# Technical Appendix:
# Constraint Files Generation

# Table of Contents

# 1. Introduction to Technical Appendix

The Incentive Auction Task Force, which is comprised of staff from the Commission's Office of Engineering and Technology, Office of Strategic Planning and Policy Analysis, and the International, Media, and Wireless Telecommunications Bureaus, is releasing in conjunction with today's **Public Notice** a set of constraint files based on certain preliminary assumptions that could be used in an incentive auction to check the feasibility of assigning permissible channels to sets of stations and ultimately to assign channels to those stations. These constraint files are for illustrative purposes only, and necessarily reflect certain preliminary assumptions that are subject to a final decision by the Commission. These constraint files consist of two files for each station:

1) A ***Domain file*** (called Domain_2013July15.csv) defining the domain of available channels of any station given certain fixed constraints.

2) An ***Interference_Paired file*** (called Interference_Paired_2013July15.csv) defining which pairs of stations cannot operate co-channel, upper-adjacent channel, or lower-adjacent channel to each other given the amount of the potential interference between them.

The constraint files will be accessible via a link on the FCC's LEARN website under the Repacking Section, which can be found at http://wireless.fcc.gov/incentiveauctions/learn-program/repacking.html. Alternatively, these files will be posted at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.

In this **Technical Appendix** of today's **Public Notice**, the Task Force outlines both the processes used and preliminary assumptions applied to create these constraint files. The Task Force also describes the format of these files by providing illustrative sample data within this **Technical Appendix**.

With the information provided in **Technical Appendix**, as well as the preliminary *Domain* and *Interference_Paired files* accessible via the FCC LEARN website, interested parties will have sufficient information to conduct their own repacking analyses based on their own assumptions about which stations stay on the air and are assigned channels in the incentive auction repacking process.

In addition to this **Introduction**, this **Technical Appendix** is divided into the following sections:

a) **Section 2:** Describes some of the new features of *TVStudy* Version 1.2 relevant for repacking analysis. This new software, an instruction manual, baseline station engineering data including populations served, and contour maps for U.S. stations will be posted at http://data.fcc.gov/download/incentive-auctions/OET-69/.

In addition, **Section 2** provides descriptions of each of the output files from *TVStudy* necessary for any repacking analysis and an outline of the post-processing required to transform these files into pairwise constraints. These pairwise constraints are contained in the *Interference_Paired file* for each station. It should be noted that the *Interference_Paired file* reflect staff application of the second of three proposals in

the Incentive Auctions NPRM for making all reasonable efforts to preserve population served in the repacking process.[1] As noted above, the approach taken is preliminary in nature and only for illustrative purposes and does not reflect any final determination by the Commission.

b) **Section 3:** Provides an overview of how the *Domain* and *Interference_Paired files* were generated. It also reviews the format of each of these files.

c) **Section 4:** Provides more details on the inputs, preliminary assumptions and rules that underlie these constraint files. The inputs include U.S. television stations, Mexican television allotments, Canadian television allotments, and Land Mobile ("LM) and Land Mobile Waiver ("LMW") stations. A full list of each of these inputs will be posted at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/. The section also discusses other limitations on repacking in the incentive auction such as radio astronomy and medical telemetry operations in Channel 37.

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[1] Incentive Auctions NPRM, 27 FCC Rcd 12357, 12394 ¶ 106 (2012) ("Under this approach, no individual channel reassignment, considered alone, could reduce another station's specific population served on February 22, 2012 by more than 0.5 percent.").

## 2. Generating Pairwise Constraints from Cell-Level Interference Data

This section discusses in detail how the *TVStudy* software can be used to generate the pairwise interference data used as an input to create the *Interference_Paired file*. Pairwise interference data are essentially yes-or-no determinations of whether interference is predicted from one television station to another at a particular location called a "cell." The second and third of the three approaches proposed in the NPRM for making all reasonable efforts to preserve population served in the repacking process are based on "pairwise" analysis of data.[2] This **Technical Appendix** assumes application of the second option ("Option 2"), which would require that the Commission seek to preserve "the same specific viewers for each eligible station."[3]

### 2.1 Release of *TVStudy* Version 1.2

*TVStudy* Version 1.2 will be available at http://data.fcc.gov/download/incentive-auctions/OET-69/. This new version includes the following functionality not available in prior releases of *TVStudy*:

- Ability to automatically conduct pairwise studies
- Ability to define the specific parameters of Mexican allotments that lack height and power in the Commission's CDBS database[4]
- Ability to automatically invert negative electrical beam tilts that would otherwise cause inaccurate predictions of coverage and interference
- Ability to choose the contour level within which Longley-Rice propagation analysis is conducted independent of the Longley-Rice parameters
- Ability to add Desired and Undesired stations independently and at any time
- The command line is no longer needed to run *TVStudy* on the Mac platform
- Ability to choose which output files to create
- New "summary" output file, which condenses the results of multiple scenarios into a single file
- Additional information is included in the output cell-level file, such as the coordinates of the study point in each cell
- Study parameters are now grouped into tabs instead of one long list
- A complete list of changes from Version 1.1 is included in the Upgrade Guide available at the URL above

One of the key advantages of the *TVStudy* Version 1.2 software is its ability to easily replicate multiple stations to generate various nationwide scenarios. The update to the *TVStudy* software also creates new output data files that are more suitable for post-processing into pairwise constraints. In particular, it creates "truth tables" which indicate whether a particular "study station" has interference-free service in any particular 2 km x 2 km cell based on thresholds as

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[2] *See* Incentive Auctions NPRM, 27 FCC Rcd at 12394 ¶¶ 106-107.

[3] Incentive Auctions NPRM, 27 FCC Rcd at 12394 ¶ 106.

[4] FCC Consolidated Database System, *available at* http://transition.fcc.gov/mb/databases/cdbs/.

specified in OET Bulletin 69.[5]  This cell-level data from *TVStudy* can then be used to create pairwise constraints between U.S. television stations and between U.S. and Canadian television stations.   A short description of this process follows in the sections below, and includes a description of the output files generated by *TVStudy* Version 1.2.

## 2.2 Parameters chosen in *TVStudy*

The following were the study parameters used by *TVStudy* in generating the output files described.  It is emphasized that the use of these parameters does not reflect any final determination by the Commission.

**Study parameter settings:**

| General |
| --- |
| Grid type = Global |
| Cell size = 2 |
| Average terrain database = 1-second |
| Average terrain profile resolution = 10 |
| Path-loss terrain database = 1-second |
| Path-loss profile resolution = 1 |
| U.S. population = 2010 |
| Canadian population = 2011 |
| Mexican population = 2010 |
| Round population coordinates = No |
| Spherical earth distance = 111.15 |
| Rule limit extra distance = 129 |
| Co-channel MX distance = 30 |
| Minimum Channel = 2 |
| Maximum Channel = 51 |

| CDBS |
| --- |
| Respect CDBS DA flag = No |
| Use generic patterns for Canadian records = Yes |
| Mexican digital ERP, VHF low = 45 |
| Mexican digital HAAT, VHF low = 305 |
| Mexican digital ERP, VHF high = 160 |
| Mexican digital HAAT, VHF high = 305 |
| Mexican digital ERP, UHF = 1000 |

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[5] Interference-free service or interference-free population is defined here as people who reside within a station's service area at locations where the station's service is not subject to interference from another station or stations. *See* OET Bulletin No. 69 (Feb. 6, 2004), *available at* http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet69/oet69.pdf   (OET Bulletin 69).  OET Bulletin 69 "provides guidance on the implementation and use of Longley-Rice methodology for evaluating TV service coverage and interference in accordance with sections 73.622, 73.623 and 74.704 of the FCC rules."  *Id.*  In the NPRM, the FCC proposed to define "population served" for purposes of section 6403(b)(2) of the Spectrum Act as populations with interference-free service.  *See* NPRM, 27 FCC Rcd at 12388 ¶ 94, 12392 ¶ 103 (stating that "OET Bulletin 69 and the Commission's rules address 'population served' in terms of the persons who reside within a station's service area at locations where the station's service is not subject to interference from another station or stations.").

| |
|---|
| Mexican digital HAAT, UHF = 365 |
| Mexican analog ERP, VHF low = 100 |
| Mexican analog HAAT, VHF low = 305 |
| Mexican analog ERP, VHF high = 316 |
| Mexican analog HAAT, VHF high = 305 |
| Mexican analog ERP, UHF = 5000 |
| Mexican analog HAAT, UHF = 610 |

| **Patterns** |
|---|
| Depression angle method = True geometry |
| Use mechanical beam tilt = No |
| Mirror generic patterns = No |
| Beam tilt on generic patterns = Offset |
| Invert negative tilts = Yes |
| Digital receive antenna f/b, VHF low = 10 |
| Digital receive antenna f/b, VHF high = 12 |
| Digital receive antenna f/b, UHF = 14 |
| Analog receive antenna f/b, VHF low = 6 |
| Analog receive antenna f/b, VHF high = 6 |
| Analog receive antenna f/b, UHF = 6 |

| **Contours** |
|---|
| Use real elevation patterns for contours |
| Digital full-service contour, VHF low = 28 |
| Digital full-service contour, VHF high = 36 |
| Digital full-service contour, UHF = 41 |
| Digital Class A/LPTV contour, VHF low = 43 |
| Digital Class A/LPTV contour, VHF high = 48 |
| Digital Class A/LPTV contour, UHF = 51 |
| Analog full-service contour, VHF low = 47 |
| Analog full-service contour, VHF high = 56 |
| Analog full-service contour, UHF = 64 |
| Analog Class A/LPTV contour, VHF low = 62 |
| Analog Class A/LPTV contour, VHF high = 68 |
| Analog Class A/LPTV contour, UHF = 74 |
| Use UHF dipole adjustment = Yes |
| Dipole center frequency = 615 |
| Propagation curve set, digital = F(50,90) |
| Propagation curve set, analog = F(50,50) |
| Truncate DTS service area = No |
| DTS distance limit, VHF low Zone I = 108 |
| DTS distance limit, VHF low Zone II/III = 128 |
| DTS distance limit, VHF high Zone I = 101 |
| DTS distance limit, VHF high Zone II/III = 123 |
| DTS distance limit, UHF = 103 |
| HAAT radial count = 8 |
| Minimum HAAT = 30.5 |
| Contour radial count = 360 |
| Service distance limit, VHF low = 0 |

| | |
|---|---|
| Service distance limit, VHF high = 0 | |
| Service distance limit, UHF = 0 | |

**Replication**

| |
|---|
| Replication method = Equal area |
| Digital full-service minimum ERP, VHF low = 1 |
| Digital full-service minimum ERP, VHF high = 3.2 |
| Digital full-service minimum ERP, UHF = 50 |
| Digital full-service maximum ERP, VHF low Zone I = 10 |
| Digital full-service maximum ERP, VHF low Zone II/III = 45 |
| Digital full-service maximum ERP, VHF high Zone I = 30 |
| Digital full-service maximum ERP, VHF high Zone II/III = 160 |
| Digital full-service maximum ERP, UHF = 1000 |
| Digital Class A/LPTV maximum ERP, VHF = 3 |
| Digital Class A/LPTV maximum ERP, UHF = 15 |

**Pathloss**

| |
|---|
| Longley-Rice error handling = Assume service |
| Receiver height AGL = 10 |
| Minimum transmitter height AGL = 10 |
| Digital desired % location = 50 |
| Digital desired % time = 90 |
| Digital desired % confidence = 50 |
| Digital undesired % location = 50 |
| Digital undesired % confidence = 50 |
| Analog desired % location = 50 |
| Analog desired % time = 50 |
| Analog desired % confidence = 50 |
| Analog undesired % location = 50 |
| Analog undesired % confidence = 50 |
| Signal polarization = Horizontal |
| Atmospheric refractivity = 301 |
| Ground permittivity = 15 |
| Ground conductivity = 0.005 |
| Longley-Rice service mode = Broadcast |
| Longley-Rice climate type = Continental temperate |

**Service**

| |
|---|
| Set service thresholds = No |

**Clutter**

| |
|---|
| Apply clutter adjustments = No |

## 2.3 Relevant Output Files from TVStudy

*TVStudy* provides the following output files (in .csv format) with the specified data elements, which are used in developing the constraint files:

### A. Stations.csv

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| facilityid | integer | The unique integer number (assigned by MB) that identifies a station | 24518 |
| channel | integer | Channel assignment | 32 |
| des (desired) flag | integer | 0=Station was not studied as desired; its coverage was not evaluated<br>1=Station was studied as desired; its coverage was evaluated | 1 |
| und (undesired) flag | integer | 0=Station was not studied as undesired; it could not cause interference to desired stations<br>1=Station was studied as undesired; it may contribute interference to desired stations | 1 |
| servicetypekey | varchar(2) | Type of service the facility provides | DT |
| callsign | varchar(10) | Callsign of facility | KDOC-TV |
| city | varchar(25) | City in which the station is located | ANAHEIM |
| state | varchar(2) | State in which the station is located | CA |
| countrycode | varchar(2) | Country: US, CA, MX | US |
| status | varchar(5) | Status | LIC |
| filenumber | varchar(25) | Station file number | BLCDT20060626ACV |

**Description:** This file lists all stations on the channels they are currently assigned in the study's "baseline scenario."[6] Thus, this file contains records exactly as they appear in the FCC's Consolidated Database System ("CDBS").[7] The des (desired) flag field in this table is a 1 if the station is flagged for study in the baseline scenario (the "Des" box is checked in the UI), or 0 if not. Stations flagged as "desired" for study in the baseline scenario will have service and interference data in the other tables. Since the baseline scenario is built manually, such stations can be included or not, as desired.

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[6] The "baseline scenario" for purposes of this Technical Appendix includes a full power or Class A television station's channel and operating parameters reflected in its license, or pending application for license to cover a construction permit, on February 22, 2012, as preliminarily determined by staff. The "baseline" scenario also includes construction permits, granted pursuant to court order, modifying the facilities of KJWY(TV), Wilmington, DE and KVNV(TV), Middletown Township, NJ. As discussed further below, the baseline scenario is limited to facilities the Commission must seek to preserve based on the proposed statutory interpretation in the NPRM, facilities the Commission proposed to seek to preserve as a matter of discretion, and two facilities that were the subjects of a court order. As discussed in the Public Notice, the inclusion or exclusion of facilities in the baseline scenario is intended for study purposes only and does not indicate which facilities the Commission will ultimately make all reasonable efforts to preserve in the repacking. Interested parties may add facilities to, or subtract facilities from, the baseline scenario to analyze different preservation assumptions using the process described herein, and the Task Force invites submissions based on such analyses.

[7] FCC Consolidated Database System, *available at* http://transition.fcc.gov/mb/databases/cdbs/.

## B. Baseline.csv

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| facilityid | integer | The unique integer number (assigned by MB) that identifies a station | 24518 |
| channel | integer | Channel assignment | 32 |
| countrykey | integer | Country: 1= US, 2= Canada, 3 = Mexico | 1 |
| noiselimitedarea | numeric | The area within noise-limited contour | 43,048 |
| noiselimitedpopulation | numeric | The population within the noise-limited contour | 17,560,396 |
| terrainlimitedarea | numeric | The area within the noise-limited contour excluding cells blocked by terrain | 33,625 |
| terrainlimitedpopulation | numeric | The population within the noise-limited contour excluding cells blocked by terrain | 16,074,975 |
| interferencefreearea | numeric | The area within the noise-limited contour excluding the area of cells blocked by terrain and of cells with interference from other stations | 33,465 |
| interferencefreepopulation | numeric | The population within the noise-limited contour excluding the population of cells blocked by terrain and of cells with interference from other stations | 15,982,341 |

**Description**: This file lists the coverage area and population totals for stations as they appear in the baseline scenario, including interference from all stations included in the baseline scenario whether or not they are part of the pair study.[8] When a station has coverage in more than one country, there will be multiple rows in this table for that facility ID and channel, one per country, with the countryKey indicating which row corresponds to coverage in each country.

## C. Replication.csv

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| facilityid | integer | The unique integer number (assigned by MB) that identifies a station | 40517 |
| channel | integer | Channel assignment on proxy channel | 3 |
| countryKey | integer | Country: 1= US, 2= Canada, 3 = Mexico | 1 |
| noiselimitedarea | numeric | The area within noise-limited contour | 18,011 |
| noiselimitedpopulation | numeric | The population within the noise-limited contour | 383,630 |
| terrainlimitedarea | numeric | The area within the noise-limited contour excluding cells blocked by terrain | 17,659 |
| terrainlimitedpopulation | numeric | The population within the noise-limited contour excluding cells blocked by terrain | 383,392 |

**Description:** This file lists the coverage totals for stations involved in a pair study after replication to a "proxy channel" in each band.[9] Each station will have a row for each channel studied.

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[8] More specifically, the baseline scenario includes the set of aggregate population and area data (1) within the station's noise-limited service contour ("noise-limited"), (2) not affected by terrain losses ("terrain-limited"), and (3) not lost to interference from other stations ("interference-free"). When determining a U.S. station's interference-free population, we considered existing interference coming from other U.S. stations, as well as predicted interference from existing Canadian and Mexican allotments. These data are an output of the software that implements OET Bulletin 69. *See* OET Bulletin 69 at 12.

[9] In § 6403 (b)(3) of the Spectrum Act, Congress has instructed the FCC that it may not involuntarily reassign a broadcast television licensee from one of these bands to another. *See* Middle Class Tax Relief and Job Creation Act

Given the computational burden of considering each station pair on every possible channel during a multi-round auction, Commission staff selected a single channel in each of the three television spectrum bands as a proxy for that band to conduct the pairwise study. In this analysis, Channel 20 is used for replication of stations in the UHF television band, which ranges from 470 MHz to 698 MHz (Channels 14 to 51). Channel 10 is used for replication of stations in the high VHF television band, which ranges from 174 MHz to 216 MHz (Channels 7 to 13). Channel 3 is used for replication of stations in the low VHF television band, which ranges from 54 MHz to 88 MHz (Channels 2 to 6).

Staff recognizes that both coverage and interference may vary from channel to channel within each band, but notes that if the Commission were to ultimately adopt an approach that uses proxy channels in its feasibility checking during the incentive auction bidding process, the Commission could analyze the variance between the proxy channel and a provisional channel assignment at the end of the reverse auction bidding process and attempt to address any variances by considering alternative assignments for stations during the final channel assignment process.[10]

*NOTE: For illustrative purposes, staff used the following proxy channels for its replication studies:*

        a.  *Channel 3 – proxy channel for low VHF band*
        b.  *Channel 10 –proxy channel for high VHF band*
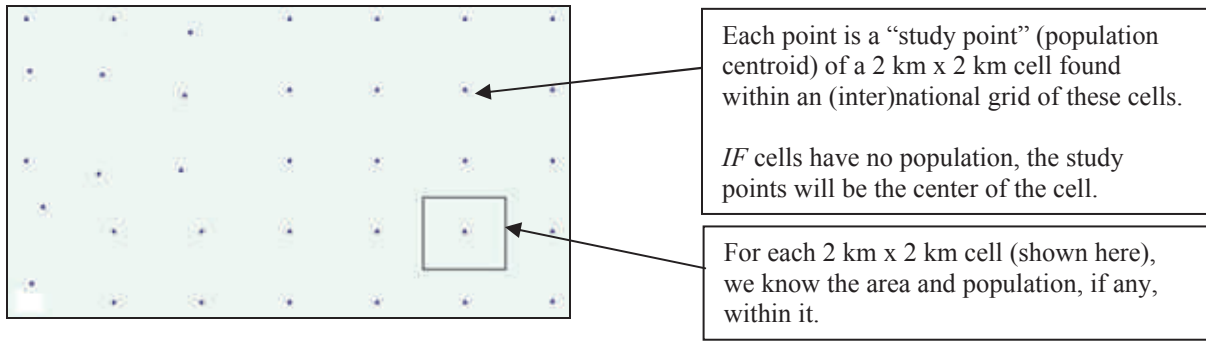        c.  *Channel 20 – proxy channel for UHF band*

## D. Points.csv

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| pointkey | integer | Unique identifier of 2x2km cell | 52571303 |
| celllatitudeindex | integer | Identifier of cell point latitude | 114205 |
| celllongitudeindex | integer | Identifier of cell point longitude | 421036 |
| countrykey | integer | Country: 1= US, 2= Canada, 3 = Mexico | 3 |
| latitude | numeric | latitude of study point within the cell (pop. Centroid) | 32 |
| longitude | numeric | longitude of study point within the cell (pop. Centroid) | 117 |
| area | numeric | Area of the 2x2 cell (in square kilometers) | 4 |
| population | numeric | Population of the cell | 0 |

**Description:** This file provides the location (latitude, longitude and country) of each 2 km x 2 km cell involved in the study. It also provides the area of and population within each cell. This is a lookup table for use with the service and interference tables.

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of 2012 (Spectrum Act), Pub. L. No. 112-96, § 6403(b)(3), 125 Stat. 156 (2012). Inclusion of data for all bands allows for the possibility of voluntary band changes.

[10] The Commission could, for example, use *TVStudy* to compare each station's interference-free population on a provisional channel (the channel provisionally assigned to the station during the auction as being feasible based on interference calculations using proxy channels) to the station's baseline interference-free population and then use optimization algorithms to attempt to mitigate interference for cases that exceed a threshold by reassigning the station to another feasible channel.

Each point is a "study point" (population centroid) of a 2 km x 2 km cell found within an (inter)national grid of these cells.

*IF* cells have no population, the study points will be the center of the cell.

For each 2 km x 2 km cell (shown here), we know the area and population, if any, within it.

## E. Service.csv

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| pointkey | integer | Unique identifier of 2x2km cell | 52571303 |
| facilityid | integer | The unique integer number (assigned by MB) that identifies a station | 10238 |
| channel | integer | Channel assignment | 18 |
| serviceflag | integer | 1 = acceptable coverage signal, 0 = unacceptable signal | 1 |

**Description:** This file lists study points that are within the service contours of stations studied, with points for each studied channel (baseline or proxy) tabulated separately. In the service table when the serviceFlag is 0, the point is inside the station's contour on that particular channel so the point is part of the noise-limited coverage, but the terrain-limited signal strength is below the applicable coverage threshold so the point is not part of the terrain-limited coverage.

## F. Interference.csv

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| pointkey | integer | Unique identifier of 2x2km cell | 55442949 |
| facilityid | integer | The unique integer number (assigned by MB) that identifies a station | 38430 |
| channel | integer | Channel assignment of studied station | 3 |
| interferingfacilityid | integer | The station identifier of the interfering station | 58,978 |
| interferingchannel | integer | The channel assignment of the interfering station | 3 |

**Description:** This file lists all points of interference found between all stations in the study, with each channel tabulated separately. For each facility, this table provides a list of points that have interference on their current channel and proxy channels, as well as the station causing that interference. For each channel assignment (both current and proxy) of the studied station, this table provides co-channel (Channel N), upper-adjacent (Channel N+1), and lower-adjacent (Channel N-1) interference caused by the interfering stations having those channel relationships. ??

*NOTE: TVStudy uses the default "culling" distances when determining which stations to consider in its replication scenarios (both current and proxy):*

   a) *When considering co-channel interference, TVStudy uses a default culling distance of* <u>*429 km*</u>.

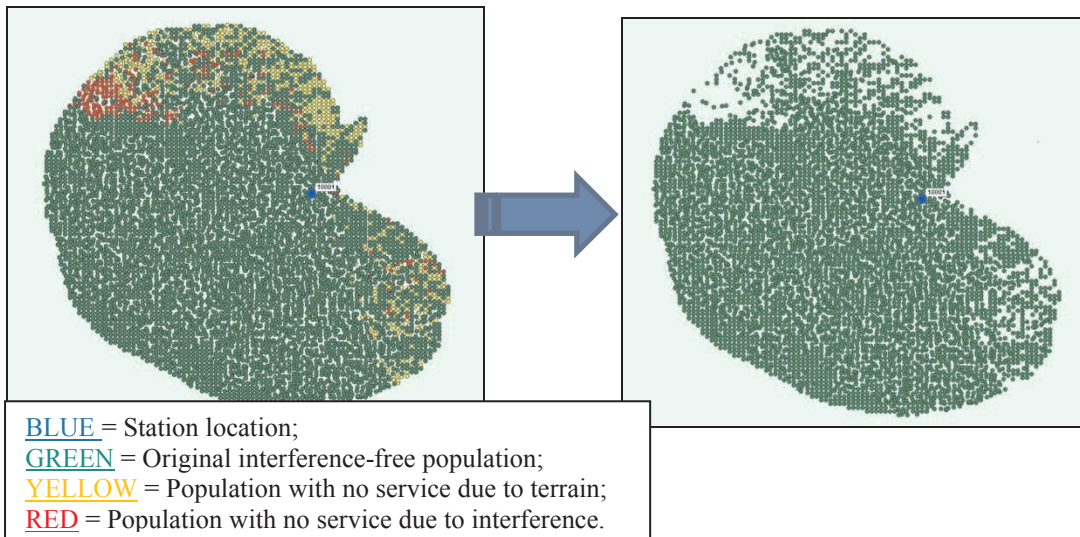b) *When considering adjacent channel interference, TVStudy uses a default culling distance of 229 km.*

*These default "culling distances" are cell-to-transmitter distances and are based on culling distances specified in Table 7 of the OET Bulletin 69[11] plus an additional distance margin.* **??????**

## 2.4 Post Processing of TVStudy Data into Pairwise Constraints (Option 2)

Some post processing of the truth tables generated by *TVStudy* is required to turn the cell-level data into pairwise constraints. As stated above, the NPRM specified three interference protection options for making all reasonable efforts to preserve "population served" in the repacking process.[12]  For purposes of this study, staff developed pairwise constraints using Option 2 where a single interfering station, when examined alone, is not permitted to reduce the interference-free population of a current station (moved to a proxy channel) by *more than* 0.5%.

**Example:**  Assessing the impact on Station 10001's interference-free population[13] caused by Station 10002 when studied on proxy channel 3.

**STEP 1:**  Determine the interference free population of Station 10001 on its existing channel 9. This is its baseline interference free population.



BLUE = Station location;
GREEN = Original interference-free population;
YELLOW = Population with no service due to terrain;
RED = Population with no service due to interference.

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[11] *See* OET Bulletin 69 at 12 Table 7 (providing guidance on how to cull undesired stations based on maximum distances from cell to undesired stations; more specifically, OET Bulletin 69 requires a culling distance of 300 km when considering DTV-to-DTV co-channel interference and 100 km when considering DTV-to-DTV adjacent channel interference).

[12] NPRM, 27 FCC Rcd at 12392 ¶ 103 (stating "we propose three alternative approaches to fulfilling the requirement to make all reasonable efforts to preserve population served in the repacking process.").

[13] Staff defined "interference-free population" as the station's "population served" at its original or existing channel for purposes of this study.  *See supra* text accompanying note 5 (defining interference-free service or population). When determining the baseline interference-free population for U.S. stations, we considered existing interference coming from other U.S. stations, as well as predicted interference from existing Canadian and Mexican allotments.

**STEP 2:** From the interference table, find Station 10001's interference (in cells that were part of Station 10001's baseline interference-free population) on proxy channel 3 caused by Station 10002 on a co-channel (channel 3) or an adjacent channel (channels 2 or 4).



BLUE = Station location;
GREEN = Original interference-free population;
ORANGE = Interference caused by Station 10002;
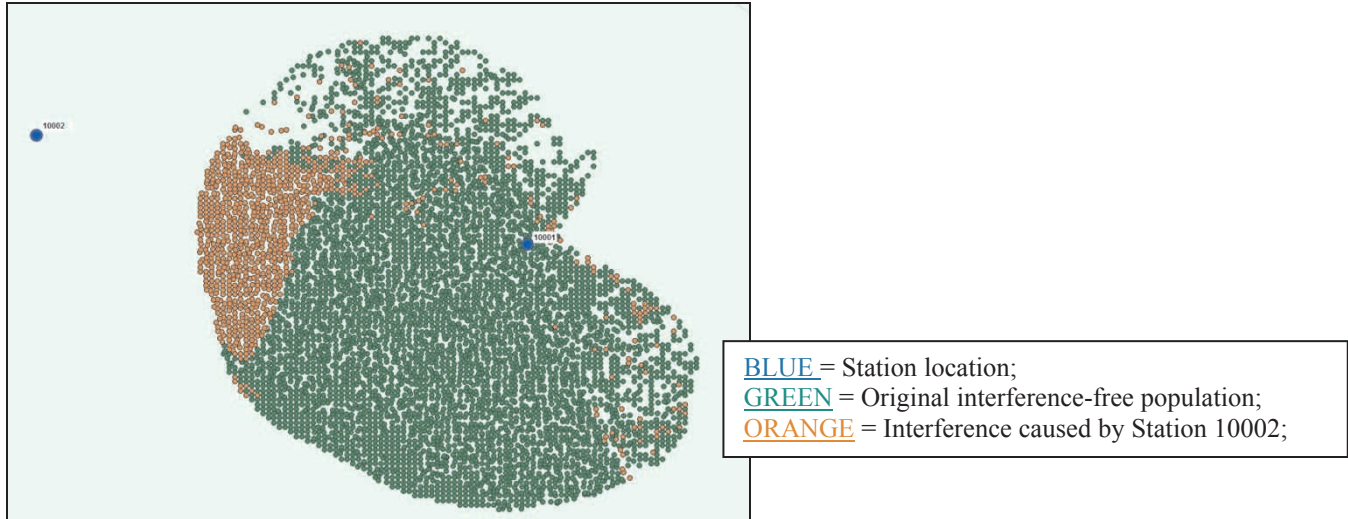
| | pointkey integer | facilityid integer | channel integer | interferingfacilityid integer | interferingchannel integer |
|---|---|---|---|---|---|
| 1 | 59899596 | 10001 | 3 | 10002 | 3 |
| 2 | 59929509 | 10001 | 3 | 10002 | 3 |
| 3 | 59959419 | 10001 | 3 | 10002 | 3 |
| 4 | 59989329 | 10001 | 3 | 10002 | 3 |
| 5 | 60019239 | 10001 | 3 | 10002 | 3 |
| 6 | 60049149 | 10001 | 3 | 10002 | 3 |
| 7 | 60049152 | 10001 | 3 | 10002 | 3 |
| 8 | 60079041 | 10001 | 3 | 10002 | 3 |
| 9 | 60079059 | 10001 | 3 | 10002 | 3 |
| 10 | 60079062 | 10001 | 3 | 10002 | 3 |

From the interference table, Station 10001 (on proxy channel 3) receives co-channel interference from Station 10002 (also on channel 3) in the ten cells indicated.

**NOTE:** For each of the three proxy channels considered by the FCC (3, 10, 20), interference analysis is conducted for the co-channel, and upper-and lower-adjacent channels.[14] Thus, nine separate calculations must be made and compiled into pairwise constraints.

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[14] Protecting each channel from co-channel and upper- and lower-adjacent channel interference is consistent with OET Bulletin 69 for Digital Television to Digital Television Protections. *See* OET Bulletin 69 at 8 Table 5A (providing interference criteria for co- and adjacent channels).

**STEP 3:** Sum the population of the points causing interference (shown in ORANGE) on Station 10001's baseline interference-free population.

*Sum of Population of Interference Points for Station 10001 on proxy channel caused by Station 10002* = 180,844

*Baseline Interference-Free Population for Station 10001 on current Channel* = 1,709,743

*Percent of Baseline Interference-Free Population impacted by this potential assignment* = 180,844/1,709,743 = **10.58%**

**>>> Since 10.58% is greater than 0.5%,[15] Station 10001 on proxy channel 3 <u>cannot exist</u> with Station 10002 also on channel 3, so a constraint is added to the Interference_Paired file to reflect that fact.**

**NOTE*:*** In a small number of cases, the study station (in this example, Station 10001) may see a change (gain or loss) in its original interference-free population (as calculated by *TVStudy* on its original channel) because its noise-limited population changed on the replicated proxy channel due to the use by *TVStudy* of an "equal area" approach to replication rather than replicating the original noise-limited contour. The choice of an "equal area" or "contour distance" approach to replication is discussed in the NPRM.[16]

Similarly, the study station could see a change (gain or loss) in its interference-free population (as calculated by *TVStudy* on its original channel) because its terrain-limited population on the replicated proxy channel changed. This could be the case even if *TVStudy* was able to replicate exactly the original noise-limited contour because of differences in propagation losses on the new proxy channel due to terrain.

For purposes of creating the constraint files referenced in this **Technical Appendix**, the staff did not count any changed population cells (either due to changes in noise-contour or terrain-limited contour) in determining whether the 0.5% threshold is reached. As noted above, if the Commission were to ultimately adopt an approach that uses proxy channels in its feasibility checking, the Commission could analyze the variance between interference on the proxy channel and a provisional channel assignment at the end of the reverse auction bidding process and attempt to address any variances by considering alternative channel assignments for stations during the final channel assignment process.

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[15] The NPRM proposes to define "*de minimis*" interference as not allowing greater than 0.5% additional interference. *See* NPRM, 27 FCC Rcd at 12394 ¶ 106.

[16] *See* NPRM, 27 FCC Rcd at 12391 ¶ 100.

# 3. Generating *Domain* and *Interference_Paired Files*

## 3.1 Overview

The Task Force is making available two files in conjunction with this **Technical Appendix** for each station:

> (1) a *Domain file* (called Domain_2013July15.csv)

> (2) an *Interference_Paired file*. (called Interference_Paired_2013July15.csv)

A link to these files will be posted on the FCC LEARN website under the Repacking Section at http://wireless.fcc.gov/incentiveauctions/learn-program/repacking.html.  Alternatively, one will find these files posted at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.

As mentioned previously, these files are based on preliminary assumptions by the staff and are for illustrative purposes; they do not reflect any decisions made by the Commission.  Moreover, these files do not reflect which channels ultimately will be assigned to television stations in the repacking process or how the Commission will select bids in the reverse auction.  However, these files could be used by interested parties to perform their own repacking analyses based on their own assumptions about which stations stay on the air and are assigned channels.

These files define constraints based on the domain of available channels and interference between stations on different bands, respectively.

To generate the *Domain* and *Interference_Paired files*, the staff combined the interference "truth tables" generated by *TVStudy* with additional fixed constraints imposed by Land Mobile ("LM"), Land Mobile Waiver ("LMW" - which are LM stations operating under waiver), Canadian television allotments, Mexican television allotments and Channel 37 incumbents.  We provide an overview of the process below in **Sections 3.2** through **3.6**.  Like pairwise constraints between U.S. stations, pairwise constraints between U.S. and Canadian allotments are also based on interference calculations from the *TVStudy* software.  LM, LMW and Mexican television allotments, however, are protected by distance restrictions.

**Section 4** provides more detailed information on each of these sources of constraints including any preliminary assumptions made by the staff as they relate to each of these inputs.

## 3.2 Step One:  Input and Map Relevant Data

The first step in creating the constraint files is to collect the data inputs that are relevant for generating the constraints.  These include the following:

(a) List of U.S. stations considered for the baseline (called US_Station_Baseline_2013July15.xlsx);
(b) List of Canadian broadcast television allotments (analog and digital) along the U.S.-Canadian border (called Canadian_Allotment_List_2013July15.xlsx);
(c) List of Mexican broadcast television allotments (analog and digital) along the U.S.-Mexican border (called Mexican_Allotment_List_2013July15.xlsx);
(d) List of LM stations (called LM_City_Center_List_2013July15.xlsx);
(e) LMW stations (operating under a waiver) (called LMW_Station_List_2013July15.xlsx)

These files will be available for download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.

We provide a sample of the type of data captured in each of the data input files for illustrative purposes immediately below.

| U.S. Stations (excluding territories) (2,177) | Canadian Allotments (2,557) | Mexican Allotments (603) |
|---|---|---|
| 1. Facility ID<br>2. Call Sign<br>3. Channel<br>4. Service Type<br>5. Specs<br>6. Latitude/Longitude | 1. Facility ID<br>2. Call Sign<br>3. Channel<br>4. Service Type<br>5. Specs<br>6. Latitude/Longitude | 1. Facility ID<br>2. Call Sign<br>3. Channel<br>4. Service Type<br>5. Specs<br>6. Latitude/Longitude |
| | **LM City Centers (25)**<br>1. Facility ID<br>2. Call Sign<br>3. Channel<br>4. Fixed/Mobile<br>5. Latitude/Longitude | **LMW Stations (424)**<br>1. Facility ID<br>2. Call Sign<br>3. Channel<br>4. Fixed/Mobile<br>5. Latitude/Longitude |

In **Section 4**, we revisit each of these data inputs, providing the complete list of preliminary assumptions necessary for interested parties looking to recreate the constraint files for themselves.  We also provide the list of fields and their formats for each of these data input files.

Second, once all the relevant data is captured, staff applied the relevant interference rules to do the following:

1) Map the protection zones for fixed constraints (*e.g.*, land mobile incumbents).
2) Cull the relevant set of stations that need to be considered for each station's pairwise constraints.



**APPLY INTERFERENCE RULES**
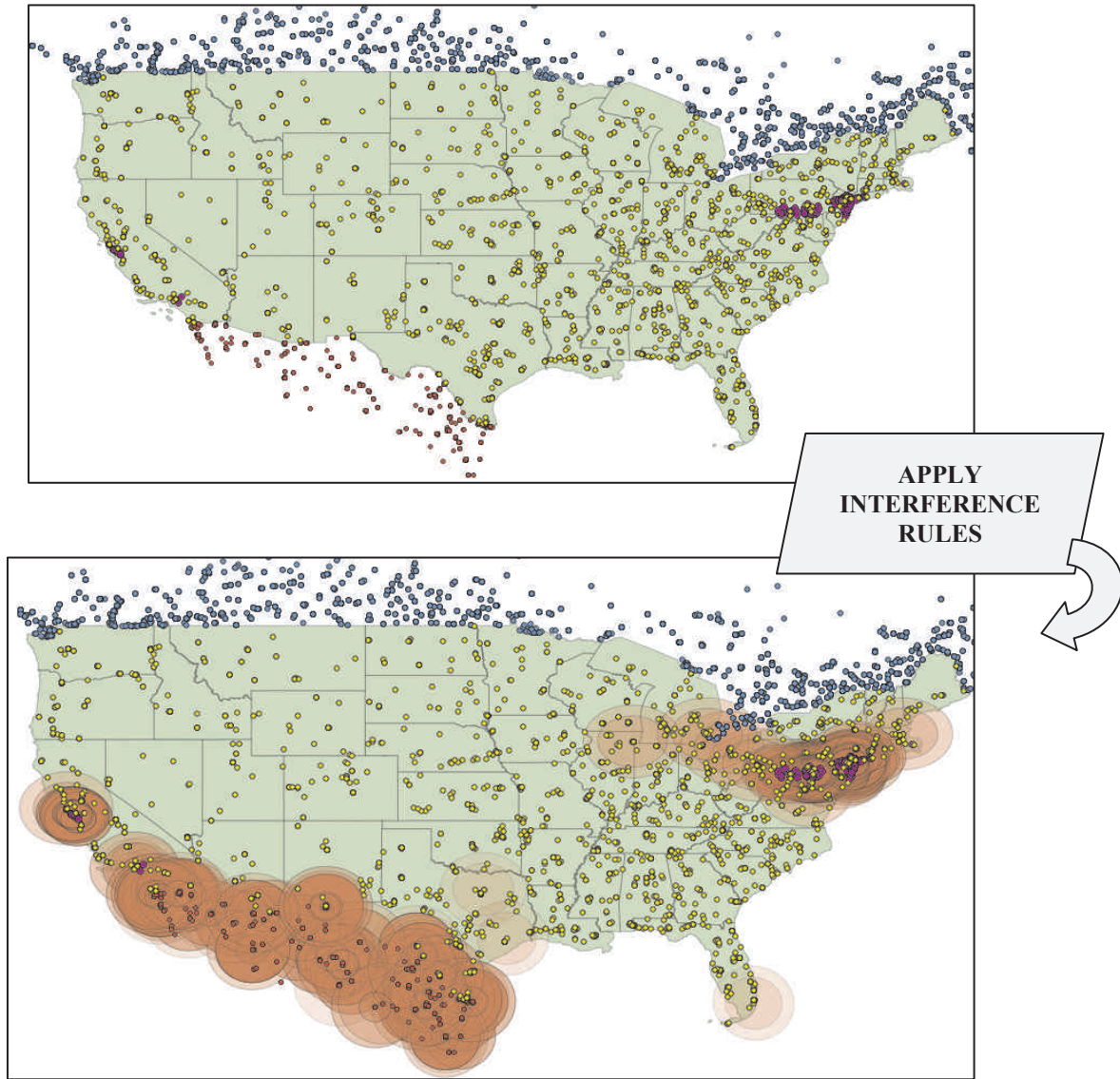
**NOTE**: Green dots represent U.S. DTV and Class A stations; blue dots represent Canadian allotments, red dots represent Mexican allotments; orange circles represent fixed, distance-based constraints.

## 3.3 Step Two:  Generating the *Domain File*

In order to protect LM base stations, LMW base stations, Mexican allotments, Canadian allotments and Channel 37, the FCC staff had to consider these as fixed constraints which will limit the channels on which any U.S. television station can be assigned or reassigned in the incentive auction repacking process.  These fixed constraints reduce the number of available channels listed in the *Domain file* for each station (a station cannot be assigned a channel that does not appear in the *Domain file*).

As shown in the graphics below, Land Mobile (LM and LMW) and Mexican allotments are fixed constraints that are based on distance separation, whereas Canadian stations are fixed constraints based on interference calculations using OET Bulletin 69.  In addition, for purposes of this analysis, staff removed Channel 37 from the list of available channels.

This section is meant to provide a quick snapshot of the rules associated with each of the constraints that impact the *Domain file*.  More detailed staff assumptions necessary for creating the constraints associated with each of these data inputs are provided in **Section 4**.

# LAND MOBILE[17]
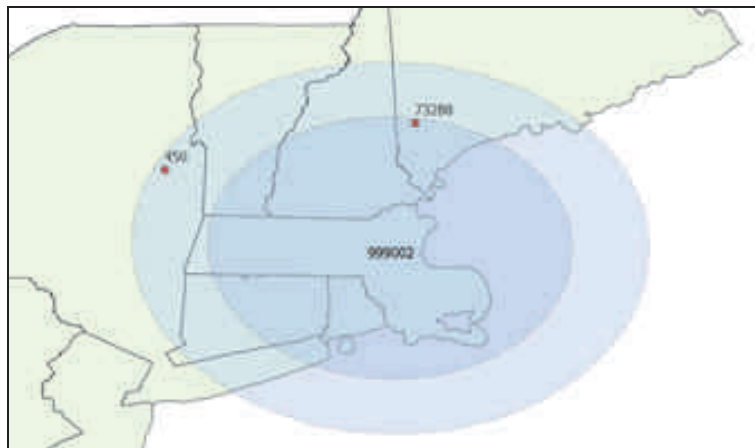


| US and Land Mobile Operations | DTV to Land Mobile (LM) City Center | DTV to LM Waiver (LMW) Base Station |
|---|---|---|
| Co-Channel: | 250 km | 185 km |
| Adjacent Channel: | 176 km | 96 km |

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[17] So-called "television band" ("T-Band") land mobile licensees have been granted certain interference protections from broadcast television stations operating in co- or adjacent channels.   Under current FCC rules, the Commission does not accept petitions to amend the Digital Television ("DTV") Table of Allotments, applications for new DTV stations, or applications to change the channel or location of authorized DTV stations that would use channels 14 – 20 where:  (a) the distance between the DTV reference point would be located less than 250 km from the city center of a co-channel land mobile operation; or (b) the distance between the DTV reference point would be located less than 176 km from the city center of an adjacent channel land mobile operation.  *See* 47 C.F.R. § 73.623(e).  Staff derived similar distance separation requirements for Land Mobile Waiver base stations from the rules for traditional Land Mobile operations as well as additional staff analysis further explained in Section 4 of this Technical Appendix.

# MEXICO[18]
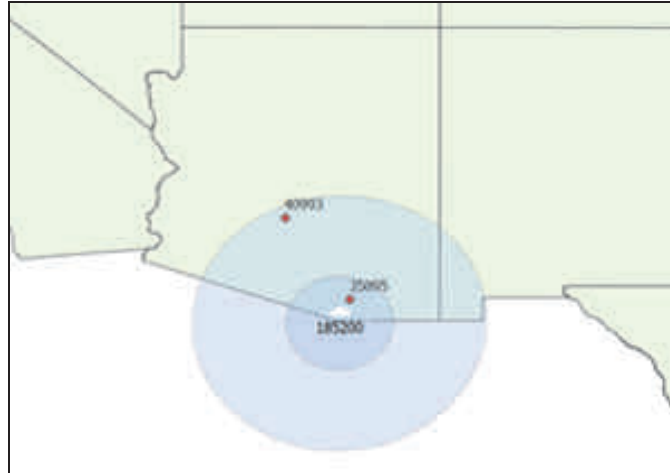


| US and Mexico Operations | DTV to DTV Station | DTV to NTSC Station |
|---|---|---|
| Co-Channel VHF: | 273 km | 273 km |
| 1st Adj. Channel VHF: | 48-96 km | 18-100 km |
| Co-Channel UHF: | 223 km | 244 km |
| 1st Adj. Channel UHF: | 32-88 km | 10-88 km |
| ± 2 UHF: | - | 24-32 km |
| ± 3 UHF: | - | 24-32 km |
| ± 4 UHF: | - | 24-32 km |
| ± 7 UHF: | - | 24-95 km |
| ± 8 UHF: | - | 24-32 km |
| + 14 UHF: | - | 24-95 km |
| + 15 UHF: | - | 24-96 km |

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[18] The DTV arrangement with Mexico applies to territory of the United States and Mexico within 275 km of the U.S.-Mexico border.  Because Mexico has not yet completed its DTV transition, the FCC must consider interference not just between U.S. stations and Mexican DTV allotments (either occupied by a Mexican DTV station or vacant), but also interference between Mexican analog (NTSC) allotments (either occupied by a Mexican NTSC station or vacant) and U.S. DTV stations operating in border regions.  The DTV arrangement specifies minimum distance separations between DTV stations operating on the same or adjacent channels.   The arrangement also specifies minimum distance separations between DTV stations and NTSC stations. *See* Memorandum of Understanding between the Federal Communications Commission of the United States of America and the Secretaria De Comunicaciones Y Transportes of the United Mexican States Related to the Use of the 54-72 MHz, 76-88 MHz, 174-216 MHz and 470-806 MHz Bands for the Digital Television Broadcasting Service Along the Common Border (1998) (1998 USA-Mexico DTV Memorandum of Understanding).

# CANADA[19]
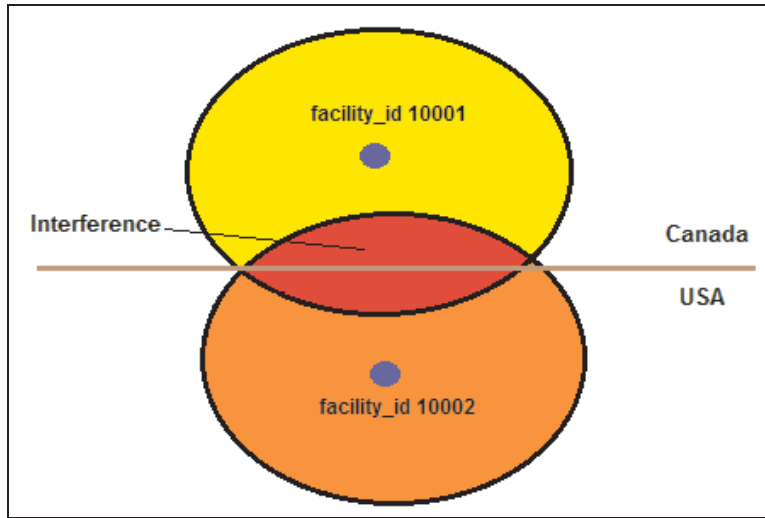


| Desired: Canadian Station | Channel (Canada) | Undesired: USA Station | Channel (USA) | % POP |
|---|---|---|---|---|
| 10001 | 43 | 10002 | 42 | 0.55 |
| 10001 | 43 | 10002 | 43 | 5.26 |
| 10001 | 43 | 10002 | 44 | 0 |

# CHANNEL 37

Channel 37 is currently allocated for radio astronomy and wireless medical telemetry[20] and for purposes of this preliminary analysis is assumed to be unavailable as a channel for repacking.

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[19] The current agreement with Canada defines the interference protection requirements using the methodology described in OET Bulletin 69. In 2008 Industry Canada defined its long-term DTV needs in its post-transition allotment plan, which was finalized through an Exchange of Letters ("EOL") with the FCC. Canada's plan provides a digital replacement channel on channels 2 to 51 for each full-service analog operation within 360 km of the common border. The plan also incorporates numerous vacant allotments as placeholders for potential future use. In addition, for those analog ("NTSC") Canadian stations outside of urban areas that are not mandated to convert to digital, we use the relevant interference protections for analog allotments. *See* Exchange of Letters Between Canada and the United States Concerning Digital Television, Dec. 20, 2008 (2008 USA-Canada DTV Exchange of Letters). *See also* 2000 USA-Canada DTV Letter of Understanding (describing modifications to the table of allotments for analog television stations). For purposes of this analysis only and as further described in Section 4 of this Technical Appendix, to determine whether a repacked U.S. Station can be co-channel or adjacent channel to a Canadian allotment we follow the same approach applied to the study of interference between U.S. DTV stations. This requires using *TVStudy* software to determine the current interference-free populations of each Canadian allotment (digital or analog) and then performing interference calculations with all possible U.S. stations (within the culling distance) on a co-channel and an upper- and lower-adjacent channel according to OET Bulletin 69. However, because Canadian allotment channels were assumed to be fixed, *TVStudy* did not use proxy channels when performing these calculations; rather, only their current channel was used.

[20] 47 C.F.R. §2.106. "Table of Frequency Allocations".

### 3.4 *Domain File*

For each U.S. TV station, the *Domain file* provides a list of channels that the station may be assigned to in the incentive auction repacking process taking into account the fixed constraints highlighted in **Section 3.3**.[21]

A sample of the comma-delimited format of this file appears immediately below (it is a sample and does not reflect real station data). This demonstrated format should match exactly the released preliminary *Domain file* (called Domain_2013July15.csv) to be made available for download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.

## PRELIMINARY *Domain File Format*:

**Station ID**                                                          **Available Channels**

```
DOMAIN, 10001, 2, 3, 4, 5, 6, 19, 20, 21, 48, 49, 50, 51
DOMAIN, 10002, 2, 3, 4, 5, 6, 7, 8, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 38, 39, 40, 41, 47, 48, 49, 50, 51
DOMAIN, 10003, 2, 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 34, 35, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51
DOMAIN, 10004, 2, 3, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45
DOMAIN, 10005, 2, 3, 4, 5, 6, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47,
DOMAIN, 10006, 2, 3, 4, 5, 6, 7, 8, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 34, 35, 36, 38, 39, 40, 41, 42, 46, 47, 48, 49, 50, 51
DOMAIN, 10007, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 21, 22, 23, 24, 25, 26, 27, 49, 50, 51
DOMAIN, 10008, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50,
DOMAIN, 10009, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 25, 26, 27, 28, 29, 35, 36, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51
```

### *In words, the first line reads:*

In re-packing, Station #10001 may only be placed on channels 2, 3, 4, 5, 6, 19, 20, 21, 48, 49, 50, or 51. A channel assignment algorithm could not place Station #10001 on any other channel.

### 3.5 Step Three:  Generating the *Interference_Paired File*

In this step, the post-processed *TVStudy* output data detailed in **Section 2** is incorporated into the *Interference_Paired file*. As described previously, staff used *TVStudy* to analyze pairs of U.S. stations and assigned proxy channels in low VHF (based on analysis conducted on proxy channel 3), high VHF (based on proxy channel 10) and UHF (based on proxy channel 20). Again, under Option 2 from the NPRM, for each station pair scenario, if the interfering station reduces the baseline interference-free population by more than 0.5%, those two stations cannot exist on that pair and a constraint is created to reflect that prohibition.

---

[21] Section 6403 (b)(3) of the Spectrum Act states that the Commission may not involuntarily reassign a UHF broadcast television licensee to the VHF band or a high VHF broadcast television licensee to the low VHF band. *See* Spectrum Act § 6403 (b)(3). Nonetheless, channels in bands below a licensee's current band may still appear in its *Domain file* record because the licensee may voluntarily choose to relinquish its usage rights in its current television band in exchange for compensation from auction proceeds and the right to broadcast in a lower band. *See* Spectrum Act § 6403 (a)(2) (defining eligible relinquishment options in the reverse auction). Moreover, the *Domain file* may also contain channels in bands above a licensee's current band because in certain limited instances such involuntarily moves may be permitted. *See* Spectrum Act § 6403 (g)(1)(B).

This section provides an overview of how the *Interference_Paired file* is created with more detailed staff assumptions listed in **Section 4,** which may be necessary to replicate the results of the sample files.

## 1. GENERATE STATION PAIRS

| Station1 | Proxy Channel | Station2 | Channel2 |
|----------|---------------|----------|----------|
| 10001 | 3 | 10002 | 2 |
| 10001 | 3 | 10002 | 3 |
| 10001 | 3 | 10002 | 4 |
| 10001 | 10 | 10002 | 9 |
| 10001 | 10 | 10002 | 10 |
| 10001 | 10 | 10002 | 11 |
| 10001 | 20 | 10002 | 19 |
| 10001 | 20 | 10002 | 20 |
| 10001 | 20 | 10002 | 21 |

## 2. RUN *TVSTUDY*
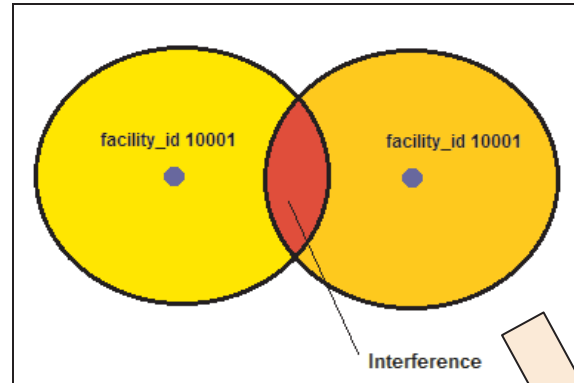


## 3. PERFORM POST PROCESSING

## 4. GENERATE RESULTS

| Station1 | Proxy Channel | Station2 | Channel2 | % POP |
|----------|---------------|----------|----------|-------|
| 10001 | 3 | 10002 | 2 | 0 |
| **10001** | **3** | **10002** | **3** | **2.66** |
| 10001 | 3 | 10002 | 4 | 0 |
| 10001 | 10 | 10002 | 9 | 0 |
| **10001** | **10** | **10002** | **10** | **3.03** |
| 10001 | 10 | 10002 | 11 | 0 |
| 10001 | 20 | 10002 | 19 | 0.29 |
| **10001** | **20** | **10002** | **20** | **3.83** |
| **10001** | **20** | **10002** | **21** | **0.63** |

### 3.6 Preliminary *Interference_Paired File*

For each station, the *Interference_Paired file* provides a list of other stations that cannot be assigned the same channel or an adjacent channel if the station were placed in one of the three television bands – (1) Low VHF (**divided into two bands due to spacing – a 4 MHz gap – between Channel 4 and Channel 5), (2) High VHF, or (3) UHF band.
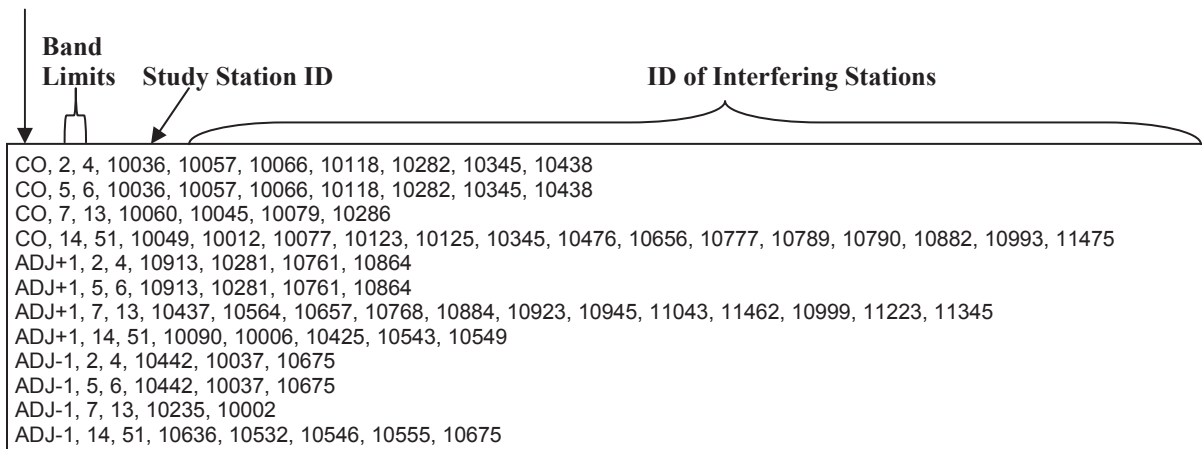
 This file includes:
- Interference type: co-channel, upper-adjacent channel, lower-adjacent channel

- Frequency Band:  Low VHF (Channels 2-4 and Channels 5-6), High VHF (Channels 7-13), and UHF (Channels 14-51), expressed in terms of the lowest and highest channels in the band ("band limits")
- Study Station:  The Facility ID of the Study Station
- Interfering Stations:  The Facility IDs of stations that cannot be assigned on a co-channel or adjacent channel in the spectrum band

A sample of the comma-delimited format appears below (it is a sample and does not reflect real station data) and this format is used in the preliminary *Interference_Paired file* (called Interference_Paired_2013July15.csv) to be made available for download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.

## PRELIMINARY *Interference_Paired File Format*:

**Interference Type**

**Band Limits**    **Study Station ID**                          **ID of Interfering Stations**

```
CO, 2, 4, 10036, 10057, 10066, 10118, 10282, 10345, 10438
CO, 5, 6, 10036, 10057, 10066, 10118, 10282, 10345, 10438
CO, 7, 13, 10060, 10045, 10079, 10286
CO, 14, 51, 10049, 10012, 10077, 10123, 10125, 10345, 10476, 10656, 10777, 10789, 10790, 10882, 10993, 11475
ADJ+1, 2, 4, 10913, 10281, 10761, 10864
ADJ+1, 5, 6, 10913, 10281, 10761, 10864
ADJ+1, 7, 13, 10437, 10564, 10657, 10768, 10884, 10923, 10945, 11043, 11462, 10999, 11223, 11345
ADJ+1, 14, 51, 10090, 10006, 10425, 10543, 10549
ADJ-1, 2, 4, 10442, 10037, 10675
ADJ-1, 5, 6, 10442, 10037, 10675
ADJ-1, 7, 13, 10235, 10002
ADJ-1, 14, 51, 10636, 10532, 10546, 10555, 10675
```

***In words, the first line reads:***
After re-packing, if Station #10036 is placed in the Low VHF band (channels 2 – 4 or channels 5 – 6), then Stations #10057, #10066, #10118, #10282, #10345, and #10438 cannot be placed on the **SAME** channel (co-channel).

***For example, in words, the seventh line reads:***
After re-packing, if Station #10437 is placed in the High VHF band (channels 7 – 13), then Stations #10564, #10657, #10768, #10884, #10923, #10945, #11043, #11462, #10999, #11223, #11345 cannot be placed on the first adjacent channel **ABOVE** it (*meaning cannot be upper-adjacent to Station #10437).*

***For example, in words, the twelfth (last) line reads:***
After re-packing, if Station #10636 is placed in the UHF band (channels 14 – 51), then Stations #10532, #10546, #10555, and #10675 cannot be placed on the first adjacent channel **BELOW** it (*meaning cannot be lower-adjacent to Station #10636*).

## 4. Details of Constraint Inputs and Assumptions

### 4.1 U.S. Stations to U.S. Stations (Option 2)

The list of U.S. stations (excluding U.S. territories) used in creating the sample *Interference_Paired* and *Domain files* are those listed in the U.S. Station Baseline List (in a file called US_Station_Baseline_2013July15) to be made available for download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.  In generating the list of US stations, staff used criteria consistent with the NPRM, which proposed to "interpret the mandate to preserve 'as of the date of this Act' to require preservation only with regard to facilities that were licensed, or for which an application for license to cover authorized facilities already was on file with the Commission, as of February 22, 2012."[22]  Thus, this list contains full power or Class A television station's that had a license, or license to cover application pending, on February 22, 2012, as preliminarily determined by staff, including Class A-Eligible LPTV stations that had a Class A license to cover application pending on February 22, 2012.

The U.S. Station Baseline List also includes certain authorized facilities the Commission proposed to protect in the NPRM, including: new full power television stations that held a construction permit, but not a license, by February 22, 2012; channel substitutions authorized in rulemaking proceedings completed by February 22, 2012; and the initial digital conversion facilities of Class A stations whether or not authorized prior to Feb. 22, 2012.[23]  Finally, it includes two facilities, which subsequent to the NPRM, were modified pursuant to federal court order.[24]

The facilities included in this list are intended for illustrative purposes only, so that interested parties can conduct an analysis of the technical aspects of repacking and auction design.  In order to release these files prior to adoption of a Report & Order in this proceeding, some assumptions had to be made about which facilities to include for protection.  Because the Commission has not yet decided which facilities will be protected, it was simplest to assume protection only of those facilities that the Commission must seek to preserve, based on the statutory interpretation proposed in the NPRM, as well as those facilities the Commission proposed in the NPRM to seek to preserve in the exercise of its discretion.  This does not in any way signal, however, which facilities the Commission ultimately will seek to preserve.  Interested parties may add

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[22] *See* NPRM, 27 FCC Rcd at 12390 ¶ 98 (citing the Spectrum Act Section 6403(b)(2), which mandates preservation of coverage area and population served for each "broadcast television licensee" which is defined as "the licensee of (A) a full power television station; or (B) a low power television station that has been accorded primary status as a Class A television station under Section 73.6001(a)" of the Commission rules).  *See* § 6403(b)(2); 47 C.F.R. §73.60001(a).

[23] *See* NPRM, 27 FCC Rcd at 12397 ¶ 114 (proposing to protect new full power television stations); *id.* at 12397 ¶ 115 (proposing to protect initial Class A digital conversion facilities); and *id.* at 12398 ¶ 116 (suggesting need to protect facilities authorized to effectuate a channel substitution).

[24] *PMCM LLC, TV v. FCC*, 701 F.3d 380 (D.C. Cir. 2012); *In the Matter of Reallocation of Channel 3 from Ely, Nevada to Middletown Township, New Jersey,* Report and Order, 28 FCC Rcd 2825 (MB 2013); *In the Matter of Reallocation of Channel 2 from Jackson, Wyoming to Wilmington, Delaware*, Report and Order, 28 FCC Rcd 2828 (MB 2013).

facilities to, or subtract facilities from, this list to analyze different preservation assumptions using the process described herein, and the Task Force invites submissions based on such analyses.

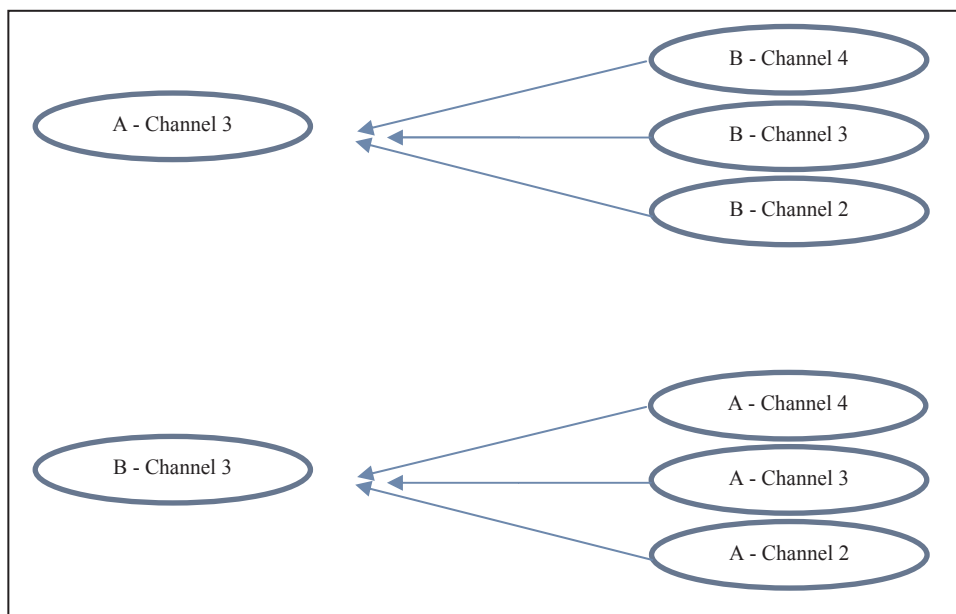The data contained and the format of this U.S. Station Baseline List is shown below:

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| channel | integer | Channel assignment | 14 |
| service | character varying(2) | The service (e.g., Digital Television Station, etc.) of interest.<br>a.    Where "DT" stands for Digital TV (the primary service of interest)<br>b.    Where Class A stations are indicated by "CA" and "DC".<br>c.    Where "DD" are Distributed Transmisson Systems (used actual facility coordinates for interference protection, but reference facility coordinates - which has ant_id of 0 - for distance protections) | CA |
| country | character varying(2) | Country  (where "US" = America, "CA" = Canada, "MX" = Mexico) | US |
| state | character varying(10) | State abbreviation | CO |
| city | character varying(50) | City | DENVER |
| lat | character varying(7) | Latitude of tower  (expressed in degrees, minutes and seconds as DDDMMSS) | 394345 |
| lon | character varying(7) | Longitude of tower (expressed in degrees, minutes and seconds as DDDMMSS) | 1051412 |
| fac_callsign | character varying(20) | Call Sign  (where a Call Sign is a set of characters that serve as the public identification for a broadcast radio or television station. For example, WCAU or WGBS-TV) | KDVR |
| arn | character varying(30) | Application Reference Number (CDBS assigned) | BLCDT20090917ACG |
| app_id | integer | Application ID (CDBS assigned) | 1331145 |
| status | character varying(10) | a.    Where "LICEN" stands for Licensed<br>b.    Where "CP Mod" stands for modification of construction permit | LICEN |
| haat | numeric | Height above average terrain (in meters)<br>a.     NOTE:  If the authorized antenna height above average terrain (HAAT) is zero or negative, the value in the table has been rounded up to a positive 0. | 314 |
| da | character varying(2) | Directional Antenna (whether a directional antenna is used - (Yes ("D"-digital/"C"-class A) or No ("No")) | D |
| erp | numeric | Effective Radiated Power (kW) | 1000 |
| facility_id | integer | The unique integer number (assigned by MB) that identifies a station | 126 |
| rcamsl | numeric | The height of the radiation center above mean sea level (meters) | 2323 |
| ref_az | numeric | Reference Azimuth (in whole degrees) | 0 |
| ant_id | integer | The CDBS-assigned antenna id number (an integer) | 101908 |

A few additional assumptions should be noted with respect to interference between U.S. to U.S. stations when the sample files were generated:

1) With respect to these pairwise constraints, interference between a pair of stations is generally not symmetric; that is, the interference station B causes station A is not the same as the interference station A causes to station B, rather both cases must be examined.  In determining whether a pair of stations can co-exist on a particular channel relationship, both relationships must be examined.

```
┌─────────────────────────────────────────────────────────────────────┐
│                                           ╭─────────────────╮         │
│                                           │  B - Channel 4  │         │
│                                           ╰─────────────────╯         │
│   ╭─────────────────╮                     ╭─────────────────╮         │
│   │  A - Channel 3  │ ◄─────────────────  │  B - Channel 3  │         │
│   ╰─────────────────╯                     ╰─────────────────╯         │
│                                           ╭─────────────────╮         │
│                                           │  B - Channel 2  │         │
│                                           ╰─────────────────╯         │
│                                                                       │
│                                           ╭─────────────────╮         │
│                                           │  A - Channel 4  │         │
│                                           ╰─────────────────╯         │
│   ╭─────────────────╮                     ╭─────────────────╮         │
│   │  B - Channel 3  │ ◄─────────────────  │  A - Channel 3  │         │
│   ╰─────────────────╯                     ╰─────────────────╯         │
│                                           ╭─────────────────╮         │
│                                           │  A - Channel 2  │         │
│                                           ╰─────────────────╯         │
└─────────────────────────────────────────────────────────────────────┘
```

In the above situation, station B could be upper-adjacent in two scenarios with respect to station A. First, if station A is the "protected" station placed on the proxy channel 3 and station B is the "interfering" station on channel 4. Second, if station B is the "protected" station placed on channel 3 and station A is the "interfering" station on channel 2. If the interference calculations in these two scenarios differ, the staff used the more conservative estimate – the one with the higher interference percentage.

2) There is 254 MHz of spectrum between stations on Channels 13 (the highest high-band VHF channel) and 14 (the lowest UHF channel). Because of this gap, there is no interference between UHF and VHF stations. Similarly, there is 86 MHz between Channels 6 (the highest low-band VHF channel) and 7 (the lowest high-band VHF channel) and there is no interference between low VHF and high VHF channels. There is also another gap between Channels 4 and 5 and there is no interference between those channels.[25]  Because of this gap, the Interference_Paired file must consider the low VHF band separately between Channels 2 – 4 and Channels 5 – 6.


## 4.2 U.S. Stations to Canadian Allotments

For purposes of this analysis only, to determine whether a repacked U.S. Station can be co-channel or adjacent channel to a Canadian allotment, FCC staff followed the same pairwise approach applied to the study of interference between U.S. DTV stations with one minor

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[25] *See* 47 C.F.R. §73.610(c)(2); 47 C.F.R. §73.613(b).

difference.[26] The staff used *TVStudy* software to determine the current interference-free populations in Canada of each Canadian allotment (digital or analog) on its current channel. Calculating the interference-free population of a Canadian station requires *TVStudy* to consider predicted interference from other existing Canadian allotments and existing interference from U.S. stations. *TVStudy's* replication engine is then used to calculate pairwise interference with all possible U.S. stations (within the culling distance). The one difference is that in performing this pairwise analysis, FCC staff did not use proxy channels for Canadian allotments as staff assumed that these channel assignments were fixed. Whether a U.S. station can be placed on a co-channel, upper-adjacent channel or lower-adjacent channel to the Canadian allotment depends on the interference data produced by *TVStudy* according to the methodology in OET Bulletin 69.[27] As with the interference protections applied to U.S. stations (namely, Option 2 listed in the NPRM), staff has used the relevant cap of 0.5% new pairwise interference in studies involving Canadian allotments.[28]

Because the Canadian channel allotments are fixed for purposes of this analysis, there is, however, a significant difference in the way staff used the pairwise interference calculations resulting from *TVStudy* from Canadian allotments. If the relevant 0.5% cap is exceeded, staff removed the relevant channel(s) from the set of domains available to the U.S. station, which violated this pairwise cap. Thus, the constraints on U.S. stations caused by Canadian allotments are captured in the *Domain file,* rather than the *Interference_Paired file*.

The staff protected all Canadian allotments as specified in Table A of the Exchange of Letters for purposes of this preliminary analysis, regardless of whether there is a Canadian station actually operating on that channel.[29] Moreover, the staff has also included any mutually agreed upon modifications to Table A that have taken place since Table A was first released and which has subsequently been captured in CDBS.[30] In addition, the staff has also included all Canadian analog allotments as currently tracked in CDBS. Although the DTV transition has largely been completed in Canada's mandatory markets, there are Canadian stations along the U.S. border that are outside of major Canadian urban centers that continue to operate as analog stations, and thus, we conservatively protect all analog allotments.[31] This preliminary list of Canadian DTV and analog allotments which are considered by the *TVStudy* software is found in the Canadian Allotment List (in a file called Canadian_Allotment_List_2013July15.xlsx) to be made available

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[26] This pairwise approach has been used for illustrative purposes; it is the subject of ongoing negotiations with Canada.

[27] 2008 USA-Canada DTV Exchange of Letters at 2 (stating "[f]or compatibility relative to digital assignments/allotments, the technical methodologies used in the development of Tables A and B (*i.e.* OET-69) are to be used.").

[28] NPRM, 27 FCC Rcd at 12393 ¶ 106.

[29] 2008 USA-Canada DTV Exchange of Letters at Table A.

[30] *See* FCC Consolidated Database System, *available at* http://transition.fcc.gov/mb/databases/cdbs/.

[31] 2008 USA-Canada DTV Exchange of Letters at 2 (stating "to assess the compatibility of a drop-in channel relative to an analog assignment/allotment, the technical provisions of the 2000 Letter of Understanding are to be used"); *see* 2000 USA-Canada DTV Letter of Understanding; *see also* FCC Consolidated Database System, *available at* http://transition.fcc.gov/mb/databases/cdbs/.

for download at download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/.[32]
The file format of this preliminary Canadian Allotment List is similar to that for the U.S. Station
Baseline List shown in **Section 4.1**.

A few additional assumptions should be noted with respect to interference between U.S. and
Canadian stations for purposes of this preliminary analysis:

1) The staff protected the Canadian digital service code DT and the Canadian analog service
   codes TV and TA.  No protection was afforded to foreign translators (service codes TX
   and LD).

2) Similar to the approach described for interference between U.S. stations, FCC staff does
   *not assume* symmetric pairwise interference.  That is, the interference station B causes to
   station A is not assumed to be the same as the interference station A causes station B. If
   the interference calculations in these two scenarios differ, the staff used the more
   conservative estimate (*i.e.*, the one with the higher interference percentage).

3) Similar to U.S. to U.S. stations, the staff recognized the spectrum gaps between certain
   DTV channels:  There is no interference between UHF and VHF stations, between low
   VHF and high VHF channel, or between Channels 4 and 5.

### 4.3 U.S. Stations to Mexican Allotments

The U.S. agreements with Mexico utilize distance-based protections between U.S. stations and
Mexican allotments.[33]  Because the Mexican allotments are assumed to be on fixed channels for
purposes of this analysis the constraints on U.S. stations caused by Mexican allotments are
captured in the *Domain* file, rather than the *Interference_Paired file.*

As with Canada, the staff protected Mexican digital television allotments in the U.S.-Mexico
border region as provided for in the Agreements and regardless of whether the channel is
currently in use.[34]  Because the Mexican DTV transition is still underway, there are also a
significant number of analog Mexican station allotments that must be protected.[35]  However,
the staff also captured mutually agreed upon modifications to either the Mexican Table of DTV
allotments or Mexican Table of NTSC allotments that have occurred since these original
agreements were signed.  The preliminary list of Mexican allotments (both digital and analog) in

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[32] Although *TVStudy* considered all Canadian allotments listed in the Canadian Allotment List, *TVStudy* ran a mutual
exclusivity check prior to starting its calculations which suppresses analog allotments if they have been subsequently
been replaced by a digital allotment which overlaps the original allotment.

[33] 1998 USA-Mexico DTV Memorandum of Understanding at Table A (listing DTV to NTSC distance separation
requirements) and Table B (listing DTV to DTV distance separation requirements).

[34] *Id.* at Appendix 3 (listing Mexican DTV allotments within 275 km of the U.S.-Mexico Border).

[35] *Id.* at Appendix 1 (listing Mexican NTSC allotments within 400 km of the U.S.-Mexico Border for VHF and 320
km for UHF).

the U.S.-Mexico border region is found in the Mexican Allotment List (in a file called Mexican_Allotment_List_2013July15.xlsx) to be made available for download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/. The format of this preliminary Mexican Allotment List is similar to that for the U.S. Station Baseline List shown in **Section 4.1**.

**Distance Restrictions**:
These distance restrictions were used in accordance with agreement obligations:

**Table 1**[36]

| DTV to DTV Television Distance Separation Requirement | | | |
|---|---|---|---|
| | | **Required Distance Separation** | |
| **Channels** | **Channel Separation** | **Lower Boundary (km)** | **Upper Boundary (km)** |
| 2 – 13 | Co-Channel | 0 | 273 |
| 2 – 13 | ± 1 | 48 | 96 |
| | | | |
| 14 – 69 | Co-Channel | 0 | 223 |
| 14 – 69 | ± 1 | 32 | 88 |

**Table 2**[37]

| DTV to NTSC Television Distance Separation Requirement | | | |
|---|---|---|---|
| | | **Required Distance Separation** | |
| **Channels** | **Channel Separation** | **Lower Boundary (km)** | **Upper Boundary (km)** |
| 2 – 13 | Co-Channel | 0 | 273 |
| 2 – 13 | ± 1 | 18 | 100 |
| | | | |
| 14 – 69 | Co-Channel | 0 | 244 |
| 14 – 69 | ± 1 | 10 | 88 |
| 14 – 69 | ± 2 | 24 | 32 |
| 14 – 69 | ± 3 | 24 | 32 |
| 14 – 69 | ± 4 | 24 | 32 |
| 14 – 69 | ± 7 | 24 | 95 |
| 14 – 69 | ± 8 | 24 | 32 |
| 14 – 69 | +14 | 24 | 95 |
| 14 – 69 | +15 | 24 | 96 |

For "truth table" generation for Mexican allotments, staff used the following process:

1) Each Mexican allotment was buffered by the distances (both co-channel and first adjacent channel) outlined in the table below. The buffered allotments are called "protected

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[36] *Id.* at Table B.

[37] *Id.* at Table A.

Mexican stations".    Because some of the distances listed above are ranges (for example: 10-88 km), buffers are created that look like donuts.
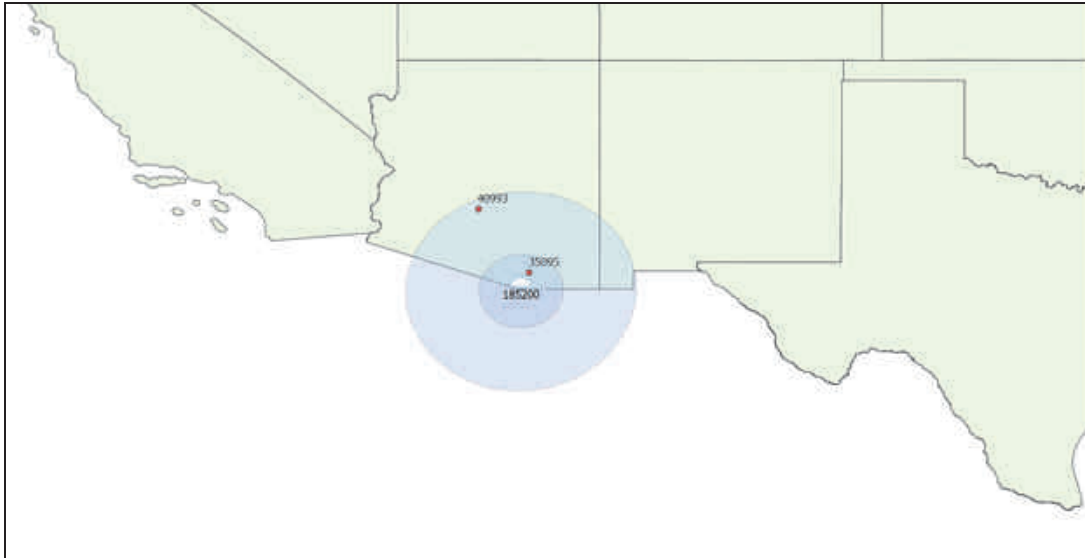


2) Staff generated a list of all U.S. stations that fall within the buffers of the Mexican allotments.

3) Staff generated "truth table" values based on the following scenarios:
   a. <u>DIGITAL (DTV)</u>
      **Scenario 1:** If U.S. station falls within the <u>co-channel buffer (outer circle) but outside the adjacent-channel buffer (inner circle)</u>, then the U.S. station cannot exist co-channel, but can exist either of the adjacent channels. *Example:* Station facility_id = 40993 in map above.
      **Scenario 2:** If a U.S. station falls within <u>both the co-channel buffer (outer circle) and adjacent channel buffer (inner circle)</u>, then the U.S. station cannot exist on co-channel or adjacent channel (either upper- or lower-adjacent). *Example:* Station facility_id = 35095 in map above.
   b. <u>ANALOG (NTSC)</u>
      **Scenario 1:** If a U.S. station falls within the <u>co-channel buffer (outer circle) only</u>, then the U.S. station cannot exist co-channel, but can exist on the adjacent channels. *No example shown*.
      **Scenario 2:** If a U.S. station falls within <u>both the co-channel buffer (outer circle) and other adjacent channel buffers (± 1, 2, 3, 4, 7, 8, +14, +15)</u>, then the U.S. station cannot exist co-channel, or those other adjacent channels. *No example shown*.

Staff also applied the following other criteria with respect to interference between U.S. stations and Mexican allotments:

1) With respect to the DTV and NTSC separation requirements above, because there is 254 MHz of spectrum between Channels 13 and 14, there are no distance separation

requirements between UHF and VHF channels.   Similarly, there is 86 MHz between Channels 6 (the highest low-band VHF channel) and 7 (the lowest high-band VHF channel), so there is no distance separation requirement between low VHF and high VHF channels.   Finally, there is also gap between Channels 4 and 5, so there is no distance separation requirement between those channels.

2) The staff protected the Mexican digital service codes DT and the Mexican analog service codes TV and TA.  Foreign translators (service code TX and LD) are not protected.

**"Short Spacing" Situations involving Mexican Allotments**
Because Mexican allotments are protected based on separation distance for the purpose of this analysis, staff made several preliminary simplifying assumptions regarding existing "short spacing" situations (situations for which the U.S. and Mexican governments have agreed to allow operation at locations less than the minimum distance separations):

1) *Co-Channel*:  If a U.S. station is currently short-spaced to a Mexican DTV allotment on any given channel, then staff allowed the U.S. station to occupy the same channel after repacking (and therefore continue to be short-spaced).  A U.S. station currently short-spaced with a co-channel Mexican DTV allotment was also allowed to occupy channels adjacent to the channel occupied by the Mexican allotment.

2) *Adjacent Channel*:  If a U.S. station is currently short-spaced with an adjacent-channel Mexican DTV allotment, then staff allowed the U.S. station to be on an adjacent channel above or below the Mexican allotment channel after repacking (assuming symmetry).

3) Because short-spacing conditions negotiated on a station-by-station basis, no other co-located U.S. stations were allowed to create short-spaced situations during repacking.

4) Moreover, because these are distance-based specifications with respect to Mexican allotments, *the staff assumed symmetry* with respect to interference.

5) **For short-spacing situations between U.S. DTV stations and Mexican NTSC (analog) allotments**, staff followed these guidelines:[38]

   a. US-DTV station to MX-NTSC (Analog) allotment: If a U.S. station and a Mexican allotment are currently short-spaced and operate co-channel, then the same U.S. station may to continue to be short-spaced to the same Mexican allotment on a co-channel or on an adjacent-channel (upper- or lower-adjacent) after repacking.

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[38] These rules apply only to distance separation requirements between U.S. DTV stations and Mexican analog (NTSC) allotments.   Because the United States' Agreement with Mexico utilizes distance separation for stations that are beyond the immediate upper- and lower-adjacencies (±1 channel), some special rules are required.  A few conservative assumptions were made with respect to those existing short-spacing situations. *See* 1998 USA-Mexico DTV Memorandum of Understanding at Table A (listing DTV to NTSC distance separation requirements).

b. US-DTV station to MX-NTSC (Analog) allotment: If a U.S. station and a Mexican allotment are currently short-spaced on an upper- or lower-adjacent channel, then the same U.S. station may continue to be short-spaced to the same Mexican allotment on an upper- or lower-adjacent channel after repacking, but there was no short-spacing relaxation beyond upper- or lower-adjacent channels for this pair of stations (i.e., distance requirements for any adjacent channel beyond ±1 must be met).

c. US-DTV station to MX-NTSC (Analog) allotment: If the U.S. station and Mexican allotment are currently short-spaced on an adjacent channel *beyond* ±1 channel (*e.g.*, adjacent ±2 channels), then staff allowed the same U.S. station to be short-spaced to the same Mexican allotment only on that specific adjacent channel relationship. Thus, if a US-DTV and a MX-NTSC allotment are short spaced on a upper third-adjacent channel (*i.e.*, adjacent +3 channels), they could continue to be short-spaced on either upper third-adjacent or lower third-adjacent channel (due to symmetrical treatment inferred by the distance-based rules).

**4.4 U.S. Stations to Land Mobile Operations**

As with Mexico, FCC rules require distance-based protections between U.S. stations and Land Mobile ("LM") city center coordinates or Land Mobile Waiver ("LMW") base stations.[39] The staff treated these operations as fixed constraints which limit the number of channels available to nearby U.S. stations. These constraints on U.S. stations are captured in the *Domain file*.

The preliminary list of Land Mobile and Land Mobile Waiver locations currently considered is found in the Land Mobile City Center List (in a file called LM_City_Center_List_2013July15.xlsx) and in the Land Mobile Waiver Station List (in a file called LMW_Station_List_2013July15.xlsx) both to be made available for download at http://data.fcc.gov/download/incentive-auctions/Constraint_Files/. Land mobile operations are allocated by rule on certain channels between Channel 14 and Channel 20 in 13 designated urban centers (although operations are authorized in only 11 of these locations due to border restrictions involving Canada).[40] The spectrum of TV channels 14-20 is commonly referred to as "television-band" ("T-Band") Land Mobile spectrum. Land Mobile stations that do not fall in these protected urban centers require a waiver to operate and are therefore listed separately.

The data contained in and the format of this preliminary Land Mobile City Center List is shown below:

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[39] 47 C.F.R. § 73.623(e). Land Mobile Waiver ("LMW") licensees currently operate on waivers, which they applied for under the exception process in Section 1.925, and which allow them to operate in variance with these specified locations and channels between 14 and 20. *See* 47 C.F.R. § 1.925.

[40] 47 C.F.R. § 90.303 (listing Boston, Chicago, Dallas/Fort Worth, Houston, Los Angeles, Miami, New York, Philadelphia, Pittsburgh, San Francisco/Oakland and Washington D.C. as urbanized areas where land mobile operations are authorized in the portion of the UHF band from 470-512 MHz (channels 14-20). This section also lists Cleveland and Detroit in the list of urbanized areas but notes in the footnotes that channels designated for land mobile operations are "not available, until further order from the Commission." *See* 47 C.F.R. § 90.303 n.2 and n.3.

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| facility_id | integer | The unique integer number (assigned by MB) that identifies a station | 999001 |
| fac_callsign | character varying(5) | Call Sign (where a Call Sign is a set of characters that serve as the public identification for a broadcast radio or television station. For example, WCAU or WGBS-TV) | LM-14 |
| fac_channel | integer | Channel assignment | 14 |
| city | character varying(100) | City | Boston |
| stateabbr | character varying(2) | State abbreviation | MA |
| lat_deg | numeric | Latitude degrees | 42 |
| lat_min | numeric | Latitude minutes | 21 |
| lat_sec | numeric | Latitude seconds | 24 |
| lon_deg | numeric | Longitude degrees | 71 |
| lon_min | numeric | Longitude minutes | 3 |
| lon_sec | numeric | Longitude seconds | 25 |
| latitude | numeric | Latitude transformed to standard format | 42.35666667 |
| longitude | numeric | Longitude transformed to standard format | -71.05694444 |
| geom | geometry | Geometry of point (used by spatial database) | GEOM |

The data contained and the format of this preliminary Land Mobile Waiver Station List is shown below:

| Data Element | Data Type | Description | Sample Value |
|---|---|---|---|
| facility_id | integer | The unique integer number (assigned by MB) that identifies a station | 999101 |
| fac_callsign | character varying(10) | Call Sign (where a Call Sign is a set of characters that serve as the public identification for a broadcast radio or television station. For example, WCAU or WGBS-TV) | WIJ783 |
| fac_channel | integer | Channel assignment | 19 |
| fac_service | character varying(2) | Radio Service where IG = Industrial/Business Pool (Conventional); PW =Public Safety Pool (Conventional); YG = Industrial/Business Pool (Trunked); YK = Industrial/Business Pool (Commercial, Trunked); YW = Public Safety Pool (Trunked). | YK |
| county | character varying(20) | County Name | MONMOUTH |
| stateabbr | character varying(2) | State abbreviation | NJ |
| location_number | integer | Location number | 1 |
| location_type | character varying(20) | These base stations are "fixed (F)" and "mobile" (M) designation of station.  Note: Only type "F" protected | F |
| lat_deg | numeric | Latitude degrees | 40 |
| lat_min | numeric | Latitude minutes | 12 |
| lat_sec | numeric | Latitude seconds | 13.4 |
| lat_direction | character varying(20) | Latitude direction | N |
| lon_deg | numeric | Longitude degrees | 74 |
| lon_min | numeric | Longitude minutes | 16 |
| lon_sec | numeric | Longitude seconds | 13.5 |
| lon_direction | character varying(20) | Longitude direction | W |
| latitude | numeric | Latitude transformed to standard format | 40.20372222 |
| longitude | numeric | Longitude transformed to standard format | -74.27041667 |
| geom | geometry | Geometry of point (used by spatial database) | GEOM |

**Distance Restrictions**:

The staff applied the following distance separations to establish whether a constraint prohibiting co- or adjacent-channel operation between Land Mobile and DTV should be established:[41]

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[41]  Staff obtained the DTV to Land Mobile City Center protection distances of 250 km for co-channel and 176 km for adjacent channel directly from 47 C.F.R. § 73.623(e).  Staff derived the separation distances for Land Mobile Waiver base stations as follows.  Because 47 C.F.R. § 90.305(a) allows Non-Waiver Land Mobile base stations to be

| US and Land Mobile Operation | DTV to LM City Center | DTV to LMW Base Station |
| --- | --- | --- |
| Co-Channel: | 250 km | 185 km |
| Adjacent Channel: | 176 km | 96 km |

Staff used the following process to generate LM city center and LMW base stations' truth tables:

1.  Each LM city center and LMW station was buffered by the distances (both co-channel and first adjacent channel) outlined in the table above (shown below). The buffered stations are the "protected LM stations".
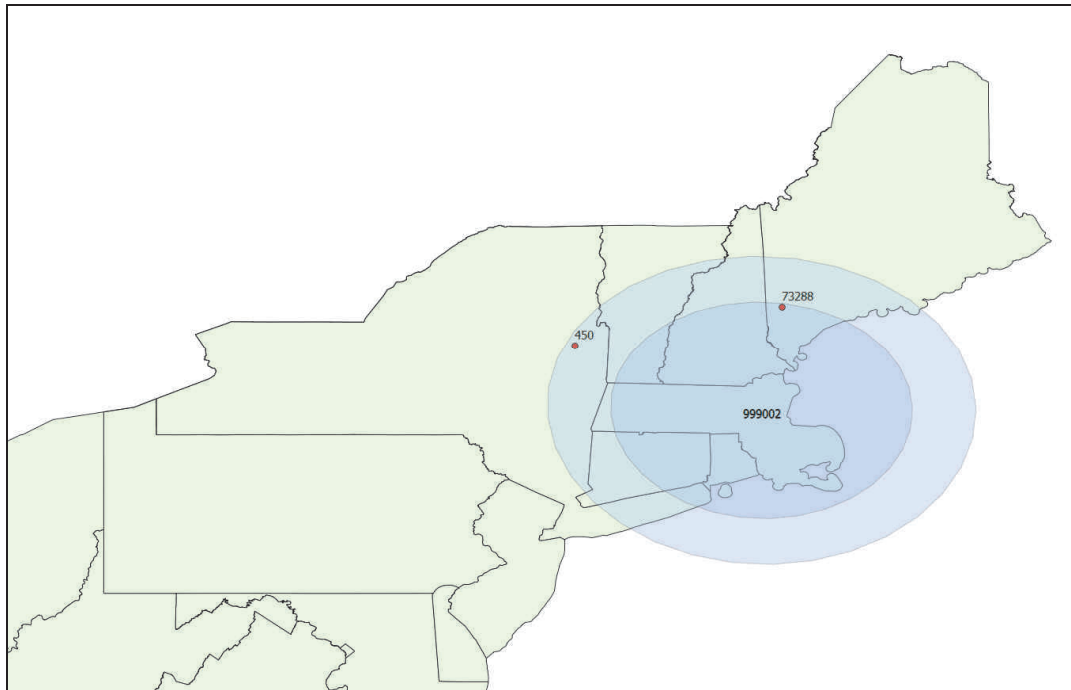


2.  A list of all U.S. stations that fall within the buffer distances of the LM city centers and LMW stations is identified.

3.  Truth table values are computed based on the following scenarios:

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located to 80 km from the city center, staff subtracted 80 km from the Land Mobile City Center distances of 250 km and 176 km to arrive at "buffer" distances of 170 km and 96 km for individual Land Mobile Waiver base stations. However, staff determined that 15 km extra buffer would be required for co-channel Land Mobile Waiver base stations as follows. Staff estimated that the 41 dBu F(50,90) contour of a 1 MW UHF DTV station at 600 m HAAT extends 121 km. 47 C.F.R. § 90.305(b) allows associated mobiles to operate up to 48 km from base stations. If the separation is only 170 km, staff assumed that mobiles might operate at the edge of DTV service area, and those mobiles could cause interference to nearby DTV receivers. The 40 dBu F(50,10) coverage of a 50-watt mobile at 30 m HAAT extends about 15 km. So, staff added an additional 15 km to the 170 km derived separation distance, for a total of 185 km.

**Scenario 1:** If a station falls within <u>co-channel buffer (outer circle) only</u>, then the U.S. station cannot exist co-channel, but can exist on an adjacent channel.
*Example: Station facility_id = 450 in map above.*

**Scenario 2:** If a station falls within <u>both the co-channel buffer (outer circle) and adjacent channel buffer (inner circle)</u>, then the U.S. station cannot exist co-channel or on an adjacent channel.
*Example: Station facility_id = 73288 in map above.*

4. Staff protected waiver-based land mobile licensees based on their tower locations.[42]

**Short Spacing Rules and Land Mobile**
Staff used the following rules about short spacing when protecting LM city centers and LMW base stations:

1) **Co-Channel**: When a television station is currently short-spaced on the same channel with either an allocated LM or a LMW base station, staff allowed that same station to continue to be short-spaced on the same or an adjacent channel in repacking.

2) **Adjacent Channel**: Similarly, the staff allowed any television station currently short-spaced on an adjacent channel with either an allocated LM or a LMW base station to continue to be short spaced on an adjacent channel following repacking. Because these restrictions are distance-based, staff assumed symmetry with respect to interference.

3) Staff did not allow other stations located the same tower as the currently short-spaced television station (co-located stations) to be short-spaced with the land mobile base station following repacking.

**4.5 Channel 37**
As noted in **Section 3.3**, Channel 37 is allocated for radio astronomy and wireless medical telemetry[43] and staff assumed it to be unavailable as a channel for repacking for purposes of this analysis. No additional constraints with respect to repacking television stations into adjacent channels (channels 36 and 38) were imposed.

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[42] The transmitter site for T-Band licensees' base stations cannot be located more than 80 km (50 miles) from the geographic center of the urbanized area unless they operate under a waiver. Moreover, mobile units must be operated within 48 km (30 miles) of their associated base station or stations. *See* 47 C.F.R. § 90.305. The staff's conservative approach to measuring separation distances (from LM city centers or from the tower location of LMW base stations) and the separation distances themselves makes this assumption of only protecting base stations reasonable. Moreover, because the LM end user devices are mobile, using base station locations for determining separation distances is the only practical option.

[43] 47 C.F.R. §2.106. "Table of Frequency Allocations".

## 4.6 U.S. Station to Offshore Radiotelephone Services

Offshore Radiotelephone Service ("ORTS") licensees operating under this service are limited to off-shore operations on Channel 17 off the coast of Southern Louisiana (Zone A), Channel 16 off the coast of the border area between Southern Louisiana and Texas (Zone B), and Channel 15 off the coast of Southern Texas (Zone C).[44]  This service is considered a primary allocation within these offshore regions.[45]  FCC rules state, however, that offshore ORTS licensees must not transmit from locations within 241 kilometers of any full-service television station that transmits on the TV channel containing the channel on which the offshore station transmits.[46]

According to the FCC's Universal Licensing Service ("ULS"), there is only one licensee operating under this service in Zones B and C.[47]  Based on the authorized operations of this one licensee and the fact that ORTS transmitters must not operate within 241 kilometers of a full-service television, staff did not apply any additional repacking constraints to protect co-primary ORTS operations from repacked television stations.

However, despite the lack of any current operating services, staff added a repacking constraint for the primary allocation given in Hawaii to Channel 17 for common carrier control and repeater stations for point-to-point inter-island communications as no distance separation requirement applies.[48]

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[44] 47 C.F.R. § 22.1007.

[45] 47 C.F.R. §2.106. "Table of Frequency Allocations".

[46] 47 C.F.R. § 22.1009(a).

[47] FCC Universal Licensing System, *available at*  http://wireless.fcc.gov/uls/weeklypn.htm?&job=home.

[48] 47 C.F.R. §2.106. "Table of Frequency Allocations".