

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of
Updating FM Broadcast Radio Service Directional
Antenna Performance Verification
MB Docket No. 21-422

REPORT AND ORDER

Adopted: May 19, 2022

Released: May 19, 2022

By the Commission: Chairwoman Rosenworcel issuing a statement.

I. INTRODUCTION

1. In this Report and Order (Order), we amend our rules to allow FM and LPFM
broadcasters using directional antennas to employ computer modeling to verify the antennas'
directional patterns. This represents a change from the current requirement that an FM or LPFM
directional antenna's performance be verified by the "measured relative field pattern," and
brings our rules for those services into regulatory conformity with our rules governing AM and
DTV directional antennas.

II. BACKGROUND

2. Four manufacturers of FM broadcast radio antennas and one licensee of FM broadcast
stations (Joint Petitioners) filed a Petition for Rulemaking seeking to amend our rules to allow
FM directional pattern verification by computer modeling. Currently, a permittee seeking to
license a facility with a directional FM antenna system must provide verification that the
directional pattern of the antenna conforms to what the Commission authorized in the
construction permit. The applicant must submit, among other things, a plot of the composite
pattern of the directional antenna, and a tabulation of the measured relative field pattern.
The required tabulation and plot of the measured relative field pattern must be obtained
either by building a full-size mockup of the antenna and supporting structures or by
constructing a scale model of the antenna and structures on a test range or in an anechoic
chamber. Joint Petitioners pointed out that FM radio is the only broadcast service that
specifically requires stations using directional antennas to provide such physical
measurements. Both the full- and scale-model measurement approaches, said Joint
Petitioners, increase costs and are time-consuming.

1 Some LPFM stations that use directional antennas must also provide physical measurements to verify their antenna
pattern. 47 CFR § 73.816(d). Because section 73.816(d) cross references section 73.316(c) of our rules, the
modifications to section 73.316(c) adopted in this Order automatically apply to LPFM stations as well. Thus, in this
Order, when referencing current or modified FM directional licensing procedures, "FM" refers to both full-service
FM stations and LPFM stations.

2 47 CFR § 73.316(c)(2)(iii).

3 See 47 CFR §§ 73.151, 73.685(f).

4 Joint Petition for Rulemaking, filed by Dielectric, LLC; Educational Media Foundation; Jampro Antennas, Inc.;
Radio Frequency Systems; and Shively Labs (June 15, 2021) (Joint Petition).

5 47 CFR § 73.316(c)(2)(ii)-(iii).

6 Joint Petition at 2-4.

7 Id. at 8-12.

also pointed out a number of difficulties with physical measurement, such as problems in accurately replicating the installed antenna environment, including nearby structures that could affect the radiated pattern.⁹ A properly implemented computer model, according to Joint Petitioners, could take these factors into account, leading to a more accurate and less expensive pattern verification.¹⁰

3. We released a *Notice of Proposed Rulemaking* in November 2021,¹¹ in which we proposed to amend our rules to provide the option for verifying FM directional patterns through computer modeling,¹² and sought comment on the proposal, which would apply not only to license applications for new FM facilities, but to FM broadcast station licensees applying to license facility modifications.¹³ We proposed, among other things, that the license applicant must provide the Commission with details of the software tools used in modeling the antenna's directional pattern and the process by which the computer modeling was carried out, as well as the qualifications of the engineer(s) who designed, modeled, and provided installation instructions for the directional antenna.¹⁴ The *NPRM* also posed several questions designed to determine whether and how best to implement a computer modeling standard. It asked whether there are easily obtainable physical measurements that can be used to verify the computer model's accuracy;¹⁵ whether there is a voluntary consensus standard or common computer model that antenna manufacturers and/or broadcast engineers agree provides the greatest accuracy;¹⁶ whether the most widely used directional FM antenna modeling software has a common theoretical basis that would allow Commission staff to evaluate the results generated by other software programs sharing the same theoretical basis;¹⁷ and how the staff should proceed in cases where there are interference complaints or other disputes as to the performance of a directional FM antenna that has been verified through a computer model (noting that such complaints are currently uncommon).¹⁸ Finally the *NPRM* sought general input regarding commenters' experiences with directional FM computer modeling software and its accuracy vis-à-vis real world performance.¹⁹

4. We received 13 comments and six reply comments in response to the *NPRM*.²⁰ Several commenters that accepted our invitation to share their experiences with computer modeling provided positive reports on the accuracy of computer models in depicting an antenna's directional pattern.²¹ The

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⁸ *Id.* at 2-4.

⁹ *Id.* at 13-16.

¹⁰ *Id.* at 14-23.

¹¹ *Updating FM Broadcast Radio Service Directional Antenna Performance Verification*, MB Docket No. 21-422, Notice of Proposed Rulemaking, FCC 21-117 (Nov. 15, 2021) (*NPRM*).

¹² *Id.* at 5, para. 11.

¹³ *Id.* at 1 n.1.

¹⁴ *Id.* at 6, para. 15 and Appendix A, proposed 47 CFR § 73.316(c)(2)(iv).

¹⁵ *Id.* at 5, para. 12.

¹⁶ *Id.* at 5-6, para. 13.

¹⁷ *Id.* at 6, para. 14.

¹⁸ *Id.* at 7, para. 17.

¹⁹ *Id.* at 7, para. 18.

²⁰ See Appendix A.

²¹ See, e.g., Comments of Communications Technologies, Inc. (CTI Comments) at 1-2 (has done many computer models of directional FM patterns, and, when properly documented, believes them to be more accurate than test range measurements); Comments of Kevin M. Fitzgerald at 1-2 (experience with various computer modeling programs shows they “in fact do an excellent job of predicting antenna pattern data accurately.”); Comments of Meintel, Sgrignoli & Wallace, LLC (MSW Comments) at 1 (experience has shown that computer modeling products

(continued...)

majority of the comments favored our proposal to amend the rules to allow computer modeling to verify FM directional antenna patterns as a means to provide license applicants with greater flexibility and to reduce overall costs for antenna manufacturers and broadcasters.²²

III. DISCUSSION

5. As discussed below, we amend our rules to allow license applicants for directional FM facilities to verify the directional antenna patterns by submitting results from computer models depicting the antenna's performance, as long as they are generated by the antenna's manufacturer. This modest rule change allows for similar treatment of FM and LPFM directional antenna performance verification and AM and DTV licensing, which do not preclude the use of computer modeling to verify directional antenna performance.²³ We envision that this rule change will reduce the cost of designing and building an FM or LPFM directional antenna, savings that should be passed on to the broadcast applicant and thus reduce the cost of station construction. Additionally, a less expensive directional antenna should provide an FM or LPFM applicant with greater flexibility in antenna siting. As is explained below, we also decline to adopt several of the proposals in the *NPRM*.

6. Based on strong record support that antenna manufacturers should be allowed to perform computer modeling of their products' directional patterns, we update section 73.316 of the rules to provide license applicants with the option to submit either computer results generated by the antenna's manufacturer, or physical proof of antenna directionality pursuant to current practice.²⁴ As CTI states in its comments, antenna manufacturers are in the best position to perform computer modeling of their own products because they have the historic data to know how a specific radiator performs in a particular environment.²⁵ After reviewing the comments, as well as our rules and application procedures, we are

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“do an excellent job of predicting accurate antenna pattern data.”); Comments of Shively Labs (Shively Comments) at 1 (in decades of experience with measured patterns and over a decade of experience with computer modeled patterns, has developed techniques that verify the correlation between measured and computer-modeled patterns).

²² See, e.g., Comments of Cesium Communications, L.P., and David L. Gates (Cesium Comments) at 2 (“[O]ne of the very best proposals to come out of the FCC in years.”); CTI Comments at 4 (“fully supports” proposal); Comments of Hatfield & Dawson Consulting Engineers (H&D Comments) at 2-3 (believes computer modeling is useful when performed by competent personnel; computers and software are available at low cost, and manufacturers who will do most of the modeling arguably should be able to pass savings on to customers); MSW Comments at 1 (“Adoption of the proposed methods would reduce costs for broadcasters, enable more accurate data for use in interference predictions, and provide much improved efficiency for antenna manufacturers. The elimination of the need for range measurements would significantly reduce costs for antenna manufacturers, broadcast stations, which would benefit the public interest.”); Comments of REC Networks (REC Comments) at 1-2 (agreeing that current method of providing proof of performance is outdated; while believing that LPFM proof of performance requirement should be eliminated, supports any changes to the requirement that any newly proposed LPFM facility specifically meet the proof of performance requirements); Comments of Edward A. Schober (Schober Comments) at 1 (“heartily agrees” with effort to allow computer modeling); Reply of National Ass’n of Broadcasters (NAB Reply) at 1 (agrees with Commission that allowing license applicants the option to submit the results of computer models can provide meaningful relief to FM broadcasters without substantially jeopardizing technical standards or service to the public); *Ex parte* of American Militia Ass’n at 1-2 (suggesting that certain antenna manufacturers have an economic motive to continue the current system of requiring measured antenna patterns).

²³ See 47 CFR §§ 73.151 (AM directional antenna systems), 73.685(f) (DTV directional antennas).

²⁴ See, e.g., CTI Comments at 2-3; H&D Comments at 2-3; MSW Comments at 1-2; Schober Comments at 3; Shively Comments at 1; Comments of Aldena Telecomunicazioni SRI (Aldena Comments) at 2. *But see* Reply of Paul Bame (Bame Reply) at 4 (questioning how to define “manufacturer” and whether further qualifications should be required); NAB Reply at 8 (disagreeing that Commission should automatically accept data from any manufacturer; stating modeler should demonstrate appropriate background in physics or electromagnetic theory).

convinced that we can provide the intended regulatory relief for broadcasters and manufacturers with only this minimal change to our verification requirements. We further find, as stated in the *NPRM*,²⁶ that this change will achieve our goal of conforming the FM directional rules with similar rules governing AM and DTV stations,²⁷ while maintaining the integrity of our licensing requirements. We disagree with antenna and transmission equipment manufacturer Electronics Research, Inc. (ERI), that opposes our proposal to allow computer modeling. ERI states that it has “serious concerns” about the proposal, which include a belief that it would lead to protracted and contentious interference disputes, as well as a conviction that computer models must always be verified through measurement at full or fractional scale.²⁸ Based on the record and our understanding of the risk, we conclude that because antenna manufacturers are best positioned to provide license applicants with accurate and sufficient proofs of performance using computer models, we amend our rules to provide license applicants with the option to submit a computer-modeled proof of performance on the condition that such proof is provided to the licensee by the antenna manufacturer.

7. We note that under our current rules, when license applicants submit the showings required by section 73.316(c)(2)(iii),²⁹ they almost always rely on antenna manufacturer-supplied tabulations of the measured relative field pattern,³⁰ performed either on a full-scale test range or with a scale model of the antenna.³¹ We believe we should continue to rely on the antenna manufacturer to validate directionality as we introduce the option for computer modeling. We agree with commenters that the manufacturers are in the best position to ensure the validity of the computer model and the accuracy of the results.³² We also find that manufacturers have an incentive to represent accurately their products’ performance, both to protect their own reputations and to avoid negative consequences for their customers who face interference complaints and regulatory action if their antenna patterns do not match what is authorized in their license.³³ Because there is general agreement among commenters that antenna manufacturers have the expertise and knowledge of their products to be able to model the directional patterns effectively,³⁴ and because the manufacturers already provide measured field patterns to their broadcast applicant/customers for submission to the Commission, we find that license applicants may submit computer-generated pattern verification from the antenna’s manufacturer in lieu of measured relative field patterns, under the conditions set forth below. We acknowledge NAB’s concern that

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²⁵ CTI Comments at 2. *See also* Reply of Electronics Research, Inc. (ERI Reply) at 3 (“Most FM antenna manufacturers have a great deal of information in their files and experience with towers’ effects on the actual radiated pattern.”).

²⁶ *NPRM* at 5, para. 11.

²⁷ *See supra* note 23.

²⁸ Comments of Electronics Research, Inc. (ERI Comments) at 1-2, 7-9, 13-14. *See also* ERI Reply at 1 (stating that while it considers a computer model to be a “good starting point,” it still believes the final antenna design should be completed and verified on a full-scale test range or in an anechoic chamber).

²⁹ 47 CFR § 73.316(c)(2)(iii).

³⁰ *See* CTI Comments at 2-3; H&D Comments at 3; Aldena Comments at 2. *But see* Cesium Comments at 5 (“Having each manufacturer with its own standard is to have no standard at all. With no standard, there is no assurance of quality, no assurance of integrity, and no assurance of replicability.”).

³¹ For three recent examples, *see* File No. 0000184622, KCML(FM), license to cover; File No. 0000184635, KCCR(FM), license to cover (both including attachments from antenna manufacturer detailing directional pattern measurements on full-scale test range); File No. 0000182542, WRLN(FM), license to cover (including antenna manufacturer’s attachment detailing directional pattern measurement on scale model of antenna).

³² *See* CTI Comments at 2; CTI Reply at 2; Shively Comments at 1. *See also* Aldena Comments at 2.

³³ *See* CDE Comments at 5; CTI Reply at 3.

³⁴ *See supra* para. 6.

manufacturer data should not be automatically accepted without a demonstration that the modeler has a background in physics or electromagnetic theory.³⁵ We would expect that any manufacturer would have an interest in providing models prepared by engineers possessing such expertise. However, given the varying backgrounds of broadcast engineers, we do not wish to codify what constitutes qualifications to perform computer modeling. Should a challenge arise to a computer model, for example, if we receive interference complaints, we can and would seek further information regarding that model, including the qualifications of those preparing and performing the modeling.

8. We decline to expand the range of entities authorized to perform computer modeling of directional FM antenna patterns beyond manufacturers at this time. Although commenters largely agree that license applicants should be able to rely on manufacturer computer modeling to verify FM directional patterns for that manufacturer's antennas, there was less agreement as to whether others should be allowed to perform computer modeling to verify FM directional antenna patterns.³⁶ For example, commenter Albert Davis states that college professors doing antenna research or computer science researchers working on modeling physical objects should automatically qualify.³⁷ Commenter Edward Schober believes that, in addition to the antenna manufacturer, a Licensed Professional Engineer of any state, territory, or foreign country should be deemed qualified, as well as anyone receiving certification if the Society of Broadcast Engineers (SBE) or other nationally recognized trade organization issues certifications in FM antenna modeling.³⁸ In addition, some commenters expressed concern that individuals lacking education in physics, electromagnetic theory, or electronic engineering should not be allowed to create computer models of antennas.³⁹ We decline at this time to expand the range of entities authorized to perform computer modeling of directional FM antenna patterns beyond antenna manufacturers. While we acknowledge that there are individuals and entities other than antenna manufacturers that are qualified to perform computer modeling of directional FM antenna patterns, we elect at this point to rely on antenna manufacturers to perform computer modeling consistent with current industry practice. Although there is no such limitation on those who can perform computer modeling for AM and DTV directional antennas, we find a more cautious approach is required for FM, given the greater number of FM stations versus DTV stations using directional antennas,⁴⁰ and given that AM directional patterns are subject to continual verification through sampling that is not possible with FM directional antennas.⁴¹ As we gain more experience with computer modeling of directional FM antenna patterns, we will explore expanding the range of entities authorized to perform computer modeling beyond manufacturers.

9. Although the *NPRM* asked several questions about which software products should be used for computer modeling, we find sufficient reason to decline to prescribe any particular modeling software that the antenna manufacturers must use, and instead leave this to the manufacturer's

³⁵ NAB Reply at 8.

³⁶ See, e.g., Reply of Albert Davis (Davis Reply) at 2 (manufacturer should not automatically qualify; those who should be automatically qualified are college professors doing antenna research or computer science researchers working on modeling physical objects); NAB Reply at 8; Schober Comments at 3 (in addition to manufacturer, a Licensed Professional Engineer of any state, territory, or foreign country should be deemed qualified, as well as anyone receiving certification if SBE or other nationally recognized trade organization issues certifications in FM antenna modeling).

³⁷ Davis Reply at 2.

³⁸ Schober Comments at 3.

³⁹ See, e.g., NAB Reply at 5, 8; H&D Comments at 3.

⁴⁰ See *NPRM* at 5, para. 11 (over 2,000 directional FM stations). We note that there are only 1,747 full-service DTV stations; 2,140 when including Class A TV stations. See *Broadcast Station Totals as of March 31, 2022*, Public Notice, DA 22-365 (rel. Apr. 5, 2022), <https://docs.fcc.gov/public/attachments/DA-22-365A1.pdf>.

⁴¹ See H&D Comments at 2; CDE Comments at 2-3.

discretion.⁴² Commenters generally agreed that we should not dictate specific software products, for reasons ranging from concern about creating software monopolies or duopolies,⁴³ to cost of software generally,⁴⁴ to encouraging creation of new and better software products.⁴⁵ Based on the comments, we conclude antenna manufacturers should have discretion to use either commercially available software products or their own proprietary software subject to the requirements set out below. Thus, if the license applicant's submission includes modeled pattern predictions from a commercially available software program, the manufacturer's report need only identify it;⁴⁶ if the antenna manufacturer generates results using custom software the manufacturer created or that was created for the manufacturer, we require a description of the software and the computational methods underlying the software sufficient to replicate the results if necessary.

10. As proposed in the *NPRM*, no matter which model or software is used, when a license application includes a proof of FM directional antenna performance obtained through computer modeling, we will require that the application include a statement setting forth the name(s) and qualifications of the engineer(s) who designed the antenna, performed the modeling, and prepared the manufacturer's instructions for installing the antenna. The submission must also include a statement from such engineer(s) identifying and describing the software tools used in the model and the procedures used in running the software.⁴⁷ NAB suggests that we require a certification that the software executed normally without generating any error messages or warnings indicating something was wrong with the inputs.⁴⁸ We agree that this would be useful, and will require such a certification. As proposed in the *NPRM*, and supported by commenters, such computer modeling must analyze the antenna mounted on a tower or tower section, and the tower or tower section model must include transmission lines, appurtenances, ladders, conduits, other antennas, and any other installations that could affect the computer modeled directional pattern.⁴⁹ The submission statement must list and describe all such elements and structures included in the model.

11. We also find sufficient reason to require verification of the accuracy of the pattern generated using a particular modeling software once for each directional antenna model number or standardized series of elements. Several commenters suggest that, once a directional antenna is modeled using a particular modeling software, a full-size or scale model of that antenna, or a single element thereof, should be constructed and the pattern measured in order to test the validity of the modeling method.⁵⁰ Two of those commenters state that once this process is completed for a particular antenna

⁴² Commenters split as to whether modeling should only be allowed using 3-D modeling software such as HFSS or CST Studio Suite (*see* Cesium Comments at 8-12; Comments of Dielectric, Inc. (Dielectric Comments) at 2), or whether less expensive and more commonly available software such as MiniNEC is acceptable (*see* Comments of Albert Davis (Davis Comments) at 4-5; H&D Comments at 3; Schober Comments at 4-5; REC Comments at 2-3; Bame Reply at 4).

⁴³ *See, e.g.*, Davis Comments at 4.

⁴⁴ *See, e.g.*, Davis Comments at 6; REC Comments at 2-3.

⁴⁵ *See* H&D Comments at 2; Schober Comments at 5.

⁴⁶ In individual cases the Bureau may also request a description of the software and computational methods for commercially available software, such as when the software is new to the market, is not readily available, or is not well known.

⁴⁷ *See* H&D Comments at 2; Schober Comments at 3; NAB Reply at 8.

⁴⁸ *See* NAB Reply at 5-6

⁴⁹ *NPRM* at App A. *See* Schober Comments at 3; NAB Reply at 7-9; ERI Reply at 2.

⁵⁰ *See, e.g.*, H&D Comments at 2; Schober Comments at 1-4; Shively Comments at 1; ERI Reply at 2-3; NAB Reply at 6. *But see* CTI Reply at 2 (“[T]est range measurements to validate every computer modeled pattern should be unnecessary.”).

using a particular modeling software, it need not be repeated unless the modeling method changes.⁵¹ We agree. In order to assist Commission staff in accuracy verification, we find that the first time the directional pattern of a particular model of antenna is verified using a particular modeling software, we will require the license applicant to submit to the Commission both the results of the computer modelling and measurements of either a full-size or scale model of the antenna or elements thereof, demonstrating reasonable correlation between the measurements achieved and the computer model results.⁵² Once a particular antenna model or series of elements has been verified by any license applicant using a particular modeling software, the Commission will permit all subsequent license applicants using the same antenna model number or elements and using the same modeling software to submit the computer model for the subsequent antenna installation, and to cross-reference the original submission by providing the application file number. We believe this will provide a sufficient basis to verify that the computer model has been shown correctly to describe the pattern generated by the antenna or elements.

12. We believe these changes, in combination with our existing requirement that the license applications include the tabulations and plot of the directional pattern prescribed in section 73.316, to be a sufficient basis for Commission staff to evaluate applications involving FM directional antennas.⁵³ Applicants will be required to submit, as they do now, a statement from the engineer responsible for installing the antenna, certifying that the antenna has been installed pursuant to the manufacturer's instructions, and a statement from a licensed surveyor, verifying that the antenna is properly oriented.⁵⁴

13. In light of the record, we will not change our current policies regarding interference complaints or disputes. In the *NPRM*, we asked whether our existing policies are sufficient to resolve any interference complaints or disputes pertaining to directional FM antennas.⁵⁵ Most commenters agreed that interference was not and would not be a problem,⁵⁶ and no changes to our current interference rules and procedures were requested.⁵⁷ ERI, which does not support computer modeling, contends that the proposed rule changes will increase FM interference due to modeled directional patterns that do not accurately reflect the actual directional signals.⁵⁸ It continues that this will increase inter-station

⁵¹ See H&D Comments at 2; Schober Comments at 4.

⁵² We delegate authority to the Media Bureau to determine on a case-by-case basis whether there is a reasonable correlation. In assessing whether there is a reasonable correlation, the Bureau should consider, for example: a comparison of the modeled and measured pattern relative field values taken every 10 degrees of azimuth; a comparison of the Root Mean Square (RMS) values of the modeled versus the measured patterns (calculated by squaring the modeled and measured pattern relative field values taken every 10 degrees of azimuth, computing a mean of all such values for the entire pattern, taking the square root of the mean, and comparing the square root values for the modeled and measured pattern values, *see* current 47 CFR § 73.316(c)(2)(ix)); and/or the depth and angle of the pattern null(s). We believe it is premature to set a specific standard for correlation between a measured and modeled directional FM antenna pattern, but based on our experience going forward we may consider setting out a more definite standard in a future action. *See, e.g.*, Schober Comments at 3 (suggesting a specific correlation standard).

⁵³ *See* current 47 CFR § 73.316.

⁵⁴ *See* current 47 CFR § 73.316(c)(2). Two commenters request that we expand the definition of "surveyor" to include a registered professional engineer in those jurisdictions where such engineers may make such determinations. *See, e.g.*, H&D Comments at 3; NAB Reply at 10. This request is beyond the scope of this proceeding.

⁵⁵ *NPRM* at 7, para. 17 (citing 47 CFR §§ 73.209, 73.211; *Involuntary Modification of License of Station KFWR(FM), Jacksboro, Texas*, Order to Show Cause, 30 FCC Rcd 2625 (MB), *modification ordered*, 30 FCC Rcd 8235 (MB 2015)).

⁵⁶ *See, e.g.*, CTI Comments at 3-4; Schober Comments at 5; Reply of Communications Technologies, Inc. at 3; NAB Reply at 3-4. *But see* ERI Comments at 2-3.

⁵⁷ *See, e.g.*, Schober Comments at 5; H&D Comments at 2 (both stating that existing interference rules are sufficient).

interference disputes because full-service FM stations, unlike secondary services such as FM translators, need not cease operations upon receiving interference complaints.⁵⁹ While we acknowledge ERI's concerns in this area, we believe that by requiring initial computer models of antennas and components using a particular modeling software to be verified by measurements, ERI's concerns are sufficiently addressed.⁶⁰

14. We find that our action today provides the least disruptive means to update licensing of FM stations with directional antennas, while still allowing for the benefits of computer modeling set forth in the Joint Petition and the *NPRM*.⁶¹ We reiterate that the rule changes we adopt today are optional, and that applicants may still submit measured relative field patterns rather than computer modeled patterns if they so desire. We finally find that the record does not provide sufficient support for further changes to our application procedures,⁶² nor does it support changes to our interference complaint and resolution policies, and therefore we make no other changes to our rules at this time.⁶³

IV. PROCEDURAL MATTERS

15. *Paperwork Reduction Act Analysis.* This *Report and Order* may contain new or modified information collection requirements subject to the Paperwork Reduction Act of 1995 (PRA), Public Law 104-13. The requirements will be submitted to the Office of Management and Budget (OMB) for review under Section 3507(d) of the PRA. OMB, the general public, and other Federal agencies are invited to comment on the new or modified information collection requirements contained in this proceeding. In addition, we note that pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, *see* 44 U.S.C. 3506(c)(4), we previously sought specific comment on how the Commission might further reduce the information collection burden for small business concerns with fewer than 25 employees.

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⁵⁸ ERI Comments at 2-3.

⁵⁹ ERI Comments at 2-5.

⁶⁰ *See supra* para. 11. At least one commenter suggested that drone measurements could be used to determine whether an FM directional antenna *in situ* was performing as designed. *See* CTI Comments at 3-4. *See also* Schober Comments at 5. This, however, would necessitate standards as to drone measurements that are beyond the scope of this proceeding. *See* CTI Reply at 3 (suggesting future proceeding to establish standards for drone measurement of installed antenna patterns).

⁶¹ Joint Petition at 4, 13-16; *NPRM* at 5, para. 11.

⁶² *See, e.g.*, H&D Comments at 3 (requesting wording changes to 47 CFR § 73.316; Fitzgerald Comments at 2-4 (requesting we authorize vertical polarization-only FM antennas). We find these proposals beyond the scope of this proceeding. Additionally, some commenters advocated that modeling be limited to specific software packages. *See, e.g.*, Aldena Comments at 3; Cesium Comments at 8-9. Finally, many commenters suggested specific details for the computer modeling procedures, or for our process of amending the rules, *See, e.g.*, CDE Comments at 8 (urging an extended period of computer model use accompanied by Further Notice of Proposed Rulemaking); Davis Comments at 3-6 (proposing the Commission maintain a "library of models," plus a "station level" wherein different models are assembled to create specific station antenna model); Schober Comments at 2-3 (Commission could maintain online list of programs approved for modeling different types of antennas, with list of classes of antennas to be individually validated); Shively Comments at 1 (urging a "period of discovery and study to determine the best methods and the most acceptable way forward while maintaining or improving the accuracy of directional antenna pattern studies."); NAB Reply at 10-11 (questioning the mounting height standard set forth in 47 CFR § 73.1690(c)(2), and stating that any change in directional FM antenna mounting height require an updated computer model). We find it premature or unnecessary to adopt these proposals at this time, but may revisit as our experience evolves with this voluntary alternative application procedure.

⁶³ Comments addressing digital equity and inclusion expressed a belief that the proposal would serve to enhance digital equity and inclusion by making software tools available to more applicants, and lowering costs of directional antennas. *See* Davis Comments at 7; REC Comments at 3. *But see* H&D Comments at 3.

16. *Congressional Review Act.* The Commission has determined, and the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, concurs that this rule is “non-major” under the Congressional Review Act, 5 U.S.C. § 804(2). The Commission will send a copy of this *Report and Order* to Congress and the Government Accountability Office pursuant to 5 U.S.C. § 801(a)(1)(A).

17. *Final Regulatory Flexibility Certification.* As required by the Regulatory Flexibility Act of 1980 (RFA),⁶⁴ an Initial Regulatory Flexibility Certification was incorporated into the *NPRM*.⁶⁵ Pursuant to the Regulatory Flexibility Act of 1980, as amended,⁶⁶ the Commission’s Final Regulatory Flexibility Certification relating to this *Report and Order* is attached as Appendix C.

V. ORDERING CLAUSES

18. Accordingly, **IT IS ORDERED** that, pursuant to the authority contained in Sections 1, 4(i), 4(j), 301, 303, 307, 308, 309, 316, and 319 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 154(i), 154(j), 301, 303, 307, 308, 309, 316, and 319, this *Report and Order* **IS ADOPTED** and **WILL BECOME EFFECTIVE** 30 days after publication in the Federal Register.

19. **IT IS FURTHER ORDERED** that Part 73 of the Commission’s rules **IS AMENDED** as set forth in Appendix B, and such rule amendments **WILL BECOME EFFECTIVE** 30 days after publication in the Federal Register, except that the rule changes to sections 73.316 and 73.1690, which may contain new or modified information collection requirements, will not become effective until the Office of Management and Budget completes review of any information collection requirements that the Media Bureau determines is required under the Paperwork Reduction Act. The Commission directs the Media Bureau to announce the effective dates for the rule changes to section 73.316 and section 73.1690 by subsequent Public Notice.

20. **IT IS FURTHER ORDERED** that the Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, **SHALL SEND** a copy of this *Report and Order*, including the Final Regulatory Flexibility Certification, to the Chief Counsel for Advocacy of the Small Business Administration.

21. **IT IS FURTHER ORDERED** that the Commission **SHALL SEND** a copy of this *Report and Order* in a report to be sent to Congress and the Government Accountability Office pursuant to the Congressional Review Act, *see* 5 U.S.C. § 801(a)(1)(A).

22. **IT IS FURTHER ORDERED** that, should no petitions for reconsideration or petitions for judicial review be timely filed, MB Docket No. 21-422 **SHALL BE TERMINATED** and its docket **CLOSED**.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

⁶⁴ *See* 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. § 601, *et. seq.*, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 847 (1996). The SBREFA was enacted as Title II of the Contract with America Advancement Act of 1996 (CWAAA).

⁶⁵ *NPRM* at App B.

⁶⁶ *See* 5 U.S.C. § 604.

APPENDIX A
List of Commenters

Commenters

Aldena Telecomunicazioni SRI
Cesium Communications, L.P., and David L. Gates
Cohen, Dippell and Everist, P.C.
Communications Technologies, Inc.
Albert Davis
Dielectric, LLC
Electronics Research, Inc.
Kevin M. Fitzgerald
Hatfield & Dawson Consulting Engineers, LLC
Meintel, Sgrignoli & Wallace, LLC
REC Networks
Edward A. Schober
Shively Labs

Reply Commenters

Paul Bame
Cohen, Dippell and Everist, P.C.
Communications Technologies, Inc.
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APPENDIX B

Final Rules

NEW LANGUAGE IN BOLD

The Federal Communications Commission amends Part 73 of Chapter I of Title 47 of the Code of Federal Regulations (CFR) as follows:

1. The authority citation for part 73 continues to read as follows:

Authority: 47 U.S.C. 154, 155, 301, 303, 307, 309, 310, 334, 336, 339.

2. Amend § 73.316 to revise paragraph (c)(2) to read as follows:

§ 73.316 FM antenna systems.

* * * * *

(c) * * *

(2) * * *

(iii) A tabulation of the measured **or computer modeled** relative field pattern required in paragraph (c)(1) of this section. The tabulation must use the same zero degree reference as the plotted pattern, and must contain values for at least every 10 degrees. Sufficient vertical patterns to indicate clearly the radiation characteristics of the antenna above and below the horizontal plane. Complete information and patterns must be provided for angles of -10 deg. from the horizontal plane and sufficient additional information must be included on that portion of the pattern lying between + 10 deg. and the zenith and -10 deg. and the nadir, to conclusively demonstrate the absence of undesirable lobes in these areas. The vertical plane pattern must be plotted on rectangular coordinate paper with reference to the horizontal plane. In the case of a composite antenna composed of two or more individual antennas, the composite antenna pattern should be used, and not the pattern for each of the individual antennas.

(iv) **When the relative field pattern is computer modeled, as permitted in paragraphs (c)(2)(iii) and (c)(2)(x) of this section and in §73.1690(c)(2), the computer model must be generated by the manufacturer of the antenna, and must include a statement from the engineer(s) responsible for designing the antenna, performing the modeling, and preparing the manufacturer's instructions for installation of the antenna, that identifies and describes the software tool(s) used in the modeling and the procedures applied in using the software. It must also include a certification that the software executed normally without generating any error messages or warnings indicating an error in the program inputs. Such computer modeling shall include modeling of the antenna mounted on a tower or tower section, and the tower or tower section model must include transmission lines, ladders, conduits, appurtenances, other antennas, and any other installations that may affect the computer modeled directional pattern. The first time the directional pattern of a particular model of antenna is verified using a particular modeling software, the license applicant must submit to the Commission both the results of the computer modeling and measurements of either a full-size or scale model of the antenna or elements thereof, demonstrating reasonable correlation between the measurements achieved and the computer model results. Once a particular antenna model or series of elements has been verified by any license applicant using a particular modeling software, subsequent license applicants using the same antenna model number or elements and using the same modeling software to verify the directional pattern may submit the computer model for the subsequent antenna installation and cross-reference the original submission by providing the application file number.**

(v) A statement that the antenna is mounted on the top of an antenna tower recommended by the antenna manufacturer, or is side-mounted on a particular type of antenna tower in accordance with specific instructions provided by the antenna manufacturer.

(vi) A statement that the directional antenna is not mounted on the top of an antenna tower which includes a top-mounted platform larger than the nominal cross-sectional area of the tower in the horizontal plane.

(vii) A statement that no other antenna of any type is mounted on the same tower level as a directional antenna, and that no antenna of any type is mounted within any horizontal or vertical distance specified by the antenna manufacturer as being necessary for proper directional operation.

(viii) A statement from an engineer listing such individual engineer's qualifications and certifying that the antenna has been installed pursuant to the manufacturer's instructions.

(ix) A statement from a licensed surveyor that the installed antenna is properly oriented.

(x) (A) For a station authorized pursuant to §73.215 or Sec. §73.509, a showing that the root mean square (RMS) of the measured **or computer modeled** composite antenna pattern (encompassing both the horizontally and vertically polarized radiation components (in relative field)) is at least 85 percent of the RMS of the authorized composite directional antenna pattern (in relative field). The RMS value, for a composite antenna pattern specified in relative field values, may be determined from the following formula:

RMS = the square root of:

$$[(\text{relative field value } 1)^2 + (\text{relative field value } 2)^2 + \dots + (\text{last relative field value})^2]$$

total number of relative field values

(B) where the relative field values are taken from at least 36 evenly spaced radials for the entire 360 degrees of azimuth. The application for license must also demonstrate that coverage of the community of license by the 70 dBu contour is maintained for stations authorized pursuant to §73.215 on Channels 221 through 300, as required by §73.315(a), while noncommercial educational stations operating on Channels 201 through 220 must show that the 60 dBu contour covers at least a portion of the community of license.

* * * * *

3. Amend § 73.1620 to revise paragraph (a)(3) to read as follows:

§ 73.1620 Program tests.

(a) * * *

(3) FM licensees replacing a directional antenna pursuant to §73.1690 (c)(2) without changes which require a construction permit (*see* §73.1690(b)) may immediately commence program test operations with the new antenna at one half (50%) of the authorized ERP upon installation. If the directional antenna replacement is an EXACT duplicate of the antenna being replaced (*i.e.*, same manufacturer, antenna model number, and measured **or computer modeled** composite pattern), program tests may commence with the new antenna at the full authorized power upon installation. The licensee must file a modification of license application on FCC Form 302-FM within 10 days of commencing operations with the newly installed antenna, and the license application must contain all of the exhibits required by §73.1690(c)(2). After review of the modification-of-license application to cover the antenna change, the Commission will issue a letter notifying the applicant whether program test operation at the full authorized power has been approved for the replacement directional antenna.

* * * * *

4. Amend § 73.1690 to revise paragraph (c)(2) to read as follows:

§ 73.1690 Modification of transmission systems.

* * * * *

(c) * * *

(2) Replacement of a directional FM antenna, where the measured **or computer modeled** composite directional antenna pattern does not exceed the licensed composite directional pattern at any azimuth, where no change in effective radiated power will result, and where compliance with the principal coverage requirements of §73.315(a) will be maintained by the measured **or computer modeled** directional pattern. The antenna must be mounted not more than 2 meters above or 4 meters below the authorized values. The modification of license application on Form 302-FM to cover the antenna replacement must contain all of the data in the following sections (i) through (v). Program test operations at one half (50%) power may commence immediately upon installation pursuant to §73.1620(a)(3). However, if the replacement directional antenna is an exact replacement (*i.e.*, no change in manufacturer, antenna model number, AND measured **or computer modeled** composite antenna pattern), program test operations may commence immediately upon installation at the full authorized power.

(i) A measured **or computer modeled** directional antenna pattern and tabulation on the antenna manufacturer's letterhead showing both the horizontally and vertically polarized radiation components and demonstrating that neither of the components exceeds the authorized composite antenna pattern along any azimuth.

(ii) Contour protection stations authorized pursuant to §73.215 or §73.509 must attach a showing that the RMS (root mean square) of the composite measured **or computer modeled** directional antenna pattern is 85% or more of the RMS of the authorized composite antenna pattern. *See* §73.316(c)(9). If this requirement cannot be met, the licensee may include new relative field values with the license application to reduce the authorized composite antenna pattern so as to bring the measured **or computer modeled** composite antenna pattern into compliance with the 85 percent requirement.

(iii) A description from the manufacturer as to the procedures used to measure **or computer model** the directional antenna pattern. The antenna measurements **or computer modeling** must be performed with the antenna mounted on a tower, tower section, or scale model equivalent to that on which the antenna will be permanently mounted, and the tower or tower section must include transmission lines, ladders, conduits, other antennas, and any other installations which may affect the measured **or computer modeled** directional pattern. **See §73.316(c)(2)(iv) for details of the showings required in connection with an application filed for a station using an FM directional antenna.**

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APPENDIX C

Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA)¹ an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Notice of Proposed Rule Making (NPRM)* to this proceeding.² The Commission sought written public comment on the proposals in the *NPRM*, including comment on the IRFA. The Commission received no comments on the IRFA. This Final Regulatory Flexibility Analysis (FRFA) conforms to the RFA.³

A. Need For, and Objectives of, the Report and Order

2. This *Report and Order* adopts rule changes to provide FM and Low-Power FM (LPFM) license applicants the option to submit computer models to verify directional antenna patterns on condition that such proof is provided to the licensee by the antenna manufacturer.

3. Amending these rules will allow for similar treatment of directional FM stations and directional TV, DTV, and AM broadcast stations, and will eliminate unnecessary burdens on broadcasters.

B. Summary of Significant Issues Raised by Public Comments in Response to the IRFA

4. There were no comments to the IRFA filed.

C. Response to comments by the Chief Counsel for Advocacy of the Small Business Administration

5. Pursuant to the Small Business Jobs Act of 2010, which amended the RFA, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration (SBA), and to provide a detailed statement of any change made to the proposed rules as a result of those comments.⁴ The Chief Counsel did not file any comments in response to the proposed rules in this proceeding.

D. Description and Estimate of the Number of Small Entities to Which the Rules Apply

6. The RFA directs the Commission to provide a description of and, where feasible, an estimate of the number of small entities that will be affected by the rules adopted herein.⁵ The RFA generally defines the term “small entity” as having the same meaning as the terms “small business,” “small organization,” and “small government jurisdiction.”⁶ In addition, the term “small business” has the same meaning as the term “small business concern” under the Small Business Act.⁷ A small business

¹ See 5 U.S.C. § 603. The RFA, *see* 5 U.S.C. §§ 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 847 (1996). The SBREFA was enacted as Title II of the Contract With America Advancement Act of 1996 (CWAAA).

² *Updating FM Broadcast Radio Service Directional Antenna Performance Verification*, MB Docket No. 21-422, Notice of Proposed Rulemaking, FCC 21-117 (Nov. 15, 2021).

³ *See* 5 U.S.C. § 604.

⁴ 5 U.S.C. § 604(a)(3).

⁵ *Id.* § 603(b)(3).

⁶ *Id.* § 601(6).

⁷ *Id.* § 601(3) (incorporating by reference the definition of “small business concern” in 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies “unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register.” 5 U.S.C. § 601(3).

concern is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the Small Business Administration (SBA).⁸

7. *Radio Stations.* Radio stations are an Economic Census category that “comprises establishments primarily engaged in broadcasting aural programs by radio to the public. Programming may originate in their own studio, from an affiliated network, or from external sources.”⁹ The SBA has established a small business size standard for this category as firms having \$41.5 million or less in annual receipts.¹⁰ Economic Census data for 2012 shows that 2,849 radio station firms operated during that year.¹¹ Of that number, 2,806 operated with annual receipts of less than \$25 million per year, and 43 firms had annual receipts of \$25 million or more.¹² Because the Census has no additional classifications that could serve as a basis for determining the number of stations whose receipts exceeded \$41.5 million in that year, we conclude that the majority of radio broadcast stations were small entities under the applicable SBA size standard.

8. Apart from the U.S. Census, the Commission has estimated the number of licensed commercial FM stations to be 6,763.¹³ According to BIA/Kelsey Publications, Inc.’s Media Access Pro Database, as of March 2020, 6,762 commercial FM stations had revenues of \$41.5 million or less. In addition, the Commission has estimated the number of noncommercial educational FM radio stations to be 4,119, and the number of Low Power FM (LPFM) stations to be 2,049.¹⁴ NCE stations are non-profit, and all LPFM stations are NCE stations, and all are therefore considered to be small entities. Accordingly, we estimate that the majority of radio broadcast stations are small entities. We note, however, that, in assessing whether a business concern qualifies as small under the above definition, business (control) affiliations¹⁵ must be included. Our estimate, therefore, likely overstates the number of small entities that might be affected by our action, because the revenue figure on which it is based does not include or aggregate revenues from affiliated companies.

9. Moreover, as noted above, an element of the definition of “small business” is that the entity not be dominant in its field of operation. The Commission is unable at this time to define or quantify the criteria that would establish whether a specific radio station is dominant in its field of operation. Accordingly, the estimate of small businesses to which rules may apply does not exclude any radio station from the definition of a small business on this basis and therefore may be over-inclusive to that extent. Also, as noted, an additional element of the definition of “small business” is that the entity must be independently owned and operated. The Commission notes that it is difficult at times to assess these criteria in the context of media entities and the estimates of small businesses to which they apply may be over-inclusive to this extent.

⁸ 15 U.S.C. § 632.

⁹ U.S. Census Bureau, 2012 NAICS Definitions, “515112 Radio Stations,” <https://www.census.gov/cgi-bin/sssd/naics/naicsrch?input=515112&search=2017+NAICS+Search&search=2017>.

¹⁰ 13 CFR § 121.201, NAICS code 515112 Radio Stations.

¹¹ U.S. Census Bureau, Table No. EC1251SSSZ4, *Information: Subject Series - Establishment and Firm Size: Receipts Size of Firms for the United States: 2012* (515112 Radio Stations) https://factfinder.census.gov/bkmk/table/1.0/en/ECN/2012_US/51SSSZ4/naics~515112|515120.

¹² *Id.*

¹³ *Broadcast Station Totals as of March 31, 2022*, Public Notice, DA 22-365 (rel. Apr. 5, 2022) (*Broadcast Station Totals*), <https://docs.fcc.gov/public/attachments/DA-22-365A1.pdf>.

¹⁴ *Id.*

¹⁵ “[Business concerns] are affiliates of each other when one concern controls or has the power to control the other or a third party or parties controls or has the power to control both.” 13 CFR § 121.103(a)(1).

E. Description of Projected Reporting, Record Keeping and Other Compliance Requirements

10. The rule changes adopted in the *Report and Order* do not include any notification or recordkeeping requirements.

F. Steps Taken to Minimize Significant Impact on Small Entities, and Significant Alternatives Considered

11. The RFA requires an agency to describe any significant alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): (1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for small entities; (3) the use of performance, rather than design, standards; and (4) an exemption from coverage of the rule, or any part thereof, for small entities.¹⁶

12. The rules adopted or amended in the *Report and Order*, while potentially imposing new substantive requirements on FM and LPFM radio stations, are voluntary in nature, giving applicants for licensing directional FM broadcast stations the option of submitting computer models rather than submitting measured directional patterns. Applicants wishing to continue submitting measured patterns may do so; however, it is anticipated that computer modeling will save applicants money and may increase the accuracy of the directional pattern verification. Significant alternatives would include continuing to require submissions of measured FM directional antenna patterns rather than computer models; however, in the Commission's judgment the option of submitting computer models rather than measurements reduces financial burdens to FM stations when installing an FM directional antenna.

G. Report to Congress

The Commission will send a copy of this Report and Order, including this FRFA, in a report to Congress and the Government Accountability Office pursuant to the Small Business Regulatory Enforcement Fairness Act of 1996.¹⁷ In addition, the Commission will send a copy of the Report and Order, including the FRFA, to the Chief Counsel for Advocacy of the Small Business Administration. A copy of the Report and Order and FRFA (or summaries thereof) will also be published in the Federal Register.¹⁸

¹⁶ 5 U.S.C. § 603(c)(1)-(c)(4).

¹⁷ *See id.* § 801(a)(1)(A).

¹⁸ *See id.* § 604(b).

**STATEMENT OF
CHAIRWOMAN JESSICA ROSENWORCEL**

Re: *Updating FM Broadcast Radio Service Directional Antenna Performance Verification*, MB Docket No. 21-422, Report and Order (May 19, 2022).

Antenna technology is evolving. You see this very clearly with FM radio stations. Right now, more than one-fifth of our FM radio stations use directional antennas. These antennas increase the operating power of a station in a specific direction while still respecting the interference ratios that are essential for shared use of these airwaves. This is smart—and spectrally efficient.

But our rules governing these antennas need an upgrade. That’s because unlike other broadcast services, FM stations choosing to use directional antennas are required to provide signal measurements from physical antenna mockups. With high-quality computer modeling tools now available, this policy no longer makes sense.

A group of broadcasting stakeholders brought this to our attention last fall. We started a rulemaking to address this discrepancy. We took a close look at the record and the need to incorporate evolving technologies into our policies. As a result, today we adopt an order to allow FM broadcasters to submit verified computer models for directional antennas, like their AM and television broadcasting counterparts.

I want to thank the agency staff who worked on this effort, including Holly Saurer, Tom Horan, Al Shuldiner, Jim Bradshaw, Lisa Scanlan and Tom Nessinger from the Media Bureau; Michelle Schaefer from the Office of Economics and Analytics; Susan Aaron and David Konczal from the Office of General Counsel; and Belford Lawson from the Office of Communications Business Opportunities.