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ADVISORY COMMITTEE ON ADVANCED TELEVISION SERVICE

IMPLEMENTATION SUBCOMMITTEE

Minutes of the Nineteenth Meeting

1. The nineteenth meeting of the Implementation Subcommittee convened at 10:45 a.m. on August 25, 1992, in the Commission Meeting Room at the Federal Communications Commission, 1919 M Street, N.W., Washington, D.C. and adjourned at 11:45 a.m.

2. The following Subcommittee members were present:

George Vradenburg III, Co-Chair
Brenda Fox, Vice Chair
Henry Baumann, Vice Chair
Charles Jackson, Chair, Working Party 1, Policy & Regulation
Craig Tanner, Co-Chair, Working Party 2, Transition Scenarios
S. Merrill Weiss, Vice Chair,
Working Party 2, Transition Scenarios

3. The designated federal employee attending was Gina Harrison, Staff Attorney, FCC Mass Media Bureau.

4. The minutes of the eighteenth meeting were adopted with one amendment.

5. Mr. Jackson reported that, since the last Subcommittee meeting, Working Party 1 has continued its review of the simulcasting issue, but that the group has not reached a consensus on the matter and may not attain a consensus in time to satisfy the deadline for the Implementation Subcommittee's submission to the Advisory Committee's Final Report. Chairman Vradenburg suggested that the Subcommittee might draft an interim summary on simulcasting to Advisory Committee Chairman Wiley, detailing the status of Working Party 1's efforts and including Chairman Vradenburg's comments. Chairman Vradenburg noted that a final decision has not been determined as to whether an interim progress summary on simulcasting would be an appropriate course of action. Both Chairman Vradenburg and Mr. Jackson stressed the importance of the Subcommittee continuing the process of moving towards a consensus. Regarding the issue of call signs for the ATV service, Working Party 1 has approached broadcast station owners for information on appropriate ATV call signs. Preliminary results of that inquiry favor allowing stations to keep their current call signs with an identifying suffix for the ATV facility.

6. Mr. Weiss reported on the activities of Working Party 2 (See the attached documents). He stated that the Working Party has completed and approved a summary of the responses received thus far to a survey of system proponents. (This summary is attached to these minutes.) Mr. Weiss added that several follow-up questions regarding: (1) peak-to-average power ratios;

(2) transmitter clipping; and (3) multiple transmitter operation, have since been posed to the proponents, and one response has been received to date. Based on the summary of these comments and other factors, Mr. Weiss stated that Working Party 2 has begun work on a comparative analysis of the proponent systems. Mr. Weiss stated that this would be a difficult document to produce, but will be of significant value in the system selection process and in the implementation process. This analysis will consider characteristics of system-specific equipment and the results of a survey taken of professional equipment manufacturers. Economic issues, such as consumer VCRs, will not be included in this analysis, but will be reviewed by Systems Subcommittee Working Party 3, Economic Assessment (SS/WP3). However, Working Party 2 will examine economic issues not under consideration by SS/WP3.

7. Mr. Weiss stated that Working Party 2 has concluded a survey of transmitter and antenna manufacturers, as a subset of its telephone survey of professional equipment manufacturers. This survey, according to Mr. Weiss, originated in response to doubts voiced about the capacity to produce transmitter and antenna equipment within the established ATV timeframe. Mr. Weiss said that the results of the survey indicate that transmitter power levels affect both transmitter and antenna production capacity and that all of the manufacturers polled plan to expand their production capacity to satisfy ATV equipment demand. Mr. Weiss summarized the findings, stating that if 1800 stations are assigned ATV channels (as predicted in the Commission's Further Notice of Proposed Rule Making), there will be a need during the three year window period for 600 transmitters per year, and that the survey reflects that this demand can be met. Mr. Weiss emphasized that the assumption is that the technology for producing radio frequency power for ATV broadcasting will be the same as that for NTSC broadcasting. The differences which do exist between ATV and NTSC radio frequency amplification are more engineering differences than differences requiring invention or research. Mr. Weiss indicated that unlike transmitter production, antenna production can be easily expanded by domestic manufacturers and through the use of imports.

8. Antenna manufacturers, as part of the survey described in paragraph 7, flagged one potential problem area regarding the scarcity of available, reliable crews capable of constructing large towers and/or installing antennas on them. He stated that in a three year period, crews can build or reinforce about 300 towers, and that during the three year ATV construction window period, about 450 to 900 stations will require tower work. Mr. Weiss further predicted that essentially all of the eligible applicants will need new antennas to broadcast ATV. Thus, Mr. Weiss stated that if 1800 eligible applicants seek ATV operation, there will be a need for installing 600 new antennas per year during the three year construction window, and there will be no way to match that surging need for tower work because of the limited crews available. Mr. Jackson questioned whether, as indicated in the Further Notice of Proposed Rule Making, 1800 eligible stations will be financially stable enough to operate ATV facilities and also need work on their tower to provide for ATV operation. Mr. Weiss indicated that if that figure proves inflated, the number of stations needing tower work will decline accordingly.

[Secretary's Note: Subsequent to the meeting, in considering Mr. Jackson's comments, IS/WP2 developed a revised report on its transmitter and antenna manufacturers survey. The revision considered the number of stations involved in the transition and requiring antenna installations to total 1,500. This put the number potentially requiring tower reinforcement or new towers at between 375 and 750, closer to but still above the three-year industry capacity of 300. The revised report was sent to all who attended the Implementation Subcommittee meeting within a week following the meeting.] Ms. Harrison noted that although eligible stations will be allowed three years to construct ATV facilities, all stations will not be constructing in the same three year period. She further stated that eligible applicants will be allowed three years to construct ATV facilities and an additional two years to apply for an ATV channel. Mr. Weiss commented that no equipment will likely be available in the first two years after adoption of an ATV system. Thus, Mr. Weiss believes it likely that the bulk of eligible applicants will be converting during the three year construction window. Chairman Vradenburg asked if the increased demand for tower work might not force an expansion in crews and in construction and fortifying towers. Mr. Weiss acknowledged that there might be a small expansion in the number of crews, but opined that if there were any way to improve the technology of building and modifying towers, it would be in use today. Finally, in this regard, Mr. Weiss stressed the importance of submitting orders early to manufacturers so that the work can be planned and completed within the three-year window for construction.

9. Mr. Weiss detailed a survey of software users and providers which Working Party 2 conducted to determine the expected availability of ATV programming. (Report attached to these minutes.) Also, the Working Party is assembling a new survey of professional equipment manufacturers, designed to pose questions to individual manufacturers geared to their particular expertise. Mr. Weiss indicated that, although professional equipment manufacturers were surveyed, with mixed results, early in the ATV process, far more is now known about the individual proponent systems. He said that Working Party 2 will be concentrating on the timing of the equipment availability and the ease or difficulty of implementing ATV facilities. Mr. Weiss reported that the survey will require some assumption about the likely production standard. He identified as a critical issue under review by the Working Party as part of this survey, what happens in the transitional television station or equivalent cable head-end that allows it to accept a signal from a satellite or a terrestrial common carrier and send it to the viewers. Mr. Weiss said that it is particularly critical in this regard to know how such signals are compressed and to understand the differences between the prospective systems. Mr. Weiss talked about the importance of switchers (equipment used to switch from program received from an incoming program stream to commercial streams and back to the programming) in that regard.

10. Mr. Weiss discussed updated information on the local area groups, now located in 15 cities across the country. These groups were established to provide the Working Party with market-related information, and to get a head start on ATV implementation in those cities which might be particularly

susceptible to problems in implementing ATV. He next spoke about a distributed transmission concept. This is an idea, submitted by the Massachusetts Institute of Technology some time ago, under consideration by Working Party 2. The concept is similar to cellular telephone, and involves multiple transmitters serving smaller areas than a single transmitter, serving an entire area. The multiple transmitters can use lower power and lower tower height, and would all operate on a single frequency channel. Working Party 2 held discussions on this matter on June 24, 1992. The distributed transmission concept would provide solutions to; (1) the short spacing of co-channel stations; and (2) limitations in capacity at the main transmitter facility. However, the drawbacks to the concept include the high cost of installing, operating, and maintaining multiple transmitter sites compared to the lower costs involved with a single site, the characteristics required in transmission systems and in the receiver, and the possibility of placing an unfair economic burden on all receivers for the sake of a few situations. Working Party 2 will be examining these possible weaknesses, and will work closely with a Systems Subcommittee Working Party 1, ATS Systems Analysis, Task Force assigned to prepare a technical analysis of the matter, and with Systems Subcommittee Working Party 2, System Evaluation and Testing, which will be identifying the operational parameters to be studied. (The attached report provides greater detail on the issue of the distributed transmission concept and the two-step approach the Working Party will use in reviewing this matter.)

11. Mr. Weiss said that, although a Specialist Group connected with the Advanced Television Systems Committee will be addressing the question of system documentation, Working Party 2 continued to be concerned with the matter and has expressed its concerns in a letter to the Specialist Group.

12. Finally, Mr. Weiss outlined the continuing activities of Working Party 2, such as preparing a report to Systems Subcommittee Working Party 4, System Standard (SS/WP4) for incorporation in the Advisory Committee's Final Report. Chairman Vradenburg asked that both Working Party 1 and Working Party 2 distribute to the Implementation Subcommittee members any reports which are submitted to SS/WP4.

13. Chairman Vradenburg announced that the next Implementation Subcommittee meeting will be on November 24, 1992, at 10:00 a.m. in the Commission Meeting Room and will concern the Final Report of the Subcommittee.

Submitted: _____
Gina Harrison

Approved: _____
George Vradenburg III

ATV Advisory Committee

MEETING: Implementation Subcommittee - August 25, 1992

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ATV Advisory Committee

MEETING: Implementation Subcommittee - August 25, 1992

ATTENDEES

Name	Representing	Phone Number
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Report to Implementation Subcommittee

from Working Party 2 on Transition Scenarios

August 25, 1992

1. Summary of Proponent Responses to IS/WP-2
2. Comparative Analysis of System Implementation
3. Survey of Transmitter & Antenna Manufacturers
4. Survey of Software Users and Providers
5. Survey of Professional Equipment Manufacturers
6. Update on Local Area Groups
7. Distributed Transmission Concept
8. Recommendations to ATSC Specialist Group
9. Continuing IS/WP-2 Activities

Summary of Proponent Responses to IS/WP-2

- Questions for Proponents
  - Analysis of initial answers during multiple conference calls
- Follow-up Questions for Proponents
  - Last written responses received for meeting of 6/24/92
- Summary tabulation of responses prepared
  - Proponents provided opportunity for review of summaries
  - Document approved at last IS/WP-2 meeting
  - Copies for distribution to Implementation Subcommittee
- Additional Questions for Proponents developed
  - Peak-to-average power ratios
  - Transmitter clipping
  - Multiple transmitter operation
- Responses requested for IS/WP-2 meeting of 6/24/92
  - Only one response received to date

Comparative Analysis of System Implementation

- IS/WP-2 developing document comparing implementation characteristics of systems
  - Responses to questions
  - PERT/Gantt charts, lists of assumptions
  - Analyses of ATV station block diagrams
  - Proponent presentations
- Characteristics of system-specific equipment
  - Master control/commercial insertion switchers
  - VTRs for commercial/promo insertion
  - ATV/NTSC multiplexers for STLs
- Results of survey of Professional Equipment Manufacturers
  - Time for equipment availability
  - Differences related to production formats
  - Differences related to compression methods
  - Television stations & cable headends

Survey of Transmitter & Antenna Manufacturers

- Concern expressed that production capacity is insufficient
- Survey conducted
  - Telephone interviews – half-hour to an hour each
  - Six (of six) major transmitter manufacturers
  - Six (of eight) major antenna manufacturers
- Transmitter production capacity
  - Power level affects production capacity
  - Current capacity – 250 @ 30 kW, 175 @ >30 kW, >300 @ 10 kW (not additive)
  - ATV capacity after expansion – 550 @ 30 kW, 700 @ 10 kW
  - ATV capacity with "surge" – 750 @ 30 kW
- Antenna production capacity
  - Transmitter power level affects production capacity
  - Current capacity – 250 @ 30 kW input, 350 @ <30 kW (not additive)
  - ATV capacity after expansion – 475 @ 30 kW, 600 @ <30 kW
  - Domestic capacity can be supplemented with imports – mostly panels

Survey of Transmitter & Antenna Manufacturers – *cont'd.*

- Antenna installation/tower construction may be serious limitation
  - Crews required to install towers in very short supply
  - Tower reinforcement takes same crews and time as new construction
  - Takes years to grow new crews because of dangers involved
- Tower construction/reinforcement capacity
  - Same crews serve television broadcast & other services
  - Weather/seasons limit productive work time
  - Approx. 300 towers in 3 years if all time given to TV broadcast
  - Estimates of 450-900 stations requiring tower work
- Antenna installation capacity
  - Different crews from tower structural, but split among same clients
  - Approx. 350 antennas/year with 50-50 split of time with other services
  - Must achieve 600 antennas/year to meet need if all stations in 3 year window
- Lead times and work flow critical
  - Vendors need time to order parts, build capacity – up to 2 yr xmtr peak lead time
  - Fixed capacity for tower/antenna work requires spread over full 3 yr period

Survey of Software Users and Providers

- Request from IS to determine expected availability of programming
  - Users' expectations of supply
  - Producers'/distributors' expectations of demand
  - Plans for production and distribution
- Decision by IS/WP-2 to conduct mini-survey as start
  - Avoid full, complex, time consuming survey, if possible
  - Identify issues to be included in larger survey, if needed
  - Hope for consistency of responses
- Survey conducted
  - Dozen questions asked
    - First HDTV programming to be offered
    - Production formats to be used
    - Timing of initial program production/distribution, equipment installations
- 10 responses obtained
  - 5 Broadcast/cable networks
  - 4 Studios/distributors
  - 1 Production/post production house

Survey of Software Users and Providers – *cont'd.*

- Programming availability
  - General concensus – available when needed
  - Film production first – prime time & movies
  - Sports likely first video production
  - Communications between companies not great
  - Strong expectations of availability nonetheless
- Production technology
  - Various levels possible – HDTV to NTSC
  - Film source generally seen going to full HDTV
  - Sports generally seen going to full HDTV
  - Other kinds of programs likely to vary in what is used
  - Depends on factors like cost, timeliness, longevity of program
  - General agreement with concept of lower quality approach to make economical
  - Appropriate for some uses & users
  - Not all in sample will use lower performance systems

Survey of Professional Equipment Manufacturers

- Professional equipment manufacturers surveyed once at beginning of process
  - Survey based solely on different production standards
  - Only information available at the time
  - Apparent that many answers were given to influence the outcome of the process
  - Results of the initial survey were discarded as inconclusive
- Professional equipment manufacturers to be surveyed once again
  - Far more known about the system proprosals
  - Fewer options for underlying raster specifications
  - Opportunities for other forms of compression must be explored
  - IS/WP-2 to concentrate on timing of availability of equipment
  - Will likely work in cooperation with SS/WP-3 handling the economic issues
- Prerequisite analysis of Proponent responses has begun
  - Will help identify nature of equipment that will be required
  - Will permit differentiation of systems
  - Survey design to be based upon responses
- Survey design to target key equipment items
  - Manufacturers specific to key items to be surveyed with limits

Update on Local Area Groups

- Local Area Groups originally established in five major cities
- Two-fold purpose
  - Gain implementation information for IS/WP-2 from potential problem cities
  - Instigate head start for broadcasters in some of the major markets
- Local Area Groups needed more information to proceed
- Most of needed information now available
  - Local Area Groups asked to look at their situations again and report
  - Some have met already, others have meetings planned
- Decision to add more cities
  - Coordinated with Broadcaster Caucus — no conflict
  - Combination of top & mid markets
- Cities now total 15
  - Original group + Providence Journal cities & Philadelphia

Distributed Transmission Concept

- Idea discussed informally in industry for some time
  - Introduced formally to ACATS process by MIT submission to SS/WP-1
  - IS/WP-2 decided to look at implications for implementation (5/26/92)
  - Further discussions and plan for examination (6/24/92)
- Concept similar to cellular television
  - Multiple transmitters serving smaller areas than single transmitter
  - Lower power, lower height
  - Unlike true cellular systems, all on a single frequency/channel
- Potential solution to two problems
  - Short spacing of co-channel stations
  - Limitations in capacity at main transmitter facility
- Potential operational & technical obstacles to be examined
  - Cost of installation/operation/maintenance of multiple sites *vs.* single
  - Characteristics required in transmission system
  - Characteristics required in receiver
  - Possibility to burden all receivers for sake of a few situations

Distributed Transmission Concept - *cont'd.*

- Two-step examination devised
  - Develop broadcaster system requirements to make technique practical
    - Small group assigned to develop needs/systems
    - Input to be sought from existing Local Area Groups
  - Seek Proponent input on characteristics of their systems
- Two approaches identified
  - Large area, few transmitters
  - Small area, many transmitters
- Large area approach determined only plausible method for full coverage area
  - Spreadsheet analysis of costs
  - Capital nearly same as single transmitter
  - Operating costs much higher if dark fiber is required
- Small area approach could be okay for fill-ins
- Technical analysis requested of SS/WP-1 Analysis Task Force
  - IS/WP-2 to identify operational parameters to be studied

Recommendations to ATSC Specialist Group

- IS/WP-2 previously expressed concerns re:
  - Responsibilities of selected proponent
  - Time for documentation process
- Responsibilities of selected proponent being handled through Chairman Wiley's office
  - IS/WP-2 retains interest in matter, will comment if it seems helpful
- Documentation process being addressed by ATSC specialist group
  - IS/WP-2 remains concerned with issue
  - Gating item for entire implementation
  - On Critical Path in all scenarios
  - Must be kept to minimum in any way possible
  - Assumed in IS/WP-2 studies to be completed at time of NPRM
- IS/WP-2 assembled concerns in letter to ATSC Specialist Group
  - Distills previous discussions
  - Carries concerns to organization likely to conduct documentation process

Continuing IS/WP-2 Activities

- Integration of PERT/Gantt/Assumptions into single Implementation program
  - Currently done by industry segment
  - Plan is to provide unified structure for overall Implementation
  - Will work out inter-industry interactions
- Comparative analysis of system implementations
  - Interaction with proponents required
- Preparation of Report to SS/WP-4
  - Detailed description of document provided by SS/WP-4
    - One page summary (to be included in ACATS Final Report)
    - Approx. 25-page backup detail document as part of Appendix
    - Other documentation as necessary for communication to FCC
- Work on Report to SS/WP-4 already begun
  - Outline prepared of IS/WP-2 Fifth Interim Report
  - Will serve as starting point for preparation of Final Report
  - First draft of Executive Summary written
  - First draft of backup detail document now beginning

FCC Advisory Committee on Advanced Television Service
Implementation Subcommittee Working Party 2 on Transition Scenarios

Report on Survey of Transmitter & Antenna Manufacturers

Some concern has been expressed by certain parties that the move to HDTV operation by broadcasters may be impeded by a lack of sufficient capacity for the manufacture of transmitters and antennas. In particular, question has been raised about the ability of manufacturers to supply the required numbers of transmitters and antennas within the total of five years the FCC has proposed to give to broadcasters in which to apply for and build facilities while retaining their preferential assignment of channels for ATV operation.

Because any serious shortfall of capacity would have significant implications for the implementation of ATV, IS/WP-2 has undertaken a survey of transmitter and antenna manufacturers to learn of their individual production capacities and thereby to guage the capacity of the industry. The results of the survey are reported herein. In the process of conducting the survey, a number of additional, related areas came to light, and they are reported also.

The outcome of the survey is that, with appropriate planning on the part of broadcasters and the placement of orders early enough during the application/construction window, there is sufficient capacity within the transmitter/antenna manufacturing industry to meet the need. There may, however, be limitations on the numbers of towers that can be built and antennas that can be installed that will impede the installation of ATV. These results are discussed in detail in this document.

The Survey

The survey was conducted during the months of July and August, 1992, through a series of telephone interviews with the managers of companies that build transmitters and antennas for broadcasting applications. Since there is a small number of companies in each of these categories, the total number of telephone contacts was also small. Six of six major transmitter manufacturers were interviewed; six of eight major antenna manufacturers were interviewed.

The survey was conducted by a single member of IS/WP-2 knowledgeable in the area of broadcast plants as well as in Advanced Television. The conversations with each manufacturer lasted from half an hour to an hour. Explored during the discussions were the numbers of units that are now produced by each company, the extent to which each could increase its production capacity in a reasonable manner, the relationship between power levels and production capacity, the technology expected to be used, tradeoffs in the technology, and any capacity limitations in related areas that might impact ATV implementation.

Transmitters

The capacity of the industry to build transmitters depends upon the power level involved. At the 30 kW level, current (NTSC) production capacity is approximately 250 transmitters per year. At higher power levels, the number reduces to about 175. At the 10 kW level, it increases to almost 300 transmitters per year. Actual sales are considerably lower than these numbers.

When considering the move to ATV, a number of assumptions are made by the manufacturers. First, it is assumed that the technology required in transmitters is comparable to that needed for NTSC. There will be no aural transmitters and no notch diplexers for combining the visual and aural transmitter outputs. The frequency response, group delay, and linearity characteristics required will be similar to those achieved currently. Second, it is assumed that the transmitter power levels required for ATV will be in the region of 30 kW. Many installations will require lower power, and few will require higher power. Third, it is assumed that the vast majority of transmitters required will be UHF.

Additional factors involved in the planning by the transmitter manufacturers derive from their assessments of the marketplace and the needs of their customers, the broadcasters. There is some expectation that not all broadcasters will choose to implement ATV, with certain estimates running as high as half of stations deciding not to proceed with ATV. There is also an expectation that most stations will build single-ended, as opposed to redundant, transmitter plants during the initial phases of implementation, thereby keeping the number of transmitters required at or below the current number of stations.

If no efforts were made to increase capacity, the industry could deliver ATV transmitters at the rate the current capacity can support, i.e. 175-300 transmitters per year depending upon power levels. But manufacturers reported planning increased capacity for the period when high volume production will be needed. To some extent, such planning calls for the construction of additional facilities. To a much greater extent, it involves the addition of a second shift for the period of heavy production. No shortage of the skilled personnel needed to implement either approach was foreseen.

With the increases planned, industry capacity to build transmitters rises to approximately 550 per year on a sustainable basis at the 30 kW level. It is possible to surge past this to a level of about 750 per year, but this was considered by the manufacturers as practical only for a fairly short time. At the 10 kW level, the sustainable capacity is on the order of 700 transmitters per year. The aggregate capacity divides over the various power levels; the capacities for 10 and 30 kW cannot be added. At power levels in the region from 1-5 kW, additional capacity does become available that can be added to the quantities producible at the higher power levels.

None of the manufacturers foresaw any shortage of components for the construction of transmitters. Items specifically explored included the tubes and semiconductors for the radio frequency amplifiers in transmitters and the high power components used in power supplies. There is currently some question whether solid state devices will be available in time to support high power at UHF. Once developed technologically, semiconductors are available in larger quantities and from multiple sources, so that their supply is assured. The favored tubes for high power UHF are currently available from only one source, but two other companies are expected

to have versions in time to meet the demand. All other components are available from multiple sources, and manufacturers maintain relationships to assure the meeting of their needs.

An important consideration in turning the gross production capacity of the industry into transmitters delivered during the required interval is the early planning and placing of orders by broadcasters. Some of the manufacturers expected lead times for transmitters to extend to two years from the current four months. This means that the last of the transmitters to be installed within the five year window must be ordered about nine months into the three-year construction period, allowing on the order of three months for installation.

It was very clear from manufacturers' comments that the potential capacity can only develop and production requirements be met if they are given enough advance warning of the need. That warning will only be in the form of orders from broadcasters. In turn, it will allow them to obtain the components they need in a timely and economical manner, and it will permit them to be prepared with the facilities, equipment, and staffing necessary to build the volume of transmitters projected to be required.

Antennas

Just as with transmitters, the capacity of the industry to build antennas depends upon the power levels involved. In this case, it is the transmitter power level that is determining of manufacturing capacity, with 30 kW into the antenna once again appearing to be a break point. The current capacity of the industry to manufacture antennas is almost 250 per year at power levels of 30 kW and up. Below that level, capacity jumps to over 350 per year. Actual sales are currently well below capacity.

Various factors are cited by the manufacturers in estimating their production capacities. Consideration must be given to whether antennas are top mount, side mount, or wrap-around. It is generally agreed that wrap-around, or panel, antennas are easier to manufacture than top or side mount versions. Conversely, installation of panel antennas takes about twice as long as for top or side mount units. There is a large international capacity for manufacture of panel antennas that is only partially represented in the capacity numbers quoted in the preceding paragraph. That international capacity could quickly and easily be brought to bear on the needs of U.S. broadcasters.

The number of antennas required will be affected by the number of locations where broadcasters work together to build common facilities and use common antennas. Panel antennas in particular are useful across a broad part of the UHF spectrum. Their use will allow multiple stations to share antennas. The number of stations possible per such antenna will be determined as much or more by the transmission line design and any required power combiners and splitters as by the antenna itself. Some manufacturers expect broadcasters to start out with individual antennas on their own towers at lower than permitted power levels, then to switch to common facilities and shared antennas later while increasing power to the maximum authorized.

There is disagreement among the manufacturers regarding the impact of the relationship between peak and average power. Some feel that the transmission lines and power combiners and splitters will be limited only by the heating effects of the average power levels. They believe that the

peaks will be of such short durations and the relative peak voltage capacity of the components so great that peak power will not be a design factor. Others believe that peak power will have a significant impact on voltage breakdown requirements, pointing out that voltage breakdown leads to an avalanche effect that can destroy equipment. Of considerable importance is the derating required in multiple station installations to account for the possibility that all stations might on occasion reach their peak powers simultaneously, thereby creating much higher voltages than normally appear in the system.

Yet another area requiring attention is the choice of coaxial or waveguide transmission lines. The impacts of this selection are on wind loading, power handling capacity *vs.* frequency, transmission line bandwidth, and transmission line losses. These issues become of increasing significance in multi-station installations.

An assumption made by all the antenna manufacturers is that far field antenna range testing will not be required for the antennas under consideration. Instead the antennas will be tested in the field after installation. Antenna range testing of all antennas would reduce capacity dramatically. The rationale for the assumption by the manufacturers is that they all use sophisticated computer models to design their products, and the agreement between the results in the field and the computer predictions of performance is now very good.

For production of antennas for the transition to ATV, manufacturers can increase their capacities, some by a factor of two. This results in a domestic industry-wide capability of about 475 antennas per year at the 30 kW power level and above. Below 30 kW, capacity can be increased to around 600 units per year. These levels can be supplemented with imported antennas, from other manufacturers, as needed by the broadcast industry.

Other Considerations

A number of antenna manufacturers, in particular, were concerned about the ability to install the numbers of antennas that will be required. There are a number of factors that contribute to their concerns. These have to do with two principal areas: the number of crews available for such installations and the limitations imposed by weather and the seasons on the time during which installations can be accomplished.

There are three companies that manufacture towers for broadcast use (1,000 feet and up). There are about a half dozen companies that can erect such towers up to about the 1,500 foot point. Beyond 1,500 feet, there are three (of the six) companies capable of the task. The same companies that erect towers are needed to make any structural changes such as reinforcements that are required. There are about twenty companies that can handle change-outs and new installations of antennas and transmission lines only, without involving structural work on the tower. Some of these companies have multiple crews.

One crew can put up a 1,000 foot tower in about three weeks. 2,000 feet take nearly double that time. With travel, preparation, and overhead time, a crew can actually erect one 1,000 foot tower about every six weeks or a 2,000 foot tower about every nine weeks. Installation of antennas takes additional time. To install a top mount antenna with its transmission line takes

about one week; a wrap-around panel antenna takes about two weeks for a crew to install. Crew sizes assumed include eight personnel.

It takes nearly as long to reinforce a tower as to build one, and the same riggers that build them are required to do the work. Thus in calculating the industry capacity to erect towers, the number to be reinforced must be figured into the equation. It must also be noted that the crews and companies discussed here construct and install a much broader range of facilities than just broadcast towers and antennas. Thus they are only available for television broadcast activities for some proportion of their time, the remainder being devoted to microwave, cellular telephone, radio broadcast, and similar operations. The same limited number of crews must service all of these needs. It is not possible to rapidly expand the number of tower/antenna crews because of the years of experience required to assure the safety of both the installers and those on the ground together with the reliability of the installation.

Another factor that enters into the productivity that can be expected in tower/antenna installations is the weather. In some areas of the country, there is cold and snow during lengthy parts of the year. In other places, heavy rains can stop work for large proportions of the time. These situations must be taken into account when figuring the number of installations that can be accomplished during the construction period.

For purposes of understanding the influence of all of these factors on the numbers of antennas that can be installed during the three year window, a number of assumptions will be made. Based on these assumptions, the capacity to install towers and antennas can be calculated. The assumptions are based upon a reasonable proportioning of the factors involved, given knowledge of the balancing elements of those factors. The reader is encouraged to apply other proportions in carrying out a similar analysis. The three year construction window will be used based upon the assumption that not many stations will be ready and able to begin construction during the two year application period that precedes it.

Other assumptions are that the construction crews will devote one-half their time to television broadcast ATV installations, that the weather will preclude activity for twenty per cent of the time, and that twenty-five per cent of stations will require new towers or reinforcement of their current towers. (All of these assumptions have been selected at the end of estimated ranges that lead to higher estimates of production capacity.) Also assumed will be that sixty per cent of towers are 1,000 feet tall, thirty per cent are 1,500 feet tall, and ten per cent are 2,000 feet tall; half of towers requiring structural work will be assumed to require new construction and half reinforcement (equal times). An estimate of twenty-five crews for antenna installations only, ten crews for towers up to 1,500 feet, and five crews for towers to 2,000 feet will be used. Antennas will be assumed to be half top or side mount and half wrap-around panels.

Using all the preceding assumptions, in a year, twelve towers up to 2,000 feet can be built or reinforced, thirty-five additional towers up to 1,000 feet can be built or reinforced, and 347 antennas can be installed. Installation of the antennas is assumed to be accomplished with different crews than build or reinforce the towers in order to maintain maximum capacity for tower construction. The number of antennas installed in a year can probably be increased by shifting the percentage of time the crews devote to television broadcast *vs.* other clients. If this number can be moved up to 600 per year and installations can be uniformly spread over the

three-year period, the need can be met. It should be noted that provision is made in this analysis only for the installation of new antennas; any rearrangement of existing equipment will necessarily reduce the number of antennas that can be installed by increasing the work and time required.

Not so easy of solution is the shortfall in tower installation and reinforcement crews. Even if they were to devote full time to television broadcast installations, there is capacity for building or reinforcing only twenty-four towers up to 2,000 feet and seventy towers up to 1,000 feet each year. Since estimates are that twenty-five to fifty per cent of stations will require either a new tower or tower reinforcement to accommodate ATV, there is a significant shortfall in capacity. In the three year construction window, a total of about 300 towers can be built or reinforced if the crews devote full time to broadcast television and the work is spread uniformly, while between 450 and 900 will require work of this sort. Even if the calculations of construction/reinforcement capability are off by a factor of two, clearly, some stations are likely not be able to get their tower and antenna work done within the three year window. IS/WP-2 believes that the Commission can expect to receive requests for extensions of time to construct that will result in these instances.

In summary, it should be noted that, under the assumptions made that broadcasters place their orders in a timely manner, the capacity to supply transmitters and antennas is significantly greater than the capacity for installation of towers and antennas. Readers of this report are encouraged to conduct their own independent evaluation of the assumptions made. Changes in only a few of these assumptions could have a major impact on the conclusions reached herein.