

(SAND2009-1171)

Appendix B: Report Template for individualized reports to Partners

National Wind Energy Reliability Database

Wind Plant Data Partner Report

COMPANY: Company X

PLANT: Plant A

Report Date: 6/30/2008



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Summary Statistics

Events Included	Metric	Last 6 Months (1/1-6/30/08)		All Available Data	
		Plant Mean Value	National Mean Value	Plant Mean Value	National Mean Value
All Events	Operational Availability	X%	X%	X%	X%
	Wind Utilization	X%	X%	X%	X%
	Utilization	X%	X%	X%	X%
	MTBE (operating hrs)	X	X	X	X
	Mean Downtime (hrs)	X	X	X	X
	Annual Cost (per Turbine)	\$X	\$X	\$X	\$X
Failures	Intrinsic Availability	X%	X%	X%	X%
	MTBF (operating hrs)	X	X	X	X
	Mean Failure Downtime (hrs)	X	X	X	X
	Annual Failure Cost (per Turbine)	\$X	\$X	\$X	\$X
Faults	MTB Fault (operating hrs)	X	X	X	X
	Mean Fault Downtime (hrs)	X	X	X	X
	Annual Fault Cost (per Turbine)	\$X	\$X	\$X	\$X
Scheduled Maintenance	MTB Scheduled Maintenance (operating hrs)	X	X	X	X
	Mean Scheduled Downtime (hrs)	X	X	X	X
	Annual Scheduled Cost (per Turbine)	\$X	\$X	\$X	\$X

All metrics, including annual cost, are for a single, representative, turbine

Table B-1: Summary Statistics – Plant vs. National

Definitions & Terms

- **Annual Cost:** the expected yearly cost for a single turbine, due to all events
 - **Annual Failure Cost:** the expected yearly cost for a single turbine, due to failures
 - **Annual Fault Cost:** the expected yearly cost for a single turbine, due to faults
 - **Annual Scheduled Cost:** the expected yearly cost for a single turbine, due to scheduled maintenance
- **Availability:** the percent of time a system is ready for use (Note: Availability can have many different definitions and formulas.)
 - **Operational Availability:** the percent of total calendar time that the system is either generating or is ready to generate (i.e., the percent of total calendar time that the system is NOT down for events)

$$= (GeneratingHours + OtherUpTime) / CalendarHours$$
 - **Intrinsic Availability:** the percent of operating and downtime that the system is operating; the percent of time the system is functioning, taking into account only the operating time and unscheduled downtime

$$= MeanTimeBetweenFailureFault / (MeanTimeBetweenFailureFault + MeanFailureFaultDowntime)$$

$$= GeneratingHours / (GeneratingHours + DowntimeDueToFailiuresAndFaults)$$
- **Calendar Hours:** for a given analysis period, the total number of hours
- **Event:** scheduled or unscheduled occurrence that stops the turbine or takes it out of service
- **Event Frequency:** the expected number of events per generating hour = 1/MTBE
- **Failure:** an unplanned event that must be reset or fixed at the turbine
- **Fault:** an unplanned event that can be reset automatically or remotely
- **Generating:** the turbine average output is > 0 kW during the measurement period (typically 10 minutes or 1 hour)

Generation	Definition
None	0% of Rated Capacity
Low	0.01 – 10% of Rated Capacity
Moderate	10 – 90% of Rated Capacity
Rated	> 90% of Rated Capacity

- **Generating Hours:** for a given analysis period, the time the system is Generating
- **Mean Downtime:** the average duration of an event (in hours)
 - **Mean Failure Downtime:** the average duration of an event that is a failure
 - **Mean Fault Downtime:** the average duration of an event that is a fault
 - **Mean Failure/Fault Downtime:** the average duration of an event that is either a failure or fault
 - **Mean Scheduled Downtime:** the average duration of an event that is a scheduled maintenance event

- **MTBE:** Mean Time Between Events: the average number of generating hours between events
 - **MTBF:** Mean Time Between Failures: the average number of generating hours between events that are failures
 - **MTB Fault:** Mean Time Between Faults: the average number of generating hours between events that are faults
 - **Mean Time Between Failure/Fault:** the average number of generating hours between events that are either failures or faults
 - **MTB Scheduled Maintenance:** Mean Time Between Scheduled Maintenance: the average number of generating hours between events that are scheduled maintenance events
- **Other Up Time:** for a given analysis period, the time the system is ready to generate, but not actively generating (i.e., it is idle); the system is neither actively producing nor down for an event
- **Scheduled Maintenance:** a planned event
- **Unavailability:** $1 - \text{Availability}$
- **Utilization:** for a given analysis period, the percent of Calendar Hours that the system was Generating

$$= \text{GeneratingHours} / \text{CalendarHours}$$
- **Wind Hours:** for a given analysis period, the total number of hours that the anemometer registered a mean wind speed of 4 – 25 m/s.

Wind	Definition
Below Cut In	0 – 4 m/s
Low	4 – 15 m/s
Rated	15 – 25 m/s
Above Cut Out	> 25 m/s

- **Wind Utilization:** for a given analysis period, the percent of Wind Hours that the system was Generating

$$= \text{GeneratingHours} / \text{WindHours}$$

Average Time Allocation

		Wind			
		Below Cut In < 4 m/s	Low 4-15 m/s	Rated 15-25 m/s	Above Cut Out > 25 m/s
Generation	Rated, > 90% Nominal Capacity	[Green grid pattern]	[Green diagonal lines]	[Green solid]	[Green checkerboard]
	Moderate, 10-90%	[Yellow grid pattern]	[Yellow diagonal lines]	[Yellow solid]	[Yellow checkerboard]
	Low, 0.01-10%	[Orange grid pattern]	[Orange diagonal lines]	[Orange solid]	[Orange checkerboard]
	None, 0% Turbine Online	[Red grid pattern]	[Red diagonal lines]	[Red solid]	[Red checkerboard]
	Turbine Offline	[Cyan grid pattern]	[Cyan diagonal lines]	[Cyan solid]	[Cyan checkerboard]
	Unknown	[White]			

Time Allocation: All Data

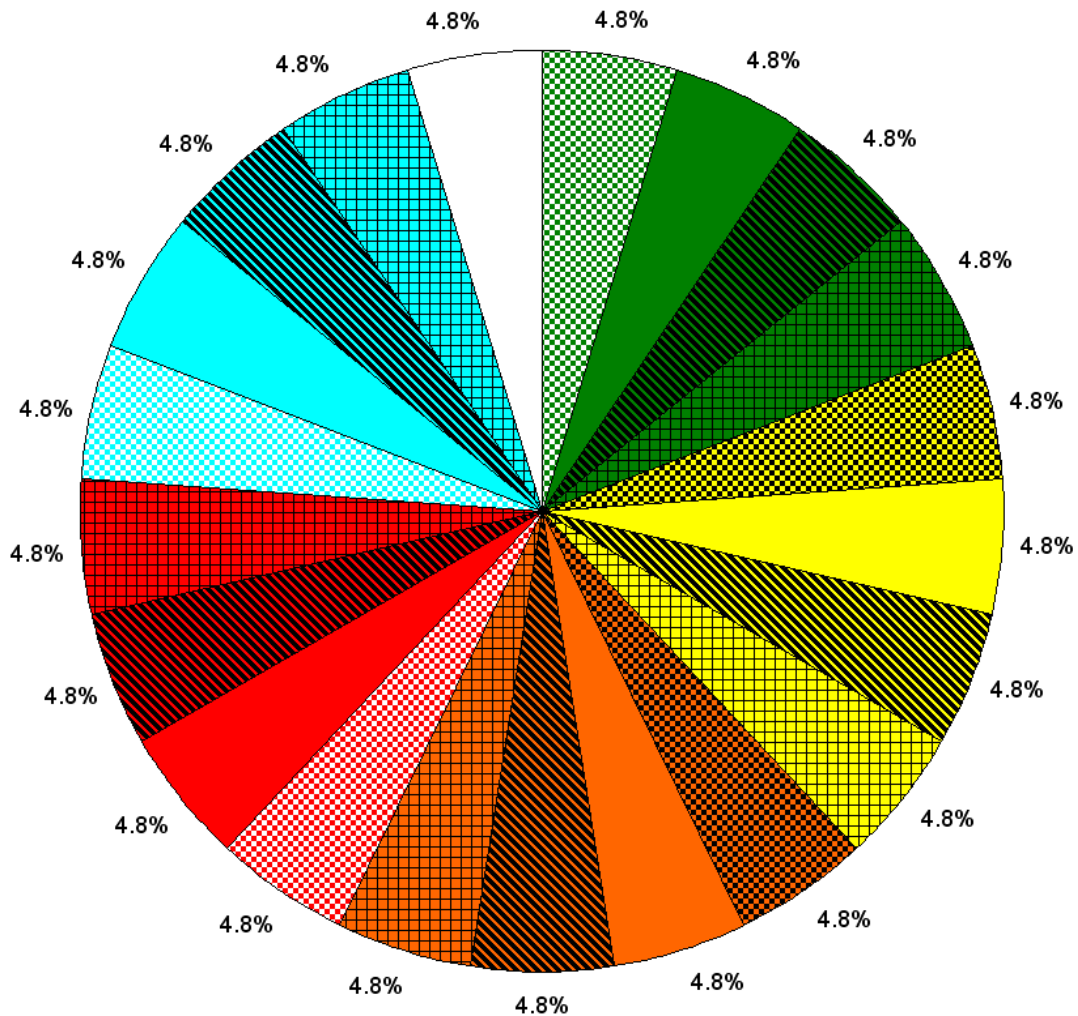


Figure B-1: Turbine Time Allocation Pie Chart

Parts Replacement Summary

This summary illustrates the frequency (“Failure Rate”) and duration (“Mean Downtime”) for failures that lead to parts replacement. Scheduled maintenance, faults, and failures that do not require parts replacement are not included. Failure Rate is the expected number of failures (requiring parts replacement) per calendar year for one turbine. Mean Downtime is the expected number of hours of downtime for each event.

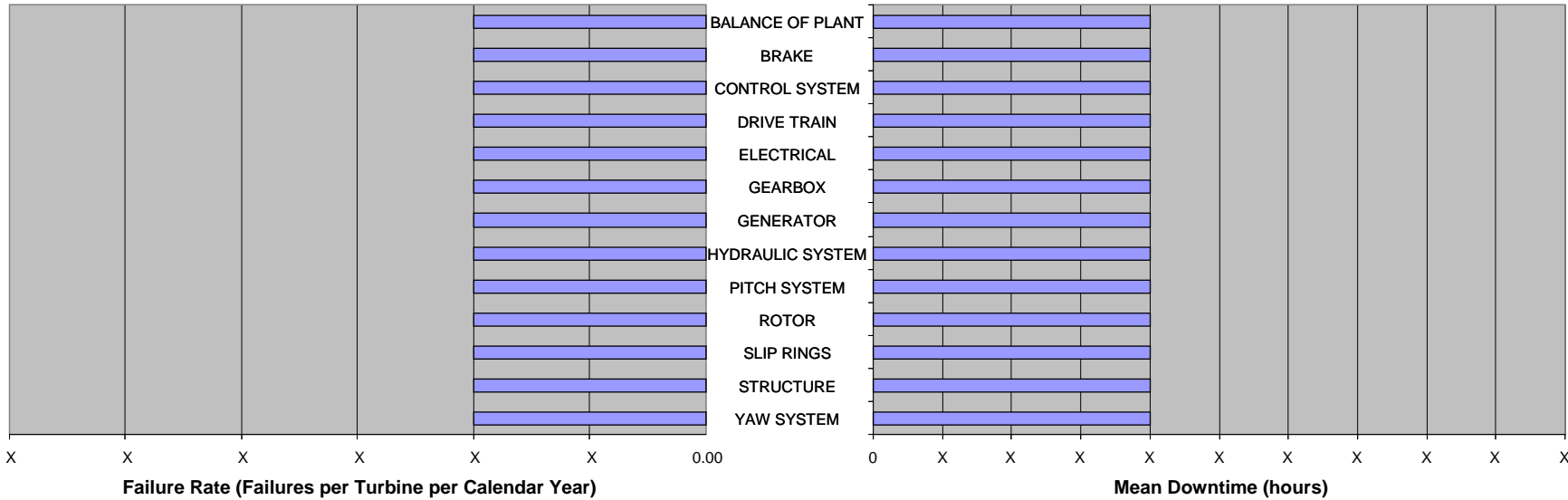


Figure B-2: Major Parts Replacements – All Data

Trends

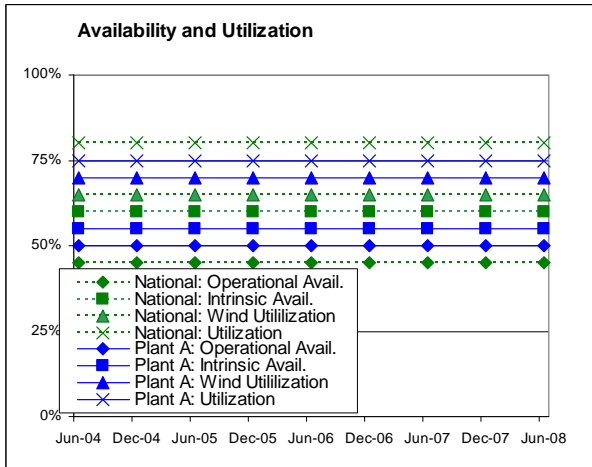


Figure B-3: Availability and Utilization Trends

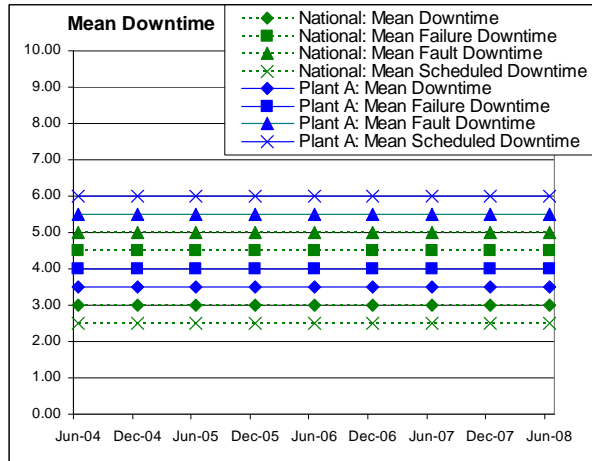


Figure B-4: Mean Downtime Trends

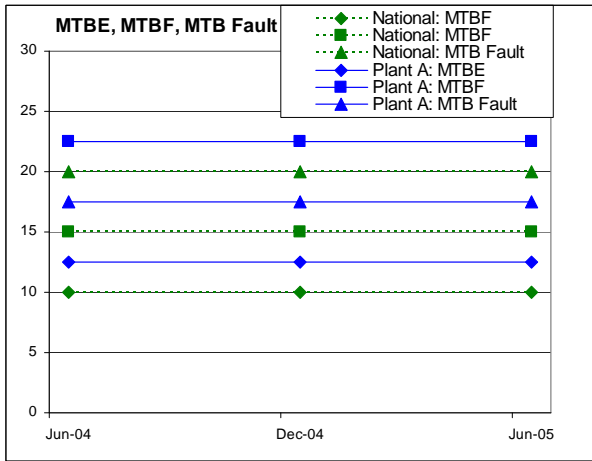


Figure B-5: MTBE, MTBF, MTB Fault Trends

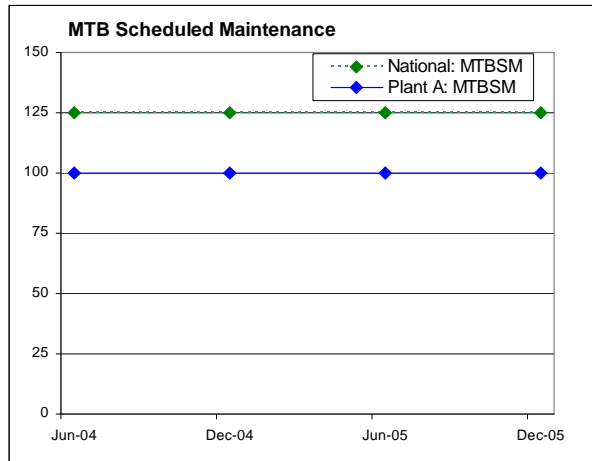


Figure B-6: MTB Scheduled Maintenance Trends

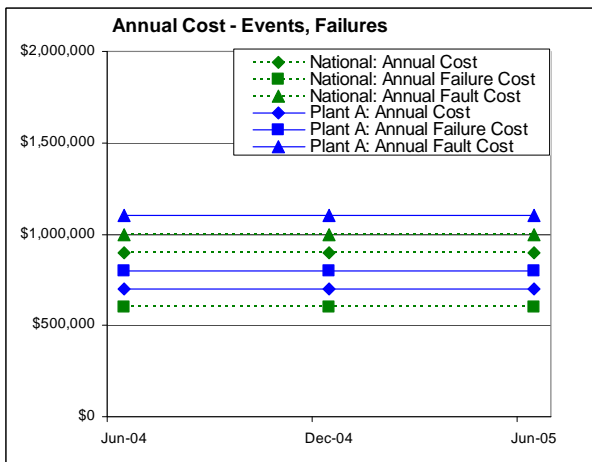


Figure B-7: Annual Event and Failure Cost Trends

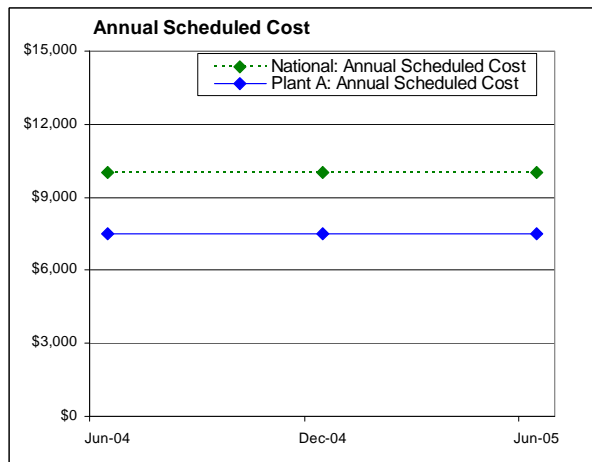


Figure B-8: Annual Scheduled Cost Trends

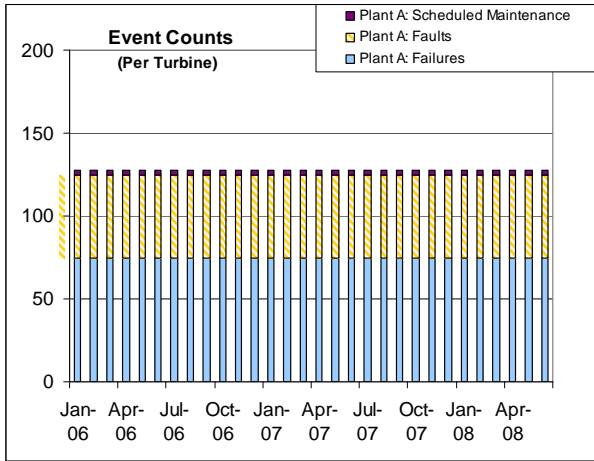


Figure B-9: Plant Event Count Trends

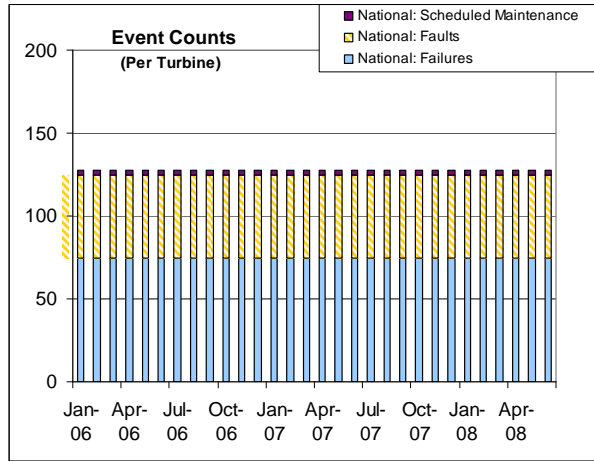


Figure B-10: National Event Count Trends

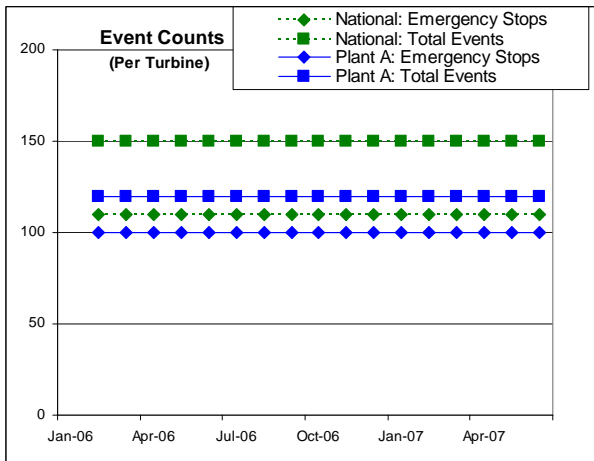
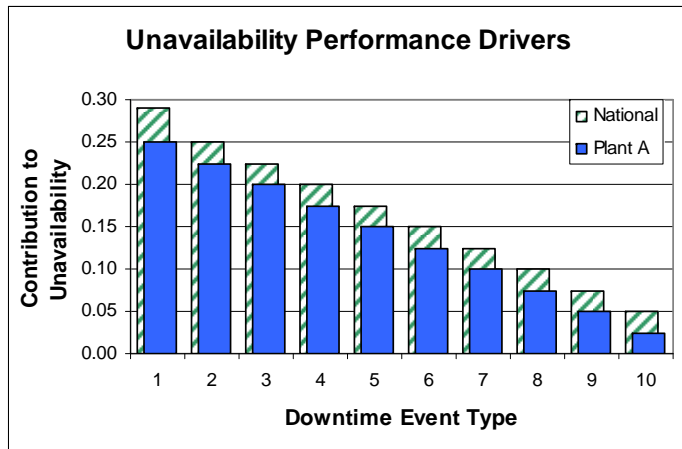


Figure B-11: Event and Emergency Count Trends

Performance Drivers – Roll Up

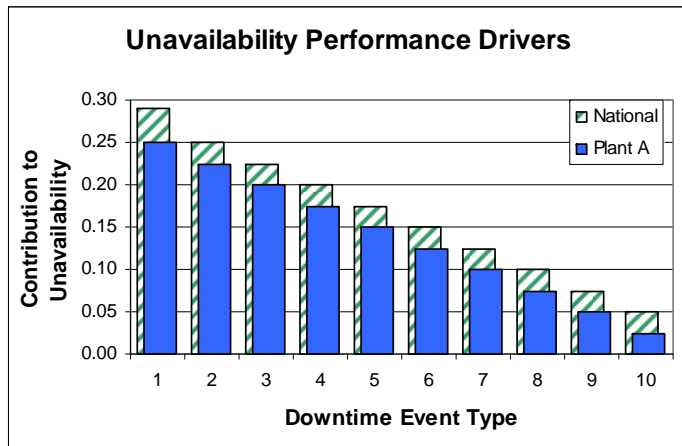
Performance drivers are events which affect reliability metrics. The following figures illustrate the performance drivers (rolled up to the second level of detail in the taxonomy¹) with the most significant negative effect on the metric listed. **For all these graphs, bigger = worse.** The top performance drivers for the plant are illustrated, along with the National value for these drivers.

Operational Unavailability Performance Drivers – Rollup



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-12: Operational Unavailability Performance Drivers – Rollup, All Data

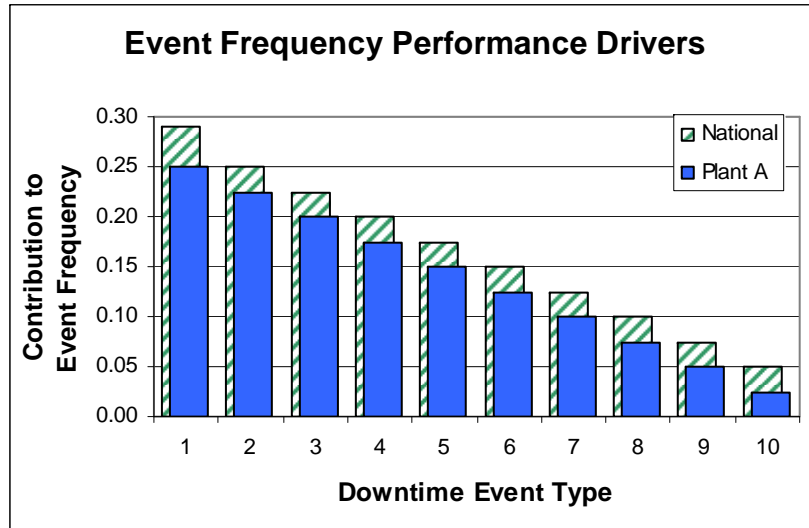


Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-13: Operational Unavailability Performance Drivers – Rollup, 1/1-6/30/2008

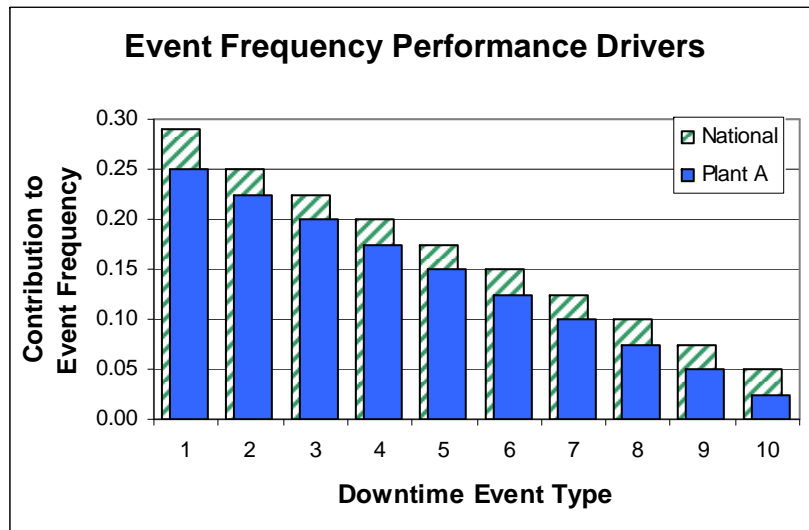
¹ See User's Guide for illustration of taxonomy.

Event Frequency (MTBE) Performance Drivers – Rollup



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

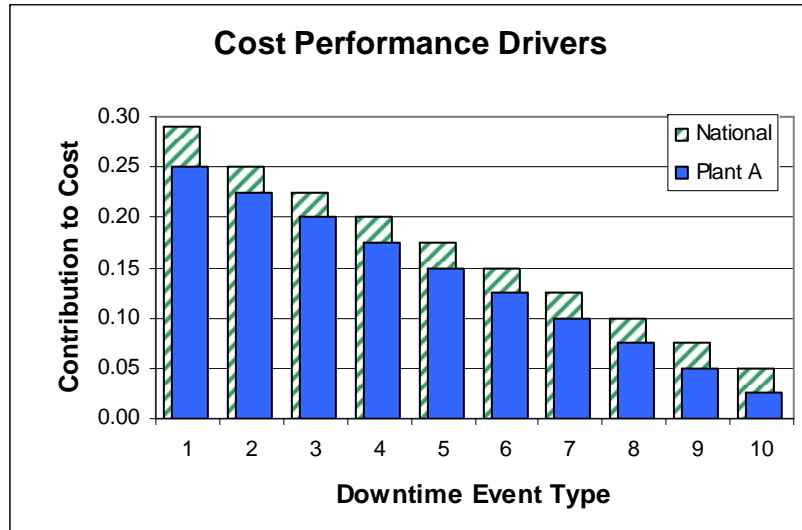
Figure B-14: Event Frequency Performance Drivers – Rollup, All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

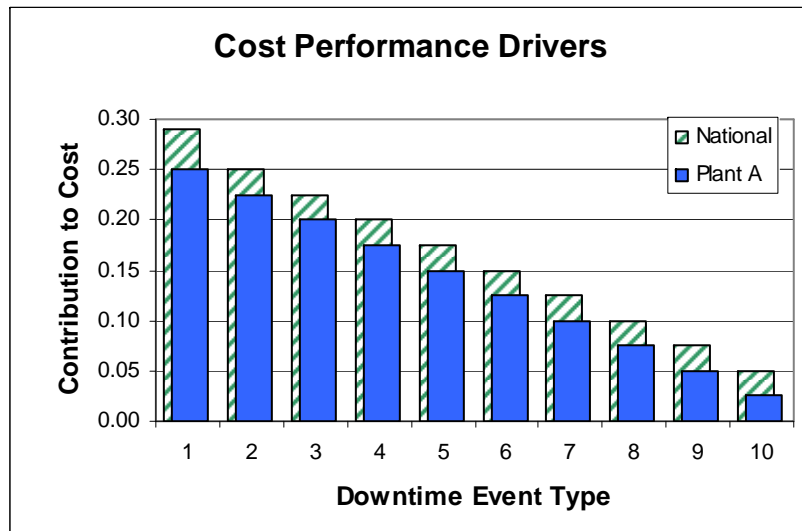
Figure B-15: Event Frequency Performance Drivers – Rollup, 1/1-6/30/2008

Cost Performance Drivers – Rollup



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

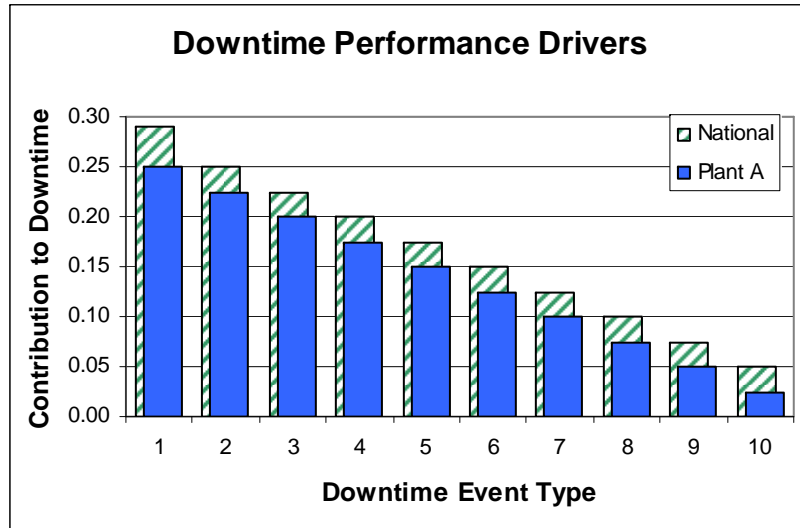
Figure B-16: Cost Performance Drivers – Rollup, All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

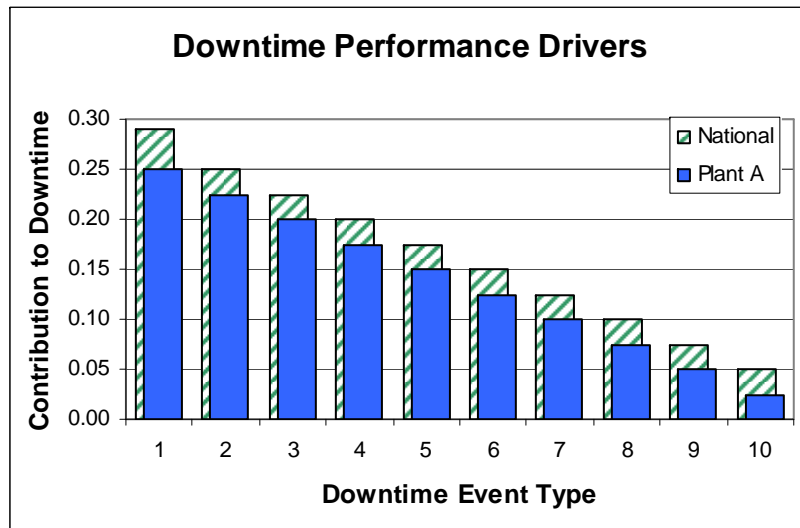
Figure B-17: Cost Performance Drivers – Rollup, 1/1-6/30/2008

Downtime Performance Drivers – Rollup



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-18: Downtime Performance Drivers – Rollup, All Data



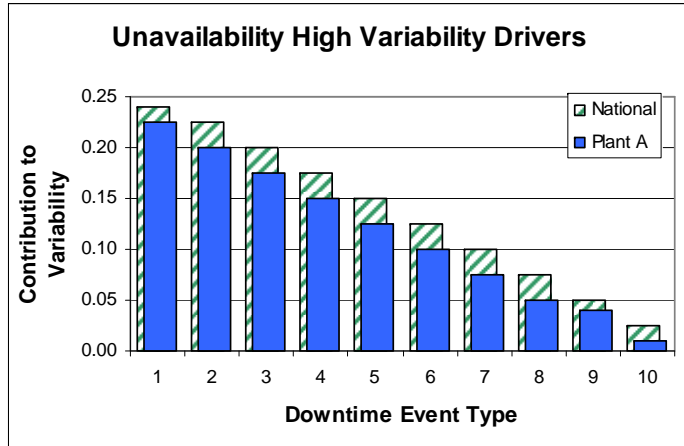
Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-19: Downtime Performance Drivers – Rollup, 1/1-6/30/2008

High Variability Drivers – Roll Up

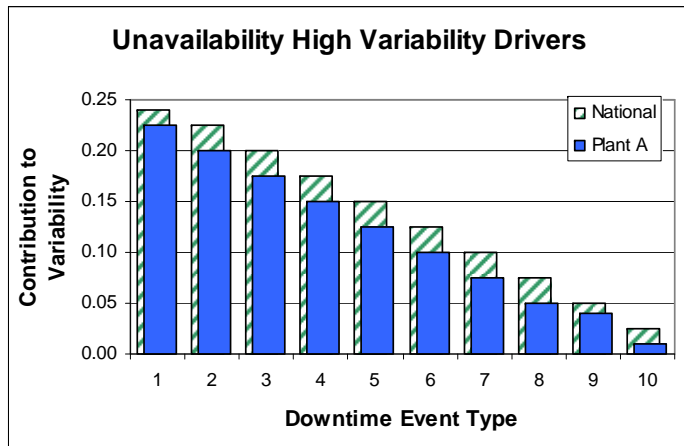
Variability drivers are events which affect the uncertainty in reliability metrics. The following figures illustrate the variability drivers (rolled up to the second level of detail in the taxonomy) with the most significant negative effect on the certainty of the metric listed. Larger variability implies bigger differences from turbine to turbine and more risk when planning for reliability impacts.

Operational Unavailability High Variability Drivers – Rollup



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

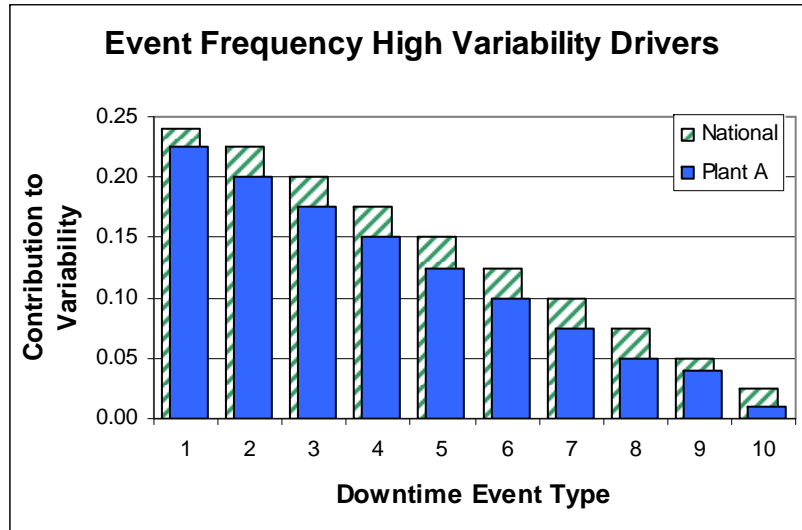
Figure B-20: Operational Unavailability High Variability Drivers – Rollup, All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

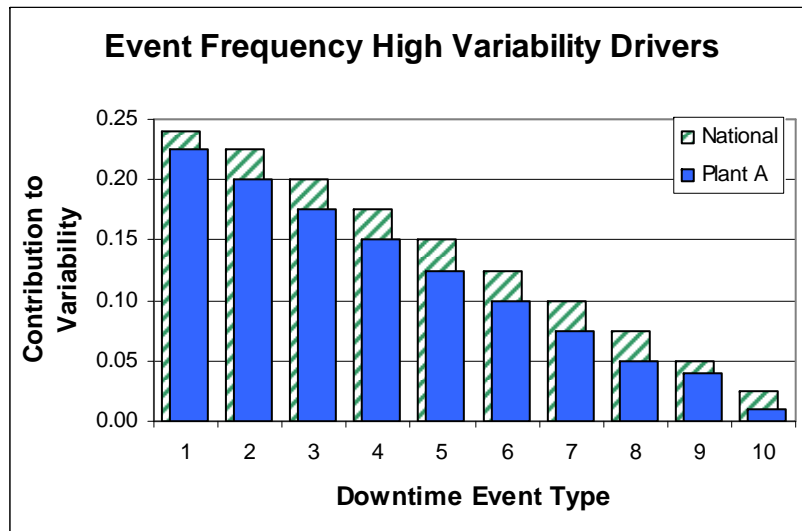
Figure B-21: Operational Unavailability High Variability Drivers – Rollup, 1/1-6/30/2008

Event Frequency (MTBE) High Variability Drivers – Rollup



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-22: Event Frequency High Variability Drivers – Rollup, All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-23: Event Frequency High Variability Drivers – Rollup, 1/1-6/30/2008

Cost High Variability Drivers – Rollup

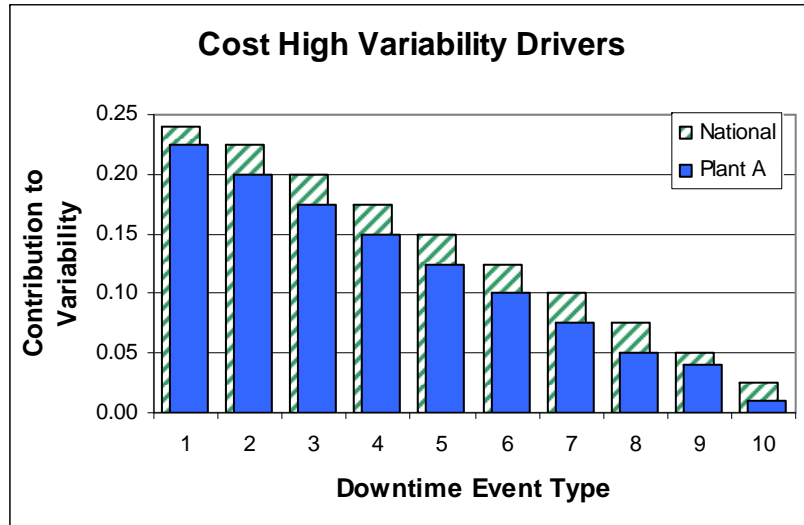


Figure B-24: Cost High Variability Drivers – Rollup, All Data

Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

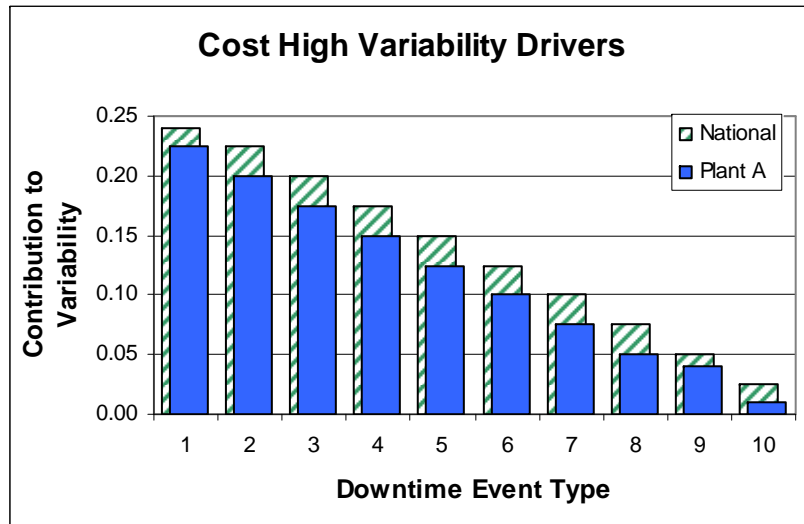


Figure B-25: Cost High Variability Drivers – Rollup, 1/1-6/30/2008

Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Downtime High Variability Drivers – Rollup

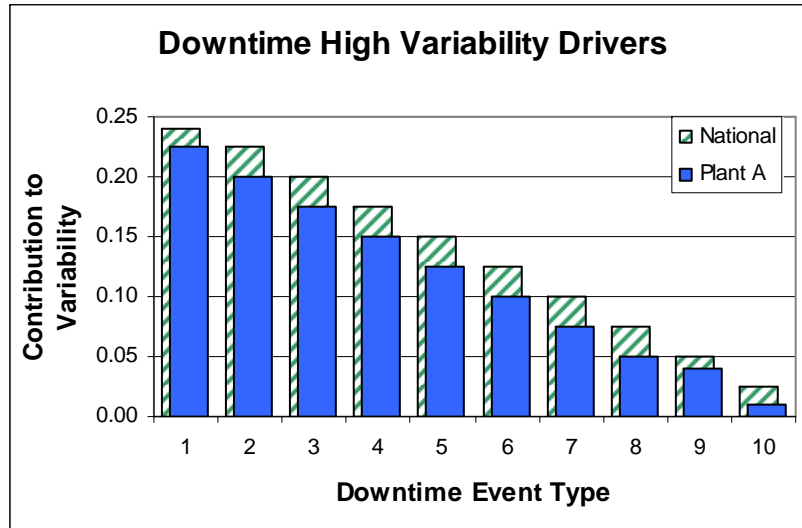


Figure B-26: Downtime High Variability Drivers – Rollup, All Data

Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

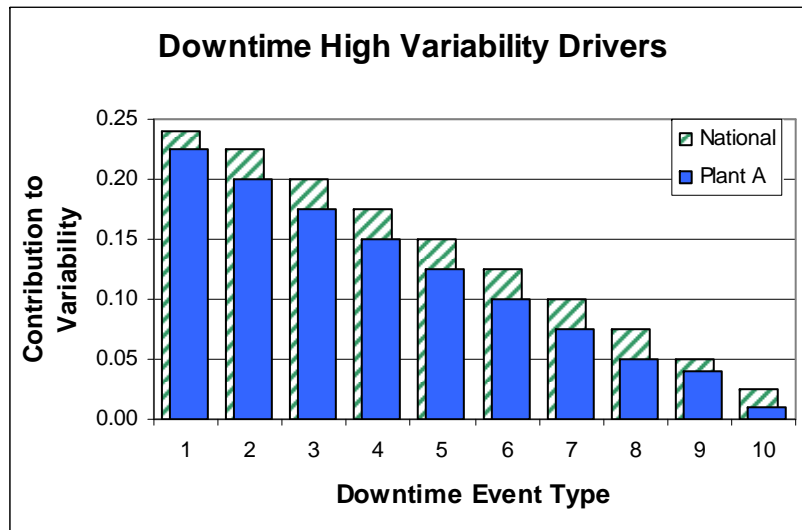


Figure B-27: Downtime High Variability Drivers – Rollup, 1/1-6/30/2008

Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Low Variability Drivers – Roll Up

Variability drivers are events which affect the uncertainty in reliability metrics. The following figures illustrate the drivers (rolled up to the second level of detail in the taxonomy) that contribute the most to overall certainty in the metric listed. Only drivers that occurred on more than 1 turbine are shown.

Operational Unavailability Low Variability Drivers – Rollup

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-2: Plant Operational Unavailability Low Variability Drivers – Rollup, All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-3: Plant Operational Unavailability Low Variability Drivers – Rollup, 1/1-6/30/2008

Event Frequency (MTBE) Low Variability Drivers – Rollup

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-4: Plant Event Frequency Low Variability Drivers – Rollup, All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-5: Plant Event Frequency Low Variability Drivers – Rollup, 1/1-6/30/2008

Cost Low Variability Drivers – Rollup

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-6: Plant Cost Low Variability Drivers – Rollup, All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-7: Plant Cost Low Variability Drivers – Rollup, 1/1-6/30/2008

Downtime Low Variability Drivers – Rollup

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

**Table B-8: Plant Downtime Low Variability Drivers – Rollup,
All Data**

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

**Table B-9: Plant Downtime Low Variability Drivers – Rollup,
1/1-6/30/2008**

Turbine Summary

Turbine	Operational Availability	Mean Time Between Events (hours)	Average Cost Per Event	Mean Downtime Per Event (hours)
Turbine 0001	X%	X	\$X	X
Turbine 0002	X%	X	\$X	X
Turbine 0003	X%	X	\$X	X
Turbine 0004	X%	X	\$X	X
Turbine 0005	X%	X	\$X	X
Turbine 0006	X%	X	\$X	X
Turbine 0007	X%	X	\$X	X
Turbine 0008	X%	X	\$X	X
Turbine 0009	X%	X	\$X	X
Turbine 0010	X%	X	\$X	X
...

Table B-10: Turbine Summary Statistics – All Data

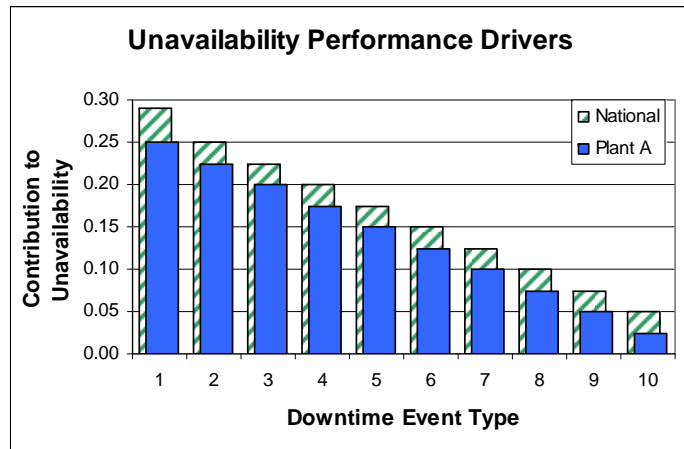
Turbine	Operational Availability	Mean Time Between Events (hours)	Average Cost Per Event	Mean Downtime Per Event (hours)
Turbine 0001	X%	X	\$X	X
Turbine 0002	X%	X	\$X	X
Turbine 0003	X%	X	\$X	X
Turbine 0004	X%	X	\$X	X
Turbine 0005	X%	X	\$X	X
Turbine 0006	X%	X	\$X	X
Turbine 0007	X%	X	\$X	X
Turbine 0008	X%	X	\$X	X
Turbine 0009	X%	X	\$X	X
Turbine 0010	X%	X	\$X	X
...

Table B-11: Turbine Summary Statistics – 1/1-6/30/2008

Appendix A: Performance Drivers – Full Taxonomy

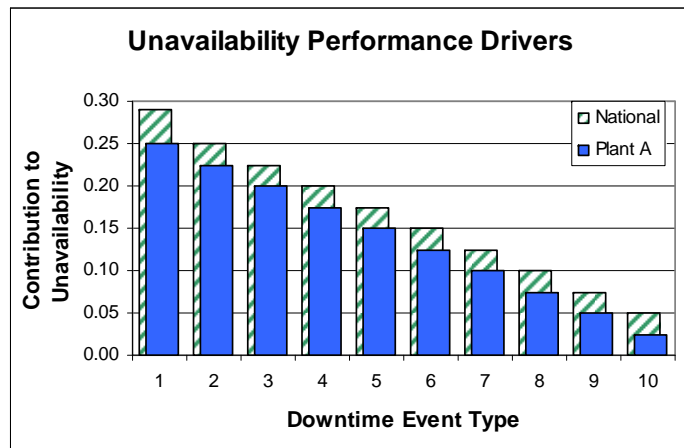
Performance drivers are events which affect reliability metrics. The following figures illustrate the performance drivers (using the full level of detail in the taxonomy²) with the most significant negative effect on the metric listed.

Operational Unavailability Performance Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-28: Operational Unavailability Performance Drivers – All Data

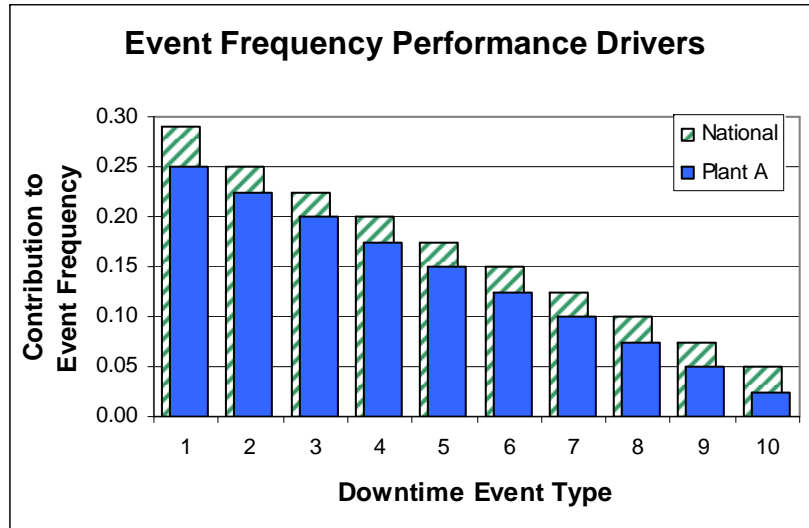


Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-29: Operational Unavailability Performance Drivers – 1/1-6/30/2008

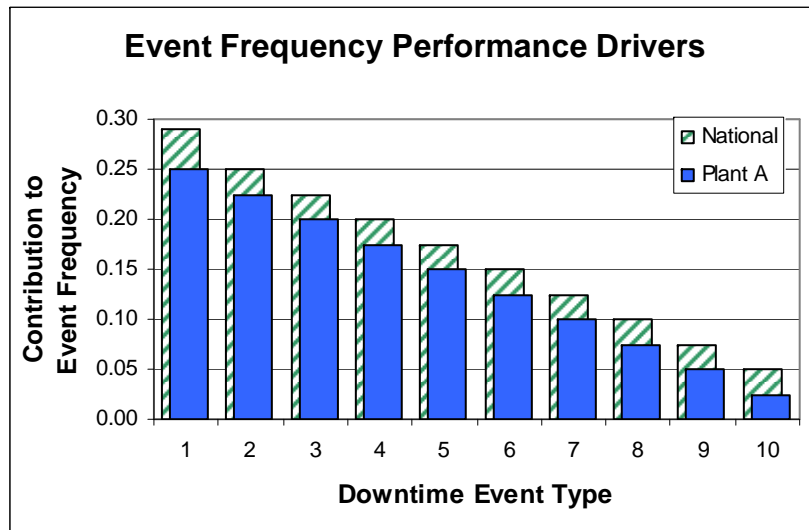
² See User's Guide for illustration of taxonomy.

Event Frequency (MTBE) Performance Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

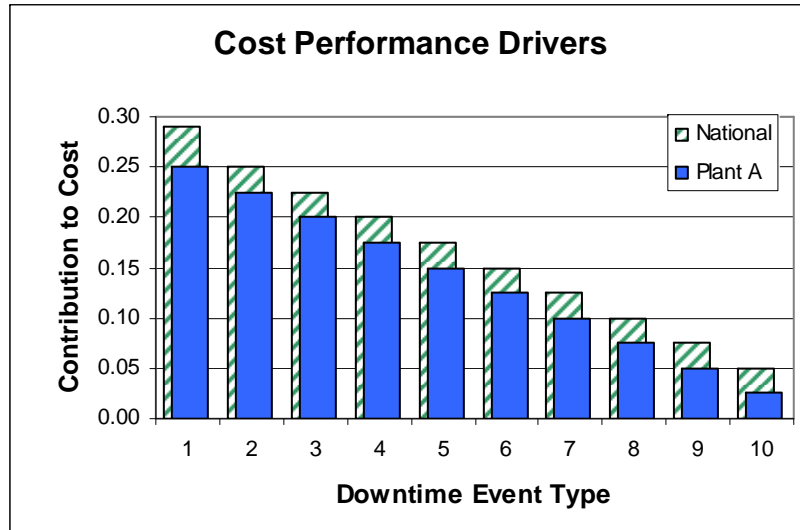
Figure B-30: Event Frequency Performance Drivers – All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

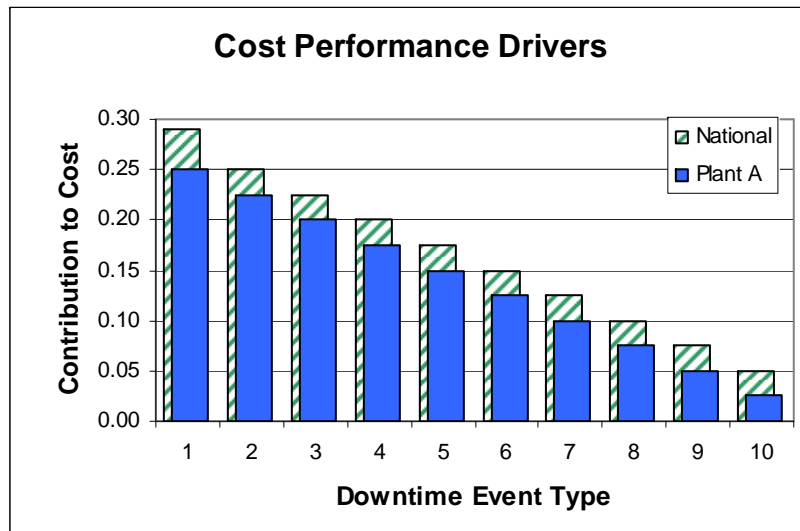
Figure B-31: Event Frequency Performance Drivers – 1/1-6/30/2008

Cost Performance Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

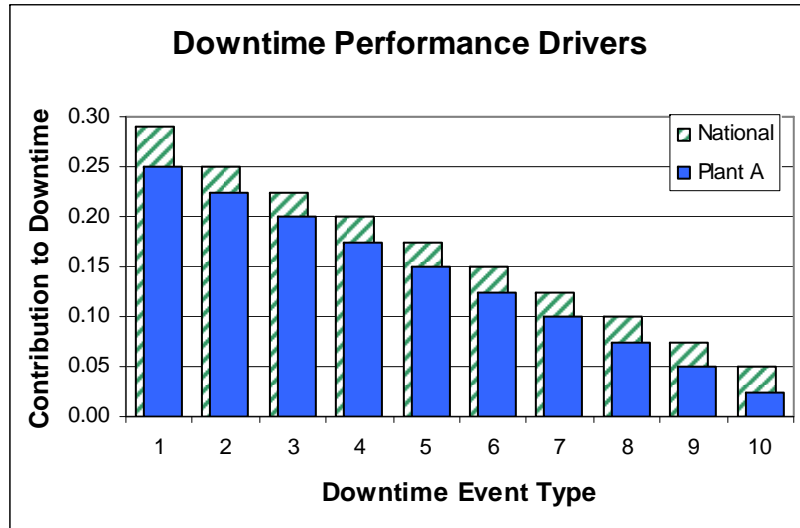
Figure B-32: Cost Performance Drivers – All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

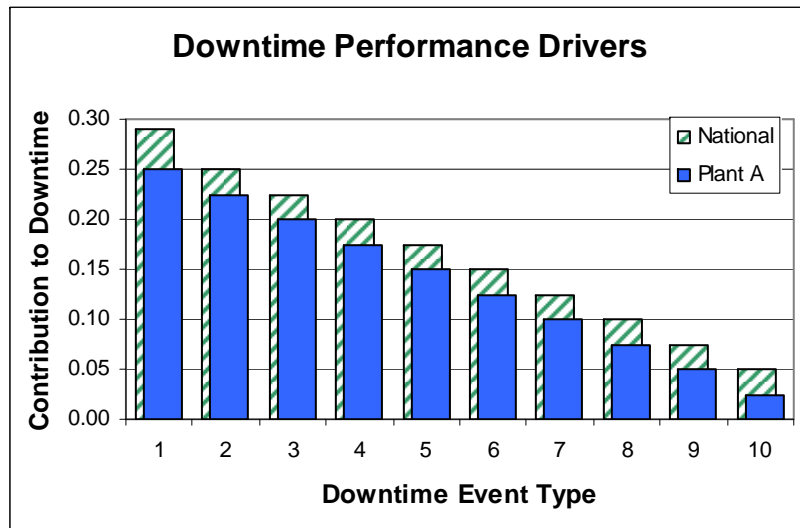
Figure B-33: Cost Performance Drivers – 1/1-6/30/2008

Downtime Performance Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-34: Downtime Performance Drivers – All Data



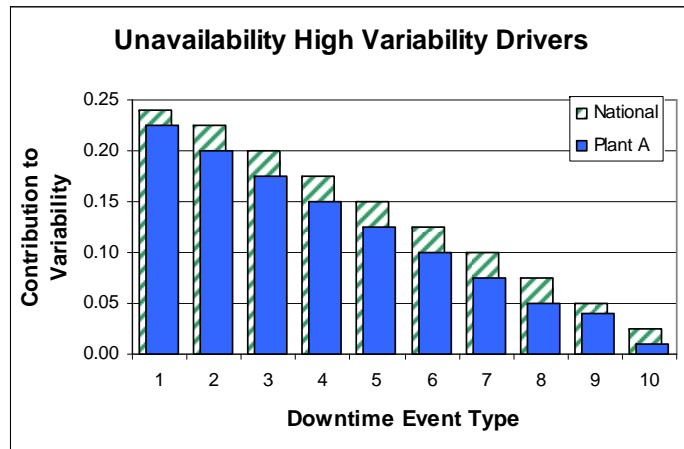
Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-35: Downtime Performance Drivers – 1/1-6/30/2008

Appendix B: High Variability Drivers – Full Taxonomy

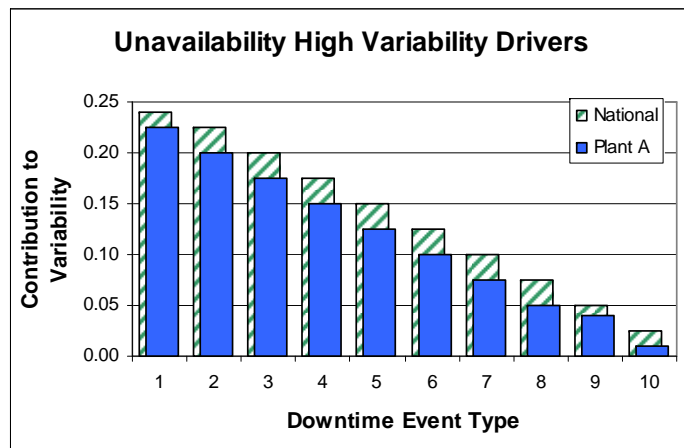
Variability drivers are events which affect the uncertainty in reliability metrics. The following figures illustrate the variability drivers (using the full level of detail in the taxonomy) with the most significant negative effect on the certainty of the metric listed.

Operational Unavailability High Variability Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

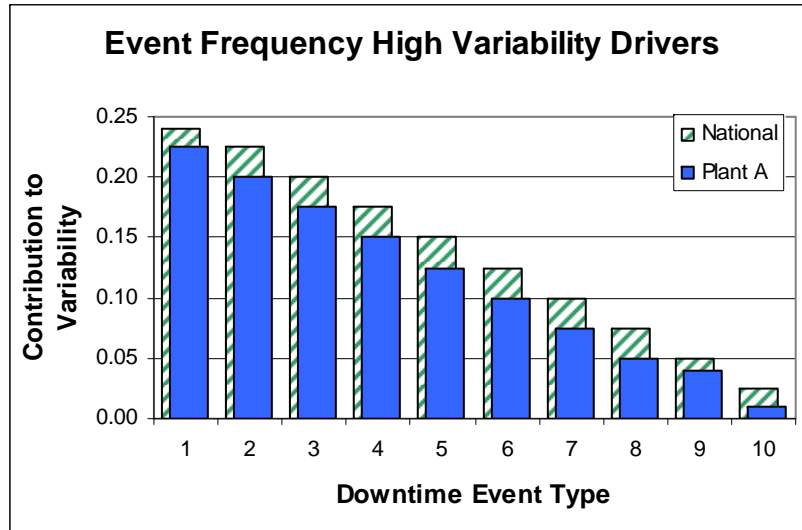
Figure B-36: Operational Unavailability High Variability Drivers – All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

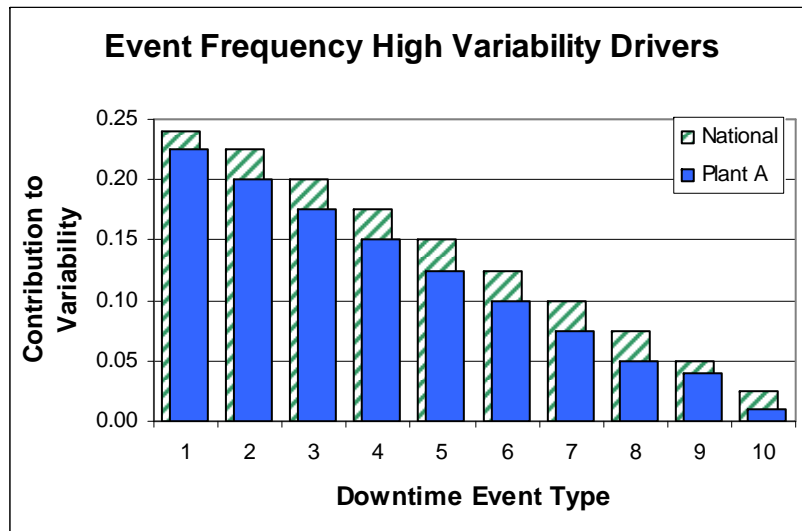
Figure B-37: Operational Unavailability High Variability Drivers – 1/1-6/30/2008

Event Frequency (MTBE) High Variability Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

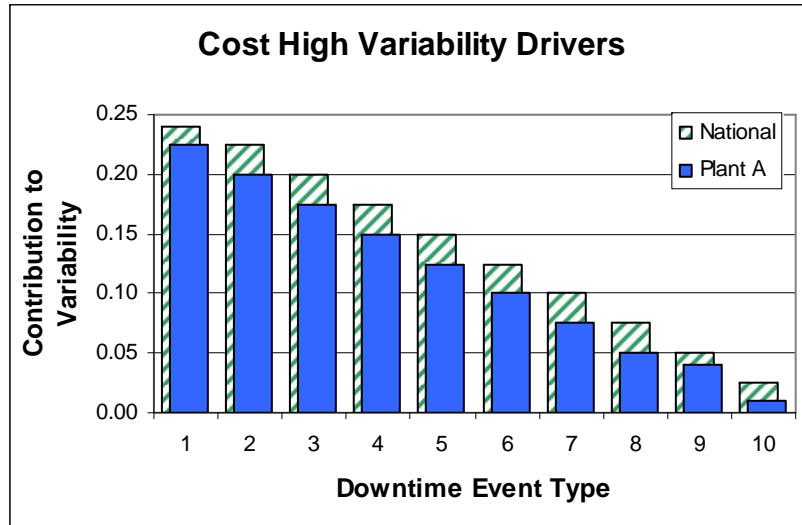
Figure B-38: Event Frequency High Variability Drivers – All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

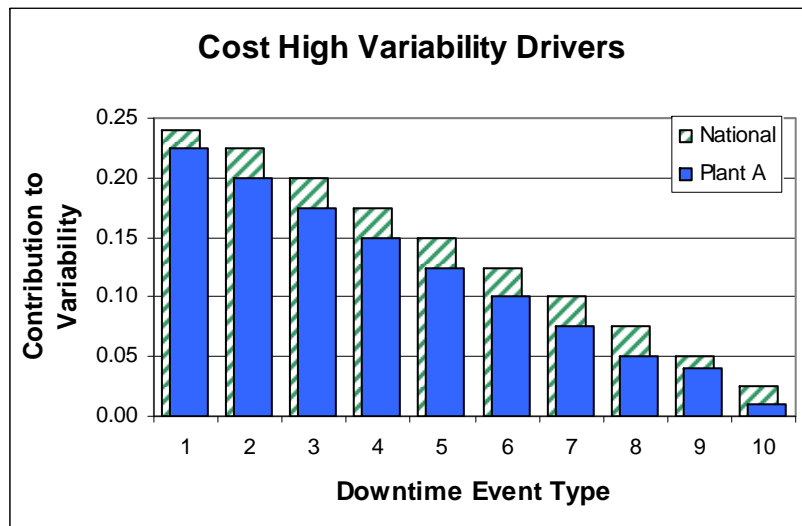
Figure B-39: Event Frequency High Variability Drivers – 1/1-6/30/2008

Cost High Variability Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

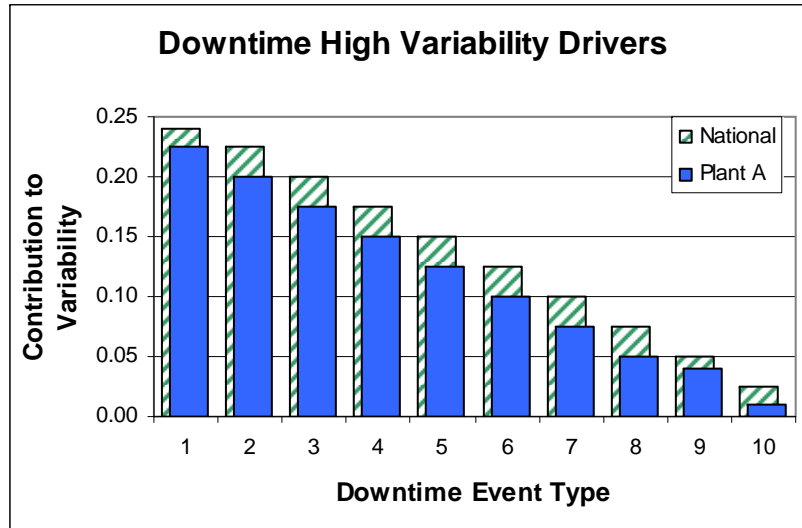
Figure B-40: Cost High Variability Drivers – All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

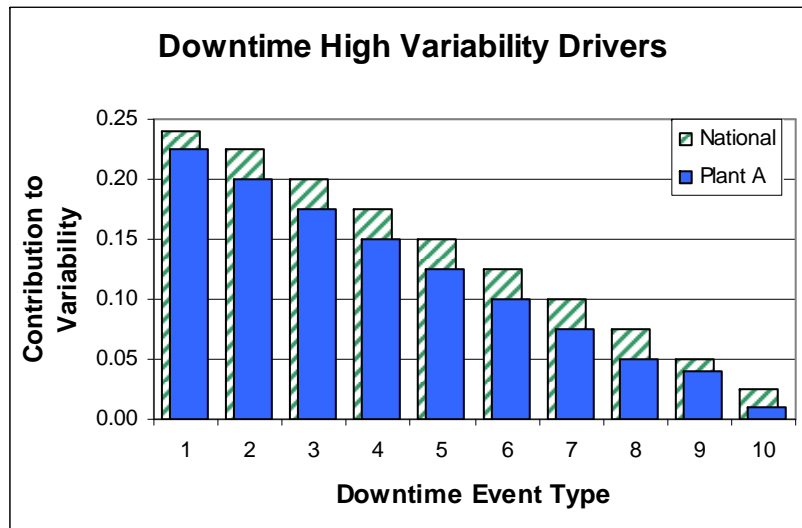
Figure B-41: Cost High Variability Drivers – 1/1-6/30/2008

Downtime High Variability Drivers – Full Taxonomy



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-42: Downtime High Variability Drivers – All Data



Downtime Event Type	
1	Component A
2	Component B
3	Component C
4	Component D
5	Component E
6	Component F
7	Component G
8	Component H
9	Component I
10	Component J

Figure B-43: Downtime High Variability Drivers – 1/1-6/30/2008

Appendix C: Low Variability Drivers – Full Taxonomy

Variability drivers are events which affect the uncertainty in reliability metrics. The following table lists the drivers (using the full level of detail in the taxonomy) that contribute most to overall certainty in the certainty of the metric listed. Only drivers that occurred on more than 1 turbine are shown.

Operational Unavailability Low Variability Drivers – Full Taxonomy

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-12: Plant Operational Unavailability Low Variability Drivers – All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-13: Plant Operational Unavailability Low Variability Drivers – 1/1-6/30/2008

Event Frequency (MTBE) Low Variability Drivers – Full Taxonomy

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-14: Plant Event Frequency Low Variability Drivers – All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-15: Plant Event Frequency Low Variability Drivers – 1/1-6/30/2008

Cost Low Variability Drivers – Full Taxonomy

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-16: Plant Cost Low Variability Drivers – All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-17: Plant Cost Low Variability Drivers – 1/1-6/30/2008

Downtime Low Variability Drivers – Full Taxonomy

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-18: Plant Downtime Low Variability Drivers – All Data

Component AA
Component BB
Component CC
Component DD
Component EE
Component FF
Component GG
Component HH
Component II
Component JJ
Component KK
Component LL
Component MM
Component NN
Component OO
Component PP
Component QQ
Component RR
Component SS
Component TT

Table B-19: Plant Downtime Low Variability Drivers – 1/1-6/30/2008

Appendix D: Taxonomy & Failure Mode Summary

Event Type	Yearly Event Rate ³	Mean Downtime ⁴	Cost/Event	Downtime Cost/Hr
Balance of Structure-Mx	X	X	\$X	\$X
Balance of Structure-Rst	X	X	\$X	\$X
Balance of Structure-Sch	X	X	\$X	\$X
Brake::Mechanical brakes	X	X	\$X	\$X
Brake::Mechanical brakes-Mx	X	X	\$X	\$X
Brake::Mechanical brakes-Sch	X	X	\$X	\$X
Brake::Parking Brake - manual transmission lock-Mx	X	X	\$X	\$X
Brake-Mx	X	X	\$X	\$X
Brake-Rst	X	X	\$X	\$X
Control system	X	X	\$X	\$X
Control system::Anemometer	X	X	\$X	\$X
Control system::Anemometer-Mx	X	X	\$X	\$X
Control system::Anemometer-Rst	X	X	\$X	\$X
Control system::Anemometer-Sch	X	X	\$X	\$X
Control system::Control SCADA	X	X	\$X	\$X
Control system::Control SCADA-Mx	X	X	\$X	\$X
Control system::Control SCADA-Sch	X	X	\$X	\$X
Control system::PLC	X	X	\$X	\$X
Control system::PLC-Mx	X	X	\$X	\$X
Control system::PLC-Rst	X	X	\$X	\$X
Control system::PLC-Sch	X	X	\$X	\$X
Control system::Sensors(static)	X	X	\$X	\$X
Control system::Sensors(static)-Mx	X	X	\$X	\$X
Control system::Sensors(static)-Rst	X	X	\$X	\$X
Control system::UPS	X	X	\$X	\$X
Control system::UPS-Mx	X	X	\$X	\$X
Control system::UPS-Rst	X	X	\$X	\$X
Control system::Wind vane-Mx	X	X	\$X	\$X
Control system-Mx	X	X	\$X	\$X
Control system-Rst	X	X	\$X	\$X
Control system-Sch	X	X	\$X	\$X
Drive Train-Mx	X	X	\$X	\$X
Electrical	X	X	\$X	\$X
Electrical::Circuit breakers and switches	X	X	\$X	\$X
Electrical::Circuit breakers and switches-Mx	X	X	\$X	\$X
Electrical::Circuit breakers and switches-Rst	X	X	\$X	\$X
Electrical::Circuit breakers and switches-Sch	X	X	\$X	\$X
Electrical::Crowbar	X	X	\$X	\$X
Electrical::Crowbar-Mx	X	X	\$X	\$X
Electrical::Crowbar-Rst	X	X	\$X	\$X
Electrical::Crowbar-Sch	X	X	\$X	\$X

³ Yearly Event Rate is the expected number of events per turbine per calendar year.

⁴ Mean Downtime is the expected number of hours of downtime for a single event.

Event Type	Yearly Event Rate³	Mean Downtime⁴	Cost/Event	Downtime Cost/Hr
Electrical::Main circuit breaker	X	X	\$X	\$X
Electrical::Main circuit breaker-Mx	X	X	\$X	\$X
Electrical::Main circuit breaker-Rst	X	X	\$X	\$X
Electrical::Main circuit breaker-Sch	X	X	\$X	\$X
Electrical::Main contactor-Mx	X	X	\$X	\$X
Electrical::Metering and relays-Mx	X	X	\$X	\$X
Electrical::Pad mounted transformer-Mx	X	X	\$X	\$X
Electrical::Pad mounted transformer-Rst	X	X	\$X	\$X
Electrical::Pad mounted transformer-Sch	X	X	\$X	\$X
Electrical::Power converters-Mx	X	X	\$X	\$X
Electrical::Soft starter-Mx	X	X	\$X	\$X
Electrical::Substation-Mx	X	X	\$X	\$X
Electrical::Substation-Rst	X	X	\$X	\$X
Electrical::Switchgear	X	X	\$X	\$X
Electrical::Switchgear-Mx	X	X	\$X	\$X
Electrical::Switchgear-Rst	X	X	\$X	\$X
Electrical::Switchgear-Sch	X	X	\$X	\$X
Electrical::Transformer-Mx	X	X	\$X	\$X
Electrical::Transformer-Rst	X	X	\$X	\$X
Electrical::Transformer-Sch	X	X	\$X	\$X
Electrical-Mx	X	X	\$X	\$X
Electrical-Rst	X	X	\$X	\$X
Electrical-Sch	X	X	\$X	\$X
Emergency stop-Mx	X	X	\$X	\$X
Emergency stop-Rst	X	X	\$X	\$X
GearBox::Bearings	X	X	\$X	\$X
GearBox::Bearings-Mx	X	X	\$X	\$X
GearBox::Bearings-Rst	X	X	\$X	\$X
GearBox::Bearings-Sch	X	X	\$X	\$X
GearBox::Gearbox casing-Mx	X	X	\$X	\$X
GearBox::Gearbox casing-Rst	X	X	\$X	\$X
GearBox::Gearbox oil system	X	X	\$X	\$X
GearBox::Gearbox oil system-Mx	X	X	\$X	\$X
GearBox::Gearbox oil system-Rst	X	X	\$X	\$X
GearBox::Gearbox oil system-Sch	X	X	\$X	\$X
GearBox::Gears-Rst	X	X	\$X	\$X
GearBox::High speed shaft-Mx	X	X	\$X	\$X
GearBox::High speed shaft-Rst	X	X	\$X	\$X
GearBox-Mx	X	X	\$X	\$X
GearBox-Rst	X	X	\$X	\$X
GearBox-Sch	X	X	\$X	\$X
Generator	X	X	\$X	\$X
Generator::Commutator and brushes	X	X	\$X	\$X
Generator::Commutator and brushes-Mx	X	X	\$X	\$X
Generator::Commutator and brushes-Rst	X	X	\$X	\$X
Generator::Commutator and brushes-Sch	X	X	\$X	\$X

Event Type	Yearly Event Rate ³	Mean Downtime ⁴	Cost/Event	Downtime Cost/Hr
Generator::Contactor	X	X	\$X	\$X
Generator::Contactor-Mx	X	X	\$X	\$X
Generator::Converter	X	X	\$X	\$X
Generator::Converter-Mx	X	X	\$X	\$X
Generator::Converter-Rst	X	X	\$X	\$X
Generator::Converter-Sch	X	X	\$X	\$X
Generator::Encoder	X	X	\$X	\$X
Generator::Encoder-Mx	X	X	\$X	\$X
Generator::Encoder-Rst	X	X	\$X	\$X
Generator::Encoder-Sch	X	X	\$X	\$X
Generator::Exciter-Sch	X	X	\$X	\$X
Generator::Generator bearings	X	X	\$X	\$X
Generator::Generator bearings-Mx	X	X	\$X	\$X
Generator::Generator bearings-Sch	X	X	\$X	\$X
Generator::Generator cooling system	X	X	\$X	\$X
Generator::Generator cooling system-Mx	X	X	\$X	\$X
Generator::Generator cooling system-Rst	X	X	\$X	\$X
Generator::Generator shaft-Mx	X	X	\$X	\$X
Generator::Insulation-Mx	X	X	\$X	\$X
Generator::Overspeed sensor	X	X	\$X	\$X
Generator::Overspeed sensor-Mx	X	X	\$X	\$X
Generator::Overspeed sensor-Rst	X	X	\$X	\$X
Generator::Wiring/Cables-Mx	X	X	\$X	\$X
Generator::Wiring/Cables-Rst	X	X	\$X	\$X
Generator::Wiring/Cables-Sch	X	X	\$X	\$X
Generator-Mx	X	X	\$X	\$X
Generator-Rst	X	X	\$X	\$X
Generator-Sch	X	X	\$X	\$X
Maintenance::Maintenance (12-month)-Sch	X	X	\$X	\$X
Maintenance::Maintenance (18-month)-Sch	X	X	\$X	\$X
Maintenance::Maintenance (3-month)-Sch	X	X	\$X	\$X
Maintenance::Maintenance (6-month)-Sch	X	X	\$X	\$X
Maintenance::Testing-Mx	X	X	\$X	\$X
Maintenance-Sch	X	X	\$X	\$X
Met Tower::Wind vane-Rst	X	X	\$X	\$X
Met Tower-Mx	X	X	\$X	\$X
Pitch system::Blade pitch bearing-Mx	X	X	\$X	\$X
Pitch system::Embedded control system	X	X	\$X	\$X
Pitch system::Embedded control system-Mx	X	X	\$X	\$X
Pitch system::Embedded control system-Rst	X	X	\$X	\$X
Pitch system::Pitch hydraulics	X	X	\$X	\$X
Pitch system::Pitch hydraulics-Mx	X	X	\$X	\$X
Pitch system::Pitch hydraulics-Rst	X	X	\$X	\$X
Pitch system::Pitch hydraulics-Sch	X	X	\$X	\$X
Pitch system-Mx	X	X	\$X	\$X
Pitch system-Rst	X	X	\$X	\$X

Event Type	Yearly Event Rate³	Mean Downtime⁴	Cost/Event	Downtime Cost/Hr
Rotor	X	X	\$X	\$X
Rotor::Blade	X	X	\$X	\$X
Rotor::Blade-Mx	X	X	\$X	\$X
Rotor::Blade-Rst	X	X	\$X	\$X
Rotor::Blade-Sch	X	X	\$X	\$X
Rotor::De-icing system-Mx	X	X	\$X	\$X
Rotor::De-icing system-Rst	X	X	\$X	\$X
Rotor::Hub-Mx	X	X	\$X	\$X
Rotor::Hub-Sch	X	X	\$X	\$X
Rotor::Root attachment-Sch	X	X	\$X	\$X
Rotor-Mx	X	X	\$X	\$X
Slip Rings	X	X	\$X	\$X
Slip Rings-Sch	X	X	\$X	\$X
Structure::Foundation-Sch	X	X	\$X	\$X
Structure::Nacelle	X	X	\$X	\$X
Structure::Nacelle-Mx	X	X	\$X	\$X
Structure::Nacelle-Rst	X	X	\$X	\$X
Structure::Nacelle-Sch	X	X	\$X	\$X
Structure::Tower-Mx	X	X	\$X	\$X
Structure::Tower-Sch	X	X	\$X	\$X
Structure-Mx	X	X	\$X	\$X
Structure-Rst	X	X	\$X	\$X
Structure-Sch	X	X	\$X	\$X
Unidentified Failure-Mx	X	X	\$X	\$X
Unidentified Fault-Rst	X	X	\$X	\$X
Yaw System::Yaw bearing-Mx	X	X	\$X	\$X
Yaw System::Yaw brake-Mx	X	X	\$X	\$X
Yaw System::Yaw brake-Rst	X	X	\$X	\$X
Yaw System::Yaw control system	X	X	\$X	\$X
Yaw System::Yaw control system-Mx	X	X	\$X	\$X
Yaw System::Yaw control system-Rst	X	X	\$X	\$X
Yaw System::Yaw lubrication system-Mx	X	X	\$X	\$X
Yaw System::Yaw motor/hydraulics	X	X	\$X	\$X
Yaw System::Yaw motor/hydraulics-Mx	X	X	\$X	\$X
Yaw System::Yaw motor/hydraulics-Rst	X	X	\$X	\$X
Yaw System-Mx	X	X	\$X	\$X
Yaw System-Rst	X	X	\$X	\$X

Table B-20: Event Type Summary