OUTAGES: THE ISSUE OF THE 90'S

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I. ABSTRACT

Outages are probably the cable industry's most important operating issue. This paper will examine the following:

* *Importance of outages and the impact on business.*
* *Customer acceptable performance.*
* *Outage definition and detection.*
* *Opportunities for significant reductions.*

In 1990 CableLabs established an outage reduction task force. Much of the information presented in this paper comes from the work of this task force and its very capable members.

It is the author's point of view that significant reductions, 50% or greater, can be made in outages in the next 12 months with minor modifications to the equipment and plant configurations now in use. Outage reductions of some 50% are required to gain customer loyalty and a rating of excellence. Additionally, it is reasonable to anticipate even greater reductions in the 1992-93 time frame by isolating trunk powering from commercial power and ensuring that all equipment is highly reliable.

II. CUSTOMER SATISFACTION: IMPORTANCE OF OUTAGES

Customer satisfaction, or customer service, is our biggest problem and opportunity. Franchise renewal difficulties are almost exclusively preceded by customer satisfaction problems. The problem in Washington D.C. could not exist if customers rated cable TV service as excellent. In addition, customer service problems create high phone traffic, high service call rates, and can result in employee turn-over which all result in higher expense levels.

Recently Viacom completed a study in which individual customers were tracked over a number of months. Data were collected and analyzed to understand how controllable disconnect and pay downgrades compared to the customer's rating of service. The results, shown in Figure 1, show customers with *Fair-Poor* service ratings disconnect and downgrade almost twice as often as customers with *Good-Excellent* service ratings; 8.4% to 4.9% for downgrades and 6.9% to 3.5% for controllable disconnects. Excellent customer satisfaction increases revenues, reduces expenses, and helps keep local and national politics on a positive and manageable level.

Customer satisfaction can be characterized with a number of attributes such as:

* Phone service; degree of access to problem resolution and information.

* Installation; availability of convenient schedules, quality of work and courteousness of personnel.

* Sales; courteousness and competency of personnel.

* Repair; quickness of resolution, availability of convenient schedules if home visit required, and competency and courteousness of personnel.

* Outages; frequency and duration.

* Pictures; lack of noise and other distortions, and sound levels constant across all channels.

* Office; convenient location and hours.

* Billing; accuracy, understandability, easy problem resolution.

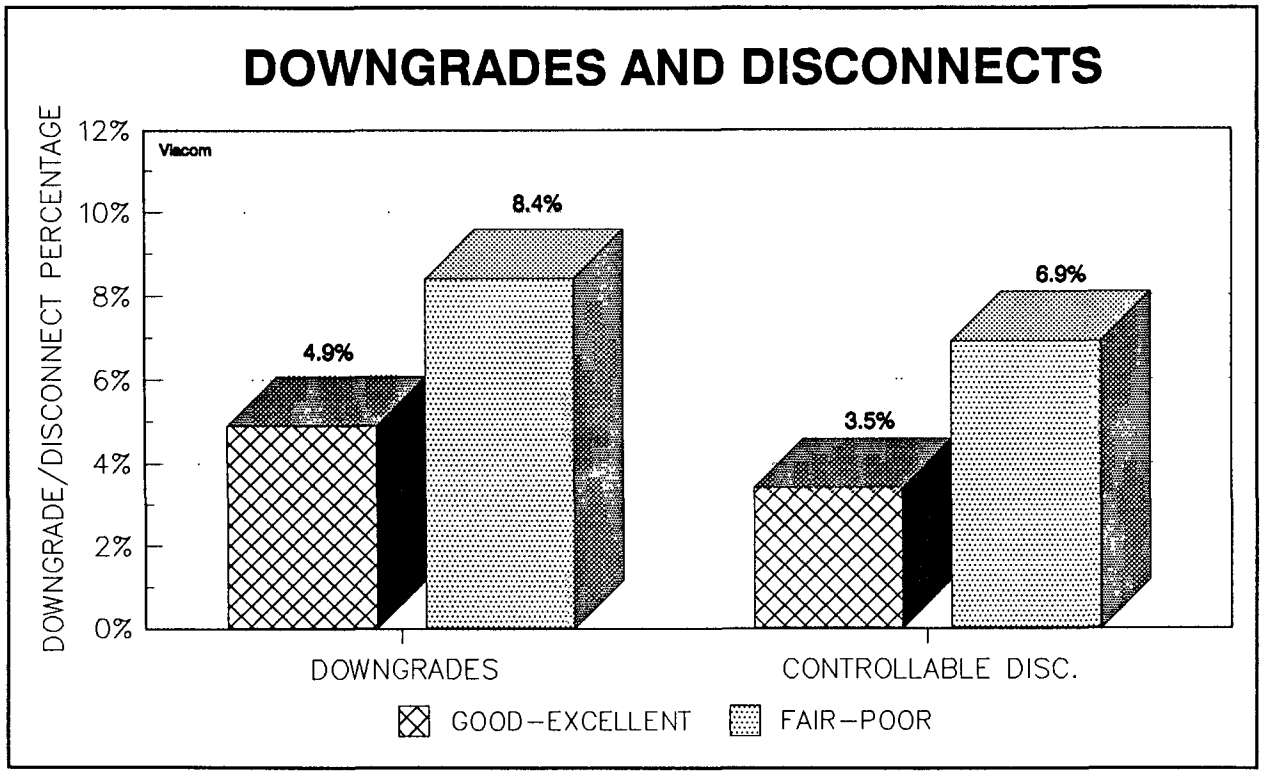

Figure 1

An effective technique for problem solving is to determine the key cause and bring focus to it. Studies have identified Outages as the most important customer satisfaction issue. Figure 2 shows data that correlates customer perception of service to the actual number of outages experienced. Clearly a strong correlation exists between satisfaction and outages.

One Warner Cable system with historically high Customer Satisfaction ratings had a drop of 7% in late 1990. Outages in this system over this same period increased by 52%. Another System that historically had low customer satisfaction scores had a 15% jump late in 1990, while outages decreased by 44%. In both cases the analysis concluded that outages are the principal cause for the change in customer satisfaction. Figure 3 shows Warner Cable's 1990 Customer Satisfaction data versus outages.

Outages directly impact the customer. Additionally, outages create activities that degrade performance in phone service, repairs, and pictures. Outages are clearly the priority issue.

Warner Cable, like many operators, has made significant service improvements in all areas except outages. We have been disappointed to find that ratings for Overall Customer Satisfaction have only marginally improved. Eliminating outages is the key to achieving ratings of Excellence.

III. OUTAGES: DEFINITION, DETECTION, ACCEPTABLE PERFORMANCE

A. Outage Definition

There are many definitions of outages varying from "all channels out to 20 or more customers, not counting loss of power or maintenance outages", to "one or more channels out to more than one customer for any reason." However, the definition must come from a customer's point of view.

If a customer watches a program and it goes out, the customer calls that an outage. The customer does not care if the Power Company is

at fault, if the plant was taken down for maintenance, or if other channels remain on. The bottom line is the customer paid for certain channels, elected to watch a specific channel but now cannot watch the channel; that is an OUTAGE. I suggest that an outage is:

"Loss of one or more channels to four or more customers."

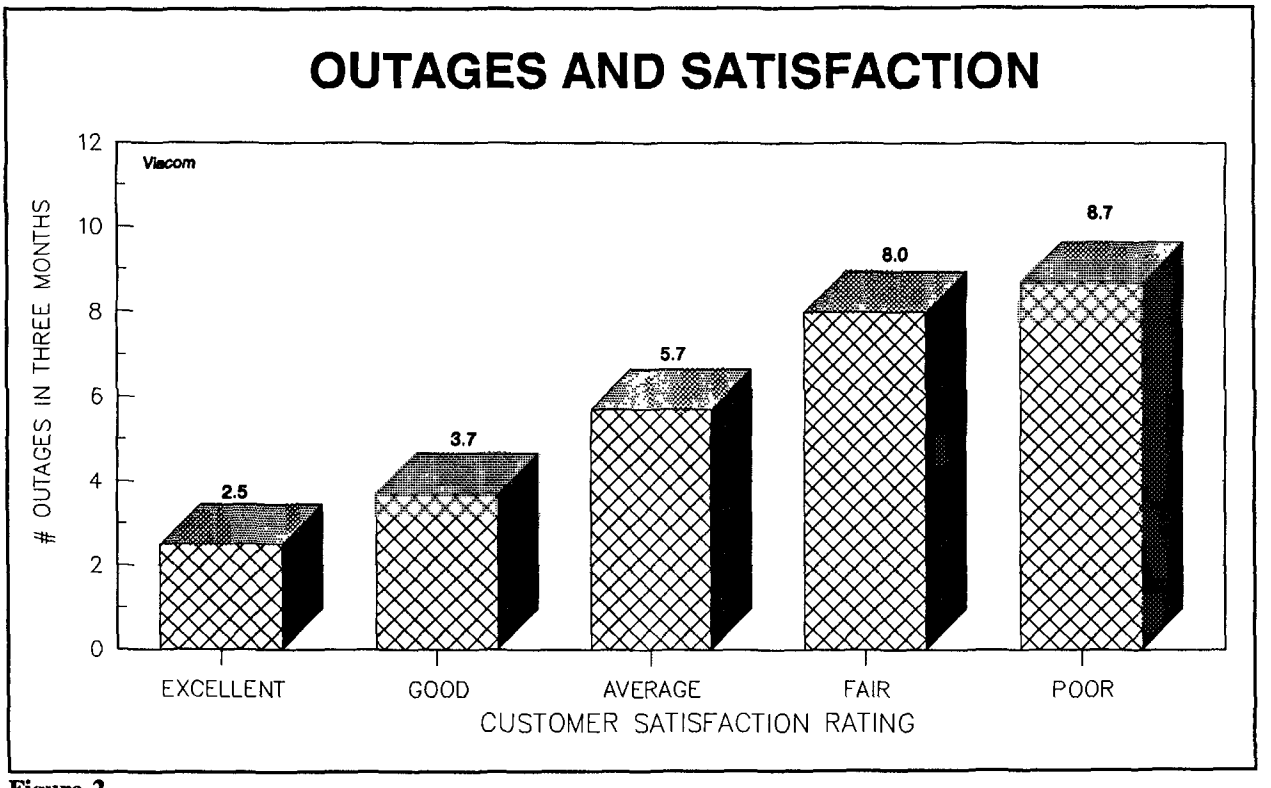

Figure 2

B. Customer Acceptable Outage Frequency

Figure 2 shows results of a study performed by Viacom which links frequency of outages to customer satisfaction levels. Note outage frequency shown in Figure 2 is over a 3-month period. On a monthly basis the data suggest that no more than about 1 outage per month can occur for the service to be rated as Excellent.

C. Outage Detection

I recently had the opportunity to ask technical operations experts from a number of MSOs how they detect outages. Outage detection today is an imprecise process. Systems today most often use the over-load created on the CSR phone switch as a way of detecting outages.

An outage detection system is needed that will:

* Automatically, quickly, and accurately, create a flag when there is an outage.

* Allow 24-hour-a-day outage detection and automatically call standby personnel.

* Provide data to track performance; frequency, repeats and duration.

* Provide data conducive to analysis leading to action to prevent outages.

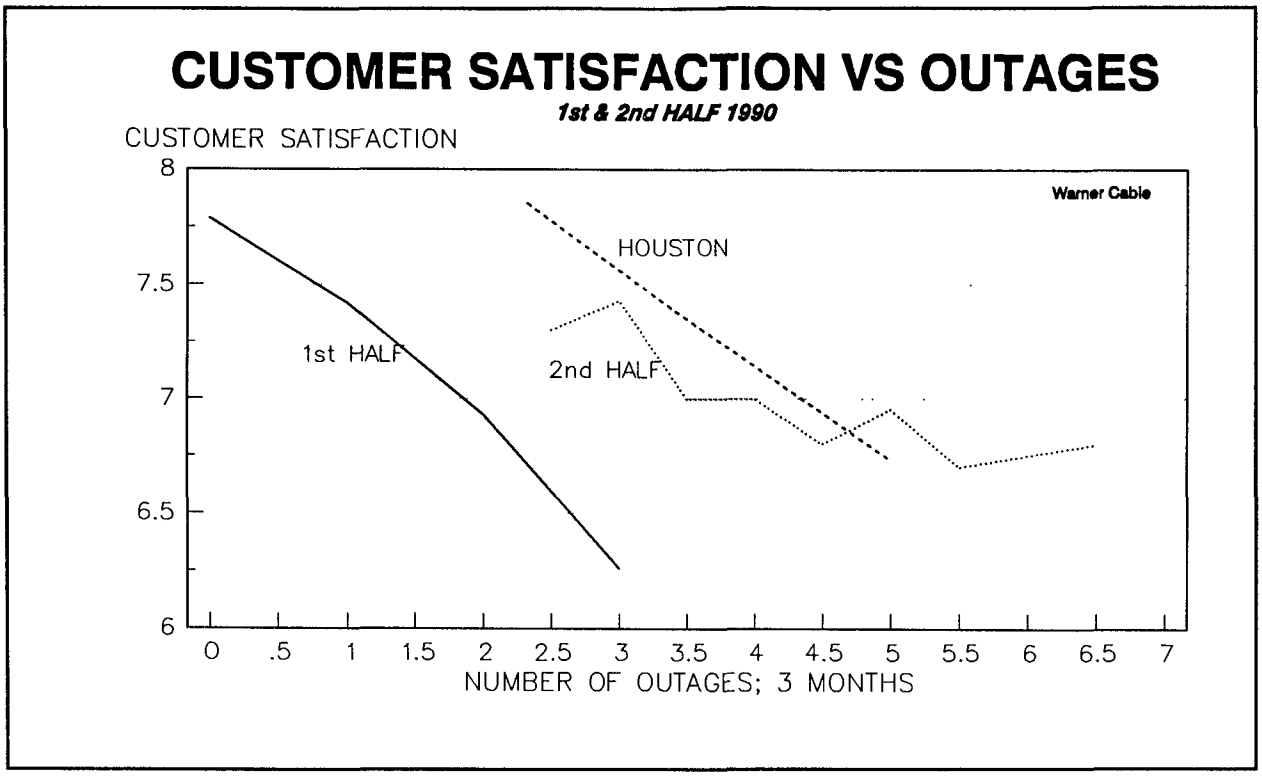

Figure 3

* Detection must be added and made operational for a nominal cost.

* Customers must be used for detection since customers are the only source for outage detection in systems with one-way plant.

Some billing systems have outage detection modules. The billing system with its customer data base and on-line tie to the CSR operation must be an integral part of outage detection. The problem most operators have with present detection systems is they require the creation of a data base that ties customers to specific amplifier locations. Creating this data base can be a significant and expensive effort.

Let me share with you an approach the Hampton, Virginia system recently implemented that avoids the large data base efforts. The system uses ZIP-plus-4 data to organize customers into geographic groups of 60 to 200 homes. Since customer addresses, phone numbers and ZIP-plus-4 data is readily available the data base is easy to establish. The billing system declares an outage whenever two or more customers call with an outage from a ZIP-plus-4 group within 120 minutes. This approach has proven to be extremely accurate to declare outages.

I am pleased to report that outage detection systems should be available by year's end to meet our needs as outlined above. The billing system vendors, ARU vendors, a number of MSOs and CableLabs are working to insure our detection and tracking needs can be met.

A reliable means to measure on-going results and to ascertain cause and effect is a prerequisite to making real progress. While cable systems have been operating nearly blind, it looks like the industry is close to bringing this important issue to closure.

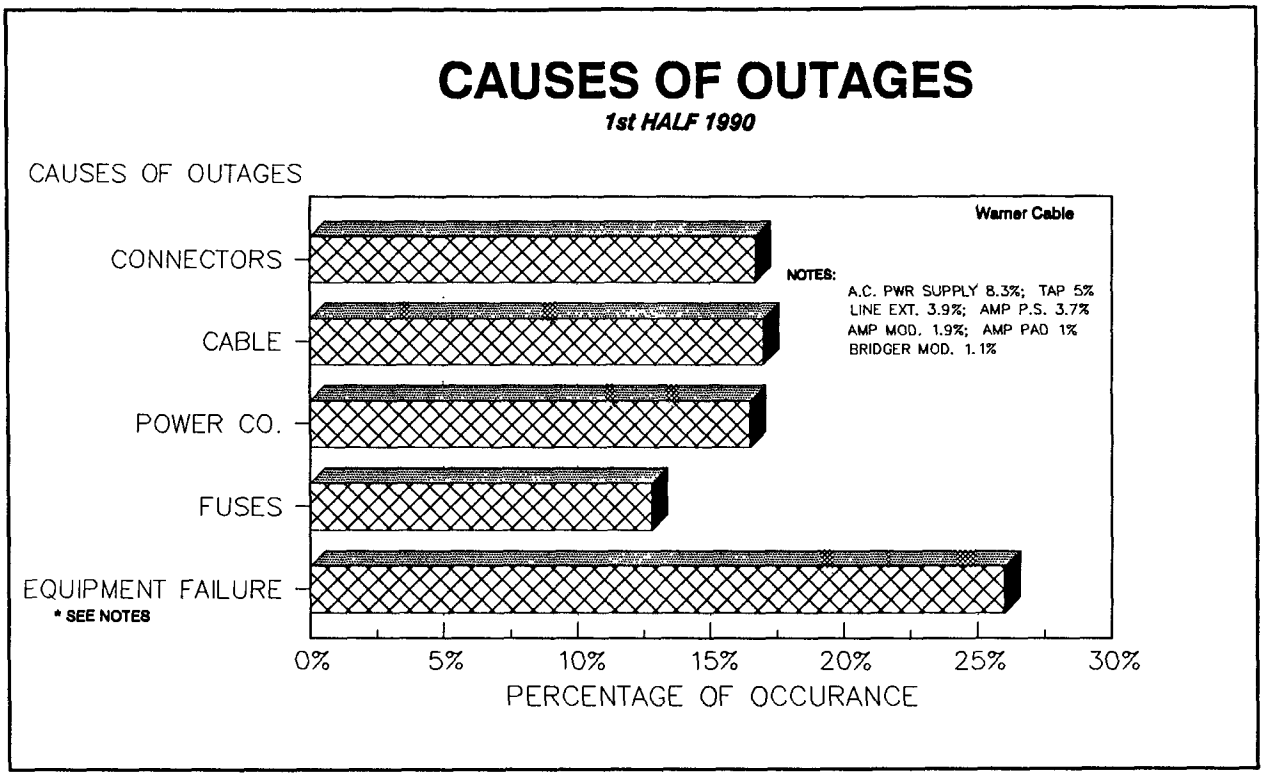

Figure 4

IV. CAUSES OF OUTAGES

A. General

Figure 4 shows the breakdown of causes of Outages and percentage of occurrence which can be summarized as:

* 25%+ Equipment Failure.
* 15% Cable Problems
* 15% Connector Problems
* 15% Power Company; Loss of A.C. Power
* 13% Nuisance Fuse Blowing

The data comes form Warner Cable over the first half of 1990. I have reviewed this data with a number of MSOs. While there are some variations in percentages, everyone agrees that these are the causes and are in the right order of importance.

One cause not listed is an outages created by system's repair and maintenance activities. Some systems do not consider plant taken down for repair or maintenance to be an outage. However, as we have mentioned earlier, the final judge, the customer, clearly considers this an outage.

Maintenance outages usually cannot be avoided but the impact can be reduced. The CSRs must know when these outages are to occur and for what duration. The impact on customers is greatly reduced if we tell them that we know about the outage because we are doing maintenance and tell them when service will be restored.

There is often latitude as to when maintenance is performed. Maintenance that creates outages should be done during low viewership periods. Some systems today require maintenance on the trunk to be performed during early a.m. hours. Naturally, plant that is in back yard easements should not be worked on during early a.m. hours.

It has been estimated, but without substantiating data, that up to 35% of all outages are from repair and maintenance. Here is an area where a significant improvement in customer perception can be obtained by simply implementing good operating practices.

B. EQUIPMENT FAILURE

Equipment failure can be categorized into two broad causes:

* Voltage surges.

* Poorly designed/manufactured equipment.

Equipment exposed to high voltage surges, unless protected will have high failure rates. Recent work, led by Roy Ehman with Jones-Inter Cable, has concluded that equipment can be adequately protected. It is interesting to note that these surge voltages often get to the equipment via sheath currents. Therefore, surge protection at the a.c. power supply is not sufficient protection.

The other category of equipment failure is poorly designed/manufactured equipment. The cable industry has gone through its share of equipment with excessive failure rates. It is time that we, as an industry, establish acceptable equipment failure rates. Most manufacturers provide reliable equipment most of the time.

Local cable system management needs a precise understanding of what failure rates to expect. The manufacturers need to know what their customers, cable operators, need. I cannot think of one complicated and reliable electronic system without established failure-rate budgets for the system components.

Outages due to equipment failure should be cut at least in half if the equipment is adequately protected from voltage surges and the equipment meets a 3-5% failure rate. There are systems operating with line equipment failure rates in the 3-5% range. Since this is our largest cause of outages, achieving significant reductions here is mandatory if we are to achieve an overall improvement.

C. CONNECTOR AND CABLE FAILURES

Outages caused by cable and connectors are usually a cable system operations issue today. Generally connector failures are workmanship/ craftsman issues which can be effectively addressed with a focused training and certification program and routine quality control.

Cable problems are often due to cable cuts, an age-old cable operational issue. Obviously, the protection against cable cuts is to work closely with local groups to ensure notification before digging and to make others aware of the existence of cable plant.

Cable and connectors represent some 30% of the failures. These should be reduced by some 50% by insuring that all personnel are sensitive to the outage issue, work is done right the first time, and people who may cut cable are motivated to first advise us of their activities.

D. POWER COMPANY; LOSS OF A.C. POWER

If there is one message I would like to get across it is the following:

> The Power Company is not responsible for most of our outages; however, the outages they cause can be significantly reduced.

Cable TV power system are designed with little regard to outages. Cable systems design are done with great attention to the number of amplifiers in cascade since this is a key factor to meeting picture quality specifications. Similar attention and design rules are needed for power supply cascade; the number of power supplies in series to feed a customer. A customer fed from 15 different power supplies will experience more outages than a customer that has a 7 power supply cascade.

The Nashua, NH system recently analyzed their powering and found the maximum number of power supplies feeding a customer was 14, and customers on a 15 amplifier cascade were at a 7 power supply cascade. Nashua is now reconfiguring the power system so the maximum power supply cascade is 7 while customers on a 15 amplifier

cascade will be on a 4 power supply cascade. The reconfiguration did not reduce the number of power supplies, only changed their location. These power supply cascade reductions will significantly reduce the outages to the customers on the longer cascades where a large number of customer outages occur.

Placement of power supplies is usually done with very little insight into the reliability of the power system at the tie points. Recent discussion with Power Companies has indicated there is differences in the power system reliability depending on a number of factors, including distance from the sub-station.

The number of outages seen by the customer can be reduced if power outages to the trunk were eliminated. Today standby power supplies are an option to insulate trunk from commercial power outages but considerable expense and operational difficulties are encountered with this approach.

Recently an investigation was undertaken looking into using higher voltages to significantly reduce number of power supplies with an eye toward powering all trunk amplifiers directly from the headend in which there is stand by power. There is a cable system in Minnesota using 300 volt supplies which has been operating without problems. There are issues concerning codes, safety, and acceptability to local utilities that need to be addressed before the industry could move to 200-300 volt supplies. But it is very intriguing when you realize that a 200 to 300 volt cable trunk power system could power all trunk amplifiers from the headend where standby power is already in place.

Reducing power supply cascades to customers, working with utilities to insure the most reliable tie points are used, and avoiding outages during planned utility outages by using generators (utilities also have scheduled repair and maintenance) should result in good reductions in power company outages. If a design can be developed that insulates the trunk from commercial power then power company outages should drop to more like 10% the present rate.

E. FUSES: "FUSES ARE OUTAGES WAITING TO HAPPEN"

Some 10% to 15% of outages are "nuisance fuse blowing." A nuisance fuse blowing is when the outage is restored by replacing only the fuse; i.e., no other problem had to be corrected. From discussions with most of the amplifier manufacturers, there is no specific rationale as to when to use fuses, how to size them, and when to use regular, slow blow, etc. Given no specific direction and their desire to protect the equipment, the vendors have often implemented a fusing approach detrimental to outage reduction and errs toward questionable equipment protection.

Fuses are used to protect circuits from high current conditions which arise from a shorting situation. Shorts, while they do occur principally due to repair, are a rare event in a cable system. The condition experienced often is over-voltage due to voltage surges. The over-voltage condition, just as a short, results in a higher current condition for the period of the over-voltage.

Since over-voltage is the condition the plant equipment needs to be protected against then fuses or any type of current sensing device is not appropriate. There are clamping circuit devices available that can very quickly sense the presence of voltage surge and short this surge to protect the circuits.

Specific suggestions will be made in the next section on providing surge protection and the use of other types of circuit protective devices. The basic approach is:

* Provide absolute protection from voltage surges.

* Use fuses only to protect from shorts; not over-voltage.

* Use slow blow fuses.

* Do not use any other current sensing protective devices; they create outages.

It seems reasonable to expect that outages due to nuisance fuse blowing can be essentially

eliminated representing in excess of 10% of all outages.

V. REDUCING OUTAGES

A. General

In 1990, CableLabs established an Outages Reduction Task Force. The task force identified 6 areas for reducing outages. These 6 areas are:

1. Plant & Head-end Protection; Bonding, Grounding, Surges, Lightning, and Fuses.
2. Equipment Reliability; MTBF.
3. Outage Detection, Definition, and Acceptable Performance.
4. System Reliability Model.
5. Plant Powering.
6. Outage Prevention Through Operating Practices.

The CableLabs Task Force has established working groups for each of these areas and will be publishing recommendations in the coming months.

B. Plant & Head-end Protection; Bonding, Grounding, Surges, Lightning, and Fuses

There are a number of plant and head-end configuration issues including the use of particular devices that impact equipment reliability and thus outages. The approach is to configure plant and headends so voltage surges do not create equipment failures. It is the opinion of a number of cable engineering experts that this approach can be successfully implemented.

Specific recommendations which will be issued by CableLabs can be summarized as follows:

* Voltage clamping/crowbar circuits used at the power supply and at trunk amplifiers. CableLabs will publish qualification tests for these devices and list devices known to meet these tests.

* Slow blow fuses are the only recommended current sensing protection devices. Remember if over voltage conditions are removed then the only current protection is for short circuit conditions. Fuses are to be used at amplifier AC input to the DC power pack, output of the AC power supply and for AC routing at trunk distribution legs.

* Amplifier coupling and by pass capacitors are to be at 1000 volt rating.

* Gas diodes (Siemen's Diodes), MOV's and circuit breakers are not recommend.

* Bonding is a safety issue and should be done only to the extent required by code. Bonds should not be located on the same pole as spark gap.

* A ground is to be placed at each active that has a clamping/crowbar circuit. The ground should not be placed where there is a power company vertical. At the time of writing this paper, there was not agreement on the need for this ground so watch for specific CableLabs recommendations on this point.

C. Equipment Reliability; MTBF

For cable systems to operate at acceptable low levels of outages and meet the customer expectations, equipment must experience low failure rates. A fair amount of work is needed to ascertain what failure rates or MTBF (Mean Time Between Failure) are acceptable for the various equipment types (trunk amplifiers, line extenders, head-end modulators, etc.) to meet the customer expectations.

As part of the Outage Reduction effort, a group has been established to develop recommended equipment MTBF's. The group will solicit input from equipment manufacturers to address questions of definitions, etc. and seek concurrence on goals to be established.

At the time of writing this paper, activity was just getting underway but is expected that MTBF's for various equipment types will be published by CableLabs in the second half of 1991.

D. System Reliability Model

A cable system is comprised of a large number of pieces of equipment from TVRO's, receivers, modulators, descramblers, encoders, trunk amplifiers, line power supplies, line extenders, etc. The reliability budget needed from each equipment to achieve a certain customer outage level requires some level of mathematical modeling and study. One of the task force sub-groups is developing this model. It is expected results will be available in mid year and the details of the model and analysis leading to establishing equipment reliability goals should be published in the second half of 1991.

E. Plant Powering

As discussed earlier, there are a number of actions that can be taken to reduce the impact to cable customers of losing commercial power. Another working group under the CableLabs Outage Reduction Task force is investigating specific approaches with special focus on:

* Minimizing power outages by working with local Power Company; develop specific areas for Systems to consider.

* Methods to reduce power supply cascade with power system design guidelines.

* Method to insulate trunk from commercial power; including the use of higher voltage.

F. Prevention Through Operating Practices

There are a number of opportunities where prudent operating practices can reduce impact of outages. One prime area is maintenance outages, which can account for up to 30% of all outages. As mentioned earlier, the scheduling of maintenance outages and insuring that CSRs are cognizant are simple but very effective operating practices. Also as mentioned earlier, doing maintenance at very low viewing times, typically early a.m., greatly reduces the number of customers affected.

If standby power supplies are being used, then operating practices dealing with the process to dispatch a generator before batteries run down, quarterly battery checks, yearly battery replacement, will all greatly impact the effectiveness of the standby units.

While a group leader was not established for this area it is expected that there will be a series of CableLabs recommendations dealing with reduction through smart operating practices later in 1991.