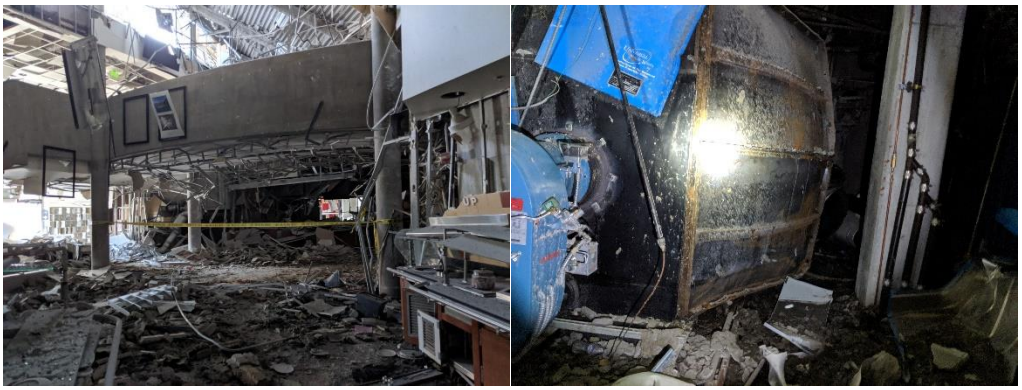
University of Nevada, Reno
Argenta Hall Explosion Event
July 5, 2019



Brennan Paterson
Chief Administrative Officer
Mechanical Compliance Section
State of Nevada Division of Industrial Relations
July 23, 2019

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Summary

On July 5, 2019, Argenta Hall on the campus of the University of Nevada, Reno, experienced an explosion event. This report describes the technical aspects of the event and proposes possible regulatory solutions to avoid a similar occurrence.

Evaluation of the event site revealed that a boiler experienced an explosion in the boiler furnace and exhaust stack. As a result of the boiler explosion, which was the first and smaller of the two explosions which occurred, a 3 inch gas feeder line was severed. This caused a release of natural gas into the building, collecting in the basement and the adjacent elevator hoistway. This natural gas subsequently exploded in a second and much larger explosion, which caused the majority of the damage to the building.

Evaluations of the conditions of both explosions suggest that the inclusion of an electrically actuated gas shut off upstream of the boiler fuel train or relocation of gas feeder lines away from areas of potential damage during a boiler explosion would be effective means to prevent or mitigate future similar occurrences.

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Introduction

Argenta Hall is a 7 story residential building constructed in 2004. The boiler/pressure vessel equipment on site consisted of the following:

00-0149NV (Boiler #1), a 1,003,000 BTU/hr natural gas fired water tube boiler
03-0190NV (Boiler #2), a 1,260,000 BTU/hr natural gas fired water tube boiler
03-0116NV (Boiler #3), a 742 lb/hr natural gas fired water tube boiler
00-0331NV (no user number), a 1,860 gallon hot water storage vessel
03-0616NV (no user number), a 1,860 gallon hot water storage vessel

All of these devices were stamped and certified by the National Board of Boiler and Pressure Vessel Inspectors, regularly inspected by licensed boiler inspectors, and were permitted at the time of the incident. There exists no history of violations for any of the boiler/pressure vessel devices at Argenta Hall. Only Boiler #1 was involved in the event at Argenta Hall.

At approximately 1300 hours on July 5, 2019, a large explosion event occurred at Argenta Hall on the campus of the University of Nevada, Reno. On that evening, the Nevada Division of Public Safety (DPS) requested the support of the Mechanical Compliance Section (MCS) in assessing the site, specifically the condition of the boilers and elevators. An investigation by the MCS took place starting that evening and concluding on July 7th. The goal of this investigation was to determine the immediate physical cause of the explosion at Argenta Hall.

Methods

During the course of the investigation, the MCS utilized the following methods to collect data:

Physical Examination of the Boiler Equipment *In Situ*

MCS inspectors were able to access the boiler room of Argenta Hall beginning on Saturday July 6. During this examination, a visual evaluation of the equipment was made and compared to inspection records and building plans. Photographs were also taken of the site as discovered and prior to the collection of physical evidence.

Physical Examination of the Site as a Whole

During the course of the investigation, MCS inspectors evaluated the entire building and surrounding areas. This examination included visual evaluation of the damaged and undamaged portions of Argenta Hall, of Nye Hall (a building immediately to the North of Argenta Hall and connected by a utility passageway), and of the grounds surrounding these buildings. Photographs of these locations were also taken prior to the collection of physical evidence.

Physical and Electronic Evaluation of Gathered Evidence

In coordination with investigators from DPS, several components of Boiler #1 were extracted from the site by DPS and evaluated at the incident command center. These components from Boiler #1 included the fuel train assembly, primary gas shut-off valve, servo controlled gas metering valve, a portion of the boiler exhaust, and the rain shield from the top of the boiler exhaust on the roof of Argenta Hall (rain shield was discovered on the ground on the North side of Nye Hall). These pieces were visually examined. Additionally, manual valves were tested for functionality via manual manipulation, and electronically controlled valves were tested for functionality utilizing circuit testers.

Interview with Boiler Personnel on Site During Explosion

In coordination with investigators from DPS, Truckee Meadows Fire Protection District, Tahoe-Douglas Fire Protection District, and Nevada OSHA, the MCS interviewed an employee of Battle Born Boiler and Mechanical who had been contracted to conduct repair work on Boiler #1. This interview took place on the afternoon of Saturday, July 6th.

Results

After completing the replacement of a servo-controlled gas metering valve on Boiler #1, the boiler mechanic attempted to restart the boiler several times. During the course of restarting the boiler, the furnace and exhaust assemblies of the boiler exploded in a fashion consistent with those assemblies having been charged with an unburned fuel and air mixture (see figures 1, 2, 3).

As a direct result of the explosion of Boiler #1, the 3-inch gas supply line to the boiler, which descended from the ceiling directly next to the body of the boiler, was severed at the point of the primary gas shut-off valve (see figure 4). This valve exhibits evidence of combustion consistent with a torch effect, which is consistent with the boiler mechanic's claim of fire coming from the area of this valve immediately following the explosion of the boiler.

UNR facility records indicate that the sprinkler system at Argenta Hall activated 90 seconds after the initial boiler explosion. This is consistent with open sprinklers in the boiler room as well as large amounts of water in the room and evidence of "washing" in areas where the sprinklers sprayed directly. Evidence shows that the fire at the primary gas shut-off valve was extinguished by the sprinklers. However, gas flowed from this valve after the fire was extinguished and continued to do so until the main gas line to Argenta Hall was closed at the street connection, approximately 10 minutes later.

Damage to Argenta Hall shows that the boiler room and adjacent elevator hoistway were filled with gas during this time. When ignition of the gas occurred, these areas sustained greater blast damage than other areas of the building (see figures 5 and 6).

The primary fuel shut-off valve for the Boiler #1 fuel train was damaged during the initial explosion. However, it could not have been actuated after the initial explosion due to the fact that it was, until the actuation of the fire sprinklers, acting as a source of flame. Additionally, the shut-off handle for this valve was not installed at the time of the initial explosion, and thus the valve could not have been actuated (handles are required to be "permanently attached" per the American Society of Mechanical Engineers Controls and Safety Devices for Automatically Fired Boilers [ASME CSD-1], 2012 version, section CF-150[a]). All other valves in the Boiler #1 fuel train were tested and found to be functioning as designed.

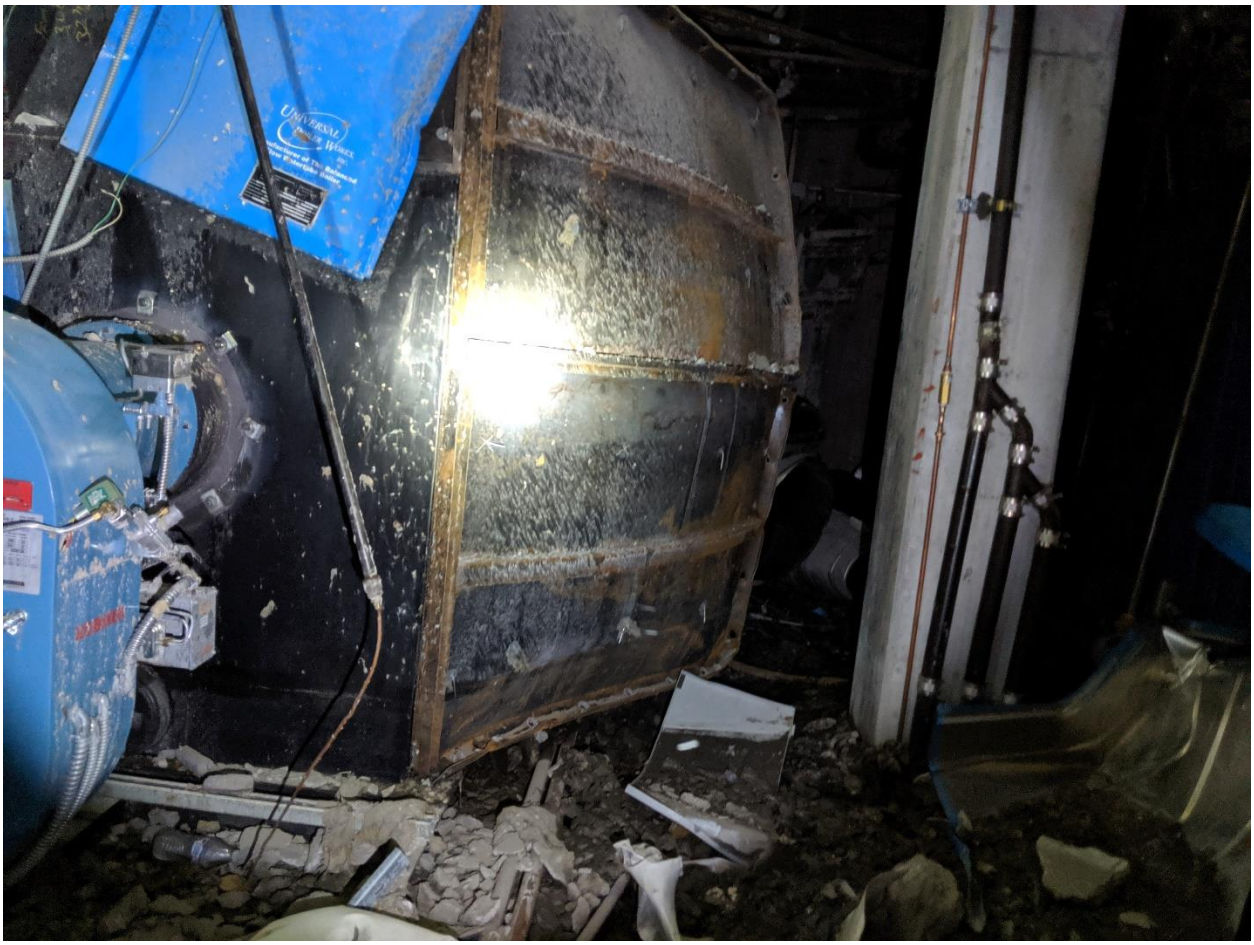

Figure 1. A front view of Boiler #1, showing damage from internal explosion of the furnace assembly.

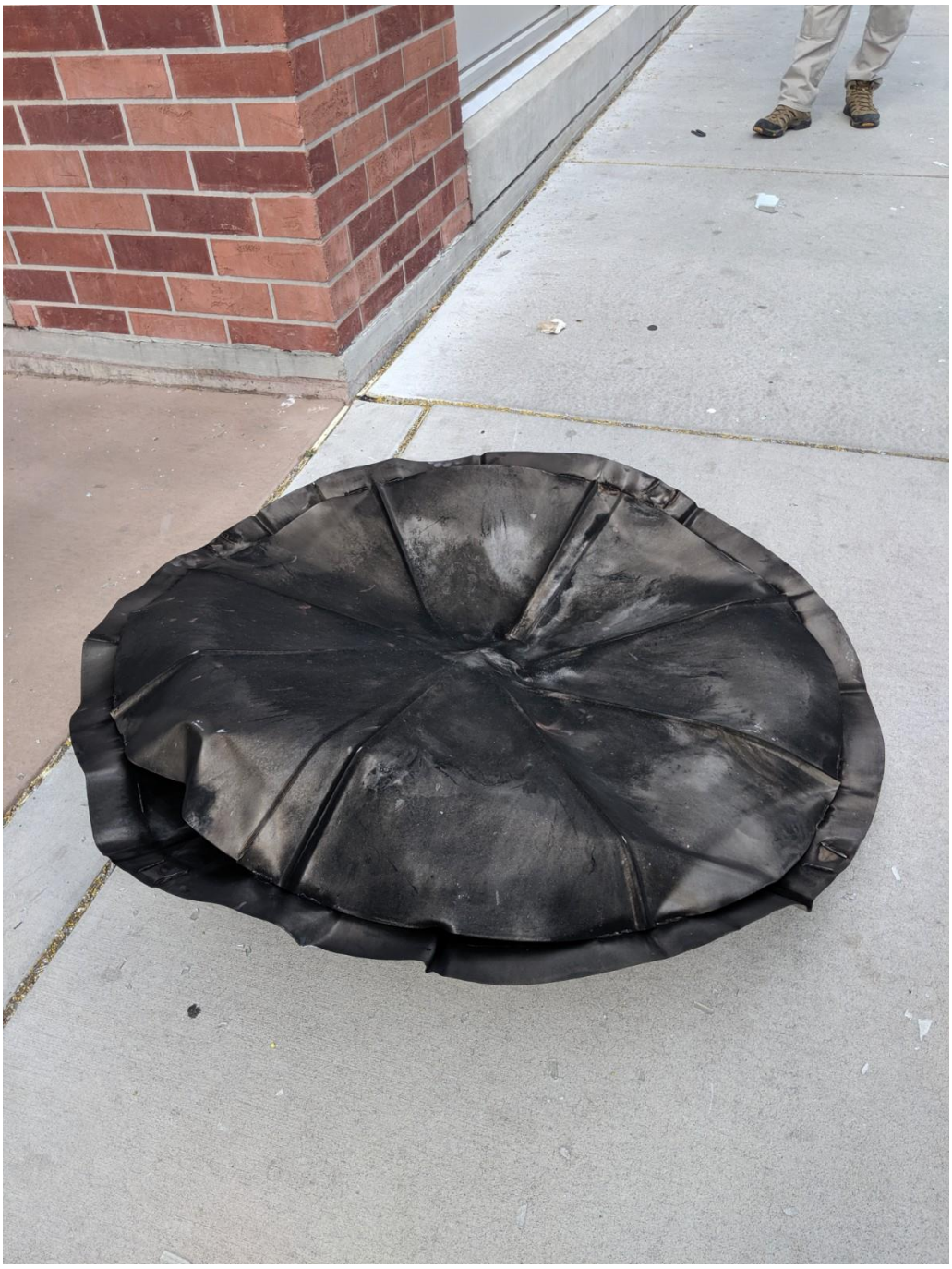

Figure 2. Rain shield from Boiler #1 exhaust assembly, found on the North side of Nye Hall. Damage is consistent with an explosion within the exhaust assembly.

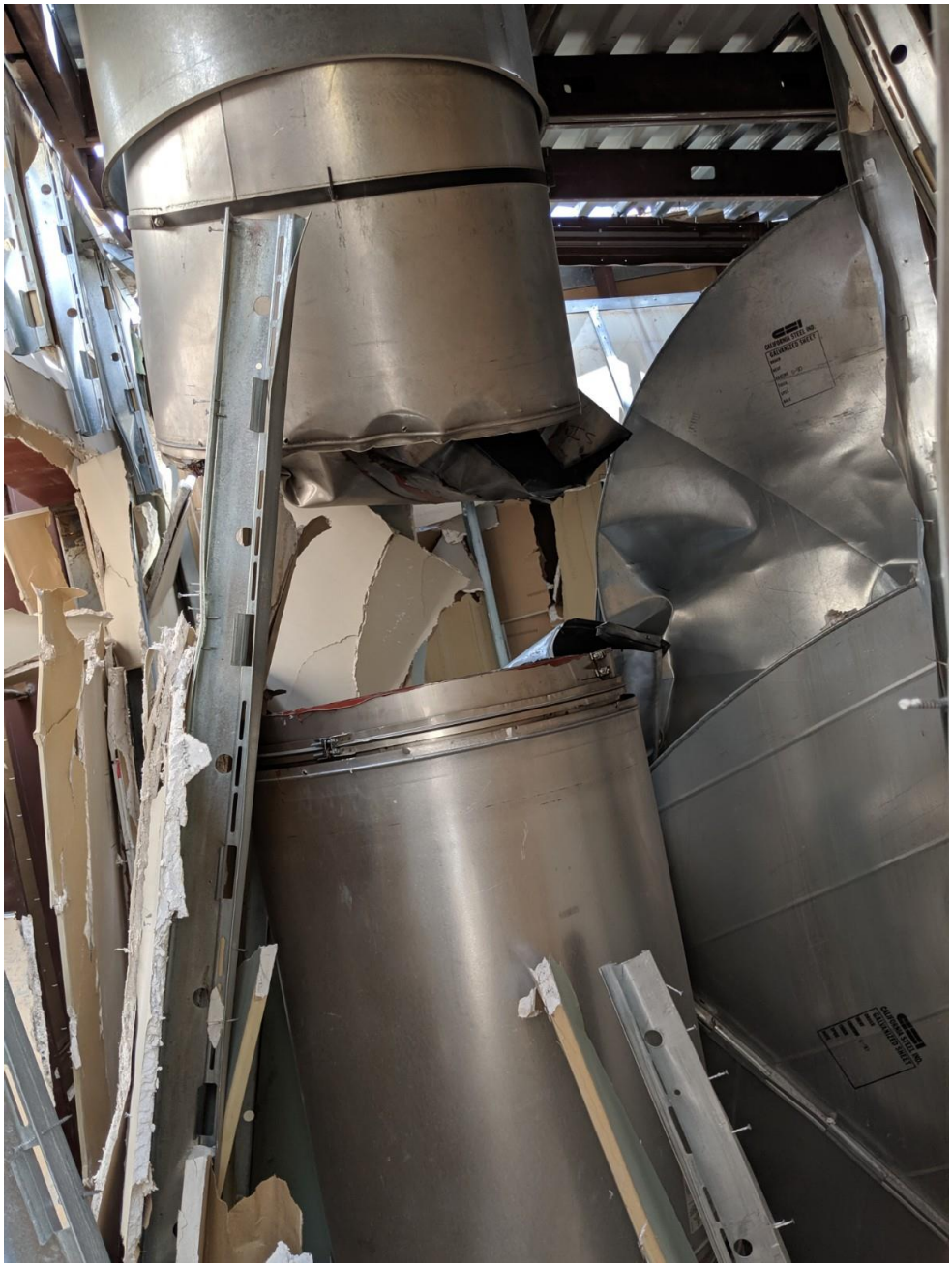

Figure 3. Exhaust assembly from Boiler #1. This is the view inside of the ducting area on the roof of Argenta Hall. Damage is consistent with an explosion occurring within this assembly.

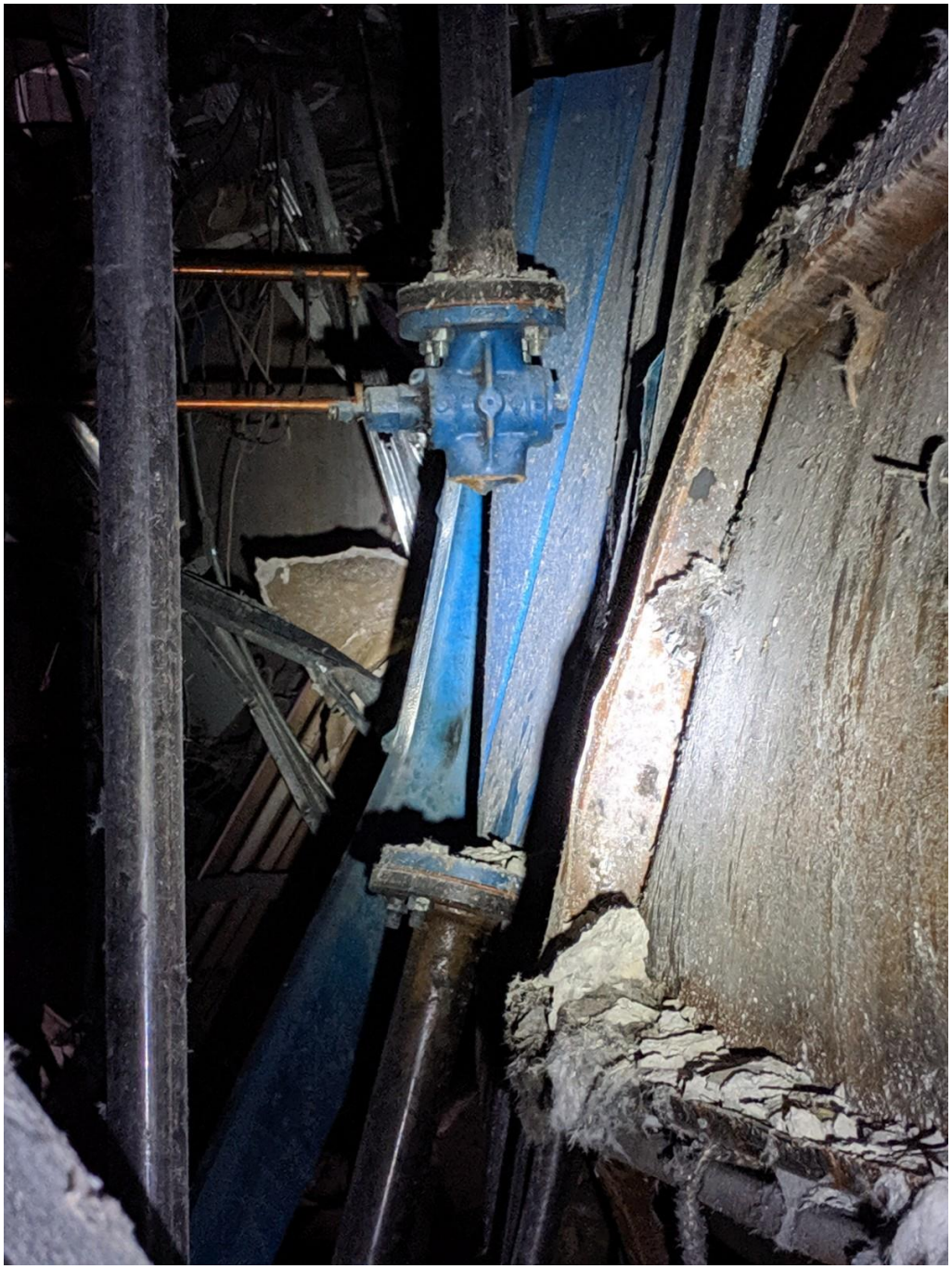

Figure 4. A view of the primary gas shut-off valve on Boiler #1 exhibiting damage from the initial explosion.

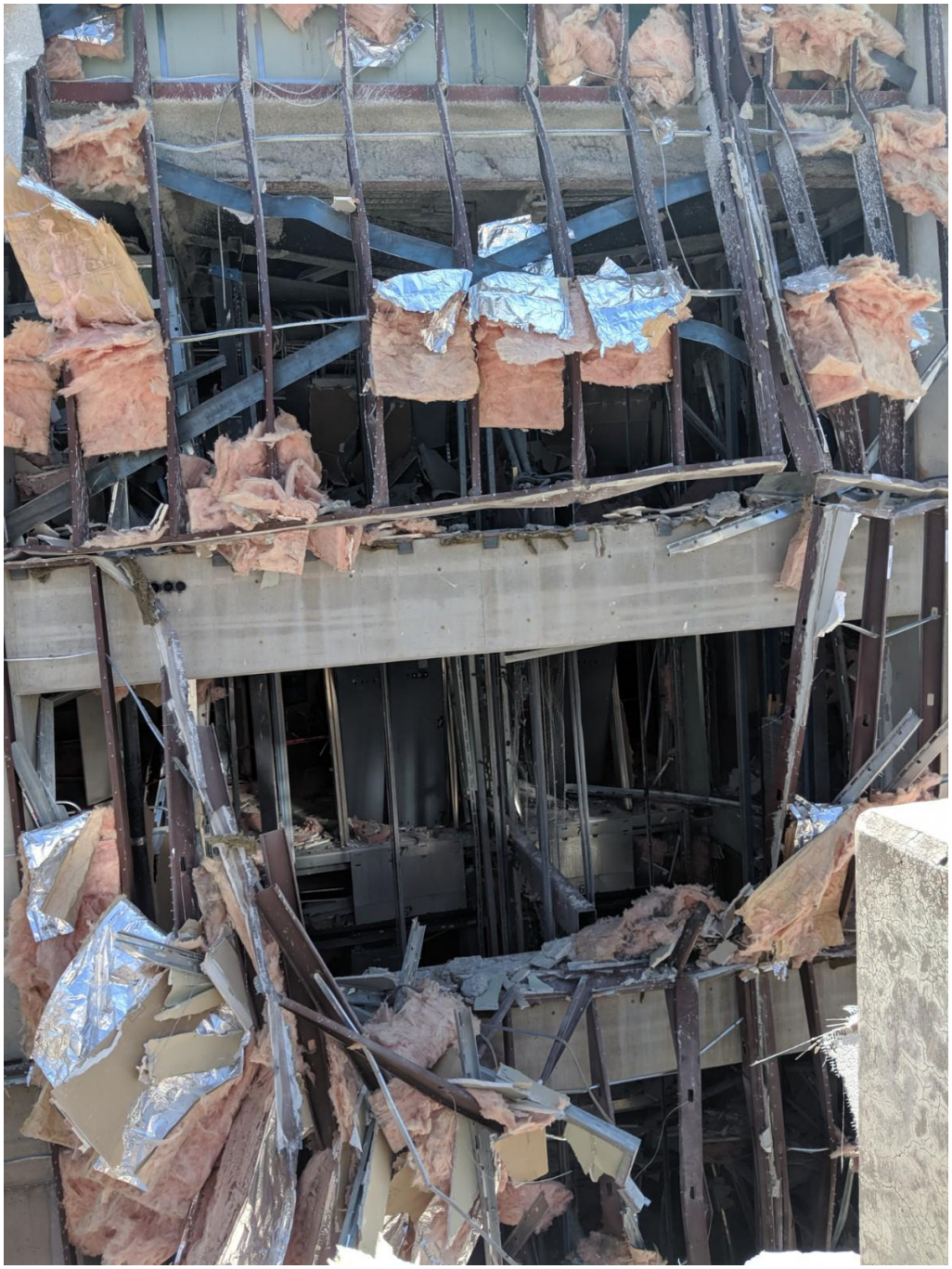

Figure 5. Argenta Hall elevator hoistway, as seen from the roof of Nye Hall. Damage is consistent with a significant blast pressure wave caused by a gas explosion.

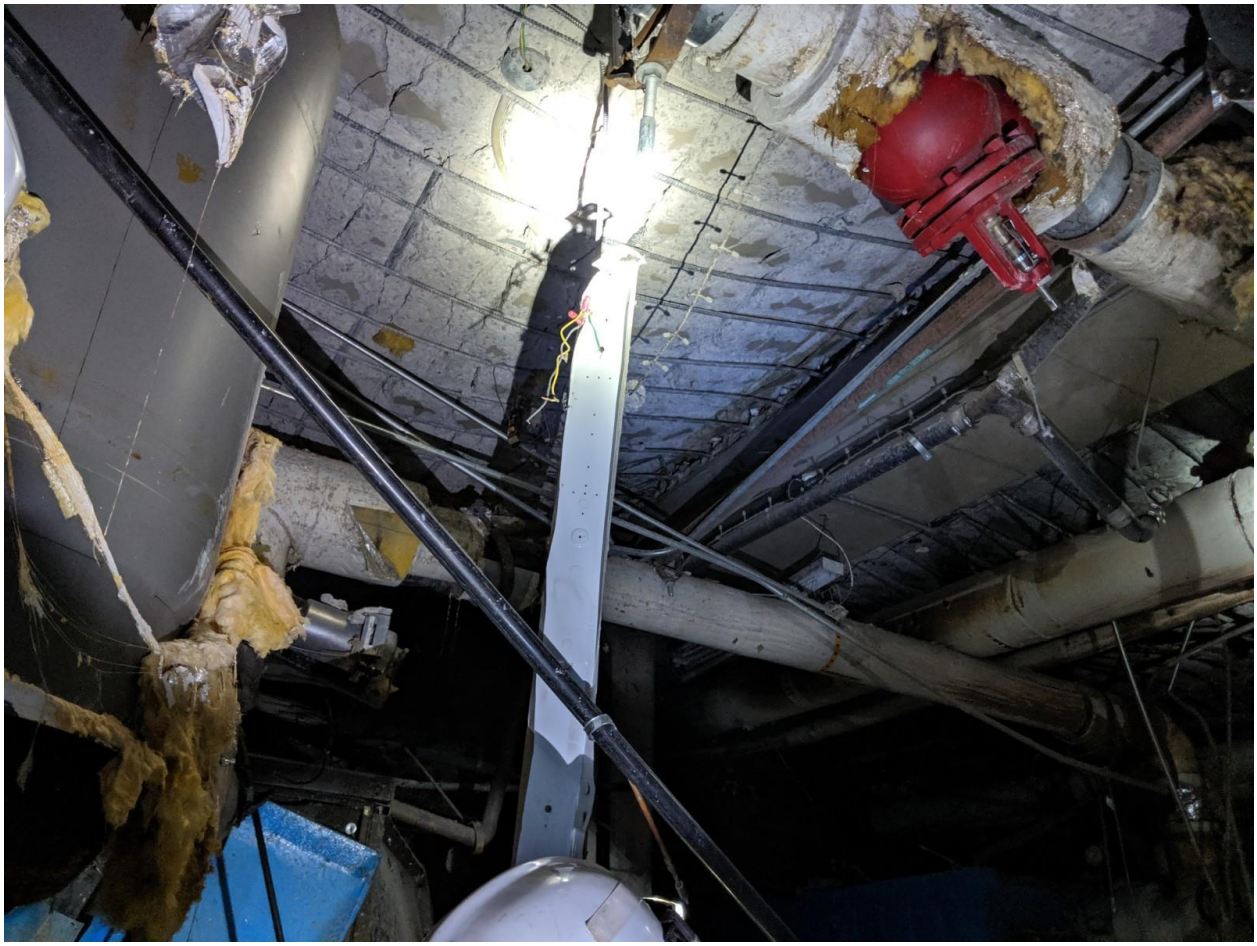

Figure 6. Ceiling of the boiler room. Damage is consistent with a significant blast pressure wave caused by a gas explosion.

Discussion

The initial explosion in Boiler #1 was caused by the existence of an explosive mixture of fuel and air in the furnace and exhaust sections of the boiler. Evidence is inconclusive as to the actual cause of ignition, though ignition may have been caused by the boiler igniter being actuated or by residual heat in the boiler as a result of previous attempts to start combustion. This boiler was equipped with a purge fan which, under normal operation, will clear these assemblies of any unburnt fuel/air mixture. It appears that this fan was not engaged during the attempted start of Boiler #1. Due to damage from the explosion, this fan could not be tested for functionality.

The secondary and larger explosion was caused by the release of natural gas into Argenta Hall due to the severance of the 3-inch gas feeder line to Boiler #1. The placement of this line close to the body of Boiler #1 is consistent with many existing boiler installations. However, relocation of this line away from the body of the boiler may have caused the survival of the line in an undamaged state, thus avoiding the secondary explosion. Additionally, the installation of an electrically controlled shutoff valve upstream of the boiler fuel train and away from the boilers, actuated by the existing emergency shut-off switch at the entrance to the boiler room, would have stopped the flow of gas into Argenta Hall upon actuation.

Conclusions

The July 5 explosion at Argenta Hall at the University of Nevada, Reno, was caused by a smaller initial explosion in Boiler #1. This initial explosion destroyed the 3-inch gas feeder line to the boiler, causing the building to fill with natural gas. This gas subsequently exploded, causing the majority of the damage to the building.

Evaluation of the boiler equipment shows that the initial explosion was caused by the existence of an explosive mixture of fuel and air in the furnace and exhaust sections of the boiler.

Evaluation of the causes of both explosions suggests that the inclusion of an electrically actuated gas shut-off valve upstream of the boiler fuel train and relocation of gas feeder lines away from areas of potential damage during a boiler explosion would be effective means to mitigate future similar occurrences. It is recommended to require such means via future revision to the Nevada Administrative Code.