Network Reliability Steering Committee

Annual Report 1999

(for the year ending June 30, 1999)

Network Reliability Steering Committee

Sponsored by the Alliance for Telecommunications Industry Solutions

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To The Telecommunications Industry

This Annual Report reviews the health of the wireline telecommunications networks for the year ending June 30, 1999, as well as trends observed over the past 7 years of FCC - ordered outage reporting. These seven years have seen dramatic changes in the structure of the telecommunications industry. This report highlights two areas that have remained constant throughout these changes — the reliability of the public switched network and the commitment and dedication of the members of this industry to ensure this continued reliability.

If we were to boil the key learnings of these years of analysis down to one fundamental message, it would be this: The "best practices," developed during the first Network Reliability Council (NRC) and refined since then, do prevent outages. Service providers and their vendors must renew their commitment to ensuring that these practices are understood and applied consistently. A large – and, unfortunately, increasing - number of incidents reported each year can be traced to a failure to apply those practices.

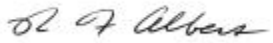
Analysis of the outage data reveals that the past 12 months (July 1998 – June 1999) were typical of recent years. Fewer outages occurred (170) than in the previous 3 years but the total was still above the Baseline year (165) by 3%. The outage index (1681), a measure of the customer impact of outages, unfortunately was the second highest in history. This fact reflects that outages in the past year have affected a larger number of customers than in previous years, a disturbing trend. Events affecting the CCS capability and Central Office Power have increased noticeably in this year while Facilities and Local Switch outages have decreased somewhat during this same period. Facilities disruptions continue to be the major cause of all outages, representing 39% of all outages during this year and 44% of the cumulative outage index. The second highest failure category, CCS outages, represents 15% of all incidents during this same period. Two observations can be made about common channel signaling. First, the deployment of CCS, and the number of networks interconnected, have increased greatly since the baseline year. Second, while the CCS failures that occurred at the start of the NRC were due to equipment problems, of late most of the failures have been due to a lack of facility diversity – a violation of Best Practices and industry standards that are of such concern.

The Network Reliability Steering Committee (NRSC) has addressed adverse trends as they have surfaced. Facilities failures have been the major cause of outages since 1992 and the NRSC's Facilities Solutions Team has spearheaded industry efforts that resulted in a new Federal One-Call law in 1998. During the past year this team has participated actively with the Department of Transportation as it works to implement the first phase of this program, defining "best practices" for effective One-Call systems. This work will continue as the focus shifts to ensuring that all states have an effective damage prevention program.

The "Best Practices" team, a Subcommittee of the FCC's Network Reliability and Interoperability Council (NRIC IV) Focus Group 3 and consisting of participants in the NRSC, has closely reviewed each outage due to CO Power during this past year. This group has concluded that the majority of these outages could have been prevented by application of existing "Best Practices." The final report from this group is contained in the NRIC IV summary report.

Deeper analysis reveals another troublesome concern. Outages attributable to "procedural errors," i.e., failures caused by missing or inadequate documentation, insufficient training, and/or insufficient supervision or control, have continued as a major root cause of all outages (46% in 1998-99). This category reflects the wisdom of Pogo—"we have met the enemy and they are us." The NRSC Procedural Errors Team, formed in early 1998, published *Procedural Outage Reduction: Addressing the Human Part* in July. This report stresses that the existing "Best Practices" are effective in preventing outages. Service providers and their suppliers are encouraged to continue sharing of knowledge about outages so that effective corrective actions may be implemented. For the future, the report emphasizes product and process improvements that focus on human factors and minimizing human involvement in an effort to reduce the incidence of outages. The report cites available documents that provide guidance for the design of equipment human interfaces and unambiguous language for maintenance instructions to minimize errors.

The telecommunications industry will continue to evolve in the new millennium, driven by boundless technological innovation, to meet the demands of sophisticated, global customers. As the threads of multiple networks bind customers together, those entrusted with building and maintaining these networks must be vigilant to ensure that these networks continue to achieve the high standards of reliability which our customers expect and deserve. The spirit of cooperation and concern demonstrated during the past year by this team of dedicated professionals, in spite of the competitive pressures in the industry, continue to be exemplary. I am proud to be associated with this team.



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MAJOR FINDINGS

- Outages in Report Year 6 were 3% higher in frequency and 15% higher in impact (as measured by the aggregated outage index) compared to Baseline Year levels.

- Procedural Errors are the root cause of 34% of outages and their frequency demonstrates an increasing trend.

- CO Power outages demonstrate an increasing trend in frequency since the Baseline Year. In Report Year 6, CO Power outages had their highest frequency and annual aggregated outage index to date.

- Despite increases over the last two years, CCS outages still demonstrate a declining trend in frequency since the Baseline Year.

- DCS outages had their highest annual frequency to date and show an increasing trend in frequency since the start of the Baseline Year

- Facility outages continue to be the major contributor to outage frequency and aggregated outage index.
    - Facility outages are more severe than outages in most other categories
    - Facility outages have longer durations than outages in other categories.

BACKGROUND

The Network Reliability Steering Committee (NRSC), under the auspices of the Alliance for telecommunications Industry Solutions (ATIS), was formed to monitor network reliability utilizing major outage reports filed with the Federal Communications Commission (FCC) pursuant to Docket 91-273. The NRSC's mission statement is:

> *The Alliance for Telecommunications Industry Solutions' Network Reliability Steering Committee is a consensus-based industry committee. The Network Reliability Steering Committee will analyze the industry's reporting of network outages to identify trends, distribute the results of its findings to industry, and where applicable, refer matters to appropriate industry forums for further resolution, in order to help ensure a continued high level of network reliability.*

The NRSC currently has three standing committees: one for processes and administrative procedures, a second to recommend procedures for and to perform data assembly and analysis, and a third to explore the cause of facility outages and recommend steps to mitigate and/or prevent their effects. The NRSC also establishes ad hoc committees as required to investigate areas of concern which may be revealed in its quarterly and annual analyses.

In addition to preparation of this Annual Report, the NRSC's Data Assembly and Analysis Team also issues periodic summaries of outages reportable to the FCC pursuant to Docket 91-273, and quarterly reports which track the number and impact of these outages. The summaries include significant data taken from the final outage reports submitted by carriers to the FCC, as well as NRSC categorization of the failure type (Local Switch, Tandem Switch, Facility, Common Channel Signaling, Central Office Power, Digital Cross-connect Systems, Overload, Natural Disaster, and Other), direct cause, and root cause. This is an excellent information sharing tool which carriers use to monitor problems in other networks, thus helping to eliminate outages or minimize the duration of similar outages in their own networks.

THE NETWORK RELIABILITY COUNCIL

The Network Reliability Council (NRC) was established by the FCC to bring together leaders of the telecommunications industry and experts from academia and consumer groups to explore and recommend measures that would enhance network reliability. In June 1993, the NRC published *"Network Reliability: A Report to the Nation,"* a compendium of technical papers prepared by the various NRC Focus Groups. This compendium became known as the "Purple Book" and the recommendations therein became known as "Best Practices." The NRC encouraged the industry to study and assess the applicability of these recommendations for implementation in their companies. It was at the request of the NRC that ATIS established the NRSC in May 1993.

In April 1996, the NRC published a second compendium of technical papers, *"Network Reliability: The Path Forward"* (a.k.a. the "Red Book"), which was prepared in response to the question: "How do we continue to keep the public switched network reliable and, at the same time, accomplish increased interconnection, and introduce major new technologies into the network?" A

group composed of the NRSC and augmented by participants from cellular, cable, and satellite service providers prepared the first of these papers.

In July 1997, a third NRC effort (renamed the Network Reliability and Interoperability Council (NRIC), issued its report on implementing Section 256 of the Telecommunications Act of 1996. Section 256 is among the many provisions of the Telecommunications Act which has as its fundamental purpose promoting additional competition, innovation and deregulation in telecommunications. The report entitled "*Network Interoperability: The Key to Competition"* (a.k.a. the "Blue Book) presents findings and recommendations related to network connectivity and planning oversight, and the FCC's role in the standards setting process.

In October 1998 NRIC-IV was launched. Its goal was to assure optimal reliability, interoperability and interconnectivity of, and accessibility to, the public telecommunications networks. Its three areas of focus included:

1. What is the impact of the "year 2000 problem" on access to the telecommunications networks?
2. What is the impact of the "year 2000 problem" on access to the telecommunications networks and services (i.e., CPE perspective)?
3. What is the current status of network reliability?

Two groups composed of the NRSC and augmented by participants from the cellular, cable, satellite, and Internet service providers, and vendors, addressed the third focus area. These groups were asked to:

- Report on the reliability of public telecommunications network services in the United States;
- Determine whether "best practices" previously recommended should be modified or supplemented; and
- Develop a proposal for future consideration relative to extending these best practices to industry segments not presently included in current practices.

These groups' final reports may be found at http://www.nric.org/fg/index.html.

ONGOING ACTIVITIES OF THE NRSC

NRSC FACILITIES SOLUTION TEAM

The Facilities Solution Team (FST) was chartered to reduce the number and impact of facility outages.[1] Facility outages continue to be the leading contributor to outages in the Public Switched Telephone Network. However, in the last report year, the number of facility outages is the lowest since 1994. The FST hopes that through its work there will be a continued decrease in the number and impact of facility outages.

The FST is composed primarily of representatives from telecommunications companies. However, in order to ensure that its work gets buy-in from other stakeholders, the FST expanded in recent years to include representatives from the excavator community, the locators, and the Department of Transportation.

The focus of the FST has been in three areas:

- Analyze facility related network outages reported to the FCC,
- Provide input to cross industry groups aimed at facility damage prevention, and
- Develop and evolve best practices.

The FST has always tried to base its work on objective information. The FST continues to provide facility outage analyses that are used to influence regulatory agencies and ultimately to reduce damages to facilities. The FST analyses were a key ingredient in getting Federal One-Call legislation passed in June of 1998. These analyses are also used to direct the focus of the FST. With the rise in digging error, the FST has recently set up a subteam to address these outages.

The FST has been actively involved in working with cross industry groups on damage prevention. In the last year, the Office of Pipeline Safety set up a Common Ground study to develop recommendations on damage prevention. There were nine subteams and the telecommunications industry was represented on all nine. In addition, the FST was represented on the Steering Team and on the Linking Team – the teams that directed the Common Ground study. There was a public readout of the Common Ground study on June 30, 1999. At that time the Secretary of Transportation, Rodney Slater, provided strong support to damage prevention.

The FST has always been committed to developing Best Practices aimed at reducing facility outages. Best Practices developed by the telecommunications industry for reducing facility outages are contained in the following documents:

[1] The NRSC defines "Facility" outages as those involving all wiring/cable, associated electronics and hardware (excluding DCSs) and any related work activities associated with these items, from the switch itself to the main frame and from there to and including all outside plant. Some specific examples include but are not limited to: aerial, underground and submarine cable, radio facilities, repeaters, multiplexers, demultiplexers, regenerators, timing source interface unit, "bits" interface card, and voltage control oscillator fuses.

- *Fiber Optic Cable Dig-Ups: Causes and Cures, Network reliability: A Report to the Nation,* Network Reliability Council, June 1993.

- *Keeping the Network Alive and Well: Solving the Problem of Cable Dig-Ups,* Network Reliability Steering Committee Facilities Solution Team, February 1996.

- *Fixing Facility Outages: Building the Tools to Make it Happen,* Network Reliability Steering Committee Facilities Solution team, November 1997.

The latter two documents were prepared by the FST. In the past year, the FST distributed a survey to determine how these best practices should evolve. The FST has developed a preliminary list of "evolved" Best Practices that will be written in the near future.

The FST recently established a website which contains a list of all meetings, meeting minutes, recommendation documents, cross industry activities, and links to other damage prevention sites. The URL for the FST website is http://www.argreenhouse.com/society/fst.

As a standing committee of the NRSC, the Facilities Solution Team is committed to determining whether there are any major changes in the reliability of telecommunications facilities, responding to any changes, developing and evolving Best Practices to increase their effectiveness, and coordinating input to other industry bodies so that overall facility damages are reduced.

NRSC PROCEDURAL ERROR TEAM

In November 1996, the NRSC determined that it might be missing some valuable insights by confining its analysis of major outages within its defined categories. Preliminary investigation of major outages across all categories suggested the need to investigate Procedural Errors as a category unto itself rather than as a subset of the existing categories. A Procedural Error Team was established to continue this investigation. That team's report was released in May 1999.

The team's approach to this study was to attack the problem from a comprehensive viewpoint, including:

- Improved product design to reduce the possibility of incorrect actions causing service interruptions,
- Simplified documentation to reduce misinterpretation,
- Methods of training verification to decrease the possibility of skill level problems, and
- Processes to determine the true root cause for network outages.

The team found that while it is impossible to apply one counter measure that will prevent procedural errors, some standardization in the design of the environment reduces the possibility of failure. The concept of human-centric design for telecommunications products and documentation has the potential for reducing the impact and/or frequency of procedural errors. This design approach is presently being implemented on new network elements. For the existing network, universal application of Best Practices provides a valuable solution for reversing the rising trend of outages attributed to procedural errors. As an industry we are moving in the right direction, but our efforts need to be more aggressive. Best Practices, generic requirements, and existing legislation should be embraced and implemented to minimize procedural errors and improve network reliability.

A copy of the Procedural Error Team report *Procedural Outage Reduction: Addressing the Human Part,* can be found at http://www.atis.org/atis/nrsc/nrschome.htm.

STATE OF THE NETWORK

The network performance described below is based on an analysis of network outages reported to the FCC. The analysis compares network performance during Report Year 6 (7/1/98 to 6/30/99) with performance during Report Year 5 (7/1/97 to 6/30/98), Report Year 4 (7/1/96 to 6/30/97), Report Year 3 (7/1/95 to 6/30/96), Report Year 2 (7/1/94 to 6/30/95), Report Year 1 (7/1/93 to 6/30/94), and the Baseline Year (7/1/92 to 6/30/93).

In general, overall network performance remained stable over the past. In particular,

- In Report Year 6, outage frequency was the lowest since Report Year 2 and was only 3% higher than in the baseline year.
- In Report Year 6, the aggregated outage index in Report Year 6 rose for the second consecutive year and was 14.6% higher than in the Baseline Year.
- Despite increases over the last two years, CCS outages still demonstrate a declining trend in frequency since the start of the Baseline Year.
- CO Power outages display an increasing trend in frequency since the start of the Baseline Year. In Report Year 6, CO Power had its highest frequency and annual aggregated outage index to date.
- The durations of Local and Tandem Switch outages are increasing annually at rates of 2.8% and 5.3% annually.
- In Report Year 6, the median numbers of customers affected by Facility, Local Switch, and CO Power outages were higher than in any previous year.
- DCS outages had their highest annual frequency to date in Report Year 6 and show an increasing trend in frequency since the start of the Baseline Year.
- Procedural Errors are the root cause of 34% of outages since the start of the Baseline Year. Their frequency and aggregated outage index both demonstrate an increasing trend.
- Facility and Tandem Switch aggregated outage indexes continue to be higher than the Baseline Year levels.
- Facility outages continue to be the major contributor to outage frequency and aggregated outage index because they are:
  – more severe than outages in most other categories
  – have longer durations than outages in most other categories.

Unless specified otherwise, all statistical tests in these analyses were performed at the 0.05 level of significance. This means that statements of the form “A is statistically significant” imply that less than a 5% chance exists that A is not true.

Control charts in this section are coded to indicate whether the network is “under control.” The control charts measure outages occurring in a particular quarter against normal variation in the Baseline Year. 95% and 99% tolerance limits are used for the control ranges. Values in the “Green” region (below the upper 95% tolerance limit) are “under control.” Values in the “Yellow” region (between the upper 95% and 99% tolerance limits) require very close scrutiny. Values in the “Red” region (above the 99% tolerance limit) should trigger immediate investigative action by the NRSC.

PERFORMANCE BY OUTAGE FREQUENCY

Table 1 gives the number of outages for the Baseline Year and Report Years 1 through 6. The number of outages in Report Year 6 is the lowest since Report Year 2. While it is higher than the

Baseline Year frequency, the difference is not statistically significant. A fit to these data indicates no statistically significant trend in outage frequency over time.

Table 1: Outage Frequency By Year

Year	Period	Number of Outages	% Above (+) or Below (-) Baseline Year Level
Baseline Year	July 1, 1992 to June 30, 1993	165	0%
Report Year 1	July 1, 1993 to June 30, 1994	149	-9.7%
Report Year 2	July 1, 1994 to June 30, 1995	169	2.4%
Report Year 3	July 1, 1995 to June 30, 1996	179	8.5%
Report Year 4	July 1, 1996 to June 30, 1997	174	5.5%
Report Year 5	July 1, 1997 to June 30, 1998	185	12.1%
Report Year 6	July 1, 1998 to June 30, 1999	170	3.0%

Figure 1 is a control chart for outage frequency by quarter. The number of outages in each quarter of Report Year 6 is clearly well within the acceptable range of this control chart. Outage frequency has been highest in the third quarter (46.9 outages per quarter on average) and lowest in the fourth quarter (38.6 outages per quarter on average). However, these differences in seasonal outage frequency are not statistically significant.

Figure 1: Outage Report Frequency Control Chart

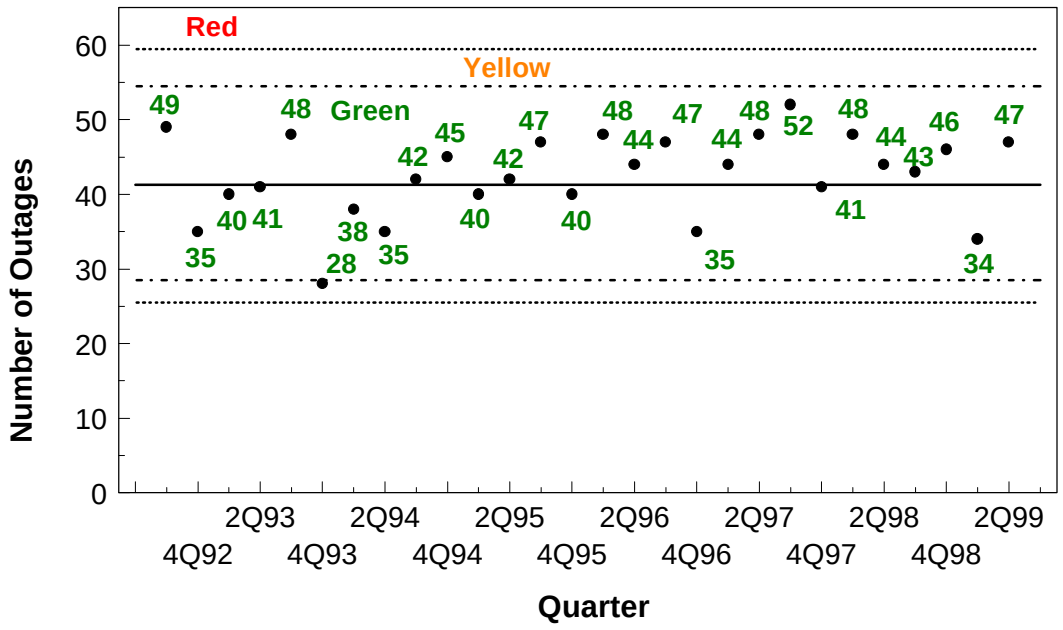
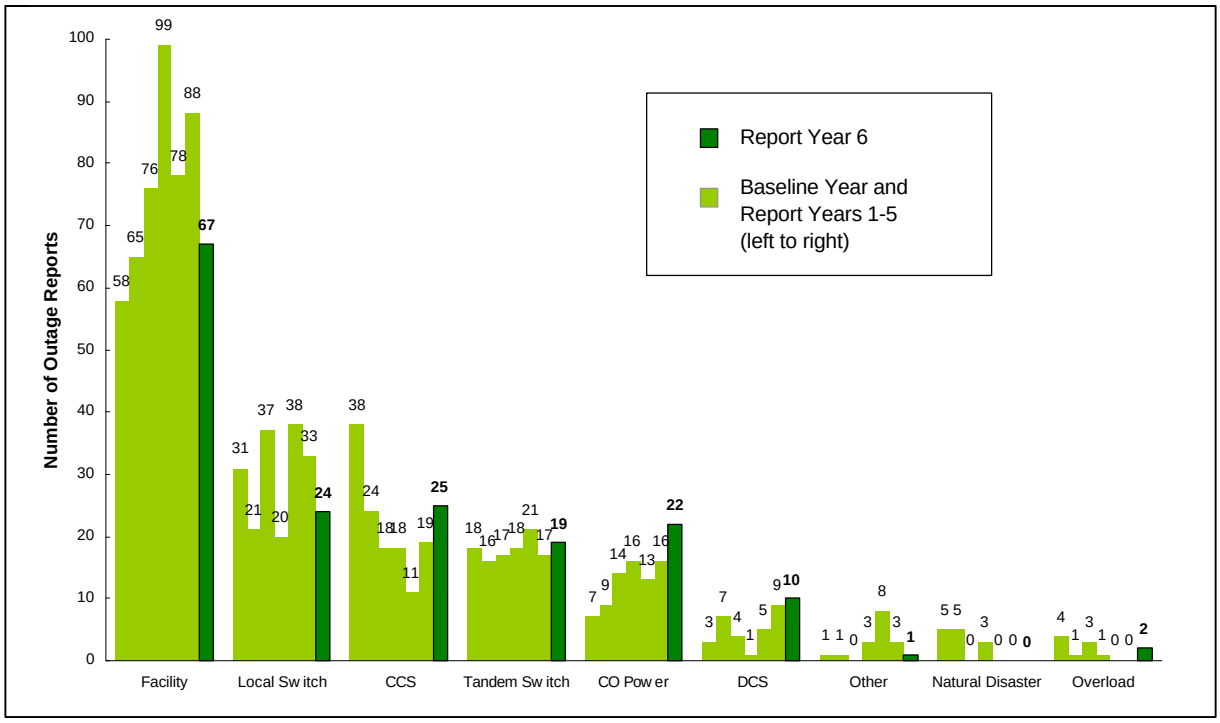


Figure 2 provides the distribution of outage frequency by outage category:

- Facility
- Local Switch
- Common Channel Signaling (CCS)
- Tandem Switch
- Central Office (CO) Power
- Digital Cross-connect System (DCS)
- Other
- Natural Disaster
- Overload

Figure 2: Number Of Outage Reports By Failure Category



The number of Facility outages dropped in Report Year 6 to the lowest level since Report Year 1. Facility outages have an increasing trend (3.5% increase per year) since July 1, 1992. However, this trend is only marginally noteworthy at the 0.11 level of significance. Facility outage frequencies in Report Year 6 (67) and over all years (75.9 outages per year) are significantly higher than in any other category. Similarly, Local Switch outage frequencies over all years (29.1 outages per year) are significantly higher than in any other category (apart from Facility). For the second consecutive year, CCS outage frequency has increased. In Report Year 6, CCS outage frequency reached its highest level since the Baseline Year. Despite these recent increases, CCS outage frequency has demonstrated a statistically significant decrease of 9.5% per year since July 1, 1992. In addition to the 25 CCS outages reported, there were 29 other outages which impacted CCS capability. In Report Year 6, CO Power outage frequency reached its highest annual level (22 outages) since July 1, 1992. CO Power outage frequency also demonstrates a statistically significant trend (15% increase per year) and seasonality (65% of outages occur in the warmer half of the year). In Report Year 6, DCS outages had their highest frequency to date (10). DCS outages exhibit a statistically significant upward trend in their frequency (18% per year) since the start of the Baseline Year. The decreasing trend in frequency

of Natural Disaster (47% decrease per year) is statistically significant while the decreasing trend in Overload outages (22% decrease per year) is not.

PERFORMANCE BY OUTAGE DURATION

Table 2 provides a summary of the distribution of outage duration for the Baseline Year and the six Report Years.

Table 2: Outage Durations (Minutes)

Percentile	Baseline Year	Report Year 1	Report Year 2	Report Year 3	Report Year 4	Report Year 5	Report Year 6
95th	902	895	846	1089	767	796	841
75th	306	398	340	360	348	349	308
Median	133	145	162	191	161	172	175
25th	57	71	82	96	68	84	72
5th	37	37	38	35	35	37	41

A percentile indicates what percent of the outages have a duration less than that value. For example, 95% of FCC-reportable outages during the Baseline Year had durations less than 902 minutes. Percentiles of the outage distribution are used because statistics like the mean outage duration are severely altered by one or two very long outages. Outage durations in Report Year 6 had a distribution similar to that in Report Year 5. The durations of switch outages are rising at statistically significant rates. The duration of Tandem Switch outages has increased annually 5.3% since the start of the Baseline Year, while durations of Local Switch outages have risen 2.8% annually over the same period. In Report Year 6, CCS outages had a median duration of 62 minutes, which was lower than in any previous year.

Table 3 provides a summary of the distribution of outage duration by category.

Table 3: Outage Duration (Minutes) By Outage Category

Category	# of Outages	Median	Mean	95th %ile
Natural Disaster	13	804	8589	43992
Facility	531	285	443	1060
Overload	11	150	816	7083
Tandem Switch	126	150	274	782
Other	17	149	279	911
CO Power	97	142	220	701
DCS	39	141	172	538
CCS	153	75	125	418
Local Switch	204	72	150	436
Overall	***1191***	***165***	***397***	***895***

Additional analyses of duration by outage category as shown in **Table 3** give the following results:

- Facility outages have a statistically significant longer median duration than other types of outages (except for Natural Disasters).
- CO Power, DCS, and Tandem Switch outages have statistically significant longer median durations than CCS and Local Switch outages.

PERFORMANCE BY CUSTOMERS POTENTIALLY AFFECTED

Table 4 depicts the major statistics for the number of customers potentially affected for the Baseline Year and the six Report Years. The median describes the number of customers affected for a typical outage. The 95th percentile measures the number of customers affected for a relatively large outage (an outage bigger than 95% of the outages). The mean shows the average number of customers affected by an outage. When the mean is much larger than the median, then the mean is driven by a number of very large outages. The table shows that the size of large outages increased in Report Year 6. The mean and 95th percentile were the highest since Report Year 1 and the median was the second highest since July 1, 1992. The number of customers potentially affected does not demonstrate a statistically significant trend over time.

Table 4: Number Of Customers Potentially Affected

Year	Median	Mean	95th %ile
Baseline Year	51,200	148,100	519,000
Report Year 1	52,600	179,500	821,000
Report Year 2	53,100	92,500	277,000
Report Year 3	60,900	104,600	317,000
Report Year 4	58,100	104,100	263,000
Report Year 5	51,900	129,000	395,000
Report Year 6	58,400	135,000	436,000

The median and mean customers potentially affected over all seven years are 55,000 and 127,000 respectively.

PERFORMANCE BY OUTAGE INDEX

Committee T1 Report No. 42 defined an outage index created by Working Group T1A1.2 to provide a single measure that describes the overall severity of a single outage or collection of outages.

In this report, *outage index* will be used for the severity of an individual outage. *Aggregated outage index* will be used for the severity of a collection of outages. The outage index is calculated using the following data items:

- Outage duration
- Customers potentially affected
- Day of the week and time that the outage started
- Services affected (i.e., intraoffice, interoffice intraLATA, interoffice interLATA, 911).

The outage index is a quantitative scale measuring outage impact. A higher number indicates a more severe outage (e.g., an outage with an index of 8 is twice as bad as one with an index of 4). To obtain a feeling for the index, note the following:

- The maximum possible index for an outage is 333.33.
- An outage of a Local Switch with 30,000 lines in which all services (intraLATA intraoffice, intraLATA interoffice, interLATA interoffice, and 911) are lost for 30 minutes during daytime hours of a weekday has an outage index of 1.92.

- A Tandem Switch outage which blocks 90,000 interLATA interoffice calls over a period of 30 minutes has an outage index of 0.48.
- A Facility outage which blocks 220,000 intraLATA interoffice and interLATA interoffice calls over a period of 5.5 hours has an outage index of 6.06.

AGGREGATED OUTAGE INDEX DISTRIBUTIONS

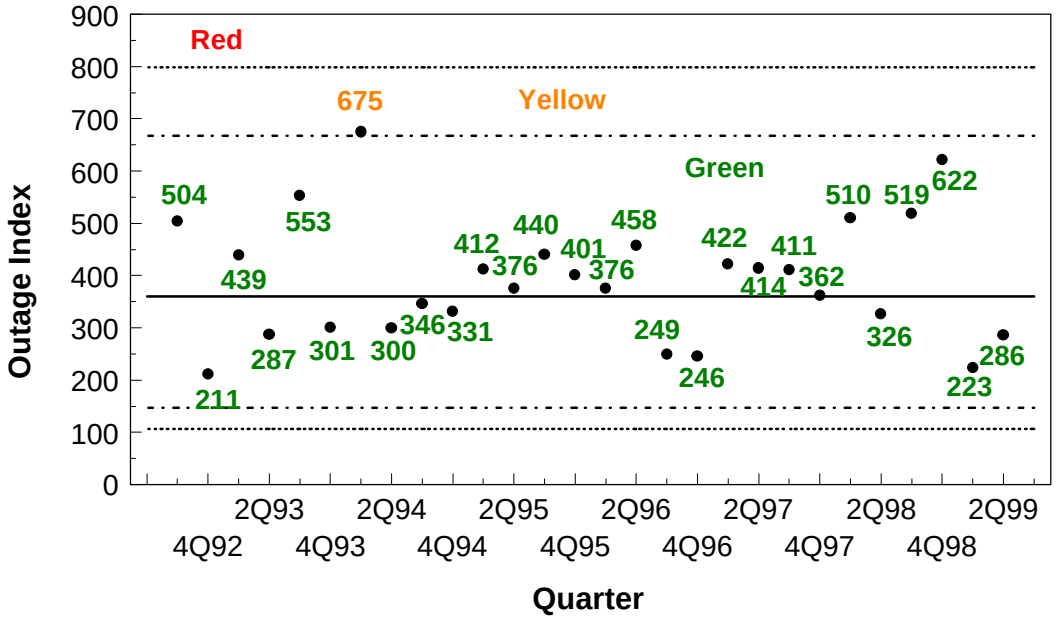
The aggregated outage indexes for the Baseline Year and the six Report Years are given in **Table 5**. Table 5 shows that the aggregated outage index rose in Report Year 6 to its highest level since Report Year 3. This increase is not statistically significant.

Table 5: Aggregated Outage Index By Year

Year	Aggregated Outage Index	% Above (+) or Below (-) Baseline Year Level
Baseline Year	1442	0%
Report Year 1	1829	26.9%
Report Year 2	1466	1.7%
Report Year 3	1675	16.2%
Report Year 4	1331	-7.7%
Report Year 5	1608	11.6%
Report Year 6	1652	14.6%

Figure 3 provides a control chart of the quarterly aggregated outage index over the Baseline Year and the six Report Years. In Report Year 6, all four quarters were within the control range.

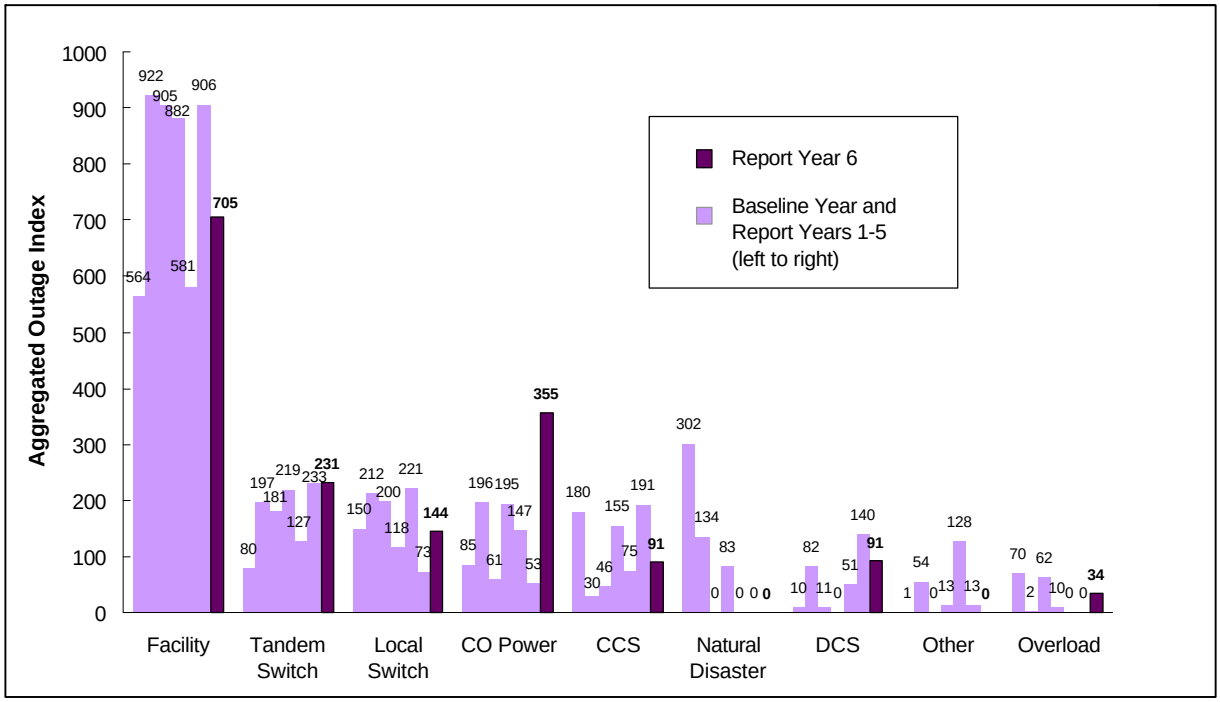
Figure 3: Aggregated Outage Index Control Chart



The aggregated outage index for each failure category is given in **Figure 4**:

- The aggregated outage index for Facility outages was significantly higher than the index for any other failure category.
- The aggregated outage index for DCS outages was significantly lower than the index for most other failure categories.
- The aggregated outage index for Local Switch outages was significantly higher than the index for most other failure categories.

Figure 4: Outage Index Aggregated By Failure Category



In addition:

- Report Year 6 is the first year that CO Power had the second highest aggregated outage index across failure categories. Over the Baseline Year and the six Report Years.
- The aggregated outage indexes for Facility and Tandem Switch outages continue to be significantly higher in the six Report Years (817 and 198 per year respectively) than in the Baseline Year (564 and 80 respectively).
- The Report Year 6 aggregated outage index for CO Power (355) in Report Year 6 was significantly higher than the average of all prior years (123).
- The aggregated outage index for DCS outages was significantly higher in Report Year 6 (91) than in the Baseline Year (10). In addition, the aggregated outage index for DCS outages has been significantly higher in the last three Report Years (94 per year) compared to the first four Report Years (26 per year).
- The aggregated outage index for Natural Disaster outages has been significantly lower in the six Report Years (36 per year) than in the Baseline Year (302).

OUTAGE INDEX DISTRIBUTIONS

An important question is whether the severity of outages varies by outage category. **Table 6** presents the distribution of outage indexes by outage category:

Table 6: Outage Index By Outage Category

Category	# of Outages	Median	Mean	95th %ile
Natural Disaster	13	10.4	39.9	156.5
Overload	11	9.3	16.2	55.4
DCS	39	5.9	9.9	35.8
Facility	531	5.3	10.3	37.6
Tandem Switch	126	4.0	10.1	37.2
CO Power	97	3.9	11.3	64.6
Local Switch	204	2.5	5.5	24.3
Other	17	1.6	12.3	57.9
CCS	153	0.4	5.0	25.0
Overall	***1191***	***3.5***	***9.2***	***38.1***

Table 6 shows that:

- CCS outages have a very low median outage index. It is significantly lower than in all other categories. This means that the typical FCC-reportable CCS outage has less customer impact than FCC-reportable outages in other categories.
- Local Switch outages also have a low median outage index. It is significantly lower than in the Facility, Tandem Switch, Natural Disaster, and Overload categories.
- The median outage index for Facility outages is statistically larger than the median index for the CCS, Local Switch, and CO Power categories.

Analysis of the data provides the following additional observations:

- In Report Year 6, CCS outages had the lowest median outage index (.06) than in all previous years and the lowest mean value (3.6) since Report Year 2.
- In Report Year 6, Facility outages had their highest mean and median outage index values (10.5 and 5.9) since Report Year 2.
- In Report Year 6, Local Switch outages had their highest mean and median outage index values (6.0 and 3.3) since Report Year 1.

ROOT CAUSE ANALYSIS

This section provides a root cause analysis of Facility, Local Switch, CCS, and Tandem Switch failures. Steps to prevent recurrence of these failures are identified in:

- the FCC's Network Reliability Council (NRC) "Network Reliability: A Report to the Nation," and "Network Reliability: The Path Forward"
- the ATIS/NRSC "Keeping the Network Alive and Well -- Solving the Problem of Cable Dig-Ups," and "Fixing Facility Outages -- Building Tools to Make it Happen."

Figures 2 and **4** in the previous section depict the major contributors by outage frequency and outage index, respectively. In particular, Facility, Local Switch, Tandem Switch, CCS, and CO Power are the five major contributors to outage frequency and to the aggregated outage index (over the seven-year reporting period). Following is an analysis of the root causes of some of the major contributors.

FACILITY

The Facility category is the major contributor to both the outage frequency (45%) and the aggregated outage index (50%) during the past seven years. While the total number of outages was only 3% higher in Report Year 6 compared to the Baseline Year, the frequency of Facility failures was 16% higher when comparing the same years. Also, the aggregated outage index for Facility failures increased by 30% from the Baseline Year to Report Year 6. Nevertheless, in Report Year 6, the Facility category had its lowest share of outages (39%) and of aggregated outage index (44%) than in any Report Year after the Baseline Year.

Further analysis of the data revealed the major sub-categories, shown in **Figures 6** and **7**, for the number of outages and aggregated outage index, respectively.

Figure 6: Number of Outage Reports by Facility Failure Sub-Category

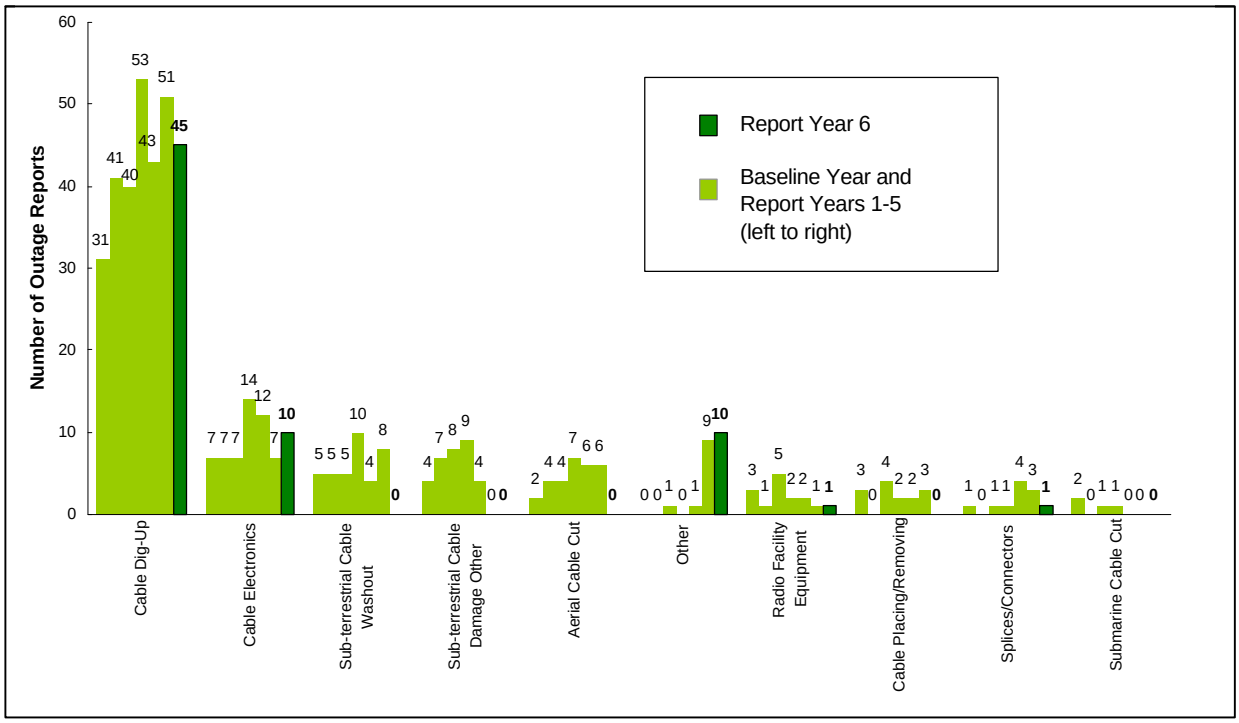
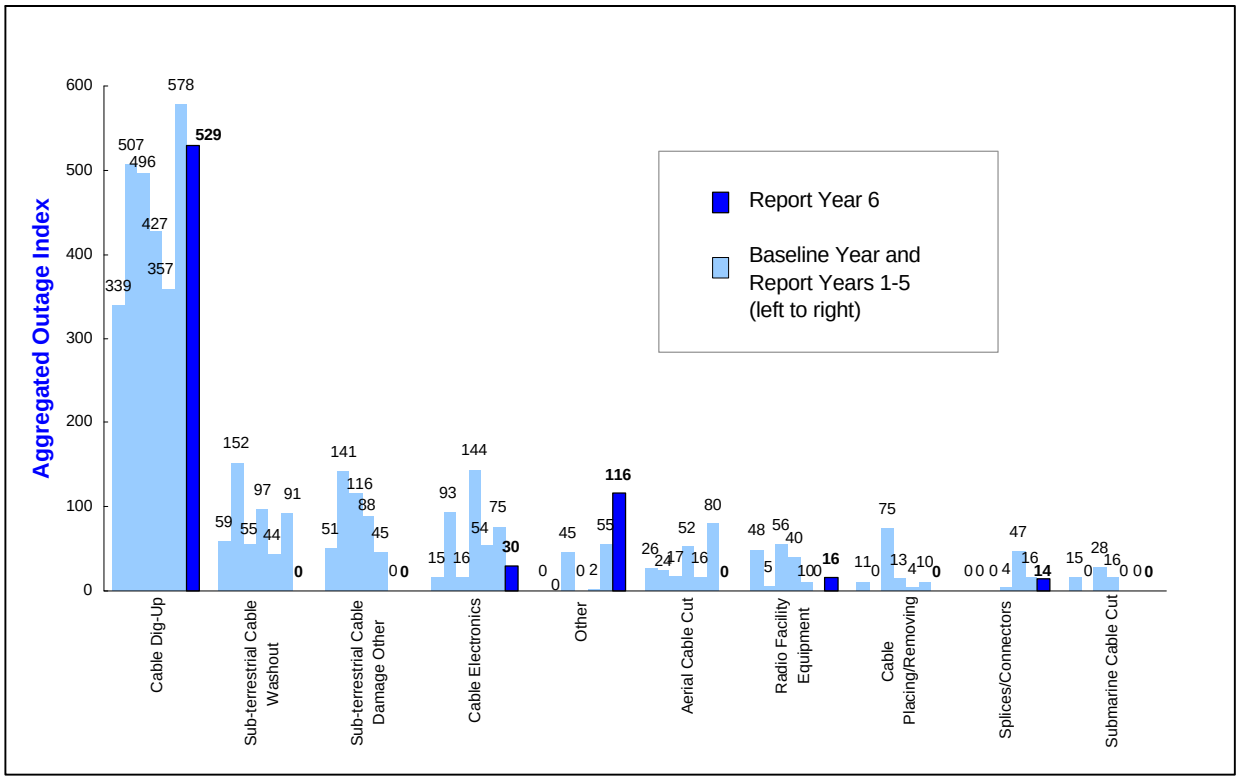


Figure 7: Outage Index Aggregated By Facility Failure Sub-Category



From the outage frequency perspective, the most noticeable finding is that there is a statistically significant upward trend (5.5% per year) in the Cable Dig-Up (DU) failure sub-category over the past seven years despite a 12% decline in the number of Cable DUs in Report Year 6 compared with the previous Report Year. Cable DUs also demonstrate a statistically significant seasonality effect; about 30% less Cable DU outages occur in the first quarter as compared to the rest of the year. The Sub-terrestrial Cable Damage Other sub-category has a statistically significant decrease in outages over the past three years. The Sub-terrestrial Cable Washout sub-category demonstrates a statistically significant seasonality effect; first quarters have about 3 such outages per year, third quarters about 1 per year, and second and fourth quarters average .5 per year. In Report Year 6, Sub-terrestrial Cable Washout had a statistically significant drop to no outages. Similarly, after a steady rise over the first six years, the Aerial Cable Cut sub-category also had a statistically significant drop to no incidents in Report Year 6. In the last two years, the Other sub-category has had almost 10 times as many outages as in the first five years; this difference is statistically significant. In the last two years, more Facility outages have occurred in the Other sub-category than in any other sub-category aside from Cable DU.

Cable DUs dominate Facility outages from the outage index perspective as well. While the aggregated outage index (529) for Cable DU outages decreased in Report Year 6, it was still the second highest level observed to date (see Figure 7). The Other sub-category contributed substantially to the Facility aggregated outage index in Report Year 6 (116), its highest annual level to date.

CABLE DIG-UP

Cable Damage was by far (88%) the largest root cause of Cable Dig-Up (DU) incidents during the seven-year reporting period. Looking at the root cause subcategories of the Cable Damage, Inadequate/No Notification was the biggest contributor (42%). However, in Report Year 6, the number of Cable Damage outages attributed to Inadequate/No Notification was at its lowest level (14) since the Baseline Year. In Report Year 6, Digging Error was the primary root cause sub-category with 20 outages (48% of the Report Year 6 total and contributing to 32% of the overall total). This is the largest number of Digging Error outages reported in a single year. Since the start of the Baseline Year, Digging Error annual outage frequency has been rising at the statistically significant rate of 21% per year. After peaking at 12 outages in Report Year 5, Inaccurate Cable Locate outage frequency in Report Year 6 had a statistically significant decrease to its lowest annual total (3 outages) observed to date. In Report Year 6, Cable Unlocated rose to its highest frequency level (5) since the Baseline Year; this frequency is significantly higher than in all other Report Years.

The aggregated outage index provided similar results. The Digging Error aggregated outage index is increasing at the statistically significant rate of 25% per year. The aggregated outage index for Inaccurate Cable Locate was significantly lower in Report Year 6 (21) than in Report Year 5 (145). Cable Unlocated had a statistically significantly higher aggregated outage index in Report Year 6 (76) than the average of all prior years (18). **Figures 8** and **9** present the number of outages and aggregated outage index for the Cable Damage root causes of Cable DU.

Figure 8: Number of Outage Reports
By Cable Damage Root Causes of Cable Dig-Up (DU) Facility Failures

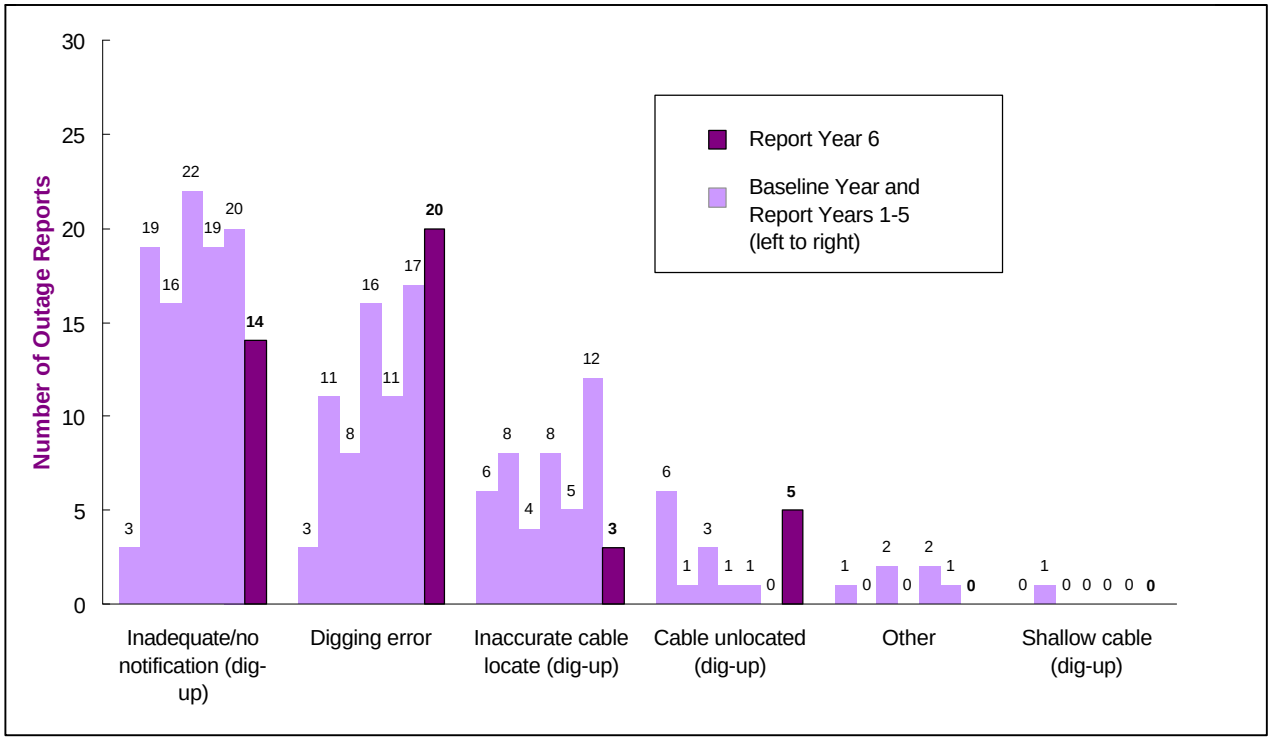
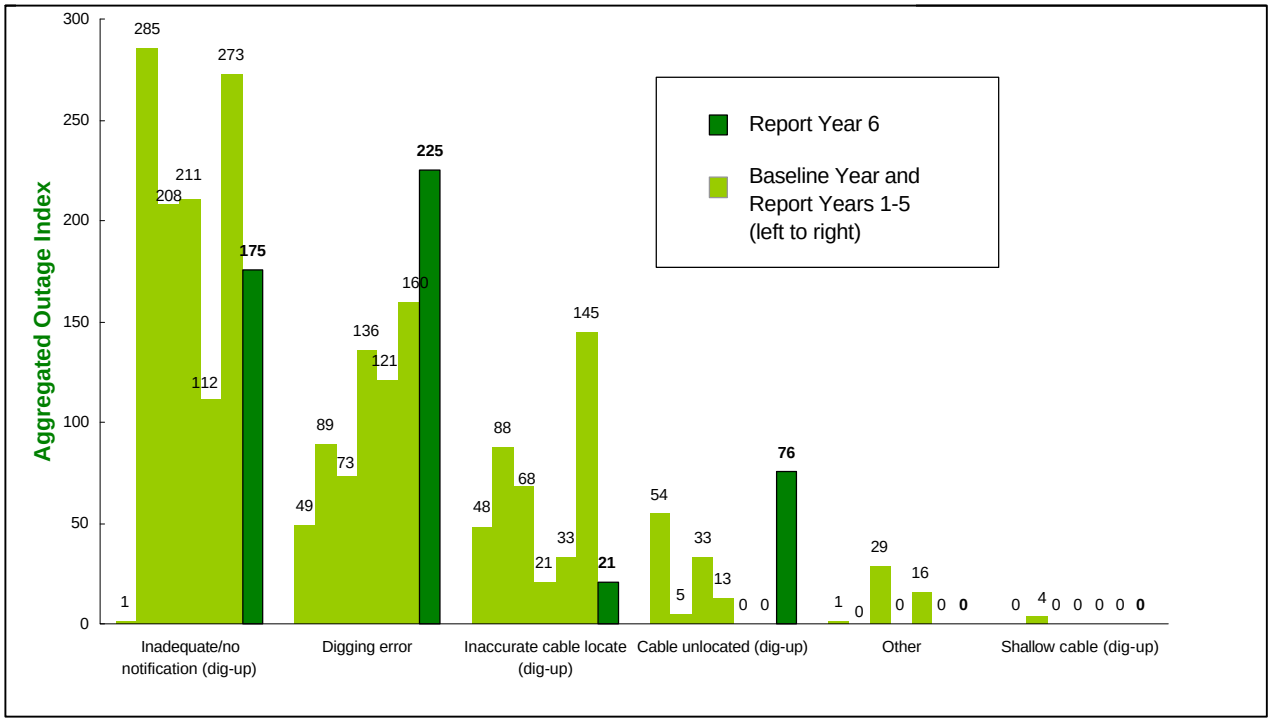


Figure 9: Outage Index Aggregated By
Failures



CABLE ELECTRONICS

The major root causes of the Cable Electronics[2] attributed facility outages are: Procedural Errors (45%), Design Hardware (20%), Hardware Failure (11%), and Design Software (11%). No Design Hardware outages were reported in the last two Report Years; this represents a statistically significant decrease in Design Hardware outage frequency compared with the Baseline Year through Report Year 4. Three Hardware Failure outages were reported in Report Year 6 compared to four over the previous six years; this difference is significant at the .07 level. When considering the aggregated outage index, Procedural Errors remains the dominant root cause (54%) followed by Design Hardware (31%). The Cable Electronics aggregated outage index for Report Year 6 (30) was at its lowest level since Report Year 2.

LOCAL SWITCH

In Report Year 6, Local Switch outages continued the decline in frequency recorded in Report Year 5 (see Figure 2). As shown in Figure 4, during Report Year 6 the aggregated outage index for Local Switch outages was near the Baseline Year level. This represents an increase over the seven-year-low posted in Report Year 5.

The major failure sub-categories for Local Switch outages during the six-year reporting period were: Hardware (43%), Software (29%), and Translations (21%). Report Year 6 saw statistically significant decreases in outage frequency in the Hardware (5 in Report Year 6 versus 13.8 average in prior years) and Software (2 in Report Year 6 versus 9.7 average in prior years) sub-categories. On the other hand, in Report Year 6 (i) a statistically significant increase occurred in the Other sub-category (up to 6 from a prior annual average of 1.2) and (ii) the increase in the Translations sub-category (up to 11 from a prior annual average of 5.3) was significant at the .08 level. Similar results occurred for the aggregated outage index. In Report Year 6, both Hardware and Software aggregated outage indexes dropped to their lowest annual levels (27 and 4 respectively) since the start of the Baseline Year.

Procedural Errors continue to be the major root cause of Local Switch outages in Report Year 6 from both the outage frequency and the outage index perspective (54% for both). For the first year since the start of the Baseline Year, no Design Software outages were reported; this represents a statistically significant decrease from the 5.6 average in prior years. Hardware Failures also decreased substantially to 1 in Report Year 6 versus 5.2 average in prior years.

COMMON CHANNEL SIGNALING (CCS)

CCS is a failure category that showed a statistically significant steady decrease in the number of outages over the seven-year period. However, in Report Year 6, CCS outages continued the increase in frequency observed in Report Year 5 after the seven-year-low recorded in Report Year 4 (see Figure 2). The aggregated outage index displayed a decrease from last year's seven-year-high.

[2] It includes repeaters, multiplexers (add/drop, M31, SONET), demultiplexers, regenerators, timing source interface unit, BITS interface card, voltage control oscillator (VCXO) fuses, power unit for facility etc.

Isolation is the dominant failure subcategory (76%) for CCS outages, followed by STP Equipment (10%), during the six-year reporting period. While the number of CCS failures attributed to Isolation has dropped at the statistically significant annual rate of 14% since the start of the Baseline Year, frequency has increased in each of the last two years (see **Figure 10**). In Report Year 6, the number of CCS outages attributed to Link(set)s reached its highest level to date (5), significantly higher than the 1.2 annual rate observed over prior years. Four of the five Report Year 6 Link(set)s outages had a Procedural Service Provider root cause; prior to Report Year 6, only one Link(set)s outage had a Procedural Service Provider root cause. Among root causes, Design Software has demonstrated the most substantial change over the years, a statistically significant decrease of 33% per year. Procedural Errors reached their highest frequency to date (16); this is significantly higher than the average of 8.2 reported in prior years.

From the outage index perspective (see Figure 11), Isolation (44%) and STP Equipment (36%) are the dominant failure sub-categories. In Report Year 6, Isolation had its highest aggregated outage index since the Baseline Year (79), representing 87% of the CCS aggregated outage index for the year. Procedural Errors have been the primary root causes of CCS outages since the Baseline Year (54%) and in Report Year 6 (82%). The decrease in CCS aggregated outage index from 191 in Report Year 5 to 91 in Report Year 6 is attributable to the decrease in the aggregated outage index of Design Software from 95 in Report Year 5 to 2 in Report Year 6.

Figure 10: Number of Outage Reports By CCS Failure Sub-Category

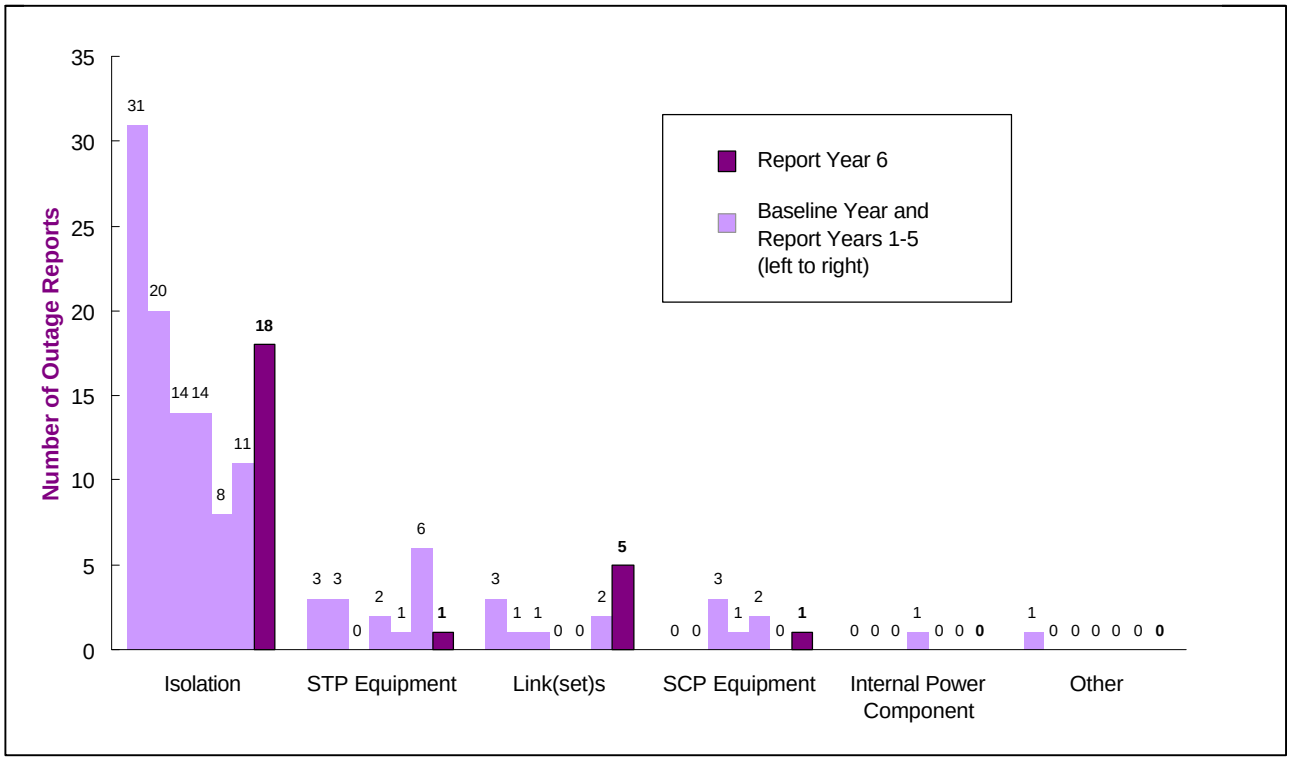
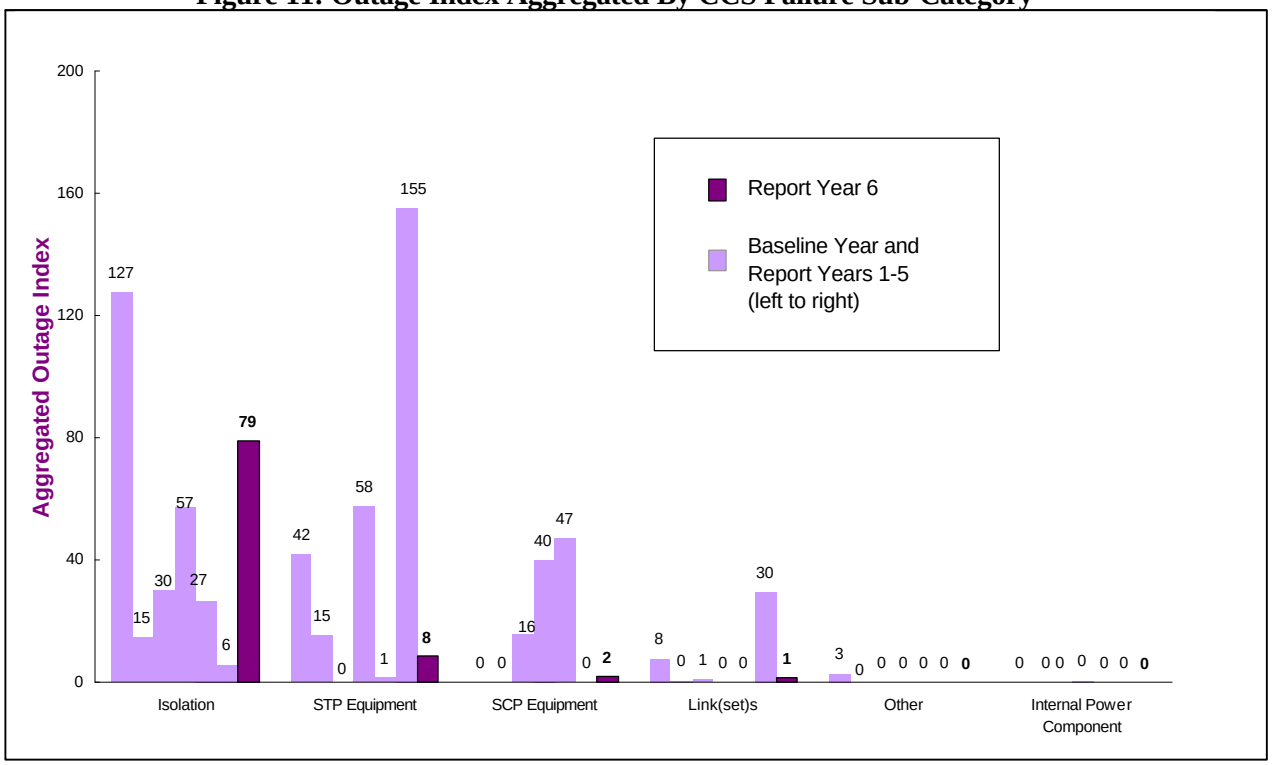


Figure 11: Outage Index Aggregated By CCS Failure Sub-Category



TANDEM SWITCH

The annual number of Tandem Switch outages has been the most stable of all failure categories throughout the seven-year history. Outage frequency has varied from a minimum of 16 to a maximum of 21; Report Year 6 frequency (19) is near the middle. The Tandem Switch aggregated outage index has been higher than the Baseline Year total in every Report Year. Report Year 6 is no exception; its total (231) is very close to last year's total (233). This increase in the aggregated outage index is mainly attributed to the Translations failure sub-category, which increased by 300% in Report Years 5 and 6 compared to the average of previous years.

Software is the major failure sub-category (38%) of the number of Tandem Switch outages in the seven-year analysis, followed by Translations (29%) and Hardware (29%). In Report Year 6, Software had the smallest number of outages (5) since the Baseline Year. In Report Year 6, the number of Hardware outages (3) was significantly lower than the Baseline Year total (12); the average Hardware annual frequency (4) over the six Report Years is significantly lower than the Baseline Year level. Translations show a statistically increasing trend (25% annually) since the start of the Baseline Year with the highest number of incidents (10) occurring in Report Year 6. Moreover, Software is the major failure sub-category (42%) with respect to the aggregated outage index for Tandem Switches during the same seven-year period, followed by Translations (35%), and Hardware (20%).

Procedural (Service Provider and System Vendor) Errors continue to be the major root cause of Tandem Switch failures in Report Year 6 from both the outage frequency (54%) and the outage index (56%) perspectives. Report Year 6 had the highest Procedural Error outage total (14) and aggregated

outage index (183) in the seven-year data history. The increasing trend in Procedural Error outage frequency (17% annually) is statistically significant.

CENTRAL OFFICE (CO) POWER

Report Year 6 had the highest number of CO Power outages in any year to date. Aside from Report Year 4, each year since the Baseline Year has seen an increase in CO Power outage frequency. The number of CO Power outages (see Figure 2) shows a statistically significant increase (15% per year) since the start of the Baseline Year. CO Power also demonstrates a statistically significant seasonality effect; the CO Power outage frequency is almost twice as high in the warmer half of the year (2Q and 3Q) as it is in the cooler half (1Q and 4Q). In Report Year 6, the CO Power aggregated outage index rose to almost double that of any previous year after a seven-year low in Report Year 5.

To put the impact of CO Power in perspective, over the past seven years there have been 1191 FCC-reportable outages, 97 of these (8%) have been CO Power related. CO Power outages are further categorized by the NRSC into the following six sub-categories: DC Plant, DC Distribution, Building AC, Standby Generator, Commercial, and Other. Examination of the distribution of outages across these sub-categories shows that the major contributors are: DC Plant 29%, DC Distribution 26%, Other 20%, and Standby Generator (13%). However, in Report Year 6, the largest number of CO Power outages were in the Standby Generator sub-category (8 outages representing 36%). This number is significantly greater than the annual average of 0.8 outages reported in prior years.

The impact of the CO Power outages in Report Year 6, as measured by the aggregated outage index, is the highest since reporting started (see Figure 4). The major contributors, by sub-category, to the CO Power aggregated outage index are: DC Plant (34%), DC Distribution (29%), and Standby Generator (21%). All three major contributors had their highest annual aggregated outage indexes in Report Year 6.

Procedural Errors are the primary root cause category among CO Power outages with respect to frequency (57%) and aggregated outage index (45%). Over all years, Commercial and/or Back-Up Power Failure was the root cause of 30% of CO Power outages. However, in Report Year 6, it was the primary root cause with 12 outages, the largest annual total reported to date. Commercial and/or Back-Up Power Failure outages have been increasing at the statistically significant rate of 53% per year. In Report Year 6, Commercial and/or Back-Up Power Failure had its largest aggregated outage index to date (308) which is significantly greater than the average in prior years (15). This total represented 87% of the CO Power aggregated outage index for Report Year 6 and 28% of the CO Power aggregated outage index totaled over all seven years of data history. Most (82%) of the Report Year 6 Commercial and/or Back-Up Power Failure aggregated outage index was from three outages which on average potentially affected 64,000 customers over 400 minutes resulting in 1.5 million blocked calls.

DIGITAL CROSS-CONNECT SYSTEMS (DCSS)

During Report Year 5, there were ten (10) Digital Cross-connect System (DCS) outages, which is the highest number in the seven-year reporting period. DCS outages exhibit a statistically significant upward trend in their frequency (18% per year). The DCS aggregated outage index (91) in Report Year 6 was the second highest in the seven-year reporting period. In the last three Report Years, the average annual DCS aggregated outage index (94) has been significantly greater than in the first four years of reporting (26).

Hardware (49%) and Software (34%) were the two major failure sub-categories for the 39 DCS outages that occurred during the seven reporting years. Report Year 6 had more Hardware DCS outages (6) than in any prior year. With respect to the aggregated outage index, the three major failure sub-categories are Hardware (35%), Software (29%), and Other (29%). In Report Year 6, DCS Software failures had a significantly higher aggregated outage index (58) than the average of the prior six years (9).

Looking at the root causes of those 39 DCS outages, 51% are attributed to Procedural (Service Provider and System Vendor) Errors, 23% to Design Software, 8% to Design Hardware, 8% to Hardware Failure, 5% to Design Firmware, and 5% to Other. Report Year 6 had the first occurrences (3) of DCS Hardware Failure in seven years of reporting; this increase is statistically significant. The distribution is similar with respect to the aggregated outage index: 55% to Procedural Errors, 27% to Design Software, 6% to Design Hardware, 5% to Hardware Failure, 5% to Design Firmware, and 3% to Other. In the last three Report Years, the average annual DCS Procedural Error aggregated outage index (62) has been significantly greater than in the first four years of reporting (7).

PROCEDURAL ERROR OUTAGES

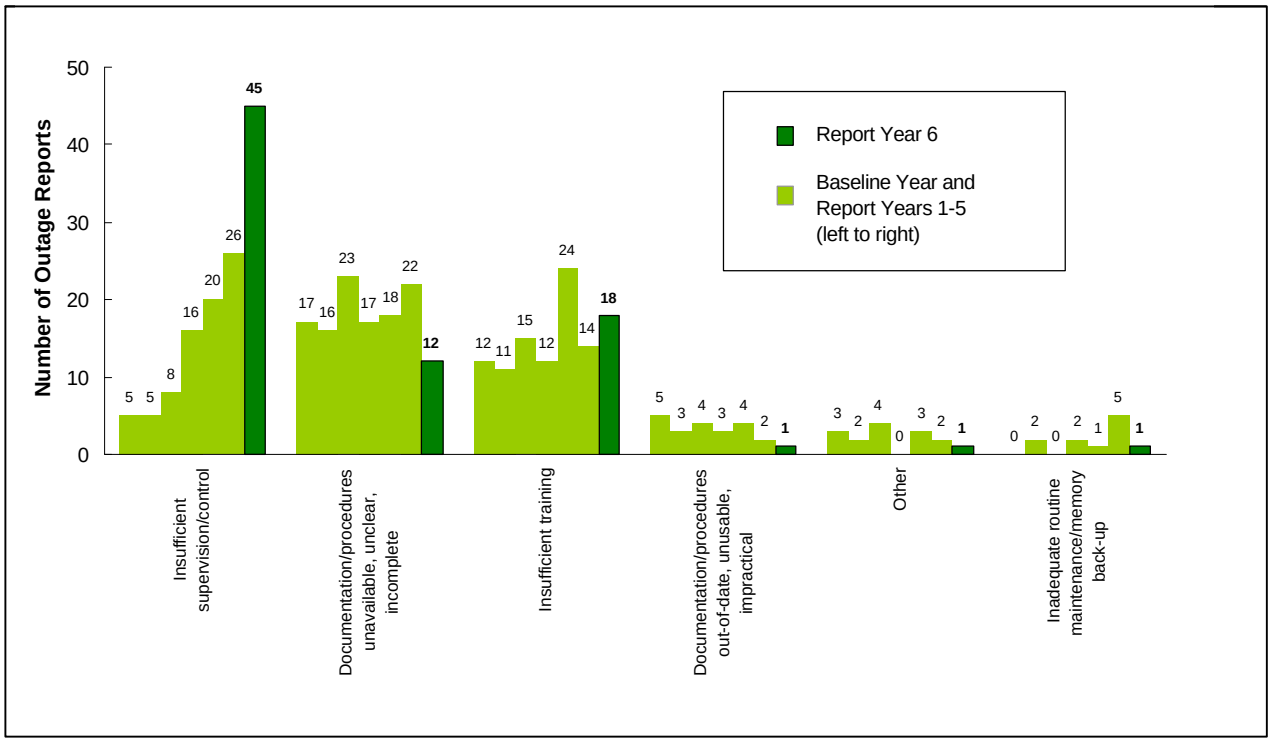
Three root cause categories can be grouped as *Procedural Errors (PE)*:

1. Procedural Service Provider,
2. Procedural System Vendor, and
3. Procedural Other Vendor.

The number of Procedural Error outages since the start of the Baseline Year is 404 out of 1191 total outages (34%). In Report Year 6, the number of Procedural Error outages was 78 out of 170 total outages (46%). The significantly largest share of the PE outages is attributable to the Procedural Service Provider (80%) as opposed to the Procedural System Vendor (17%) or Procedural Other Vendor (3%). The frequencies of PE outages have been increasing at the statistically significant rate of 12% annually. **Figure 12** shows the frequency of PE outages by root cause subcategory. The three major root cause subcategories are Documentation/Procedures (unavailable, unclear, incomplete), Insufficient Training, and Insufficient Supervision/Control which stands out because of its significantly increasing trend of 47% annually. The average frequency of Insufficient Training outages in the past three years (18.7 annually) is higher than in the first four years (12.5 annually); this difference is statistically significant. Over the six Report Years, Documentation/Procedures (out-of-date, unusable, impractical) PE outages have been significantly less frequent compared to the Baseline Year level. In Report Year 6, the frequency of Inadequate Routine Maintenance/Memory back-up outages returned to its level in the first five years after rising to a peak (5) in Report Year 5. Each Report Year after the Baseline Year has a higher aggregated outage index attributable to Procedural Errors than in the Baseline Year.

The annual aggregated outage index of Procedural Errors has risen at the statistically significant rate of 40 per year. Much of this increase is attributable to Insufficient Supervision/Control in which the annual aggregated outage index has risen at the statistically significant rate of 75% annually. Counterbalancing this trend to some degree is the statistically significant decline (35% annually) in the annual aggregated outage index of Documentation/Procedures (out-of-date, unusable, impractical) outages.

Figure 12: Number Of Outage Reports By Procedural Error Root Cause Subcategory


Number of Outage Reports
50
40
30
20
10
0
Report Year 6
Baseline Year and Report Years 1-5 (left to right)
5 5 8 16 20 26 45
17 16 23 17 18 22 12
12 11 15 12 24 14 18
5 3 4 3 4 2 1
3 2 4 0 3 2 1
0 2 0 2 1 5 1
Insufficient supervision/control
Documentation/procedures unavailable, unclear, incomplete
Insufficient training
Documentation/procedures out-of-date, unusable, impractical
Other
Inadequate routine maintenance/memory back-up

OUTAGE METRICS RELATIVE TO NETWORK GROWTH

The public telecommunications network is continually growing and changing. More lines and facilities are added, switches are centralized or decentralized, the signaling network is expanding, etc. **Table 7** presents two metrics for network growth in absolute terms and relative to the Baseline Year. While no study has been done to verify the relationship between network growth and network outages, these two metrics are relevant particularly to FCC-reportable outages because of the use of subscriber lines potentially affected and blocked calls in determining the reportable status of outages relative to FCC-defined thresholds. Since December 31, 1992 is the midpoint of the Baseline Year, 140.3 million subscriber lines is used as the Baseline Year level of subscriber lines. For the same reason, the Baseline Year level of calls is 507.8 billion calls, the average of calls in 1992 and 1993.

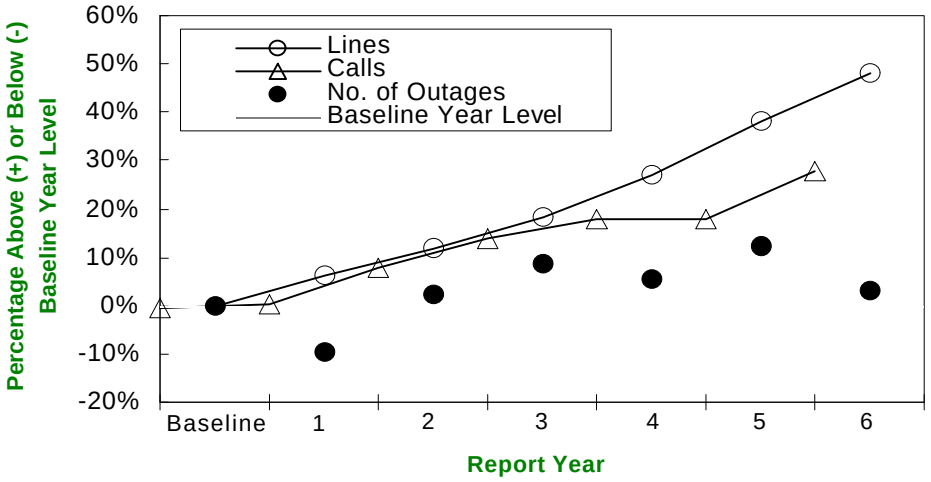
Table 7: Network Growth Metrics

Year	Total (Millions)		% Above (+) or Below (-) Baseline Year Level	
	Lines (on 12/31)	Calls (1/1 - 12/31)	Lines	Calls
1992	140.3	505,700	0.0%	-0.4%
1993	149.0	510,000	6.2%	0.4%
1994	157.2	548,600	12.0%	8.0%
1995	166.0	578,200	18.3%	13.9%
1996	177.9	597,300	26.8%	17.6%
1997	193.6	598,400	38.0%	17.8%
1998	207.7	649,500	48.0%	27.9%

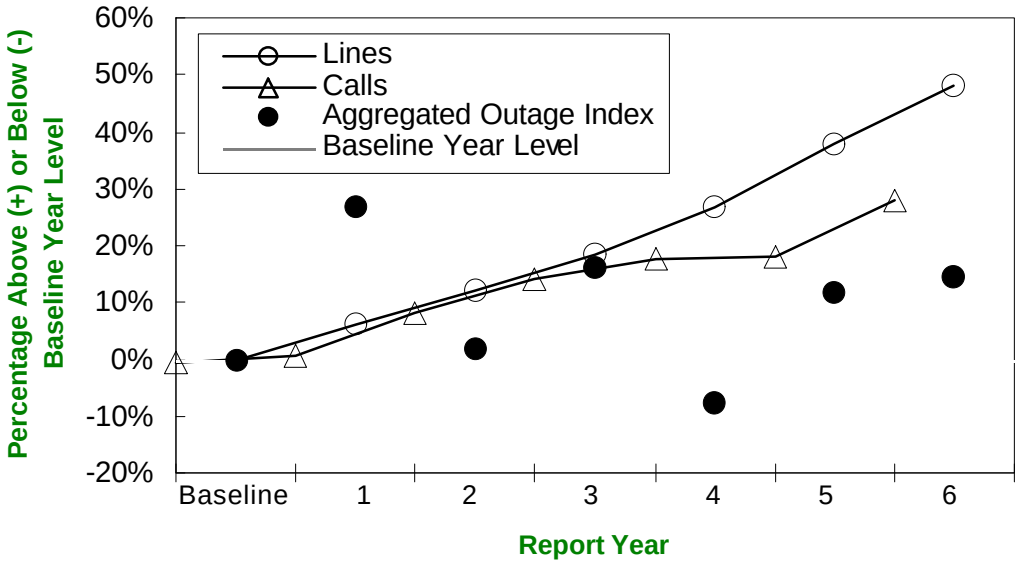
Figure 5 plots the annual network growth data in Table 7 and annual network outage metrics from Tables 1 and 5 (relative to their Baseline Year levels) versus time. Figure 5a indicates that, in every Report Year, annual outage frequency has been less than network size as measured by the number of subscriber lines or by annual call volume after these values have been scaled relative to Baseline Year levels. As shown in Figure 5b, this statement also holds for the annual aggregated outage index (with the exception of Report Years 1 and 3). Generally, the figure indicates that network outage measures have increased at a slower rate than standard measures of network size and call volume.

Assuming that a FCC-reportable outage occurs, an important question is whether the severity of that outage is different from the Baseline Year to Report Year 6. The median outage index was 2.1 in the Baseline Year and 3.8 over the subsequent six years; this change is statistically significant. Report Year 6 had the highest median outage index (4.4) since the start of the Baseline Year. The standard deviation of the outage index increased to its highest level since Report Year 1 (14.6); this indicates greater variability in outage severity over the past year.

Figure 5: Annual Network Growth And Outage Metrics Over Time



(a) Outage Frequency and Network Growth



(b) Aggregated Outage Index and Network Growth

"SPECIAL FACILITIES" ANALYSIS

In addition to the outages discussed and analyzed previously, the FCC also requires carriers to report outages below the 30,000 customer threshold that affect large and medium airports, 911 service, nuclear power plants, major military installations, and key government facilities. Carriers are also required to report fire-related incidents which impact 1,000 or more lines for 30 minutes or longer. Prior to 1994, the FCC received about four "Special Facilities" outage reports per quarter; between August 1994 and November 1995 the average was more than 20 per quarter; and since that time the average has been about three per quarter. The NRSC attributes the large drop in the number of Special outages reported directly to the reporting clarifications issued by the FCC in October 1995. Prior to that time, there were varying degrees of understanding of the reporting requirements and, rather than risk not reporting a required outage, carriers were reporting all potential outages.

Of the ten outages which fell below the 30,000 customer threshold which the NRSC did not include in its earlier analyses, nine were Special outages and one was incorrectly reported to the FCC (it did not meet reporting thresholds). Of the nine Special outages, eight were Facility outages and one was a Central Office (CO) Power outage. Two of the Facility outages were the result of cable dig-ups, rodents caused one, and five were fire related. The root cause of one of the cable dig-ups was procedural error due to insufficient supervision, and the second was due to insufficient or no notification to the facility owner prior to digging. The five outages caused by fire were all located outside the buildings of service providers. In one case an aerial cable was burned by fire which resulted from a tractor trailer collision; one occurred when a power company capacitor bank ruptured, leaked oil, and caught fire, burning the cable below; and, three were the result of wildfires burning aerial cables. The root cause of the single CO Power outage was procedural, due to insufficient training.

The average duration of these nine outages was 657 minutes versus 397 minutes for the larger reported outages. Two of these outages, however, were exceptionally long. The outage caused by rodent damage was 1616 minutes in duration due to the isolated location of the outage, which required the chartering of an airplane to reach and the need to repair multiple gopher chews. And, one of the outages caused by wildfire (1295 minutes in duration) could not be repaired until authorities allowed access to the affected area. The remaining seven outages had an average duration of 429 minutes.

The average number of customers affected by these outages was 6,006. However, by definition these outages affect less than 30,000 customers and therefore comparison of the number of customers impacted to larger reported outages is meaningless.

RELATED WORK

This section contains brief descriptions on a number of issues related to network reliability that other forums are currently working on.

THE NETWORK RELIABILITY AND INTEROPERABILITY COUNCIL (NRIC-V)

Since 1992, the Federal Communications Commission has chartered four Network Reliability Councils (a.k.a., Network Reliability and Interoperability Council (NRIC)) to assure optimal reliability and interoperability of public telecommunications networks. Beginning in the year 2000 a fifth council, NRIC-V, will begin its work. The topics that NRIC-V will address will be organized into three focus areas:

Y2K Review

NRIC-V will continue the work of NRIC-IV relating to the year 2000 date rollover on telecommunications networks, including a review of the effectiveness of the work done prior to the date change an d an analysis of the date change on those networks, to include recommendations on any future actions that should be taken.

Network Reliability

The Council will evaluate and report on the reliability of public telecommunications network services in the United States, including the reliability of packet switched networks. To accomplish this it will:

- Evaluate those guidelines that were developed to improve the quality of outage reporting for those carriers currently required to report outages, and, if appropriate, recommend further refinements to those guidelines.
- Monitor the process, analyze the data obtained, and report on the efficacy of the voluntary reporting program for those telecommunications and information service providers not currently required to report outages which was recommended by NRIC-IV.
- Evaluate existing network outage reporting requirements and make recommendations for improving, or where appropriate initiating, reporting requirements for telecommunications carriers currently required to report outages and those not presently required to report service outages.
- Continue to develop best practices recommendations and refine or modify, as appropriate, best practices recommendations developed by previous Councils.
- Evaluate the extent to which telecommunications common carriers are using best practices recommendations and applicable Committee T1 standards, and identify ways to increase the use of best practices and relevant Committee T1 standards.

Network Interoperability

- The Council will make recommendations concerning technical standards to ensure spectral compatibility in wireline networks and facilitate the deployment of xDSL and associated technologies.

- The Council will make recommendations concerning the development of spectrum management processes within the wireline network that facilitate competition among CLECs and ILECs using different technologies, while still maintaining network integrity.

- The Council will make recommendations with respect to such additional topics as the Commission may specify. These topics may include requests for recommendations and technical advice on interoperability issues that may arise from convergence and digital packet networks, and how the Commission may best fulfill its responsibilities, particularly with respect to national defense and safety of life and property under the Communications Act.

The NRSC has been an active participant in all the previous Network Reliability Councils and fully expects to continue this participation in NRIC-V.

NETWORK SURVIVABILITY PERFORMANCE (COMMITTEE T1 - WORKING GROUP T1A1.2)

As mentioned previously in this report, Committee T1 Technical Report (TR) No. 42 has provided techniques to analyze data from FCC-reportable service outages since the ATIS/NRSC 1996 Annual Report. The T1A1.2 Working Group developed TR No. 42 primarily for this purpose.

Currently, T1A1.2 is revisiting the network survivability techniques and performance measures in TR No. 24, "Network Survivability Performance" and TR No 24A, "Supplement to Technical Report No. 24" with a goal to incorporate any changes or enhancements in a new TR (to be issued in the fourth quarter of 2000).

Other areas of interest at T1A1.2 include:

- Network survivability and reliability aspects of Number Portability (NP).

- Enhancement of the existing trend analysis methods of TR No. 42. This includes developing (i) generalized analysis techniques to adjust for seasonality, and (ii) trend testing techniques to adjust for network size and demand.

- Study of end-to-end Internet survivability performance.

CONCLUSION

As has been the case in all of the previous NRSC annual reports, this report presents a mixed bag of results. Compared to the Baseline Year outage frequency was up by slightly more than one outage per quarter, while the impact of those outages increased by 17%. For the year, Central Office Power outages were up, Facility outages were down. Local Switch outages were also down, but Digital Cross-Connect System outages were up. Despite increases over the past two years, Common Channel Signaling outages continue to demonstrate a downward trend. While the frequency of Tandem Switch outages has remained relatively steady since the Baseline Year, the number of outages with a Procedural root cause continues to demonstrate an increasing trend.

These varying results notwithstanding, the NRSC's primary measures—overall outage frequency and overall outage index—continue to perform well within the limits of the control charts by which they are measured. For the sixth consecutive year, under the outage categorizations and statistical methods chosen, networks appear to remain stable and continue to provide a high level of reliability.

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Network Reliability Steering Committee