INDOOR AIR QUALITY ASSESSMENT

Ralph B. O'Maley Middle School Gymnasium
32 Cherry Street
Gloucester, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Brian Tarr, Business Manager for the Gloucester Public Schools (GPS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA), provided assistance and consultation regarding indoor air quality concerns within the gymnasium at the O'Maley Middle School in Gloucester, Massachusetts. Reported complaints of odors and symptoms experienced in the gymnasium prompted the request.

On June 13, 2002, a visit was made to this school by Michael Feeney, Director of the Emergency Response/Indoor Air Quality Program (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Kevin Hutchinson, School Principal, Joseph Lucido, Facilities Director for GPS, Dave Anderson, school custodian and Mr. Tarr for various parts of this assessment. An indoor air quality assessment conducted by BEHA staff detailing general indoor air quality conditions was subject of a separate report (MDPH, 2002). This report describes the findings and recommendations concerning the gymnasium and vicinity.

The school is a two-story brick building with a basement level constructed in 1973. The gymnasium wing is a several-story structure. The gymnasium occupies the upper level of the wing. The ground floor contains locker rooms and an auxiliary gymnasium. The shops and boiler room are located within an adjacent wing on the ground level. The Dorothy Talbot Ice Rink is a freestanding facility located south of the gymnasium.

Methods

Air tests for carbon monoxide were taken with the TSI, Q-Trak ™, IAQ Monitor Model 8551. Ductwork, water damage and chimney/exhaust vent inspection was done by visual observation.

Discussion

Based on information concerning symptoms of building occupants described by GPS officials (headache, nausea, lethargy, and tiredness), BEHA staff suggested that digital readout carbon monoxide (CO) detectors (see Picture 1) be installed and allowed to operate for several days prior to the visit described in this report.

The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include carbon monoxide (CO), carbon dioxide, water vapor and smoke. Of these materials, CO can produce immediate, acute health effects upon exposure. BEHA staff identified three possible combustion processes that can produce CO that may enter the gymnasium: the boiler room, the hallway connecting the school to the ice rink and vehicle exhaust.

All areas surveyed by BEHA staff within the building were sampled for CO. No detectable levels of CO were measured in any area of the building, including the main office, gymnasium, locker rooms, art room, hallway to the ice rink, gymnasium mechanical room and the fresh air intake chamber (see Picture 2) of the vent located above the entrance to the gymnasium.

Nighthawk brand CO alarms were installed in the gymnasium and boiler room as a precautionary measure. The Nighthawk sonic alarm is set to activate if a CO level above 50 parts per million (ppm) is detected. The lowest level of CO that this measuring device can detect is 11 ppm (Kidde Safety, 1999). The Nighthawk detector would store in its electronic memory measured CO levels between 11 ppm to 30 ppm. No measurable CO levels were stored in the memory of any of the Nighthawk alarms installed.

The Boiler Room

BEHA staff examined the ventilation system ducts, hallways, other structures and blueprints to identify possible pathways for products of combustion to enter the gymnasium (Todesco, 1971).

BEHA staff believes that the primary source of CO is the exhaust vent/chimney for the boiler (see Picture 3). Of note is a duct that transverses the boiler room/pottery room interior wall. Located in close proximity to the boiler room/pottery room duct junction is a return vent for HV4, the air handling unit (AHU) that services the shops (see Blueprints 1 and 2). Significant spaces existed between the duct and the wall and the boiler room/pottery room duct junction (see Picture 4), which may allow for air to move from the boiler room into the ceiling space (called a plenum). The presence of a return vent can create a localized depressurization of the ceiling plenum, which can then serve to draw boiler room air.

The vent connecting the chimney to the boiler has developed several holes, which have the potential to release CO (see Pictures 5 and 6). The metal plate through which the exhaust vent passes has buckled, resulting in the exhaust vent dropping downward (see Pictures 7 and 8). The movement of the exhaust vent has created spaces in the exterior wall for outdoor air to penetrate into the boiler room. Since cold air moves to hot air, it is expected that cold outdoor air during the winter would move through these spaces to the warmer boiler room. Pollutants released into this air (e.g., leaks from the boiler) could then be drawn into the boiler room. The boiler room/pottery room duct junction and the chimney exhaust vent/exterior wall junction are in close proximity, which may serve as a direct pathway for CO to migrate from the boiler room into the return vent in the pottery room and to HV4 in Mechanical Room 2.

The configuration of Mechanical Room 2 may provide a pathway for CO to migrate into the gymnasium. The components for the ventilation system that service the shops (HV4) and the gymnasium (HV2) are located within Mechanical Room 2 (see Blueprint 3). The following conditions may exist that allow for CO to transfer from the HV4 system to the HV2 system:

- Both HV4 (the shop AHU) and HV2 (the gym AHU) share a common fresh air plenum (see Blueprints 4 and 5). According to the blueprint, the draw of air by the HV2 was originally designed to be 7,000 cubic feet per minute (cfm) greater that the total draw of HV4 (see Blueprint 1, "Fan Data, Tot. CFM"). If this disparity in draw of air was greater, it is possible that air may be drawn from HV4 into HV2.

- Both HV2 and HV4 share a common exhaust vent plenum (see Blueprint 5). Each AHU is located a significant distance from the exhaust vent terminus (see Blueprint 5). Air velocity decreases as distance from the propelling source (fan) is increased. Exhaust air for both HV2 and HV4 must travel the length of the Mechanical Room to exit the building through the same exhaust air plenum. The exhaust vent plenum is oriented toward the north. Under certain wind conditions, it is conceivable that exhaust air may be forced back into the exhaust plenum, resulting in CO crossing into the gymnasium system.

In both cases, the presence of CO from the boiler room would be the source of CO within the gymnasium. Blocking the source of CO (the boiler room) is the primary measure that should be taken.

Dorothy Talbot Memorial Rink

The school is connected by a hallway (the ice rink passageway) to the Dorothy Talbot Memorial Rink (Talbot Rink), a city-owned and operated indoor ice arena. Based on the configuration of the doors and hallways, the potential exists for air infiltration from the rink to penetrate into the school. The ice rink passageway was originally configured to have closeable doors at each end to create an air lock effect to prevent ice rink air from penetrating into the school. Examination of the ice rink passageway reveals several pathways by which air from the rink can penetrate the gymnasium and subsequently, the school.

- Air spaces exist in the ice rink door (see Picture 9). A draft of cold air was detected moving from the colder ice rink into the warmer ice rink passageway. Light from the rink can be seen in and around doors and light from the rink can be seen through the electrical box in the cinder block wall.

- A large wooden wall was observed above the ice rink passageway (see Picture 10). Utility pipes pass through this wooden wall. If connected to the rink, it may be a pathway for rink air to migrate into the ice rink passageway.
- The doors separating the ice rink passageway from the school were missing (see Picture 11), which can allow for ice rink air to penetrate into the school.

The refrigerated air of the ice rink, in combination with heated air of the school and gymnasium creates convection currents. These currents move from the rink into the gymnasium through a connecting hallway and into the front hall of the school (see Figure 1).

To resurface ice, rinks use an ice resurfacer and a lawn mower-like machine called an edger. The Talbot Rink acquired an electric ice resurfacer, which would not produce products of combustion regulated by MDPH (e.g., carbon monoxide and nitrogen dioxide) (MacEachern, J.D., 1999). Inspection records also indicate that the Talbot rink has a propane-powered ice resurfacer, which is used as a backup for the electric machine in case of breakdown (MDPH, 2000). This type of ice resurfacer will emit carbon monoxide and/or nitrogen dioxide as part of exhaust gas. The Talbot rink also possesses a gasoline-powered edger (MDPH, 1999), which can emit carbon monoxide and/or nitrogen dioxide as part of exhaust gas. As indicated by ice rink air sampling records recorded by Talbot Rink from 1997 to 1999, CO was measured in every sample (DTR, 1999; DTR, 1998; DTR, 1997). Each of these results, as well as air monitoring conducted by the BEHA ice rink compliance staff during an inspection in 1999 (DTR, 1999), indicate the presence of CO within the rink when the propane-powered ice resurfacer and/or gasoline-powered edger was utilized. If either of these ice resurfacing equipment were used currently, it is possible for these pollutants to migrate from the Talbot Rink to the school via the ice rink passage.

In recognition of indoor air hazards associated with the operation of gasoline or propane powered ice resurfacing equipment the Department of Public Health promulgated regulations requiring air testing for carbon monoxide and nitrogen dioxide. If carbon monoxide levels exceed 30 ppm or nitrogen dioxide levels exceed 0.5 ppm, an ice rink operator must take steps to reduce air concentration below this regulatory standard (MDPH, 1997).

The US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for exposure to carbon monoxide in outdoor air. Carbon monoxide levels in outdoor air must be maintained below 9 ppm over a twenty-four hour period in order to meet this standard. These NAAQS are used by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) as measures for assessing indoor air quality in buildings (BOCA, 1993; ASHRAE, 1989).

In addition, where airflow means of egress are found, water vapor from the rink can also pass into the gymnasium and school. Uncontrolled water vapor can lead to wetting of porous building materials and possible mold growth under certain conditions.

Vehicle Exhaust

The school is built into the side of a hill, where an access road exists at or near the fresh air intake for Mechanical Room 2. In addition, parking is allowed in an area below the mechanical room fresh air intakes. In this configuration and under certain wind conditions, products of combustion from idling vehicles may be entrained by the fresh air intakes. Once entrained, the ventilation system can then serve to distribute vehicle exhaust from idling vehicles into occupied areas of the school. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1986).

Conclusions/Recommendations

A number of possible pathways exist for products of combustion to migrate into occupied areas of the school. These pathways, combined with the symptoms reported by individuals in the gymnasium area, tend to indicate that CO exposure may be the most likely source of symptoms. In order to prevent possible CO exposure, the following recommendations should be considered.

1. Continue to use wall-mounted alarms to monitor CO concentrations in the gymnasium and boiler room. CO levels should be checked daily after the boiler is fired up during the heating season.
2. Continue with plans to repair the chimney/boiler exhausts vent.
3. Seal outdoor penetrations in the boiler exhaust vent pipe.
4. Seal holes in the common wall between the boiler room and classrooms.
5. Consider moving the return vent grill to a position away from the common wall.
6. Examine the feasibility of installing mechanical exhaust fans on each exhaust vent in the Mechanical Room 2 plenum to decrease the possibility of cross contamination of exhaust air.
7. Examine the feasibility of separating the fresh air intake for HV2 and HV4. Remove plywood sheet within the fresh air intake plenum (see Picture 2) to decrease pooling air.
8. Render the Talbot Rink access door from the ice rink passage as airtight as feasible. Remediation steps should include:
   - installing weather stripping on the doorframes;
   - installing a door sweep at the bottom of the ice rink door; and
   - sealing the door frame/wall junction with an appropriate sealing compound.
9. The doors separating the ice rink passage from the school should be reinstalled. All doors should be remediated in the manner listed in recommendation #8.
10. Render the wall shown in Picture 4 airtight.

11. It is unclear whether the back up propane-powered ice resurfacer or gasoline-powered edger is used. If the back up propane-powered ice resurfacer or gasoline-powered edger is used ***at any time***, the operator of the Talbot Rink is obligated to comply with Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. These requirements include air monitoring for CO and nitrogen dioxide; record keeping; and notification of appropriate authorities if minimum air concentrations for CO or nitrogen dioxide are exceeded (MDPH, 1997). Failure to do so is a violation of the state sanitary code and would subject the ice rink operator to penalties denoted in this regulation.

12. Contact Steven Hughes of the BEHA ER/IAQ staff concerning ice rink compliance issues with regard to the operation of the Talbot Rink.

13. In addition to compliance with 105 CMR 675.000, the ice rink operator should also inform the school department if/when either the back up propane-powered ice resurfacer or gasoline-powered edger is used.

14. Post a sign by the upper access road and parking area adjacent to the ice rink passageway instructing vehicle operators to shut down engines in compliance with Massachusetts law. Schedule deliveries after school hours. If no other option, examine the feasibility of relocating parking in these areas.

References

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Blueprint 3

List of AHUs and Locations, Note HV-1, HV-2 and HV-3 are in the same location (Mechanical Room #2)

HEAT & VENTILATING UNIT SCHEDULE

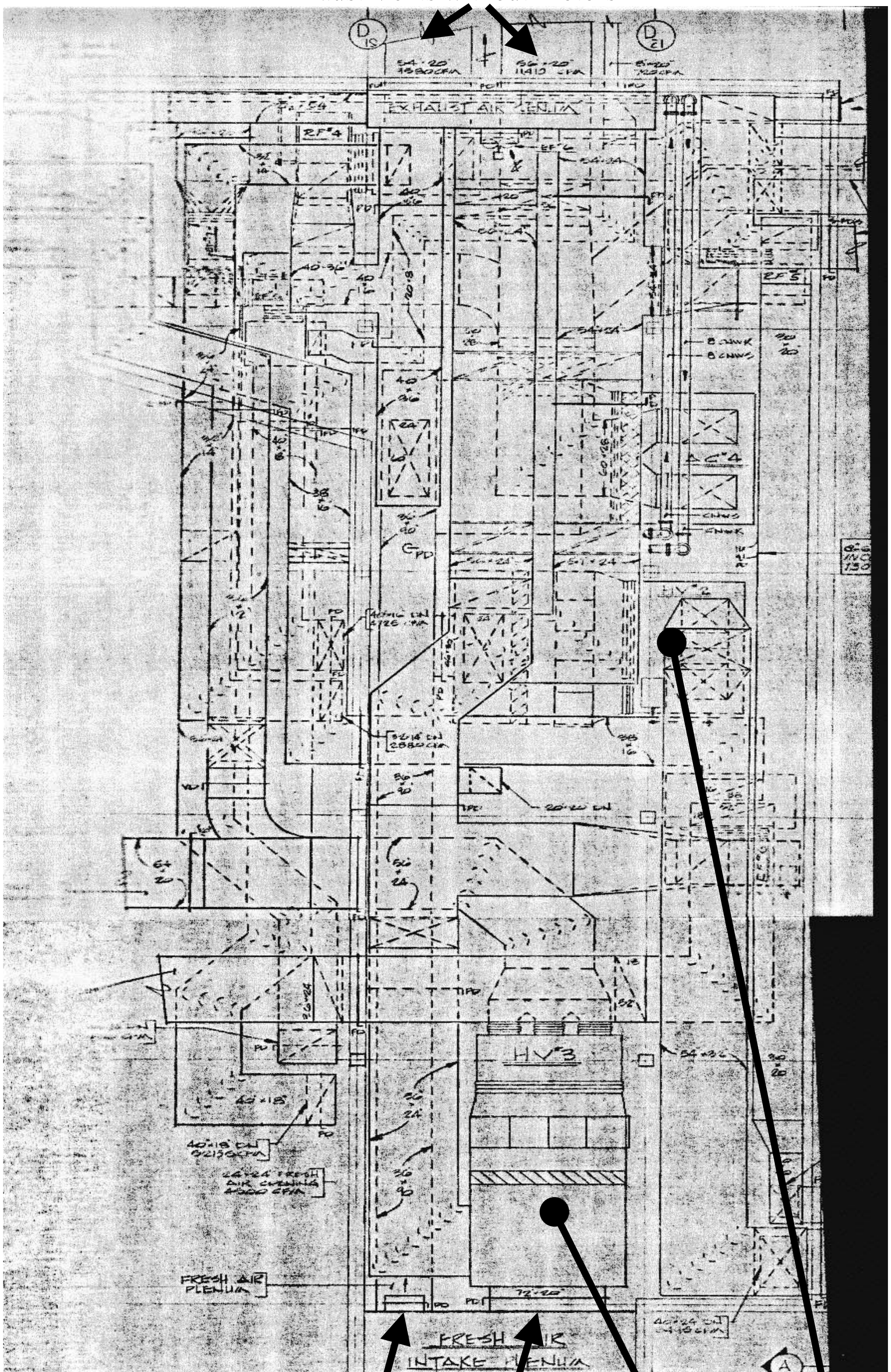
UNIT NO.	FAN DATA					HEATING COIL				HOT WATER			ELECTRICAL INTERLOCKS	SERVICE	LOCATION
	TOT CFM	OA CFM	CV. DIA	ESP	HP	CFM	VEL	ENT	LVG	GPM	ENT	LVG			
HV-1	12550	12550	1420	2"	[illegible]	12550	[illegible]	55	100	[illegible]	240	200	EF#7-#9 RF#11-12	DINING ROOM	DISHWASH CLG.
2	19495	3700	1140	2"	15	—	—	—	—	—	—	—	EF#5 [illegible] RF#3	GYM & SHOWER RM	MECH. ROOM #2
3	13300	6700	1200	1¾	10	—	—	—	—	—	—	—	RF#6	AUDITORIUM	" " "
4	12400	9500	1400	1¾	7½	—	—	—	—	—	—	—	EF#[illegible] RF#7	SHOPS	" " "
5	16000	16000	1740	1½	7½	16000	540	-5	90	825	240	200	EF#3	BOILER ROOM	BOILER ROOM
6	12300	[illegible]	1510	1.60	10	12300	[illegible]	[illegible]	[illegible]	41	240	200	—	ENTRANCE BLDG	UTILITY ROOM

HV #1 MULTI-ZONE UNIT
HV #5 SHALL HAVE FACE & BYPASS DAMPERS
COIL SHALL BE PIPED IN ACCORDANCE TO PREHEAT COIL DETAIL.

Todesco, 1971, Page H-14

Blueprint 5
Mechanical Room 2

Exhaust Vents without Motors



HV4 Location
(beneath HV3)

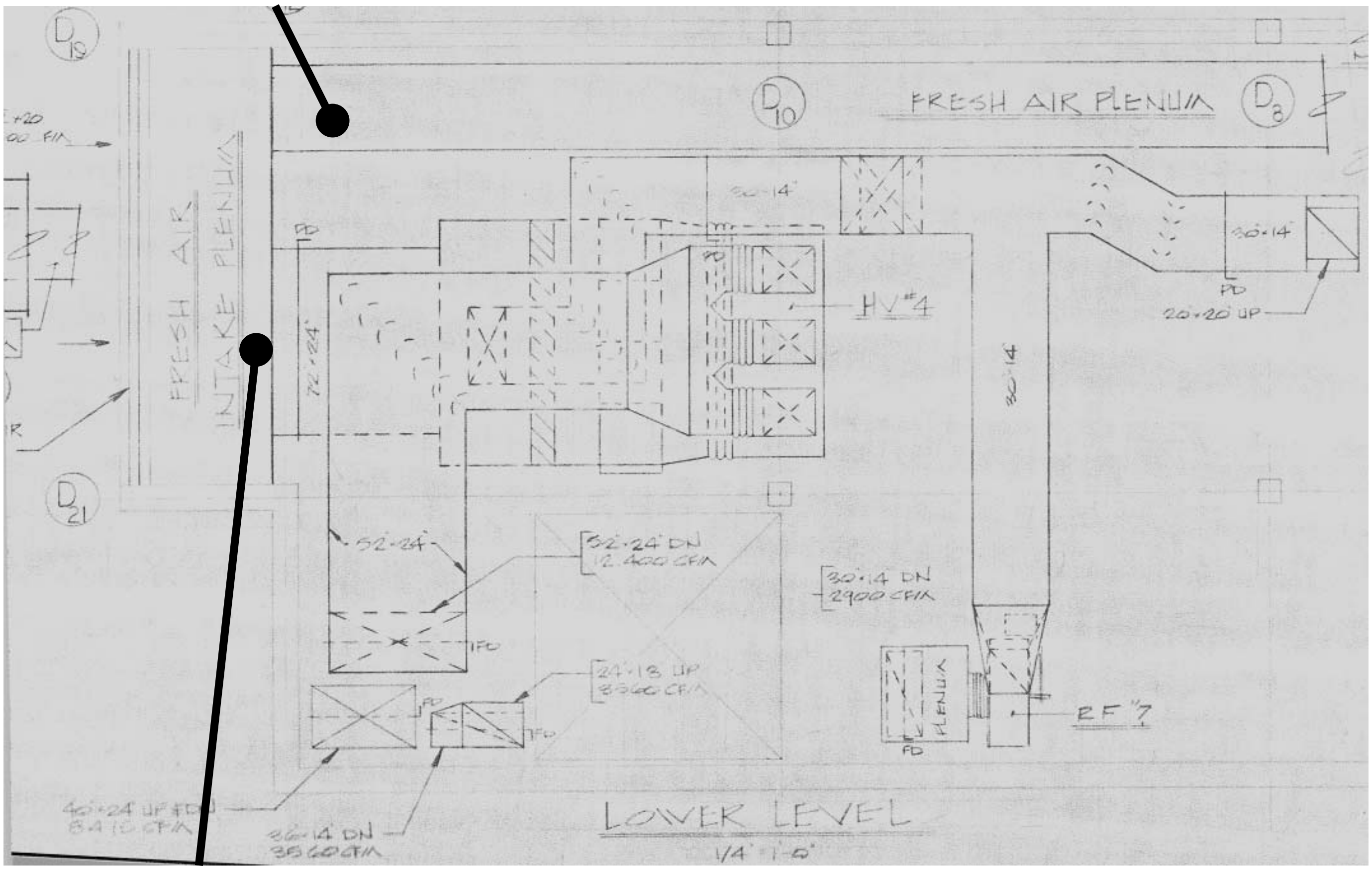
HV2 Location

HV 2 HV 4
Fresh Air Intakes

Todesco, 1971, Page H-13

Blueprint 4
Fresh Air Intake Plenum, Mechanical Room 2

HV2 Fresh Air Intake



HV4 Fresh Air Intake

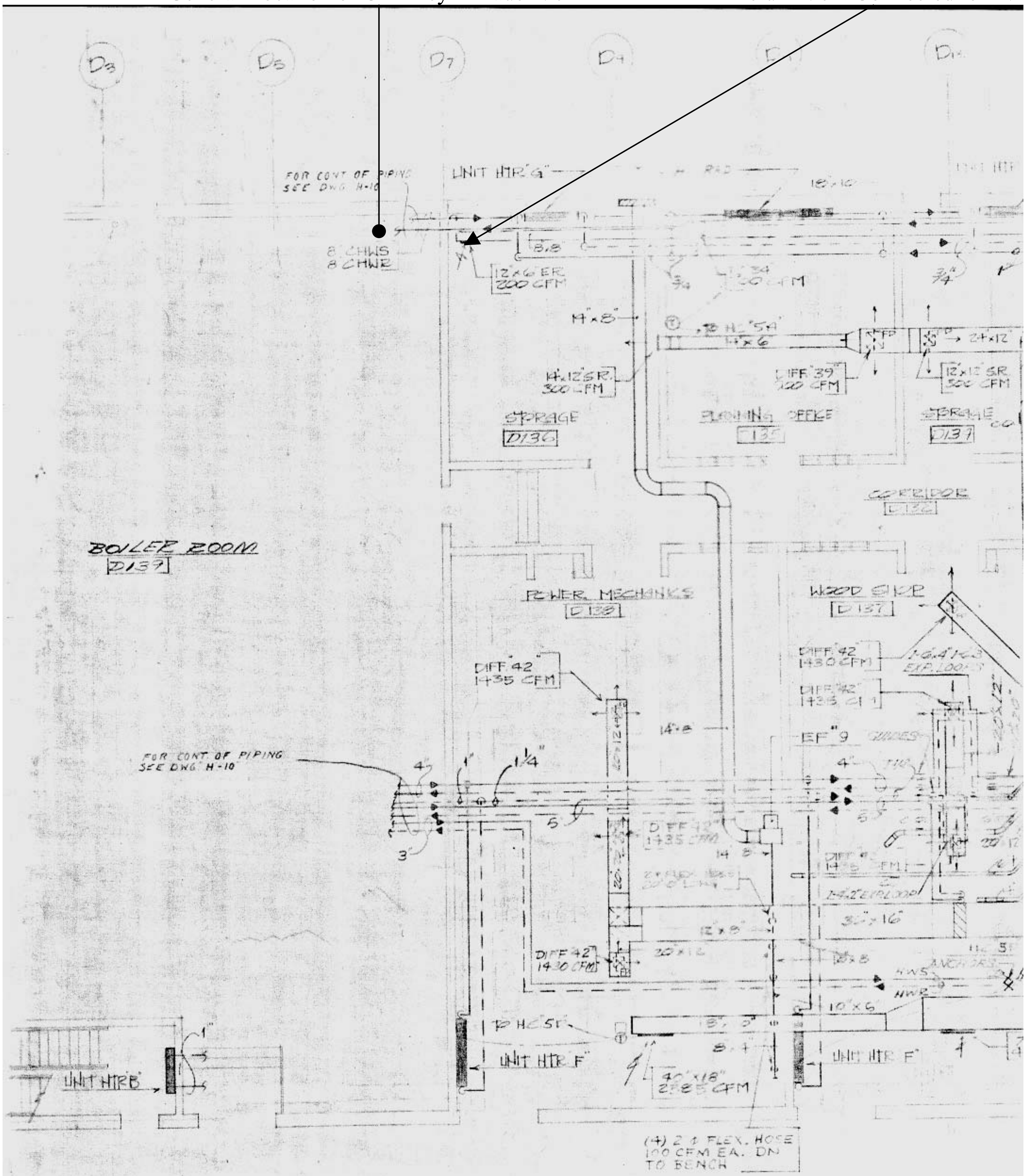
Todesco, 1971, Page H-13

Blueprint 2

Location of Return Vent in Current Pottery Room (Labeled Storage D196) to Boiler Room

General Location of Chimney Exhaust Vent

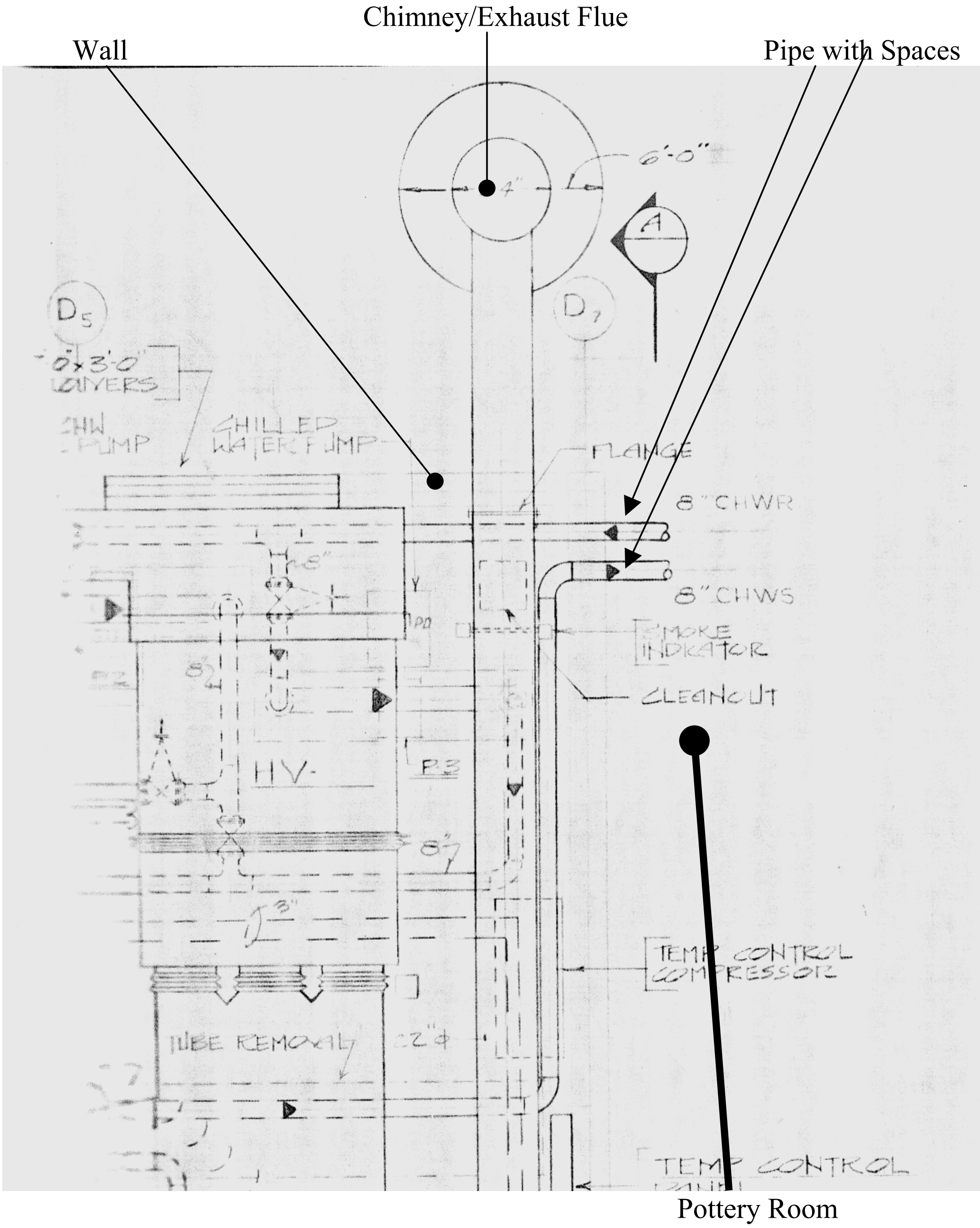
Return Vent Connected to HV4



Todesco, 1971, Page H-7

Blueprint 1

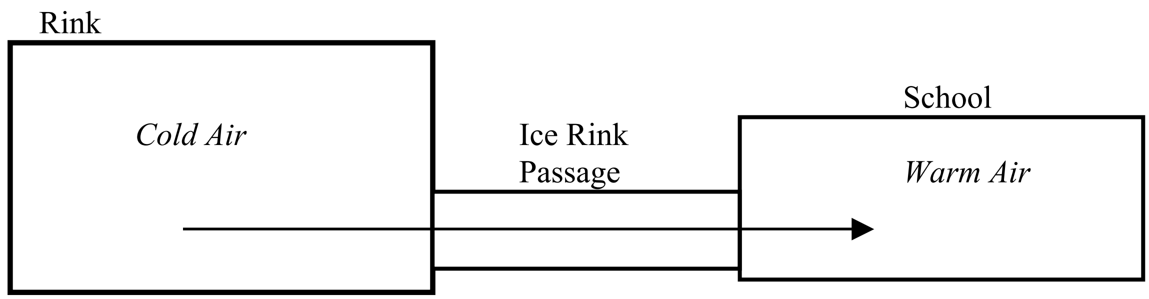
Boiler Room Chimney/Vent Configuration (Match to Blueprint 2)



Todesco, 1971, Page H-10

Figure 1

Convection Currents From the Talbot Rink to the O'Maley Middle School via the Ice Rink Passage



→ Represents convection currents created by temperature differences between the rink and school.
(figure not to scale)

Picture 1

CO Monitor Installed In Gymnasium

Picture 2A

Interior Of Gymnasium Fresh Air Intake (Mechanical Room 2)

Picture 2B

Exterior of Gymnasium Fresh Air Intake

Picture 3

Exhaust Vent/Chimney for the Boiler

Picture 4

Significant Spaces Existed Between the Duct and The Wall and The Boiler Room/Pottery Room Duct Junction, Now Sealed With Fiberglass

Picture 5

Holes In Boiler Exhaust Vent

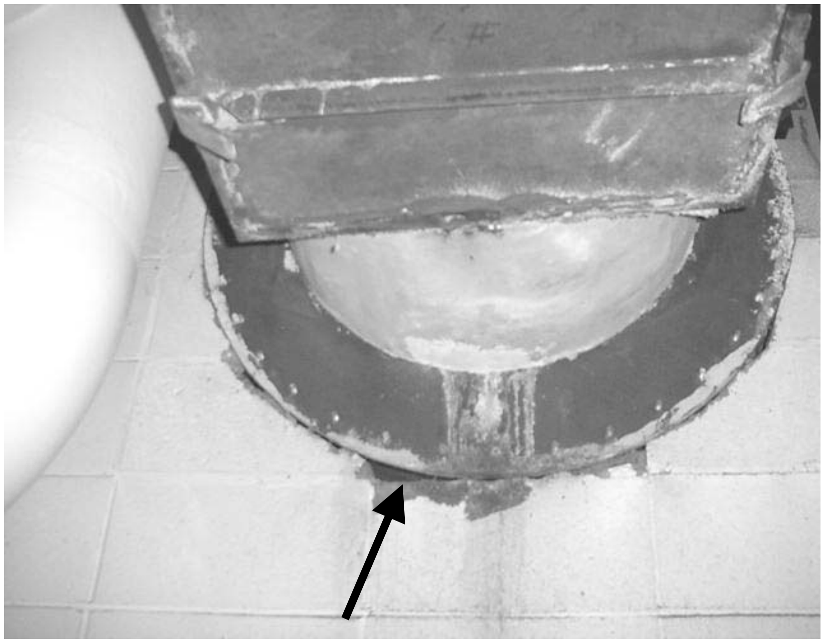
Picture 6

Holes in Boiler Exhaust Vent

Picture 7

Space Around Exhaust Vent, Exterior View

Picture 8



Space Around Exhaust Vent, Boiler Room Interior View

Picture 9

Space In Ice Rink Access Door

Picture 10

Large Wooden Wall and Utility Pipes in Ice Rink Passageway

Picture 11

Missing Door Separating the Ice Rink Passageway Doors from the School