THE STEEL TRIANGLE

United States Steel
Builds
A Corporate Center
"Whenever technology reaches its real fulfillment, it transcends into architecture."

MIES VAN DER ROHE, 1886-1969

This book, describing the design genesis of one of the largest new office structures in the United States, has been organized along the lines of commonly accepted subject areas in building technology. The United States Steel Corporation hopes that this editorial arrangement will prove most useful to a readership of building professionals.

To all building professionals and to those owners or occupants directly concerned with current planning concepts of high-rise office buildings, USS offers an insight into its own experiences in the creation of a corporate home.

Comments and questions are welcome, and a phone call or note to the General Manager, Construction Marketing, United States Steel Corporation, Pittsburgh, Pa. 15230, will receive prompt attention.
CONSOLIDATION OF MANAGEMENT OFFICES—USS personnel in early 1965 occupied all or part of 12 Pittsburgh office buildings situated throughout the triangular-shaped downtown area known locally as the “Golden Triangle.” Increased centralization, made possible through improvements in data-processing computers and electronic communications networks, brought about the need for a single structure that would permit more rapid interchange of ideas to facilitate and expedite corporate operations.

The new USS Pittsburgh corporate center was designed to function as an efficient, productive unit in much the same way as a new steel mill or plant. Potential needs of the Corporation were analyzed so that this building would satisfy corporate requirements in future years.

With more than $1 billion of U.S. Steel products going into the construction market annually, it was apparent that the building of a major structure was a unique commercial opportunity. It could be a valuable proving ground to evaluate the merits of steel used in many building products—old and new—and in several innovative ways.

Moreover, because the building represents a major investment of capital funds, it was designed to yield “dividends”—dividends in operating economies and, to use the late Norbert Wiener’s phrase, in the “human use of human beings.”

When United States Steel decided to erect a corporate center in Pittsburgh, it marshaled its own talents and resources to work with a group that included some of the nation’s leading building design, fabrication and construction professionals.

From the outset, this experienced team of technical talent established design criteria and selected materials and building techniques of high performance characteristics, all within the framework of anticipated future demands upon this computer-oriented structure.

Comprising high-level representatives of the owners, planners, designers, engineers and builders, the team was created early and given time and resources to do its planning work.

The planning approach was also a reflection of the Corporation’s determination to con-
struct a functionally useful structure that would at the same time be a welcome addition to the Pittsburgh cityscape.

THE INNOVATIONS COMMITTEE—Preliminary planning was far more complex and took much longer than the usual time it takes to create a conventional high-rise office building. As a first step, a special committee of USS experts was established. These men from the Research, Metallurgy, Accounting, and Marketing Departments and the American Bridge Division established the program and fixed the broad planning parameters that were to be followed. This committee was geared to work in close cooperation with the planners, architects and engineers as well as with other USS divisions and groups.

Known as the USS Innovations Committee, it was formed in May, 1965 and was directed to serve as liaison between USS management and the building professionals retained to work on preliminary design studies. Moreover, in order to extend its investigatory scope even further, the committee and its consultants sought the counsel of and worked with building product manufacturers at each step of the way. Each of these manufacturers was encouraged to use his full creative talents and his own research facilities to help develop new and better products and installation techniques.

The Innovations Committee was charged with implementing the Corporation’s desire to exploit new techniques and materials, with the proviso that such use would be kept within practical and economical bounds.

Historically, the high-rise building has been the pacesetter for the construction industry. When new concepts are embodied in such structures, they generally have considerable influence on the entire building field.

Over the years, USS Research, USS Marketing and other operating arms of the Corporation have devised many new concepts. There is, however, a great distance to be covered between the formulation of an idea and its ultimate realization in practice. The innovative suggestions put forth by USS personnel, along with those offered by the various outside consultants, were each thoroughly analyzed for both functional and economic soundness.
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The planning approach was also a reflection of the Corporation's determination to con-
1. hollow, box-section, exterior columns, each fireproofed by liquid,
2. USS ULTIMET Wall Framing System,
3. plate spandrel panels;

[ ] a flexible, totally modular layout with modular wall, floor and ceiling components, based on 4 ft-4 inch squares designed to facilitate servicing and conversion of office space;

[ ] a lighting system designed as a standard component in an integrated ceiling system, having central switching of all lights, and permitting an increase of illuminating intensity merely by the installation of additional fixtures in the space ceiling modules;

[ ] the installation of all electrical, communications and control wiring in the cellular floor, eliminating all partition wiring;

[ ] a variable-volume air-conditioning system, also part of the integrated ceiling, with individual room temperature control and split-air bar diffusers which, because of their two-way diffusion, can accommodate any partition arrangement, and

[ ] a complete operations and control system that operates everything electrical—from air conditioning and elevator dispatching to fire-alarm control and light switching.

CREDITS

Owner United States Steel Corporation  Pittsburgh, Pa.

Consultant for Site Assembly, Construction Supervision and Building Management Galbreath-Ruffin Corporation New York, N.Y.

Architects Harrison & Abramovitz & Abbe New York, N.Y.

Structural Engineers Skilling, Helle, Christiansen, Robertson New York, N.Y.

Edwards & Hjorth New York, N.Y.

Foundation Engineers Mueser, Rutledge, Wentworth & Johnston New York, N.Y.

Mechanical Engineers Jaros, Baum & Bolles New York, N.Y.

Electrical Engineers Ebner-Schmidt Associates New York, N.Y.

General Contractor Turner Construction Company New York, N.Y.
II
EARLY STUDIES AND PRELIMINARY DESIGN
During the first six months of research studies carried on by the architects, engineers and USS Innovations Committee, many new departures in basic building layouts and equipment systems were evaluated.

For example, the entire concept of vertical transportation was reviewed and five different elevator systems were analyzed. Also, several energy systems were considered. Five basic building layouts along with structural concepts to satisfy each were thoroughly evaluated from both cost and operational points of view.

PREREQUISITES—Essentially, the major controlling factor in the building design was the need for totally flexible space to accommodate the wide variety of U.S. Steel requirements in addition to those common to any corporate headquarters operation.

A study of records indicated that 20 percent of the partitions dividing the present staff work areas are relocated each year. These data led to the establishment of a number of design criteria—not the least of which was the setting up of a 4 ft-4 inch building module. This module provides, at least for the USS building, the most efficient unit for office layout, based upon the experience record of USS office operations.

THE MODULE—In a building of this immense size, it is quickly apparent that a variation from the usual AIA module of 4 ft can be justified on the basis of mass component production. Consider, for example, the windows: there are 11,000 of them—a quantity of this order is a mass market in itself. Thus, economical production of special, non-stock windows, as well as most of the other building components, can be readily sustained.

But modular space cannot be economically built nor maintained when it must contend with interior obstructions such as columns. Therefore, it was decided that the columns, vertical transportation, communications, and building services would have to be either confined within a service core or outside the office space proper, or both. This decision led to the next design consideration—that of the building frame.

THE STRUCTURAL CONCEPT—With a large area (approximately 2,900,000 sq ft, exclusive of parking) and the open space requirements, it was apparent that the corporate center

Based upon the experience record of USS office operations, a 4 ft-4 inch building module was chosen as the most efficient unit for office layout.
would have to be a core building with part of the structural supporting system inside the core and part inside or outside the peripheral wall. It was at this point that several unique and profitable suggestions were made, the most interesting being to put the exterior columns outside as a bold architectural expression.

But what about fireproofing? This question led to the suggestion of leaving the structure bare, using USS COR-TEN Steel and resurrecting an old (but untried) idea for fire protection: liquid-filled columns. It would be difficult to recreate the excited mood that prevailed while the architects refined their plan, the engineers completed structural evaluations, and the research engineers developed the necessary support data for the idea of liquid-filled, fireproofed columns.

These efforts led to a focus upon a triangular shape modified by notched corners. The diagonally braced core retained its true triangularity and the office areas became rectangular projections from each of the three sides.

The rectangular office areas, each 221 ft long and 45½ ft wide, furnish three column-free spaces of 10,000 sq ft on each floor. Each office area is interconnected at each end as well as through the core. The offices surround the equilateral triangular service core, each side of which is 162 ft long. Within this core, elevators, stairs, utility shafts, washrooms, corridors, and other service spaces are efficiently housed.

Other design decisions then fell into place. Original considerations called for attaching 39 exterior columns to the building at every floor. Aesthetic, functional and economic considerations—related to the inherent capacity of structural steel to permit long-span framing—led to a determination that 18 columns, 6 per side, attached every 3 floors, would be optimum. It was determined that there should be a system of primary floors at every third floor with two secondary floors between. Each primary floor would carry the two secondary floors.

THE WALL SYSTEM—After this last decision, the selection of a wall system became imperative. The columns were to be a USS COR-TEN Steel box expression. Then why not express the three-floor interior structural system with a plate spandrel at these levels
and use a USS ULTIMET curtain wall in three-story lifts as infill.

The succeeding sections will discuss and illustrate the final design details. Unfortunately, the dynamics of the design process can only be hinted at here.

A FEW STATISTICS—Some idea of the size and scope of the building can, however, be gleaned from the fact that the building is 64 stories and 841 ft high. With a gross area of 2.9 million sq ft (plus parking), the USS corporate center is one of the world's largest commercial office structures.

The total building construction contains 44,000 tons of structural steel and 90,000 cu yd of concrete; the foundation required the excavation of 300,000 cu yd of earth and rock. There are 11,000 windows, 54 elevators and 10 moving stairs. The refrigeration plant has a capacity of 8,500 tons; the electrical system is initially designed for a connected capacity of 35,000 kw—a load equal to that required by 20,000 single-family houses. ■
III

SITE EXPLORATION
AND FOUNDATION
THE SITE—The building's three-acre site (116,561 sq ft), at the edge of the Golden Triangle, readily passed the feasibility study. It provides road access from the north, south and east because the site is on the fringe of the downtown triangle instead of in its center; it is accessible to commuters using mass transit or automobiles; and the cost of land assembly requiring 27 parcel purchases was reasonable in relation to the total cost.

Long before the spectacularly tall, unusually shaped superstructure started to rise from its foundations, certain major construction work was completed.

In addition to the ordinary problems of rebuilding on a downtown site—relocation of sewers, telephone cables, water and gas lines—this site required the closing of a number of streets and a swapping of land parcels with the City. This exchange, which rounded off a bad street-traffic corner while developing a large parcel for a major building, was helpful to both the City and to USS.

Far more complex were the removal and relocation of a railroad tunnel, which had to be rebuilt as an isolated enclosed trestle over a three-level underground garage.

The site measures 250 ft along its north side at Seventh Avenue and 500 ft along its western boundary at Grant Street. Linking its northeast and southwest corners is Bigelow Boulevard, a curving street which cuts off the southeast corner.

As is common when building in the downtown areas of older American cities, the subsoil investigation of the site required historical research. Delving into the archives for additional information on subsurface conditions, the foundation consultants discovered a 1795 map showing part of an old pond on the site. By 1830, Hogg's Pond, as it was called, had apparently been filled in, and a map of that date shows the Pennsylvania Canal cutting across the property. The existing railroad tunnel first appeared on a map dated 1884.

SOME UNDERGROUND PROBLEMS—The Penn Central Railroad tunnel, temporarily closed during the period of construction, posed an unusual challenge, requiring an elaborate job of design shoehorning. The existing tunnel cut through the site on a 390-ft
line, roughly north and south, with a gentle horizontal curve. It crossed the planned substructure of the new building about 35 ft above the lowest parking level. Hence, though the existing tunnel had to be demolished, the track elevations had to be maintained at both ends.

Structural engineers designed a steel-framed, X-braced trestle, 36 ft high, to support a new reinforced-concrete railroad tunnel 21 ft high and 19 ft wide. The trestle is designed for a Cooper E72 loading. Encased in concrete fireproofing, the trestle and the tunnel itself are isolated from the surrounding substructure of the building and are connected to the main structure only at the trestle-column base plates.
The old railroad tunnel was replaced by a new tunnel structure that is designed to eliminate sound and vibration transmission.
To arrive at the final design, there had to be agreement among the acoustical consultants, the structural engineers and the Penn Central Railroad.

VIBRATION DAMPING—The acoustical consultants quite naturally considered the question of vibration damping as paramount. The design gives vibration damping within acceptable limitations.

The isolation of vibration is achieved in three ways. First, there is the damping of vibrations at track level with ¾-inch rubber mats of 30-40 Durometer placed between the rail tie plates and timber ties. Then, below the stone ballast under the ties, three ½-inch-thick continuous rubber mats rest on 1 ¼-inch-thick, asphalt-impregnated wood planks. The mats turn up at the sides to form a continuous damping tray.

Finally, there are washers of elastomeric material between the anchor bolt nuts and the top of the base plate, and there are compressible bushings between the anchor bolts and base plate. Isolation of the base plate and the top of the concrete is achieved through the use of an elastomeric pad. The elastomeric material is a laminated, neoprene-impregnated fabric.

AIRBORNE SOUND ISOLATION—Control of the airborne sound transmission is achieved by the combined mass of the concrete tunnel walls, floor and roof and of the fireproofed steel structure. This mass is sufficient to reduce sound transmission to acceptable levels, particularly in the critical areas adjacent to the auditorium.

In short, two problems were solved. The massive tunnel structure encasement effectively eliminates sound transmission, and the various damping devices eliminate vibration transmission.

THE SUBSTRUCTURE—Another challenge created by the tunnel was its interruption of the substructure slabs; these were designed to act as diaphragms resisting both the great lateral soil pressures against the deep foundation walls, and the horizontal forces from lateral loads on the building. To prevent the tunnel from interfering with the function of the slabs, the engineers called for a design which threads extra-heavy pipe struts through
the trestle framing. These struts transfer the compressive stresses across the interrupted segments of the slabs. The pipe struts clear the trestle framing to prevent vibration transmission into the slabs.

The railroad trestle added four other complications to the project's design: 1) the transfer of column loads from the building above; 2) ductwork and piping from the concourse-level mechanical room had to be dropped below the trestle and passed under it to service the building; 3) because the trestle is close to the street level, the plaza elevation was raised, and 4) it became necessary to create an upper and lower lobby and raise the elevator pits.

FOUNDATION SLAB—For the tower foundation, a continuous concrete mat up to 12 ft thick was designed to bear on hard, shaly sandstone. Under a foundation design load of 63,500 kips, the calculated settlement of any column is 0.44 inch, and the differential settlement is estimated at less than 1/4 inch. In the basement areas outside the tower, a 5-ft-thick foundation mat for the four-level garage and concourse substructure was anchored to the underlying rock to resist hydrostatic pressures that may reach 1,700 psf under a head of 33 ft of ground water. High-strength steel rods, with 96,000-psi minimum tensile strength, were used for tie-down anchors, which were grouted into the rock.

EXCAVATION AND THE TIEBACK SYSTEM—Excavation reached a maximum depth of 90 ft. In an excavation of this magnitude, a conventional system of soldier piles, wales, sheeting, and rakers that slant down into the excavation would create a bristling obstacle course for men and machines.

A system of rock-anchored tiebacks was used to provide a logical means of keeping the excavation uncluttered. Conventional braces were replaced by slanting, prestressed steel tendons anchored outside the excavation.

In the uncluttered excavation for the USS building, crawler-mounted track drills, unhindered by rakers, were used to put down blast holes.

INTERLOCKING SHEETPILING—For this structure, the foundation engineers specified a
The tieback system and interlocking steel sheet piling kept the excavation site uncluttered for maximum work efficiency.
continuous wall of USS interlocking Z-shaped sheetpiling because steel sheetpiling provides an excellent toehold in the rock.

After the Z piling was driven, excavation proceeded to about 2½ ft below the level where tie holes were burned through the projecting surfaces of the Z piling. Horizontal spacing of the tie holes is about 15 ft. Next, a pneumatically driven "drifter" mounted on a small crawler was used to drive pipe casing diagonally downward at 45° behind the sheetpiling until it hit rock. The same machine drilled a rock socket about 20 ft into the rock.

Laborers cleaned out each hole with an air or water jet, and a tendon made of from 6 to 12 USS SUPER-TENS strands was inserted. Grout made from USS UNIVERSAL ATLAS high-early-strength cement was then pumped into the annular space between the strands and the surrounding rock.
While the grout was setting, welders installed bracket seats on the Z-piling surface to carry the 18-inch, wideflange wale sections designed to resist the lateral pressure of the earth. The tendon was attached to the wales with special tieback anchorage details.

After the grout had attained a strength of about 4,000 psi, the tendon was prestressed to about 10 percent above working stress and maintained at that stress for 15 minutes as a pre-test. After release of the overstress, an auxiliary ram in the hydraulic jack forced the anchorage cone in place, leaving the tendon at its working stress to resist the lateral earth pressure.

In vertical spacing, the procedure was repeated about every 12 ft as the excavation continued. Where warranted by the depth of overburden, four horizontal lines of tiebacks were installed.

Maximum design load for the largest (12-strand) tiebacks is 246 kips. Minimum design load for the smallest (6-strand) tendons is 129 kips.

The tiebacks, as previously mentioned, were helpful during the excavation stage. They were of further value during construction because, until the concrete floors of the basement garage were in place, the basement walls still needed bracing against earth pressure. Rakers would still be needed, and the contractor would have had to form around rakers for both wall and floor construction. The use of tiebacks avoided this annoyance and eliminated added cost.

Like many other substructure elements, locating the ramps for the underground garage and for truck access was an exercise in careful planning. Each ramp had to recognize existing street traffic patterns and thread through the concourse, the building service core, and the railroad trestle.
IV
STRUCTURE
THE FRAMING PROBLEM—For superskyscrapers such as this, the design for lateral wind forces is a far more decisive factor than it is in moderately high buildings. Overturning moments increase basically in proportion to the building height squared. If the wind pressure were uniform throughout a building height, an 850-ft structure would have to resist twice the overturning moment of a 600-ft structure. But since wind velocities and consequent pressures increase with height, the overturning moments increase at a greater rate than the building height squared.

For these tall buildings, the major tasks of the structural frame are to provide sufficient lateral strength and stiffness to resist the high lateral wind loading, and to limit wind-induced swaying motion for human comfort and safety.

Lateral stability can be provided in a number of ways: by moment resisting frames, by bracing, or by many combinations of these two basic methods. In a braced-core building, the bracing is limited to those planes which surround the elevators and other service areas in the core.

THE “HAT”—To prevent excessive sidesway in the USS corporate center, the structural engineers tied the top of the core to the exterior columns. This space frame—or “hat”—develops the tension and compression capabilities of the exterior columns to help resist lateral movement. The interaction of the hat and the columns puts a counter-rotational moment into the core frame. Thus, the structure exhibits a reverse curvature with a point of contraflexure at about 70 percent of the height. Compared to an unrestrained cantilever, the overturning moment in the core is reduced about 30 percent and the lateral deflections are significantly reduced.

This hat serves another purpose by helping to restrain movement in the exterior columns that is generated by temperature changes. Such movement tends to occur because the exterior columns are exposed and uninsulated while the columns within the core are relatively unaffected by outside temperatures. If the exterior columns were not restrained by the hat, they would contract and expand through a range of almost 9 inches, while the length of the interior columns would remain essentially constant. This would create movement in the floors and make the structure untenable.

*The space frame—or “hat”—develops the tension and compression capabilities of the exterior columns to help resist lateral movement.*
WIND STUDIES AND TESTS—The aerodynamic efficiency of the modified triangular shape was confirmed in a study of 6 building shapes tested in the Boundary Layer Wind Tunnel at the University of Western Ontario in London, Ontario.

Though the corner-notched triangular shape did not show the best record aerodynamically, it did perform well. These results, reinforced by the high rating of the modified triangle in all other respects, made this the shape of ultimate choice.

The wind tunnel provided the means to study the effects of local topography on wind patterns at the building site. The structural engineers used a scale model (1:2,000) that simulated the rugged terrain in Pittsburgh's Golden Triangle, where cliffs rise sharply to 400 ft above the Monongahela River.
Based on the model tests, the engineers predict that the combined static and dynamic deflection at the top of the Steel Triangle will total 17 inches, with the static component roughly equal to one half the dynamic component. Thus, with a probability of maximum wind occurring once in 50 years, designers expect the tower to deflect about 6 inches and then oscillate with an amplitude of about 1 ft at a frequency of about 7 cycles per minute.
Wind-tunnel tests were also made with the model to determine the nature of the airflow over the rooftop heliport. Using the flow-visualization technique and a hot-film anemometer sensor, the engineers found that turning vanes would have no consistently significant influence on airflow characteristics, and that patterns of maximum turbulence are similar to those occurring over the top of the Pan Am Building in New York. Thus,
the USS heliport was designed without turning vanes or other special airflow-control devices.

To establish minimum structural requirements the engineers followed the Pittsburgh Building Code. An investigation of local wind velocities was also conducted. This comprehensive study of U.S. Weather Bureau records for the Pittsburgh area was correlated with city data. These facts made up the input data for wind-tunnel tests which were programmed to determine:

- the velocity profile of the wind;
- its turbulent structure;
- its directional characteristics.

Wind data for the Pittsburgh area were collected from as far back as 1873. These covered velocity and other pertinent information at four key points in the area. Corrected for varying heights, these data helped formulate a design wind speed of 84 mph for a 20-minute average, based on a return period of 50 years.

Similar studies were undertaken for the exposed column design to determine the frequency of occurrence of extreme temperatures. These data were also corrected to provide an accurate estimate of temperature conditions at the building site.

**STRUCTURAL SYSTEM**—To maintain a 45 ft-6 inch, unobstructed, column-free interior in the main office spaces on each floor, the structural engineers spanned the 50 ft-4 inch length from the service core to the spandrels with 27-inch-deep wideflange beams spaced 13 ft (three modules) center-to-center. Careful integration of the mechanical-system components with the modular structural system, and the fact that structural steel framing over the office areas is in one direction only, allow a low floor-to-ceiling height of only 8 ft, 6 inches. The beams have holes in the webs to permit passage of air-conditioning ducts and piping, and only a minimum number of holes require reinforcing.

The floor beams carry a 3-inch-deep cellular deck designed for composite action with lightweight structural concrete. The cellular deck is fabricated in half-module (26-inch) widths. Because the slab is a diaphragm between the outer frame and the core frame,
it required structural reinforcing in addition to reinforcing for temperature shrinkage. USS AMERICAN Deformed Welded Wire Fabric (ASTM A 497) was used as reinforcing steel instead of bars. This reduced the reinforcing tonnage and the total cost of reinforcement.

Because all floors are not needed in the same degree as wind diaphragms or column-restraint levels, the designers were able to make every third floor a primary floor with two secondary floors between. At the primary floors, the exterior columns are braced by a box-spandrel beam. This spandrel is placed behind the columns inside the building.
wall and it is connected to them with box-section stubs. The spandrel supports three stories in that it supports the primary floor beams and the 6-inch wide-flange columns that carry the secondary floor beams. Thus the framing is, in effect, a series of three-story buildings stacked within a main structure of three-story frames. The primary frame resists both wind and gravity loads, and the secondary frame resists only the latter.

The choice of a three-story vertical interval between primary floors satisfies several structural fabrication requirements.

Box-shaped columns, together with the horizontal and diagonal bracing members, form the core-wall bracing system. At the concourse, first-floor and second-floor levels, unusual tie bars resist the horizontal components of the diagonal members. To control the deformation, the engineers provided a large area of steel 27 inches wide and between 4 and 8 inches thick. The greater thickness resists loads at the first floor, where columns are offset to clear the railroad tunnel.

Typical Cross Section

The framing is, in effect, a series of three-story buildings stacked within a main structure of three-story frames.
Exterior columns also are box sections. Because the columns must be watertight, special procedures were followed when the plates were welded together, since the hydrostatic head of the fluid exerts an outward pressure on the plates. Additionally, USS COR-TEN Steel is intrinsically resistant to atmospheric corrosion.

SPECTRUM OF STEELS—Many grades of USS steel are used in the structural system. Principal grades are ASTM A 36 with a 36-ksi yield point; USS COR-TEN Brand, a high-strength, low-alloy steel with a 50-ksi yield point; and USS EX-TEN 42 with a 42-ksi yield point. In addition to these, other members of the USS “Family of Steels” were used: EX-TEN 50, EX-TEN 60, and “T-1” constructional alloy steel.

The 28-psf weight of the structural steel used compares more than just favorably with the weights often found in conventionally framed skyscrapers of similar or less height. As demonstrated by this building, careful preliminary study along with an awareness of the properties of modern high-strength steels will enable a designer to make dramatic reductions in structural steel tonnage.
### Table 1IV  STRUCTURAL STEEL TYPES AND TONNAGES

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**FABRICATION AND ERECTION**—At least 18 months before fabrication of steel began, USS American Bridge engineers assisted the architect-engineer planning team in developing the most economical shapes and connections for the structural framework. The American Bridge Division’s specialized knowledge of materials, fabrication and erection techniques not only reduced costs but also saved valuable construction time.

Perhaps the most sophisticated fabrication technique was used for the exposed, liquid-filled columns. All of the steel in these sections is USS COR-TEN B Steel with a yield
point of 50 ksi. Flanges range in thicknesses up to 4 inches, but web thicknesses are usually restricted to 1½ inches because of economic considerations. These cost factors are related to the requirement for full-penetration welds to provide leak-proof joints. All plates were cut to required width on a multiple-flame stripping machine and straightened whenever necessary. To control the dimensional accuracy of the box sections, American Bridge engineers developed a special full-penetration J-groove weld for connecting webs to flange plates.

The grooved plates were joined in a "Box Tacker" which held the flanges and webs together under hydraulic pressure while automatically tack-welding them. The assembled shaft then went to an automatic welding machine for finish welding. Because the USS COR-TEN Steel columns are exposed, the weld metal had to match the plates. Hence, root and intermediate welds were made with standard electrode, and the final surface passes were made with electrode material which provides a color match with the base metal.

At each primary-floor level of the three-story column sections, a stub assembly supports the box spandrel beams. These stubs are closed box weldments each made of USS COR-TEN Steel plates. Stubs were fabricated, pressure-tested, welded to the columns, and the whole assembly blast-cleaned before being shipped to a storage yard. During the fabrication of the weathering USS COR-TEN Steel, care was taken to protect it from nicks and scratches; during handling, further precautions were taken to prevent marking or staining.

Box columns for the core wall were fabricated in a manner similar to the exterior columns, except that they were fillet-welded instead of groove-welded.

At the top of the building, the hat framing includes wideflange steel shapes, welded H sections and box members. Vertical submerged-arc welding was used extensively in fabricating this framework. In fact, the entire project called for a variety of welding techniques, each chosen for its applicability to the given material and to the position of the particular joint. In shop and in field, the following welding processes were used: manual-shielded metal arc, gas-shielded metal arc with core-gas or core-wire process, semi-
automatic submerged arc, single- and multiple-wire automatic submerged arc, and the consumable guide method of electroslag welding.

ERECTION—Steelwork below the 4th-floor level was erected with crawler cranes on the plaza level; but above that floor, American Bridge used equipment usually associated with bridge construction.

Three climbing creeper derricks raised themselves by means of electric winches. With 52-ton capacity at the end of 60-it booms, the three derricks provided total coverage for the building.

Because the structural steelwork is part of an architecturally exposed frame, restrictive erection tolerances were necessary to assure that the modular building components would fit properly. These restrictive tolerances apply primarily to the plumbness and
alignment of the exterior columns, and were achieved by using elongated holes for all field bolts. To adjust the connections for diagonal bracing members connecting at the core columns, the designers specified holes 3/8 inch larger than the nominal bolt diameter.

The majority of field connections were made with A 490 or A 325 high-strength bolts. However, column and tie-bar splices were field-welded, as were some horizontal and some diagonal bracing members. All the field welds were manual-shielded metal arc, automatic submerged arc, and semi-automatic gas metal arc welding using the flux-core wire process.

QUALITY CONTROL—Because this project presented many unusual service demands, American Bridge established a strict quality control program. Goals of this program were to provide higher quality of workmanship, to reduce field and shop costs, and to provide a sufficient number of inspectors to cover every phase of the work. The inspectors used magnetic particle inspection for fillet welds and the latest non-destructive testing techniques, such as ultrasonic inspection, for complete-penetration buttwelds.

An independent inspection agency was retained to monitor the American Bridge inspectors, and this agency submitted reports both to the Pittsburgh City Building Department and to the USS design team.
THE OVER-ALL CONCEPT—Inside the structure, fireproofing methods are fairly conventional. Sprayed cementitious fireproofing is specified within the building to provide a four-hour rating for the interior columns and bracing and a three-hour rating for the other structural members (beams, roof framing) and for the underside of the ribbed cellular floor deck. In some locations subject to heavy abuse, concrete is used for fireproofing in below-plaza areas, and it provides a similar rating for the framing of the core and substructure.

Exterior-column fireproofing on this building is, however, another matter: it is accomplished by using hollow box-column sections filled with liquid (water plus antifreeze and corrosion-inhibitor additives). The idea of using liquid-filled exterior columns is not new in theory, but it marks a significant departure from usual practice.

THE EXTERIOR COLUMNS—Eighteen USS COR-TEN Steel liquid-filled columns, six on each side of the triangular-shaped building, rise to a height of 841 ft. They contain a total of about 400,000 gallons of water and 625 tons of potassium carbonate for antifreeze. The columns are rectangular box-column sections fabricated from four steel plates. At the base, the plates are 4 inches thick, but this thickness is reduced toward the top of the building where structural loads are not as great.

Because the columns are located 3 ft from the building face, their exposure to fire will be considerably less severe than would be the case for interior columns. Direct flame impingement could occur because of the close window spacing; therefore, calculations for steel temperature were based on the assumption of such impingement.

As previously discussed, the architect set the columns outside the wall to preserve the modular flexibility of the interior office space. Had they been set inside the wall plane, these columns would have obstructed the uniformly open interior and marred the architects' plan for complete flexibility throughout the 221-ft length of each office space.

The design uses the concept that the water inside the box-column sections will absorb heat in much the same way as water in a water-tube steam boiler. Any steam that may be generated in the columns will escape through an open vent. Thus, pressure should
The liquid-filled exterior columns are used as a fireproofing technique that is an architectural boon with an economic bonus. Total savings attributable to this system are estimated at $1 million.
have no chance to build up inside the columns.

Under severe fire exposure, the maximum temperature which the exterior surfaces of these columns would reach is conservatively calculated at 640 F—a figure far below the generally accepted safe average temperature limit of 1,000 F.

These conclusions were based on conventional heat-transfer theory. Heat transfer to a structural member exposed to fire in a building may be affected by the intensity, duration and disposition of the fire, and by the dimensions and location of the member. A detailed discussion of the application of the heat-transfer theory to liquid-filled structural members is available from U.S. Steel.

The water-cooling scheme, almost paradoxically, presented another challenge: how to prevent the freezing of the column water. Severe pressures could develop if ice should form inside the columns. The answer lies in the use of an antifreeze: potassium carbonate with potassium nitrite as a corrosion inhibitor.

To protect the component parts of the columns from excessive stress due to internal pressure, the engineers divided the 841-ft columns by solid diaphragms at the 16th, 34th and 50th floors. Each of these four vertical zones is roughly 16 stories high.

These levels were chosen so that hydrostatic pressure in the columns—due to the height of the liquid—will not exceed 130 psi. This pressure is calculated on the basis of a 1.3 specific gravity for the antifreeze mixture, with a reserve tank a few floors higher.

Located at the top of each of these vertical zones, inside the triangular service core, is a single, vented storage tank connected by pipe loops serving all 18 exterior columns at the top and bottom of each zone.

Additionally, this water-cooling fireproofing technique proved to be an economic bonus as well as an architectural boon. The architects could have maintained the uniform exposed USS COR-TEN Steel column finish by using sprayed-on fireproofing or cement plaster faced with light-gage USS COR-TEN Steel. The cost of conventional fireproofing,
plus about four acres of USS COR-TEN Steel column covers for the three miles of column, far exceeded the estimated combined cost for the water-cooling system and the extra cost of precision welding required to insure watertight joints in the columns.

Total savings attributable to the water-cooling fireproofing are estimated at $1 million as against the cost of a conventional system.
VI
EXTERIOR WALL TREATMENT
THE PROBLEM—The systems-analysis design technique required careful integration of the curtain wall with all interior and exterior building components. This important system had to be combined logically with partitions, ceilings, air-conditioning systems, and structural framing.

To arrive at the most effective solution, USS and the building designers evaluated three basic exterior-wall concepts:

1. **Load bearing**—an exterior wall with the ability to participate in the structural integrity of the building as a primary load-transfer medium;

2. **Building stiffening**—an exterior wall designed to function as a secondary stress-transfer medium which helps reduce building sway caused by lateral or wind loads;

3. **Weather curtain**—an exterior wall with the primary function of controlling interior building environment while resisting only those positive and negative lateral loads caused by wind.

The principal design determinants for the exterior wall were the building's structural system and the layout requirements of the interior space. The structural frame function, member size, and location—previously established—were basic influences in the final selection of curtain wall from the three basic systems studied.

THE SOLUTION—As noted, the structural system of this building is a triangular-shaped, centrally braced core with a stiffening system that utilizes the hat truss to develop tension and compression stresses in the exterior columns.

This framing system (discussed in Section IV) does not need an exterior wall that either provides assistance in stress transfer or contributes to the building's stiffness. Hence, a weather curtain was chosen as the most efficient exterior wall system.

With this design decision made, aesthetic and weathering requirements, interior climate control and maintenance costs of the curtain wall were the next considerations. The architects recognized the client's product interest and therefore addressed themselves to a steel expression consistent with the wall requirements. USS COR-TEN High-Strength, Low-Alloy Steel—the classic weathering steel—was the logical choice.
**USS COR-TEN STEEL**—USS COR-TEN Steel has the exceptional ability to form a tightly adherent, dark-russet, ferrous-oxide surface coating which, after several years of exposure, becomes a protective surface that retards further corrosion.

Having established the basic exterior wall concept, the architects then determined such factors as area relationship of vision glass to insulated panel area and thermal characteristics of the wall. They also considered the advantages of operable sash for window cleaning versus the use of exterior washing equipment. The operable-sash system was chosen primarily because problems generated by heliport requirements and the roof overhang made the installation of washing equipment impractical. The operable-sash system offers compensating economies in lower insurance rates, in labor costs, and in elimination of equipment.

**THE USS ULTIMET WALL FRAMING SYSTEM**—It was originally felt that the facade design should provide windows in each module while maintaining the building’s ability to control heat losses and gains. The final design met these requirements with a bronze-tinted glass area representing about 25 percent of the wall surface. This helped establish a window size at approximately half the width of one 4 ft-4 inch module and half the height of one 11 ft-10 inch story, and placed one window in each module.

A significant contribution to the success of the exterior wall in meeting the criteria set for it was the development and use of the USS ULTIMET Wall Framing System—in USS COR-TEN Steel. This versatile and efficient framing system more than met the weathering and structural performance requirements established by the planners. Further, the components are precision roll-formed, light weight and finely detailed.

The USS ULTIMET System offers a number of significant advantages over conventional wall systems:
- Horizontal members that snap-lock to mullions thus eliminating welding, bolting or other more intricate mechanical connecting methods on the site;
- Horizontal members that are designed with a built-in drainage system—to the outside—from both the window and spandrel areas. They are also designed to permit adequate expansion and contraction;
The modular USS ULTIMET Wall Framing System is in bare USS COR-TEN Steel.
1/8" THICK LAMINATED PANEL—16 GAUGE COR-TEN EXTERIOR PANEL & 22 GAUGE 3 COAT PORCELAIN ENAMELED STEEL ON INTERIOR SIDE WITH RIGID INSULATION CORE

FORGED STEEL ANCHOR

BUILT-IN ANGLE

FLOOR SLAB

MULLION NOTCHED TOP & BOTTOM TO CLEAR SPANDREL STEEL

FORGED STEEL ANCHOR (TOP & BOTTOM)

22 GAGE STAINLESS STEEL WATERTIGHT CATCH PAN ONE REQUIRED AT BOTTOM OF EACH MULLION AND TACK WELDED TO SPANDREL BEAM COVER

MULLION SECURING TO FLOOR SLAB AT 'J'
The easily assembled USS ULTIMET Wall Framing System is economically sound for both low-rise and high-rise structures.
A dry-glazing system utilizing specially designed, long-lasting neoprene gaskets that snugly retain both the fixed glass in the windows and the insulated panels within the framing grid.

The USS ULTIMET COR-TEN Steel millions were roll-formed from 0.045-inch-thick material; the outside horizontal muntins are .030-inch USS COR-TEN Steel. Lighter gage USS COR-TEN Steel was used to make the exposed face sheets of the insulated spandrel panels. The stainless steel vents are horizontally pivoted.

The USS ULTIMET Wall Framing System meets the standards of the National Association of Architectural Metals Manufacturers’ Specifications for Metal Curtain Walls for Buildings.

In tests at the University of Miami’s Housing Research Laboratory, a three-story mock-up of the curtain-wall system—roughly 10 ft x 39 ft over-all and including 6 windows—passed the NAAMM structural, water- and air-infiltration tests. These tests are described by the following NAAMM specifications: Test A—Structural Performance at Room Temperature; Test B—Air Infiltration at Room Temperature; Test C1—Water Infiltration at Room Temperature by Static Pressure (Standard and Supplemental); Test C2—Water Infiltration at Room Temperature by Dynamic Pressure (Standard and Supplemental).
VII

INTERIOR WALLS AND CEILING SANDWICH
MODULES OF THE MODULE—The building design, an architectural reflection of the total modularity concept, was developed from the dimensions established for the basic office unit. This unit, determined after careful study of USS needs, resulted in a design that gave optimum efficiency and flexibility.

This modular office unit became a sort of building block, and its dimensions determined the depth of interior space from core wall to exterior wall. Further, this basic unit was the module for the curtain wall, the window openings and air-conditioning induction units. Movable steel partitions, the ceiling, linear air-handling equipment, and under-floor electrical distribution were all designed to conform to the same basic module and were interrelated within the modular unit.

The result is a total modular system that affords the highest order of space use, while providing at the same time a remarkably high degree of interior flexibility that obviates changes or modifications to the architectural, mechanical or structural elements.
Movable steel partitions and doors were all factory-fabricated, delivered to the job, and quickly and easily installed. They can be relocated easily when office spaces must be rearranged.

The basic interior core walls were constructed of two 1-inch layers of laminated gypsum coreboard set in roll formed galvanized steel channels and covered with two ½-inch layers of gypsum wallboard. The steel channels were formed from either 16, 18 or 20 gage sheets, depending on the height and strength requirements of the wall.
CONTROL FLEXIBILITY—The need for optimum flexibility in the office layouts created a corresponding need for flexibility in the air-conditioning system. Thus, the program called for a system of individual controls that can be maintained without changes to the diffusers or connected ductwork, and without rebalancing the system.

Office areas are divided into two air-distribution zones. The space extending three modules from the outer wall is called the perimeter zone, and all remaining space is referred to as the interior zone.

NEW AIR-DISTRIBUTION TECHNIQUE—The air conditioning for the interior zone uses a new technique of variable-volume, constant-temperature air distribution. Unlike the perimeter, which may require heating or cooling along different wall exposures, the interior zone requires only cooling throughout the year. Even on Pittsburgh’s coldest winter day, the human heat load and the heat given off by the lighting make comfort-cooling necessary in the interior office space. Linear air diffusers direct cooled air into the offices throughout the year.

The diffusers are designed and spaced to permit modular partitioning. Draft-free air can be diffused on either side of a partition that is located directly below the diffuser, and the amount of air on each side can be controlled independently. Thus different quantities of air can be discharged into each of the offices that share the same partition and the same diffuser.

Distribution characteristics of the unit are such that, regardless of the size of the space and the varying air quantities required for a conventional office or for special areas such as conference rooms, the requirements can be handled without modification to the air-distribution system, to the ceiling, or in the number of air-diffusion devices. In addition, adjacent spaces can be maintained at different temperatures.

Specially designed for this project, these diffusers can be easily readjusted for any future building occupancy changes. It is a system that can meet all foreseeable demands during the life of the building. It is expected that this feature will save considerable money per year during the life of the building and provide maximum comfort.
SINGLE-DUCT SYSTEM—In addition to this unique diffuser feature, the interior-zone air conditioning has all the normal advantages of a variable-volume system. Installation cost is reasonable and the variable-volume system minimizes the space requirements of the main supply and return ducts.

Further, it eliminates: 1) mixing boxes and their damper controls for each module, as are required in a dual-duct system; 2) the hot water piping distribution network required in a terminal-reheat system; and 3) the constant modification to the distribution and/or control schemes required with either of the above commonly used systems.

Its operating costs are low because above the minimum circulation standard the refrigeration output and fan horsepower adjust to the actual air-conditioning load. During intermediate seasons, outdoor air can replace mechanically cooled air to provide inexpensive cooling. Moreover, this system requires no supplementary local heat and thus eliminates the need for resistance heating elements (and wiring) or local zone coils (and water piping), as needed in the terminal-reheat system.

THE DIFFUSERS—The variable-volume interior-zone air supply is distributed through high-pressure ductwork of conventional design to each train of diffuser units extending from the interior core wall to the exterior zone. The diffuser unit itself is furnished with a factory-fabricated steel plenum, thermally and acoustically insulated with fiber glass to attenuate noise from the high-pressure, high-velocity air. The 30-ft-long air-train diffuser section is served by two flexible ducts connected to the main supply duct.

LINEAR DIFFUSER CONTROLS—The distribution units, each equipped with two-way-blow linear air diffusers, are spaced 13 ft center-to-center down the length of each office area, perpendicular to the core walls. The distribution characteristics of the diffuser are such that it is a simple task to adjust the air quantity without affecting the air motion and temperature traverse in the space. Changes in air quantity are made by dialing the desired cfm on a factory-furnished and calibrated vernier-type regulator.

This control works under varying conditions. Discharging from either the ceiling area or from directly above a partition, the units can maintain a draft-free environ-
Air conditioning for the interior zone uses a new technique of variable-volume, constant-temperature air distribution. This zone requires cooling throughout the year.
ment at any of the projected air quantities for varied occupancy ranging from 1.0 cfm/sq ft to a maximum of 2.0 cfm/sq ft.

In another feature of the system, an optional thermostat can be concealed in the linear diffuser where required and can be set to maintain a desired temperature. The thermostat activates a damper operator, powered by the high-pressure supply air, and permits independent volume control from either or both of the parallel air slots. Because this control system uses the air-conditioning system supply air as its motive power, there is no need for an independent, high-pressure control air grid or an electrical wiring system.

The thermostatic controls can be plugged into outlets from beneath the diffusers whenever individual room control is required. Units located directly over partitions can also be quickly and simply equipped with a complete control system for one-side or two-side control without moving the partition.

In open interior spaces, where individual control is not feasible because of the numerous occupants, the units discharge air at constant volume pre-set on the regulator. But changes in volume in those areas under thermostatic control do not affect the volume of air being supplied to these areas, since this regulator allows delivery of the proper design quantity of air without regard to fluctuation in duct static pressure that may be caused by the flow of different air quantities in other areas.

PERIMETER ZONE—For the perimeter zone of offices along the building’s exterior, the mechanical engineers’ design of a conventional two-pipe induction system for perimeter heating and cooling displays the value of the systems-design approach. The inherent economies both in installation and operating costs were quickly proved at the outset.

Because windows occupy only 25 percent of the wall area, the architect was able to restrict heat gains and losses to relatively modest proportions. Therefore, the more flexible but more expensive four-pipe system was not necessary. The excellent insulation characteristics of the USS ULTIMET Wall Framing System reduce the required capacity of the refrigeration and the heating plants as well as the cost of energy to run them.
The heating and cooling in the exterior perimeter zones is the economically proven two-pipe induction system.
THE INDUCTION SYSTEM—Induction units along the walls serve minimum spaces of three modules (13 ft) measured from the outside wall toward the center of the building. One unit is provided for each 4 ft-4 inch exterior module measured along the outside of the wall.

One inherent advantage of this induction system is that the secondary-water system, distributed to the coil on each unit at about 50 F at time of maximum cooling, provides most of the cooling in a particular space. Thus, the quantity of cooled air needed is reduced to that amount required for good ventilation and air motion. Air is delivered to the induction units from the loop main above the ceiling below, through branch take-offs stubbing up through the floor within the unit enclosure. Each stub-up or riser serves three induction units. Because the amount of air is smaller and is delivered at high speed and high pressure, a comparatively small riser diameter of only 5 inches is sufficient. Correspondingly, less space is required for ductwork and central air-handling equipment.

In this conventional air-water induction system, dry primary air offsets such latent heat gains as perspiration and moist air infiltration. Through its jet-discharged siphoning action, dry primary air pulls room air across the secondary water coil, where the room air is cooled (or heated, depending on the season). A mixture of both primary and room air is then delivered to an office space at the proper temperature needed to maintain desired thermal control levels. Basic control is achieved by modulating the flow of cooled or heated water to the secondary water coil with a thermostatically controlled automatic valve located in the piping of the unit.

Since water in the two-pipe secondary system must be of one temperature, variations in air temperature will satisfy the demand for simultaneous heating or cooling that may be required in any of the three different office zones on each floor. This problem arises because the load in each of the exterior office spaces is subject to four variables: sunshine, people, lights and other electrical equipment, and the transmission due to the difference between outside temperature and room temperatures.

The performance capability of any air-conditioning system is greatly affected by variable
sun load and by the fact that the transmission load can be a heating or cooling load,
depending on outside temperature. The two-pipe induction system, however, maintains
proper comfort levels regardless of exposure, water conditions or time of year.

CONTROLLING THE AIR IN LOBBIES AND CORE AREAS—The air-conditioning system
for the elevator lobbies and other core areas includes the same diffuser principle that
is used in the interior zone. Here, however, all units operate at constant volume because
there is no variation in load.

Air ducts serving both interior and peripheral units are housed in the building’s triangular
core. Branch ducts threaded through the floor beams serve the variable-volume diffusers
through flexible ducts. A trunk-loop duct in the ceiling space carries air from the core-
duct shafts to the induction units.

Return air from both perimeter and interior zones enters the ceiling plenum through
slots in the light fixtures. From the ceiling plenum it goes to the return risers.

MECHANICAL EQUIPMENT AREAS—The building has four large mechanical equipment
rooms housing fans, pumps and heat exchangers which reduce 200-psig steam to 10 psi
and then heat water to temperatures ranging from 100 F to 200 F.

A concourse-level equipment room serves the substructure and the lobby areas; a 3rd-
floor equipment room serves the lower quarter of the tower (floors 3 through 78); a 34th-
floor room serves the midsection (floors 19 through 48); and an equipment room at the
63rd and 64th floors handles the top quarter and houses the main refrigeration com-
pressors and cooling tower. Fans are looped in parallel for more efficient operation at
partial cooling loads. If, for example, only three floors out of a 15-floor stack are in use,
several fans can be cut out for the interior zone. Automatic shut-off dampers in the duct
system allow air to be diverted from unoccupied to occupied floors. Controls for these
shut-off dampers are centrally located in the 63rd-floor mechanical equipment room.
Largest of the fans deliver 100,000 cfm.

An 8,500-ton-capacity refrigeration plant is located at the 63rd floor. This location was
selected chiefly to economize on condenser-cooling water piping.

The 63rd-floor location also relieves the hydrostatic pressure on the condenser water pumps, chilled-water pumps, refrigeration machines and on the largest sizes of pipes and valves. It also cuts the requirement for basement space, which is more critical than superstructure space. Because of the existing railroad tunnel, basement space is especially limited in this building.

The availability of relatively low-cost electric power made electrically driven centrifugal water-chillers the choice for the giant refrigeration plant with its two 3,500-ton chillers and one 1,500-ton chiller.

Because it was readily available at lower cost, street steam was chosen as the heat source rather than an oil- or gas-fired boiler plant or electrical energy. Avoiding a space-consuming and expensive boiler system was a significant consideration.

Among the many alternatives considered and rejected were a system of gas-turbine-driven centrifugal machines with waste-heat boilers, and a system of electrically driven centrifugal machines arranged as a heat-conservation type of heat-pump system. These were rejected because they promised relatively minor operating cost savings in return for a substantial increase in capital cost.
IX

ELECTRICAL SYSTEMS AND COMMUNICATIONS
WIRING FOR EXPANDING NEEDS—Obviously, this building requires a rather large electrical energy supply. But how large may be seen from the following: the total electrical capacity is 35,000 kw, a power supply equivalent to the demand of 20,000 single-family homes. A portion of this capacity provides the flexibility to anticipate future needs. Wiring was designed to accommodate a 50-percent increase in lighting levels within specified areas, or a combination of lighting and receptacle growth.

To satisfy the need for total flexibility in office partition location (limited only by the module itself), the electrical engineers eliminated partition receptacles and switches in these areas. Lighting wiring is restricted to the ceiling. Outlets in the underfloor-duct system provide connection for copying machines, electric typewriters and other office equipment.

A central switching system replaces the normal room or floor switching unit. It provides for key-switch manual over-ride in case, for example, a department is working overtime or a watchman wishes to inspect a floor during off hours. Ultimately, when controlled by the central computer, the switching system will be programmed to turn lights on and off automatically at predetermined times.

POWER DISTRIBUTION—A novel aspect of the power-distribution system is the continuation of 11,500-volt primary feeders up through the building without reducing the voltage to the normal 480-volt risers in a basement-level transformer bank. Instead of the usual 480-volt secondary service risers, 8 high-voltage risers—500 mcm strand copper (USS AMERZONE B)—feed this 11,500-volt supply all the way to the top of the building.

Voltages are reduced by a number of relatively small transformers located throughout the building at or near the floor where this converted voltage is used. The high-voltage riser system proved to be the most economical in first cost. It trades the additional cost of the more numerous transformers—required on 60 percent of the floors—for feeder savings. This last more than outweighs the cost of additional transformers.

CIRCUITRY—The USS Steel Triangle has five basic circuits. Two are three-phase, four-wire circuits: 120/208 volts and 227/480 volts. The 120-volt circuits serve general light-
ing and receptacle loads; the seldom-used 208-volt circuit serves special uses like radiant quartz lamps in the covered portions of the garage entrance ramps; and the 227-volt circuits also provide service for special lighting, e.g., underground parking areas, heliport and lobby.

The 480-volt circuits of the three-phase, four-wire power supplement the three-phase, three-wire 480-volt circuits that supply the basic building power for water-supply pumps, moving-stair motors, heliport fire pumps, elevators and fans. Another three-phase, three-wire circuit, stepped down to only 2,300 volts, supplies power for large electric motors (300 to 1,500 hp), including 5 large chilled-water pumps and a 1,500-ton chiller-compressor motor in the 63rd-floor mechanical room. For the 2 largest (3,500-ton) chiller-compressor motors, the power supply is primary feeder voltage—an untransformed 11,500 volts.

An ingenious arrangement of lighting circuits and transformers assures continued lighting for at least half of each 10,000-sq-ft office space in the event of transformer failure.

Office lighting circuits on each floor feed out from three electrical closets, each located as closely as practical to an apex of the triangular service core. From each of these three electrical closets the lighting circuits feed out in two opposite directions, each serving half of one-third of a floor. Also within the service core, transformers are located on 3 of 5 typical office floors. Since the power of any main office space comes from two transformers, at least half this space will remain lighted if one transformer fails.

The transformers are dry-type, delta-Y connections, with forced-air fan-cooling in units rated at 750 kva and larger, and convection cooling in smaller sizes.

LIGHTING—Lighting is designed to take a great increase in intensity whenever and wherever needed. The basic illumination level is 100 fc, but a limited area can be increased to 200 fc and special areas raised to 250 fc.

Because the lighting circuits are 120 volts (the voltage at which high frequency lighting is being developed today), it will be possible to consider switching to high-frequency
lighting at such time when the ballasts on the conventional fixtures need replacement.

**EMERGENCY POWER**—If the commercial power supply should fail, the Steel Triangle will continue functioning by virtue of its standby auxiliary power supply. Two diesel-powered generators rated at 800 kw each will maintain communications, provide lighting for personal safety and mobility, and provide power for emergency elevator service as described in Section XI.

**TELEPHONE SYSTEM**—Telephone engineers have pointed out that the telephone system serving the USS building is as large as a communication network needed for a town with a population of 30,000.

The main or central equipment is housed in a room at concourse level; cables extend from this point to a telephone equipment closet on each floor. The header duct and cellular steel floor deck provide raceway space for the lines connecting each closet with the desk locations on a given floor.

Seven telephone consoles provide attendant service, and all individual telephones have a separate number for direct inward dialing."
The SYSTEM—The plumbing system devised for the USS corporate center is basically a conventional concept. There were, nonetheless, certain interesting aspects of the design and materials selection.

The system is designed to produce a peak water flow of 1,300 gpm. Forcing this great volume of water through the 64-story tower are four variable-speed (constant pressure) WILSON-SNYDER pumps manufactured by the OILWELL Division of USS. Each of these 100-hp units is capable of pumping 360 gpm against a 1,000-ft head.

Stainless-steel piping carries water from cast-iron street mains through the pump-discharge riser to the pressure-reducing valve stations in the 3rd- and 34th-floor mechanical equipment rooms.

PUMPED SUPPLY VS. GRAVITY SUPPLY—The pumped-supply system was selected because it offers several advantages over a gravity-supply system fed by conventional, constant-speed pumps.

To hold water pressure to the desired 150-psi limit, a gravity-supply system in this building would have required supply tanks on at least three separate levels in the building. These tanks would have preempted valuable rental space outside the core or encroached on space required for elevators and other services.

A large single storage tank near the roof level would require a second full-size riser to supply the pressure-reducing valve stations. And by transferring weight to upper floors, the gravity system would have raised structural costs, chiefly because increased column sizes to carry the additional loads to the foundation would be needed.

Moreover, the numerous conventional pumps required to keep these supply tanks filled would have required a greater power capacity than the four variable-speed pumps in the pumped-supply system. Wiring costs would have been higher, and because conventional, constant-speed pumps continue cycling on and off from zero flow to full capacity, the energy used by the gravity system would have exceeded that used for the pumped-supply system.
PRESSURE REDUCTION AND CONTROL—The mechanical engineers divided the water supply into three zones:

Zone 1: Downfeed from the 64th-floor mechanical equipment room.
Zone 2: Upfeed from the 34th-floor mechanical equipment room to the 40th floor; downfeed to the 17th.
Zone 3: Upfeed from the 3rd to the 16th.

This zoning aids in controlling the widely varying pressures within the total network. Too much pressure creates a number of undesirable conditions, ranging from rattling pipes and water wastage to the risk of overstress in pipes, valves and fittings.

A branch from the main supply line serves the substructure at about 70 psi. No boosting is required because street pressure is adequate for these underground levels. Pressure in the pump discharge riser on the 3rd floor is 370 psi; it is 200 psi on the 34th; and the desired 25 psi on the 64th is maintained by variable-speed pumps.

Pressure-reducing valves, connected in series, reduce in two stages the pump-discharge riser pressures at the zone branch lines. At the 3rd floor, for example, the total 300-psi pressure drop is achieved in two steps; from 370 to 220 after the first valve, and from 220 to 90 after the second.

Bypass valves, connected in parallel with the branch lines, permit uninterrupted operation when a valve sticks or other failures occur. If one of the pressure-reducing valves fails, the other takes over the full pressure stepdown.

At the top of the building where minimum pressure is required, the first demand drops the pressure in the pneumatic cushion tank and switches on Pump No. 1. This pump operates at the varying speed needed to maintain constant pressure in the distribution system. When Pump No. 1 cannot maintain the required pressure, Pump No. 2 is switched on automatically and this pattern continues up to the full 1,300 gpm capacity.

HOT WATER AND OTHER SUBSYSTEMS—The hot-water distribution system parallels that of the cold and is divided into the same zones. Total capacity of this system is 250
gpm. Preheaters, connected in series with the steam system's heat exchangers, extract the heat from returning steam condensate to lighten the work of the heat exchangers in Zones 2 and 3. Zone 1 has no preheater because no condensate is readily available at the 64th-floor mechanical equipment room. Hot water is delivered at a maximum of 140°F and is recirculated by pumps.

**DRINKING WATER**—A separate subsystem circulates drinking water throughout the building in a similar three-zone network. Three electrically driven chillers, one in each mechanical equipment room, provide a total of 27 tons of refrigeration—enough to air-condition a fair-sized supermarket. These units chill the drinking water to the required 45-50°F range. Drinking fountains are located in the core to serve the large office areas.

**FIRE STANDPIPE SYSTEM**—The water in the four fire standpipes is supplied by two 250-hp, 750-gpm WILSON-SNYDER pumps manufactured by the OILWELL Division of USS. These 6-inch pipes are located near the apexes of the triangular core to provide ready access to the main office areas.

Fire protection for the rooftop heliport requires a 6,000-gallon steel water tank in the 64th-floor mechanical equipment room, and a 300-gallon foam-solution storage tank, two 600-gpm pumps and three movable dispensing stations. The system also serves four stations of fixed, oscillating dispensing nozzles for automatic flooding of landing areas.

Hot-dip galvanized USS steel pipe is used in the sanitary waste and vent system for sizes up to 2 inches, and cast iron is used for the larger diameters. USS black steel pipe is used in many systems, including central soap-dispensing, heliport fire protection, fire standpipes and substructure sprinkler.**
XI
VERTICAL TRANSPORTATION
CHOOSING A SYSTEM—The building's vertical transportation system represents the end result of long, careful and cooperative study by elevator engineers and the entire USS planning team.

As commercial building heights increase, there is a corresponding increase in vertical transportation problems. In recent years, quite a few new concepts have been advanced to meet the demands of what may properly be called mass vertical transportation. It seems, however, that significant progress has been confined to such aspects as higher cab speeds, greater passenger comfort and safety, and more sophisticated operating controls.

Most of the radically different operating schemes put forward in recent years were given serious consideration by the planning group. Ultimately, the standard single-car-per-shaft operation was agreed upon as the most feasible in terms of this building's need. It may be added that the 2-floor lobby strongly influenced this decision. And, as will be shown, this system reflects in great measure the most advanced elevator technology.

Preliminary studies showed that a standard system equipped with the most advanced electronic controls could meet all the operating criteria set by the planning group.

HOW MANY ELEVATORS?—To minimize the number of elevators, locations of the various facilities were carefully plotted. Some of the factors affecting passenger-handling capacities were lunchrooms located in the upper floors, services below the lower terminal, and the use of double-floor terminals.

For USS, minimizing the problems of intrafloor traffic is achieved by locating within the same zone or bank those associated functions which require a great deal of intercommunication.

ELEVATOR TERMINALS—The plaza or street floor is normally the principal lower terminal for all elevators. But the presence of the railroad tunnel made it impossible to establish all elevator pits below street level. The principal elevator lobby (i.e. the lower terminal) for 32 of the elevators was established on a mezzanine floor. Traffic from the street level...
to the mezzanine level is handled by four moving stairs. Elevators serving the upper restaurant and several upper floors have lower terminals at both plaza level and mezzanine level because the tunnel does not interfere with the lower pit location in this area.

SERVICE ELEVATORS—A completely separate service-elevator system is another basic necessity. This distinct system is used almost exclusively for transportation of building maintenance personnel, bulk packages, mail, mechanical equipment and so forth. A separate service system eliminates interference with or discomfort to passengers when large items must be hauled. Further, cab interiors of the passenger elevators are not subjected to the hard usage and consequent damage that service elevators receive.

THE TOTAL ELEVATOR SERVICE—As designed, the USS building has six main passenger elevator banks and four freight elevators in its central core. Each of the six passenger banks contains eight elevators, giving a total of 48 passenger and four freight elevators. Each office floor is served by eight passenger and by all four freight elevators.

USS TIGER BRAND Wire Ropes operating this system include elevator hoist cable (8 x 19 Seale construction), governor cable (8 x 19), and compensation rope (8 x 25).

Elevator control is achieved through USS TIGER BRAND traveling electrical control cables. Depending on the travel distance of the elevator car, as many as 8 cables, each with 130-140 conductors per cable, maintain safe, smoothly operating elevator cars.

The elevator system occupies a large portion of the lower central core, but in the higher stories where elevators are progressively cut out, core space is gained and is used for additional offices.

MOVING STAIRS—Four of the elevator banks (Nos. 1 through 4) do not serve the main lower lobby because the Penn Central Railroad tunnel passes directly under these banks. Because of this fixed obstruction and because of the large volume of traffic anticipated, four 48-inch-wide high-speed moving stairs have been located to serve the upper and lower lobbies. Moving stairs have also been provided to serve the concourse and parking levels and other areas below the lower lobby.
CONVEYORS—To move mail and correspondence, two vertical automatic conveyors will be installed. The lower conveyor, serving between the concourse and 34th floor, will be connected to the second, serving between the 34th and 62nd floors, so that a conveyor box can be sent rapidly and automatically to any floor in the building.

SPECIAL ELEVATORS AND MOVING STAIRS—The public restaurant on the 62nd floor is served by elevators from the lobbies. A special elevator from the 60th and 61st floors serves private dining rooms on the 62nd floor and the heliport lounge on the 64th floor. A moving stairway runs from the heliport lounge to the heliport control room and loading station which is located about 4 ft below the landing pad.
THE ARRANGEMENT OF ZONES—Elevator speed and passenger (weight) capacities vary as the shaft height varies. For example, two banks of elevators serving the 44th to 54th and 54th to 62nd floors can travel at 1,600 fpm and have a 3,500-lb capacity. A single bank serving the 4th to 15th floors has a 500-fpm maximum speed and a 4,000-lb capacity.

A zone or bank arrangement of the main passenger elevators, along with their respective capacities, speeds and floors served, is shown in Table 1/XI.

<table>
<thead>
<tr>
<th>Elevator Bank</th>
<th>Number of Elevators</th>
<th>Capacity and Speed</th>
<th>Max. No. of Passengers</th>
<th>Floors Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eight (8)</td>
<td>4,000 lb at 500 fpm</td>
<td>21</td>
<td>Upper Lobby 4th to 15th</td>
</tr>
<tr>
<td>2</td>
<td>Eight (8)</td>
<td>4,000 lb at 800 fpm</td>
<td>21</td>
<td>Upper Lobby 15th to 25th</td>
</tr>
<tr>
<td>3</td>
<td>Eight (8)</td>
<td>4,000 lb at 1,200 fpm</td>
<td>21</td>
<td>Upper Lobby 25th to 36th</td>
</tr>
<tr>
<td>4</td>
<td>Eight (8)</td>
<td>4,000 lb at 1,400 fpm</td>
<td>21</td>
<td>Upper Lobby 36th to 45th</td>
</tr>
<tr>
<td>5</td>
<td>Eight (8)</td>
<td>3,500 lb at 1,600 fpm</td>
<td>19</td>
<td>Lower Lobby 45th to 54th</td>
</tr>
<tr>
<td>6</td>
<td>Eight (8)</td>
<td>3,500 lb at 1,600 fpm</td>
<td>19</td>
<td>Lower Lobby 54th to 62nd</td>
</tr>
</tbody>
</table>

There are 8 elevators in each bank. And any bank can easily be split to operate as two 4-car banks. This arrangement is better able to handle the morning up-peak and thereby increases the available capacity of the elevator system.
Table 2/XI shows the relative efficiency of each passenger bank in the total system.

Table 2/XI  MORNING PEAK PERFORMANCE DATA

<table>
<thead>
<tr>
<th>8 Cars Each Bank</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervals* (in seconds)</td>
<td>22.5</td>
<td>23.3</td>
<td>23.5</td>
<td>24.4</td>
<td>23.5</td>
<td>23.8</td>
</tr>
<tr>
<td>Passengers (carried in 5-minute intervals)</td>
<td>280</td>
<td>270</td>
<td>268</td>
<td>258</td>
<td>268</td>
<td>265</td>
</tr>
<tr>
<td>Percentage of population (carried in 5-minute intervals)</td>
<td>15.1</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.1</td>
</tr>
<tr>
<td>Potential passenger capacity</td>
<td>1,860</td>
<td>1,800</td>
<td>1,785</td>
<td>1,720</td>
<td>1,780</td>
<td>1,760</td>
</tr>
</tbody>
</table>

*Average interval between elevators at the lower terminal.

Since the potential population served by each bank is approximately 1,800, and in each case the interval lies between 22 and 25 seconds with 15 percent of the population handled in five-minute periods, the result is good-to-excellent service in terms of the established criteria.

INDEPENDENT FUNCTIONING—While functionally integrated with the total system, each elevator bank can operate independently on its own supervisory control. As designed, this system automatically (without attendants) matches service to demand and completely eliminates needless operation of any car or cars. This subsystem provides instant response to an unlimited variety of traffic conditions by the use of its own computer, a governing device which constantly directs the operation of all elevators in its bank to meet traffic conditions collectively and individually.

This is a new operating concept that obviates the need for elevators to make complete or through-trips between top and bottom terminals on a time-dispatch basis. By eliminating unnecessary car travel, this system significantly reduces passenger waiting time. More-
over, there is virtually no limit to the demand variation for elevator service. Demands and surges can be of any duration—up or down, in both directions at the same time, fairly steady or markedly intermittent—and the system will recognize and react immediately. It will function with equally high efficiency either at times of peak requirements or at those times, day or night, when there may be merely one lone call in the entire building.

Cars in each bank operate only as they may be required to match any given traffic demand; when the traffic is light, only those cars necessary to handle such passenger demand remain in operation. While other cars remain at rest at these slow periods, they are always available for immediate dispatch to any floor as traffic demand increases.

**EMERGENCY SYSTEMS**—An auxiliary or standby system has been designed to take over whenever a failure of the dispatching system may occur. When such failure happens, a signal on the traffic director's panel immediately notes both the failure and the transfer of car operations to this auxiliary system.

Even if a power failure occurs, service will not be totally terminated. Provision has been made to turn on elevators in each bank using emergency power. As the first phase in this eventuality, all cars will be returned to the lobby, one at a time in each bank. After all have been brought down, one car in each bank can be kept in operation on emergency power. This emergency system also operates the service elevator bank.

**DOOR CONTROLS**—The door-operating system electronically supervises and initiates door-closing to conform to traffic movement; distinguishes between car and corridor calls; between light and heavy traffic; and minimizes the time required for doors to remain open. All car doors are equipped with an especially sensitive guard on the leading edge of each door. Even the slightest pressure will cause the doors either to re-open or it will keep them from closing. Should the opening be blocked for an extended time, the closing action is initiated. Though the doors open and close automatically, they do not move at the same speed in both directions. They are adjusted to open at a given speed and close at a somewhat reduced speed.
When a car fails to start within a predetermined time, it is automatically removed from service, and a signal is flashed at the traffic director's panel. A fully loaded car automatically bypasses any corridor call without canceling that call. During travel, in case of over-speed or tripping of the overload relay, the car will continue and will stop at the next floor rather than make an emergency, between-floors stop.

Though they operate in a separately programmed system, the four service elevators are part of the total elevator system and serve every floor. Three of the elevators are rated 4,000 lb at 800 fpm and one is rated 10,000 at 500 fpm.

A freight elevator capable of transporting 10,000 lb is rather unusual in an office building. But, in a building of this height and because of the complexity of its system, it was found that maintenance replacement components, numerous other bulky items, and heavy office equipment must be transported with marked frequency. Thus, one unusually large-capacity service elevator became a virtual necessity.
XII

COMPUTERIZED CONTROL CENTER
PROGRAMMING THE CONTROLS—During the first two years of occupancy, maintenance men will regulate all the fans, pumps, dampers, and other air-conditioning equipment either manually or through remote controls located in the control room. Throughout this period, electronic data-processing equipment will store and organize all the data accumulated from daily operation of the building in every temperature situation.

For example, empirical data on solar heat absorbed hourly by the sun-baked walls will be fed into a computer for correlation with the volume of chilled water required to reduce the temperatures in peripheral offices to desired levels.

After storing and correlating this great mass of air-conditioning and operational data, the computers will be programmed to serve as an automatic control center. Situated on the 63rd floor with the refrigeration plant, this center will control and automatically adjust the air-handling and other related machinery.

At the end of the two-year period, the control center will be programmed to accomplish the following:
- more efficient and more economical performance of pumps, fans, compressors and related operating equipment;
- immediate detection of overheating, overcooling or other possible system failures;
- surveillance and control of faulty equipment;
- closer detection of deviations from desired comfort level so that corrections can be made quickly.

COMFORT AND SAFETY—Air-conditioning control is but one of the many tasks that can be performed by the control center. Along with the economies and efficiencies achieved in reducing the maintenance and operating force and in lowering energy consumption, the control center will contribute toward the safety and security of the equipment, the building's occupants and the building itself. The control center will monitor not only the mechanical and electrical systems but also the following functions: fire alarms; security system; emergency control and alarm; emergency power control; closed-circuit television; civil defense and disaster alarms, and building paging.
The fire-alarm, security and guard-tour systems work off separate four-wire trunks in the corridors of each floor, and code transmitters for each system are attached to the trunks for signaling the central control room. These signals are recorded on a print-out and shown graphically on a screen.

The three basic systems are:

Fire: Provision has been made for rate-of-rise thermal detectors and smoke detectors to actuate electrically a coded transmitting station. Temperature detectors and smoke detectors in each elevator shaft trip transmitters located every 12 floors. Sprinkler risers also signal the control center, and these together with the floor and elevators circuits are shown on a panel marked in building silhouettes.

Security: Tenant-security systems are plugged into the wiring trunks through code transmitters. Main stairs are protected with motion detectors at the 3rd floor, and stair-exit doors lock at the sound of an alarm.

Guard Tour: Each tour covers 22 floors with one station per floor. Recall lights and intercom phones enable patrolling guards to communicate with the control center, and a timing device triggers an alarm if a guard doesn't check into the next station within a prescribed time.

It was manifest during the planning stages that the estimated first cost of the computerized control center would exceed the first cost of separately functioning conventional control systems (for air conditioning, fire alarms, etc.) by about 24 percent.

But it became evident that the anticipated economies would quickly override this differential. With the estimated annual savings in labor, in cost of energy and in extended equipment life, the central control system could be amortized in three to five years.

In the final analysis, the systems approach enabled the designers to demonstrate the often neglected fact that initial installation cost is but one factor in the total cost equation.
THE PLAZA AND LOBBY—The broad expanse of the plaza, occupying about 60 percent of the site, is an open, unencumbered area. Pedestrians in large or small groups can move about with ease in a pleasantly large space.

The plaza is paved with the aggregate exposed and the mortar tinted brown to complement the deep russet color of the building's bare USS COR-TEN Steel structure. Walkways and steps can be kept free of snow and ice by electrical resistance heating of the paved surface.

The lobby, in a sense an extension of the plaza, has a ceiling height of 60 ft and is enclosed by large areas of glass supported by USS COR-TEN Steel mullions.

The lower lobby is paved with terrazzo of the same mix as the exposed aggregate paving of the plaza. The upper lobby (or mezzanine) has a white terrazzo floor. Core walls through both levels of the lobby and extending beyond the glass enclosing walls on the west are finished with Palladiane, a terrazzo using large pieces of the same marble aggregate used in the plaza and lower lobby. The structural framing of the building core is expressed in this core wall finish.

Lobby lighting equipment is of two general types: gas-discharge downlights, and incandescent downlights and wall-washers. These units are programmed and automatically controlled (taking into account seasonal variations) to produce light levels of appropriate intensity for all times of the day.

GARAGE—The underground parking garage occupies three levels, and parking space is
provided for more than 600 cars. A truck-loading dock permits direct access to the freight elevators that serve the building.

THE CONCOURSE—The largest single unit on the concourse level, located below the lobby, is the cafeteria. It is designed for public use, and seats up to 500 persons. This restaurant is directly accessible to the building’s occupants.

Additionally, there are two dining areas on the 62nd floor. A public restaurant seats 250, and a restaurant exclusively for USS executive personnel seats 90.

THE AUDITORIUM, EXHIBIT AREAS AND MEETING ROOMS—There is a general auditorium, located on the concourse level below the plaza. It has electromechanical and structural capabilities for many kinds of exhibits, displays, and for a great number of activities such as seminars, lectures and meetings. The auditorium also serves as a theatre for motion pictures, slide projections and other audiovisual presentations.

The main assembly area has a seating capacity of 350. Five microphones, strategically located, can pick up speech at any point for amplification through stage speakers.

The stage, approximately 30 ft wide by 15 ft deep, has a draped movie screen which serves as a backdrop. The stage occupies the entire end wall of the assembly area. The opposite entrance wall is lined with specially designed, perforated stainless steel acoustical panels. A section of each side wall is also faced with these panels to eliminate reverberations.

A complete stage-lighting system, both overhead and apron, is supplemented by powerful accent lights and a follow-spot operated from the control room. Additionally, several high-wattage accent lights in the modular steel-troffered ceiling amply serve the general assembly area.

For movies and slides, there is a projection room situated on an upper level. Distance from the screen to the projector is about 70 ft. The screen measures 28 ft by 10½ ft. The projection system permits a remarkable variety of visual effects, combining simul-
taneous projection of three images, slide images with movies, and so forth.

Flanking the assembly area are 10 permanent display booths, arranged five on each side wall. These booths may be used for many kinds of showings and they are designed as independently functioning units. Portable and easily removable auditorium seats permit additional exhibit space to be quickly created, and a great variety of display treatments can be achieved in this added exhibit space. Television presentations, live or taped, can be relayed from one part of the auditorium to another. The nerve center of the entire auditorium is the control room. From this point all sound and light operations are directed and controlled.

THE LIBRARY—The need for library facilities is fulfilled by a large space (10,000 sq ft) designed to house a general reference collection of 22,000 volumes.

EXECUTIVE FLOOR—Executive facilities on the 51st floor are divided into three functional areas. Each of these is designed to satisfy a specific activity within the operational management environment. These space divisions are:

- a board room and reception area,
- executive office suites,
- one guest living suite.

Though each space is designed to function independently, the need for efficiency dictated a scheme that integrates their related activities. Access from area to area was carefully planned.

Board Room and Reception Area—The board room and reception area, located in the center of the core, are adjacent to the entrance area.

The curvilinear shape of the board room reflects the horseshoe configuration of the conference table. The shape of the table was not arbitrarily chosen. For groups of 19 to 51 persons, studies showed that a horseshoe or U-shaped table is the best seating arrangement for optimum visual and auditory reception of all types of presentations: films, slides, talks from the lectern, roundtable discussions, and ordinary meetings.
A movable wall permits room size changes in this room. A rear projection system for films or slides equips the board room for the most advanced audiovisual techniques. There is a sophisticated electronic system that permits complete communication and control links with the projection room and the anteroom.

The reception area for the executive floor and the board room is linked by the open plan of the anteroom.

Executive Office Suites—The 11 executive office suites are arranged around the perimeter of the floor. Five extend along one entire side of the building and three extend part way along each of the other two sides.

The reception area and board room have easy access to, and a well-organized traffic pattern between, their related activities. Long, narrow corridors (which can be so distressing) were avoided by the creation of a series of staggered openings to the individual suites. An expansive, open feeling characterizes the entire area.

Guest Living Suite—One corner of the triangular floor plan is given over to a single guest living suite. It is by necessity architecturally separated from the routine activities taking place elsewhere on the executive floor. A living room, bedrooms, a kitchen and other living-area essentials are provided. This suite will be used by certain guests of the Corporation and any executives who must remain overnight at their offices.

HELIPORT AND LOUNGE—The roof is designed to function as a heliport. Though this facility may eventually be open to others, its current use is restricted to the business needs of USS. It is also designed to accommodate vertical-take-off jet aircraft when these become operative.

The planning of the heliport owes much to the data obtained from the wind-tunnel tests and to the design experience gained from the increasing number of rooftop heliports. Below the roof-heliport level there is a well-designed lounge to provide spacious and comfortable passenger accommodations.
XIV

THE CORPORATE CENTER
AS A PRODUCTIVE UNIT
The USS corporate center, as planned and built, is an efficiently functioning, economically sound unit as a result of realistically determined budgeting by the entire planning and construction team.

The structure is a dramatic architectural expression, yet it is not a monument to corporate "ego". The building could have been made "entirely" of steel had the Corporation so desired, but USS steel products were used first for reasons of economy and adaptability and secondly for their "showcase" value.

This office structure must function as efficiently as any other production facility. While its product is not ingots, plate or bar, it must provide the means of carrying out the myriad daily decisions that affect the way USS does business—a way that must serve USS customers and stockholders in the best possible manner.

Comfortably and efficiently housing the thousands of people who initiate and implement business procedures, the building is expected to yield dividends in the speed, accuracy and quality of work in each departmental group.

Further, the USS corporate center will unquestionably yield technological dividends for the entire building industry. Innovations, performance and systems studies, the planning approach, and the occupancy experience will provide realistic data for all those concerned with commercial high-rise structures.

This building is an attractive and eminently meaningful demonstration of a belief and a commitment: United States Steel Corporation's belief in an ever-expanding and almost limitless market for steel in its many forms and alloys, and a commitment to total participation in the exciting future of building technology.

USS personnel are always available to answer questions on any aspect of this building or on any aspect of structural planning. Please contact:

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