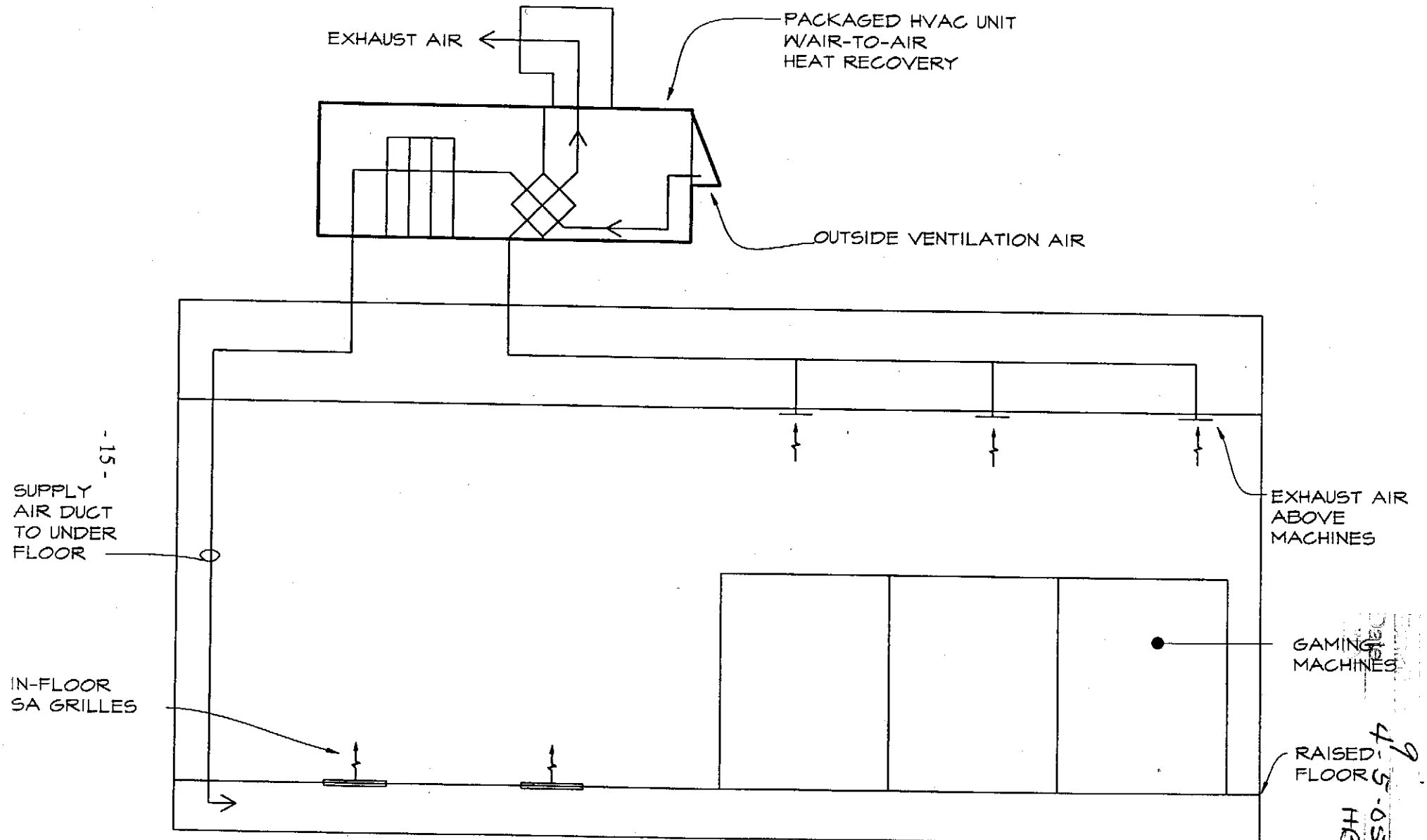

FIGURE 6: NEW CASINO HVAC SCHEMATIC

Add the following new Section:

6.1.3.5 Ventilation in Smoking Areas. Smoking areas shall have more ventilation and/or air cleaning than comparable no-smoking areas. Specific ventilation rate requirements cannot be determined until cognizant authorities determine the concentration of smoke that achieves an acceptable level of risk. Air from smoking areas shall not be recirculated or transferred to no-smoking areas.

Add the following new Informative Appendix:

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process.)

APPENDIX I

GUIDELINES FOR VENTILATION IN SMOKING-PERMITTED AREAS

I-1. DEFINITIONS

acceptable perceived indoor air quality: air in an occupied space toward which a substantial majority of occupants may reasonably be expected to express no dissatisfaction with respect to odor and sensory irritation.

adapted person: person who has occupied a space for a sufficient period of time to become adapted to the odors in a space.[1] Such a person is also referred to as an "occupant."

smoking lounge: an area in which smoking is a primary, rather than incidental, activity of the occupants.

unadapted person: a person entering a space from another area with acceptable perceived indoor air quality whose sensory perception has yet to become desensitized to some air constituents (such as ETS) in the space. Also referred to as a "visitor."

environmental tobacco smoke (ETS): the aged and diluted combination of both side-stream smoke (smoke from the lit end of a cigarette or other tobacco product) and exhaled mainstream smoke (smoke that is exhaled by a smoker).[2] ETS is commonly referred to as second hand smoke.

ETS-free area: an area where no smoking occurs and that is separated from ETS areas according to the requirements in Section 5 of this standard. Thus, a no-smoking area is not necessarily an ETS-free area.

ETS area: spaces where smoking is permitted, as well as those not separated from spaces where smoking is permitted in accord with the requirements in Section 5 of this standard.

I-2. PURPOSE, SCOPE, AND APPLICABILITY

The purpose of this appendix is to present design guidance that can improve perception (satisfaction with respect to odor and sensory irritation) in the presence of ETS. The method in this appendix allows the designer to take into account the rate of smoking, fraction of smokers, and density of occupancy. The guidance presented in this appendix is not intended to replace engineering experience and judgement. Engineering judgement may be used in lieu of the guidance presented in this appendix.

I-3. GENERAL

I-3.1 Directional airflow should be provided in order to achieve good ETS removal effectiveness. For example, supply and transfer air outlets should not be located where smokers are expected, and exhaust and return air inlets should be located where smokers are expected.

I-3.2 Air from ETS areas should not be recirculated or transferred to ETS-free areas. This may be a requirement of the latest version of ASHRAE Standard 62, the building code, or other codes and standards.

I-3.3 All calculations and design assumptions should be documented and provided with the rest of the design documentation.

I-4. EQUATION METHOD

A space where smoking occurs requires more ventilation than the minimum quantity that could achieve acceptable perceived indoor air quality in the same space without smoking. The method described in Sections I-5 to I-7 may be used to determine the extra ventilation. Once the extra air for ETS (V) is determined, it should be added to the ventilation rate for the space without smoking, in accordance with the latest version of ASHRAE Standard 62, to determine the total ventilation.

1 While adaptation to ETS odors may increase over time, the response to the irritant characteristics of ETS may remain the same or even increase.

2 The composition of ETS varies depending on factors including temporal and spatial proximity to the side-stream plume; contact with duct, room, filter, and other adsorption surfaces and the characteristics of those surfaces; and the characteristics of the air into which ETS enters, including its movement, temperature, humidity, and the concentration and distribution of particles. Because of these features, there is no standard distribution of the large number of gaseous and condensed-phase species contained in ETS.

p. 3, 4, & 5 excerpted from ASHRAE ventilation standard.

I-5. CALCULATION OF AIRFLOW

The amount of ventilation air in an ETS area with smoking is equal to the amount in a comparable ETS-free area, plus the amount V determined by the following expression:

$$V = DSD * VA * A / 60*E \quad \text{(I-1a) (IP)}$$

$$V = DSD * VA * A / 3.6*E \quad \text{(I-1b) (SI)}$$

where

V is the recommended extra flow rate of ventilation air required by smoking in cfm [L/s],

DSD is the design smoking density, or the estimated number of cigarettes smoked per hour per unit area in the space,

VA is the volume of ventilation air per cigarette for the room being designed in ft^3/cig [m^3/cig] (see Equation I-2 or Table I-1),

A is the occupiable floor area in ft^2 [m^2], and

E is the contaminant removal effectiveness. For a fully mixed condition, use E=1. For displacement ventilation systems, E may be greater than 1. When supply air "short circuits" to a return, E will be less than 1. (For additional discussion, refer to *2001 Fundamentals*, p. 26.4,[I1] and the spring 2000 edition of ASHRAE's *IAQ Applications*.[I2])

I-6. VENTILATION CRITERIA

I-6.1 Volume of Ventilation Air per Cigarette (VA) for Different Occupants. *VA* is the volume of outdoor or cleaned, recirculated air necessary to dilute ETS so that it is perceived as acceptable. Table I-1 specifies the required extra volume of ventilation air for four occupant types. A cigar may be considered equal to about four cigarettes.

TABLE I-1a
Volume of Ventilation Air per Cigarette (VA) (IP Units)

	Unadapted [ft^3/cig]	Adapted [ft^3/cig]
Nonsmokers (VAns)	5600	3900
Smokers (VAsm)	1400	1100

TABLE I-1b
Volume of Ventilation Air per Cigarette (VA) (SI Units)

	Unadapted [m^3/cig]	Adapted [m^3/cig]
Nonsmokers (VAns)	160	110
Smokers (VAsm)	40	30

Note that the above data are based upon chamber studies from Cain, Leaderer, Isseroff et al.[I3] *using subjects who volunteered to expose themselves to ETS. Some individuals that are involuntarily exposed to ETS may be less likely to find ETS exposure acceptable. It is reasonable to expect that average populations at the time of publication of this appendix will require greater volumes of ventilation air than given in Tables I-1a and I-1b.*

The data above also assume a well-mixed condition. Therefore, the ventilation rates in Tables I-1a and I-1b may not provide acceptable perceived air quality in the proximity of a smoker. The rates also do not take into account the sink and source effects of surfaces.

Subjects in the above studies were in laboratory spaces, focusing only on odors. In many occupied spaces such as bars, restaurants, and casinos, they may be much less sensitive to ETS, and acceptability may result from lower dilution volumes.

These chamber studies were performed on healthy adult volunteers and therefore do not apply to other groups, such as children and those with lung disease.

I-6.2 Volume of Ventilation Air for Mixed Occupancies. The volume of ventilation air may be determined based on acceptability for smokers, nonsmokers, or a mixture, in accordance with the design objectives. If the space is being designed exclusively for smokers or nonsmokers, use the appropriate row of Table I-1. For a mixture of smokers and nonsmokers, the following formula may be used:

$$VA = SM*VAsm + (1-SM)*VAns, \quad \text{(I-2)}$$

where VA is the volume of ventilation air per cigarette in ft^3/cig [m^3/cig] for the room being designed, SM is the proportion of occupants who are smokers, and $VAsm$ and $VAns$ are the respective volumes of ventilation air from Table I-1.

I-7. DESIGN SMOKING DENSITY

I-7.1 Design Smoking Density (DSD). The design smoking density is the estimated number of cigarettes smoked per hour per unit area in the space.

I-7.2 The DSD is the product of the fraction of smokers, rate of smoking, and number of smokers:

$$DSD = SM*SR*EMO/1000 \quad \text{(I-3a) (IP)}$$

$$DSD = SM*SR*EMO/100 \quad \text{(I-3b) (SI)}$$

where

DSD is the design smoking density in cig/h-ft^2 [cig/h-m^2],

SM is the proportion of occupants who are smokers,

SR is the smoking rate of the smokers [cigarettes/smoker-h], and

EMO is the estimated maximum occupancy in persons/1000 ft^2 [persons/100 m^2].

I-7.3 When site-specific information is available for SM, SR, and EMO, it should be used. When it is not, use EMO from Table 2 of the latest edition of Standard 62 and SM and SR from Table I-2.

I-8. SOURCE OF VENTILATION AIR

I-8.1 Extra ventilation air for smoking may be provided by outdoor air, cleaned recirculated air, or a combination of the two. This air may be supplied to the smoking-permitted ETS area indirectly by overventilation of another area with the rec-

cont'd

ommended amount of additional outdoor air and transferring this additional outdoor air from the other area to the smoking-permitted ETS area. While it may be acceptable to use transfer air from another area that is not overventilated, care must be exercised in that the use of poor or marginal quality transfer air may result in decreased acceptance levels, which may be as low as 60% when the transfer air is already fully vitiated. The general aim both in smoking-permitted ETS areas and ETS-free areas is to reach a perceived indoor air quality with an 80% acceptance level. The lower acceptance may be tolerated in smoking lounges and other occupancies due to the short occupancy time and other factors.

Recirculated air from ETS areas may be used, provided the odorants and irritants have been filtered in accord with the provisions of Section I-8.2.

I-8.2 The amount of cleaned, recirculated air that may be counted toward the volume of extra ventilation air required by smoking is given below:

$$Vf = Ef\,Vr \qquad \text{(I-4)}$$

where

Vf is the volume flow rate of qualified cleaned recirculated air in cfm [L/s],

Ef is the demonstrated efficiency for removal of both gas and particulate phase ETS components that impact perceived indoor air quality, and

Vr is the volume flow rate of recirculated air being passed through the filter in cfm [L/s].

TABLE I-2
Range of Parameters in Typical Smoking Occupancies

Occupancy Type	SM [Fraction]	SR [Cig/ Smoker-h]
Smoking Lounges	1.00	3-6
Bars, Cocktail Lounges, Casinos, Lunchrooms	0.25-0.50	1-2
All Others (from U.S. Average)	0.20-0.25	0.6

TABLE I-3a
Sample Calculations Using Equation Method for Determining Recommended Extra Outdoor Ventilation Rates in Smoking-Permitted Areas in Various Facilities (IP Units)

	Proportion of Smokers, SM	Smoking Rate, SR	Outdoor Air Requirements			
			Extra Ventilation Rate		Total Ventilation Rate	
Smoking-Permitted Application		Cigarette/ smoker-h	cfm/person (unadapted)	cfm/person (adapted)	cfm/person (unadapted)	cfm/person (adapted)
Smoking lounge	1	3	--	55	--	70
Heavy smoking lounge	1	6	--	110	--	125
Bar, cocktail lounge	0.25	1	19	13	39	33
Heavy smoking bar, cocktail lounge	0.5	2	--	42	--	62
Dining room 1	0.2	0.6	10	7	30	27
Dining room 2	0.5	0.6	18	13	38	33
Gambling casino 1	0.25	1.5	28	20	48	40
Gambling casino 2	0.2	1.5	24	17	44	37
Conference room	0.2	1.1	17	12	32	27
Game arcade	0.2	1.1	17	12	42	37
Bowling alley (seating area)	0.2	1.5	24	17	49	42
Office	0.2	0.6	10	7	30	27

Note: The base ventilation rate for an ETS-free area comparable to a smoking lounge is 15 cfm/person.

Executive Summary

1. OSHA-ACGIH Ventilation Workshop Summary

A panel of 14 experts on ventilation engineering and ventilation practices in the hospitality industry was charged with determining technically and economically feasible engineering controls for ETS in restaurants, bars, and casinos, assuming that total elimination of ETS was not an option. The panel recognized that there was a lack of information on typical ETS exposure levels in such venues, as well as a lack of recognized standards for acceptable exposure. Panelists concluded that well-mixed dilution ventilation, the overwhelming majority of current installations, was unsatisfactory for controlling worker exposure to ETS in hospitality venues. Local area exhaust ventilation, smokeless ashtrays, air cleaning, and displacement ventilation were identified as potentially more effective. Of these, displacement ventilation was viewed as the most promising, with estimated 90% reductions under the most favorable conditions. These estimates were based on professional judgment rather than on measured data. Moreover, the panel raised several concerns about displacement technology, including lack of familiarity by many ventilation engineers, difficulty with retrofitting existing installations, and potential aesthetic problems.

Ventilated ashtrays as currently available did not appear to be effective, although panelists felt the technology could be made 40% to 50% efficient, provided smokers could be persuaded to use them, a significant potential problem in areas where foreign tourists are frequent customers. These conclusions were professional judgments as opposed to data-based analysis. Although air filters are capable of high capture efficiencies, they also require high airflow to be effective, and needed regular effective maintenance to remain effective. Costs are a major consideration in the restaurant industry, which limits the implementation of high technology solutions such as 100% outside air 1-pass systems. Costs are not a limiting factor in the casino industry for the large casinos, although they are for the small ones. Large fluctuations (e.g., factors of 3) in the smoking population of these venues may occur. A further significant problem is that some building codes do not require that the ventilation system actually be operated, especially in the small non-chain establishments.

In brief, The OSHA/ACGIH workshop concluded that presently available ventilation technology (well-mixed dilution ventilation) was unsatisfactory for controlling worker exposure to ETS. It also concluded that air cleaning was similarly problematic. Of proposed new technology, displacement ventilation was

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Better Odds On Better Breathing

By **Joanna Turpin**

—Posted: 04/30/2004

The Turning Stone Casino Resort in Verona, NY, operated by the Oneida Indian Nation, had a problem with environmental tobacco smoke (ETS). During peak hours as gamblers filled up the gaming floor, a blue haze would cover occupants, and the existing ventilation system didn't do enough to clear the air.

Drastic measures were needed to solve the ETS problem. Interestingly enough, smoking is prohibited in public buildings throughout New York, but visitors to the casino are permitted to smoke, because the facility is located on sovereign land. The Oneida Indian Nation, while wanting to permit smoking, felt strongly about eliminating as much ETS as possible. To achieve that, they were even willing to tear out all the existing mechanical systems in order to improve the air quality within the casino.

And that's just about what happened. A two-phase construction project included demolition of existing mechanical systems and installation of new ones. The first phase of the construction, which was completed in August 2002, consisted of an 80,000-sq-

ft expansion of the gaming room. The second phase, which was completed in January 2003, involved a complete renovation of the existing 70,000-sq-ft of gaming floor.

Now 18 months later, a new underfloor air system has helped eliminate the ETS problem, and patrons (and owners) can breathe easy.

Displacing Traditional Systems

Installing the underfloor air system in the existing gaming area was a challenge because trenches had to be dug in the existing floor slabs in order to accommodate the system.

Prior to the renovation, the casino used seven air cooled chillers and a traditional overhead air distribution system that employed heat recovery. Even with 100% outside air entering the building, a smoke haze continued to fill the casino. Engineering firm Sacks and Associates, (Syracuse, NY) was brought on board to see what it could do to correct the problem with ETS.

Jerry Cowden, an engineer with Sacks and Associates, said, "We put a lot of thought into the best way to get rid of the smoke, and we came up with the displacement air system, or underfloor air system. We supplied the conditioned outside air down low and exhausted it up high."

Cowden said the firm considered other types of air distribution systems as well, including those used in hospital operating rooms. There, air is often supplied in the middle of the room and exhausted low down on the sides. But the engineers didn't think it would be as effective as pushing the smoke up and exhausting it out the top of the building.

As a result of their research, York's FlexSys™ underfloor air system was installed in the expanded gaming room. The VAV boxes in the underfloor air system modulate to meet the needs of a particular space; subsequently, the speed of the heat recovery unit fans changes in order to meet the static pressure requirement in the floor plenum.

Rick Lopez, owner and sales engineer, Pro Air Plus, Inc., (Syracuse, NY) explained that with an underfloor air system, 100% fresh air is introduced at the floor and all the polluted air is exhausted at the ceiling. "If you go into the gaming area right now and watch people sitting at the slot machines with cigarettes in their hands, you can watch the cigarette smoke move directly towards the ceiling and be carried away by the return air system."

Lopez noted that one of the issues they had to be careful about when installing the new underfloor system was air leakage. The raised floor creates a pressurized supply air plenum, so a good seal is needed where the raised floor is connected to the perimeter walls, interior walls, and columns.

"You have to make sure that partitions and columns go all the way to the subfloor. Taking measures to adequately seal penetrations is very important. Otherwise you see things like the fresh air in the pressurized raised floor going up the column and coming out the thermostat, resulting in poor temperature control," said Lopez.

New Air-Handling System Needed

Phase I also included the removal of the casino's air-handling equipment, which contained heat wheels. "The wheels were all getting contaminated from the smoke, so the decision was made to utilize air-to-air plate-type heat exchangers. There's no cross contamination between the two airstreams, so it keeps the heat exchangers clean," said Cowden.

Twenty two brand new, 12,000 cfm, 100% outside air heat recovery units manufactured by Venmar were installed. The units use 95% filters, and a water wash system on the exhaust air cleans all the ETS tar and film from the plate heat exchangers.

The Venmar units are outfitted with cooling coils and hot water coils, along with gas-fired Nortec humidifiers. The humidifiers are necessary, because Syracuse experiences harsh winters, with indoor rh levels down around 20%. With all the fresh air being brought into the casino, humidity must be added back in for occupant comfort.

Installing the new heat recovery equipment was a challenge, because it turned out the units were heavier than anticipated. A helicopter was hired to place the equipment on the roof. However, the units were too heavy, and each unit had to be disassembled into sections, hoisted to the roof by helicopter, then reassembled.

Energy Efficient Changes

The six and 10-year-old air cooled chillers didn't have adequate capacity to cool the new space, so a new 1,000-ton water-cooled York chiller was installed for the addition. The original goal was for the air cooled and water cooled chillers to run together to

meet the expanded needs of the casino. However, in a short period of time, the casino grew from a 3,000-ton connected load to a 6,000-ton connected load.

More capacity will also be needed in the near future, because the casino is in the process of building a 20-story hotel, 300-room lodge, an indoor garden area with waterfalls and plants, and a new showroom. With these new additions scheduled to open by fall 2005, it was decided to abandon the air cooled chillers in favor of a central station chilled water plant.

Pockets of natural gas were also found on the reservation, and a cogeneration plant was subsequently built. The original water cooled York chiller was moved over to the power plant, and two 1,500-ton Trane two-stage absorption chillers were also installed, along with two Trane 1,000-ton centrifugal chillers.

The casino will use the waste steam off the electricity-producing gas turbine for the absorption chillers to produce approximately 3,000 tons of free cooling during the summer months. In the winter, a plate-and-frame heat exchanger will be used for the base load.

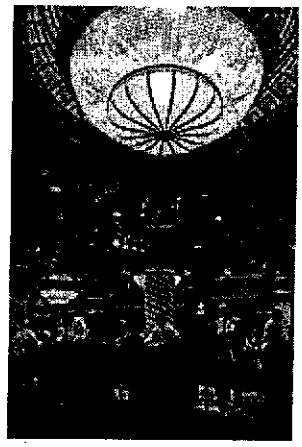
Bill Hollenbeck, senior facilities supervisor, Turning Stone Casino, said that even though it cost a lot to purchase all the new chillers, they're already seeing a big difference in their operating costs. "We get more for our money with the power plant. The air cooled chillers were only 1.3 kW/ton, but the York chiller is 0.3 kW/ton. That's because it's got a 10% turndown on variable speed, so we can run it way down low."

The Venmar units also have VSDs on the supply and exhaust fans, so Hollenbeck can lower the power consumption on all 22 of the units. "We can run a low static pressure on the duct, run the fans down, and get the amperage down. If you look at the whole picture, you can see how much energy we're saving. Say a motor that used to run 70 amps, we can run it under 20 now. The power savings is phenomenal."

Fourteen new high-efficiency, 2,000,000-Btu gas-fired modulating boilers were also installed, along with variable-speed pumping systems for energy conservation. The casino was already using an Alerton BAS, so it was expanded into the addition. The existing BAS was also upgraded for the new chilled water plant, heating plant, and additional renovations.

Renovation a Challenge

Turning Stone Casino added 80,000-sq-ft of gaming area in August 2002. An underfloor air system helped eliminate the smoke that settled over the space in the past.



Once the addition was finished, it was time to turn everyone's attention to the existing gaming space. The entire building was gutted, which made it a little easier to install the new mechanical systems. But there were still challenges.

As Cowden noted, the biggest hurdle during the renovation was to fit all the equipment into an existing space and still be able to get rid of the ETS as effectively as the systems did in the addition. "In the addition we could do whatever we wanted. For example, we could support our equipment on the roof, because it was a brand new building, and we could design the structure to support everything. In the existing building, we had to reinforce the roof and build platforms and that was a big challenge."

It was also challenging to install the underfloor air system in the existing area, because trenches had to be dug in the existing floor slabs to accommodate this system. Hollenbeck said that it also took time to lag in all the floor supports, construct the raised floor, then put in the units. "We had to install access panels carefully, because we only have 32 or 34 in. to do our work in. It was time consuming, but in the long run, it's paying for itself."

Decorative fake columns were installed to distribute the air at floor level. Heavier gauge floor platforms and panels had to be used to allow casino personnel to drive forklifts on the gaming floor to service lighting fixtures and other equipment.

Although the primary purpose of the underfloor plenum was for air distribution, once the space was created, everyone wanted to take advantage of it, said Cowden. As a result, the plenum was also utilized for power, data, and control wiring.

Now that all the work is finished, everyone agrees that the air is much clearer with the underfloor air system in place. "We have floor space sensors that modulate the dampers, and everything's running fine," said Hollenbeck. "I don't know how long the underfloor system has been available, but it's something that's really helped us out considerably." **ES**

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Turpin has been with Business News Publishing since 1991, first heading up the company's technical book division before moving over to write for *Engineered Systems* in 1996. She graduated from the University of Washington and worked on her master's degree in technical communication at Eastern Michigan University. As contributing editor, Turpin writes on a variety of HVACR topics from her sunny location in Phoenix. E-mail her at Joanna Turpin.

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