When it came time to renovate the building, one of the design-build team’s major goals was to reduce the building’s energy use to below 30 kBtu/ft²·year (which was more aggressive than the General Services Administration’s project requirement to be lower than 39.1 kBtu/ft²·year). The challenge was how to achieve these aggressive energy targets with this old, poorly sited building. Rather than fight the building, the team changed its perspective and thought about how it could use the original attributes to its benefit.

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**Balancing Act**

This project was a balancing act of multiple, sometimes competing, goals and expectations and necessitated an integrated team that brought creativity, longevity and confidence to the final solutions:

- Preserve the historic design and provide a contemporary interior design in harmony with the building’s original architecture. Built in 1965, the building remains an emblem of its time, and
is a noteworthy piece of federal architecture in Denver (see sidebar Modern Architecture: A Stellar Example).

- Upgrade the existing envelope to support aggressive energy reduction goals, improve occupant comfort, and reduce stack effect.
- Provide significant safety improvement, invisibly, for progressive collapse, blast protection and seismic upgrades.
- Set the building on a path to achieve GSA’s 2030 energy goals.

**Project Scope**

A nearly total gut of the building’s interior (including complete asbestos abatement) only left historically significant interior design elements, the primary structure, and the historic exterior envelope. These bones served as the framework on how to best rethink, design, and operate the high-rise building in the future.

A major focus was to reorganize the core building functions into a more efficient and flexible arrangement. The team focused on the user’s experience to simplify wayfinding while creating a memorable experience. The design of the central core and primary circulation paths provides: unobstructed views to the exterior; equally obvious men’s and women’s toilet locations (relocated from the ends of the building); a consolidated, symmetrical core maximizing efficient and flexible tenant layouts for single or multi-tenant floors; and the “race track” circulation path on each

**The Complex**

The Rogers Complex consists of a five-story courthouse and an 18-story office building linked by an exterior canopy; each component is an integral part of the overall design. A landscaped plaza with trees, lawn panels, and outdoor seating completes the site. The formal site configuration, which includes prominently situated public art, gives a distinguished quality to the entire complex.
Guided by the GSA’s First Impressions Initiative, the design improved the appearance and efficiency of the public spaces, articulated the entrance area and alleviated security-check queuing delays.

BUILDING AT A GLANCE

Name Byron G. Rogers Federal Building
Location Denver
Owner General Services Administration
Principal Use Office building
Employees/Occupants 850
Expected (Design) Occupancy 900
- Percent Occupied 94
Gross Square Footage 494,500
Year Built 1965
Major Renovation 2013
Renovation Scope Full renovation
Total Renovation Cost $159 million
Cost per Square Foot $322

ENERGY AT A GLANCE (U.S.)

- Annual Energy Use Intensity (EUI) (Site) 39.63 kBtu/ft²
- Electricity (Grid Purchase) 35.59 kBtu/ft²
- Natural Gas 4.04 kBtu/ft²
- Annual On-Site Renewable Energy Exported 0 kBtu/ft²
- Annual Net Energy Use Intensity 39.63 kBtu/ft²
- Annual Source (Primary) Energy 115.99 kBtu/ft²
- Annual Energy Cost Index (ECI) $1.08/ft²
- Annual Load Factor 84.64
- Savings vs. Standard 90.1-2007 Design Building 51.4%

ENERGY STAR Rating 99

Heating Degree Days (Base 65°F) 6,020 hours
Cooling Degree Days (Base 65°F) 2,732 hours
Annual Hours Occupied 3,120 hours

KEY SUSTAINABLE FEATURES

Water Conservation Low-flow and infrared fixtures to achieve water savings of 30%.

Daylighting To maximize daylight, induction units were removed from in front of windows, opening up nearly one-third of the nine-foot-tall glass panes. By placing mechanical systems overhead instead, the team was able to let in 30% more daylight through the windows. The design also includes motorized window shades, translucent and transparent partition walls, daylight photosensor controls, and occupancy sensors.

Individual Controls Task/ambient lighting design.

Other Major Sustainable Features One of the first buildings of this scale to be lit with 100% LED lights; solar thermal heat sources will fuel 30% to 50% of the building’s domestic hot water; high-performance window glazing; innovative envelope insulation; chilled beam system; thermal mechanical system; regenerative drive technology will reduce elevator transportation energy by 15%.

BUILDING ENVELOPE

Roof
- Type TPO
- Overall R-value R-30
- Reflectivity SRI of 77

Walls
- Type Precast, 4 in. mineral wool, 2 in. to 4 in. of medium-density spray foam
- Overall R-value R-20
- Glazing Percentage 33.33

Basement/Foundation
- Slab Edge Insulation R-value Existing condition
- Basement Wall Insulation R-value Existing condition
- Basement Floor R-value Existing condition
- Under-Slab Insulation R-value Existing condition

Windows
- Effective U-factor for Assembly 0.27
- Solar Heat Gain Coefficient (SHGC) 0.17 at south, 0.22 at north
- Visual Transmittance 24% at south, 35% at north

Location
- Latitude 39.7392
- Orientation Southwest

BUILDING TEAM

Building Owner/Representative U.S. General Services Administration
Architect Bennett Wagner & Grody Architects with HOK
General Contractor MA Mortenson
Mechanical Engineer The RMH Group
Electrical Engineer The RMH Group
Energy Modeler The RMH Group
Structural Engineer Martin/Martin
Lighting Design The RMH Group
LEED Consultant HOK
Commissioning Agent eCube
Modern Architecture: A Stellar Example

Modern architecture began in the early 20th century and was in direct opposition to the ornately carved and heavily embellished classical buildings of the past. Modern architecture embraced and celebrated new building technologies, materials and construction methods such as precast concrete, aluminum, plastics, and structural steel frames.

These “new” materials were an expression of their own making, which originated in the Industrial Revolution. For example, structural steel and aluminum could be extruded to create highly efficient and effective materials that had no decoration. Architects and designers were free to explore new ideas of design where a building’s beauty was found in its simplicity of mass, shape, and detailing. Decoration was unnecessary.

The Mid-Century Modern (MCM) movement was an experimental time between roughly 1930 and 1960. In America, the MCM building became more organic and sometimes was referred to as “Space Age” when compared to some European counterparts, especially compared to the earlier modern Bauhaus or International style buildings.

Many of our country’s mid-century buildings have been lost. However, the Byron G. Rogers Federal Building served as an opportunity to preserve a strong and representative design from that era. The building reflects an evolution of the modern and mid-century modern architecture styles of the time toward a more restrained and less experimental design compared to some of its contemporaries.

The primary building shape extrudes a floor plan in the shape of an elongated fish. The building mass is a solid grey precast concrete volume with boxed edges in contrasting white precast to accentuate the shape and cast a sharp tapering line against the sky. The tall, slender windows are the primary “decoration,” and the architects (Fisher and Davis & James Sudler Associates) made subtle movements by pushing the windows in and out of plane of the larger mass.

Inside the building, ceilings float and are separated from the walls. Cove lights further the concept. Rich marble wall panels are simply expressed. The waterfall stair to the second floor is a strong statement of the 1960s.

Floor-by-floor main distribution pathways (ducts, hydronic pipes, and conduit) were organized above the racetrack circulation hallway. These lower ceilings reinforce the main circulation path, celebrate the “fish” shape of the building, and provide flexibility for multi-tenant floors. Higher ceilings were achieved at the perimeter, which allowed natural daylight to penetrate further into the building and into enclosed internal offices.

Envelope and Windows
Solving the building envelope issues required a highly integrated team. The envelope system had to address several factors: maintain the historic building design, keep the existing

The window upgrades kept in place the historic projecting aluminum frames that have a U-value 0.27 and keeps tons of aluminum from the recycle bin.
Emerging Technologies

From the outset, an overarching goal was to deliver a project that sets the standard for public and private sector office renovation projects alike. Active chilled beams, heat pump chillers, thermal storage, and 100% LED lighting were determined to be viable design strategies for future General Services Administration (GSA) office renovation projects, in part, through their successful performance on this project.

In addition, the Byron Rogers project informed the GSA’s then-new Green Proving Ground (GPG) program, which leverages GSA’s real estate portfolio to test innovative building technologies and to accelerate the transition between bench-scale technology and commercial viability. Changes to GSA’s design standards have also been informed by the emerging technologies successfully used on the Byron Rogers project.

Also, due to its age and condition, the building was selected to receive funding for a complete remodel through the 2009 American Reinvestment and Recovery Act (ARRA). Because the GSA received additional ARRA funding strictly to incorporate emerging energy-efficiency technologies such as LED lighting into the design, the GSA established aggressive sustainability targets well beyond federal requirements for the project.

The upper floors’ 1,500 dark bronze windows project 4 inches out from the precast panels. While architecturally critical to the design of this mid-century modern building, however, they also act like fins on a radiator, transferring heat in and out of the building. The design-build solution maintained the historic window frames, while also achieving a high performing and thermally broken solution.

The most prominent historic design element of the building is the pattern of slender aluminum windows and carefully articulated polished aggregate precast concrete panels. The tall windows on the upper floors project out past the face of the precast panels, while at the lower floors the windows are recessed deeply into the building plane. The precast is irreplaceable and known to be brittle when handled; therefore, it was decided to keep the existing precast panels in place and perform all work from the building interior. This also avoided scaffolding 18 stories or performing work from a swing stage.

The precast in place, accurately match window frame profiles and details, provide glass tint that is historically accurate yet reduces heat gain and maximizes daylight admittance, install blast windows and supporting structure, install progressive collapse structure, achieve an effective R-9 exterior wall (total of all window and opaque walls), and maintain vapor barrier continuity around existing structural elements.

Fortunately, the frames were generally in good shape and could remain if alternative solutions were developed to reduce heat loss and address blast requirements. The frame manufacturer studied ways to recreate a new and better projected window
frame that limited the “radiator” effect and could resist blast loads. Unfortunately, it was not possible.

The team developed another option: to keep the existing frame in place, and then install a new blast window on the interior. This proved to be the most viable option because it also increased the thermal performance of the window system and facilitated an easier installation and fabrication of blast structural steel and window. It was determined that an operable glazing unit on the interior side of the existing frame would provide an insulating chamber between layers of glass, could accommodate breather tubes to prevent heat buildup, and would allow for routine maintenance at the inside faces of the window chamber. Careful engineering and modeling software studied how solar orientation and temperature/relative humidity differentials affected the cavity.

Ultimately, everyone contributed to the solution by fine-tuning each piece of the assembly: the building’s relative humidity was controlled more accurately, the tint color performance was fine-tuned, the type and face of low-e coatings were adjusted to allow more heat from the building interior, the thickness of blast film adjusted, and vent holes to the exterior were added to relieve pressure.

The precast panels are supported by a secondary structure that is held off the primary structure/slab edge by a few inches. The secondary structure vastly complicated solutions to insulate the wall, separate floor-to-floor air atmospheres, and maintain continuity of the air/vapor barrier. The final solution placed mineral wool directly against the back of the precast, which was then covered with spray foam insulation that functions as the thermal, air, and vapor barriers. A 15-minute thermal (think fire) barrier was added to allow the spray foam to be exposed to the ceiling plenum space. Vapor barrier transition membranes were designed where materials changed. Cementitious fire-proofing was studied to determine its vapor permeance and maintain continuity of the vapor barrier. Through this process, the team reduced the thickness of the exterior wall assembly, increasing leasable area.

The window and opaque wall upgrades were a success. The solution was invisible from the outside (and ostensibly from the inside, too), running at 45 degrees to the four cardinal points. The main building façade faces southwest into the hot afternoon sun, acting much like a solar heat collector.

The design-build team’s sustainability strategy would achieve LEED Gold and simultaneously set the building on a path to incorporate future technologies that could achieve 2030 Net Zero Benchmarks.

Sustainable Strategies

A Reduce irrigation
B High-performance windows
C Skin: insulate walls and roof

D Air/water economizers
E Ventilation air recovery
F Chilled beams
G High temperature heat pumps
H Reduced water consumption
J Regenerative power elevators
K Fire protection (nitrogen charged)

L Natural daylighting
M Continuous dimming lighting
N Lightshelves
P Occupancy sensors
Q Power management
R Task lighting

U PV (courthouse roof)
V Solar thermal (office building roof)
W High recycled content (office building interior)

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Building Challenges and Solutions

When the project was announced in 2009, this 1965 building had never undergone a major upgrade of its systems or finishes. Over the years there were maintenance projects for MEP systems and large tenant improvement; however, the "bones" of the building had never been touched. Some of the project’s challenges and some solutions:

**CHALLENGES**

- Building orientation was a major factor in excessive heat gain and glare.
- The tall vertical windows are not ideal for providing natural daylight deep into the space.
- The building was not a productive or enjoyable place to come to work. It was drafty, cold/hot at the wrong times, worn, and an uninspired place to work every day.
- Upper floor elevator lobby designs were inconsistent from floor to floor, unwelcoming, disorienting and in need of a facelift.

**SOLUTIONS**

- One of the primary goals of the project was to create a unified building design that equaled a Class A office space and was inspiring, comfortable, flexible and allowed natural daylight and views from every space in the building.
- The building envelope and windows were significantly upgraded to provide a stable interior environment. The opaque exterior walls achieved an effective (average) R-20, while the windows achieved an effective (average) R-3.7. An integrated team of architects, engineers, contractors, installers and material suppliers developed the solution.
- An active chilled beam mechanical system that is quieter and uses slower air movement than other standard air systems was implemented.
- For energy efficiency, the chilled water and heating water temperatures in the building are not the standard temperatures—the chilled water is warmer than normal, and the heating water is cooler than normal.

**CONFERENCE ROOM BEFORE/AFTER**

A conference center, café, fitness center and health clinic were designed on the second floor to serve the over 14 different federal agencies housed in the building. The creation of engaging spaces with access to daylight make these amenities critical to attracting and retaining top talent for the federal workforce.
protected occupants from a bomb blast and progressive collapse, and achieved superior thermal performance with an effective wall value of R-9 (effective R-3.7 windows and R-20 opaque walls). In addition, through the integrated team approach, several steps were simplified to reduce construction time and increase quality.

**Lighting**

A key challenge to the project was procuring American-made fixtures to meet the GSA requirements of using 100% LED lighting throughout the tower. At the time of the design, domestic production of LED fixtures was in its infancy, and there simply were not enough manufacturers with the capability or capacity to adequately serve the needs of the project (see sidebar *Emerging Technologies* on Page 30).

To circumvent this, GSA and the design-build team worked closely with manufacturers to help them develop solutions to meet design criteria, while making certain concessions that enabled lamp and fixture production to ramp up to meet quality specifications.

An ambitious project goal was to light the entire building with LEDs at 0.55 W/ft². Achieving this goal was complicated because “standard” office-type LED fixtures were not commercially available at the time. To address this issue, the team conducted a design competition to compare custom-designed LED fixture prototypes from different manufacturers. A workable LED fixture was selected for the project, and a majority of the custom-designed prototypes ultimately went into full-scale production.

Light fixtures within 15 ft of the building perimeter have daylight sensors. These fixtures were originally programmed not to provide any light if a sufficient amount of daylight entered a given space. On average, the lights were turned off approximately 40% of the time on the southwest façade and 20% of the time on the northeast façade. After occupancy, a tenant survey was done, in part, to evaluate the performance and user satisfaction of the lighting controls. Based on the results, it was determined that more light was needed in the perimeter zones for a combination of reasons (e.g., height and width of the windows, configurations of columns and pilasters, desk location within the office). The lighting was reprogrammed so the lowest light output level during occupied hours would be 20% of the light source’s maximum output level. Reprogramming the lighting was relatively easy due to the adjustable nature of LED fixtures, and the reprogramming had a very minimal impact on energy savings or ROI.

**HVAC Systems**

One building façade faces northeast while the other building façade faces southwest, making one side of the building much warmer than the other. Therefore, the design team applied a whole-systems approach featuring heat reclamation, chilled beams, and a thermal storage system that transfers heat from the warmer side of the building to the cooler side and vice versa. A chilled beam system primarily uses moderate temperature water (an extremely efficient heating/cooling medium) to condition building spaces. After capturing heat generated in the building by occupants, computers, lighting and solar gain, a hybrid magnetic bearing heat recovery chiller and
Before the building automation program was implemented, the design-build team tested the program without controlling any devices. The desired condition parameters were set, and the team observed how the program reacted to those parameters. If certain components did not respond as intended, adjustments were made to reconfigure the system. Also, the design-build contractor and subcontractors conducted training sessions of all building systems for the building management staff. These training sessions were video-recorded for future reference. “Refresher courses” were conducted several months after occupancy to familiarize existing and new O&M staff. During the second round of training, manufacturer representatives and subcontractors assisted O&M staff with issue resolution. These step-by-step tutorials help O&M staff diagnose and troubleshoot common issues.

A chilled beam system uses water pipes that require significantly less space than conditioned air ducts, allowing for greater floor-to-ceiling heights throughout the building. With the greater ceiling heights and removal of the induction units, 30% more window area was created for daylight and views. For spaces with private offices on the perimeter, the design-build team encouraged tenants to install translucent or transparent side lights to provide more light into the interior spaces.

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