

1099

United States Department of the Interior
National Park Service
National Register of Historic Places Registration Form



1. Name of Property

Historic Name: The Astrodome
Other name/site number: Houston Astrodome
Name of related multiple property listing: NA

2. Location

Street & number: 8400 Kirby Drive
City or town: Houston State: Texas County: Harris
Not for publication: Vicinity:

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended, I hereby certify that this nomination request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property meets does not meet the National Register criteria.

I recommend that this property be considered significant at the following levels of significance:
 national statewide local

Applicable National Register Criteria: A B C D

Mark Wolfe State Historic Preservation Officer Date 11/26/13
Signature of certifying official / Title
Texas Historical Commission
State or Federal agency / bureau or Tribal Government

In my opinion, the property meets does not meet the National Register criteria.
Signature of commenting or other official Date
State or Federal agency / bureau or Tribal Government

4. National Park Service Certification

I hereby certify that the property is:
 entered in the National Register
 determined eligible for the National Register
 determined not eligible for the National Register.
 removed from the National Register
 other, explain: _____

[Signature]
Signature of the Keeper

1/15/2014
Date of Action

The Astrodome, Houston, Harris County, Texas

5. Classification

Ownership of Property

	Private
X	Public - Local
	Public - State
	Public - Federal

Category of Property

X	building(s)
	district
	site
	structure
	object

Number of Resources within Property

Contributing	Noncontributing	
1	0	buildings
0	0	sites
0	0	structures
0	0	objects
1	0	total

Number of contributing resources previously listed in the National Register:

6. Function or Use

Historic Functions: Recreation and Culture: Sports Facility (stadium)
 Other: Livestock Show and Rodeo Facility (arena)

Current Functions: Vacant / Not in Use

7. Description

Architectural Classification: Other: Domed Stadium

Principal Exterior Materials: Concrete, Steel, Plastic

Narrative Description (see continuation sheets 7-6 through 7-11)

Property Name, City, County, Texas

8. Statement of Significance

Applicable National Register Criteria

<input checked="" type="checkbox"/>	A	Property is associated with events that have made a significant contribution to the broad patterns of our history.
<input type="checkbox"/>	B	Property is associated with the lives of persons significant in our past.
<input checked="" type="checkbox"/>	C	Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.
<input type="checkbox"/>	D	Property has yielded, or is likely to yield information important in prehistory or history.

Criteria Considerations: G

Areas of Significance: Architecture, Engineering, Entertainment & Recreation

Period of Significance: 1965-2000

Significant Dates: 1965

Significant Person (only if criterion b is marked): NA

Cultural Affiliation (only if criterion d is marked): NA

Architect/Builder: Lloyd & Morgan, associated w/ Wilson, Morris, Crane & Anderson); Walter P. Moore & Associates, Roof Structures Inc., Praeger, Kavanagh & Waterbury, Dr. Henri Marcus, Dr. Z.S. Makowski

Narrative Statement of Significance (see continuation sheets 8-12 through 8-19)

9. Major Bibliographic References

Bibliography (see continuation sheets 9-20 through 9-22)

Previous documentation on file (NPS):

- preliminary determination of individual listing (36 CFR 67) has been requested. (Approved March 24, 2006)
- previously listed in the National Register
- previously determined eligible by the National Register
- designated a National Historic Landmark
- recorded by Historic American Buildings Survey #
- recorded by Historic American Engineering Record # TX-108

Primary location of additional data:

- State historic preservation office (*Texas Historical Commission, Austin*)
- Other state agency
- Federal agency
- Local government
- University
- Other -- Specify Repository:

Historic Resources Survey Number (if assigned): NA

Property Name, City, County, Texas

10. Geographical Data

Acreage of Property: Approximately 23.5 acres

Coordinates Latitude/Longitude Coordinates

Datum if other than WGS84: NA

1. Latitude: 29.686339° Longitude: -95.409323°
2. Latitude: 29.686326° Longitude: -95.407024°
3. Latitude: 29.685675° Longitude: -95.406350°
4. Latitude: 29.684863° Longitude: -95.406091°
5. Latitude: 29.683874° Longitude: -95.406531°
6. Latitude: 29.683394° Longitude: -95.407770°
7. Latitude: 29.683234° Longitude: -95.409197°

Verbal Boundary Description: The nominated parcel includes the Astrodome and its immediate surroundings, bounded on the north by Reliant parkway, bounded on the east and south by a circular driveway, and bounded on the west by a north-south oriented driveway separating the Astrodome parcel from the Reliant Stadium parcel. The boundary is illustrated on the accompanying map with seven pairs of latitude & longitude coordinates.

Boundary Justification: The boundary includes all the property historically associated with the Astrodome, with the exception of adjacent parking lots.

11. Form Prepared By

NAME/TITLE: Ted Powell (with assistance from THC staff); adapted with permission from a 2006 Historic Preservation Tax Credit Application (Parts 1 and 2) by MacRostie Historic Advisors LLC., Washington DC.

ORGANIZATION: NA

DATE: April 15, 2013

STREET & NUMBER: 1700 Roscoe Street

TELEPHONE: 281-799-2920

CITY OR TOWN: La Porte

STATE: Texas

ZIP CODE: 77571

Additional Documentation

Maps (see continuation sheet Map-23 through Map-25)

Additional items (see continuation sheets Figure-26 through Figure-36 and Plans-37 through Plans-41)

The Astrodome, Houston, Harris County, Texas

Photographs

The Astrodome
Houston, Harris County Texas
Photographed by MacRostie Historic Advisors in 2005 and 2006.
Digital files at the Texas Historical Commission

These photographs are submitted due to lack of access to the interior of the building by the current applicants during the preparation of the nomination, but they generally reflect the current condition of the building, especially the volume contained by the dome. The seats are in the process of being removed.

Photo 1
Aerial, looking northeast towards downtown Houston. Astrodome at right, adjacent to the 2002 reliant stadium.
July 2005

Photo 2
Northwest elevation
Camera facing southeast
July 2005

Photo 3
West elevation
Camera facing east
July 2005

Photo 4
Southwest tower
Camera facing southeast
July 2005

Photo 5
West elevation detail with metal screen panels
Camera facing east
July 2005

Photo 6
Interior photograph from level one, facing west from east entrance to playing field
May 2006

Photo 7
Interior photograph from level seven, facing southeast towards northeast seating area
July 2005

Photo 8
Interior photograph from level seven at south side, facing east
July 2005

The Astrodome, Houston, Harris County, Texas

Photo 9
Interior photograph from level two at southwest side, facing northeast
May 2006

Photo 10
Interior photograph from level two at southeast side, facing north
May 2006

Photo 11
Interior photograph from level one at north side, facing southwest
May 2006

Photo 12
Interior photograph from playing field, facing southwest
May 2006

Photo 13
Interior photograph from northeast side, facing northwest
May 2006

Photo 14
Interior photograph from north side of playing field, facing southeast
May 2006

Photo 15
Interior photograph from east side of playing field, facing west
May 2006

Photo 16
Interior photograph facing west down east entry to playing field
May 2006

Photo 17
Level One, Inner Concourse, facing west
May 2006

Paperwork Reduction Act Statement: This information is being collected for applications to the National Register of Historic Places to nominate properties for listing or determine eligibility for listing, to list properties, and to amend existing listings. Response to this request is required to obtain a benefit in accordance with the National Historic Preservation Act, as amended (16 U.S.C.460 et seq.).

Estimated Burden Statement: Public reporting burden for this form is estimated to average 100 hours per response including time for reviewing instructions, gathering and maintaining data, and completing and reviewing the form. Direct comments regarding this burden estimate or any aspect of this form to the Office of Planning and Performance Management, U.S. Dept. of the Interior, 1849 C. Street, NW, Washington, DC.

The Astrodome, Houston, Harris County, Texas

Narrative Description

The 1965 Astrodome, approximately six miles southwest of downtown Houston, Texas, is a domed circular concrete and steel framed building, featuring a steel Lamella truss roof structure capped with 4,596 skylights of clear Lucite plastic. Encompassing an area of over nine acres, the Astrodome was the first permanently-enclosed multi-purpose stadium in the United States. Featuring an outer diameter of 710 feet and a clear span of 642 feet, the Astrodome, at the time of its construction, was touted as, "the largest clear-span building ever constructed."¹ The playing or event field is a concrete surface that provided space (208,000 ft² or 4.8 acres) for football and baseball playing fields on artificial turf, and was also reconfigured as necessary to host concerts, rodeos, conventions, and other events. The Astrodome has not been used for major events since 2002, but served as a temporary home to victims of Hurricane Katrina in 2005. Since that time, the Astrodome has sat vacant, but it nevertheless retains a high degree of integrity.

The Astrodome parcel encompasses approximately 23.5 acres in the center of Reliant Park (formerly Astrodomain Complex), a multi-purpose public event and entertainment facility. Reliant Park encompasses approximately 350 acres, and is bounded by Kirby Drive to the west, South Loop Interstate 610 to the south, Fannin Street to the east and La Concha to the north. The Astrodome is in the center of the park, immediately east of Reliant Stadium (2002), a retractable-roof professional football, rodeo and multi-purpose event stadium with a seating capacity of 69,500. North and east of the Astrodome is Reliant Center (2002), a 1.4 million square foot convention center, featuring over 700,000 square feet of single-level, contiguous exhibition space. To the south and east of the Astrodome is Reliant Arena (1974, formerly known as the Astroarena), a multi-purpose arena featuring 250,000 square feet of exhibit space and an 8,000 seating capacity arena. In 2002 the fifth building in the complex, originally known as Astrohall and temporarily renamed Reliant Hall, was demolished in order to provide for additional Reliant Stadium parking facilities. The remaining area within Reliant Park is reserved for parking and access roads, with space for approximately 26,000 cars, including additional lots available on the west side of Kirby Drive.

Structure

The Astrodome is a domed circular concrete and steel framed building featuring a lamella truss roof. Encompassing an area of over nine acres, the building has an outer diameter of 710 feet with a clear span of 642 feet. The roof rises to a height of 208 feet at its peak, while the floor rests at 25 feet below grade. Despite its magnificent size, the dome is relatively shallow; the outer perimeter wall houses its tension ring and the interior of the dome stands at 202 feet tall. The key to the structure is the tension ring, which is a 376-ton, continuous band of steel, encircling the stadium and resting on 72 steel columns, each of which is capable of supporting 220,000 pounds or a total of 8,000 tons. The Astrodome was designed in skewed framing and rests on articulated joints consisting of two sets of bearings to allow for movement without stressing the lower structure. At eight points, columns rest on strap footings located 11 feet below the playing surface. The columns are semi-rigid and can move radially. The footings are T-shaped, with the stem approximately 50 feet long and the bar approximately 70 feet long. The footings are 10 feet deep and eight feet wide. The structural system permits the Astrodome to expand and contract and was necessary to allow for temperature changes because steel shrinks in cold weather and expands in warm weather. The design allows for the Astrodome to move five and a half inches in either direction and to withstand wind gusts of up to 165 miles per hour or sustained winds of 130 miles per hour.¹

The roof consists of three parts: a deck around the outside edge that is made of three-inch-thick wood-fiber-concrete boards, both acoustically corrected and water resistant; the steel trusses that hold up the Lucite panels; and the Lucite panels. The roof is made of 9,000 tons of high-strength carbon steel and U.S. Steel Corporation Tri-Ten Steel (A-441) lamella trusses that are five-feet deep. The roof is covered with 4,596 Lucite panels are approximately five and a half inches thick, sealed to the roof with Neoprene (synthetic rubber by DuPont Chemicals) rubber strips and set in 44x84-inch

¹ "Inside the Astrodome (Souvenir Program)," (Houston Sports Association. Inc.: Houston), 1965.

The Astrodome, Houston, Harris County, Texas

aluminum frames. The pattern of the skylights was chosen to accomplish both the acoustical needs of the structure and to provide for the admission of light to approximately 50% of the playing field below. The skylights cover roughly 50% of the dome's upper portion. The panels or skylights feature built-in prisms to diffuse the light and prevent shadows.²

Exterior

The spherical structure was built in a futuristic style in homage to the arrival of the 'Space Age' in Houston, with its roof a "curving, blister bubble."³ The exterior circular perimeter of the Astrodome is wrapped in decorative concrete lattice or grillwork. (The east side latticework was added during 1988-89 alterations). The symmetrical grillwork is interrupted by twelve overflow scuppers (3 x 18 inches), evenly spaced around the upper level of the latticework. Public entrances into the stadium are evenly spaced along the perimeter at the north, west, and south sides. Three huge concrete ramps at 8% grade and 100 feet wide allow entry into the stadium at these locations. Two 40-foot wide ramps are located on the east side, also at 8% grade. The southwest service area features a dock level entry. The electrical sub-station and cooling towers are also located on the east side of the stadium. Detached small concrete ticket booths are located on the ramps in front of each of the west, north and south elevations.

At the time of completion, 28 flags and pennants were flown along the exterior perimeter of the Astrodome. Flagpoles extend from the top of the pylons or concrete latticework structural members at the ninth level elevation. A total of 54 ticket windows are located along the exterior of the stadium. The electrical sub-station is located on the east side of the stadium. On top of the dome rests a 'weather station' that provides wind direction, velocity, outside air dry-bulb and wet-bulb temperatures as well as sun-load information. A traffic observation platform was also provided at this location and used to direct traffic approaching the stadium.

Interior

The Astrodome encloses a vast column-free stadium space. General seating is arranged on six levels for over 75,000 (66,000 at time of completion) and surrounds the center playing field, with patrons entering the stadium at mid-level via the north, south or west entrances and proceeding up or down to their seating level on wide, low-gradient ramps, or via escalators or elevators. There are six ramps inside the stadium at 16 feet wide, extending from the first to seventh levels at the north, south and west entrances. Two 8-foot ramps are also located in the left center and the right center to service general admission and pavilion areas on levels one through four. Escalators are located at the north and south entrances on the third and first base sides. These serve all seven levels. The stadium also features six elevators for patrons and two for personnel and teams.⁴ The entire surface of the interior stadium walls have been sprayed with acoustical plastic to one inch thick to assist in the absorption of sound.

Seating levels one through seven (field level, mezzanine, pavilion, club, loge, upper, and skybox) are distinguished by the seat's cushion colorings, ranging from red to blue. At the time of completion, seating capacity ranged between approximately 44,000 seats and 66,000, depending on the event. At the top or skybox level the Astrodome featured 53 luxury skyboxes with seats ranging from 30 to 54 in each. Each skybox featured access to a private club room with amenities such as telephone, radio, television, bar, and furniture. Each club room was decorated in a different motif including styles such as "Spanish Provano, Roman Holiday, Bangkok, Las Vegas, and Old English" to name a few. Skybox holders also had access to the skybox level club room called the "Skybox Dome" which was a glass-enclosed room with a view of Houston. The lower stadium levels also feature concession stands and restrooms. The Astrodome

² Edgar, Ray W. "The Grand Huckster: Houston's Judge Roy Hofheinz, genius of the Astrodome," (Memphis: Memphis State University, 1980), 297. See also HSA, pp. 23-26: 30.

³ "Inside the Astrodome," 8.

⁴ "Inside the Astrodome," 85.

The Astrodome, Houston, Harris County, Texas

originally boasted a total of five separate restaurants (including the Skybox Dome and a second private restaurant for season-ticket holders) and 49 concession stands. The mezzanine level was originally equipped with 53 spaces for wheelchairs, 30 spaces for the visually-impaired, and a four-room first aid area.⁵

The club level features two press boxes (one for baseball, one for football) with seats for 58 and two auxiliary press boxes for an additional 58 journalists. Members of the press were supplied with a dining room, workroom, lockers, interview rooms and six photography darkrooms. Because the stadium is enclosed, the Astrodome was once boasted to hold, "the world's largest room air conditioner."⁶ In order to keep the interior at a steady 74° (plus or minus two degrees) when events are being held, four centrifugal refrigeration machines supply 6,600 tons of cooling capacity from air ducts located throughout the interior. Housed in the Control Center on the first floor behind center field, the system was built to circulate 2,500,000 cubic feet of air per minute.

The centerfield entrance features a nine-ton steel rolling door (44 feet wide and 24 feet high) to provide for mammoth event equipment. The playing field area features 120-foot-long dugouts running along the stands and on either side of the catcher's box. These were touted as the "world's longest dugouts" at the time of completion.⁷ Their location was intended to allow for fans to see and/or talk to players and furthered the demand for "premium seats." Each end of both dugouts features booths for photographers. The baseball playing field was described as one of the "most symmetrical parks in the major leagues."⁸

Floodlights located continuously around the interior perimeter of the building are mounted on a catwalk that circles the inner rim of the dome at 145 feet above the field. Suspended from the center of the dome is a 64-foot diameter gondola that can be lowered or raised from the floor to the roof and used to provide sound for events in which people are seated in the field, or for photographing playing action.

To serve an enclosed stadium, unique grass was developed to grow properly indoors. Originally, the grass or turf on the field was Tifway 419 Bermuda grass, which was conceived, developed and nurtured over five years especially for the Astrodome under direction of a Texas A&M agronomist and grown by contractors Davidson Grass Farm in Wharton, Texas. The turf's seed bed was laid out on the playing field in such a way as to be rolled up and re-placed as necessary depending on the event nature."⁹

Alterations & Integrity

Skylights Alterations

On April 9, 1965, during the Astrodome's opening day exhibition baseball game between the Houston Astros and the New York Yankees, a flaw was discovered in the design, as outfielders could not see flyballs due to the jigsaw pattern of the skylights above. As a result, during that game the outfielders took to wearing helmets for safety as balls dropped near them or at other times, good distances away from them. Five of the first seven runs in the game, in fact, resulted from lost or invisible flyballs.¹⁰ On April 21, 1965 the three-day job of painting the skylights began. Painting the skylights proved a

⁵ See "Inside the Astrodome," pp. 1-94 for 1965 facts and figures about the Astrodome.

⁶ Ibid., 49.

⁷ "Inside the Astrodome," 97.

⁸ Ibid, 60.

⁹ Ibid, 76 – 77.

¹⁰ "Flaw Discovered in New Astrodome, Outfielders Can't See Ball in Daytime," *Washington Post*, April 9, 1965.

The Astrodome, Houston, Harris County, Texas

success in eliminating the sun's glare seen in the outfield, but because the stadium's normal light level was reduced, stadium lights became the norm for day games.¹¹

Grass Alterations

Painting the skylights and the ensuing reduction of light on the field prevented the grass from growing, and within one month, patches of threadbare grass appeared around home plate and in the heavily traveled parts of the outfield. For a temporary fix, the grass was spray-painted green beginning in May 1965, a practice that continued while a substitute for grass was sought.¹² In March 1966, the infield was laid with synthetic turf, a nylon-type polyester with an inhibitor to prevent sunlight degradation, and eventually an outfield was also installed. The turf, developed by Monsanto Industries, was soon renamed and patented as "AstroTurf" in honor of the Astrodome and the Astros baseball team.¹³ The Astrodome was the first athletic field to receive artificial turf; other stadiums soon followed suit.

1988-89 Alterations

In 1988-89 the Astrodome underwent renovations in order to compete with the larger stadiums constructed in the 1970s and later. The goal was to increase general seating capacity by 10,000 and to add 72 additional luxury skyboxes. To install 800 new seats behind home plate, engineers designed the "first ever" retractable seating sections, constructed as 20 individual 10-foot wide units.¹⁴ Four hundred new seats were also added behind the last row of the existing mezzanine section. Thirty-six new luxury seats were added by renovating the Astrodome Club (the private restaurant for season-ticket holders). Private quarters, three-stories high, located above right field, and originally used by former Astros owner Judge Roy Hofheinz, were also removed to accommodate the new seating.¹⁵ 8,000 new seats in three new balconies were added behind center field at the east end of the stadium. A fourth new balcony was also added, featuring 36 luxury suites. To support the new balconies, all existing columns, beams and footings were strengthened using a variety of methods including reinforced steel, cast concrete, and cantilever transfer frames. The new balconies required new floors to be added from levels five to nine behind center field; as a result, at the fifth floor level, a new concrete pan-joint roof was created and became part of the spectator concourse. To meet city egress code that would accommodate the 9,000 additional people behind center field, two 78-foot-diameter ramp towers and two 48-foot stair towers were constructed outside the existing footprint of the Astrodome with crossover bridges linking them to the stadium. The towers are poured-in-place concrete structures on drilled pier foundations. Precast concrete stair treads span between the concrete landings in the stair towers. All four towers are clad in concrete masonry units. Alterations to the building's parapet at the east side were made in order to accommodate office build-out, concourses, toilets and concession areas at Level 9. As a result, the building's east façade at this level extends out to the parapet line at the concrete grill work (also added at this time to the east side), featuring a glass and aluminum exterior wall extending above it. Glass and aluminum elevator towers were also added adjacent to the northeast concrete stair tower.

Additional renovations in 1989 included removal of the original scoreboard, which had stretched 474 feet across the centerfield wall behind pavilion seats, and measured more than four stories high. Weighing 300 tons and requiring 1,200 miles of wiring, the sign encompassed more than half an acre, and was touted as "the biggest spectacle in lights ever constructed."¹⁶ The original scoreboard was removed in order to provide for the additional seating. Renovations at that

¹¹ "Early Painting Indicates Success at Astrodome," *Washington Post*, April 21, 1965; "Astros Try Dome Again, Say Paint Solves Problem of Flies Lost in Sun," *Washington Post*, April 23, 1965.

¹² "Astrodome Grass Sprayed Green," *Washington Post*, May 11, 1965.

¹³ Edgar, 344-45.

¹⁴ Cain, John. "Domed Renovations," *Civil Engineering* (September 1989): 53.

¹⁵ The Houston Post, "Dome Hits 30," April 9, 1995.

¹⁶ *Ibid.*, 80.

The Astrodome, Houston, Harris County, Texas

time also included relocation of the Diamond Vision replay screen, addition of a second replay screen, addition of a 30 square-foot matrix board for messages, as well as several smaller score and message boards, and an improved sound-system.¹⁷ The AstroTurf, too, was replaced by a newer Monsanto brand artificial turf product called "Magic Carpet." In 1993, two manually-operated scoreboards were installed in the outfield wall.¹⁸

Mechanical, Electrical, Plumbing & HVAC Systems

The primary cooling system components, chillers, cooling tower, pumps and piping, are all original to the Astrodome. The primary heating system components, boilers, heat exchangers and piping are also original to the facility construction. The ventilation system is a mixture of original equipment along with new air handling units added in the 1988 remodel project. The temperature controls system has been upgraded. The electrical systems (both primary and secondary) appear to be in working condition and the existing lighting system at the playing field appears to be in good working order.

Summary of Integrity

Despite the alterations described above and the various mechanical, technical or field upgrades made to the stadium over the years, the mammoth Astrodome remains intact with a high degree of integrity. Its location and setting has been retained. It remains nestled in the center of Reliant Park in the center of a multi-venue entertainment complex. Aside from the Reliant Stadium, parking lots continue to be the major visible feature surrounding the Astrodome. The structure's original construction materials - concrete and steel - are intact, as are original design intents such as the decorative concrete grillwork, the numerous array of seating, and of course, the incredible lamella truss dome. The Astrodome remains a structural icon, and retains its significance as an American civil engineering landmark.

The building is currently undergoing partial demolition, including the removal of the exterior berms, ticket booths, and seating. The circular exterior staircases (added in 1988-89) are scheduled for removal in December 2013. None of these changes affect the overall integrity of the original structure, which retains its exterior finishes, interior circulation network, multilevel seating areas, open playing field, and the characteristic lamella truss dome.

¹⁷ Cain, pp. 53-55.

¹⁸ "Astrodome," Ballparks.com, <http://www.ballparks.com/baseball/national/astrod.htm>. Accessed 25 April, 2013.

The Astrodome, Houston, Harris County, Texas

Statement of Significance

Completed in 1965, the Astrodome in Houston, Harris County, Texas, is an engineering marvel of its time. As the first enclosed and air-conditioned sports stadium in the United States, the Astrodome boasted the largest clear span dome at the time of its completion (642 feet). Dubbed the "Eighth Wonder of the World," by the influential Houston Judge Roy M. Hofheinz, the Astrodome provided over 60,000 seats while it served as home playing field to Major League Baseball's Houston Astros, the National Football League's Houston Oilers, and the University of Houston's Cougars. The Astrodome also served as a multi-use facility for events such as the Houston Livestock Show and Rodeo, boxing matches, tennis matches, concerts, trade-shows, and religious assemblies. The Oilers left Houston after the 1996 season, and the Astros played their last game in the Astrodome in 2000 before moving to Enron Field in downtown Houston. In 2005, the building provided temporary shelter to thousands of residents displaced by Hurricane Katrina flooding, but the Astrodome has sat unused since then. The Astrodome is nominated under Criterion C at the national level in the areas of Architecture and Engineering for its innovations in clear-span dome design and construction. It is also nominated under Criterion A in the area of Recreation/Entertainment at the national level as the progenitor of enclosed multi-purpose sports stadiums, now an American sports archetype architectural form, and at the local level of significance for its role in sports and popular entertainment in Houston and the surrounding region. The period of significance extends from 1965 to 2000, the period during which major-league sporting events were regularly held in the arena. The property meets Criteria Consideration G (*Properties that Have Achieved Significance within the Past Fifty Years*) as an exceptionally significant example of stadium construction. In April 2006, the National Park Service approved Part 1 of a Federal Preservation Tax Incentives application, concurring that the building is eligible for listing under these criteria.

The history of the Astrodome begins with Judge Roy M. Hofheinz (1912-1982), a Houston politician and entrepreneur. Hofheinz served as a representative in the Texas Legislature (1934-36), as Harris County judge (1936 -1944), and as Mayor of Houston (1953-1955). He was also Lyndon B. Johnson's campaign manager when he ran for the U.S. Congress and Senate. Hofheinz became a multi-millionaire through various interests in land, law practice, oil, and radio stations, and in the late 1950s he developed a concept for a regional shopping center in Houston covered with a dome. At the time, he reportedly consulted with famed domed expert Buckminster Fuller, who convinced Hofheinz that, "it was possible to cover any size space if you didn't run out of money."¹⁹ The shopping center plan was dropped, however, after Hofheinz was approached in 1960 about bringing a major league baseball team to Houston. With the Houston Sports Association, Inc. he devoted the next five years to ensuring the existence of a major league team in Houston and the construction of an enclosed domed stadium for that team. After plans for such a stadium were revealed, the Major League Baseball's National League awarded Houston a team franchise in 1962, initially called the "Houston Colt .45s." For the next three years, the Colt .45s played at Colt Stadium adjacent to the Astrodome site.

The Houston Sports Association and Harris County Commissioners felt that Houston's sub-tropical climate would not be conducive to bringing fans to an outdoor stadium. They believed an indoor stadium would be needed, but the idea for a covered, air-conditioned stadium at the time was controversial and too radical to ensure that authorized revenue bonds would attract investors. As a result, Harris County Commissioners turned to tax-supported bonds for financing. The first general obligation bond issue was approved for \$18 million in 1961. A second \$9.6 million bond issue was approved by voters in 1962. The total project cost was \$35.5 million, including the bond issues, as well as \$3.7 million from the State Highway Department and the City of Houston for off-site street, storm sewers and bridge improvements.

Hofheinz exerted a great deal of influence over the baseball franchise and the stadium itself. In the early 1960s, he purchased 495 acres of land south of downtown Houston. He sold 180 acres to Harris County, retaining the remainder for private development. This development would eventually include various hotels and the famed Astroworld (later Six Flags Astroworld; closed in 2005). It was upon this county land that the Astrodome was built. Hofheinz also bought a

¹⁹ Ray, 257.

The Astrodome, Houston, Harris County, Texas

controlling share in the Colt 45s and renamed the team the "Astros" in 1965 to honor the arrival of the NASA manned spacecraft center in Houston.

Groundbreaking for the Astrodome commenced on January 3, 1962, and entailed commissioners firing Colt .45s into the ground. Three years later, on February 8, 1965, the Astrodome was unveiled to the press, and the Houston Sports Authority reported choice comments regarding the new stadium:

"Wow!...It just overpowers you ...It's like something from outer space ...This is every man's stadium - from the cushioned center field to the blue suites...There's never been anything to compare with it - There probably won't be for a long time...It's a monumental thing ...It will probably change the whole concept of a sports arena."²⁰

The completion of the dome even generated a message from President Lyndon Johnson: "You and the people of Houston and Harris County have shown the world what men can accomplish when imagination, energy and sheer determination are combined in one tremendous project. The Astrodome will stand as a deserved tribute to the genius of its planners."²¹

Opening day for the Astrodome's first baseball game was an April 9, 1965 exhibition game in which the Astros played the New York Yankees, with the first official league game on April 12th. The Astrodome immediately began playing host to other events as well. The Houston Fat Stock Show (changed to "Houston Livestock Show and Rodeo" in 1961) had played a role in the development of the Astrodome. In the late 1950s the Show's board expressed an interest in a new city stadium because it felt the show had outgrown its facilities at the Sam Houston Coliseum. Chairman of the show's board, Archer Romero, was one of the Harris County Commissioners at the time the funding for the Astrodome was proposed. The needs of the Stock Show, as a result, were given "prime consideration" in the development [and design] of new stadium.²² The Rodeo was first held at the Astrodome in February 1966 when "record crowds turned out," at almost five times attendance numbers at the Coliseum.²³ The Rodeo moved to Reliant Stadium in 2003.

The Houston Sports Authority prompting the new facility by promising "You name it, and the Astrodome undoubtedly can handle it."²⁴ Holding true to this multi-purpose stature, other events, including boxing matches, tennis matches, soccer tournaments, religious revivals, conventions, concerts and trade-shows have been held in the Astrodome since its inception. Famed evangelist Billy Graham held a nine-day "crusade" in the Astrodome in 1965. In 1966 heavyweight boxing champion Mohammed Ali beat Cleveland "Big Cat" Williams in a famous bout at the Astrodome. In 1973, tennis ace Billie Jean King beat Bobby Riggs in their well-publicized 1973 match dubbed "The Battle of the Sexes" at the Astrodome, and King's win helped usher in a new era in women's sport.²⁵ The 1992 Republican National Convention was held at the Astrodome (nominating Houston resident George Bush) and country-singer George Strait performed to a record-breaking crowd in 2002. In 2005, the building provided temporary shelter to thousands of New Orleans residents who were displaced by Hurricane Katrina flooding. In 2008 dome officials could not produce a valid certificate of occupancy during their annual City of Houston fire inspection. The county's application for a new certificate triggered an inspection by city building code officials and fire marshal's office, which identified approximately 30 problems, including malfunctioning sprinkler and fire alarm systems. The city fire marshal could have ordered the building shut down, but the

²⁰ "Inside the Astrodome," 44-45.

²¹ *Ibid.*, 3.

²² Ray, 259.

²³ Ray, 344; "HLSR-Show History," Houston Livestock Show and Rodeo, <<http://www.hlsr.com/AboutUs/WhoWeAre/History.aspx>>. Accessed April 30, 2013.

²⁴ "Inside the Astrodome," 68.

²⁵ Eng, Christina, "Billie Jean King's Victory Beyond the Court: Tennis Great's 'Battle of the Sexes' in '73 Ushered in a New Era in Women's Sports," San Francisco Chronicle, August 14, 2003.

The Astrodome, Houston, Harris County, Texas

county voluntarily relocated the three dozen employees who had offices there and agreed not to host any future public events.²⁶

Significance under Criterion C: Architecture and Engineering

Since its opening, the Astrodome has received such accolades as the "Eighth Wonder of the World;"²⁷ the "daddy of them [domed stadiums] all;"²⁸ "the granddaddy of domed stadiums;"²⁹ and has been described as one of the "most remarkable domes."³⁰ It has been hailed as a, "landmark in civil engineering,"³¹ along with such marvels as the Brooklyn Bridge and the Hoover Dam. It has also been touted as a structure that "they said...couldn't be done," or alternatively, the "Can-do Cathedral."^{32,33}

Having surpassed the largest clear span dome at the time of its completion by 200 feet, the first monumental engineering problem the design of the Astrodome overcame was how to span a distance of over 640 feet without interior supports. Although a relatively small span for bridge builders, 642 feet, at the time, was unusually large for a roof structure. Numerous roof structure systems were considered, including suspension-type cantilever trusses, a Kaiser dome system, a timber-space frame, and the fairly recently invented geodesic dome system. The final Astrodome design, a Lamella braced-dome system, was chosen both to control costs and because such a system had been known to successfully work for dome spans of up to 285 feet.

Domes have been of interest to engineers and architects for centuries because they can enclose a maximum amount of space with a minimum surface, thereby being economical in construction materials. Friedrich R. B. Zollinger, architect for the City of Dessau, Germany, first developed wood lamella roof structures in 1918 as a solution to the post-World War I housing crisis. First applied in workers' housing, the lamella design became widely used in schools, churches, and public halls. By the 1930s steel lamella roofs were utilized throughout Germany and England in aircraft hangars, factories, garages, ice rinks, sports arenas and market halls.³⁴ The lamella system was imported to the United States in 1925 and was used in a wide range of projects requiring a clear span and low cost. This compressive structure, still in its arch formation, was efficient in its ability to span large areas without interruption of vertical support; it still required a secondary system of buttresses or tie rods, however, to resist the horizontal thrust of the arch. The design was lauded for its low cost, for the ease of its fabrication, and the simplicity of field construction with minimal need for formwork or scaffolding. The typical method of erection involved the construction of one bay at a time, in which the lamella network could be woven upward from a supporting sill beam. The process would continue from both sides of the span, until each met at the apex of the desired arch. In early steel lamella systems, joints were fused by rivets; after 1950, bolts or field welds become more common. In the United States the lamella system was typically executed in wood until the 1950s.³⁵

Beginning in the late 1940s, Buckminster Fuller promoted the design of uninterrupted enclosures using the geodesic dome (a related framing system based on equilateral triangles), but the lamella system was infrequently utilized, and was

²⁶ Peterson, Liz Austin, "Broken-down Astrodome may have seen its last rodeo," Houston Chronicle, February 20, 2009.

²⁷ Ibid., cover page.

²⁸ "The Ball Park Becomes A Palace," *Fortune* (March 1973): 112.

²⁹ Cain, 53.

³⁰ Makowski, Z.S., ed., "A History of the Development of Domes and a Review of Recent Achievements Worldwide," (Nichols Publishing Co.: New York, 1984), 63.

³¹ "Landmarks in Civil Engineering," *Civil Engineering* (November/December 2002): 148-49.

³² Olney, Ross. "They Said it Couldn't Be Done," (Dutton: New York, 1979), 102

³³ "The Future as Relic: Houston's Space Age Icon in an Uncertain Orbit," *Common Ground* (Winter 2005): 11.

³⁴ J.S. Allen, "A Short History of 'Lamella' Roof Construction." *Transactions of the Newcomen Society* 71:1, 1999.

³⁵ Terry Drefke and Gregory Smith, *Valley Fruit Company, Pharr, Hidalgo County, Texas*, National Register nomination (2011), 13-14.

The Astrodome, Houston, Harris County, Texas

generally overlooked in significant architectural publications such as the Museum of Modern Art's seminal *Built in U.S.A.: Postwar Architecture* (1952). By midcentury, however, G.R. Kiewitt, an engineer working with Roof Structures, Inc., of Webster Groves, Missouri, endeavored to apply the basic system nationwide, and his efforts expanded the application of steel lamella systems in the U.S. Lamella units could differ in size and shape, as at the domed-roof formation of the 1957 Brown County Veterans Memorial Arena, Green Bay, Wisconsin (John Sommerville, architect), and the buttress-free system at the 1950 National Orange Show Exhibition Center, San Bernadino, California, in which the barrel form was pulled down to ground level (Harwell Hamilton Harris, architect).³⁶

Parallel lamella domes (including the Astrodome) are exceptional in withstanding excessive wind loadings and seismic disturbances. Lamella domes consist of a large number of similar units (lamellas) that are arranged in a diamond or rhombus pattern. Each lamella has a length which is twice the length of the side of a diamond. Roof coverings or purlins are used to triangulate the diamond and to complete stability requirements. In the 1950s and 1960s Fuller generated many protégé architects as well as publicity, leading to the general public's acceptance of the advantages of braced domes.³⁷

A large team of architects and engineers was engaged to complete the Astrodome project. The architects selected were Lloyd and Morgan, associated with Wilson, Morris, Crane and Anderson. These firms employed the services of Roof Structures, Inc. in St. Louis to assist in the engineering design of the lamella roof. Structural engineers were Walter P. Moore & Associates. Stadium design consultants included Praeger, Kavanagh & Waterbury of New York, who retained Dr. Henri Marcus to verify roof engineering calculations. Dr. Z. S. Makowski, a renowned engineer who, at the time, specialized in dome design (and of the Space Structures Research Center, University of Surrey) was also retained for "theory validity."³⁸

The Astrodome was designed without computer models, requiring arduous calculations in order to predict what that deflection of the dome would be once the shoring and temporary supports were removed.³⁹ Roof Structures, Inc. analyzed the dome mathematically and built a test model to 1/8-inch scale to verify the analysis. The model was then tested by McDonnell Aircraft Co. for 48 different conditions of opening positions and wind angles. The successful and most economical design resulted in requiring 2,150 tons of steel for the 350,000 square foot roof frame, plus the tension ring. It took the American Bridge Division of U.S. Steel a little more than four months to fabricate the structural steel. The lamella dome was built of prefabricated steel trusses fastened together to form arches, which were then linked by a lattice of interlocking diagonals. The dome is divided into twelve 30 degree sectors; each sector is divided into six joints along the tension ring and six joints along the meridian ribs. This design permitted all ring purlins and lamellas to be the same five-foot depth.⁴⁰ The dome structure was built from the center outwards, and required the use of 37 temporary towers for scaffolding, with the tallest tower at 212 feet located in the center. The longer lamella units were 122 feet long in order to span between the towers. When completed, the weight of the roof structure, including the outer tension ring was approximately 16 pounds per square foot.⁴¹ The roof structure can withstand a live load of 15 psf and a dead load of 30 psf. The loading condition calculations were complex due to allowances for such factors as unsymmetrical mechanical equipment, sonic dynamic loading from aircraft, temperature fluctuations of 140 degrees, wind load variants around the structure and live loads. Also noteworthy from an engineering standpoint are the column connections. As described

³⁶ Ibid.

³⁷ Makowski, 29-32.

³⁸ Bass, Louis. "Unusual Dome Awaits Baseball Season in Houston," *Civil Engineering* (January 1965): 63.

³⁹ Quoting Merindra Gosain of Walter B. Moore and Associates, the Astrodome's structural engineering firm during both original construction and renovations, "The Future as Relic: Houston's Space Age Icon in an Uncertain Orbit," *Common Ground* (Winter 2005), 9.

⁴⁰ Makowski, 64.

⁴¹ Bass, Louis. "Lamella Domes in the United States," excerpt from *Space Structures*, Davis, R.M., ed. (New York: John Wiley & Sons, 1967) available online at Astrodome: Lamella Domes, <http://www.columbia.edu/cu/gsap/BT/DOMES/HOUSTON/h-lamel.html>, Accessed April 25, 2013.

The Astrodome, Houston, Harris County, Texas

previously, the columns are free to move radially and are semi-rigid tangentially under the tension ring. The column stubs are pinned at their lower end, six-feet from the tension ring and have rockers at the upper end, thus preventing build-up of primary and secondary movements between the roof and the supporting structure.⁴²

The Astrodome's Lucite roof was the largest application of acrylic resin panels in a single building. "Lucite" is the trademarked name for a lightweight and shatterproof glass substitute made of transparent thermoplastic (polymethyl methacrylate, or PMMA), originally produced by DuPont in 1936. First developed in the 1880s, PMMA was refined and engineered for commercial use in the late 1920s by DuPont and the Rohm and Haas Company, which brought the material to market in 1933 under the trademark "Plexiglas." During World War II, PMMA products were used in submarine periscopes, windshields, canopies, and gun turrets in airplanes. After the war, PMMA found uses in jewelry, shoes, furniture, and other consumer products. In 1993, DuPont sold its acrylic resin operations to Lucite International.

During construction and when completed, the Astrodome received accolades throughout the engineering world, for the feat of cooling and heating 41 million cubic feet of space, designing and fabricating the diamond-shaped truss system, and designing the building's lighting system. The Astrodome was recognized as a nationally significant property by the Historic American Engineering Record (HAER), which documented the Astrodome in 2005.⁴³

Significance: Criterion A: Recreation/Entertainment

The Astrodome is significant under Criterion A in the area of Entertainment/Recreation at both the local and national levels of significance. The building's national significance under this criterion is due to the various innovative features of the building's design (its all-weather dome, artificial turf, and elite skyboxes) that set new standards for American sports stadiums in the following decades, dramatically changing the game experience for both the fans and players. Upon completion, the Astrodome's features included a number of architectural "firsts" and superlatives applied to a large sports facility: first air-conditioned, enclosed, domed sports arena; first all-flat (except pitching mound) major league baseball playing field; longest baseball dugouts; longest and largest scoreboard; brightest playing field; first baseball seats to be vacuumed clean. These wonders and the Astrodome as a whole, effectively "changed the game and business of baseball [and football]," and many of the features first presented in the construction of the Astrodome became the norm in subsequent domed multi-purpose sports and recreation stadiums.⁴⁴

The building's local significance under Criterion A is based on the role that the Astrodome played in the cultural and civic life of the Houston region, providing a venue for professional and college sports, concerts, rodeos and livestock shows, and other events not easily classified. Some highlights from the period of significance include:

- the 1968 Game of the Century between the University of Houston Cougars and the UCLA Bruins before a crowd of 52,963, which set the record for the attendance at a basketball game until 2003. It was the first NCAA regular season game broadcast nationwide in prime time.
- the filming of Robert Altman's 1970 comedy *Brewster McCloud*, which was set at the Astrodome. The eponymous hero played by Bud Cort is an eccentric man who lives at the stadium.
- daredevil Evel Knievel's two-night engagement in January 1971, during which he jumped 13 cars on a motorcycle on successive evenings, drawing over 100,000 spectators.
- the November 1966 boxing match that paired three-time World Heavyweight Champion Muhammad Ali with Cleveland Williams, which Ali won in a third-round knockout.

⁴² Bass (1965), 64.

⁴³ *Houston Astrodome*. Record, Historic American Engineering. "Houston Astrodome, 8400 Kirby Drive, Houston, Harris County, TX." Still image. Accessed June 11, 2013. <http://www.loc.gov/pictures/item/tx1045/>.

⁴⁴ *Civil Engineering*, (November/December 2002), 149. The HAER recordation (TX-108) was approved in 2006.

The Astrodome, Houston, Harris County, Texas

- Elvis Presley's six performances in February and March, 1970, setting an attendance record with 200,000 over the six shows. He performed at the Astrodome again in March 1974, setting a single day attendance record.
- the much-hyped "Battle of the Sexes" tennis match was played on September 20, 1973, with Billie Jean King defeating Bobby Riggs in three straight sets. The match made national headlines and stands as a milestone in the progress of women's sports.

Domed / Multi-Purpose Stadiums

Described as a city where its location and weather make, "the pursuit of sport something of an ordeal," where outdoor events were often canceled by driving rains or thick fog, the new slogan derived for the Astrodome's home of Houston after the Astrodome was completed became, "Come to Houston where the outdoors is in!"⁴⁵ Bringing the outdoors in soon became the norm in many cities. The round, domed and enclosed structure that departed from the diamond-shape traditional baseball stadium became a standard that many U.S. cities desired to follow and did follow. These buildings allowed major sporting events to take place under any weather condition, allowing sales to be retained and fans to be comfortable. In the weeks approaching to the Astrodome's April 1965 opening, columnists and city leaders elsewhere described desires for more enclosed, domed stadiums. Ed Rumill, sports columnist for the *Christian Science Monitor* wrote, "The days when the sports fan will sit unprotected in an open stadium, chilled by winter winds and soaked by rain, are numbered. This tough breed of fan is already in the minority. Soon he will be extinct...now that I have inspected the Astrodome, I am more convinced than ever. This sort of structure is not a spectacle; it's an absolute necessity!"⁴⁶ New York City Sports Commissioner, Ben Finney announced in March of 1965, even before the Astrodome officially opened, a plan that would enclose the new Shea Stadium (1964), home of the Major League Baseball Mets. The plan to enclose the stadium with a dome of glass and laminated steel was reportedly directly inspired by the "revolutionary" Astrodome.⁴⁷ In time, other cities in the U.S. followed Houston's lead, building domed or enclosed sports and multi-purpose stadiums. Texas Stadium in Dallas, completed in 1971, provided a half-dome cover to fans, shielding them (but not the players) from the weather. The 1975 New Orleans Superdome was the first domed arena to be completed after the Astrodome. The Superdome surpassed the Astrodome by encompassing 13 acres of land, and having a clear span of 700 feet. The Seattle Kingdome, another dome covering some 9 acres, was completed in 1976 and served for 24 years as home to the National Football League Seahawks and Major League Baseball Mariners until it was demolished in 2000.

Five more multi-purpose sports 'domes' and enclosed stadiums were constructed after the Kingdome over the course of the next ten years, including the Hubert Humphrey Metrodome (1982) in Minneapolis and the Pontiac Silverdome (1975) in Michigan. Since then, the Georgia Dome (constructed for the National Football League Atlanta Falcons in 1992) has been noted as the largest cable-supported dome in the world. Reliant Stadium (located adjacent to the Astrodome) was completed in 2002 and is the first U.S. football stadium to have a retractable roof, demonstrating that Houston is once again a leader in innovative stadium engineering and design.

AstroTurf

As noted earlier, a result of the Astrodome's skylights being painted during the first year the Astrodome was open was the development of a substitute for grass on the playing field. At the time, the Chemstrand Corporation (which was acquired by Monsanto in 1964), had been developing artificial turf. Judge Hofheinz consulted with Monsanto about the potential of this turf as a sports playing surface, and in 1966 the first major system of artificial turf was installed in the Astrodome. Its

⁴⁵ "Baseball 65," *Chicago Tribune*, April 4, 1965; and "Houston's New Stadium Brings Outdoors Inside," *Chicago Tribune*, February 28, 1965.

⁴⁶ "More Astrodomes Needed," *The Christian Science Monitor*, March 13, 1965.

⁴⁷ "Dome is Proposed for Shea Stadium," *New York Times*, March 18, 1965. The dome for Shea Stadium was never built because subsequent studies showed the stadium might collapse under the weight of a roof.

The Astrodome, Houston, Harris County, Texas

success at the Astrodome eventually led to a patent of the product under the name "AstroTurf" in 1967. Because the turf requires minimal maintenance and can exist in an enclosed space, AstroTurf became the norm for indoor sports stadiums around the country; it even became a norm for household doormats beginning in 1969. Since then, numerous variations of AstroTurf or artificial turf, such as FieldTurf or Sport Grass continue to be developed, used and improved upon, each generation having properties closer to natural grass.

Luxury 'Skybox' Seats

The Astrodome's original 53 skyboxes or luxury seats for an elite class of sports fans also changed the games of baseball and football. These enclosed seating options for the wealthy- another first for the Astrodome and for its time - "represent(ed) a milepost in the evolution of the contemporary notion of upscale and transformed the financial structure of professional sports."⁴⁸ The skyboxes then and today "bring surrogate living rooms and even corporate board rooms into the modern arena."⁴⁹ Supposedly based on the Roman Coliseum concept that provided rulers with elevated seats at the top of an arena, the Astrodome's luxury skyboxes effectively "sequestered the rich...duplicating the class stratification of American society," which had previously been, "leveled in older stadiums as rich and poor alike sat in uncomfortable bleachers in the rain."⁵⁰ As the *Los Angeles Times* reported in 1965, "No poor folks will be found in the Skydome Club, an eagle's aerie high enough to give you a nosebleed."⁵¹ The annual cost to rent an Astrodome Skybox in its opening year ranged from \$15,000 to over \$18,000, with a minimum five year lease required. Seats for the general public at field level through club level for games in 1965, on the other hand, ranged in price from \$1.50 to \$5.50. The Astrodome method of providing luxury seating options set the standard for both future sports stadiums and seating for the wealthy. For example, to obtain Texas Stadium Circle Suites in the early 1970s, occupants had to purchase \$50,000 worth of stadium bonds in exchange for a forty-year lease and then buy twelve \$120 season tickets each every year.⁵² Since then and still today, demand for club seating and private skyboxes in both college and professional sports stadiums has surged, and are essential for teams to generate more revenue.⁵³ Annual rents in 2005 for skyboxes at the Dallas Cowboys' Texas Stadium, for instance, ranged from \$30,000 to \$125,000.⁵⁴

Multi-media technology

Featuring the largest and longest scoreboard in history at the time, the Astrodome can also be considered the progenitor of providing sports fan attendees multi-media presentations during their presence at games, now considered a necessary part of a game experience. The Astrodome's original scoreboard featured a 100 line television screen able to produce animated or still pictures and written messages. It featured a "Home Run" spectacular on the top of the board that consisted of a series of four animated lighting sequences lasting about 45 seconds. The board also had room to display scoring, averages, lineups, clocks, and advertisements.⁵⁵ As on commercial television, the screen provided replays and advertisements. Again, as it had with luxury skyboxes, the Astrodome brought the living room into the stadium. Some critics even complained that as a result of the Astrodome's massive scoreboard, sports fans were being transformed into, "passive

⁴⁸ Harvey, Douglas Pegues. "Il Duomo," *Texas Architect* (May 6, 1990): 30.

⁴⁹ Astrodome Introduction, "The Houston Astrodome,"

<http://www.columbia.edu/cu/gsap/BT/DOMES/HOUSTON/intro.html>. Accessed April 25, 2013.

⁵⁰ Introduction, "Housing the Spectacle," <http://www.columbia.edu/cu/gsap/BT/OMES/HISTORY/overview.html>. Accessed January 20, 2006.

⁵¹ "Houston's Domed Stadium Big - Like Texas, Podner," *Los Angeles Times*, April 5, 1965.

⁵² Le Sport is Profitable for Beers Construction," *Atlanta Business Chronicle*, July 6, 2001.

⁵³ *Forbes*, (March 1973), 110.

⁵⁴ Dallas Cowboys Luxury Seats, "Official Website of the Dallas Cowboys," <http://www.dallascowboys.clms.com>. Accessed April 25, 2013.

⁵⁵ HSA, st.

The Astrodome, Houston, Harris County, Texas

recipients of a big-business entertainment spectacle."⁵⁶

Today electronic scoreboards, in particular those in full color and high definition, are an integral part of a stadium presentation. According to one manufacturer of such video screens, sport stadium entertainment "is all about the audience and giving them the best entertainment value at that stadium, both in the teams providing the best sport experience to stadium guests and from the stadium offering the best video playback presentation they can put on a scoreboard." In one measure of how important that has become he further states, "even college sport stadiums and minor league teams are getting video displays for their scoreboards."⁵⁷

Summary

The 1965 Astrodome is nominated under Criterion C at the national level in the areas of Architecture and Engineering for its innovations in clear-span dome design and construction. It is also nominated under Criterion A in the area of Recreation/Entertainment at the national level as the progenitor of enclosed multi-purpose sports stadiums, now an American sports archetype architectural form, and at the local level of significance for its role in sports and popular entertainment in the Houston region. The period of significance is 1965-1999, from the time of its completion to the year of the last major-league sporting event held at the arena.

⁵⁶ Astrodome Introduction, "The Houston Astrodome," <http://www.columbia.edu/cu/gsap/BT/DOMES/HOUSTON/intro.html>. Accessed April 25, 2013.

⁵⁷ Brill, Louis M. "Sport Scoreboards: Making Larger-than-Life Sports Even More Gigantic," [SignIndustry.Com. http://www.signindustry.com/led/articles/2003-04-29-LB-LED-Scoreboards.php3](http://www.signindustry.com/led/articles/2003-04-29-LB-LED-Scoreboards.php3). Accessed April 25, 2013.

The Astrodome, Houston, Harris County, Texas

Bibliography

- Allen, J.S. "A Short History of 'Lamella' Roof Construction." *Transactions of the Newcomen Society*, 1999.
- Angell, Roger. "The Cool Bubble." In *The Summer Game*. New York, Viking, 1972.
- "Astrodome," Ballparks.com, <http://www.ballparks.com/baseball/national/astrod.htm>. Accessed 25 April, 2013.
- "Astrodome Grass Sprayed Green," *The Washington Post*, May 11, 1965.
- "Astros Try Dome Again, Say Paint Solves Problem of Flies Lost in Sun," *Washington Post*, April 23, 1965.
- "The Ball Park Becomes a Palace," *Fortune* (March 1973): 112.
- "Baseball 65," *Chicago Tribune*, April 4, 1965.
- Bass, Louis. "Lamella Domes in the United States," excerpt from *Space Structures*, Davis, R.M., ed. (New York: John Wiley & Sons, 1967) available online at Astrodome: Lamella Domes, <http://www.columbia.edu/cu/gsap/BT/DOMES/HOUSTON/h-lamel.html>, Accessed April 25, 2013.
- Bass, Louis. "Unusual Dome Awaits Baseball Season in Houston," *Civil Engineering* (January 1965): 63
- Brill, Louis M. "Sport Scoreboards: Making Larger-than-Life Sports Even More Gigantic," *SignIndustry.Com*. <http://www.signindustry.com/led/articles/2003-04-29-LB-LED-Scoreboards.php3>. Accessed April 25, 2013.
- Cain, John. "Domed Renovations," *Civil Engineering* (September 1989): 53.
- Cooper, Dale S. "Houston County Stadium...A Report." *Air Engineering* (November 1964): 32-36.
- Cooper, Dale S. "Houston Astrodome—Power Plant and Mechanical Services Design." *ASHRAE Journal, Official Publication of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.* 8, no. 6 (June 1966): 90-91.
- Dallas Cowboys Luxury Seats, "Official Website of the Dallas Cowboys," <http://www.dallascowboys.com> <http://cowboys.c1ms.com>. Accessed 25 April, 2013.
- "Dome Hits 30," *The Houston Post*, April 9, 1995.
- "Dome is Proposed for Shea Stadium," *New York Times*, March 18, 1965.
- "The Dome Must Be Blacked Out." *Engineering News-Record* (April 15, 1965): 31.
- Drefke, Terry, and Gregory Smith, *Valley Fruit Company, Pharr, Hidalgo County, Texas*, National Register nomination (2011).
- "Early Painting Indicates Success at Astrodome," *Washington Post*, April 21, 1965.
- Edgar, Ray W. "The Grand Huckster: Houston's Judge Roy Hofheinz, genius of the Astrodome," (Memphis: Memphis State University, 1980).

The Astrodome, Houston, Harris County, Texas

Eng, Christina, "Billie Jean King's Victory Beyond the Court: Tennis Great's 'Battle of the Sexes' in '73 Ushered in a New Era in Women's Sports," *San Francisco Chronicle*, August 14, 2003.

"Flaw Discovered in New Astrodome, Outfielders Can't See Ball in Daytime," *Washington Post*, April 9, 1965.

"The Future as Relic: Houston's Space Age Icon in an Uncertain Orbit," *Common Ground* (Winter 2005). Archeology and Ethnography Program (U.S.), National Center for Cultural Resources (U.S.), and United States. *Common Ground: Archeology and Ethnography in the Public Interest*. Washington, DC: National Park Service, Archeology and Ethnography Program.

Harvey, Douglas Pegues. "Il Duomo," *Texas Architect* (May 6, 1990): 30.

"The Houston Astrodome," Housing the Spectacle: Dome Case Studies.
<http://www.columbia.edu/cu/gsap/BT/DMES/HOUSTON/houston.html> Accessed June 11, 2013.

Houston Astrodome. Record, Historic American Engineering. "Houston Astrodome, 8400 Kirby Drive, Houston, Harris County, TX." Still image. Accessed June 11, 2013. <http://www.loc.gov/pictures/item/tx1045/>.

Houston Chronicle, Peterson, Liz Austin, "Broken-down Astrodome may have seen its last rodeo," *Houston Chronicle*, February 20, 2009.

Houston Sports Association, Inc. (HSA) "Inside the Astrodome (Souvenir Program)," (Houston Sports Association. Inc.: Houston), 1965.

"Houston's New Stadium Brings Outdoors Inside," *Chicago Tribune*, February 28, 1965.

"Houston's Domed Stadium Big - Like Texas, Podner," *Los Angeles Times*, April 5, 1965.

Jefferson, T.B. "Welded Steel Frames World's Largest Clear-Span Domed Stadium." *Welding Engineer* 49, no. 6 (June 1964): 55-57.

Kammer, David John. "Take Me Out to the Ballgame: American Cultural Values as Reflected in the Architectural Evolution and Criticism of the Modern Baseball Stadium." PhD. Dissertation, University of New Mexico, 1982.

Karp, David A. and William C. Yoels. "Sport and Urban Life." *Journal of Sport and Social Issues*: 77-102.

"Landmarks in Civil Engineering," *Civil Engineering* (November/December 2002): 148-49.

Le Sport is Profitable for Beers Construction," *Atlanta Business Chronicle*, July 6, 2001.

Leerhsen, Charles. "Happy Birthday, Old Dome." *Newsweek* (15 April 1985): 11.

Lipsitz, George. "Sports Stadia and Urban Development: A Tale of Three Cities." *Journal of Sport and Social Issues* 8, no. 2: 1-18.

Makowski, Z.S., ed., "A History of the Development of Domes and a Review of Recent Achievements Worldwide," (Nichols Publishing Co.: New York, 1984).

"More Astrodomes Needed," *The Christian Science Monitor*, March 13, 1965.

The Astrodome, Houston, Harris County, Texas

Naman, L.A. "Domed Stadium Air-Conditioning Design." *ASHRAE Journal, Official Publication of the American Society of Heating, Refrigerating and Air-Conditioning Engineers* 8, no. 8 (August 1966): 82-84.

Olney, Ross. *They Said it Couldn't Be Done*, (New York: Dutton), 1979.

"Paint the Houston Dome White." *Engineering News-Record* (April 29, 1965): 24.

Peterson, Liz Austin, "Broken-down Astrodome may have seen its last rodeo", *Houston Chronicle*, February 20, 2009.

Ray, Edgar W. *The Grand Huckster: Houston's Judge Roy Hofheinz, Genius of the Astrodome*. Memphis, Tenn: Memphis State University Press, 1980.

"Record-Span Dome Roofs Air Conditioned Stadium." *Engineering News-Record* (February 27, 1964): 26-32.

Scherwitz, Wallace W. "Natureproof Astrodome Gets Controlled Lighting." *Illuminating Engineering: Journal of the Illuminating Engineering Society* LXI, no. 12 (December 1966): 714-717.

'Stadium Domed Roof Completed." *Engineering News-Record* 173 (August 6, 1964):64.

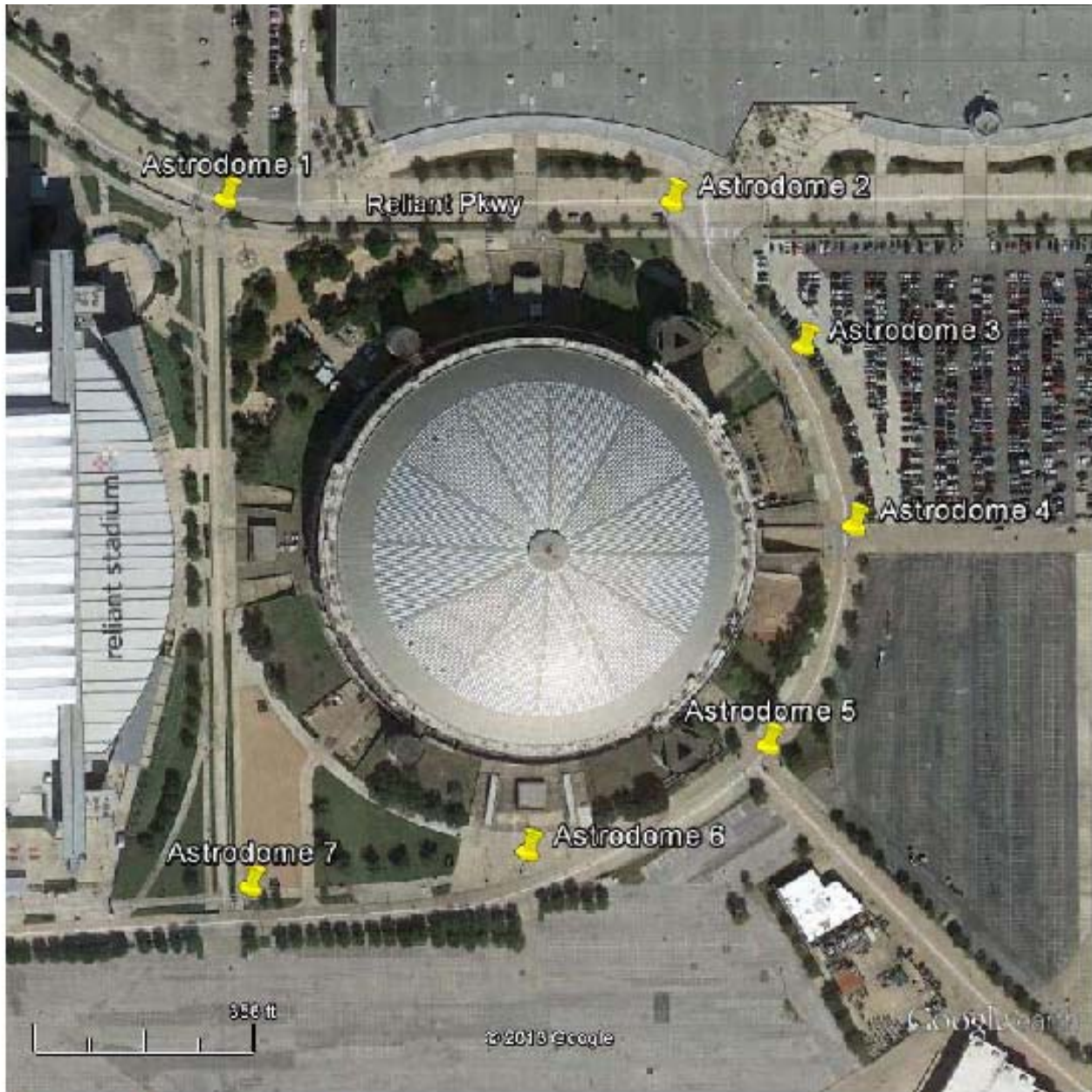
Webb, Bruce C. "Diamond in the Round: The Astrodome Turns 25." *Cite: The Architecture and Design Review of Houston* 24 (Spring 1990): 7-10.

"World's Largest Domed Stadium Takes Shape in Texas." *Civil Engineering* 34, no. 1 (January 1964): 74.

The Astrodome, Houston, Harris County, Texas

Boundary Map

1. Latitude: 29.686339° Longitude: -95.409323°
2. Latitude: 29.686326° Longitude: -95.407024°
3. Latitude: 29.685675° Longitude: -95.406350°
4. Latitude: 29.684863° Longitude: -95.406091°
5. Latitude: 29.683874° Longitude: -95.406531°
6. Latitude: 29.683394° Longitude: -95.407770°
7. Latitude: 29.683234° Longitude: -95.409197°

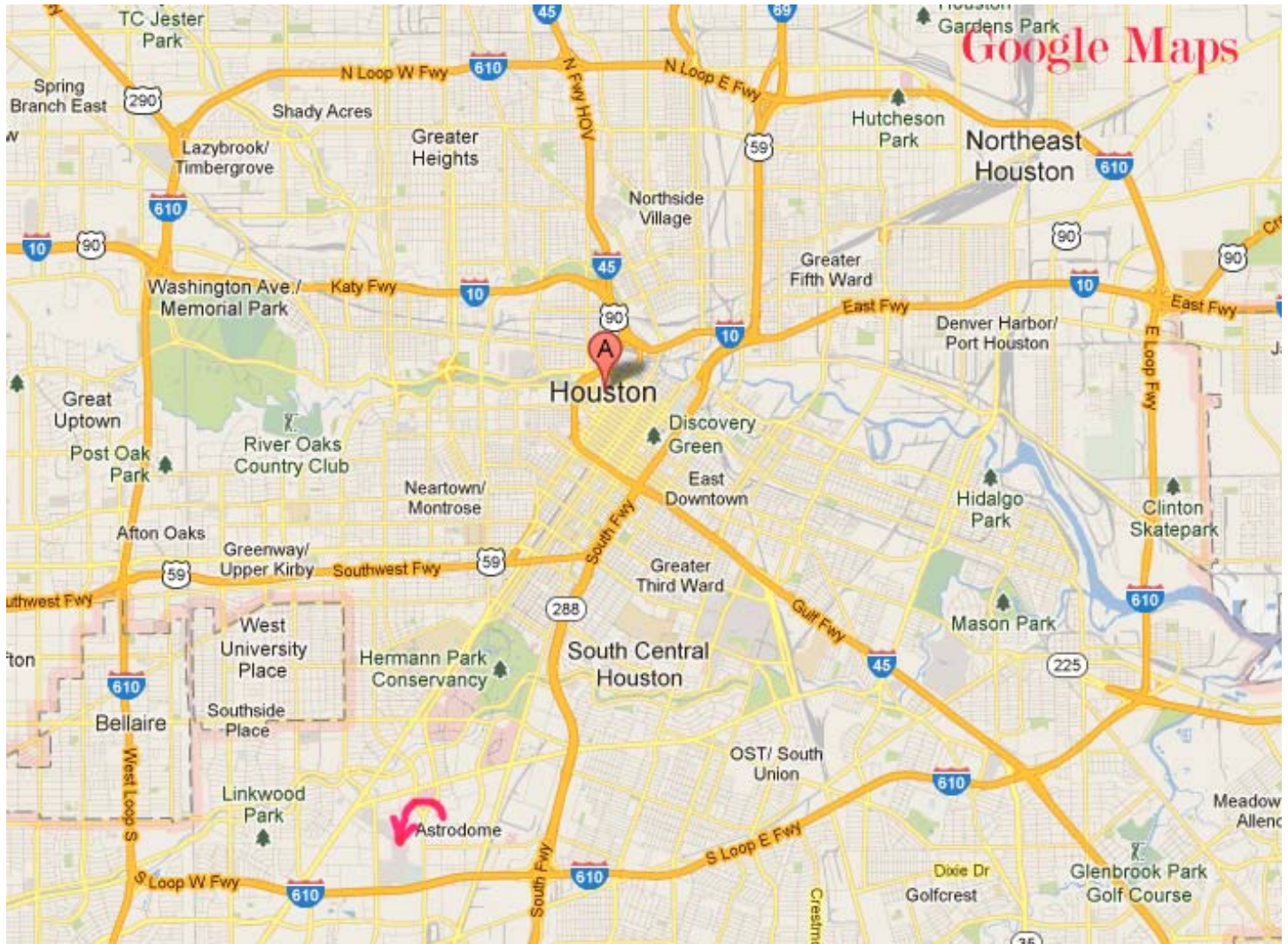


Google earth

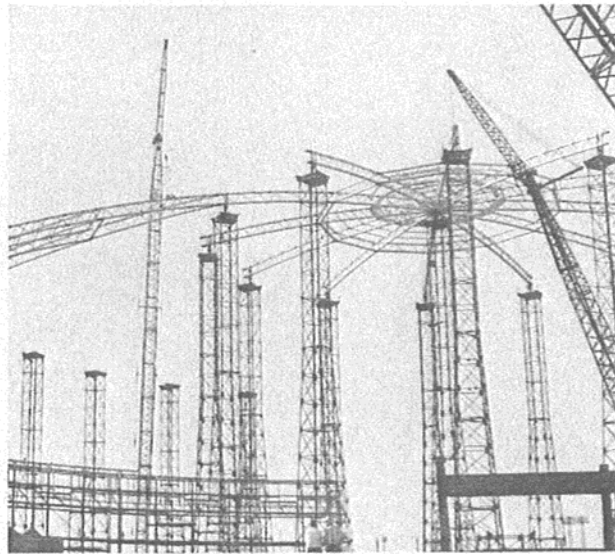


The Astrodome, Houston, Harris County, Texas

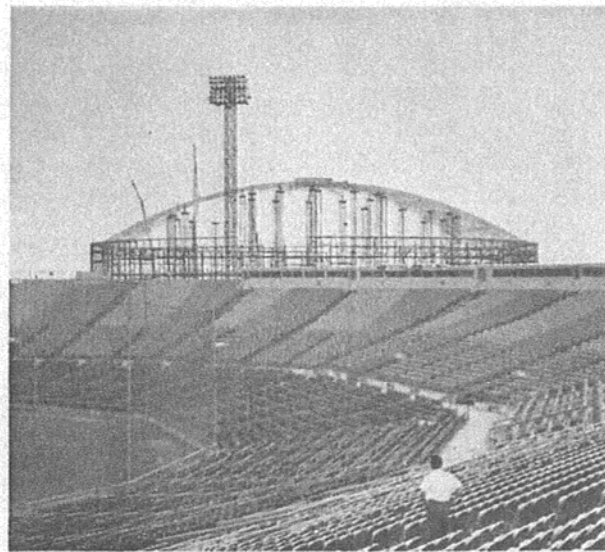
Astrodome in relation to central Houston
No Scale



The Astrodome, Houston, Harris County, Texas



37 falsework erection towers used to support construction of 642-foot span of dome roof.



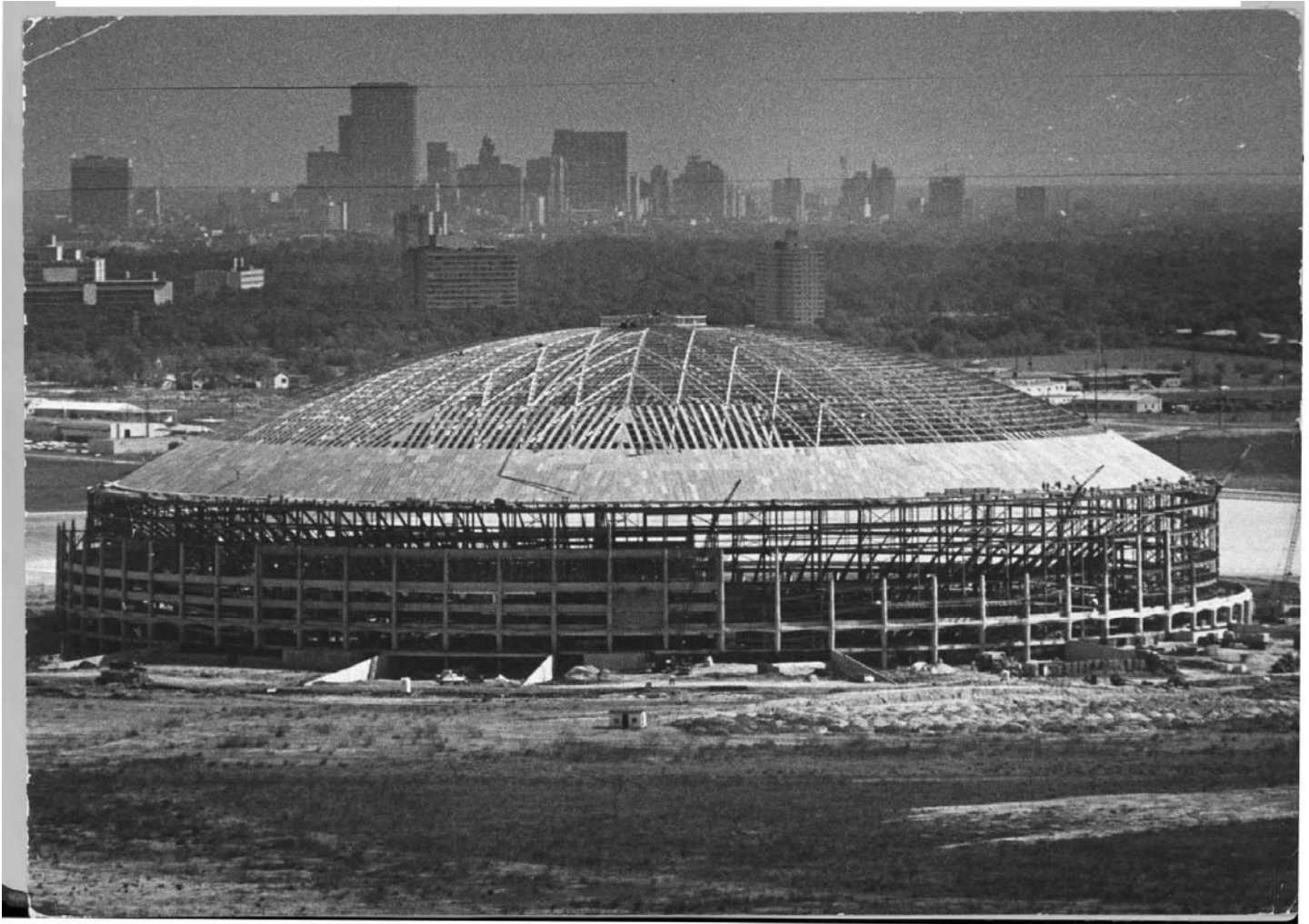
A view of the clear span from Colt Stadium.

Houston Astrodome under construction, 1962-1965
(Credit: Houston Sports Association, 'Inside the Astrodome,' souvenir booklet)

The Astrodome, Houston, Harris County, Texas

Astrodome under construction, 1964.

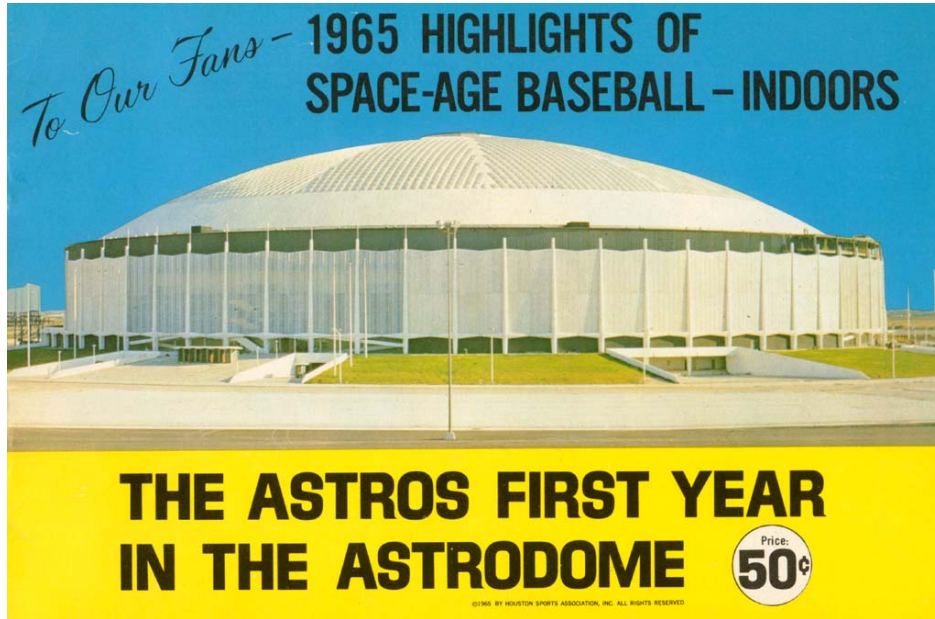
Source: <http://www.houstonchronicle.com/news/houston-texas/houston/article/Rodeo-Texans-put-Dome-demolish-cost-at-29-4368256.php>



The Astrodome, Houston, Harris County, Texas

Brochure Cover Photo, Houston Sports Association, 1965.

Source: The Houston Astrodome, Astrodome Image Gallery,
<http://www.columbia.edu/cu/gsap/BT/DOMES/HOUSTON/images.html>



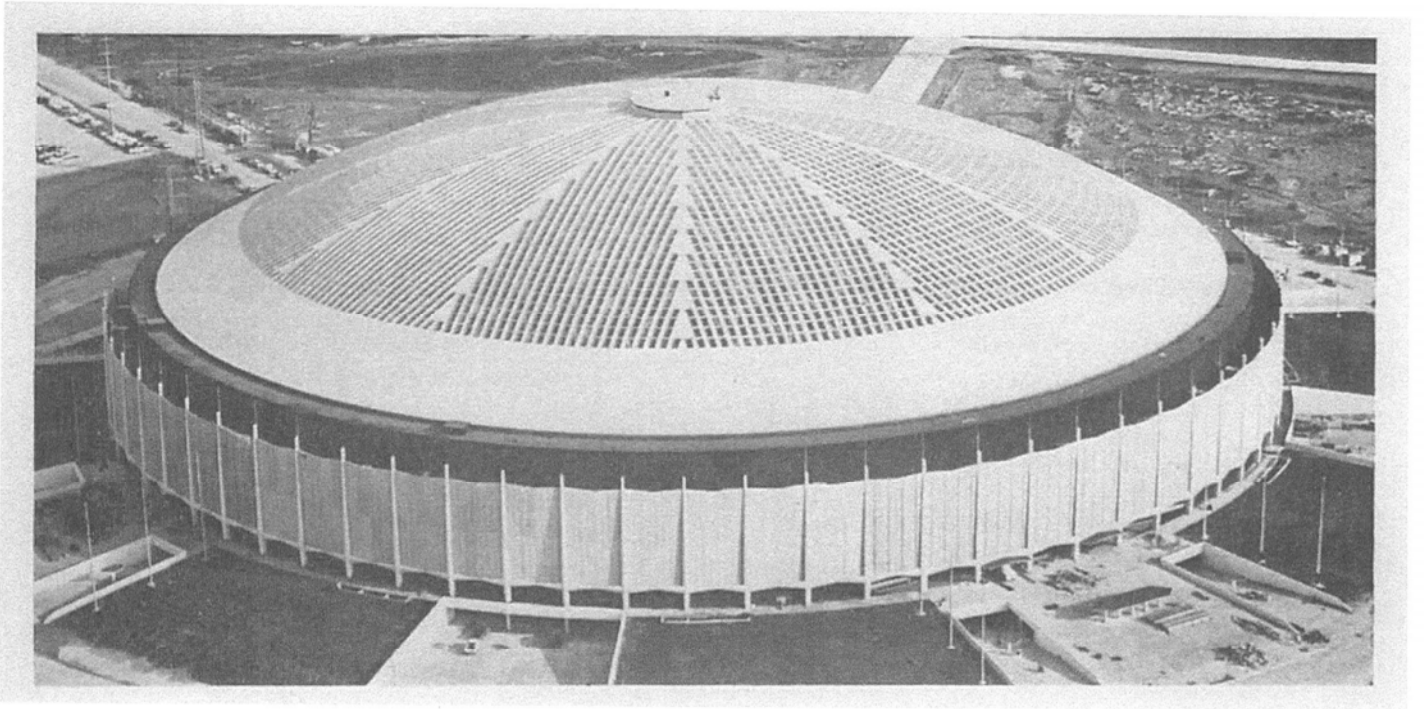
Aerial North view of Astrodome with Colt 45 Stadium in background, 1965.

Barnes, Mark F. Photo

<http://www.houstonarchitecture.com/haif/topic/2540-old-houston-amusement-places/page-11>



The Astrodome, Houston, Harris County, Texas



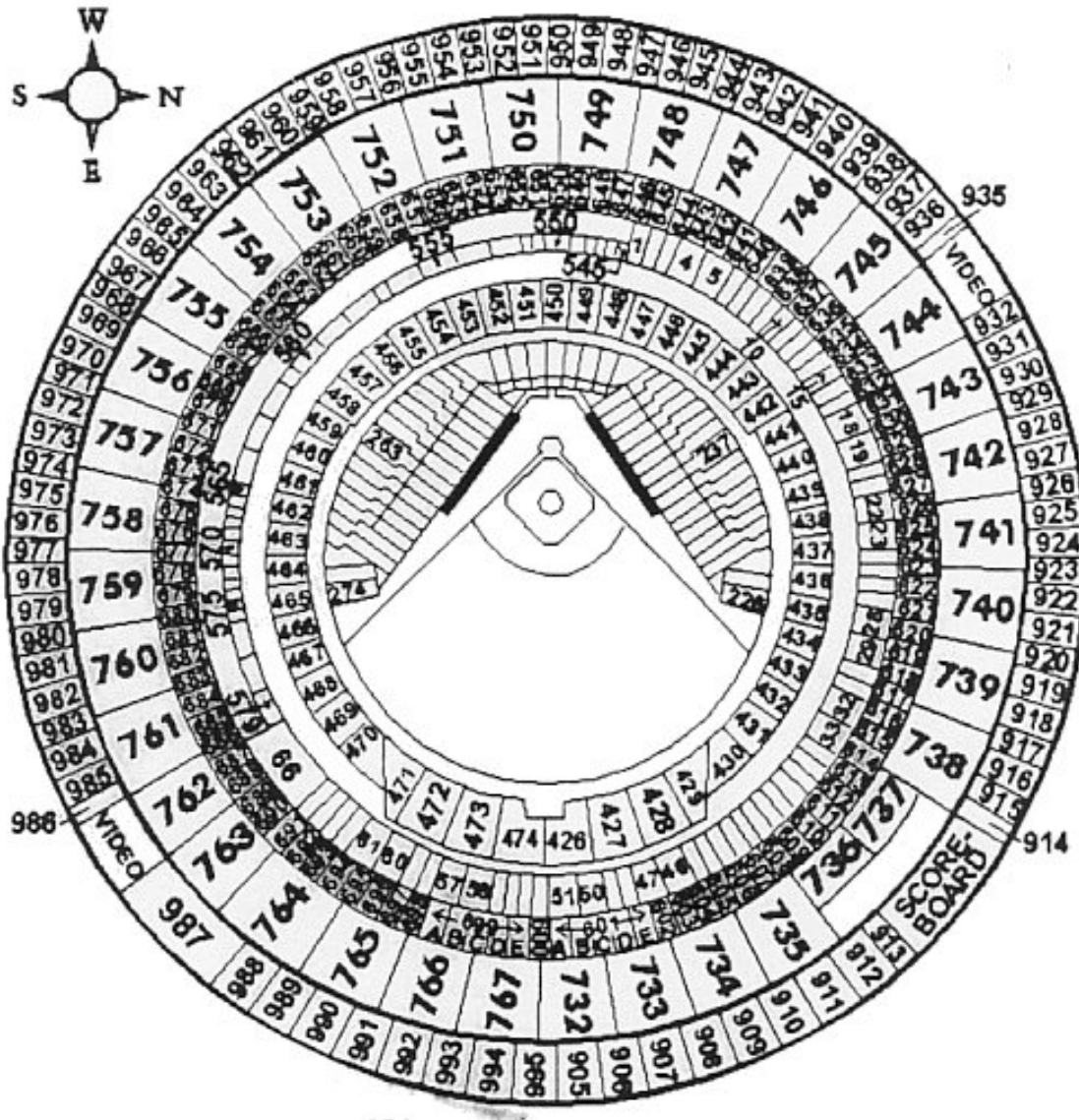
Houston Astrodome, 1965

(Credit: Houston Sports Association, Inc., 'Inside the Astrodome' souvenir booklet)

The Astrodome, Houston, Harris County, Texas

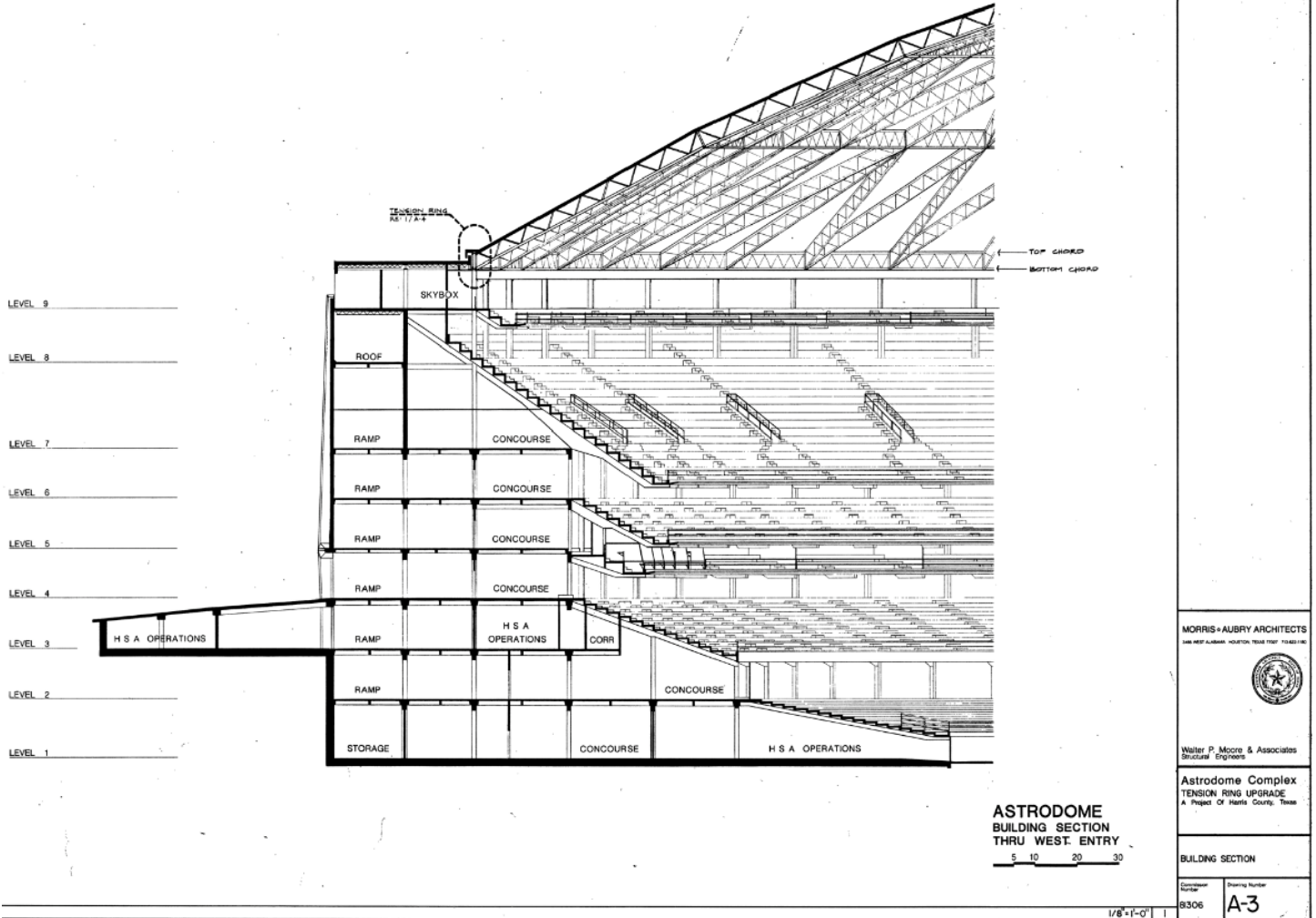
Astrodome Seating Chart

Source: http://www.johnnyroadtrip.com/cities/houston/images/astrodome_seating.jpg



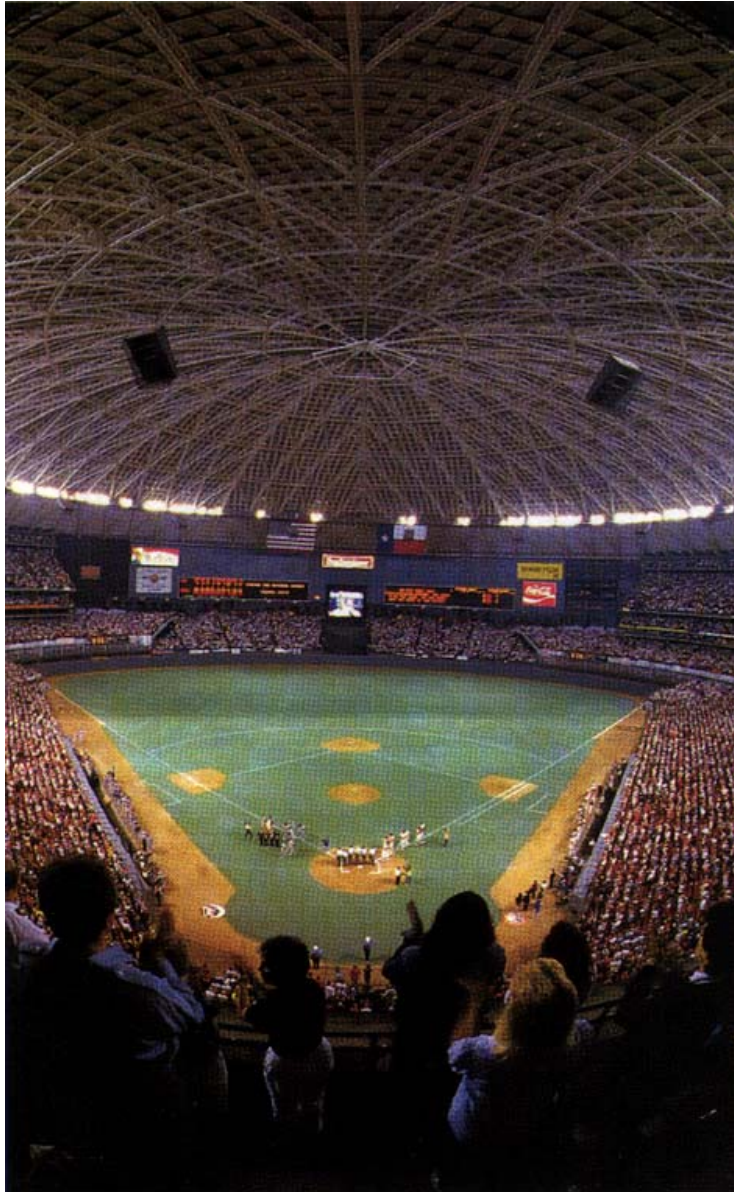
The Astrodome, Houston, Harris County, Texas

Astrodome Section, Document A-3, *The Houston Astrodome, How It Works, Construction Documents*,
<http://www.columbia.edu/cu/gsap/BT/DOMES/HOUSTON/condoc.html>



The Astrodome, Houston, Harris County, Texas

“Houston fans watch baseball game in air-conditioned comfort at the Astrodome, which opened in 1965.”
Interior photograph looking west; Smith, F. Calter; *Smithsonian*, January 1988.



The Astrodome, Houston, Harris County, Texas

North Elevation, looking south
HAER documentation, 2005.
<http://www.loc.gov/pictures/item/tx1045/>



The Astrodome, Houston, Harris County, Texas

View south towards movable field level seats.
HAER documentation, 2005.
<http://www.loc.gov/pictures/item/tx1045/>



The Astrodome, Houston, Harris County, Texas

Structural detail at crown of lamella dome showing partial view of compression ring at lower center
HAER documentation, 2005.

<http://www.loc.gov/pictures/item/tx1045/>



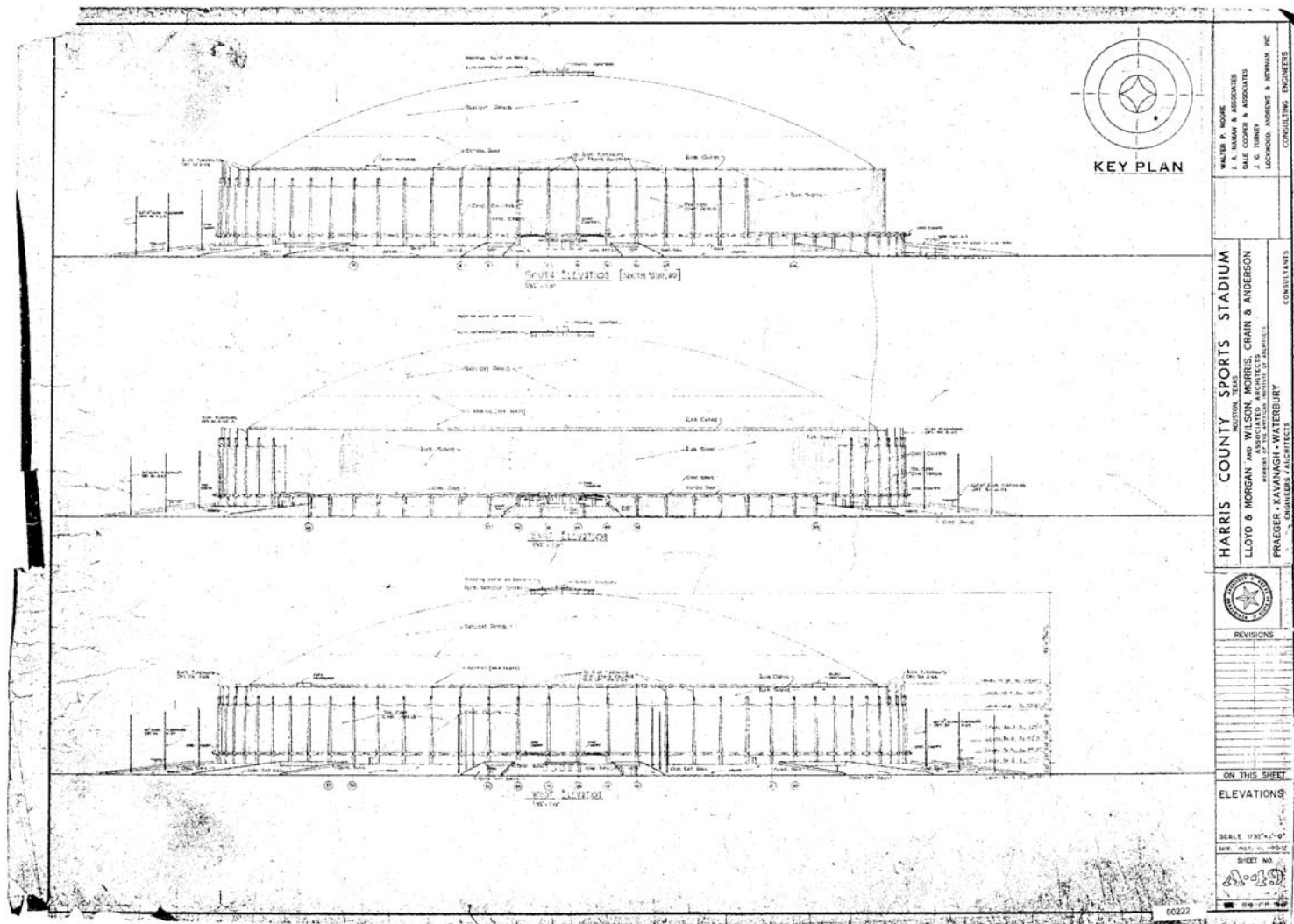
The Astrodome, Houston, Harris County, Texas

Dome roof truss view midway up catwalk to cupola at crown of dome
HAER documentation, 2005.
<http://www.loc.gov/pictures/item/tx1045/>



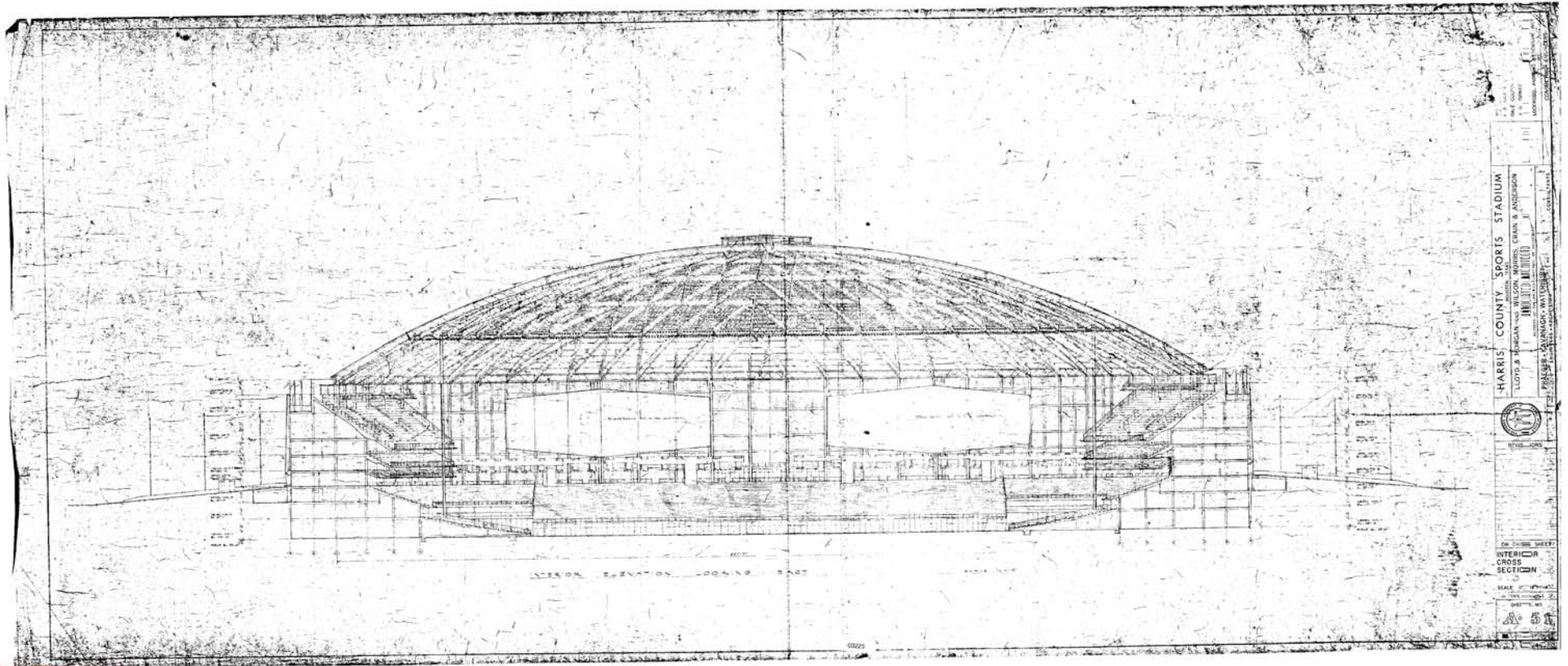
The Astrodome, Houston, Harris County, Texas

Historic Plan - Elevation



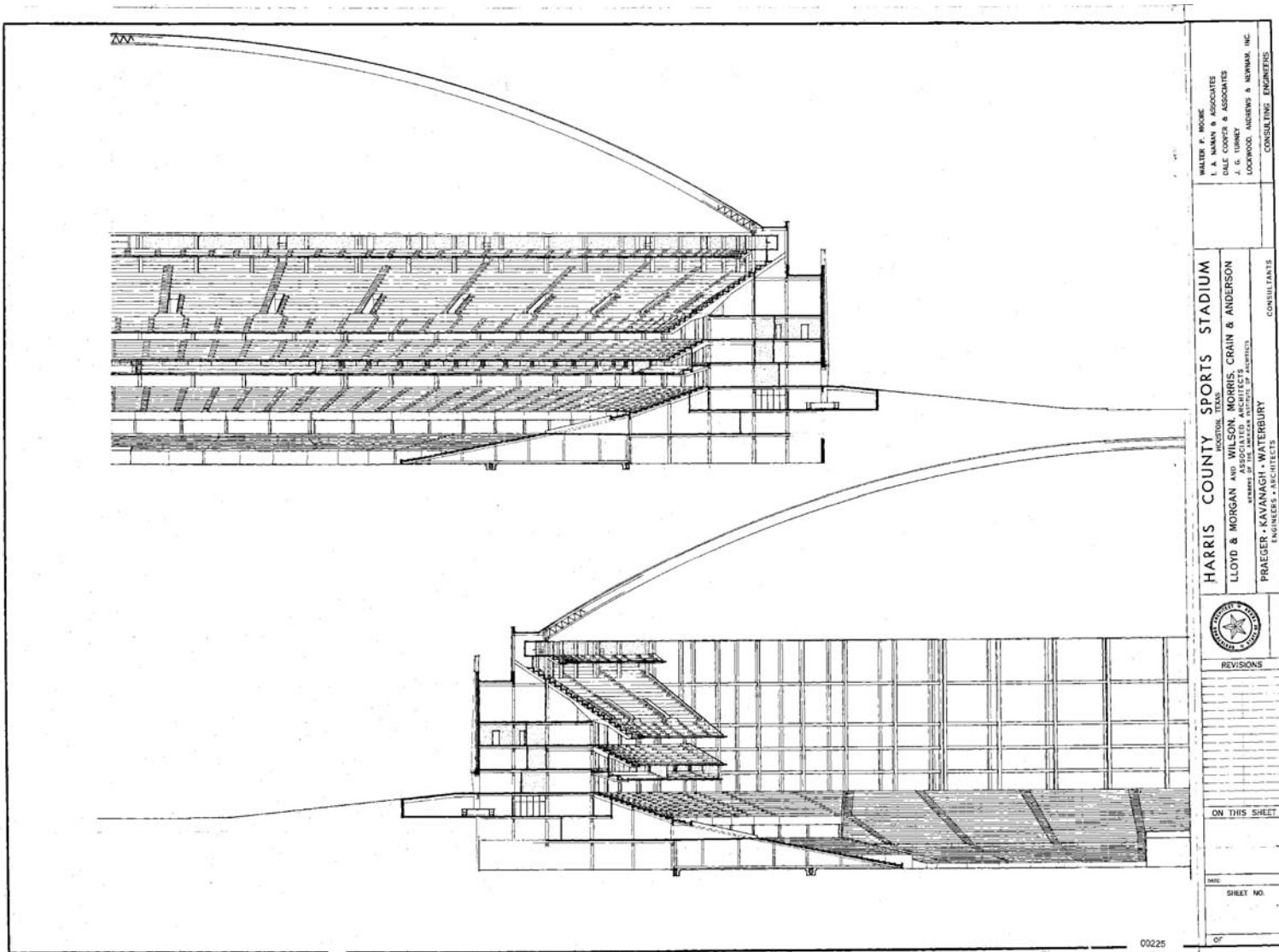
The Astrodome, Houston, Harris County, Texas

Historic Plan - Section



The Astrodome, Houston, Harris County, Texas

Historic Plan - Section detail

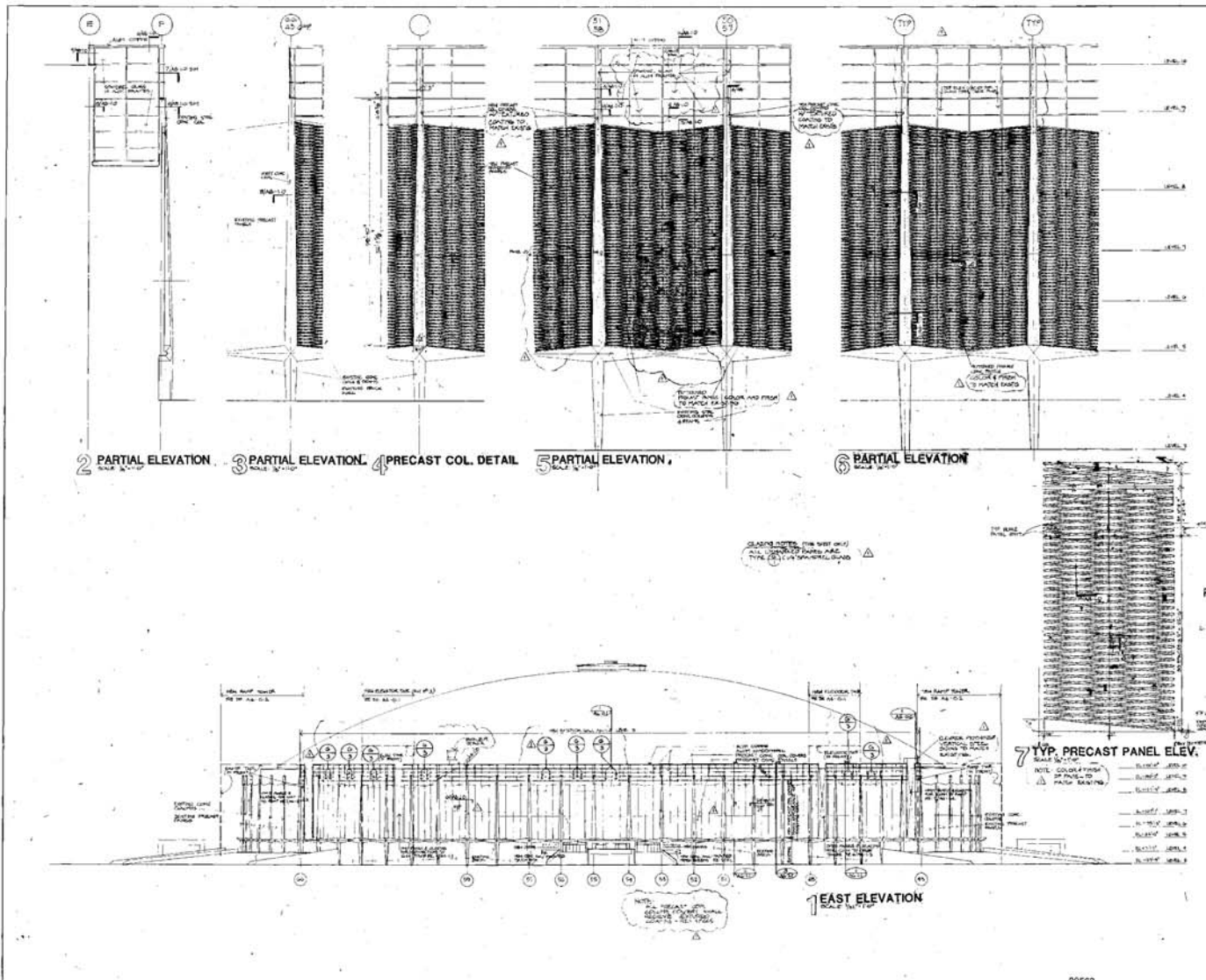


WALTER F. MOORE E. A. NAWAY & ASSOCIATES DALE COOPER & ASSOCIATES J. G. LUNNEY LOCKWOOD, ANDREWS & HURMAN, INC. CONSULTING ENGINEERS	
HARRIS COUNTY SPORTS STADIUM HOUSTON, TEXAS LLOYD & MORGAN AND WILSON MORRIS, CRAIG & ANDERSON ARCHITECTS MEMBERS OF THE AMERICAN INSTITUTE OF ARCHITECTS PRAEGER • KAVANAGH • WATERBURY ENGINEERS • ARCHITECTS	
REVISIONS	
ON THIS SHEET	
SHEET NO.	

00225

The Astrodome, Houston, Harris County, Texas

Historic Plan - Elevation detail



CRSS
 CRS Serrina, Inc.
 Architects & Engineers

With Assistance
 Associate Architects
 John S. Chase FAIA, Architect, Inc.
 Associate Architects
 Haywood, Jordan, McCowan of Houston, Inc.
 Associate Architects
 Walter P. Moore & Associates, Inc.
 Structural & Civil Engineers

DMC
 #5157

Astrodome
 Restoration and Expansion
 A Project of Harris County, Texas

Set Package: 5 General Construction
 PHASE TWO

REVISION FOR SET 04 APRIL 1988

ADDENDUM THREE 29 APRIL 1988

PROJECT RECORD DOCUMENT
 ASTRODOME PHASE II

11436.02
 04 APRIL 1988

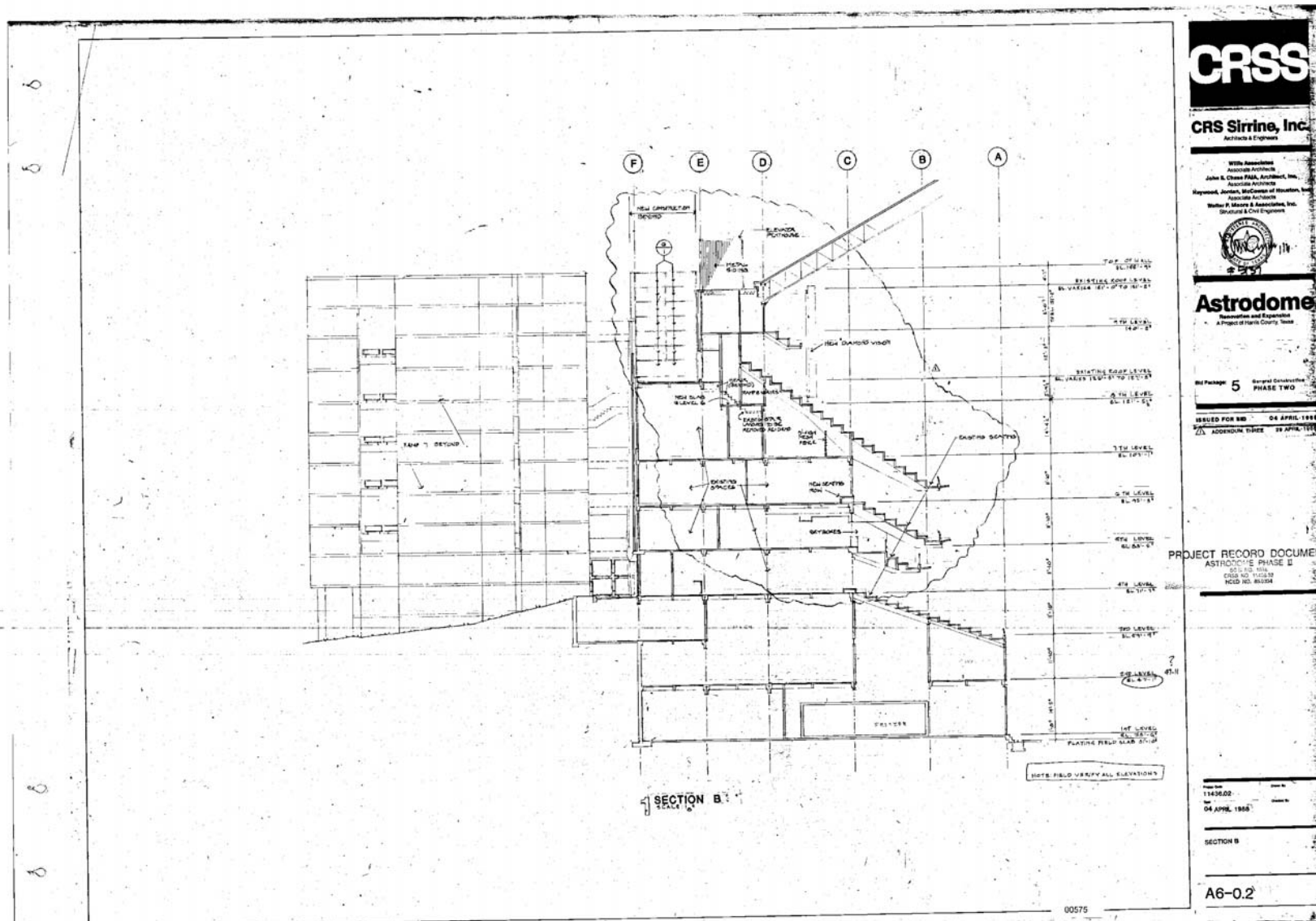
BUILDING ELEVATION
 TYPICAL ELEVATIONS

A5-0.1

Please purchase PDF Split-Merge on www.verypdf.com to remove this watermark.

The Astrodome, Houston, Harris County, Texas

Historic Plan - 1988 additions detail









Reliant
Astrodome

WEST

West

W



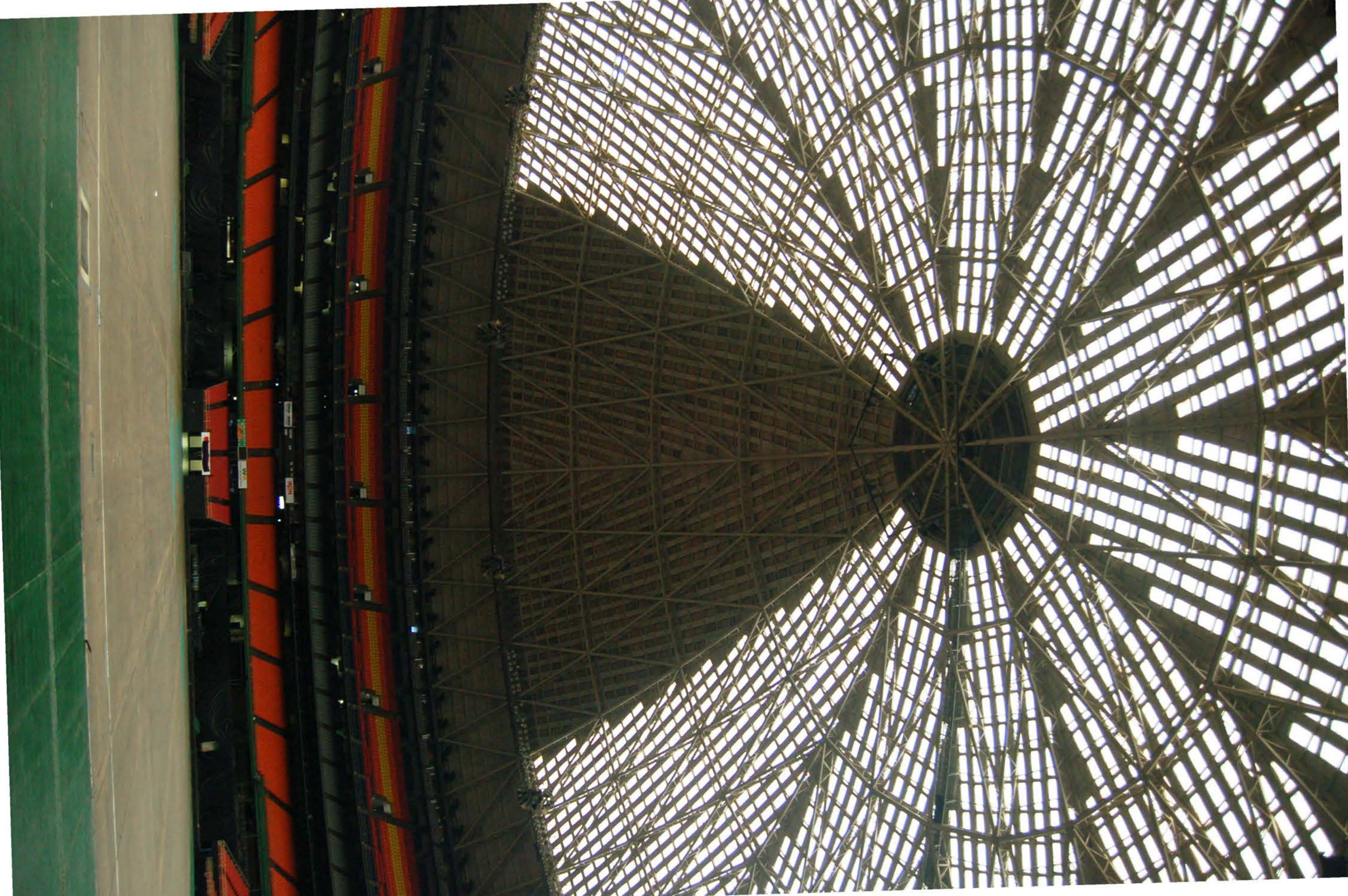
WM
Reliant
Park

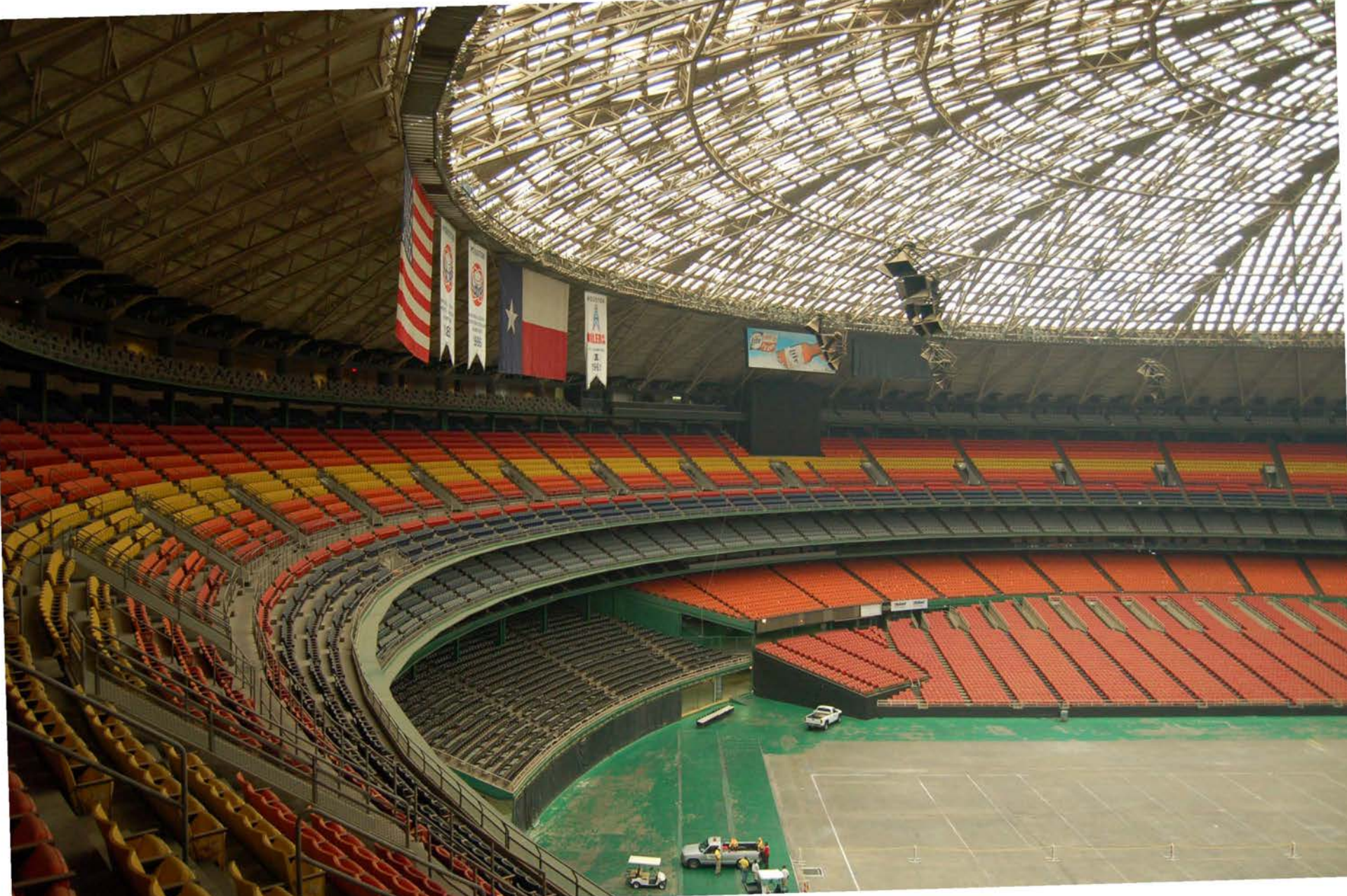
NATIONAL
RENT & SERVICE
1-800-255-5475

NATIONAL
RENT & SERVICE
1-800-255-5475

NATIONAL
RENT & SERVICE
1-800-255-5475

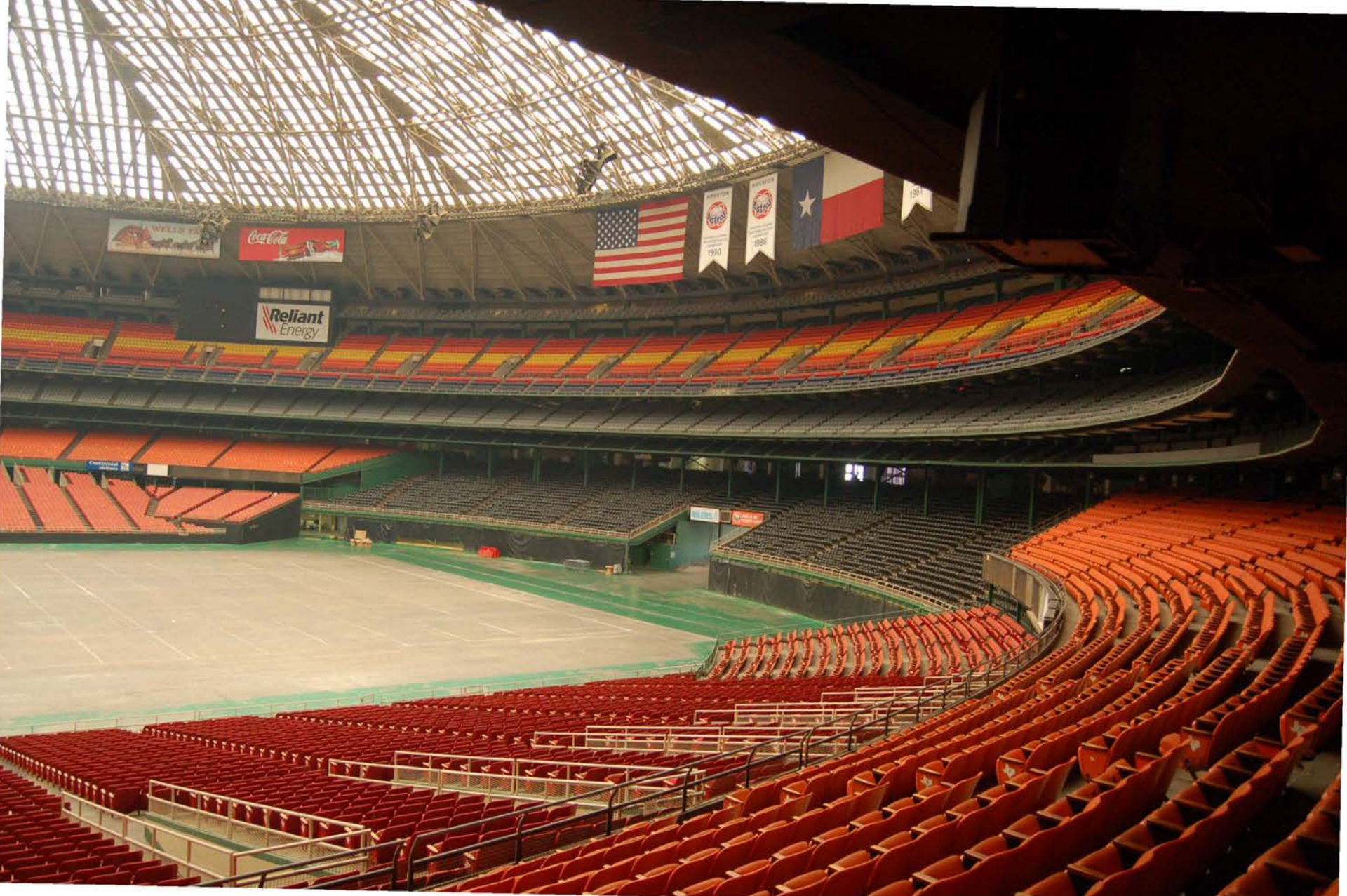


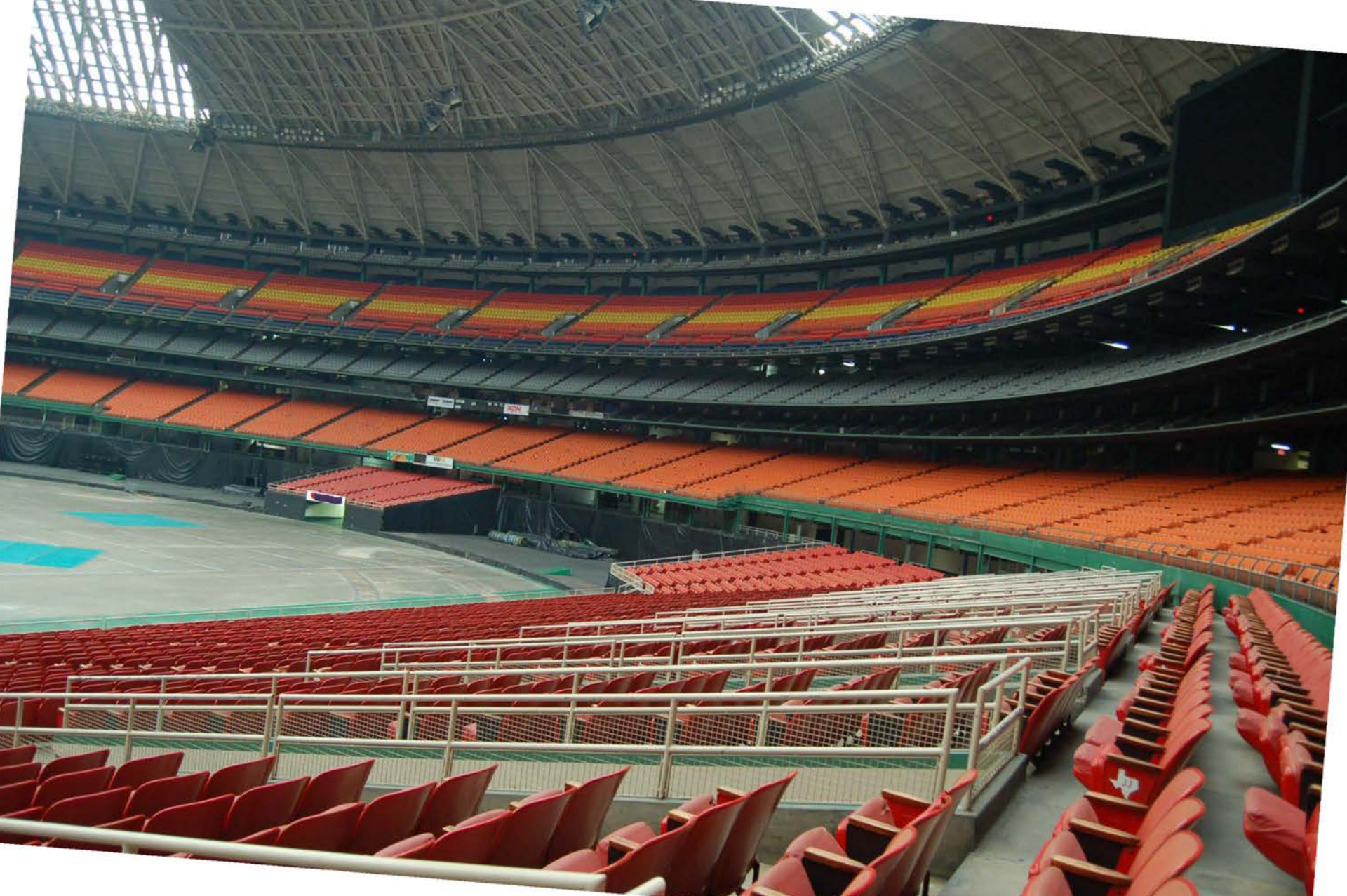




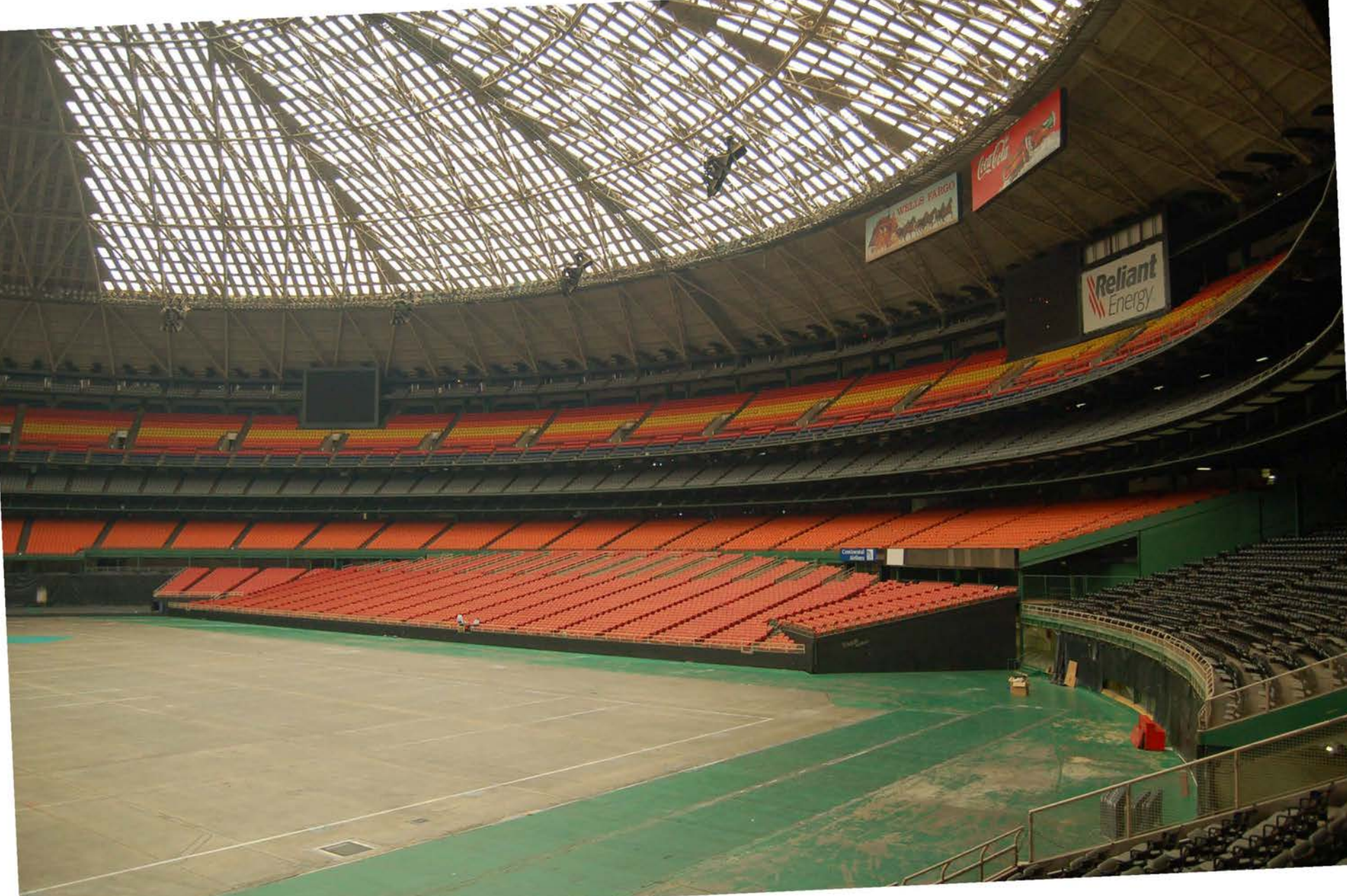


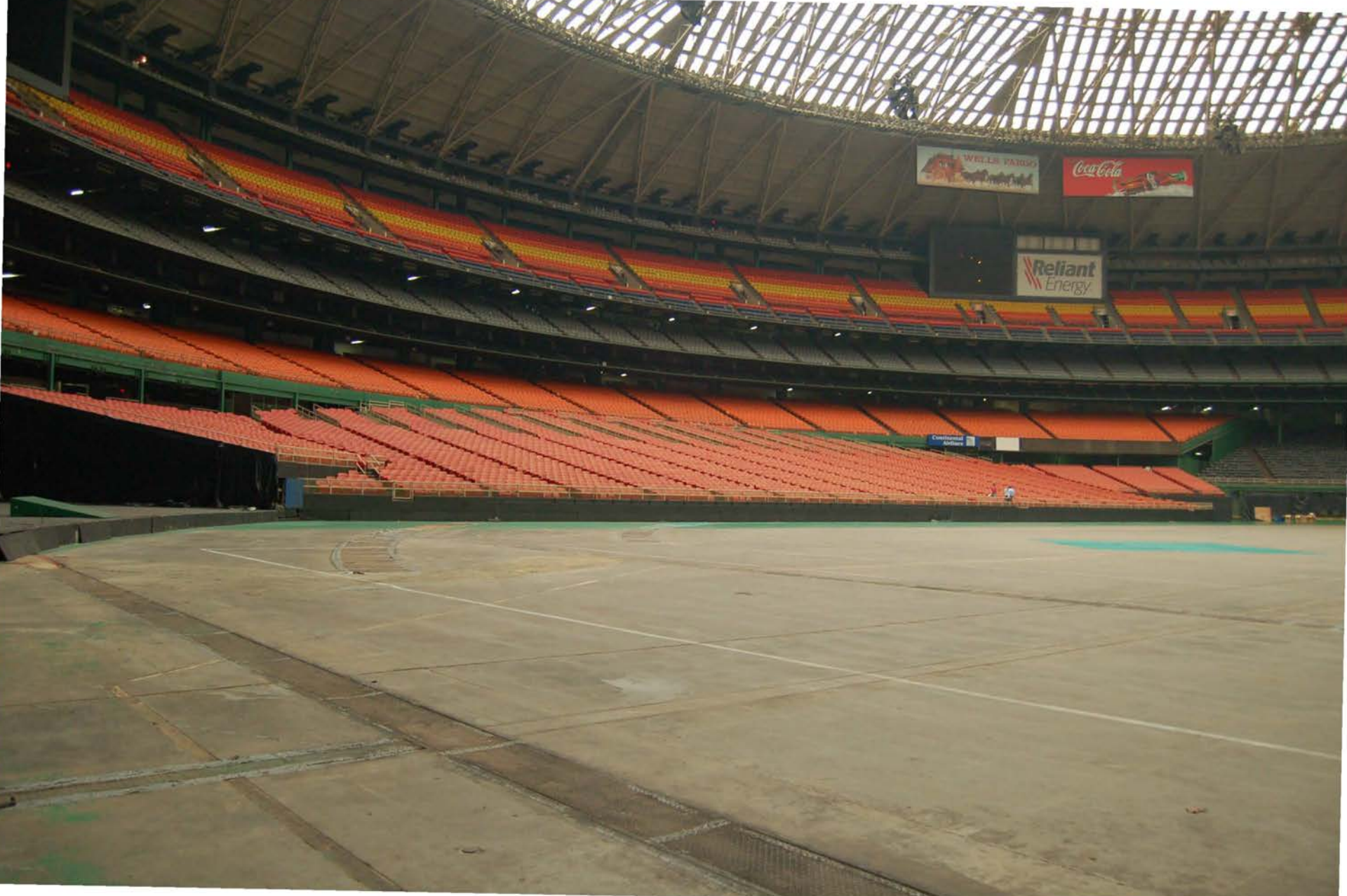












WELLS FARGO

Coca-Cola

Reliant Energy

Comcast







UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
EVALUATION/RETURN SHEET

REQUESTED ACTION: NOMINATION

PROPERTY NAME: Astrodome, The

MULTIPLE NAME:

STATE & COUNTY: TEXAS, Harris

DATE RECEIVED: 11/29/13 DATE OF PENDING LIST:
DATE OF 16TH DAY: DATE OF 45TH DAY: 1/15/14
DATE OF WEEKLY LIST:

REFERENCE NUMBER: 13001099

REASONS FOR REVIEW:

APPEAL: N DATA PROBLEM: N LANDSCAPE: N LESS THAN 50 YEARS: Y
OTHER: N PDIL: N PERIOD: N PROGRAM UNAPPROVED: N
REQUEST: Y SAMPLE: N SLR DRAFT: N NATIONAL: Y

COMMENT WAIVER: N

___ ACCEPT ___ RETURN ___ REJECT _____ DATE

ABSTRACT/SUMMARY COMMENTS:

The Astrodome meets National Register Criteria A and C at the national level in the areas of Architecture, Engineering, and Entertainment/Recreation. Erected in 1965, the Astrodome is an exceptional example of mid-twentieth century engineering design, incorporating important innovations in clear-span dome design and construction. Under Criterion A, the property is exceptionally significant as the progenitor of enclosed multi-purpose sports stadiums, now an American sports archetype architectural form. It is also significant at the local level for its role in sports and popular entertainment in the Houston region.

RECOM./CRITERIA Accept Criteria A & C

REVIEWER Paul R Lusyan DISCIPLINE HISTORIAN

TELEPHONE _____ DATE 1/15/2014

DOCUMENTATION see attached comments Y/N see attached SLR Y/N

If a nomination is returned to the nominating authority, the nomination is no longer under consideration by the NPS.

**The United States Department of the Interior
National Park Service**

**National Register of Historic places
Comment Sheet**

**Property Name:
The Astrodome, Harris County, Texas**

The Astrodome meets National Register Criteria A and C at the national level in the areas of Architecture, Engineering, and Entertainment/Recreation. Erected in 1965, the Astrodome is an exceptional example of mid-twentieth century engineering design, incorporating important innovations in clear-span dome design and construction. Under Criterion A, the property is exceptionally significant as the progenitor of enclosed multi-purpose sports stadiums, an American sports archetype architectural form. It is also significant at the local level for its role in sports and popular entertainment in the Houston region.

When completed in 1965, the concrete and steel frame structure was the first permanently enclosed, multi-purpose stadium facility in the United States. In the context of modern sport stadiums, the construction of the Houston Astrodome marked an exceptionally significant precedent that radically changed the concept of sports arena design and operation around the country. City after city attempted to create their own totally enclosed sports venue, modeled after the successful Astrodome model. Year-round use of such facilities, in both warm and cold-climate communities, significantly changed the economics of the sports/entertainment industry, as did concepts like incorporating luxury, skybox seating, full-time air-conditioning, and expansive programmable scoreboards, all first introduced in Houston. While fully enclosed stadiums would see their popularity diminish in later years, the introduction of the Astrodome marked an exceptional moment in sports recreation/entertainment history.

A unique example of engineering design, the Astrodome featured a dramatic Lamella-truss roof system that created the largest clear-span, domed building at the time, encompassing a column free area of over 9 acres. The Astrodome was also the first venue to introduce the use of an artificial turf playing field in 1966, with the development of "Astroturf." The building designers, Lloyd & Morgan, along with a host of engineering and construction specialists created a remarkable illustration of cutting edge mid-twentieth century engineering design, dubbed the "Eighth Wonder of the World" by its builder/promoter, Judge Roy M. Hofheinz, and largely supported by the national public.

Locally, the Astrodome was the city's major sports and entertainment venue for a large part of the late twentieth century, hosting football, baseball, rodeo and other popular local events in year round, air conditioned comfort. The unique character of the stadium and the popularity of the venue in the eyes of the American public and event promoters helped bring significant national entertainment events to the stadium, further raising its profile, and that of the city, locally and across the country. The venue brought a significant level of prestige to the host city--Houston, which held the Astrodome as an iconic symbol of its modernity and growing prosperity in the emerging Space Age.

The Astrodome is a widely recognized civil engineering landmark with sufficient scholarly documentation to evaluate its exceptional significance within the context of twentieth-century engineering and stadium design.

TEXAS HISTORICAL COMMISSION
real places telling real stories



TO: Edson Beall
 National Park Service
 National Register of Historic Places
 1201 Eye Street, NW (2280)
 Washington , DC 20005

FROM: Gregory Smith
 National Register Coordinator
 Texas Historical Commission

RE: The Astrodome, Houston, Harris County, Texas

DATE: November 26, 2013

The following materials are submitted:

	Original National Register of Historic Places form on disk.
<input checked="" type="checkbox"/>	The enclosed disk contains the true and correct copy of the nomination for the Astrodome to the National Register of Historic Places.
	Resubmitted nomination.
<input checked="" type="checkbox"/>	Original NRHP signature page signed by the Texas SHPO.
	Multiple Property Documentation form on disk.
	Resubmitted form.
	Original MPDF signature page signed by the Texas SHPO.
<input checked="" type="checkbox"/>	CD with TIFF photograph files, KMZ file, and PDF
	Correspondence

COMMENTS:

- SHPO requests substantive review (cover letter from SHPO attached)
- The enclosed owner objections (do___) (do not___) constitute a majority of property owners
- Other:

