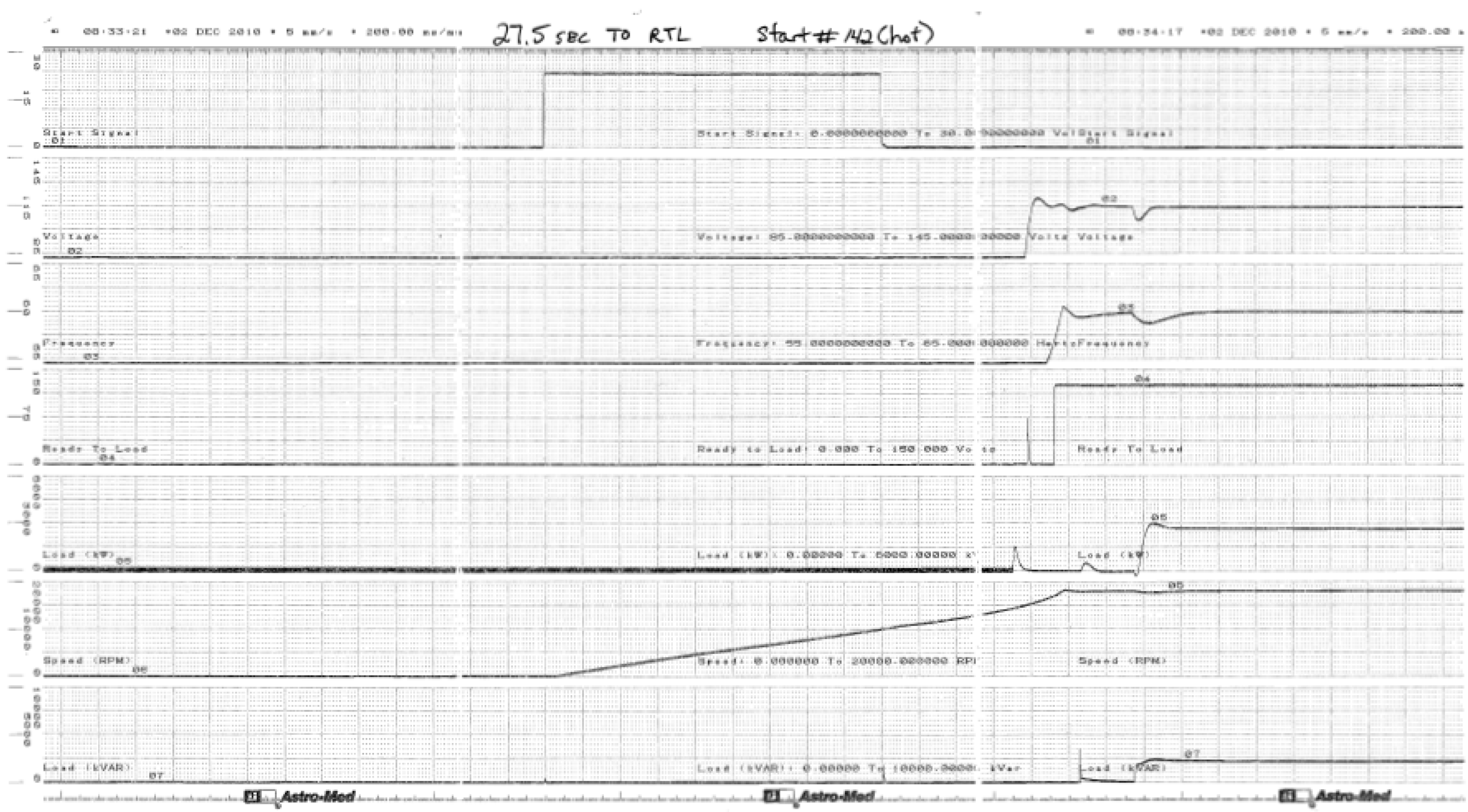

Figure C.1.0-147 Parameter Chart of Start and Load Acceptance Test, No.142, Hot

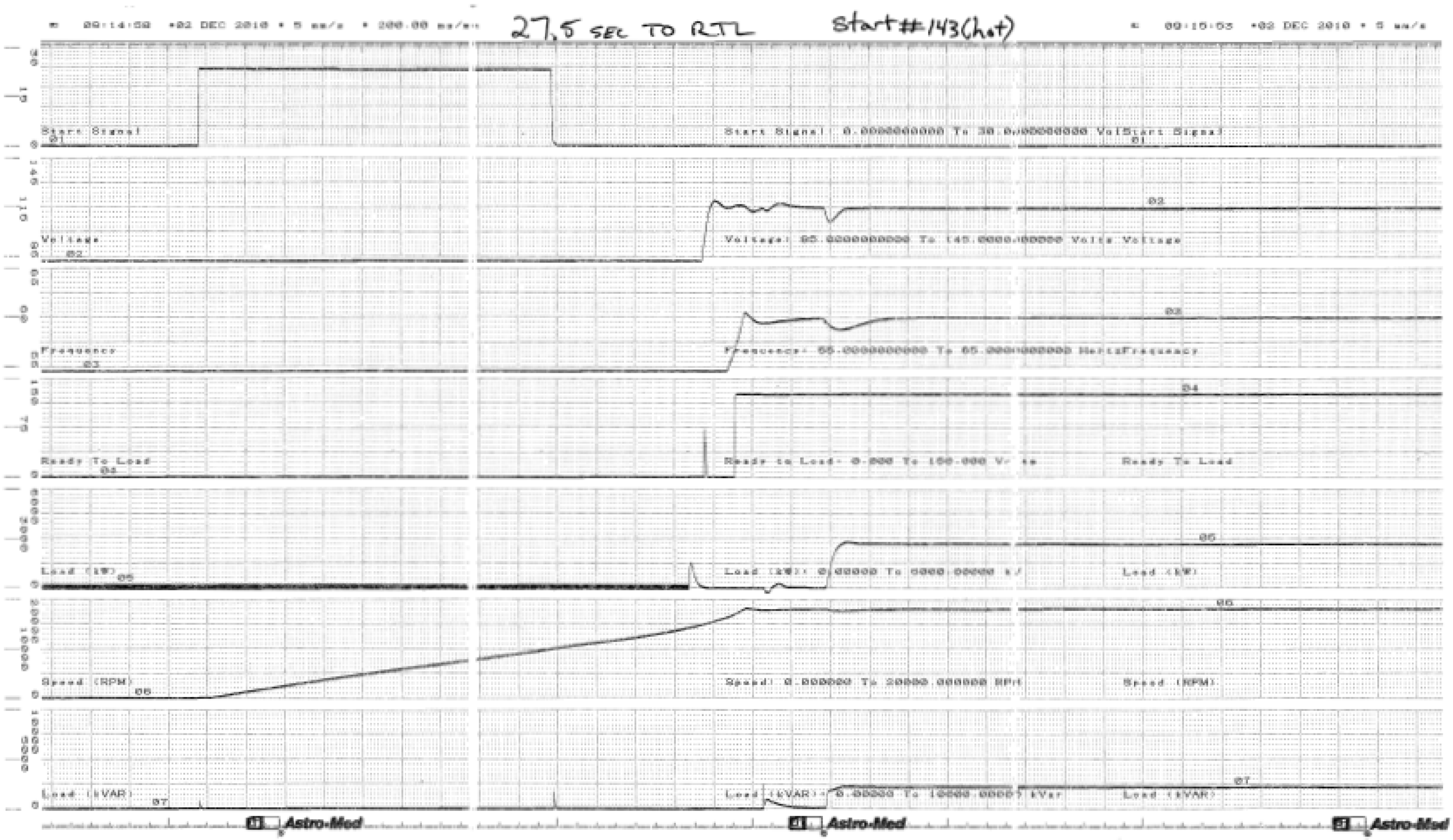

Figure C.1.0-148 Parameter Chart of Start and Load Acceptance Test, No.143, Hot

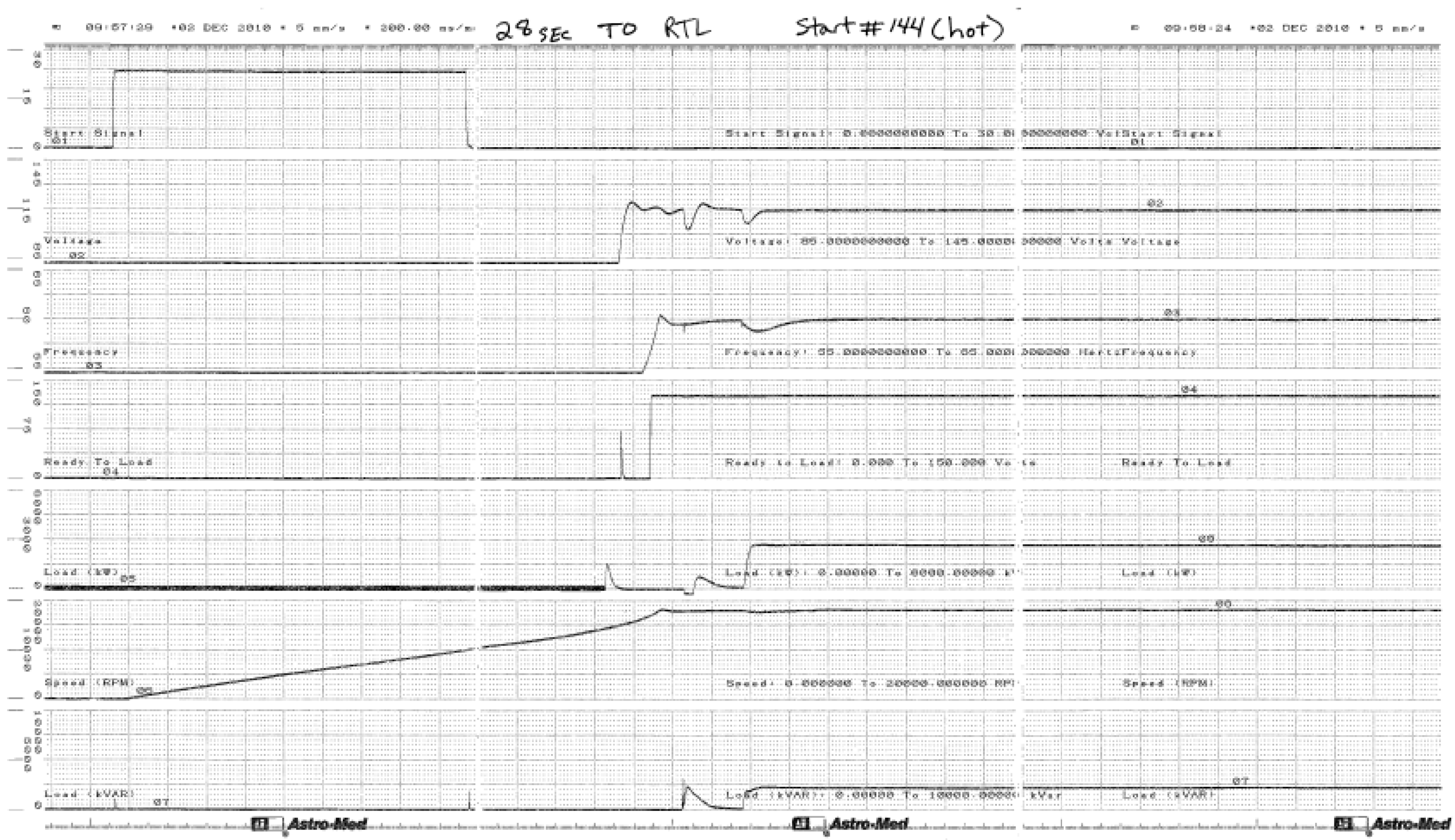

Figure C.1.0-149 Parameter Chart of Start and Load Acceptance Test, No.144, Hot

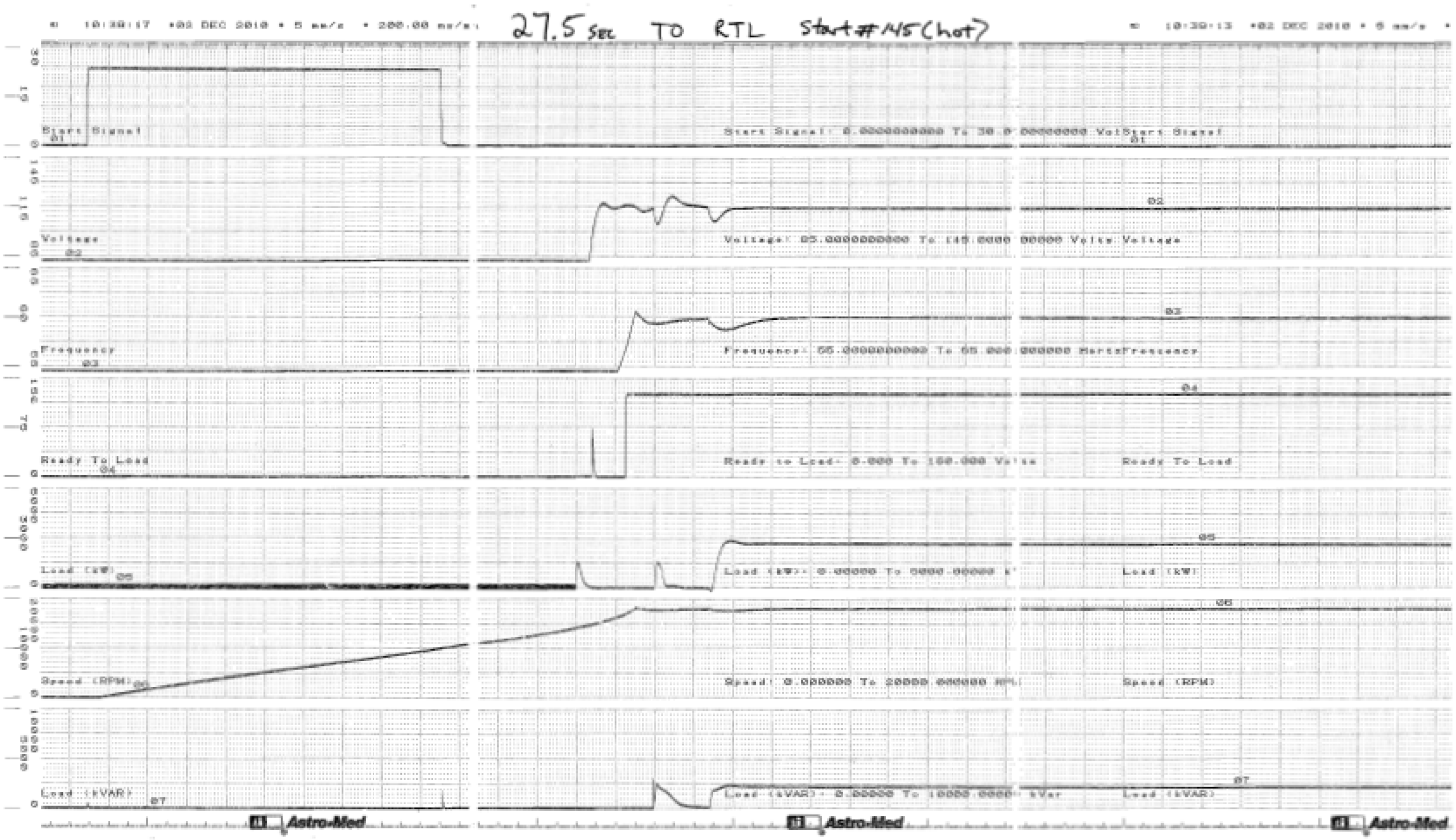

Figure C.1.0-150 Parameter Chart of Start and Load Acceptance Test, No.145, Hot

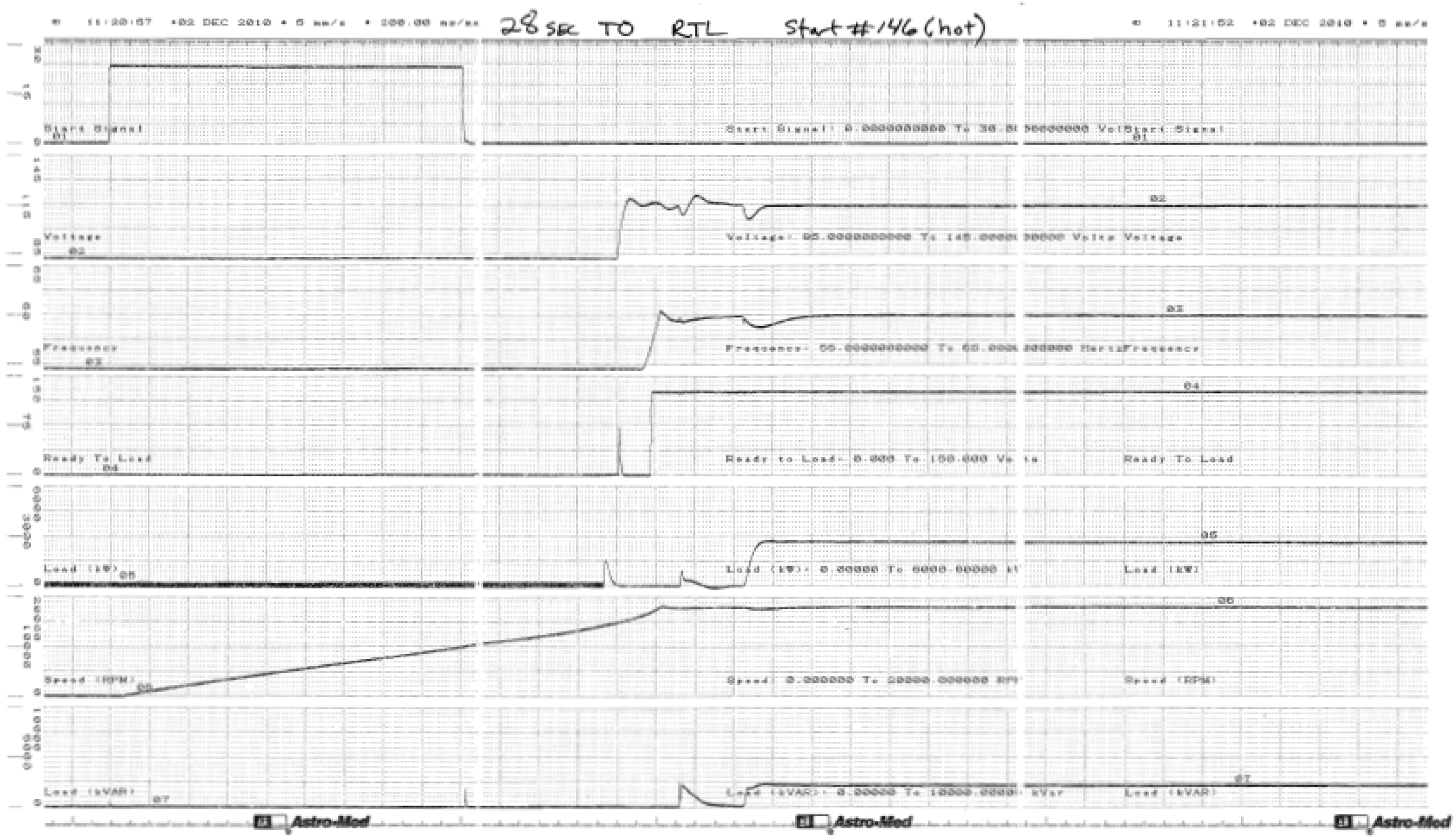

Figure C.1.0-151 Parameter Chart of Start and Load Acceptance Test, No.146, Hot

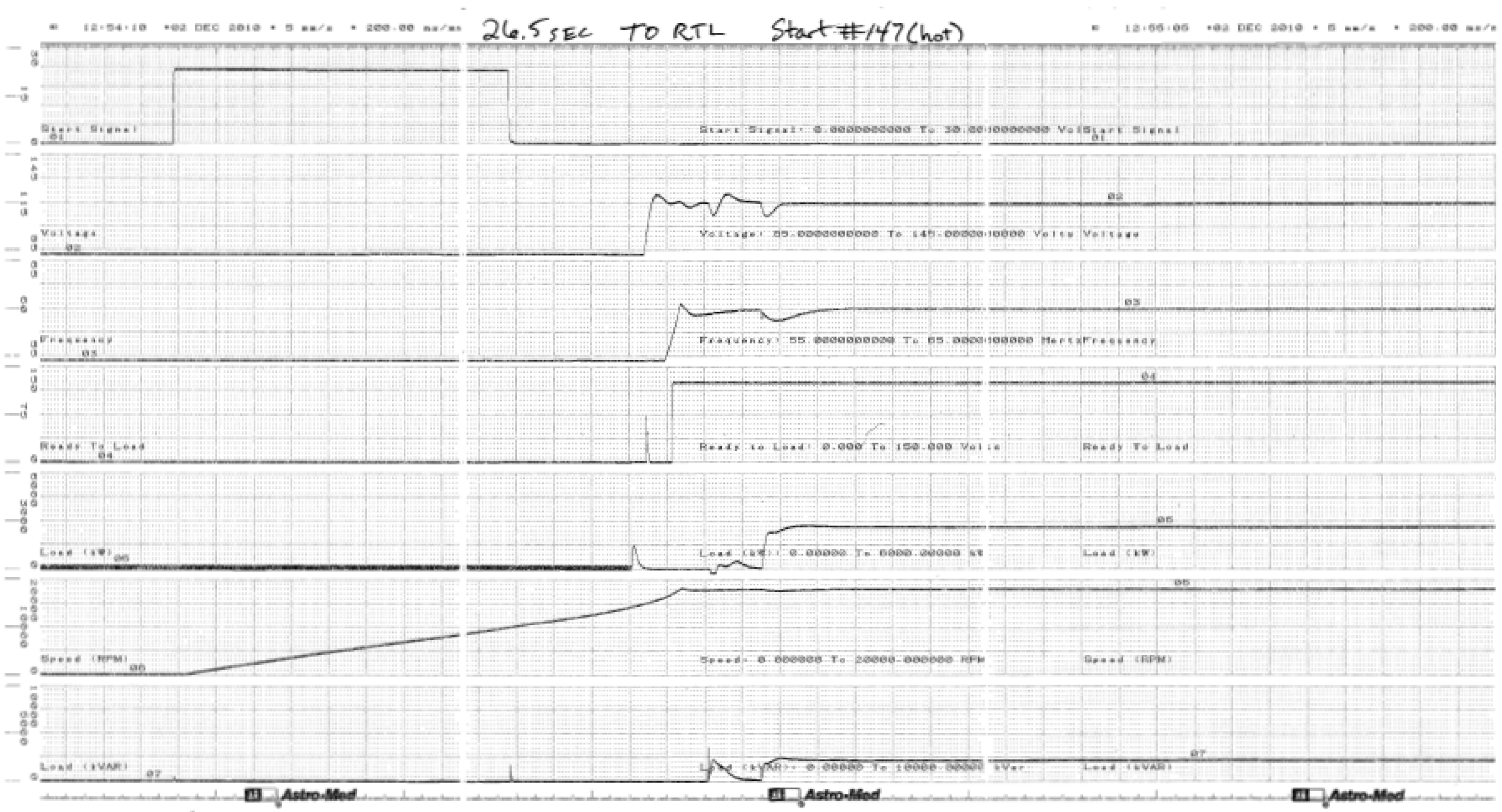

Figure C.1.0-152 Parameter Chart of Start and Load Acceptance Test, No.147, Hot

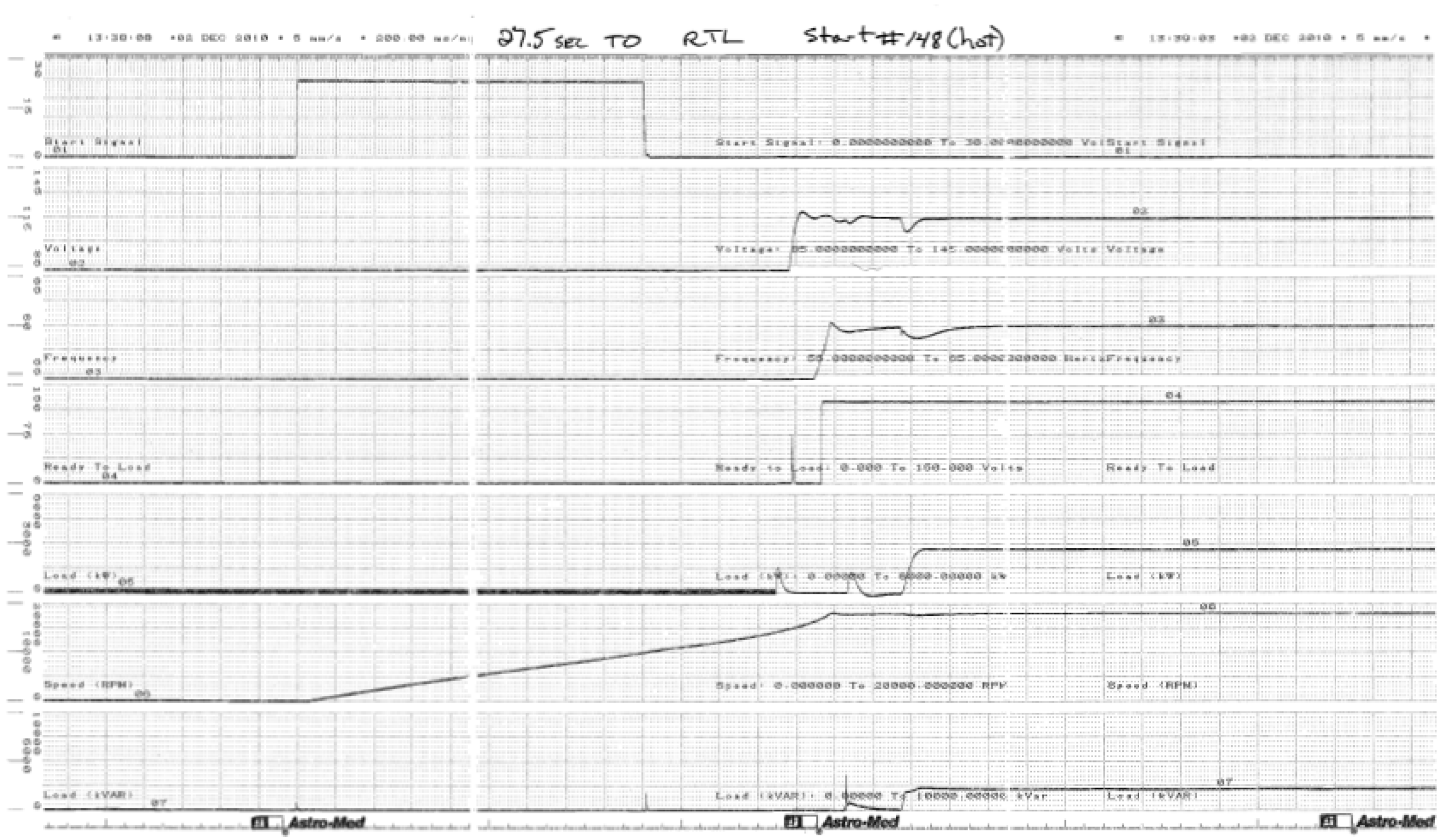

Figure C.1.0-153 Parameter Chart of Start and Load Acceptance Test, No.148, Hot

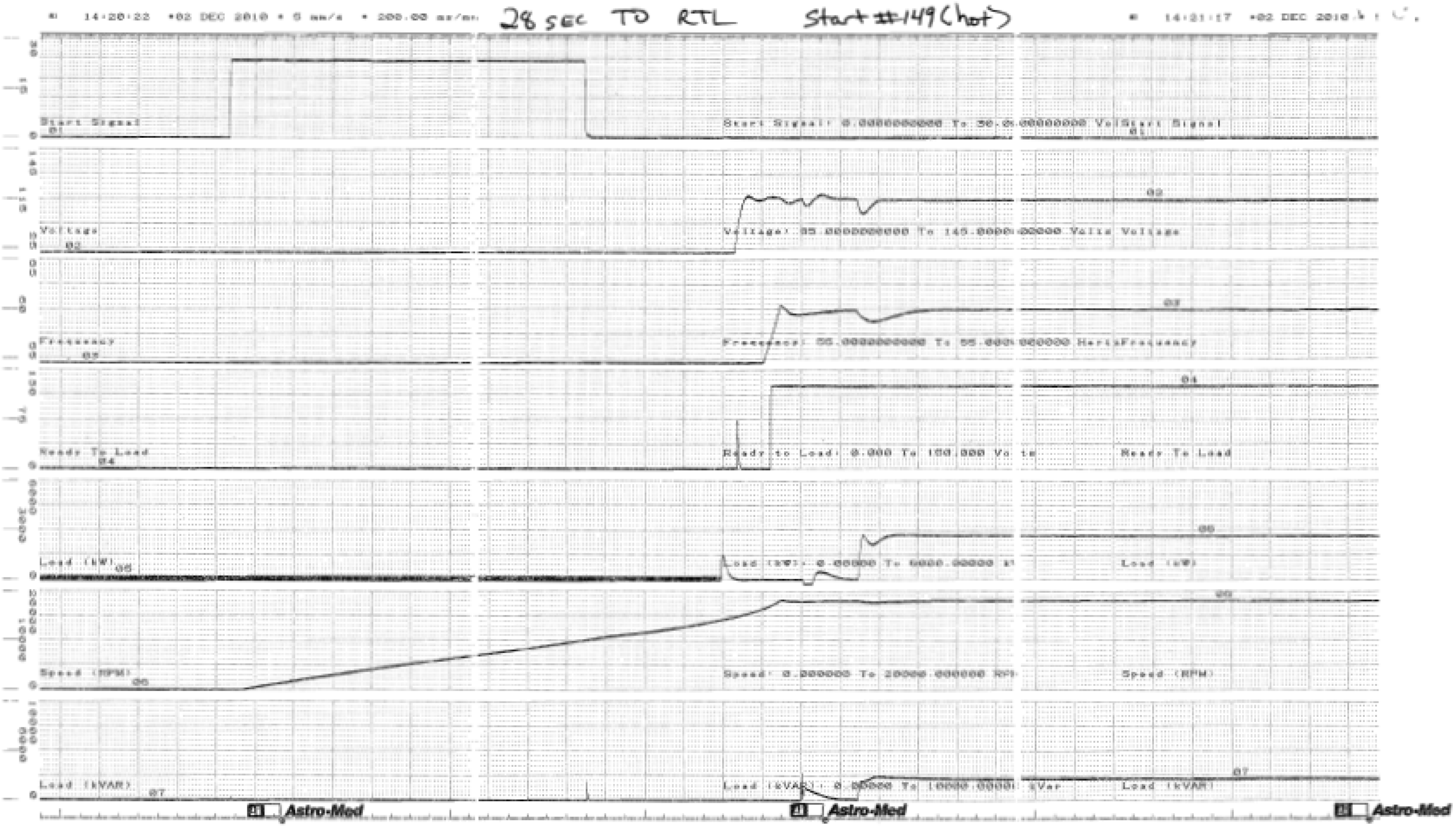

Figure C.1.0-154 Parameter Chart of Start and Load Acceptance Test, No.149, Hot

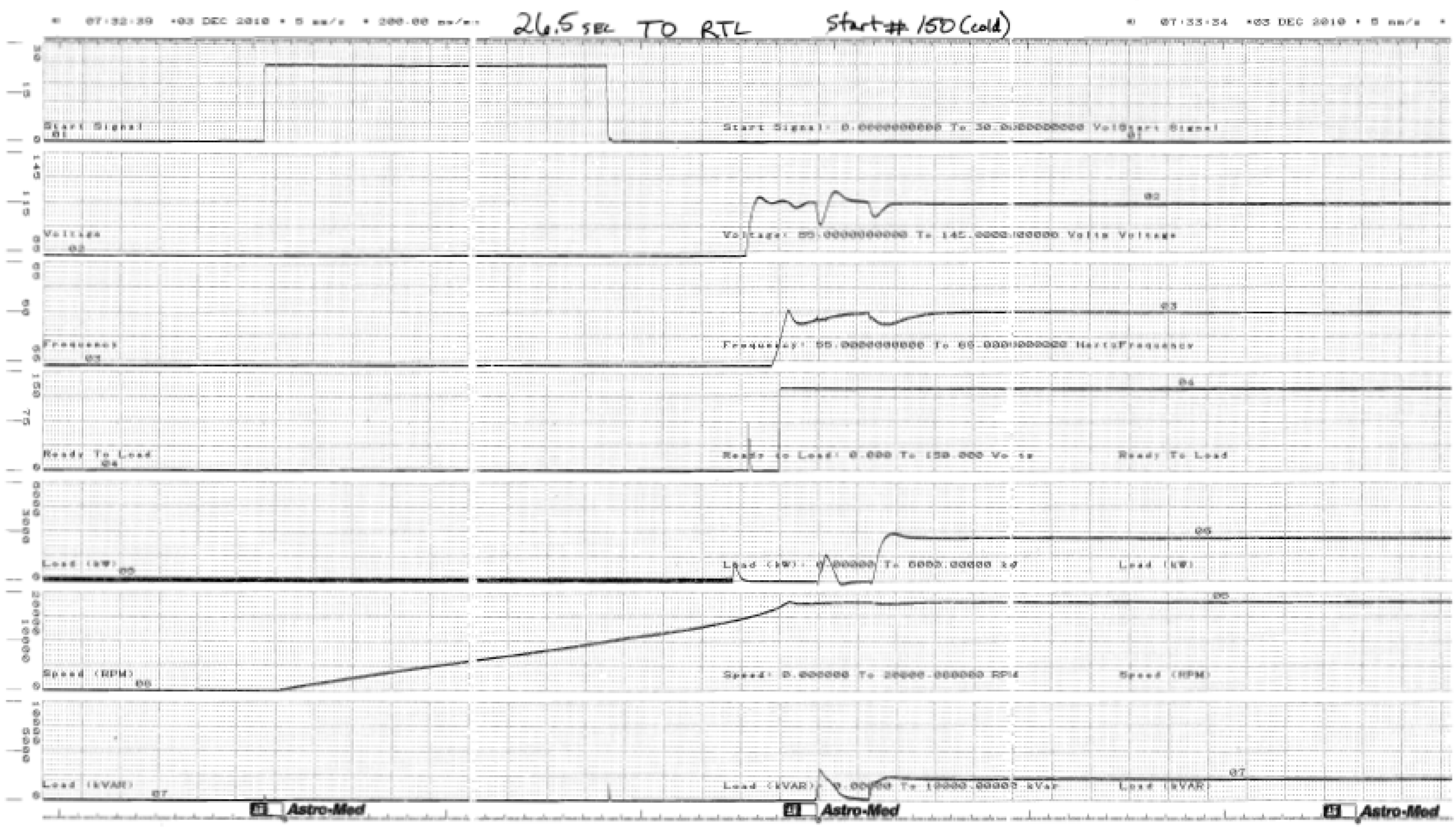

Figure C.1.0-155 Parameter Chart of Start and Load Acceptance Test, No.150, Cold

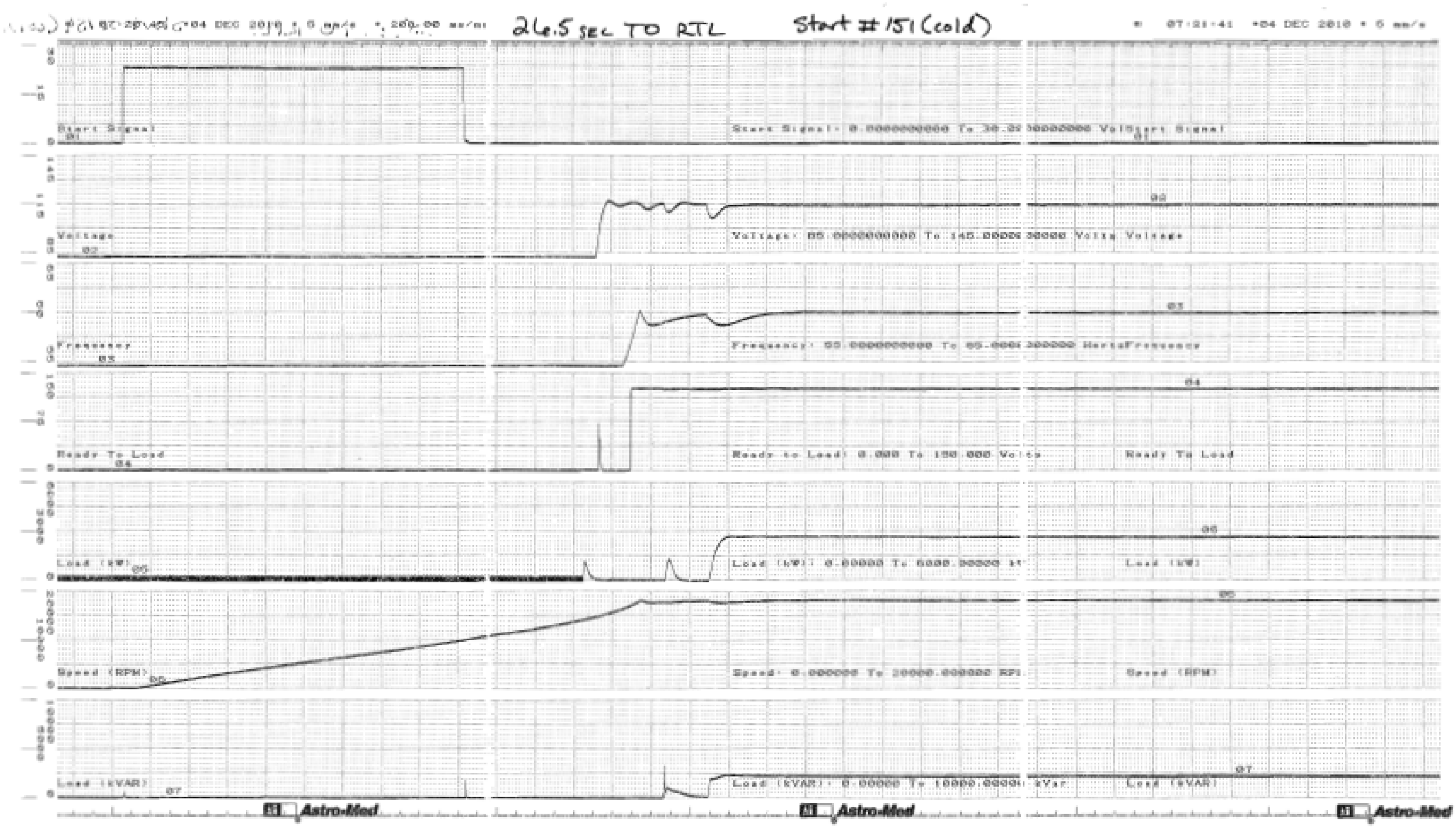

Figure C.1.0-156 Parameter Chart of Start and Load Acceptance Test, No.151, Cold

Figure C.1.0-157 The daily inspection log of fuel nozzle maintenance for GTG performed for the first time. (Sheet 1 of 2)

Figure C.1.0-157 The daily inspection log of fuel nozzle maintenance for GTG performed for the first time. (Sheet 2 of 2)

Figure C.1.0-158 The daily inspection log of fuel nozzle maintenance for GTG performed for the second time. (Sheet 1 of 2)

Figure C.1.0-158 The daily inspection log of fuel nozzle maintenance for GTG performed for the second time. (Sheet 2 of 2)

[redacted]

Figure C.1.0-159 Parameter Chart of No.1 Margin Test

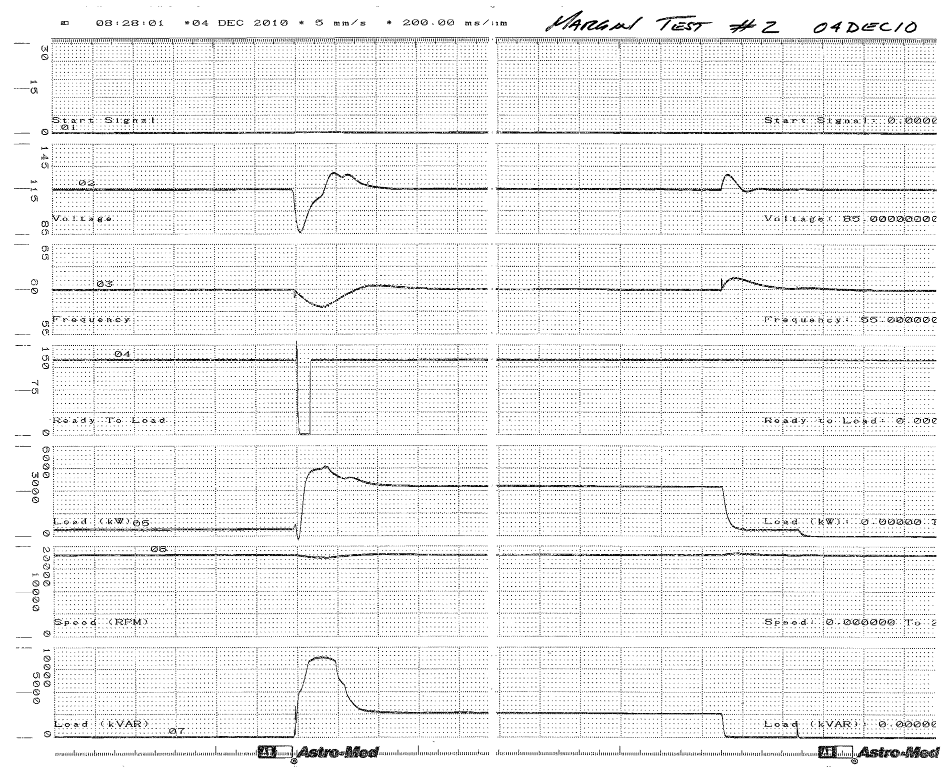

Figure C.1.0-160 Parameter Chart of No.2 Margin Test

Sheet 1

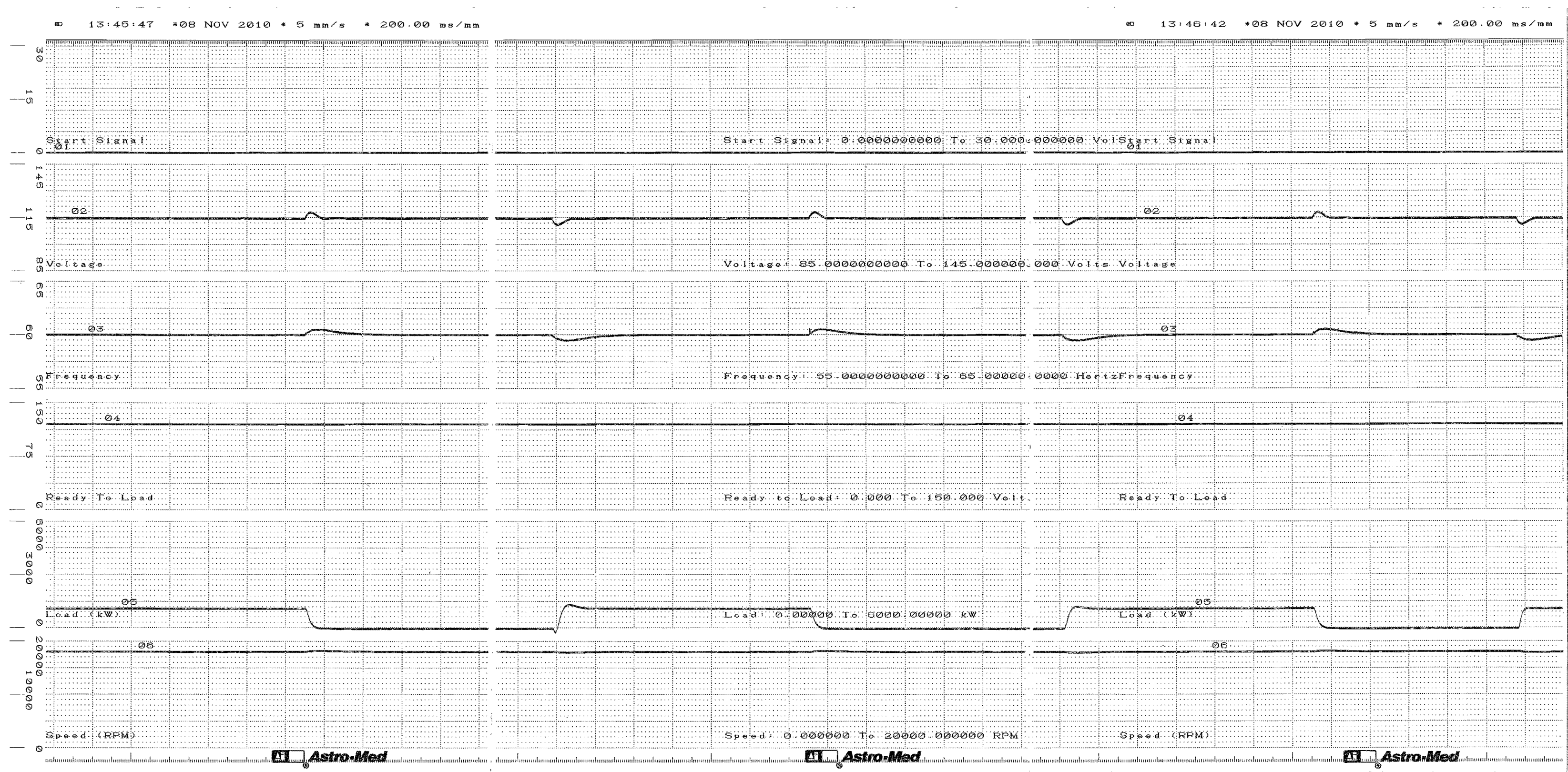

Figure C.1.0-161 Parameter Chart of Load Transient Test , 25%

Sheet 1

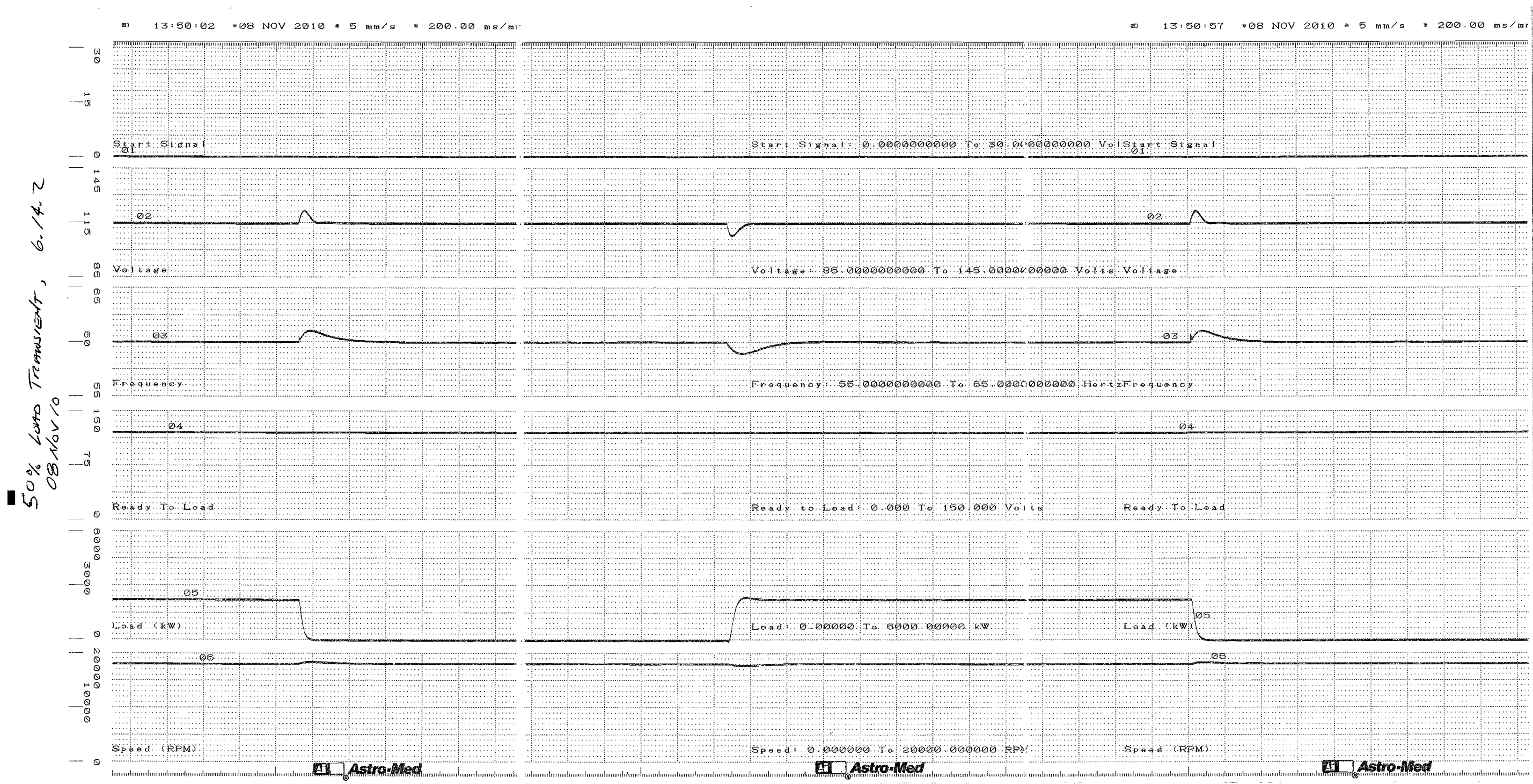

Figure C.1.0-162 Parameter Chart of Load Transient Test , 50% (Sheet 1 of 2)

Sheet 2

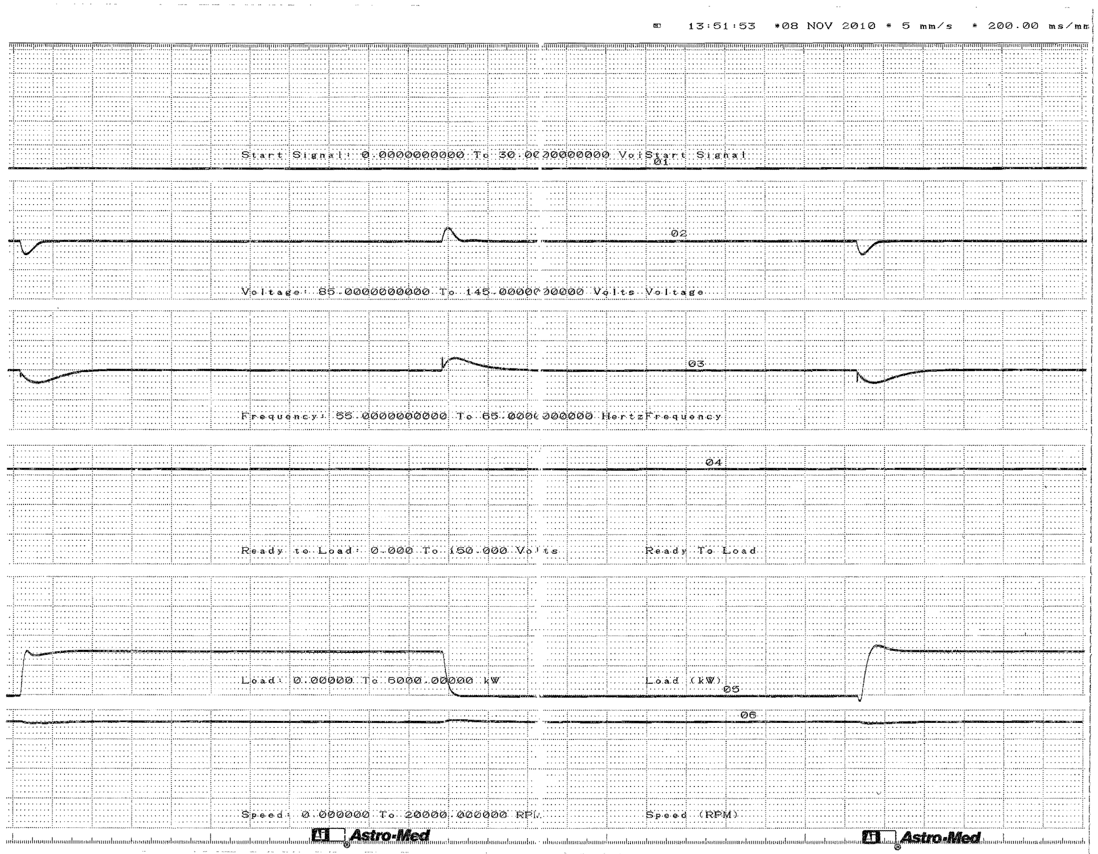

Figure C.1.0-162 Parameter Chart of Load Transient Test , 50% (Sheet 2 of 2)

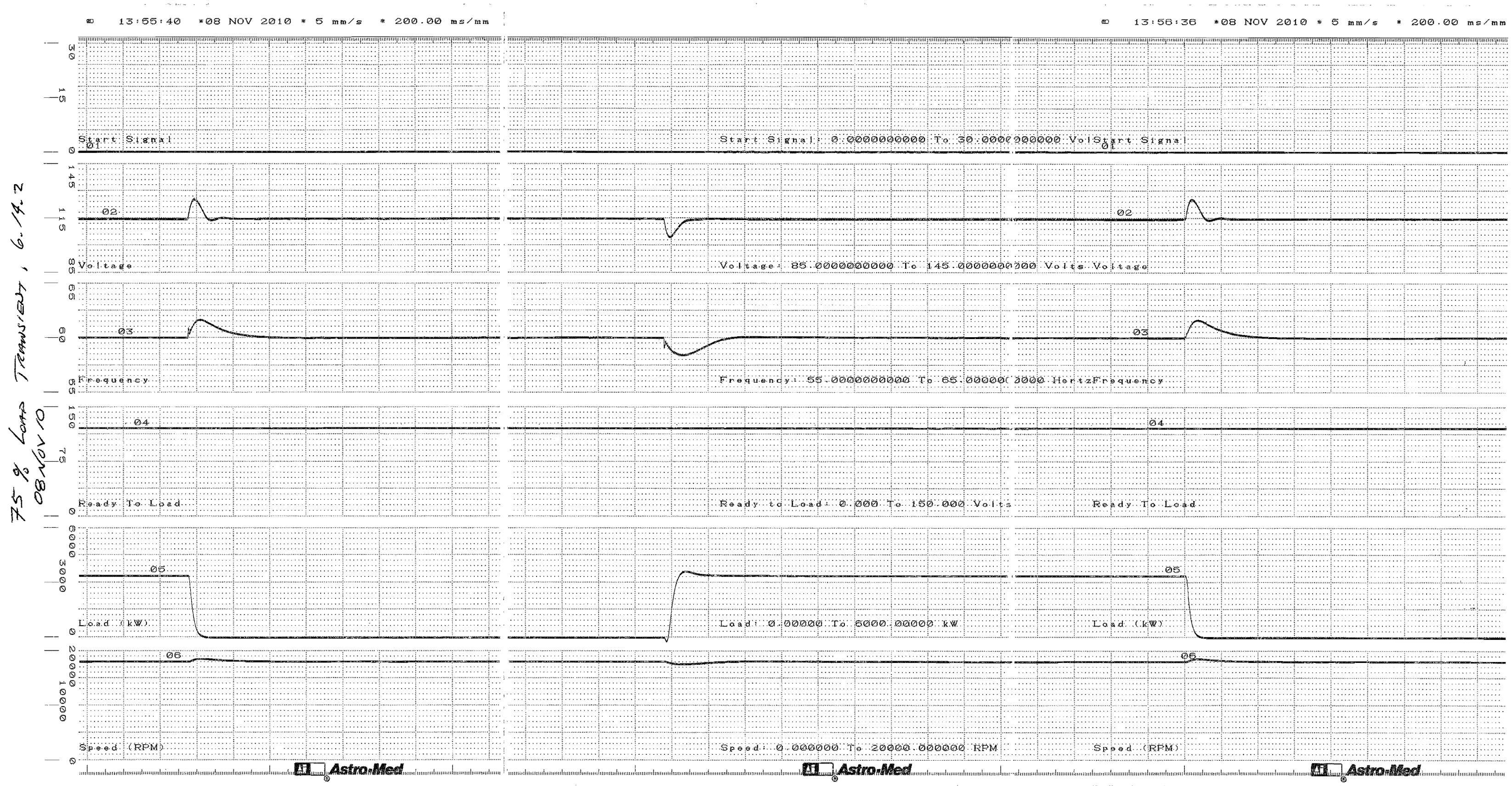

Figure C.1.0-163 Parameter Chart of Load Transient Test , 75% (Sheet 1 of 2)

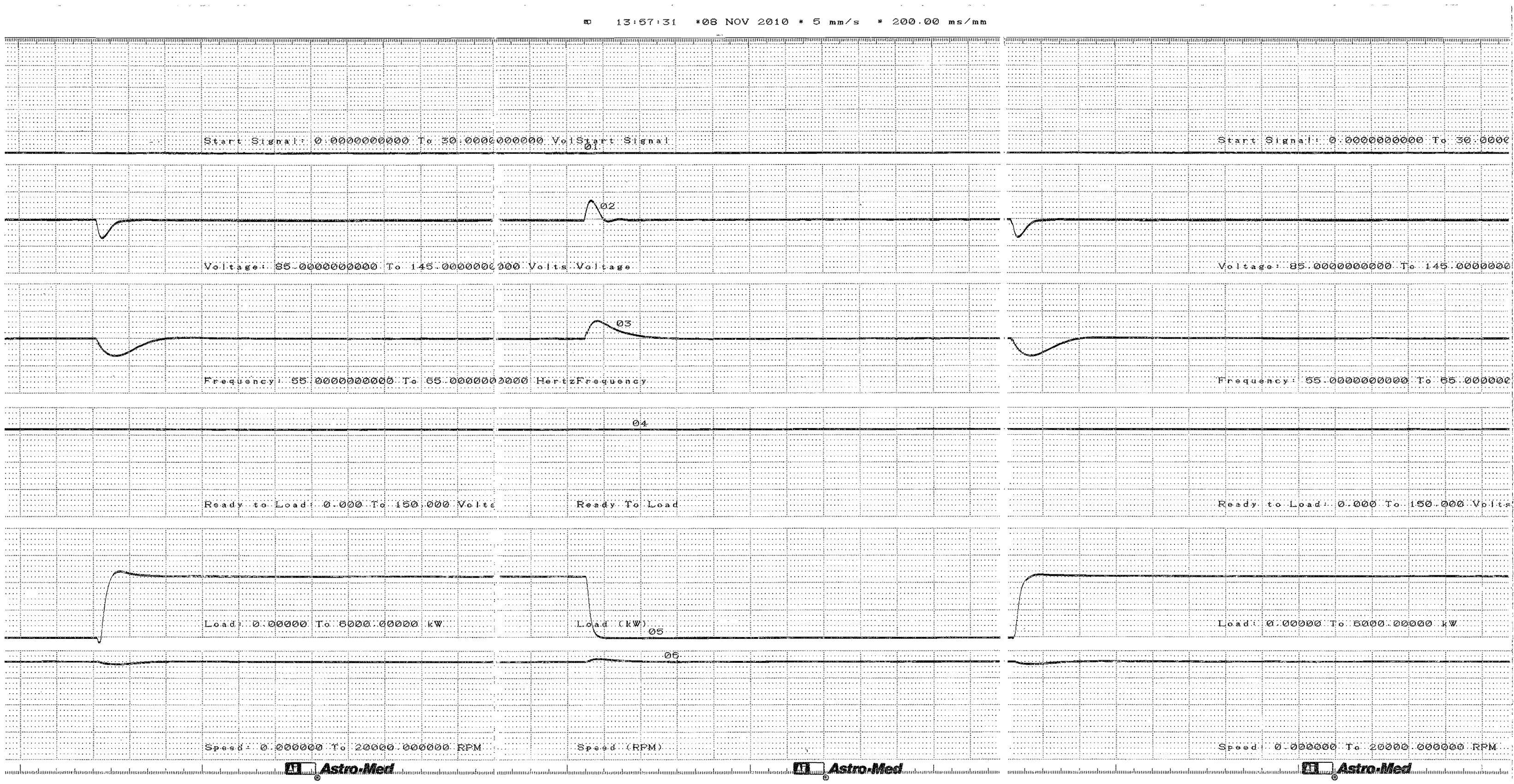

Figure C.1.0-163 Parameter Chart of Load Transient Test , 75% (Sheet 2 of 2)

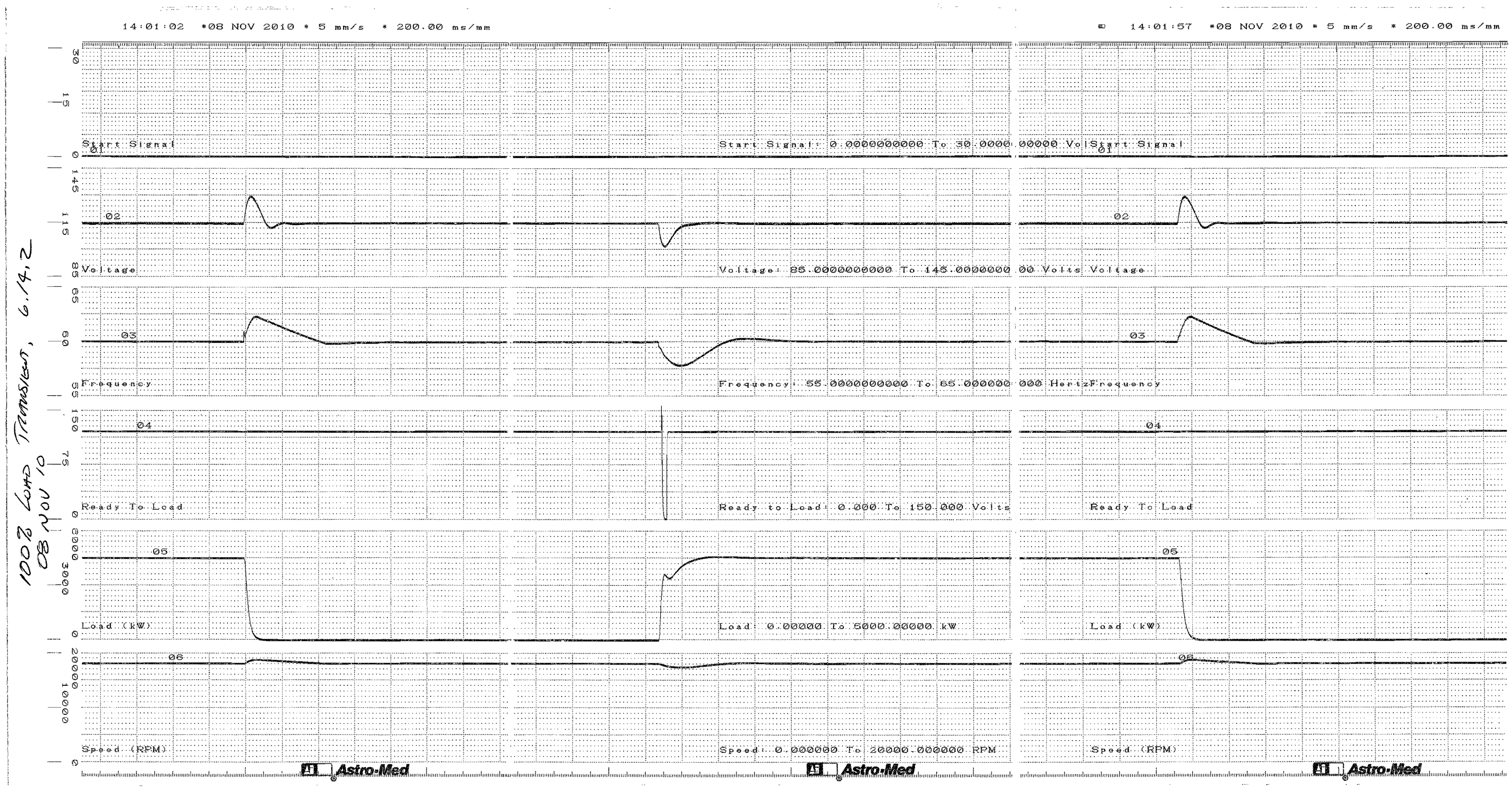

Figure C.1.0-164 Parameter Chart of Load Transient Test , 100% (Sheet 1 of 2)

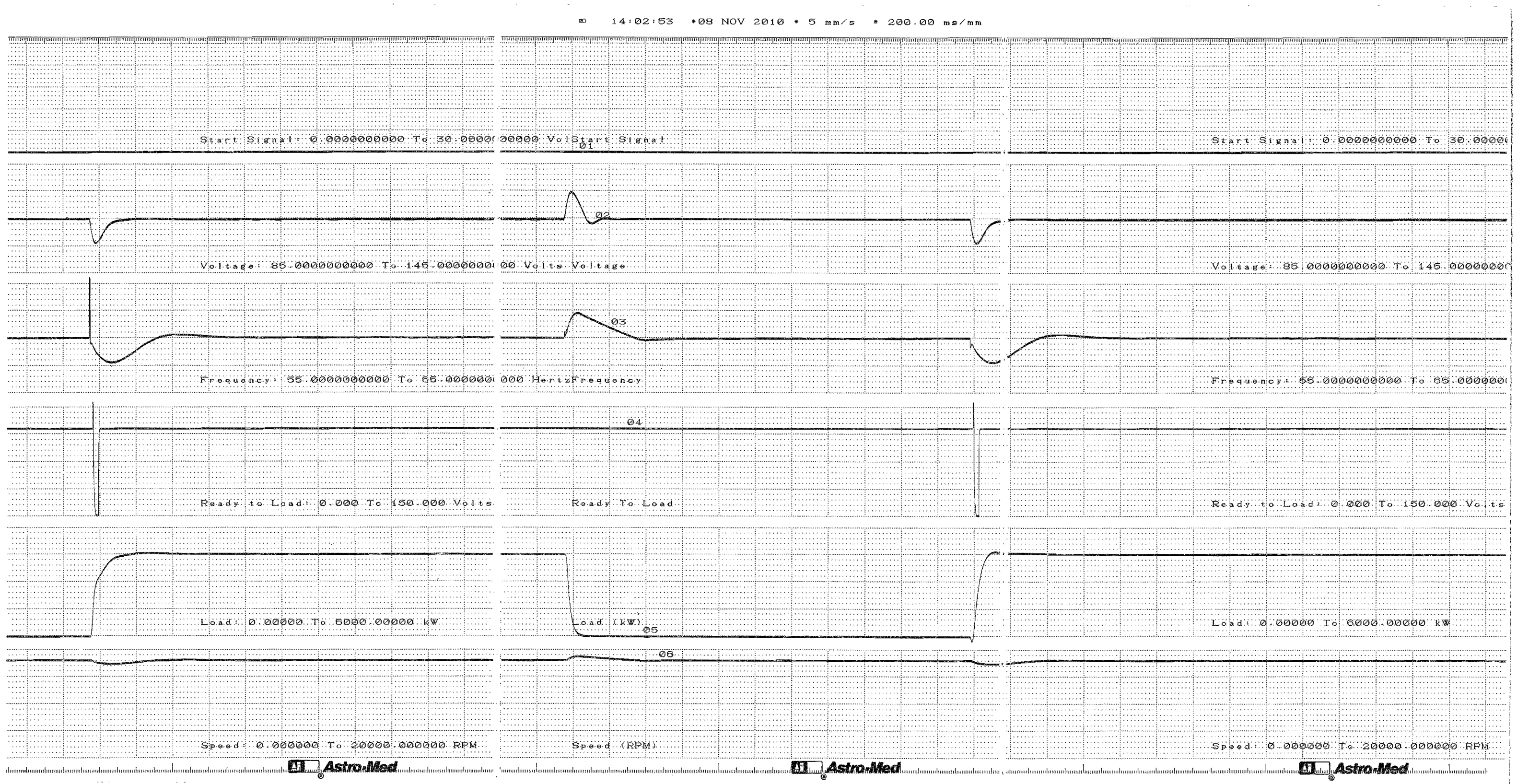

Figure C.1.0-164 Parameter Chart of Load Transient Test , 100% (Sheet 2 of 2)

Appendix D Initial Type Test Procedure

Appendix E Hot/Cold Starting Comparison

E.1.0 PRIME MOVER COMPARISON

E.1.1 Diesel Generator (DG)

As shown in Figure E.1.1-1, DGs consist of a shaft producing a rotary motion and a piston producing an up-and-down movement and are complex in structure. Therefore, the direction and amount of thermal expansion and contraction vary from element to element and that makes it difficult to include each thermal behavior of the components in the design. DGs used in standby power application, including Nuclear power plants need to start and assume loads in a short time. The interaction and combined effects of these components negatively impact the ability of the engine to start. In order to meet the start and load time requirements a DG must be kept warm, typically 35°C. It is important that DGs maintain the engine coolant and lube-oil at adequate temperature by keep warm systems. This is to optimize conditions in terms of starting reliability and reduce stress on the mechanical portion of the engine during emergency starts. Additionally, keep warm systems prevent damage and improper operation of components caused by friction due to the rapid thermal expansion and contraction which occur at startup. Each manufacturer has their own recommended temperature for warm standby conditions that are based on the dynamic characteristics, starting characteristics, and ignition characteristics of DGs.

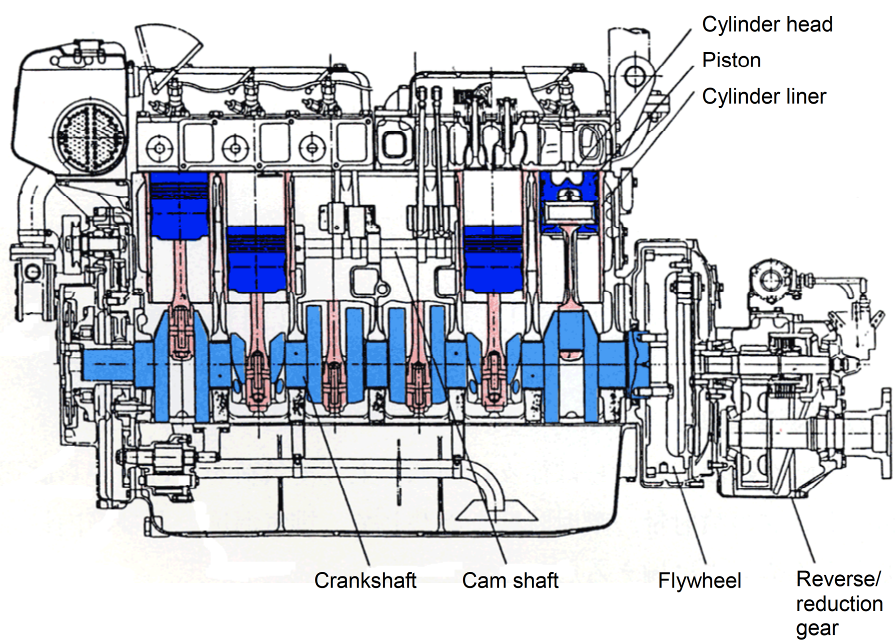

Figure E.1.1-1 Diesel Engine Structure

E.1.2 GAS TURBINE GENERATOR (GTG)

GTGs are different from DGs in structure, characteristics/starting characteristic, and ignition characteristics. As indicated by Figure E.1.2-1, unlike DGs, GTGs produce a rotary motion directly, not a reciprocating motion that is converted to a rotary motion. GTGs start by rotating a rotor/blade disks mechanically with a power outside and igniting fuel when they reach a specified speed that is typically around 20% of the operating speed. The number of critical components necessary to establish combustion is dramatically reduced.
Additionally, since the thermal expansion and contraction is only toward the circumferential and axial direction and the components are few, it is easy to include the thermal behavior of the critical components in the design. The negative effects of thermal expansion and the interaction of the critical components and material are well known and have been eliminated or significantly reduced in the design. This significantly reduces the effect of starting temperature conditions that impact starting the unit. Therefore, the start reliability is significantly higher across a broader range of starting conditions.

In conclusion, unlike DGs, whose starting characteristics are affected by heat expansion and contraction of components, it is not necessary for ground-based GTGs to be kept warm and many GTGs are not designed to need to be kept in a warm condition. This enables the GTG to consistently start under a broad range of ambient and component temperatures. None of the inherent operating principles are not significantly affected by ambient or component temperatures at the time of starting.

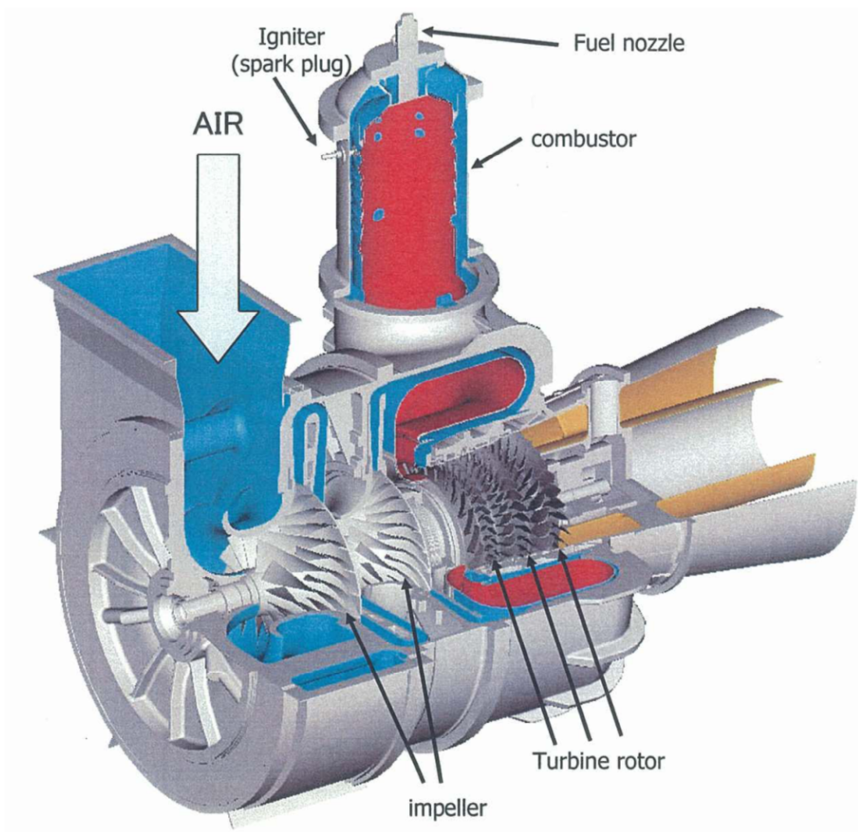

Figure E.1.2-1 Gas Turbine Engine Structure

E.2.0 Starting Functional Comparison

Impact evaluation of cold/hot start (starting reliability) is shown in Table E.2.0-1.

Table E.2.0-1 Impact Evaluation of Cold/Hot Start (Starting Reliability)

Starting Basic Function	Major Component or subsystem	Function	Temperature effects		Diesel Engine Differences
			Hot Start (Normal Operating)	Cold Start (Warm Standby)	
Ignition	Combustion Chamber	To contain the combustion and convert the energy released to mechanical energy; rotational torque and velocity. The combustion chamber is also where the air and fuel are mixed and combust to produce energy.	**Negligible;** At normal operating temperature the air entering the combustion chamber is slightly warmer; therefore fuel/air mixture is easier to ignite and ignition performance is better.	**Negligible;** At warm Standby conditions the air entering the combustion chamber is slightly cooler; therefore fuel/air mixture is slightly harder to ignite and ignition performance is reduced.	Diesel engines are significantly more sensitive to low ambient conditions. A diesel engine relies upon the heat of compression to initiate combustion. The flow of air into the cylinders is directly related to the movement of the pistons during starting.
			<u>Basis Discussion:</u> At ignition there is little difference in the fuel/air mixture temperature within the combustion chamber during starting. But also, any air remaining in the combustion chamber from the previous operating cycle is effectively purged during the starting sequence as the rotation of the main shaft accelerated.		
	Igniter	The function of the igniter is to initiate combustion of the fuel during starting. An igniter is similar to a spark plug in an internal combustion engine utilizing rapid burning fuels such as gasoline.	**Independent of temperature.** The spark produced contains sufficient energy to initiate combustion of the fuel independent of the temperature of the fuel air mixture.	**-Independent of Temperature**	Typical Diesel engines do not contain igniters or spark plugs within the cylinders. They rely only upon the heat of compression to ignite the fuel air mixture. Consequently are susceptible cold temperatures.
			<u>Basis Discussion:</u> The presence of an igniter in the combustion chamber is to initiate the combustion of the fuel. The operation of an igniter produces a highly localized area of very high temperature that will initiate combustion independent of temperature.		
	Fuel properties	Variations of Fuel temperature affect the energy content or the amount of fuel delivered to the combustion chamber (s).	**Negligible;** Fuel density is less at higher temperatures.	**Negligible;** Fuel viscosity and density is greater.	
			<u>Basis Discussion:</u> Neither condition significantly affects the ability to start and assume load. The turbine is designed to use standard fuels the effects will be insignificant provided that the fuel is within specified properties set by the manufacture.		

<table>
<tr><th rowspan="2">Starting Basic Function</th><th rowspan="2">Major Component or subsystem</th><th rowspan="2">Function</th><th colspan="2">Temperature effects</th><th rowspan="2">Diesel Engine Differences</th></tr>
<tr><th>Hot Start (Normal Operating)</th><th>Cold Start (Warm Standby)</th></tr>
<tr><td rowspan="2"></td><td rowspan="2">Rotation</td><td rowspan="2">The function of the starter motors is to bring the turbine to its starting rotational speed, typically approximately 20% of Rated.</td><td>Negligible; under high ambient or operating temperatures friction is less due to oil viscosity, the turbine may reach starting speed slightly quicker.</td><td>Negligible; under warm standby temperatures or low ambient temperatures friction is greater due to oil viscosity; the turbine may take slightly longer to reach starting speed.</td><td rowspan="2">Temperatures less the 50°C significantly reduces the start reliability of Diesel engines. As a compensatory action “keep warm systems,” are generally required for Diesel engines utilized in standby power applications.</td></tr>
<tr><td colspan="2"><u>Basis Discussion:</u> Combustion chamber compression is established by the rotation of the main shaft; it does not depend upon seals or piston rings as in an engine driven generator. Because it does not rely upon components that are sensitive to tolerances which are impacted by temperature performance is not impacted.</td></tr>
<tr><td rowspan="4">Fuel control</td><td rowspan="2">Fuel pump</td><td rowspan="2">The function of the fuel pump is to deliver fuel at the correct pressure and rate to the combustion chamber through a set of control and stop valves.</td><td>Independent of temperature.</td><td>Independent of temperature.</td><td rowspan="2">With a diesel engine the amount of fuel injected into the cylinders is controlled by the engine governor in conjunction with the fuel injectors.</td></tr>
<tr><td colspan="2"><u>Basis Discussion:</u> A separate DC motor driven starting fuel pump is provided to supply fuel during starting. The flow rate required during starting is less than 25% of rated load. The fuel oil pump is insulated from the high temperature turbine components; therefore independent of turbine temperature. The engine mounted fuel pump is designed to deliver the required flow rate for rated load conditions plus margin during normal operations.</td></tr>
<tr><td rowspan="2">Fuel stop valve /Fuel control valve</td><td rowspan="2">The function of the fuel control valves and piping are to control the amount of fuel delivered to the combustion chamber and is proportional to the load.</td><td>- Independent of temperature</td><td>- Independent of temperature</td><td rowspan="2">Diesel engines do not have fuel control valves, the amount of fuel injected into the cylinder is controlled by the fuel injectors and engine governor.</td></tr>
<tr><td colspan="2"><u>Basis Discussion:</u> The fuel control valves and piping are designed to deliver the required flow rate for rated load conditions plus margin. The flow rate required during starting is less than 25% of rated load. The flow rate is controlled by the engine governor and flow control valves. These valves are insulated from the high temperature turbine components; therefore independent of turbine temperature.</td></tr>
</table>

E.3.0 Manufacture’s Analysis

Manufacture’s analysis is shown in Table E.3.0-1.

Table E.3.0-1 Manufacture's Analysis of Starting Reliability

		Difference in performance between cold/hot starts	Is it cold or hot start that affects performance negatively	Influence on starting reliability
Ignition performance	Fuel nozzle	**Independent of Temperature**	-	**Independent of Temperature**
	Combustor	**Negligible** (Any remaining air is purged.)	-	**Independent of Temperature** (Since large volumes of air are drawn into the combustor at startup, at the time of ignition the ambient temperature is about the same between cold and hot start conditions. In addition, none of our record shows a failure of start caused by the ambient temperature of combustors.)
	Exciter/ ignitor	**Independent of Temperature**	-	**Independent of Temperature**
	Fuel property	**Independent of Temperature**	-	**Independent of Temperature**
Rotational resistance characteristics	Lube oil viscosity of GT bearing	**Negligible** (In a cold condition lube oil viscosity is higher and rotational resistance increases.)	Cold	**Independent of Temperature** (It takes longer (about 1 second) to start in a cold starting condition because rotational resistance increases due to an increase in the lube oil viscosity. However, lube oil viscosity has no influence on starting reliability.)
	Labyrinth seal clearance/ blade tip clearance	**Negligible** (The clearance decreases at a high temperature.)	Hot	**Independent of Temperature** (The clearance is designed assuming an increase during operation. The temperature is higher and the labyrinth seal clearance/ blade tip clearance are smaller during operation than startup. Therefore, the starting reliability is not affected by the temperature at startup and none of our record shows a failure of start caused by rubbing due to a higher temperature.)
Starting torque characteristics	Starter	**Independent of Temperature**	-	**Independent of Temperature**

		Difference in performance between cold/hot starts	Is it cold or hot start that affects performance negatively	Influence on starting reliability
Fuel control performance	Fuel pump	**Independent of Temperature**	-	**Independent of Temperature**
	Fuel stop valve	**Independent of Temperature**	-	**Independent of Temperature**
	Fuel control valve	**Independent of Temperature**	-	**Independent of Temperature** (The fuel amount is automatically controlled depending on the exhaust gas temperature of startup. When the temperature of the engine is either high or low, the fuel amount is suitably controlled and there is no influence on the starting reliability including starting time.)

Appendix F Reliability

F.1.0 US EDG Reliability Data

(1) NUREG/CR-6928 reports the reliability of nuclear EDG. This data is based on EPIX database which collects and evaluates operational experiences of nuclear EDG units applied to US NPPs. In addition, NRC had issued the report in 2007 about reliability of EDG based on EPIX database. (Note 1)

Both NUREG/CR-6928 and NRC's 2007 report are based on EPIX database. However, NRC's 2007 report had considered longer period of operation experiences than period evaluated in NUREG/CR-6928.

(Note 1) "Enhanced Component Performance Study Emergency Diesel Generators 1998-2007"

(2) NRC's 2007 report shows that 223 units consist of a large variety of products of engine. The report provides the breakdown of 223 units shown in Table F.1.1-1 and Table F.1.1-2. This shows that design of EDG (manufacture, type, output, number of cylinders) has large varieties.

Table F.1.1-1 US EDG Data(1/2)

Output	Number of Units
50 to 249 kW	2
1000 to 4999 kW	169
Over 5000 kW	52

Table F.1.1-2 US EDG Data(2/2)

Manufacture	Number of Units
A	4
B	3
C	8
D	20
E	24
F	65
G	31
H	68

(3) Even if it is assumed that one manufacture supplies only one type EDG, number of identical EDGs is estimated only 68 units as maximum. If one manufacture had supplied 2 or more same type of engines, it is supposed the largest identical engine group does not consist of over 30 units. Also this data is classified from only difference of engine type. If the differences of support system components (cooling system components, starting system components, lubricant system components etc.) are considered, completely identical GTG sets are less.

(4) US reliability data is evaluated by operational experiences of those various products, in NUREG/CR-6928. And “Failure to Start (FTS)” is calculated as following.

- mean: 4.53×10^{-3} / demand
- 95%: 1.32×10^{-2} / demand

F.2.0 MHI GTG Reliability Data

(1) MHI has shown NRC the operational experiences of commercial GTGs in MHI RAI responses No.5 issued on June 6 in 2008 shown in Table F.2.0-1.

Table F.2.0-1 MHI GTG Data

Data GroupNo.	Number of GTG Sets	Number of Failures/ Number of Starts	Type			
			Output (kVA)	Single engine or Twin engine	Fuel Type	Starting system
1	70	2/4891	150 to 300	Single	Diesel Oil	DC motor
2	19	0/2503	1000 to 1750	Single	Kerosene	DC motor
3	9		1000 to 1750	Single	Diesel Oil	DC motor
4	157		1000 to 1750	Single	Heavy Oil	DC motor
5	1		1000 to 1750	Single	Kerosene	Air
6	9		1000 to 1750	Single	Heavy Oil	Air
7	10		2000 to 4500	Twin	Kerosene	DC motor
8	5		2000 to 4500	Twin	Diesel Oil	DC motor
9	90		2000 to 4500	Twin	Heavy Oil	DC motor
10	5		2000 to 4500	Twin	Heavy Oil	Air

(2) The GPS series is designed based on same design concept and manufacturing control. MHI thinks the data of GPS series is applicable to evaluate the EPS's reliability using the same approach as NUREG's.

(note)
MHI shows the classical estimation as follows;

- mean: 2.7×10^{-4} / demand (2/7394)
- S (standard deviation): 1.91×10^{-4} / demand
  S = {p(1-p)/n}1/2
- maximum (95% distribution):
  mean + 2S = 6.52×10^{-4} / demand

Mean and 95% maximum are low than US nuclear GTG's data.

(3) MHI understands there are differences between GTG's data, which is based on commercial products, and EDG's data, which is based on nuclear GTG's data qualified as safety-related. It is proper to consider that product qualified as nuclear safety-related would have higher reliability than commercial product. However, MHI has never used Kawasaki engines for nuclear safety-related application. MHI performs detailed analysis of the data of commercial products to be able to evaluate reliability precisely.

F.3.0 MHI's Reliability Verification

(1) As explained before by MHI, the reliability target of US-APWR Class 1E GTG is as shown below. It is based on US EDG's data of NUREG-CR/6928. And this value is used to perform PRA analysis.

Fail to Start
- Mean : 5.0×10^{-3} / demand
- 95% maximum : 1.5×10^{-2} / demand

Fail to Run
- Mean : 8.0×10^{-4} / hr
- 95% maximum : 2.0×10^{-3} / hr

(2) MHI shows GTS6000 satisfies with reliability target of US-APWR using Bayesian approach.
(note)
Bayesian approach is one of general method of statistics, and is widely used to evaluate component reliability.
NUREG-CR/6928 also uses this approach.

(3) In order to estimate GTS6000's reliability accurately, collection of data based on appropriate categorization is necessary. MHI has analyzed the GPS's operational data. Operational data has been collected from manufacture's records as shown in Table F.3.0-1.

Table F.3.0-1 GPS's Operational Data (1/2)

Product	Output(kVA)	Single engine or Twin engine	Fuel Type	Starting system	Failure/Number of starts	Failure/Operation hours
1	2000	Twin	Heavy Oil	Air	0 /251 d	0 /98 hr
2	2000	Twin	Heavy Oil	DC	0 /265 d	0 /75.4 hr
3	2000	Twin	Diesel Oil	DC	0 /100 d	0 /71.3 hr
4	2000	Twin	Kerosene	DC	0 /1053 d	0 /205 hr
5	2500	Twin	Heavy Oil	Air	0 /383 d	0 /1129.8 hr
6	2500	Twin	Heavy Oil	DC	0 /95 d	0 /16.4 hr
7	4000	Twin	Heavy Oil	Air	0 /540 d	0 /982 hr
8	4000	Twin	Heavy Oil	DC	0 /149 d	0 /96.8 hr
9	4000	Twin	Diesel Oil	Air	0 /225 d	0 /156.4 hr
10	4000	Twin	Diesel Oil	DC	0 /105 d	0 /50.8 hr
11	4000	Twin	Kerosene	DC	0 /263 d	0 /109.6 hr

Table F.3.0-2 GPS's Operational Data (2/2)

Product	Output(kVA)	Single engine or Twin engine	Fuel Type	Starting system	Failure/Number of starts	Failure/Operation hours
12	4500	Twin	Heavy Oil	Air	0 /327 d	0 /125.1 hr
13	4500	Twin	Heavy Oil	DC	0 /130 d	0 /63.2 hr
14	4500	Twin	Diesel Oil	DC	0 /69 d	0 /80.3 hr
15	4500	Twin	Diesel Oil	DC	0 /147 d	0 /32.1 hr
16	4500	Twin	Kerosene	Air	0 /341 d	0 /455.1 hr
17	4500	Twin	Kerosene	DC	0 /251 d	0 /68.0 hr
18	5000	Twin	Unidentified	DC	0 /48 d	Operation period of those products are short. These are not used for evaluation as conservative.
19	5000	Twin	Unidentified	DC	0 /48 d	
20	6000	Twin	Unidentified	DC	0 /24 d	
21	6000	Twin	Unidentified	DC	0 /24 d	
22	6000	Twin	Unidentified	DC	0 /13 d	
23	6000	Twin	Unidentified	DC	0 /13 d	
24	6000	Twin	Unidentified	DC	0 /12 d	
25	6000	Twin	Unidentified	DC	0 /12 d	
26	6000	Twin	Unidentified	DC	0 /6 d	
27	6000	Twin	Unidentified	DC	0 /1 d	

(4) Data collection of GTG fail to start

- GPS series have been produced with common design concept such as structure, dynamic characteristics and materials. Increase of output is achieved by sizing up the design of small output product analogously. The smaller the difference of output is, the more similar design the products have. MHI applies GPS6000 as EPS. GPS5000 is similar design as GPS6000. Also, GPS4000/4500 are nearly the same design as GPS6000, and there are no significant difference of starting capability based on operation experiences. Another mean of increasing of output is using two engines with one generator. Over GPS 2000 products are all twin type.

- Starting type is also considered whether air or DC motor.

- MHI has selected the data of Table F.3.0-3 as follows;
  - Data of GPS4000 to 6000 with air starting type

    ⇒ 1433 demands with 0 failure

  This data is used to perform Bayesian approach of GTG reliability.

(5) Data collection of GTG fail to run

From view point of running reliability, type of starting system is not needed to consider. Also, there are no significant differences from operation experiences of large output twin engine products of over GPS2000. MHI has classified the data of running time into over GPS2000 and over GPS4000.

1) Data of over GPS2000 ⇒ 3820 hours with 0 failure
2) Data of over GPS4000 ⇒ 2224 hours with 0 failure

Although MHI evaluates it is appropriate to use both 1) and 2) above to perform Bayesian approach, MHI performs evaluation using only data of 2) conservatively.

(6) Reliability estimation of GTGs based on industry operational experience

- Applicable data
  - 1433 demands with 0 failure
  - 2224 run hours with 0 failure

- Uncertainty of failure rate/probability
  - Estimated applying simplified constrained non-informative distribution

Table F.3.0-3 Reliability Estimation of GTGs Based on Industry Operational Experience

	5%	Mean	95%	Distribution		
				Type	a	b
Fail to start	1.4E-6	3.5E-4	1.3E-3	Beta	0.5	1433
Fail to run	8.9E-7	2.2E-4	8.3E-4	Gamma	0.5	2224

F.4.0 Requirement for Initial Type Test

(1) According to a domestic GTG's field data, the GTG failure rate is statistically evaluated as 3.5×10^{-4}/demand, which proves high reliability of the GTG.

(2) R.G.1.155 describes the requirement for reliability of Class 1E EDG: 0.975 with 95% confidence or 0.95 with 95% confidence. MHI has chosen 0.975 with 95% confidence as a reliability target.

(3) The initial type test condition to achieve reliability 0.975 with 95% confidence is statistically evaluated with the following math formula:

Reference; Probability Concepts in Engineering Planning and Design
Alfredo H-S. Ang Wilson H.Tang

$$\sum_{i=0}^{r} \frac{n!}{(n-i)!\,i!}(1-R)^{i}\cdot R^{(n-i)} = 1-C$$

n: number of trials
c: confidence
R: reliability
r: number of failure

(4) If the number of failure (r) is 0, the above formula is rearranged as follows:

$R^n = 1\text{-}C$

If the number of trials 150 is assigned to the above, 97.75% of confidence is obtained as follows:

$0.975^n = 1\text{-}C$

$C = 1-(0.975^{150})$

$=97.75\%$

As a conclusion, if the GTG startup test results in 150 trials with zero failures, that means the reliability of GTGs is higher than 0.975 with approximately 98% confidence.
In this way, the initial type test condition to achieve the required reliability has been determined to be 150 times with no failure.

Appendix G Initial Type Test Consideration

Figure G.1.0-1 Voltage Dip with Motor Starting

Appendix H Result of seismic test for Gas Turbine Engine and Gearbox Assembly

Table H.1.0-1 List of the Test Run

Figure H.1.0-1 Vertical Resonance Search for Test Run 1 (Sheet 1 of 9)

Figure H.1.0-1 Vertical Resonance Search for Test Run 1 (Sheet 2 of 9)

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Figure H.1.0-1 Vertical Resonance Search for Test Run 1 (Sheet 7 of 9)

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Figure H.1.0-2 Horizontal Resonance Search for Test Run 2 (Sheet 1 of 9)

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Figure H.1.0-3 Radom Multifrequency Test for Test Run 3 (Sheet 1 of 2)

Figure H.1.0-3 Radom Multifrequency Test for Test Run 3 (Sheet 2 of 2)

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Figure H.1.0-6 Radom Multifrequency Test for Test Run 6 (Sheet 2 of 2)

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Figure H.1.0-12 Horizontal Resonance Search for Test Run 12 (Sheet 1 of 9)

Figure H.1.0-12 Horizontal Resonance Search for Test Run 12 (Sheet 2 of 9)

Figure H.1.0-12 Horizontal Resonance Search for Test Run 12 (Sheet 3 of 9)

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Figure H.1.0-14 Radom Multifrequency Test for Test Run 14 (Sheet 1 of 2)

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Figure H.1.0-15 Radom Multifrequency Test for Test Run 15 (Sheet 1 of 2)

Figure H.1.0-15 Radom Multifrequency Test for Test Run 15 (Sheet 2 of 2)

Figure H.1.0-16 Radom Multifrequency Test for Test Run 16 (Sheet 1 of 2)

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Figure H.1.0-17 Radom Multifrequency Test for Test Run 17 (Sheet 1 of 2)

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Figure H.1.0-18 Radom Multifrequency Test for Test Run 18 (Sheet 1 of 2)

Figure H.1.0-18 Radom Multifrequency Test for Test Run 18 (Sheet 2 of 2)

Figure H.1.0-19 Radom Multifrequency Test for Test Run 19 (Sheet 1 of 45)

Figure H.1.0-19 Radom Multifrequency Test for Test Run 19 (Sheet 2 of 45)

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Figure H.1.0-19 Radom Multifrequency Test for Test Run 19 (Sheet 44 of 45)

Figure H.1.0-19 Radom Multifrequency Test for Test Run 19 (Sheet 45 of 45)

Appendix I Result of seismic test for Generator Bearing Lubrication Oil System

Table I.1.0-1 North-South RRS for Generator Bearing Lubrication Oil System
(Sheet 1 of 2)

Table I.1.0-1 North-South RRS for Generator Bearing Lubrication Oil System

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Table I.1.0-2 East-West RRS for Generator Bearing Lubrication Oil System

(Sheet 1 of 2)

Table I.1.0-2 East-West RRS for Generator Bearing Lubrication Oil System

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Table I.1.0-3 Vertical RRS for Generator Bearing Lubrication Oil System

(Sheet 1 of 2)

Table I.1.0-3 Vertical RRS for Generator Bearing Lubrication Oil System

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Figure I.1.0-1 OBE 1 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure I.1.0-1 OBE 1 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure I.1.0-1 OBE 1 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure I.1.0-2 OBE 2 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure I.1.0-2 OBE 2 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure I.1.0-2 OBE 2 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure I.1.0-3 OBE 3 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure I.1.0-3 OBE 3 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure I.1.0-3 OBE 3 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure I.1.0-4 OBE 4 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure I.1.0-4 OBE 4 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure I.1.0-4 OBE 4 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure I.1.0-5 OBE 5 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure I.1.0-5 OBE 5 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure I.1.0-5 OBE 5 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure I.1.0-6 SSE 1 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure I.1.0-6 SSE 1 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure I.1.0-6 SSE 1 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure I.1.0-7 OBE 1 Correlation Plots

Figure I.1.0-8 OBE 1 Stationarity Plots

Figure I.1.0-9 SSE 1 Correlation Plots

Figure I.1.0-10 SSE 1 Stationarity Plots

Appendix J Result of seismic test for Lube Oil Cooler Fan Assembly

Table J.1.0-1 North-South RRS for Lube Oil Cooler Fan Assembly (Sheet 1 of 2)

Table J.1.0-1 North-South RRS for Lube Oil Cooler Fan Assembly (Sheet 2 of 2)

Table J.1.0-2 East-West RRS for Lube Oil Cooler Fan Assembly (Sheet 1 of 2)

Table J.1.0-2 East-West RRS for Lube Oil Cooler Fan Assembly (Sheet 2 of 2)

Table J.1.0-3 Vertical RRS for Lube Oil Cooler Fan Assembly (Sheet 1 of 2)

Table J.1.0-3 Vertical RRS for Lube Oil Cooler Fan Assembly (Sheet 2 of 2)

Figure J.1.0-1 OBE 1 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure J.1.0-1 OBE 1 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure J.1.0-1 OBE 1 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure J.1.0-2 OBE 2 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure J.1.0-2 OBE 2 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure J.1.0-2 OBE 2 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure J.1.0-3 OBE 3 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure J.1.0-3 OBE 3 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure J.1.0-3 OBE 3 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure J.1.0-4 OBE 4 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure J.1.0-4 OBE 4 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure J.1.0-4 OBE 4 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure J.1.0-5 OBE 5 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure J.1.0-5 OBE 5 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure J.1.0-5 OBE 5 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure J.1.0-6 SSE 1 Test Response Spectra Plots and Time History Plots (Sheet 1 of 3)

Figure J.1.0-6 SSE 1 Test Response Spectra Plots and Time History Plots (Sheet 2 of 3)

Figure J.1.0-6 SSE 1 Test Response Spectra Plots and Time History Plots (Sheet 3 of 3)

Figure J.1.0-7 OBE 1 Correlation Plots

Figure J.1.0-8 OBE 1 Stationarity Plots

Figure J.1.0-9 SSE 1 Correlation Plots

Figure J.1.0-8 SSE 1 Stationarity Plots