Shell Dia	1164mm
Shell Length	3000mm
Thickness	4mm
Operating Pressure / Temperature	Atm.
Painting	As per FBL specs
Insulation	Rock wool as per FBL design
Cladding	Pre-painted Sheet
Instruments	Level Glass, Level Control, Temperature Control

- **DEAERATOR – 01 No.**

Material of Construction	MS

- **CHEMICAL DOSING PUMP – 01 Lot.**

i. DUCTING

- **DUCTING BETWEEN DAMPER & WHRB – 01 No. Per Engine**

Exhaust gases from engine outlet are introduced into the boiler inlet smoke box by mean of this duct.

Duct Length	6,000 mm maximum including Bends
Diameter	As per engine duct size
Material of Construction	A - 36 or Equivalent
Insulation	Rock wool as per Micas design
Cladding	Pre Painted Sheet
Painting	As per Micas specs

ii. CHIMNEY – 01 No. Per Engine

Chimney Height	6,000 mm
Diameter	As per engine duct size
Material of Construction	As per code
Painting	As per FBL specs

iii. Steam Header 01 – No.

Configuration	Horizontal supported on saddles.
Dia	10" x Length 10' 01 No
Material of Construction	GB / A-106 Gr. B
Nozzles	01 No.1" 03 Nos 3/4", 02 No, 1/2"

(Drawing with Steam Trap, included Pressure & Temperature Gauge & Vent)

Insulation	Rock wool as per design
Cladding	G. I. Pre-Painted Sheet
Painted	Temperature resistant aluminum paint.

COMMERCIAL TERMS & CONDITIONS

1 **Terms of Payment:**

Import Scope

- 30% T/T & 70 % L/C in favor of our principals import scope.

1.1 **Local Scope:**

- 75% Advance of FBL local supervision services.
- 15% During erection works.
- 10% After commissioning of boiler

2 **Taxes:**

- All offers are exclusive of taxes.
- **Note:** - If any tax is charged, it will be added to the offered price.

3 **Sales Tax:**

- Above price are without Sales Tax and it would be paid by Customer.
- (If customer need sale tax invoice

4 **Delivery Conditions (6 Weeks):**

WHR Boiler with its ancillary equipment would be delivered within 6 weeks from China of your firm order and advance payment or L/C. We foresee another Four (4) weeks for Erection of steam generator & WHRB at site however this responsibility of buyer and commissioning would be done within 07 days after erection. We shall complete the job from the effective project start date and subject.

FBL has right to raise delivery & commissioning invoices due to any delay incurred due to customer requirement. If the customer does not provide the fuels within one week of Erection Completion, FBL reserves the right to raise and claim the commissioning invoice and the customer shall be obliged to honor it. The customer must ensure that the approach to the steam generator installation location from the entrance including all above ground clearances should confirm to FBL requirements otherwise.

5 **Base Frame:**

A mild steel base frame is welded to the oil heater, designed to support and distribute weight through the main cross members of the oil heater.

6 **Insulation:**

WHR Boiler body and the periphery of the front are insulated and clad in painted sheeting.

7 **Paint Work:**

On completion, the steam generator is externally cleaned mechanically and finished with temperature-resistant paint. The steam generator is then insulated, clad and finally painted with multiple coats.

8 **Warranty Clause:**

FBL provide warranty against design, materials and workmanship for the products manufactured by it. Warranty is valid for one year after commissioning or 12 months after delivery whichever occurs first.

This warranty is subject to the following conditions.

9 **Consequential Damages:**
Neither party shall at any time be liable to the other for any loss of profits or any similar indirect damages, howsoever described, incurred or suffered by either party in respect of the profit

10 **Warranty Clause:**

FBL provide warranty against design, materials and workmanship for the products manufactured by it. Warranty is valid for one year after commissioning or 18 months after delivery whichever occurs first. This warranty is subject to the following conditions

11 **Consequential Damages:**
Neither party shall at any time be liable to the other for any loss of profits or any similar indirect damages, howsoever described, incurred or suffered by either party in respect of the profit.

12 **Secrecy:**
All data, specification and drawings submitted by FBL as a part of the contract will not be passed on by the purchaser to any third party, for whatever reason, without FBL written consent.

13 **Terms of Possession:**
Until paid for in full, the title to and right of possession of the equipment shall remain with FBL.

14 **Arbitration:**
Any controversy of claim arising out or relating to any agreement resulting from this proposal or the breach thereof shall be handled by arbitration. The agreement is for arbitration within the meaning of the Pakistan Arbitration and Conciliation Act, including any statutory re-enactment or any other modification thereof. The arbitration proceedings shall take place in Lahore, Pakistan or any other location as finalized by the arbitrators.

15 **Force Majeure:**
This offer is subject to a force Majeure which may include but is not limited to acts of nature, or by the public enemy, wars, floods, epidemics, riots, civil disorders or any other cause which adversely affect the ability of contractor to perform the work diligently. In such cases the deviations and time extension for the contract shall be mutually agreed.

RESPONSIBILITIES

Responsibilities of FBL

Supervision/Consultancy for Installation, Erection for steam generator. (To Buyer Team)

All consultancy services concept to commissioning.

- Client Training.
- Packing Rail/Sea Worthy in Thermo Retractable PVC as applicable/if required.
- Supervision of Installation & Commissioning of FBL Scope of Supply
- 1 X Site Supervisor With Team (as required)
- 1 X Commissioning Engineer
- Documentation Sets Incl.

CUSTOMER RESPONSIBILITIES / FBL EXCLUSIONS

1. All type of civil work including RCC foundations for WHR Boiler, Feed Water Tank and pumps.
2. Registration with Insurance Company/Governing Body as and if required.
3. Inland shipping/Transportation (Customer Site)
4. Un-loading at site & Placement on Foundation
5. Loading, unloading & transportation crane works.
6. Main Electric Supply Cable up to FBL Supplied Electric Control Panel & Field wiring Earthing etc.
7. Certification of boiler from local boiler inspector for its operation at site.
8. Air conditioned room of the boiler control panel.
9. Free of cost three-phase electricity for Erection and Commissioning at customer site.
10. One lockable room for the Tools and Tackle storage during Erection and Commissioning.
11. One room with Telephone/ Electricity would be provided to FBL site supervisor during erection and commissioning phase.
12. Boarding and lodging of FBL staff during erection work would be provided by the customer.
13. Any item not specifically included in our offer.

——End of Document——

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(Vii):

YEAR MAKE/MODEL,OPERATION DATE AND EXPECTED REMAINING LIFE.

YEAR MAKE:

MTU GAS GENERATOR SETS ROLLS ROYCE POWER SYSTEM GERMANY 2020 MODEL

MODEL:

"MTU 12 V 4000 GS".

OPERATION DATE:

EXPECTED DATE APRIL 2021.

REMAINING LIFE:

LIFE CYCLE OF THE ENGINE IS 84,000 UPTO MAJOR OVERHAUL.(10 Year)

Attachment: MTU Tech Specification data sheet.

Maintenance Schedule

Onsite Energy
MTU 8V4000 GS - 8V4000L64FNER
MTU 12V4000 GS - 12V4000L64FNER
MTU 16V4000 GS - 16V4000L64FNER
MTU 20V4000 GS - 20V4000L64FNER
Natural gas - Interval 3,000 h - 84,000 h
Application group 3A

MS50298/00E

A Rolls-Royce solution

Maintenance Spare Cost For MTU 12V4000L64 FNER - [illegible]

[illegible]	0 hrs to 8000 hrs	8001 hrs to 16000 hrs	16001 hrs to 24000 hrs	24001 hrs to 32000 hrs	32001 hrs to 40000 hrs	40001 hrs to [illegible]
	1st Year	2nd Year	3rd Year	4th Year	5th Year	[illegible]
Routine Maintenance Interval 3,000 hrs			€ 6,428.57	€ 6,428.57	€ 6,428.57	€ [illegible]
Routine Maintenance Interval 3,000 hrs			€ 6,428.57	€ 6,428.57	€ 6,428.57	€ [illegible]
Routine Maintenance Interval 3,000 hrs			€ 6,428.57		€ 6,428.57	€ 6,428.57
Gas Filter Element Maintenance Interval 9,000 hrs		€ 496.25	€ 496.25	€ 496.25	€ 496.25	€ [illegible]
Turbo Charger K1 Maintenance Interval 10,500 hrs						€ [illegible]
1st Top End Overhaul Maintenance Interval 21,000 hrs			€ 69,831.00			
2nd Top End Overhaul Maintenance Interval 42,000 hrs						€ 69,831.00
3rd Top End Overhaul Maintenance Interval 63,000 hrs						
Vibration Damper Maintenance Interval 31,500 hrs					€ 8,000.00	
Total	€ -	€ 496.25	€ 89,612.96	€ 13,353.39	€ 27,781.96	€ [illegible]

[illegible] € 364,463.00

Note:

** Prices above are FOB Germany Freight will be charged extra based on mode of transportation i.e by air or by sea.
** 3 % Escalation will be applicable per annum on parts.
** Turbo Charger maintenance, parts and repairing expense will be in ABB scope.
** Alternator maintenance, parts and repairing expense will be in buyers scope.
** In case of any fault in electronic equipments like governer, actuator etc, expense will be in buyer scope after warranty.
** Parts consumption is guaranteed except Air filters as it is based on environment.
** Above parts consumption is guaranteed on the basis that all the maintenance is carried out as per manufaturer recommendation [illegible]
** The above guarantee is based on use of genuine parts procured from MTU/ Authorized dealer.
** Alternator and TurboCharger Service Charges shall be quoted separately.

Mr. Tahir Mahmood
GM (Fsd)
[illegible] Engineering & Services (Pvt) Ltd.

Mr. Muhammad Amjid Hussain [illegible]
PM (Power)
[illegible] (Pvt)

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(Viii):

INSTALLED CAPACITY , DE-RATED CAPACITY , AUX CONSUMPTION , NET CAPACITY.

INSTALLED CAPACITY:

GAS GENERATOR SETS "1.521 MW MTU Rolls Royce power systems AG Germany"

SIZE OF PLANT 3 X 12V64FNER_400 V = 4.56 MW

NO OF GAS GENERATORS = 03 Nos.

De-RATED CAPACITY:

As confirmed by OEM, there is no de-aeration @ 45 degree c up to life cycle of the Gas generators, if OEM maintenance recommendations followed. (Certificate attached for reference).

AUX. CONSUMPTION:

AUX CONSUMPTION FOR ONE GAS GENERATOR = 40 KW.
AUX CONSUMPTION FOR THREE GAS GENERATOR = 120 KW.

NET CAPACITY:

NET CAPACITY OF PLANT WOULD BE = 4.443 MW.

Attachment: MTU /RA Letter attached .

R.A. ENGINEERING

ITTEHAD TEXTILES

SALES CONTRACT FOR

4 x MTU 12VL64 1521 KW @ 400V GAS GENSET

Ref (RA. Eng 01) **Dated: September 9th, 2020**

Dear Sir,

We are pleased to confirm the following points as decided in the meeting.

Price

Agreed Price for MTU Gas Generator is **EURO 325,000 /-** per genset. Total **EURO 1,300,000/-** for **04** no of Gensets CNF Karachi.

Engine Consumables parts for **15,999 hours** included in the package price.

Guarantees

Guaranteed Output is **1521 KW (100%)** at 80 Methane number. Gen-set has no deration up to 45°C in life cycle.

Two years Genset warranty as mentioned in quotation

Guaranteed Fuel Consumption at 100% load is 0.228 Nm3/kwh or 0.241 Sm3/kwh at 1000 BTU/ft3 GCV). This fuel consumption is subject to +5% ISO tolerance

Guaranteed lube oil consumption is **0.27 liters/ hour.** The test will be carried out within 1,000 hours of operation.

Parts

Please see attached Annexure C.

Best regards.

Mr. Anwar ul Hasan
COO
R.A. Engineering & Services (Pvt) Ltd

Mr. ASIM Maqsood
CEO
Ittehad GROUP

Mr. Tahir Mahmood
GM (Fsd)
R.A. Engineering & Services (Pvt) Ltd

Mr. Muhammad Amjid Hussan
PM (Power)
Ittehad (Pvt)

Mr. Faisal Tufal
Technical Director (Actg)
Ittehad (Pvt)

Technical Director
Ittehad (Pvt) Limited
1-Km, Jaranwala Road,
Khurrianwala, Faisalabad.
Pakistan

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3- FUEL TYPE.

SNGPL GAS PIPE LINE FOR SUPPLY OF GAS :

SNGPL PROVIDING PIPE LINE QUALITY GAS 2 MMCFD AS PER AGREEMENT TO ITTEHAD(Pvt)Ltd. FOR CAPATICE POWER PLANT THROUGH 8 INCH PIPE LINE.

THE CHEMICAL COMPOSITION REQUIRED TO OPERATE MTU GAS GERATORS ARE ATTACHED FOR REFERENCE.

THE CHEMICAL COMPOSITION OF SNGPL SUPPLIED GAS IS ALSO ATTACHED FOR YOUR REFERENCE.

MTU 03 NOS GAS GENERATORS GAS REQUIREMENT:

TOTAL CAPACITY OF POWER PLANT IS = 4.5 MW
GAS ALLOCATION FROM SNGPL FOR POWER PLANT = 2 MMCFD

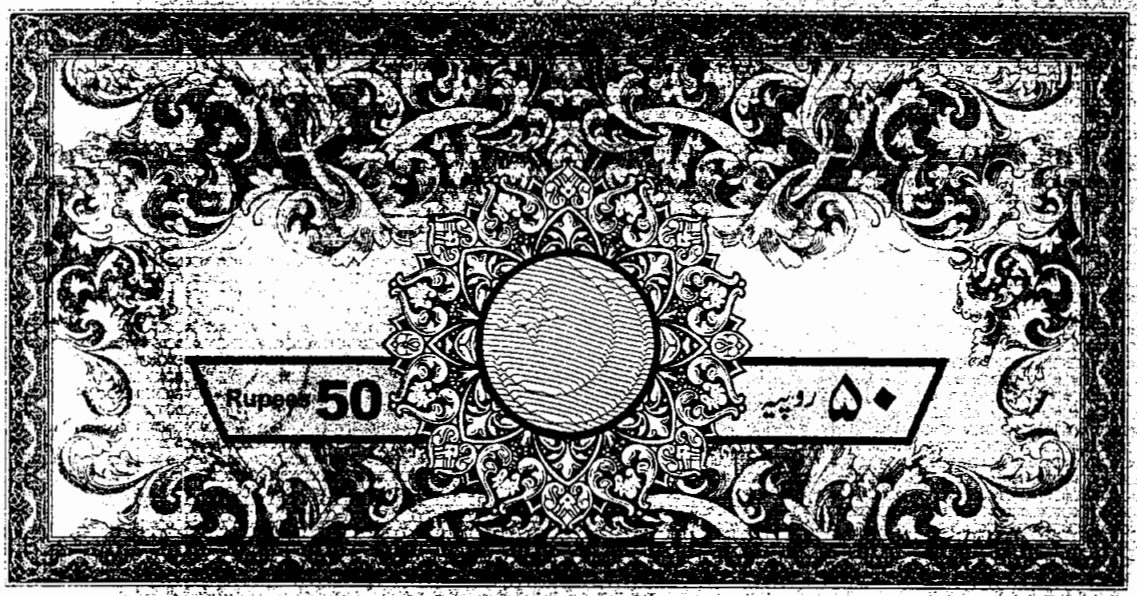
HEAT RATE OF ONE MTU GAS GENERATOR = 0.26 M3 / KWh.

GAS REQUIREMENT FOR 03 NOS OF MTU GERATORS = 0.78 M3 / KWh.

Attachment:

MTU Rolls Royce Gas Specification requirement attached.

R588655



This agreement is made at Faisalabad on this the 29th day of December , 2015 **by and between** SUI NORTHERN GAS PIPELINES LIMITED , a public limited company incorporated under the laws of Pakistan , with its registered office at 21 Kashmir Road, Lahore (hereinafter referred to as **"Seller"**, which expression shall , where the context so permits , include its permitted successors and assigns) ; **M/s Ittehad Private Limited , 1-K.M Jaranwala Road, Khurrianwala, Faisalabad** acting through its Chief executive/Director – Mr. Asim Maqsood (hereinafter referred to as **"Buyer"** which expression shall , where the context so permits , include its permitted successors and assigns) . **WHEREAS :**

A. In light of the shortage of natural gas in Pakistan, the Government of Pakistan has informed SNGPL that it has decided to import LNG to meet local requirements and in this regard LNG Sale and Purchase Agreements have been or will be executed with Pakistan State Oil Company Limited (**"PSO"**) as the designated buyer .

B. PSO, Sui Southern Gas Company Limited (**"SSGC"**) and SNGPL have entered or will enter into an agreement (the **"LNG Supply Agreement"**) under which PSO will agree to import LNG and to supply the same to SSGC/SNGPL and such LNG will thereafter be re-gasified (the **"RLNG"**) by SSGC or its contractor pursuant to separate re-gasification arrangements and made available to SNGPL for onward supply.

C. Whereas RLNG sales are to be Ring-Fenced in line with decision of ECC of the Cabinet made in its meetings held on 09.04.2015 and 23.04.2015 vide case No. ECC-52/07/2015 and Case No. ECC-62/08/2015 respectively , therefore Seller can only supply RLNG to textile if it bears actual line losses of distribution system through price to be charged to them .

D. Whereas the average of distribution losses (UFG) for last three years expressed in percentage terms shall be borne by the Buyer in line with the principle laid down in OGRA Third Party Access (TPA) Rules, 2012.

E. The Parties acknowledge that it is their intent that the Buyer shall have back to back obligations to SNGPL for its allocated RLNG hereunder to mirror the obligations of SNGPL under the LNG Supply Agreement in order to enable SNGPL to fulfill its obligations under the LNG Supply Agreement .

NOW, THEREFORE, in consideration of the mutual benefits to be derived the Parties enter this arrangement and intending it to be legally bound, the Seller and the Buyer hereby agree as follows :

1) The Seller shall supply RLNG to the Buyer on As and When Available basis. The quantity of RLNG to be supplied is determined by SNGPL from time to time pursuant to the prevailing policy of SNGPL (**"Buyer's RLNG Volume"**) .

2) Natural gas is swapped with SSGC, at fields mutually agreed between SNGPL and SSGC; in lieu of RLNG. All natural gas supplied to the Buyer under this agreement shall be considered supply of RLNG .

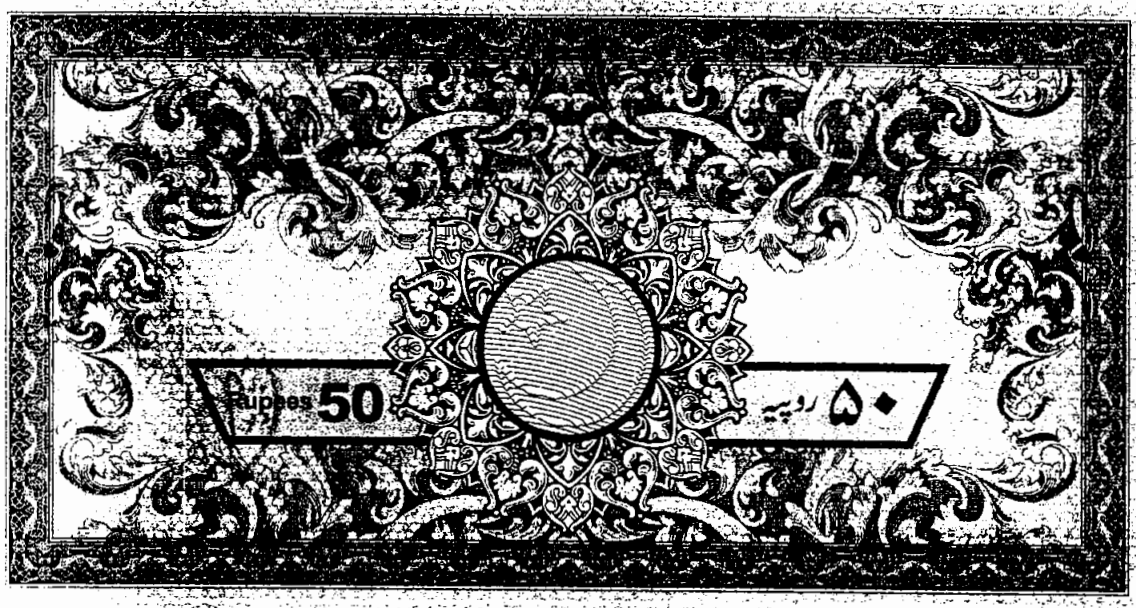
3) The Seller shall only supply RLNG to the Buyer, when such LNG is procured by a government designated owner of LNG, which is subsequently re-gasified by SSGC into RLNG and such RLNG is delivered to SNGPL by SSGC either through transportation or through swap from the agreed gas fields and is received by SNGPL in its system and is sufficient to supply to the Buyer as per the Buyer's RLNG Volume .

For & on behalf of
ITTEHAD (PRIVATE) LIMITED
Chief Executive

ANJUM MAHMOOD AWAN
ISSUE
OATH
COMMISSIONER
Expires on
16-1-16
District Courts Faisalabad

ANJUM MAHMOOD AWAN
ATTESTED
29 DEC 2015
OATH COMMISSIONER

R588656



4) Buyer shall make payment of all RLNG supplied by SNGPL in accordance with RLNGTariff as determined by Oil and Gas Regulatory Authority "**OGRA**") and subsequently notified by PSO ("**Notified Price**") . In addition to Notified Price for the RLNG supplied , Buyer agrees to pay an amount towards transportation / transmission and distributions losses in respect of RLNG , such amount being determined by SNGPL in accordance with the principles set forth in the OGRA Natural Gas (Regulated Third Party Access) Rules 2012 relating to system use gas , transportation loss and line pack etc .

5) The Notified Price or the RLNG price determined by OGRA is provisional and is subject to change after final determination of the RLNG price by OGRA. Differential of RLNG price shall be recoverable/adjustable by the Seller in the subsequent billing period. The Buyer undertakes to pay the differential as and when notified and to furnish guarantee, in the form acceptable to the Seller, for the anticipated differential amount in case of change in Notified Price .

6) The Seller shall invoice the Buyer after seven (7) days of supply of RLNG ("**Billing Cycle**") or at interval deemed appropriate by Seller and the Buyer shall make all payments pursuant to such invoice within three (3) days (Both days inclusive i.e. Bill Issue Date and "**Due Date**") of receipt of such invoice . All invoices of the Seller will be paid without any deduction or set off or adjustment . If the payment is not made within the Due Date , the Seller shall have no obligation to supply.

7) If payment of any bill rendered by the Seller to the Buyer is not made by the Due Date, the Buyer shall pay delayed payment charges to the Seller at the rate of eighteen (18) percent (%) per annum ("**Late Payment Surcharge**") from the due date up to (but not including) the date when payment is made.

8) Payment shall be made to the Seller, at the Seller's designated bank in the designated account of the Seller in favor of "SUI NORTHERN GAS PIPELINES LIMITED", on or before the Due Date; provided that, in the event that payment in the manner identified above is not possible, delivery by the Buyer of a bank draft drawn on a scheduled bank in favor of the Seller at a designated office of the Seller shall be deemed to be an acceptable form of payment, subject to its realization. In the event that the payment is not realized within the Due Date, the Delayed Payment Charges will be levied on the Buyer accordingly .

9) The security shall be maintained during the supply period, the amount of the security deposit may be varied by SNGPL from time to time by notice to the Buyer in the event of a change in SNGPL policy regarding the same or the Notified Price and on notice of such variation Buyer shall within three (3) Days deposit any additional amount required to be provided as security. In the event that the Buyer fails to pay any amount payable to the Seller when due, the Seller shall be entitled to withdraw RLNG Supply and collect such amounts from the security.

10) Following any change in the consumption pattern or Notified Price or Taxes or Meter rent the security deposit will be liable to be adjusted to take account of such change within three (3) Days of SNGPL notifying such change to the Buyer. Such security deposit shall be maintained for a period of at least one (1) Month following the expiry or earlier termination of this Agreement. SNGPL shall have the right to set off and adjust from amount of security deposit any amounts ascertained by SNGPL as due from the Buyer to SNGPL on any account whatsoever and shall inform the Buyer regarding such adjustment.

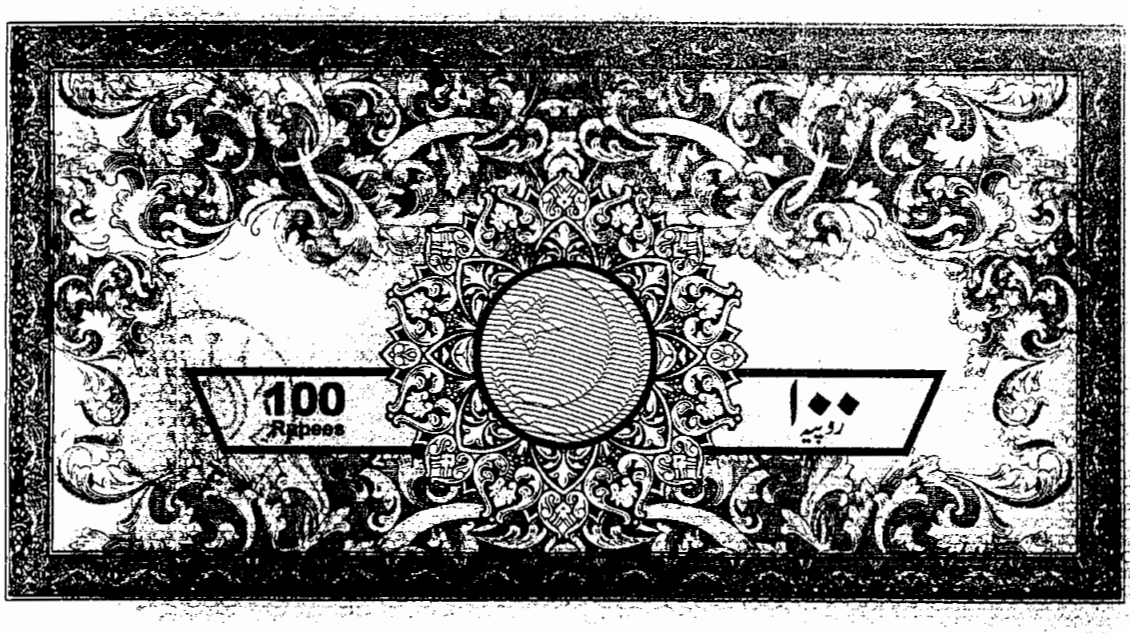
11) If the Seller adjusts any amount against the security deposit the Buyer shall replenish the same within three (3) Days of

ANJUM MAHMOOD AWAN
ISSUE
OATH
Expires on
16-1-16
District Courts Faisalabad

For & on behalf of
ITTEHAD (PRIVATE) LIMITED
Chief Executive

ANJUM MAHMOOD AWAN
ATTESTED
29 DEC 2015
OATH COMMISSIONER

M107260



being notified by the Seller. The Seller shall be under no obligation to supply RLNG hereunder unless there is full and valid security in place as contemplated by the terms of this Article. Without prejudice to the foregoing, SNGPL will also have no obligation to supply RLNG hereunder if amounts owed by the Buyer or amounts that would be owed by the Buyer following supply exceed the amount of security deposit available with the Seller .

12) The Seller reserves the right to discontinue supply of RLNG to any Buyer involved in theft or pilferage of gas. The Buyer shall be liable to pay on demand the price (including all Taxes and other applicable charges) of RLNG consumed illegally and un-authorize dally, computed as per procedure and policy of SNGPL or as per relevant Rules/Regulations of OGRA and applicable Laws of Pakistan. Restoration of Gas supply will be subject to clearance of total dues of SNGPL .

13) This agreement is a supplemental to the existing Contract for supply of gas, already executed between the Seller and Buyer. All terms contained in the existing Contract for supply of gas shall apply, unless otherwise amended through this supplemental agreement. The terms of this supplemental agreement shall supersede the relevant terms of the existing contract, for the purpose of supply of RLNG only.

14) Any Rules/Procedures notified from time to time by the GOP and or Seller will be applicable on the RLNG Supply.

For and on behalf of
SUI NORTHERN GAS PIPELINES LIMITED ,

Dated :

For and on behalf of
ITTEHAD (PRIVATE) LIMITED ,

ITTEHAD PRIVATE LIMITED FSD

Mr. Asim Maqsood
Chief Executive/Director
Dated : 29 . 12 . 2015

Witnesses :

1. **Sohaib Javed s/o Javed Iqbal**
House No. P – 176 , Mohallah Factory area ,
Ahaata garry mill . Tehsil & District – Faisalabad .
CNIC No. 33100 – 6079541 – 3

2. **Muhammad Qasim s/o Gulzar Ahmed**
House No. P – 527/A , Mohallah new Civil
lines , Chandni chowk , Tehsil & District - Faisalabad
CNIC No. 33100 – 7803863 – 5

ANJUM MAHMOOD AWAN ISSUE 17-01-13 OATH COMMISSIONER Expires on 16-1-16 District Courts Faisalabad

ANJUM MAHMOOD AWAN ATTESTED

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(x)-INERCONNECTION WITH NATIONAL GRID:

The Operating system is 400 V ,

(NOT APPLICABLE)

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(xi)- PLANT CHARACTERISTICS:

GENERATION VOLTAGE, POWER FACTOR, FREQUENCY, AUTOMATIC GENERATION CONTROL, RAMPING RATE, CONTROL METERING AND INSTRUMENTATION.

GENERATION VOLTAGE:

Generation voltage = 400 volts.

POWER FACTOR:

Power factor (cos ϕ) = 1

FREQUENCY:

Frequency = 50 Hz

AUTOMATIC GENERATION CONTROL:

- Engine governor controls , starting , stopping and emergency stop sequence.
- Monitor the engine operating parameters.
- Control the throttles and sets gas mixture for required speed / power.
- Monitors the first solenoid valve the gas train to the engine.
- Evaluation unit fot PT1000 temperature sensor to determine and monitor exhaust temperature of individual cylinders.
- Controls the cylinders with regard to the knock characteristics.
- Generator excitation system AREP.
- Generator protection class IP23.
- Dynamically balanced as per ISO1940 and NFC 51-111.

RAMPING RATE:

- As confirmed by MTU ramping rate of generator is 15 mints up to 100 % load.
- MTU will provide the exact ramping rate at the time of commissioning.

CONTROL METERING AND INSTRUMENTATION.

Catalog and P&ID attached for Reference

Attachment: MTU Tech Specification data sheet and P&ID drawing.

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(xii):

SYSTEM STUDIES , LOAD FLOW ,PROVISION OF METERING , INSTRUMENTATION PROTECTION AND CONTROL ARRANGEMENT.

SYSTEM STUDIES:

Ittehad (Pvt) Ltd is a spinning unit, having its associated companies in weaving and Processing sector located at 1-Km Jaranwala road, Khurrianwala , Faisalabad, Pakistan.

Ittehad (Pvt) Ltd is a spinning unit, has Captive Power Plant, 3 x 1.521 MW (4.56 MW) MTU efficient Engines, gas quota has already been allocated by SNGPL for subject captive power plant.

"Ittehad (Pvt) Ltd- The Spinning Mills" intends to sell excessive electricity through gas generation to one of its associated companies **"Ittehad Fabrics (Pvt) Limited-The Weaving Mill" & Ittehad Textiles (Pvt) Limited-The process Mill,** having the same board of directors but registered in Securities & Exchange Commission of Pakistan as separate legal entity. We have captive power plant in spinning mill and want to supply electricity to Weaving mill & Process Mill, weaving, process and spinning units separated by 25 ft public road.

As the System is 400 volts MTU Rolls Royce from Germany, due to 400 volts system, there is no interconnection with any FESCO facilities.

Therefore, there is no technical constraints or problems under flow, short circuit currents and dynamic /transient conditions and are requested to be adopted.

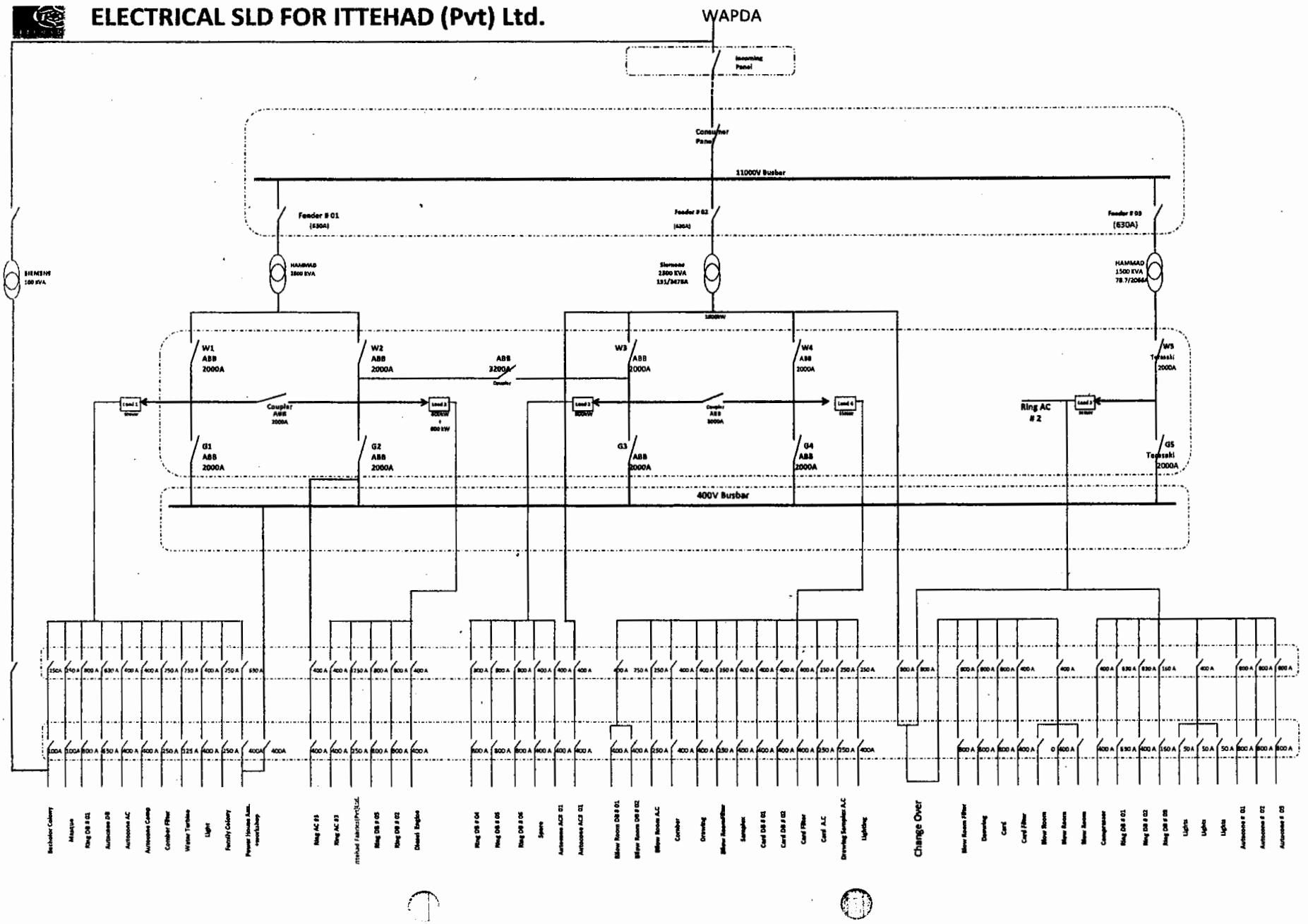
OBJECTIVE OF THIS POWER PLANT:

The main objective of this Captive power plant is efficient, reliable and economical supply of electricity for Ittehad production units without tripping.

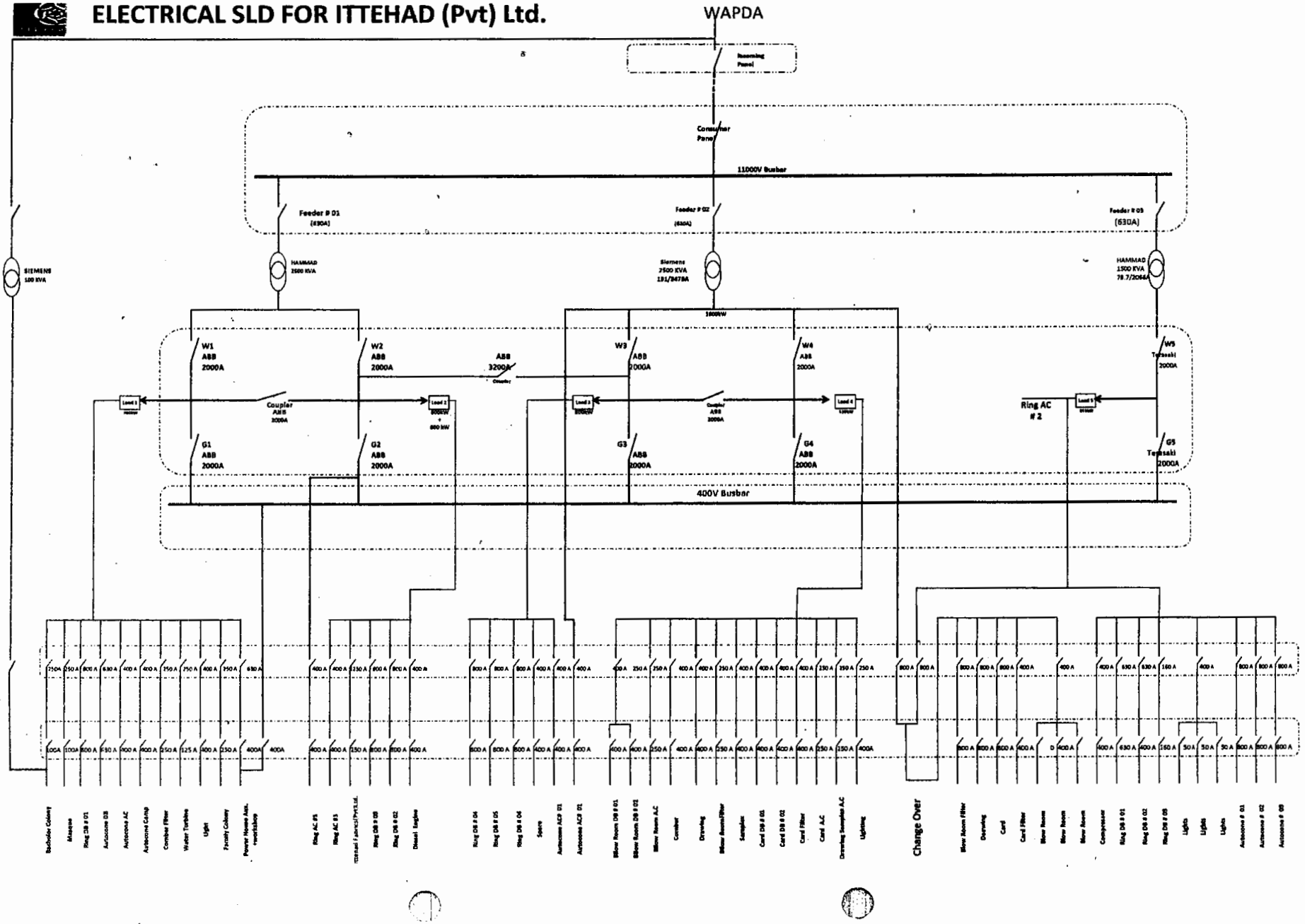
ELECTRIC LOAD DETAIL:

1 X 12 V64 FNER_400 V MTU Rolls Royce	=	1521 KW.
3 X 12 V64 FNER_400 V MTU Rolls Royce	=	4563 KW.
Electric Consumption of Ittehad Spinning (Pvt)Ltd	=	3600 KW.
Electric Consumption of Ittehad Fabrics (Pvt)Ltd	=	600 KW.

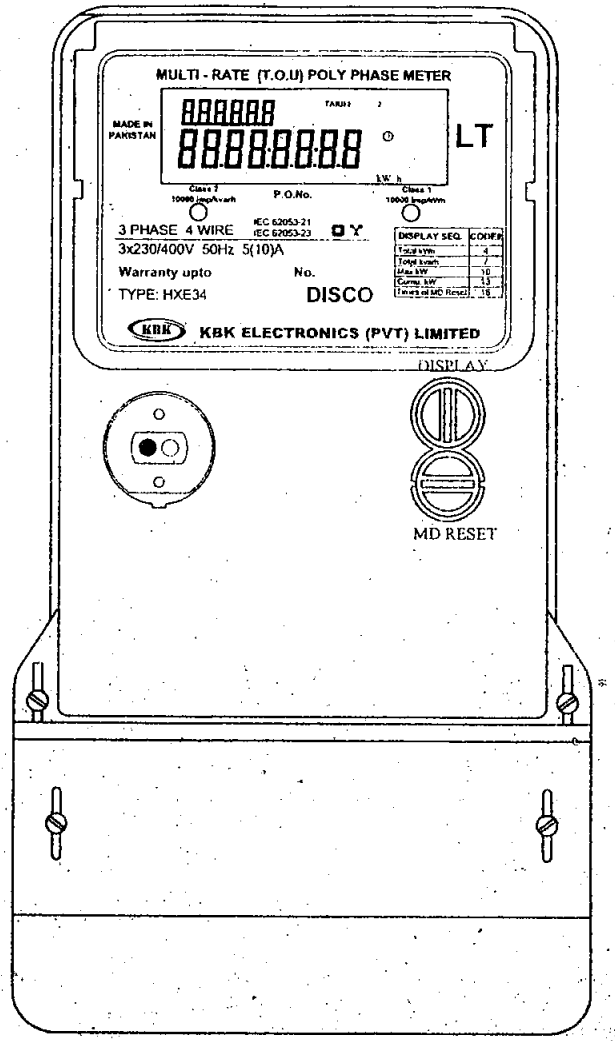
ELECTRICAL SLD FOR ITTEHAD (Pvt) Ltd.



ELECTRICAL SLD FOR ITTEHAD (Pvt) Ltd.



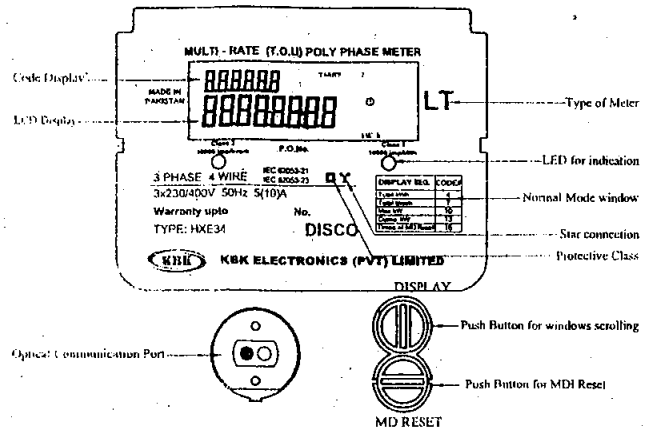
THREE PHASE FOUR WIRE ELECTRONIC ENERGY METER



Features

- Three phase four wire connection.
- 3x230/400V 50Hz 5(10)A.
- 10000 impulses/kWh, 10000 impulses/kvarh.
- Meter's Specifications comply with IEC standards and WAPDA Specifications (Amended to date) for kWh class 1 and kvarh class 2.
- Tampering information along with date and time stamp is recorded.
- "OPENED" is permanently displayed on LCD in case of meter cover opening.
- Works under individual phase failure and accurately records consumed Active & Reactive energies even on low voltage.
- Using Micro-processor based advanced technology for higher accuracy,reliability,programming flexibility and upgradability.
- Built-in power line transient protection.
- High sampling rate to maintain accuracy even with distorted line voltage and current.
- Ideal for Commercial and Industrial energy metering requirements.
- Independent of mounting style/orientation.

Introduction of Meter



KBK ELECTRONICS (Pvt.) LTD.

HEAD OFFICE
1st Floor Sanam Building,
37-Ferozepur Road,Lahore-Pakistan
Tel: +92-42-37426080-2 Fax:+92-42-37426079

FACTORY
31st Km, Ferozepur Road,Lahore-Pakistan
Tel:+92-42-35935101-02 Fax:+92-42-35935103

KBK ELECTRONICS (PVT.) LTD.
KBK ELECTRONICS (PVT.) LTD.

Static Three Phase Four Wire, LT Type CT Operated Energy Meter

HXE 34 is Three Phase Electronic electricity meter designed for measurement of active and reactive energy as well as maximum demand, multi-tariffs for commercial and industrial customers in three phase networks. The meter comply with IEC 62052-11, IEC 62053-21, IEC 62053-23 and relevant WAPDA Standards.

Metering System

The metering system employs a high quality special measuring IC. The metering elements is shielded against strong external magnetic fields up to 0.5 Tesla and is protected against over voltages and high frequency disturbances. Such a design of metering element assures excellent metering features, high metering reliability and negligible effect of influence quantities and requires no re-calibration over meter's entire life span.

Meter Housing

Ergonomically designed housing is made of fire retardant poly-carbonate and can be recycled at the end of the meter life. It assures protection class II (double insulation) and IP51 compliant for protection against dust and water penetration. The meter cover is made of transparent poly carbonate and fixed with sealing screws. The terminal cover is fixed with two sealing screws. It is fixed with two sealing screws. LT Type CT operated meter cover and base is made of fire retardant Poly-carbonate to withstand against high temperature as per IEC standards.

LCD Display

The 7-segment LCD is 8-digit, measuring data are displayed as eight digit value (all integers or with multiple decimals). The identification codes are available on LCD for each parameter/quantity. Symbol of energy flow direction, flags of a valid tariffs and meters status are also displayed.

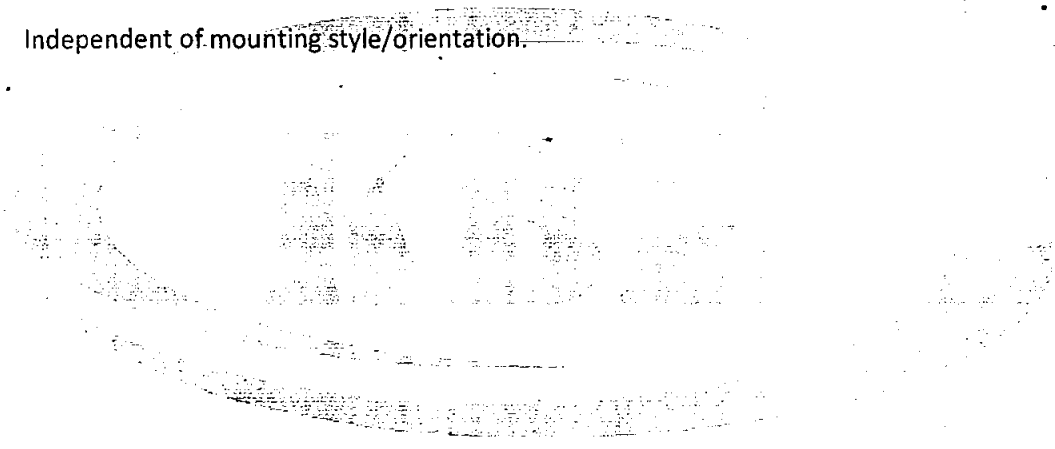
Time-Of-Use Registration

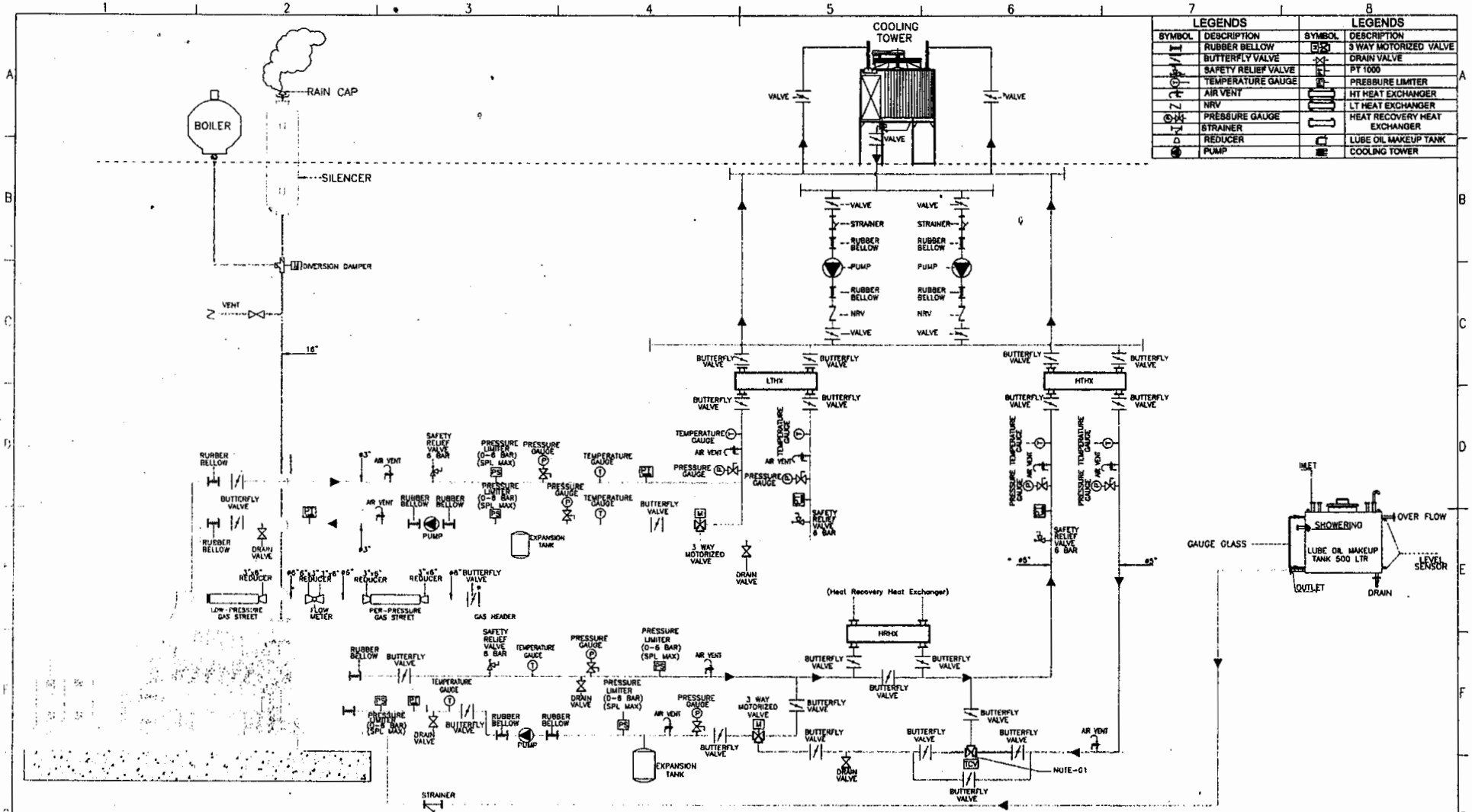
The meters enable registration of energy in different tariffs changing over schedules, Time of changing over tariffs are set with hour and minute with resolution of one minute. Maximum four tariffs can be programmed in multiple seasons and holidays.

Main Features

- Three phase four wire connection.
- 3*230/400V 50Hz 5(10) A.

- 10000 impulses/Kwh, 10000 impulses/kvarh.
- Meter's Specification comply with IEC Standards and WAPDA Specification for accuracy class up to 0.2.
- Tampering information along with date and time stamp is recorded.
- "OPENED" is permanently display on LCD in case meter cover is opened.
- Works under individuals phase failure and accurately records consumed Active & Reactive energies even is low voltage.
- Using Micro-processes based advanced technology for higher accuracy, reliability, programming flexibility and adaptability.
- Built in power line transient protection.
- High Sampling rate to maintain accuracy even with distorted line voltages and current.
- Ideal for Commercial and industrial energy metering requirements.
- Independent of mounting style/orientation.





LEGENDS		LEGENDS	
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	RUBBER BELLOW		3 WAY MOTORIZED VALVE
	BUTTERFLY VALVE		DRAIN VALVE
	SAFETY RELIEF VALVE		PT 1000
	TEMPERATURE GAUGE		PRESSURE LIMITER
	AIR VENT		HT HEAT EXCHANGER
	NRV		LT HEAT EXCHANGER
	PRESSURE GAUGE		HEAT RECOVERY HEAT EXCHANGER
	STRAINER		
	REDUCER		LUBE OIL MAKEUP TANK
	PUMP		COOLING TOWER

NOTE-01:
Ports to be defined as per Manufacturer
- Bypass port from HRHX
- Cooling port from Radiator
- Mixing port toward Engine

Rev.	Date	Revision Note
4		
3		
2		
1		
0		

Scale	Revision	Format	Sheet
NTS	00	A4	01

Drawn By	Checked By	Approved By
Rizwan	Abdul Rahim	M.Ali

Customer:

Project Title: MTU 12V L64 P&ID

Drawing-No

R.A ENGINEERING & SERVICES (PVT) LTD

Technical Description

Gas Genset

Scope of supply Series 4000 (50Hz)

MTU 8V4000 GS

MTU 12V4000 GS

MTU 16V4000 GS

MTU 20V4000 GS

MS61016/00E

SLU Name	Sales Name	
GG08V4000A1	MTU 8V4000 GS	
GG12V4000A1	MTU 12V4000 GS	
GG16V4000A1	MTU 16V4000 GS	
GG20V4000A1	MTU 20V4000 GS	

Table 1: Applicability

Table of Contents

1 Scope of Supply

1.1 General description

The product consists of the following main groups:

- Engine (including gas train)
- Generator
- Heat utilization (with heat recovery module, optional)
- MMC (MTU Module Control) for system control, regulation and diagnosis
- MIP (MTU Interface Panel) for engine control, regulation, diagnosis

Fuel energy is converted into mechanical power and heat in the internal combustion engine.

The generator, which converts the mechanical power into electrical energy, is connected to the engine by means of a resilient coupling. The engine is mounted on two slide rails, so that it can be moved when the coupling element needs to be replaced. The engine and the generator are joined to the base frame through resilient, vibration-damped elements.

Version with heat utilization

A separate heat recovery module enables heat utilization. The engine heat and the mixture heat from the 1st stage can be transferred via the engine cooling water and a plate-core heat exchanger to the heating water circuit. The mixture heat of the 2nd stage is dissipated via a recooler.

The heat recovery module represents the interface between the product and the customer-side heating system.

All regulation, control and monitoring functions, as well as communication options to and from outside, are implemented by means of hardware and software inside the control cabinet.

Details on the construction of the individual systems, functions, interfaces and assemblies can be obtained from the Functional Description, the biogas connection systems and the schematic diagrams.

1.2 General description of engine

The 4-stroke Otto gas turbocharged Series 4000 engine with mixture cooling works in lean-burn operation, which means that the fuel in the engine is burned with an excess of air (lean gas/air mixture).

As an option, the engine can also be equipped with an oxidizing catalytic converter for the reduction of carbon monoxide and formaldehyde emission.

Basic-configuration engine

- Gray cast iron crankcase with assembly holes; SAE 00 flywheel housing, 21" flywheel, gray cast iron oil sump
- Forged crankshaft
- Forged connecting rod
- Individual, four-valve cylinder heads; armored valves with "Rotocap" valve rotator
- Single-component ring carrier piston of light alloy with cast cooling channel, piston cooling via oil spray nozzles

Mixture formation

- Air intake via engine-mounted dry-type air filters
- Venturi gas mixer with gas supply via electronically controlled metering valve

Mixture cooling

- Two-stage mixture cooling
- 1st stage as HT stage integrated in the engine cooling system or as HT circuit coupled with a heating system for heat recovery.
- 2nd stage as LT stage with external cooling circuit

Turbocharging

- Mixture compression via turbocharger
- Two-stage mixture cooling
- Throttle valves located between mixture coolers and receivers

Exhaust system

- Uncooled, insulated exhaust manifold in the engine Vee

Lube oil system

- Lube oil pump with safety valve for forced-feed lubrication and piston cooling
- Lube oil heat exchanger, engine-mounted
- Lube oil paper filter elements as easy-change filter cartridges
- Level sensor for lube oil monitoring, engine-mounted
- Oil dipstick
- Crankcase ventilation via oil separator into the mixture line upstream of turbocharger
- Connections for oil replenishing and draining

Cooling system, dual circuit engine cooling system

- HT circuit with integrated oil cooling, first stage of mixture cooling and cylinder cooling
- Rubber expansion joints with companion flanges for connecting to the external cooling circuits
- Integrated coolant preheating system

Starting equipment

- Electric starter

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Ignition system

- Microprocessor-controlled high-voltage ignition system with low-voltage distributor; no moving parts; no-wear
- Automatic ignition energy control
- Variable ignition timing
- Sensors on flywheel and camshaft
- One ignition coil per cylinder
- Industrial-engine spark plugs

1.3 Generator and coupling

The torque generated by the engine is transferred to the generator by means of a highly resilient flange coupling. This drives the (magnetized) rotor of the generator and induces an alternating voltage in the coils of the stator.

Before the generator can be connected to the grid, the frequency, voltage and phase angle between the generator and mains must be synchronized.

The generator is designed as synchronous generator with power factor and digital voltage regulator. This keeps the power factor (cosφ) to the preset setpoint independent from system voltage fluctuations or load changes.

1.4 Color scheme

Engine, generator, heat recovery module	RAL 9006
Baseframe	RAL 5002
Control cabinet / MIS / MIP	RAL 7035

1.5 Gas system

The gas train comprises the following components

- Gas filter
- Double solenoid valve
- Balanced pressure regulator
- Valve tightness check
- Pressure monitor
- Flexible stainless steel hose assembly
- Flame arrestor (only for biogas)

The cabling between the MIP and the gas train is done in accordance with the MTU basic circuit diagrams.

1.6 Lube oil system

There is a used oil pump integrated in the lube oil system, which is used for the genset oil bleed system and for prelubrication.

- Oil collection pan below the genset (without the WHG (Federal Water Resources Act) approval) with oil leakage monitoring
- Solenoid valve for fresh oil replenishment
- Used oil/prelubrication pump group with three-way solenoid valve
- Oil bleed system assembly
- Genset connecting hoses

1.7 Heat recovery module

The heat recovery module with accessories kit (supplied loose, optionally upon request) for connection to the genset consists of:

Control group for mixture cooling with pump

- Membrane expansion tank (MAG)
- Three-way valve
- Throttle and shut-off valves
- Safety valves
- Safety temperature limiter
- Safety pressure limiter
- Sensors

Control group for engine cooling water with pump

- Membrane expansion tank (MAG)
- Thermostatic three-way valve
- Plate-type heat exchanger
- Safety valves
- Safety pressure limiter
- Safety temperature limiter
- Sensors

Connections for exhaust heat exchanger (L32FB)

- The heat recovery module has pre-fitted connections to connect the exhaust heat exchanger. These connections include a differential pressure regulator (supplied loose) and a minimum flow monitor for the exhaust heat exchanger.
- The connection to the genset is designed as a flexible connection.

Control group for heating water (L32FB)

- Two-way control valve with actuator
- Flange connection for connection to the heating water system
- Sensors

Heat recovery module terminal box

- All the components are wired in a terminal box that is fitted on the heat recovery module

Connection to genset

- The connection between the genset and the heat recovery module is designed as a flexible connection.

1.8 Mode of operation

Operating periods with partial load for BR4000

Gas engines have been designed and optimized for continuous operation at 100 % load.

The following restrictions apply to ensure maximum operational availability of the engine plant and to reduce maintenance to a minimum:

Power, referenced to nominal load	Recommended maximum duration with this load	Recommended minimum duration with subsequent operation at a load > 50 %
0 % to 30 %	30 minutes	120 minutes
30 % to 50 %	120 minutes	120 minutes
50 % to 100 %	No restriction	No restriction

TM-ID: 0000062688 - 001

2 Appendix A

2.1 Abbreviations

Abbreviation	Meaning	Explanation
CSA	Canadian Standards	Approval for USA and Canada
ADF	Auxiliary Drive Field	
HT	High Temperature	
IPC	Industrie-PC	Industrial PC
LLK	Ladeluftkühler	Mixture cooler
CB	Circuit Breaker	
LT	Low Temperature	
MAG	Membranausgleichstank	Membrane expansion tank
MAP	Manifold Absolute Pressure	Intake pipe pressure
MMC	MTU Module Control	Module controller (controls the customer-side auxiliaries)
MIP	MTU Interface Panel	Genset controller (controls the basic functions of the genset)
NEPA	National Environmental Policy Act	Environment Act in the USA
SPS	Speicherprogrammierbare Steuerung	Programmable Logic Controller
UL	Underwriters Laboratories	Approval for USA and Canada

2.2 MTU Onsite Energy contact person / service partner

Service

The worldwide network of the sales organization with subsidiaries, sales offices, representatives and customer service centers ensure fast and direct support on site and ensure the high availability of our products.

Local Support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For our locally available support, go to MTU's Internet site:
- http://www.mtuonsiteenergy.com/haendlersuche/index.de.html

24-h Hotline

With our 24-h hotline and the flexibility of our service staff, we are always ready to assist you - either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

For our locally available support, go to MTU's Internet site:
- http://www.mtuonsiteenergy.com/haendlersuche/index.de.html

Your contact at Headquarters:
- support-oeg@mtu-online.com

Spare Parts Service

Quick, easy and correct identification of the spare part required for your system. The right spare part at the right time at the right place.

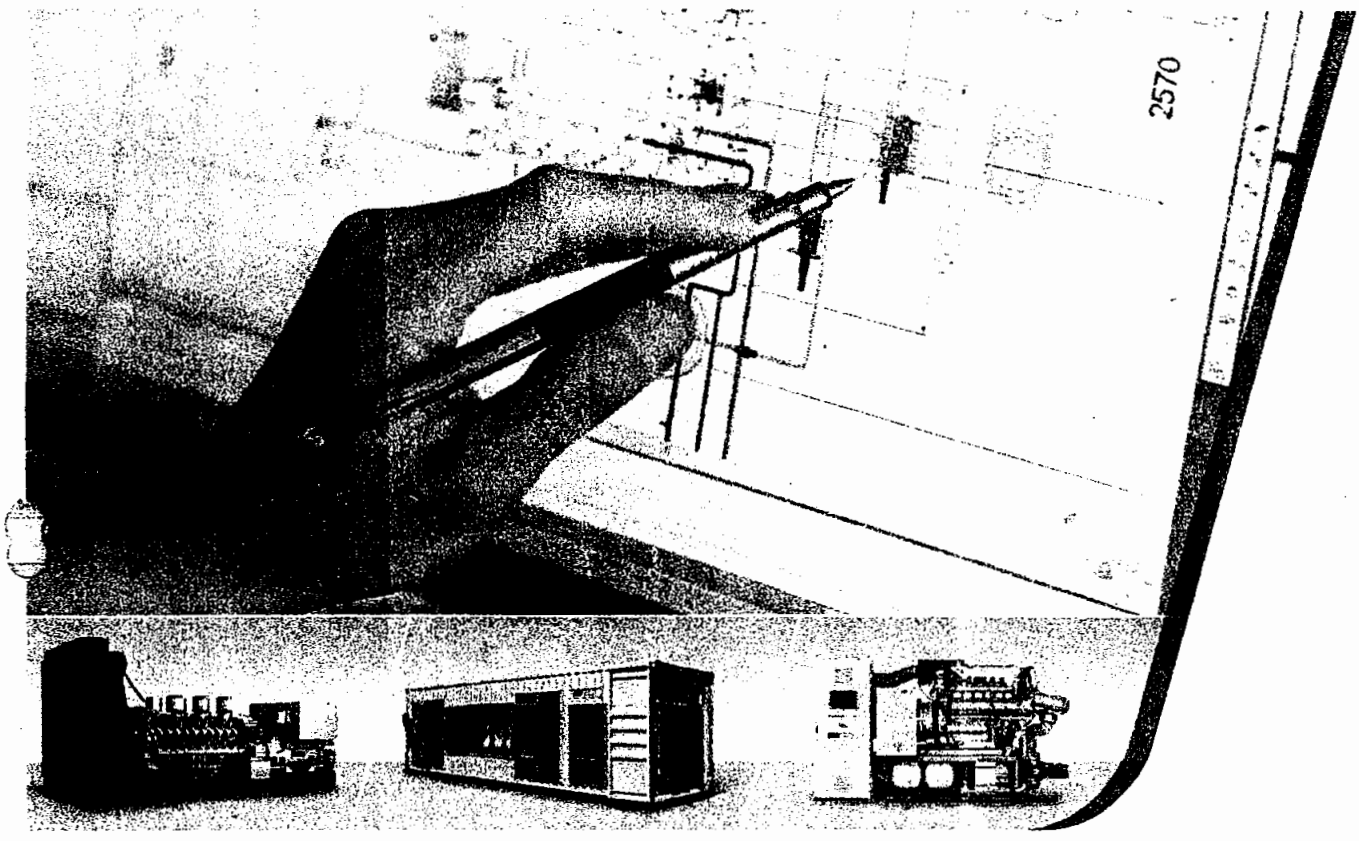
With this aim in mind, we can call on a globally networked spares logistics system.

Your contact at Headquarters:

Germany:
- Phone: +49 821 74800
- Fax: +49 821 74802289
- E-mail: spareparts-oeg@mtu-online.com

Worldwide:
- Phone: +49 7541 908555
- Fax: +49 7541 908121
- E-mail: spare.parts@mtu-online.com

OVERVIEW OF SAFETY CONCEPT



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The original document is in German.

We reserve the right to make technical changes in line with further development.

Table of contents

1 Overview of safety concept

1.1 Introduction

This description of the safety concept shall be used by the operating agency as an aid for the risk analysis of the total plant system to be carried out in keeping with the BetrSichV (German Ordinance on Industrial Health and Safety) technical rules. The focus here is on the individual safety functions and the explosion protection measures. All safety functions which can be implemented by MTU Onsite Energy GmbH are described. The safety functions actually integrated depend on the respective scope of supply. The possibility of deviations from this cannot be excluded, owing to the possibility of another, higher-level safety concept of the total plant system. A detailed summary of all the risk-reduction protective measures is given in the risk analysis which, for reasons of confidentiality with regard to the competition, shall remain as part of the manufacturer's internal documentation and is not to be confused with the user information provided for the user. The risk analysis is based on the procedure described in DIN EN ISO 12100. By implementing the suitable protective measures described, the hazards to humans and the environment are reduced to a minimum. The information required for hazard evaluation is provided to the customer through the operating manual. For the residual risks associated with the components supplied by MTU Onsite Energy GmbH that are to be taken into account by the customer, which may have to be considered in a conformity declaration for the whole plant system, reference is made to the operating manual. For the safe handling of the machine, it is imperative to follow the safety instructions within the operating manual and the notices at the machine. The machine is to be used as intended..

1.2 Product scope

The machine is used exclusively for electrical power generation and waste heat utilization in stationary operation in sufficiently ventilated rooms and container solutions. Gas is fed to the reciprocating internal combustion engine and mechanical work is generated. This drives the synchronous generator connected via an elastic coupling, resulting in a conversion to electric energy. The engine and the generator are joined to the base frame with elastic, vibration-damped elements. The waste heat generated during the combustion process is dissipated to the surroundings via radiators (power generator) and/or made available to the customer via heat exchangers (combined heat and power plant). All regulation, control and monitoring processes, as well as communication to and from the outside, are realized through hardware and software.

Operation of the machine can be classified into 3 different modes:

- Parallel grid operation
- Grid backup operation
- Isolated operation

The machine or the plant system consists of the following main assemblies:

- Gas engine
- Generator
- Gas train / Fuel feed
- Heat de-coupling or recooling unit in case of power generators
- Engine, plant-system and safety controllers

Other components are:

- Container integration unit
- Gas treatment device or compressor
- Various heat exchangers, emergency cooling circuit, plate-type cooler, etc.
- Oil supply system
- Exhaust-gas after-treatment device
- Ventilation systems (obligatory)
- 60-Hz gearbox

1.3 Responsibilities of the operating agency concerning technical safety

According to § 3 of the BetrSichV ((German Ordinance on Industrial Health and Safety) technical rules, the operating agency is required to carry out a hazard assessment for the entire plant system.

The following types of hazards are to be taken into account:

- Those related to the use of the operating equipment itself and
- those arising at the workplace through the interaction between the operating devices, or between operating devices and working materials or the working environment.

At the time of introduction to the market (in accordance with the Machinery Directive), the machine represents the state of the art for the given scope of supply. According to the BetrSichV technical rules, the operating agency shall operate the machine according to the state of the art and shall retrofit it as required over the course of time.

1.4 General protective measures

The main requirement is the reduction of hazards to humans and the environment through protective measures. According to DIN EN ISO 12100, a distinction is made between

- Design-based protective measures or "inherently safe design" measures, for example: Rounding of edges and corners to avoid cutting injuries
- Technical protective measures, for example: Inclusion of safety function for switching off engine in case of excessive speed
- Organizational protective measures or user information, for example: Safety instructions in the operating manual

Design-based protective measures must be implemented before technical or organizational protective measures. **Organizational protective measures are no substitute for correctly-applied design-based or technical measures.**

Despite the implementation of design-based and technical protective measures, a small proportion of the hazards can be reduced but not entirely avoided. Organizational protective measures are implemented (user information provided) to further reduce the residual injury risks.

Using all three types of protective measure, an attempt is made to reduce the residual risk associated with a hazard to protected materials to a minimum.

1.5 Explosion protection

An explosion is only possible if a flammable mixture and an ignition source are present simultaneously.

There are three protective-measure categories:

- **Primary explosion protection (preventive)**
  The formation of a flammable mixture is avoided
- **Secondary explosion protection (preventive)**
  The formation of a flammable mixture is possible, but:
  ignition sources are avoided or shielded
- **Tertiary explosion protection (mitigating)**
  The formation of a flammable mixture is possible and
  an ignition source is present.
  Ignition can occur but the propagation of explosions is restricted by structural shielding or the effects of pressure waves are reduced.

Primary explosion protection is to be preferred to secondary and tertiary explosion protection. A distinction is to be made between "inner" explosion protection (relevant as regards dangerous oxygen content in fuel gas, upper explosion limit) and the "outer" explosion protection (relevant as regards dangerous methane content in air, lower explosion limit).

1.6 Safety function

Definition of "safety function"

"Function of a machine, the failure of which can result in an immediate increase of the risk(s)." (DIN EN ISO 13849-1)

To suitably set up a safety function according to DIN EN ISO 13849-1, the so-called "performance level" (PLr) is determined in each case. The required performance level (a, b, c, ...) is determined by the severity of possible injuries, the frequency and/or the duration of exposure to a hazard and the possibility of avoiding the hazard. In terms of structure and quality, the safety functions must conform at least to the determined performance level or be constructed according to a higher level, in order to sufficiently prevent the risk of failure of safety functions. For the purpose of assessing the safety components responsible for the execution of the safety functions, additional input values such as failure rates and usage durations are considered. The component quality specification for manufacturing the safety encoder is to be taken into consideration.

2 Safety concept / Applied safety functions

The safety functions of the machine controller are described below. The number of safety functions depends on the system configuration and the fuel.

2.1 External explosion hazard (explosion in installation room)

In the installation room, the expected escape of flammable gas must be reduced as much as possible for explosion protection purposes.

The following primary explosion protection measures are implemented:

- Technically tight design of the gas-conveying components
- Reduction to a minimum of all detachable joints across which air-fuel mixtures are conveyed
- Technical ventilation
- Regular maintenance and checking

With the plant system at a standstill, the dual solenoid valve is closed in a de-energized (fail-safe) state. For extensive standstill periods, it is also necessary for the gas supply to be shut off via the customer's manually operated shut-off valve. Since the gas-conveying components involved in the supply of gas up to this solenoid valve are technically tight at all times, no gas can enter the machine room. To ensure permanent technical tightness, the components, gas train and piping upstream of the dual solenoid valve in this gas section have to be checked at regular intervals and corrective adjustments made where necessary (see maintenance plan). During the operation of the plant system, small quantities of gas or gas mixture can escape on the engine side, in spite of all the design-based preventive measures implemented.

Due to the fact that such small quantities of gas or mixture can escape, it must be ensured that the ambient air in the installation room, which may consequently be contaminated with traces of fuel gas or mixture, is sufficiently ventilated by technical means, so that the fuel contained by the air in the installation room does not become so rich that the lower explosion limit (LEL) is exceeded.

The required safety air quantity is approx. 1 % of the required cooling air quantity of the machine. The required safety air quantity is inherently guaranteed, since any drop below this air quantity specification will result in the genset failing within a few minutes due to overheating (since the radiation heat of the machine can then no longer be dissipated).

The only exception here is with pure air circulation operation, in which the circulating air is recooled. For such a setup, the plant planner/ operating agency must carry out a separate risk assessment.

To avoid machine damage, the ventilation system has to be checked for correct functioning. Safety-based monitoring of the ventilation system is not necessary.

As a supplementary measure, the installation of a gas alarm system is prescribed (with alarm threshold set to 15 % of the LEL). If the gas alarm system responds, the continued supply of gas is prevented due to the closing of the dual solenoid valve and, if available, the safety shutoff valve (not included in standard scope of supply). Also the manual EMERGENCY STOP linkage system will be triggered, as a result of which the dual solenoid valve within the gas train and the auxiliary drive units are deactivated. The manual EMERGENCY STOP linkage system can be fully set up using the circuit diagrams. If there is a gas alarm, the gas compressor (if supplied) is switched off safely. The necessary maintenance intervals of the gas alarm system are indicated in the manufacturer's documents. Information on the positioning and number of sensors can be found in the "Installation conditions" and "Installation manual" documents.

As an additional measure, the flashing horn and siren are activated whenever the gas alarm system responds . Furthermore, the ventilation is ramped up to 100% to ensure rapid dilution of the escaped gas. The gas alarm takes precedence over the fire alarm and EMERGENCY STOP, i.e. in case of a simultaneous gas alarm and fire alarm or EMERGENCY STOP, the ventilation is always increased to 100 % while the air circulation flaps are closed (safe state: closed and de-energized)). The exhaust air in the machine room must be directly conveyed to the outside of the building.

To prevent a shortage of gas, the minimum pressure within the gas train is monitored. If there is a pressure drop in the gas train, then it can be assumed that there are either faults within the fuel supply system or else a substantial leak in the gas-conveying system upstream of the gas train (or, in the case of biogas, between the gas compressor and the gas train). Concerning the gas supply, any further operation involving the gas train for impermissibly low pressures and running of the gas engine or feeding of gas to the room is prevented, due to the closing of the dual solenoid valve.

Note:

For naturally aspirated engines from the series 400, the installation of a gas alarm system is not necessary, since during operation no mixture or fuel gas can escape beyond the safety gas train (zero-pressure regulator). It is essential that the intervals specified in the operating manual for professional leakage testing of the gas train are strictly complied with for all plant systems.

2.2 Danger of internal explosion

The risk of an internal explosion must be considered from the gas supply point to the chimney of the exhaust gas section:

- Gas supply unit / Gas train
- Re-ignition in the intake section
- Detonation in the exhaust gas section
- Explosion inside the fuel supply pipe

2.2.1 Gas supply unit / Gas train

Due to the specified limit values for oxygen, a potentially explosive mixture concerning natural gas from the pipeline is not to be expected and the formation of such can be totally ruled out by monitoring the minimum gas pressure at the gas train (see information on safety functions for external explosion protection). It is not permissible under any circumstances for an explosive natural gas / air mixture to be supplied up to the entrance to the gas mixer or natural gas with a dangerously high oxygen content to be supplied. The operating agency is responsible for compliance with the fluids and lubricants specifications.

With the biogas application, an intake of oxygen from the air in the biogas plant section can result in an explosive mixture inside the feeding fuel gas pipe. Through the monitoring of the minimum gas pressure upstream of the compressor and other safety functions, further intake of oxygen from the air can be avoided via the de-energization of the gas compressor. Other required safety functions, such as monitoring of condensate receivers or fermenter pressure, are to be determined by the manufacturer of the whole plant system by means of a risk assessment. Required access points for incorporation in the machine/manual EMERGENCY STOP linkage system can be provided by MTU. With biogas, there is always an additional deflagration guard integrated in the gas train. The biogas compressor is integrated in the machine EMERGENCY STOP linkage system, i.e. the dual solenoid valves are closed.

MIN gas pressure at gas compressor too low - deactivation of compressor
Signals from customer-provided unit - deactivation of compressor

2.2.2 Intake tract

All machines from MTU Onsite Energy GmbH that operate according to the lean-burn spark-ignition procedure are equipped with flame protection filters. The possibility of re-ignition from the combustion chamber in the intake section is thus eliminated. Ignition of the mixture in the intake section between the air-fuel mixer and the cylinder head inlet is not possible, since there is no ignition source present.

2.2.3 Exhaust gas tract

The following operating states are relevant when considering the protection against explosion in the exhaust gas branch:

- ON (AUTO or MANUAL) - machine in operation
- STANDBY - machine ready to start at any time

ON (AUTO or MANUAL) - machine in operation:

If there is a malfunction of the ignition system (failure of a complete bank of cylinders), the design is inherently safe. The unburned mixture will ignite owing to the existing ignition sources (hot outlet valve, turbine, thermoelement tip) with simultaneously high, prevailing gas temperatures upstream of the turbine (the temperatures downstream of the turbine and the temperature of the mixture / exhaust gas itself (relief via turbine) being significantly lower). According to calculations / simulations, a detonation upstream of the turbine results in the following maximum pressure amplitude constraints: $p_{abs} < 9$ bar upstream of turbine and $p_{abs} < 2$ bar downstream of turbine. The pipes and components are designed according to the maximum amplitudes.

When the machine is running, the ignition function is additionally monitored (or the amount of misfiring is monitored) by the

- engine regulator and controller
- ignition system
- EMU temperature measurement module and monitoring module (for series 4000 only)

According to the state of the art, the engine is not directly switched off in the event of misfiring of individual cylinders. Hence during engine operation, a non-hazardous deflagration through ignition at hot spots is possible despite the dilution of the unburned mixture with the exhaust gas of the other cylinders in the respective exhaust gas branch. The piping and components of the plant system are to be designed to withstand a bursting pressure $p_ü$ of at least 1 bar. The bursting resistance can also vary due to differences in piping geometry, jumps in cross-sectional area values, elbows and SCR catalytic converters. As part of an additional plant-system-specific risk assessment, any new risks that arise are to be determined and documented. Burst flaps may need to be fitted or plant system parts provided with an enclosure, if the required bursting resistance cannot be complied with.

STANDBY - machine ready to start at any time:

Prior to each startup of the machine or engine, the inlet and exhaust gas sections are flushed with sufficient quantities of fresh air, so that any unburned mixture cannot come into contact with hot exhaust gas during a restart. Following three unsuccessful attempts to start the engine, resetting within the control system is necessary before further start attempts can be made. A distinction is made between cold starts and warm starts of the engine.

Cold start of the machine

See *STANDBY - machine ready to start at any time*. Hot surfaces for initiating safe and non-hazardous deflagration are not present.

Warm/Hot start of the machine

When carrying out a hot start of the machine or the engine (after flushing with fresh air), the same logical sequence applies for machines without exhaust gas after-treatment as for the operating state **ON (AUTO or MANUAL) - machine in operation**.

With exhaust gas after-treatment, there is a risk of oxidation / deflagration of unburned mixture in the catalytic converter. Many years of experience in the field have shown that oxidation of the unburned mixture can result in overheating of the catalytic converter, which in turn can result in the functionality of the catalytic converter being greatly limited or piping elements undergoing plastic deformation. There is, however, no known case of a detonation in the exhaust gas section downstream of the turbine, triggered by a reaction in the oxidation-type catalytic converter, that leads to components bursting.

Supplementary organizational measure:

Prior to performing a hot start of the machine, the room housing the machine or the exhaust gas system should be exited, if possible. Time spent in the machine room while the machine is running is to be kept to a minimum; there is, in particular, an increased risk of deflagration while a hot start is being performed.

2.3 Danger of poisoning

The technical ventilation, among other things, helps to prevent poisoning by fuel or exhaust gas. As is the case with endangerment from escaping fuel or mixture, it is assumed here that the exhaust gas system is not continuously technically tight and that small leaks can occur. The operator must carry out an inspection every day including a visual check of the exhaust gas system for escaping condensate.

2.4 Danger of fire

Generated smoke or heat is detected by the fire detector. The response of the fire detector triggers the closing operation for the dual solenoid valve or safety shutoff valve (if fitted). This prevents the further intake of gas into the system and the operation of the machine is stopped. As an additional protective measure, the ventilation is stopped and the supply air and exhaust air flaps are closed.

Information on the positioning and number of sensors can be found in the "Installation conditions" and "Installation manual" documents.

The operating agency should clarify with the local authorities whether a thermally-triggered shutoff device or a safety shutoff valve with temperature monitoring is to be fitted. These are not part of the standard scope of supply.

2.5 Danger of bursting (induced thermally or through increased pressure)

All cooling circuits are limited to certain temperatures and pressures due to their design. If the design-based limits are exceeded and vapor bubbles form, there is a risk of pipes and associated components bursting. Further introduction of heat into the cooling circuits is avoided through the shutting off the dual solenoid valve. Some of the safety functions for combating the risk of bursting also play a role in the fulfilling of the environmental protection requirements according to the water resources act, given that there are water-polluting substances in the circuits, such as antifreeze or corrosion protection agents. The individual safety functions are described below:

Explanations and abbreviations:

EHE	Exhaust gas heat exchanger
EC	Engine coolant
MC	Mixture coolant
WRA	Water resources act
ET	Expansion trap

EC temperature too high (no EHE) - closing of dual solenoid valve
EC temperature too high (no EHE with no ET) - closing of dual solenoid valve
EC temperature too high (installed EHE) - closing of dual solenoid valve
EC temperature too high (installed EHE with no ET) - closing of dual solenoid valve
Temperature of heating water too high - closing of dual solenoid valve
Pressure of heating water too low - closing of dual solenoid valve
Flow rate of EC/heating water too low (installed EHE) - closing of dual solenoid valve
EC pressure too low (WRA) - closing of dual solenoid valve
MC temperature too high - closing of dual solenoid valve
MC pressure too low (WRA) - closing of dual solenoid valve
EC pressure too low (WRA) - closing of dual solenoid valve
EC pressure too high - closing of dual solenoid valve
EC pressure too high (no ET) - closing of dual solenoid valve
Pressure of EC/heating water too high (installed EHE) - closing of dual solenoid valve
Pressure of EC/heating water too high (installed EHE with no ET) - closing of dual solenoid valve

The gas supply unit is designed for specific operating and bursting pressures. If the design-based pressure is exceeded, tightness of the gas train is no longer guaranteed. With escaping gas, the risk of explosion will increase. A further pressure increase is prevented by the closing of the dual solenoid valve.

Danger OF BURSTING (pressure-induced) - gas train pressure too high – closing of dual solenoid valve

2.6 Danger from parts being thrown out

In the impermissible excess-speed range, movable components (e.g. the connecting rod) can detach, penetrate through the housing and be ejected from the engine at high energy. In case of excessive speed, the dual solenoid valve is closed.

2.7 Manual EMERGENCY STOP

Pressing the EMERGENCY STOP button results in electrical consumers being de-energized and, as a consequence, operation being interrupted. Dual solenoid valves and, if fitted, the safety shutoff valve (not included in standard scope of supply) are closed. The EMERGENCY STOP is a safety function intended to avert or reduce injury risks to persons and damage risks to the machine, and is activated manually .

2.8 Prioritization between gas alarm, fire alarm and manual EMERGENCY STOP

In case of a gas alarm, fire alarm or manual EMERGENCY STOP, the dual solenoid valves are closed and the supply of gas thereby shut off. In case of a simultaneous gas alarm, fire alarm and manual EMERGENCY STOP, the gas alarm takes precedence, i.e. the ventilation is ramped up to 100% as an additional protective measure, the supply air and exhaust air flaps are automatically opened and the air circulation flaps (if present) are closed.

3 Integration of machines / pressure equipment / gas appliances in a whole plant system

In order to determine possible safety-related linking between several machines / pressure devices / gas appliances, a higher-level risk assessment of the whole plant system is to be drawn up. The manufacturer of the whole plant system is responsible for the drawing up of the higher-level risk assessment and also for the implementation of the higher-level safety concepts thus derived.

The following aspects, among others, may need to be considered

- Deactivation of all systems in case of fire and/or gas alarm
- Ventilation concept
- Protection of heat-conducting systems
- EMERGENCY STOP
- Biogas application

4 Overview of safety functions

The component quality guideline for the design of the safety encoder is to be taken into consideration.

RISK OF EXPLOSION (extensive amount of leakage) - MIN pressure setting for gas train too low - closing of dual solenoid valve
RISK OF EXPLOSION - sensor for MIN pressure in gas train bypassed - closing of dual solenoid valve
RISK OF EXPLOSION - response from gas alarm system - closing of dual solenoid valve
RISK OF EXPLOSION - response from gas alarm system - flashing light and siren warnings
RISK OF INTERNAL EXPLOSION - (gas supply) - MIN gas pressure at gas compressor too low - deactivation of compressor
RISK OF INTERNAL EXPLOSION - (gas supply) - signals from customer-provided unit - deactivation of compressor
RISK OF FIRE - response from fire detector - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - EC temperature too high (no EHE) - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - EC temperature too high (no EHE with no ET) - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - temperature of EC/heating water too high (installed EHE) - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - temperature of EC/heating water too high (installed EHE with no ET) - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - temperature of heating water too high - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - pressure of heating water too low - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - flow rate of EC/heating water too low - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - EC pressure too low (WRA) - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - MC temperature too high - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - MC pressure too low (WRA) - closing of dual solenoid valve
RISK OF BURSTING (thermally induced) - EC pressure too low (WRA) - closing of dual solenoid valve
RISK OF BURSTING (pressure induced) - gas train pressure too high - closing of dual solenoid valve
RISK OF BURSTING (pressure induced) - EC pressure too high - closing of dual solenoid valve
RISK OF BURSTING (pressure induced) - EC pressure too high (no ET) - closing of dual solenoid valve
RISK OF BURSTING (pressure induced) - pressure of EC/heating water too high (installed EHE) - closing of dual solenoid valve
RISK OF BURSTING (pressure induced) - pressure of EC/heating water too high (installed EHE with no ET) - closing of dual solenoid valve
EXCESSIVE SPEED - MAX speed setting too high - switching off of engine
ELECTRICAL HAZARD - EMERGENCY STOP - shutting off of power

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Rev	Date	Prepared	Reviewed	Approved

Doc. Title

SAFETY AND EMERGENCY RESPONSE PROCEDURE & PLAN

PJT Title

4.5 MW Ittehad Gas Fired Generator Power Plant

GM Admin & HR :_____

TABLE OF CONTENTS

1. CHANGE RECORDS

Revision	Reason / Description of change
1	
2	

EMERGENCY RESPONSE PROCEDURE

1. PURPOSE

The purpose of this Plant Emergency Response Procedure/Site Emergency Preparedness Plan is:

- To provide a prompt and co-ordinated response during an unexpected event that will ensure the protection of the staff, the plant, the public and the environment.
- To list the foreseeable hazards and emergencies that could arise and provide procedures to be adhered to and outline the responsibilities and actions to be taken by designated company staff.
- To ensure an effective mode of communications between company staff, between company staff and the relevant authorities for the co-ordination and management of the response to an emergency.
- This Site Emergency Preparedness Plan/Plant Emergency Response Procedure is based on the maximum credible accidents and consequent analysis and it is also a contingency plan for requirement of emergency prevention.

2. SCOPE

The procedure covers, recognizing the types of emergency that could occur, providing information and instructions for company staff, allocation of resources and co-ordination with offsite emergency services.

3. Definitions

3.1 Incident

An event, usually injury, fire or spillage, with the potential to cause or causing minor injury or minor internal damage that can be handled using the station internal resources without calling for external help. Poses no external threat and can be fully contained within the station site.
Examples: Minor cuts and bruises, small fires that can be put out with extinguishers or 2" hose reel, small spillages.

3.2 Emergency

An event, usually injury, fire, spillage or explosion, with the potential to cause or causing major injury (any injury causing lost time beyond the day of the accident) or damage that will require the help of outside teams/agencies and /or with the potential to pose a threat external to our site.

4. Procedure

4.1 Introduction

The design, construction and operation of Power Plant takes into account the highest standards of safety. Nevertheless procedures are necessary to respond to and control any emergency that could arise.
The purpose of this document is to set out measures to be taken by all staff at Power Plant in the event of an emergency.

Given the varied circumstances which might arise, it is impractical to document every detailed action to be taken in every emergency. Instead this EMERGENCY RESPONSE Procedure (E.R.P.) provides a clear and concise picture of important actions for the foreseeable emergency situations.

4.2 Emergency Evacuation Procedure

4.2.1 OBJECTIVE

The purpose of this procedure is to facilitate and to organize individual's actions during workplace emergencies and get plant people out of danger quickly and efficiently. A disorderly evacuation under emergency condition can lead to confusion, injury and property damage.

4.2.2 RESPONSIBILITIES

Observer on Scene

- Activate the Alarm (fire)
- Inform Control Room by radio/call on Ext. 15 and 21.
- Start local action

CCR Operator

- Check and respond to alarm.
- Inform to Emergency team Leader/Shift engineer on radio/mobile.
- Ensure the fire fighting system is working.
- Inform to all operators for reaching operators assembly points.
- Records in the log, the time of all actions and events.

Shift Engineer/Emergency Team Leader

- Examines the event to determine if it is an emergency or incident.
- Contacts Plant manager or Acting Plant Manager/HSE Officer to inform about the emergency.
- Immediately inform to the HSE Officer and must reach at emergency place in shortest possible time and act as emergency team leader.
- Act as an Emergency Team Leader until HSE Officer will not reach. After reaching of HSE Officer at emergency location, shift engineer will hand over to him and then HSE Officer will act as Emergency Team Leader.
- Initiates site evacuation if required.
- Issues orders to available persons to take the appropriate actions
- Keeps the Plant manager or Acting Plant manager advised on the situation.
- Help to HSE Officer for making a full report on the emergency.
- Inform gate security about the situation.

Health, Safety & Environment Officer

- Immediately reach to the location of emergency.
- Take the charge from shift engineer and work as Emergency Team Leader.
- Debrief to staff and responsible for making a report on emergency.
- Co-ordinate among all the Emergency Response Teams.
- Calls for outside assistance from the relevant agencies.

Emergency Response Team (Fire Fighting Team)

- Proceed to scene of incident on receiving the call.
- Act under the instructions of Fire Fighting Team Leader/Emergency Team Leader/Emergency Controller.
- Also give necessary assistance e.g. Evacuation, first aid etc.
- Report to Emergency Team Leader when incident is under control.

Emergency Response Team (Search and Rescue Team)

- Proceed to scene of incident on receiving the call.
- Act under the instructions of Search and rescue Team Leader.
- Also give necessary assistance e.g. Evacuation, first aid etc.
- Report to Emergency Team Leader when incident is under control.

Emergency Response Team (First aid Team)

- Proceed to scene of incident on receiving the call.
- Act under the instructions of First Aid Team Leader.
- Also give necessary assistance e.g. Evacuation, Fire fighting etc.
- Report to Emergency Team Leader when incident is under control.

Emergency Response Team (Security Team)

- Proceed to scene of incident on receiving the call.
- Act under the instructions of Security Team Leader.
- Also give necessary assistance e.g. Evacuation, Fire fighting etc.
- Report to Emergency/Security Team Leader when incident is under control.

Emergency Response Team (Spill Team)

- Proceed to scene of incident on receiving the call.
- Act under the instructions of Spill control Advisor.
- Also give necessary assistance e.g. Fire fighting etc.
- Report to Emergency Team Leader/Spill Advisor when incident is under control.

All Other person

- Make safe exit, go to plant/site assembly point.
- If required assistance then assist the teams.

Plant Manager

- Proceed to emergency control center (CCR or nominated control center).
- Communicate by using radio.
- Declare himself as 1st Emergency Controller.
- Alert mutual aid partners.
- Check call out response.
- Support on scene response.
- Liaise with local authorities though Admin/directly.
- When incident is secure, announce "ALL CLEAR".
- Commence investigation of the incident.

All Ittehad people are responsible for the contractor people working in their area to guide them to the assembly/Mustering area.

The Ittehad person receiving visitors to the site will be responsible for the visitor's health and safety.

All shift personnel will report in CCR/at operation assembly point. They will remain on duty to continue **operation** of plant or shut down activities as required unless main emergency controller (Plant Manager) asks them to evacuate.

All Contractors: Contractor workers will be made aware of Emergency Response Plan prior to commencing the work. Prior to leave the site they will ensure that their work area is in safe position. On emergency call they will report in assembly area.

Head Count at Assembly Point: To ensure that all personnel are accounted for and searches mounted for any missing persons, a head count after any evacuation, must be carried out by departmental head.

Responsibility of Plant Security:

- Security Team Leader shall pass necessary information to Security Head/security Officer by radio/cell phone.
- Security Head or his designee will collect the plant entry sheets in case of emergency and submit at assembly area.
- Security Guards should not block the people, in case of emergency exit from the plant.
- Security Guards should not block the entrance of fire tender and/or ambulance and its crew and the persons permitted by the Incident Controller. Information should be given to security gates about the emergency situation and ALL Clear announcement.
- Security Guards should not leave the gate without the permission of Security Team Leader or his designee.

Emergency Drill: Biannual drill will be conducted to test the emergency program and its record will be kept with Emergency Response Team for at least 5 year.

4.3 TYPICAL EMERGENCIES RESPONSE PROCEDURES

4.3.1 Possible Situations:

A wide variety of emergencies both man-made and natural may require a workplace to be evacuated. These emergencies include

Type of Hazard or Emergency	Possible locations or events
FIRE	Central Control Building Administration Building Workshop and Stores Building Fuel Storage Tank Fuel Handling Systems Gas Generator sets HRSG Gas Receiving Station Transformers Electrical Switchgear Emergency Diesel Generator WTP Building

EXPLOSIONS	Stores Building Fuel Handling Systems Gas Generators Gas Receiving Station Transformers Electrical Switchgear Emergency Diesel Generator Battery Charging Area

Type of Hazard or Emergency	**Possible Locations or Events**
SPILLS	Workshop and Stores Building Fuel Storage Tank Fuel Handling Systems Gas Generator sets Transformers Chemical Storage WTP Area and Laboratory

Type of Hazard or Emergency	**Possible Locations or Events**
GAS LEAK	Gas Receiving Station Gas Lines Gas Turbine Chemical Storage Laboratory

Type of Hazard or Emergency	**Possible Locations or Events**
CIVIL	Bomb Theft/ Riot Security Threats

Type of Hazard or Emergency	Possible Locations or Events
MEDICAL EMERGENCY	Electric Shock Burns Heart Attack Fracture Cut/Abrasion Biting Bleeding Shock Heat Stress/Stroke

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4.3.2 Fire/Explosion Response

Purpose:

To provide for safety against potential fire/Explosion and minimize the risks of damaged or personal injuries in the event of a fire at 4.5 MW Gas fired Generator power plant Faisalabad.

Classifications of Fire:

FIRE CLASSIFICATION	
Fire Classification	**Description**
A	Solid combustible materials that are not metals like, Paper, wood, cloth, etc. where quenching by water or insulating by dry chemical is effective. (Class-A fires generally leave an Ash)
B	Any non-metal in a liquid state, on fire. This classification also includes flammable gases like, gasoline, oil, grease , acetone etc (Class-B fires generally involve materials that Boil or Bubble)
C	Live electrical equipment where the non-conductivity of extinguish ant is vital.
D	Material used in laboratories like, potassium, sodium, aluminum, magnesium. It takes special extinguishing agents (Metal-X, foam) to fight such a fire.

Responsibilities:

The responsibilities of observer or First on Scene, CCR Operator, Emergency Team Leader, HSE Officer, Plant Manager, Doctor, and other people are the same as in section above Evacuation Plan. The responsibilities of other areas are as follows,

Observer or First on Scene

See above for Observer or First on Scene responsibilities. Other responsibilities are,

In case of Minor Fire:

Minor fire is one that can be extinguished with portable extinguisher.

- Inform CRO/Shift Engineer by radio/call on 2000-2001.
- Extinguish the fire by using suitable extinguisher.

Incase of Major Fire:

Major fire is one that cannot be extinguished with portable extinguishers alone.

- Inform CRO/Shift Engineer by radio/call on2000-2001.
- Check Automatic fire system operated or not.

Fire in Community:

Following sequence of events will be observed during any emergency,

- Inform CRO/Shift Engineer by radio/call on2000-2001.
- Inform to HSE Officer for help.
- Shift Engineer will control the fire.
- A small fire can be extinguished with the Fire extinguisher available.
- Fire response team will handle the situation if major fire.
- Orderly evacuation of the building if required.
- Search and Rescue safely.
- Identification of casualties.
- Take Medical Care for injured.
- Security of building, prevent unauthorized entrance.

4.3.3 SPILL Response

Purpose:

Although every effort is made at plant to prevent spills of potentially hazardous chemicals or fuels in the workplace, accidents resulting from the release of chemicals. This procedure is provided to mitigate the effects of spills of potentially hazardous chemicals in workplace.

Minor Spill:

A spill of solid or liquid materials which involves the release of a type or quantity of a chemical which does not pose an immediate risk to health and does not involve chemical contamination to the body.

Major Spill / Release:

A spill of solid or liquid materials which involves:
Release of a type or quantity of a chemical that poses an immediate risk to health.

- An uncontrolled fire or explosion
- A major Oil leak where there is a contamination of the drains or outbreak of fire or explosion.
- A Hazardous Chemical Leak that is thought to be a hazard to personnel.

Procedure:

1. **In case of Minor Oil Leakage or Hazardous Material:**
   - Inform CRO/Shift Engineer by radio/call on 2000-2001.
   - Locate the source of the spill, and stop the spill.

- Close secondary containment drain valve.
- Also inform to HSE Officer.
- Remove ignition sources and unplug nearby electrical equipment.
- Establish exhaust ventilation. Vent vapors to outside of building.
- Shitf engineer/ HSE Ofiicer call the spill response team.
- Choose appropriate PPE (goggles, face shields, gloves, clothing, etc).
- Make arrangement to collect or dispose off the spilled hazardous substance safely and properly as per procedure.
- In case of Major Fire, follow "Fire Response Program" along with " Emergency Evacuation Plan"

2. **In case of Major Oil Leakage or Hazardous Material:**
   Not applicable

4.3.4 Bomb Threat Message/Security Threat (Civil) Response
Not Applicable

4.3.5 Gas Leakage Response

Purpose:
This procedure outlines the responsibilities of people in dealing with Gas Leakage.

Procedure:
Following sequence of event will be observed during any emergency,

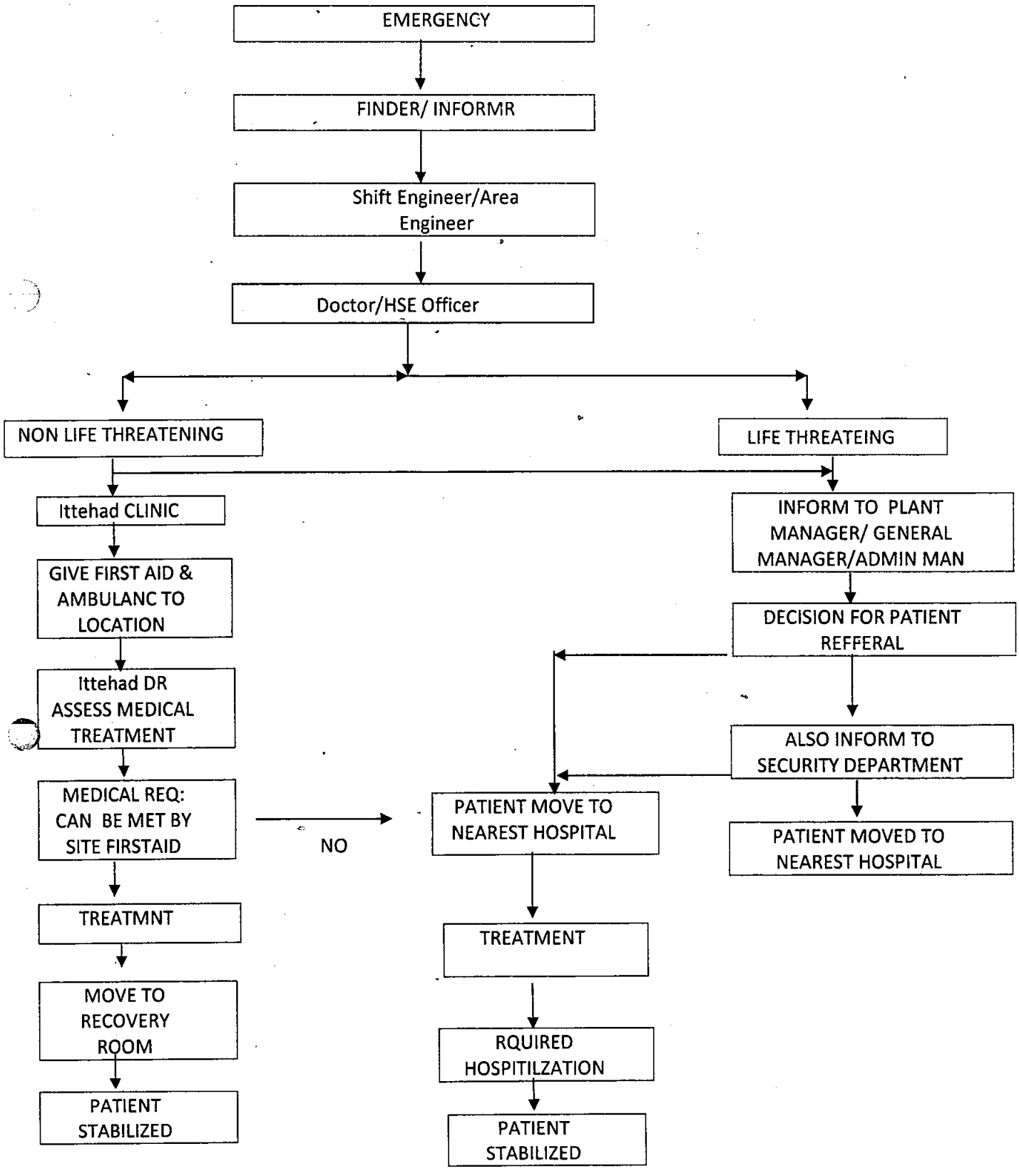
- Inform CRO/Shift Engineer by radio/call on 2000-2001.
- CRO/Shift Engineer will inform to other plant people and people in shift.
- ETL will reach at location of leakage and take the appropriate actions.
- In case of leakage of gas, team (On duty shift) will response immediately.
- Shift Engineer also call the HSE Officer.
- ETL/Incident Controller will announce if evacuation is required. (Follow Emergency Evacuation Plan)
- Area should be barricaded to stop the unauthorised entrance.
- Emergency Team Leader will call the others Teams for help if required.

4.3.6 Medical Emergency Response
Purpose:
This procedure outlines the responsibilities of people in dealing with Medical emergency at the plant.

Procedure:
In case of medical emergency follow the plan as below.

- Inform to CRO/Shift Engineer by radio/call on 2000-2001.
- Shift Engineer/CRO will inform to Doctor/HSE Officer.
- Emergency Team Leader/HSE Officer will reach at scene immediately.
- During that time, first observer will provide the first aid.
- If require whole First aid Team will be called.
- Ambulance/transport will be arranged for shifting to clinic/other out station medical facility.

MEDICAL EVACUATION PLAN



4.3.6 Earthquake

Purpose:

This procedure outlines the responsibilities of people in dealing with Earthquake.

Procedure:

Following sequence of event will be observed during any emergency,

- Inform CRO/Shift Engineer by radio/call on 2000-2001.
- CRO/Shift Engineer will inform to other plant people and people in shift.
- All plant people will evacuate the building immediately and rush to the mustering point.
- In case of earthquake, team (On duty shift) will response immediately.
- Emergency Team Leader will call the others Teams for help if required.
- HSE officer/other nominated person will collect information from GSP and Meteorology Department of Pakistan about earthquake magnitude, focal depth and location and pass to management.

4.3.7 Flood

Purpose:

This procedure outlines the responsibilities of people in dealing with flood.

Procedure:

Following sequence of event will be observed during any emergency,

- HSE officer/other nominated person will remain in contact with flood forecasting center during such situation directly/through admin.
- In case of any disastrous situation, Inform CRO/Shift Engineer by radio/call on 2000-2001.
- CRO/Shift Engineer will inform to other plant people and people in shift.
- In case of flood, team (On duty shift) will response immediately.
- Emergency Team Leader will call the others Teams for help if required.
- Incident Controller will decide, if evacuation is required. (Follow Emergency Evacuation Plan)

4.4 Emergency Services

It is vital to the safety of personnel and plant that the nearby emergency services are called quickly. It is better to call out and find that they are not needed, than to wait and then find they are badly missed.

The gate security should be informed that the nearby emergency services are coming as they can inform them of the nature and extent of the emergency, where they should report to.

When the emergency services arrive on site, Ittehad staff shall provide them with whatever assistance and advice they require.

When first calling the nearby emergency services, they should be informed of the following,

NAME OF STATION: **Ittehad Spinning (Pvt)Ltd**
LOCATION: Fasialabad
PHONE NUMBER:
NUMBER AND NATURE OF INJURED PERSONS

TYPE NATURE AND EXTENT OF FIRE OR SPILL
NATURE AND EXTENT OF OTHER HAZARDs

4.5 Security

Gate security should be informed of the emergency. They will need to know its nature, its location, what nearby emergency services are on the way and where they should direct them when they arrive.

4.6 Senior Management

The senior management available onsite should be informed as early as possible of the nature and extent of the emergency so as they can assist the Shift Engineer/HSE Officer in handling the situation.

4.7 Media

At no time is any member of Ittehad to enter into discussion with or make comments to any members of the radio, television or newspapers. If any member of the media makes contact with you, they are to be politely referred to the Plant Manager or Acting Plant Manager.

4.8 TERMINATION OF EMERGENCY

As the emergency situation diminishes, consideration should be given to its termination. A major portion of the site may only be conditionally safe, due to the presence of waste materials and/or equipment/material damage. Decide whether to maintain standby facilities until final inspection and clean up.

The levels of clean up also require to be considered. If a large quantity of waste is involved, it is preferable to have agreed this disposal previously, rather than face later dispute.

After the incident has terminated it is important to ensure that all the available information is collected as soon as possible. The facts require to be collected in order to ascertain whether any significant lessons can be learned. The information should cover the events leading up to the emergency and the handling of the emergency at site. Any interviews need to be carried out immediately after the emergency, before recall is influenced by others.

4.9 E.R.P. Review and Update.

The Emergency Response Plan is to be reviewed and updated to correct deficiencies or omissions and to reflect changes in emergency response resources and capabilities, which will occur from time to time.

A review shall be carried out after the following circumstances or conditions:

- After the occurrence of an emergency
- A drill or desktop exercise
- A change in operational procedures
- Major modification or addition of new equipment
- Every six months after previous review

Updates and amendments to the E.R.P can be performed after every review. All updates or amendments are to be approved by the Plant Manager.

4.10 Training

All staff and contractors shall receive basic emergency response training during the induction process.

Other staff will receive detailed Emergency Response training appropriate to their job .

ATTACHMENT-1

EMERGENCY RESPONSE PROCEDURE SUMMARY

EMERGENCY CONTACT LIST

INSPECTIONS FREQUENCY & CHECKLISTS

ITTEHAD(Pvt) Ltd CAPTIVE POWER PLANT (4.563 MW) 1 KM JARANWALA ROAD KHURRIANWALA FASIALABAD.

3(5)-A(xiii):

EFFICIENCY PARAMETERS.

INSTALLED CAPACITY:

GAS GENERATOR SETS "1.521 MW MTU Rolls Royce power systems AG Germany"

SIZE OF PLANT 3 X 12V64FNER_400 V = 4.56 MW

NO OF GAS GENERATORS = 03 Nos.

EFFICIENCY:

Efficiency Parameters		
(i)	Designed Efficiency of power plant %	90 %
(ii)	Gross Efficiency of power plant at Mean Site Conditions %	90%
(iii)	Net Efficiency of power plant at Mean Site Conditions %	88 %

Attachment: MTU data sheet attached.