TPC Benchmark™ E and

TPC Benchmark™ Energy

Full Disclosure Report for

PRIMERGY RX900 S2

Using

Microsoft SQL Server 2008 R2
Datacenter Edition

Using

Microsoft Windows Server 2008 R2
Datacenter Edition SP1

TPC-E Version 1.12.0

TPC-Energy Version 1.2.1

Submitted for Review

May 6, 2011

First Edition May 2011

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Benchmark results are highly dependent upon workload, specific application requirements, system design and implementation. Relative system performance will vary as a result of these and other factors. Therefore, TPC Benchmark™ E should not be used as a substitute for a specific customer application benchmark when critical capacity planning and/or product evaluation decisions are contemplated.

All performance data contained in this report were obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. We do not warrant or represent that a user can or will achieve similar performance expressed in transactions per second (tpsE) or normalized price/performance ($/tpsE). No warranty of system performance or price/performance is expressed or implied in this report.

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Abstract

This report documents the TPC Benchmark™ E results achieved by Fujitsu using Microsoft SQL Server 2008 R2 Datacenter Edition.

The TPC Benchmark™ E tests were run on a PRIMERGY RX900 S2 system using the Microsoft Windows Server 2008 R2 Datacenter Edition SP1 operating system.

The results, summarized below, show the number of TPC Benchmark™ E transactions per second (tpsE), the price per tpsE ($/tpsE) and the TPC-Energy (Watts/tpsE).

Hardware	Software	Total System Cost	tpsE	$ USD/tpsE	Availability Date
Fujitsu PRIMERGY RX900 S2	**Microsoft SQL Server 2008 R2 Datacenter Edition Microsoft Windows Server 2008 R2 Datacenter Edition SP1**	**$ 989,779 USD**	**4,555.54**	**$ 217.27 USD**	**July 1, 2011**

Hardware	TPC-Energy	Average Power of REC	Idle Power of REC
Fujitsu PRIMERGY RX900 S2	**1.00 Watts/tpsE**	**4,572.18 Watts**	**3,477.73 Watts**

The benchmark implementation and results were audited by Doug Johnson and Francois Raab for InfoSizing Inc. (www.sizing.com). The auditor's attestation letter is contained in Section 8 of this report.

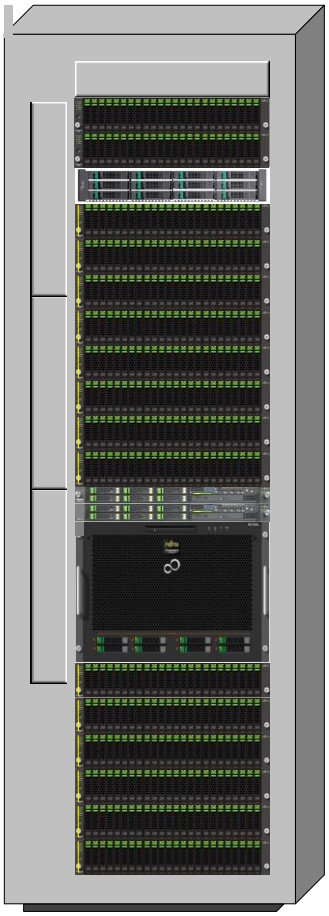
FUJITSU	PRIMERGY RX900 S2	TPC-E 1.12.0 TPC Pricing 1.6.0 TPC-Energy 1.2.1 Report Date May 6, 2011

TPC-E Throughput **4,555.54 tpsE**	Price/Performance **$ 217.27 USD per tpsE**	Availability Date **July 1, 2011**	Total System Cost **$ 989,779**	TPC-Energy Metric **1.00 Watts/tpsE**

Database Server Configuration

Operating System **Microsoft Windows Server 2008 R2 Datacenter Edition SP1**	Database Manager **Microsoft SQL Server 2008 R2 Datacenter Edition**	Processors/Cores/Threads **8/80/160**	Memory **2048 GB**

SUT



Tier A (2x)
PRIMERGY RX200 S6
2x Intel Xeon E5647 2.93 GHz
12 GB Memory
1x 73 GB 15k rpm SAS Drive
2x onboard LAN 1 Gb/s
2x Dual Port LAN 1 Gb/s

Tier B
PRIMERGY RX900 S2
8x Intel Xeon E7-8870 2.40 GHz
2048 GB Memory
2x 146 GB 10k rpm SAS Drives
6x 450 GB 10k rpm SAS Drives
6x onboard LAN 1 Gb/s
1x onboard SAS RAID Controller
16x SAS RAID Controller

Storage
1x PRIMECENTER Rack
16x ETERNUS JX40
384x 64 GB SSD Drives
1x FibreCAT SX40
5x 2 TB 7.2k rpm SATA Drives

Initial Database Size **19,267 GB**	Redundancy Level 1 **RAID-5 data and RAID-10 log**	Storage **384 x 64 GB SSD** **5 x 2 TB 7.2k rpm HDD** **6 x 450 GB 10k rpm HDD**

Description	Part Number	Price Source	Unit Price	Qty	Extended Price	3-yr. Maint. Price
Database Server (Tier B) Hardware						
FSCR800_S26361-K1403-V800		1	173,188.42	1	173,188.42	
PY RX900S2	S26361-K1403-V800			1		
CPU MEMORY Riser Board	S26361-D3145-E100			4		
Intel Xeon E7-8870 10C/20T 2.40 GHz 30 MB 6.4GT/s(130W)	S26361-F4471-E887			8		
64GB (4x16) LV DDR3	S26361-F4523-E945			32		
DVD-RW supermulti slimline SATA	S26361-F3269-E2			1		
HD SAS 6G 146GB 10K HOT PLUG 2.5" EP	S26361-F4482-E114			2		
HD SAS 6G 450GB 10K HOT PLUG 2.5" EP	S26361-F4482-E145			6		
RAID Ctrl SAS 6G 5/6 512MB (D2616)	S26361-F3554-E512			1		
RAID Ctrl SAS 6G 8Port ex 512MB FH LSI	S26361-F3593-E1			16		
Rack Mount Kit for RX900	S26361-F2735-E109			1		
Cable mgmt. RX900 fr asym. 19" Racks	S26361-F2735-E17			1		
PYRX800 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYR800-U004361-0NA	1	3,078.70	1		3,078.70
PYRX800 during normal business hours, Primergy Installation, High-end Server, w/o OS, One Time billing	PYR800-N037005-0NA	1	390.15	1		390.15
				Subtotal	173,188.42	3,468.85
Storage						
FSCPCTR_S26361-K826-V214		1	2,584.00	1	2,584.00	
PRIMECENTER Rack 46U, 1100mm deep	S26361-K826-V214			1		
Dummy panel, plastics, 2U + assembly	S26361-F2735-E131			4		
Socket strip 3phase 3x 8 sockets	S26361-F2262-L31	1	157.25	1	157.25	
PYPCTR Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYPCTR-U004361-0NA	1	720.00	1		720.00
				Subtotal	2,741.25	720.00
FSCJX40_FTS:ETJXS11BG		1	2,219.52	16	35,512.32	
ETERNUS JX40	FTS:ETJXS11BG			16		
PRIMERGY Rackinstallation SX/DX ex works	D:FCSX-INPSR			16		
SSD SATA 3G 64GB SLC HOT PLUG 2.5" EP	S26361-F3298-L64	1	1,013.88	384	389,329.92	
SAS CABLE 1X SFF 8088-1X SFF 8088 2M	D:KBSAS1S-1S-2M	1	66.30	16	1,060.80	
PYJX40 Warranty Uplift, 12 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), ncl. Holidays, Prepaid billing	PYJX40-U004121-0NA	1	609.00	16		9,744.00
PYJX40 Post Warranty, 24 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYJX40-P004241-0NA	1	1,218.00	16		19,488.00
PYJX40 during normal business hours, Primergy storage installation, One Time billing	PYJX40-N043005-0NA	1	450.00	16		7,200.00
				Subtotal	425,903.04	36,432.00
FSCSX40_S26361-K1122-V200		1	6,752.60	1	6,752.60	
FibreCAT SX40 SAS Disk Subsystem	S26361-K1122-V200	1		1		
HD SATA 2000GB hot p 3.5" SX40	S26361-F3245-E200	1		5		
Rack installation ex works, SX10, 1U Nod	S26361-F1647-E302	1		1		
PYSX40 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYSX40-U004361-0NA	1	1,827.00	1		1,827.00
PYSX40 during normal business hours, Primergy storage installation, One Time billing	PYSX40-N043005-0NA	1	450.00	1		450.00
SAS CBL EXT 2m 8088-8470	S26361-F3246-L203	1	62.90	1	62.90	
				Subtotal	6,815.50	2,277.00

Database Server (Tier B) Software						
SQL Server 2008 R2 Datacenter Edition Per Processor License	USD-00445	2	38,376.00	8	307,008.00	
Windows Server 2008 R2 Datacenter Edition Per Processor License	P71-06367	2	2,310.00	8	18,480.00	
Microsoft Problem Resolution Services	n/a	2	259.00	1		259.00
				Subtotal	325,488.00	259.00
Application Server (Tier A) Hardware						
FSCR2S6_S26361-K1342-V101		1	4,414.90	2	8,829.80	
PY RX200 S6, 6HD-bays 2.5"	S26361-K1342-V101			2		
Intel Xeon E56474C/8T 2.93 GHz 12 MB	S26361-F4489-E293			4		
Performance Mode Installation	S26361-F3284-E2			4		
SP 6GB 3x2 DDR3 1333 MHz PC3-10600 rg s	S26361-F3604-E533			4		
CD-RW/DVD slimline SATA	S26361-F3269-E2			2		
HD SAS 6G 73GB 15K HOT PLUG 2.5" EP	S26361-F4006-E573			2		
RAID 0/1 SAS based on LSI MegaRAID 4Port	S26361-F3257-E4			2		
Eth Ctrl 2x1Gbit PCIe x4 D2735 Cu lp	S26361-F3610-E201			4		
RMK-P_1-2U servers (new)	S26361-F2735-E110			2		
Power Supply Module 450W gold hp	S26113-F570-E1					
PYRX200 S6 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 hours), Incl. Holidays, Prepaid billing	PYR2S6-U004361-0NA	1	550.00	2		1,100.00
PYRX200 S6 during normal business hours, Primergy installation, Low-end Server, w/o OS, One Time billing	PYR2S6-N039005-0NA	1	200.00	2		400.00
				Subtotal	8,829.80	1,500.00
Application Server (Tier A) Software						
Windows Server 2008 R2 Standard x64 Edition	P73-04980	2	711.00	2	1,422.00	
Miscellaneous						
DISPLAY A19-5 ECO (incl. 2 spares)	S26361-K1339-V140	1	176.80	3	530.40	
Infrastructure or Connectivity						
KB SLIM MF USA (incl. 2 spares)	S26381-K370-V510	1	20.40	3	61.20	
Mini Optical Mouse (incl. 2 spares)	S26381-K452-L100	1	10.20	3	30.60	
LAN-CAT 5 Enhanced, l=3m	S26361-F3417-L3	1	18.70	6	112.20	
				Subtotal	2,156.40	0.00
				Total	945,122.41	44,656.85

Notes:	**Three-Year Cost of Ownership USD**	$989,779
Price Source: 1=Fujitsu, 2=Microsoft Corporation	**TPC-E Throughput**	4,555.54
	$ USD/tpsE	$217.27

The benchmark results and test methodology were audited by Doug Johnson for InfoSizing Inc. (www.sizing.com)

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing section of the TPC benchmark pricing specifications. If you find that the stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.

Numerical Quantities Summary				
Reported Throughput:	**4555.54 tpsE**	**Configured Customers:**		**2,400,000**
Response Times (in seconds)	**Minimum**	**Average**	**90th%tile**	**Maximum**
Broker Volume	0.00	0.03	0.06	0.65
Customer Position	0.00	0.02	0.04	1.82
Market Feed	0.00	0.01	0.04	3.78
Market Watch	0.00	0.02	0.05	1.88
Security Detail	0.00	0.01	0.02	1.82
Trade Lookup	0.00	0.10	0.17	2.41
Trade Order	0.00	0.04	0.07	1.89
Trade Result	0.00	0.03	0.07	1.51
Trade Status	0.00	0.01	0.03	1.82
Trade Update	0.01	0.11	0.18	2.14
Data Maintenance	0.00	0.03	N/A	0.21
Transaction Mix		**Transaction Count**		**Mix %**
Broker Volume		16,071,811		4.900%
Customer Position		42,639,701		13.000%
Market Feed		3,279,999		1.000%
Market Watch		59,040,086		18.000%
Security Detail		45,920,177		14.000%
Trade Lookup		26,239,501		8.000%
Trade Order		33,127,572		10.100%
Trade Result		32,799,933		10.000%
Trade Status		62,319,957		19.000%
Trade Update		6,559,743		2.000%
Data Maintenance		120		N/A
Test Duration and Timings				
Ramp-up Time (hh:mm:ss)		00:33:21		
Measurement Interval (hh:mm:ss)		02:00:00		
Business Recovery Time (hh:mm:ss)		02:10:45		
Total Number of Transactions Completed		327,998,480		

PRIMERGY RX900 S2	Energy Summary	TPC-E 1.12.0 TPC Pricing 1.6.0 TPC-Energy 1.2.1 Report Date May 6, 2011 Availability Date July 1, 2011

TPC-E Throughput	Price/Performance	Availability Date	Total System Cost	TPC-Energy Metric
4,555.54 tpsE	**$ 217.27 USD per tpsE**	**July 1, 2011**	**$ 989,779**	**1.00 Watts/tpsE**

Numerical Quantities For Reported Energy Configuration:

REC Idle Power: **3,477.73 Watts**
Average Power of REC : **4,572.18 Watts**

Subsystem Reporting:

	Secondary Metrics	Additional Numerical Quantities			
	watts/tpsE	Full Load Avg Watts	Full Load % of REC	Idle Avg Watts	Idle % of REC
Database Server *)	0.53	2,415.42	52.83%	1,641.41	47.20%
Storage *)	0.37	1,689.77	36.96%	1,623.69	46.69%
Application Server *)	0.10	448.00	9.80%	212.13	6.10%
Miscellaneous *)	0.00	19.00	0.42%	0.50	0.01%
Total REC	1.00	4,572.18	100.00%	3,477.73	100.00%

*) see pricing for list of components

Lowest ambient temperature at air inlet: **21.19 Degrees Celsius**

Items in Priced Configuration not in the Reported Energy Configuration
None

Items in the Reported Energy Configuration not in the Measured Energy Configuration
Fujitsu Display A19-5 ECO

Table of Contents

Clause 0: Preamble

Introduction

TPC Benchmark™ E (TPC-E) is an On-Line Transaction Processing (OLTP) workload. It is a mixture of read-only and update intensive transactions that simulate the activities found in complex OLTP application environments. The database schema, data population, transactions, and implementation rules have been designed to be broadly representative of modern OLTP systems. The benchmark exercises a breadth of system components associated with such environments, which are characterized by:

- The simultaneous execution of multiple transaction types that span a breadth of complexity; Moderate system and application execution time;
- A balanced mixture of disk input/output and processor usage; Transaction integrity (ACID properties);
- A mixture of uniform and non-uniform data access through primary and secondary keys;
- Databases consisting of many tables with a wide variety of sizes, attributes, and relationships with realistic content;
- Contention on data access and update.

The TPC-E operations are modelled as follows: The database is continuously available 24 hours a day, 7 days a week, for data processing from multiple Sessions and data modifications against all tables, except possibly during infrequent (e.g., once a month) maintenance Sessions. Due to the worldwide nature of the application modelled by the TPC-E benchmark, any of the transactions may be executed against the database at anytime, especially in relation to each other.

Goal of the TPC-E Benchmark

The TPC-E benchmark simulates the OLTP workload of a brokerage firm. The focus of the benchmark is the central database that executes transactions related to the firm's customer accounts. In keeping with the goal of measuring the performance characteristics of the database system, the benchmark does not attempt to measure the complex flow of data between multiple application systems that would exist in a real environment.
The mixture and variety of transactions being executed on the benchmark system is designed to capture the characteristic components of a complex system. Different transaction types are defined to simulate the interactions of the firm with its customers as well as its business partners. Different transaction types have varying run-time requirements.
The benchmark defines:

- Two types of transactions to simulate Consumer-to-Business as well as Business-to-Business activities
- Several transactions for each transaction type
- Different execution profiles for each transaction type
- A specific run-time mix for all defined transactions

For example, the database will simultaneously execute transactions generated by systems that interact with customers along with transactions that are generated by systems that interact with financial markets as well as administrative systems. The benchmark system will interact with a set of driver systems that simulate the various sources of transactions without requiring the benchmark to implement the complex environment.
The Performance Metric reported by TPC-E is a "business throughput" measure of the number of completed Trade-Result transactions processed per second (see Clause 6.7.1). Multiple Transactions are used to simulate the business activity of processing a trade, and each Transaction is subject to a Response Time constraint. The Performance Metric for the benchmark is expressed in transactions-per-second-E (tpsE). To be compliant with the TPC-E standard, all references to tpsE Results must include the tpsE rate, the associated price-per-tpsE, and the Availability Date of the Priced Configuration (See Clause 6.7.3 for more detail).
Although this specification defines the implementation in terms of a relational data model, the database may be implemented using any commercially available Database Management System (DBMS), Database Server, file

system, or other data repository that provides a functionally equivalent implementation. The terms "table", "row", and "column" are used in this document only as examples of logical data structures.
TPC-E uses terminology and metrics that are similar to other benchmarks, originated by the TPC and others. Such similarity in terminology does not imply that TPC-E Results are comparable to other benchmarks. The only benchmark Results comparable to TPC-E are other TPC-E Results that conform to a comparable version of the TPC-E specification.

Restrictions and Limitations

Despite the fact that this benchmark offers a rich environment that represents many OLTP applications, this benchmark does not reflect the entire range of OLTP requirements. In addition, the extent to which a customer can achieve the Results reported by a vendor is highly dependent on how closely TPC-E approximates the customer application. The relative performance of systems derived from this benchmark does not necessarily hold for other workloads or environments. Extrapolations to any other environment are not recommended.
Benchmark Results are highly dependent upon workload, specific application requirements, and systems design and implementation. Relative system performance will vary because of these and other factors. Therefore, TPC-E should not be used as a substitute for specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.
Benchmark Sponsors are permitted various possible implementation designs, insofar as they adhere to the model described and pictorially illustrated in this specification. A Full Disclosure Report (FDR) of the implementation details, as specified in Clause 9.1, must be made available along with the reported Results.

Clause 1: Overview

Order and Titles

The order and titles of sections in the Report and Supporting Files must correspond with the order and titles of sections from the TPC-E Standard Specification (i.e., this document). The intent is to make it as easy as possible for readers to compare and contrast material in different Reports (9.1.1.1).

The order and titles in this report correspond to those in the TPC-E specification.

Executive Summary Statement

The TPC Executive Summary Statement must be included near the beginning of the Report (9.2).

The Executive summary has been included near the beginning of this FDR.

Benchmark Sponsor

A statement identifying the benchmark sponsor(s) and other participating companies must be provided (9.3.1.1).

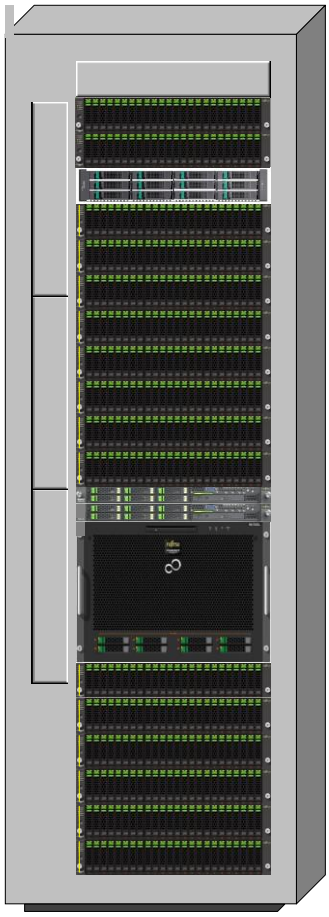
Fujitsu is the sponsor of this TPC Benchmark™ E result.

Configuration Diagram

Diagrams of both measured and Priced Configurations must be reported in the Report, accompanied by a description of the differences (9.3.1.2).

The measured and priced configurations are shown in the following figures. There are differences between both configurations at additional storage used for database setup and backup in the measured configuration. This storage is not used during measurement and not required for pricing.

Figure 1-1: Priced Configuration

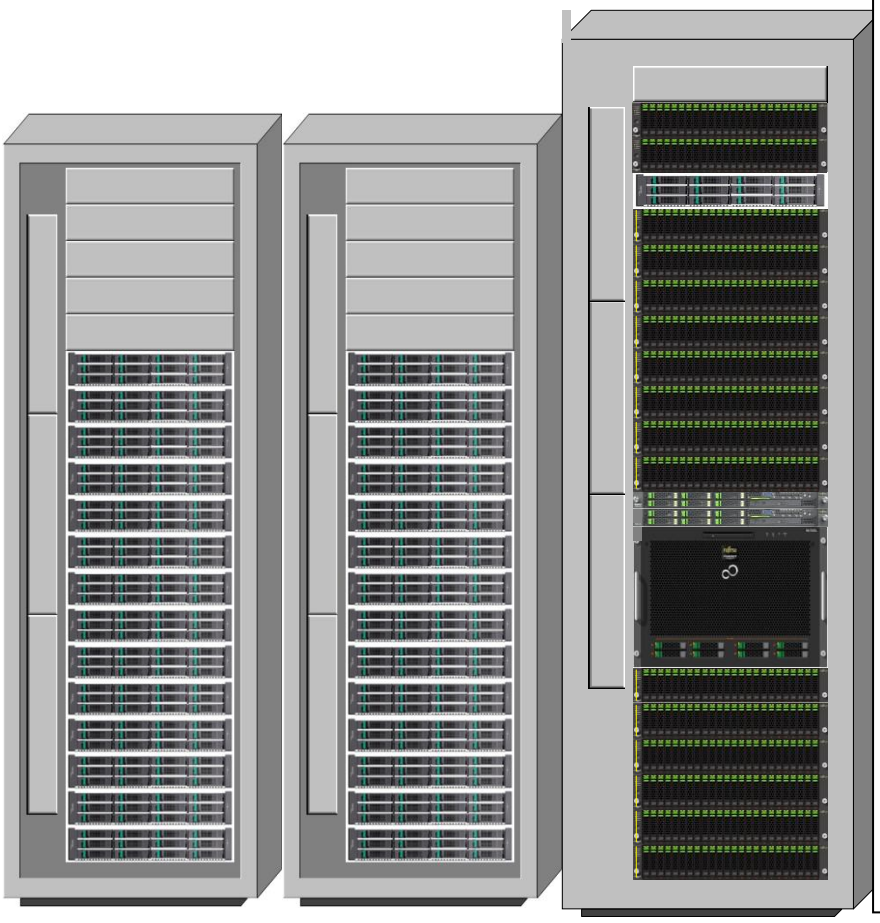


Tier A (2x)
PRIMERGY RX200 S6
2x Intel Xeon E5647 2.93 GHz
12 GB Memory
1x 73 GB 15k rpm SAS Drive
2x onboard LAN 1 Gb/s
2x Dual Port LAN 1 Gb/s

Tier B
PRIMERGY RX900 S2
8x Intel Xeon E7-8870 2.40 GHz
2048 GB Memory
2x 146 GB 10k rpm SAS Drives
6x 450 GB 10k rpm SAS Drives
6x onboard LAN 1 Gb/s
1x onboard SAS RAID Controller
16x SAS RAID Controller

Storage
1x PRIMECENTER Rack
16x ETERNUS JX40
384x 64 GB SSD Drives
1x FibreCAT SX40
5x 2 TB 7.2k rpm SATA Drives

Figure 1-2: Measured Configuration



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Storage
1x PRIMECENTER Rack
16x ETERNUS JX40
384x 64 GB SSD Drives
1x FibreCAT SX40
5x 2 TB 7.2k rpm SATA Drives
14x FibreCAT SX40
12x 73 GB 15k rpm SAS Drives
14x FibreCAT SX40
12x 146 GB 15k rpm SAS Drives

Hardware Configuration

A description of the steps taken to configure all the hardware must be reported in the Report (9.3.1.4).

Driver

The driver systems Fujitsu PRIMERGY RX200 S5 are not part of the System Under Test (SUT) and priced configuration. Two systems were connected, each with one Tier A system, using onboard LAN controller and 2 x 1 Gb/s Ethernet. There are two LAN segments for these connections per driver – Tier A connection.

Tier A

Two identical systems are used as Tier A. The Tier A server is a Fujitsu PRIMERGY RX200 S6 with two Intel Xeon E5647 Six-Core Processor and 12 GB of memory. One SAS 73 GB 15k rpm disk drive is connected to the onboard controller. Two 1 Gb/s dual port Ethernet LAN cards are plugged in the PCI-E slots. Three of these four ports are directly connected with one of the 1 Gb/s Ethernet onboard LAN ports of Tier B using a LAN crossover cable. There are three LAN segments for these connections. The two onboard 1 Gb/s LAN ports are used for driver connection.

Tier B
The Tier B or database server is a Fujitsu PRIMERGY RX900 S2 with eight Intel Xeon E7-8870 Ten-Core Processors and 2048 GB memory. The eight 2.5" disk bays are used with 2x SAS 146 GB 10k rpm disk drives RAID1 for OS and database and 6x SAS 450GB 10k rpm disk drives RAID10 for database log. All drives are connected to a LSI SAS RAID Controller and configured with the MegaRAID BIOS Configuration Utility (enter with <CTRL>H at boot). Sixteen (16) RAID controllers LSI MegaRAID SAS9280-8e with 512MB cache are used to connect the external disk drives to the server. The controller cache is configured with Write Through. The LAN connection of the six onboard 1 Gb/s Ethernet ports are connected to the two Tier A systems as described above. The two 10 Gb/s Ethernet ports are not used.

Storage
16 Fujitsu ETERNUS JX40 are used, each with 24x 64GB SSD 2.5" RAID5 and 1 Fujitsu FibreCAT SX40 with 5x 2TB 7.2k rpm HDD 3.5" RAID 5. The enclosures are connected to the LSI MegaRAID SAS9280-8e. For details see table 2-2 Disk Configuration. The disk configuration can be done with the MegaRAID BIOS Configuration Utility or ServerView RAID Manager, which is shipped on ServerStart DVD together with the Server.

Software Configuration

A description of the steps taken to configure all the software must be reported in the Report (9.3.1.5).

The default installation of the operating system was executed on Tier A and B as well as the installation of the database SW on Tier B. Information about changes to the software, settings and BenchCraft can be found in the SupportingFiles directory Introduction - Software.

Clause 2: Database Design, Scaling and Population

Database Creation

A description of the steps taken to create the database for the Reported Throughput must be reported in the Report (9.3.2).
The physical organization of tables and indices, within the database, must be reported in the Report. (9.3.2.1)

The database has been created for 2,400,000 customers. The SQL Server scripts and setup command files are included in the SupportingFiles\Clause2 folder. One file group is used for all tables and indices. The distribution is shown in table 2-1. For creating the database additional storage was assigned to the database (see Figure 1-2 Measured Configuration) and removed at the end before backing up the database.

Partitioning

While few restrictions are placed upon horizontal or vertical partitioning of tables and rows in the TPC-E benchmark (see Clause 2.3.3), any such partitioning must be reported in the Report.(9.3.2.2)

There is no partitioning implemented in this configuration.

Replication and Duplicated Attributes

Replication of tables, if used, must be reported in the Report (9.3.2.3).
Additional and/or duplicated attributes in any table must be reported in the Report along with a statement on the impact on performance (9.3.2.4).

There is no replication implemented in this configuration.
No duplications or additional attributes were used.

Cardinality of Tables

The cardinality (e.g. the number of rows) of each table, as it existed after database load (see Clause 2.6), must be reported in the Report (9.3.2.5).

The database was configured for 2,400,000 customers. The cardinality of the tables after database load is as shown in the following table 2-1.

Table 2-1: Table Cardinality and File Groups

Table	Cardinality after database load	File Group
ACCOUNT_PERMISSION	17040108	1
ADDRESS	3600004	1
BROKER	24000	1
CASH_TRANSACTION	38154316860	1
CHARGE	15	1
COMMISSION_RATE	240	1
COMPANY	1200000	1
COMPANY_COMPETITOR	3600000	1
CUSTOMER	2400000	1
CUSTOMER_ACCOUNT	12000000	1
CUSTOMER_TAXRATE	4800000	1
DAILY_MARKET	2145420000	1
EXCHANGE	4	1
FINANCIAL	24000000	1
HOLDING	2123445459	1
HOLDING_HISTORY	55579497927	1
HOLDING_SUMMARY	119360046	1
INDUSTRY	102	1
LAST_TRADE	1644000	1
NEWS_ITEM	2400000	1
NEWS_XREF	2400000	1
SECTOR	12	1
SECURITY	1644000	1
SETTLEMENT	41472000000	1
STATUS_TYPE	5	1
TAXRATE	320	1
TRADE	41472000000	1
TRADE_HISTORY	99532602851	1
TRADE_REQUEST	0	1
TRADE_TYPE	5	1
WATCH_ITEM	239964184	1
WATCH_LIST	2400000	1
ZIP_CODE	14741	1

Distribution of Tables, Partitions and Logs

The distribution of tables, partitions and logs across all media must be explicitly depicted for the measured and Priced Configurations (9.3.2.6).

Table 2-2: Disk Configuration

HBA - Port	Disk	Drives	Partition	Size	Use
Crtl 0	0 – onboard	2x146GB 10K SAS, RAID1	C:\	136 GB	OS, DB
	1 – onboard	6x450GB 10K SAS, RAID10	L:\	1256 GB	DB Log
Crtl 1 Port 0	2 – JX40	24x64GB SSD, RAID5	C:\jp\tpce01	1360 GB	Filegroup1
Crtl 1 Port 1	3 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help01	1635 GB	DB setup Backup
	4 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help02	814 GB	DB setup Backup
Crtl 2 Port 0	5 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce02	1360 GB	Filegroup1
Crtl 2 Port 1	6 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help03	1635 GB	DB setup Backup
	7 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help04	814 GB	DB setup Backup
Crtl 3 Port 0	8 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce03	1360 GB	Filegroup1
Crtl 3 Port 1	9 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help05	1635 GB	DB setup Backup
	10 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help06	814 GB	DB setup Backup
Crtl 4 Port 0	11 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce04	1360 GB	Filegroup1
Crtl 4 Port 1	12 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help07	1635 GB	DB setup Backup
	13 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help08	814 GB	DB setup Backup
Crtl 5 Port 0	14 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce05	1360 GB	Filegroup1
Crtl 5 Port 1	15 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help09	1635 GB	DB setup Backup
	16 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help10	814 GB	DB setup Backup
Crtl 6 Port 0	17 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce06	1360 GB	Filegroup1
Crtl 6 Port 1	18 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help11	1635 GB	DB setup Backup
	19 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help12	814 GB	DB setup Backup
Crtl 7 Port 0	20 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce07	1360 GB	Filegroup1
Crtl 7 Port 1	21 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help13	1635 GB	DB setup Backup
	22 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help14	814 GB	DB setup Backup
Crtl 8 Port 0	23 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce08	1360 GB	Filegroup1
Crtl 8 Port 1	24 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help15	1635 GB	DB setup Backup
	25 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help16	814 GB	DB setup Backup
Crtl 9 Port 0	26 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce09	1360 GB	Filegroup1
Crtl 9 Port 1	27 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help17	1635 GB	DB setup Backup
	28 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help18	814 GB	DB setup Backup
Crtl 10 Port 0	29 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce10	1360 GB	Filegroup1
Crtl 10 Port 1	30 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help19	1635 GB	DB setup Backup
	31 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help20	814 GB	DB setup Backup

Crtl 11 Port 0	32 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce11	1360 GB	Filegroup1
Crtl 11 Port 1	33 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help21	1635 GB	DB setup Backup
	34 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help22	814 GB	DB setup Backup
Crtl 12 Port 0	35 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce12	1360 GB	Filegroup1
Crtl 12 Port 1	36 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help23	1635 GB	DB setup Backup
	37 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help24	814 GB	DB setup Backup
Crtl 13 Port 0	38 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce13	1360 GB	Filegroup1
Crtl 13 Port 1	39 – SX40	7x2TB, 7.2K SATA, RAID5	C:\jp\addsize	7450 GB	DB data
Crtl 14 Port 0	40 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce14	1360 GB	Filegroup1
Crtl 14 Port 1	41 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help25	1635 GB	DB setup Backup
	42 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help26	814 GB	DB setup Backup
Crtl 15 Port 0	43 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce15	1360 GB	Filegroup1
Crtl 15 Port 1	44 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help27	1635 GB	DB setup Backup
	45 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help28	814 GB	DB setup Backup
Crtl 16 Port 0	46 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce16	1360 GB	Filegroup1

Database Interface, Data Model and Load Methodology

A statement must be provided in the Report that describes:
The Database Interface (e.g., embedded, call level) and access language (e.g., SQL, COBOL read/write) used to implement the TPC-E Transactions. If more than one interface / access language is used to implement TPC-E, each interface / access language must be described and a list of which interface /access language is used with which Transaction type must be reported.
The data model implemented by the DBMS (e.g., relational, network, hierarchical) (9.3.2.7).
The methodology used to load the database must be reported in the Report (9.3.2.8).

Microsoft SQL Server 2008 R2 Datacenter Edition is a relational database. The interface used was Microsoft SQL Server stored procedures accessed with Remote Procedure Calls embedded in C++ code using the Microsoft ODBC interface.
The methodology used to load the database is described in Clause2 of the SupportingFiles directory.

Clause 3: Transactions

Vendor-Supplied Code

A statement that vendor-supplied code is functionally equivalent to Pseudo-code in the specification (see Clause 3.2.1.6) must be reported in the Report (9.3.3.1).

The vendor supplied code is functionally equivalent to the pseudo-code.

Database Footprint Requirements

A statement that the database footprint requirements (as described in Clause 3.3) were met must be reported in the Report (9.3.3.2).

Database footprint requirements were met as described in the specification.

Network Configuration

The Network configurations of both the measured and Priced Configurations must be described and reported in the Report. This includes the mandatory Network between the Driver and Tier A (see Clause 4.2.2) and any optional Database Server interface networks (9.3.4.2):

Figures 1-1 and 1-2 show the configuration of the measured and priced configurations. Both are identical in case of the network configuration.
Tier B system PRIMERGY RX900 S2 has 2x onboard Ethernet 10 Gb/s ports, which are disabled, and 6x Ethernet 1 Gb/s ports, which are connected with two Tier A systems.
Each of the two Tier A systems PRIMERGY RX200 S6 has an onboard Ethernet controller with two 1 Gb/s ports used for driver system connection. Each Tier A system was extended with two dual-port 1 Gb/s Ethernet controller cards. Three of these four ports were directly connected with three of the six onboard ports of Tier B using different LAN segments. The second Tier A system is connected to the other three ports of Tier B.

Clause 5: EGen

EGen Version

The version of EGen used in the benchmark must be reported (9.3.5.1).

The EGen version used was 1.12.0.

EGen Code

A statement that all required TPC-provided EGen code was used in the benchmark must be reported (9.3.5.2).

All the required TPC-provided code was used in the benchmark.

EGen Modifications

If the Test Sponsor modified EGen, a statement EGen has been modified must be reported in the Report. All formal waivers from the TPC documenting the allowed changes to EGen must also be reported in the Report (see Clause 5.3.7.1). If any of the changes to EGen do not have a formal waiver that must also be reported (9.3.5.3).
If the Test Sponsor extended EGenLoader (as described in Appendix A.6), the use of the extended EGenLoader and the audit of the extension code by an Auditor must be reported (9.3.5.4).

There were no modifications to the EGen. EGenLoader was not extended for this benchmark.

EGen Driver

The number of EGenDriverMEE and EGenDriverCE instances used in the benchmark must be reported in the Report (see Clause 6.2.5) (9.3.1.1).

Two Tier A systems were used and configured to drive 9 EGenDriverMEE and 9 EGenDriverCE instances each. The total numbers are 18 EGenDriverMEE and 18 EGenDriverCE instances.

Measured Throughput

The Measured Throughput must be reported in the Report (see Clause 6.7.1.2) (9.3.6.2).

The measured throughput was 4555.54 tpsE.

Test Run Graph

A Test Run Graph of throughput versus elapsed wall clock time must be reported in the Report for the Trade-Result Transaction (see Clause 6.7.2) (9.3.6.3).

Figure 6-1: Test Run Graph

Steady State

The method used to determine that the SUT had reached a Steady State prior to commencing the Measurement Interval must be reported in the Report (9.3.6.4).

During the run the tpsE throughput was observed to determine steady state. After the run steady state was confirmed by:

1. Looked at the Test Run Graph and verified that tpsE was steady prior to commencing the Measurement Interval.
2. Calculated 60 minute average tpsE during the Steady State moving the time window 10 minutes each time. Then confirmed that the minimum 60 minute average tpsE was not less than 98% of the Reported Throughput, and that the maximum 60 minute average tpsE was not greater than 102% of the Reported Throughput.
3. Calculated 10 minute average tpsE during the Steady State moving the window 1 minute each time. Then confirmed that the minimum 10 minute average tpsE was not less than 80% of the Reported Throughput, and that the maximum 10 minute average tpsE was not greater than 120% of the Reported Throughput.
4. Two completed full checkpoints.

Work Performed During Steady State

A description of how the work normally performed during a Test Run, actually occurred during the Measurement Interval must be reported in the Report (for example checkpointing, writing Undo/Redo Log records, etc.) (9.3.6.5).

The Microsoft SQL Server recovery interval parameter was set to the maximum allowable value to perform checkpoint at specific intervals. Checkpoints were automatically issued at specified intervals (448 seconds) and specified duration (435 seconds). SQL Server was started with trace flag 3502, which caused it to log the occurrence of the checkpoints. This information was used to verify that the checkpoints occurred at the appropriate times and duration during steady state.

Transaction Input Parameter Averages

The recorded averages over the Measurement Interval for each of the Transaction input parameters specified by clause 6.4.1 must be reported (9.3.6.6).

Table 6-2: Transaction Input Parameter Averages.

Transaction	Parameter	Range Min	Range Max	Value	Check
Customer Position	By Tax ID	48.00%	52.00%	50.00%	Ok
	Get History	48.00%	52.00%	50.00%	Ok
	Overall				Ok
Market Watch	By Watch List	57.00%	63.00%	60.00%	Ok
	By Customer Account	33.00%	37.00%	35.01%	Ok
	By Industry	4.50%	5.50%	5.00%	Ok
	Overall				Ok
Security Detail	Access LOB	0.90%	1.10%	1.00%	Ok
	Overall				Ok
Trade Lookup	Frame 1	28.50%	31.50%	29.99%	Ok
	Frame 2	28.50%	31.50%	30.00%	Ok
	Frame 3	28.50%	31.50%	30.02%	Ok
	Frame 4	9.50%	10.50%	9.99%	Ok
	Overall				Ok
Trade Update	Frame 1	31.00%	35.00%	33.00%	Ok
	Frame 2	31.00%	35.00%	32.99%	Ok
	Frame 3	32.00%	36.00%	34.01%	Ok
	Overall				Ok
Trade Order	By Non-Owner	9.50%	10.50%	9.99%	Ok
	By Company Name	38.00%	42.00%	40.00%	Ok
	Buy On Margin	7.50%	8.50%	8.00%	Ok
	Rollback	0.94%	1.04%	0.99%	Ok
	LIFO	33.00%	37.00%	35.00%	Ok
	Trade Qty 100	24.00%	26.00%	25.01%	Ok
	Trade Qty 200	24.00%	26.00%	25.01%	Ok
	Trade Qty 400	24.00%	26.00%	24.99%	Ok
	Trade Qty 800	24.00%	26.00%	25.00%	Ok
	Market Buy	29.70%	30.30%	29.99%	Ok
	Market Sell	29.70%	30.30%	30.01%	Ok
	Limit Buy	19.80%	20.20%	19.99%	Ok
	Limit Sell	9.90%	10.10%	10.01%	Ok
	Stop Loss	9.90%	10.10%	10.00%	Ok
	Overall				Ok

Clause 7: Transaction and System Properties

ACID Tests

The results of the ACID tests must be reported in the Report along with a description of how the ACID requirements were met, and how the ACID tests were run (9.3.7.1).

The TPC Benchmark™ E Standard Specification defines a set of transaction processing system properties that a system under test (SUT) must support during the execution of the benchmark. Those properties are Atomicity, Consistency, Isolation and Durability (ACID). This section quotes the specification definition of each of those properties and describes the tests done as specified and monitored by the auditor, to demonstrate compliance. See also file MSTPCE ACID Procedures.pdf in the SupportingFiles directory.

Redundancy Level and Data Accessibility

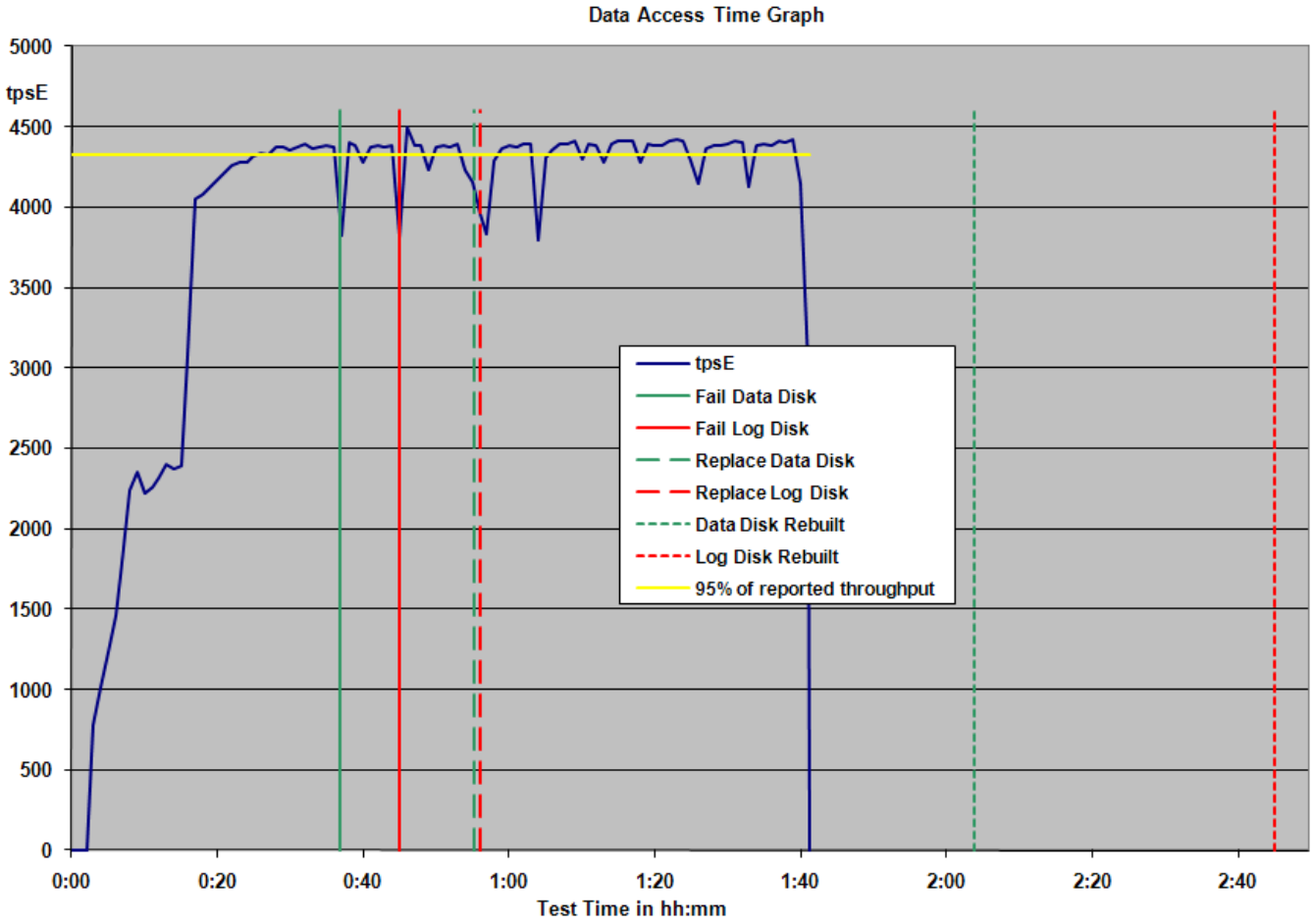
The Test Sponsor must report in the Report the Redundancy Level (see Clause 7.5.7.1) and describe the Data Accessibility test(s) used to demonstrate compliance (9.3.7.2).
A Data Accessibility Graph for each run demonstrating a Redundancy Level must be reported in the Report (see Clause 7.5.7.2) (9.3.7.3).

Redundancy Level 1 was used for the storage system. To prove Redundancy Level 1, the following steps were successfully performed on a database data and log disk. The test for Redundancy Level 1 is the test for Permanent Irrecoverable Failure of any single Durable Medium. The different steps and the various states of the two disks are reported by ServerView RAID and written to the system event (see SupportingFiles).

1. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
2. Start submitting Transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 5 minutes.
3. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in a database data array and then a disk in the database log array. The transactions continue since RAID5 or RAID10 is used for at least 8 minutes.
4. Begin the necessary recovery process, by replacing the failed drives in the database data array and start the rebuild process.
5. Begin the necessary recovery process, by replacing the failed drives in the database log array and start the rebuild.
6. Continue running the Driver for at least 20 minutes with throughput above 95% of reported throughput.
7. Terminate the run gracefully from the Driver.
8. Wait until rebuild process has finished.
9. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
10. Run the evaluation of Trade-Result Transactions executed and compare it with the difference of the SETTLEMENT rows counted.

The Graph in Figure 7-1 show the measured throughput versus time and the different test stated.

Figure 7-1: Redundancy Level and Data Accessibility Graph



Business Recovery

The Test Sponsor must describe in the Report the test(s) used to demonstrate Business Recovery (9.3.4.7). The Business Recovery Time must be reported on the Executive Summary Statement and in the Report. If the failures described in Clauses 7.5.2.2, 7.5.2.3 and 7.5.2.4 were not combined into one Durability test (usually powering off the Database Server during the run), then the Business Recovery Time for the failure described for instantaneous interruption is the Business Recovery Time that must be reported in the Executive Summary Statement. All the Business Recovery Times for each test requiring Business Recovery must be reported in the Report (9.3.7.6). 9.3.7.6 The Business Recovery Time Graph (see Clause 7.5.7.4) must be reported in the Report for all Business Recovery tests (9.3.7.7).

The tests for “Instantaneous interrupt,” “Failure of all or part of memory,” and “Loss of external power to the SUT” were combined by power off Tier A and B.

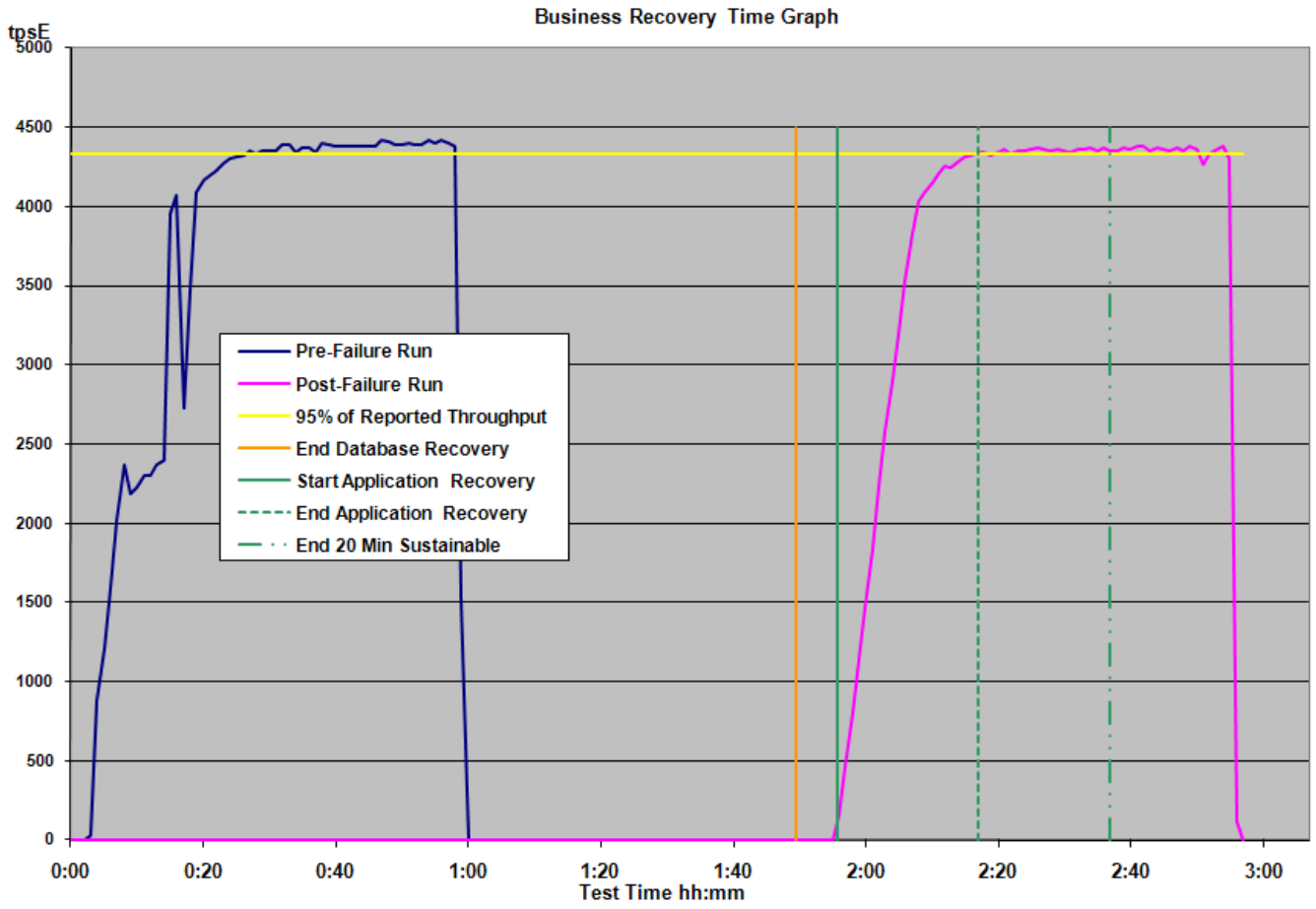
1. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
2. Start submitting transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 20 minutes.
3. Induce the failures by simultaneously power off Tier A and B.
4. On the driver side the number of MEE connections is captured and after transaction failures is noted by the drivers, terminate the run and collect the data for Pre-Failure Run.
5. Re-power and restart Tier A and B.

6. When restarting the database on Tier B, it automatically starts the recovery and records timestamps. The Database Recovery Time was 01:49:38 (hh:mm.ss).
7. After recovery has completed Trade-Cleanup has been executed. A new run started again submitting transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 20 minutes. The Application Recovery Time was 00:21:07 (hh:mm:ss).
8. Terminate the run gracefully from the Driver and collect the data for Post-Failure Run.
9. Verify that there are no errors in the Post-Failure run and check the consistency of the database as specified in Clause 7.3.1.1.
10. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
11. Run the evaluation of Trade-Result Transactions executed in both runs and compare it with the difference of the SETTLEMENT rows counted. The difference must be less than or equal to the maximum number of Transactions which can be simultaneously in-flight from the Driver to the SUT.

The Business Recovery Time (per Clause 7.5.7 Step15) was 02:10:45 (hh:mm:ss).

The Graph in Figure 7-2 shows the measured throughput versus time and the Business Recovery.

Figure 7-2: Business Recovery Graph



Clause 8: Pricing Related Items

60-Day Space

Details of the 60-Day Space computations along with proof that the database is configured to sustain a Business Day of growth must be reported (9.3.8.1).

Table 8-1: Space Requirements

			TPC-E Disk Space Requirements				
Customers Used	2,400,000						
Performance	**4555.54**	**TpsE**	**settlements after 8 hours (Busines Day)**			131,199,552	
					initinal size	grow size	
Table	**Initial Rows**	**Data (KB)**	**Index size (KB)**	**Extra 5% (KB)**	**Total + 5% (KB)**	**After run (KB)**	**Growth (KB)**
ACCOUNT_PERMISSION	17040108	938632	7728	47318	993678	946432	72
ADDRESS	3600004	207904	3024	10546	221474	210952	24
BROKER	24000	1752	2008	188	3948	3760	0
CASH_TRANSACTION	38154316860	3963418200	8361944	198589007	4170369151	3980585368	8805224
CHARGE	15	8	8	1	17	16	0
COMMISSION_RATE	240	16	16	2	34	32	0
COMPANY	1200000	256264	74400	16533	347197	330672	8
COMPANY_COMPETITOR	3600000	96960	81048	8900	186908	178008	0
CUSTOMER	2400000	393576	107528	25055	526159	501136	32
CUSTOMER_ACCOUNT	12000000	1087688	235208			1322896	0
CUSTOMER_TAXRATE	4800000	100384	2976	5168	108528	103512	152
DAILY_MARKET	2145420000	100581440	295736	5043859	105921035	100878480	1304
EXCHANGE	4	8	8	1	17	16	0
FINANCIAL	24000000	2704800	10480	135764	2851044	2715608	328
HOLDING	2123445459	141944952	90046080	11599552	243590584	234951688	2960656
HOLDING_HISTORY	55579497927	2021073304	1168185752	159462953	3348722009	3198787344	9528288
HOLDING_SUMMARY	119360046	5231496	23552	262752	5517800	5255048	0
INDUSTRY	102	8	24	2	34	32	0
LAST_TRADE	1644000	102776	2960	5287	111023	105736	0
NEWS_ITEM	2400000	260363344	8600			260371944	0
NEWS_XREF	2400000	60088	2808	3145	66041	62896	0
SECTOR	12	8	24	2	34	32	0
SECURITY	1644000	228040	62368	14520	304928	290440	32
SETTLEMENT	41472000000	1977546232	4172744	99085949	2080804925	1986623264	4904288
STATUS_TYPE	5	8	8	1	17	16	0
TAXRATE	320	24	16	2	42	56	16
TRADE	41472000000	4950934272	2496282088	372360818	7819577178	7472456984	25240624
TRADE_HISTORY	99532602851	2993462336	7814784	150063856	3151340976	3010213216	8936096
TRADE_REQUEST	0	8	56	3	67	485880	485816
TRADE_TYPE	5	8	1032	52	1092	1040	0
WATCH_ITEM	239964184	6733520	27416	338047	7098983	6761208	272
WATCH_LIST	2400000	60064	51472	5577	117113	111536	0
ZIP_CODE	14741	488	136	31	655	624	0
			Initial Database Size			Settlements	48,994,094
			19,729,876 (MB)			**Grown Database Size**	
			19,267 (GB)			19,789,312 (MB)	

DB filegroups	partition size (MB)	file size (MB)	alloc total (MB)	loaded (MB)	loaded +5% (MB)	after run (MB)	Business Day (MB)
16	1,392,512	1,390,000	22,280,192	19,729,876	20,716,369	19,789,312	19,889,039
		Number of disks	384				
		Disk Capacity (MB)	60,544				
		RAID5 Overhead	4%				
Initial Growing Space (MB)	19,363,767	Total Space (MB)	22,280,192				
Final Growing Space (MB)	19,423,202	Number of disks	5	Initial Log Size (MB)	25,152	Log units	1
Delta (MB)	59,435	Disk Capacity (MB)	1,907,200	Final Log Size (MB)	351,405	Disks per unit	6
Data Space per Trade (MB	0.001213	RAID5 Overhead	20%	Log Growth (MB)	326,253	Disk Capacity (MB)	428,704
1 Day Data Growth (MB)	159,158	Total Space (MB)	7,628,800	Log Space per Trade	0.006659	RAID10 Overhead	50.0%
60 Day Space (MB)	29,279,338	Total Space (MB)	29,908,992	1 Day Log Space (MB	873,661	Log Space (MB)	1,286,112

Attestation Letter

The Auditor's Attestation Letter, which indicates compliance, must be included in the Report (9.3.8.2).

INFO SIZING

TPC TRANSACTION PROCESSING PERFORMANCE COUNCIL CERTIFIED AUDITOR

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May 5, 2011

We verified the TPC Benchmark™ E performance and the TPC-Energy measurement of the following configuration:

Platform: PRIMERGY RX900 S2
Operating System: Microsoft Windows Server 2008 R2 Datacenter Edition SP1
Database Manager: Microsoft SQL Server 2008 R2 Datacenter Edition

The TPC-E results audited by Doug Johnson were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: PRIMERGY RX900 S2				
8 x Intel Xeon E7-8870 (2.40GHz)	2048 GB (8 x 30 MB L3)	384 x 64GB SSD 5 x 2TB 7.2K HDD 6 x 450GB 10K HDD	0.07 Seconds	4,555.54
Tier A, Two Clients: PRIMERGY RX200 S6				
2 x Intel Xeon E5647 (2.93 GHz)	12 GB (2 x 12 MB L3)	1 x 73 GB 15K SAS	n/a	n/a

In my opinion, these performance results were produced in compliance with the TPC requirements for the benchmark. The following verification items were given special attention:

- All EGen components were verified to be v1.12.0.
- The transactions were correctly implemented.
- The database was properly scaled and populated for 2,400,000 customers.
- The mandatory network between the driver and the SUT was configured.
- The ACID properties were met.
- Input data was generated according to the specified percentages.

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- The reported response times were correctly measured.
- All 90% response times were under the specified maximums.
- The measurement interval was representative of steady state conditions.
- The reported measurement interval was 120 minutes.
- The implementation used Redundancy Level 1.
- The Business Recovery Time of 02:10:45 was correctly measured.
- The 60 day storage requirement was correctly computed.
- The system pricing was verified for major components and maintenance.

The TPC-Energy measurements audited by Francois Raab were:

TPC-Energy Metric	REC Idle Power	Average REC Power	Temperature
1.00 Watts/tpsE	3,477.73 Watts	4,572.18 Watts	21.19 C

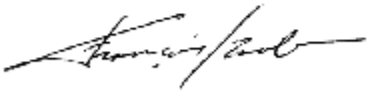
In my opinion, these energy measurements were produced in compliance with the TPC-Energy benchmark requirements and the following verification items were given special attention:

- The power analyzers used met the benchmark requirements and were correctly calibrated.
- The primary metric, secondary metrics and the idle power were calculated correctly.
- Version 1.2.0 of the EMS software package was used.

Additional Audit Notes:

The temperature reporting by the PTDM showed some jitter. An examination of the PTD log showed that all samples were correctly measured and that none were below the required minimum of 20 degree.

Respectfully Yours,



Doug Johnson, Auditor

François Raab, President

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Clause 9: Supporting Files

Supporting Files Index table

An index for all files required by Clause 9.4 Supporting Files must be provided in the Report. The Supporting Files index is presented in a tabular format where the columns specify the following:
• The first column denotes the clause in the TPC Specification
• The second column provides a short description of the file contents
• The third column contains the path name for the file starting at the SupportingFiles directory.
If there are no Supporting Files provided then the description column must indicate that there is no supporting file and the path name column must be left blank (9.3.9.1).

Clause	Description	Path	Filename
	overview	SupportingFiles	SupportingFiles.doc
Introduction	System Configuration	SupportingFiles/Introduction/	SysInfo_TierA1.txt SysInfo_TierA2.txt SysInfo_TierB.txt
	Disk Configuration	SupportingFiles/Introduction/Hardware/	DiskConfiguration.doc flatfilelocations.txt makehelpdirff.cmd Readme.txt Remove_Addon_Files.sql tempdb28.sql
	Parameter OS Tunables Database Setup	SupportingFiles/Introduction/Software/	IO_System.reg MemoryMamagement.reg MSTPCE Database Setup Reference.doc NUMA.reg set160CPU.sql SQL_IP.reg SQL_Nodes.reg SQL_Server_Configuration.ver sqlservr_LargePages.reg
	Startup Scripts Tier A	SupportingFiles/Introduction/Software/	start_all_RX900-1.cmd start_all_RX900-2.cmd start_CE1_RX900S1.cmd start_CE2_RX900S1.cmd … start_CE18_RX900S1.cmd start_MEE1_RX900S1.cmd start_MEE2_RX900S1.cmd … start_MEE18_RX900S1.cmd
	Startup Scripts Tier B	SupportingFiles/Introduction/Software/	sqlstartR2.cmd
Clause 2	Create Database	SupportingFiles/Cause2	Backup_Database.sql Checkpoint_TPCE_Database.SQL Count_Customers.sql Create_Database.sql Create_DM_Audit_Table.sql Create_TID_Ranges_Table.sql Create_Timer_Table.sql Create_TL_TU_Warnings_Table.sql Create_TPCE_VERSIONS_Table.sql Database_Options_1.sql Database_Options_2.sql Drop_and_Create_TPCE_INFO.sql End_Load_Timer.sql Get_Next_T_ID.sql Install_Load_Timer_Proc.sql Load_TPCE_Info.sql Output_TPCE_VERSIONS_Table.SQL Remove_Database.sql Restore_Database.sql SQL_Server_Configuration.sql tempdb28.sql

			TPCE_Setup.cmd Trade_Cleanup.cmd Trade_Cleanup.sql Version.sql
	Create Database output	SupportingFiles/Cause2/DB_setup	2400000Customers_Load_Timer1.log 2400000Customers_Load_Timer2.log 2400000Customers_Load_Timer3.log Backup_Database.log BrokerVolume.log BulkInsert_1.out … BulkInsert_112.out Check_Constraints_Fixed.log Check_Constraints_Growing.log Check_Constraints_Scaling.log Convert_NI_ITEM_Data.log Create_DB_Audit_Tables.log Create_DM_Audit_Tables.log Create_Indexes_Fixed_Tables.log Create_Indexes_Growing_Tables.log Create_Indexes_Scaling_Tables.log Create_TID_Ranges_Table.log Create_TL_TU_Warnings_Table.log Create_TPCE_VERSIONS_Table.log CreateDB.log CustomerPosition.log Database_Options_1.log Database_Options_2.log DataMaintenance.log DB_Build_Steps1.log DB_Build_Steps2.log DB_Build_Steps3.log DB_Check.log DB_FK_Constraints.log DB_Primary_Key_Check.log DB_RI_Check.log DB_Tables.log Drop_DB_Audit_Tables.log Drop_Fixed_Tables.log Drop_FK_Constraints.log Drop_Growing_Tables.log Drop_Scaling_Tables.log EGenLoaderFrom1To21000.log EgenLoaderFrom21001To43000.log …. EgenLoaderFrom2379001To2400000.log ERRORLOG.txt FK_Constraints.log Get_Next_T_ID.log Insert_Duplicates_Tests.log Load_Timer.log Load_Timer_Proc.log Load_TPCE_Info.log MarketFeed.log MarketWatch.log Referential_Integrity_Tests.log Remove_Addon_Files.sql RemoveDB.log SecurityDetail.log spfiles.ver spfiles_setup.ver splog.ver spused.ver spused_setup.ver SQL_Server_Configuration.log Tables_Fixed.log Tables_Growing.log Tables_Scaling.log TPCE_Types.log TPCE_VERSIONS1.log TPCE_VERSIONS2.log TPCE_VERSIONS3.log

			TradeLookup.log TradeOrder.log TradeResult.log TradeStatus.log TradeUpdate.log Version1.log Version2.log Version3.log
	Index Creation Scripts	SupportingFiles/Cause2/DDL	BulkInsert_<1..112>.sql Convert_NI_ITEM_Data.SQL Create_Check_Constraints_Fixed.sql Create_Check_Constraints_Growing.sql Create_Check_Constraints_Scaling.sql Create_FK_Constraints.sql Create_Indexes_Fixed.sql Create_Indexes_Growing.sql Create_Indexes_Scaling.sql Create_Tables_Fixed.sql Create_Tables_Growing.sql Create_Tables_Scaling.sql Create_Tables_Scaling_Flat.sql Create_TPCE_Types.sql Drop_FK_Constraints.sql Drop_Tables_Fixed.sql Drop_Tables_Growing.sql Drop_Tables_Scaling.sql
	Database Audit Scripts	SupportingFiles/Cause2/Audit_Scripts/Database	Create_DB_Audit_Tables.SQL DB_Check.sql DB_FK_Constraints.sql DB_Primary_Key_Check.SQL DB_Tables.sql Drop_DB_Audit_Tables.SQL Insert_Duplicates_Tests.sql Referential_Integrity_Tests.sql
	Database Space Scripts	SupportingFiles/Cause2/Audit_Scripts/Space	SPFiles.sql SPLog.sql SPUsed.sql
Clause3	Transaction Frames	SupportingFiles/Cause3	BrokerVolume.sql CustomerPosition.sql DataMaintenance.sql MarketFeed.sql MarketWatch.sql SecurityDetail.sql TradeLookup.sql TradeOrder.sql TradeResult.sql TradeStatus.sql TradeUpdate.sql
	BaseServer	SupportingFiles/Cause3/BaseServer	BaseServer.cpp BaseServer.h BaseServer.vcproj stdafx.cpp stdafx.h SUTServersLocals.h
	SUT_CE_Server	SupportingFiles/Cause3/SUT_CE_Server	Release\SUT_CE_Server.exe CEServer.cpp CEServer.h CEServerMain.cpp PortDefinitions.h stdafx.cpp stdafx.h SUT_CE_Server.vcproj SUTServer.sln SUTStructs.h
	SUT_MEE_Server	SupportingFiles/Cause3/SUT_MEE_Server	Release\SUT_MEE_Server.exe MEEServer.cpp MEEServer.h MEEServerMain.cpp stdafx.cpp stdafx.h SUT_MEE_Server.vcproj

	TransactionsSP	SupportingFiles/Cause3/TransactionsSP	BrokerVolumeDB_SP.cpp BrokerVolumeDB_SP.h CheckpointDB_SP.cpp CheckpointDB_SP.h CustomerPositionDB_SP.cpp CustomerPositionDB_SP.h DataMaintenanceDB_SP.cpp DataMaintenanceDB_SP.h MarketFeedDB_SP.cpp MarketFeedDB_SP.h MarketWatchDB_SP.cpp MarketWatchDB_SP.h SecurityDetailDB_SP.cpp SecurityDetailDB_SP.h stdafx.cpp stdafx.h TradeLookupDB_SP.cpp TradeLookupDB_SP.h TradeOrderDB_SP.cpp TradeOrderDB_SP.h TradeResultDB_SP.cpp TradeResultDB_SP.h TradeStatusDB_SP.cpp TradeStatusDB_SP.h TradeUpdateDB_SP.cpp TradeUpdateDB_SP.h TransactionsSP.vcproj TxnHarnessDBBase.cpp TxnHarnessDBBase.h TxnHarnessDBConn.cpp TxnHarnessDBConn.h
	TxnHarness	SupportingFiles/Cause3/TxnHarnes	TxnHarness.vcproj TxnHarness_stdafx.cpp TxnHarness_stdafx.h TxnHarnessSendToMarket.cpp TxnHarnessSendToMarket.h
Clause4			
Clause5	EGen Driver Configuration	SupportingFiles/Cause5	RX900S2_2400KCus_E7-8870-20.xml
	EGenLoader Parameter	SupportingFiles/Cause5	BuildSteps1.log BuildSteps2.log BuildSteps3.log EGenLoaderFrom1To21000.log EGenLoaderFrom21001To43000.log …. EGenLoaderFrom2379001To2400000.log
	EGenLogger Output	SupportingFiles/Cause5	TxnReportE-MI.xls
Clause6	EGenValidate	SupportingFiles/Cause6	EGenValidate.txt
Clause7	ACID	SupportingFiles/Cause7	MSTPCE ACID Procedures.docx
	ACID Procedures	SupportingFiles/Cause7/AcidProcs	AcidProc.cmd AcidProc.out Remove_AcidProcs.cmd
	ACID Scripts	SupportingFiles/Cause6/AcidProcs/Scripts	AcidProc.vbs CustomerPosition_Iso3.sql CustomerPosition_Iso4.sql Remove_AcidProcs.vbs TradeOrder_C.sql TradeOrder_Iso1_1.sql TradeOrder_Iso1_2.sql TradeOrder_Iso2.sql TradeOrder_Iso3.sql TradeOrder_Iso4.sql TradeOrder_RB.sql TradeResult_Iso1_1.sql TradeResult_Iso1_2.sql TradeResult_Iso2_1.sql TradeResult_Iso2_2.sql TradeResult_Iso3.sql TradeResult_Iso4.sql

	Atomicity	SupportingFiles/Cause7/Atomicity	Atomicity.cmd Atomicity_C.out Atomicity_RB.out
		SupportingFiles/Cause7/Atomicity/Scripts	atom.vbs Atomicity_C.sql Atomicity_RB.sql
	Consistency	SupportingFiles/Cause7/Consistency	Consistency.cmd Consistency.out
		SupportingFiles/Cause7/Consistency/Scripts	Consistency.sql Consistency.vbs
	Durability Business Recovery	SupportingFiles/Cause7/Durability/BusinessRecovery	BR_BenchCraft_Config.xml BR_Consistency.out BR_Count_Settlement1.ver BR_Count_Settlement2.ver BR_ERRORLOG_1.txt BR_ERRORLOG_2.txt BR_Systemevents_TierA1.txt BR_Systemevents_TierA2.txt BR_Systemevents_TierB.txt BusinessRecov_Part1_step60.xlt BusinessRecov_Part1_TxnReportE_20.xls BusinessRecov_Part1_TxnReportE_all.xls BusinessRecov_Part2_step60.xlt BusinessRecov_Part2_TxnReportE_20.xls BusinessRecov_Part2_TxnReportE_all.xls BusinessRecov_TimeGraph.xls
	Durability Data Accessibility	SupportingFiles/Cause7/Durability/Data Accessibility	DA_BenchCraft_Config.xml DA_Count_Settlement1.ver DA_Count_Settlement2.ver DA_ERRORLOG.txt DataAccess_TimeGraph.xls DataAccess_TxnReportE_5min<1,2>.xls DataAccess_TxnReportE_20min.xls DataAccess_TxnReportE_all.xls SystemEvents_Application.txt
	Isolation	SupportingFiles/Cause7/Isolation	Isolation1_S1.rpt Isolation1_S2.rpt Isolation1_S3.rpt Isolation1_S4.rpt Isolation2_S1.rpt Isolation2_S2.rpt Isolation2_S3.rpt Isolation2_S4.rpt Isolation3_S1.rpt Isolation3_S2.rpt Isolation3_S3.rpt Isolation4_S1.rpt Isolation4_S2.rpt Isolation4_S3.rpt
		SupportingFiles/Cause7/Isolation/Scripts	Isolation1_S1.sql Isolation1_S2.sql Isolation1_S3.sql Isolation1_S4.sql Isolation2_S1.sql Isolation2_S2.sql Isolation2_S3.sql Isolation2_S4.sql Isolation3_S1.sql Isolation3_S2.sql Isolation3_S3.sql Isolation4_S1.sql Isolation4_S2.sql Isolation4_S3.sql
Clause8	60-Day Space Calculations	SupportingFiles/Cause8	tpce_space.xls

Appendix: Third Party Price Quotations

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

Tel 425 882 8080
Fax 425 936 7329
http://www.microsoft.com/

Microsoft

April 28, 2011

Fujitsu
Detlev Seidel
Fujitsu TEchnology Solutions GmbH
Neinz-Nixdorf-Ring 1
Paderborn, Germany 33106

Here is the information you requested regarding pricing for several Microsoft products to be used in conjunction with your TPC-E benchmark testing.

All pricing shown is in US Dollars ($).

Part Number	Description	Unit Price	Quantity	Price
USD-00445	**SQL Server 2008 R2 Datacenter Edition** *Per Processor License* *Open Program - Level C* *Unit Price reflects a 33% discount from the retail unit price of $57,498.*	$38,376	8	$307,008
P71-06367	**Windows Server 2008 R2 Datacenter Edition** *Per Processor License* *Open Program - Level C* *Unit Price reflects a 23% discount from the retail unit price of $2,999.*	$2,310	1	$2,310
P73-04980	**Windows Server 2008 R2 Standard Edition** *Server License with 10 CALs* *Open Program - Level C* *Unit Price reflects a 31% discount from the retail unit price of $1,029.*	$711	2	$1,422
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident).*	$259	1	$259

SQL Server 2008 R2 Datacenter Edition, Windows Server 2008 R2 Datacenter Edition, and Windows Server 2008 R2 Standard Edition are currently orderable and available through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found in the Microsoft Product Information Center at
http://www.microsoft.com/products/info/render.aspx?view=22&type=how

Defect support is included in the purchase price. Additional support is available from Microsoft PSS on an incident by incident basis at $259 call.

This quote is valid for the next 90 days.
Reference ID: TPCE_qhtplylGYLKTVUKfhljPjhiIihlMlqf85757.

Appendix B: TPC-Energy Disclosure Report

TPC-Energy Clause 2-related items (Methodology)

The minimum ambient temperature must be disclosed. (7.3.2.1)

The Minimum Temperature reported by EMS : 21.19 Degrees Celsius

The characteristics of the external electric power source must be disclosed. In particular, the voltage, frequency in Hertz, and phase information must be reported. (7.3.2.2)

The external electric power source has the following characteristics: 230V, 50Hz, single phase

A statement is required that assures that nothing was done to alter the air-pressure in the measurement environment. (7.3.2.3)

Nothing was done to alter the air-pressure in the measurement environment

A description of where the temperature was measured and how it was determined that this was representative of the lowest ambient temperature is required. (7.3.2.4)

The temperature was measured for several air inlets located on different components of SUT and the lowest temperature is reported.

If a method of cooling other than circulation of ambient air is employed in the REC, a statement describing this method must be included. (7.3.2.5)

No other method of cooling was used

7.3.2.6 To be compliant with licenses associated with EMS, the following statement must be included in every FDR which contains a TPC-Energy Metric: (7.3.2.6)

The power and temperature characteristics of the MEC were measured using TPC's Energy Measurement Software (EMS). This includes the EMS-PTD, a modified version of the SPEC PTDaemon, which is provided under license from the Standard Performance Evaluation Corporation (SPEC).

TPC-Energy Clause 3-related items (Metrics)

Primary Metric. (7.3.3.1)

1) *The normalized work derived from the Performance Metric (as described in Clause 3.2.1) must be disclosed*
2) *The computation for total energy used (REC Energy Consumption) for each measurement segment that contributes to a Performance Metric must be disclosed. If the energy of the entire Priced Configuration is not derived from direct measurements, the methods for deriving the energy for components which were not measured must be disclosed (See Clause 7.3.3.4)*
3) *The duration of each measurement that produces a Performance Metric must be disclosed*.
4) *The average power requirement for each measurement that produces one of these metrics*
5) *The TPC-Energy Primary Metric must be disclosed, including the calculation that is used to derive it.*

PMU-1 = Tier B (Database Server)				Device: Hioki 3334		Calibrated: 07. Jun 10	
Measurement Interval		**Meter**		**Delta**		**PMU Energy**	
Average (watt)	2,404.01	% of Reading	0.10%	Reading Delta	2.4040	Accuracy Factor	0.47%
Total (watt-sec)	17,308,890.10	% of Range	0.10%	Range Delta	9.0000	Adjusted (watt-sec)	17,390,999.06
Duration (sec)	7,200.00	Range (watt)	9,000.00	Total Delta	11.4040	Avg Power (watt)	2,415.42

PMU-2 = Tier A (Application Server)				Device: Hioki 3334		Calibrated: 07. Jun 10	
Measurement Interval		**Meter**		**Delta**		**PMU Energy**	
Average (watt)	446.65	% of Reading	0.10%	Reading Delta	0.45	Accuracy Factor	0.30%
Total (watt-sec)	3,215,892.60	% of Range	0.10%	Range Delta	0.90	Adjusted (watt-sec)	3,225,588.52
Duration (sec)	7,200.00	Range (watt)	900.00	Total Delta	1.35	Avg Power (watt)	448.00

PMU-3 = Storage				Device: Hioki 3334		Calibrated: 07. Jun 10	
Measurement Interval		**Meter**		**Delta**		**PMU Energy**	
Average (watt)	1,686.39	% of Reading	0.20%	Reading Delta	3.37	Accuracy Factor	0.20%
Total (watt-sec)	12,142,040.10	% of Range	0.00%	Range Delta	0.00	Adjusted (watt-sec)	12,166,324.18
Duration (sec)	7,200.00	Range (watt)	3,000.00	Total Delta	3.37	Avg Power (watt)	1,689.77

PMU-4 = Monitor (Nameplate) (Misc)	
PMU Energy	
Average (watt)	19.00
Duration (sec)	7,200.00
Total Energy (watt-sec)	136,800.00

Avg REC Energy (watt)	4,572.18
Total REC Energy (watt-sec)	32,919,712
Run Duration (sec)	7,200
Reported tpsE	4,555.54
Total Transactions	32,799,888.00
Energy (watts/tpsE)	**1.00**

Total REC Energy Consumption = 32,919,712 watt-seconds

SUT Total Work = Run Duration * Reported tpsE
SUT Total Work = 32,799,888 transactions

32,919,712 watt-seconds / 32,799,888 transactions = 1.00 watts/tpsE

Secondary Metrics At Reported Performance. (7.3.3.2)

If the TPC-Energy Secondary Metrics are reported, the components of the REC which are included in each subsystem must be identified. This can be achieved with separate lists to be included in the FDR or with a specific designation in the price spreadsheet. Every component in the REC that consumes energy must be included in exactly one subsystem.
For each defined subsystem, the calculations defined for the TPC-Energy Secondary Metrics in Clause 3.3 must be reported, using the Performance Metric of the entire SUT and the energy consumption for each REC subsystem.

	Secondary Metrics	Additional Numerical Quantities			
	watts/tpsE	Full Load Avg Watts	Full Load % of REC	Idle Avg Watts	Idle % of REC
Database Server *)	0.53	2,415.42	52.83%	1,641.41	47.20%
Storage *)	0.37	1,689.77	36.96%	1,623.69	46.69%
Application Server *)	0.10	448.00	9.80%	212.13	6.10%
Miscellaneous *)	0.00	19.00	0.42%	0.50	0.01%
Total REC	1.00	4,572.18	100.00%	3,477.73	100.00%

*)See pricing for list of components

Database Server	17,390,999.06 watt-seconds/	32,817,312 transactions =	0.53 watts/tpsE
Storage	12,166,324.18 watt-seconds/	32,817,312 transactions =	0.37 watts/tpsE
Application Server	3,225,588.52 watt-seconds/	32,817,312 transactions =	0.10 watts/tpsE
Miscellaneous	136,800.00 watt-seconds/	32,817,312 transactions =	0.00 watts/tpsE

Idle Power reporting. (7.3.3.3)

1) The Idle Power measurement/calculation for the REC must be reported as numerical quantities.

2) If TPC-Energy Secondary Metrics are reported, then the Idle Power measurement/calculation for each subsystem must also be reported as numerical quantities.
3) The length of time between the conclusion of the performance measurement and the start of the idle measurement must be reported.

4) The duration of the idle measurement must be reported

5) A statement is required that assures that the system is in a state that is ready to run the Application(s) of the benchmark for the duration of the idle measurement.

PMU-1 = Tier B (Database Server)		**Device: Hioki 3334**				**Calibrated: 07. Jun 10**	
Idle Interval		**Meter**		**Delta**		**PMU Energy**	
Average (watt)	1,630.78	% of Reading	0.10%	Reading Delta	1.6308	Accuracy Factor	0.65%
Total (watt-sec)	978,465.00	% of Range	0.10%	Range Delta	9.0000	Adjusted (watt-sec)	984,843.45
Duration (sec)	600.00	Range (watt)	9,000.00	Total Delta	10.6308	Avg Power (watt)	1,641.41

PMU-2 = Tier A (Application Server)		**Device: Hioki 3334**				**Calibrated: 07. Jun 10**	
Idle Interval		**Meter**		**Delta**		**PMU Energy**	
Average (watt)	211.02	% of Reading	0.10%	Reading Delta	0.21	Accuracy Factor	0.53%
Total (watt-sec)	126,613.00	% of Range	0.10%	Range Delta	0.90	Adjusted (watt-sec)	127,279.62
Duration (sec)	600.00	Range (watt)	900.00	Total Delta	1.11	Avg Power (watt)	212.13

PMU-3 = Storage		**Device: Hioki 3334**				**Calibrated: 07. Jun 10**	
Idle Interval		**Meter**		**Delta**		**PMU Energy**	
Average (watt)	1,620.45	% of Reading	0.20%	Reading Delta	3.24	Accuracy Factor	0.20%
Total (watt-sec)	972,271.80	% of Range	0.00%	Range Delta	0.00	Adjusted (watt-sec)	974,216.34
Duration (sec)	600.00	Range (watt)	3,000.00	Total Delta	3.24	Avg Power (watt)	1,623.69

PMU-4 = Monitor (Nameplate) (Misc)	
PMU Energy	
Average (watt)	0.50

Idle Power (watt)	**3,477.73**

Idle power measurement for REC = 3477.73 Watts
The Idle measurement was started 15 minutes after all data processing was completed.
Idle measurement duration was 10 minutes
The system was in a state that was ready to run the applications of the benchmark for the duration of the idle measurement. This was verified by executing one transaction after the idle measurement interval was completed. The transaction time was compared to the allowed 90 th percentile and found to meet the required specification.

Disclosure requirements when only part of the REC is measured for power. (7.3.3.4)

The monitor power consumption in the PMU-4 was calculated using the Nameplate

Disclosure requirements when component substitution is used. (7.3.3.5)

The Priced Configuration was identical to the Measured Configuration

TPC-Energy Clause 4-related items (Drivers/Controller)

A statement indicating the version of EMS used must be included in the FDR, including a statement that no alterations of this code were made for the benchmark, except as specified by Clause 7.3.4.3. This includes levels for the EMS-PTD Manager, EMS-PTD, EMS Report Generator, and EMS-controller. (7.3.4.1)

The TPC Energy Management System V1.2.0 was used

Input parameters for the EMS software must be disclosed. (7.3.4.2)

See supporting files

Any changes in the EMS components must be documented. Documentation must include a description of the issue, the reason the change was necessary for disclosure of the Result, and the changes made to resolve it. Any change to TPC-Provided Code must be included with the submission as a Supporting File. (7.3.4.3)

No changes to EMS components were made

TPC-Energy Clause 6-related items (Instrumentation)

For each separate energy measurement (each subset measurement for each distinct measurement period), the following must be reported:

1) Analyzer used (make, model)
2) Date of certification of the analyzer (NIST or equivalent)
3) Range settings for Amperage, Voltage, and other settings for the measurement period
4) Specifications of any additional probes used in the energy measurement
5) The accuracy percentages used in the calculations and the source of those percentages. (7.3.6.1)

Power Analyzer Specifications and Settings

							Full Load		Idle	
	Make	Model	Serialnumber	Calibration date	Range Settings Current [A]	Range Settings Voltage[V]	%of reading	%of range	%of reading	%of range
PMU1 - Database Server	HIOKI	3334	90604932	07. Jun 10	30	300	0.1	0.1	0.1	0.1
PMU2 - Application Server	HIOKI	3334	90604934	07. Jun 10	3	300	0.1	0.1	0.1	0.1
PMU3 - Storage	HIOKI	3334	90604933	07. Jun 10	10	300	0.2	0	0.2	0

Accuracy percentages are taken from the HIOKI Instruction Manual 3334 3334-01 AC/DC POWER HiTESTER

The make and model of the temperature sensor and/or probe must be disclosed. (7.3.6.2)

Digi WatchportH

The accuracy percentage for the temperature sensor and/or probe and the source of this information must be disclosed. (7.3.6.3)

Temperature accuracy from Manufacturer's Datasheet:
+/- 0.5° C at -10° C to 85° C

TPC-Energy Clause 8-related items

INFO SIZING

TPC CERTIFIED AUDITOR

Detlev Seidel
Fujitsu Technology Solutions
Heinz-Nixdorf-Ring 1
33106 Paderborn, Germany

May 5, 2011

We verified the TPC Benchmark™ E performance and the TPC-Energy measurement of the following configuration:

Platform: PRIMERGY RX900 S2
Operating System: Microsoft Windows Server 2008 R2 Datacenter Edition SP1
Database Manager: Microsoft SQL Server 2008 R2 Datacenter Edition

The TPC-E results audited by Doug Johnson were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: PRIMERGY RX900 S2				
8 x Intel Xeon E7-8870 (2.40GHz)	2048 GB (8 x 30 MB L3)	384 x 64GB SSD 5 x 2TB 7.2K HDD 6 x 450GB 10K HDD	0.07 Seconds	4,555.54
Tier A, Two Clients: PRIMERGY RX200 S6				
2 x Intel Xeon E5647 (2.93 GHz)	12 GB (2 x 12 MB L3)	1 x 73 GB 15K SAS	n/a	n/a

In my opinion, these performance results were produced in compliance with the TPC requirements for the benchmark. The following verification items were given special attention:

- All EGen components were verified to be v1.12.0.
- The transactions were correctly implemented.
- The database was properly scaled and populated for 2,400,000 customers.
- The mandatory network between the driver and the SUT was configured.
- The ACID properties were met.
- Input data was generated according to the specified percentages.

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- The reported response times were correctly measured.
- All 90% response times were under the specified maximums.
- The measurement interval was representative of steady state conditions.
- The reported measurement interval was 120 minutes.
- The implementation used Redundancy Level 1.
- The Business Recovery Time of 02:10:45 was correctly measured.
- The 60 day storage requirement was correctly computed.
- The system pricing was verified for major components and maintenance.

The TPC-Energy measurements audited by Francois Raab were:

TPC-Energy Metric	REC Idle Power	Average REC Power	Temperature
1.00 Watts/tpsE	3,477.73 Watts	4,572.18 Watts	21.19 C

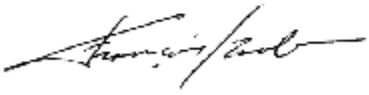
In my opinion, these energy measurements were produced in compliance with the TPC-Energy benchmark requirements and the following verification items were given special attention:

- The power analyzers used met the benchmark requirements and were correctly calibrated.
- The primary metric, secondary metrics and the idle power were calculated correctly.
- Version 1.2.0 of the EMS software package was used.

Additional Audit Notes:

The temperature reporting by the PTDM showed some jitter. An examination of the PTD log showed that all samples were correctly measured and that none were below the required minimum of 20 degree.

Respectfully Yours,



Doug Johnson, Auditor

François Raab, President

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Supporting Files Index (7.4.4)

Clause	Description	Path
7.4.1	PTDM Log Files (XML)	ptdmanager-logs\A-Power-logresults-002.xml
7.4.1	PTDM Log Files (XML)	ptdmanager-logs\A-Temperature-logresults-002.xml
7.4.1	PTDM Log Files (XML)	ptdmanager-logs\B-Power-logresults-002.xml
7.4.1	PTDM Log Files (XML)	ptdmanager-logs\B-Temperature-logresults-002.xml
7.4.1	PTDM Log Files (XML)	ptdmanager-logs\S-Power-logresults-002.xml
7.4.1	PTDM Log Files (XML)	ptdmanager-logs\S-Temperature-logresults-002.xml
7.4.1	EMS-Report Generator output	RUN-REPORTS\rgen-A-Power.txt
7.4.1	EMS-Report Generator output	RUN-REPORTS\rgen-A-Temperature.txt
7.4.1	EMS-Report Generator output	RUN-REPORTS\rgen-B-Power.txt
7.4.1	EMS-Report Generator output	RUN-REPORTS\rgen-B-Temperature.txt
7.4.1	EMS-Report Generator output	RUN-REPORTS\rgen-S-Power.txt
7.4.1	EMS-Report Generator output	RUN-REPORTS\rgen-S-Temperature.txt
7.4.1	EMS-Report Generator output	IDLE-REPORTS\rgen-A-Power.txt
7.4.1	EMS-Report Generator output	IDLE-REPORTS\rgen-A-Temperature.txt
7.4.1	EMS-Report Generator output	IDLE-REPORTS\rgen-B-Power.txt
7.4.1	EMS-Report Generator output	IDLE-REPORTS\rgen-B-Temperature.txt
7.4.1	EMS-Report Generator output	IDLE-REPORTS\rgen-S-Power.txt
7.4.1	EMS-Report Generator output	IDLE-REPORTS\rgen-S-Temperature.txt
7.4.1	Calculation Sheet for REC Energy Consumption	RX900S2_TPC-Energy_TPC-E_v4.xlsx
7.4.2	EMS-Controller log	EMSC-log\emsc-002.log
7.4.3	EMS-Controller input	EMSC-log\emsc_commands.ems
7.4.3	PTD output at start	ptd-logs\A-Power-ptd-out.txt
7.4.3	PTD output at start	ptd-logs\A-Temperature-ptd-out.txt
7.4.3	PTD output at start	ptd-logs\B-Power-ptd-out.txt
7.4.3	PTD output at start	ptd-logs\B-Temperature-ptd-out.txt
7.4.3	PTD output at start	ptd-logs\S-Power-ptd-out.txt
7.4.3	PTD output at start	ptd-logs\S-Temperature-ptd-out.txt
7.4.3	PTD Log File	ptd-logs\A-Power-ptd.log
7.4.3	PTD Log File	ptd-logs\A-Temperature-ptd.log
7.4.3	PTD Log File	ptd-logs\B-Power-ptd.log
7.4.3	PTD Log File	ptd-logs\B-Temperature-ptd.log
7.4.3	PTD Log File	ptd-logs\S-Power-ptd.log
7.4.3	PTD Log File	ptd-logs\S-Temperature-ptd.log