AEI CORPORATION
Advanced Engineering Investigations

PRELIMINARY INVESTIGATION REPORT

Lake Forest, Sprinkler System Water Loss

Representing:	Lake Forest HOA
Location:	1620 Lakeview Terrace, Unit B304, Frisco, Colorado
Date of Loss:	November 27, 2023
AEI Project No.:	16020

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Report Prepared for:

Summit Resort Group/Lake Forest HOA
Thane De Puey
350 Lake Dillon Drive
Dillon, Colorado 80443

Submitted by:

AEI Corporation

Charles B. Sullivan, ASCR2, CKH2
Senior Consultant
charlie@AEIengineers.com

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Date

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INTRODUCTION

AEI Corporation (AEI) was contacted and retained by Thane De Puey with Lake Forest HOA on December 14, 2023. At the request of Mr. De Puey, AEI investigated a water loss involving a sprinkler system passing through the attic above Unit B304 at 1620 Lakeview Terrace in Frisco, Colorado. AEI was asked to evaluate the installation and service of the subject sprinkler system as it related to the applicable codes and industry standards of care. This report provides the results of our findings to date.

BACKGROUND

The subject multi-story residential building was constructed circa 1994. The adopted codes in Frisco, Colorado at the time of construction were the 1991 Edition of the Uniform Fire Code (UFC), and the 1989 Editon of National Fire Protection Association (NFPA) 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to Four Stories in Height*. Based on these codes, the installation of a sprinkler system was required throughout the building, excluding the attic.

Western States Fire Protection (WSFP) completed an annual sprinkler inspection and a 5-year inspection in 2021.

In February 2022, there was a sprinkler loss in the attic of Unit B304 above the west end of the kitchen and the mechanical room. At the time of this water loss, WSFP was servicing the sprinkler system in the subject building, including both inspections and repairs. Additionally, the building had a Poz-Lok sprinkler system, which according to Mr. De Puey, was replaced with a black steel system by WSFP. The sprinkler system replacement included Units B104, B204, and B304.

On November 27, 2023, the sprinkler system failed in Unit B304 proximate to the same location that the sprinkler system failed in 2022. It was determined by the property management/owners and the fire department that a sprinkler head failed and discharged water into the structure.

INVESTIGATION TASKS

The following tasks were performed by AEI during the course of the investigation:

1. Attended a site inspection on December 20, 2023.
2. Reviewed the items listed below.

REVIEWED ITEMS

The following items were reviewed in whole or in part by AEI during the investigation:

1. 1991 Edition of the Uniform Fire Code (UFC).
2. 1989 Edition of NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to Four Stories in Height*.
3. 2016 Edition of NFPA 13R, *Standard for the Installation of Sprinkler Systems In Low-Rise Residential Occupancies*.
4. 2020 Edition of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

SITE INSPECTION

This writer met with HOA board member Sally DeLong. Ms. DeLong provided access to the subject unit, the units below the subject unit, and the sprinkler riser room. The subject building was entered from the parking lot level, as shown in Figures 1 and 2. It was noted that Units 104B and 204B were a single story, and Unit 304B had a second floor. The main floor of Unit 304B had a bedroom and large bathroom located on the west end of the unit, with an attic over the space. There was a second level over the kitchen/dining area. The sprinkler riser room was located on the ground floor at the base of the west stairwell, as depicted in Figure 3. The third level of the structure, Unit 304B (Figure 2), was entered from the exterior stairwell landing. Unit 304B was undergoing mitigation work at the time of the inspection, as exhibitied in Figures 4 and 5. A sprinkler head had reportedly failed and discharged over the refrigerator, as illustrated in Figure 6. The sprinkler head had been repaired prior to the date of the loss, also illustrated in Figure 6.

Figure 1. Unit 304B exterior (16020_CBS_1-003).

Figure 2. Entrance to Unit 304B (16020_CBS_1-011).

Figure 3. Sprinkler riser room (16020_CBS_1-132).

Figure 4. Interior of Unit 304B, kitchen area (16020_CBS_1-016).

Figure5. Unit 304B, kitchen area looking west towards mechanical room and built out wall for the refrigerator (16020_CBS_1-018).

Figure 6. Location of the failed sprinkler head (16020_CBS_1-020).

The black-steel sprinkler branch line for the subject sprinkler (i.e., the head that failed) was installed in the ceiling of the kitchen and extended from the attic over the west bedroom/master bathroom area of the unit, as shown in Figures 7 through 9. The sprinkler piping had cardboard tented over the pipe and expanding spray foam around the cardboard, also shown in Figures 7 through 9 and in Figure 10. The sprinkler piping for this portion of the unit was fed from the floor below through the vertical west wall between the kitchen and bedroom, then west into the attic over the bedroom. The piping had a drop for the sprinkler in the mechanical room, and then ran diagonally across into the ceiling between the upper level and the kitchen. The path of the piping can also be followed in Figures 7 through 9, and Figure 11.

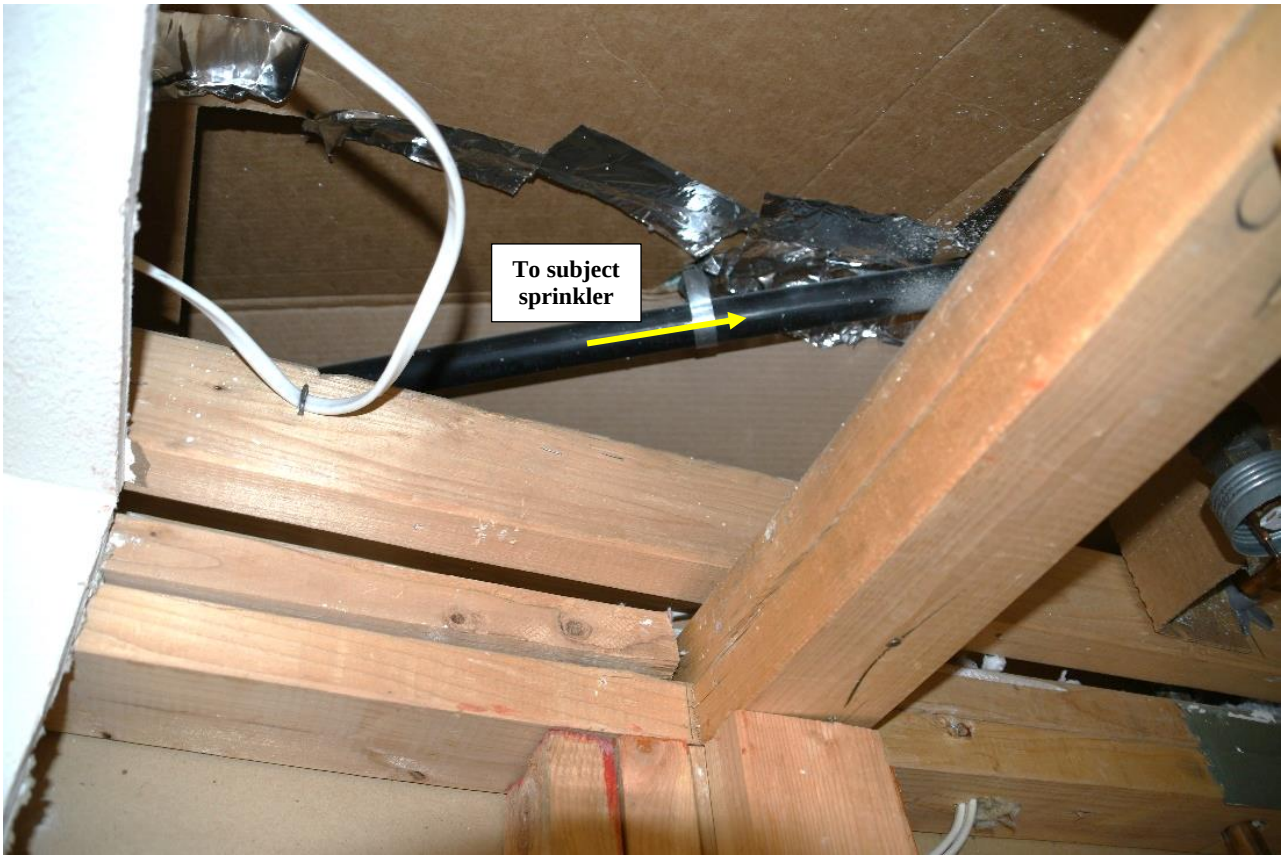

Figure 7. Sprinkler branch for the subject sprinkler head (16020_CBS_1-035).

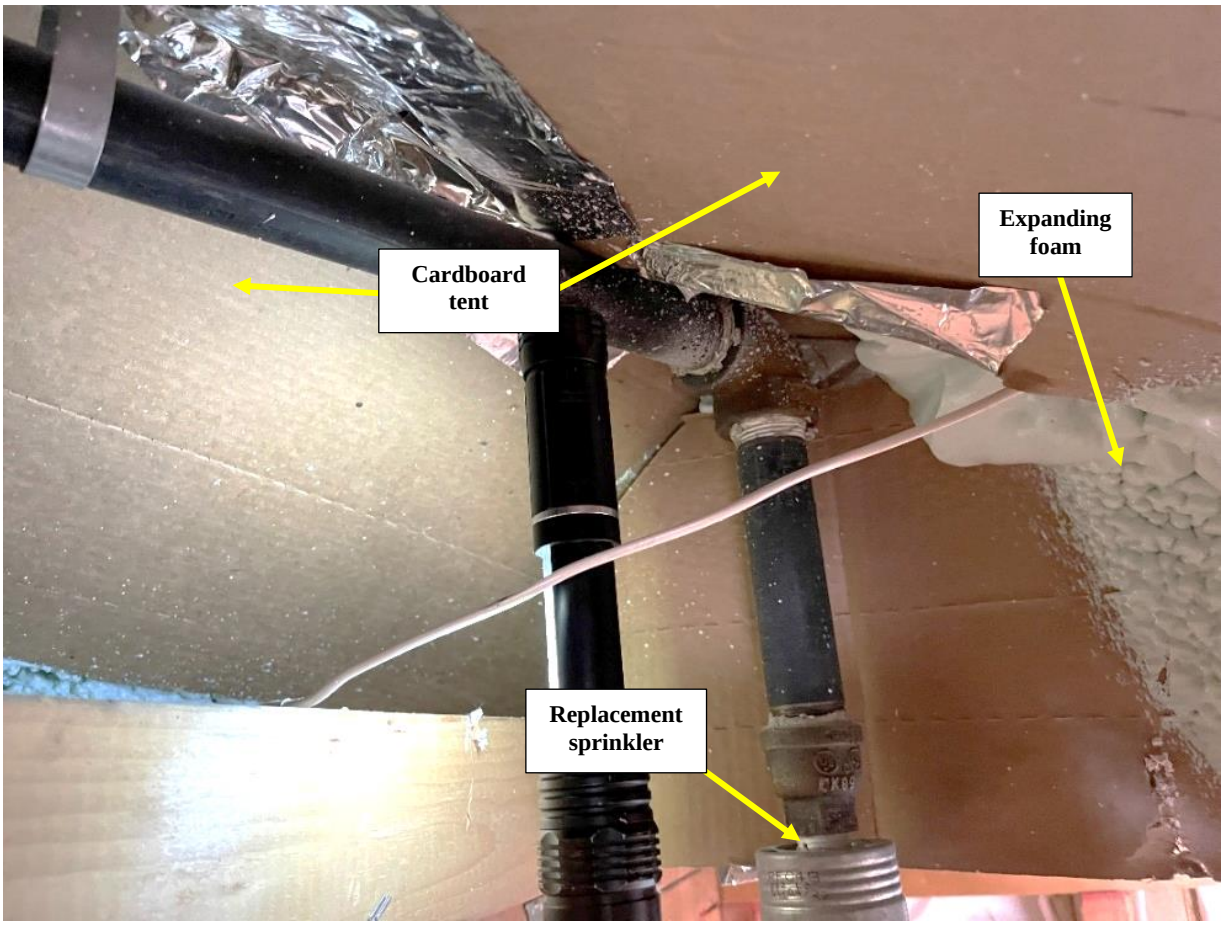

Figure 8. Sprinkler branch line for the subject sprinkler (16020_CBS_2-037).

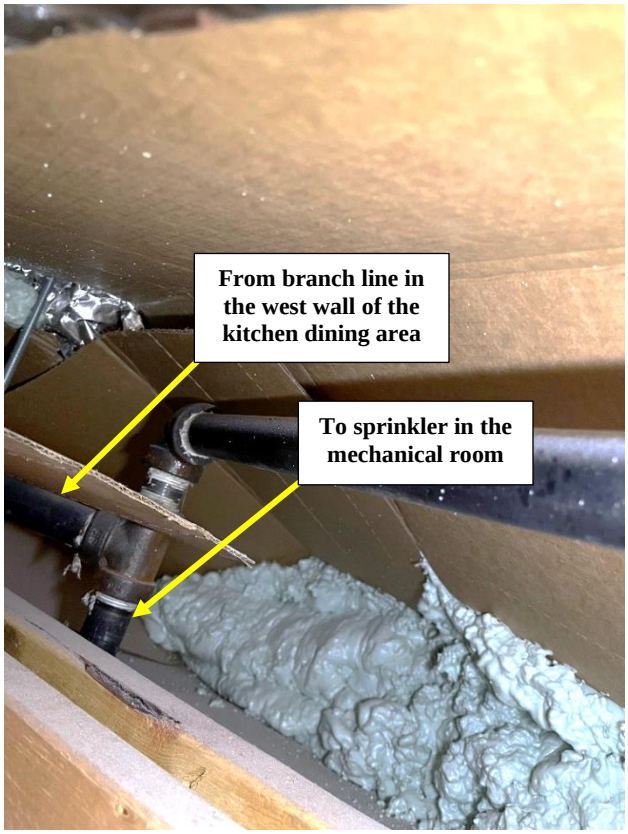

Figure 9. Sprinkler branch for the subject sprinkler (16020_CBS_2-042).

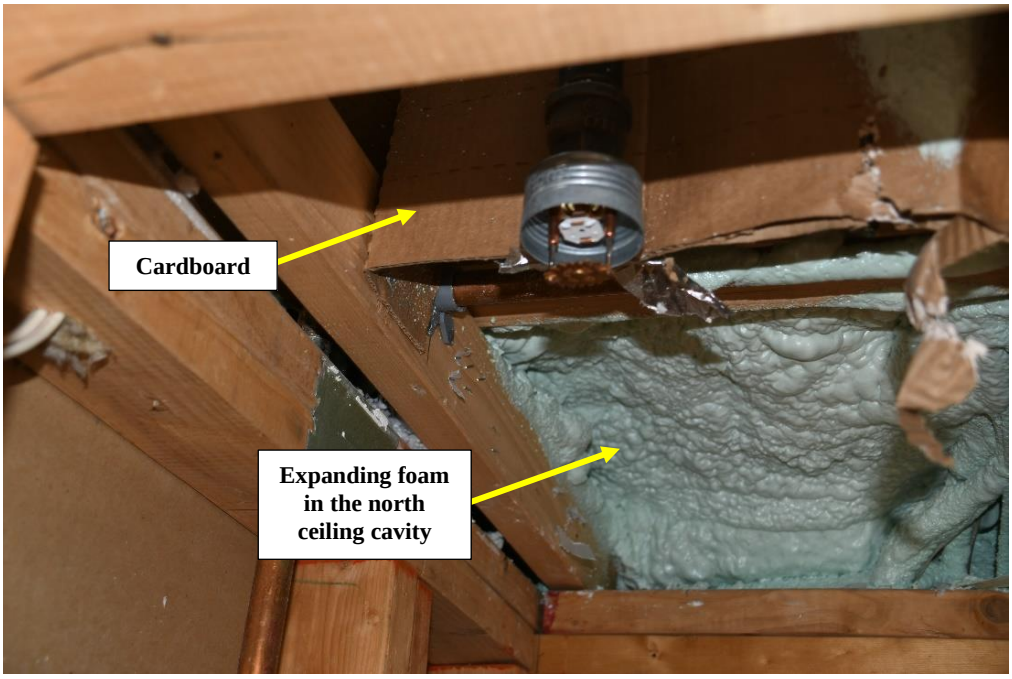

Figure 10. Replacement sprinkler (16020_CBS_1-043).

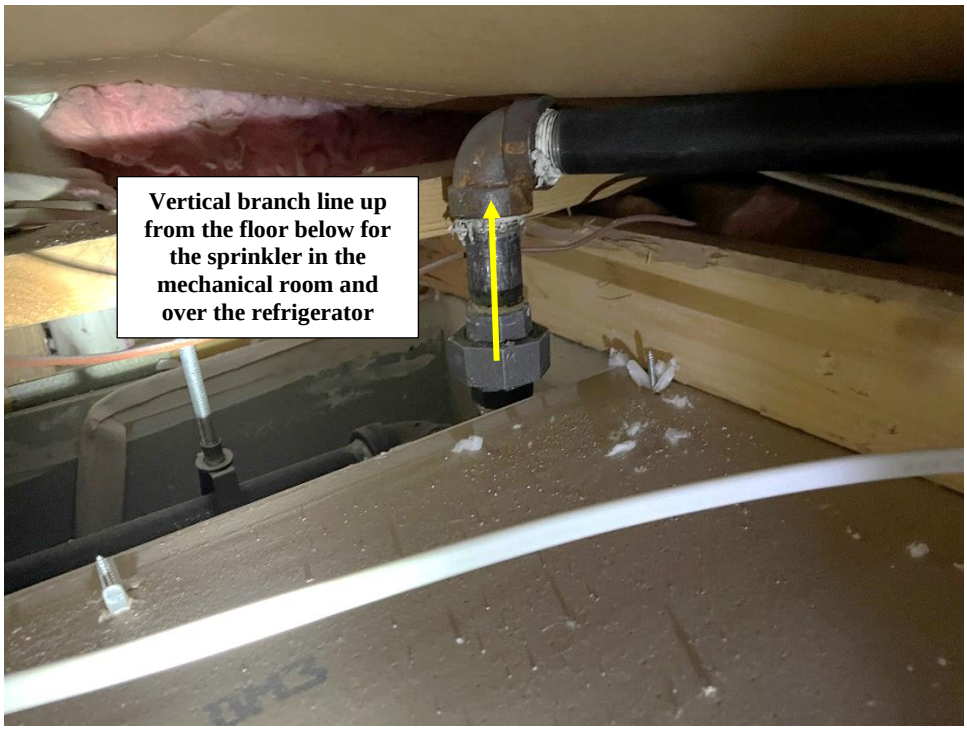

Figure 11. Vertical branch line from the floor below (16020_CBS_2-047).

The high point of the cardboard tent was approximately 12-inches above the ceiling construction, as depicted in Figure 12. The sprinkler pipe was approximately 2-inches below the high point of the cardboard, also depicted in Figure 12.

Figure 12. Measurements for the high point of the cardboard and distance of pipe from the cardboard (16020_CBS_ 2-054, 16020_CBS_2-055).

The attic over the west bedroom was entered via an access panel in the ceiling, as illustrated in Figure 13. White loose fill cellulose insulation was observed in the attic, as shown in Figure 14. The depth of the

insulation was approximately 14-inches, as depicted in Figures 15 and 16. Based on measurements, there would have been approximately 2-inches of insulation over the cardboard tent covering the sprinkler piping.

Figure 13. Attic access panel in west bedroom (16020_CBS_1-071).

Figure 14. Looking north into the attic from the access panel (16020_CBS_1-078).

Figure 15. Insulation depth (16020_CBS_1-080).

Figure 16. View over the area where the sprinkler branch piping for the subject sprinkler was installed (16020_CBS_1-081).

The sprinkler head that failed was and has been in possession of the properties' HOA since the date it was removed, as illustrated in Figure 17. All of the components of the sprinkler were recovered after the loss, also illustrated in Figure 17. The sprinkler deflector, arms, orifice, and other surfaces exhibited no damage

and/or witness marks, as shown in Figure 18. The cup for the concealed cover plate was observed to be damaged, as depicted in Figure 19. The components were documented and non-destructively examined.

Figure 17. Subject sprinkler and components of the sprinkler (16020_CBS_2-001).

Figure 18. Subject sprinkler, typical of the deflector arms and orifice (16020_CBS_2-023).

Figure 19. Cup on the subject sprinkler, to which the concealed plate would be assembled (16020_CBS_2-021).

The fusible element for the sprinkler was intact and was not separated, as illustrated in Figure 20. The components of the sprinkler seat/plug were undamaged and exhibited no witness marks indicative of physical damage, as shown in Figures 21 and 22. The tension arms from the sprinkler exhibited no witness marks indicating damage, as depicted in Figure 23. When the inspection concluded, the subject sprinkler and the sprinkler components were left with Sally DeLong.

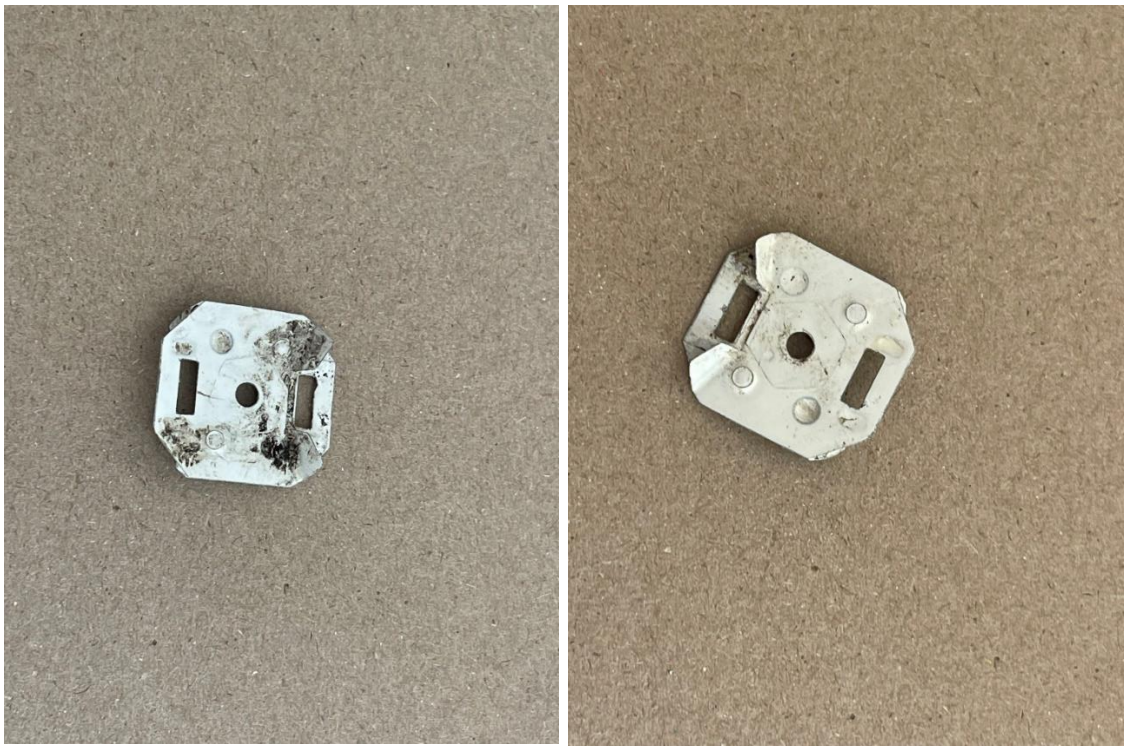

Figure 20. Fusible element from the subject sprinkler, both sides (16020_CBS_2-025, 16020_CBS_2-026).

Figure 21. Component of the sprinkler seat/plug (16020_CBS_2-029, 16020_CBS_2-030).

Figure 22. Component of the sprinkler seat/plug (16020_CBS_2-031, 16020_CBS_2-032).

Figure 23. Tension arms from the subject sprinkler (16020_CBS_2-035).

DOCUMENT REVIEW

Requested documents such as inspection reports, service records, contracts, etc., had not been provided for review at the time this report was prepared.

WEATHER HISTORY

The weather history for Frisco, Colorado was reviewed for dates between October 28, 2023, and November 23, 2023. The weather data was acquired from Weatherspark.com. The low temperature during the reviewed time period was -13°F recorded on October 30, 2023, as illustrated in Figure 24. The high and low temperatures on November 23, 2023, i.e., the date of loss, were 37°F and 16°F respectively, as exhibited in Figure 25.

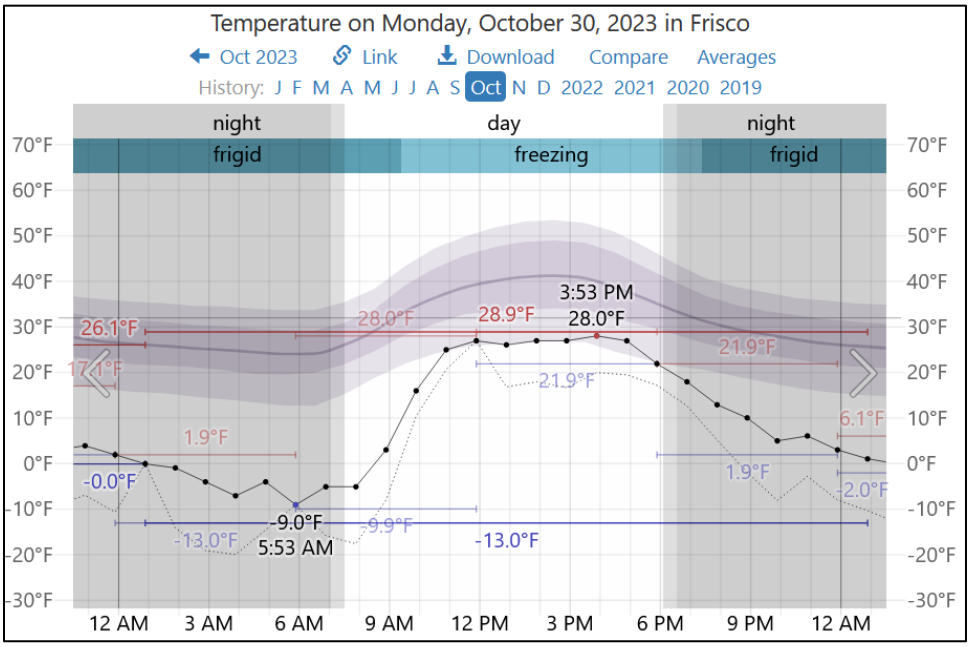

Figure 24. Excerpts of the weather history extracted from Weatherspark.com for October 30, 2023.

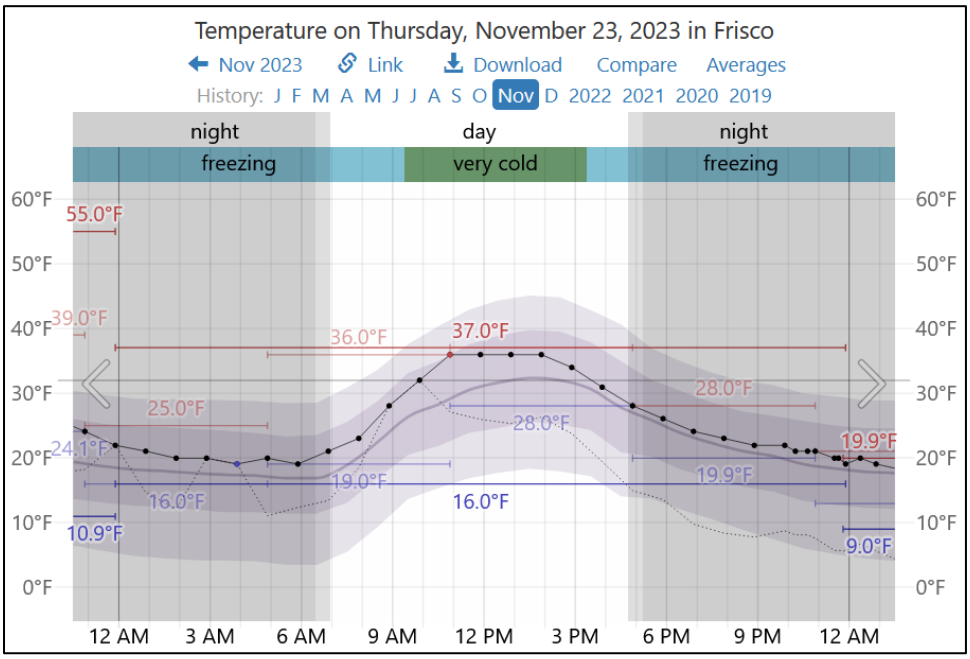

Figure 25. Excerpts of the weather history extracted from Weatherspark.com for November 23, 2023.

DISCUSSION

Based on available information and observations during the site inspection, the subject sprinkler more likely than not failed as the result of freezing temperatures leading up to the date of the loss. Temperatures in Frisco, Colorado, dropped to a low of -13°F on October 30, 2023. Additionally, although temperatures were moderate through the date of the loss, they were below freezing each night, and the sprinkler that failed was located on a wet pipe sprinkler system that passed through the north-facing attic of the structure.

On February 23, 2022, the building suffered a water loss in the same unit in the same proximate area of the attic over the kitchen. At that time, the sprinkler system was a Poz-Lok system. HOA board member Thane De Puey informed this writer that the Poz-Lok sprinkler system for Units B104 through B304 was replaced by WSFP. Information regarding the replacement of the sprinkler system was requested from Mr. De Puey but has not been received.

Per NFPA 13R, where a sprinkler system cannot be adequately heated at/or above 40°F, it shall be protected by 1 of 5 different methods, as shown in Figure 26. NFPA 13R states that pipe covered by insulation is considered to be part of the area below the ceiling, also shown in Figure 26. Additionally, Figure 26 shows one of six examples of how to protect pipe with insulation.

5.4.2* Systems in Areas Subject to Freezing. Where any portion of a system is subject to freezing and the temperature cannot be maintained reliably at or above 40°F (4°C), the pipe shall be protected by use of one of the following methods:

(1)* Antifreeze system using a listed antifreeze solution in accordance with NFPA 13
(2) Dry pipe system
(3) Preaction system
(4) Listed dry pendent, dry upright, or dry sidewall sprinklers extended from pipe in heated areas
(5) Heat tracing in accordance with 6.7.2.2

A.5.4.2 Piping covered by insulation, as shown in Figure A.5.4.2(a) through Figure A.5.4.2(f), is considered part of the area below the ceiling and not part of the unheated attic area.

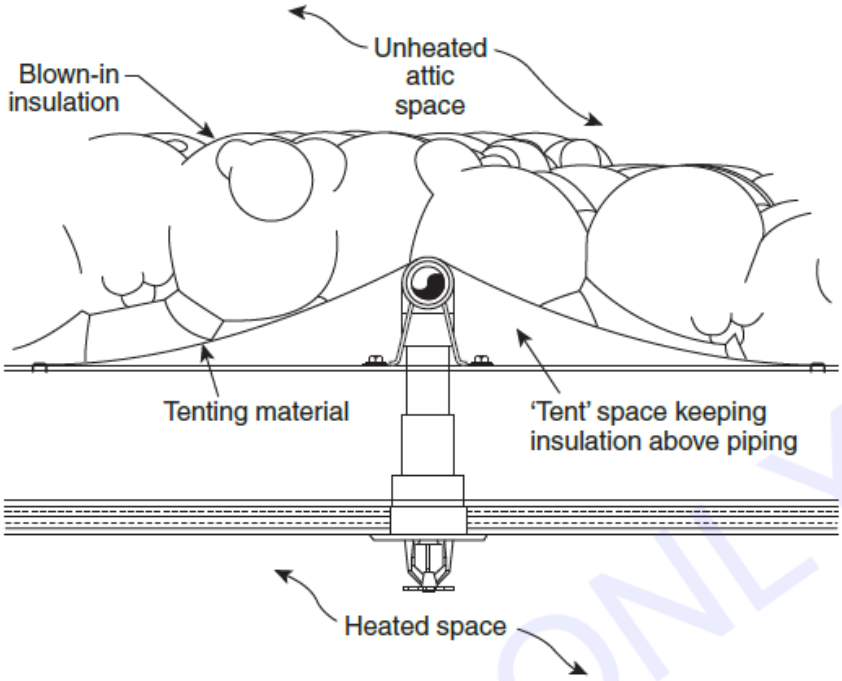

FIGURE A.5.4.2(f) Insulation Recommendations — Arrangement 6.

Figure 26. Excerpts from the 2019 Edition of NFPA 13R with one method of insulating shown.

The attempt to install a cardboard tent over the black-steel sprinkler pipe did not take into account the R-value of insulation needed to protect the pipe from freezing. The pipe was approximately 10-inches above the sheetrock ceiling. The cardboard tent was, at its highest point, approximately 12-inches above the sheetrock ceiling. The measured depth of the white loose-fill insulation in the attic was approximately 14-inches in depth throughout the attic. Based on these measurements and observed conditions in the

attic, there were approximately 2-inches of insulation covering the peak of the cardboard tent. Considerably more insulation, depth-wise, was needed to protect the subject pipe from freezing. The subject sprinkler piping was inadequately protected from freezing, which likely resulted in the formation of an ice block within the pipe, leading to the failure of the sprinkler pipe.

Two suggestions are being provided to assist with providing adequate heat for the sprinkler piping installed in the attic over the subject kitchen.

1. Add additional insulation over the cardboard tent installed in the attic over the kitchen, as well as installing a small louver in the ceiling to allow warm air to enter the cavity created by the cardboard tent. This method would only be effective if additional insulation were installed over the cardboard tent.
2. Bring the black-steel pipe into the heated envelope of the unit. Although NFPA 13R indicates that pipe installed under insulation is considered to be below the ceiling, improper insulation depth negates the thermal protection of the pipe. The sprinkler pipe could be relocated into the unit and installed where the ceiling and the wall meet. A small soffit could be constructed around the pipe, concealing the pipe, as it follows a path to the area over the refrigerator. A side wall sprinkler could be installed for the mechanical room from the same run of pipe.

Additional items were requested as part of the investigation and had not been provided at the time this report was prepared, including service records, inspection reports, and contracts relating to the installation of the new sprinkler system. These items would be useful in determining the scope of work for each party involved in the installation. Typically, sprinkler contractors would indicate on the sprinkler plans requirements for protection of the pipe from freezing. This information would be shared with an insulation contractor to ensure that sprinkler piping is adequately protected from freezing if it has been installed under insulation.

The sprinkler system installer was WSFP. The insulation contractor's name has not been provided by Mr. De Puey. It has been alluded to that the insulation installer may have been a handyman, not an insulation contractor. It is currently unknown what communications, if any, took place between the trades regarding the protection of the pipe from freezing.

PRELIMINARY CONCLUSIONS

The investigation performed to date indicates the following:

1. A concealed sprinkler failed in the kitchen of Unit 304B, resulting in the discharge of water damaging Unit 304B, and Units 104B and 204B.
2. The sprinkler likely failed due to freezing conditions/temperatures and the lack of thermal protection of the sprinkler.
3. Had the sprinkler piping been properly protected from freezing, the loss could have been avoided.

The opinions expressed in this report are based upon this writer's education, training, and work experience. The opinions are also based upon a reasonable degree of certainty and the information available to this writer at the time the report was authored. This writer reserves the right to modify and/or supplement these opinions should new information become available.