Dielectric®

YOUR GUIDE TO THE FCC TV CHANNEL REPACK

More stations** have **Dielectric antennas** than all other manufacturers **combined.

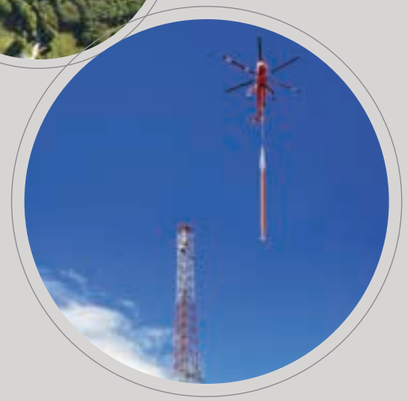
Trusted for Decades. Ready for Tomorrow.

Dielectric®

SPANNING THE WORLD OF BROADCAST TECHNOLOGY

Dielectric has been a leading innovator throughout the history of broadcasting, with more than 100 patents in RF transmission technology since our founding in 1942. Today, Dielectric is the world leader in the innovative engineering, design and manufacturing of complete broadcast systems. Our engineering team is designing antennas never imagined 60 years ago.

Our engineers bring hundreds of years of combined experience, working on more than 10,000 antennas, to meet your customized needs for the future. Whatever new technologies emerge, there's a good chance they'll start here at Dielectric world headquarters in Raymond, Maine.



TV Stars: Dielectric has received two Emmy awards for technical innovation.

OVERVIEW OF THE FCC'S INCENTIVE AUCTION PROCESS

A key part of the FCC's efforts to meet the demand for spectrum is the first-of-its-kind Incentive Auction, a means of repurposing spectrum by encouraging TV licensees to voluntarily relinquish usage rights through a Reverse Auction, in exchange for a share of the proceeds from a Forward Auction to winning licensees of the repurposed spectrum.

1. FCC issues Channel Reassignment Public Notice that:

- Announces the list of stations that won bids to relinquish their spectrum.
- Provides the new channel assignments for stations that won bids to move from high-VHF to low-VHF or from UHF to high-VHF or low-VHF.
- Provides the new channel assignments for remaining UHF stations.
- Starts the 39-month transition period.

2. Repacked stations have three months from the date of the Channel Reassignment Public Notice to:

- Submit construction permit applications (FCC Form 301) for the facilities on their new channel.
- Submit estimated costs of construction of facilities on their new channel (FCC Form 399).

3. Following the submission deadline for estimated costs, FCC will make an initial allocation to each repacked broadcaster of up to 80% of its estimated costs (up to 90% for non-commercial stations).

4. Following the submission deadline for construction permit applications, FCC will assign an individual deadline for each repacked station to complete construction.

5. Once a repacked station begins to incur costs, it may submit a request for reimbursement along with cost documentation (such as a copy of a vendor invoice) via FCC Form 399 electronically using the FCC's License and Management System (LMS).

6. As they are approved, payments will be made to the bank account designated by each repacked station to receive payments from the TV Broadcaster Relocation Fund.

ANTENNA CONSIDERATIONS

Looming over many broadcasters today are the questions of bandwidth, the possibility of re-tuning the antenna system, and the logistics of the conversion to a new, future broadcast standard.

Pylon Antennas

Approximately 90% of all installed UHF antennas in the U.S. are "pylon" or slotted coaxial antennas. Pylon antennas offer advantages in cost, reliability and wind load, but are inherently narrowband.

COVERAGE REPLICATION

OET-69 "Dipole Factor"

Channels	Defining Field Strength, dBu, to be predicted for 50% of locations, 90% of time
2-6	28
7-13	36
14-69	41-20 log [615/(channel mid-frequency in MHz)]

For equivalent coverage, moving down in frequency will also mean a reduction in ERP for the same equivalent coverage. Conversely moving up in frequency could limit coverage due to the 1 MW ERP cap.

Moving down in frequency with a pylon style antenna of the same gain will mean a larger antenna and increased tower loading, but fortunately, lower frequency requires a lower ERP and/or lower gain. Since maintaining the same coverage at a lower ERP requires less gain, this adjustment can minimize tower-loading concerns. In certain cases, going up in channel can be problematic. For example, a station which is already maximized to 1 MW ERP will give up coverage if forced to move to a higher channel.

If the antenna is top-mounted, the FAA restricts the overall structure height. For a lower channel antenna of the same aperture length, the gain will be reduced as well. Typically, however, the lower antenna gain penalty is offset by the ERP reduction, so the antenna input power remains similar, unless the addition of vertical or full circular polarization is contemplated.

If the antenna is omni-directional, there is a very good chance the new antenna will have weight and windload characteristics similar to the existing one. If that channel is directional, however, obtaining an azimuth pattern similar to the existing one generally requires a larger antenna pole diameter, pattern-

shaping elements, and higher antenna windload. A structural analysis is highly recommended when anything changes on the tower.

ANTENNA/WINDLOAD CHANNEL CHANGES

Channel 51
TFU-30JTH-RO4
Ø10.75" Pipe
27 Gain

(EPA) = 42.4 FT²
W = 3,800 LBS

Channel 24
TFU-30JTH-RO4
Ø14" Pipe
27 Gain

(EPA) = 68.7 FT²
W = 7,000 LBS

Same gain antenna most likely not required due to reduction in ERP.

Due to reduction in ERP for CH. 24, same transmitter can be used.

Consider adding VPOL, up to 20%.

Channel 51
TFU-30JTH-RO4
Ø10.75" Pipe
27 (14.13 dB) Gain

(EPA) = 42.4 FT²
W = 3,800 LBS

1 MW ERP
Input Power = 37 kW

Channel 24
TFU-22JTH-RO4
Ø10.75" Pipe
20 (13.01 dB) Gain

(EPA) = 45.0 FT²
W = 3,600 LBS

588 kW ERP
Input Power = 29.4 kW

Panel Antennas

In contrast to pylon antennas, most (but not all) panel antennas are inherently broadband, making them a good candidate for re-channelizing. The following checklist will aid in making a well-informed decision about your antenna system.

ANTENNA CONSIDERATIONS CHECKLIST:

- ☐ **Check type of antenna.** Is the antenna broadband? Consult manufacturer for complete details.
  - ☐ If broadband, schedule a broadband system RF sweep to verify performance and condition.
- ☐ **Check antenna power rating.**
  - ☐ If replacing the antenna is required, determine cost, delivery and installation logistics. Obtain proposals.
- ☐ **Check tower impact.** Will the tower support the weight and wind load of a new antenna? Obtain structural analysis.
  - ☐ Will the project require changing towers or constructing a new tower? Consider lease space and cost, zoning, permits, upgrades to new standards, etc.
  - ☐ Add VPOL to enhance mobile and handheld reception associated with future ATSC 3.0.

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TRANSMISSION LINES AND COMPONENTS CONSIDERATIONS

Rigid transmission line may be able to be reused if the new channel assignment is within the recommended channel set for the line length. Typically, coaxial line comes in three lengths for TV use: 19.5', 19.75', and 20' sections, with recommended channels for each length of line. Those recommended channels typically utilize a 3 MHz guard band on each side of the channel edge, a practice that goes back to the early analog days of television when visual and aural carriers were closer to the band edge. For digital, however, a line that is new or in relatively good shape may be reused if the flange addition occurs outside the channel bandwidth.

Even if the current line length happens to be usable for your new channel assignment, elbow complexes may be tuned narrowband, in which case they need to be replaced. Rigid digiTLine™ runs, which use a proprietary mixed-line-length algorithm, are broadband and can be reused at any UHF channel. The elbows used in digiTLine™ runs are tunable but typically are broadband in nature.

Flex lines are another broadband transmission option. Facilities using air dielectric cable to feed their antenna will most likely be able to reuse the cable on a new channel. Gas barriers used to pressurize transmission lines are broadband, and can be used at any channel. It is highly recommended that, before any decisions are made, a broadband TDR sweep of the (load-terminated) transmission line take place to characterize the line's performance.

COAXIAL LINE "STICK" LENGTH, 3 MHZ GUARD BAND

TABLE 1: SHOWS THE PROHIBITED CHANNELS FOR THE 3 MHZ GUARD BAND.

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
20			■	■			■	■				■	■			■	■		
19 3/4 FT.	■			■	■				■	■			■	■			■	■	
19 1/2 FT.	■	■			■	■				■	■			■	■			■	■

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
20	■	■			■	■			■	■			■	■			■	■	
19 3/4 FT.		■	■			■	■			■	■			■	■			■	■
19 1/2 FT.			■	■			■	■				■	■			■	■		

■ Prohibited Channel per Catalog

COAXIAL LINE "STICK" LENGTH, 1.5 MHZ GUARD BAND

TABLE 2: SHOWS THE MANY MORE CHANNELS AVAILABLE IF THE GUARD BAND IS REDUCED TO 1.5 MHZ.

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
20				■				■				■				■			
19 3/4 FT.	■				■				■				■				■	■	
19 1/2 FT.		■				■				■					■			■	■

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
20	■				■	■			■	■			■	■			■	■	
19 3/4 FT.		■	■			■	■			■	■				■				■
19 1/2 FT.			■	■				■				■				■	■		

■ Prohibited Channel per Catalog

For short transmission line runs, or those feeding a VHF, the flange stack-up may be insignificant. Check with manufacturer.

A 1.15 VSWR at a single discrete frequency may not be detrimental to a Solid State transmitter; consider that when evaluating field data.

Consider replacing connections for older lines.

For waveguides runs, check with manufacturer.

TRANSMISSION LINE CONSIDERATIONS CHECKLIST:

- ☐ **Identify type of transmission line.** Is the line rigid (standard or digiTLine™), flex or waveguide?
  - ☐ If standard rigid line, what is the line length? Refer to Table 1 and 2 for detailed information.
- ☐ **Get a VSWR sweep of the transmission line to determine whether it can be reused.**
- ☐ **Examine elbow complexes.** Have they been tuned for narrowband? Is field-tuning practical?
- ☐ **Check power rating of line.**
  - ☐ If replacing the line is required, understand cost, delivery and installation logistics. Obtain proposals.

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RF SYSTEM CONSIDERATIONS

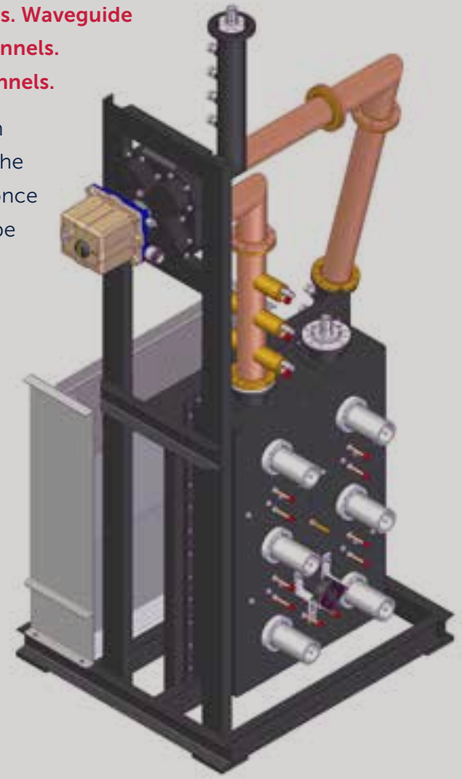
Transmitter RF systems typically perform power combining, mask filtering, switching and power monitoring functions. Today, the purchase of a new transmitter includes power combining and filtering functions in the form of a new RF system.

RF system planning must consider the overnight "flash cut" and how to switch between old and new transmitters. The flash cut requirement precludes reuse of most components in an RF system. **Mask filters will need to be replaced.** Even low power transmitters with band-tunable mask filters will require a second filter pre-tuned to the new channel, since retuning filters on the night of transition is not practical.

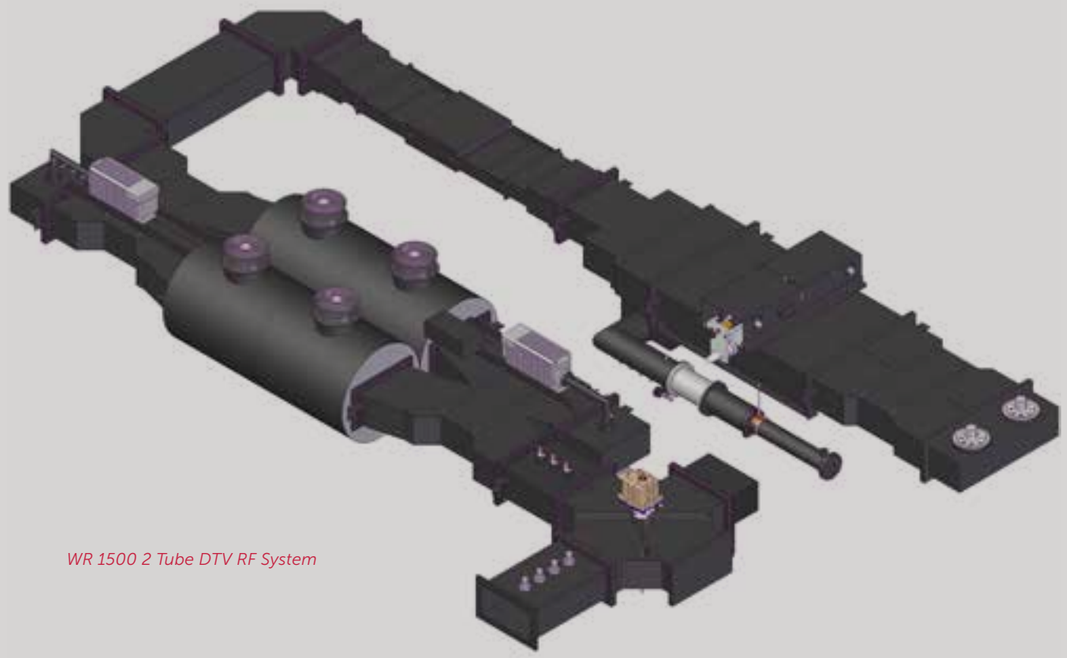
If the same transmission line run to antenna is used, the switching network at the filter output can accommodate the channel change. **Coaxial switches and patch panels are generally broadband and may be used at both channels. Waveguide switches are banded and usually optimized over a few channels. WR1500 is the only guide size suitable for use at both channels.**

Space in the transmitter room is an important consideration for the new RF system. Ensure that there is space to install the new equipment, and also space to remove old equipment once it is decommissioned. A lower power interim solution may be required in order to avoid adding square footage to the transmission site.

If retuning any existing components is part of the plan, schedule the field engineer in advance.



10 kW Reflective Filter with Output Switch



WR 1500 2 Tube DTV RF System

RF SYSTEM CONSIDERATIONS CHECKLIST:

- ☐ **Determine TPO at the new channel.** Allow headroom for ATSC 3.0 operation (higher peak power/ slightly wider signal).
- ☐ **Decide on possible addition of Vertical Component to the new antenna (extra TPO required).**
- ☐ **Decide on new or retuned transmitter.**
- ☐ **Decide on new or retuned RF system.**
  - ☐ Determine space available for new RF system.
- ☐ **Plan how to install and proof new transmitter and switch to new antenna.**
- ☐ **Obtain RF System quotes for FCC budget submittal.**

Notes: _____

STRUCTURAL ANALYSIS AND TOWER WORK

Tower work can take many months of planning to achieve the optimum balance of performance, timing and cost. Early planning is essential.

Once a broadcaster selects the antenna and transmission line needed to achieve FCC compliance, the impact on the tower must be considered. All the files available at the station that relate to the most recent primary broadcast tower should be reviewed. The following checklist will help broadcasters gather the needed documents:

- ☐ **Tower drawings**
- ☐ **Most recent tower inspection**
- ☐ **Size of transmission line**
- ☐ **Most recent tower analysis**
- ☐ **New antenna model**
- ☐ **Elevation of new equipment**
- ☐ **Existing equipment located on the tower (A few pictures of the coax bridge, tower base and looking up the tower are excellent tools to assist the engineer.)**
- ☐ **Are building permits required? Request a Permit Package from the Engineer of Record (EOR).**
- ☐ **Coordinate planning meetings between the antenna manufacturer and tower engineer to jointly set milestones and set expectations.**
- ☐ **Set and review budget.**

In most cases, the tower will be required to meet the latest building codes with reference ANSI/TIA 222 Rev "G", which became effective in 2006. In some cases, previous codes (C-F) may be used, but this decision should be made in conjunction with the risk management team to take into account insurance costs and license requirements of various tenants, such as critical services of first responders, and contract provisions that require more conservative considerations. The decision about which standard revision is the most appropriate often lies with the EOR and the station's chief engineer.

There are two types of structural evaluation:

- **Cursory reviews** are helpful in the early phases, since they seek to define if one of several options provides a good compromise of cost vs. benefit. A cursory analysis is done quickly with only cursory attention to detail.
- A **rigorous analysis** is more exacting and thorough, characterized by or adhering to strict standards or methods. It is important to note that only a rigorous analysis is acceptable to proceed to installation.

The structural analysis report will list the results and recommendations. Consideration will be given to previous structural analyses and modifications performed by the EOR. Structural evaluations and modifications performed by others must be provided to the EOR to be included in the evaluation. If the results of the analysis require modification materials or adjustments, those will be addressed in a separate proposal.

The tower company must receive the following information from the customer prior to the start of an analysis:

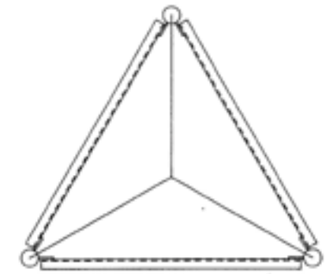
A. List of all existing appurtenances, i.e., antennas, lines, etc.
B. List of any new equipment to be considered in evaluation
C. Cross section with transmission line and conduit locations

The analysis will be performed and conclusions will be based on the assumption that the tower has been properly installed and maintained, based on measurements including, but not limited, to the following:

1. Proper plumb and alignment
2. Correct bolt tightness
3. No significant deterioration or damage to any component

Sample Tower Equipment Schedule

Prepared by:
Date:
Site Name:
Customer Name:



Instructions:

1. Fill out forms as completely as possible.
2. Print or type all information.
3. Use one (1) line for each antenna.
4. Show location of lines and elevations on typical tower cross section.
5. Use miscellaneous column to indicate the presence or special items for that antenna, such as deicers, radomes, ice shields, etc.
6. Fill out one form for each condition to be investigated.

Antenna Manufacturer	Model #	Ctr. Rad. Above Grade	Ant Freq. or Channel No.	TX Line Size	Antenna Azimuth	Misc. Data

Conclusion

The station is expected to provide the information on existing and proposed antennas, transmission lines, or other appurtenances, and the EOR will rely upon this information in the structural evaluation. See example of required information above under Sample Tower Equipment Schedule.

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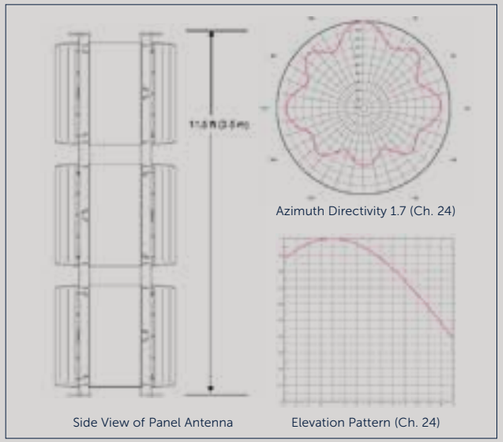
*Section courtesy of Don Doty, *Regulatory Compliance Advisor,* FDH Velocitel

STAYING ON-AIR DURING NEW CHANNEL CHANGEOVER

Following are key decisions, considerations and options for auxiliary systems, from a transmitter/antenna/line perspective:

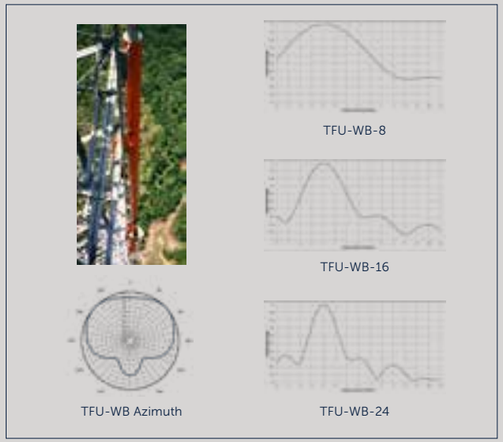
- Will temporary or back-up transmission equipment be required?
- Need to be on-air with existing equipment while new system is being installed?
- Reduced power operation on current channel may allow some components to be reused.
- Physical space issues?
- Availability of RF talent to retune & install components is very limited.
- Some older equipment may not be supported, e.g., 50000 series switches, W/G Directional Couplers (older designs).
- Channel combiners at current multi-channel sites will have to be either replaced or retuned.
- Temporary operation at reduced power may be required for all tenants.

Following are examples and options for auxillary antennas:



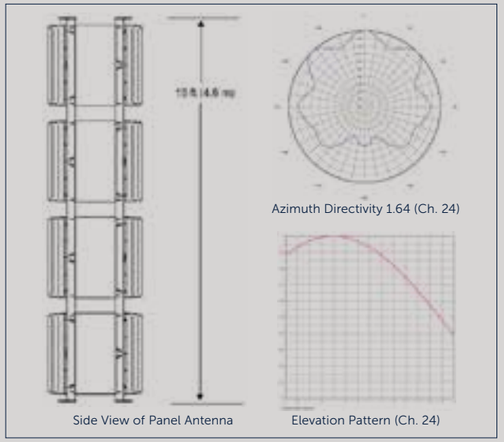
Panel Antenna Model TUA-SP4-3/11"X"-1

- Broadband 14-51
- Horizontal polarization
- 10 kW or 45 kW
- ERP 100 kW peak or 60 kW RMS
- Omnioid or directional patterns
- 11.5 FT aperture



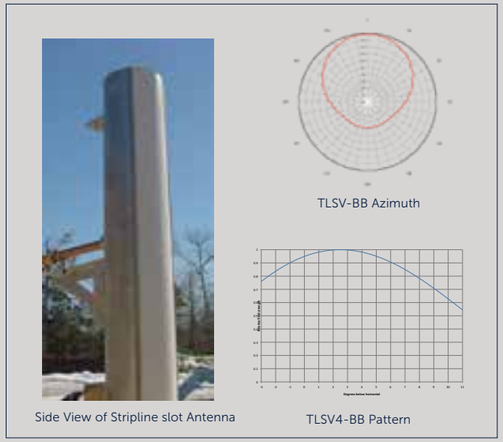
Slot Cavity Antenna Model TFU-WB

- Broadband 14-51
- HPOL or with VPOL
- 20 kW average power for 8 bay
- 8, 16, 24 bays



Panel Antenna Model TUM-LP-SP4-4/14M-1

- Broadband 14-51
- 30% vertical polarization
- 10 kW with 3 1/8" input
- ERP 100 kW peak or 60 kW RMS with 30% vertical
- Omnioid or directional patterns
- 15 FT aperture



Stripline slot Antenna Model TLSV-BB

- Broadband 7-13
- HPOL or EPOL
- 7.5 kW Per 4 bay section
- 4, 8 and 12 bays
- Omnioid pattern

TRANSITION CONSIDERATIONS CHECKLIST:

- ☐ **Determine whether transition will be flash cut or staged/regional.**
- ☐ **Establish a plan for an auxiliary antenna or back-up site to keep operating while main work is done.** It is recommended the auxiliary antenna and line be broadband for use at both current and repacked channels.
- ☐ **Determine required ERP, height, and antenna pattern for Auxiliary/Standby status.** Use FCC Consultant if necessary.
- ☐ **Optimize Transmitter Size, Transmission line Length, Size and Type (rigid or flex), and Antenna Gain for Cost, Performance, and Coverage Effectiveness.** Use FCC Consultant if necessary.
- ☐ **Incorporate Aux System (Antenna & Line) into any Structural Analysis.**

Notes: _____

TRANSMITTER CONSIDERATIONS

The impact of a channel change on the transmitter equipment can vary widely depending on the type, the age and the make of transmitter, as well as the magnitude of the channel change.

VHF

VHF transmitters will likely be the least affected since they use solid-state power amplifiers. As long as a manufacturer is still in business, changing channel *within a VHF band* should be straightforward. Changing channel to a different VHF band, however, will require a new transmitter.

UHF/IOT Tube

The majority of UHF transmitters use IOT power amplifiers, which are inherently broadband and can be tuned to the new channel, provided the cavity assemblies are in good condition. Other parts of the transmitter, e.g., driver amplifiers and circulators, may not be broadband. It may be possible to obtain new or used replacement parts for the new channel if the manufacturer is still supporting that product. It is recommended that the viability and scope of channel change be ascertained now.

UHF Solid State

An increasing number of UHF transmitters, including Class A stations, use solid-state power amplifiers. In general, newer transmitters have broadband capabilities while older ones do not. Again, we recommend that you establish the viability of channel change now by contacting the manufacturer.

TRANSMITTER CONSIDERATIONS CHECKLIST:

- ☐ **Confirm type of transmitter and power rating.** Is it still supported by manufacturer?
  - ☐ Is it broadband? Can it be retuned/rechanneled?
  - ☐ If not, obtain proposals to replace the transmitter, including installation.
- ☐ **If a new transmitter is needed, confirm there is sufficient space for installation.**
- ☐ **If transmitter can be rechanneled, establish a transition plan.** Is a standby transmitter available?

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ANTENNA CONSIDERATIONS FOR ATSC 3.0

The broadcasters that are going to stay on air after the spectrum auction are committing to the long-term viability of over-the-air broadcasting. The most discussed change in the industry to encourage that commitment is ATSC 3.0. This change in the transmission scheme offers the flexibility to provide either higher quality video and audio content; a much more robust signal; or a combination of both. Possible benefits include non-linear delivery to recording devices, small mobile device reception, high-resolution transmission, off-load of downlink for wireless networks, and targeted advertising.

In installing an antenna for the new channel, consideration must be given to ATSC 3.0 operation. The most discussed option for an antenna is the addition of vertical polarization. Television ERP is based on horizontal polarization only. Adding vertical polarization to the signal allows the broadcaster to put more power out through the antenna, which helps reception with non-rooftop antennas.

An additional transition scheme is to put up a transmission site in the market but not near the main site to use while construction is done on the main site. This alternate site could then become part of a single frequency network once ATSC 3.0 is adopted.

Signal saturation due to inadequate receive antenna in devices:

- High null fill
- Lower gain antennas
- VPOL
- SFN to increase signal strength

ANTENNA CONSIDERATIONS FOR ATSC 3.0 CHECKLIST

- ☐ **Consider lower gain, higher null fill antenna options.**
- ☐ **Determine how much VPOL is needed.**

Notes: _____

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