TECHNICAL AUDITS FOR LARGE METROPOLITAN CABLE TELEVISION SYSTEMS

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ABSTRACT

As CATV operators secured franchises in large metropolitan cities, it became apparent that the services promised would provide an enormous technical and organizational challenge. In the initial stages of the system build, the overriding focus is the construction of facilities and outside plant while equilibrium in operations is struggling to emerge. During this period, technical quality is sometimes compromised by underqualified and transient personnel, lack of interdepartmental communications, absence of standardized practices and procedures, as well as a non-uniform understanding of the overall goals of the system. The system operator will eventually move out of this construction mode and into the real day-to-day operations of a large system, but by this time there will be many technical problems and non-standard procedures that have become part of the daily operations. A technical audit at this time can stabilize operations, reduce technical problems and solidify the communications between system personnel and Corporate Engineering.

INTRODUCTION

Warner Amex currently has franchises in several large metropolitan areas such as Houston, Dallas, Cincinnati, Pittsburgh, St. Louis, Columbus Ohio, Milwaukee and New York City. The construction is basically complete in all of these cities except Milwaukee and New York City, which meant that six sites consisting of approximately 13,000 miles of plant, large master control facilities, studios, video vans, high speed two-way data communications, complex AML and satellite networking, would now be faced with maintaining the technical integrity of the system.

Corporate Engineering was tasked to develop a method of providing senior management with a clear understanding of the present technical operations of these large systems and outline a long term plan for improved technical integrity with standardization of practices and procedures. A technical audit was then outlined to accomplish this goal.

The key technical areas were chosen and classified as CATV Engineering, Data Communications Engineering and Video Engineering.

CATV Engineering was defined to encompass the main headend, all hub sites, the outside plant and the records and procedural documents associated with each area. The testing at each of these locations was intended to give insight into the performance of modulators, processors, microwave equipment, satellite receivers and peripheral equipment used to supply programming for transmission on the CATV plant. Forward signal quality is observed at selected extremities of the system, and the physical condition of the outside plant is checked for proper construction practices. Subsequently, a set of tests were prepared with specific parameters that would allow an efficient and expedient analysis of CATV Engineering in the system.

CATV ENGINEERING

A. The headend/hub tests are performed at all sites and consists of the following:

Hum	-	60 dB down
C/N (Headend)	-	55 dB or greater on all channels
C/N (Hub Sites)	-	hubsite C/N dependent on interconnect to main headend

All of the above tests are to be performed on three selected channels, preferrably off-air, satellite and pay-per-view (or subscription pay) channels that represent low frequency, mid-band and high frequency portions of the spectrum.

The picture quality, audio levels and video levels are checked on all channels and the operation of standby power at all sites was evaluated. General observations are made at all sites with respect to neatness, cable identification, space utilization, and equipment grounding.

B. Outside plant testing is divided into field tests and field observations.

Field tests are performed at the last trunk location of a long cascade in every 200 miles of plant and the field observations are performed on 10% of the total plant. Field testing consisted of the following:

Peak to Valley	=	[N/10 + 1/N] N = number of trunk amps
C/N	=	Base # - N.F. + input - 10 log N, where N = # of trunk amps
Hum	=	less than 2%

These three tests are performed on the three channels defined in the previous section. In addition, picture quality, audio levels, video levels, and visual observation of the spectrum are to be checked on all channels. Signal leakage should also be checked.

Field observations are performed on a 10% random sample of the system with attention given to grounding, bonding, expansion loops, lashing wire, equipment placement, splicing, clearance, sagging, riser attachments, pedestal installation, subscriber installation, apartment lock boxes, apartment conduit and molding placement, apartment cable routing, apartment security and general condition of the plant.

C. Technical records are checked for FCC public files, PM (Preventative Maintenance) procedures, PM reports, as-built maps and availability of spares.

This list was prepared for CATV Engineering along with a list of test equipment required and a proposed schedule (time-frame) for the testing to be completed.

DATA COMMUNICATIONS ENGINEERING

Data Communications Engineering on a large scale in a CATV systems is relatively new and fairly specialized to individual systems or MSO's. This section will attempt to remain as generic as possible, but will undoubtedly refer to some specifics in an attempt to fill up the pages of this report. (Ha! Ha!) The systems that were to be audited were all high speed (256 kbs), two-way interactive with several pay-per-view channels delivered to the subscriber. In order to understand the reasoning for our selection of testing, I will give you a brief overview of the data communications network.

A Data General computer (Model C-350) formats the data necessary to talk to the BGC's (bridger gate controllers) and the subscriber terminal and delivers it through a two-way communications interface board (BCU), which in turn provides the path to and from the RF modem. This modem is located in the computer room and is interfaced to the headend for transmission onto the cable system and to the terminal in the subscriber's home. The terminal responds on the reverse spectrum, is routed through the headend and is received by the modem in the computer room and provides the necessary data back to the computer. All of the systems have been subdivided into sections of approximately 200 miles of plant for each modem and interface board. This was done in conjunction with the BGC's to help control the ingress for proper data communications. The BGC's also provide system status monitoring for outage analysis.

Data Communications Engineering tests and parameters were selected as follows:

A. Error analysis - Error testing was performed on each BCU (approximately 200 miles of plant) to determine the overall error rate and identify the types of errors in a given area. Special software diagnostics allowed us to perform error rate analysis without using bit error rate testers or specialized equipment. The areas tested were:

BCU Timeout -	This is an error associated with communication between the main CPU and the BCU interface board.
PSK Errors -	Errors associated with excessive noise in the reverse portion of the CATV plant. PSK (Phase Shift Keying) is used on the upstream data carrier.
Parity Errors -	Errors associated with block code checking of the received data.

B. Distribution Analysis - Three distribution amplifiers are randomly selected per BCU area to observe the overall RF level variance of terminal responses to analyze reverse distribution balancing. The RF levels are provided via the modem to the computer (A to D conversion) and can be printed.

C. Modem analysis - FSK (Frequency Shift Keying) is used on the downstream data carrier. Frequency accuracy, output level and sideband equality will be checked. On the PSK receiver portion, receiver level tracking and input sensitivity will be checked.

D. Data path checking - The downstream and upstream paths to and from the headend will be checked for attenuation accuracy and overall design to ensure the design parameters of the modem are met.

E. Reverse Plant C/N and C/I -

C/N - A 6 MHz and 29 MHz CW carrier will be injected at proper levels into one of the longest trunk cascades within a BCU area. One location per BCU will be selected and the C/N will be measured at the main headend.

C/I - Carrier to interference will be measured in a spectrum ±3 MHz from the center frequency of the data carrier.

F. Non-RF analysis - Non-RF (data related) is the name we have given to the overall data base management and data related workflow associated with a two-way system. This encompasses installation, DM, PM, billing, data entry and computer operations. A review of the overall procedures and interdepartmental communications was the key focus of this analysis.

G. Headend diagnostics - In a two-way interactive system, the headend becomes the hub for communicating and analyzing data, plant, service, computer and video related problems. Special software and test procedures were developed to assist the headend technician in his role as departmental coordination. All of the procedures are reviewed and software functionality checked.

H. Encoder analysis - This was included under data communications because it was directly related to the two-way terminals and the expertise for alignment and testing was within the Data Communications group. The test performed was residual ripple (analog scrambling was used) and the alignment procedure was reviewed in addition to checking the setup log.

A list of test equipment required and a proposed schedule for the testing was included for this section.

VIDEO ENGINEERING

Video Engineering was defined to encompass master control and equipment center, commercial insertion edit suites, local access studios, post production edit suites and remote vans.

The tests conducted on the master control facility were designed to give an indication of the general condition of all of the equipment in the signal path. This was accomplished by making baseband measurements at various points in the path. The points that were measured were; as the signal exited the headend for processing in the master control, as the signal exited the master control and finally, as the signal appeared after being modulated onto the cable system. This provided an overall view of the path travelled by the video signals. In addition, approximately 10% of the video tape playback machines and character generator equipment is evaluated.

The tests performed on the production facility consists of measuring the baseband response of the signal at the location closest to the point of origination and then making a similar set of measurements at a point closest to its final destination.

Parameters for this testing are as follows:

1. Video amplitude
2. Burst amplitude
3. Sync amplitude
4. Pedestal amplitude
5. Horizontal blanking interval
6. Front porch width
7. Vertical blanking interval
8. Burst frequency
9. Video signal to noise
10. Chrominance to luminance gain
11. Chrominance to luminance delay
12. Differential gain
13. Differential phase
14. Video crosstalk
15. Video frequency response
16. Audio level
17. Audio gain
18. Audio hum

The number of channels subjected to the above tests are to be 33% of the total and the test results should conform to EIA specification standards. In addition to the quantitative tests made, qualitative tests and observations will be made on general operations of the system, neatness, efficiency, etc.

GENERAL

The final area is classified as report analysis and deals with DM service and outage log reports. DM service should be averaging six (6) calls per one hundred subscribers per month or less. If this number is significantly higher than six, a recommendation should be made to have a complete analysis of this situation performed by on-site personnel so that it can be rectified.

The outage log reports should be analyzed for repetitive technical discrepancies, and if found, a report prepared that outlines the specific steps to be taken to rectify the situation. In addition to this, the average resolution time for outage related problems should be noted. Analysis of the above areas provide insight into the relative balance of preventative maintenance and demand maintenance in the system.

The areas of the techncial audit have now been defined and a plan must be devised to perform the test in a concise manner, coordinated with on-site personnel.

To achieve this goal, an on-site audit coordinator should be selected who will organize the personnel, test equipment, vehicles and appropriate time for testing. An outline of the technical audit should then be sent to the audit coordinator so that the on-site assistance will match the overall needs of the audit team. An agreed upon time for starting the audit is now selected and a preliminary meeting is scheduled with on-site personnel. This meeting usually takes one full day and allows system personnel that have been selected for the audit testing to review the test procedures with the corporate audit team and get acquainted with the key people from corporate engineering. The second day, testing can begin in each area with a target for completion of approximately two weeks. Two important things should happen in conjunction with the testing that enhance the performance of the audit and they are:

1. Repair of technical problems encountered if schedules permit.

2. Schedule meetings with various departments to improve technical knowledge and interdepartmental communications (i.e., technical operations, billing, and non-RF departments).

As the testing portion of the technical audit comes to a close, a review meeting should be held with the general manager and the key members of the techncial auditing team. The meeting should be structured to communicate the results of the technical testing, comment on the overall technical performance of the system, provide recommendations and discuss the time frame for the delivery of an executive summary and a final audit report to the system. The executive summary should be completed in approximately two weeks and the final report in approximately five weeks.

CONCLUSIONS

This now concludes the technical and organizational makeup of the audit and I would like to end this paper with a few general comments about the results of technical auditing.

The primary benefits that we have realized from the technical audits have been:

A. movement from demand maintenance to preventive maintenance

B. improved interdepartmental communications

C. correction of repetitive problems

D. increase in on-site knowledge of technical areas

E. improved communications between on-site personnel and corporate engineering

F. coordinated effort to lower service calls, churn and disconnects