ROUTING AND TRANSMITTAL SLIP

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

ORIGINAL FILE

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.