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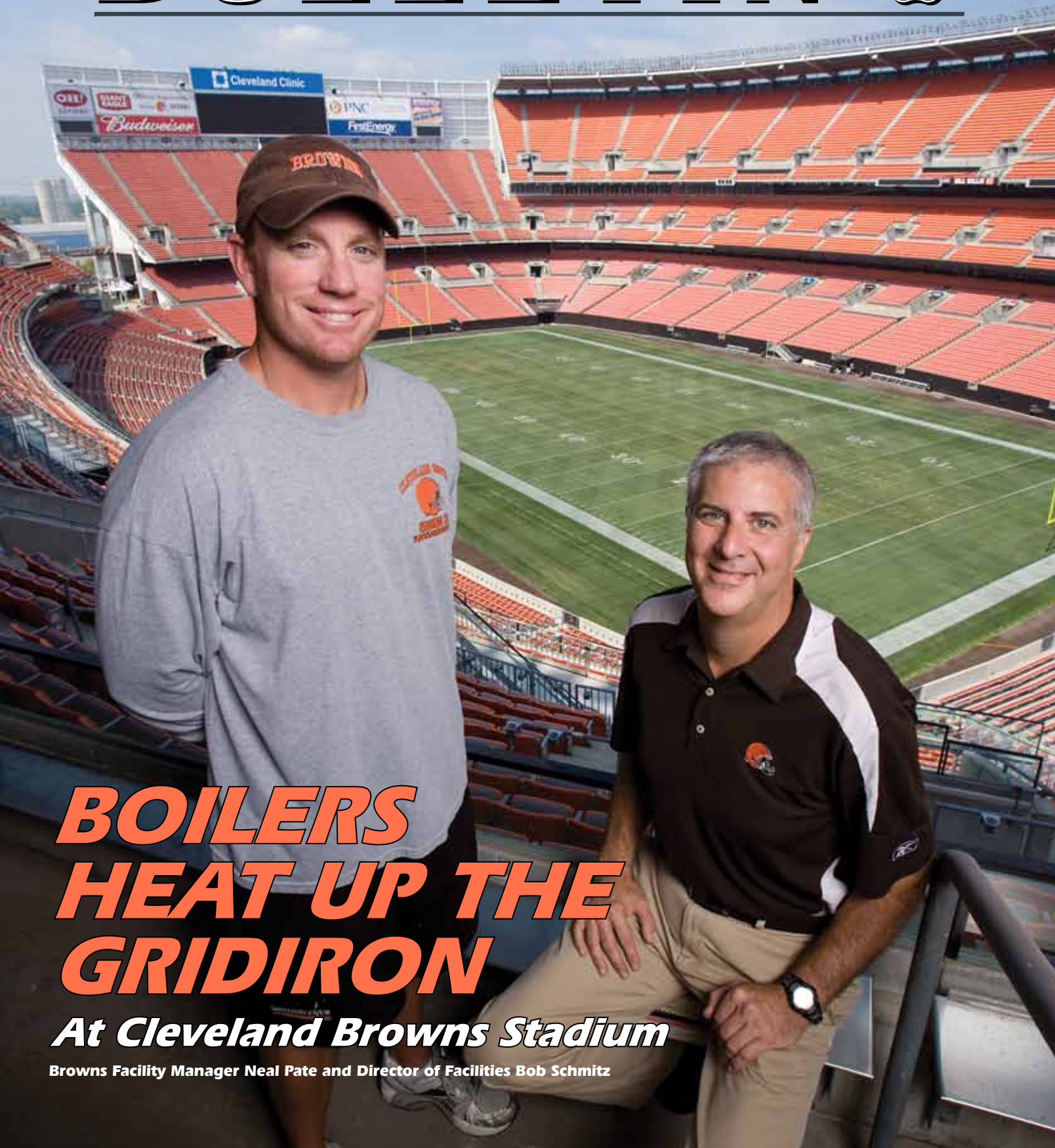


BOILERS HEAT UP THE GRIDIRON

At Cleveland Browns Stadium

Browns Facility Manager Neal Pate and Director of Facilities Bob Schmitz

TURF CONDITIONING SYSTEMS

A Unique Application of Modern Boiler Technology

PHOTOS BY GREG SAILOR & REHAU

Systems like Cleveland's give field managers control over live turf to ensure safe playing conditions year-round.

State-of-the-art turf conditioning systems are installed in over 15 NFL stadiums across the United States. At the heart of the systems are boilers that feed warm fluid through miles of tubing just inches beneath natural playing surfaces. Heat radiates through the soil to keep fields at desired temperatures at the root zone level. This prevents grass from going dormant and extends the growing season.

The goal of natural turf is to provide professional athletes safer and softer playing surfaces. Turf conditioning systems enable stadiums in cold-weather climates to maintain green, healthy fields well into late December and January.

Stadiums in Germany and other European countries began using turf conditioning systems in the 1980s. North American stadiums picked up the trend in the mid-1990s. Cleveland Browns Stadium, then newly constructed, was one of the first in line to install the system.


Courtesy of REHAU

Beneath the Browns' gridiron is 40 miles of 3/4-inch crosslinked polyethylene (PEX) tubing

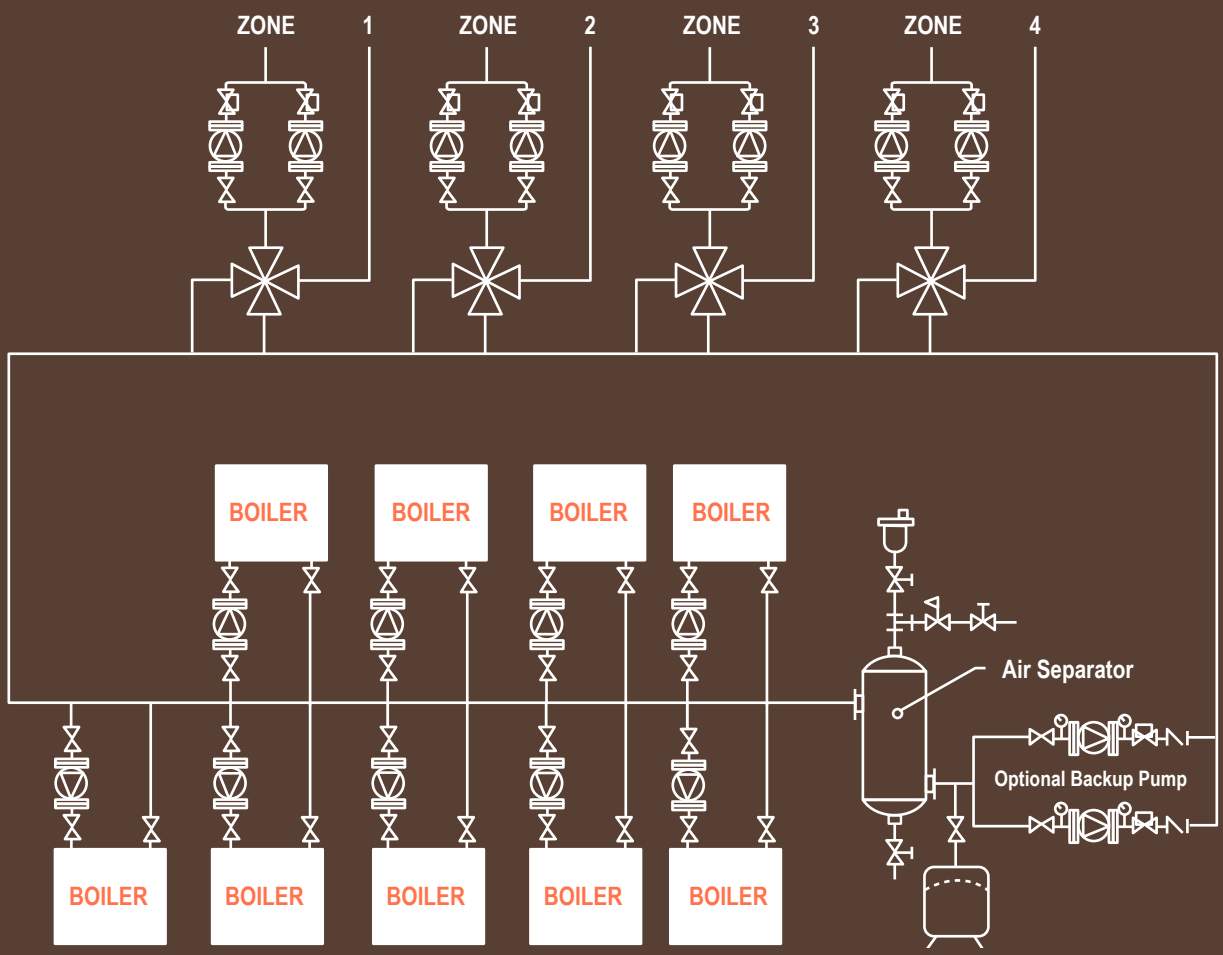
Cleveland Browns Stadium opened its doors in 1999, replacing Cleveland Municipal Stadium, which operated from 1946-1995. In keeping with tradition, the new stadium was built on the same Lake Erie shoreline as its predecessor. The field still runs east to west and the Dawg Pound remains on the east side of the stadium.

If the newly built Browns Stadium was robed in rich tradition, it's certainly crowned with 21st century technology—from architectural "gaps" providing soaring views, specially designed lighting, high-resolution ProStar VideoPlus display boards, and a recently installed phone substation (providing 70,000 guests fast access on their smartphones)—all the way down to the very roots in the soil.

Boilers Behind the Browns

Beneath the Browns' gridiron is 40 miles of 3/4-inch crosslinked polyethylene (PEX) tubing. The tubing is fed by nine boilers through 19 pumps. The system also includes 1,600 feet of supply/return manifold header piping, 2,460 feet of distribution tubing, and an advanced controls system. The 3/4-inch tubing holds about 0.0189 gallons per foot—over 4,000 gallons of fluid (a biodegradable water/propylene glycol solution) fill the tubes under the field.

Piping Schematic



The boiler room is located at field level just inside the tunnel where Browns players enter the field. Nine Ajax Ace B15 Series 'G' boilers dominate the space like ready linemen. Each boiler is rated at 36 BHP and 1,500,000 Btu/hr, has a maximum allowable working pressure (MAWP) of 160 psi, and contains a patented, self-supporting copper fin coil. Safety relief valves are set at 125 psi with a relieving capacity of 1,700,000 Btu/hr.

Jane Terry, president of Ajax Boiler Inc. of Santa Ana, California, explains why this series was the right system for the job. "The customer specified wanting commercial grade boilers with a long-standing reputation for consistent operations and good value over years of service. Our reputation for these boilers is very good—we have a known unit that has been in operation for 47 years now."

Terry's late father, Ed Cancilla, purchased the company in 1967. In 1969 he patented the innovative self-supporting copper cone coil, which solved the problem of sagging coils and extended the life of coils by decades. Currently, Ajax manufactures three brands of boilers used for commercial and industrial applications.

The Ajax boilers were installed in Browns Stadium in 1999 and are still going strong. "One interesting thing Bob Schmitz (director of facilities, Cleveland Browns Stadium) told me is that the boilers are used only part of the year, but they start up like new every time. And that is a good thing," says Terry— a good thing for Ajax and the Browns.

ABOVE: Piping schematic of Browns' boiler system.

RIGHT: Partial shot of boiler area. Note orange inspection stickers and state operating certificates (foreground). The State of Ohio requires an annual inspection.

LEFT: Installation of PEX tubing (white) to main manifold (black) at Browns Stadium.

RIGHT: Close-up look at the manifold. Also shown are the fixing rails.

Photos courtesy of REHAU

ABOVE: Tubing connections to the manifold.

Pure Engineering

The Browns' radiant heating system was designed by REHAU, an international provider of polymer-based innovations and systems in construction, automotive, and industry. REHAU has participated in more than 160 stadium turf heating systems in Europe.

"Cleveland was our first stadium in North America, although we had done different types of turf conditioning (greenhouse applications) prior to that. REHAU Europe has done dozens of German football (soccer) fields and they appear to be the leader in this area," says Bill Johansen, business unit manager, building technology at REHAU's North American headquarters in Leesburg, Virginia. Johansen was directly involved with the Browns' heat transfer system.

"Cleveland Browns Stadium was an interesting business and engineering case for us. We worked with Paul Franks (field contractor), Populous (design group formerly known as HOK Sport Venue Event), and others to come up with a properly engineered system. We got to know the world of sports turf science a little better through the process."

Johansen and staff had several objectives to meet. "We had to understand the exact expectations for the operation of the system, especially desired root zone temperature and under what operating conditions. Also, soil make-up had an enormous impact on performance, and this had to be defined fairly precisely." The Browns' heating system needed to keep the field from freezing but also control grass root zone temperatures. Meeting these objectives hurled Johansen into the competitive and complex realm of turf science.

"We discovered that each type of grass, as well as the type of over-seeding being used, required different design temperatures at either the root zone or grass canopy level," Johansen explains. Adding to the challenge, each sports field designer had a different, often proprietary, soil construction designed to properly protect players, support the type of turf being grown, and ensure proper drainage of fields.

"At that time, the NFL Players Association pushed for natural turf fields. There was a lot of discussion going on about real turf versus artificial. We were just heating engineers and we walked into all of this discussion—the science behind turf growth, liability concerns, and more. It was very interesting for us from an engineering-manufacturing point of view. A bunch of worlds came together—it was pure engineering and a lot of fun!"

Johansen continues. "While the science was quite fascinating, it was also a new area for us. To help, we relied on our own knowledge and engineering experience with heat transfer, but we could also draw upon our collective experience from Europe."

REHAU applied several analytical tools to determine exactly how heat would transfer through the soil and ultimately what root zone temperatures could be achieved under various weather and climatic conditions.

"Working with HOK Sports and the field contractor, we gained an understanding of the soil makeup, the type of grass, and the expectations for temperature at the root zone. Once we had this information, we used an analytical tool called Finite Element Analysis (FEA). This computer tool allowed us to create a 3-D model of the field and to define input "boundary" conditions, such as soil, surface, and tube temperatures; soil thermal conductivity; and operating parameters, such as weather and water conditions; to help evaluate heat transfer and steady state condition within the soil."

The 3-D model also helped Johansen understand how the field would behave given specific data and tube conditions (tube size, depth in the soil, fluid temperature in the tubes, etc.).

"It was interesting to take this data back to the turf specialist, who helped point out how our design would either accommodate their needs or not. For example, in one of our early iterations of the field, we achieved proper root zone temperatures, but our tubes were not located deep enough to accommodate the aerator tines used to condition the turf during the year. This pushed us back to the analytical tool to determine a better design."

A Better Design

The Browns' turf conditioning system is divided into four zones at the 50-yard line going across and down the middle. There are 189 loops per zone and each supply and return circuit is identical in length to ensure even temperature distribution throughout the field. Over 1,500 connectors are located at the manifolds. The fitting system is REHAU's proprietary EVERLOC® system. The fittings are stainless steel and each connection was covered with a specially designed protective barrier.

The system was installed in the following layers: drain tiles, 4 inches of pea gravel, forty miles of PEX tubing (laid sideline to sideline), 10 inches of sand-based root zone, and then the sod.

It took approximately two weeks to install the tubing using two crews of four people. The flexible white tubing was snapped into fixing rails to prevent bending and bowing while also keeping rows straight and even. REHAU provided the tubing and fixing rails and had representatives on hand to oversee the work.

Each zone has four sensors at the 3- to 4-inch soil depth and at the 7- to 8-inch soil depth. "The sensors are simple thermistors that react to temperature with a control wire that runs back to the mechanical room where temperatures are carefully monitored," explains Johansen.

Neal Pate, facility manager at Cleveland Browns Stadium, closely monitors the field. He has cared for it since the system was installed, which he remembers well. "I literally couldn't look at the field because it was so bright," he says, recalling the glare of the white PEX tubing.

Pate explains that if a zone doesn't get enough sunlight, a portion of turf could freeze. (For example, sunlight doesn't reach over part of the stadium's roof in October.) Pate relies on setpoint averages to maintain a healthy lawn.

He inputs a desired field temperature (the setpoint) into the computer system much like setting a home thermostat. Software reads the temperatures at the four 3- to 4-inch soil level sensors, adds them up, and divides by four to get the average actual temperature. It compares the average temperature to the setpoint. In the boiler room, each zone has its own pump. If the average temperature is below the setpoint, the system opens the mixing valve and adds more hot water. Likewise, if the average temperature is above the setpoint, the mixing valve closes to restrict hot water from being added to the system. The desired result? Well-balanced, healthy turf that optimizes player safety and performance.

Three of the four zone piping arrangements with pumps.

Safe Turf, Good Cuts

Players need both agility and stability on the field. That's why turf condition is critical. So critical, in fact, that in 1994 the first NFL Players Playing Surfaces Opinion Survey was conducted. AstroTurf dominated NFL fields and many players believed it was an unsafe surface.

The survey is given biennially at player union meetings in the fall and is completed by nearly 1,400 active players. The last survey in 2008 showed that 84.4% of athletes agreed artificial infilled surfaces were more likely to contribute to injury than natural grass fields. An overwhelming 91% agreed artificial turf caused more soreness and fatigue. Of the 31 NFL teams represented on the survey, 18 teams used grass fields and 13 artificial.

"Beyond anything—beyond the way the field looks—safety is our number one priority," says Pate, glancing at the Browns' field. "I want to make sure our players can get their feet in the turf and make good cuts."

Vibrant green grass looks good to thousands of fans watching from the stands or on TV, but Pate knows field conditions equate to player safety.

"The field gave them what they needed to play the game on Saturday—it gave good cuts," Pate says, referring to the August 7 practice game. Director of Facilities Bob Schmitz agrees. "We want the turf to be soft enough so spikes grab into the ground, but not so soft that they'll slide."

Schmitz says two common ways players sustain injury are directly related to field conditions. "If the field is too hard and a player makes a quick stop, there's a chance his spike won't grab and he can slip. If the grass is too soft and gives way when he stops, there can be injury."

Turf and cleats go hand in hand. "The players have jars of cleats, all different sizes, to choose from. Each player determines how he wants his shoes," says Schmitz. The position of the player, type of field (live or artificial), and even weather determine the type of cleat a player will use. Shorter studs may be used on a hard, dry surface and longer studs on a wet, soppier field. In any given game, a player could have five or six different pairs of shoes available.

Longtime kicker Phil Dawson offers the most feedback about field conditions. "He's the only player who's been here for every season since the new stadium was built in 1999. We've gotten to know him pretty well. And kickers have their routines—footing is extremely important to them," Pate shares. "But if we don't hear anything from players and the front office, it's good."

Systems like Cleveland's give field managers control over live turf to ensure safe, year-round training and playing conditions. Pate and Schmitz can't control the weather or the type of cleats players will use, but they do everything they can to provide an optimal playing field for the Browns and visiting teams.

Field Goals

The Browns' field is a Kentucky bluegrass irrigated field with a sand soil root. "The bluegrass is durable and stays green, but it doesn't grow very fast," says Schmitz, "so we supplement it with ryegrass."

Pate nods. "We constantly seed the field with ryegrass after each game. It's used as a supplement to add density to the bluegrass and fill in any thin areas on the field," he explains. Pate re-sods patches of turf on an as-needed basis. The section between the hash marks and goal lines is replaced mid-season.

According to Pate, after a Sunday game the field looks "beaten up" until about Wednesday. That's when new grass begins to spring up. "The bluegrass doesn't like this heat. This has been the longest recovery we've had in quite a while," he says, referring to sweltering August heat combined with wear and tear from the recent practice game.

The Browns' turf conditioning system is used only a couple of months each year. The fluid stays in the system year-round and doesn't need to be drained. "I may kick on the boilers in March and slowly bring up the soil temperature to jump-start the grass out of dormancy," says Pate. "I like to get a start over everyone else," he smiles.

Pate and crew must adapt to a changing climate in order to keep the field healthy and resilient year-round, but especially in frigid conditions. "The system tricks grass into thinking it's nicer weather during cold months," Pate says. "It also helps keep the field from freezing."

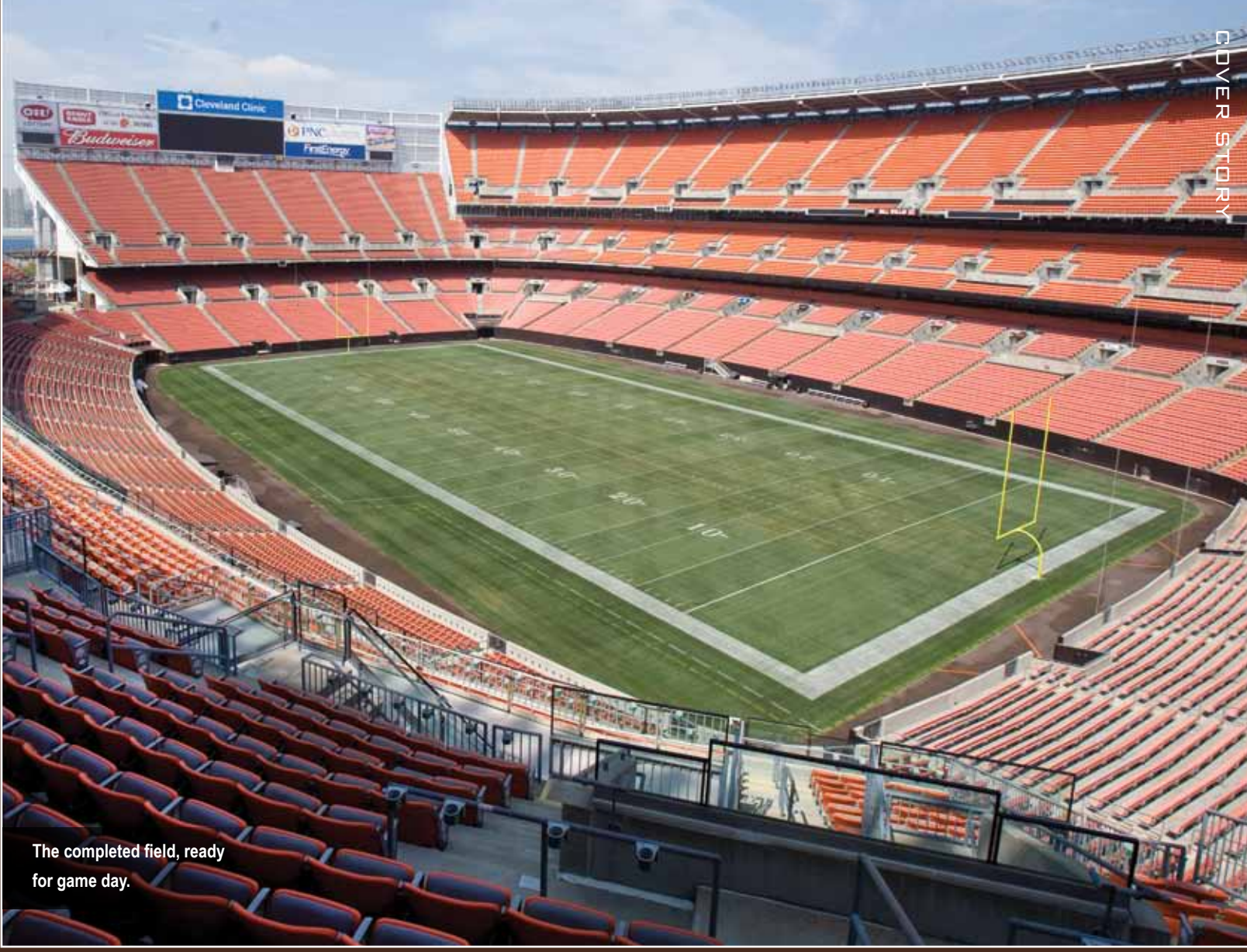
Anytime it rains or snows three to four days before a game, tarps are pulled out across the field. But tarps can also pull moisture out of the ground. On extremely cold mornings this can pose a problem. "There have been mornings when we've pulled back the tarps and the field looks like it's covered in snow," he says.

"Sometimes people wonder why there is still snow on the field (during a snowy game day) but they don't understand all that goes into finding the right balance. Players need to get their cleats into the field," Pate adds. "They would rather play in snow than in mud. They can get better footing and balance."

Turf can't be too soft or too hard, and maintaining that balance from week to week is both science and art. Johansen agrees. "A lot of science goes into running a field."

With over 40 miles of tubing buried beneath the field, detecting problems (such as leaks) is tricky. Pate can measure fluid levels with the sensor system and narrow a problem down to a specific zone, but pinpointing the exact location is a matter of good guesswork—and digging. Tubing is accessed only by stripping back the sod and digging through 10 inches of root zone soil.

A leak was detected after the first season in the new stadium. "We tried many ways to locate it. We narrowed it



The completed field, ready for game day.

down to a few areas and literally dug along until we found it. Luckily we haven't had any leaks since then," says Pate.

Browns Stadium is multi-functional and hosts other sporting events (such as international soccer), concerts, and more. The field is able to bear the loads of forklifts and cranes for venue setup. Fifty-ton cranes, two at a time, put down pressed plastic flooring for protection. Another reason turf conditioning systems are preferred is they promote faster grass resilience after the wear and tear of hosting large-scale events.

Final Score

"If a cow cannot eat it, we shouldn't be playing on it," remarked one athlete on the 2008 NFL Players Playing Surfaces Opinion Survey.

Players want and prefer the benefits of natural turf, but maintaining a suitable and safe gridiron for professional athletes is a bit more challenging than opening up pasture for grazing cattle. Professional playing fields endure hit after heavy hit year-round. Cleveland's field sustains such action as the Browns clawing out victory, frigid lake-effect conditions, and the wear of hundreds of concert-goers rushing a stage.

No matter the occasion, the on-field action may not be as important as what is beneath it.

Turf conditioning systems are a unique application of modern boiler technology. Without them, grass could not repair itself after heavy traffic nor withstand year-round usage. Players would likely sustain more injuries and professional football would not be what it is today.

As technology in turf conditioning progresses, Johansen believes advances in turf/soil engineering and in drainage of fields will lead the way. Pate says "stitching" procedures, a process whereby a machine stitches threads of artificial field material into the ground for added stability, is another option some stadiums use to obtain ideal playing surfaces.

Either way, natural playing fields are here to stay and rely upon the science of heat transfer systems fed by robust boilers—and the expertise of dedicated staff who maintain the turf in support of a safe and winning season.