

Report of the Committee on  
Rack Storage

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Robert C. Everson, Calabash, NC [SE]  
James G. Gallup, Rolf Jensen & Assoc., Inc., IL [SE]  
William W. Glassmyer, St. Onge Ruff & Assn., Inc., PA [SE]  
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Rep. TC on General Storage  
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Rep. American Fire Sprinkler Assn., Inc.  
Novell Liston, Rapistan Systems, UT [IM]  
Rep. Material Handling Inst. Inc.  
Peter J. McWilliams, Eastman Kodak Co., NY [U]  
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Andy Miller, Hallmark Cards Inc., MO [U]  
Rep. NFPA Industrial Fire Protection Section  
Gerald W. O'Rourke, O'Rourke & Co., CA [SE]  
Gene V. Paolucci, Yasuda Fire & Marine Insurance Co. of  
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Rep. American Insurance Services Group, Inc  
Douglas Rice, Central Sprinkler Corp., PA [M]  
Rep. American Fire Sprinkler Assn., Inc  
Chester W. Schirmer, Schirmer Engr Corp., NC [SE]  
Todd E. Schumann, Industrial Risk Insurers, IL [I]  
Rep. Industrial Risk Insurers  
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Rep. Nat'l Fire Sprinkler Assn.  
Peter Thomas, The Viking Corp., MI [M]  
Rep. Nat'l Fire Sprinkler Assn.  
William J. Tomes, Tomes, VanRickle & Assoc., GA [SE]  
Rep. Home Depot

Alternates

Donald "Don" D. Becker, Midland Automatic Sprinkler Co., Inc.,  
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Roland J. Huggins, American Fire Sprinkler Assn., TX [M]  
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Paul F. Roberto, Wausau HPR Engr, MI [I]  
(Alt. to H. N. Davidson)  
Arthur H. Roede, The DuPont Co., DE [U]  
(Alt. to A. Miller)  
Robert D. Spaulding, Factory Mutual Research, MA [I]  
(Alt. to J. B. Hankins Jr.)  
Lee F. West, Travelers Insurance Co., CT [I]  
(Alt. to A. C. Gumkowski)  
Roger Wilkins, Grinnel Corp./Tyco, RI [M]  
(Alt. to P. Thomas)

Nonvoting

Christopher T. Lummus, Insurance Services Office Inc., TX [I]  
Staff Liaison: Milosh T. Puchovsky

*This list represents the membership at the time the Committee was  
balloted on the text of this edition. Since that time, changes in the  
membership may have occurred. A key to classifications is found at the  
front of this book.*

**Committee Scope:** This Committee shall have primary  
responsibility for documents on fire prevention and fire protection  
considerations for the rack storage of materials, including  
automatic systems. This Committee also shall have primary  
responsibility for emergency operations, including fire fighting  
operations in facilities used for the rack storage of materials.

This portion of the Technical Committee Report of the  
Committee on Rack Storage is presented for adoption.

This Report on Comments was prepared by the Technical  
Committee on Rack Storage and documents its action on the  
comments received on its Report on Proposals on NFPA 231C-  
1995, Standard for Rack Storage of Materials, as published in the  
Report on Proposals for the 1998 Annual Meeting.

This Report on Comments has been submitted to letter ballot of  
the Technical Committee on Rack Storage which consists of 27  
voting members. The results of the balloting, after circulation of  
any negative votes, can be found in the report.

NFPA 231C — A98 ROC

(Log #1)

231C- 1 - (Entire Document): Accept in Principle
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers
COMMENT ON PROPOSAL NO: 231C-1
RECOMMENDATION: Add the following to recommendation number 2:

For the purpose of this standard, ordinary temperature rating shall range from 155°F to 170°F.
SUBSTANTIATION: In NFPA 13, ordinary temperature rating range from 135°F to 170°F. Allowing the use of 135°F may adversely effect the number of operating sprinklers. This fact would have to be put in 1-3 Definitions or in the text as needed.
COMMITTEE ACTION: Accept in Principle.

Add a new Section 5-2.3 to read as follows:
5-2.3 The minimum temperature rating of ceiling sprinklers shall be 150°F (C).

COMMITTEE STATEMENT: The change was placed in chapter 5 to cover all situations in the standard. We chose the 150°F to not allow the use of the 135°F sprinkler but to allow some deviation in the 155°F sprinkler.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 25
NOT RETURNED: 2 Miller, O'Rourke

(Log #13)

231C- 2 - (Entire Document): Accept
SUBMITTER: Roger S. Wilkins, Grinnell Corp.
COMMENT ON PROPOSAL NO: 231C-1
RECOMMENDATION: Replace 165°F and 286°F with ordinary and high temperature, respectively, for Figure 6-11(a) through 6-11(g); Table 7-8.1; and Table 7-11.

SUBSTANTIATION: Fulfills the recommendation of the Technical Committee.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 25
NOT RETURNED: 2 Miller, O'Rourke

COMMENT ON AFFIRMATIVE:
SCHUMANN: I agree with the proposal but the change was not made in the preprint copy of NFPA 231C. Change must be made in future editions.

(Log #2)

231C- 3 - (Chapter 2): Accept in Principle
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers
COMMENT ON PROPOSAL NO: 231C-6
RECOMMENDATION: Under batteries, the words "Dry cells" should be in the commodity column not the commodity class column. Under barley, rice and oats should have their own entries. Under bottles/jars, all items filled with noncombustible powers should be together. Under candles, expanded Group A plastic should be in the commodity class column.
SUBSTANTIATION: Comments made to correct typographical errors.

COMMITTEE ACTION: Accept in Principle.
Revise entries in Table A-2-1 "Examples of Commodities" as follows:

- Batteries
Dry Cells (non-lithium or similar exotic metals) (pp 786 in Report on Proposals)
Batteries
Dry Cells (non-lithium or similar exotic metals) (pp 788 in Report on Proposals)
Batteries
Dry Cells (non-lithium or similar exotic metals) (pp 789 in Report on Proposals)
Replace Barley, Rice, Oats with:
Grains packaged in cartons Class III
Barley
Rice
Oats (pp 786 in Report on Proposals)
In Table A-2-1.3.3 on pp 790 in Report on Proposals, Replace Barley, Rice, Oats with:
"Grains packaged in cartons
Barley
Rice
Oats "(pp 786 in Report on Proposals)

In Table A-2-1.3, replace bottles/jars with:
Bottles/Jars
Filled noncombustible powders
-glass, cartoned (I)
-plastic, cartoned (<1 gallon) (IV)
-plastic, uncartoned (other than PET) (any size) (A)
-plastic, cartoned or uncartoned (>1 gallon) (A)
-plastic, solid plastic crates (A)
-plastic, open plastic crates (A)
on pp 787 of Report on Proposals, replace Plastic Containers with :

Plastic Containers
-Noncombustible liquids or semiliquids in plastic containers less than 5 gallon capacity Class I
- Noncombustible liquids or semiliquids (such as ketchup) in plastic containers with nominal wall thickness of 1/4 in. or less and larger than 5 gallons Class II
- Noncombustible liquids or semiliquids (such as ketchup) in plastic containers with nominal wall thickness greater than 1/4 in. and larger than 5 gallons Group A
In Table A-2-1.3.1 on pp 788 in Report on Proposals, revise Plastic Containers to read as follows:

Plastic Containers
-Noncombustible liquids or semiliquids (such as ketchup) in plastic containers with nominal wall thickness of 1/4 in. or less and larger than 5 gallons.
In Table A-2-1.4.1 on pp 792 of the Report on Proposals, revise Plastic Containers to read as follows:

Plastic Containers
-Combustible or noncombustible solids in plastic containers and empty plastic containers
-Noncombustible liquids or semiliquids (such as ketchup) in plastic containers with nominal wall thickness greater than 1/4 in. and larger than 5 gallons

COMMITTEE STATEMENT: Editorial changes have been made for clarification.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 25
NOT RETURNED: 2 Miller, O'Rourke

(Log #42)

231C- 4 - (Chapter 2): Reject
SUBMITTER: Southeast Regional Fire Code Dev. Committee
COMMENT ON PROPOSAL NO: 231C-6
RECOMMENDATION: Move all appendix material related to Alphabetized Listing of Commodity Classes to the body of the code in the appropriate places.
SUBSTANTIATION: Move all appendix material related to Alphabetized Listing of Commodity Classes to the body of the code in the appropriate places.
COMMITTEE ACTION: Reject.
COMMITTEE STATEMENT: The Section in the Appendix A-2-1 is to create a list of common commodities and not to be an all inclusive list of commodities.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 25
NOT RETURNED: 2 Miller, O'Rourke

(Log #19)

231C- 5 - (2-1.1.2): Accept
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.
COMMENT ON PROPOSAL NO: 231C-6
RECOMMENDATION: In Exception No. 1, change "may be" to "shall be permitted to be." Also, in Exception No. 2, change "material can be" to "materials are."
SUBSTANTIATION: Removes permissive language.
COMMITTEE ACTION: Accept.
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27
VOTE ON COMMITTEE ACTION:
AFFIRMATIVE: 25
NOT RETURNED: 2 Miller, O'Rourke

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(Log #21)

231C- 6 - (2-1.3.4(c)): Accept  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-6  
RECOMMENDATION: In the last sentence, change "may be" to "shall be permitted to be any of the following materials."  
SUBSTANTIATION: Removes permissive language.  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #36)

231C- 7 - (3-3): Reject  
SUBMITTER: Mark Chubb, Southeastern Assn. of Fire Chiefs, Inc.  
COMMENT ON PROPOSAL NO: 231C-10  
RECOMMENDATION: Revise Section 3-3 to read as follows:  
3-3† Vents and Draft Curtains. Where roof vents and draft curtains or mechanical smoke exhaust are installed, the effect of smoke and heat venting on automatic sprinkler operation shall be taken into account. Design curves are based on the assumption that roof vents and draft curtains or mechanical smoke exhaust are not being used. Designs using these fire protection features in combination with one another shall be based on engineering judgment and recognized good practice.  
SUBSTANTIATION: In rejecting proposal 231C-10, the Technical Committee cited the absence of data upon which to evaluate the interaction of sprinklers, smoke and heat vents, and draft curtains. In actuality, a great deal of research and data exists which explores the potential interaction among these elements. However, very little consensus exists on how to interpret the information currently available in the literature. The project currently proceeding under the direction of the National Fire Protection Research Foundation to investigate possible interactions among these features continues to pursue answers to nagging questions regarding possible conflicts among these fire protection features. However, this work remains ongoing with two of five scheduled tests completed at the time this comment was prepared. The submitter anticipates that upon completion, the NFPRF project will provide additional information (beyond the substantial volume cited in the research conducted to date) which will aid designers and authorities having jurisdiction in reaching informed judgments, and possibly local consensus, about the value and potential interactions of these fire protection features. Adding the proposed language now will improve the existing Section by making it more than an explanation, and encourage users of the Standard to avail themselves of the knowledge which emerges from the NFPRF project. Providing explicit acknowledgment that data exists which may be of value to designers and authorities having jurisdiction will improve decision-making in this complex and controversial area and help reduce conflicts between the Standard and current model code requirements.  
COMMITTEE ACTION: Reject.  
COMMITTEE STATEMENT: The NFPRF project has not been completed and the report has not been finalized.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #41)

231C- 8 - (3-3): Accept  
SUBMITTER: Southeast Regional Fire Code Dev. Committee  
COMMENT ON PROPOSAL NO: 231C-10  
RECOMMENDATION: Hold the proposal for further study.  
SUBSTANTIATION: There is a current project in the Research Foundation dealing with this issue. No action should be taken until the final report has been released and all parties can review.  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #35)

231C- 9 - (5-1 Exception): Accept in Principle  
SUBMITTER: David S Eason, Detroit Edison Co.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Revise Exception No. 1 to 5-1.1 as follows:  
Exception No. 1: In areas subject to freezing or where special conditions exist, dry pipe and preaction systems shall be permitted. Ceiling sprinkler areas of operation shall be increased 30 percent for dry pipe and double interlocked preaction systems over the areas specified by Chapters 6, 7 and 8. Densities and areas shall be selected so that the final area of operation (after the 30 percent increase) is not greater than 6000 sq ft.  
SUBSTANTIATION: All types of preaction systems are not prone to the same response delay as dry pipe systems experience. The single and non-interlocked preaction systems do not depend on air release to allow water to fill the piping. The proposed change above will recognize the differences.  
COMMITTEE ACTION: Accept in Principle.  
COMMITTEE STATEMENT: The proposal may not meet the performance criteria of water delivery. See Committee Action and Statement on Comment 231C-10 (Log #15).  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #15)

231C- 10 - (5-1.1): Accept in Principle  
SUBMITTER: Roger S. Wilkins, Grinnell Corp.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Revise text as follows:  
5-1 Protective Systems.  
5-1.1\* Sprinkler systems shall be wet pipe.  
Exception: In areas subject to freezing or where special conditions exist, dry pipe and preaction systems shall be permitted.  
5-1.2 Where dry pipe systems are permitted, the ceiling sprinkler areas of operation shall be increased 30 percent over the areas specified by chapters 6, 7, and 8. Densities and areas shall be selected so that the final area of operation after the 30 percent increase is not greater than 6000 ft<sup>3</sup>.  
5-1.3.1 Where preaction systems are permitted, preaction systems shall be treated as dry pipe systems.  
Exception: Where it can be demonstrated that the detection system activating the preaction system will cause water to be at the sprinklers when they operate, preaction systems shall be permitted to be treated as wet pipe systems.  
5-1.3.2 Detectors for preaction systems shall be installed in accordance with 5-8.3.  
SUBSTANTIATION: 1. As originally presented, the concept of when a preaction system can be treated as a wet system was not presented as it had been in 9-1.7 for large drop sprinklers.  
2. As originally presented, Exception No. 2 is not an exception to 5-1.1.  
3. The revised text is offered as an alternative, which should be more user friendly and more concise.  
COMMITTEE ACTION: Accept in Principle.  
Revise the proposed Exception to read as follows (balance of proposal remains as submitted):  
Exception: Where it can be demonstrated that the detection system activating the preaction system will cause water to be discharged from sprinklers as quickly as wet systems.  
COMMITTEE STATEMENT: The change in the Exception was made to clarify the desired performance criteria.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke  
COMMENT ON AFFIRMATIVE:  
GUMKOWSKI: In Sections 5-1.2 and 5-1.3.1, change the word "permitted" to "used", so Section 5-1.2 will read "Where dry pipe systems are used...", and Section 5-1.3.1 will read "Where preaction systems are used..."  
As currently proposed, if I choose to use an antifreeze solution in a cold area to keep the sprinkler system wet, the 30 percent area penalty still would apply (because a dry or preaction system would be permitted).  
THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

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(Log #38)

231C- 11 - (5-1.1 Exception No. 1): Accept in Principle  
SUBMITTER: Peter Thomas, The Viking Corp.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Revise 5-1.1 Exception No. 1 as follows:  
In areas subject to freezing or where special conditions exist, dry pipe and preaction systems shall be permitted.  
SUBSTANTIATION: NFPA 13 treats preaction systems as wet pipe systems. If proper detection methods are used, water will be available at the sprinkler when it operates. A 30 percent area penalty is much to severe of a penalty because a preaction system doesn't behave like a dry pipe system.  
COMMITTEE ACTION: Accept in Principle.  
COMMITTEE STATEMENT: See Committee Action and Statement on Comment 231C-10 (Log #15).  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #37)

231C- 12 - (5-1.1 Exception No. 2): Accept  
SUBMITTER: Peter Thomas, The Viking Corp.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Eliminate Exception 2 to paragraph 5-1.1.  
SUBSTANTIATION: Already covered this in Section 9-1.7 which is the Chapter on Large Drop Sprinklers.  
COMMITTEE ACTION: Accept.  
COMMITTEE STATEMENT: Exception in section 9-1.7 should also agree with the exception in Comment 231C-10 (Log#15).  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #20)

231C- 13 - (5-1.1 Exception No. 2): Accept in Principle  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Revise Exception No. 2 to read as follows:  
"Exception No. 2: Where large drop sprinklers are used, Section 9-1.7 shall apply."  
SUBSTANTIATION: The action taken by the Committee on Proposal 231C-70 is inconsistent with the action taken on this item. This comment will clarify the conflict.  
COMMITTEE ACTION: Accept in Principle.  
COMMITTEE STATEMENT: See Committee Action and Statement in Comment 231C-12 (Log #37).  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #25)

231C- 14 - (5-1.1 and Exception No. 1): Reject  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Revise the proposed Section 5-1.1 and Exception No. 1 to the original language of the Proposal (231C-15 Section 5-1.1 and Exception) as printed in the ROP.  
SUBSTANTIATION: There is no reason to subject single interlock and non-interlock preaction systems to the 30% increase requirements. Preaction systems have been operational for almost 100 years without demonstrating any problem (and without the 30% increase). The original proposal was submitted to deal with dry-pipe systems, which are a known problem. Since double interlock systems act much like dry systems, they were included in the proposal. This is consistent with NFPA 13 on the subject.  
COMMITTEE ACTION: Reject.  
COMMITTEE STATEMENT: There is some evidence that preaction systems could cause water delivery delay.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #3)

231C- 15 - (5-1.2): Reject  
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers  
COMMENT ON PROPOSAL NO: 231C-17  
RECOMMENDATION: 5-1.2 now appears as 5-2.2 in the reprint in the A98 Report on Proposals. Exception No. 1 and No. 3 both cover the 5/8 in. orifice sprinkler.  
SUBSTANTIATION: Comments made to correct typographical errors.  
COMMITTEE ACTION: Reject.  
COMMITTEE STATEMENT: Exceptions 1 and 3 cover different sprinklers.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #26)

231C- 16 - (5-1.2 (New)): Reject  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Add a new Section 5-1.2 and renumber existing (proposed) Section 5-1.2 to 5-1.3.  
"5-1.2 The ceiling sprinkler system area of operation shall be increased by 30 percent, without revising the density, when spray sprinklers are used under sloped roof/ceilings with a pitch exceeding 2 in. in 12 in.. The number of ceiling sprinklers calculated (see Table 9-1) shall be increased by 30 percent, without revising the density, when large drop sprinklers are used under sloped roof/ceilings with a pitch exceeding 2 in. in 12 in."  
SUBSTANTIATION: Fire testing, modeling and experience has shown that additional sprinklers will open due to a highly pitched roof/ceiling. This needs to be taken into account in the sprinkler system design. NFPA 13 has addressed this issue in Section 5-2.3.2.5 of the 1996 edition. NFPA 231C should not be less stringent than NFPA 13.  
COMMITTEE ACTION: Reject.  
COMMITTEE STATEMENT: This requirement presently resides in NFPA 13, Standard for the Installation of Sprinkler Systems in Section 5-2.3.2.5. There is no reason to repeat it here.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #17)

231C- 17 - (5-2.2): Accept in Principle in Part  
SUBMITTER: Roger S. Wilkins, Grinnell Corp.  
COMMENT ON PROPOSAL NO: 231C-18  
RECOMMENDATION: Revise text as follows:  
5-2.2\* Standard response 1/2-in. (12.7-mm) orifice or 17/32-in. (13.5-mm) orifice spray sprinklers shall be used in applying the curves and tables in Chapters 6, 7, and 8. (See Chapters 9 and 10 for large drop and ESFR sprinklers.)  
Exception No. 1: The use of quick response spray sprinklers shall be permitted.  
Exception No. 2: The use of 5/8-in. (15.9-mm) or 3/4-in. (19.0-mm) orifice spray sprinklers shall be permitted where listed for such use and in accordance with their listed minimum design pressure.  
A-5-2.2 The densities and areas provided in chapters 6, 7, and 8 are based on fire tests using standard response 1/2-in. (12.7-mm) and 17/32-in. (13.5-mm) orifice spray sprinklers.  
SUBSTANTIATION: 1. The term "standard response" clarifies the base type of sprinkler recognized by Section 5-2.2.  
2. The words "applying the curves and tables in" is consistent with NFPA 231.  
3. The use of the term "spray sprinkler" throughout Section 5-2.2 clarifies the base type of sprinkler recognized by Section 5-2.2.  
4. Exception No. 1 as presented is believed to be the intent of Section 5-2.2. The use of an exception to permit quick response ceiling sprinklers is consistent with the way quick response sprinklers are permitted for in-rack locations per Chapters 6, 7, and 8.  
5. Exception No. 2 as presented will now, in addition to permitting the use of 3/4-in. orifice sprinklers (NFPA 231C-18, Log #20), permit the use of 5/8-in. orifice sprinklers at design pressures less than 10 psi.

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The original 10 psi minimum design pressure for 5/8-in. orifice spray sprinklers was based on fire tests of the first developed 5/8-in. (ELO) sprinklers, where it was found that an undesirable number of sprinklers opened with a minimum design pressure of 7 psi and a desirable number of sprinklers opened with a minimum design pressure of 11 psi.

A recent fact finding investigation performed by Underwriters Laboratories Inc. (File Ex 1226, Project 97NK24727, 10/6/97) using the Grinnell Model F892 5/8-in. Orifice Upright Spray Sprinklers illustrates that 5/8-in. spray sprinklers incorporating an appropriate design can successfully pass the previously failed fire test at a minimum design pressure of 7 psi with less than the maximum desirable number of sprinkler operations.

Allowing the 5/8-in. orifice sprinklers to be used in accordance with their listed minimum design pressure will allow the use of the recognized normal minimum design pressure of 7 psi for spray sprinklers, where listed, while permitting the use of other special application sprinklers at their already listed minimum design pressure of 10 psi.

6. The appendix material clarifies the original basis of the densities and areas, which was part of the original text for Section 5-1.2 before the rewrite of Chapter 5.

NOTE: Supporting material is available for review at NFPA Headquarters.

**COMMITTEE ACTION:** Accept in Principle in Part.

Reject the proposed Exception No. 1. The balance of the comment is accepted. Delete the words "and in accordance with their listed minimum design pressure." The exception now reads as follows:

Exception: The use of 5/8-in. (15.9-mm) or larger orifice spray sprinklers shall be permitted where listed for such use.

**COMMITTEE STATEMENT:** Quick response sprinklers were eliminated due to a lack of full scale fire testing which has proven their effectiveness for all rack storage configurations. Editorial changes have been made to agree with actions on Comment 231C-18 (Log #16). The listed minimum design pressure language was eliminated to defer to the NFPA 13 minimum of 7 psi.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 24

**NEGATIVE:** 1

**NOT RETURNED:** 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

**SCHIRMER:** Contrary to the Committee statement, tests S27 and S28 compared with S29 and test S30 compared with test S31 from quick response ELO sprinkler tests conducted at Underwriters Laboratories as well as tests of ESFR sprinklers conducted at Factory Mutual Research Corporation demonstrate the effectiveness of quick response sprinklers for rack storage configurations as well as their superior performance compared to standard response sprinklers.

(Log #16)

231C- 18 - (5-2.2 Exception No. 3): Reject

**SUBMITTER:** Roger S. Wilkins, Grinnell Corp.

**COMMENT ON PROPOSAL NO:** 231C-17

**RECOMMENDATION:** Delete proposed Exception No. 3.

**SUBSTANTIATION:** There are no fire tests to support that spray sprinklers with orifice sizes larger than 3/4-in. will be effective.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** The comment discourages new technology which is contrary to the intent of the standard.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 25

**NOT RETURNED:** 2 Miller, O'Rourke

(Log #24)

231C- 19 - (5-2.3 Exception): Accept in Principle

**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**COMMENT ON PROPOSAL NO:** 231C-15

**RECOMMENDATION:** Revise the new proposed Exception to 5-2.3 to read as follows:

"When separated by a partition continuous from the floor to the roof/ceiling of the storage area capable of preventing the passage of smoke, the sprinkler discharge criteria is not required to be continued into the adjacent space."

**SUBSTANTIATION:** The barrier doesn't necessarily need to be noncombustible. Anything which prevents the passage of heat (smoke) will work.

**COMMITTEE ACTION:** Accept in Principle.

Reword the Exception to read as follows:

"Exception: When separated by a barrier partition capable of preventing heat from a fire in the rack storage area from fusing sprinklers in the non rack storage area."

**COMMITTEE STATEMENT:** The comment was rewritten to express the requirement for a barrier in performance based terms.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 25

**NOT RETURNED:** 2 Miller, O'Rourke

(Log #43)

231C- 20 - (5-2.3 Exception): Reject

**SUBMITTER:** Southeast Regional Fire Code Dev. Committee

**COMMENT ON PROPOSAL NO:** 231C-15

**RECOMMENDATION:** Change the exception to read: Exception:

When separated by at least two one-hour rated fire resistive construction which is continuous from floor to ceiling of the storage area.

**SUBSTANTIATION:** This is inconsistent with the model building codes and fire prevention codes on the fire resistance rating of separation requirements. This is also consistent with a comment to 231.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** A one hour fire resistance rating is beyond the need for preventing sprinklers from operating in the non rack storage area.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 25

**NOT RETURNED:** 2 Miller, O'Rourke

(Log #CC2)

231C- 21 - (5-2.3 Exception): Accept in Principle

**SUBMITTER:** Technical Committee on Rack Storage, Nat'l Fire Sprinkler Assn.

**COMMENT ON PROPOSAL NO:** 231C-15

**RECOMMENDATION:** Revise the new proposed Exception to 5-2.3 to read as follows:

"When separated by a partition continuous from the floor to the roof/ceiling of the storage area capable of preventing the passage of smoke, the sprinkler discharge criteria is not required to be continued into the adjacent space."

**SUBSTANTIATION:** The barrier doesn't necessarily need to be noncombustible. Anything which prevents the passage of heat (smoke) will work.

**COMMITTEE ACTION:** Accept in Principle.

Reword the Exception to read as follows:

"Exception: When separated by a barrier partition capable of preventing heat from a fire in the rack storage area from fusing sprinklers in the non rack storage area."

**COMMITTEE STATEMENT:** The comment was rewritten to express the requirement for a barrier in performance based terms.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 25

**NOT RETURNED:** 2 Miller, O'Rourke

**COMMENT ON AFFIRMATIVE:**

**THACKER:** Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

(Log #4)

231C- 22 - (5-3): Accept in Principle

**SUBMITTER:** Todd E. Schumann, Industrial Risk Insurers

**COMMENT ON PROPOSAL NO:** 231C-21

**RECOMMENDATION:** This paragraph does not appear in the NFPA 231C-A98 Report on Proposals reprint. It should be retained and revised to apply to 1/2 orifice sprinklers. "For the purpose of selecting sprinkler spacing in hydraulically designed sprinkler systems using 1/2 in. orifice sprinklers to achieve..."

**SUBSTANTIATION:** Suspect that this pressure limitation was to apply to 1/2 in. orifice heads so they would generate drops rather than mist.

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**COMMITTEE ACTION:** Accept in Principle.

Include 17/32 in. orifice sprinklers also.

**COMMITTEE STATEMENT:** The Committee decided that 17/32 in. falls into the same category.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 25

NOT RETURNED: 2 Miller, O'Rourke

**COMMENT ON AFFIRMATIVE:**

THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

(Log #12)

231C- 23 - (5-3): Reject

**SUBMITTER:** Paul Roberto, Wausau Insurance Cos.

**COMMENT ON PROPOSAL NO:** 231C-21

**RECOMMENDATION:** Revise text as follows:

5-3 In-Rack Sprinklers

5-3.1 In-Rack Sprinkler System Size. The area protected by a single system of sprinklers in racks (in-rack sprinklers) shall not exceed 40,000 ft<sup>2</sup> (3,716 m<sup>2</sup>) of floor area occupied by the racks, including aisles, regardless of the number of intermediate sprinkler levels.

5-3.2\* In-Rack Sprinkler System Control Valves. Where sprinklers are installed in racks, separate indicating control valves and drains shall be provided and arranged so that ceiling and in-rack sprinklers can be controlled independently.

Exception No. 1: Installation of 20 or fewer in-rack sprinklers supplied by any one ceiling sprinkler system.

Exception No. 2: The separate indicating valves shall be permitted to be arranged as sectional control valves where the racks occupy only a portion of the area protected by ceiling sprinklers. (See 5-2.3)

5-3.3 In-Rack Sprinkler Water Demand. The water demand for sprinklers installed in racks shall be added to the ceiling sprinkler water demand at the point of connection. The demand shall be balanced to the higher pressure.

5-3.4 In-Rack Sprinkler Pipe Size. The number of sprinklers and the pipe sizing on a line of sprinklers in racks is restricted only by hydraulic calculations and not by any piping schedule.

5-3.5 In-Rack Sprinkler Type. Sprinklers in racks shall be ordinary temperature, standard response or quick response, nominal 1/2-in. (12.7-mm) or 17/32-in. (13.5-mm) orifice size, pendent or upright sprinklers.

Exception No. 1: Sprinklers with intermediate temperature or high temperature rating shall be used near heat sources as required by NFPA 13, Standard for the Installation of Sprinkler Systems.

Exception No. 2: Quick response sprinklers shall be used in racks when ceiling protection is by an Early Suppression Fast Response (ESFR) sprinkler system.

5-3.6 In-Rack Sprinkler Water Shields. Water shields shall be provided directly above in-rack sprinklers or listed sprinklers equipped with water shields shall be used where there is more than one level, if not shielded by horizontal barriers.

(See B-6.4)

5-3.7 In-Rack Sprinkler Clearance. A minimum of 6 in. (152.4 mm) vertical clear space shall be maintained between the sprinkler deflectors and the top of a tier of storage.

Exception: The elevation of in-rack sprinkler deflectors with respect to storage shall not be a consideration in single- or double-row rack storage of Class I, II, III, and IV commodities without solid shelves and with storage up to and including 20 ft (6.1 m) high.

(See B-6.5.1)

5-3.8 In-Rack Sprinkler Head Location

5-3.8.1 Longitudinal flue in-rack sprinklers shall be located at the intersection with the transverse flue space and with the deflector located above or below adjacent horizontal rack members. Such in-rack sprinklers shall be a minimum of 3 in. from rack uprights.

(See B-6.6.2)

5-3.8.2 Face sprinklers in racks shall be located a minimum of 3 in. (76.2 mm) from rack uprights and no more than 18 in. (0.46 m) from the aisle face of storage.

Other proposed changes:

Delete 5-3.4

Delete A-5-3.2

Delete A-6-5.1

Delete A-6-5.2

Revise B-6-5.1 to include the commodity classes tested.

**SUBSTANTIATION:** a. The changes in the comment above are mostly editorial in nature. In-rack sprinkler protection requirements are currently spread throughout the standard and putting them in one place would be more user friendly. Several of the paragraphs should be eliminated or further refined as requirements are moved from this document into NFPA 13 in the future, these are noted below.

b. In 5-3.1, add the metric equivalent for the 40,000 sq ft area. This paragraph is in NFPA 13-1996 (4-12.1) and could be deleted from NFPA 231C.

c. In 5-3.2, change "(see 5-1.3)" or delete this reference. This paragraph is in NFPA 13-1996 (4-12.2) and could be deleted from NFPA 231C. Exception No. 2 does not appear to add anything and deletion should be considered.

d. In 5-3.3, change "...sprinklers stored in racks..." to "...sprinklers installed in racks..." This section could be deleted from NFPA 231C since it is contained in NFPA 13-1996 (6-6.2).

e. Add 5-3.4 and delete 6-3, 7-3, and 8-1.5.2. The three existing paragraphs are identical to the one new one. This paragraph could be deleted from NFPA 231C since it is contained in NFPA 13-1996 (6-6.1).

f. Add 5-3.5 and delete 6-2, 7-1, 8-1.5.1, and 8-3.3. The four existing paragraphs contain the same information except:

I. 6-2 does not permit the use of 17/32-in. sprinklers in racks. The use of these heads may not make economic sense but, with the 15 psi design requirement, they would provide better fire protection than 1/2-in. sprinklers.

II. Chapter 8:

1. 8-1.5.1 does not include allowable orifice sizes. Allowable orifice sizes are identified in the Notes to Figure 8-2 (which have design specifications for both 1/2-in. and 17/32-in. sprinklers) and in 8-3.3.

2. Does not mention deflector style of sprinklers in 8-1.5.1, because of this, the first part of the chapter could be interpreted as allowing the use of sidewall sprinklers in racks. 8-3.3 does limit in-rack sprinklers to pendent or upright.

3. The first exception of 8-1.5.1 does not mention the use of intermediate temperature sprinklers. NFPA 13 may require use of this temperature rating in some areas.

The proposed new paragraph could be deleted with revision of paragraph 4-12.3 of NFPA 13-1996 which contains part of this information.

g. Add 5-3.6 and delete 6-4, 7-4, and 8-1.5.3. These paragraphs are identical except that the wording is slightly changed in 8-1.5.3 and it contains no reference to paragraph B-6.4. Consideration should be given to requiring the water shields for all in-rack sprinklers.

h. Delete 5-3.4 from Log #26 and add 5-3.7, 5-3.8, 5-3.8.1, and 5-3.8.2. Also delete 6-5.1, A-6-5.1, 6-5.2, A-6-5.2, 6-6.2, 7-5, and 8-1.5.4.

All of these existing paragraphs and proposed paragraph 5-3.4 address in-rack sprinkler clearance or location. 6-6.2 allows for no spacing to rack uprights, however, B-6-6.2 refers to testing which used 3-in. spacing.

B-6.5.1 should be revised to include information concerning the commodity classes tested.

Proposed new paragraph 5-3.7 could be omitted from NFPA 231C, a minimum 6-inch clearance is required by NFPA 13-1996 (4-12.4.1) without any exceptions.

Proposed 5-3.8.1 and 5-3.8.2 could be omitted from NFPA 231C with revision to existing paragraphs 4-12.4.3 and 4-12.4.5 in NFPA 13-1996.

i. Delete A-5-3.2. I do not think this adds anything to what is already being required by 5-3.2 above.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** The proposed language was more complicated than the original and did not improve the usability of the standard.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 25

NOT RETURNED: 2 Miller, O'Rourke

(Log #40)

231C- 24 - (5-5): Reject

**SUBMITTER:** Northeast Regional Fire Code Dev. Committee

**COMMENT ON PROPOSAL NO:** 231C-15

**RECOMMENDATION:** Add an exception to read: 5-5 Hose Connections. For first aid fire fighting and for mop-up operations, small (1 1/2 in. hose lines shall be available to cover all areas of the rack structures. These hose connections shall not be required

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to meet the requirements of Class II hose systems defined by NFPA 14. Hose connections shall be supplied from one of the following:

- (a) Outside hydrants
- (b) A separate piping system for small hose stations.
- (c) Valved hose connections on sprinkler risers where such connections are made upstream of all sprinkler control valves.
- (d) Adjacent sprinkler systems
- (e) The ceiling sprinkler system in the same area as long as in-rack sprinklers are provided in the same area and are separately controlled.

Exception: The authority having jurisdiction can omit the hose stations requirements due to local conditions.

**SUBSTANTIATION:** There are condition where the authority having jurisdiction may not want hose stations such as freezers. By adding this exception the authority having jurisdiction can omit these stations based on a determination of the authority having jurisdiction and local conditions.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** There are sufficient alternates in the standard such as 2-1/2 in. hose connections.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 25

NOT RETURNED: 2 Miller, O'Rourke

(Log #34)

231C- 25 - (5-13.1): Accept in Principle

**SUBMITTER:** Tracey D. Bellamy, Tomes, Van Rickley & Assoc. (TVA)

**COMMENT ON PROPOSAL NO:** 231C-23

**RECOMMENDATION:** Incorporate new text and new Section 5-13.1.1 as follows:

5-13.1 Slatted shelves shall be considered to be equivalent to solid shelves, except as permitted by 5-13.1.1.

5-13.1.1 Slatted shelves in single and double row racks shall not be considered as solid shelving when as all of the following conditions are met:

(a) The sprinkler system shall be a wet pipe system designed to provide a minimum 0.60 gpm per ft<sup>2</sup> (24 L/min per m<sup>2</sup>) over a minimum design area of 2000 ft<sup>2</sup> (186 m<sup>2</sup>).

(b) Sprinklers shall be standard response ELO sprinklers with a temperature rating of either ordinary, intermediate or high and listed for protection of storage occupancies.

(c) The protected commodities shall be limited to Class-IV, Group B Plastics, Group C Plastics, Unexposed (Expanded and Unexpanded) Group A Plastics, Exposed (Unexpanded) Group A Plastics, and

(d) Shelves shall be slatted using slats up 6 in. (150 mm) wide held in place by spacers which maintain a minimum 2 in. (50 mm) opening between each slat, and

(e) There shall be no slatted shelf levels above 12 ft (3.7 m) height in the rack (although there may be other open shelf or wire mesh shelf levels above), and

(f) Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.1 m) horizontally, and

(g) Longitudinal flue spaces at least 6 in. (150 mm) wide shall be provided for double row racks, and

(h) The aisle widths are at least 7.5 ft (2.3 m), and

(i) The maximum roof height is 27 ft (8.23 m), and

**SUBSTANTIATION:** A full-scale test program was conducted with various double-row rack storage arrangements of a Cartoned Group A Unexpanded Plastic Commodity at the Factory Mutual Research Corporation (FMRC) test facility. The series of nine (9) tests included several variations, one of which involved the use of four (4) distinct shelving arrangements, slatted wood, solid wood, wire mesh and no shelving. The results of the testing program, specifically test numbers 1, 2, 3, and 5, clearly demonstrate the acceptable performance of sprinkler systems protecting storage configurations involving the use of slatted shelving as described by the above proposal. As a result of the aforementioned test program Factory Mutual has amended FM Loss Prevention Data Sheet 8-9 to allow the protection of slatted shelving the same as open rack arrangement.

Complete details of the test program are documented in the Factory Mutual Research Corporation (FMRC) Technical Report, FMRC J.I. 0X1R0.RR, Large-Scale Fire Tests of Rack Stored Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, November 1994.

Additionally, an article has been published in the Journal of Fire Protection Engineering, Volume 8, No. 1 1996, pp 1-12, Protection of Warehouse Retail Occupancies with Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, Factory Mutual Research Corporation.

The following amendments were incorporated into the original proposal as a result of input from the NFPA 231C, Standard for Rack Storage of Material Warehouse Retail Store Subcommittee meetings:

1. The proposal has been amended to incorporate the exception to Section 5-13.1 as a new Section 5-13.1.1.

2. The absolute design density of 0.60 gpm/ft<sup>2</sup> indicated by item (a) has been changed to a minimum design density.

3. Requirements that the sprinkler system be a wet system and a minimum design area of 2000 ft<sup>2</sup> have been added to item (a).

4. A requirement for the temperature rating and listing of the sprinklers has been added in item (b).

5. Item (c) of the revised proposal has been corrected to refer to Exposed (Unexpanded) Group A Plastics rather than Exposed (Expanded) Group A Plastics. The provisions of Factory Mutual (FM), Loss Prevention Data Sheet, 8-9 do not allow the use of slatted shelving with Exposed (Expanded) Group Plastics.

6. A requirement for the installation of spacers to maintain the slatted shelf arrangement has been added in item (d).

7. Item (e) of the revised proposal has been amended to remove the reference to solid shelves since the use of solid shelves would already be excluded under the provisions of the exception.

8. Item (g) of the revised proposal has been amended to remove the reference to multi row racks since the cited test program did not include multi row racks.

9. A requirement limiting the maximum roof height to not more than 27 ft has been added as Item (i).

The following response is offered as a result of the Committee Statement to Proposal 231C-23 (Log #15) from the San Antonio meeting held March 20-21, 1997:

The allowance for the use of slatted shelving was developed based on the cited test program and the provisions of FM 8-9. While it is possible that additional test information may be available to support the proposed shelving information, no such information was directly available. As a result, the proposal has been amended to provide the additional information as described above. A full description of the slatted shelving arrangement is detailed in Appendix B of the cited test report. This arrangement was utilized with successful results in four separate full scale test arrangements as detailed in the substantiation to the original proposal.

**COMMITTEE ACTION:** Accept in Principle.

Revise proposed Section 5-13.1 to read as follows, and include first paragraph and the first sentence of the second paragraph of the substantiation as appendix B material:

5-13.1 Slatted shelving racks shall be protected as solid shelving racks except as permitted by 5-13.1.1.

5-13.1.1 A wet pipe sprinkler system designed to provide a minimum of .6 gpm/sq ft density (24 L/min per m<sup>2</sup>) over a minimum design area of 2000 ft<sup>2</sup> (186 m<sup>2</sup>), shall be permitted to protect single and double row slatted shelf racks when all of the following conditions are met:

(a) Sprinklers shall be standard response 5/8 in. orifice spray sprinklers with a temperature rating of either ordinary, intermediate or high and listed for protection of storage occupancies.

(b) The protected commodities shall be limited to Class-IV, Group B Plastics, Group C Plastics, cartoned (Expanded and Unexpanded) Group A Plastics, Exposed (Unexpanded) Group A Plastics, and

(c) Shelves shall be slatted using a minimum nominal 2 in. (50 mm) thick by maximum nominal 6 in. (150 mm) wide slat held in place by spacers which maintain a minimum 2 in. (50 mm) opening between each slat, and

(d) There shall be no slatted shelf levels above 12 ft (3.7 m) height in the rack. Wire mesh (greater than 50% opening) shall be permitted for shelf levels above 12 ft (3.7m) and

(e) Transverse flue spaces at least 3 in. (75 mm) wide shall be provided at least every 10 ft (3.1 m) horizontally, and

(f) Longitudinal flue spaces at least 6 in. (150 mm) wide shall be provided for double row racks, and

(g) The aisle widths are at least 7.5 ft (2.3 m), and

(h) The maximum roof height is 27 ft (8.23 m), and

(i) the maximum storage height is 20 ft. (6.1 m) and



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(j) solid plywood or similar materials shall not be placed on the slatted shelves so as to block the 2 in. (50.8 mm) spaces between slats nor be placed on the wire mesh shelves.

COMMITTEE STATEMENT: These changes have been made to rationalize the test results with the real world storage methods.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 23  
NEGATIVE: 2  
NOT RETURNED: 2 Miller, O'Rourke  
EXPLANATION OF NEGATIVE:

GOTTO: The results of the full scale fire testing were reviewed with the entire Committee, however in one of the tests, significant fire damage to the commodity was noted at the end of the test rack, but this test was labeled "successful". It appears as though the fire would have continued horizontally in this test had there been additional length in the rack. Also, the restrictions placed by the provisions in newly added section 5-13.1.1 make this a non-enforceable part of the standard, especially with regard to the maintenance of the transverse and longitudinal flue spaces. The many provisions in this section do not add anything to the usefulness of the standard and do not provide a measurable acceptable alternative to the installation of in-rack sprinklers.

SCHUMANN: The conditions set forth in the proposed 5-13.1.1 read like setup instructions for a lab science project. Very difficult to establish at installation and maintain in the real world. While it may be possible for the industry, for which these tests were conducted, to do this, it must be remembered that others will try to use this protection scheme. In several of the large scale tests, which were used to develop this proposal, the fire burned to the ends of the 40 ft long ignition rack array. As proposed, there is no limit to the length of the racks and it is not known that if the rack were longer, the fire would not have continued its horizontal spread and opened additional ceiling sprinklers.

(Log #5)

231C- 26 - (6-9.1): Reject  
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers  
COMMENT ON PROPOSAL NO: 231C-31  
RECOMMENDATION: Instead of deleting words from the second sentence of this section, revise it as follows:

"The 165°F (74°C) design curves shall be used for sprinklers of with ordinary and or intermediate temperature classification but not less than 150°F(65°C) 160°F(71°C) rating."  
SUBSTANTIATION: Revision responds to the submitter's request but avoids the use of low temperature rated heads.  
COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: Words were not deleted from the second sentence, the 150° F rating problem was handled by 231C-1 (Log #1).  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #CC1)

231C- 27 - (6-9.10): Accept  
SUBMITTER: Technical Committee on Rack Storage  
COMMENT ON PROPOSAL NO: 231C-6

RECOMMENDATION: In the first sentence, remove the word "wood" and add the word "combustible", the section now reads as follows:

6-9.10 Where solid, flat-bottom combustible pallets are used, with storage height up to and including 25 ft (7.6 m), the densities indicated in the design curves, based on conventional pallets, shall be increased 20 percent for the given area. This percentage shall be applied to the density determined in accordance with Figure 6-9.2. This increase shall not apply where in-rack sprinklers are installed.

SUBSTANTIATION: Plastic pallets allowed by new section 2-1.2 are expected to produce similar increases in flame spread as wood slave pallets  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #6)

231C- 28 - (7-5, Table 7-10.1): Accept in Principle  
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers  
COMMENT ON PROPOSAL NO: 231C-39

RECOMMENDATION: There is no statement of how far the head can be away from the transverse flue and still be in compliance with the code.

SUBSTANTIATION: If the rack uprights are located so close together that the 3 in. minimum clearance to the uprights can't be maintained, then the head must be moved along the longitudinal flue out of the transverse flue. What is the maximum distance the head can be from the transverse flue?

COMMITTEE ACTION: Accept in Principle.

Add to Section 7-5, the following:

"at least 50% of the sprinkler shall be located within the plan view area of the transverse or longitudinal flue space as appropriate."

COMMITTEE STATEMENT: This change clarifies the positioning of in rack sprinklers.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #7)

231C- 29 - (Figure 8-1.1, Entire Document): Accept  
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers  
COMMENT ON PROPOSAL NO: 231C-53

RECOMMENDATION: Retain the term exposed. Do not replace it with uncartoned.

SUBSTANTIATION: The change from exposed plastic to uncartoned plastic will be out of sync with terms used in NFPA 231, Standard for General Storage. There is no similar proposal to NFPA 231. NFPA 13, Standard for the Installation of Sprinkler Systems also uses the term exposed. Whatever term is chosen, it should be used throughout all standards.

COMMITTEE ACTION: Accept.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #8)

231C- 30 - (8-1.4): Reject  
SUBMITTER: Todd E. Schumann, Industrial Risk Insurers  
COMMENT ON PROPOSAL NO: 231C-54

RECOMMENDATION: Revise 8-1.4 as follows:

"Ceiling sprinklers shall be spray sprinklers having have and orifice size larger than 1/2 in. and be rated ordinary or high temperature.

SUBSTANTIATION: Revision states that Chapter 8 pertains to spray sprinklers.

COMMITTEE ACTION: Reject.

COMMITTEE STATEMENT: This information already exists in the Chapter title.

NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:

AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

COMMENT ON AFFIRMATIVE:

GUMKOWSKI: Change the word "and" to "an", so Section 8-1.4 reads:

"Ceiling sprinklers shall be spray sprinklers having an orifice size larger than 1/2 in. and be rated ordinary or high temperature."

(Log #27)

231C- 31 - (8-1.4): Reject  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-54

RECOMMENDATION: Revise Section 8-1.4 to read:

"Ceiling sprinklers shall have a nominal orifice size larger than 1/2 inch (of an acceptable type in accordance with Chapter 5) and shall be rated ordinary to high temperature."

SUBSTANTIATION: The word "nominal" was added to make sure someone didn't try and use a nominal 1/2 inch sprinkler with an orifice that was slightly larger than 1/2 inch.

The parenthetical statement was added to make sure that sprinklers larger than those currently allowed aren't used until Chapter 5 says it's okay.



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**COMMITTEE ACTION:** Reject.  
**COMMITTEE STATEMENT:** These items are obvious to the user already.  
**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**  
 AFFIRMATIVE: 25  
 NOT RETURNED: 2 Miller, O'Rourke

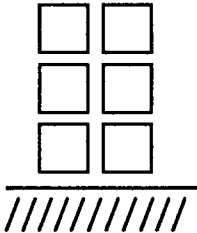
(Log #32)

231C- 32 - (Figure 8-2): Accept in Principle  
**SUBMITTER:** Tracey D. Bellamy, Tomes, Van Rickley & Assoc. (TVA)  
**COMMENT ON PROPOSAL NO:** 231C-56  
**RECOMMENDATION:** Add reference to Note 6 and 7 to Figure 8-2, Part c as follows:

**Part c: 15-ft (4.57-m) storage  
 5-ft (1.52-m) to 10-ft (3.05-m) ceiling clearance**

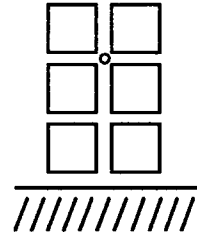
0.60 gpm per ft<sup>2</sup>/4000 ft<sup>2</sup>  
 (24.5 L/min per m<sup>2</sup>/372 m<sup>2</sup>)

See 8-2.1.3, 8-2.1.5,  
 Note 6, and Note 7



0.30 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (12.2 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 2  
 and Figure 8-2 Part h

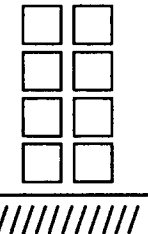


Add reference to Note 6 to Figure 8-2, Part d as follows:

**Part d: 20-ft (6.10-m) storage, < 5-ft (1.52-m) ceiling clearance**

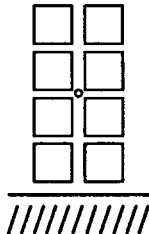
0.60 gpm per ft<sup>2</sup>/4000 ft<sup>2</sup>  
 (24.5 L/min per m<sup>2</sup>/372 m<sup>2</sup>)

See 8-2.1.3, 8-2.1.5,  
 and Note 6



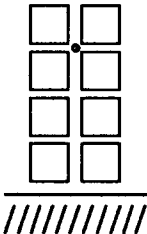
0.45 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (18.3 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 2  
 and Figure 8-2 Part h



0.30 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (12.2 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 2  
 and Figure 8-2 Part h

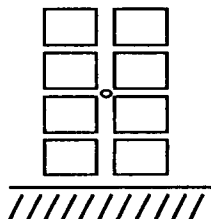


Delete reference to Note 5 and add reference to Note 8 to Figure 8-2, Part e:

**Part e: 20-ft (6.10-m) storage  
 5-ft (1.52-m) to 10-ft (3.05-m) ceiling clearance (See Note 5)**

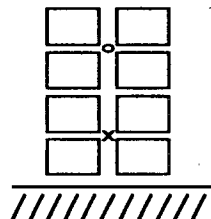
0.45 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (18.3 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 2, Note 8 and  
 Figure 8-2 Part h



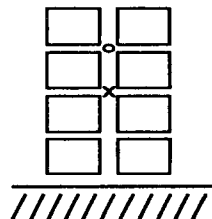
0.30 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (12.2 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 4  
 and Figure 8-2 Part j



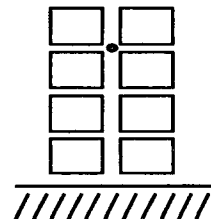
0.30 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (12.2 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 4  
 and Figure 8-2 Part j



0.30 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup>  
 (12.2 L/min per m<sup>2</sup>/186 m<sup>2</sup>)

See Note 3  
 and Figure 8-2 Part i



Add the following notes to Figure 8-2:

6.† When ELO sprinklers are installed at the ceiling only, the water demand may be reduced to 0.60 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup> (24 L/min per m<sup>2</sup>/186 m<sup>2</sup>).

7.† When ELO sprinklers are installed at the ceiling only and the ceiling height in the protected area does not exceed 22 ft (6.71 m), the water demand may be reduced to 0.45 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup> (18.3 L/min per m<sup>2</sup>/186 m<sup>2</sup>).

8.† When ELO sprinklers are installed at the ceiling, the in-rack sprinklers may be eliminated provided the water demand is increased to 0.60 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup> (24 L/min per m<sup>2</sup>/186 m<sup>2</sup>) and the ceiling height in the protected area does not exceed 27 ft (8.23 m).

Add the following to Appendix B:

B-8-2 The protection of Group A Plastics by ELO sprinklers designed to provide 0.60 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup> or 0.45 gpm per ft<sup>2</sup>/2000 ft<sup>2</sup> without the installation of in-rack sprinklers was developed from full-scale testing conducted with various double-row rack storage arrangements of a Cartoned Group A Unexpanded Plastic Commodity at the Factory Mutual Research Corporation (FMRC) test facility under the test program, Large-Scale Tests of Rack Stored Group A Plastics In Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers. The results of this test program are documented in the Factory Mutual Research Corporation (FMRC) Technical Report, FMRC J.I. 0X1R0.RR, Large-Scale Fire Tests of Rack Stored Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, November 1994. This test program was initiated to address the fire protection issues presented by warehouse-type retail stores with regard to the display and storage of Group A Plastic commodities, including but not limited to ABS piping, PVC hose and hose racks, and tools boxes; polypropylene trash and storage containers, and patio furniture. Tests No. 1 and 2 of this series included protection of the Group A Plastic Commodity stored to 20 ft under a 27 ft ceiling by a design density of 0.60 gpm per ft<sup>2</sup> utilizing ELO sprinklers. The results of the testing program clearly demonstrate the acceptable performance of sprinkler systems protecting storage configurations involving Group A Plastics up to 20 ft in height under a 27 ft ceiling when utilizing ELO sprinklers to deliver a design density of 0.60 gpm per ft<sup>2</sup> and Group A Plastics up to 14 ft in height under a 22 ft ceiling when utilizing ELO sprinklers to deliver a design density of 0.45 gpm per ft<sup>2</sup>. The following tabulation of the pertinent tests demonstrates this acceptable performance:

	Date of Test	8/20/93	8/25/93	9/2/93	10/7/93	2/17/94	2/25/94	4/27/94
	Type of Shelving	Slatted Wood	Slatted Wood	Slatted Wood	Slatted Wood	Slatted Wood	Slatted Wood	Wire Mesh
T	Other Conditions/Inclusions	-	-	-	-	Draft Curtains	Draft Curtains	-
E	Storage Height (ft-in.)	19-11	19-11	15-4	15-4	19-11	19-11	13-11
S	No. of Tiers	6 <sup>a</sup>	6 <sup>a</sup>	5 <sup>a</sup>	5 <sup>a</sup>	6 <sup>a</sup>	6 <sup>a</sup>	3
T	Clearance to Ceiling/Sprinklers (ft-in.)	6-10/6-3	6-10/6-3	11-5/10-10	11-5/10-10	6-10/6-3	6-10/6-3	8-4/7-9
P	Longitudinal/Transverse Flues (in.)	6/6 to 7-1/2	6/6 to 7-1/2	6/6 to 7-1/2	6/6 to 7-1/2	6/6 to 7-1/2	6/6 to 7-1/2	6/3 <sup>b</sup>
A	Aisle Width (ft)	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2	7-1/2
R	Ignition Centered below (No. of Sprinklers)	2	2	1	1	2	2	1
A	Sprinkler Orifice Size (in.)	0.64	0.64	0.64	0.64	0.64	0.64	0.64
M	Sprinkler Temperature Rating (°F)	165	286	286	165	165	286	286
E	Sprinkler RTI (ft-sec) <sup>1/2</sup>	300	300	300	300	300	300	300
T	Sprinkler Spacing (ft x ft)	8 x 10	8 x 10	8 x 10	8 x 10	8 x 10	8 x 10	10 x 10
E	Sprinkler Identification	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231	ELO-231
R	Constant Water Pressure (psi)	19	19	19	19	19	19	15.5
S	Minimum Density (gpm/ft <sup>2</sup> )	0.60	0.60	0.60	0.60	0.60	0.60	0.45
	First Sprinkler Operation (min:s)	2:03	2:25	1:12	0:44	1:25	0:52	0:49
T	Last Sprinkler Operation (min:s)	2:12	15:19	6:34	7:34	15:54	14:08	10:58
E	Total Sprinklers Opened	4	9	7	13	35	18	12
S	Total of Sprinklers Discharge (gpm)	205	450	363	613	1651	945	600
T	Avg. Discharge per Sprinkler (gpm)	51	50	52	47	47	52	50
R	Peak/Max. One Min. Avg. Gas Temperature (°F)	1107/566	1412/868	965/308	662/184	1575/883	1162/767	1464/895
E	Peak/Max. One Min. Avg. Steel Temperature (°F)	185/172	197/196	233/232	146/145	226/225	255/254	502/500
S	Peak/Max. One Min. Avg. Plume Velocity (ft/s)	27/15	25/18	18/15 <sup>2</sup>	14/10 <sup>2</sup>	26/23	20/18 <sup>2</sup>	33/20
U	Peak/Max. One Min. Heat Flux (Btu/ft <sup>2</sup> /s)	0.6/0.5	2.0/1.9	2.8/2.5	1.1/0.8	1.0/0.9	4.8/3.0	1.6/1.4
L	Aisle Jump, East/West Target Ignition (min:s)	None	8:24/None	5:35/10:10	None	None	Note 4/8:18	Note 4/None
T	Equivalent No. of Pallet Loads Consumed	3	9	6	5	12	13	12
S	Test Duration (min)	30	30	30	30	30	30	30
	Results Acceptable	Yes	Yes	Yes	Yes	No <sup>3</sup>	No <sup>3</sup>	Yes

**Notes**

1. Main (Ignition) Racks divided into five or six tiers; bottom tiers each about 2 ft high and upper tiers each about 5 ft high. Wood shelving below commodity at second through fifth tiers; wire mesh shelving below commodity at sixth tier or below fifth (top) tier commodity in tests marked with asterisk on note 1.
2. Instrumentation located 5 ft North of Ignition.
3. High water demand.
4. Minor surface damage to cartons.
5. Excessive fire spread; marginally high water demand.
6. Transverse flues spaced 8 ft apart (versus 3 1/2 ft apart in all other tests).

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**SUBSTANTIATION:** A full-scale test program was conducted with various double-row rack storage arrangements of a Cartoned Group A Unexpanded Plastic Commodity at the Factory Mutual Research Corporation (FMRC) test facility. Tests No. 1 and 2 of this series included protection of the Group A Plastic Commodity stored to 20 ft under a 27 ft ceiling by a design density of 0.60 gpm per ft<sup>2</sup> utilizing ELO sprinklers. Tests No. 3 and 5 of this series included protection of the Group A Plastic Commodity stored to 15 ft under a 27 ft ceiling by a design density of 0.60 gpm per ft<sup>2</sup> utilizing ELO sprinklers. Test No. 8 of this series included protection of the Group A Plastic Commodity stored to 14 ft under a 22 ft ceiling by a design density of 0.45 gpm per ft<sup>2</sup> utilizing ELO sprinklers. The results of the testing program clearly demonstrate the acceptable performance of sprinkler systems protecting storage configurations involving Group A Plastics up to 20 ft in height under a 27 ft ceiling when utilizing ELO sprinklers to deliver a design density of 0.60 gpm per ft<sup>2</sup> and involving Group A Plastics up to 14 ft in height under a 22 ft ceiling when utilizing ELO sprinklers to deliver a design density of 0.45 gpm per ft<sup>2</sup>.

Complete details of the test program are documented in the Factory Mutual Research Corporation (FMRC) Technical Report, FMRC J.I. 0X1R0.RR, Large-Scale Fire Tests of Rack Stored Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, November 1994. Additionally, an article has been published in the Journal of Fire Protection Engineering, Volume 8, No. 1 1996, pp 1-12, Protection of Warehouse Retail Occupancies with Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, Factory Mutual Research Corporation.

The following amendments were incorporated into the original proposal as a result of input from the NFPA 231C, Standard for Rack Storage of Material Warehouse Retail Store Subcommittee meetings:

1. The term "over" in Note 7 of the proposal has been changed to the term "in" to avoid misinterpretation to mean above the top of the stored commodity.

2. Additional protection criteria from Test No. 8 of the test series has been incorporated as an additional Note to Figure 8-2, Part c.

3. Proposed explanatory material was added to Appendix B along with appropriate references for all tests in the series which substantiated the proposed change. Additionally, a tabulation of the pertinent full scale tests from the cited test series have been incorporated into Appendix B.

The following response is offered as a result of the Committee Statement to Proposal 231C-59 (Log #18) from the San Antonio meeting held March 20-21, 1997:

The primary objective of this proposal is to expand the property protection options currently allowed by NFPA 231C and not to present new requirements aimed at life safety. However, as with all the property protection options allowed by NFPA 231C, a secondary life safety benefit would inherently be provided. It is further recognized that the requirements for life safety are appropriately mandated by either the model building codes or NFPA 101. As an installation standard, the provisions of NFPA 231C do not mandate when the installation of protection is required but rather provides installation and design criteria to meet the minimum property protection objectives where such protection is mandated. These concepts are not unique to NFPA 231C but are carried through in other NFPA documents such as NFPA 13 and NFPA 231. The proposal and supporting test information, as presented, simply provides appropriate design criteria for the protection of Group A Plastics using ELO sprinklers and does not mandate when such protection is required.

A review of the proposal, with respect to life safety, revealed one reference in Appendix B which alludes to the initiation of the Factory Mutual test program being related to concerns for life safety. While concerns for safety prompted the initiation of the test program, the design criteria developed demonstrates the appropriate property protection required when storing Group A plastics in the indicated configurations. To this end, the references to safety have been eliminated from the proposal.

**COMMITTEE ACTION:** Accept in Principle.

In all notes, remove the reference to ELO and add 5/8 in. orifice listed for storage use", in notes 6 and 7, change "water demand" to read "ceiling sprinkler design".

**COMMITTEE STATEMENT:** Editorial changes were made to maintain consistency.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 25

NOT RETURNED: 2 Miller, O'Rourke

**COMMENT ON AFFIRMATIVE:**

THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

(Log #33)

231C- 33 - (8-2.1.3): Accept

**SUBMITTER:** Tracey D. Bellamy, Tomes, Van Rickley & Assoc. (TVA)

**COMMENT ON PROPOSAL NO:** 231C-61

**RECOMMENDATION:** Delete the final paragraph from the cited section as follows:

~~Where utilizing the strategies for ceiling sprinklers only, as shown in Figure 8-2 Parts (c) and (d), column steel shall be protected in accordance with 3-2.3(a) or (b). Roof structural steel shall be protected in such a manner as to provide a minimum of 15 minutes fire resistance.~~

**SUBSTANTIATION:** A full-scale test program was conducted with various double-row rack storage arrangements of a Cartoned Group A Unexpanded Plastic Commodity at the Factory Mutual Research Corporation (FMRC) test facility. The series of nine (9) tests all included measurement of the peak/maximum one minute average roof steel temperatures. The results of the testing program clearly demonstrate the acceptable performance of sprinkler system in maintaining the roof steel temperature well below the threshold temperature of 1180°F.

Complete details of the test program are documented in the Factory Mutual Research Corporation (FMRC) Technical Report, FMRC J.I. 0X1R0.RR, Large-Scale Fire Tests of Rack Stored Group A Plastics in Retail Operation Scenarios Protected by Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, November 1994. Additionally, an article has been published in the Journal of Fire Protection Engineering, Volume 8, No. 1 1996, pp 1-12, Protection of Warehouse Retail Occupancies with Extra Large Orifice (ELO) Sprinklers, Joan M.A. Troup, Factory Mutual Research Corporation.

The following response is offered as a result of the Committee Statement to Proposal 231C-61 (Log #17) from the San Antonio meeting held March 20-21, 1997.

The proposed deletion of the last sentence of NFPA 231C, Section 8-2.1.3 would allow the omission of roof steel protection; however, the omission of column protection by the use of increased design densities as provided by NFPA 231C, Section 3-2.3(c) would not be allowed. This would result in a remaining conflict between Sections 8-2.1.3 and 3-2.3(c). To resolve this conflict it is proposed that the entire final paragraph of NFPA 231C, Section 8-2.1.3 be deleted.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 24

NEGATIVE: 1

NOT RETURNED: 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

SCHUMANN: The substantiation for the removal of the need for roof structural steel is based on test results using 5/8 in. orifice sprinklers. Will other size orifices be as effective at controlling roof steel temperatures? I agree with dropping the need for column protection.

(Log #9)

231C- 34 - (8-3): Accept in Part

**SUBMITTER:** Todd E. Schumann, Industrial Risk Insurers

**COMMENT ON PROPOSAL NO:** 231C-62

**RECOMMENDATION:** Delete the terms "uncartoned unexpanded plastic" and "uncartoned expanded plastic" from all figures.

**SUBSTANTIATION:** Figure 8-1.1 Decision Tree indicates that uncartoned plastics are outside the scope of Chapter 8.

**COMMITTEE ACTION:** Accept in Part.

Change "uncartoned, unexpanded" to "exposed, unexpanded." Eliminate "uncartoned, expanded plastic" and, revise Figure 8-1.1 to include "exposed, unexpanded".

**COMMITTEE STATEMENT:** Because of the severity of fire test commodity (polystyrene jars in compartmented cartons) and past

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15 years of positive loss experience it was decided to include exposed, unexpanded Group A plastics.  
**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 23

**NEGATIVE:** 2

**NOT RETURNED:** 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

**GOTTO:** No test data was presented to the Committee to demonstrate the lack of severity between fires involving unexposed and exposed plastics. While 15 years of positive loss experience was considered in the decision, no results of losses were offered where fires were controlled with exposed plastics in racks.

**SCHUMANN:** With the ever increasing amounts of plastics in products, packaging and containers, such as tote bins and boxes, there is a very real exposed plastic hazard. Exposed plastics were outside the scope of Chapter 8 prior to this proposal. No data beyond a statement that the Group A fire test commodity represents exposed unexpanded Group A plastic has been presented.

(Log #10)

231C- 35 - (Table 9-1.1): Reject

**SUBMITTER:** Todd E. Schumann, Industrial Risk Insurers

**COMMENT ON PROPOSAL NO:** 231C-66

**RECOMMENDATION:** Delete uncartoned plastics from the table.

**SUBSTANTIATION:** While test data may show that uncartoned unexpanded plastics can be included in the table, no such data has been submitted to the committee for review. By introducing uncartoned plastics into the table, this allows open and closed top plastic totes to be stored. Is there any problem with open top combustible containers and large drop heads?

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** Because of the severity of fire test commodity ( polystyrene jars in compartmented cartons ) and past 15 years of positive loss experience it was decided to include exposed, unexpanded Group A plastics.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 23

**NEGATIVE:** 2

**NOT RETURNED:** 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

**GOTTO:** While 15 years of positive loss experience was considered in the decision, no results of losses were offered where fires were controlled with exposed plastics in racks. As stated by the submitter commodities including open and closed top plastic totes are not addressed.

**SCHUMANN:** With the ever increasing amounts of plastics in products, packaging and containers, such as tote bins and boxes, there is a very real exposed plastic hazard. Prior to this proposal, Chapter 9 did not specify cartoned or exposed. No data beyond a statement that the Group A fire test commodity represents exposed unexpanded Group A plastic has been presented. This proposal was rejected by one vote.

(Log #39)

231C- 36 - (Table 9-1.1): Accept

**SUBMITTER:** Peter Thomas, The Viking Corp.

**COMMENT ON PROPOSAL NO:** 231C-66

**RECOMMENDATION:** Additions to Table 9-1.1 as shown on page 418.

**SUBSTANTIATION:** Allows larger clearance which represents current protection scheme for approved large-drop sprinklers.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 22

**NEGATIVE:** 3

**NOT RETURNED:** 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

**CAREY:** Underwriters Laboratories Incorporated wishes to be recorded as voting negatively on Comment 231C-36 (Log #39) because no fire test data was provided to the Committee to validate the increased clearances for large drop sprinklers. This same comment was rejected by the General Storage Committee, NFPA 231, due to a lack of fire test data. Also, minimum aisle widths of 5.5 ft for double row and 8 ft for multiple row rack storage arrangements have been omitted from the revised Table 9-1.1.

**GOTTO:** No test result were offered to the Committee demonstrating the justification for these additional clearances.

**SCHUMANN:** The revised table 9-1.1, which was submitted as part of the proposal, omitted the aisle space requirements for double-row and multiple-row racks. No substantiation was submitted for this change. Larger clearances between top of stock and Large Drop sprinklers were also proposed the NFPA 231 Technical Committee. In those discussions it was learned that the tests for increasing the clearance up to 20 ft were done by using the 10 ft clearance test and reducing the stock height 10 ft rather than maintaining stock height and raising the sprinklers 10 ft. The proposal to increase clearance was rejected by the NFPA 231 Technical Committee.

(Log #11)

231C- 37 - (10-1): Accept

**SUBMITTER:** Todd E. Schumann, Industrial Risk Insurers

**COMMENT ON PROPOSAL NO:** 231C-74

**RECOMMENDATION:** 1. In response to this proposal, the committee added new Section 10-2.2.6. In the preprint it is Section 10-2.5. Revise 10-2.5 as follows: "When required by Table 10-1, one level of 17/32-in. orifice, quick response, ordinary temperature in-rack sprinklers shall be installed at the tier level closest to but not exceeding 1/2 of the maximum storage height. In-rack sprinkler hydraulic design criteria is the most hydraulically remote eight heads at 50 psi (3.4 bar). In-rack sprinklers shall be located at the intersection of the longitudinal and transverse flue space. Horizontal spacing shall not be permitted to exceed 5 ft (1.5 m) intervals."

**SUBSTANTIATION:** 1. There was nothing in 10-2.5 to indicate when the in-rack sprinklers were required. There was no hydraulic design data given. There was no metric conversion for the spacing interval.

2. Cartoned plastic was used in the FM 45 ft high building tests. Is the inclusion of uncartoned plastic justified?

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 25

**NOT RETURNED:** 2 Miller, O'Rourke

**COMMENT ON AFFIRMATIVE:**

**THACKER:** Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

(Log #18)

231C- 38 - (10-2.2): Accept

**SUBMITTER:** Roger S. Wilkins, Grinnell Corp.

**COMMENT ON PROPOSAL NO:** 231C-74

**RECOMMENDATION:** In third line change "up to 40 ft (12.2 m)" to "up to 45 ft (13.7 m)".

**SUBSTANTIATION:** Coincides with Table 10-1 changes.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27  
**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 24

**NEGATIVE:** 1

**NOT RETURNED:** 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

**COLLINS:** Although I support the application of ESFR and would like to be able to vote Affirmative, I am professionally compelled to vote negative at this time.

The application of ESFR faces many dangers as described in FM Data Sheet 2-2. Its application in 40 ft high buildings is dangerous. A high level of knowledge and experience is required for proper application. Amending NFPA 231C to extend ESFR application to include building height exceeding 40 ft and storage height exceeding 35 ft is extremely dangerous and requires careful, deliberate and complete consideration.

The six tests and results described in the Technical Report FMRC J.I. OBOR9.RR provide most interesting information. However, the information is not adequate to support the conclusions described in this TIA. I do not find sufficient evidence to fully support this TIA without some qualification.

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Table 9-1.1 Large-Drop Sprinkler Design Criteria for Single-, Double-, and Multiple-Row Racks

Commodity	Maximum Storage Height	Maximum Roof/Ceiling Height	Type of System	Minimum Operating Pressure, psi (bar)			Hose Stream Demand gal/min (dm <sup>3</sup> /min)	Water Supply Duration (hr)
				25 (1.7)	50 (3.4)	75 (5.2)		
Class I or II	25 ft	45 ft	Wet	20	20	20	500 (1900)	1 1/2
			Dry	30	30	30		
Class I or II	30 ft	35 ft	Wet	20 plus one level of in-rack sprinklers	20 plus one level of in-rack sprinklers	20 plus one level of in-rack sprinklers	500 (1900)	1 1/2
			Dry	30 plus one level of in-rack sprinklers	30 plus one level of in-rack sprinklers	30 plus one level of in-rack sprinklers		
Class I, II, or III	20 ft	40 ft	Wet	15	15	15	500 (1900)	1 1/2
			Dry	25	25	25		
Class I, II, or III	25 ft	45 ft	Wet	15 plus one level of in-rack sprinklers	15 plus one level of in-rack sprinklers	15 plus one level of in-rack sprinklers	500 (1900)	1 1/2
			Dry	25 plus one level of in-rack sprinklers	25 plus one level of in-rack sprinklers	25 plus one level of in-rack sprinklers		
Class IV	20 ft	40 ft	Wet	NA	20	15	500 (1900)	2
			Dry	NA	25	25		
Class IV	25 ft	45 ft	Wet	NA	20 plus one level of in-rack sprinklers	15 plus one level of in-rack sprinklers	500 (1900)	2
			Dry	NA	25	25		
Cartoned or Uncartoned Unexpanded Plastics	20 ft	40 ft	Wet	15 plus one level of in-rack sprinklers	30	20	500 (1900)	2
			Dry	NA	25 plus one level of in-rack sprinklers	25 plus one level of in-rack sprinklers		
Cartoned or Uncartoned Unexpanded Plastics	25 ft	45 ft	Wet	NA	30 plus one level of in-rack sprinklers	20 plus one level of in-rack sprinklers	500 (1900)	2
			Dry	NA	25 plus two levels of in-rack sprinklers	25 plus two levels of in-rack sprinklers		
Class IV	20 ft	40 ft	Wet	NA	15	15	500 (1900)	2
			Dry	NA	25	25		
Cartoned or Uncartoned Unexpanded Plastics	20 ft	25 ft	Wet	15 plus one level of in-rack sprinklers	15	15	500 (1900)	2
			Dry	NA	25 plus one level of in-rack sprinklers	25 plus one level of in-rack sprinklers		
Class IV	25 ft	30 ft	Wet	NA	15 plus one level of in-rack sprinklers	15 plus one level of in-rack sprinklers	500 (1900)	2
			Dry	NA	NA	NA		

NA: Not allowed  
(ROP 231C-66, 231C-67, 231C-68)

Specific concerns are:

(a) The storage array, dimensions of pallet loads and pallet spaces do not represent any industry practice. This "perfectly aligned" array appears to significantly enhance the situation that permits ESFR to appear to perform. Likewise, I suspect that locating the bottom tier of storage nine inches off the floor contributes to improved performance of ESFR.

In essence, I visualize the perfect "chimney" to rapidly draw the fire to the ceiling and to provide ample space for high velocity water discharge downward to floor level. At the time of sprinkler activation, the fire does not appear to be "deeply seated" into the array.

Real world storage arrays contrast greatly when compared to this test array. Indeed, current practice is to overhang stock on pallets and/or double-stack pallets such that pallet loads range between seven and nine ft high. Vertical flue spaces are nearly choked and

spaces are ample to support fire growth horizontally through these spaces.

(b) Studying this data independent of other Committee members and without a chance to view videotapes of these tests makes it difficult to conclusively determine that ESFR is adequate and safe for the height changes proposed.

The synergism gained by Committee deliberation is of paramount importance. Likewise, it is my experience that viewing a videotape many times to study flame intensity and movement results in a different impression compared to studying test data in a table or matrix form. These situations often times lead to an erroneous conclusions. Likewise, quickly viewing a videotape allows much information to be missed.

(c) Only six tests were conducted, three of which support the TIA. Tests 1 through 3 simply address a building height of 50 ft without considering limits of the test configuration.

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Tests 4 through 6 are dissimilar and seem to fail to produce conclusive results to a high level of comfort considering the ramifications that could occur with failure of an ESFR system to perform.

The dynamics of fire are dramatically changed when changes are made to either the storage array, storage height, building height or some combination thereof. Extrapolating test data taken from previous tests that result in a lesser or different challenge is most dangerous.

(d) Last, this TIA is not of an emergency nature. While it is true that ESFR is currently limited as described in NFPA 231C, there are reasonable and viable methods of protection for rack storage of materials in situations where the limits of ESFR are exceeded. Indeed, it is true that the use of sprinklers within open metal racks may be superior to ESFR in some applications. Moreover, many fires involving rack storage of materials are extinguished or are controlled to the point whereby hot particles, if any, would be incidental, especially when sprinklers are installed within the racks.

Enough for now. Hopefully, full Committee discussion including study of videotapes will raise more concerns that should be fully addressed either in the standard or as explainable material.

(Log #14)

231C- 41 - (A-5-2.1): Accept  
SUBMITTER: Roger S. Wilkins, Grinnell Corp.  
COMMENT ON PROPOSAL NO: 231C-15  
RECOMMENDATION: Change "A-5-2.1 Ceiling Sprinklers" to "A-5-1.1." Relocate \* from 5-2.1 to 5-1.1.  
SUBSTANTIATION: Coincides with Chapter 5 rewrite.  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #28)

231C- 42 - (A-6-12 (New)): Accept  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-36  
RECOMMENDATION: Add a new Appendix Note that states:  
"Data indicates that the sprinkler protection criteria in Table 6-12 is not effective, by itself, for rack storage with solid shelves, if the required flue spaces are not maintained. Use of the Table and the Figures it references, along with additional provisions required by this Standard can provide acceptable protection."  
SUBSTANTIATION: The Committee agreed to leave the words "without solid shelves" in the Table even though the intent is to require the user to use this Table with additional provisions if solid shelves exist. This Appendix Note lets the user know about this intent.  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke  
COMMENT ON AFFIRMATIVE:  
SCHUMANN: The table referred to in A-6-12 should be Table 6-11 not Table 6-12. Committee Action did not note the editorial change.  
THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

(Log #29)

231C- 43 - (A-7-10.1 (New)): Accept  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-43  
RECOMMENDATION: Add a new Appendix Note that states:  
"Data indicates that the sprinkler protection criteria in Table 7-10.1 is not effective, by itself, for rack storage with solid shelves, if the required flue spaces are not maintained. Use of the Table and Figures it references, along with additional provisions required by this Standard can provide acceptable protection."  
SUBSTANTIATION: The Committee agreed to leave the words "without solid shelves" in the Table even though the intent is to require the user to use this Table with additional provisions if solid shelves exist. This Appendix Note lets the user know about this intent.  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke  
COMMENT ON AFFIRMATIVE:  
SCHUMANN: The table referred to in A-7-10.1 should be Table 8.1 not Table 10.1. Committee Action did not note the editorial change.  
THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

(Log #30)

231C- 44 - (A-7-12.1 (New)): Accept  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-51  
RECOMMENDATION: Add a new Appendix Note that states:  
"Data indicates that the sprinkler protection criteria in 7-12.1 is not effective, by itself, for rack storage with solid shelves, if the required flue spaces are not maintained. Use of 7-12.1, along with additional provisions required by this Standard can provide acceptable protection."

231C- 39 - (A-2-1): Accept  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-6  
RECOMMENDATION: In the first sentence, fourth line, change "so the fire may be" to "so that the fire will be"  
SUBSTANTIATION: Better grammar. Also eliminates the permissive language with a more positive one about sprinkler protection.  
COMMITTEE ACTION: Accept.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

(Log #22)

231C- 40 - (A-2-1.3): Accept in Principle  
SUBMITTER: Kenneth E. Isman, Nat'l Fire Sprinkler Assn.  
COMMENT ON PROPOSAL NO: 231C-6  
RECOMMENDATION: In the alphabetical listing, for Bottles/Jars:  
1) Move the words "Empty, cartoned" down below "Bottles/Jars"  
2) Under "Filled noncombustible powders" clarify that the "plastic (other than PET) (any size) applies when the plastics are not in cartons. Also add information for when the exposed plastic bottles are PET.  
3) The "Filled noncombustible powders" information is in the list twice and contradicts itself. Delete or fix.  
SUBSTANTIATION: 1) The heading appears to be applicable to the entire section in its present position.  
2) The items are not mutually exclusive and are confusing.  
3) Contradictory information needs to be fixed or eliminated.  
COMMITTEE ACTION: Accept in Principle.

(Log #23)

Add PET in the listing as a Class IV commodity in each table as follows:

pp 786 in the Report on Proposals under Bottles/Jars  
Filled noncombustible powders  
Plastic PET Class II  
Filled noncombustible liquids  
Plastic PET Class I  
pp 787 in Report on Proposals after Plastic Containers add the words "(except PET)"  
pp 789 in Report on Proposals under Bottles/Jars  
Empty, cartoned  
-Plastic PET  
pp 789 in Report on Proposals in Table A-2-1.3.2 add:  
Bottles/Jars  
Filled noncombustible powders  
-Plastic PET

COMMITTEE STATEMENT: This was to clarify and to improve usability.  
NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE: 27  
VOTE ON COMMITTEE ACTION:  
AFFIRMATIVE: 25  
NOT RETURNED: 2 Miller, O'Rourke

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**SUBSTANTIATION:** The Committee agreed to leave the words "without solid shelves" in the Section even though the intent is to require the user to use this Table with additional provisions if solid shelves exist. This Appendix Note lets the user know about this intent.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 25

NOT RETURNED: 2 Miller, O'Rourke

**COMMENT ON AFFIRMATIVE:**

SCHUMANN: The table referred to in A-7-12.1 should be Table 7-11 not 7-12.1. Committee Action did not note the editorial change.

THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

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(Log #31)

231C- 45 - (A-7-15.1 (New)): Accept<sup>es</sup>

**SUBMITTER:** Kenneth E. Isman, Nat'l Fire Sprinkler Assn.

**COMMENT ON PROPOSAL NO:** 231C-52

**RECOMMENDATION:** Add a new Appendix Note that states:

"Data indicates that the sprinkler protection criteria in 7-15.1 is not effective, by itself, for rack storage with solid shelves, if the required flue spaces are not maintained. Use of 7-15.1, along with additional provisions required by this Standard can provide acceptable protection."

**SUBSTANTIATION:** The Committee agreed to leave the words "without solid shelves" in the section even though the intent is to require the user to use this table with additional provisions if solid shelves exist. This Appendix Note lets the user know about this intent.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 27

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 24

NEGATIVE: 1

NOT RETURNED: 2 Miller, O'Rourke

**EXPLANATION OF NEGATIVE:**

SCHUMANN: There is no Section 7-15.1 in the preprint and it cannot now be determined where this proposal may apply. My notes from the Technical Committee meeting indicate that 7-15.1 was changed to 7-10.1 and accepted. The logic of what was done is missing.

**COMMENT ON AFFIRMATIVE:**

THACKER: Agree with Ken Isman's comments on the items in his letter dated January 8, 1998.

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