APPENDIX

CATALOG OF POTENTIAL EXPENSES AND ESTIMATED COSTS

11472

October 13, 2016

2016 Update

Catalog of Potential Expenses and Estimated Costs

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I. ABOUT THIS CATALOG

This catalog of expenses (Catalog) contains descriptions of the expenses that broadcasters and MVPDs are most likely to incur as a result of broadcaster repacking. While we believe the Catalog is relatively comprehensive, it does not cover every expense, for every situation, nor is it an exhaustive list of all expenses that may potentially qualify for reimbursement.

Widelity, Inc. (Widelity) developed the original Catalog in 2013 for the Federal Communications Commission (FCC) as part of the Widelity Report, which was published for comment in 2014 (DA/FCC: DA-14-389). As part of the ongoing Broadcast Television Incentive Auction, the FCC engaged Widelity to update the Catalog to reflect the current pricing for the equipment and services that repacked broadcasters may need to purchase to facilitate the moves to their new channel assignments, and the current pricing for equipment and services that MVPDs may need to purchase to continue to carry broadcasters. Widelity first developed the information contained in this Catalog based on its research and interviews with industry stakeholders, conducted in 2013, and later updated in August of 2016, pursuant to its contract with the FCC. The categories and costs contained in the Catalog are intended to serve as a reference guide, and are not intended to identify the particular expenses for which individual broadcasters or MVPDs would be eligible for reimbursement.

Individual broadcasters and/or MVPDs will incur only some of the expenses listed in the Catalog, depending upon the broadcaster's or MVPD's existing equipment and the particular transition changes that the entity must make. Some of the expenses will apply only in limited situations, such as, for example, broadcasters operating on a shared antenna or those that require additional power to support an interim transmitter.

Supply and demand constraints may have an impact on future costs.

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II. BROADCAST COSTS

A. TRANSMITTERS AND IN-BUILDING EXPENSES

1. Retuning Existing Transmitters

Depending on a broadcaster's new channel assignment, it may be able to retune its existing transmitter to transmit on the new channel rather than replace it. Transmitters can be retuned only to channels within the same band (*e.g.*, UHF transmitters can only be retuned to channels within the UHF band). *See* Widelity Report pp. 17-18 regarding banding issues. Whether retuning is feasible depends on a number of factors, including the type of transmitter, the range of channels (sub-band) for which it and its component parts are designed, and whether replacement parts and manufacturer support are available. In some cases, replacement may be the preferred option if the cost of retuning exceeds the cost of a new transmitter. The transmitter output mask filter is channel-specific and must be replaced to accommodate any channel change.

Our discussions indicate that there are a number of potential issues with Inductive Output Tube (IOT) transmitter retuning, including:

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- *IOT tubes that have been in service for an extended period may not "come back up" on the new channel once they have been powered down necessitating replacements that cannot be predicted before starting the retuning process.*
- *The lead time for delivery of new IOT tubes can be as long as 6 to 9 months.*
- *The skill set to retune IOT transmitters is no longer broadly available. This will cause resource constraints as stations consider retuning their existing IOT transmitters.*
- *Manufacturer support and certain parts necessary for retuning existing IOT transmitters may no longer be available.*

	Range of Estimated Costs (*in dollars*)	**Proposed RoEC (*in dollars*)**
UHF – Inductive Output Tube (IOT) Transmitter (Price would include banded drivers, RF system, and labor. The price does not include the cost of IOT tubes, finger stock and/or tube trolleys. Cost varies by manufacturer.)		
~~Single IOT system, minor banding issues (30 kW)~~	~~115,000 – 150,000~~	
~~Two IOT system, minor banding issues (60 kW)~~	~~145,500 – 225,000~~	
~~Three IOT system, minor banding issues (90 kW)~~	~~160,000 – 315,000~~	
~~Single IOT system, major banding issues (30 kW)~~	~~226,000~~	

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~~Two IOT system, major banding issues (60 kW)~~	~~339,000~~	
~~Three IOT system, major banding issues (90 kW)~~	~~452,000~~	
One IOT system (30kW)		*115,000 – 226,000*
Two IOT systems (60 kW)		*145,000 – 339,000*
Three IOT systems (90 kW)		*160,000 – 452,000*
IOT replacement tube with accessories (price per tube)		*75,000 – 121,000*
Solid State Transmitter Prices based on specific channel move and would include field engineering and parts to retune the RF system but would not include the cost of a new mask filter, which is a separate line item below. Costs vary widely by manufacturer and power level. Retuning solid state transmitters is usually only feasible if the banding issues are minor. Stations that use solid state transmitters that have major banding issues will likely need a replacement solid state transmitter.		
UHF and VHF – minor banding issues	10,000 – 100,000	*10,000 – 100,000*
New Mask Filter – A new mask filter is required for any channel change		
1.5 kW mask filter	2,700	*2,800*
3 kW mask filter	3,800	*3,950*
7 kW mask filter	5,600	*5,900*
10 kW mask filter	7,500	*7,900*
30 kW mask filter	30,000	*31,000*
60 kW mask filter	80,000	*85,000*
90 kW mask filter	90,000	*95,000*
New Exciter – In a few cases, a station may need to purchase a new exciter if the existing exciter cannot be retuned.		
Single frequency agile exciter	20,000	*20,000*
Dual exciter system with change over	45,000	*45,000*

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2. New Transmitters

If retuning is not possible or if the cost of retuning exceeds the cost of replacement, a new transmitter may be required. The price of a new transmitter includes installation, mask filter, and proof of performance testing.

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
UHF –IOT Transmitter		
~~Single~~ *One* IOT system (30 kW)	450,000 – 525,000	*475,000 – 549,000*
Two IOT systems (60 kW)	815,000 – 855,000	*835,000 – 907,000*
Three IOT systems (90 kW)	1,205,000	*1,275,000 – 1,345,000*
UHF – Air Cooled Solid State Transmitter		
1 – 2.5 kW	35,000 – 90,000	*40,000 – 120,000*
4 - 6 kW	157,000 – 180,000	*157,000 – 225,000*
10 – 12 kW	245,000 – 320,000	*245,000 – 320,000*
15 kW	335,000 – 450,000	*392,500*
20 kW	530,000 - 580,000	*555,000*
~~**UHF – Liquid Cooled Solid State Transmitter**~~		
~~6.3 – 9.25 kW~~	~~250,000 – 315,000~~	
~~10.5 – 12.3 kW~~	~~345,000 – 465,000~~	
~~15 kW~~	~~460,000 – 550,000~~	
~~18 - 20 kW~~	~~530,000 – 600,000~~	
~~23.8 – 29.3 kW~~	~~685,000 – 835,000~~	
~~40 - 50 kW~~	~~940,000 – 1,075,000~~	
UHF – Liquid Cooled Solid State Transmitter	*Previously Unavailable in Updated Ranges*	
4.9 – 6.5 kW		*225,000 – 260,000*
8.2 - 13 kW		*270,000 – 470,000*
14.2 - 20 kW		*495,000 – 650,000*

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21 - 31 kW		*675,000 – 900,000*
35 - 50 kW		*1,000,000 – 1,400,000*
52 - 61 kW		*1,550,000 – 1,700,000*
68.5 - 75 kW		*1,750,000 – 1,900,000*
86.8 – 106 kW		*2,100,000 – 2.500,000*
~~**High VHF – Air Cooled Solid State Transmitter**~~		
~~*1 kW*~~	~~*82,000*~~	
~~*2.4 kW*~~	~~*135,000*~~	
~~*3.3 kW*~~	~~*175,000*~~	
~~*5 kW*~~	~~*260,000*~~	
~~*10 – 12 kW*~~	~~*315,000*~~	
~~*15 kW*~~	~~*450,000*~~	
~~*20 kW*~~	~~*575,000*~~	
High VHF – Air Cooled Solid State Transmitter	*Previously Unavailable in Updated Ranges*	
1.1 – 4.4 kW		*47,000 – 145,000*
6.5 – 12.5 kW		*175,000 – 315,000*
16.6 – 20.7 kW		*400,000 – 500,000*
24.5 kW		*650,000*
High VHF – Liquid Cooled Solid State Transmitter	*Additional Category*	
3.3 – 6.5 kW		*135,000 – 237,000*
8.5 – 12.5 kW		*291,000 – 425,500*
16.6 – 20.7 kW		*540,000 – 675,000*
24.5 – 31.6 kW		*877,500 – 950,000*
48.0 kW		*1,350,000*
62.0 kW		*1,700,000*

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3. Other Transmitter Expenses

In limited situations, these expenses may apply in addition to those listed in Sections II.A.1 or II.A.2, above.

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Combiners for Shared (Broadband Panel) Antenna (UHF/VHF)		
New combiner, cost per channel (without antenna)	50,000 – 60,000	*50,000 - 80,000*
Adding a module to existing combiner (without antenna)	50,000	*50,000 – 80,000*
Combiner output splitting/switching for dual feed lines, if applicable	(*additional item*)	*120,000*
Electrical Service – A station installing replacement transmitter equipment may have to increase the power supply to the transmitter or perform other electrical work (*prices include labor and installation*).		
Service entrance 3 phase/800 amp/208 volt	12,500	*13,700*
Switchgear – industrial 800 amp	33,300	*36,300*
Transformer 3 phase/480v – 150 KVA	22,300	*24,300*
Transformer 3 phase/480v – 300 KVA	32,200	*35,000*
Transformer 3 phase/480v – 500 KVA	42,300	*46,000*
2" Rigid Conduit and Wiring (Cost per foot)	23	*25*
3" Rigid Conduit and Wiring (Cost per foot)	45	*49*
4" Rigid Conduit and Wiring (Cost per foot)	88	*96*
HVAC Service – Cooling only – A station installing replacement transmitter equipment may need additional cooling capability (*prices include labor and installation*).		
5 Ton system	17,500	*19,250*
10 Ton system	33,500	*37,000*
15 Ton system	48,000	*53,000*
25 Ton system	79,000	*87,000*
50 Ton system	150,000	*164,000*
HVAC Service – Heating and Cooling – A station installing replacement transmitter equipment may need additional air-handling capacity that includes both		

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heating and cooling capability (*prices include labor and installation*).		
10 Ton system	52,500	*57,500*
15 Ton system	76,000	*84,000*
20 Ton system	99,000	*110,000*
30 Ton system	144,000	*158,000*
50 Ton system	230,000	*253,000*
Transmitter Building Addition – In limited situations, expansion of the transmitter building may be required to accommodate new equipment.		
Approx. 600-1500 square foot addition (costs vary with location, site access, and construction type)	variable	*variable*

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B. ANTENNAS

Most stations moving to a new channel will require new antennas. The price of an antenna does not include installation or removal of existing antennas (for those expenses, *see* Section II.D, Tower Equipment and Rigging). In some cases, new transmission lines will also be required (for those expenses, *see* Section II.C, Transmission Lines).

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
UHF – High Power Top Mount (200-1000 kW)		
One station antenna, *horizontally polarized*	150,000 – 225,000	*150,000 – 235,000*
One station antenna, ~~-with V polarization or C polarization~~ *elliptically or circularly polarized*	180,000 – 270,000	*180,000 – 275,000*
Two station broadband panel antenna ~~with combiner~~, *horizontally polarized*	450,000	*240,000 – 520,000*
Two station broadband panel antenna, elliptically or circularly polarized	(*additional item*)	*325,000 – 730,000*
Four station broadband panel antenna ~~with combiner~~, *horizontally polarized*	850,000	*285,000 – 740,000*
Four station broadband panel antenna, elliptically or circularly polarized	(*additional item*)	*528,000 – 1,036,000*
UHF – Lower Power Side Mount		
One station –200-500 kW, *horizontally polarized*	125,000 – 180,000	*125,000 – 180,000*
One station –200-500 kW, *elliptically or circularly polarized*	150,000 – 216,000	*150,000 – 216,000*
One station antenna – medium power (50-200 kW), *horizontally polarized*	50,000 – 72,000	*50,000 – 85,000*

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One station antenna – medium power (50-200 kW), elliptically or circularly polarized	(*additional item*)	*56,000 – 98,000*
Class A single station antenna – basic	12,000 – 21,000	*12,000 – 25,000*
Class A broadband panel (cost per panel)	825	*825 – 1,200*
Class A broadband panel (multiple channel array - example 4 panel complete array)	6,000	*6,000 – 8,000*
UHF – Broadband Slot, Side Mount	(*additional category*)	
8 bay, 5 kW input, directional, horizontally polarized		*10,000*
8 bay, 20 kW input, directional, horizontally polarized		*42,000 – 57,000*
8 bay, 20 kW input, directional, elliptically or circularly polarized		*82,000*
16 bay, 8 - 10 kW input, directional, horizontally polarized		*20,000 – 36,000*
16 bay, 16 kW input, directional, horizontally polarized		*43,000*
16 bay, 40 kW input, directional, horizontally polarized		*64,000 – 123,000*
16 bay, 40 kW input, directional, elliptically or circularly polarized		*157,000*
24 bay, 15 kW input, directional, horizontally polarized		*30,000*
24 bay, 60 kW input, directional, horizontally polarized		*145,000 – 181,000*
24 bay, 60 kW input, directional, elliptically or circularly polarized		*235,000*
32 bay, 16 kW input, directional, horizontally polarized		*71,000*
32 bay, 32 kW input, directional, horizontally polarized		*85,000*
32 bay, 60 - 65 kW input, directional, horizontally polarized		*120,000 – 200,000*
UHF – Broadband Panel, Side Mount Aux/Interim	(*additional category*)	
10 kW input, low gain, horizontally polarized		*30,000 – 45,000*
45 kW input, low gain, horizontally polarized		*100,000 – 135,000*
High-VHF		
One station antenna – top mount, *horizontally polarized*	250,000 – 275,000	*250,000 – 325,000*
One station antenna – top mount, ~~with V polarization or C polarization~~ *elliptically or circularly polarized*	280,000 – 330,000	*280,000 – 374,000*
One station antenna – side mount, *horizontally polarized*	62,000 – 100,000	*62,000 – 180,000*
One station antenna – side mount, elliptically or circularly polarized	(*additional item*)	*68,000 – 207,000*
Shared broadband panel antenna – 5 station, ~~with V polarization or C polarization~~ *elliptically or circularly polarized*	700,000	*700,000 – 890,000*

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~~Shared broadband panel antenna – 5 station with V polarization or C polarization, including combiner and transmission line~~	~~1,000,000~~	
High-VHF, Low Power		
Class A basic slot antenna – side mount, *horizontally polarized*	19,000	*19,000 – 23,000*
Class A basic slot antenna – side mount, elliptically or circularly polarized	(*additional item*)	*23,000 – 26,500*
Class A broadband panel (cost per panel) , *horizontally polarized*	4,000	*4,000 – 5,000*
Class A broadband panel (multiple channel array - example 4 panel complete array), *horizontally polarized*	16,500	*16,500 – 19,800*
Other		
Sweep test of *transmission line and* ~~existing~~ antenna	4,500	*4,500 – 6,400*
Elbow complex, single channel, at antenna input, per 3-1/8" feedline (if needed)	(*additional item*)	*7,400*
Elbow complex, broadband, at antenna input, per 3-1/8" feedline (if needed)	(*additional item*)	*8,880*
Elbow complex, single channel, at antenna input, per 4-1/16" feedline (if needed)	(*additional item*)	*9,100*
Elbow complex, broadband, at antenna input, per 4-1/16" feedline (if needed)	(*additional item*)	*10,400*
Elbow complex, single channel, at antenna input, per 6-1/8" feedline (if needed)	(*additional item*)	*11,700*
Elbow complex, broadband, at antenna input, per 6-1/8" feedline (if needed)	(*additional item*)	*13,000*
Elbow complex, single channel, at antenna input, per 7-3/16" feedline (if needed)	(*additional item*)	*13,200*
Elbow complex, broadband, at antenna input, per 7-3/16" feedline (if needed)	(*additional item*)	*16,000*
Elbow complex, single channel, at antenna input, per 8-3/16" feedline (if needed)	(*additional item*)	*14,500*
Elbow complex, broadband, at antenna input, per 8-3/16" feedline (if needed)	(*additional item*)	*18,000*
Side mount brackets for high power antennas (if not included in antenna base cost)	(*additional item*)	*7,500 – 22,000*
Pattern scatter analysis for side mount high/med power antennas (if not included in antenna base cost)	(*additional item*)	*3,800 – 5,000*
Note: For stacked antennas, the cost of the bottom antenna will likely double due to the increased cost of structural components, such as heavier steel and longer structures		

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C. TRANSMISSION LINES

In some situations, transmission lines can be reused in the event of a channel change (*e.g.*, if the move is to a non-prohibited channel or if the transmission line is broadband capable). *See* Fig. 1 below. New transmission lines, if needed for purchase, are generally priced per foot, based on a length of 1,000 feet. The price generally includes elbows and hangers.

	2013 Range of Estimated Costs	2016 Estimated Costs

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	(*in dollars*)	**Proposed** (*in dollars*)
Flexible Transmission Line		
Line Diameter:		
7/8" foam dielectric	10	*10*
1 5/8" foam dielectric	23	*23*
~~2 1/4" foam dielectric~~	~~30~~	*discontinued*
7/8" air dielectric	17	*17*
1 5/8" air dielectric	31	*31*
~~2 1/4" air dielectric~~	~~42~~	*discontinued*
3" air dielectric	53	*56*
4" air dielectric	66	*70*
5" air dielectric	91	*100*
Rigid Transmission Line – copper		
Line Diameter:		
3 1/8"	75 – 96	*77 - 99*
4 1/16"	95 – 130	*99 - 135*
6 1/8"	150 – 185	*158 - 192*
7 3/16"	263	*276*
8 3/16"	270 – 327	*280 - 330*
3 1/8" broadband	*previously reported as percentage*	*89 – 114*
4 1/16" broadband	*previously reported as percentage*	*114 - 155*
6 1/8" broadband	*previously reported as percentage*	*182 – 221*
7 3/16" broadband	*previously reported as percentage*	*317*
8 3/16" broadband	*previously reported as percentage*	*322 – 379*
~~**Note:** Broadband rigid transmission line sections are generally 15% more expensive than other rigid line sections.~~		

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D. TOWER EQUIPMENT AND RIGGING

If replacement or additional antennas are required, it may be necessary to modify the existing tower or to construct a new tower. In addition to these expenses, a broadcaster replacing or adding an antenna would incur rigging costs.

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Existing Towers – Towers without sufficient documentation of tower specifications may need to be mapped prior to completion of a tower load study.		
Tower mapping for an undocumented/poorly documented tower and preparation of documentation necessary for tower load study	12,000 – 16,000	*16,000 - 25,000*
Structural engineering tower load study for documented tower	5,000 – 7,000	*5,000 - 12,000*
Structural engineering tower load study for a documented tower with candelabra	10,000	*15,000 - 19,000*
Minor tower reinforcement/modifications (*see* Fig. 2 for sample minor modifications)	100,000 – 150,000	*100,000 – 150,000*
Major tower reinforcement/modifications (*see* Fig. 2 for sample major modifications)	300,000 – 400,000	*300,000 – 400,000*
Serious tower reinforcement/modifications (*see* Fig. 2 for sample serious modifications)	500,000 – 1,000,000	*500,000 – 1,000,000*
New Towers – Cost includes constructing a new tower, priced per foot.		
New tower between 1000' and 1500' without elevator, *presumptive* soil conditions	2,000	*2,500*
New tower between 1500' and 2000' without elevator, *presumptive* soil conditions	2,500	*3,000*
Note: Costs may be higher for tower sites with difficult soil or other site conditions and for towers with an elevator. Costs may be lower for towers under 1,000 feet		

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Tower Rigging – Costs include fees paid to expert tower crews for equipment removal and installation, such as removing an existing antenna and installing a replacement antenna, and removing an existing transmission line and installing a replacement transmission line.		
Tall Tower (greater than 500')	100,000 – 200,000	*100,000 – 200,000*
Short Tower (less than 500')	60,000 – 80,000	*60,000 – 80,000*
Complex Tower (includes, *e.g.*, towers with candelabras and/or stacked antennas)	100,000 – 300,000	*100,000 – 400,000*
Helicopter Lift (*e.g.,* for a rooftop tower, complex tower, tall structure, or terrain constrained location requiring helicopter lift)	variable	*variable*

E. INTERIM FACILITIES

Stations may need to use interim facilities in order to avoid prolonged off-air periods during the repacking or to enable stations to meet their construction deadlines. Some stations currently either have a licensed auxiliary facility or own backup equipment that they can repurpose for this use post-auction, while others may need to purchase or rent equipment or facilities.

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	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Transmitter		
Stations may need additional transmitters for interim use on either their pre- or post-auction channels to permit continued operation during construction of their post-auction facilities. Existing auxiliary or backup transmitters may require retuning or replacement. Transmitter retuning and replacement costs are listed above.		
Antenna		
Interim antenna rental and installation – Costs will depend on antenna size and height and/or complexity of the tower.	35,000 – 100,000	*35,000 - 110,000*
For purchase of interim antennas and/or replacement of existing auxiliary antennas, see Section II.B.		
Transmission Line		
For additional transmission line, see Section II.C.		
Tower Equipment and Rigging		
Costs will be similar to those described in Section II.D, Tower Equipment and Rigging, above.		
Interior RF Systems – A station that needs an additional transmitter for interim use		

may need an additional interior RF system.		
UHF inside RF system including switching	130,000	*140,000*
VHF inside RF system including switching	70,000	*75,000*

F. SPECIAL CASES

1. Channel 14

Television broadcasters operating on Channel 14 are required to guard against interference with mobile use on frequencies 467-470 MHz. (*See* 47 CFR § 73.687(e))

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
RF Consulting Engineer (to determine correct mask filter to avoid interference)	5,000	*5,000*
Channel 14 Mask Filter	180,000	*180,000*
Additional field engineering time, 10-30 days (to test for interference after mask filter is installed)	20,000 – 60,000	*20,000 – 60,000*

2. Distributed Transmission Services (DTS)

Television stations operating DTS systems will incur engineering costs related to each DTS site (instead of, and not in addition to, the RF consulting engineer category in Section II.H, Professional Services, below).

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
RF Consulting Engineer (*priced per DTS site*)		
Critical Facility: "Critical" refers to operations that have signal overlap between adjacent DTS sites that are not terrain-shielded; such facilities will require exact power levels, signal synchronization, and antenna directional and elevation patterns to minimize interference between sites.	2,000 – 8,000	*2,000 – 8,000*
Terrain-Shielded Facility: "Terrain-shielded" refers to operations that serve	1,000 – 2,500	*1,000 – 2,500*

regions that are terrain blocked from each other, resulting in less interference as compared to critical facilities.		

3. AM Pattern Disturbance

Stations constructing or making significant modifications to an antenna tower in the immediate vicinity of an AM radio station are required to analyze whether such construction or modification would result in disturbance to the AM station's radiation pattern. If it would, the television station is required to notify the AM station of the disturbance and take measures to correct it. (*See* 47 CFR § 1.30000 et seq.)

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Impact study: to assess the potential impact of tower construction or modification on AM radio stations.	2,500 – 7,500	*2,500 – 7,500*
Remedy: price includes installing the detuning apparatus or adjusting the existing detuning apparatus as necessary to restore proper operation of the directional or non-directional AM antenna, including before and after field measurements.	5,000 – 20,000	*5,000 – 20,000*

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G. MISCELLANEOUS EXPENSES

1. DTV Medical Facility Notification

DTV broadcasters are required to notify nearby medical facilities of DTV channel changes pursuant to a condition in their construction permit.

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Medical Facility Notification	1,300 – 3,500	*2,000 – 11,000*

2. Other

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Obtain building permits from local zoning authorities (cost of preparation, submission, and prosecution of necessary forms or applications)	variable	*variable*

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Obtain local permits other than for zoning (cost of preparation, submission, and prosecution of necessary forms or applications)	variable	*variable*
Coordinate with Bureau of Land Management and National Forest Service (this may be necessary for towers located on land managed by these agencies and would include the cost of preparing and submitting the relevant forms)	variable	*variable*
Disposal Cost (for equipment and other waste, if applicable)	variable	*variable*
Equipment Delivery and Handling Charges	variable	*variable*
Equipment Storage	variable	*variable*
Develop and Air Announcements of Upcoming Channel Change	variable	*variable*
Notification to MVPDs of channel change	variable	*variable*
Other Miscellaneous expenses	variable	*variable*

H. PROFESSIONAL SERVICES

Stations without sufficient internal resources, either at the station itself or at an affiliated station or company, may have to obtain professional services from an outside source to complete the station's channel relocation.

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	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
RF Consulting Engineer Fees		
Perform engineering study for new channel assignment and antenna development	2,000 – 7,000	*2,000 – 7,000*
Prepare engineering section of FCC Form 2100, Construction Permit Application	1,000 – 3,000	*1,000 – 3,000*
Prepare engineering section of FCC Form 2100, License to Cover Application	250 - 750	*500 - 1,500*
Prepare engineering section of FCC Form 2100, Construction Permit Application for an Auxiliary Antenna	(*additional item*)	*500 – 2,000*
Prepare engineering section of FCC Form 2100, License to Cover Application for an Auxiliary Antenna	(*additional item*)	*500 - 1,500*
Prepare request for Special Temporary Authorization	750 – 1,250	*1,000 - 1,500*
Attorney Fees		
Prepare and File FCC Form 2100, Construction Permit Application	750 – 2,500	*750 - 5,000*
Prepare and File FCC Form 2100, License to Cover Application	750 – 1,500	*750 - 2,250*
Prepare and File request for Special Temporary Authorization	750 – 1,500	*750 - 3,500*
Prepare and File FCC Form 2100, Construction Permit or License Application for an Auxiliary Antenna	(*additional item*)	*500 - 2,000*

Catalog of Potential Expenses and Estimated Costs

Negotiation of Lease and other matters for Shared Locations	(*additional item*)	*2,200 - 4,000*
FCC Filing Fees (*adjusted biennially*)		
~~Form 301 minor change CP~~	~~970~~	
FCC Form 2100, license to cover application	295	*325*
Special Temporary Authorization request	175	*190*
Other Transition-Related ~~Personnel~~ *Professional* Services Costs		
Project management of the transition, if needed (cost per hour)	50 – 125	*50 - 150*
Prepare and/or review reimbursement form	(*additional item*)	*750 - 2,500*
Address transition timing and coordination issues with other stations and wireless	(*additional item*)	*900 - 2,500*
Field Engineering Fees		
Comprehensive coverage verification via field study, if needed	20,000 – 80,000	*20,000 – 80,000*
RF Exposure Measurements (for sites where post-construction measurements have customarily been required or conducted)	3,000 – 20,000	*3,000 – 20,000*
Change in Structure Height Services: Modification to Antenna Structure Registration (ASR) (costs can be much higher for new towers)		
NEPA Section 106 environmental review, if needed	3,000 – 6,000	*3,000 – 6,000*
Environmental Assessment, if triggered by NEPA Section 106 review or for certain structures over 450 feet (cost in addition to NEPA review)	5,000 – 10,000+	*5,000 – 10,000*
ASR modification (prepare FCC Form 854)	500 – 2,000	*500 – 2,000*
FAA consultant, including cost of preparing FAA Form 7460 (Notice of Proposed Construction), if needed for height increase	750 – 2,000	*750 – 2,000*

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III. MVPD COSTS

MVPDs that receive signals over-the-air may be required to make changes to their receive facilities in order to continue to receive a television station's signal that is changing channels. This table identifies the kinds of changes MVPDs may be required to make in order to continue delivering a repacked broadcaster's signal to its customers after the broadcaster has delivered its signal to the MVPD. *Costs in this section will vary based on market size and the type of system utilized.*

	2013 Range of Estimated Costs (*in dollars*)	**2016 Estimated Costs Proposed (*in dollars*)**
Equipment Costs		
New Receive Antenna – Installed. Necessitated if existing antenna is channel-specific or uses directivity to minimize interference from other stations. Some UHF and VHF broadband receive antennas should be able to continue receiving stations that are not changing bands.	1,500 – 2,000	*1,500 – 2,000*
New Receive Antenna – Hi-Gain Quad Antenna, installed	5,000 – 6,000	*5,000 – 6,000*
New Receive Antenna – uninstalled	500 – 1,000	*500 – 1,000*
New Receiver or other RF Processing Equipment (such as pre-amplifiers)	300 – 1,000	*300 – 3,500*
Coaxial cable – cost per foot (for MVPDs that install new receive antennas and/or receivers)	2 - 3	*2 - 3*
Structural or Capacity Augments for Towers (to meet new tower loading requirements as a result of installation of replacement equipment)	Varies by tower construction.	*Varies by tower construction.*
Tower Rigging – two-man crew (price includes removal of existing antenna and transmission line, if necessary, and installation of replacement equipment)	2,500 – 4,000	*3,000 -5,500*
Professional Services		
Structural Study of tower capacity (to determine if additional support is necessary for any replacement equipment)	1,500 – 3,500	*1,500 -5,500*
Engineering Study (to estimate receive strength of new channel assignments, capabilities of current equipment, and determine whether and what replacement equipment may be necessary)	1,500 – 3,500	*1,500 – 3,500*

IV. FIGURES

~~**Figure 1: Rigid coaxial line section lengths and the channels not supported.**~~

~~Transmission line connects the transmitter or combiner output to the antenna, running from the equipment building up the tower to the antenna. While lines typically come in lengths of about 20 feet, the exact section length is determined by the station's assigned channel. After repacking, the transmission line may have to be replaced depending on whether the new channel is allowable for the existing line section length. This is principally an issue for lines that have been in use to feed a single-station antenna. Transmission line is usually "broadbanded" for use with shared antennas by making minor, non-repeating changes to the section lengths, designed for the channels involved. Following is a chart of transmission line section lengths and the channels that are prohibited for each length.~~

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Prohibited Channels per Line Length

20' Sections	4,10,16,17,20,21,25,26,29,30
	31,34,35,38,39,42,43,46,47,50
	51,55,56,59,60,63,64,67,68
$19^1/_2$' Sections	5,7,14,15,18,19,23,24,27,28,31
	32,35,36,39,40,44,45,48,49,
	52,53,56,57,60,61,65,66,69

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Catalog of Potential Expenses and Estimated Costs

Figure 1: Rigid coaxial line section lengths and the channels not supported.

Transmission line connects the transmitter or combiner output to the antenna, running from the equipment building up the tower to the antenna. While lines typically come in lengths of about 20 feet, the exact section length is determined by the station's assigned channel due to VSWR buildup from the repetitive connections between sections. After repacking, the transmission line may have to be replaced depending on whether the new channel is allowable for the existing line section length. This is principally an issue for lines that have been in use to feed a single-station antenna. Transmission line is usually "broadbanded" for use with shared antennas by making minor, non-repeating changes to the section lengths, designed for the channels involved.

The accompanying charts provide transmission line section lengths, and the channels that are prohibited for each length, based on two guard band intervals. Traditional practice was to utilize a guard band of approximately 3 MHz, while a smaller guard band can be considered for repacked stations to employ existing lines that are in in good condition. For a smaller guard band, stations should consult with the line's manufacturer and/or perform a sweep test of the transmission line to determine whether the line should be replaced for use on a new channel.

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			X	X			X	X				X	X			X	X		
19 3/4 FT.	X			X	X				X	X			X	X			X	X	
19 1/2 FT.	X	X			X	X				X	X			X	X			X	X

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

X 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				X				X				X				X			
19 3/4 FT.	X				X				X				X				X	X	
19 1/2 FT.		X				X				X				X	X			X	X

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

X Prohibited Channel per Catalog

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Figure 2: Tower Modifications

This chart provides representative samples of minor, major, and serious tower modifications.

Tower Modifications		
Minor	**Major**	**Serious**
Guy wire retensioning	Guy wire replacement 2 to 3 levels	Guy wire replacement > 4 levels
Tension Diagonal replacement < 12 bays	Tension Diagonal replacement > 15 bays	Addition of guy levels
Horizontal (struts) reinforcing < 12 levels	Horizontal (struts) reinforcing > 15 bays	New Anchors for new guy levels
Leg reinforcing (addition of redundants)< 12 levels	Horizontal (struts) replacement > 15 bays	Replacement of tower sections
Minor foundation reinforcing at anchors	Leg reinforcing (addition of redundants) > 15 bays	Tension Diagonal replacement > 15 bays
	Leg reinforcing (requiring welding)	Horizontal (struts) reinforcing > 15 bays
	Tension/Compression Diagonal replacement	Horizontal (struts) replacement > 15 bays
	Tension/Compression Diagonal -requiring welding	Leg reinforcing (addition of redundants) > 15 bays
	Minor foundation reinforcing at base and anchors	Leg reinforcing (requiring welding)
		Tension/Compression Diagonal replacement
		Tension/Compression Diagonal -requiring welding
		Foundation reinforcing at base and anchors

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