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IS/WP2-0242
23 SEP 92

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**ADVISORY COMMITTEE ON ADVANCED TELEVISIONS SERVICE
IMPLEMENTATION SUBCOMMITTEE
WORKING PARTY 2 - TRANSITION SCENARIOS
MINUTES OF FORTY-THIRD MEETING 9/15/92**

87-268

1. The meeting was called to order by Vice Chairman, Merrill Weiss, at 10:15 A.M. at NCTA in Washington, DC.
2. The agenda was adopted as issued.
3. The minutes of the 8/20/92 meeting were approved with the following change:

Page 2, item 7 - change document number to IS/WP2-0229.

Page 3, line 3 - delete redundant "of".
4. A list of attendees is attached.
5. Review of Action Items.
 - a) Complete.
 - b) Will not be pursued because Proponent systems have been or are being tested. Jim Kutzner suggested that a short letter be sent to Proponents informing them of the adaptive signal coding proposal for their future consideration. Merrill Weiss will follow up on this suggestion.
 - c) Progress since last meeting. Carry as action item.
 - d) Complete.
 - e) Complete.
 - f) Complete.
 - g) Complete.
 - h) Complete.
 - i) Complete.

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6. Implementation Subcommittee Report.

Merrill Weiss distributed copies of the report he gave at the Implementation Subcommittee Meeting. IS/WP2-0237. Merrill stated that the final antenna/transmitter survey document was modified to change the number of TV stations from 1800 to 1500 based upon discussion at the IS meeting. The 1800 stations used in the original document included unbuilt public stations. A follow-up letter was sent to Implementation Subcommittee attendees clarifying this issue. IS/WP2-0238. An updated survey document was also attached.

Jim Kutzner noted that the number of stations identified in the survey document did not include low power stations. Merrill Weiss volunteered to draft a supplement to the survey document discussing this issue.

7. Final Report preparation.

Jim Kutzner provided a draft of the final report for the Working Party's review. This draft was a working document only and will not be part of the IS/WP2 public record. Much of the draft was taken from the IS/WP2 5th Interim Report with inclusion of work which has taken place since that time. Jim reviewed the draft for the Working Party and a discussion took place on those areas of the draft which needed further work. It was agreed that Working Party members would individually review the document and provide assistance in rewriting the next draft. A series of conference calls were scheduled at 9:00 A.M. EST on the following dates to further develop the final report: October 10th, 21st, 28th and November 4th, 11th, and 18th.

8. Software Survey.

Results of the software survey were presented at the August 25 Implementation Subcommittee Meeting. This document, IS/WP2-0229, was included with the minutes of the 8/15 IS/WP2 minutes.

9. Local Area Groups.

Dave Folsom reported that no additional information has been received from the new Local Area Groups, but information is expected within the next two weeks. A leader for the Dallas/Ft. Worth Group is still being sought. A short discussion ensued on how to maintain Local Area Group momentum after the work of IS/WP2 is completed.

10. Distributed Transmission Study.

Merrill Weiss stated that he has provided additional information on the distributed transmission proposal to Birney Dayton, SS/WP1 Chairman, for his groups technical analysis. SS/WP1 was asked to provide an analysis prior to the October 14 IS/WP2 meeting.

Jeff Krauss submitted a letter to Merrill Weiss with estimated costs of providing dark fiber service. IS/WP2-0239.

11. ATV Standards Documentation.

Attached is the letter from Craig Tanner to ATSC T3/S1 Chairman Lynn Claudy summarizing discussions at recent IS/WP2 meetings concerning the importance of timely documentation of the ATV standard. IS/WP2-0240.

12. Professional Equipment Survey.

Dave Folsom distributed a draft of a professional equipment manufacturer survey letter for the Working Party's review. Considerable discussion took place on the format and exact wording to be used in the survey. It was decided that the ATV TV station block diagram and description will be included with the survey letter. A working group consisting of Dave Folsom, Merrill Weiss and Dave Chilsom will finalize the survey document with a target of issuing it within two weeks. Dave Folsom also provided a list of professional equipment manufacturers to whom the survey will be sent. IS/WP2-0241. A brief discussion took place on the use of non-traditional professional equipment manufacturers as suppliers of ATV equipment. While it was agreed that this was likely to occur, it was also concluded that it would be very difficult at this time to forecast the identity of these potential suppliers.

13. Comparative Analysis of Proponent Systems.

Merrill Weiss presented for discussion a partially completed draft document of a comparative analysis of Proponent systems. Jeff Krauss objected to the wording in several sections of the document. After some discussion, it was decided that Merrill would complete the document and revise as agreed upon during the meeting.

14. Release of ATTC Peak Power Data.

Craig Tanner reported that the Advisory Committee has authorized the early release, for IS/WP2 use, of ATTC data on Proponent peak power requirements.

15. Agenda for Next Meeting.

The agenda for the next October 14 meeting was prepared and will be mailed with the minutes of this meeting.

16. Summary of Action Items.

- a) Complete draft of comparative analysis of proponent responses. - Merrill Weiss
- b) Send letter to Proponents summarizing adaptive coding proposal. - Merrill Weiss
- c) Prepare addendum on LPTV for Antenna/Transmitter survey. - Merrill Weiss
- d) Finalize and mail Professional Equipment Manufacturers survey. - Merrill Weiss, Dave Folsom, Dave Chilson

17. The next meeting is scheduled as follows:

Wednesday, October 14, 1992
10:00 A.M.
PBS
Conference Room 2A
1320 Braddock Place
Alexandria, VA

A meeting has also been scheduled for November 19, 1992.

18. The meeting was adjourned at 3:30 P.M.

TRANSITION SCENARIOS

WP-2

September 15, 1992

NAME	COMPANY	ADDRESS	PHONE
LARRY COCHRAN	THOMSON CONSUMER ELEC.	600 N. SHERMAN DR INDPLS, IND 46201	317-231-4226 (FAX) 317-267-5946
CRAIG TANNER	CABLE TELEVISION LABORATORIES	1050 WALNUT ST, SUITE 500 BOULDER, CO 80302	303-939-8500 TEL. 303-939-9189 FAX
Dieter Scherer	Hewlett & Packard	1501 Post Mill Rd Mailstop 5M	(415) 857-3595
WAYNE BUEHL	ZENITH	1500 MILWAUKEE AVE GLENVIEW, IL 60025	TEL: 708 391 8550 FAX: 708 391 8555
DAVE FOLSON	WCNC-TV PROVIDENCE JOURNAL	1001 WOODBRIDGE CTR DR CARRVILLE N.C. 28226-1901	704-329-3632 704-357-4980
James Kutzner	PBS	1320 Braddock Place Alexandria VA 22314	P: 703 739-5473 F: 703 739-8938
David Felland	MATC/WMUS/WMUT	1036 N. 8th St. Milwaukee, WI 53233	Voice: (414) 271-1036 FAX: (414) 225-1895
S. Merrill Weiss	Consultant	25 Mulberry Lane Edison, NJ 08820-2908	(908) 906-0907 Phone & FAX
JOE WIDOFF	ATTC	1330 BRADDOCK R. #200 ALEXANDRIA, VA 22314	(703) 139-3850 / (703) 739-9230 (FAX)
JEFF KRAUSS	CONSULTANT/G.F.	17 W. JEFFERSON ST #106 ROCKVILLE, MD 20850	301-309-3703 / 301-309-9323 fax
CHUCK WILK	CORPORATION FOR PUBLIC BROADCASTING	901 E ST., NW WASHINGTON, DC 20004	(202)-879-9673 / (202)-783-1019 FAX
DAVID CHILSON	ABC-TV	47 WEST 66ST NEW YORK, NY 10023	212-456-3663 / FAX - 3852

FCC ADVISORY COMMITTEE ON ADVANCED TELEVISION SERVICE
WORKING PARTY ON TRANSITION SCENARIOS
(WP2)

Tuesday, September 15, 1992
10:00 A.M.
NAB
6th Floor Conference Room
1771 N Street NW
Washington, DC

AGENDA

1. Adoption of Agenda.
2. Approval of 8/20/92 Minutes.
3. Review of Action Items.
4. Implementation Subcommittee Report.
5. Final Report Preparation.
6. Software Survey.
7. Local Area Group Update.
8. Distributed Transmission Study.
9. Professional Equipment Survey.
10. Comparative Analysis of Systems.
11. New Business.
12. Conclusions and Action Items.
13. Agenda for Next Meeting.
14. Next Meeting.

15 SEPT 92

**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 proposals
 - 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**

IS/WP2-0238
15 SEPT 92

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

To: Participants in Implementation Subcommittee Meeting of August 25, 1992

From: Merrill Weiss

Date: September 1, 1992

Re: Update of Report on Survey of Transmitter & Antenna Manufacturers

At the Implementation Subcommittee meeting of August 25, 1992, a report was presented on the survey conducted by IS/WP-2 of transmitter and antenna manufacturers. During the discussion, it became apparent that the number of television stations used for some of the calculations might not be as conservatively derived as the remainder of the values. The number of stations was based on the number of allotments listed in the recent Further Notice of Proposed Rulemaking from the Commission.

A more conservative value for the number of stations is the total of those currently on the air plus some proportion of the Construction Permits already issued. There are 1500 stations now on the air and 191 CPs issued. Thus a better number for the number of stations that are likely to be on the air during the transition period is probably 1600 (rather than 1800 as originally included in the report). Since some will be newly constructed, a somewhat lower number will actually require tower work. Thus the calculations in the report may be reasonably based upon 1500 stations.

Another issue raised during the discussion is the number of stations that share a tower. This will reduce the number of towers that must be reinforced and possibly the number that must be built. Data on this is not included in the studies undertaken by IS/WP-2. While the significance of this factor is not known, since the arrangements that stations will make with each other for ATV operations is not known and may not be the same as for NTSC operations, it will tend to reduce the total number of towers that must be built or reinforced.

For the reasons given above, the report has been slightly revised in its final section to reflect a smaller number of stations requiring tower construction or reinforcement. A copy of the revised report is attached. You are asked to substitute this version for the one you received at the Implementation Subcommittee meeting. The new one will become the official report of the Working Party on the matter.

IS/WP2-0239
15 SEPT 92

JEFFREY A. KRAUSS, PH.D.
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SUITE 106
ROCKVILLE, MD 20850

TEL: 301-309-3703
FAX: 301-309-9323

MEMORANDUM

TO: Merrill Weiss, IS/WP2

FROM: Jeffrey Krauss

SUBJECT: Cost of Dark Fiber Service

DATE: September 15, 1992

In work submitted to IS/WP2 several months ago to estimate the cost of distributed transmission of ATV, the major operating cost was the lease cost of dark fiber. That study used a cost of \$350 per mile per month.

The attached FCC decision (Memorandum Opinion and Order in Docket No. 88-136, released July 19, 1991, 6 FCC Rcd 4891) is a prescription of rates for dark fiber for four Bell Operating Companies. It prescribes rates from \$112 to \$266 per mile per month for dark fiber, depending on the company. Consequently, the cost estimates submitted to IS/WP2 would appear to be too high by a substantial amount.

**Advisory Committee on
Advanced Television (ATV) Service**

Doc. No. IS/WP2-0240

Date 15 SEPT 92

To: Lynn Claudy
Chairman, ATSC T3/S1
Specialist Group on Macro Systems Approach

From: Craig K. Tanner *CKT*
Co-Chairman, IS/WP-2
Working Party on Transition Scenarios

Date: August 24, 1992

At recent meetings of the Implementation Subcommittee's Working Party 2 on Transition Scenarios, discussions have been held regarding the importance of timely documentation of the ATV standard. The Working Party considers this step as critical to allowing professional and consumer equipment manufacturers to introduce service-enabling ATV products without undue delay. Members of the IS/WP-2 contributed to the following suggestions that may be of interest to your Specialist Group in considering the matter.

1. The winning ATV proponent must take the leadership role in drafting the standard document, with assistance from a small group of ATSC members. Care must be taken to keep the effort focused on documentation of the approved system, including any changes or improvements adopted by the Advisory Committee's Special Panel, but to prevent expansion of the effort to that a general forum for industry creation of new and untested ideas.
2. Completion of the ATV standard document might best be achieved via a multi-pass effort. It may be possible to structure the publication in two phases, with initial publication of the critical parameters, to be augmented in a second phase with additional details. It is reasonable to assume that interested manufacturers will approach the winning proponent directly for system details, and are not likely to rely solely upon the published ATSC standard, making this two-pass approach possible.
3. Advance determination of the FCC's requirements for the ATV standard document will be helpful in planning the required work. If the Commission's requirements turn out to be a subset of the complete system specification, perhaps this can form the core of the first

published standard, as suggested in item 2 above.

4. Given that the Advisory Committee's ATV system recommendation will have resulted in some large measure from the basic quality achieved by the tested system, it will be important to document in the standard the essential elements of the compression/decompression algorithms necessary to guarantee that video and audio quality (and transmission performance) in any manufactured encoding/transmission equipment. It may be advantageous to ask all proponents to begin drafting these descriptions now, in advance of selection of a winning system.

While there is also a need to publish specifications for interpreting and processing the transmitted bit stream, it may be desirable to allow consumer manufacturers to implement a range of receivers at different price points, with varying levels of performance.

5. Given the nature of evolving digital signal and image processing technology, it is probably desirable to enable future improvements (or extensions) to the standard (backward compatible with receivers sold to consumers, of course). A permanent mechanism will need to be identified for evaluating and documenting these improvements.

I hope these comments will be helpful in your Specialist Group's discussions.

cc: G. Vradenburg III, Fox Inc., (Chairman, IS)
P. Bingham, Philips Laboratories, (Co-Chair, IS/WP-2)
M. Weiss (Vice-Chair, IS/WP-2)✓
R. Hopkins, ATSC
J. McKinney, ATSC
D. Wells, Comsat
R. Green, B. Futa, CableLabs
C. Jackson, (IS/WP-1 Chairman)
B. Fox, (IS Vice-Chair)

Satellite Receivers- continued

Microdyne Corporation
P.O. Box 7213
Ocala, FL 32672

Scientific Atlanta Inc., Network Systems Group
4356 Communications Drive
Norcross, GA 30093

Standard Communications Corporation
P.O. Box 92151
Los Angeles, CA 90009-2151

Microwave - Studio-to-Transmitter Links

Broadcast Microwave Services, Incorporated
7322 Convoy Court
San Diego, CA 92111

Ikegami Electronics (USA), Incorporated
37 Brook Avenue
Maywood, NJ 07607

ITELCO
Piazza Febei 3
1-05018 Orvieto, Italy

Microwave Radio Corporation
20 Alpha Rd.
Chelmsford, MA 01824

RF Technology Incorporated
16 Testa Place
South Norwalk, CT 06854

Character Generators

Abekas Video Systems
101 Galveston Drive
Redwood City, CA 94063

Ampex Corporation
401 Broadway
Redwood City, CA 94063-3199

Character Generators- continued

Aston Electronics (from PALTEX)
2752 Walnut Avenue
Tustin, CA 92680

Broadcast Televisions Systems
2300 South 2300 West
Salt Lake City, Utah 84109

Chyron (Pesa)
265 Spagnoli Road
CS 1901
Melville, NY 11747

Grass Valley Group, Inc. (Dubner)
13024 Bitney Springs Road
Grass Valley, CA 95945

Quanta Corporation
180 Wright Brothers Drive
Suite 670
Salt lake City, UT 84119

Quantel
655 Washington Blvd.
Stamford, CT 06901

Standards Converters (NTSC to ADTV or ADTV to NTSC)

AVS Broadcast
Venture House, Davis Rd
Chessington KT9 1TT
United Kingdom

Grass Valley Group, Inc.
13024 Bitney Springs Road
Grass Valley, CA 95945

I-Den Videotronics Corporation
9620 Chesapeake Drive
Suite 204
San Diego, CA 92123