CABLE TELEVISION TECHNICAL STANDARDS --- CONCEPTS AND INTERPRETATIONS

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As cable television enters its third decade, the Federal Communications Commission has issued for the first time a comprehensive set of rules to provide regulatory guidance for the industry. An analysis of the new rules suggests that they are intended to accomplish several things:

---to encourage cable television to grow and to function as a social tool;

---to force it to expand to perform new functions, provide new services, assume new responsibilities;

---to protect existing communications channels to an extent consistent with the public interest;

---to provide a reasonable assurance that the subscribing public receives a television reception service of at least a minimum prescribed quality.

These various aims do not necessarily lead to the same ends. As you may have perceived in studying the new rules, compromises have had to be made and complicated approaches have had to be devised; relatively simple matters have become complex.

A reading of the new rules shows that throughout the various sections and subsections, technical considerations are interwoven with administrative and operational requirements, seemingly in nonchalant unconcern and without due regard to their impact on engineering. This seems to be unavoidable, either because of the nature of cable television operations, or because of the regularatory approach seen necessary by the Commission.

The subject of this particular discussion is limited to that special group of rules which will be found in Subparts A and K of the new Part 76 of the Commission's rules. These are the technical requirements, performance parameters, and definitions which cable television engineers and technicians will find of most immediate interest.

Insofar as these technical requirements are concerned, the Commission's approach has been to recognize that the end product--- the television signal delivered to the subscriber---is the matter

of paramount concern. (In the future, this may change.) The Commission has avoided as much as possible any regulation of the hardware or of the distribution system design, preferring rather to impose requirements on the quality of the signals delivered to the subscriber. For this reason you will not find specifications on, for example, the maximum noise figure of amplifiers or head end equipment, or on the frequency stability of the channels within the system. Instead, there are limitations on the minimum signal-to-noise ratio and a prescribed tolerance on the frequency of the visual carrier frequency as it is delivered to subscriber terminals.

Cable Television signal categories.

The Commission's approach also involves consideration of the multitude of signals and activities which soon will characterize cable system operations. With local origination to be required of many systems, the question arises: should the standards for locally originated programs be the same as for off-air signals? Cable systems are expected to provide facilities for unspecified upstream communications---two-way non-voice signals. What kinds of requirements should be imposed on such signals? With the possibility of pay-TV or encoded television occupying some of the cable spectrum, what standards and what limitations will be necessary? As between these various operations, what are the relative priorities for interference protection? Obviously, no single set of standards can be applied to such a widely ranging---and still uncertain--- gamut of signals.

Therefore, the Commission provided for four categories of cable television channels which are distinguished by the kinds of signals they carry. The definition of these four categories are found in the special section of definitions---Section 76.5 of the new rules. Briefly, Class I cable television channels are channels which carry off-air broadcast television signals. Class II cable television channels are those channels carrying locally originated programs ---"cablecasting." Class III cable television channels are those devoted to other forms of downstream communication such as facsimile, encoded TV, private or closed circuit TV, digital or analog data, off-air FM or AM signals. Class IV channels are those which carry upstream or "return" communications. At this time, we can imagine only some of the kinds of signals upstream communications will involve in the future. I contemplate that the future may see the Commission setting up additional channel categories.

As a result of setting up this classification, as the cable industry grows the Commission can proceed with a scheduled expansion of rules and technical standards for each of the categories. At this time, obviously, the bulk of cable operations is concerned with traditional CATV, and with some ventures into local origination of various types. Thus the technical standards which the Commission adopted last March are applicable only to Class I cable TV channels.

Class II cable television channels probably will receive attention soon. Preliminary staff studies already are underway. Then, as experience dictates, specific regulations and technical standards for Classes III and IV cable television channels will be considered. The possibility also has been investigated of providing a separate set of technical standards for cable systems operating in the top 50 markets, recognizing that in these markets there may be a broader economic base to support increased performance requirements.

However, with respect to Class I cable TV channels, probably the first order of business will be to augment the technical standards already adopted by adding subsections on such matters as ghosting and color performance, possibly other parameters. Before completing this, however, the Commission should have acquired enforcement experience with the rules already adopted and some additional measurement methods should be developed and tested.

Cable TV Industry Advisory Committee.

In adopting this procedure for gradually expanding the rules and technical standards, the Commission recognized that it would have to depend upon technical advice from various segments of the cable television industry. As outlined in Report and Order, the Commission served notice that it would call for the formation of a cable advisory committee. As a result, the Cable Bureau has been deluged with the names of technical experts who have been nominated to serve on the Committee. Although the exact procedure which will be followed has not been determined in finality yet, it seems probable that a Steering Committee will be formed from among the large body of nominees. And then, to accomplish individual missions, smaller working groups will be formed. It is our view that work on augmenting the existing technical standards to provide performance requirements and measurement methods for such things as envelope delay, differential phase, and possibly cross-modulation should come first. Possibly at the same time, a full-scale study should be launched to develop technical standards for Class II cable TV signals. One of the unresolved questions here is: Should Class II cable signals be required to adhere to broadcast fidelity requirements, or should less rigid standards be permitted? One approach would require a substantially higher investment in equipment and technical personnel for which the subscriber inevitably would pay. The other would permit a lower standard of technical performance, encouraging cable operators to invest more effort in local origination, public access, and special educational or public service projects. Insistence upon broadcast standards of quality would eliminate, at least for a time, the use of relatively inexpensive videotape equipment which, up to now, has been used extensively in CATV origination. However, experience to date indicates that the 1/2-inch tape, while stimulating inovation in programming, has been somewhat less than satisfactory in practical performance.

Cable System definitions.

Before discussing the standards themselves, I'd like to invite attention in particular to two of the definitions. Section 76.5(ee) defines a very important point in the system--the subscriber terminal. This is the point of interface between the property of the cable system and the subscriber-owned equipment. If a set-top converter is supplied by the system, and is the last item of cable equipment before connecting to the subscriber's receiver, then the converter output terminals are the subscriber terminals for that subscriber. If the system supplies a length of cable and a balun transformer at the subscriber's receiver, then the balun output forms the subscriber terminals. The subscriber terminals are the points in the system at which conformity with the technical standards is determined.

The other definition concerns "system noise," Section 76.5(ff). Here, the noise of interest is not confined simply to thermal or gaussian noise, but includes all the various disturbing effects which are random or fluctuating in nature, whether it is produced by thermal effects, component leakage, modulation by-products, or atmospheric processes. In practice all of these disturbances are somewhat similar in nature and combine to have a degrading effect upon picture transmission. We see no real merit in attempting to treat them individually by setting up separate specifications for thermal noise and the multiplexing noise which results from transmitting simultaneously a number of signals through a common channel. So the Commission adopted a definition which lumps all of these phenomena together, recognizes that the combination is an unwanted interference to the picture, and provides a minimum signal-to-unwanted-interference ratio which must be met at the subscriber terminals.

Performance Tests.

Now, turning to Subpart K of the new rules, we find the first section (76.601) is entitled "Performance tests." This section defines the responsibilities of the cable system operator and sets forth several matters which he must undertake in order to fulfill those responsibilities. In addition to certain logging and record-keeping, the cable operator is required to make performance tests "directed at determining the extent to which the system complies with all the technical standards..." These are to be made annually and are expected to be made at three widely separated points, at least one of which is representative of subscriber terminals farthest in terms of cable distance from the system input.

Even though the performance tests are required to be made annually at only 3 points on the system, successful completion of the performance tests does not relieve the system of the obligation to comply with all pertinent technical standards at all subscriber terminals. Furthermore,

if it is necessary, additional tests on the system may be required by the Commission in order to secure compliance at subscriber terminals.

The approach the Commission has taken here recognizes two things: the impracticability of requiring annual full performance tests at every subscriber terminal in the system, and the necessity of requiring the cable operator to undertake monitoring performance on a routine but thorough basis. Why require only three measurement points? We consider that protection of the subscriber's interests could be achieved only by increasing the number of measurement points to several dozens, which number becomes unrealistic. So the rationale is to rely upon the basic requirement that every subscriber is to receive a grade of service which is obtainable under the technical standards, that measurements demonstrating compliance with the standards would be made only as necessary, but that as a means of monitoring the general operation of the system, a full set of measurements must be made at a minimum of three points annually. This is not a "Proof of Performance" nor is it intended to be. It simply is a requirement that the system operator take minimum steps to maintain his system properly, become capable of making all the required system measurements, and to keep those data for future reference.

We think this new requirement for a measurement capability is a substantial step forward. Our experience to date, when being involved in disputes over picture degradation or poor service, indicates that the preponderant majority of systems in trouble with the law, so to speak, do not have an adequate measurement capability. Our field personnel find, time and again, that cable complaints they have been called upon to investigate involve systems whose operators plead that they don't know how to measure some of the important performance parameters, or that they do not have the necessary equipment, or do not have personnel with the necessary expertise. This is no longer a valid excuse. The performance tests rule is effective now.

Technical Standards.

The next Section (76.605) of Subpart K is entitled "Technical Standards." Here are outlined about a dozen different parameters which affect the quality of cable service and for which threshold or limiting values are listed. These technical standards are applicable to the system performance as measured at any and all subscriber terminals. It may be of use to discuss several of them here.

We were surprised to find that, of all of the technical standards adopted, the matter of visual carrier frequency tolerance occasioned the most comment. The standard which the Commission adopted provides for a frequency tolerance of plus or minus 25 kHz for the visual carrier. However, in

recognition of the difficulties of obtaining a frequency stability of this amount in set-top converters of current design, the Commission provided further that, when set-top converters were supplied by the cable system, the applicable tolerance is plus or minus 250 kHz. Objections to this latter tolerance have been that it is too loose, that it is too tight, and that it doesn't apply to signals within the system. We agree with all three objections.

A tolerance of ±250 kHz does not assure that the adjacent channel traps in most television sets will provide the protection that the manufacturer feels he builds into his receiver. In this respect that tolerance obviously is too loose. However, after looking at the frequency stability which reasonably can be expected from the present generation of set-top converters (and at the stability of present TV receiver tuners which are of not greatly different quality), we were unable to conclude that a substantially tighter tolerance could be specified in 1972. We are in agreement, however, with suggestions that soon a tighter tolerance should be required and that both users and manufacturers should plan for this, now. The matter of tolerances may be a future subject for consideration by the Cable TV Industry Advisory Committee.

The other complaint about the frequency tolerance specification involves a situation like the following hypothetical case. Suppose a system is receiving channel 8 off the air and carrying it straight through the system to the subscribers' converter inputs unchanged in frequency. It also is receiving a UHF station and converting it to channel 7 for delivery to the subscriber converters. Now assume that because of instability in the head end equipment, the channel 7 signal drifts upward and overlaps the channel 8 signal as they appear at the input to the converter. The subscriber attempting to view channel 8 gets a lot of disturbance in his picture from channel 7. And he can't tune it out becuase the converter simply shifts both frequencies together. The converter adjustment permits either signal to be delivered to the subscriber terminal within tolerance, but neither can be delivered without interference. The required tolerance is not applicable to signals within the cable system. To protect the subscriber, the argument is made, we need an additional specification.

The additional specification already is in the rules, Sections 76.605(a)(9) and 76.605(a)(10). Either or both may apply. If the disturbance to channel 8 from channel 7, or vice versa, is great enough to exceed either specification, the cable operator is obligated to apply the appropriate correction. If he can clear the problem without correcting the channel frequencies within the system, that's his prerogative, but it seems obvious that the first thing he would do would be to get channel 7 back on frequency.

To sum it up, I think the best we can say about cable frequency tolerance is that, as experience indicates and as technology permits, it will be made more restrictive. The cable operator should plan on that.

Signal levels.

Section 76.605(a)(5) is a specification on the permissible variation in levels which may be delivered to subscribers. The most vigorous reaction to this specification comes from broadcasters. Some feel strongly that it is imperative that the Commission specify a maximum signal level, on the grounds that if too strong a signal is delivered by the system, overloading may occur in the subscriber's receiver, causing picture degradation. The Commission's approach recognized that we don't know what the maximum permissible signal should be--it varies from receiver to receiver and from channel to channel. What's more, there is disturbing evidence that the overload threshold may be substantially lower when the imput consists of several strong signals on adjacent channels than when the input is only a single strong signal. We simply do not know enough at this time about the effects of applying a dozen or two dozen strong adjacent channel signals to present day receivers to adopt a safe upper limit on visual signal level. The qualitative limit which the Commission adopted is preferable, I think, to an inflexible quantitative limit for which we have little authoritative measurement data to justify. The qualitative limit which the Commission adopted also gives the cable engineer a latitude in the design of his sytem which should help him cope effectively with the myriad individual circumstances he encounters in real life.

The provision in 76.605(a)(5) regarding the maintenance of signal level requires clarification. As adopted by the Commission, the rule reads, in part, "The visual signal level on each channel shall not vary more than 12 decibels overall..." The provision has not been thoroughly understood. I think it will be modified soon to read, "The visual signal level on each channel shall not vary more than 12 decibels within any 24-hour period..." The purpose of the requirement is to restrict the permissible variation caused by temperature fluctuations, amplifier instability, switching operations, or whatever, to no more than 12 dB over a day's operation.

Cable system radiation.

Section 76.605(a)(12) also may undergo some modification shortly. This is the provision restricting radiation from the cable system. The rule as adopted by the Commission fails to make clear a rather obvious qualification: radiation from the system is not amenable to measurement at subscriber terminals as are the other technical standards but should be measured by techniques outlined in a following section of the rules.

In this connection, radiation from the system also may provide an indication of leakage into the system. There have been several reports

recently of problems due to pick-up of land mobile signals in the 150-170 MHz band. Interference of this sort can be particularly difficult to find and eliminate unless the cable system is well shielded and grounded in an effective manner. The land mobile signals are intermittent or sporadic--on-again-gone-again---but they can cause no end of displeasure to your subscribers who may want to watch midband channels. It is strongly recommended that the cable operator inaugurate a frequent schedule for checking both for radiation from the system and leakage into the system.

Measurements and procedures.

The commission has adopted a rather lengthy rule for the cable operator's guidance with respect to measurement methods. The rule is not intended to restrict the cable operator to only those methods described in the text. It is aimed rather at illustrating techniques and procedures which probably will be accomplished with ease and acceptable accuracy. Other methods and variations upon the outlined methods may be acceptable. And, conversely, the mere use of a suggested technique will not assure the operator that **his** measurements will be found acceptable. The Commission will review the statements concerning the measurement technique and the resulting data, looking for evidence of technical competence, integrity, and accuracy. In making these measurements, the operator or his consultant must not ignore the opening statement of this section: "Measurements made to demonstrate conformity with the performance requirements set forth in Sections 76.601 and 76.605 shall be made under conditions which reflect system performance during normal operation..." Obviously, some system measurements cannot be made with the system under completely normal operations. It may be necessary to disconnect antennas, drop a channel, or remove a pilot tone in order to accomplish some measurements. However, steps should be taken to ensure that the rest of the system functions as normally as possible. The purpose of the language is to preclude making measurements which bear no real relationship to conditions of normal operations.

It is recognized that, in promulgating a group of technical standards and in launching the necessary enforcement effort the standards will entail, the Commission in a sense is pioneering in an area where regulation has not been applied before. A great deal of attention probably will be paid to reviewing the cable standards program and its progress and possibly some early readjustments of the rules will be made. Certainly, extension of the technical standards to cover other facets of cable operation is to be expected soon. I think that the cable operator should recognize and appreciate that all this effort is evidence of the high expectations which the government and the public have for cable communications.