



Standards Council Decision (Long Form):	D#01-26
Standards Council Agenda Item:	SC#00-60
Date of Decision:	04 October 2001
Subject: NFPA 780, <i>Standard for the Installation of Lightning Protection Systems</i>	

This decision concerns the question whether the NFPA should continue its lightning protection project and, in particular, continue to issue NFPA 780, *Standard for the Installation of Lightning Protection Systems*. The Standards Council decided to take up this question in Standards Council Decision Nos. 00-30 and 00-22. In connection with these decisions, the Council announced in October 2000 that it was giving proponents of NFPA 780 an opportunity to provide substantiation in support of the continued development of the standard. (For the full background see, especially, Standards Council Decision Nos. 00-30; 00-22; 00-13, and 95-25. See also Decisions of the NFPA Board of Directors dated June 15, 2001 [re Standards Council Decision Nos. 00-22 and 00-30] and July 18, 1995 [re Standards Council Decision No. 95-25].) Specifically, the Council stated:

Such substantiation should include, at a minimum, an independent literature review and analysis from a reliable source demonstrating the validity of the basic technology and science underlying traditional lightning protection systems. Without prescribing who would be most appropriate to conduct or organize this independent review and analysis, the Council encourages governmental users of lightning protection systems...to consider whether they might play a useful role.

(See Standards Council Decision No. 00-30 at 2-3.)

The Council received submissions in response to Decision No. 00-30, made those submissions available for public review and comment, and thereafter held a hearing on October 4, 2001, to consider the status of NFPA 780 and the lightning protection project.

Among the submissions received by the Standards Council in response to Decision No. 00-30, is a report entitled "The Basis of Conventional Lightning Protection Technology: A Review of the Scientific Development of Conventional Lightning Protection Technologies and Standards." This report is the work of the Federal Interagency Lightning Protection User Group, which is characterized as a group to coordinate the position of lightning protection experts throughout the U.S. government. The Council has concluded that this report (hereafter, the "Federal Interagency User Group Report"), alone, provides the minimum independent literature review and analysis that the Council was soliciting in its Decision No. 00-30. Based on this report, as well as several other

useful submissions received by the Council concerning conventional lighting protection systems, the Council has voted, after a review of the entire record before it, to continue the project on lightning protection and to issue the 2000 edition of NFPA 780, *Standard for the Installation of Lightning Protection Systems*. The basis for the Council's decision now follows.

The Substantiation

Before directly discussing the substantiation provided in response to Decision No. 00-30, it is important to stress that the Council's purpose in requesting substantiation for NFPA 780 was not to displace the NFPA codes and standards development process, but only to assure itself that the results reached by the standards development process had a sufficient, reasonable basis.

In this regard, NFPA 780 has never failed to receive the overwhelming support of the NFPA standards development process. Indeed, NFPA 780 and its predecessors have been successfully processed through the NFPA codes and standards development process in numerous editions going back to 1904. Most recently the proposed 2000 edition of NFPA 780 was developed by the Technical Committee on Lightning Protection and recommended for issuance by the NFPA membership. The technical validity of NFPA 780 has, however, been challenged by those opposed to the continued issuance of this standard. (See Standards Council Decision No. 00-22 at 2.) Typically, the failure of this challenge to succeed through the process itself would be dispositive, and the Council would not inquire further.

Here, however, in the course of proceedings concerning whether the NFPA would issue proposed NFPA 781 on the installation of Early Streamer Emission (ESE) lightning protection systems, concerns were raised about the technical validity of NFPA 780 and conventional lightning protection technology. In particular, concerns were raised in the Bryan Panel Report, a report that concluded that the claims for ESE lightning protection systems had not been technically validated, and went on to question whether technical validation existed for conventional lightning protection technology as well. While the Council did not view the Bryan Panel's criticisms of the conventional technology as definitive, it decided that, coming as they did from respected and neutral observers, they could not be overlooked. The resolution the Council has sought, in the form of an independent literature review and analysis from a reliable source, was meant not to replace the NFPA codes and standards development process, but to provide the Council with some assurance that the validity determination implicit in the continued support of NFPA 780 through the standards development process had some basis in the scientific and technical literature. (See Standards Council Decision No. 00-30 and 00-22.)

That assurance has now been provided primarily in the form of the Federal Interagency User Group Report. This Report is a review of the body of literature, theoretical and empirical, that exists to substantiate the methods and practice of lightning protection as embodied in the current NFPA 780. The development of this Report was in direct response to the request of the Standards Council in Decision No. 00-30 for governmental

users to participate in the submission of technical substantiation regarding conventional lightning protection systems. It is authored by an ad hoc group of federal scientists and engineers and others concerned with safety representing an array of government agencies that use NFPA 780 and rely on lightning protection systems. The participants include the following:

John. M. Tobias, P.E., Electronics Engineer, Department of the Army, Communications Electronics Command. (Chair)

Charles L. Wakefield, Electrical Safety Team Leader, Naval Ordnance Safety and Security Activity, Indian Head, Maryland

Larry W. Strother, Electronics Engineer, HQ Air Force Civil Engineer Support Agency, Technical Support Directorate, Mechanical/Electrical Division

Vladislav Mazur, Ph.D., Physicist, National Oceanic and Atmospheric Administration, National Severe Storms Laboratory, Department of Commerce

Josephine Covino, Ph.D., Chairperson, Lightning Protection Working Group, Department of Defense Explosives Safety Board

John R. Fredlund, Electrical Engineer, National Nuclear Security Administration, Department of Energy

Hugh J. Christian, Jr., Ph.D., Senior Scientist, Global Hydrology and Climate Center, Marshall Space Flight Center, National Aeronautics and Space Administration

Monte Bateman, Ph.D., Thunderstorm Scientist (Contractor), Global Hydrology and Climate Center, Marshall space Flight Center, National Aeronautics and Space Administration.

Warren K. Jordan, Airway Operations Support (AOS), Federal Aviation Administration, Department of Transportation

Greg Heles, U.S. Army Technical Center for Explosives Safety, Department of the Army

The Standards Council has reviewed the Federal Interagency User Group Report, and it has concluded that this report constitutes the independent literature review and analysis from a reliable source that the Council was seeking. The report comes from scientists and others whose credentials, expertise, and objectivity have not been credibly challenged. It reflects the views of government users of lightning protection systems who have a clear interest in the effectiveness of lightning protection systems.

The report provides a detailed account of the development of lightning protection science and a thorough review of the available literature, theoretical and empirical. It first reviews the development of lightning protection science from its beginning with Benjamin Franklin in 1752 up through 1980, and it concludes that “there is a solid trail of scientific investigation into lightning protection techniques.” (Federal Interagency User Group Report at 15.) It then identifies a large bibliography of recent (i.e. post 1980) literature. It concludes in its “Summary of Literature and Theoretical Results” as follows:

Review of the key literature, as presented here, leads to the overwhelming conclusion that lightning protection systems have been intensively studied and have been proven effective many times over in the past 250 years. In that time, observations and theoretical developments (notably in electromagnetic theory) have led to system refinements and associated specification changes. Early work validated the effectiveness of these systems leading to lightning protection standards, which were also refined as new findings became available. Evidence demonstrates a solid scientific basis in lightning protection technology from 1904 through the latest edition of the NFPA 780 in 2000. Parallel study of lightning in Russia and their development of similar standards have become available recently to further increase the already substantial weight of evidence.

(Federal Interagency User Group Report at 17.)

The Report goes on to examine specific empirical and experimental lightning protection studies, including laboratory testing and the results of numerous field tests and reports of field experience. It acknowledges the limited utility of laboratory testing and the difficulty of obtaining reliable field data, and it, therefore, reviews the key studies critically. Based on this review, the Report concludes:

There was both laboratory testing to support the baseline requirements of NFPA 780 and field studies to quantify the system-level requirements for lightning protection systems. It is generally agreed in the scientific and technical community that conventional lightning protection system technology will not be 100 percent effective in all applications. . . . However, the field data reported in this document provides conclusive evidence that conventional lightning protection systems such as those specified in NFPA 780 can provide substantial reductions in lightning-related incidents. This data clearly demonstrates the validity of the basic technology when the requirements are properly applied.

(Federal Interagency User Group Report at 30-31.)

The Report’s overall conclusion and recommendation is as follows:

From the time of the first installation of lightning protection systems to the present day, characterization of the effectiveness remains a recurring question.

This question has been addressed several times during the past 250 years and answered successively. The consensus of the scientific literature, field testing, etc., is that conventional, or Franklin, lightning protection systems, in the venue of the NFPA 780 standard, are highly effective when properly installed and adequately maintained. We can see a trail of scientific inquiry and engineering practice throughout the years. Indeed, the current lightning protection standards, as embodied in NFPA 780, are the result of a consensus process that spans over a century and has had international participation. In this time, lightning protection systems have been subject to studies invoking the latest evolving theory and experimental technique, from the empirical eyewitness of the 1700's, development of electromagnetic theory in the 1800's, the employment of more advanced instrumentation in the 1900's continuing to rocket-triggered lightning and advanced lightning studies of the present day. Indeed, our knowledge increases daily as researchers build on this trail of effort.

....

Consequently the Federal Interagency Lightning Protection User Group recommends:

Continuance of the Project on Lightning Protection and continued maintenance of the NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

Immediate release of NFPA 780, 2000 edition to ensure consistency of lightning protection techniques used in the United States with best available practice and new findings in lightning protection technology.

(Federal Interagency User Group Report at 34, 37.)

The analysis in the report appears considered and thoughtful, and it concludes that there is ample basis in the scientific and technical literature for meaningful standards development for conventional lightning protection systems. The Council has not attempted to independently review each piece of literature cited in the report nor has the Council itself attempted to independently answer the question of technical validity of NFPA 780. Rather, the Council sought an independent analysis by a reliable source with sufficient expertise to review the existing literature and draw valid conclusions. The Federal Interagency User Group Report constitutes precisely such a document. The Council believes that the report provides ample validation for the result reached by the NFPA consensus standards development process and fully justifies the Standards Council in deferring, as it usually would, to the consensus judgments rendered by that process.

In addition to the Federal Interagency User Group Report, the Council has received numerous other submissions. In particular, the Council has received and reviewed several other technical reports. Principal among these are a report of the Committee on Atmospheric and Space Electricity (CASE) of the American Geophysical Union, entitled

“The Scientific Basis for Traditional Lightning Protection Systems” (the CASE Report), and a report authored by Charles B. Moore, Professor Emeritus, Atmospheric Physics, and Graydon D. Aulich, Atmospheric Research Scientist, both of the Langmuir Laboratory for Atmospheric Research of New Mexico Tech.

The Council has found these reports and others of the submissions useful and informative. In general, they fully support and corroborate the analysis and conclusions contained in the Federal Interagency User Group Report, and, while the Federal Interagency User Group Report independently fulfills the Council’s request for a review and analysis in support of NFPA 780, these additional reports add further support to the Council’s conclusion that scientific and technical grounding for NFPA 780 clearly exists.

The Opponents of NFPA 780

The opponents of NFPA 780, and in particular the representative of the Heary Brothers Lightning Protection Co., Inc., and others (“the Hearys”), have made a multitude of arguments attacking the reports, the ethics and bias of the authors, and the soundness of their conclusions. The Hearys have also requested delays in the Council’s hearing on this subject and requested that the Council conduct further “investigations” and issue certain “orders.” The Council has reviewed all of these arguments and has found no basis to delay its consideration of the issues or to take any other requested action. More importantly, none of the arguments made have caused the Council to alter its basic conclusion that the submissions confirm that the overwhelming support within the NFPA codes and standards development process for NFPA 780 has a reasonable basis as evidenced by the existing and generally accepted scientific and technical literature on lightning protection.

Without attempting to comment on each and every one of the arguments made by the opponents of NFPA 780, the Council makes the following observations.

- The Hearys suggest something improper in the fact that members of the NFPA 780 committee played a part in the preparation of reports that have been submitted to the Council. The Council has earlier made clear that it did not envision a formal role for the NFPA 780 Technical Committee in sponsoring or soliciting the requested technical review and analysis. It made equally clear, however, that individual committee members were free to participate as appropriate. (See minute item 00-60, Standards Council Minutes of April 5, 2001.)

Although Technical Committee members do appear in their individual capacities as signatories to the Federal Interagency User Group Report, the CASE Report and other submissions, they represent a small proportion of the total number of signatories. The perspectives represented go far beyond that of the NFPA 780 Technical Committee membership. In any case, technical committee members are hardly disqualified from contributing to or participating in an independent review and analysis simply because they have views about the validity of the NFPA 780 lightning protection technology. What is important to the Council in evaluating the submissions it has received are such

factors as the quality of the submissions, the professional credentials and expertise of the submitters, and the existence of significant business, financial or other interests or affiliations that might unfairly skew the conclusions contained in those submissions. As to such factors, the Council has found, particularly with respect to the Federal Interagency User Group Report, but also with respect to the CASE Report and several other submissions, that the quality of the content was high, the professional credentials and expertise of the signatories was exemplary, and the absence of disqualifying biases or conflicts of interest was evident.

- The Hearys attack in various ways the bona fides of the reports, particularly the Federal Interagency User Group Report and the CASE Report. The Council, however, has found no credible basis on which to question the status of the reports or whether the reports represent the views of the signatories or their representative agencies.

In particular, the Council views as irrelevant to its task any evaluation of the claim that the Federal Interagency User Group Report did not comply with “the Federal Advisory Committee Act.” The claim is that, owing to alleged violation of this Act, the Federal Interagency User Group Report does not represent the official view of the federal agencies whose representatives have signed the report. The Chair of the Federal Interagency User Group, however, has represented to the Council that the report was transmitted to the NFPA under signature authority of government management of several federal agencies, making the document an official government position. (See hearing transcript at 10.) Even if this were not an “official” report, however, the Council’s view of the report or the weight the Council has given it would not change. Even viewed as a document reflecting only the personal views of the individual government scientists, engineers and technical experts who authored it, the report provides more than adequate basis for the Council’s conclusions concerning the lightning protection project.

- Finally, the Hearys have vigorously argued that continuing the existing NFPA 780 lightning protection project is unfair because the NFPA has not gone forward with the proposed NFPA 781 standard on the newer early streamer emission, or ESE, lightning protection technology. They say that NFPA 780 can only continue if NFPA also issues NFPA 781 and that anything less would be unfair, disparate treatment of the newer, and to their point of view, more effective ESE technology.

This argument is important to explore because it reveals, as far as the Hearys are concerned, that the real issue that this appeal raises is not the validity of conventional lightning protection, but the asserted validity of the ESE technology that they champion. Indeed the argument reveals that the Hearys, in fact, contend that conventional lightning protection technology is a valid technology.

On this point the record is clear. A Heary representative has consistently participated on the NFPA 780 committee and has voted in favor of each new edition of 780, up to and including the 2000 edition. The Hearys produce and install NFPA 780 compliant systems, and they acknowledge them to be safe and effective. They even candidly admit

that they believe NFPA 780 to be worthy of continued issuance, provided only that their desired standard for ESE technology also be issued. (See, especially, hearing transcript at 113-117).¹ The Hearys have explicitly tied their newfound opposition to NFPA 780 to the asserted unequal treatment accorded the ESE technology within the NFPA system. As to the Hearys, then, this appeal is not so much about the validity of NFPA 780, as it is an opportunity to reargue their case for a standard on ESE.

The Council has already addressed the validity of ESE, a subject that it has considered over a period of many years and several Council decisions. (See the following Standards Council Decisions: Decision of October 14, 1993, agenda item 93-100; Decision No. 94-11, January 12, 1994; Decision No. 95-26, July 18, 1995; Decision No. 98-40, October 8, 1998; Decision No. 00-13, April 28, 2000. See also the following Appeals and Petitions to the NFPA Board of Directors: May 3, 1994 [re Standards Council decision of October 4, 1993, Agenda item No. 93-100]; December 7, 1995 [re Standards Council Decision No. 95-26]; October 6, 2000 [re Standards Council Decision No. 00-13].) Suffice it to say that there has been no disparate treatment of ESE. The Council is well aware of its obligation to ensure that new products, services or methods receive a fair hearing within the NFPA codes and standards development system. It is for this reason that the Council has given the subject of ESE lightning protection lengthy and, indeed, unprecedented consideration, even after the proposed standard for ESE failed to receive the support of the NFPA codes and standards development process. And it is in large part for this reason that the Council, when confronted with the Hearys' claims of disparate treatment combined with the questions raised in the Bryan Panel Report, sought substantiation beyond that generated through the standards development process itself.

¹ Indeed, it appears that the ESE lightning protection technology which they champion relies to a great extent on the same general principles as conventional lightning protection systems, namely that: 1) cloud to ground lightning preferentially strikes well-exposed, tall, conducting objects that are connected to the Earth; it does not strike bodies that are shielded from strong atmospheric electric fields; and 2) sufficiently large diameter wires, suitably connected, can convey lightning discharges from the strike receptor to ground, without damage to the structures on which they are mounted. (See CASE Report at 8.) Leaving aside alternative theoretical models such as that of Dr. Richard Briet, systems based on ESE devices and another alternative technology known as lightning elimination devices or charge transfer systems (CTS) each contain the three components of traditional lightning protection systems --- strike termination devices, a grounding system, and low-impedance conductors to connect the two together. "The main difference in the design of a system using enhanced protection zone devices [such as ESE] is the claim that one enhanced air terminal protects a much larger area than does one traditional air terminal of the same height." (CASE Report at 10.) The advantage claimed for ESE is, in the words of another report, that "well-exposed 'ESE' air terminals will furnish upward-going streamers that connect to an approaching stepped-leader earlier than will those from conventional lightning rods thereby creating a superior, 'taller,' conducting strike receptor." (Moore and Aulich at 2.) As pointed out in the CASE Report, "ESE and CTS proponents, many of whom recommend termination of the NFPA lightning protection standard, use the basic principles set out in NFPA 780 in the design of systems for their products. All these alternative technologies recognize the validity of the basic elements of traditional lightning protection systems, and incorporate these elements into their designs." (CASE Report at 10.)

In evaluating the Hearys' claims of disparate treatment, it is well to note that the proponents of ESE do not claim that their technology is equal to that of conventional lightning protection systems and therefore deserving of an equivalent standard. Rather, they claim that ESE air terminals are vastly more effective than conventional terminals, and the standard they advocated allows systems to be installed with drastically reduced numbers of air terminals and with limited down conductors and grounding. The Council voted to decline to issue a standard for ESE lightning protection systems because it failed to receive the support of the NFPA codes and standards development system, and because, apart from the doubts about the technology that were reflected in that failure, two separate independent reviews of the technology, by the National Institute of Standards and Technology and by the Bryan Panel, concluded that the claims of vastly superior performance of ESE terminals over conventional terminals simply had not been validated.

In contrast, the Council has voted to continue its project on conventional lightning protection systems because NFPA 780 has repeatedly, unfailingly and overwhelmingly received the support of the NFPA codes and standards development process. As the Council has previously stated, this process is the usual means by which the NFPA satisfies itself concerning questions of technical validity. (See Standards Council Decision No. 00-30 at 1.) In addition to this usual means, however, the Council has sought and been provided with an independent review and analysis from a reliable source demonstrating the validity of the basic technology and science underlying conventional lightning protection systems. This review has been supplemented by other analysis and support from other credible and independent sources. No reasonable or credible arguments have been made to undermine these analyses or to cause the Council to question the conclusions of the scientists, engineers and safety experts who authored them. There has been no disparate treatment.

The 2000 edition of NFPA 780

Having concluded that the lightning protection project should continue, there remains the questions of what to do with the proposed 2000 edition of NFPA 780. When the proposed 2000 edition was initially presented to the Council, the Council delayed its issuance pending resolution of the larger question whether the lightning protection project should continue at all. (See Standards Council Decision Nos. 00-30 and 00-22.) That question has now been resolved in favor of continuing the lightning protection project. Having so concluded, the Council believes that it is appropriate at this time to issue the proposed 2000 edition of NFPA 780. This new edition was fully processed within the NFPA codes and standards development system and received the overwhelming support of the Technical Committee and the NFPA membership. Those who have opposed the continuation of the lightning protection project, moreover, have not leveled any criticism of the updates contained in this proposed new edition, and the Federal Interagency User Group Report as well as others indicate that the 2000 edition has incorporated several provisions in response to recent advances in lightning protection science. (See, e.g., Federal Interagency User Group Report at 15.) In sum, there remains no reason why this document, which has been fully processed and recommended by the

NFPA codes and standards development system, should not now be issued, and the Council has voted to do so.

Conclusion

The Council's decision to consider whether to continue to issue NFPA 780 was largely brought about by questions about the validity of NFPA 780 that were raised in the Bryan Panel Report. While the Council noted the limits of that report with respect to NFPA 780, the Council concluded that the doubts raised in that report, coming as they did from a respectable and reliable source, could not, in the circumstances, be ignored. The Council believes that, as a result of the submissions that it has received, principally the Federal Interagency User Group Report, but also several others, those questions have been adequately answered in favor of continuing the NFPA 780 lightning protection project. The Bryan Panel's principal task was the evaluation of ESE lightning protection technology, not conventional lightning protection, and it is now apparent, from the Federal Interagency User Group Report and other submissions, that a large body of literature confirming the basic principles of conventional lightning protection technology was not considered by the Bryan Panel. (See especially the CASE Report at 11 for a criticism and analysis of the bibliographic and analytic weaknesses of the Bryan Report.) It is also clear that one of the Bryan Panel's principal criticisms of conventional lightning protection systems, namely that the classic sharp-tipped lightning rods recommended by Franklin himself may not be optimal, has already been acknowledged by the scientific community and has been addressed by NFPA 780, which no longer requires sharp-tipped rods, and which, in the 2000 edition, presents the latest findings on sharp- versus blunt-tipped rods. (See NFPA 780 at Appendix A-3-6.1 [2000 edition]. See also CASE Report at 11-12.)

Scientific knowledge of lightning and the methods of lightning protection are imperfect and evolving. There is general agreement that the study of lightning and lightning protection is difficult. It is hampered by the inadequacy of laboratory experimentation as a tool to study such a large scale and chaotic phenomenon. Testing in natural lightning conditions is likewise difficult as is the collection and documentation of field experience and the collection of meaningful statistical data. Certain theoretical models used, for example, to determine zones of protection of lightning rods, may be the subject of legitimate scientific debate and may, in time, be revised or replaced as new knowledge is developed. Nevertheless, it appears that there is widespread agreement that the basic scientific principles of conventional lightning protection are sound, and that there is sufficient evidence - experimental, experiential, statistical, theoretical and otherwise - to make meaningful consensus judgments about the best way to design and install conventional lightning protection systems.

The Council wishes to thank the submitters of the various reports and other submissions concerning this issue, and to urge the government users and other experts with an interest in this subject to continue to actively participate in NFPA's lightning protection project, either through application for membership on the technical committee, submission of Proposals and Comments for future editions, or otherwise.

For all of the foregoing reasons, the Council has voted to continue the existing project on lightning protection and to issue the 2000 edition of NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

Owing to recusal and/or absence, Council members Hawkins, Talka, Benarick, and O'Sullivan did not participate in the deliberations and vote on this issue.