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|------------|--------------|--------|--------------|
| Doc. No.: | 100005 64542 | Rev. 0 | ATP&R-THM |
| Code Word: | VILLARPIPE 1 | | Appendix RVT |
| Order No.: | H.0200017 | | Page 1 of 41 |



Acceptance Test Procedure and Report for the THM Gas Turbine

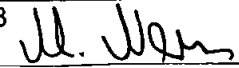
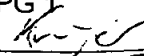
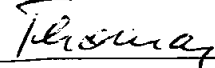
Appendix RVT Results of Thermodynamic and Mechanical Verification Test

| | |
|----------------------------|--|
| Contract Engine | Gas Turbine Type: THM 1304 – 12 DLN Serial No. GG: 2154 / PT: 2154 |
| Location of Test | MAN Turbo AG, Oberhausen, Germany |
| Date of Test | 20.01.10 |
| Test Engineer | B.Flöer, M.Nern |
| Customer's Representatives | Mr. Karsten Sattelkau (SGS) |

Contents

- 1 General
- 2 Comments on the Verification Test
- 3 Results
- 4 Graphical Analysis
- 5 Test Run Log Sheets
- 6 Measurement Readings
- 7 Fuel Gas Analysis
- 8 Vibration Report SMB 1785


REVIEWED ONLY
 Date: 26.03.2010
 Signed: 

| | | | |
|-------|------------|--------------|---|
| Date: | 28/01/10 | prepared by: | Nern / PP53  |
| Date: | 04/02/10 | checked by: | Krüger / PG 1  |
| Date: | 10/02/2010 | released by: | Thomas / PP53  |

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|------------|--------------|--------|--------------|
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| Order No.: | H.0200017 | | Page 2 of 41 |

1 General

This document is an Appendix to the document "Acceptance Test Procedure an Report for the THM Gas Turbine, Cover Sheet ", No. 100005 64540.

The verification test was performed on 20.01.10 as described in Appendix DVT.

2 Comments on the Verification Test

The handwritten log sheets of the test and the signed printouts of the measured data were given to the customer's representative at the end of the test run.

3 Results

The thermodynamic performance test and the mechanical running test were conducted on the test stand of MAN Turbo AG, to furnish proof of compliance with designed data of the gas turbine.

Guarantee values

The expected shaft power output of 12.3 MW according to Document 100001 65361 (Annex LGD) was reached at a measured PT inlet temperature T4 of 788 °C. This temperature is below the max. allowable temperature of 797 °C .

The emission measurement values related to 15 % O2 are below the guarantee values NOx (50 mg/m³_n) and CO (30 mg/m³_n) according ATP Appendix LGD.

Operating Point A

| Measured Values | MP. 40 |
|--|--------|
| Ambient pressure [kPa] | 100.82 |
| Ambient temperature [°C] | 4.8 |
| Inlet pressure loss [kPa] | 2.445 |
| Outlet pressure loss [kPa] | 0 |
| Power turbine speed [rpm] | 7220 |
| Torque [Nm] | 5626 |
| Fuel gas volume flow [m ³ _n/h] | 2234 |
| Calorific value [MJ/m ³ _n]* | 32.536 |
| Correction factor of inlet loss | |
| ε ₁ Power | 0.9521 |
| ε ₁ Heat rate | 0.9772 |
| Calculated Values (real) | |
| Power [kW] | 4254 |

* Calorific value according the taken gas sample

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|------------|--------------|--------|--------------|
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| | MP.40 | Operating point A (ISO Cond.) |
|--------------------------------------|-------|----------------------------------|
| Calculated Values (ISO Cond.) | | |
| Power turbine speed [rpm] | 7351 | 7354 |
| Power [kW] | 4572 | 4577 |
| Heat Rate [kJ/kWh] | 16699 | 17690 |

The heat rate guarantee for operating point A has been met.

Therefore all guarantees have been met.

The vibratory condition of the gas turbine "VILLARPIPE 1" is good and according to the above mentioned specifications.

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|------------|--------------|--------|--------------|
| Doc. No.: | 100005 64542 | Rev. 0 | ATP&R-THM |
| Code Word: | VILLARPIPE 1 | | Appendix RVT |
| Order No.: | H.0200017 | | Page 4 of 41 |

4 Graphical Analysis

Conversion of Measured Data to Guarantee Conditions CMG Rev. 2

Order: VILLARPIPE 1
 Order No.: H.0200017
 Mach-No.: 2154

Date of Test: 20.01.2010
 Prepared: M.Nem
 Checked: D.Kruger

Date: 25.01.2010
 Date: 28.01.2010



Measured Data during Acceptance Test Fuel Lower Heating Value : 32,5360 MJ/m³

| Measuring Point | Time | GG Speed rpm | PT Speed rpm | TORQUE Nm | Fuel Volume Flow m ³ /h | Ambient Pressure kPa | Inlet Press. Loss kPa | Average Inlet Temperature °C | Average PT Inlet Temperature °C | Exh. Press. Loss kPa | Degradation Factor |
|-------------------|----------|--------------|--------------|-----------|------------------------------------|----------------------|-----------------------|------------------------------|---------------------------------|----------------------|--------------------|
| GG Speed 1 | | | | | | | | | | | |
| 1 | 11:27:54 | 10618 | 6098 | 7322 | 2340 | 100,81 | 2,550 | 5,1 | 574,2 | 0,000 | 1,000 |
| 2 | 11:30:16 | 10618 | 6884 | 6518 | 2355 | 100,80 | 2,560 | 5,2 | 577,9 | 0,000 | 1,000 |
| 3 | 11:32:49 | 10618 | 7666 | 5801 | 2375 | 100,80 | 2,540 | 5,1 | 580,8 | 0,000 | 1,000 |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| GG Speed 2 | | | | | | | | | | | |
| 1 | 11:47:38 | 11028 | 6881 | 9047 | 2911 | 100,77 | 3,340 | 5,4 | 634,8 | 0,000 | 1,000 |
| 2 | 11:50:02 | 11028 | 7687 | 8162 | 2915 | 100,77 | 3,310 | 5,5 | 637,9 | 0,000 | 1,000 |
| 3 | 11:52:12 | 11028 | 8461 | 7343 | 2926 | 100,77 | 3,325 | 5,6 | 642,0 | 0,000 | 1,000 |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| GG Speed 3 | | | | | | | | | | | |
| 1 | 12:07:06 | 11232 | 7283 | 10110 | 3252 | 100,75 | 3,730 | 5,6 | 678,9 | 0,000 | 1,000 |
| 2 | 12:09:45 | 11233 | 7673 | 9660 | 3248 | 100,75 | 3,795 | 5,5 | 680,3 | 0,000 | 1,000 |
| 3 | 12:12:27 | 11232 | 8067 | 9246 | 3260 | 100,75 | 3,740 | 5,6 | 681,6 | 0,000 | 1,000 |
| 4 | 12:14:25 | 11233 | 8454 | 8785 | 3283 | 100,75 | 3,745 | 5,5 | 682,9 | 0,000 | 1,000 |
| 5 | 12:16:36 | 11232 | 9036 | 8118 | 3283 | 100,74 | 3,750 | 5,8 | 685,4 | 0,000 | 1,000 |
| 6 | | | | | | | | | | | |
| GG Speed 4 | | | | | | | | | | | |
| 1 | 12:31:55 | 11422 | 7278 | 11526 | 3610 | 100,74 | 4,145 | 6,1 | 719,2 | 0,000 | 1,000 |
| 2 | 12:34:28 | 11421 | 7679 | 11090 | 3622 | 100,74 | 4,145 | 6,0 | 720,4 | 0,000 | 1,000 |
| 3 | 12:37:34 | 11422 | 8073 | 10679 | 3632 | 100,74 | 4,130 | 5,9 | 721,5 | 0,000 | 1,000 |
| 4 | 12:40:12 | 11422 | 8467 | 10230 | 3641 | 100,73 | 4,180 | 5,8 | 722,6 | 0,000 | 1,000 |
| 5 | 12:43:23 | 11427 | 9038 | 9549 | 3645 | 100,73 | 4,160 | 5,8 | 724,7 | 0,000 | 1,000 |
| 6 | | | | | | | | | | | |
| GG Speed 5 | | | | | | | | | | | |
| 1 | 12:59:46 | 11627 | 7288 | 13143 | 4055 | 100,71 | 4,670 | 6,3 | 768,7 | 0,000 | 1,000 |
| 2 | 13:03:22 | 11627 | 7683 | 12724 | 4064 | 100,71 | 4,660 | 5,9 | 768,9 | 0,000 | 1,000 |
| 3 | 13:05:38 | 11627 | 8072 | 12311 | 4079 | 100,71 | 4,675 | 5,6 | 770,2 | 0,000 | 1,000 |
| 4 | 13:07:45 | 11628 | 8463 | 11889 | 4086 | 100,71 | 4,715 | 5,8 | 771,5 | 0,000 | 1,000 |
| 5 | 13:09:53 | 11626 | 9041 | 11191 | 4086 | 100,71 | 4,705 | 5,9 | 773,0 | 0,000 | 1,000 |
| 6 | | | | | | | | | | | |
| GG Speed 6 | | | | | | | | | | | |
| 1 | 13:26:45 | 11706 | 7681 | 13359 | 4260 | 100,69 | 4,835 | 5,8 | 788,2 | 0,000 | 1,000 |
| 2 | 13:29:09 | 11710 | 8074 | 12983 | 4249 | 100,69 | 4,820 | 6,1 | 788,5 | 0,000 | 1,000 |
| 3 | 13:32:12 | 11706 | 8474 | 12432 | 4261 | 100,68 | 4,875 | 5,9 | 789,1 | 0,000 | 1,000 |
| 4 | 13:34:54 | 11706 | 9041 | 11824 | 4276 | 100,67 | 4,835 | 5,6 | 790,6 | 0,000 | 1,000 |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |

Degradation Factors acc. to Document 10000010153

Conversion of Measured Data to Guarantee Conditions CMS Rev. 2

Order: VILLARPIPE 1
 Order No.: H0200017
 Mach No.: 2154
 Date of Test: 20.01.2010
 Prepared: M.Nern
 Checked: D.Kruger
 Date: 25.01.2010
 Date: 28.01.2010



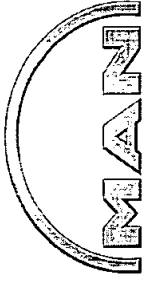
Correction of Measured Data
 Reference Inlet Temperature T₀: 5.6

Data corrected to:
 Sea Level, No Losses, 5.6°C Inlet Temperature

| Measuring Point | Time | Measured Shaft Power kW | Power | | | Efficiency | | | Corr. Factor Ambient Press. 6 | Corr. Factor Average Inlet Temp. 0 | PT Speed rpm | GG Speed rpm | Shaft Power Output kW | Efficiency [%] | PT Inlet Temperature °C | Reference Inlet Temp. °C | Average GG Speed rpm |
|-------------------|------|-------------------------|---|--|--|--|---|--|-------------------------------|------------------------------------|--------------|--------------|-----------------------|----------------|-------------------------|--------------------------|----------------------|
| | | | Corr. Factor Inlet Press. Loss p ₀ ,in | Corr. Factor Exh. Press. Loss p ₀ ,ex | Corr. Factor Exh. Press. Loss p ₀ ,in | Efficiency Exh. Press. Loss p ₀ ,ex | Efficiency Inlet Press. Loss p ₀ ,in | Corr. Factor Exh. Press. Loss p ₀ ,ex | | | | | | | | | |
| GG Speed 1 | | | | | | | | | | | | | | | | | |
| 1 | 41 | 4676 | 0.9481 | 1.0000 | 0.9754 | 1.0000 | 0.9949 | 0.9981 | 0.9981 | 6104 | 10928 | 4961 | 22.06 | 576 | 5.1 | 10627 | |
| 2 | 42 | 4699 | 0.9479 | 1.0000 | 0.9753 | 1.0000 | 0.9948 | 0.9986 | 0.9986 | 6899 | 10925 | 4986 | 22.63 | 579 | | | |
| 3 | 43 | 4657 | 0.9483 | 1.0000 | 0.9754 | 1.0000 | 0.9948 | 0.9981 | 0.9981 | 7673 | 10928 | 4941 | 22.24 | 582 | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| GG Speed 2 | | | | | | | | | | | | | | | | | |
| 1 | 44 | 6519 | 0.9346 | 1.0000 | 0.9659 | 1.0000 | 0.9945 | 0.9992 | 0.9992 | 6884 | 11933 | 7016 | 25.37 | 636 | | | |
| 2 | 45 | 6570 | 0.9352 | 1.0000 | 0.9692 | 1.0000 | 0.9945 | 0.9998 | 0.9998 | 7689 | 11930 | 7066 | 25.73 | 638 | | | |
| 3 | 46 | 6505 | 0.9348 | 1.0000 | 0.9691 | 1.0000 | 0.9945 | 1.0001 | 1.0001 | 8461 | 11928 | 6997 | 25.38 | 642 | | | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |
| GG Speed 3 | | | | | | | | | | | | | | | | | |
| 1 | 47 | 7711 | 0.9270 | 1.0000 | 0.9653 | 1.0000 | 0.9943 | 1.0001 | 1.0001 | 7283 | 11232 | 8395 | 27.18 | 670 | | | |
| 2 | 48 | 7778 | 0.9257 | 1.0000 | 0.9647 | 1.0000 | 0.9943 | 0.9998 | 0.9998 | 7675 | 11235 | 8452 | 27.46 | 681 | | | |
| 3 | 49 | 7811 | 0.9298 | 1.0000 | 0.9652 | 1.0000 | 0.9943 | 1.0001 | 1.0001 | 8067 | 11231 | 8475 | 27.47 | 682 | | | |
| 4 | 50 | 7777 | 0.9287 | 1.0000 | 0.9652 | 1.0000 | 0.9943 | 0.9995 | 0.9995 | 8456 | 11236 | 8442 | 27.16 | 683 | | | |
| 5 | 51 | 7882 | 0.9286 | 1.0000 | 0.9651 | 1.0000 | 0.9942 | 1.0005 | 1.0005 | 9034 | 11229 | 8336 | 26.83 | 685 | | | |
| 6 | | | | | | | | | | | | | | | | | |
| GG Speed 4 | | | | | | | | | | | | | | | | | |
| 1 | 52 | 8784 | 0.9188 | 1.0000 | 0.9615 | 1.0000 | 0.9942 | 1.0017 | 1.0017 | 7272 | 11412 | 9807 | 28.00 | 717 | | | |
| 2 | 53 | 8918 | 0.9189 | 1.0000 | 0.9615 | 1.0000 | 0.9942 | 1.0014 | 1.0014 | 7673 | 11413 | 9765 | 28.33 | 719 | | | |
| 3 | 54 | 9028 | 0.9192 | 1.0000 | 0.9616 | 1.0000 | 0.9942 | 1.0005 | 1.0005 | 8071 | 11419 | 9877 | 28.00 | 721 | | | |
| 4 | 55 | 9071 | 0.9182 | 1.0000 | 0.9611 | 1.0000 | 0.9941 | 1.0006 | 1.0006 | 8494 | 11419 | 9934 | 28.68 | 722 | | | |
| 5 | 56 | 9038 | 0.9186 | 1.0000 | 0.9613 | 1.0000 | 0.9941 | 1.0008 | 1.0008 | 9034 | 11422 | 9863 | 28.54 | 724 | | | |
| 6 | | | | | | | | | | | | | | | | | |
| GG Speed 5 | | | | | | | | | | | | | | | | | |
| 1 | 57 | 10031 | 0.9096 | 1.0000 | 0.9566 | 1.0000 | 0.9939 | 1.0024 | 1.0024 | 7279 | 11513 | 11084 | 28.62 | 766 | | | |
| 2 | 58 | 10237 | 0.9088 | 1.0000 | 0.9567 | 1.0000 | 0.9939 | 1.0010 | 1.0010 | 7679 | 11521 | 11329 | 29.13 | 768 | | | |
| 3 | 59 | 10407 | 0.9085 | 1.0000 | 0.9565 | 1.0000 | 0.9939 | 1.0000 | 1.0000 | 8072 | 11527 | 11525 | 29.52 | 770 | | | |
| 4 | 60 | 10536 | 0.9077 | 1.0000 | 0.9562 | 1.0000 | 0.9939 | 1.0005 | 1.0005 | 8461 | 11525 | 11675 | 29.84 | 771 | | | |
| 5 | 61 | 10566 | 0.9079 | 1.0000 | 0.9562 | 1.0000 | 0.9938 | 1.0010 | 1.0010 | 9036 | 11520 | 11736 | 30.00 | 772 | | | |
| 6 | | | | | | | | | | | | | | | | | |
| GG Speed 6 | | | | | | | | | | | | | | | | | |
| 1 | 62 | 10745 | 0.9054 | 1.0000 | 0.9550 | 1.0000 | 0.9937 | 1.0006 | 1.0006 | 7679 | 11703 | 11940 | 29.22 | 788 | | | |
| 2 | 63 | 10892 | 0.9056 | 1.0000 | 0.9552 | 1.0000 | 0.9937 | 1.0019 | 1.0019 | 8087 | 11699 | 12062 | 29.70 | 787 | | | |
| 3 | 64 | 11032 | 0.9046 | 1.0000 | 0.9547 | 1.0000 | 0.9936 | 1.0011 | 1.0011 | 8468 | 11700 | 12267 | 30.00 | 788 | | | |
| 4 | 65 | 11195 | 0.9054 | 1.0000 | 0.9550 | 1.0000 | 0.9935 | 1.0001 | 1.0001 | 9040 | 11705 | 12445 | 30.33 | 790 | | | |
| 5 | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | |

Correction Factors for Pressure Losses acc. to Document 1090088928

Conversion of Measured Data to Guarantee Conditions CMG Rev. 2

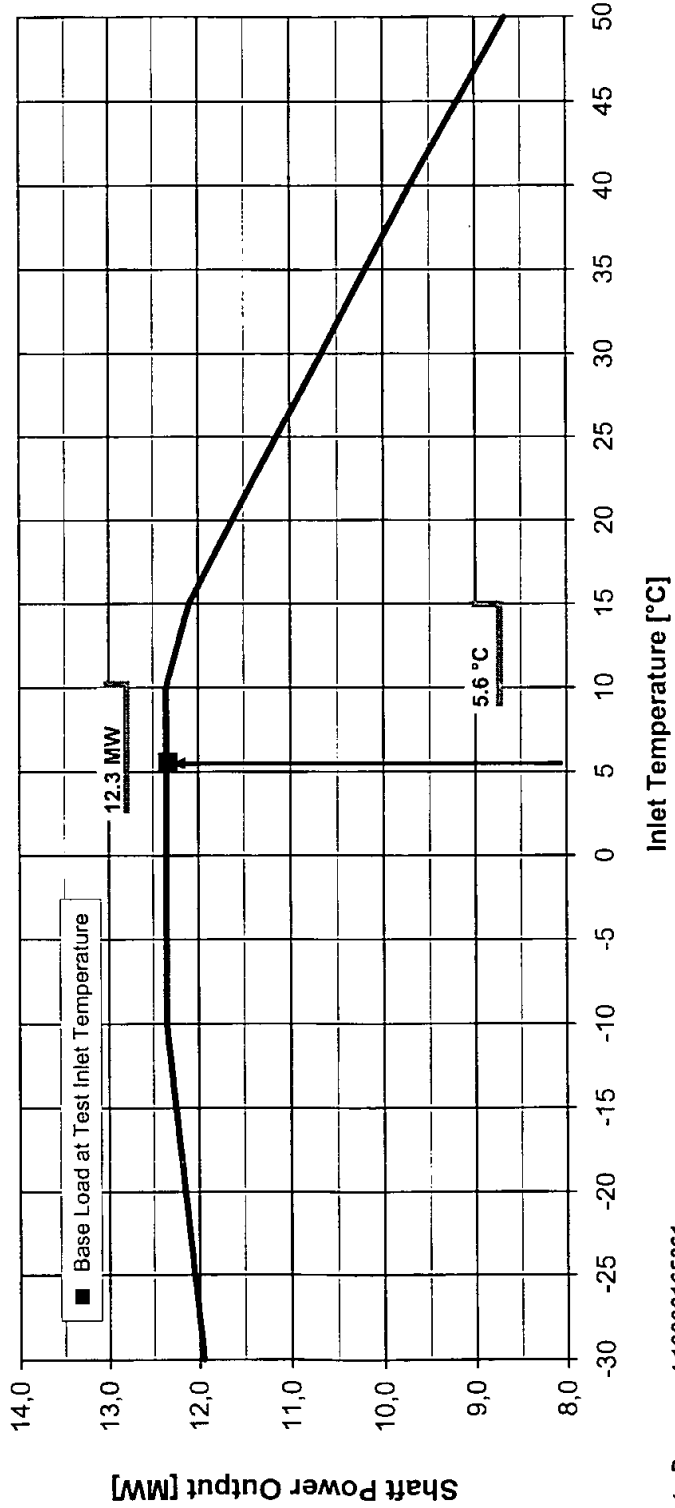


Order: VILLARPIPE 1 Date of Test: 20.01.2010 Date: 25.01.2010
 Order No.: H.0200017 Prepared: M.Nern Date: 28.01.2010
 Mach No.: 2154 Checked: D.Krüger

Sea Level, No Losses

Shaft Power Output vs. Inlet Temperature

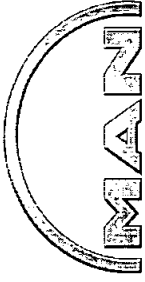
Power Turbine Speed 8600 rpm
 No Water Injection



Refer to Document 10000165361

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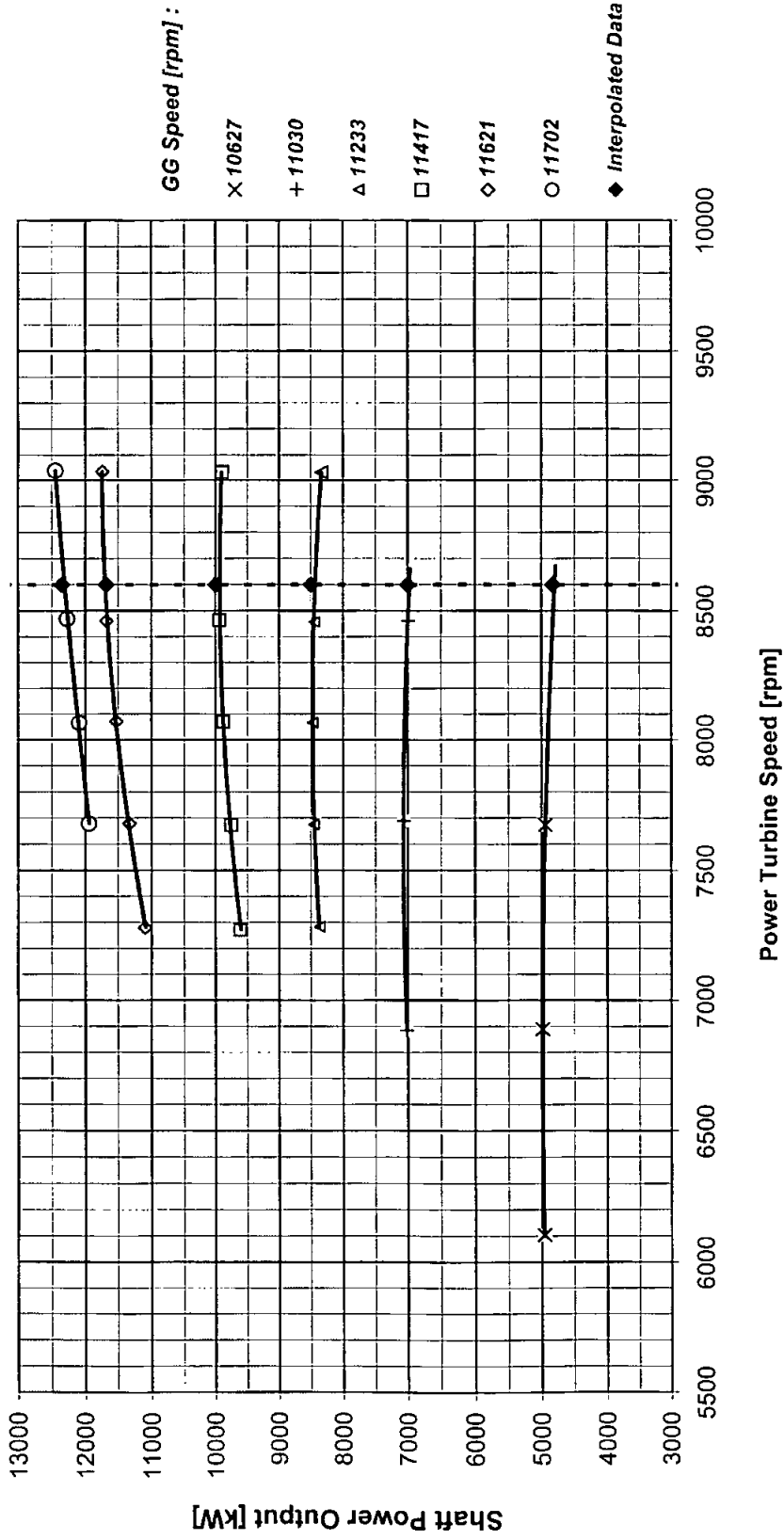
Conversion of Measured Data to Guarantee Conditions CMG Rev. 2



Order: VILLARPIPE 1 **Date of Test:** 20.01.2010
Order No.: H.0200017 **Prepared:** M.Nem **Date:** 25.01.2010
Mach No.: 2154 **Checked:** D.Krüger **Date:** 28.01.2010

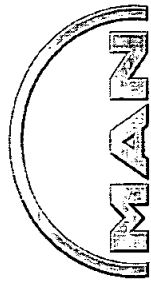
Sea Level, No Losses, 5,6°C Inlet Temperature

Shaft Power Output vs. Power Turbine Speed



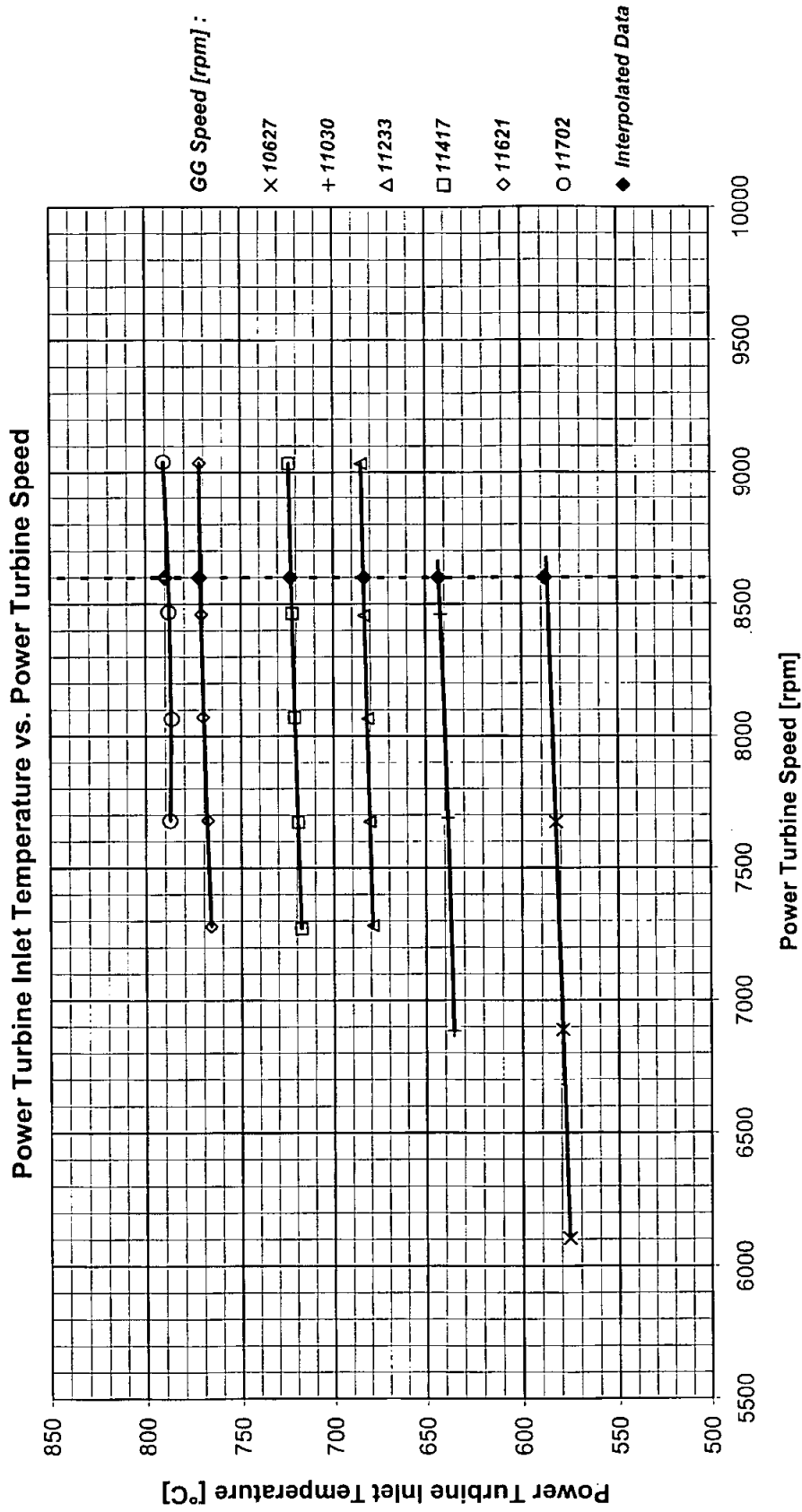
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Conversion of Measured Data to Guarantee Conditions CMG Rev. 2



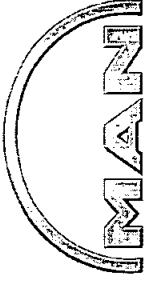
Order: VILLARPIPE 1 Date of Test: 20.01.2010 Date: 25.01.2010
 Order No.: H.0200017 Prepared: M.Nern
 Mach No.: 2154 Checked: D.Krüger Date: 28.01.2010

Sea Level, No Losses, 5,6°C Inlet Temperature



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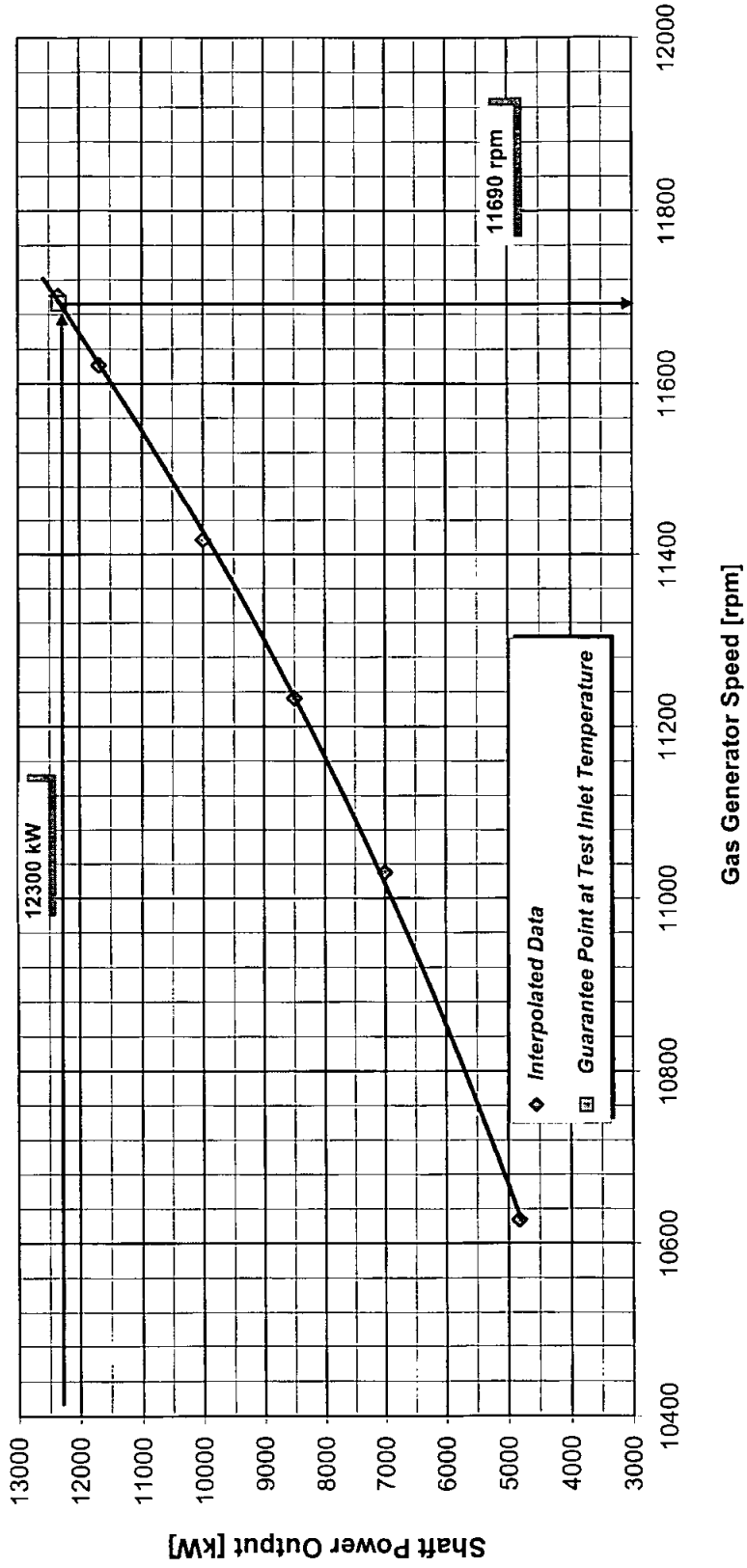
Conversion of Measured Data to Guarantee Conditions CMG Rev. 2



Order: VILLARPIPE 1 Date of Test: 20.01.2010 Date: 25.01.2010
 Order No.: H.0200017 Prepared: M.Nern Date: 28.01.2010
 Mach No.: 2154 Checked: D.Krütger

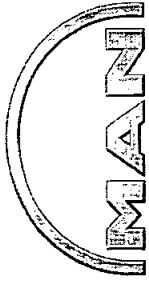
Sea Level, No Losses, 5,6°C Inlet Temperature, 8600 rpm Power Turbine Speed

Shaft Power Output vs. Gas Generator Speed



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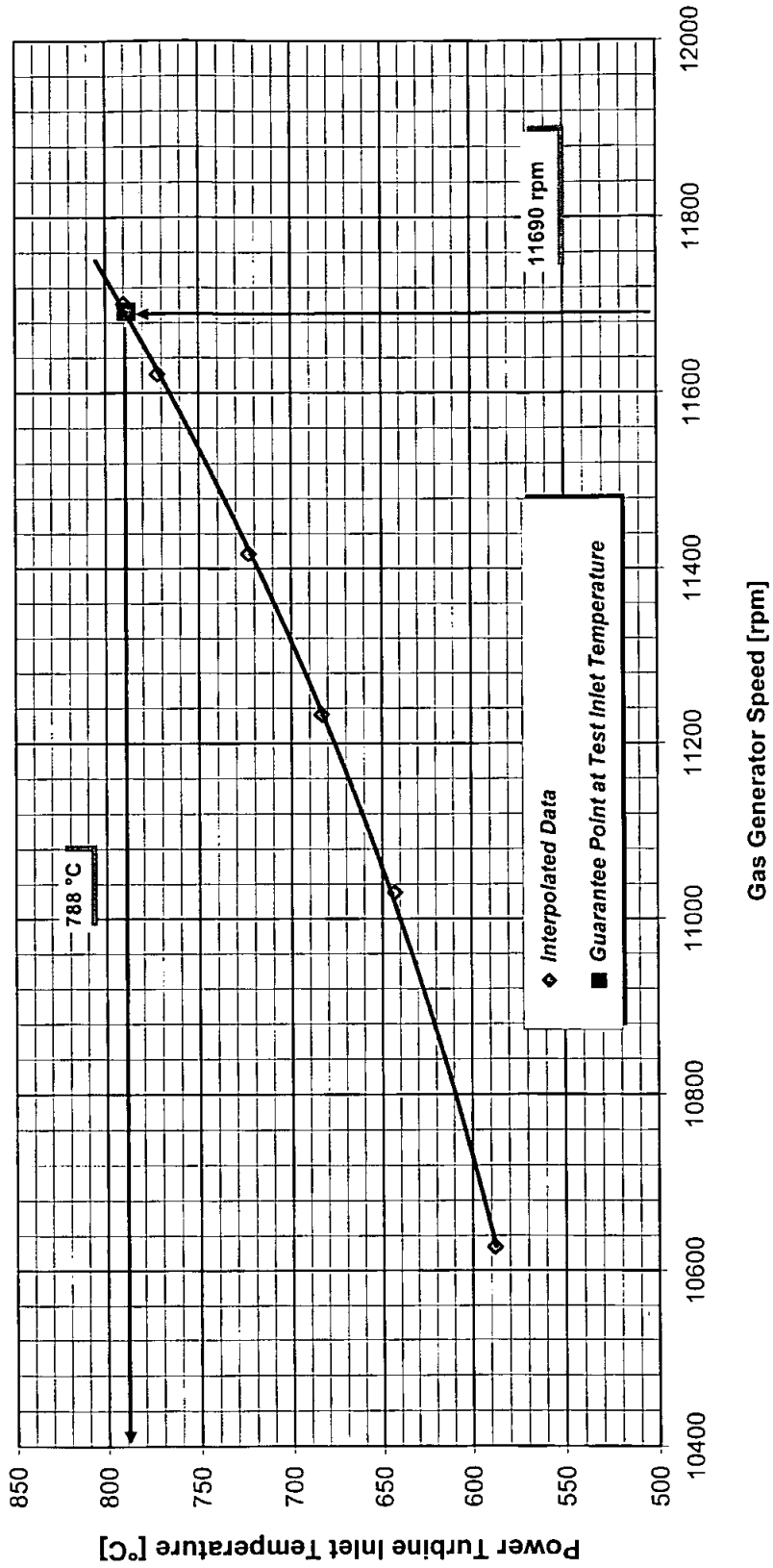
Conversion of Measured Data to Guarantee Conditions CMG Rev. 2



Order: VILLARPIPE 1 Date of Test: 20.01.2010
 Order No.: H-0200017 Prepared: M.Nern Date: 25.01.2010
 Mach No.: 2154 Checked: D.Krüger Date: 28.01.2010

Sea Level, No Losses, 5,6°C Inlet Temperature, 8600 rpm Power Turbine Speed

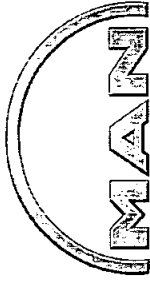
Power Turbine Inlet Temperature vs. Gas Generator Speed



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Conversion of Measured Data to Guarantee Conditions CMG Rev. 2

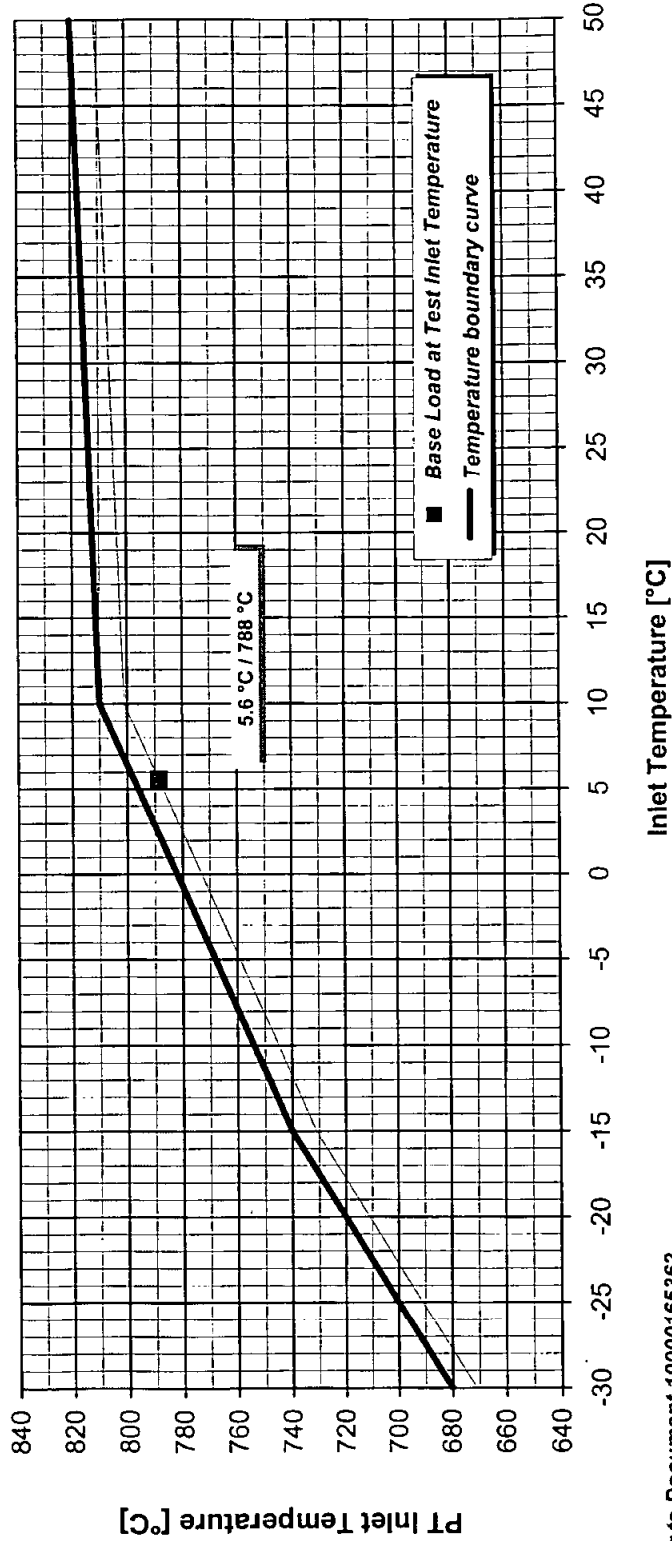
Order: VILLARPIPE 1 Date of Test: 20.01.2010 Date: 25.01.2010
 Order No.: H.0200017 Prepared: M.Nern Date: 28.01.2010
 Mach No.: 2154 Checked: D.Krüger



Sea Level, No Losses

Power Turbine (PT) Inlet Temperature vs. Inlet Temperature

Power Turbine Speed 8600 rpm
 Standard Combustion System, No Water Injection

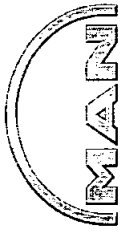


Refer to Document 10000165362

Temperature curve points

| | | | | |
|---------------------------|-----|-----|-----|-----|
| Inlet Temperature [°C] | 50 | 10 | -15 | -30 |
| PT Inlet Temperature [°C] | 811 | 801 | 731 | 671 |

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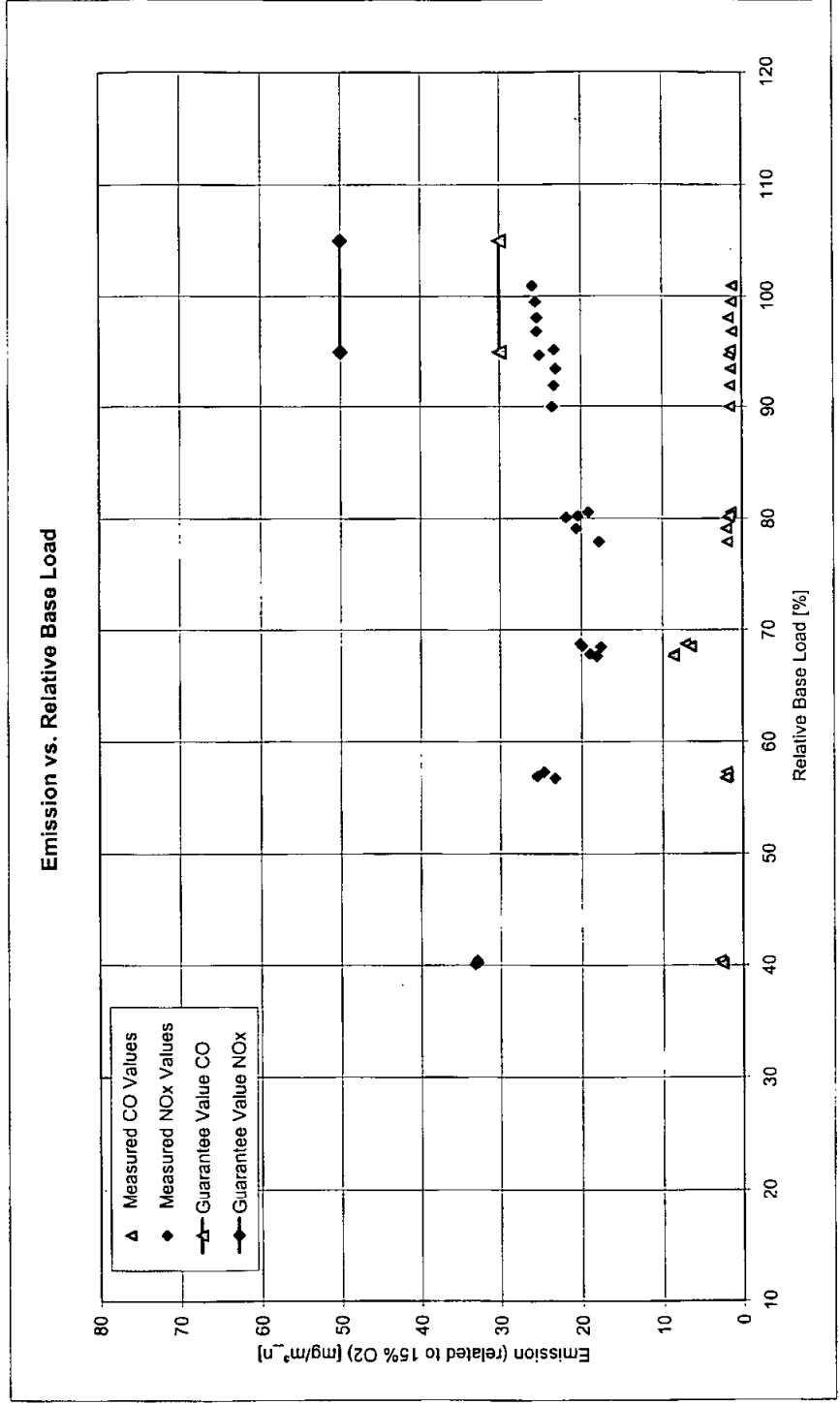


Conversion of Measured Data to Guarantee Conditions CMG Rev. 2

Order: VILLARPIPE 1 Date of Test: 20.01.2010
 Order No.: H.0200017 Prepared: M.Nem
 Mach No.: 2154 Checked: D.Krüger

Date: 25.01.10
 Date: 28.01.10

| Measuring Point | GG Speed 1 | | | | GG Speed 2 | | | | GG Speed 3 | | | | GG Speed 4 | | | | GG Speed 5 | | | | GG Speed 6 | | | | |
|---------------------------------|------------|------|------|------|------------|------|------|------|------------|------|------|------|------------|------|------|------|------------|------|------|------|------------|------|------|------|------|
| | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 |
| O2 measured Vol. % | 17,0 | 17,0 | 17,0 | 16,5 | 16,5 | 16,5 | 16,2 | 16,2 | 16,2 | 16,1 | 16,2 | 16,1 | 15,9 | 15,8 | 15,8 | 15,8 | 15,4 | 15,4 | 15,4 | 15,3 | 15,3 | 15,2 | 15,2 | 15,2 | 15,2 |
| CO Measured mg/m³ n | 1,7 | 1,9 | 1,7 | 1,4 | 1,5 | 1,6 | 6,9 | 5,3 | 5,3 | 5,8 | 5,2 | 7,0 | 1,6 | 1,7 | 1,5 | 1,2 | 1,4 | 1,4 | 1,3 | 1,5 | 1,3 | 1,2 | 1,6 | 1,3 | 1,2 |
| NO measured mg/m³ n | 9,6 | 9,7 | 10,0 | 7,6 | 7,1 | 6,5 | 4,8 | 5,3 | 5,4 | 4,1 | 4,4 | 4,4 | 4,6 | 6,1 | 7,0 | 5,4 | 6,2 | 8,6 | 8,4 | 9,6 | 8,5 | 9,9 | 10 | 10,2 | 10,4 |
| NO2 measured mg/m³ n | 7,0 | 7,1 | 7,0 | 7,4 | 7,6 | 7,6 | 7,8 | 7,9 | 8,0 | 7,9 | 7,9 | 8,2 | 8,4 | 8,2 | 8,3 | 8,2 | 8,8 | 8,9 | 8,8 | 8,9 | 8,9 | 9,5 | 9,3 | 9,2 | 9,3 |
| NOx measured mg/m³ n | 21,7 | 22,0 | 22,3 | 19,1 | 18,5 | 17,6 | 15,2 | 16,0 | 16,3 | 14,2 | 14,6 | 15,3 | 17,8 | 18,9 | 16,6 | 17,7 | 22,0 | 21,8 | 21,7 | 23,6 | 21,9 | 24,7 | 24,6 | 24,8 | 25,2 |
| CO (related to 15% O2) mg/m³ n | 2,6 | 2,8 | 2,5 | 1,9 | 2,0 | 2,1 | 8,6 | 6,6 | 7,2 | 6,4 | 8,7 | 1,9 | 2,0 | 1,7 | 1,4 | 1,6 | 1,5 | 1,4 | 1,4 | 1,6 | 1,4 | 1,2 | 1,6 | 1,3 | 1,2 |
| NOx (related to 15% O2) mg/m³ n | 32,8 | 32,9 | 33,2 | 25,5 | 24,6 | 23,3 | 18,9 | 19,9 | 20,1 | 17,6 | 18,1 | 17,8 | 20,6 | 21,9 | 19,1 | 20,4 | 23,5 | 23,3 | 23,1 | 25,1 | 23,3 | 25,4 | 25,4 | 25,5 | 25,9 |
| CO (related to 15% O2) ppm | 2,1 | 2,3 | 2,0 | 1,5 | 1,6 | 1,7 | 6,9 | 5,3 | 5,7 | 5,2 | 6,9 | 1,5 | 1,6 | 1,4 | 1,1 | 1,3 | 1,2 | 1,2 | 1,1 | 1,3 | 1,1 | 1,0 | 1,3 | 1,1 | 1,0 |
| NOx (related to 15% O2) ppm | 16,0 | 16,0 | 16,2 | 12,4 | 12,0 | 11,3 | 9,2 | 9,7 | 9,8 | 8,6 | 8,8 | 8,7 | 10,1 | 10,7 | 9,3 | 9,9 | 11,5 | 11,4 | 11,2 | 12,2 | 11,3 | 12,4 | 12,4 | 12,4 | 12,6 |



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| | | | |
|------------|--------------|--------|---------------|
| Doc. No.: | 100005 64542 | Rev. 0 | ATP&R-THM |
| Code Word: | VILLARPIPE 1 | | Appendix RVT |
| Order No.: | H.0200017 | | Page 14 of 41 |

5 Test Run Log Sheets

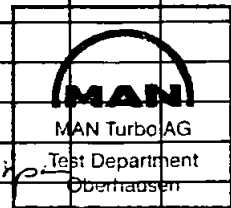
TEST READINGS

Official Mechanical Running and Shop Performance Test



-15-

| Dept. PP53 | | Code Word VILLARPIPE 1 | | | Job No. H.0200017 | | | Machine No. GG 2154 / PT 2154 | | | | | | | | | |
|---------------|-------|---------------------------|-----------------------|-----------------------------------|----------------------|--|--|----------------------------------|--------------|--|--|--|--|--|--|--|--|
| | | Name Flör | | | | | | Date 20.01.10 | Sheet 1/2 | | | | | | | | |
| MP-No. | Time | Speed GG actual | Speed PT actual | | | | | | | | | | | | | | |
| / | hh:mm | rpm | rpm | | | | | | | | | | | | | | |
| | | | | Gas Turbine | | | | | | | | | | | | | |
| | | | | Type: TNH 1504-12 | | | | | | | | | | | | | |
| | | | | Location: 2154 | | | | | | | | | | | | | |
| | 10:04 | | | Start of the gas turbine | | | | | | | | | | | | | |
| | 10:08 | | | Warming up speed reached | | | | | | | | | | | | | |
| 40 | 11:19 | 10492 | 7220 | Measurement for operating point A | | | | | | | | | | | | | |
| 41 | 11:24 | 10618 | 6098 | Measurement } for n = 10800 rpm | | | | | | | | | | | | | |
| 42 | 11:30 | 10618 | 6384 | | | | | | | | | | | | | | |
| 43 | 11:32 | 10618 | 7666 | | | | | | | | | | | | | | |
| 44 | 11:47 | 11018 | 6881 | Measurement } for n = 11200 rpm | | | | | | | | | | | | | |
| 45 | 11:50 | 11018 | 7677 | | | | | | | | | | | | | | |
| 46 | 11:52 | 11028 | 8461 | | | | | | | | | | | | | | |
| 47 | 12:07 | 11232 | 7273 | Measurement } for n = 11400 rpm | | | | | | | | | | | | | |
| 48 | 12:09 | 11233 | 7673 | | | | | | | | | | | | | | |
| 49 | 12:12 | 11232 | 8067 | | | | | | | | | | | | | | |
| 50 | 12:14 | 11233 | 8454 | | | | | | | | | | | | | | |
| 51 | 12:16 | 11212 | 9036 | | | | | | | | | | | | | | |
| 52 | 12:31 | 11422 | 7278 | Measurement } for n = 11600 rpm | | | | | | | | | | | | | |
| 53 | 12:34 | 11421 | 7675 | | | | | | | | | | | | | | |
| 54 | 12:37 | 11422 | 8073 | | | | | | | | | | | | | | |
| 55 | 12:40 | 11422 | 8467 | | | | | | | | | | | | | | |
| 56 | 12:43 | 11427 | 9038 | | | | | | | | | | | | | | |



Flör



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Date: 2010-11-20-10

Signed: *[Signature]*

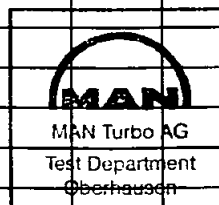
TEST READINGS

Official Mechanical Running and Shop Performance Test



-16-

| Dept. PP53 | | Code Word VILLARPIPE 1 | | Job No. H.0200017 | | Machine No. GG 2154 / PT 2154 | |
|---------------|-------|---------------------------|-----------------------|--|-----------------------------------|----------------------------------|--|
| Name Flörv | | | | Date 20.01.10 | | Sheet 2/2 | |
| MP-No. | Time | Speed GG actual | Speed PT actual | | | | |
| 1 | hh:mm | rpm | rpm | | | | |
| 57 | 12:55 | 11667 | 7283 | Measurement | } for n = 11800 rpm C-6 150 | | |
| 58 | 13:03 | 11662 | 7673 | " | | | |
| 59 | 13:05 | 11667 | 8072 | " | | | |
| 60 | 13:07 | 11628 | 7463 | " | | | |
| 61 | 13:09 | 11666 | 9041 | " | | | |
| 62 | 13:26 | 11706 | 7691 | Measurement | } for n GG test-max | | |
| 63 | 13:29 | 11710 | 8019 | " | | | |
| 64 | 13:32 | 11706 | 8474 | " | | | |
| 65 | 13:34 | 11706 | 9041 | " | | | |
| 66 | 13:36 | 11710 | 9035 | Measurement | } mechanical test run | | |
| 67 | 13:51 | 11615 | 9038 | " | | | |
| 68 | 14:06 | 11707 | 9035 | " | | | |
| | 14:08 | | | Speed near trip speed of power turbine reached | | | |
| 69 | 14:12 | 11675 | 9106 | Measurement | | | |
| | | | | Speed decreased | | | |
| | 14:18 | | | Normal stop | | | |
| | | | | End of test run | | | |



Flörv

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Date: 2010-12-10
Signed: *[Signature]*

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| | | | |
|------------|--------------|--------|---------------|
| Doc. No.: | 100005 64542 | Rev. 0 | ATP&R-THM |
| Code Word: | VILLARPIPE 1 | | Appendix RVT |
| Order No.: | H.0200017 | | Page 17 of 41 |

6 Measurement Readings



MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | | 040 | 041 | 042 | 043 |
|---------------------------|-------|---------|---------|---------|---------|
| SAMPLETIME | | 11:19 | 11:27 | 11:30 | 11:32 |
| Gas Generator (GG) speed | 1/min | 10492 | 10618 | 10618 | 10618 |
| Power turbine (PT) speed | 1/min | 7220 | 6098 | 6884 | 7666 |
| Torque at PT | Nm | 5625.7 | 7321.9 | 6518.0 | 5801.4 |
| Guide vane position | GRAD | -19.0 | -19.0 | -19.0 | -19.0 |
| Ambient pressure | bar | 1.0082 | 1.0081 | 1.0080 | 1.0080 |
| Relative humidity | % | 67.5 | 65.0 | 64.8 | 64.5 |
| Reference temperature | GrdC | 6.6 | 7.1 | 7.1 | 7.1 |
| Pressure loss filter | bar | -0.0016 | -0.0017 | -0.0017 | -0.0017 |
| Pressure loss venturi A | bar | 0.0951 | 0.1028 | 0.1026 | 0.1024 |
| Pressure loss venturi B | bar | 0.0946 | 0.1022 | 0.1020 | 0.1020 |
| Pressure loss venturi C | bar | 0.0967 | 0.1044 | 0.1042 | 0.1043 |
| Inlet press. compressor A | bar_g | -0.0245 | -0.0267 | -0.0267 | -0.0265 |
| Inlet press. compressor B | bar_g | -0.0244 | -0.0263 | -0.0265 | -0.0263 |
| Inlet temp. compr. Tt_11 | GrdC | 5.3 | 5.5 | 5.6 | 5.5 |
| Inlet temp. compr. Tt_12 | GrdC | 5.2 | 5.4 | 5.6 | 5.5 |
| Inlet temp. compr. Tt_13 | GrdC | 4.7 | 4.9 | 5.1 | 4.9 |
| Inlet temp. compr. Tt_14 | GrdC | 5.0 | 5.2 | 5.3 | 5.2 |
| Inlet temp. compr. Tt_15 | GrdC | 4.7 | 5.0 | 5.1 | 4.8 |
| Inlet temp. compr. Tt_16 | GrdC | 4.1 | 4.5 | 4.6 | 4.5 |
| Outlet press.compressor A | bar_g | 5.8725 | 6.1388 | 6.1465 | 6.1610 |
| Outlet press.compressor B | bar_g | 5.9327 | 6.2013 | 6.2081 | 6.2237 |
| Outlet temp. compr. Tt_21 | GrdC | 262.2 | 266.9 | 267.4 | 267.6 |
| Outlet temp. compr. Tt_22 | GrdC | 264.1 | 268.8 | 269.2 | 269.5 |
| Inlet press. PT | bar_g | 1.0475 | 1.1017 | 1.1096 | 1.1172 |
| Inlet temp. PT Tt_41 | GrdC | 631.1 | 638.3 | 647.8 | 654.5 |
| Inlet temp. PT Tt_42 | GrdC | 602.5 | 607.3 | 604.0 | 600.1 |
| Inlet temp. PT Tt_43 | GrdC | 521.8 | 524.9 | 528.4 | 532.7 |
| Inlet temp. PT Tt_44 | GrdC | 509.8 | 514.7 | 520.8 | 527.1 |
| Inlet temp. PT Tt_45 | GrdC | 574.1 | 582.2 | 581.0 | 581.5 |
| Inlet temp. PT Tt_46 | GrdC | 636.6 | 644.9 | 649.1 | 651.4 |
| Inlet temp. PT Tt_47 | GrdC | 528.6 | 533.7 | 542.8 | 547.4 |
| Inlet temp. PT Tt_48 | GrdC | 543.7 | 547.7 | 549.4 | 552.0 |
| Outlet press. PT A | bar_g | -0.0010 | -0.0007 | -0.0001 | -0.0017 |
| Outlet press. PT B | bar_g | -0.0026 | -0.0009 | -0.0026 | -0.0030 |
| Outlet temp. PT Tt_51 | GrdC | 420.3 | 413.5 | 420.2 | 425.9 |
| Outlet temp. PT Tt_52 | GrdC | 424.9 | 414.9 | 424.6 | 432.7 |
| Outlet temp. PT Tt_53 | GrdC | 427.2 | 427.6 | 423.8 | 434.9 |
| Outlet temp. PT Tt_54 | GrdC | 422.0 | 418.9 | 424.6 | 425.8 |
| Fuel gas temp. | GrdC | 23.8 | 25.6 | 26.0 | 26.4 |
| Fuel gas pressure | bar | 18.9989 | 19.1643 | 19.1663 | 19.0300 |
| Fuel gas volume flow | m3n/h | 2234.4 | 2340.3 | 2355.3 | 2375.3 |
| Oil press.GG f. bearing | bar_g | 2.4 | 2.4 | 2.4 | 2.4 |



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Date: 2010.01.20.10

Signed: *[Signature]*

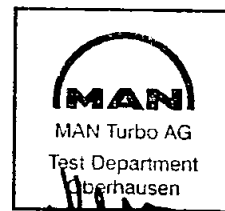




MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | 040 | 041 | 042 | 043 |
|---------------------------|-------------|-------|-------|-------|
| SAMPLETIME | 11:19 | 11:27 | 11:30 | 11:32 |
| Oil press.GG r. bearing | bar_g 1.9 | 1.9 | 1.9 | 1.9 |
| Oil press.PT | bar_g 2.1 | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. | GrdC 45.4 | 45.1 | 45.0 | 44.9 |
| Oil vol.flow GG f.bearing | l/min 132.0 | 132.2 | 132.0 | 131.8 |
| Oil vol.flow GG r.bearing | l/min 59.3 | 59.5 | 59.5 | 59.4 |
| Oil vol.flow PT | l/min 117.9 | 117.1 | 117.5 | 117.9 |
| Oil outl.temp.GG f.bear. | GrdC 50.2 | 50.2 | 50.1 | 50.0 |
| Oil outl.temp.GG r.bear. | GrdC 65.2 | 65.4 | 65.3 | 65.3 |
| Oil outl.temp.PT | GrdC 62.7 | 60.1 | 61.3 | 63.0 |
| Shaft vib. GG f.1 unfilt. | my_pp 15 | 16 | 18 | 17 |
| Shaft vib. GG f.2 unfilt. | my_pp 38 | 40 | 41 | 41 |
| Shaft vib. PT r.1 unfilt. | my_pp 31 | 36 | 34 | 36 |
| Shaft vib. PT r.2 unfilt. | my_pp 32 | 35 | 32 | 35 |
| Shaft position GG axial | mm 0.16 | 0.15 | 0.16 | 0.16 |
| Shaft position PT axial | mm 0.15 | 0.15 | 0.15 | 0.15 |
| Temp.journal bear. GG f.1 | GrdC 71.2 | 71.4 | 71.2 | 71.3 |
| Temp.journal bear. GG f.2 | GrdC 54.3 | 54.6 | 54.3 | 54.3 |
| Temp.thrust bear.GG act.1 | GrdC 54.1 | 54.3 | 54.0 | 54.0 |
| Temp.thrust bear.GG act.2 | GrdC 53.1 | 53.3 | 53.1 | 53.2 |
| Temp.journal bear. GG r.1 | GrdC 86.0 | 86.6 | 86.6 | 86.8 |
| Temp.journal bear. GG r.2 | GrdC 59.5 | 59.4 | 59.2 | 59.4 |
| Temp.journal bear. PT f.1 | GrdC 60.2 | 57.5 | 58.9 | 60.2 |
| Temp.journal bear. PT f.2 | GrdC 75.7 | 72.5 | 74.5 | 77.0 |
| Temp.journal bear. PT r.1 | GrdC 61.2 | 60.9 | 61.1 | 61.6 |
| Temp.journal bear. PT r.2 | GrdC 53.1 | 51.8 | 52.5 | 53.7 |
| Temp.thrust bear.PT act.1 | GrdC 57.8 | 56.1 | 57.6 | 58.6 |
| Temp.thrust bear.PT act.2 | GrdC 67.4 | 65.5 | 67.1 | 69.4 |
| Measured O2 | % 17.05 | 17.01 | 16.98 | 16.95 |
| Measured CO | mg/m3 2.7 | 1.7 | 1.9 | 1.7 |
| Measured NO | mg/m3 9.4 | 9.6 | 9.7 | 10.0 |
| Measured NO2 | mg/m3 7.0 | 7.0 | 7.1 | 7.0 |

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 Signed: *[Signature]*



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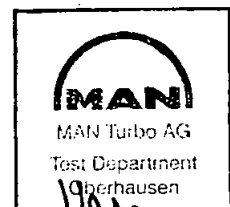
MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | | 044 | 045 | 046 |
|---------------------------|-------|---------|---------|---------|
| SAMPLETIME | | 11:47 | 11:50 | 11:52 |
| Gas Generator (GG) speed | 1/min | 11028 | 11028 | 11028 |
| Power turbine (PT) speed | 1/min | 6881 | 7687 | 8461 |
| Torque at PT | Nm | 9046.7 | 8162.1 | 7343.0 |
| Guide vane position | GRAD | -12.0 | -12.0 | -12.1 |
| Ambient pressure | bar | 1.0077 | 1.0077 | 1.0077 |
| Relative humidity | % | 63.1 | 61.5 | 60.2 |
| Reference temperature | GrdC | 7.4 | 7.8 | 7.8 |
| Pressure loss filter | bar | -0.0020 | -0.0021 | -0.0021 |
| Pressure loss venturi A | bar | 0.1313 | 0.1309 | 0.1307 |
| Pressure loss venturi B | bar | 0.1305 | 0.1301 | 0.1299 |
| Pressure loss venturi C | bar | 0.1336 | 0.1334 | 0.1332 |
| Inlet press. compressor A | bar_g | -0.0334 | -0.0332 | -0.0333 |
| Inlet press. compressor B | bar_g | -0.0334 | -0.0330 | -0.0332 |
| Inlet temp. compr. Tt_11 | GrdC | 5.9 | 6.1 | 6.1 |
| Inlet temp. compr. Tt_12 | GrdC | 5.7 | 5.8 | 5.8 |
| Inlet temp. compr. Tt_13 | GrdC | 5.3 | 5.4 | 5.5 |
| Inlet temp. compr. Tt_14 | GrdC | 5.4 | 5.5 | 5.8 |
| Inlet temp. compr. Tt_15 | GrdC | 5.1 | 5.1 | 5.4 |
| Inlet temp. compr. Tt_16 | GrdC | 4.8 | 5.0 | 5.1 |
| Outlet press.compressor A | bar_g | 7.2442 | 7.2429 | 7.2510 |
| Outlet press.compressor B | bar_g | 7.3169 | 7.3152 | 7.3261 |
| Outlet temp. compr. Tt_21 | GrdC | 288.5 | 288.7 | 289.1 |
| Outlet temp. compr. Tt_22 | GrdC | 290.2 | 290.3 | 290.9 |
| Inlet press. PT | bar_g | 1.3662 | 1.3715 | 1.3756 |
| Inlet temp. PT Tt_41 | GrdC | 713.5 | 716.1 | 711.8 |
| Inlet temp. PT Tt_42 | GrdC | 638.7 | 639.6 | 639.5 |
| Inlet temp. PT Tt_43 | GrdC | 561.0 | 563.5 | 573.2 |
| Inlet temp. PT Tt_44 | GrdC | 618.7 | 621.3 | 624.6 |
| Inlet temp. PT Tt_45 | GrdC | 537.2 | 538.4 | 537.3 |
| Inlet temp. PT Tt_46 | GrdC | 688.3 | 691.2 | 687.3 |
| Inlet temp. PT Tt_47 | GrdC | 679.4 | 684.5 | 697.8 |
| Inlet temp. PT Tt_48 | GrdC | 641.3 | 648.7 | 664.6 |
| Outlet press. PT A | bar_g | -0.0013 | -0.0002 | -0.0007 |
| Outlet press. PT B | bar_g | -0.0019 | -0.0038 | -0.0022 |
| Outlet temp. PT Tt_51 | GrdC | 444.5 | 458.8 | 459.9 |
| Outlet temp. PT Tt_52 | GrdC | 470.4 | 459.2 | 450.9 |
| Outlet temp. PT Tt_53 | GrdC | 453.5 | 441.1 | 455.0 |
| Outlet temp. PT Tt_54 | GrdC | 441.1 | 456.1 | 463.6 |
| Fuel gas temp. | GrdC | 28.3 | 28.4 | 28.6 |
| Fuel gas pressure | bar | 18.6682 | 18.6407 | 18.5516 |
| Fuel gas volume flow | m3n/h | 2910.9 | 2914.7 | 2926.4 |
| Oil press.GG f. bearing | bar_g | 2.5 | 2.5 | 2.5 |

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Date: 2010/01/20/10
 Signed: *[Signature]*





MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | | 044 | 045 | 046 |
|---------------------------|-------|-------|-------|-------|
| SAMPLETIME | | 11:47 | 11:50 | 11:52 |
| Oil press.GG r. bearing | bar_g | 1.9 | 1.9 | 1.9 |
| Oil press.PT | bar_g | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. | GrdC | 45.3 | 45.3 | 45.3 |
| Oil vol.flow GG f.bearing | l/min | 133.0 | 132.9 | 132.9 |
| Oil vol.flow GG r.bearing | l/min | 60.9 | 61.0 | 60.9 |
| Oil vol.flow PT | l/min | 118.6 | 119.2 | 118.9 |
| Oil outl.temp.GG f.bear. | GrdC | 50.8 | 50.8 | 50.8 |
| Oil outl.temp.GG r.bear. | GrdC | 67.8 | 67.9 | 67.9 |
| Oil outl.temp.PT | GrdC | 63.3 | 64.8 | 66.8 |
| Shaft vib. GG f.1 unfilt. | my_pp | 19 | 17 | 18 |
| Shaft vib. GG f.2 unfilt. | my_pp | 49 | 48 | 47 |
| Shaft vib. PT r.1 unfilt. | my_pp | 35 | 33 | 35 |
| Shaft vib. PT r.2 unfilt. | my_pp | 34 | 36 | 32 |
| Shaft position GG axial | mm | 0.14 | 0.14 | 0.15 |
| Shaft position PT axial | mm | 0.14 | 0.14 | 0.14 |
| Temp.journal bear. GG f.1 | GrdC | 72.0 | 72.0 | 72.3 |
| Temp.journal bear. GG f.2 | GrdC | 54.8 | 54.5 | 54.6 |
| Temp.thrust bear.GG act.1 | GrdC | 55.2 | 55.2 | 55.1 |
| Temp.thrust bear.GG act.2 | GrdC | 54.3 | 54.2 | 54.2 |
| Temp.journal bear. GG r.1 | GrdC | 88.6 | 88.5 | 88.3 |
| Temp.journal bear. GG r.2 | GrdC | 61.2 | 61.2 | 61.5 |
| Temp.journal bear. PT f.1 | GrdC | 63.3 | 65.5 | 67.2 |
| Temp.journal bear. PT f.2 | GrdC | 73.7 | 74.8 | 76.1 |
| Temp.journal bear. PT r.1 | GrdC | 62.4 | 63.1 | 65.0 |
| Temp.journal bear. PT r.2 | GrdC | 52.4 | 52.7 | 54.2 |
| Temp.thrust bear.PT act.1 | GrdC | 59.9 | 61.1 | 60.7 |
| Temp.thrust bear.PT act.2 | GrdC | 71.6 | 73.5 | 73.9 |
| Measured O2 | % | 16.50 | 16.48 | 16.46 |
| Measured CO | mg/m3 | 1.4 | 1.5 | 1.6 |
| Measured NO | mg/m3 | 7.6 | 7.1 | 6.5 |
| Measured NO2 | mg/m3 | 7.4 | 7.6 | 7.6 |

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Date: 2010-1-20-10

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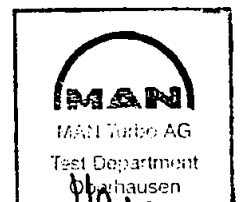




MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | 047 | 048 | 049 | 050 | 051 | |
|---------------------------|-------|---------|---------|---------|---------|---------|
| SAMPLETIME | 12:07 | 12:09 | 12:12 | 12:14 | 12:16 | |
| Gas Generator (GG) speed | 1/min | 11232 | 11233 | 11232 | 11233 | 11232 |
| Power turbine (PT) speed | 1/min | 7283 | 7673 | 8067 | 8454 | 9036 |
| Torque at PT | Nm | 10110.0 | 9679.9 | 9245.8 | 8784.7 | 8118.3 |
| Guide vane position | GRAD | -7.2 | -7.2 | -7.2 | -7.2 | -7.2 |
| Ambient pressure | bar | 1.0075 | 1.0075 | 1.0075 | 1.0075 | 1.0074 |
| Relative humidity | % | 60.5 | 59.8 | 60.9 | 61.1 | 57.8 |
| Reference temperature | GrdC | 8.1 | 7.9 | 7.8 | 8.1 | 8.6 |
| Pressure loss filter | bar | -0.0022 | -0.0022 | -0.0022 | -0.0022 | -0.0022 |
| Pressure loss venturi A | bar | 0.1474 | 0.1478 | 0.1476 | 0.1476 | 0.1477 |
| Pressure loss venturi B | bar | 0.1466 | 0.1468 | 0.1467 | 0.1468 | 0.1467 |
| Pressure loss venturi C | bar | 0.1502 | 0.1504 | 0.1502 | 0.1504 | 0.1500 |
| Inlet press. compressor A | bar_g | -0.0373 | -0.0379 | -0.0374 | -0.0375 | -0.0375 |
| Inlet press. compressor B | bar_g | -0.0373 | -0.0380 | -0.0374 | -0.0374 | -0.0375 |
| Inlet temp. compr. Tt_11 | GrdC | 6.3 | 6.0 | 6.3 | 6.1 | 6.3 |
| Inlet temp. compr. Tt_12 | GrdC | 5.9 | 5.3 | 5.9 | 5.7 | 5.7 |
| Inlet temp. compr. Tt_13 | GrdC | 5.5 | 5.4 | 5.6 | 5.3 | 5.6 |
| Inlet temp. compr. Tt_14 | GrdC | 5.6 | 5.8 | 5.7 | 5.5 | 5.9 |
| Inlet temp. compr. Tt_15 | GrdC | 5.3 | 5.4 | 5.3 | 5.1 | 5.7 |
| Inlet temp. compr. Tt_16 | GrdC | 5.1 | 5.0 | 5.0 | 5.0 | 5.3 |
| Outlet press.compressor A | bar_g | 7.8898 | 7.8954 | 7.9029 | 7.9097 | 7.9148 |
| Outlet press.compressor B | bar_g | 7.9639 | 7.9684 | 7.9756 | 7.9839 | 7.9877 |
| Outlet temp. compr. Tt_21 | GrdC | 302.4 | 302.2 | 302.5 | 302.5 | 303.0 |
| Outlet temp. compr. Tt_22 | GrdC | 304.4 | 304.5 | 304.5 | 304.4 | 305.2 |
| Inlet press. PT | bar_g | 1.5149 | 1.5191 | 1.5234 | 1.5284 | 1.5312 |
| Inlet temp. PT Tt_41 | GrdC | 684.8 | 686.1 | 688.9 | 690.2 | 693.9 |
| Inlet temp. PT Tt_42 | GrdC | 705.8 | 707.1 | 708.4 | 709.0 | 709.9 |
| Inlet temp. PT Tt_43 | GrdC | 681.8 | 682.7 | 685.2 | 687.3 | 691.0 |
| Inlet temp. PT Tt_44 | GrdC | 633.5 | 635.1 | 635.4 | 635.8 | 636.5 |
| Inlet temp. PT Tt_45 | GrdC | 622.7 | 624.2 | 627.4 | 626.5 | 633.5 |
| Inlet temp. PT Tt_46 | GrdC | 696.8 | 697.5 | 698.3 | 702.6 | 707.7 |
| Inlet temp. PT Tt_47 | GrdC | 711.7 | 713.4 | 713.2 | 714.1 | 713.6 |
| Inlet temp. PT Tt_48 | GrdC | 694.3 | 696.3 | 696.2 | 697.5 | 696.7 |
| Outlet press. PT A | bar_g | 0.0005 | 0.0003 | 0.0009 | -0.0005 | 0.0000 |
| Outlet press. PT B | bar_g | -0.0001 | -0.0001 | -0.0031 | -0.0042 | -0.0030 |
| Outlet temp. PT Tt_51 | GrdC | 477.7 | 476.0 | 474.3 | 477.1 | 479.0 |
| Outlet temp. PT Tt_52 | GrdC | 475.2 | 472.6 | 464.7 | 466.3 | 466.9 |
| Outlet temp. PT Tt_53 | GrdC | 474.1 | 462.7 | 455.6 | 464.6 | 470.4 |
| Outlet temp. PT Tt_54 | GrdC | 464.4 | 460.2 | 473.6 | 478.0 | 478.9 |
| Fuel gas temp. | GrdC | 29.2 | 29.2 | 29.3 | 29.3 | 29.4 |
| Fuel gas pressure | bar | 18.2843 | 18.2806 | 18.3118 | 18.4249 | 18.5519 |
| Fuel gas volume flow | m3n/h | 3251.5 | 3248.4 | 3259.5 | 3283.0 | 3282.8 |
| Oil press.GG f. bearing | bar_g | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |

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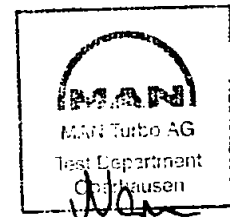


MACHINE NO. : 2154
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

Shop Performance Test

| MEASURINGPOINT | 047 | 048 | 049 | 050 | 051 | |
|---------------------------|-------|-------|-------|-------|-------|-------|
| SAMPLETIME | 12:07 | 12:09 | 12:12 | 12:14 | 12:16 | |
| Oil press.GG r. bearing | bar_g | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| Oil press.PT | bar_g | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. | GrdC | 45.3 | 45.3 | 45.4 | 45.4 | 45.4 |
| Oil vol.flow GG f.bearing | l/min | 133.3 | 133.4 | 133.4 | 133.3 | 133.3 |
| Oil vol.flow GG r.bearing | l/min | 61.7 | 61.7 | 61.8 | 61.8 | 61.8 |
| Oil vol.flow PT | l/min | 119.3 | 119.6 | 119.9 | 120.1 | 119.8 |
| Oil outl.temp.GG f.bear. | GrdC | 51.1 | 51.1 | 51.1 | 51.2 | 51.2 |
| Oil outl.temp.GG r.bear. | GrdC | 69.4 | 69.5 | 69.5 | 69.6 | 69.6 |
| Oil outl.temp.PT | GrdC | 65.6 | 66.4 | 67.6 | 68.6 | 70.0 |
| Shaft vib. GG f.1 unfilt. | my_pp | 15 | 15 | 15 | 16 | 15 |
| Shaft vib. GG f.2 unfilt. | my_pp | 49 | 49 | 49 | 48 | 49 |
| Shaft vib. PT r.1 unfilt. | my_pp | 25 | 31 | 28 | 31 | 34 |
| Shaft vib. PT r.2 unfilt. | my_pp | 27 | 35 | 31 | 29 | 30 |
| Shaft position GG axial | mm | 0.14 | 0.14 | 0.14 | 0.14 | 0.14 |
| Shaft position PT axial | mm | 0.13 | 0.13 | 0.13 | 0.14 | 0.14 |
| Temp.journal bear. GG f.1 | GrdC | 72.6 | 72.7 | 72.7 | 72.9 | 72.6 |
| Temp.journal bear. GG f.2 | GrdC | 55.1 | 55.5 | 55.2 | 55.4 | 55.2 |
| Temp.thrust bear.GG act.1 | GrdC | 55.5 | 55.6 | 55.5 | 55.6 | 55.4 |
| Temp.thrust bear.GG act.2 | GrdC | 54.7 | 54.8 | 54.7 | 54.9 | 54.7 |
| Temp.journal bear. GG r.1 | GrdC | 88.8 | 88.9 | 88.8 | 89.0 | 88.9 |
| Temp.journal bear. GG r.2 | GrdC | 61.8 | 61.9 | 61.9 | 62.2 | 62.1 |
| Temp.journal bear. PT f.1 | GrdC | 63.8 | 64.6 | 65.4 | 66.6 | 66.9 |
| Temp.journal bear. PT f.2 | GrdC | 73.0 | 73.8 | 74.6 | 75.6 | 76.6 |
| Temp.journal bear. PT r.1 | GrdC | 64.6 | 65.0 | 65.3 | 65.7 | 66.5 |
| Temp.journal bear. PT r.2 | GrdC | 52.5 | 53.2 | 53.5 | 54.2 | 55.6 |
| Temp.thrust bear.PT act.1 | GrdC | 61.9 | 62.6 | 63.1 | 63.8 | 62.8 |
| Temp.thrust bear.PT act.2 | GrdC | 74.8 | 75.9 | 77.1 | 78.1 | 76.9 |
| Measured O2 | % | 16.18 | 16.15 | 16.14 | 16.15 | 16.14 |
| Measured CO | mg/m3 | 6.9 | 5.3 | 5.8 | 5.2 | 7.0 |
| Measured NO | mg/m3 | 4.8 | 5.3 | 5.4 | 4.1 | 4.4 |
| Measured NO2 | mg/m3 | 7.8 | 7.9 | 8.0 | 7.9 | 7.9 |

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MACHINE NO. : 2154
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

Shop Performance Test

| MEASURINGPOINT | | 052 | 053 | 054 | 055 | 056 |
|---------------------------|-------|---------|---------|---------|---------|---------|
| SAMPLETIME | | 12:31 | 12:34 | 12:37 | 12:40 | 12:43 |
| Gas Generator (GG) speed | 1/min | 11422 | 11421 | 11422 | 11422 | 11427 |
| Power turbine (PT) speed | 1/min | 7278 | 7679 | 8073 | 8467 | 9038 |
| Torque at PT | Nm | 11525.5 | 11089.8 | 10679.3 | 10230.2 | 9549.2 |
| Guide vane position | GRAD | -2.5 | -2.5 | -2.5 | -2.5 | -2.5 |
| Ambient pressure | bar | 1.0074 | 1.0074 | 1.0074 | 1.0073 | 1.0073 |
| Relative humidity | % | 59.8 | 58.5 | 56.3 | 55.8 | 56.0 |
| Reference temperature | GrdC | 8.4 | 8.4 | 8.7 | 9.0 | 8.9 |
| Pressure loss filter | bar | -0.0024 | -0.0024 | -0.0023 | -0.0024 | -0.0024 |
| Pressure loss venturi A | bar | 0.1638 | 0.1637 | 0.1646 | 0.1642 | 0.1646 |
| Pressure loss venturi B | bar | 0.1629 | 0.1631 | 0.1635 | 0.1635 | 0.1637 |
| Pressure loss venturi C | bar | 0.1667 | 0.1671 | 0.1675 | 0.1674 | 0.1675 |
| Inlet press. compressor A | bar_g | -0.0416 | -0.0415 | -0.0413 | -0.0417 | -0.0417 |
| Inlet press. compressor B | bar_g | -0.0413 | -0.0414 | -0.0413 | -0.0419 | -0.0415 |
| Inlet temp. compr. Tt_11 | GrdC | 6.7 | 6.7 | 6.4 | 6.4 | 6.5 |
| Inlet temp. compr. Tt_12 | GrdC | 6.3 | 6.2 | 6.2 | 6.2 | 6.0 |
| Inlet temp. compr. Tt_13 | GrdC | 6.1 | 5.9 | 5.8 | 5.8 | 5.8 |
| Inlet temp. compr. Tt_14 | GrdC | 6.0 | 6.0 | 5.6 | 5.7 | 5.9 |
| Inlet temp. compr. Tt_15 | GrdC | 5.8 | 5.7 | 5.3 | 5.3 | 5.5 |
| Inlet temp. compr. Tt_16 | GrdC | 5.6 | 5.5 | 5.2 | 5.2 | 5.3 |
| Outlet press.compressor A | bar_g | 8.4640 | 8.4775 | 8.4948 | 8.4987 | 8.5041 |
| Outlet press.compressor B | bar_g | 8.5405 | 8.5539 | 8.5723 | 8.5746 | 8.5821 |
| Outlet temp. compr. Tt_21 | GrdC | 315.4 | 315.6 | 315.6 | 315.6 | 315.9 |
| Outlet temp. compr. Tt_22 | GrdC | 317.4 | 317.5 | 317.3 | 317.4 | 317.9 |
| Inlet press. PT | bar_g | 1.6653 | 1.6714 | 1.6784 | 1.6816 | 1.6870 |
| Inlet temp. PT Tt_41 | GrdC | 723.2 | 724.6 | 725.2 | 726.4 | 728.6 |
| Inlet temp. PT Tt_42 | GrdC | 739.4 | 740.8 | 741.7 | 742.7 | 744.8 |
| Inlet temp. PT Tt_43 | GrdC | 724.3 | 725.2 | 726.9 | 727.7 | 729.9 |
| Inlet temp. PT Tt_44 | GrdC | 672.0 | 673.3 | 674.1 | 675.3 | 677.0 |
| Inlet temp. PT Tt_45 | GrdC | 696.8 | 698.5 | 698.4 | 700.1 | 702.0 |
| Inlet temp. PT Tt_46 | GrdC | 739.2 | 740.0 | 741.4 | 742.4 | 744.2 |
| Inlet temp. PT Tt_47 | GrdC | 738.1 | 739.1 | 740.7 | 742.0 | 744.0 |
| Inlet temp. PT Tt_48 | GrdC | 720.4 | 721.8 | 723.5 | 724.4 | 726.8 |
| Outlet press. PT A | bar_g | -0.0012 | 0.0001 | 0.0009 | 0.0011 | 0.0011 |
| Outlet press. PT B | bar_g | 0.0002 | -0.0002 | -0.0003 | -0.0003 | -0.0035 |
| Outlet temp. PT Tt_51 | GrdC | 495.7 | 502.6 | 501.0 | 498.2 | 498.7 |
| Outlet temp. PT Tt_52 | GrdC | 497.3 | 495.7 | 495.0 | 491.8 | 489.7 |
| Outlet temp. PT Tt_53 | GrdC | 504.0 | 503.3 | 496.1 | 487.0 | 481.9 |
| Outlet temp. PT Tt_54 | GrdC | 503.9 | 497.9 | 487.1 | 485.2 | 498.8 |
| Fuel gas temp. | GrdC | 29.5 | 29.5 | 29.4 | 29.4 | 29.4 |
| Fuel gas pressure | bar | 18.8618 | 18.8028 | 18.7195 | 18.7100 | 18.5950 |
| Fuel gas volume flow | m3n/h | 3610.3 | 3622.3 | 3632.1 | 3641.0 | 3644.8 |
| Oil press.GG f. bearing | bar_g | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |

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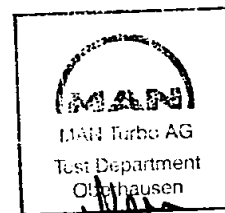


MACHINE NO. : 2154
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

Shop Performance Test

| MEASURINGPOINT | 052 | 053 | 054 | 055 | 056 |
|---------------------------|-------------|-------|-------|-------|-------|
| SAMPLETIME | 12:31 | 12:34 | 12:37 | 12:40 | 12:43 |
| Oil press.GG r. bearing | bar_g 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| Oil press.PT | bar_g 2.2 | 2.2 | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. | GrdC 45.6 | 45.6 | 45.7 | 45.7 | 45.7 |
| Oil vol.flow GG f.bearing | l/min 133.9 | 134.0 | 133.9 | 133.9 | 133.9 |
| Oil vol.flow GG r.bearing | l/min 62.6 | 62.7 | 62.7 | 62.7 | 62.7 |
| Oil vol.flow PT | l/min 120.3 | 120.7 | 120.8 | 120.9 | 120.6 |
| Oil outl.temp.GG f.bear. | GrdC 51.6 | 51.6 | 51.6 | 51.6 | 51.6 |
| Oil outl.temp.GG r.bear. | GrdC 71.1 | 71.2 | 71.3 | 71.3 | 71.4 |
| Oil outl.temp.PT | GrdC 66.6 | 67.5 | 68.8 | 69.9 | 71.4 |
| Shaft vib. GG f.1 unfilt. | my_pp 17 | 17 | 18 | 17 | 16 |
| Shaft vib. GG f.2 unfilt. | my_pp 51 | 51 | 51 | 50 | 50 |
| Shaft vib. PT r.1 unfilt. | my_pp 25 | 30 | 28 | 30 | 33 |
| Shaft vib. PT r.2 unfilt. | my_pp 28 | 35 | 31 | 29 | 30 |
| Shaft position GG axial | mm 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| Shaft position PT axial | mm 0.12 | 0.12 | 0.13 | 0.13 | 0.13 |
| Temp.journal bear. GG f.1 | GrdC 72.8 | 73.0 | 73.1 | 73.1 | 73.0 |
| Temp.journal bear. GG f.2 | GrdC 55.6 | 55.7 | 55.8 | 55.6 | 55.7 |
| Temp.thrust bear.GG act.1 | GrdC 55.9 | 56.0 | 56.1 | 55.9 | 55.9 |
| Temp.thrust bear.GG act.2 | GrdC 55.3 | 55.3 | 55.4 | 55.2 | 55.3 |
| Temp.journal bear. GG r.1 | GrdC 90.2 | 90.3 | 90.3 | 90.2 | 90.4 |
| Temp.journal bear. GG r.2 | GrdC 62.6 | 62.7 | 62.8 | 62.7 | 62.9 |
| Temp.journal bear. PT f.1 | GrdC 64.0 | 64.8 | 65.6 | 66.2 | 67.4 |
| Temp.journal bear. PT f.2 | GrdC 72.6 | 73.3 | 74.3 | 75.1 | 76.3 |
| Temp.journal bear. PT r.1 | GrdC 65.2 | 65.8 | 66.5 | 66.6 | 67.5 |
| Temp.journal bear. PT r.2 | GrdC 52.5 | 53.3 | 53.9 | 54.1 | 55.8 |
| Temp.thrust bear.PT act.1 | GrdC 63.2 | 63.9 | 64.7 | 64.9 | 64.1 |
| Temp.thrust bear.PT act.2 | GrdC 77.4 | 78.4 | 79.7 | 80.3 | 80.1 |
| Measured O2 | % 15.85 | 15.83 | 15.80 | 15.79 | 15.78 |
| Measured CO | mg/m3 1.6 | 1.7 | 1.5 | 1.2 | 1.4 |
| Measured NO | mg/m3 4.6 | 6.1 | 7.0 | 5.4 | 6.2 |
| Measured NO2 | mg/m3 8.2 | 8.4 | 8.2 | 8.3 | 8.2 |

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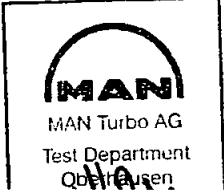




MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | | 057 | 058 | 059 | 060 | 061 |
|---------------------------|-------|---------|---------|---------|---------|---------|
| SAMPLETIME | | 12:59 | 13:03 | 13:05 | 13:07 | 13:09 |
| Gas Generator (GG) speed | 1/min | 11627 | 11627 | 11627 | 11628 | 11626 |
| Power turbine (PT) speed | 1/min | 7288 | 7683 | 8072 | 8463 | 9041 |
| Torque at PT | Nm | 13143.2 | 12724.0 | 12311.3 | 11888.7 | 11191.3 |
| Guide vane position | GRAD | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 |
| Ambient pressure | bar | 1.0071 | 1.0071 | 1.0071 | 1.0071 | 1.0071 |
| Relative humidity | % | 57.1 | 55.5 | 53.8 | 53.5 | 56.3 |
| Reference temperature | GrdC | 8.9 | 9.0 | 8.9 | 9.0 | 8.9 |
| Pressure loss filter | bar | -0.0026 | -0.0025 | -0.0025 | -0.0025 | -0.0026 |
| Pressure loss venturi A | bar | 0.1833 | 0.1835 | 0.1838 | 0.1843 | 0.1836 |
| Pressure loss venturi B | bar | 0.1823 | 0.1826 | 0.1830 | 0.1831 | 0.1826 |
| Pressure loss venturi C | bar | 0.1865 | 0.1868 | 0.1871 | 0.1871 | 0.1867 |
| Inlet press. compressor A | bar_g | -0.0470 | -0.0469 | -0.0470 | -0.0475 | -0.0474 |
| Inlet press. compressor B | bar_g | -0.0464 | -0.0463 | -0.0465 | -0.0468 | -0.0467 |
| Inlet temp. compr. Tt_11 | GrdC | 6.9 | 6.6 | 6.3 | 6.5 | 6.6 |
| Inlet temp. compr. Tt_12 | GrdC | 6.4 | 6.1 | 5.9 | 6.0 | 6.1 |
| Inlet temp. compr. Tt_13 | GrdC | 6.3 | 5.8 | 5.5 | 5.6 | 5.8 |
| Inlet temp. compr. Tt_14 | GrdC | 6.3 | 5.9 | 5.6 | 5.8 | 5.9 |
| Inlet temp. compr. Tt_15 | GrdC | 6.0 | 5.5 | 5.2 | 5.3 | 5.6 |
| Inlet temp. compr. Tt_16 | GrdC | 5.7 | 5.3 | 5.1 | 5.3 | 5.3 |
| Outlet press.compressor A | bar_g | 9.1018 | 9.1183 | 9.1366 | 9.1420 | 9.1359 |
| Outlet press.compressor B | bar_g | 9.1872 | 9.2042 | 9.2214 | 9.2275 | 9.2216 |
| Outlet temp. compr. Tt_21 | GrdC | 330.3 | 329.9 | 329.7 | 330.2 | 330.2 |
| Outlet temp. compr. Tt_22 | GrdC | 332.3 | 331.8 | 331.7 | 332.0 | 332.2 |
| Inlet press. PT | bar_g | 1.8455 | 1.8507 | 1.8581 | 1.8628 | 1.8641 |
| Inlet temp. PT Tt_41 | GrdC | 769.0 | 769.5 | 770.7 | 772.1 | 773.5 |
| Inlet temp. PT Tt_42 | GrdC | 788.1 | 788.0 | 789.6 | 791.5 | 792.3 |
| Inlet temp. PT Tt_43 | GrdC | 773.9 | 774.4 | 775.7 | 777.7 | 778.2 |
| Inlet temp. PT Tt_44 | GrdC | 719.0 | 718.7 | 719.8 | 721.1 | 722.5 |
| Inlet temp. PT Tt_45 | GrdC | 745.9 | 745.9 | 746.5 | 749.7 | 749.6 |
| Inlet temp. PT Tt_46 | GrdC | 790.3 | 790.3 | 791.8 | 793.9 | 795.3 |
| Inlet temp. PT Tt_47 | GrdC | 793.2 | 793.5 | 795.6 | 795.0 | 798.2 |
| Inlet temp. PT Tt_48 | GrdC | 770.2 | 770.6 | 772.2 | 771.1 | 774.5 |
| Outlet press. PT A | bar_g | -0.0020 | -0.0009 | -0.0011 | 0.0008 | 0.0005 |
| Outlet press. PT B | bar_g | 0.0003 | 0.0014 | 0.0021 | 0.0006 | -0.0025 |
| Outlet temp. PT Tt_51 | GrdC | 524.2 | 519.2 | 524.3 | 530.0 | 528.7 |
| Outlet temp. PT Tt_52 | GrdC | 531.2 | 527.8 | 526.7 | 525.1 | 524.9 |
| Outlet temp. PT Tt_53 | GrdC | 534.2 | 532.5 | 532.9 | 531.6 | 517.2 |
| Outlet temp. PT Tt_54 | GrdC | 534.3 | 532.4 | 530.9 | 523.8 | 514.6 |
| Fuel gas temp. | GrdC | 29.3 | 29.2 | 29.2 | 29.1 | 29.1 |
| Fuel gas pressure | bar | 18.2659 | 18.2183 | 18.1509 | 18.1100 | 18.1253 |
| Fuel gas volume flow | m3n/h | 4054.7 | 4064.2 | 4078.6 | 4085.9 | 4086.4 |
| Oil press.GG f. bearing | bar_g | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |

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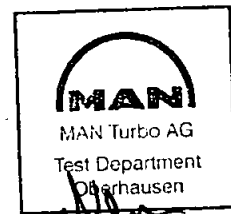


MACHINE NO. : 2154
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

Shop Performance Test

| MEASURINGPOINT | 057 | 058 | 059 | 060 | 061 |
|---------------------------|-------------|-------|-------|-------|-------|
| SAMPLETIME | 12:59 | 13:03 | 13:05 | 13:07 | 13:09 |
| Oil press.GG r. bearing | bar_g 1.9 | 1.9 | 1.9 | 1.9 | 1.9 |
| Oil press.PT | bar_g 2.2 | 2.2 | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. | GrdC 46.0 | 46.0 | 46.0 | 46.0 | 46.1 |
| Oil vol.flow GG f.bearing | l/min 134.7 | 134.6 | 134.6 | 134.6 | 134.7 |
| Oil vol.flow GG r.bearing | l/min 63.8 | 63.8 | 63.8 | 63.8 | 63.9 |
| Oil vol.flow PT | l/min 121.4 | 121.7 | 121.9 | 122.0 | 121.6 |
| Oil outl.temp.GG f.bear. | GrdC 52.1 | 52.2 | 52.2 | 52.2 | 52.2 |
| Oil outl.temp.GG r.bear. | GrdC 73.0 | 73.1 | 73.1 | 73.1 | 73.2 |
| Oil outl.temp.PT | GrdC 67.8 | 68.8 | 69.8 | 71.0 | 72.4 |
| Shaft vib. GG f.1 unfilt. | my_pp 20 | 20 | 21 | 21 | 19 |
| Shaft vib. GG f.2 unfilt. | my_pp 55 | 55 | 55 | 55 | 55 |
| Shaft vib. PT r.1 unfilt. | my_pp 26 | 32 | 30 | 32 | 33 |
| Shaft vib. PT r.2 unfilt. | my_pp 30 | 37 | 33 | 30 | 33 |
| Shaft position GG axial | mm 0.12 | 0.12 | 0.12 | 0.12 | 0.13 |
| Shaft position PT axial | mm 0.11 | 0.12 | 0.12 | 0.12 | 0.13 |
| Temp.journal bear. GG f.1 | GrdC 73.7 | 73.6 | 73.8 | 73.8 | 74.0 |
| Temp.journal bear. GG f.2 | GrdC 55.9 | 56.0 | 56.0 | 56.1 | 56.3 |
| Temp.thrust bear.GG act.1 | GrdC 56.6 | 56.7 | 56.7 | 56.6 | 56.7 |
| Temp.thrust bear.GG act.2 | GrdC 56.0 | 56.1 | 56.2 | 56.1 | 56.2 |
| Temp.journal bear. GG r.1 | GrdC 91.8 | 91.8 | 91.9 | 92.0 | 92.1 |
| Temp.journal bear. GG r.2 | GrdC 63.6 | 63.8 | 63.9 | 63.9 | 64.1 |
| Temp.journal bear. PT f.1 | GrdC 64.6 | 65.4 | 66.2 | 66.9 | 67.9 |
| Temp.journal bear. PT f.2 | GrdC 72.4 | 72.9 | 73.7 | 74.5 | 75.6 |
| Temp.journal bear. PT r.1 | GrdC 66.0 | 66.6 | 67.3 | 67.8 | 68.9 |
| Temp.journal bear. PT r.2 | GrdC 52.5 | 53.4 | 54.0 | 54.6 | 56.3 |
| Temp.thrust bear.PT act.1 | GrdC 64.9 | 65.6 | 66.2 | 66.5 | 65.8 |
| Temp.thrust bear.PT act.2 | GrdC 80.4 | 81.5 | 82.7 | 83.5 | 83.9 |
| Measured O2 | % 15.39 | 15.39 | 15.36 | 15.34 | 15.34 |
| Measured CO | mg/m3 1.4 | 1.4 | 1.3 | 1.5 | 1.3 |
| Measured NO | mg/m3 8.6 | 8.4 | 8.4 | 9.6 | 8.5 |
| Measured NO2 | mg/m3 8.8 | 8.9 | 8.8 | 8.9 | 8.9 |

SGS
 REVIEWED
 Date: 2010.11.20.10
 Signed: *[Signature]*

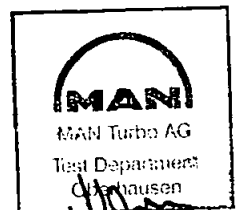




MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | | 062 | 063 | 064 | 065 |
|---------------------------|-------|---------|---------|---------|---------|
| SAMPLETIME | | 13:26 | 13:29 | 13:32 | 13:34 |
| Gas Generator (GG) speed | 1/min | 11706 | 11710 | 11706 | 11706 |
| Power turbine (PT) speed | 1/min | 7681 | 8074 | 8474 | 9041 |
| Torque at PT | Nm | 13358.8 | 12882.6 | 12431.5 | 11824.4 |
| Guide vane position | GRAD | 4.5 | 4.6 | 4.6 | 4.6 |
| Ambient pressure | bar | 1.0069 | 1.0069 | 1.0068 | 1.0067 |
| Relative humidity | % | 54.8 | 56.0 | 53.9 | 54.8 |
| Reference temperature | GrdC | 8.3 | 8.5 | 8.7 | 8.3 |
| Pressure loss filter | bar | -0.0026 | -0.0026 | -0.0026 | -0.0026 |
| Pressure loss venturi A | bar | 0.1914 | 0.1908 | 0.1908 | 0.1914 |
| Pressure loss venturi B | bar | 0.1903 | 0.1898 | 0.1898 | 0.1904 |
| Pressure loss venturi C | bar | 0.1946 | 0.1940 | 0.1940 | 0.1946 |
| Inlet press. compressor A | bar_g | -0.0484 | -0.0481 | -0.0486 | -0.0483 |
| Inlet press. compressor B | bar_g | -0.0483 | -0.0483 | -0.0489 | -0.0484 |
| Inlet temp. compr. Tt_11 | GrdC | 6.6 | 6.9 | 6.7 | 6.4 |
| Inlet temp. compr. Tt_12 | GrdC | 6.0 | 6.4 | 6.1 | 5.8 |
| Inlet temp. compr. Tt_13 | GrdC | 5.7 | 6.2 | 5.9 | 5.6 |
| Inlet temp. compr. Tt_14 | GrdC | 5.7 | 6.0 | 5.8 | 5.7 |
| Inlet temp. compr. Tt_15 | GrdC | 5.3 | 5.7 | 5.5 | 5.2 |
| Inlet temp. compr. Tt_16 | GrdC | 5.3 | 5.5 | 5.4 | 5.1 |
| Outlet press.compressor A | bar_g | 9.3753 | 9.3587 | 9.3633 | 9.3851 |
| Outlet press.compressor B | bar_g | 9.4647 | 9.4472 | 9.4514 | 9.4746 |
| Outlet temp. compr. Tt_21 | GrdC | 336.2 | 336.6 | 336.3 | 336.2 |
| Outlet temp. compr. Tt_22 | GrdC | 338.1 | 338.4 | 338.1 | 338.1 |
| Inlet press. PT | bar_g | 1.9284 | 1.9254 | 1.9286 | 1.9384 |
| Inlet temp. PT Tt_41 | GrdC | 790.2 | 791.0 | 791.0 | 793.0 |
| Inlet temp. PT Tt_42 | GrdC | 812.3 | 812.8 | 813.3 | 815.2 |
| Inlet temp. PT Tt_43 | GrdC | 796.6 | 797.0 | 798.4 | 799.2 |
| Inlet temp. PT Tt_44 | GrdC | 738.8 | 739.4 | 739.5 | 741.2 |
| Inlet temp. PT Tt_45 | GrdC | 773.3 | 774.8 | 774.2 | 777.0 |
| Inlet temp. PT Tt_46 | GrdC | 815.4 | 815.8 | 816.0 | 817.7 |
| Inlet temp. PT Tt_47 | GrdC | 806.0 | 805.3 | 806.7 | 807.2 |
| Inlet temp. PT Tt_48 | GrdC | 772.8 | 771.9 | 773.5 | 774.1 |
| Outlet press. PT A | bar_g | -0.0010 | -0.0003 | -0.0002 | 0.0001 |
| Outlet press. PT B | bar_g | 0.0017 | 0.0028 | 0.0018 | -0.0011 |
| Outlet temp. PT Tt_51 | GrdC | 535.5 | 533.1 | 538.3 | 540.1 |
| Outlet temp. PT Tt_52 | GrdC | 540.3 | 537.8 | 535.4 | 534.8 |
| Outlet temp. PT Tt_53 | GrdC | 543.8 | 543.8 | 543.1 | 537.8 |
| Outlet temp. PT Tt_54 | GrdC | 545.9 | 544.6 | 541.8 | 532.0 |
| Fuel gas temp. | GrdC | 28.8 | 28.8 | 28.7 | 28.7 |
| Fuel gas pressure | bar | 18.6775 | 18.7020 | 18.6642 | 18.6704 |
| Fuel gas volume flow | m3n/h | 4259.7 | 4248.7 | 4261.4 | 4275.7 |
| Oil press.GG f. bearing | bar_g | 2.5 | 2.5 | 2.5 | 2.5 |

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 REVIEWED
 Date: 2010-11-20-10
 Signed: *[Signature]*





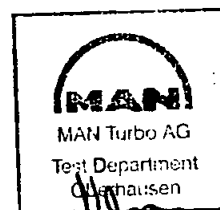
MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | 062 | 063 | 064 | 065 |
|---------------------------|-------------|-------|-------|-------|
| SAMPLETIME | 13:26 | 13:29 | 13:32 | 13:34 |
| Oil press.GG r. bearing | bar_g 1.9 | 1.9 | 1.9 | 1.9 |
| Oil press.PT | bar_g 2.2 | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. | GrdC 46.3 | 46.3 | 46.4 | 46.4 |
| Oil vol.flow GG f.bearing | l/min 135.3 | 135.3 | 135.4 | 135.3 |
| Oil vol.flow GG r.bearing | l/min 64.4 | 64.4 | 64.4 | 64.4 |
| Oil vol.flow PT | l/min 122.7 | 122.9 | 123.0 | 122.5 |
| Oil outl.temp.GG f.bear. | GrdC 52.5 | 52.5 | 52.6 | 52.5 |
| Oil outl.temp.GG r.bear. | GrdC 73.8 | 73.8 | 73.8 | 73.9 |
| Oil outl.temp.PT | GrdC 69.4 | 70.2 | 71.5 | 72.9 |
| Shaft vib. GG f.1 unfilt. | my_pp 25 | 26 | 25 | 23 |
| Shaft vib. GG f.2 unfilt. | my_pp 57 | 56 | 57 | 58 |
| Shaft vib. PT r.1 unfilt. | my_pp 33 | 32 | 33 | 36 |
| Shaft vib. PT r.2 unfilt. | my_pp 39 | 34 | 31 | 35 |
| Shaft position GG axial | mm 0.12 | 0.12 | 0.12 | 0.12 |
| Shaft position PT axial | mm 0.11 | 0.11 | 0.12 | 0.12 |
| Temp.journal bear. GG f.1 | GrdC 74.0 | 74.1 | 74.0 | 74.0 |
| Temp.journal bear. GG f.2 | GrdC 56.2 | 56.1 | 56.1 | 56.5 |
| Temp.thrust bear.GG act.1 | GrdC 57.1 | 57.2 | 57.0 | 57.0 |
| Temp.thrust bear.GG act.2 | GrdC 56.6 | 56.7 | 56.5 | 56.7 |
| Temp.journal bear. GG r.1 | GrdC 92.5 | 92.6 | 92.5 | 92.7 |
| Temp.journal bear. GG r.2 | GrdC 64.1 | 64.2 | 64.1 | 64.4 |
| Temp.journal bear. PT f.1 | GrdC 64.7 | 64.9 | 65.6 | 66.4 |
| Temp.journal bear. PT f.2 | GrdC 73.1 | 73.7 | 74.2 | 75.6 |
| Temp.journal bear. PT r.1 | GrdC 66.5 | 67.1 | 67.6 | 68.6 |
| Temp.journal bear. PT r.2 | GrdC 55.0 | 56.0 | 56.8 | 59.4 |
| Temp.thrust bear.PT act.1 | GrdC 66.2 | 66.8 | 67.1 | 66.6 |
| Temp.thrust bear.PT act.2 | GrdC 82.9 | 83.6 | 84.4 | 85.6 |
| Measured O2 | % 15.17 | 15.17 | 15.16 | 15.15 |
| Measured CO | mg/m3 1.2 | 1.6 | 1.3 | 1.2 |
| Measured NO | mg/m3 9.9 | 10.0 | 10.2 | 10.4 |
| Measured NO2 | mg/m3 9.5 | 9.3 | 9.2 | 9.3 |

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Date: 2010/1/20/10
 Signed: *Pattelhan*





MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

| MEASURINGPOINT | | 066 | 067 | 068 | 069 |
|---------------------------|-------|---------|---------|---------|---------|
| SAMPLETIME | | 13:36 | 13:51 | 14:06 | 14:12 |
| Gas Generator (GG) speed | 1/min | 11720 | 11689 | 11707 | 11689 |
| Power turbine (PT) speed | 1/min | 9035 | 9038 | 9035 | 9306 |
| Torque at PT | Nm | 11900.8 | 11649.7 | 11717.2 | 11404.2 |
| Guide vane position | GRAD | 4.8 | 4.5 | 4.5 | 4.5 |
| Ambient pressure | bar | 1.0067 | 1.0065 | 1.0065 | 1.0065 |
| Relative humidity | % | 53.1 | 52.7 | 52.1 | 50.9 |
| Reference temperature | GrdC | 8.4 | 8.9 | 8.2 | 8.2 |
| Pressure loss filter | bar | -0.0026 | -0.0026 | -0.0026 | -0.0024 |
| Pressure loss venturi A | bar | 0.1928 | 0.1889 | 0.1906 | 0.1900 |
| Pressure loss venturi B | bar | 0.1918 | 0.1879 | 0.1894 | 0.1894 |
| Pressure loss venturi C | bar | 0.1948 | 0.1923 | 0.1931 | 0.1930 |
| Inlet press. compressor A | bar_g | -0.0499 | -0.0471 | -0.0484 | -0.0494 |
| Inlet press. compressor B | bar_g | -0.0495 | -0.0474 | -0.0487 | -0.0487 |
| Inlet temp. compr. Tt_11 | GrdC | 6.1 | 6.8 | 6.4 | 6.6 |
| Inlet temp. compr. Tt_12 | GrdC | 5.3 | 6.3 | 5.8 | 6.0 |
| Inlet temp. compr. Tt_13 | GrdC | 5.1 | 6.1 | 5.4 | 5.6 |
| Inlet temp. compr. Tt_14 | GrdC | 5.6 | 6.2 | 5.7 | 5.8 |
| Inlet temp. compr. Tt_15 | GrdC | 5.3 | 5.8 | 5.3 | 5.3 |
| Inlet temp. compr. Tt_16 | GrdC | 4.9 | 5.6 | 5.1 | 5.2 |
| Outlet press.compressor A | bar_g | 9.4196 | 9.3150 | 9.3465 | 9.3374 |
| Outlet press.compressor B | bar_g | 9.5046 | 9.4010 | 9.4285 | 9.4264 |
| Outlet temp. compr. Tt_21 | GrdC | 336.2 | 335.4 | 335.3 | 335.3 |
| Outlet temp. compr. Tt_22 | GrdC | 338.1 | 337.4 | 337.1 | 337.2 |
| Inlet press. PT | bar_g | 1.9556 | 1.9110 | 1.9226 | 1.9254 |
| Inlet temp. PT Tt_41 | GrdC | 810.8 | 788.1 | 788.8 | 790.3 |
| Inlet temp. PT Tt_42 | GrdC | 817.0 | 809.5 | 811.4 | 811.7 |
| Inlet temp. PT Tt_43 | GrdC | 784.2 | 794.7 | 797.2 | 797.3 |
| Inlet temp. PT Tt_44 | GrdC | 740.3 | 737.8 | 739.2 | 739.5 |
| Inlet temp. PT Tt_45 | GrdC | 780.3 | 768.3 | 773.3 | 774.5 |
| Inlet temp. PT Tt_46 | GrdC | 818.4 | 812.0 | 813.4 | 812.2 |
| Inlet temp. PT Tt_47 | GrdC | 808.9 | 804.8 | 803.4 | 803.1 |
| Inlet temp. PT Tt_48 | GrdC | 774.5 | 772.5 | 771.1 | 770.3 |
| Outlet press. PT A | bar_g | 0.0002 | 0.0004 | 0.0001 | 0.0008 |
| Outlet press. PT B | bar_g | -0.0003 | -0.0013 | -0.0013 | -0.0025 |
| Outlet temp. PT Tt_51 | GrdC | 539.5 | 538.4 | 537.6 | 536.7 |
| Outlet temp. PT Tt_52 | GrdC | 534.3 | 532.1 | 532.5 | 532.3 |
| Outlet temp. PT Tt_53 | GrdC | 537.8 | 533.2 | 533.6 | 526.9 |
| Outlet temp. PT Tt_54 | GrdC | 532.6 | 527.4 | 528.9 | 525.0 |
| Fuel gas temp. | GrdC | 28.7 | 28.7 | 28.5 | 28.4 |
| Fuel gas pressure | bar | 18.6985 | 18.7733 | 18.4646 | 18.4054 |
| Fuel gas volume flow | m3n/h | 4279.7 | 4240.3 | 4248.8 | 4240.3 |
| Oil press.GG f. bearing | bar_g | 2.5 | 2.5 | 2.5 | 2.5 |

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Date: 2011012010

Signed: *[Signature]*





MACHINE NO. : 2154 Shop Performance Test
 ORDER-NO. : H.0200017
 CODEWORD : VILLARPIPE 1
 TYPE : THM 1304-12 DLN
 DATE OF TEST: 20.01.2010

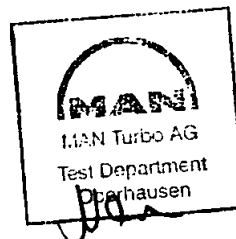
| MEASURINGPOINT | 066 | 067 | 068 | 069 |
|---------------------------------|-------|-------|-------|-------|
| SAMPLETIME | 13:36 | 13:51 | 14:06 | 14:12 |
| Oil press.GG r. bearing bar_g | 1.9 | 1.9 | 1.9 | 1.9 |
| Oil press.PT bar_g | 2.2 | 2.2 | 2.2 | 2.2 |
| Oil inlet temp. GrdC | 46.5 | 47.0 | 47.2 | 47.1 |
| Oil vol.flow GG f.bearing l/min | 135.4 | 135.8 | 135.8 | 135.9 |
| Oil vol.flow GG r.bearing l/min | 64.5 | 64.5 | 64.6 | 64.6 |
| Oil vol.flow PT l/min | 122.7 | 123.5 | 123.6 | 123.9 |
| Oil outl.temp.GG f.bear. GrdC | 52.7 | 53.0 | 53.2 | 53.2 |
| Oil outl.temp.GG r.bear. GrdC | 74.0 | 74.5 | 74.6 | 74.6 |
| Oil outl.temp.PT GrdC | 73.4 | 74.6 | 74.8 | 75.8 |
| Shaft vib. GG f.1 unfilt. my_pp | 23 | 21 | 22 | 22 |
| Shaft vib. GG f.2 unfilt. my_pp | 58 | 57 | 57 | 57 |
| Shaft vib. PT r.1 unfilt. my_pp | 36 | 37 | 37 | 39 |
| Shaft vib. PT r.2 unfilt. my_pp | 35 | 34 | 34 | 34 |
| Shaft position GG axial mm | 0.12 | 0.12 | 0.12 | 0.12 |
| Shaft position PT axial mm | 0.13 | 0.13 | 0.13 | 0.14 |
| Temp.journal bear. GG f.1 GrdC | 74.5 | 73.7 | 73.9 | 74.2 |
| Temp.journal bear. GG f.2 GrdC | 56.5 | 56.7 | 57.0 | 56.8 |
| Temp.thrust bear.GG act.1 GrdC | 57.2 | 57.0 | 57.3 | 57.2 |
| Temp.thrust bear.GG act.2 GrdC | 56.6 | 57.0 | 57.1 | 56.9 |
| Temp.journal bear. GG r.1 GrdC | 92.9 | 92.4 | 92.4 | 92.5 |
| Temp.journal bear. GG r.2 GrdC | 64.4 | 64.8 | 65.0 | 64.8 |
| Temp.journal bear. PT f.1 GrdC | 66.2 | 65.6 | 65.5 | 65.5 |
| Temp.journal bear. PT f.2 GrdC | 75.9 | 76.4 | 76.5 | 76.6 |
| Temp.journal bear. PT r.1 GrdC | 68.6 | 67.9 | 68.4 | 69.1 |
| Temp.journal bear. PT r.2 GrdC | 59.4 | 61.7 | 62.6 | 65.0 |
| Temp.thrust bear.PT act.1 GrdC | 66.8 | 66.6 | 66.9 | 67.1 |
| Temp.thrust bear.PT act.2 GrdC | 85.5 | 84.9 | 85.1 | 85.3 |
| Measured O2 % | 15.13 | 15.19 | 15.19 | 15.19 |
| Measured CO mg/m3 | 1.3 | 1.5 | 1.6 | 1.7 |
| Measured NO mg/m3 | 10.7 | 9.8 | 10.4 | 11.8 |
| Measured NO2 mg/m3 | 9.3 | 8.9 | 8.8 | 8.7 |

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Date: 2010-11-20-10

Signed: *[Signature]*



MAN TURBO AG



| | | | |
|------------|--------------|--------|---------------|
| Doc. No.: | 100005 64542 | Rev. 0 | ATP&R-THM |
| Code Word: | VILLARPIPE 1 | | Appendix RVT |
| Order No.: | H.0200017 | | Page 32 of 41 |

7 Fuel Gas Analysis

DEPARTMENT : PP53
VILLARPIPE 1



Fuel Gas Data Analysis

Instrument : Gaschromatograph Foxboro Typ 931C-1C1A1B3
Ser.No. 94F21196-01-701

Sampling time : 20.01.2010 14:14:00 hours

Readings :

| Components | Equation | Vol.-% |
|----------------|----------|----------------|
| Helium | He | 0,061 |
| Nitrogen | N2 | 11,831 |
| Methane | CH4 | 82,743 |
| Carbon Dioxide | CO2 | 1,450 |
| Ethane | C2H6 | 3,155 |
| Propane | C3H8 | 0,481 |
| i-Butane | i-C4H10 | 0,079 |
| Butane | n-C4H10 | 0,088 |
| i-Pentane | i-C5H12 | 0,022 |
| Pentane | n-C5H12 | 0,022 |
| Summary C6+ | C6+ | 0,067 |
| Summary | | 100,000 |

Determination of Fuel Gas Data according to DIN 51857 :

Calorific Value (MJ/m³-n) 32,5360
Specific Density Ratio (-) 0,6426

Date

20.1.10

Signature

P. S.

MAN TURBO AG



| | | | |
|------------|--------------|--------|---------------|
| Doc. No.: | 100005 64542 | Rev. 0 | ATP&R-THM |
| Code Word: | VILLARPIPE 1 | | Appendix RVT |
| Order No.: | H.0200017 | | Page 34 of 41 |

8 Vibration Report SMB 1785



| | | | |
|--------------------|--|---------------------------|----------------------------|
| Abt./Dept. PP53 | MAN Turbo Kennwort/Code Word : MAN Turbo Auftrag-Nr./Job No.: | VILLARPIPE 1 H.0200017 | Seite/Page 1/5 SMB 1785 |
|--------------------|--|---------------------------|----------------------------|

Date: 27.01.10

SMB 1785

Vibration Measurements during the Mechanical Shop Running Test

| | |
|--------------|----------------|
| Code Word | "VILLARPIPE 1" |
| Job Number | H.0200017 |
| Date of Test | 20.JAN.2010 |

| 1. Machines, Serial Numbers, Manufactures, ... | |
|--|--|
| Air Multi-shaft Compressor | ---- |
| Air Axial Compressor | ---- |
| Screw Compressor | ---- |
| Expander | ---- |
| Steam Turbine | ---- |
| Gas Turbine | THM 1304 – 12 / No. 2154 / 2154 / MAN Turbo AG |
| Gear | ---- |
| Electric Motor | ---- |
| Generator | ---- |

| 2. Operation Speeds [rpm]. | | | | | |
|----------------------------|--------------------|------------------|-------------------|------------------|-------------------|
| Machine | | N _{min} | N _{norm} | N _{max} | N _{trip} |
| 1 | Gas Generator (GG) | 9400 | 11900 | 12100 | 12200 |
| 2 | Power Turbine (PT) | 3870 | 8600 | 9030 | 9480 |
| 3 | ---- | -- | -- | -- | -- |
| 4 | ---- | -- | -- | -- | -- |
| 5 | ---- | -- | -- | -- | -- |
| 6 | ---- | -- | -- | -- | -- |

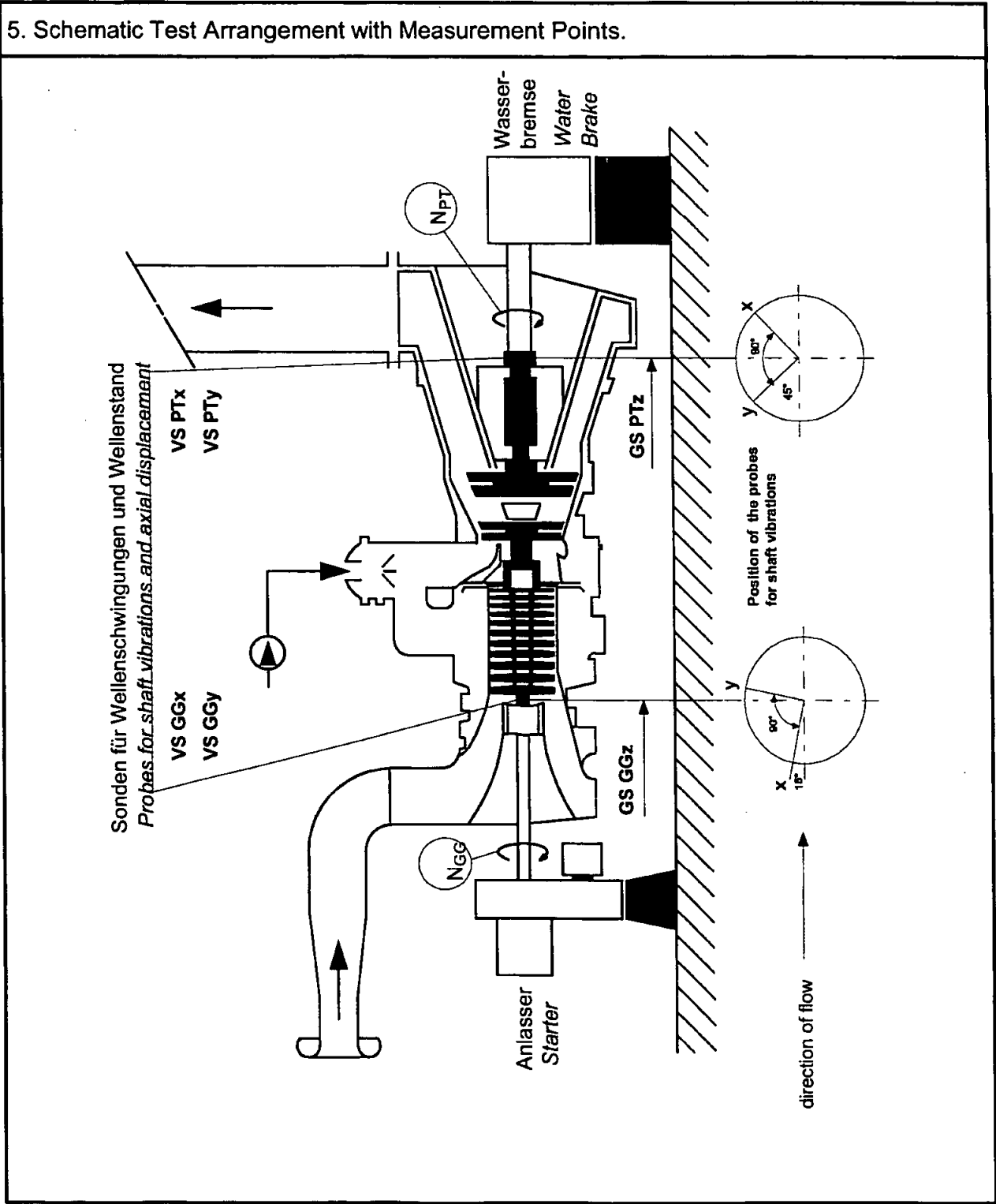


| | | | |
|--------------------|--|---------------------------|----------------------------|
| Abt./Dept. PP53 | MAN Turbo Kennwort/Code Word : MAN Turbo Auftrag-Nr./Job No.: | VILLARPIPE 1 H.0200017 | Seite/Page 2/5 SMB 1785 |
|--------------------|--|---------------------------|----------------------------|

| 3. Lateral Critical Speeds [rpm]. | | Calculated | | |
|-----------------------------------|--------------------|-----------------|-----------------|-----------------|
| Machine | | N _{c1} | N _{c2} | N _{c3} |
| 1 | Gas Generator (GG) | ~20000 | -- | -- |
| 2 | Power Turbine (PT) | ~21000 | -- | -- |
| 3 | ---- | -- | -- | -- |
| 4 | ---- | -- | -- | -- |
| 5 | ---- | -- | -- | -- |
| | | Measured | | |
| Machine | | N _{c1} | N _{c2} | N _{c3} |
| 1 | Gas Generator (GG) | -- | -- | -- |
| 2 | Power Turbine (PT) | -- | -- | -- |
| 3 | ---- | -- | -- | -- |
| 4 | ---- | -- | -- | -- |
| 5 | ---- | -- | -- | -- |

| | | | | | | | |
|---|---------------|----|-------|--|----|------|--|
| 4. Applicable Specifications. | | | | | | | |
| 4.1. Vibrations measured on the shafts.**) | | | | | | | |
| Specification: | Limits [µm] | GG | 60* | | PT | 60* | |
| ATP & R -THM Rev.1 | Speeds [rpm] | GG | 11900 | | PT | 8600 | |
| Measurement Quantity: *) Peak to Peak Value S _{p-p} | | | | | | | |
| 4.2. Vibrations measured on the Bearing Housings. | | | | | | | |
| Specification: ISO 10816-4 not applicable. | Limits [mm/s] | GG | 4.5* | | PT | 4.5* | |
| Measurement Quantity: *) RMS Value | | | | | | | |
| Remarks: **) Filtered values (rotational frequency, only). | | | | | | | |

| | | | |
|--------------------|--|---------------------------|----------------------------|
| Abt./Dept. PP53 | MAN Turbo Kennwort/Code Word : MAN Turbo Auftrag-Nr./Job No.: | VILLARPIPE 1 H.0200017 | Seite/Page 3/5 SMB 1785 |
|--------------------|--|---------------------------|----------------------------|





| | | | |
|--------------------|--|---------------------------|----------------------------|
| Abt./Dept. PP53 | MAN Turbo Kennwort/Code Word : MAN Turbo Auftrag-Nr./Job No.: | VILLARPIPE 1 H.0200017 | Seite/Page 4/5 SMB 1785 |
|--------------------|--|---------------------------|----------------------------|

6. Instrumentation.

6.1 Vibration Measurements on the Shafts.

Transducers, Proximitors S 3300 (Bently Nevada),
Monitors S 3500 (Bently Nevada),
Data Acquisition Interface Unit 208 DAIU (Bently Nevada),
ADRE for Windows Version 5.1 (Bently Nevada).

6.2 Vibration Measurements on the Bearing Housings.

Not applicable.

7. Other.

See appendix to this report on plot 1 – 2.

8. Commentary of Results.

The vibratory conditions of the Gas Turbine set „VILLARPIPE 1“ are good and according to the specifications.

The survey of the vibration spectrum during the mechanical shop running test gave no indication of a vibration problem.



| | | | |
|--------------------|--|---------------------------|----------------------------|
| Abt./Dept. PP53 | MAN Turbo Kennwort/Code Word : MAN Turbo Auftrag-Nr./Job No.: | VILLARPIPE 1 H.0200017 | Seite/Page 5/5 SMB 1785 |
|--------------------|--|---------------------------|----------------------------|

| 9. Enclosures: Plots 1 – 2. | |
|-----------------------------|--|
| Plot | Commentary |
| 1 | Spectra at high speed (GG and PT), |
| 2 | Bode diagrams of shutdown (GG and PT). |
| - | --- |
| - | --- |
| - | --- |

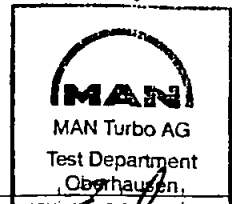
| | |
|--------------------------------|--------------------------|
| 10. Tester: Friedhoff / PP53 | Checked: Nem / PP53 |
| 27.01.2010 <u>R. Friedhoff</u> | 27.01.2010 <u>M. Nem</u> |

MAN Turbo AG

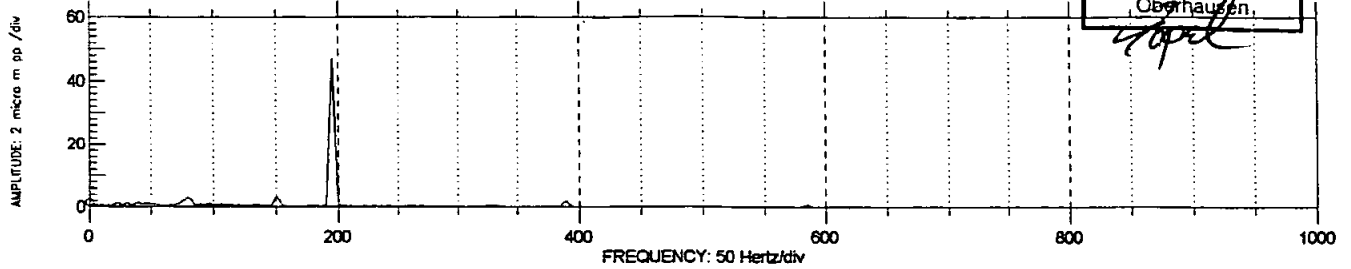


HALF SPECTRUM PLOT
 COMPANY: MAN Turbo AG
 MACHINE TRAIN: VILLARPIPE 1

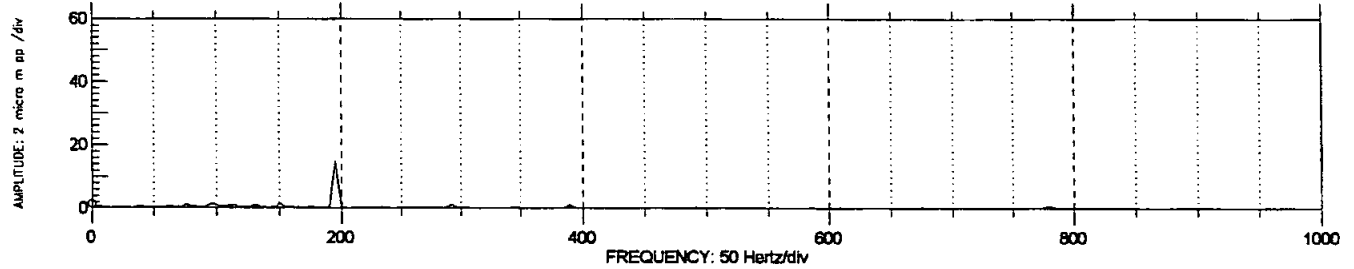
PLOT NO. 1
 PLANT: Test Stand
 JOB REFERENCE: H.0200017/2154



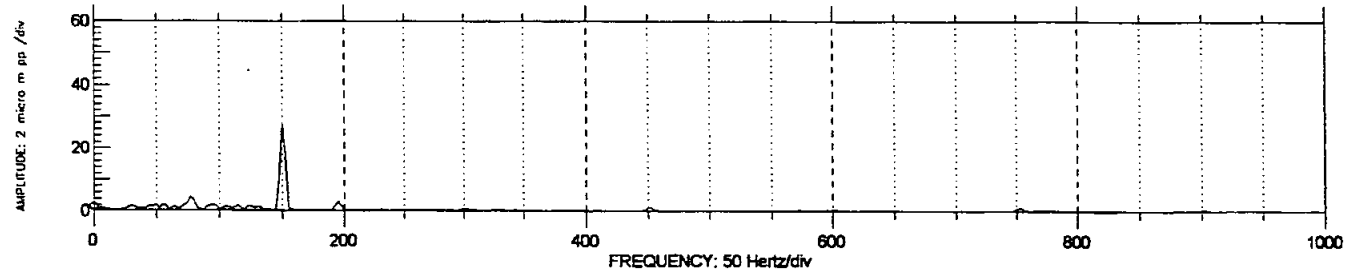
POINT: VS GG X /75° Left DIR AMPL: 51.0 micro m pp
 MACHINE: THM 1304-12 DLN MACHINE SPEED: 11.7 krpm
 20 JAN 2010 13:59:29.2 Steady State
 WINDOW: Hanning SPECTRAL LINES: 400 RESOLUTION: 2.5 Hertz



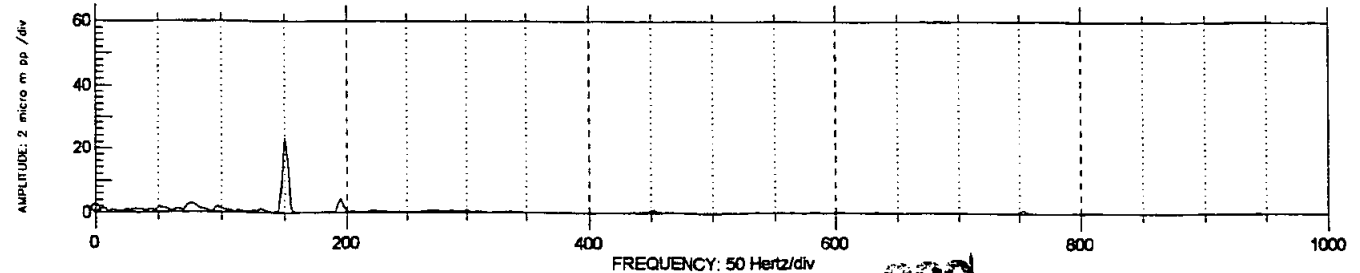
POINT: VS GG Y /15° Right DIR AMPL: 18.1 micro m pp
 MACHINE: THM 1304-12 DLN MACHINE SPEED: 11.7 krpm
 20 JAN 2010 13:59:29.2 Steady State
 WINDOW: Hanning SPECTRAL LINES: 400 RESOLUTION: 2.5 Hertz



POINT: VS PT X /45° Left DIR AMPL: 34.0 micro m pp
 MACHINE: THM 1304-12 DLN MACHINE SPEED: 9027 rpm
 20 JAN 2010 13:51:34.2 Steady State
 WINDOW: Hanning SPECTRAL LINES: 400 RESOLUTION: 2.5 Hertz



POINT: VS PT Y /45° Right DIR AMPL: 31.4 micro m pp
 MACHINE: THM 1304-12 DLN MACHINE SPEED: 9027 rpm
 20 JAN 2010 13:51:34.2 Steady State
 WINDOW: Hanning SPECTRAL LINES: 400 RESOLUTION: 2.5 Hertz



REVIEWED
 Date: 2010-11-20-10
 11:10

MAN Turbo AG

SGS

REVIEWED

Date: 2010/1/29/10

Signed: *[Signature]*

2

PLOT NO. 2

PLANT: Test Stand

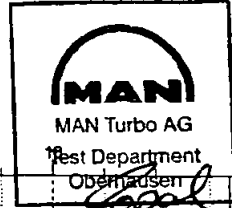
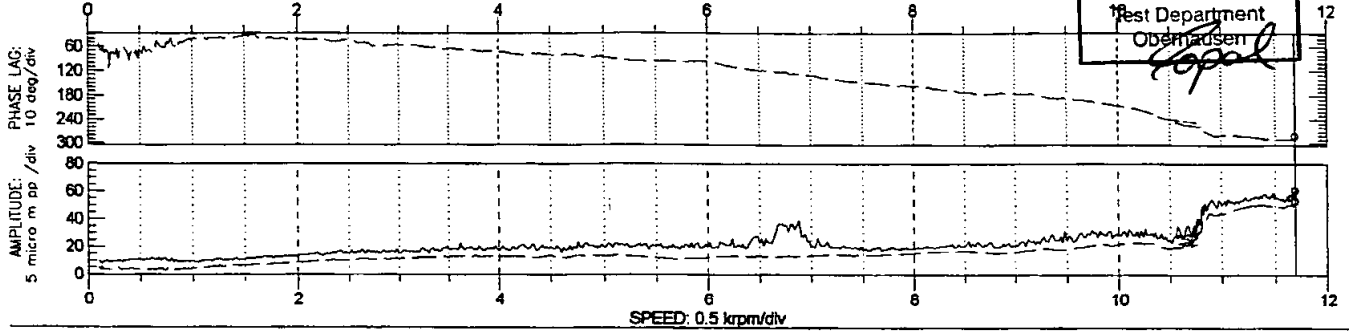
JOB REFERENCE: H.0200017/2154



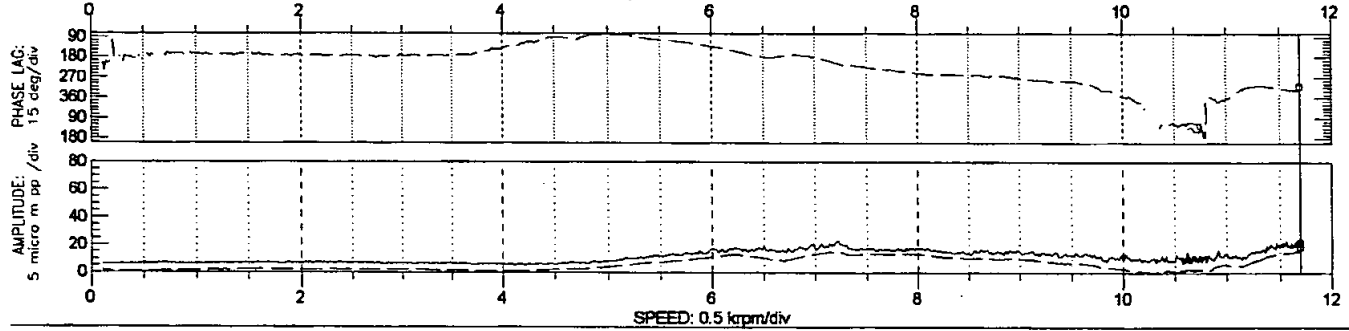
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BODE PLOT
 COMPANY: MAN Turbo AG
 MACHINE TRAIN: VILLARPIPE 1

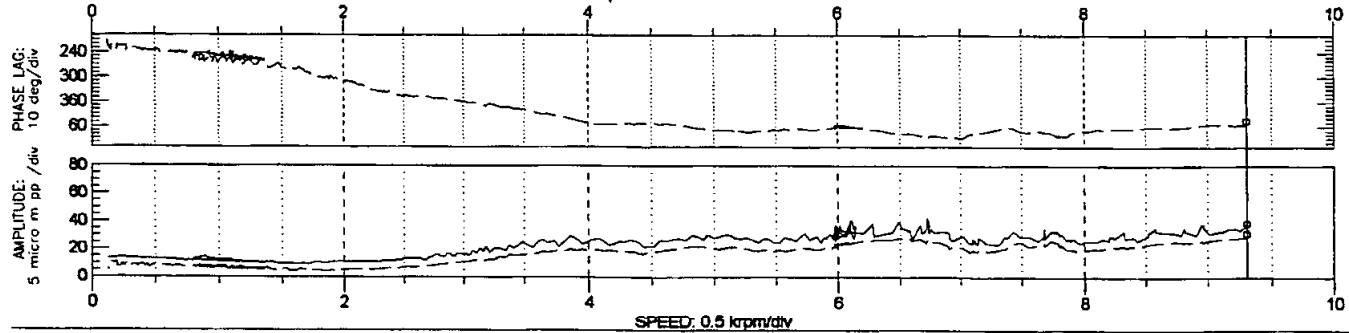
POINT: VS GG X /75° Left — DIRECT 58.3
 POINT: VS GG X /75° Left - - 1X UNCOMP 50.7/290°
 MACHINE: THM 1304-12 DLN
 From 20JAN2010 14:11:03.6 To 20JAN2010 14:17:21.2 Shutdown 11.7 krpm



POINT: VS GG Y /15° Right — DIRECT 19.2
 POINT: VS GG Y /15° Right - - 1X UNCOMP 15.9/325°
 MACHINE: THM 1304-12 DLN
 From 20JAN2010 14:11:03.6 To 20JAN2010 14:17:21.2 Shutdown 11.7 krpm



POINT: VS PT X /45° Left — DIRECT 36.0
 POINT: VS PT X /45° Left - - 1X UNCOMP 28.6/55°
 MACHINE: THM 1304-12 DLN
 From 20JAN2010 14:10:49.2 To 20JAN2010 14:17:21.2 Shutdown 9310 rpm



POINT: VS PT Y /45° Right — DIRECT 28.0
 POINT: VS PT Y /45° Right - - 1X UNCOMP 23.4/327°
 MACHINE: THM 1304-12 DLN
 From 20JAN2010 14:10:49.2 To 20JAN2010 14:17:21.2 Shutdown 9310 rpm

